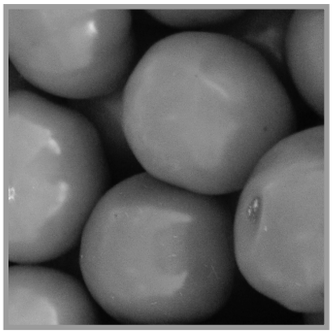
2017 Mid-Atlantic Fruit and Vegetable Convention

Proceedings

FOR THE

VEGETABLE, POTATO, GREENHOUSE, SMALL FRUIT AND GENERAL SESSIONS



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High Tunnel Display at the 2016 Pennsylvania Farm Show (display and photo by Kitchen Table Consultants).

TABLE OF CONTENTS

TABLE OF CONTENTS

GREENHOUSE ORNAMENTALS

COVER CROPS

ONIONS

SWEET CORN

SMALL FRUITS

AGRITOURISM AND DIRECT MARKETING

TOMATOES

TABLE OF CONTENTS

HIGH TUNNELS

POTATOES

CUT FLOWERS

CSAs

LEAFY GREENS

SOCIAL MEDIA AND ADVERTISING MARKETING STRATEGIES

SPECIALITY VEGETABLES

OTHER

UPDATE ON PVGA FUNDED PUMPKIN VARIETY TRIAL

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Selecting which cultivar to grow is critical to successful commercial production. When a cultivar suited to an area and having high yield and quality for market is grown, growers can make a profit. In 2016 we evaluated 15-25 lb orange, smooth-faced pumpkins. Pumpkins are an important crop for diversified vegetable operations in Pennsylvania. They are grown on 1330 of Pennsylvania's 3968 vegetable farms, ranking 1st in the US (2012 Census of Agriculture).

The study was conducted in central Pennsylvania at Pennsylvania State University's Russell E. Larson Research Center in Pennsylvania Furnace, in southeastern Pennsylvania State University's Southeast Research and Extension Center in Manheim and in southwestern Pennsylvania. Results from the central and southeastern sites are reported here.

Twenty-four pumpkin cultivars (see Table 1 below) were evaluated in a conventional system. All seed was treated with Farmore except 'Camaro' seed which was untreated.

At both sites, pumpkins were direct seeded in rows spaced 8 feet apart with 4 feet between plants in a row. Four plots of each cultivar was planted with each plot consisting of 6 plants. Data were collected from all 6 plants.

Plants were provided with 1-1.5 acre-inches of water each week through drip irrigation. Pests were managed following recommendations in the 2016 Commercial Vegetable Production Recommendation guide.

The standard used was 'Gladiator' based on conversations with growers.

Table 1. Cultivars, seed sources, maturity date of cultivars evaluated in 2016.

Cultivar	**Source**	**Maturity[z]**
Ares	Harris Moran Seed Co., Davis, CA	115
Bayhorse Gold	Rupp Seeds Inc., Wauseon, OH	100
Bellatrix	Enza Zaden, San Juan Bautista, CA	95
Camaro	Hollar Seeds, Rocky Ford, CO	110
Cargo	Johnny's Selected Seeds, Winslow, ME	100
Challenger	Hollar Seeds, Rocky Ford, CO	100
Eagle City Gold	Rupp Seeds Inc., Wauseon, OH	100
Earlipak	Sakata Seed America, Morgan Hill, CA	95
Early King	Abbot & Cobb	90
El Capitan	Sakata Seed America, Morgan Hill, CA	105
El Toro		95
Gladiator	Harris Moran Seed Co., Davis, CA	115

Elsa Sánchez is an Associate Professor of Horticulture in the Department of Plant Science at Penn State University. Her responsibilities are 60% extension and 40% undergraduate teaching. Current extension projects focus on sustainable and organic production of vegetable crops. She earned a BS in Horticulture and a MS in Agricultural Biology at New Mexico State University and a PhD in Horticulture at Washington State University. Elsa and her husband, Chris, live in State College, PA with their daughters Laurel and Lilly.

Gold Challenge	Rupp Seeds Inc., Wauseon, OH	105
Hannibal	Hybrid Seed Co., Feastervillle, PA	105
Honky Tonk	Sakata Seed America, Morgan Hill, CA	105
Kratos	Harris Moran Seed Co., Davis, CA	100
Magic Lantern		110
Magic Wand		115
Mr. Wrinkles	Sakata Seed America, Morgan Hill, CA	100
Orange Rave	Rupp Seeds Inc., Wauseon, OH	105
Rhea	Harris Moran Seed Co., Davis, CA	105
Solid Gold	Rupp Seeds Inc., Wauseon, OH	100
Spartan	Sakata Seed America, Morgan Hill, CA	100
Zeus	Harris Moran Seed Co., Davis, CA	110

[z]Based on seed catalogs.

At the central site, based on soil test recommendations, 60 lb/acre potash and 50 lb/acre nitrogen were broadcast preplant on 23 May 2016. An additional 25 lb/acre nitrogen was fertigated throughout the growing season. At this site a plasticulture system using a single line of drip tape (T-Tape model 508-12-450; John Deere, Moline, IL) placed on the center of the bed and black embossed plastic mulch (Sigma Plastic Groups, Allentown, PA) was used. Beds were pulled and plastic and drip tape were installed on June 10th. Herbicide was also applied on June 10th. Planting holes were punched and direct seeding occurred on June 13th.

Pumpkins were harvested on September 16th and 20th. Pumpkins were counted and weighed in these categories: fully orange, turning orange or mature green (full sized and dark green) and unmarketable. Immature green fruit were left in the field.

At the southeastern site pumpkin seed were planted in a no-till system into rye residue on June 7th. A single line of drip tape tape (T-Tape model 508-12-450; John Deere, Moline, IL) was placed in the center of each row. Based on soil test recommendations, phosphate and potash were not applied. Nitrogen was applied at a rate of 90 lb/acre with 50 lbs broadcast preplant and the remainder fertigated throughout the growing season.

Pumpkins were harvested on October 14th. Pumpkins were categorized as fully orange and mature green. At this site harvest occurred when all fruit was classified in either of these categories (no fruit was turning orange). Quality of the handles (stems) was rated at this site using a 1-5 scale with 5 indicating the highest quality.

Data were analyzed using the mixed procedure and means were separated at the 5% level using pdiff.

Results

Yield and Stem Ratings

Central Site

At the central site pumpkins were categorized as fully orange, turning orange, mature green, and unmarketable. According to seed industry descriptions, cultivars evaluated had maturity dates between 90 and 115 days (Table 1). Harvest occurred over a 2 day period. Had harvest occurred as each cultivar reached maturity, pumpkins in the turning orange and mature green category likely would have had time to reach the fully orange stage. The three separate categories are intended to serve as a measure of relative maturity.

'Honky Tonk' and 'Magic Lantern' produced a larger mean number of fully orange pumpkins than 'Gladiator' (Table 2). The number of fully orange pumpkins produced by the other cultivars was not different than 'Gladiator'. 'Early King', 'Camaro', and 'Challenger' produced heavier pumpkins than 'Gladiator' which was not different than any other cultivar.

When combining the fully orange and turning orange pumpkins, none of the cultivars produced a mean number that was different than 'Gladiator'. 'Challenger' and 'Early King' mean pumpkin weight was higher than 'Gladiator' for the combined category. All other cultivars were not different than 'Gladiator'.

'Magic Lantern' produced a higher mean number and weight of mature green pumpkins than 'Gladiator'. All other cultivars were not different than 'Gladiator'.

Mean number and weight of unmarketable pumpkins for all cultivars was not different from 'Gladiator'.

Southeastern Site

Mean number of fully orange pumpkins produced by all cultivars was not different from 'Gladiator' (Table 3). Mean weight of pumpkins produced by 'Challenger' and 'Bellatrix' was heavier than 'Gladiator'. All other cultivars were not different than 'Gladiator'.

The mean number of mature green pumpkins from all cultivars was not different than from 'Gladiator'.

The mean number and weight of unmarketable pumpkins from all cultivars was not different than from 'Gladiator'.

'Ares' and 'Rhea' produced handles with a mean rating that was higher than 'Gladiator', while 'Early King', 'Camaro', 'Spartan', and 'Challenger' handles had lower mean ratings. Ratings for all other cultivars were not different than 'Gladiator'.

Rind Color

Rind color varied slightly within a site and also between sites for most cultivars (Table 5). However, 'Kratos' and 'El Capitan' were consistently rated as dark orange and 'Solid Gold' as orange within and between sites.

Yearly environmental conditions can affect results and recommendations; therefore, we have proposed to evaluate the same pumpkin cultivars again in 2017.

Table 2. Mean number and weight per plot (6 plants) of 24 pumpkin cultivars categorized as fully orange, fully orange and turning orange, mature green, and unmarketable grown in Pennsylvania Furnace, Pennsylvania in 2016.

Cultivar	Mean fully orange fruit no.	Mean fully orange fruit weight (lb)	Mean fully orange and turning fruit no.	Mean fully orange and turning fruit weight (lb)	Mean mature green no.	Mean mature green weigh (lb)	Mean unmarketable No.	Mean unmarketable weight (lb)
Ares	11.5 a-e	204.6 a-d	16.3 a-e	293.7 a-d	2.5 b	37.6 bc	0.0	0.0
Bayhorse Gold	9.3 de	165.8 d	13.3 b-e	223.0 c-f	1.8 b	18.7 bc	0.5	7.5
Bellatrix	11.8 a-e	215.8 a-d	14.8 a-e	261.3 a-f	3.0 b	35.2 bc	0.3	2.1
Camero	10.3 b-e	262.1 ab	13.3 b-e	309.6 abc	4.8 ab	61.2 ab	0.0	0.0
Cargo	9.3 de	187.9 a-d	11.8 cde	236.1 b-f	2.0 b	24.9 bc	0.0	0.0
Challenger	11.3 a-e	255.4 abc	17.0 a-d	354.5 a	2.3 b	33.0 bc	0.0	0.0
Eagle City Gold	10.0 b-e	157.3 d	13.5 b-e	206.7 def	3.0 b	39.1 abc	0.0	0.0
Earlipak	10.3 b-e	184.6 a-d	13.3 b-e	233.7 b-f	2.5 b	30.3 bc	0.0	0.0
Early King	12.3 a-e	272.7 a	15.0 a-e	323.5 ab	3.3 b	42.6 abc	0.3	1.5
El Capitan	8.3 e	129.7 d	10.8 e	179.3 ef	1.8 b	20.0 bc	0.0	0.0
El Toro	11.0 a-e	207.0 a-d	12.8 b-e	239.9 b-f	2.8 b	44.7 abc	0.0	0.0
Gladiator	9.8 cde	134.2 d	15.0 a-e	200.5 def	1.0 b	15.2 bc	0.5	6.4

Gold Challenger	9.3 de	168.1 cd	11.5 de	209.9 def	1.8 b	21.9 bc	0.5	4.3
Hannibal	11.5 a-e	188.8 a-d	13.0 b-e	215.7 c-f	.8 b	12.7 bc	0.0	0.0
Honky Tonk	15.5 a	191.1 a-d	20.0 a	248.2 b-f	2.5 b	27.8 bc	0.0	0.0
Kratos	12.5 a-e	200.3 a-d	17.0 a-d	277.5 a-e	2.3 b	29.8 bc	0.0	0.0
Magic Lantern	15.0 ab	181.1 bcd	18.0 ab	223.7 c-f	8.0 a	89.0 a	0.3	3.4
Magic Wand	14.3 a-d	179.9 bcd	18.0 ab	231.8 b-f	2.0 b	15.7 bc	0.0	0.0
Mrs. Wrinkles	9.3 de	142.8 d	12.5 b-e	183.1 ef	3.5 b	41.1 abc	1.0	20.8
Orange Rave	14.3 a-d	214.9 a-d	17.5 ab	255.1 b-f	2.0 b	20.0 bc	0.3	3.7
Rhea	14.5 abc	203.4 a-d	17.3 abc	249.7 b-f	2.8 b	30.9 bc	0.5	4.8
Solid Gold	9.8 cde	191.1 a-d	13.0 b-e	254.3 b-f	1.3 b	10.3 c	0.3	5.3
Spartan	12.3 a-e	180.9 bcd	14.8 a-e	225.2 c-f	1.8 b	19.0 bc	0.0	0.0
Zeus	10.3 b-e	129.8 d	13.0 b-e	164.8 f	4.8 ab	42.3 abc	0.3	2.4

[z]Values are the mean of 4 replications; data were analyzed using the mixed procedure and means were separated using pdiff; values followed by different letters within a column are significantly different at the 5% level; 'Gladiator' was considered the standard and values are bolded; values in orange are statistically higher than 'Gladiator'.

Table 3. Mean number and weight per plot (6 plants) of 24 pumpkin cultivars categorized as fully orange, mature green, and unmarketable. Mean pumpkin handle (stem) rating. Pumpkins were grown in Manheim, Pennsylvania in 2016.

Cultivar	Mean fully orange fruit no	Mean marketable fruit weight (lb)	Mean mature green fruit no	Mean unmarketable fruit no	Mean unmarketable fruit weight (lb)	Mean handle rating (1-5; 5 = great)
Ares	12.0z ab	192.0 a-d	0.8	0.8	7.4	5.0 a
Bayhorse Gold	12.5 ab	164.4 cd	0.5	2.0	16.5	3.3 c-f
Bellatrix	17.0 a	262.7 ab	1.0	1.3	15.0	3.5 bcd
Camero	10.8 b	152.2 cd	1.5	3.3	39.4	2.4 fg
Cargo	11.0 ab	195.8 a-d	0.0	0.8	13.7	3.3 c-f
Challenger	15.5 ab	286.2 a	0.3	2.5	38.6	2.3 g
Eagle City Gold	10.5 b	130.5 d	1.5	1.3	10.9	3.0 c-g
Earlipak	10.3 b	174.1 bcd	0.0	1.0	14.3	3.0 c-g
Early King	14.8 ab	247.0 abc	1.3	1.0	15.9	2.5 efg
El Capitan	9.8 b	145.5 d	1.3	1.0	14.1	2.8 d-g
El Toro	10.5 b	173.9 bcd	0.8	0.5	5.7	3.5 bcd
Gladiator	11.8 ab	152.4 cd	0.5	1.0	13.9	3.5 bcd
Gold Challenger	10.0 b	162.6 cd	0.3	1.8	22.1	3.8 bc
Hannibal	10.3 b	164.6 cd	0.5	2.8	29.7	3.5 bcd
Honky Tonk	13.8 ab	169.3 bcd	0.3	0.5	3.3	3.0 c-g

Kratos	12.8 ab	196.0 a-d	1.3	0.3	4.4	3.8 cde
Magic Lantern	15.3 ab	166.9 bcd	2.0	0.8	5.3	3.0 c-g
Magic Wand	13.0 ab	168.8 bcd	0.8	1.0	11.9	3.3 c-f
Mrs. Wrinkles	14.5 ab	186.7 bcd	1.0	1.3	12.9	3.3 c-f
Orange Rave	12.0 ab	172.7 bcd	1.0	2.0	18.7	2.9 c-g
Rhea	10.0 b	144.9 d	0.3	1.0	12.5	5.0 a
Solid Gold	10.8 b	193.4 a-d	0.0	1.3	21.2	4.4 ab
Spartan	15.0 ab	219.3 a-d	0.0	0.8	9.6	2.3 g
Zeus	14.8 ab	170.6 bcd	0.3	1.5	17.2	3.0 c-g

[z]Values are the mean of 4 replications; data were analyzed using the mixed procedure and means were separated using pdiff; values followed by different letters within a column are significantly different at the 5% level; 'Gladiator' was considered the standard and values are bolded; values in orange are statistically higher and blue lower than 'Gladiator'.

Table 5. Level of orange rind color of 24 cultivars of pumpkins grown in Pennsylvania Furnace and Manheim, Pennsylvania in 2016.

Cultivar	Central rating	Southeastern rating
Ares	Orange – dark orange	Orange – dark orange
Bayhorse Gold	Orange – dark orange	Orange – dark orange
Bellatrix	Orange – dark orange	Orange
Camero	Light orange – orange	Light orange
Cargo	Dark orange	Light orange – orange
Challenger	Orange	Light orange – orange
Eagle City Gold	Orange – dark orange	Light orange – orange
Earlipak	Dark orange	Orange – dark orange
Early King	Orange – dark orange	Orange – dark orange
El Capitan	Dark orange	Dark orange
El Toro	Orange – dark orange	Orange – dark orange
Gladiator	Dark orange	Orange – dark orange
Gold Challenger	Orange – dark orange	Orange – dark orange
Hannibal	Orange – dark orange	Orange – dark orange
Honky Tonk	Orange – dark orange	Orange – dark orange
Kratos	Dark orange	Dark orange
Magic Lantern	Orange – dark orange	Dark orange
Magic Wand	Orange – dark orange	Orange – dark orange
Mrs. Wrinkles	Dark orange	Orange – dark orange
Orange Rave	Orange – dark orange	Orange – dark orange
Rhea	Orange – dark orange	Light orange – orange
Solid Gold	Orange	Orange
Spartan	Orange – dark orange	Dark orange
Zeus	Orange – dark orange	Orange – dark orange

FALL AGRITAINMENT AT ACKERMAN FARMS

John & Eve Ackerman, Ackerman Family Farms, LLC

How We Got Here

My name is John Ackerman. My wife, Eve, and I live in Morton, Illinois, in a five bedroom home that my great grandfather designed, my grandfather built, and in which my father was born. We have a small farm of approximately 300 acres where we raise corn, soybeans and wheat. We also raise 160 varieties of ornamental pumpkins squash and gourds. Some years we contract with a local pumpkin canning factory. I grew up raising hogs and cattle and was a member of 4-H and FFA. I attended a local community college where I received my Associates Degree in Liberal Arts and Science, and I transferred to the University of Illinois where I received my Bachelor of Science Degree in Agricultural Economics. My expectation was to be a cattleman my whole life.

A series of events brought us to a decision to raise specialty crops. I started farming full-time in 1983, the year of the worst drought in Central Illinois since 1936. Five years later, we experienced an even worse drought! The 1980s saw interest rates rise to 19%, and Willie Nelson had his first "Farm Aid Concert" 90 miles from my farm. Our farm is a small farm of only 300 acres, some of which is crop share, some is cash rent. We wanted to farm full-time, however, at one point, I was selling insurance door to door, and my wife was working full-time outside the farm. We made several attempts to supplement our income. We tried fresh cut flowers and had some limited success selling roadside sweet corn. We found it was difficult to get customers to slow down and stop to buy one thing on our busy highway.

In 1998, I had contracted with Libby's (a Division of Nestle USA), our local canning factory, to raise pumpkins. I took some of the pumpkins that were not harvested, and for fun, I decorated at the end of the driveway to surprise our children when they got off the bus. To our surprise people began to stop and ask if the pumpkins were for sale. This led to our decision in 1999 to raise and sell ornamental pumpkins. That year, we raised 20 different varieties of pumpkins and squash on 1 ¼ acre. The following years were 5 acres, 8 acres, and 12 acres. We now raise over 160 varieties on approximately 30 acres.

We have several advantages on our farm. Our farm is bordered by an interstate and our farm entrance is off a state highway. Also, our home town of Morton, Illinois is known as the "Pumpkin Capital of the World." Over many of the last years, 85% of the world's and 95% of our nation's canned pumpkins are produced in Morton.

Currently

We have just completed our 17th year of being open seasonally to the public. At Ackerman Family Farms, we sell pumpkins, straw bales, corn stalk bundles, and mums. We have a gift shop, an animal area, and a corn maze. We give hay rack rides during school field trips, and offer them to the public on the weekends and special holidays. We have a U-Pick Pumpkin Patch as well.

Our pumpkins are all hand-picked, brought in from the fields and washed and then displayed in our sales yard. Despite some interest, we rarely wholesale. Our only sales location is our farm itself. I purchase seeds mainly through commercial catalogs and sometimes through other growers or off the internet. Each year, I try to calculate the percentage of each type of pumpkin seed I will need and order accordingly. We currently sell our pumpkins by the piece and not by weight, and have no immediate plans to change this policy.

John Ackerman, along with his wife, Eve, own and operate Ackerman Family Farms in the "Pumpkin Capital of the World," Morton, Illinois. They have raised four children on their Centennial Family Farm. There John also raises corn, soybeans, and wheat along with specialty crops that include over 160 varieties of pumpkins and squash. John received his Bachelor of Science Degree from the University of Illinois in Agricultural Economics. He is a past American Farm Bureau Federation Discussion Meet Winner, has traveled to India to speak on agricultural matters as a guest of Rotary International, and is currently a Lay-Speaker for the United Methodist Church. John and Eve's operation has been featured in several national magazines, and their farm was the focus of an episode of the Reality TV Show, "Pitchin' In." John is quick to point out that he is not nearly as good a speaker as his resume might suggest.

Each year, we sell between 2000 and 2500 mums. In our second year of operation, we grew 1200 of our own mums. When that number didn't come close to meeting our sales needs, we over expanded that part of our operation and raised over 4800 mums. In subsequent years, we have found between 2 and 3 thousand to be the appropriate number to raise. We have since found a local grower who will deliver a quality mum at the price point we need.

We converted an old hog building into our gift shop. Our emphasis is on carrying local, state and regionally produced foods and gifts. It adds considerably to our labor and paperwork, but it is a part of the draw of our operation. The shop would not probably stand-alone financially. Enterprise analysis for each segment of the operation is difficult because they are so interconnected. While many of our customers visit us several times during our season, other customers want "one stop shopping" for their fall decorating needs and their entertainment.

Our animal area consists of alpacas, a donkey, sheep, goats, and various birds like chickens, peacocks and pheasants. We provide coin operated feeders that allow our guests to interact with our animals through fencing. A surprising draw are on our farm are our barn cats.

The corn maze consists of approximately 6 acres. It is "family friendly" by design in that it is relatively easy to navigate. The challenge is to find the clues in order to solve the message within the maze. A local artist designs a different maze each year, and the design is constructed by John in a very "old fashioned" manner.

Our school field trips serve approximately 2000+ children per year. It is a three part program that consists of an educational talk, a hayrack ride through the growing fields, and a hands-on experience with our farm animals. They also take home a goodie bag.

Customer Service is first and foremost our main focus. We hire our staff accordingly. We continue to improve accessibility for our special needs guests and in the future, we intend to change our hayrack ride design to be more accommodating. Also, we provide a lot of photo opportunities through landscape design, and local artist photo boards.

Problems

We have had our share of problems. We erected a high tunnel in an attempt to sell fall tomatoes. We discovered our customer base was not overly interested in that particular produce.

We have had a few instances of negative social media that we felt was unfair, but the majority of our feedback is very positive.

Our "No Smoking" and "No Pets" policy has led to a few hard feelings. We are having a difficult time defining a pet vs. a service animal.

This past year, we removed our 3 acre, high density orchard, since it wasn't profitable.

We are cautious about adding new enterprises as each new venture requires its own time, research and specialty equipment.

On at least 2 occasions, we have had to deal with inappropriate behaviors that required law enforcement resolution.

Media Coverage

We have been featured on national and local news shows, radio shows, and magazines, and our operation was the focus of an episode of the reality TV show "Pitchin' In." We feel there is an obligation to speak up regarding agricultural or Christian issues. While time consuming, we feel it is important to make ourselves available to the media.

Future Considerations

It is our goal to begin charging admission to our animal area. We are currently looking to build an animal barn. We feel an admission charge would justify the cost of our animal area, and discourages our farm being treated like a public park.

We are also considering building a wedding venue. This requires us to consider the farm succession and the future of our operation.

PUMPKIN PRODUCTION AT ACKERMAN FARMS

John Ackerman, Ackerman Family Farms, LLC

My name is John Ackerman and with my wife Eve, we own and operate Ackerman Family Farms, LLC in Morton, IL. Each year we raise over 160 varieties of pumpkins, squash and gourds on aPproximately 30 acres. Some years we are offered a contract to grow processing pumpkins per the local canning factory. We have raised processing pumpkins since 1984 and ornamentals since 1999.

We are blessed with highly productive soils of silty clay loam. Our immediate area was originally "swampy" and tiles are a necessity. Drainage is a large concern.

Our fertility goals include a pH of 6.3 or higher. Issues occur with the use of liquid nitrogen as it will make the soil more acidic. High pH allows our herbicides to work more effectively. We strive to maintain phosphorus at 50 and potassium at 400 on our soil tests. We limit nitrogen applications to 100 pounds of actual nitrogen for ornamental and 120 pounds actual nitrogen for processing pumpkins. Too much nitrogen leads to excessive vegetative growth and reduce fruiting.

We follow a 3 year rotation. If year one is pumpkins, we will do a light fall tillage to cut vines but to not bury residual chemicals deeply. The second year will be early maturing soybeans using conventional tillage. This is followed by fall seeding of winter wheat with a no-till drill. The wheat is harvested in late June or early July of year 3. If time allows, double crop soybeans are planted no-till into the wheat stubble after straw harvest. The following year will then be pumpkins again. We do not follow pumpkin with wheat because of residual herbicide concerns. There were also insect related problems if we followed pumpkins with corn. This may be averted with more modern corn variety selections.

Our seed selection involves ordering amounts based on records of field area percentages by categories of pumpkin. We generally break down our varieties into the following categories: minis, smalls, standard jacks, large jacks, whites, giants, "fancies" (winter squash) and gourds. An example is, this past year, standard jacks were planted so as to make up approximately 46% of our fields or about 17 of our 30 acres. We order most of our seeds from commercial catalogs and always look for new varieties.

When we first started with pumpkins, we used an IH 800 drum style planter. It was modified by covering rows of drum holes to plan pairs of rows with wide spaces between row pairs. This was an 8 row "wide" configuration with 36 inches between rows. It worked reasonably well for large quantities of seed as is used for processing pumpkins. However, as we added many ornamental varieties removing the drum to change seeds was difficult. We switched to 30 inch rows for corn and soybeans and purchased a finger-pickup style planter. 9 of the 12 "fingers" were removed for pumpkin planting to allow for low pumpkin seed population.

Our most common seed planting population is around 2200 seeds per acre for many ornamentals. Actual plant population final stand goal is closer to 1800 per acre, giving approximately an 80% plant stand count compared to seeding rate. Minis and small have sometimes been planted at a double rate simply by driving the same track twice at a

John Ackerman, along with his wife, Eve, own and operate Ackerman Family Farms in the "Pumpkin Capital of the World," Morton, Illinois. They have raised four children on their Centennial Family Farm. There John also raises corn, soybeans, and wheat along with specialty crops that include over 160 varieties of pumpkins and squash. John received his Bachelor of Science Degree from the University of Illinois in Agricultural Economics. He is a past American Farm Bureau Federation Discussion Meet Winner, has traveled to India to speak on agricultural matters as a guest of Rotary International, and is currently a Lay-Speaker for the United Methodist Church. John and Eve's operation has been featured in several national magazines, and their farm was the focus of an episode of the Reality TV Show, "Pitchin' In." John is quick to point out that he is not nearly as good a speaker as his resume might suggest.

slight offset. Giant pumpkin seed population is lowered by planting only half of the rows. Processing pumpkin seed population can be determined by one of two planting methods. If it is done "plant-to-stand", approximately 4500 seeds per acre are planted and allowed to grow. The other method involves planting twice the population with the intention of cultivating out half of the pumpkin plants. We have done both methods, but generally "plant to stand".

Our pumpkin plot layout is to plant short rows across generally long, narrow fields. While an inefficient method of planting, this allows for ease of harvest by giving access to most varieties at the row ends. Also, we do not have to drive over unripe fruit to get to mature pumpkins.

Planting dates are staggered from mid-May to late June. In 2014, there were 9 successive plantings. This lead to a somewhat seamless harvest with pumpkin ripening at times when needed for sales. Different planting dates can overcome bad weather that interferes with germination. Later planting makes weed control easier.

Harvest of the ornamentals is all done by hand. We wash off the produce as it comes out of the field. Processing pumpkins are mechanically harvested. It is a two step process. The first is simply a cylinder pushed ahead of a tractor at an angle. This gently knocks the fruit of the stem while rolling them into win rows. The second part involves a large machine with paddles to flip the pumpkins onto conveyors. This allows loading into trucks or dump carts.

Working with the canning factory starts with contract offered and signed generally in January or February. A price per ton is offered. For many years in the 1980s and 90s the price was around $17 to $18 per ton. Along with other commodities and rising values, prices rose to around $45 per ton a few years ago. They were near $38 per ton in 2016. Organic growers were paid about $90 per ton. The company pays for seed fungicide, late insect control, and all harvest cost.

Weed control is perhaps our biggest problem with water hemp and pig weed being the hardest to control. We have used a variety of labeled herbicides with various degrees of success. One of our most effective herbicides is Command but it is not labeled for jack-o-lanterns. Sandea has not worked well for us in post-emerge spraying. Cultivation continues to be our best weapon against weeds.

In 2015 we experimented with spring oats as a cover crop to plant into using no-till. It worked somewhat against weeds. In the fall of 2015, we planted a cover crop of radishes and cereal rye. This did not work well, as heavy rains ruined rye germination. We will try again in the future with a higher seeding rate and we will allow the rye to gain more growth before killing it.

In the future we will consider a vacuum planter and perhaps a hydrostat tractor for planting.

SILICON NUTRITION FOR POWDERY MILDEW DISEASE SUPPRESSION

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Soils contain an abundance of silicon (Si) but much of the element is not in a chemical form available for plant uptake. Perhaps because of its abundance, Si has not been given the same level of attention as other limiting factors in crop production. Agronomists and horticulturalists, however, are becoming more aware of the valuable function of Si nutrition in crops and soils and even animal life. Silicon is now officially designated as a "plant beneficial substance" by the Association of American Plant Food Control Officials (AAPFCO). Product labels on fertilizers and soil amendments are now permitted to list the content of plant available silicon.

Of the many benefits associated with enhanced Si nutrition (resistance to pathogens, resistance to stress, regulation of metabolism), the one that appears most outstanding is suppression of powdery mildew disease. Pumpkin, wheat, Kentucky bluegrass, and dogwood are examples of crops where enhanced Si nutrition helps to control powdery mildew disease.

Research conducted in New Jersey compared various fertilizer sources for plant available Si and powdery mildew disease suppression using pumpkin as the test crop. The most the most effective material for supplying plant available Si and for disease suppression was found to be Wollastonite. This is a calcium silicate mineral mined from the earth in New York State. As a naturally occurring mineral it is also approved for use in organic agriculture.

Besides supplying calcium and silicon for plant nutrition and disease suppression, calcium silicate can also serve to neutralize soil acidity. When calcium silicate is applied at equivalent recommended rates it can replace the need for the same amount of agricultural limestone. Wollastonite is thus a multipurpose soil amendment that helps crops resist powdery mildew disease, supply plant available Si, and also serve as a substitute for agricultural limestone.

My newsletter provides a comprehensive summary silicon nutrition and soil fertility. See link here: http://njaes.rutgers.edu/pubs/soilprofile/

Joseph Heckman, Ph.D. is a Professor of Soil Science, Rutgers University, where he teaches courses in Soil Fertility, Organic Crop Production, and Agroecology. He conducts research and extension programs on optimizing nutrition and soil quality in support of plant, animal, and human health. Dr. Heckman has served as Associate Editor of the Journal of American Society of Horticulture Science, Chair of the Council on History, Philosophy, and Sociology of Soil Science, and Chair of the Committee on Organic and Sustainable Agriculture. Dr. Heckman is past President of the Northeast Branch of the Crops, Soils, and Agronomy Tri-Societies. In addition to guest lectures on Soil Fertility, Dr. Heckman is frequently invited to speak on History of Organic Farming, and Raw Milk with Informed Consumer Choice.

OVERVIEW OF CANTALOUPE, CUCUMBER, AND SUMMER SQUASH

"SELECTING THE PRECISE VARIETIES FOR YOUR FARMING OPERATION"

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In the preceding five growing seasons, we have trialed approximately 85 cantaloupe, 50 cucumber, and 75 summer squash cultivars in our experimental research station at Wauseon, OH. These varieties were supplied by several vegetable breeding companies, which include: Abbott and Cobb, Emerald, Enza Zaden, Harris Moran, Hollar Seeds, Nunhems, Sakata, Seminis, Seneca Veg Research, Syngenta, Takii, and US Agriseeds.
The cantaloupe hybrids were evaluated for six separate categories: fruit size, % brix, flavor, rind thickness, flesh color, and flesh firmness. The cucumbers were assessed for yield, grade type, harvest fruit length, and fruit color. The summer squash had data collected for size of petiole spines, easy-twist fruit damage, fruit uniformity, blossom scar, fruit gloss, and plant type. The collected data is then compiled over a multi-year span, which assists us to analyze data between current commercial cultivars and advanced experimental hybrids. This process also provides a broad picture of how those varieties perform in various conditions. Below are varieties, listed in alphabetical order by specie, that have recently risen to the top.

CANTALOUPE

(Flavor, Rind Thickness, Flesh Color, and Flesh Firmness have a scale of: (1)Poor (9) Excellent)

Accolade

- Eastern type trialed as ME3743
- 5.5 lbs. / fruit average
- 11.0% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.0	7.0	6.0	8.0

Astound

- Eastern type trialed as ME3716
- 6.0 lbs. / fruit average
- 10.2% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.0	7.0	6.0	8.0

Atlantis

- Average size between Athena and Aphrodite
- 6.5 lbs. / fruit average
- 9.8% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.0	8.0	7.0	6.7

Aphrodite

- Todays standard for Eastern shipping types
- 7.3 lbs. / fruit average
- 10.5% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.5	7.0	7.3	6.7

Athena

- Formerly the standard for Eastern shipping types
- 5.3 lbs. / fruit average
- 11.0% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.8	7.5	6.5	6.8

Avatar

- Very large Eastern type
- 9.5 lbs. / fruit average
- 10.1% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.0	5.0	7.0	4.0

Sheldon Sutton is involved with vegetable product development for Rupp Seeds Inc., located at Wauseon, Ohio. He has been employed with the company for nearly 25 years. Annually, he conducts numerous trials for numerous breeder/supplier companies over a plethora of diverse crops. His desire is to bring superior products to the forefront for vegetable growers to utilize in their farming operations. He and his wife, Gina, live in Northwest Ohio and have three children: Roman, Bronson, and Petra.

CANTALOUPE (Cont.)

Goddess
- Very early Eastern type
- 4.5 lbs. / fruit average
- 10.5% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.3	6.7	6.3	7.0

Majus
- Tuscan type
- 4.7 lbs. / fruit average
- 12.2% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.8	6.8	7.3	7.8

Solstice
- Old Eastern "Superstar" type
- 7.3 lbs. / fruit average
- 11.0% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.0	9.0	6.0	6.0

Infinite Gold
- Long shelf life (LSL) type
- 4.8 lbs. / fruit average
- 12.9% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.3	5.7	8.3	9.0

Shockwave
- Long shelf life (LSL) type
- 4.8 lbs. / fruit average
- 13.0% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
7.5	5.0	7.5	9.0

Tirreno
- Tuscan type
- 4.4 lbs. / fruit average
- 11.8% average brix content

Flavor	Rind Thickness	Flesh Color	Flesh Firmness
6.8	8.0	6.3	8.3

CUCUMBER (Open Field)

Bristol
- Early maturing variety
- Moderate DM tolerance
- Multi-virus tolerant
- Dark fruit color
- Moderately vigorous plant

Super Selects	Selects	Culls
14%	71%	15%

Darlington
- Mid-late maturing variety
- Low DM tolerance
- Good yields of consistent high quality fruit
- Excellent fruit length
- Very vigorous plant

Super Selects	Selects	Culls
50%	45%	5%

Cobra
- Mid maturing variety
- Fruit size similar to Darlington
- Multi-virus tolerant
- Dark fruit color
- Vigorous plant

Super Selects	Selects	Culls
37%	48%	15%

SV4719CS
- Early-mid maturing variety
- Low-moderate DM tolerance
- Dark fruit color
- Moderately vigorous plant
- Replaces SV3462CS

Super Selects	Selects	Culls
45%	46%	9%

Jay Ruwet has worked with Rupp Seeds, Inc. for nearly eight years. He assists New York, Pennsylvania, New Jersey and New England as a vegetable specialist. Yearly, he organizes multiple field trials with commercial vegetable growers, as well as on his family farms in New York and Connecticut. Besides trialing vegetables, he is a student of numerous aspects of the vegetable growing industry, including treatment and fertilizer. He lives in Auburn, NY.

SUMMER SQUASH (Open Field)

Dunja
- Standard commercial variety for dark green hybrids
- Medium-small petiole spines
- Slight damage on easy-twist harvest
- Good fruit uniformity
- Very open plant type

Payload
- Standard commercial variety for med. green hybrids
- Very small petiole spines
- Slight damage on easy-twist harvest
- Good early yield
- Medium-open plant type

Blonde Beauty (RZX 6104)
- Classic yellow straightneck shape
- Spineless hybrid
- Medium-open plant type
- Smooth skin
- Good fruit uniformity
- Green stemmed

Goldprize
- Current standard for yellow straightneck hybrids
- Very good fruit uniformity
- Excellent neck to bulb ratio
- Heavy petiole spines
- Green stemmed

CUCUMBER / SQUASH (Protected Culture)
Alcazar (Cucumber)
Corinto (Cucumber)
Vitaly (Cucumber)
Kopana (Green zucchini)

Green Machine
- Medium-dark green hybrid
- Very small petiole spines
- Excellent fruit uniformity
- Medium-open plant
- Gorgeous fruit gloss / flecking

Golden Glory
- Standard commercial yellow zucchini hybrid
- Very small petiole spines
- Very good fruit uniformity
- Medium-open plant type
- Good early yield, great fruit to handle color contrast

Fortune
- Former standard for yellow straightneck hybrids
- Good early yields
- Heavy petiole spines
- Less refined skin surface
- Good fruit uniformity
- Yellow stemmed

PUMPKIN DISEASES

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Every year in the northeast, cucurbit crops are potentially affected by more diseases than most other vegetable crops! Powdery mildew always occurs due to the quantity of easily wind-dispersed spores that the pathogen produces and the breadth of conditions under which it can develop (no high moisture requirement). The downy mildew pathogen also can move long distance; its occurrence in the northeast varies yearly, especially on crops other than cucumber. Occurrence of other diseases varies among farms depending on whether the pathogen is in the soil (several including Phytophthora blight), surviving in alternative host plants including weeds (e.g. white mold, viruses), present in insect vectors (e.g. bacterial wilt) or present in/on crop seed (e.g. bacterial leaf spot). Infected crop at a near-by farm can also be a source of pathogens that move short distances such as during a rainstorm (e.g. Plectosporium blight). Most diseases are more severe during a rainy than dry season because wet leaves or soil are favorable conditions for most pathogens (exceptions include powdery mildew, bacterial wilt, and virus diseases). Successful management is based on knowledge of pathogen biology, in particular sources of inoculum and conditions favoring disease development, which is used to identify appropriate cultural management practices. Knowing early symptoms facilitates early detection. It is also important to have current information on fungicides and resistant varieties. Mobile fungicides are more effective than contact ones due to ability to move in plants to where pathogens are, but prone to resistance development as they typically have single site mode of action. Below is information on select diseases followed by an integrated management program.

Powdery mildew

An integrated program with both management tools (resistant varieties and fungicides) is recommended to maximize likelihood of effective control. The pathogen has been evolving and becoming less effectively controlled by these. Alternate among targeted, mobile fungicides in the 5 chemical groups below, and apply with protectant fungicide to manage resistance development and avoid control failure if resistance occurs, and also to comply with label use restrictions. Note that the goal is delaying resistance development, not managing resistance. Begin very early in disease development (one older leaf out of 50 with symptoms).

Vivando (FRAC Code U8). Cucurbits are on a supplemental label. It has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. Do not mix with horticultural oils. It can be applied three times per year with no more than two consecutive applications. REI is 12 hr. PHI is 0 days.

Torino (Code U6) has exhibited excellent control in fungicide evaluations conducted recently. Activity is limited to powdery mildew. It can only be applied twice to a field in a 12-mo period. Consecutive applications are not recommended. REI is 4 hr. PHI is 0 days.

Quintec (Code 13) has been consistently effective in fungicide evaluations; however, resistance was confirmed on Long Island in 2015. Activity is limited to powdery mildew. Label specifies no more than two consecutive applications plus a crop maximum of four applications, and no aerial applications. REI is 12 hr. PHI is 3 days.

Luna Privilege (Code 7) is the recommended carboxamide fungicide. Pathogen strains resistant to boscalid, the first active ingredient available in this chemical group, were first detected in 2008 and are likely the reason efficacy of Pristine has varied. Cross resistance was documented between Pristine, Aprovia Top, Fontelis, and Merivon, but not with Luna fungicides. REI is 12 hr. PHI is 0 day. Apply at most twice consecutively and 13.7 fl oz/A.

Meg McGrath is an Associate Professor with a research/extension appointment in Cornell University's Plant Pathology and Plant-Microbe Biology Section. She is stationed at the Long Island Horticultural Research and Extension Center where she has been working since 1988 on optimizing management of diseases affecting vegetable crops. She has degrees from Pennsylvania State University (Ph.D.), University of Vermont (M.S.), and Carleton College (B.A.). Meg grew up in CT.

DMI fungicides (Code 3) include Proline and Procure, which are considered most effective, plus Aprovia Top, Rally, Tebuzol, Folicur, and Inspire Super. Resistance is quantitative. Highest label rate is recommended because the pathogen has become less sensitive to this chemistry. Efficacy has varied in fungicide evaluations. Procure applied at its highest label rate provides a higher dose of active ingredient than the other Code 3 fungicides. Five applications can be made at this rate. REI is 12 hr for these fungicides. PHI is 0 - 7 days. Powdery mildew is the only labeled cucurbit disease for these fungicides, except for Proline, which is labeled for Fusarium, and Inspire Super, which contains another active ingredient (Code 7 and 9, respectively) and are labeled for additional diseases.

Resistance continues to be very common to MBC fungicides (FRAC code 1; Topsin M) and QoI fungicides (Code 11; Quadris, Cabrio and Flint); therefore these are not recommended.

There are several protectants for powdery mildew, including chlorothalonil, sulfur, copper, botanical and mineral oils, and several biopesticides.

Phytophthora blight

This destructive disease has more been severe recently in areas where there were intensive rainfall events, which created unusually favorable conditions. A key to successfully managing this disease is managing soil moisture to avoid saturated conditions. Achieving this is difficult when rainfall amounts are large. Another key has been fungicides registered in recent years with targeted activity for pathogens in this biological group (Oomycetes). Information about these follows section on downy mildew. These are considered the reason many growers recently have been effectively managing Phytophthora blight. A preventive fungicide program is considered essential. Ineffective control with fungicides has been associated with poor application timing in some fields (application missed when rain began before expected) while in others favorability of environmental conditions seemed to have been too great. Development of fungicide resistance is a concern with all targeted fungicides due to single site mode of action; therefore, alternation amongst chemistry is recommended. Resistance to Ranman has been detected in the southeastern US. Protectant fungicides, such as coppers, are not sufficiently effective to be recommended alone for Phytophthora blight; however, they are useful tank-mixed with targeted fungicides to manage resistance.

Biopesticides can be applied to soil pre-transplant, at planting, and via drip to manage the blight pathogen, Phytophthora capsici, in the root and crown zone or to induce resistance. Products include Actinovate, Double Nickel, Regalia, RootShield, Serenade ASO, SoilGard, Bio-Tam. Most of these can also be applied to foliage.

Typically Phytophthora blight begins to develop in low areas where water drainage is poor, but symptoms have been found first in sloped areas. This documents the need to look throughout a crop for symptoms and not focus exclusively on low areas. It is better to avoid planting low areas. While crops planted in a field lacking the pathogen (based on crop and disease history) typically will be free of Phytophthora blight, this is not absolute. The pathogen can be moved between farms via water and in soil on equipment. Two cultural practices that have proved useful are biofumigation and deep zone reduced tillage. Biofumigation can be accomplished by growing a biofumigant mustard cover crop typically in early spring, chopping into small pieces 4-6 weeks after onset of flowering, and immediately incorporating the mustard, then sealing the soil surface with a culti-packer and irrigation. At least 7 days afterwards, lightly disk then plant.

Downy mildew

As with powdery mildew, fungicides are the main management tool and resistance is a concern; therefore the fungicide program recommended is also targeted, mobile fungicides applied in alternation based on FRAC Code (see list below) on a weekly schedule and tank mixed with a protectant fungicide (chlorothalonil or mancozeb) beginning very early in disease development.

An important tool for determining when fungicide application is warranted is the forecast web site for this disease at http://cdm.ipmpipe.org. Cucurbit plants are susceptible to downy mildew from emergence; however, this disease usually does not start to develop in the northeast until later in crop development when the pathogen is dispersed

by wind into the region. The forecast program monitors where the disease occurs and predicts where the pathogen likely will be successfully spread. The pathogen needs living cucurbit crops to survive, thus it cannot survive where it is cold during winter. The risk of downy mildew occurring throughout the eastern USA is forecast and posted three times a week. Forecasts enable timely fungicide applications. Label directions for some fungicides state to begin use before infection or disease development. The forecasting program helps ensure this is accomplished. Growers can subscribe to receive customizable alerts by e-mail or text message. Information is also maintained at the forecast web site of cucurbit crop types being affected by downy mildew. This is important because the pathogen exists as pathotypes that differ in their ability to infect the various crops, with cucumber most susceptible. Forecast system success depends on knowledge of where downy mildew is occurring; thus prompt reporting of outbreaks by growers is critical.

Fungicides for Phytophthora blight (PB) and/or downy mildew (DM):

Orondis (FRAC Code U15). This exceptionally effective fungicide is marketed as three combinations with other fungicides. Orondis Gold also has mefenoxam and is only labeled for PB applied to soil including at planting and through drip. It cannot be used with the other formulations because both soil and foliar applications to a crop are prohibited. Orondis Opti with chlorothalonil and Orondis Ultra with mandipropamid are also labeled for DM. Apply no more than 6 times in a season with no more than 2 consecutive applications and at most for 33% of the total foliar fungicide applications. Minimum interval is 3 days. 4 hr REI. O day PHI.

Presidio (43). Recommended used early in the season for PB when DM not a concern. No longer reliably effective for DM due to resistance. Apply no more than 4 times in a season with at most 2 consecutive applications. Must be applied with another fungicide.

Ranman (21). Use organosilicone surfactant when water volumes are less than 60 gallons per acre. REI is 12 hr. PHI is 0 day. Apply no more than 6 times in a season with no more than 3 consecutive applications.

Zing! and Gavel (22). These are the only products that have a targeted fungicide and a protectant fungicide (chlorothalonil or mancozeb). Only Gavel is labeled for PB as well as DM. REI is 12 hr for Zing! and 48 hr for Gavel. PHI is 0 and 5 days, respectively. Apply no more than 8 times in a season with no more than 2 in succession. Limit total use with all products used to 1.6 lb zoxamide and 9.44 lb chlorothalonil per acre per season. The amount of chlorothalonil in an application of Zing! (1.18 lb/A) is less than the highest label rate of chlorothalonil fungicides for downy mildew (1.5 lb/A) and is below the range for other diseases including powdery mildew (1.5-2.25 lb/A). Increasing the amount of chlorothalonil applied is prudent for these diseases. To obtain an application rate of 1.5-2.25 lb/A chlorothalonil, tank mix Bravo WeatherStik at 0.43-1.43 pt/A with Zing!.

Zampro (40, 45) and Revus (40). While in the same fungicide chemical group, there is indication they may have slightly different mode of action, thus there may be benefit to using one for the first application of a product in this group in a fungicide program and then switching to the other product later in the program. REI is 12 hr. PHI is 0 day. Apply no more than 3 times (4 for Revus) in a season with no more than 2 consecutive applications (none with Revus). Revus must be applied with a spreading/penetrating type adjuvant. Zampro cannot be used in Suffolk and Nassau counties (Long Island).

Ariston, Curzate or Tanos (27). These have some curative activity (up to 2 days under cool temperatures) but limited residual activity (about 3-5 days). They can be a good choice when it was not possible to apply fungicide at the start of a high risk period when temperature is below 80 F. Apply another targeted fungicide 3-5 days later. Curzate and Tanos must be tank-mixed with a protectant; Ariston also contains chlorothalonil. REI is 12 hr. PHI is 3 days. Apply no more than 4 times in a season (6-9 for Curzate depending on rate); no consecutive applications of Tanos are permitted. Ariston and Curzate are not labeled for PB.

Phosphorous acid fungicides (33). There are numerous products (e.g. Agri-Fos, Fosphite, K-Phite, Phostrol, ProPhyt, Rampart), all effective only for PB. They are recommended used at a low label rate tank mixed with the targeted fungicides listed above for PB.

Recommended protectant fungicides. Chlorothalonil and mancozeb are the main protectant fungicides for DM and PB. Copper is also good for PB, but isn't very effective for DM.

No longer recommended for DM. Resistance to mefenoxam (e.g. Ridomil) and to strobilurins (Cabrio) is sufficiently common that fungicides with these ingredients, which use to be highly effective, are now ineffective for DM. Resistance to Previcur Flex is also suspected based on poor efficacy in recent fungicide evaluations; it was ineffective when tested in central NY in 2016. These fungicides are not labeled for PB.

Bacterial leaf spot
Pathogen can be seed-borne and survives in crop debris. Rain provides favorable conditions for pathogen dispersal and infection. Rotate, clean equipment between fields, do not work when leaves are wet, use drip irrigation, apply copper fungicide, and incorporate infested debris right after harvest.

Plectosporium blight
This disease is more common when weather is rainy providing favorable conditions. Rotate, clean equipment between fields, apply chlorothalonil before rain, and incorporate infested debris right after harvest.

Integrated Management Program for Diseases of Pumpkin and Other Cucurbits:

SIGN UP FOR ALERTS ABOUT DOWNY MILDEW OCCURRENCE **AT HTTP://CDM.IPMPIPE.ORG BEFORE THE SEASON STARTS. MONITOR THIS SITE DURING THE SEASON FOR INFORMATION ON OUTBREAKS AND CROPS AFFECTED.**

SELECT RESISTANT VARIETIES. **SEE VEGETABLEMDONLINE.PPATH.CORNELL.EDU/TABLES/TABLELIST.HTM.**

USE FUNGICIDE-TREATED SEED AND/OR SEED THAT HAS BEEN TESTED FOR PATHOGENS. **FARMMORE COMMERCIAL SEED TREATMENT ALSO HAS AN INSECTICIDE. ALTERNARIA LEAF BLIGHT, ANGULAR LEAF SPOT, ANTHRACNOSE, DAMPING-OFF, FUSARIUM WILT, GUMMY STEM BLIGHT/BLACK ROT, SCAB, SEPTORIA LEAF SPOT.**

ROTATE LAND **TO CONTROL DISEASES CAUSED BY PATHOGENS THAT CAN SURVIVE IN SOIL OR ON WEEDS IN HEDGE ROWS, WHICH INCLUDE ALTERNARIA LEAF BLIGHT, ANTHRACNOSE, ANGULAR LEAF SPOT, BACTERIAL LEAF SPOT, FUSARIUM CROWN AND FRUIT ROTS, FUSARIUM WILT, GUMMY STEM BLIGHT/BLACK ROT, PHYTOPHTHORA BLIGHT, PLECTOSPORIUM BLIGHT, SCAB, SCLEROTINIA WHITE MOLD, SEPTORIA LEAF SPOT, AND VIRUSES (WHICH CAN SURVIVE IN WEEDS).**

SELECT A WELL-DRAINED SITE **TO MANAGE DAMPING-OFF, PHYTOPHTHORA BLIGHT, AND SCAB.**

MINIMIZE LEAF WETNESS. **SELECT A SITE WITH GOOD AIR MOVEMENT AND OVERHEAD IRRIGATE WHEN LEAVES WILL HAVE TIME TO DRY BEFORE EVENING DEW PERIOD TO MANAGE FOLIAR DISEASES.**

PHYSICALLY SEPARATE CUCURBIT PLANTINGS.

AVOID MOVING INFESTED SOIL INTO CLEAN FIELDS. **WORK LAST IN FIELDS WHERE PATHOGENS OCCUR THAT SURVIVE IN SOIL, THEN CLEAN EQUIPMENT BEFORE WORKING IN FIELDS WHERE THESE DISEASES HAVEN'T OCCURRED (SEE LIST UNDER ROTATE ABOVE). APPLY PESTICIDES TO AREAS WITHOUT SOIL-BORNE DISEASES FIRST.**

SCOUT FOR DISEASES **REGULARLY DURING THE GROWING SEASON. FOCUS ON OLDER LEAVES AS DISEASES OFTEN START TO DEVELOP THERE. LOOK ON BOTH LEAF SURFACES. IT IS ESPECIALLY IMPORTANT TO SCOUT ONCE PLANTS START TO PRODUCE FRUIT. CHECK LOW AREAS FOR PHYTOPHTHORA BLIGHT. LOOK FOR CUCUMBER BEETLES.**

APPLY PESTICIDES AS NEEDED **(FUNGICIDES BEFORE RAIN FOR MOST DISEASES EXCEPT POWDERY MILDEW):**

INSECTICIDE ADMIRE PRO AT PLANTING OR TRANSPLANTING FOR CUCUMBER BEETLES, WHICH CARRY

BACTERIA THAT CAUSE BACTERIAL WILT. OR USE FARMORE-TREATED SEED. PLANTING BLUE HUBBARD OR ANOTHER CUCURBIT HIGHLY ATTRACTIVE TO BEETLES AROUND THE CROP TO FORM A PERIMETER TRAP IS AN EFFECTIVE STRATEGY THAT CAN RESULT IN INSECTICIDE ONLY BEING NEEDED ON THE TRAP PLANTS.

CONTANS BEFORE OR AT PLANTING FOR WHITE MOLD.

RIDOMIL GOLD EC (CODE 4), PREVICUR FLEX (28) OR BIOPESTICIDES (ACTINOVATE, BIO-TAM, DOUBLE NICKEL, REGALIA, ROOTSHIELD, SERENADE ASO, SOILGARD, ETC) AT PLANTING FOR DAMPING-OFF.

BIOPESTICIDES (SEE ABOVE) AT PLANTING FOR PHYTOPHTHORA BLIGHT AND FUSARIUM CROWN ROT.

PROLINE (3) CAN BE APPLIED ONCE TO SOIL FOR FUSARIUM.

PROTECTANT FUNGICIDES (CHLOROTHALONIL, MANCOZEB, AND/OR COPPER) BEFORE DISEASE ONSET. A PREVENTIVE SCHEDULE IS ESPECIALLY IMPORTANT WITH COPPER FOR ANGULAR AND BACTERIAL LEAF SPOTS.

WHERE BACTERIAL WILT IS A CONCERN, APPLY INSECTICIDE IF TREATMENT AT PLANTING IS NO LONGER KILLING CUCUMBER BEETLES EARLY IN CROP GROWTH, ESPECIALLY PRIOR TO CANOPY CLOSURE. LABELED PRODUCTS ARE ASANA, ASSAIL, BAYTHROID, BRIGADE, DANITOL, LANNATE, POUNCE, SEVIN XLR PLUS, VOLIUM XPRESS, AND ADMIRE APPLIED THROUGH DRIP.

APPLY TARGETED FUNGICIDES IN ALTERNATION BASED ON FRAC CODE WHEN THE FOLLOWING DISEASES OCCUR STARTING AT FIRST SYMPTOM OR WHEN RISK HIGH, TANK-MIX WITH PROTECTANT FUNGICIDE:

> **ALTERNARIA LEAF SPOT. INSPIRE SUPER (3,9), LUNA EXPERIENCE (3,7), LUNA PRIVILEGE (7), PRISTINE (7,11), QOI FUNGICIDES (11), REASON (11), TANOS (27).**
>
> **ANTHRACNOSE. INSPIRE SUPER (3,9), LUNA EXPERIENCE (3,7), PRISTINE (7,11), QOI FUNGICIDES (11), TANOS (27), AND TOPSIN M (1).**
>
> **DOWNY MILDEW. POWDERY MILDEW, PHYTOPHTHORA. SEE SECTIONS ABOVE.**
>
> **GUMMY STEM BLIGHT/BLACK ROT. INSPIRE SUPER (3,9), LUNA PRIVILEGE (7), PROLINE (3), SWITCH (9,12), QOI FUNGICIDES (11)*, PRISTINE (7,11)*, AND TOPSIN M (1)*.**
>
> **PLECTOSPORIUM BLIGHT. INSPIRE SUPER (3,9), AND QOI FUNGICIDES (11)*.**
>
> **SEPTORIA LEAF SPOT. INSPIRE SUPER (3,9).**
>
> *** RESISTANCE DETECTED IN THE US.**

HASTEN DECOMPOSITION OF INFESTED CROP DEBRIS **BY CHOPPING DEBRIS TO BREAK IT UP AND THEN INCORPORATING WITH DISK, ROTO-TILL OR PLOW. DO IMMEDIATELY AFTER HARVEST.**

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. Check labels for use restrictions. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

MANAGING WEEDS IN A WARMER WORLD

Steve Young
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Weeds in cropping systems reduce yields directly by restricting harvest operations and/or indirectly by competing for available resources. In the U.S., crop losses from weeds can be significant – up to 50% or more. An integrated weed management (IWM) approach includes several essential components such as rotating between different crops, using a number of diversified control tactics, and monitoring plant populations. The use of multiple weed tactics integrated together is critical in being able to prevent economic and environmental damage for a range of conditions, including climate variability.

Currently, rising atmospheric CO2 concentrations are affecting weather conditions and the biology of plants. Springs are arriving earlier, summers are longer and hotter, winter temperatures are warmer and plant hardiness zones have shifted northward. Since 1895, the average temperature increase in the U.S. has been 1.3 to 1.9°F with most of this increase occurring in the last 45 years. The decade 2001-2010 was the hottest recorded ever, and the trajectory is set for the average global temperature to continue to warm into the future from 3.2 to 7.2°F by 2100.

With the increases in annual average temperatures and changes in precipitation patterns and greater variability in the weather, implications are profound for managing weeds in cropping systems. For weeds and climate variability, there is uncertainty in (a) the biological characteristics related to function, fecundity, and habitat that are likely to determine biological "winners" and "losers" within the weed community; (b) how these biological changes will increase or decrease the ability of weeds to inflict damage on plant and human systems; and (c) the implications for weed management and control.

This talk will cover the topics of weed control and the importance of biology and ecology in an era of increasing climate variability with examples of how weeds may become weedier in their characteristics and distribution patterns and more difficult to manage with current tactics. Finally, an example of a weed succumbing to extreme weather in a recent research study will be presented.

Dr. Young is an adjunct professor of weed ecology in the School of Integrative Plant Science at Cornell University in Ithaca, NY. His research is focused on plant competition in cropping systems and the impact of abiotic and biotic stressors. He has a MS in plant science from the University of Idaho and a PhD in soils and biogeochemistry from the University of California, Davis. He was a faculty member at the University of Nebraska-Lincoln before taking his current position, which also includes directing the Northeastern IPM Center.

MANAGING VEGETABLE INSECTS IN A CHANGING CLIMATE

Shelby J. Fleischer, Department of Entomology
The Pennsylvania State University, University Park, PA 16802

Regardless of what some politicians shout, the science is clear: anthropogenic (human-caused) climate change is real. Insect populations are very sensitive to temperature. We expect changes in insect phenology (timing of insect life stages), voltinism (the number of generations per year), when migrants arrive, and species composition (which species are expected to be present).

Temperature-dependent models (degree-day models) are used to project the timing of when different life stages of insects will be present. These are called phenology models – phenology is the term for the timing of biological events. For most of our pests, temperature dependent development rises rapidly from a lower threshold, reaches a maximum development rate, and then plummets rapidly (Fig. 1). Thus, in the simplest case, we can expect more rapid insect development as temperatures rises, unless it exceeds the upper threshold.

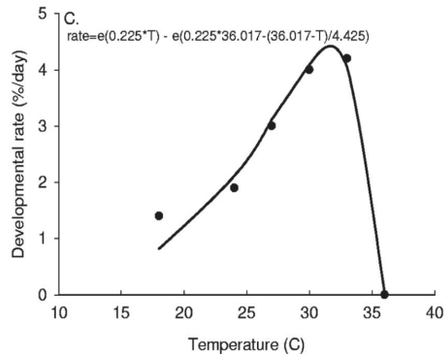

Fig. 1. Typical shape of a temperature-dependent growth curve for our pest insects. This one is for the egg-to-adult development of striped cucumber beetle. Ellers-Kirk & Fleischer 2006

Pests that overwinter in our latitude go through diapause – a state of arrested development – to survive the winter. Initiation and termination of diapause is often cued by photoperiod (daylength), which will not be affected by climate change. So in the simplest case, we can consider population growth as a function of temperature during the time frame when the insect is not in diapause. We've done exactly that with really cool agent-based models, which we verified with field data. We then ran the same models for the past 40 years ('backcasting') and for the next ~80 years ('forecasting') under different scenarios from the Intergovernmental Panel on Climate Change, downscaled to provide realism for the location we worked with (Erie, PA) (Fig. 2). We can see that the backcasting did a good job of approximating the gradual increase in average number of generations per year, and the forecasting shows how this will increase in the future, depending on the degree of reliance on fossil fuels. It also important to note that we are locked into a continuing increase until about midcentury due to the amount of greenhouse gasses already in the atmosphere. We've also applied these agent-based methods to brown marmorated stink bug, and can easily see how the warmer years resulted in higher damage.

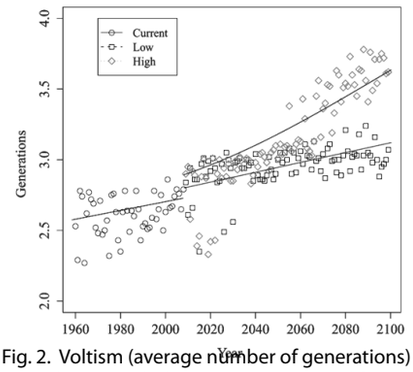

Fig. 2. Voltism (average number of generations) of grape berry moth during recent past and future climates. We're locked into a gradual rise until mid-century due to existing greenhouse gas concentrations. Beyond that, the rate of increase levels out if we adopt renewable energy based economies, but continues to rise, if we continue current fossil-fuel economies. Chen, Tobin, Saunders, Fleischer 2011.

Many insects that reach pest status in our vegetable cropping systems do not overwinter in our area. They arrive via migration from southern locations. We now also have models to estimate timing of immigration. As the proximity for overwintering populations comes closer, we can expect changes in immigration timing and intensity, but it is too early to project how these changes will play out.

Beneficial species and pollinators are also expected to shift their geographic distribution. Work in progress will discuss how some bee species are anticipated to shift in their geographic range.

Dr. Fleischer is on the faculty of the Department of Entomology at The Pennsylvania State University where he specializes in population dynamics of insects. He has been worked in vegetable agroecosystems for 25 years. He previously was a Research Scientist at Virgina Tech and Research Associate at Auburn University. He received his B.S. in Biology from St. Mary's College of Maryland, his M.S. in Entomology from Virgina Tech and his Ph.D. in Entomology from Auburn. A native of Washington, D.C., he and his wife Barbara have two daughters, Megan and Erin.

ORGANIC HERB PRODUCTION

Tony Ricci, Green Heron Farm

This presentation will focus on organic herb production and be applicable to both retail and wholesale operations. The discusion will begin by identifying the most common herbs for commercial production, but also include references to less popular herbs that may be of interest for retail and restaurant trade.

Cultural practices for both annual and perennial herbs will also be discussed and will include the use of plastic and organic mulches, weed control, pest and disease pressure, and harvesting methods.

The presentation will conclude with post harvest handling and packaging for wholesale and retail markets.

1. Common Herb Varieties: Choosing the right variety for commercial production.
   a. Annual – Parsley (Itlaian and Curly), Basil (Italian, Purple, Thai), Cilantro, Dill, Summer Savory, Sweet Marjoram, Green and Red Shiso.
   b. Perrenial – Thyme, Rosemary (tender perrenial), Sage, Mints, Chives, Garlic Chives, French Tarragon, Greek Oregano, French Sorrel.

2. Cultivation.
   a. Determine space needed for proper production based on sales history.
   b. Use raised beds. Keep annuals and perennials separate. Group annuals that have similar traits and growing habits together so they can be rotated out during succession plantings. Treat perennials as annuals to control weeds. Rotate every 2 years like strawberries.
   c. Using Mulch. Black plastic mulch works for all herbs. Avoid red mulch because it is too translucent. Plastic on perennials harder to pull up. Hay and straw also works well, between plastic rows or on the bed itself without plastic. Organic mulches are more labor intensive at the beginning of the season because you have to lay it by hand, but has the advantage of composting by the end of the season without removal.
   d. Most herbs are tolerant of a wide range of soil types and conditions. Excessive moisture or dry weather can cause problems.
   e. Herbs generally have fewer pest and disease problems than vegetable crops but there are some significant exceptions.
      i. Basil – Flea beetle when first tranplanted, Japanese beetles, powdery mildew, fusarium.
      ii. Parsley – parsley worm (Swallow tail butterfly), root rot.
      iii. Cilantro – aphids, especially in greenhouse or high tunnel production.
      iv. Oregano and mints – flea beetle damage in late spring, early summer.
      v. Most herbs – spittle bugs.

3. Harvest. Most herbs should be harvested dry to prevent degredation in storage. Some herbs like parsley and sorrel can be rinsed but should be allowed to thoroughly drain before packing. There is a narrow window for harvest, especially in the mid-summer, because picking should occur after the dew and before temperatures get too hot.

Most herbs can be harvested with clippers. Certain herbs, like parsely benefit from picking individula stems. Herbs should not be allowed to heat up in the field. Pick small quantities at a time and bring them into the packing shed for processing.

Tony Ricci and his wife Becky Smith of Green Heron Farm have been farming since 1984 in Huntingdon county PA. They have been certified organic since 1989 and market their produce at farmers markets and wholesale outlets. They specialize in herbs, berries, and alliums. They are founding members of Tuscarora Organic Growers Cooperative.

4. Packing and Storage.
   a. Herbs for wholesale are usually packed in small boxes. Half pound boxes are good for restaurant sales. 12 and 24 bunch cases for some herbs are good for wholesaling to retailers. For farmers market bunching is preferable so they be displayed in containers.
   b. Storage temeperatures vary for each herb. Basil, cilantro and oregano prefer warmer temperatures (40° to 50°.) Parsley, thyme, sorrel, prefer cooler temperatures (35°.)

ROTATIONAL NO-TILL AND INSECTARY STRIPS FOR ORGANIC CUCUMBER PRODUCTION

Gladis Zinati, Associate Research Scientist
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Rodale Institute, Kutztown, PA 19530

Weed and insect management are two of the biggest impediments to competitive organic vegetable production. Tillage and plastic mulch have been widely used among cucumber organic growers for bed preparation and weed management. While frequent tillage leads to soil degradation by decreasing structural stability, organic carbon content and microbial activity, plastic mulch use has a negative impact on the environment and do not add fertility to soil organisms and plant roots.

Striped cucumber beetle (Acalymma vittatum) is a major pest of Cucurbitaceae crops across the Northeast. The larvae of this pest damage young cucurbit plants when feed on plant roots and their adults damage cucurbit crops and reduce yield and marketability by feeding on plant leaves and flowers, scaring fruits, and transmitting bacterial wilt disease. Bacterial wilt, caused by the pathogen Erwinia tracheiphila, is regarded as a major threat for cucurbit production and is expanding from its epicenter in the northeast United States into areas of the Midwest and mid-Atlantic. Cucumber (Cucumis sativa) and muskmelon (Cucumis melo) are highly susceptible to E. tracheiphila which can result in up to 80% yield loss. Strategies to manage bacterial wilt are entirely focused on reducing densities of the striped cucumber beetles. Despite the preventive measures taken by organic cucumber growers in using row covers at time of transplanting and spraying organic pesticides throughout the season, unacceptable losses still frequently occur and cucumber plants and fruits are being damaged by striped cucumber beetles during cucumber production. Organic insecticides are not only costly but also, as research data have shown, have negative impact on diversity and densities of beneficial and predatory insects.

With increased PA growers' awareness on benefits of reduced tillage and soil health, organic cucurbit growers have expressed great interest in finding strategies that can be integrated to increase their competitiveness by improving weed and insect control, soil health, without impacting cucumber crop yield. Reduced tillage using rolled-crimped cover crops and biological control by including insectary strips offer potential opportunities for controlling weeds, conserving soil health, and striped cucumber beetle management.

A research project is underway in Pennsylvania with research objectives to 1) identify and assess the impact of cover crop residue mulch on weed management compared to tilling the cover crop and using plastic mulch, 2) quantify soil health indicators, 3) asses crop yield, and 4) assess the impact of diverse flowering insectary plant strips on attracting beneficial insects and predators to control striped cucumber beetle.

Gladis Zinati is an Associate Research Scientist at Rodale Institute, Kutztown, PA. Dr. Zinati research focuses on the development of strategies to optimize soil, weed and insect pest management in organic crop production. These strategies include compost formulations, cover crops, reduced tillage, and natural habitats. She has a set of undergraduate degrees in General Agriculture and Agriculture Engineering and MSc. degree in Horticulture from the American University of Beirut, Beirut, Lebanon. Her Ph.D. is in Soil Fertility from Michigan State University, E. Lansing, MI. She has 21 peer-reviewed publications and 37 proceedings and outreach educational publications, and experienced in giving scientific and educational presentations and hands-on workshops.

The experimental design is a randomized complete block, with four replications, 2x2x2 factorial, with two cover crop mix treatments (cereal rye/hairy vetch and cereal rye followed by field peas), established in the fall of 2015 (field peas in spring 2016), two management practices (rolling-crimping cover crops vs. tilled with plastic), with and without insectary flowering strips.

Insectary strip plants are groupings of flowering plants that include alyssum, lemon balm, lemon basil, fava bean, bouquet dill, marigold, and calendula with alfalfa as a base perennial plant. These flowering plants were chosen based on their flowering periods to provide beneficial insects with continuous source of pollen and nectar and a shelter to populate and hide from heat during the summer time. By choosing this suite of flowers we anticipated to attract beneficial insects such as lady beetles, hover flies, soldier beetles, wolf spiders, ground beetles, and parasitoids.

Two cover crop mixes were chosen for this experimental study – hairy vetch with rye (HV/R) and rye with field pea (R/P) and were either plowed under or rolled-crimped in spring 2016. Cover crop biomass was sampled in each plot during the third week of May of 2016 when hairy vetch and field pea were 50% blooming and rye at anthesis. Cucumber seedlings were either transplanted into black plastic using the water-wheel planter (Photo 1) at 18-inch in-row (between plants) or into rolled cover crops using the no-till planter (Photos 2) and covered with row covers to protect the young seedlings from cucumber beetles while forming roots in the soil.

Each replicate has plots with insectary strip sections (three strips of flowering plants, each 5-ft wide and 30-ft long) and plots without insectary sections where ryegrass was planted. Treatments with insectary strips were separated from non-insectary treatments by a 30-ft buffer.

Weeds were assessed at cover crop biomass sampling and after removal of row covers. Cucumber fruits were harvested twice a week and grouped into marketable premium, scared/damaged by beetles, and culls. After removal of row covers, sticky yellow cards were placed in the middle of each of cucumber bed and insectary strip for 48 hr. The cards were collected on a weekly basis for three weeks to assess the number of cucumber beetles and beneficial insects. Similarly pitfall traps were installed in each bed and along the perimeter of experimental trial. The lids on the pitfalls were propped open for 48 hr before numbers of ground beetles and wolf spiders were counted. Two samplings were made during the season. Soil samples were collected at rolling of cover crops (beginning of the season) and mid-season for physical and chemical assessment.

Cover crop biomass and weeds: Results showed plots with R/HV cover crop mulch had 30% greater biomass than those in R/P. Weeds were negligible at biomass sampling in May however wild radish started to show soon after removal of row cover. The weeds were greater under rolled-crimped cover crop mulch treatments in R/HV. It seems the site selected for this project was infested with wild radish and the cover crop mixture increased its expression. Whereas, R/P cover crop residue suppressed weeds and cucumber plant growth. Plastic mulch provided in-row weed suppression.

Soil properties: Irrespective of cover crop mixture, soil bulk density measured at 0-8 inches depth was not different in plots that were under rolled cover crop mulch or plastic mulch. Soil density ranged between 0.28 lb/inch3 and 0.34 lb/inch3. There was no significant change in soil %N and %C between treatments.

Cucumber yield: Whether plants were grown in R/HV or R/P cover crop mixtures, mean total marketable (premium) cucumber yield in 2016 was greater in black plastic treatments than in rolled cover crop mulched treatments. Mean marketable cucumber yield was greater in cover crop tilled in and covered with plastic mulch than in cover crop rolled-crimped mulch, irrespective of cover crop mixture. Cucumber premium marketable yield in plastic mulch was 36% greater in R/HV than in R/P and similarly it was 99% greater in cover crop mulch.

Cucumber beetles and beneficial insects: During pea and hairy vetch flowering, many honey bees and bumble bees were visiting the plots. The first sighting of beneficial insects hovering over insectary strips were seen on June 20, 2016. Soldier beetles were seen on fava bean and dill plants whereas hover flies were detected on alfalfa. Preliminary results of pitfall traps showed that ground beetles and wolf spiders exist in both rolled cover crops and plastic plots. Average number of wolf spider was greater in cucumber plots without insectary and equally in cucumber

plots surrounded with insectary strips, insectary strips and perimeter locations (Figure 1). However, number of ground beetle was highest in the insectary strips, followed by perimeter, cucumber beds with insectary and least in cucumber beds without insectary. Other beneficial insects such as daddy long-leg and other spiders were greater in the insectary strips.

Results from yellow sticky cards showed that mean number of cucumber beetles was 2.5 in cucumber beds (17 plants) with non-insectary strips and not different from those with insectary strips on July 20, 2016. However, the number cucumber beetles increased more in the cucumber beds with insectary strips than those without on July 27. Similarly, wolf spiders and ground beetles increased in number in cucumber beds with insectary on July 27 than those without insectary. As season progressed, the number of cucumber beetles decreased with time as well as wolf spider and ground beetles. On the other hand, the increase and decrease in mean number of lady beetles was more drastic in cucumber beds that are not bordered with insectary strips. Apparently, the plants in the insectary strips provided shelter and food for lady beetles during the hot weather in August and kept the population leveled out throughout the season.

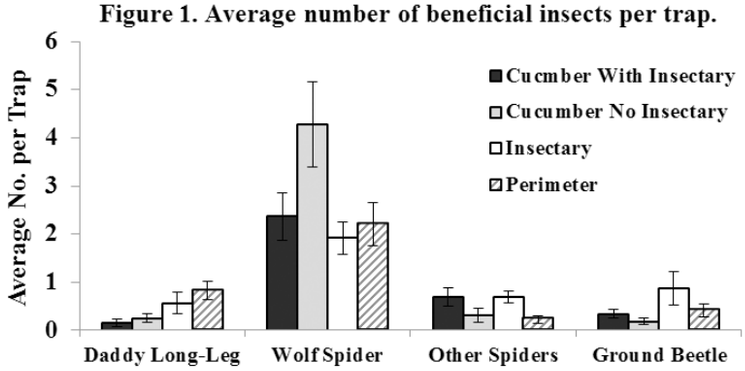
It is interesting to note that during the 2016 growing season that despite the presence of striped cucumber beetles in the experimental site and around the perimeter of the study, cucumber plants never succumbed to wilting. This is an interesting observation that would require more in-depth research studies on the impact of these systems on the presence or absence of bacterial wilt.

In summary, based on our first-year data, cover crop mixtures impacted crop yield differently and the presence of insectary strips increased both wolf spiders and ground beetles and provided lady beetles with shelter and food without impacting negatively their population. The proposed integrated system will be evaluated again in 2017 for crop yield and soil health indicators and weed pressure. In addition, we will increase number of sampling dates to assess changes in number of cucumber beetle and beneficial insects and potential parasitism by parasitoids.

Photo 1. Transplanting into plastic mulch with the water-wheel planter.

Photo 2. Transplanting on rolled cover crops using the no-till planter.

Figure 1. Average number of beneficial insects per trap.



NEW MORNING FARM ORGANIC GREEN BEAN PRODUCTION PRESENTATION

Jennifer Glenister, New Morning Farm

Overview:
At New Morning Farm we grow green beans as part of a diversified organic vegetable operation. Out of the forty acres that are in production each year, green beans comprises about 4 acres. This gives us about 22 to 23 weeks of consistent harvests that satisfy several retail markets and our wholesale marketing cooperative.

1 st Planting Dates – Seed in greenhouse 4/1 for transplant 4/20 two plants per plug, Direct seed 5/20

Plant spacing – Black Plastic - 6“ in row, 2 rows per 34” bed, for the first 5 weeks of planting

Bare Ground - Transplants 6” in row, 36” between rows, two plants per plug

Total Planted – 3.75 acres

Number of plantings – 20-21; 0.12A/planting on plastic, 0.16A/planting bare ground

Direct Seed – MaterMacc vacuum seeder for all plantings #6-21, 2” in row, 36” rows

TP Method – Water-Wheel Transplanter into black plastic, 2 rows per 3’ bed, 6” in row, and two plants per plug

Lannen Carousel Transplanter bare ground, 36” rows, 6” in row, and two plants per plug

Irrigation – two tapes under plastic, or hand-moved sprinklers, 1”/week

Varieties – Jade II, Provider

Storage – 40-45 degrees F, high humidity; keeps for just over 7 days

Varieties selection:
We use two varieties based on specific factors that allow us to consistently market high quality green beans. We exclusively grow Jade II and Provider. Jade II are by far our favorite, dark green, long, straight, and tender beans even when full size. The Provider is a lighter green and quicker to maturity, and we always use it for the first planting. For these two varieties, there is about a week between the days to harvest. This difference gives us the ability to fall back on Provider when weather conditions prevent tillage and seeding. This ultimately allows us to achieve our goal of supplying our customers with a consistently high quality product at market every week. We also take advantage of varieties with good disease resistance.

Fertility:
We plant beans within rotation of other vegetable and cover crops. Poultry manure and compost along with cover crops form the foundation of our fertility program. Generally we do not apply any amendments to the bean ground, instead we rely on organically active soil, and the beans own ability to fix nitrogen. Often our beans are planted in ground that was manured 18 months or more previous and has grown at least two vegetable crops, and a couple cover crops since.

Season extension/consistent harvests:
We seed about the first 5 plantings of beans in the greenhouse starting April 1st, and transplant them at about 18-20 days from seed date. This allows us to circumvent issues that come with trying to direct seed into cold soil, being seed corn maggot and poor germination. Seed corn maggot is by far the most regular and devastating problem we face in our early beans. By transplanting, we totally eliminate the risk from seed corn maggot.

The first planting of beans we seed is the variety with the least days to maturity, Provider. We also seed Jade II on the same day as these will mature a week later. The Jade II will be our second harvest of beans. When we are done transplanting and ready to move into direct seeding into the field, we want to be on track to seed our standard variety Jade II. So we have the flexibility to seed a shorter days to harvest variety later on if the field conditions do not allow

us to work or if soil temperatures are still low. We want soil temperatures to be at least 50-55 degrees F; not so much for germination, but quick plant growth to jump ahead of the seed corn maggot.

We transplant with a water-wheel transplanter into black plastic for the first 5 plantings. We aim to have plastic pre-laid to receive at least one generation of beans. Often if the soil is too wet to transplant bareground, we are still able to transplant into plastic.

We cover the spring transplants with hoops and row cover. The row cover is .55 oz. per square yard, the equivalent of Agribon 19. All row cover is removed from the transplants when threat of frost has passed, usually the last week of May, which is a week or two after we begin direct seeding.

Pest and disease control:
Beginning in June, we scout for Mexican Bean Beetle. As soon as we find adult beetles, we order a parasitic wasp, Pediobius foveolatus which is available from IPM Laboratories. We release the wasps around the bean patch as soon as they arrive, and make a second release a week later for security since timing is critical. After that, we completely stop worrying about the bean beetle for the remainder of the season. Occasionally we will find a bit of feeding damage here or there, but nothing that requires action.

Deer have been the most costly pest this past year. We have used two repellents, but the deer become accustomed within a season or two. Now we are using a 3-D electric fence, 3' wide and 4' high. So far it's been very effective, though we did see some fawns picking their way through.

Weed control:
Successful weed control is largely dependent upon successful timing with a tine weeder, targeting weeds at thread stage. This is followed by belly mounted sweeps when the beans are 4-6" tall. When the beans are on black plastic, we use a Hillside Cultivator to maintain weed control on the plastic edges. This has to be done before or at transplant, since we cover everything with hoops and row cover at transplant.

Harvest and post-harvest handling:
We begin harvesting beans for markets in the first week or so of June and will continue harvesting weekly into October. We strive to harvest when the beans are dry, without dew or moisture from rain. This helps them stay very clean. Beans on black plastic are picked through at least twice. All other beans are picked once. This requires careful judgement of optimal maturity. For most harvests our pickers pull the whole plant from the ground, flip it upside down and pull off the beans. The beans are dropped straight into a plastic tote or 1 bushel waxed box. The boxes are stacked in the shade and ferried to the cooler every few hours on hot days. In the cooler, the boxes are opened and stacked to maximize airflow. They are left this way for at least a day. This cooling period is crucial to maximizing quality and storage life. Once cool, the boxes are adjusted to 25 lbs. Lids closed, and stacked onto pallets.

Marketing and sales:
Consistently bringing high quality, delicious, organic beans to our markets adds to our credibility for our customers, and allows us to charge a premium price for our product. Successfully and consistently providing this specialty crop has brought people back to our stand again and again. We purposely overplant in order to be sure to meet the maximum retail market demand, but we stay within the limits of what can be absorbed through our wholesale market where we also can claim a profitable price.

USING COVER CROPS ON VEGETABLE FARMS

Elsa Sánchez
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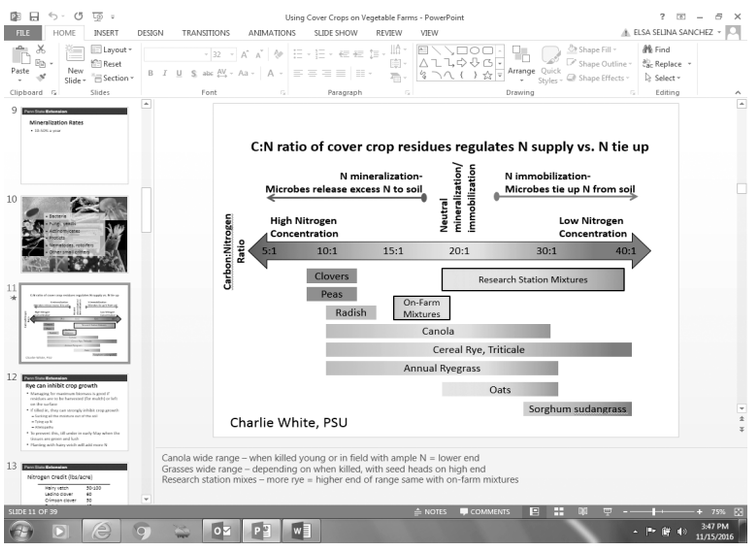
There are a lot of good reasons for growing covers crops on vegetable farms. Including:

- Minimizing soil erosion. Cover crops reduce the impact of wind and water passing over the soil surface.
- Improving soil structure. Cover crops add organic matter when they are incorporated into soil.
- Suppressing weeds. Cover crops compete with weeds for light, water, and nutrients.
- Adding nitrogen to soil. Many cover crops can add nitrogen to the soil. Legume cover crops are most often associated with nitrogen credits because they have developed relationships with symbiotic soil bacteria which can convert nitrogen gas, which plants cannot uptake, to ammonia, which is converted to plant useable forms.
- Creating habitat for beneficial insects. Using cover crops can increase plant diversity on the farm and may create habitats for beneficial insects.

There are also a lot of cover crop species to choose from which can make selecting which to plant a difficult choice. Answering this question can help narrow in on which cover crop species to grow: What do you want the cover crop to do for you? A single cover crop species cannot accomplish all of the potential benefits. Some reasons for growing cover crops are examined below.



Charlie White, a research associate at Penn State University who studies cover crops, provided the figure here showing how different cover crops and mixtures of cover crops affect nitrogen availability or tie-up. The top of the figure has a two-way arrow with carbon-to-nitrogen ratios of cover crop residues starting at 5:1 and going to 40:1. Carbon-to-nitrogen (C:N) ratios are important in determining nitrogen availability or tie-up by affecting mineralization. Mineralization is the process where organic nitrogen, which is largely not available to plants, is converted by soil microorganisms into nitrogen forms that are plant available. When carbon-to-nitrogen ratios of plant material are below 20:1 these microorganisms release excess nitrogen into soil which plants can then use. When ratios are above 20:1 microorganisms tie-up nitrogen in the soil which can result in plants being nitrogen deficient. Looking at the figure, clovers, peas, and radish have low carbon-to-nitrogen ratios while oats and sorghum sudangrass have high ratios. Ratios of canola, cereal rye, triticale and, annual ryegrass are highly variable. This has to do with when the cover crop is terminated. If it is terminated when it is still young, before it has produced flowers and seed, carbon-to-nitrogen ratios are lower than if terminating when the cover crop is mature. Cover crop mixtures from growers farms and those tested at the Penn State University research farm also had variable carbon-to-nitrogen

Elsa Sánchez is an Associate Professor of Horticulture in the Department of Plant Science at Penn State University. Her responsibilities are 60% extension and 40% undergraduate teaching. Current extension projects focus on sustainable and organic production of vegetable crops. She earned a BS in Horticulture and a MS in Agricultural Biology at New Mexico State University and a PhD in Horticulture at Washington State University. Elsa and her husband, Chris, live in State College, PA with their daughters Laurel and Lilly.

ratios. When the mixture had more rye in it the carbon-to-nitrogen ratio was on the higher end of the scale.

When using rye as a cover crop, growing it for maximum above-ground growth is a good strategy when your goal is to harvest it or leave it on the soil surface as a mulch. When rye is tilled into the soil it can inhibit the growth of vegetables by tying-up nitrogen and allelopathy (producing a substance that is harmful to vegetable plants). To add nitrogen to the soil, till in rye while it is still lush and green. Also consider planting it with hairy vetch to add more nitrogen to the mix. More information on managing cover crop mixtures, including calculating seeding rates, is available in this Penn State Extension Fact Sheet: http://extension.psu.edu/publications/ee0166/view.

Another reason to grow cover crops is to scavenge or recycle nutrients from soil. In this case cover crop species with large, deep root systems that develop quickly are planted at times when cash crops are not. Cover crops uptake nutrients and use water that may have otherwise been lost through leaching out of the top of the soil profile or through runoff. When cover crops are incorporated back to the soil, nutrients can be made available for the next cash crop. A study in Maryland found that fall-planted cover crop species differ in their effectiveness at scavenging nutrients. The most effective was cereal rye and the least was legumes.

Increasing soil organic matter content is often a priority. For field-grown vegetable crops in Pennsylvania 2% - 5% organic matter is a common goal, with 5% being preferred. Cover crop species that produce large above-ground plant canopies like non-legume species or mixes of grasses and legumes are commonly used for increasing organic matter content. When adding organic material, soil organic matter content increases slowly over time because much of it is converted to carbon dioxide. Here is an explanation from University of Minnesota Extension: An acre of soil 6 inches deep weighs about 1000 tons, so increasing the proportion of organic matter from 2% to 3% is actually a 10 ton change. However, you cannot simply add 10 tons of manure or residue and expect to measure a 1% increase in soil organic matter. Only 10% to 20% of the original material becomes part of the soil organic matter. Much of the rest is converted over several years into carbon dioxide (http://www.extension.umn.edu/agriculture/tillage/soil-management/soil-management-series/organic-matter-management/).

Leaving a cover crop residue on the soil surface can help manage weeds. Using this method helps suppress early season weeds for about the first 35-75 days after terminating the cover crop. Having a plan for mid- and late-season weeds will also be needed. Research at Penn State University looked at how living cover crops can smother out weeds (http://extension.psu.edu/publications/ee0166). This works primarily by shading soil which reduces the ability of weed seeds to germinate and grow. In this case chose cover crop species that establish and shade the soil quickly such as, rye, oats, radish, canola and mixtures of species.

Regardless of the purpose of growing a cover crop, tips for success are to maintain a moderate carbon-to-nitrogen ratio and maximize biomass of the cover crop. As show in the figure, it is important to avoid incorporating excessive carbon into the soil because this results in nitrogen being tied-up by soil microorganisms.

Biomass can be maximized by selecting fast-growing species and growing cover crops for as long a period as possible through careful selection of planting and terminating dates. Warm season grasses, tillage radish, oats, canola, winter cereals, and hairy vetch are examples of cover crops that produce large biomasses.

Research at Cornell University examined planting and termination dates of different cover crops. Researchers found for a spring oats and field peas mixture, plant as early as possible. In the study planting in mid-April resulted in higher biomass production than in late April when terminating in early July. This mixture also provided good weed suppression. With hairy vetch, planting date was not as important as long as planting occurred before September 19th. Termination date was more critical for hairy vetch, with more biomass produced with later (early June) termination dates than earlier ones (late April or May).

Another way to maximize cover crop biomass and benefits is to plant polycultures. Recent research at Penn State University has looked at different cover crop cocktails or mixtures to obtain several benefits. These guidelines for polycultures are from that research (http://agsci.psu.edu/organic/research-and-extension/cover-crop-cocktails).

1. For managing weeds choose 1-2 species that provide fast ground cover in the fall, then add species to achieve other goals.
2. To support beneficial insects for pollination or biological control of insect pests, manage mixtures to include flowers.
3. For adding nitrogen to the soil combine a well-adapted legume with a low seeding rate of a winter hardy grass or brassica.
4. Overall aim for balanced biomass from all species for a range of benefits.

Cornell University has developed an online tool for deciding which cover crop to use based on management goal for the cover crop, planting time, and the length of time the cover crop will be grown. It can be found at: http://cover-crops.cals.cornell.edu/decision-tool.php. Selecting which species to grow is an important first step when using cover crops on vegetable farms. Careful consideration can help to grow species to meet the goals for you farm.

MANAGING LATE BLIGHT ON ORGANIC FARMS

Abby Seaman
NYS IPM Program
Cornell University

Late blight is a serious plant disease that adds significant risk to organic production of potato and tomato when disease inoculum is present and weather is favorable. Steps organic growers can take to minimize losses from late blight are outlined below.

Pathogen biology

To our knowledge, in the U.S Phytophthora infestans, the pathogen causing late blight, only overwinters in living tissue such as potato tubers or infected tomato plants that survive the winter. Therefore, the primary way late blight is introduced or persists in an area is in infected seed potatoes, or infected cull or unharvested potatoes that survive the winter. One of the most important preventive practices for minimizing late blight is to purchase phytosanitary certified seed potatoes and eliminate as much as possible any potentially infected potatoes surviving the winter on your farm. Be aware that certified seed can have up to 1% tuber defects, which could include late blight, so it is not a guaranteed to be free of late blight. To minimize the chances of overwintering or introducing late blight in infected tubers:

- **Leave any unharvested or culled potatoes on the soil surface to freeze**
- **Deeply bury infected culls**
- **Destroy potato volunteers in the field that was planted to potatoes last year**
- **Ask for the field inspection and Florida grow-out reports for your certified seed potato lots**

Unfortunately you can do everything right on your farm, and late blight spores could arrive from nearby farms or gardens to start disease in your crops. Stem lesions form on potato plants growing from infected tubers and progress above ground, producing sporangia under wet or humid conditions. Those sporangia are released and float into the air, infecting nearby plants, resulting in the production of more sporangia. Under cloudy, humid conditions sporangia can travel miles on air currents.

Disease resistance

Very little resistance to late blight is available in potato varieties grown in the U.S. The varieties Elba, Kennebec, Sebago, and Serran are considered moderately resistant. This level of resistance will slow but not prevent disease development. More resistance is available in tomato (Table 1). Including at least some resistant varieties in those you grow can help manage risk from late blight.

Table 1: resistant and moderately resistant tomato varieties

Cultivar Name	Susceptibility
Defiant PHR F1	resistant
Jasper	resistant
Lemon drop	resistant
Matts Wild Cherry	resistant
Mountain magic F1	resistant
Aunt Ruby's German Green	moderately resistant
Black Krim	moderately resistant
Black Plum	moderately resistant

JTO 545	moderately resistant
Mountain Merit	moderately resistant
Mr. Stripey	moderately resistant
Prudens Purple	moderately resistant
Red Currant	moderately resistant
Yellow Currant	moderately resistant
Yellow Pear	moderately resistant

Cultural practices

Any cultural practice that minimizes leaf wetness will help prevent or slow late blight epidemics. These include following recommended plant spacing, staking and pruning tomatoes, choosing fields with good air circulation, and growing tomatoes in high tunnels.

Tracking and Monitoring

Late blight reports can be tracked at the usablight.org web site. You can also sign up for text or email alerts of late blight reports in a defined area around your farm. Scout tomatoes and potatoes weekly (more often in persistently wet or humid conditions) for early signs of late blight. Good photos of late blight can be found on Dr. Meg McGrath's web site: http://livegpath.cals.cornell.edu/gallery/potatoes/late-blight/ and http://livegpath.cals.cornell.edu/gallery/tomato/tomato-late-blight/. The video Identifying and scouting for late blight on farms (https://www.youtube.com/watch?v=uCzIFVfyNow&feature=youtu.be) includes photos and tips on scouting for late blight. The video Distinguishing Late blight from other tomato and potato diseases (https://www.youtube.com/watch?v=aA4PuEKaQpY&feature=youtu.be) provides information on distinguishing between late blight and other diseases of tomato and potato. Report suspected late blight finds to local Cooperative Extension personnel or submit samples to your state plant disease diagnostic lab for confirmation so they can be reported to the usablight site. The usablight.org web site is only useful if reports are submitted so nearby growers can take action.

Fungicide timing

Research has shown that fixed copper fungicides are the most effective of those allowed for organic for managing late blight. Because they act as protectants, they need to be applied before spores land on plants to prevent infection. Your chances of successfully managing late blight will be much higher if fungicide applications begin before symptoms are present on your farm. Late blight forecasts that help time fungicide applications on potato and tomato are available through the Late Blight Decision Support System (http://blight.eas.cornell.edu/blight/) or on the Network for Weather and Environmental Applications (NEWA) (http://newa.cornell.edu/index.php?page=potato-diseases and http://newa.cornell.edu/index.php?page=tomato-diseases-tomcast). Monitoring late blight reports through usablight.org and using disease forecasting tools where available will help minimize risk of losses from late blight.

OVERCOMING TUNNEL VISION: USING COVER CROPS IN HIGH TUNNELS

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High Tunnels and Cover Crops:
High tunnels (sometimes called hoop houses or poly tunnels) are semi-permanent, plastic-film covered, protected field environments with a unique microclimate: hot, dry summer conditions and warmer spring and fall conditions. In high tunnels, most producers plant crops directly into the ground and irrigate through a dripline. The hot, dry summer conditions allow growers to produce high value warm season crops earlier and later in the season. Where we work in Minnesota, high tunnels can be the only way a grower can get enough heat for vine ripe tomatoes and colored bell peppers. The warmer spring and fall conditions allow many growers extra weeks to months of cool season crop production, including specialty salad mixes. Growers can get a price premium for this "off-season" produce, especially when marketed as local. High tunnels also increase marketable crop quality by reducing the incidence of soil-borne disease, since they block out rain and prevent soil splashing up onto fruit and leaves.

Access to local produce markets in combination with recent cost-share incentives (NRCS EQIP) have stimulated a rapid expansion in high tunnel construction. Many growers experience a 3-5 year "honeymoon" phase with their high tunnels, where both yields and quality are high, but soon after they notice a decline in production. Anecdotal evidence suggests that some of this decline may be due to soil problems such as salt build up and loss of organic matter, but more replicated research is still needed.

To address these issues, our project uses legume cover crops as a tool to decrease nitrogen fertilizer demands and maintain or improve soil health in high tunnels. Legumes have a unique ability to fix atmospheric nitrogen into a form that plants can use through an association with rhizobia bacteria that live in their roots. Growing legume cover crops and incorporating them into the soil is a way to fertilize with nitrogen without using synthetic fertilizer or manure, both of which can increase soil salinity. The nitrogen from legume cover crops is not immediately available to other plants and requires breakdown by microbes in the soil. Adding cover crop biomass to the soil gives these microbes food and promotes microbial communities in the soil, a key component of soil health. Growing legume cover crops also insures that there are living roots on the soil for more of the year, which is another important factor for soil health.

This research is useful for all growers concerned with soil health and reducing fertilizer inputs, and it is especially useful for organic growers who are directed by the National Organic Program to use cover crops in their crop rotations.

Our Experiment:
This research project planted three different cover crop treatments and compared them to a bare control in three existing high tunnels across Minnesota. The tunnels are located in Grand Rapids, MN (zone 3b), Morris, MN (zone 4a), and Rosemount, MN (zone 4b). Each cover crop treatment was comprised of one legume species and zero to two non-legume species. Treatments included 1) Red clover monoculture, 2) Austrian winter pea/winter rye 1:1

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mix, and 3) Hairy vetch/winter rye/tillage radish 4:15:1 mix. The bare control was weeded as needed.

Cover crops were seeded in two planting dates, once in late August 2015 in between rows of bell peppers and once in mid-September 2015 after bell peppers were removed. Cover crops grew slowly in the fall, remained dormant over the winter under row cover, and began growing again in early spring. Cover crops were sampled, mowed, and tilled in early May 2016. Bell pepper transplants were planted a week later. Bell peppers received no additional fertilizer, and were harvested from early August to mid-September 2016. Soil was sampled just before cover crops were tilled in, 2 weeks after tillage, 5 weeks after tillage, and at final pepper harvest. Data collected includes cover crop biomass dry weight, cover crop percent carbon and nitrogen, potentially mineralizable nitrogen in soil, microbial biomass in soil, active carbon in soil, and pH and EC of soil.

Results:

Cover crop growth:

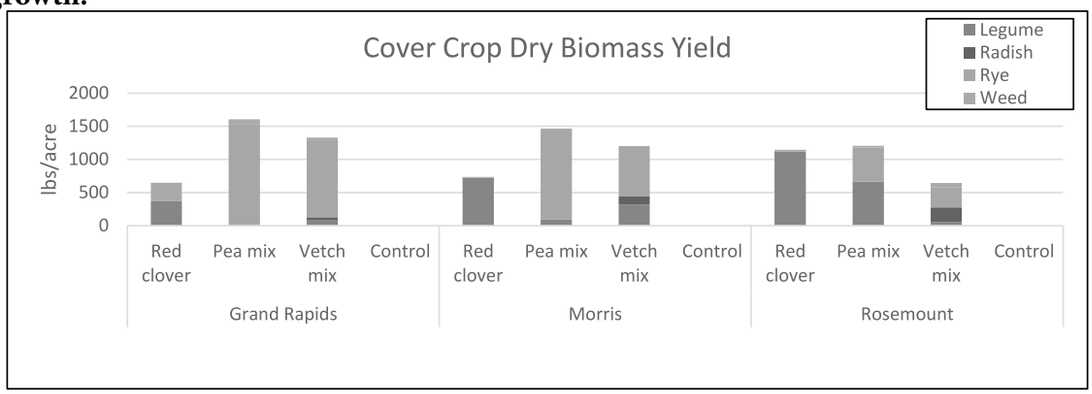

Figure 1. Legume Biomass Yield: Bars represent dry biomass (lbs/acre) by cover crop type, each bar is an average of 3 replicates.

Figure 1 shows the amount and type of cover crop for each treatment at each site. Legume biomass and radish biomass increased at warmer sites. Cover crop mixes with rye had less weed biomass than mixes without rye. Pea mix had that most biomass at each site. We expected that as legume biomass increased, higher rates of nitrogen would be available for the cash crop.

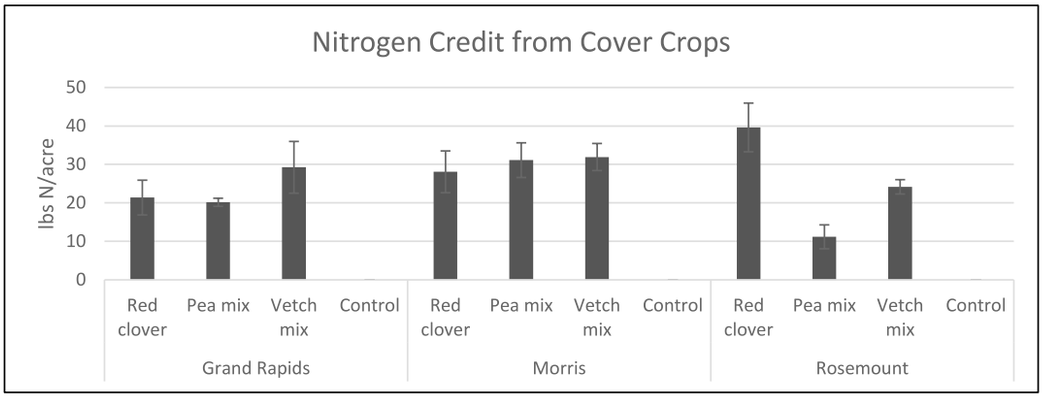

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Figure 2: Nitrogen credit from Cover Crops: Bars represent total nitrogen credit (lbs/acre) from all cover crops and weeds in a treatment. Error bars represent 1 standard error, and bars are an average of 3 replicates.

As expected, all cover crop treatments contributed nitrogen to the pepper cash crop, with no nitrogen contribution from the bare control.

Cash crop yield:

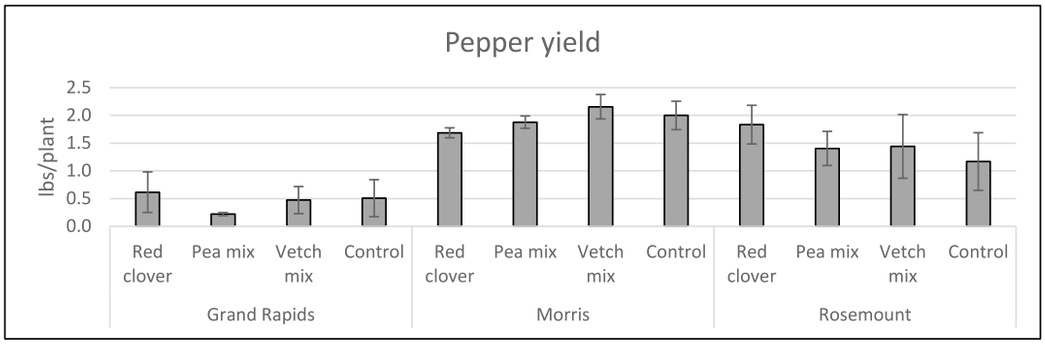

Figure 3: Pepper Yield: Bars represent total pepper yield (lbs) per plant throughout the season. Error bars represent 1 standard error, and bars are an average of 3 replicates.

The data do not suggest that pepper yield is affected by cover crop treatment, although differences clearly exist across sites. The average yield per site at Grand Rapids, Morris, and Rosemount were 0.5, 1.9, and 1.5 lbs per plant, respectively.

Soil health measures:

Potentially mineralizable nitrogen (PMN) is a measure of how quickly soil nitrogen is being converted from a plant-unavailable form to a plant-available form via decomposition. Soil microbes carry out the decomposition process, so we also measured soil microbial biomass (MB). A third soil health measure, active soil carbon (ASC), measures soil carbon that microbes can use for food. While plants do not directly use this carbon, microbes use it in the process of making nitrogen plant-available. These three soil health measures (PMN, MB, and ASC) help us understand a soil's capacity to convert plant matter from cover crops into plant available nitrogen for cash crops.

Our data suggests that, in most cases, plots with cover crops have a higher rate of PMN than plots without cover crops, yet no similar trend in MB. Overall, ASC had an increasing trend from pre-termination to two weeks post-termination. Data suggest that site was a stronger driver of changes in soil health parameters than cover cropping.

Conclusions:

Using cover crops in high tunnels is possible. Our short term results show that cover crops maintain soil health parameters without reducing cash crop yield. Soil health parameters are known to change over longer periods of time than a single season, so it is possible that with repeated years of cover cropping soil health will improve in high tunnels. Regardless of the long term soil health impacts, our research shows that in one season a grower can rely on a good stand of cover crops to meet nitrogen needs of a pepper cash crop.

CONSERVING SOIL QUALITY THROUGH ZONE TILLAGE IN ORGANIC VEGETABLE PRODUCTION SYSTEMS

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Challenge of reducing tillage in organic systems

Conservation tillage has been shown to increase soil carbon stocks, yet in most agricultural systems is reliant on high rates of synthetic herbicides for weed control, posing a challenge for organic production that prohibit such inputs. Cover cropping and ground cover maintenance are foundational principles of organic systems that build both passive and active organic matter pools, increase aggregation, and enhance soil adsorption and water holding capacities. These qualities enable diverse soil microbial communities to function in dynamic roles of decomposers, nutrient cyclers, and mediators of ecosystem services. Yet organic farming systems have been characterized as highly dependent on tillage and cultivation approaches to help manage weeds and incorporate cover crop residue and manure into soils. Such practices reduce overall soil quality by breaking up aggregates that can serve to protect organic matter, and by increasing microbial decomposition rates. Moreover, soil warming can be slowed when remaining cover crop material forms a thick surface mulch. This poses a significant obstacle for organic growers in colder regions of the U.S., where tillage is the primary tool used to expose and warm seedbeds. Clearly, new strategies are needed to successfully reduce tillage in organic production.

Zone tillage can be defined as a reduced tillage strategy where rows are tilled and between-row areas are maintained with ground cover. While successful in conventionally managed systems, zone tillage in organic systems has not been thoroughly explored for its effect on soil quality, nutrient cycling and weed control. Zone tillage is an attractive middle ground between intensive tillage and no tillage, and involves tilling only the row areas where crops will be planted, maintaining the benefits of ground cover in between-row areas. Moreover, when legume cover crops are used, residue incorporation in rows provides readily mineralizable N for subsequent cash crops. Most zone tillage research to date has been conducted in conventional systems where the cover crop or living mulch is suppressed with glyphosate and yield or nitrate losses are assessed. Zone tillage has clear potential to overcome several obstacles faced by organic growers, such as delayed soil warming, yet few studies have examined it in organic production. Here we present data from two projects in-progress at the University of Minnesota that explore the use of zone tillage in organic vegetable production systems.

Perennial cover crops. The first study evaluates the use of zone tillage in perennial legume stands for contributions to soil quality and nitrogen. Zone tillage can be used in perennial systems, where within-row areas are tilled and living perennial between-row vegetation is maintained. Like other cover cropping strategies, living perennial mulches protect soil from erosion by covering the soil surface, outcompeting and suppressing weeds, reducing subsurface nutrient losses through assimilation, and finally, with a leguminous mulch, supplying mineralizable N where incorporated within rows. Perennial legume mulches present a cover cropping approach that can maintain long-term ground cover as well as build soil quality through continuous rhizodeposition. Living mulches have been an underutilized resource in organic cropping systems. Zemenchik et al. (2000) reported that kura clover, a perennial legume, is a suitable living mulch for cold climates. Qi et al. (2011a) found kura clover had more aboveground biomass and

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N uptake than a rye cover crop or perennial forage system, suggesting potential to reduce N losses and provide mineralizable N within rows. The first project we report here investigated the impact of intensive zone tillage on soil quality parameters in a 10-year old kura clover stand in Rosemount, MN in 2015 and 2016 by comparing two spatially distinct regions: within the tilled cash crop row, and between rows where clover has been left undisturbed in an organic system.

Methods. A PTO-driven rotary zone tiller was used to create zones using a ten year stand of kura clover in May of 2015 and again in 2016. Corn was the cash crop in both years, and soils were collected at three time points within each rotation: 1) pre spring tillage (pre), 2) 10d after tillage (post), and 3) at corn harvest (harvest). A composite of 10 soil cores were collected from 0-6" both between (BT) and within (IN) crop rows. Soil quality measures included two indicators of active soil carbon (permanganate oxidizable carbon, POX; and Particulate Organic Matter, POM-C and POM-N), potentially mineralizable nitrogen (PMN), and microbial biomass (MB). While POX-C is a chemically-based measure of C availability, POM is a physically fractionated component of SOM that represents a labile food source for microbes.

Photo 1: Zone tillage within perennial 10-year stands of kura clover in Minnesota.

Results. In both years, between row regions where kura clover was allowed to persist resulted in increases in soil health indicators. These results suggest that living roots were a strong driver of soil carbon increases, possibly via rhizodeposition from the 10-year old clover root systems. Following creation of zones via spring tillage, POX and POM both showed a decreasing trend. Data analysis continues for year two of this study.

Annual cover crops. The second study evaluates the potential of wider zone tillage in warm season vegetable production proceeded by winter annual legume mixes. Since legume cover crops are at their highest nitrogen concentration at maturity, organic growers using late spring-maturing cover crops often receive reduced nitrogen credits as early termination is often needed to accommodate vegetable planting dates. Cover crops are first terminated via mowing or roller-crimping in the spring, and planting zones created in the decomposing mulch via tillage. Cash crops are planted in the terminated zones, while between-row cover cropped regions are left to mature. The second study we will present here seeks to increase soil nitrogen and labile soil organic matter pools by modifying zone tillage in a plasticulture based organic squash system.

Methods. Plots in 2015 and 2016 were located in a certified organic field in Minnesota. Main plots included cover crop species mixes, with sub-plots as tillage type (conventional v zone till). Each subplot consisted of three 6.8m length rows on 2.5m spacing between rows. In conventional till plots, the entire width was terminated before bed preparation, resulting in bare ground for almost 1m between crop rows. In zone till plots, only center 1.5m were terminated at spring planting with between-row area left to continue growth until legumes reached flowering, at which point they were assumed to have maximum N concentration and terminated (Photo 2) after taking plant biomass samples. Rye/vetch and red clover were fall seeded in fall 2014 (year one), but cold winter temperatures and lack of snow cover resulted in exceedingly low winter legume survival and plots were replanted with oat/pea and rye/vetch in April, 2015. In year two, cover crop mixtures including rye/vetch and red clover planted in the fall and persisted until spring, when they were terminated as in year one. No fertilizer, compost, or manure was applied in this system; cover crops were the sole source of nutrient input. Soils were collected at four times over the growing season: mid-June ("pre-till"), late June ("post-till"), late July ("mid-season"), and October ("harvest"). Soil quality measures included permanganate oxidizable carbon (POX-C, a measure of active soil organic matter), potentially mineralizable nitrogen (PMN), and microbial biomass (MB).

Photo 2: Zone tillage treatment with winter annual cover crops of vetch and rye in Minnesota

Results: Annual cover crops in both years contributed nitrogen to vegetables within rows where cover crops were terminated early, and then again later in the season when between-row zones were terminated. Although plasticulture was used within vegetable rows, weed control was still a challenge between plastic edges and the living cover crops (photo) and needed to be hand weeded to avoid plastic disturbance. Soil quality measures were identical to those in the perennial trial. Preliminary results suggest that living roots were a strong driver of active organic matter, with regions where living cover crop roots remained often having higher concentrations of active organic matter than in-row regions where cover crops were terminated early. Our results show that annual legumes have potential to be a valuable contributor to both soil N and quality, but weed control continues to be a challenge even when plasticulture is combined with zone tillage approaches.

SNAP BEANS WEED CONTROL UPDATE

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Management of weeds is a major concern to snap bean producers and a critical component to provide optimal crop yield. The major weeds of concern in snap bean production in Pennsylvania include foxtail, barnyardgrass, fall panicum, crabgrass, lambsquarters, pigweed, common ragweed, smartweed, nightshade, velvetleaf, horsenettle, and yellow nutsedge. In conjunction with non-chemical strategies such as crop rotation and cultivation, herbicides are routinely applied to snap beans to reduce weed competition. About 85% of the snap bean acres in Pennsylvania are treated with herbicides (Crop Profile for Snap Beans in PA, 2004). Over 71% of the treated acres received a preemergence application of a metolachlor-based product (e.g., Dual Magnum), primarily to control annual grass problems. Other pre or soil-applied herbicides that are labeled for use in snap bean include clomazone (Command), EPTC (Eptam), halosulfuron (Sandea), and trifluralin (Treflan). Most weed control in snap bean occurs prior to or soon after planting, however, postemergence herbicides may be necessary to control escaped weeds. Postemergence herbicide options include bentazon (Basagran), halosulfuron (Sandea), fomesafen (Reflex), imazamox (Raptor), clethodim (Select Max), quizalofop (Assure II/Targa), and sethoxydim (Poast). Glyphosate (Roundup) and paraquat (Gramoxone) are commonly used in burndown applications to aid in field preparations. Scythe (pelargonic acid), Matran (clove oil), and vinegar are postemergence, non-selective, contact herbicides that are not widely used but may be used by organic growers to control actively growing weeds prior to crop emergence.

Currently, there are really not many new herbicides to discuss and the number of active ingredients (and modes of action) of snap bean herbicides is limited. There could be a major negative impact for successful snap bean weed management programs, if certain herbicides lose their snap bean registrations. Some negative impacts include, less or non effective herbicides to control existing weed populations, increased chance for weed populations to develop herbicide resistance or weed shifts, and overall increased costs to manage weeds with numerous weed control tactics per season. Since herbicides play an important role in snap bean production, it is important that currently registered herbicides are used judiciously and new herbicides (i.e., ones with different active ingredients and modes of action than those currently labeled) are identified that fit into a snap bean production system and provide effective weed control, minimal crop injury, and environmental safety.

Using herbicides correctly and in the most effective combinations is critical for effective weed control and to maximize crop yields. Below are some ways to optimize weed control in snap beans:

Use herbicides that are effective on target weeds. This is a basic concept, but one that is often overlooked. Out of routine, the same herbicide programs are often used with varying results. It is essential to consider impending weed problems and know the history of the field in order to plan according, especially on rented ground. It is helpful to understand strengths and weaknesses of different herbicides. Just because a herbicide may, in general, be "good" on annual broadleaves, does not mean it will control all annual broadleaves, there will be some weaknesses. The same is true for herbicides that claim activity on grassy weeds. Also, use the right rate at the right time or in specific tank-mixes for best results. Furthermore, some herbicides can be applied both preemergence and postemergence, however weed control activity may be different depending on when it is applied. Sandea and Reflex provide different levels of control when they are applied either pre or post. For example, soil-applied

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Sandea provides control of lambsquarters, pigweed, smartweed, but is weak on yellow nutsedge. When Sandea is applied post controls it provides good control of nutsedge, pigweed, ragweed, velvetleaf, cocklebur but is weak on lambsquarters. Reflex provides good control of lambsquarters pre but in general, is better when applied post on weeds such as pigweed, and ragweed. Also the tank-mix of Reflex + Basagran complement each other well and provides good to excellent control of several broadleaves such as pigweed, ragweed, smartweed, velvetleaf, cocklebur, galinsoga; fair-good control of lambsquarters, morningglory, yellow nutsedge; and fair control of horsenettle, Canada thistle, pokeweed, and bindweed. This combination also provides an alternative to ALS-herbicides (Group 2; Sandea, Pursuit, Raptor) since more weeds are becoming ALS-resistant weeds and thus provides a good resistance management option. In addition, it has little to no impact on crop rotations. Below is a table that shows the efficacy of selected herbicides on some common weeds.

Weeds	**Dual Mag. (pre)**	**Prowl (pre)**	**Reflex (pre)**	**Reflex (post)**	**Basagran (post)**	**Sandea (pre)**	**Sandea (post)**	**Raptor (post)**
Giant foxtail	**9**	8	N	N	N	N	N	**8+**
Crabgrass	**9**	**9**	N	N	N	N	N	7
Yellow nutsedge	8	6	6	7	8	7	**9**	6
Lambsquarters	6	**9**	**9**	7	8	**9**	N	**8+**
TR Lambsquarters	6	**9**	**9**	7	8	**9**	N	**8+**
Nightshade	7+	N	8	7+	N	6	6	8
Pigweed	8	8	8	**9**	6+	**9**	**9**	**9**
Common ragweed	6	N	8?	**9**	8	**8+**	**9**	7+
Smartweed	N	8	8?	8	**9**	**9**	8	8
Velvetleaf	N	8	7	7+	**8+**	**8+**	**9**	**9**
Cocklebur	N	N	6	8	**9**	8	**9**	**9**
Morningglory	N	N	6	8	N	N	6	7
Galinsoga	8	6	**9**	**9**	8	8	8	**8+**
Purslane	7	8	**9**	**9**	8	6	6	7+

Weed control rating scale: 9 = 85-95%; 8 = 75-85%; 7 = 65-75%; 6 = 55-65%; N = no activity

- Include residual herbicides. Having residual herbicides in the program broadens the spectrum of weed control; improves weed control consistency throughout growing season; and allows timely post applications by widening the application window. Plus it can add extra herbicide modes of action for resistance management.

- Don't spray weeds when too big. For various reasons weeds are often sprayed when they are too large resulting in reduced herbicide effectiveness and causing poor weed control. Most herbicide labels list maximum weed sizes or growth stages. The sizes can vary depending on the weed species and/or amount of product used.

- Add necessary adjuvants to the spray solution. Soil applied herbicides do not require the addition of additives that improve herbicide efficacy, but post herbicides often do. Depending on the herbicide it is necessary to include the appropriate spray additives listed on the product label. These improve and optimize the activity of herbicides. If left out of the mixture, generally poor weed control will result. It is very important to use the correct type (e.g., surfactant, crop oil concentrate, nitrogen fertilizer) and rate, otherwise weed control will be compromised or significant crop injury could occur. Crop oil concentrates tend to cause more crop injury. Assure II/Targa, Basagran, Poast, Raptor, Sandea, and Reflex all require some type of adjuvant when applied postemergence.

- Use correct spray nozzles. Not only is using the correct herbicide at the right rate and time important but it is critical to apply the herbicide in the proper spray volume (gallons per acre) and use the appropriate nozzle. Most labels suggest a spray application volume (typically 10 to 20 gallons per acre) and some specify a certain type of spray nozzle. These factors are important especially when using contact herbicides such as Basagran and Reflex. Newer nozzle types (e.g., air induction or venture) designed to reduce spray drift produce larger and fewer droplets and typically will not provide effective spray coverage necessary for contact herbicides to work.

- Avoid using the same herbicide mode of action in rotational crops. As more weed species become resistant to herbicides, certain precautions such as tank-mixing, crop rotations, and a combination of weed management techniques, must be implemented to prevent resistance. Understanding herbicide modes of action is a key factor in this process. The Weed Science Society of America (WSSA) developed a grouping system to help with this process. Herbicides that are classified as the same group number kill weeds using the same mode of action. *Thus, it is best to select or combine herbicides that provide at least two different, yet effective, modes of action against the same weed.* Group numbers can be found on many herbicide product labels and can be used as a tool to choose herbicides in different mode of action groups so mixtures or rotations of active ingredients can be planned to better manage weeds and reduce the potential for resistant weed species.

- Control perennials in previous crops. Since most of the herbicides used in snap beans are not that effective on perennial weeds, it is best to consider crop rotations that will allow for more effective perennial control in other crops such as corn or soybeans. Roundup Ready crops can help with this problem, but if possible include a small grain prior to the snap bean crop. Once the small grain is harvested, allow perennials to regrow and apply systemic herbicides (e.g., glyphosate, 2,4-D, dicamba) in late summer/early fall before a killing frost occurs. During the time period, perennials are preparing for winter survival and subsequent regrowth the next spring by transporting carbohydrates into their large root systems. Herbicides applied during this period will be readily taken with the carbohydrates into the roots for a more effective kill. As mentioned, perennial weed control in crop is difficult. However, some research for example has been conducted on horsenettle and applications of Raptor or Sandea may be useful for reducing berry production. This is a "rescue type" treatment and for better management of horsenettle it needs to be a planned program with fall applications of glyphosate and effective in-crop applications. Also, scout fields and avoid planting snap beans in fields infested with horsenettle or other perennials.

Since there are really no new and unique herbicides to consider in snap beans and you still want to have better weed control, follow the above principles. However having said this, there are times when despite following all the rules and devising a good herbicide program, certain weeds will not be controlled. During these situations, it may be best to control problem weeds in other crops that allow more effective herbicides or other weed management options.

IMPROVING THE MANAGEMENT OF WHITE MOLD IN SNAP BEAN

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White mold, caused by the fungus, *Sclerotinia sclerotiorum* results in major losses to many vegetable and field crops annually, including snap bean. Infection of snap bean flowers leads to a lower number of marketable pods because of premature pod abscission, whereas fungal growth on the pods that remain attached to the plant requires additional sorting during post-harvest processing. Secondary infections of the leaves and stems cause the canopy to collapse, thus making mechanical harvest problematic which results in further economic losses. When disease severity is high the crop may even be considered unviable to harvest. Furthermore, sclerotia (resting bodies of the fungus) which form on the diseased plant tissues are returned to the soil and serve as primary inoculum for epidemics in future crops. Currently, white mold is managed by prophylactic application of fungicides in Pennsylvania, New York, and surrounding states. This is because of the high crop losses incurred from the disease and absence of available fungicides with substantial eradicant activity. Until the early 2000s, the fungicides Ronilan® and Benlate® were the most commonly used for the management of white mold and other pod diseases in snap bean. Ronilan® was highly efficacious and was still effective when applied after disease symptoms were observed. Registration of these products was revoked because of human health and environmental concerns and they were replaced by fungicides with predominantly protectant activity, such as Topsin®. However, despite the intensive use of fungicides, suboptimal control of white mold persists and annual epidemics result in substantial crop loss.

Why is white mold so problematic to manage?

Survival in the soil. *Sclerotinia sclerotiorum* survives in the soil predominantly as sclerotia, which are the black resting bodies of the fungus. A small proportion of the sclerotia remain viable for up to five years. Sclerotia germinate and produce apothecia upon which ascospores are produced. These ascospores are transported by wind to the susceptible flowers. **Even a small number of sclerotia may result in substantial crop loss because of the large numbers of ascospores produced.**

Broad host range and susceptible varieties. Many of the crops encountered in a typical vegetable rotation, including bean (snap, dry, soybean, and lima), potato, carrot, squash, cabbage, and tomato are susceptible to white mold. Every year there are several confirmed reports of white mold on tomato across Pennsylvania and significant losses have been observed in select pumpkin fields under favorable conditions. Broadleaf weeds, such as velvet leaf are also susceptible to white mold. No resistant varieties are available for vegetables.

Factors associated with high crop yield exacerbate white mold. In general, agronomic management of crops for high yields (e.g. dense plant populations, irrigation, and nitrogen application), promote canopy development and increase white mold severity.

Research Outcomes:

The objectives of our studies were to determine the optimal timing for two conventional fungicides (2015) and to compare the efficacy of conventional and OMRI-listed fungicides for the control of white mold in snap bean available to Pennsylvania and other growers in the region (2016).

Small plot, replicated trials were conducted at the New York State Agricultural Experiment Station in Geneva, NY in 2015 and 2016. The snap bean crops were established using a Monosem planter at the rate of 8.7 seeds/ft with 30 in. row spacing with var. Huntington. The entire trial areas were inoculated with *S. sclerotiorum* ascospores. The effect of treatments on

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white mold incidence was analyzed.

2015. This trial compared the optimal timing of the two fungicides, Topsin® (30 fl oz/A) and the newer product, Omega® (0.67 pt/A), according to flowering stage (10 or 100% flowering) and whether an additional application at pin-pod was beneficial (Table 1). Results suggested that if the application of Topsin® did not coincide with 10% flowering, disease control was reduced and an application at pin-pod was not beneficial. Disease control was maximized when Topsin® was applied at 10% flowering. Moreover, an additional application of Topsin® at pin-pod was also not beneficial. Alternatively, application of Omega® at 10% or 100% flowering resulted in similar disease incidence and an application at pin pod did not provide further disease control (Table 1).

Table 1. Effect of Topsin® and Omega® applied at either 10% or 100% flowering (± pin-pod) on the incidence of white mold on plants and pods in snap bean in a small plot, replicated trial at Geneva, New York in 2015.

Product × Timing	Incidence of white mold on plants (%)	Incidence of white mold on pods (%)
Topsin® (10%)	7.7 e	6.4 de
Topsin® (10% + pin-pod)	25 d	4.6 ef
Topsin® (100%)	41.2 c	13.9 c
Topsin® (100% + pin-pod)	59.9 b	10.5 cd
Topsin® (pin-pod)	68.4 b	20.5 b
Omega® (10%)	0.6 e	1.4 f
Omega® (10% + pin-pod)	2.7 e	3.8 ef
Omega® (100%)	7.3 e	3.5 ef
Omega® (100% + pin-pod)	5.5 e	8.3 de
Omega® (pin-pod)	5.6 e	3.7 ef
Nontreated	85.7 a	36.3 a
LSD	13	5.4
F =	7.13	3.51
P =	0.001	0.026

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GROWING LEAFY GREENS USING LEDS

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In be manipulated to elicit desired attributes of leafy greens including leaf shape, leaf color, nutrition, flavor, texture, and aroma.

Most LED fixtures used in the horticulture industry look purplish because they primarily emit red (600 to 700 nm) and blue (400 to 500 nm) light. It's no secret that red and blue light are effective in driving photosynthesis, and LEDs of these colors are efficient in converting electrical energy into light. Other LED arrays combine red, green, blue, and/or white LEDs to generate a broad spectrum that appears more white. Regardless of the spectrum, the intensity of photosynthetically active radiation (PAR, 400 to 700 nm) is crucial for plant growth. Plants not only convert PAR into chemical energy for photosynthesis, but also use light as a signal that elicits adaptive responses to the environment. Radiation outside the PAR range, such as ultraviolet (UV, 300 to 400 nm) and far red (700 to 800 nm), regulates numerous signaling pathways in plants. For instance, UV signals plants to commence protective mechanisms against stress.

Figure 1. An indoor facility producing leafy vegetables using LEDs emitting multiple colors of light.

Far red is best known for its role in the shade-avoidance response, which is mediated by phytochrome photoreceptors. A low ratio of red to far red is indicative of shade that triggers elongation growth, upward leaf orientation, and reduced branching. The potential of using far red to obtain desirable morphological traits merits consideration in horticultural lighting. Although the dynamics between red and far red is fairly well understood, how far red interacts with both red and blue is not clear. We investigated the value of adding far red to red and blue LEDs for indoor production of leafy greens and herbs.

Our first experiment shows that supplemental far red at a moderate intensity is a viable tool to manipulate extension growth. When added to red and blue at 180 μmol·m−2·s−1, far red at 30 μmol·m−2·s−1 can increase leaf size and thus fresh weight (Figure 2), but at the expense of leaf pigmentation or coloration. As leaf area increases because of more far red, the plant captures more radiation that can be used for whole-plant photosynthesis. Moreover, recent research at Michigan State University indicates that far red can—to some extent at least—promote instantaneous photosynthesis. A second experiment shows that increasing PAR and/or the intensity of far red increases shoot dry weight of lettuce. While plants are more compact under higher PAR, high far-red light induces leaf elongation under both low and high PAR (Figure 3). Taken together, far red is influential in the appearance and growth of leafy greens.

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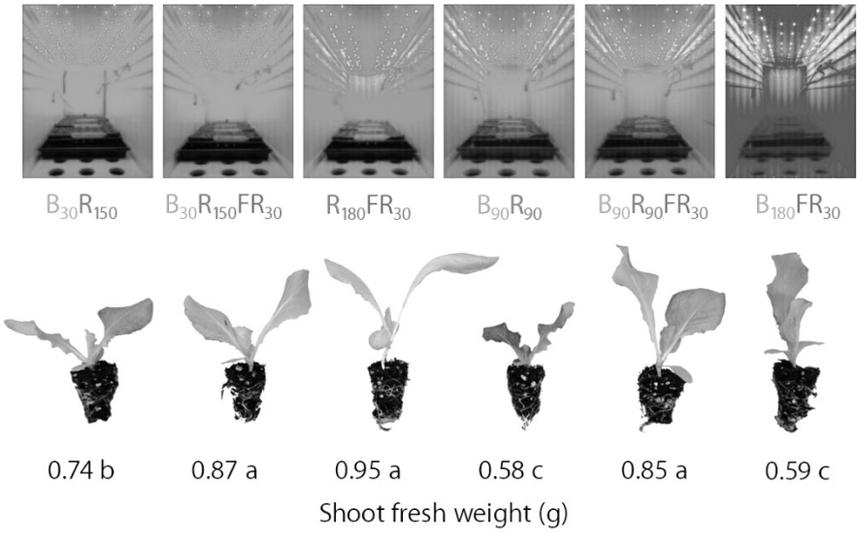

Figure 2. Adding far red (FR) to blue (B) and red (R) LEDs increases the biomass of 12-day-old red oakleaf lettuce 'Cherokee'. Numbers following each color of light indicate its intensity in µmol·m−2·s−1. Weights followed by different letters are statistically different.

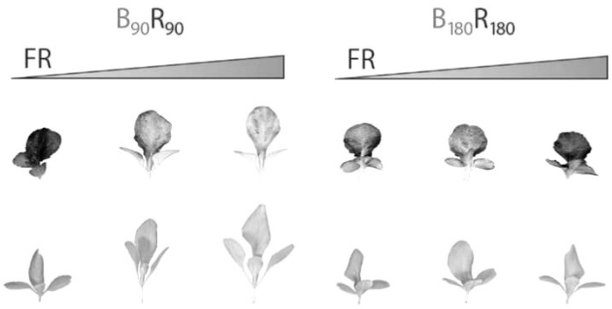

Figure 3. Red oakleaf lettuce 'Rouxai' (top) and green butterhead lettuce 'Rex' (bottom) are more compact under higher PAR from blue (B) and red (R) light, but more elongated as the intensity of far-red (FR) light increases from 0 to 75 µmol·m−2·s−1. Numbers following each color of light indicate its intensity in µmol·m−2·s−1.

Blue, red, and far red have antagonistic effects on biomass accumulation, extension growth, and pigmentation. For instance, blue inhibits leaf expansion but promotes pigmentation, whereas far red does the opposite. The spectral distribution for plants should have an appropriate balance in these three wavebands. Because different crops often have unique responses to light quality, it would be ideal to develop and use crop-specific light recipes. However, there's no such thing as a "perfect" spectrum, even for the same crop, because the desired crop traits often vary among growers and markets. To complicate the issue, light quality also interacts with other environmental factors such as light intensity and temperature.

The "best" spectrum is what produces the crop characteristics growers want for their customers in their particular growing environments. Some lighting companies have already included far red in some of their commercial LEDs for horticultural production. Growers can take advantage of far red to increase yield and extension growth, but should keep in mind that the effects of far red often depend on blue:red and species. In some cases, far red can cause unwanted responses such as reduced plant pigmentation and compactness. Regardless, far red opens the door to more sophisticated control of plant growth. It's the new kind of red that can be valuable to indoor farming.

GROWING AND MARKETING ASPARAGUS

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Introduction

Asparagus is a perennial vegetable that is gaining popularity with more customers at farmers markets who ask for the tasty and nutritious vegetable that is very easy to grow, with yields averaging 3,000 lbs. per acre and retailing for $3.00/lb. or more. For over 20 years, new asparagus varieties that have been released are male hybrids. Asparagus is normally dioecious, meaning that it has male and female reproductive structures (flowers) on separate plants. Female plants expend energy to produce seed while in the fern growth stage. Because of this, female plants produce one-half the number of spears than male plants, which produce no seed. Seeds from female plants fall to the ground and germinate, causing a seedling asparagus weed problem.

For this reason, asparagus breeders in the U.S. and other countries have gone with male hybrids obtained from super male parent plants. When these super males are crossed with a female, the majority of the F1 generation is male, with few seeds produced. These super male hybrids yield about three times the amount of the older dioecious open-pollinated varieties, such as Mary Washington.

Soil Preparation

It is important to eliminate all perennial weed problems at least one year before planting. This can be done effectively by treating the actively growing weeds with a non-selective herbicide. Another way to reduce weed populations and help build soil organic matter is to prepare the field at least one year in advance. This can be done by planting a cover crop such as clover, or an early-maturing soybean variety. The soybeans can then be harvested, or clover can be chopped and plowed down and seeded to winter wheat or rye at 3-4 bushels per acre in the fall before planting asparagus. The cover crop can be plowed under the next spring to increase soil organic matter content before planting asparagus.

Soil test to determine pH and fertilizer requirements. The ideal pH range for asparagus is between 6.7 and 7.0. Asparagus does not tolerate acid soils and will not grow well at a pH of less than 6.0. Also, a fungus disease that contributes to asparagus decline (Fusarium crown and root rot) survives better at a low pH. Liming the soil to bring the pH up to 7.0-7.5 reduces the survivability of Fusarium, especially if asparagus has been grown there previously. Phosphorus and potassium should be provided so that the soil contains 250 lbs of available phosphorus and 300 lbs of available potassium per acre. Phosphorus does not move readily in the soil and cannot be incorporated easily into the soil after the asparagus is planted. Essentially, one must incorporate phosphorus before planting. Also, apply 70 lbs of actual nitrogen per acre.

Asparagus grows and yields best in a deep, well-drained sandy loam soil, but will tolerate heavier soils as long as the soil has good internal drainage and the water table does not come within four feet of the surface. This would interfere with the extensive and deep root system.

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Broadcast the fertilizer and plow it under when preparing the land for the planting furrows. Then, each year after harvest, broadcast 70 lbs actual nitrogen and other nutrients (if needed) per acre so it will be utilized by the new fern growth to store for the following year's crop. Lime can also be added at this time if needed. Soil test every year for the first four years to determine if fertility and pH adjustments are necessary. Then soil test every two years.

An asparagus crown is the crown and fleshy root system of a one-year-old plant that is grown from seed. Buds enlarge to produce the spear. Buds are arranged in a dominant hierarchy system where the first bud is the largest, and each succeeding bud gives rise to a smaller diameter spear. This is why harvesting needs to stop after a specified period, otherwise, food reserves in the crown will be exhausted.

Planting

Soil temperature for planting crowns should be at least 50 degrees F so that the crowns can start to grow immediately. There is no advantage to planting crowns in cold soils. In fact, prolonged cool, wet soils might make crowns more susceptible to Fusarium crown rot. Crowns can be planted in mid-March in the Coastal Plain, early April in the Piedmont, and in mid-late April in the Mountains if the soil has warmed sufficiently. Growers all over the state can have the entire month of May to plant the crowns, if needed. Do not accept the crowns until the field is ready to plant. **If crowns are received before the field is ready to plant, they have to be stored in a refrigerator between 33-38 degrees. Otherwise, the buds on the crown will sprout, causing the fleshy roots to shrivel and die.**

Apply 200 lbs of 0-20-0 or 100 lbs of 0-46-0 fertilizer per acre applied in the bottom of the furrow before planting transplants or crowns. This is in addition to the phosphorus that was incorporated before breaking the furrows. The crowns are then placed into the furrow, right-side up or upside down, on top of the fertilizer. Crown orientation is not important. However, crowns with the buds oriented upward will emerge faster. The fertilizer will not burn the crowns. If phosphorus is not added at this time, it is difficult to get it down to the roots later because it does not move readily in the soil. Roots literally have to grow through the phosphorus to receive the benefit.

Research shows that pre-plant applications of phosphorus below the crown are an important factor in long-term asparagus production. Omitting the phosphorus placed in the bottom of the furrow will reduce yields in subsequent years as compared with not adding the additional phosphorus.

Asparagus crowns are received in bulk or in bundles of 25 crowns per bundle. After receiving, separate the different sized crowns into separate piles for small, medium, and large. It takes about an hour to separate 1,000 crowns. When ready to plant, plant all the smalls together in the same row, all the mediums together, and all the large crowns together. Do not plant a small crown next to a medium or large sized crown. This will cause the larger one to shade the smaller one, which will never attain its full growth potential.

It's not uncommon to get a 5-6-foot tall fern growth in one season with the male hybrid varieties with ample soil moisture. A five-foot between row spacing is needed because the fern growth is vigorous and will usually fill the between-row space after one growing season if one-year-old crowns are planted. It also allows for better air circulation to promote faster fern drying from rain and morning dews. This helps to delay the onset of foliar fungus diseases.

Use a middlebuster or lister plow to open the soil in opposite directions. On a heavy soil, plant no deeper than 5 inches, on a light textured soil, no more than 6 inches. Research shows the deeper the planting depth, the more large diameter spears are obtained, but total yield is less than planting at a shallower depth.

Crown spacing between crowns in the row can be anywhere from 9-18 inches. Research shows that there is really no advantage of planting 9 inches between crowns in the row. A larger yield is obtained earlier at a 9-inch spacing, but after 4 or 5 years, the yield will be the same as 18-inch spaced crowns in the row. Also, the closer the crowns are spaced in the row, the more crowns are needed, increasing the cost. A crown spacing of 18 inches between crowns in the row with 5 feet between rows would need 5,808 crowns per acre. A crown spacing of 12 inches between crowns in the row with 5 feet between rows would need 8,712 crowns per acre.

Asparagus crowns should not be planted in a solid block; rather, plant the field with drive rows spaced between a block of five rows. An air-blast sprayer is needed to blow insecticides and fungicides into the dense fern canopy from both sides of the five-row block to get good coverage. More rows can be planted in a block if the spray swath can penetrate through one half of the block on one side and can spray into the other half-block from the other side. Boom sprayers usually cannot be set high enough to prevent the knocking over of ferns, which will cause damage.

The furrows can be filled in completely to soil level after planting without damaging the crowns. However, do not drive on or compact the soil over the newly planted furrows or emergence of the spears will be severely delayed or reduced. With good soil moisture, the new spears will break through the soil in 1-2 weeks.

Variety Selection

Varieties that are among the highest yielding and available as one-year-old crowns include Jersey Giant, Jersey Supreme, and Guelph Millennium.

Another variety is Viola or Purple Passion that has purple spears. It is higher in sugar content than green asparagus. When it's cooked, the purple color is lost and it reverts back to green. It is strictly a novelty type. It is not a male hybrid, but is one that might fit into a niche market with a premium price. It is also a prolific seedling asparagus weed producer by the female plants, so watch out for that!

Yields of the California hybrid varieties, including UC 157, Atlas, Apollo, and Grande are similar to the NJ male hybrids and have the attributes of taller spear growth (8-10 inches) with tighter spear tips under warm temperatures. A disadvantage of these varieties is that they do not overwinter well in cold climates, which cause yield reductions over the life of the planting. They have been bred for the warmer, arid climates.

Weed Control

Weed control is very important in asparagus. If young plants compete with weeds, they will stress the plants and prevent them from making good fern growth during the planting year. There is no need to cultivate the soil to control weeds in asparagus. Use herbicides to control weeds. Research shows that even the shallowest of cultivations between asparagus rows cuts and injures roots, predisposing them to Fusarium root rot fungus that eventually will kill the asparagus.

Growers can use Linuron or Diuron pre-emergence herbicide to control broadleaf and grassy weeds immediately after the furrows are filled in after planting. This can be applied over the newly covered furrow and between the rows. In the spring, mow off the dead fern about one month before spears normally start emerging. Then tank mix Linuron or Diuron as a pre-emergence treatment along with Glyphosate as a post-emergence treatment.

After harvest is over, the entire field can be snapped, leaving only cut spears. Then apply another tank-mix of Linuron or Diuron along with Glyphosate. If grassy weeds emerge while the asparagus is in the fern growth state, Poast and Crop Oil can be sprayed to control emerged grassy weeds. For broadleaf weed control in the fern growth stage, apply the amine salt of 2,4-D as a basal spray, contacting only the asparagus fern stalk at the base of the plant, without directly contacting the fern.

Asparagus is very salt tolerant and salt can be used to control weeds, but salt will seal the soil surface, impeding water infiltration and percolation. Also, after a heavy rain, the salts can leach horizontally through the soil and can kill other vegetables adjacent to the asparagus which are not as salt tolerant as asparagus.

Harvesting

As previously stated, during the second year, about 4 weeks before the spears start to emerge, mow off the dead fern and spray a pre-emergence herbicide right over the dead fern. Do not cut the fern down in the fall because the dead fern will catch moisture and snow in the winter and it will keep the soil temperature about 5 degrees colder than the temperature of bare soil. This colder soil temperature will delay early spear emergence in the spring when warm day temperatures would force the growth of new spears in bare soil, causing frost injury, making them spoil and be unmarketable. Mow the dead fern off as close to the ground as possible to prevent skinned knuckles on the sharp

dead fern stalks while harvesting.

Under cool air temperatures, (<70 degrees) harvesting might be done once every 2-3 days, harvesting a 7-9-inch-tall spear with tight tips. Over 70-degree air temperature will cause the tips of the spears to open up or "fern out" at a shorter height, which causes fiber development in the spear that makes it tough. Spear diameter has no bearing on toughness. Fiber development is determined by the tightness of the spear tip. Harvesting under warm temperatures forces the grower to pick shorter, 5-7-inch-tall spears, before the spear tips fern out, in order to have tender spears of high quality. This may involve harvesting in the morning and evening of the same day, as spears elongate rapidly under high temperatures.

Research shows that asparagus can be harvested for 2 weeks during the year after planting with no harm. In fact, harvesting for 2 weeks the year after planting stimulates more buds (spears) to be produced on the crown that gives rise to greater yields in future years as compared with not harvesting them until the second or third year after planting.

One can safely harvest for 2 weeks during the second year, 4 weeks during the third year, 6 weeks during the fourth year, and 8 weeks during the fifth year, depending on spear diameter. When 3/4 of the spears are pencil sized in diameter, it's best to stop harvesting, instead of continuing to harvest for the specified number of weeks. This will take some experience in growing the crop to determine this.

Asparagus can be harvested with a knife, below the soil, resulting in a tough and fibrous butt that has to be trimmed off and is not usable. Asparagus grown in western states are harvested with a knife so that the white butt serves as a plug to help prevent moisture loss through the tip of the spear as they are shipped east. Cutting below the soil with a knife increases the chances of cutting into other buds on the crown that would normally produce more spears.

Snapped asparagus contains no fibrous butt since the spear snaps off at the point where it starts to become tough. It is all usable, with no waste. Snapped asparagus should command a higher price than cut asparagus.

Do not allow any small spindly spears that are not marketable to grow into ferns while harvesting. If this is allowed to happen, it provides an excellent site for asparagus beetles to lay their eggs, change into larvae, and into adult beetles. The field should look absolutely clean during harvest, except for new spears coming up or ones ready to be harvested.

Harvesting asparagus can be done by walking and stooping, but is hard on the back. A harvest-aid can be built, which is nothing more than a low-hung cart that people can ride on, leaning forward, snapping asparagus, and placing them in trays on the unit. These can be made by taking a steering mechanism off of a wagon, welding some pieces of iron to form a frame, and building it wide enough to hold 3 people to straddle 3 rows of asparagus. The person in the middle steers with his feet while he picks at the same time, so the driver can help harvest.

Two person hours are needed to pick asparagus by walking and stopping. Using a harvest-aid will reduce the time by about 15-20% and workers are usually content to ride a harvest-aid rather than walk and stoop to pick asparagus.

Harvest asparagus in the morning when the temperatures are cool. It has a very high respiration rate, just like a fresh cut flower. Spears can be harvested into plastic containers that have holes in them to let water pass through, and plunging them into ice-cold water for about 5 minutes. This will take the field heat out of the spears. Then pull them out of the water, let drain, and put them into plastic bags and refrigerate at about 36 degrees F. Storage life at 36 degrees is about 2 weeks, but growers should try to sell the asparagus soon after it is picked, to let the consumer hold it for 2 weeks, if needed.

Marketing

Can asparagus work as a pick-your-own crop? Yes, if one has plenty of field supervision showing customers how and where to pick. One grower uses a 12-quart plastic bucket to pick into that is about 7" tall. He instructs customers to put the bucket down next to the spear. If the spear is at least as tall as the bucket or taller, it can be picked. Most growers sell asparagus unsorted as field-run asparagus and put them in plastic bags. Others will sort them by spear

diameter. Some will place one pound bundles of asparagus bunched with a rubber band in a tray of standing water to keep them fresh, if selling retail to the public at a farmers market.

Growing White Asparagus

White asparagus, grown in the absence of sunlight, is sometimes desired by specialty restaurant chefs, and are known to pay 3-4 times the price of green asparagus. Opaque 55-gallon drums can be cut in half lengthwise, and butted up against each other down the row. To harvest, lift up the drum to harvest the white asparagus, and then put it down. After harvest season is over, remove the drums and allow the spears to turn green and elongate into ferns.

Insects and Diseases

Cutworms feed on the spear tips at night before emerging from the soil. They feed on one side of the spear, causing the tip to bend over. They can easily be controlled with approved insecticides.

Asparagus beetle adults will chew on the fern, stripping off the green material and reducing photosynthesis, causing a loss of stored food reserves in the crown for next year's crop. They also lay eggs on the spears during harvest. The best way to control them during harvest is to pick on a timely basis and never let any spears get tall and spindly, or allow them to fern out.

Asparagus growing north of the 40° latitude across the U.S., will be conducive to asparagus getting asparagus rust. South of the 40° latitude is conducive to *Cercospora* needle blight which is more commonly present in the Midwest and Southeast. These are both fungus diseases.

Cercospora spores are blown in the air during the summer, when it's hot and humid. It turns the needles of the fern yellow, then brown, and then they fall off. This severely reduces the photosynthetic capability of the fern to manufacture carbohydrates to move down the plant into the crown for next year's spears.

Alternate sprays of Mancozeb and Chlorothalonil fungicides once a week from mid-July to late September to control *Cercospora* and asparagus rust. Neglecting to spray will severely reduce spear yield the following year. Burning the old ferns off instead of mowing them off and letting the residue remain on the ground will not stop spears from getting *Cercospora* or rust. All it will do is delay the start of the disease by about one week. So be prepared to spray, regardless if the old ferns are burned or not.

Fusarium crown and root rot is the major destructive disease of asparagus and the one that usually takes fields out of production. There are no controls once the plants succumb. The main way to prevent from getting it is to prevent stresses from occurring to the plant. These stresses include overharvesting, low soil pH, low soil fertility, frost damaged spears, waterlogged soil, and insect, disease, and weed problems.

The best time to fertilize is right after harvesting is over. This will allow the fertilizer to be used by the new fern growth to allow the translocation of nutrients down to the crown for next year's spears. Soil test every other year to determine your fertilizer and lime requirement.

Asparagus Crown and Seed Sources – 2017

Scott WalkerWalker Plants, Inc.
105 Porchtown Rd.
Pittsgrove, NJ 08318
856-358-2548
856-358-6127 FAX

Tim Nourse
Nourse Farms, Inc.
41 River Rd.
South Deerfield, MA 01373
413-665-2658
413-665-7888 FAX

David Daisy
Daisy Farms
28355 M-152
Dowagiac, MI 49047
269-782-6321

Dick Walsworth
Rt. 1
Mears, MI 49436
269-873-2418

Ron Richter Farms
Rt. 2
90487-60th St.
Decatur, MI 49045
269-423-7339

Krohne Plant Farms
65295 CR342
Hartford, MI 49057
269-424-5423
269-424-3126 FAX

ON THE GROUND EVOLUTION OF FARMERS MARKETS, CSA'S & OTHER ADVENTURES IN DIRECT MARKETING

Art King, Harvest Valley Farms

It used to be that you load up your fruits and vegetables and a couple of tables: an umbrella or tent and you were off to make tons of money selling at a farmers market.

Now it has been taken to a whole other level. People have a vision of what a farmers market should look like. It looks more like a picture out of a Martha Steward magazine. The thing is that the more your stand looks like that magazine picture, the more customers want to shop there. But it is increasingly more difficult to have it look like that. Here are a few things I have learned that are needed:

In the field:
1) Pick most crops in the morning when it is cool
2) Once picked, it should never see the sun again
3) Everything must be hauled in a covered truck

In the Washroom:
1)Most things are washed immediately after being picked
2) Everything is stored in a walk-in cooler as soon as possible
3) Sensitive things are iced : broccoli, cauliflower, sweet corn

Transport to market
1) Must be in an enclosed vehicle (such as a box truck)
2) Heat sensitive crops should be iced: Lettuce, green beans
3) Sensitive crops should be in enclosed containers: ie, Kale

Displaying at market
1) Sensitive things could be in plastic bags: lettuce, kale
2) Display some items in bulk: green beans, peas
3) Do not put like colors together
4) Price needs to be obvious and should include an attribute
5) Stack things high in a decorative manor

Sales People
1) Everyone needs to smile
2) Proper sales training is critical

Market Promotion
1) Do your own advertising (not in print)
2) Special High Tech advertising: Facebook, Farm Fan
3) It all starts with your truck

Evolution of CSA

We started doing CSA 17 years ago with pickup at the farm with 10 members. It has grown every single year since then. Little did we know when we started, that the model that we came up with that fist year would be the most successful part of our CSA.

Art King operates Harvest Valley Farms with his son David and his brother Larry in Valencia, PA, just north of Pittsburgh. Their marketing is just as diversified as their product list. Over 58 varieties of small fruits and vegetables are grown on 165 acres. They have a 493 member CSA, sell at 3 farmers markets, Paragon, a large Farm Market & Bakery in Gibsonia, and host pick-your-own pumpkin activities in October.
Art holds a BA Degree in Nature Conservation from California University, Calif., PA and an associate degree in Business Management from Butler Community College. He is Past President of the Pennsylvania Vegetable Growers Association, serves on the PA Simply Sweet Onion Committee, a member of Royal Grange and PASA

After several years doing CSA pickup at the farm, we "advanced" to doing two drop sites in Pittsburgh. After a couple of years we were no longer satisfied with the 57 members at those two sites. We expanded to 9 drop sites and within a few years we peaked at delivering to 157 members at those 9 sites. But after several years this CSA model has become diluted and no longer vogue. This year was the last for our drop site deliveries.

Meanwhile back at the farm: things are booming! We continue to increase membership every year. And we have taken our farm CSA model on the road to another site. This, I believe is the CSA model of the future for most farmers.

Here is how it works: Set up is just like at a farmers market, except there are no prices. (people really like not having to bring cash) All the items are displayed to allow the same dollar value. Ours is 3.00 per item. So three zucchini equals 1 item. Each regular member gets 8 items total. However, 2 of the items are mandatory. These are things that we need to move when we have a lot of them. They get to pick the other 6.

CSA members have a 3 1/2 hour window to come and pick up their share. This should comfortably accommodate 100 members with two people to keep the table full. This should be increased to 4 hours with more members.

In todays society, I believe, "it is all about having a choice". With this model, CSA members get to pick what they want and are much happier doing so. One member stated, "Why would anyone do that other kind of CSA?"

Other Direct Marketing possibilities

The backbone of most farm retail endeavors is the Farm Market. Adding to the success of a good Farm Market is the advertising behind it. I attribute much of the success of our farm market to the weekly newsletter that I write. In it I tell stories about my life and what is happening on the farm. Usually it focuses on what crops are in the fields, but I also write about my family and occasionally write a fictional story. The most important thing about writing a weekly newsletter is that it creates a personal connection between the customer and the farmer. You want people to say things like "he is my farmer" when referring to you. It goes a long way to creating a sense of community and more sales at your market. A good Facebook page, with regular postings, can also be very valuable, but only when the farmer replies to comments. Without the replies, there is no personal connection.

INSECT PESTS OF COLE CROPS

Thomas P. Kuhar[1] and James A. C. Mason[2]
[1]Professor and [2]Graduate student– Dept. of Entomology,
Virginia Tech Department of Entomology, Blacksburg, VA
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Cole crops are attacked by a wide range of insect pests including a complex of lepidopteran larvae (caterpillars) that can chew leaves and infest heads. In the mid-Atlantic Region these can often include diamondback moth, imported cabbageworm, and cabbage looper, and sometimes cabbage webworm, corn earworm, armyworms, and many others as well. Typically IPM strategies include the entire complex of lepidopteran pests. Aphids are another pest group that can build up in high numbers particularly on fall cole crops. Harlequin bugs are brightly colored stink bugs that feed on leaves leaving behind unsightly white starburst feeding marks that can hurt the marketability of leafy cole crops like collards and kale. Flea beetles are another common pest on cole crops that if ignored can destroy new plantings with their sheer numbers; death by a million tiny feeding holes. In this presentation, we assess the yield effect of flea beetle feeding on cabbage and evaluate different chemical control strategies. We also review some recent insecticide trials that included a number of novel more selective insecticides that have recently been registered for use on cole crops in the U.S. Most of the new chemicals are considered more IPM-friendly control options than the more traditional broadspectrum insecticides.

Experiment 1. Effect of flea beetle feeding on cabbage yield

An experiment was conducted in Whitethorne, VA on "Bravo" cabbage planted in May of 2015 and 2016 to determine the impact of flea beetle feeding injury on crop yield. Beetle density and defoliation were assessed weekly for about one month after transplanting by counting the number of beetles present on ten plants per plot, and using a percent defoliation scale counting 10 randomly selected leaves per plot: 1= no defoliation; 2= 1-20% defoliation; 3= 21-40% defoliation; 4= 41-60% defoliation; 5= >60% defoliation. After 1 month, all plots were treated with a high rate of Voliam Xpress, a broad spectrum insecticide that eliminated any further insect injury to the crop. Crop yield was assessed by taking the total weight of all 16 cabbage heads per plot. Individual plants were monitored using the same defoliation scale by assigning an overall defoliation rating 1-5 to the entire plant, ten plants were used for each category of defoliation. The predominant flea beetle species found were Phyllotreta striolata and Phyllotreta cruciferae. There was a highly significant effect of flea beetle defoliation on cabbage yield in 2015 (Fig. 1) and 2016 (Fig. 2). Results showed that as little as 1-20% defoliation resulted in significant yield loss.

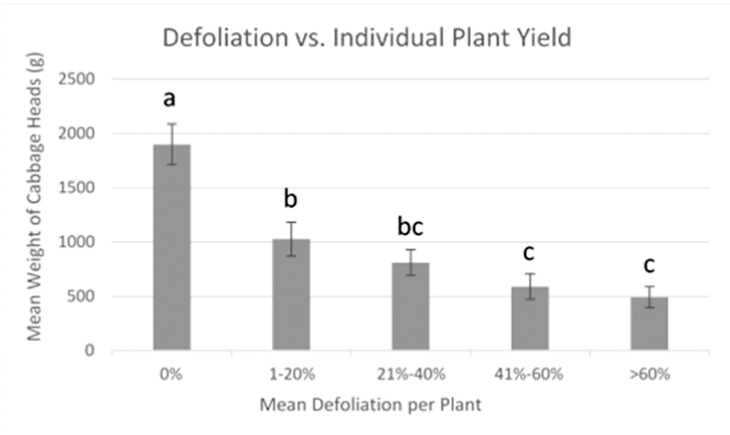

Fig. 1. Yield of 'Bravo' cabbage under different levels of flea beetle defoliation, transplanted 22 May 2015.

Tom Kuhar is a Professor and Vegetable IPM Specialist in the Department of Entomology at Virginia Tech. Dr. Kuhar's research focuses on the ecology and integrated pest management of insect pests of potato and vegetable crops. He has published over 75 peer-reviewed papers and book chapters on insect pest management in agricultural crops and has given hundreds of presentations on the topic. He received his B.S. degree in biology from Towson, University, Towson, MD in 1992 and his Master's (1996) and Ph.D. (2000) degrees in entomology from Virginia Tech. He formerly worked as a postdoctoral research associate at Cornell University, Ithaca, NY researching alternative methods for managing vegetable pests. A native of Baltimore, MD, he and his wife, Stacey, who also works at Virginia Tech, have two children, Daniel (13) and Brianna (12). Outside of work, his passion is playing, watching, and coaching team sports like softball, basketball, and volleyball.

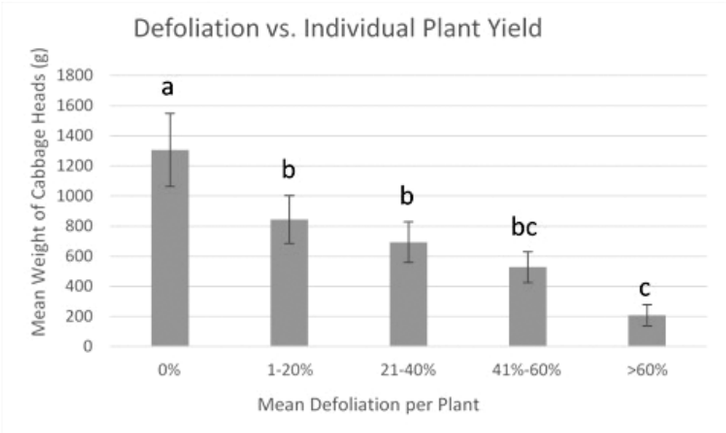

Fig. 2. Yield of 'Bravo' cabbage under different levels of flea beetle defoliation, transplanted 26 May 2016.

Experiment 2. Control of flea beetles in cabbage with soil drench or foliar insecticides; Whitethorne, va

VARIETY: 'Bravo' cabbage; PLANT DATE: 22 May 2015; TREATMENT DATES: Foliar: 29 May

			Mean # of flea beetles per 10 plants			Mean wt. (lbs.) of cabbage heads per plot
Treatment*	Rate per acre	Application Method	6/5	6/9	6/13	
Untreated Control	–	–	16.3a	35.0a	374.0b	23.0d
Admire Pro 4.6SC	7.3	Soil-drench	0.5b	33.8a	458.5ab	33.5cd
Venom 70SG	6.0	Soil-drench	1.5b	0.3d	11.3c	58.5a
Verimark 1.67SC	6.75	Soil-drench	2.0b	13.0bcd	558.0ab	40.8bc
Admire Pro 4.6SC	1.3	Foliar spray	0.8b	19.3ab	375.3ab	29.3cd
Venom 70SG	1.0	Foliar spray	1.0b	9.8bcd	633.0a	27.5cd
Exirel 0.83SOE	13.5	Foliar spray	0.0b	17.8abc	346.0b	32.0cd
Brigade	2.1	Foliar spray	2.0b	1.0cd	28.5c	54.3ab

* Admire Pro and Venom are neonicotinoids, Verimark and Exirel contain the same Diamide insecticide chlorantraniliprole (=cyazypyr), and Brigade is a pyrethroid.

Experiment 3. Control of green peach aphids in cabbage; Eastern Shore AREC

VARIETY: 'Late Flat Dutch' cabbage; PLANT DATE: 25 Aug 2016; TREATMENT DATES: Foliar Spray Date: 4 Oct

Treatment	Rate / acre	Mean no. green peach aphids / 5 plants
Untreated check		288.0 a
Movento + Li-700	5 fl. oz + 0.25% v/v	57.8 a
Sivanto + Li-700	10 fl. oz + 0.25% v/v	0.3 b
P-value from Anonva		0.0050

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

Experiment 4. Control of harlequin bugs in collards; Virginia Beach

VARIETY: 'Champion' collards; PLANT DATE: 19 May 2016; TREATMENT DATES: Foliar Spray Date: 28 July

		Mean no. harlequin bugs / 5 plants			
		Nymphs		Adults	
Treatment	Rate / acre	3-Aug (6 DAT)	10 Aug (13 DAT)	3-Aug (6 DAT)	10 Aug (13 DAT)
Untreated check		266.3 a	90.8 a	5.5	3.0
Certador* (dinotefuran) + Scanner	6.5 fl. oz + 0.25% v/v	0.3 b	7.5 b	0.0	0.3
Certador* + Scanner	19.5 fl. oz + 0.25% v/v	1.3 b	0.3 b	0.0	0.5
Certador* + Scanner	26 fl. oz + 0.25% v/v	3.3 b	2.0 b	0.5	0.5
Actara 25WG + Scanner	5.5 oz + 0.25% v/v	0.8 b	1.5 b	1.3	1.0
Brigade 2EC + Scanner	5.20 fl. oz + 0.25% v/v	1.8 b	9.3 b	0.3	3.0
Harvanta* 50SL + Scanner	11 fl. oz + 0.25% v/v	6.8 b	12.3 b	4.0	2.3
Harvanta* 50SL + Scanner	16.4 fl. oz + 0.25% v/v	8.3 b	1.8 b	3.8	2.3
Sivanto + Scanner	10 fl. oz + 0.25% v/v	3.8 b	18.0 b	0.8	1.5
P-value from Anova		0.0002	0.0013	ns	ns

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different ($P>0.05$).

*Not currently labeled for collards

Experiment 5. Control of lepidopteran larvae in collards; Virginia Beach

VARIETY: 'Champion' collards; PLANT DATE: 19 May 2016; TREATMENT DATES: Foliar Spray Date: 1 and 10 June

Treatment	Rate / acre	Mean no. total lepidopteran larvae* / 5 plants				% unmarketable leaves
		9-Jun	15-Jun	22-Jun	29-Jun	
Untreated check		9.3 a	8.8 a	1.8 a	9.8 a	67.5 a
Endigo ZC + Scanner 0.25%v	4.0 fl. oz	0.0 b	0.0 b	0.3 b	2.5 b	25.0 abc
Intrepid Edge + Scanner0.25%v	8.0 fl. oz	0.0 b	0.0 b	0.3 b	2.5 b	17,5 abc
Radiant + Scanner 0.25%v	5.8 fl. oz	0.0 b	0.5 b	0.0 b	1.8 b	7.5 c
Coragen + Scanner 0.25%v	4.8 fl. oz	0.3 b	0.3 b	0.0 b	0.3 b	12.5 bc
Avaunt + Scanner 0.25%v	7.0 oz	0.3 b	0.8 b	0.0 b	3.3 ab	50.0 ab
Belt + Scanner 0.25%v	1.5 fl. oz	1.5 b	3.5	0.0 b	1.5 b	17.5 abc
P-value from Anova		<0.0001	<0.0001	0.0056	0.0074	0.0032

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (*P*>0.05).

MISCELLANEOUS BRASSICA (COLE) CROPS

Lewis W. Jett
Commercial Horticulture Extension Specialist
2102 Agriculture Sciences Building
West Virginia University"

Figure 1. *Brassica* or cole crops are a diverse group of leaf- and head-type vegetable crops.

Cole crop or brassica vegetables include a diverse group of vegetables with very unique colors, shapes and flavors. Many Asian vegetables are brassica crops which grow successfully in the Mid-Atlantic region as early or late season crops. Asian greens include vegetables in the turnip family and cabbage family (Table 1). Napa cabbage is very easy to grow and is a perfect substitute for green cabbage. Suitable varieties of Napa cabbage include 'Blues', Jade Pagoda' 'Optiko' and 'China Express'. Pak choy or bok choi is a fast growing green (45 days from seeding) and is used for a variety of dishes including braising mixes, stir fry or salads. Mizuna is an Asian mustard with thin, white stems and fringed (red or green) leaves which is cold and heat tolerant and is an excellent salad green. Tatsoi is an Asian green which produces a cluster of spoon-shaped leaves. Tatsoi can be seeded throughout the summer and fall. A larger version of tatsoi with crinkled leaves is Yukina Savoy. Yukina Savoy has both heat and cold tolerance. Komatsuna is a mustard spinach which is grown in the fall since this plant grows best in cool weather. Senposai is a cross between green cabbage and komatsuna and is a relatively large plant which produces leaves with a sweet, mild flavor. Senposai is an excellent replacement for collards in the garden.

Kohlrabi is becoming a very popular cole crop for both retail sales and institutions (Figure 1). Kohlrabi has a swollen stem base and is relatively fast maturing. Being hardy to 15°F, makes this crop an excellent choice for fall production in the Mid-Atlantic region.

Radishes and turnips are fast-maturing brassica vegetables which are grown primarily in spring and fall for either greens or roots. Salad radish varieties are widely grown in high tunnels across the Mid-Atlantic and make an excellent companion plant. Turnips, particularly the white salad turnips, are very cold tolerant and have a sweet flavor when grown in the winter.

Collards are a very cold tolerant leafy green brassica which can be grown within high tunnels or low tunnels through winter. Collards provide an opportunity to diversify the variety of full-leaf greens.

Kale is one of the most popular leafy green vegetables grown year-round in the Mid-Atlantic region. Siberian or 'Russian' type kales are extremely cold tolerant while the Tuscan and other flat-leaf varieties are heat tolerant. Kale can be harvested as small leaves for mixes or bunched as single stems.

Dr. Jett is WVU State Extension Horticulture Specialist with an emphasis in commercial, edible horticulture crops. He is a native of West Virginia and has received degrees in agriculture and horticulture from West Virginia University and Virginia Tech. His research and outreach program focuses on methods to lengthen the traditional growing season and expanding locally grown production of fruits, vegetables, herbs and nut crops as well as evaluating new and diverse types of specialty crops. Other areas of research include stand establishment, seed production, heirloom vegetable production, no-till crop production and organic horticulture.

Table 1. Some miscellaneous cole crop vegetables which can be grown successfully in West Virginia and the Mid-Atlantic region.

Variety	DTH[z]	Description/Variety Selection
Asian Greens:		
Yukina Savoy	45	Similar to tatsoi but larger with dark green crinkled (savoy) leaves with good heat and cold tolerance. Individual leaves are harvested
Mizuna	40	Can be green or dark red with serrated leaves. Loose leaves have a mild mustard flavor. Used as a loose leaf crop.
Komatsuna	35	Upright leaves with flavor similar to spinach. Very productive.
Tatsoi	35	Spoon-shaped leaves in a tight rosette. Excellent replacement for spinach.
Tokyo Bekana	45	Light green leaves used for loose leaves or heads. Very cold tolerant.
Pak Choy	45	'Joi Choy'; 'Win Choi', 'Black Summer' Loose heading Chinese cabbage with wide market appeal.
Mustard	45	Harvest as small leaves for salad mixes. Large leaves are hot flavored.
Chinese Cabbage (napa)	55	'Jade Pagoda'; 'Blues' Cylinder –shaped cabbage used for stir fry and pickling.
Senposai	55	Heat and cold tolerant plant which is a cross between cabbage and komatsuna.
Collards:	70	'Vates'; 'Champion', 'Top Bunch' Lightly savoyed, dark green leaves
Kale	50	'Dwarf Siberian'' Lacinato''Starbor', 'Redbor
Kohlrabi:	55	'Grad Duke''Kolibri'; 'Winner'
Radishes:	25	'Crunchy Royale'; 'Rudolf' (crack tolerant) 'Amethyst' (purple)
Turnips:	40	'Tokyo Cross' (white); 'Hakeuri' (white);

[z]Days to harvest from seeding

ONIONS

Mike Orzolek, Prof Emeritus Plant Science Department
The Pennsylvania State University

Production requirements

Long term storage of onions will depend on the growing season conditions prior to harvest. It also depends on the type of onion being grown, sweet Spanish or storage. Storage onions are more pungent than sweet Spanish types, but generally will store for 8 to 10 months after harvest. Sweet Spanish types are sweeter, less pungent than storage type onions, but will store after harvest for only 4 to 6 months.

Of course, onion varieties also differ in their storage characteristics. Not only will bulbs began to develop soft rot symptoms in storage, but also sprout. Both of these characteristics result in non-marketable onion bulbs.

In the Mid-Atlantic region, onions should only be produced from transplants that are either grown by a reputable greenhouse plant (plug) producer or from southern field grown onion transplants. Since quality onion transplants should be 10 to 12 weeks old prior to transplanting into the field, producing local onion transplants requires the grower to seed the onions in 200 to 338 cell trays between January 1 and January 30 in the Mid-Atlantic area.

Maintain the top growth of the onion transplant to a uniform height of 4 inches to induce a thicker stem and stockier plant. Depending on growing conditions in the greenhouse, this may require cutting back the onion transplants several times. Do not harden off the onion transplants by withholding water and/or nutrients: instead, acclimate the onion transplants before planting them in the field by placing the transplants between greenhouses or open buildings during the day and covering them with a polypropylene row cover at night if temperatures fall below 32°F. Do this for 3 to 5 days prior to transplanting the onion transplants in the field. If using field grown onion transplants, be sure to grade the onion plants by size (height) and vigor before transplanting them in the field to insure uniform bulb size. **Warning:** Check onion field grown transplants for any insect or disease problem that could become serious in the field as onion plants begin to grow. Also, if planting field grown transplants that need to be stored prior to planting in the field, do not wet the plants in the box prior to placing them in a 40°F to 45°F storage temperature and keep the shipping boxes open.

Onions are shallow-rooted, and unless soil moisture supply is constant, onions will initiate early bulbing and result in too small a bulb size for retail marketing. Light, frequent irrigations should be used when plants are small to minimize leaching of nitrogen from the root zone. Increase water applications as plants and roots increase in size. Maintaining moisture near the surface, at the onion stemplate, is important in root generation. Onions generate new roots at the stemplate only when moisture is present. Proper moisture management is important in alleviating pink root problems, general root health and bulb growth vigor. Also, maintaining a uniform level of soil moisture helps to reduce the incidence of double-centered bulbs.

Pest Management

Pest Management will influence onion storage potential after harvest. It is critical to minimize/eliminate all potential weed, insect and disease problems to maximize the length of onion storage.

Weeds

Onions compete very poorly with weeds. Fields with low weed pressure and no perennial weeds like Canada thistle,

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quackgrass and yellow nutsedge should be selected for growing onions. Both quackgrass and yellow nutsedge will produce rhizomes that can and will grow into the onion bulb, reducing the storage potential of that bulb.

Insects

Onion Maggot feed on the roots and leaves of developing onion plants. Larval feeding reduces plant vigor and often results in plant death and stand reduction. Larval feeding can also increase rots when bulbs are placed in storage. Thrips can infect plants from early vegetative stages (3 to 4 leaf stage) until harvest. Thrip feeding reduces chlorophyll content of the leaves, resulting in the onion plant taking on a silvery appearance. Damage also occurs to the onion bulb with thrips located beneath the dry scales of the bulb and potentially promoting decay losses during storage.

Diseases

Onions are susceptible to a wide variety of fungal and bacterial diseases. Fungal leaf blights including purple blotch (*Alternaria porri*), and botrytis leaf blight (or blast, *Botrytis squamosa*), infect the leaves of onions, kill foliage, stunt plant growth, and spread rapidly throughout the field.

Stemphylium leaf blight (*Stemphylium vesicarium* and *Stemphylium botryosum*) has occurred in onion growing area in Northeast US, and may become a problem in Pennsylvania as well. Downy mildew (*Peronospora destructor*) is another fungal pathogen that is potentially serious, especially during cool, wet conditions, but is not commonly found in Pennsylvania.

Botrytis neck rot, caused by the fungal pathogen *Botrytis allii*, is an important post-harvest and storage disease that begins with infection of bulbs in the field. Bacterial rots such as soft rot, slippery skin and sour skin can be very serious problems in onions, particularly under wet growing conditions. Various species of *Erwinia* and *Pseudomonas* bacteria can infect onion bulbs and leaves, resulting in a characteristic slimy, watery softening of the bulb tissue, often with a foul odor. Soft rots can spread in storage, causing serious losses. Minimizing injury throughout the growing season, efficient water management, avoiding highly susceptible onion varieties, and proper curing of onions after harvest are cultural practices that can help in a disease management and storage program.

Harvest

Uniformity of maturity (rate at which onion tops turn brown and fall down – *tops-down*) is very important in bulb size uniformity and storage quality. Tops-down in hybrid onion varieties tends to occur rapidly, requiring only a day or two to complete top-fall. Non-uniform onion varieties may have tops falling over a period of several weeks with a percentage of the tops not falling at harvest. In these varieties, bulbs with early tops-down contribute to incidence of bald onions at harvest, while bulbs whose tops resist falling do not dry properly, contributing to decay in storage.

Drying

Drying of onion bulbs is generally accomplished by forcing air of low relative humidity through the bottom of the onion pile up to the top. If the neck of the onion bulb is not 100% dry, than onions in storage will rot. Two to three cubic feet of air per minute for each cubic foot of onions is recommended, with the higher air-flow rate used initially to remove surface moisture and seal onion necks. If the weather is cool and wet, forced air at 75°F to 85°F and 60-70% relative humidity is recommended. If the onions are also wet, forced air at 85°F to 95°F and a relative humidity of 25-35% should be used as soon as storage loading is completed. This process should be continued until all the outer skins and neck are dry.

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Drying can also be accomplished by placing harvested onion bulbs with tops removed into burlap bags that can hold 50 to 80 pounds of onions. The burlap bags are than stacked two high and either placed on wooden pallets on top of a flat wagon that is pulled into a high tunnel or the burlap bags are placed on wooden tables in the high tunnel to dry. It is recommended that polypropylene white row covers be placed on top of the burlap bags filled with onions to reduce/eliminate sunscald and/or sunburn problems on the bulbs. Onions placed in the high tunnel as described above will normally dry (especially the neck of the onion) in 5 to 7 days.

Storage

Onions are held in either common or cold storage. The storage quality of the onions is influenced by variety and the conditions under which they were grown. Onions are considered cured or dry when the neck is tight and the outer scales are dry and will rustle. This condition is reached when onions have lost 3 to 5 percent of their weight. If not adequately cured, the onions are likely to decay in storage.

Onions should be adequately cured in the field, in open sheds, or by artificial means before or in storage. Adequate curing in the field or in open sheds may require 2 to 4 weeks, depending on the weather. The best skin color develops at 75°F to 90°F. The commonest method of curing in northern areas is by forced ventilation in the storage by blowing heated air 80°F to 95°F through the onions.

Refrigerated storage is often used for onions to be marketed late in the spring. Onions to be held in cold storage should be placed there immediately after curing. A temperature of 32°F will keep onions dormant and reasonably free of decay, provided the onions are sound and well cured when stored. Air circulation should be sufficient to prevent heating of the bulbs and to remove moisture from within bins or bags. Sprout growth indicates too high a storage temperature, poorly cured bulbs, or immature bulbs. Root growth indicates too high a relative humidity. A comparatively low relative humidity (65 to 70 percent) is recommended for the successful storage of onions.

HIGH TUNNEL ROOT CROP PRODUCTION

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Carrots (*Daucus carota*), beets (*Beta vulgaris*). radishes (*Raphanus sativus*), turnips (*Brassica rapa*) and parnsips (*Pastinaca sativa*) are popular cool season root crops for high tunnel production and marketing in West Virginia. Beets are closely related to spinach and Swiss chard vegetables while carrots are botanically related to celeriac, celery, dill, fennel and parsnips. Radishes and turnips are *Brassica* vegetables. Beets are a great source of folate while carrots are high in vitamin A.

Most root crops such as beets and carrots do best in a light textured, deep soil without stones. Raised beds, which can be filled with a lighter texture soil/compost blend, are well suited for root vegetables.

Beets, radishes, turnips, parsnips and carrots should be seeded early or late enough in the year to grow or mature under cool weather conditions which favors both yield and quality. Parnsips have a long growing season and can be overwintered within high tunnels.

Figure 1. Root crops are a profitable crop choice for high tunnels.

Choosing a root crop:
There are several types of carrots based mainly on shape and intended market use such as fresh market, processing or storage. Carrots vary in color from orange, yellow, red, purple and white. Shape and size of carrot roots differ as well. 'Nantes' carrots have a long, cylindrical shape and blunt tip. 'Imperator' carrots have long, tapered roots and grow best in deep soils. 'Chantenay' carrots have a thicker, cone-shaped appearance and do well in heavy soils. In West Virginia, most carrots produced within high tunnels are Nantes-type carrots.

Beet roots and turnips are actually enlarged portions of the stem called the hypocotyl with most modern varieties having a round shape. However, there are some beet, radish and turnip cultivars which have a cylindrical shaped root (Table 1). Some beets also have edible foliage and are eaten as greens. Root crops can be harvested as small vegetables often referred to as "baby vegetables".

Radishes and turnips are fast-maturing cool season crops which have a diversity of skin color with white or yellow flesh. Both radishes and turnips are excellent companion plants for such crops as tomatoes and peppers during early

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season production.

Planting root crops:
Root vegetable crops grow best in a soil with a pH of 6.0-6.8. Beet "seeds" are actually fruits containing several seeds (Figure 2). Thus, when seeded, beets are typically thinned to one plant. Each seed is planted 1-2 inches apart and thinned to one plant every 2-3 inches. Beets can be either direct-seeded or transplanted. Transplant trays containing 128-200 cells should be appropriate. Beets should be sown beginning in February within a high tunnel to 6 weeks before the last spring frost for open-field production. For fall beets seeding in August-September is suitable for high tunnels or low tunnel production. For a continuous supply of beets and carrots, a new seeding is made after the first true leaf appears on the current planting.

If the objective is to harvest beet greens for a salad mix, the beets can be broadcast- seeded over a raised bed. When the leaves are approximately 2 inches long, they can be harvested.

Radishes are seeded in spring and fall when temperatures are cool with shorter day length and less pest pressure. They are not recommended for summer production.

Radishes are direct seeded and thinned to 2-3 inches between plants. Turnips can be seeded in both spring and fall, but have better quality when exposed to progressively cooler weather. Parsnips have a long growing season and are seeded in spring in both high tunnels and open field plantings.

Carrot seeds are very small, but pelleted seeds are available which make it easier to sow and reduces thinning labor (Figure 2). The pellet is an inert clay material which dissolves in the soil moisture. Carrots within high tunnels are typically grown as fall-winter carrots which are seeded from August-October for harvest in December-March. In the open field, carrots can be seeded 4-6 weeks before the last frost in spring or 6-8 weeks before the first frost in fall. Seeding rate is approximately 30 seeds per linear foot when using non-pelleted (raw) seed. The seed is sown approximately 0.25 inches deep either in rows or broadcast-seeded. When seeding in rows, the rows are spaced 12-18 inches apart for spring and summer carrots and 6-8 inches apart when growing winter carrots. Even watering is critical for good germination and emergence of carrots. While drip lines can be used for growth, overhead watering (e.g., misters) will be needed to have good germination in hot weather. After emergence, the carrots can be thinned to approximately 1-2 inches apart.

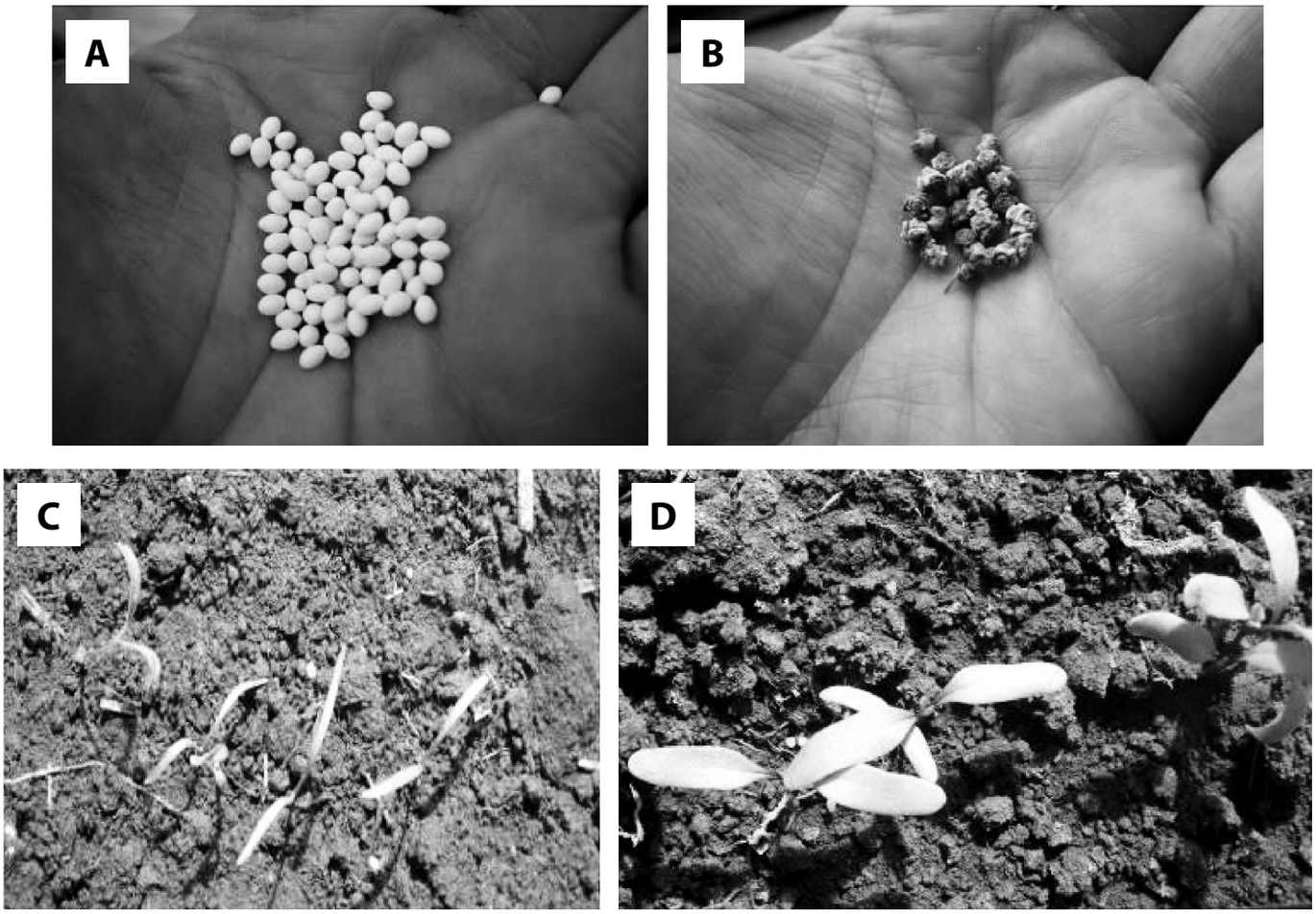

Figure 2. Pelleted carrot seed (**A**) and raw beet 'seed" (**B**). Carrot (**C**) and beet (**D**) seedlings can be thinned soon after emergence.

After thinning, the carrots, radishes, turnips and beets should be evenly watered. Drip irrigation is the preferred method of watering root crops since this form of irrigation wets only the soil without wetting the foliage. Approximately 60 lbs./acre (1.4 lbs/1000 ft2) of actual nitrogen can be applied before planting with an additional 30 lbs. (0.7 lbs./1000 ft2) applied as a sidedress 4-6 weeks after planting. Do not apply nitrogen through the drip lines when growing beets or carrots. Too much nitrogen can reduce quality of both beets and roots. Carrots will fork when too much nitrogen is applied to the crop. Uneven soil moisture will cause carrots to be misshapen and beets exhibit a condition called "zoning" which is uneven internal color. Both beets and carrots can be grown on either organic or plastic mulches. Since both crops do not compete well with weeds, the mulches reduce weed competition and soil moisture loss. However, the preferred way to manage weeds is to use a stale seedbed technique in which weeds are allowed to germinate in advance of seeding. The emerged weeds are then desiccated with a contact herbicide or tilled followed by seeding the root crop.

COMMON CONCERNS, CHALLENGES OFTEN SEEN, AND SOLUTIONS FOUND

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"Our greatest responsibility is to be good ancestors." *Salk*

In my experiences over a few decades in production agriculture and extension as well as more recently as a Farm Business Transition Coordinator; the primary barrier to effective business transition can be the clash between the "family" and the "business." The values and beliefs of the farm family impact our conduct linking us through shared relationships, and judgements. Because of this, open, honest, and civil conversations to identify and prioritize everyone's needs and desires for the farm's future can be stressful.

However, we are finding that utilizing a professional to facilitate and guide the needed family and business communications is proving to be an effective method to achieve common family and business goals. Business transition is a process, not an event.

Key pieces in the process of designing, building, implementing, and managing a business succession plan includes:

When is the best time to start the discussion?

- Retirement plan
- Business plan
- Transfer plan
- Estate plan

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Certified Farm Business Transition Coordinator, International Farm Transition Network
John and Maureen have been married since 1975 and are quite proud of their three young-adult children, their spouses, and three grandchildren. We are all active and engaged with a desire to help each other and the community in which we live and work. The entire family is crazy over dogs.
The best part of my career with Penn State is the opportunity to develop long term relationships with any number of farm families across the northeast and mid-Atlantic states. Getting to know a wide range of individuals working in a diverse set of conditions has been great. I enjoy helping where I can, but more significantly I value the chance to listen and understand what people are experiencing and what they see as their future. I find that occasionally I can be of assistance in achieving their goals.

Determining what you want.

- Net worth
- Cash flow
- SWOT
- The value of sweat equity

- Treatment of heirs
- Goals

The next generation and the family legacy

- Developing the next manager
- Business transfer process
- Transferring management
- Transferring assets
- Transferring ownership

When is the best time to start planning?

- Gender differences
- Generational differences
- Meaningful family business meetings
- Group problem solving
- Resolving family and business conflicts

Family and business working together

- Professional involvement
- The 5 D's

The value of a succession plan

HERE IS A PATH FOR PLANNING, IMPLEMENTING AND MANAGING THE PROCESS

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Exit Planning is more than thinking and talking. It is taking the actions necessary to enable you to reach all of your exit objectives. These objectives include leaving your business when you want, to the successor you choose, for the amount of cash you desire. Further, Exit Planning takes time. The farther in advance of your exit that you start planning, the more options you have and the better the outcome is likely to be.

The Exit Planning process we describe in this session was created over 20 years ago, and has been refined by the experience of thousands of owners and their advisors. While each Exit Plan is as unique as the owner who creates it, properly crafted Exit Plans have several signature characteristics.

- They aim to increase business value both in the short term and long term.
- They are put into writing so that all involved can measure their progress toward the owners goals.
- They incorporate accountability by holding the owner and each advisor to deadlines for completing each task.

THE SEVEN STEP EXIT PLANNING PROCESS™

STEP 1: SET EXIT OBJECTIVES / GOALS

"When a man does not know which harbor he is heading for, no wind is the right wind." Seneca

Seneca was, indeed, a wise philosopher. His advice is as sound for business owners today as it was centuries ago. Yet, few owners heed that advice or appreciate its implicit warning. Many owners do not set exit objectives precisely because it is emotionally too wrenching to contemplate separating themselves from a business they have created, nurtured, lived with, suffered with, brought to maturity and in which they have totally immersed themselves. Your Exit Plan should be based on your goals. It is difficult, if not impossible, for any planning professional to engage you in the planning process until you are emotionally prepared to begin planning to leave your business.

Where do I start? The Romans believed that "Victory loves careful preparation" and we know that preparation starts with setting achievable goals. But owners who are emotionally ready to face their departures often do not know what to do or where to begin. This is the point at which the need to set clear, simple exit objectives is of paramount importance.

Phil Mason is Vice President – Family Business Practice at Peerless Business Advisors. He received his Certified Family Business Specialist (CFBS) designation from The American College and has over twenty years of experience working with and strategizing for family business owners. His professional mission and passion is to help business owners understand, build and protect the value of their company while preparing and executing succession/exit plans on their terms... His financial planning practice involves advanced estate planning, business succession planning, executive compensation and benefit plan designs, and retirement planning.

Phil began his 25+ year career in the AT&T CFO organization. After five years, he left to become EVP & CFO of 2nd generation family-owned Allied Steel in Newark, NJ. After three years, he joined 2nd generation family-owned Martec International in S. Plainfield, NJ, as CFO. He was promoted to CFO & COO after twelve months and provided financial and operational leadership while the company expanded product distribution throughout North, Central and South America. In 2004, he launched and became President of 3-D Excellence, LLC, a management consulting firm. He has vested over 15,000 hours advising family business owners in strategy, execution and succession. He earned a B.A. in Int'l Business at the State University of New York, a MBA from Fairleigh Dickinson University, a graduate certificate in Personal Financial Planning at Moravian College and a graduate certificate in Business Succession Planning at The American College. Phil and his wife Fran celebrated their 25th wedding anniversary in 2016. Their twins graduated from college in December: daughter Makayla from Penn State and son Rocco from Kutztown University. Phil & Fran raised the twins in rural farmland communities in Warren County, NJ and Northampton County, PA. CRN201703-190422

There are three straightforward exit-related goals that, once established, allow owners to cut through a lot of muddled thinking that otherwise bars them from moving forward. These objectives are:

1. How much longer do I want to work in the business before retiring or moving on?
2. What is the annual after-tax income I want during retirement (in today's dollars)?
3. To whom do I want to transfer the business:
   - family?
   - key employee(s)?
   - co-owner?
   - outside third party?
   - Employee Stock Ownership Plan (ESOP)?

No owner can effectively begin planning (or acting in an efficient and coordinated manner) to leave his business without establishing each of these objectives. Many owners set other objectives as well, such as:

- Maintaining family harmony;
- Transferring wealth to family members;
- Giving to charity;
- Living a life of significance.
- Providing for one or more employees;
- Getting maximum value for the business;
- Taking the business to the next level with someone elses money; or

Remember, your objectives direct all subsequent planning efforts and actions. You are the person primarily responsible for this step, but you need not work alone. Who can help? Owners need not reinvent the Exit Planning wheel themselves. We have experience in creating and implementing Exit Plans for owners with varying goals and in a variety of industries.

STEP 2: QUANTIFY AVAILABLE RESOURCES

A universal ownership objective is to secure the income stream that you (the owner) and your family will need to support a future lifestyle. Three elements constitute your financial resources: 1. Business value, 2. Non-business sources of income, and 3. Projected business cash flow.

A Word About Business Value.

Knowing the value of the business is critical to the planning necessary to successfully exit your business because for most owners their businesses constitute their most valuable asset. Accomplishing financial goals depends on converting that asset to cash. Based on an owner's knowledge of the current value of the business, owners and their advisors can determine:

1. If an owner's financial objective can be met at present through a conversion of value to cash.
2. Or, as is more likely, how much the business value must grow in order to reach the owner's retirement objectives.
3. If, and how quickly, they make progress.

STEP 3: FOCUS ON BUSINESS VALUE

There are three parts to focusing on business value:

1. Increase the value of your business.
2. Protect its existing value.
3. Minimize current tax liability as well as liability when you transfer ownership.

Increase Business Value.

An inevitable by-product of a consistently well-run business is consistently increasing value. There are numerous actions an owner can and should take to maximize value. These include:

- Maintaining and consistently increasing cash flow;
- Documenting the sustainability of earnings;
- Creating and using efficient systems;
- Motivating and keeping key employees.

This step goes to the heart of a successful business and to the essence of your role within the business: to enhance value.

Minimize Risk.
A future buyer may not even consider purchasing your company if there's a risk that its value will decrease. Have you taken steps to make sure your key employees stay with a new owner after you exit?

Minimize Tax Liability.
There are a number of tax-minimizing techniques owners employ as they work toward their exits. Charitable Remainder Trusts, Employee Stock Ownership Plans, Defined Benefit Plans and lowest defensible value are examples of tools we use to minimize taxes. At best, it takes years to reap the benefits from most tax-planning strategies. Given that both income and business tax rates are likely to increase, can you afford to wait to investigate various tax-saving strategies?

STEP 4: SALE TO A THIRD PARTY
There are a variety of ways to market a business for sale, but if your company is worth at least $5 million, one of the best ways to reap top dollar is to have an investment banking firm orchestrate a competitive (or controlled) auction. In a competitive auction multiple qualified buyers come to the negotiating table at the same time, all with the same information, and all prepared to make an offer for the company. This process maximizes sellers' leverage and enables them to select the sale price, deal structure, and on-going operating philosophy that are most attractive. Key to the success of this process is the ability to bring a large number of qualified buyers to the table at the same time. Of course, competitive auctions don't just happen. They take careful preparation, marketing and execution. If you are considering a sale to a third party as your exit route, we suggest that you read about how you can prepare for and stay in control of the process in Cash Out Move On — Get Top Dollar and More Selling Your Business, by John H. Brown and Kevin M. Short.

If your company is worth less than $5 million, you may be able to retain the services of an investment banker skilled in competitive auctions, but more likely you will use the services of a business broker and engage in a negotiated sale. Again, a key to success is using the most capable broker available.

STEP 5: TRANSFER TO INSIDERS (COOWNERS, FAMILY MEMBERS OR KEY EMPLOYEES).
Owners who wish to transfer their businesses to family, co-owners or key employees must:

- Minimize the income tax consequences of the transfer to both the seller and the buyer.
- Minimize the departing owners risk of not being paid the entire purchase price by having the owner stay in control until he or she receives every dime of the purchase price. The reason we emphasize these two conditions is simple: the buyer(s) (children, coowners or key employees) have no cash.

Minimize Taxes.
The only way you (as the owner/seller) will receive your purchase price is to receive installment and other payments (directly from the company) over an extended period of time. All the money you receive will come from the future cash flow of the business; that is, income the business earns after you depart. Therefore, it is imperative that your Exit Plan works to minimize the tax consequences to the business and to the buyer in order to preserve a greater part of the company's cash flow for the departing owner. There are several techniques we can use to accomplish this.

Minimizing ownership value of the business.
The lower the price paid for the ownership interest, the fewer dollars are subject to the double-tax whammy. The first whammy is the income tax charged to the buyer (key employee, co-owner or family member) and the second whammy is the capital gains tax assessed against the seller (the departing owner). In other words, for the seller to receive money for his ownership interest, the company must first earn the cash that the buyer pays tax on when he or she receives it. The buyer then pays that after-tax amount to the seller as partial payment for the ownership interest and the seller (owner) pays a capital gains tax upon receiving that money. Hence, there is a double tax on each dollar of cash flow earned by the business that is used to pay for the departing owner's interest in the company.

Create unfunded obligations.
The best way to protect the business's cash flow (or "golden goose") from the double tax is to create unfunded obligations to the owner from the business long before the actual transfer. These obligations include:

- Non-qualified deferred compensation for you, the owner
- Subchapter S dividends
- Indemnification fees
- Licensing and royalty fees
- Leasing obligations between you and the business such as a building or equipment

Reduce Risk by Maintaining Control.
The best way to minimize a departing owner's risk of not receiving the full purchase price is to keep that owner in control until he or she receives every dollar. To accomplish this, your Exit Plan might include one or more of the following techniques:

- Securing personal guarantees from the buyer, including business and personal assets.
- Holding a controlling interest in your company until financial security is assured. One technique is to use a two phase process in which the insiders purchase a minority interest in the business.
- Remaining involved in the company until you are satisfied that the cash flow will continue without you.

Transferring a business to children, coowners or key employees is a high-risk venture. The ace in the owner's pocket is usually the option to sell to an outside party if the insider/buyers are unable to fulfill their obligations.

STEP 6: DEVELOP A CONTINGENCY PLAN FOR THE BUSINESS
One of the benefits of developing an overall exit strategy is that you quickly appreciate how contingency planning is an integral part of it.

Taking prudent measures so that your business continues if you don't is a natural part of the planning process. In the ideal situation, business continuity needs (upon the death or incapacity of an owner) can be met by a business continuity agreement with a co-owner. Most businesses, however, are solely owned. If sole owners do nothing else, they have a duty to their families and to their businesses to create written plans that answer the following questions:

- In my absence, who can be given the responsibility to continue and supervise:
- Business operations?
- Financial decisions?
- Internal administration?

- How will these people be compensated for their time and, most importantly, for their commitment to continue working until the company is transferred or liquidated?
- What should happen to the business at my death or permanent incapacity?

When owners make the decision to begin transferring their businesses, the last thing they are likely to consider is the need for adequate planning to protect the business if they should suddenly die or become incapacitated. Yet this is precisely the point when the business is most vulnerable: it has peaked in value, but the event creating liquidity (the sale of the business) is likely years away. The remedy is usually straightforward: adequate legal documentation in the form of a buy-sell agreement or a stay bonus program for important employees with adequate funding.

STEP 7: DEVELOP A CONTINGENCY PLAN FOR THE OWNER'S FAMILY

With this final step, your Exit Planning Process comes full circle. Review your financial objectives established in Step One: if you don't survive until your business exit, what financial resources will your family need and where will they come from? What actions can you take to minimize or avoid estate taxes?

As a business owner, your estate plan is another part of your overall Exit Plan. Unlike some of your lifetime objectives (e.g. financial security), estate planning objectives and business continuity objectives are relatively easy to meet upon your death or incapacity. To acquire the liquidity sufficient to meet your financial objective, consider the purchase of life insurance and disability insurance. Using insurance, you may be surprised at how easy it is to meet death objectives. Once owners complete the first two steps of the process (Setting Objectives and Quantifying they often jump to this Step (preparation of appropriate estate planning documents and funding of financial needs by insurance) so they can minimize the financial impact their death would have on their families and their companies' ability to survive.

CONCLUSION

All of the techniques that produce operational business success (learning from mistakes, developing business strategies based upon experience, trial and error and conducting business efficiently and effectively) do not guarantee a successful business departure. Sadly, the valuable experience owners develop over the course of their business lives does not equip them to leave their businesses successfully. Experience, learning and "trial and error" all require time—a luxury most business owners do not enjoy as they approach the end of their ownership lives.

All this planning sounds complex and time consuming—but it need not be for you. We can help create a written and comprehensive Exit Plan that gets you the money you need and achieves all of your other objectives in a time and cost-efficient manner. An Exit Plan that:

- Is based on your objectives;
- Includes all of the seven steps summarized in this session;
- Holds you (the owner) and all advisors accountable;
- Provides a means of measuring your progress toward a successful exit; and
- Imposes deadlines to ensure that you and your advisors act in a timely manner.

Armed with a written Exit Plan, a team of skilled and experienced advisors, and with (ideally) several years before you exit, you can optimize your ability to leave your business in style. CRN201711-192848

CHOOSING A HIGH TUNNEL PLASTIC TO SUIT YOUR NEEDS

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Many different brands and types of plastic film coverings are available to growers – at last count, at least 50 different ones were available to growers in North America. Plastic coverings affect transmitted light and the high tunnel environment, plus they have other characteristics affect their performance.

Types of Coverings Available

The covers most frequently used on high tunnels are thin plastic films, usually 6-mil in thickness with an expected life of 4 years, and that is the type of covering that this information focuses on. Films are also available that are thinner (1-mil, 3-mil, or 4-mil), but these are intended for shorter-term use or are for use on structures other than high tunnels. Plastics used on low tunnels are generally thinner (4-mil), as the thinner plastic is easier to manipulate when tying the plastic to anchor posts.

If growers want a covering with additional durability or additional insulation, there are woven materials, reinforced materials, semi-rigid materials, and one product that resembles bubble-wrap.

How Plastics Affect Light/Heat Transmittance

Visible light

The light that we see, which includes the wavelengths that plants use for photosynthesis, is referred to as (not surprisingly) visible light. Crop plants best conduct photosynthesis utilizing wavelengths that we see as red and blue light. That is why "grow lights" and LED lights used for indoor plant culture have a purple hue to them - the color results from higher output in the wavelengths that produce the colors red and blue.

High tunnel plastic film coverings transmit the majority of the visible light reaching the tunnels, generally in the range of 85 to 95%. This is enough to keep leaves that are receiving all of this light working at their maximum photosynthesis rates, though other factors (inadequate soil moisture, wrong temperature, or leaves shading other leaves) can limit photosynthesis of the whole plant. One interesting characteristic of some films is that the light being transmitted through the film may "come through" at different wavelengths than the ones that originally reached the plastic, so that transmittance values of certain wavelengths are sometimes greater than 100%. Having sufficient light transmittance is important for plants that require high amounts of light for maximum yield and quality light (tomatoes, raspberries).

Some portion of the visible light (and also wavelengths outside of this range) striking the tunnel is diffused as it passes through the plastic. The amount of diffusion taking place varies for different plastics, and can be judged by how clearly one can see through the plastic and by the presence of shadows in the tunnel on a bright day, or more correctly the lack of shadows. Plastics that diffuse a greater proportion of the light are referred to as diffuse or diffusing films. With more diffusing films, the majority of the light striking the plastic is transmitted, but it is scattered as it passes through the plastic and so is more evenly spread throughout the tunnel and plant canopy. Lower leaves receive more light instead of being shaded by upper leaves, especially with taller plants such as raspberries or indeterminate tomatoes. Thus, total photosynthesis for the entire plant, especially for tall crops, would be expected to be higher in a tunnel with a diffusing film than in a tunnel with a less diffusing film, as long as the total amount of light being transmitted is roughly the same.

Kathy Demchak has been at Penn State since 1983, working first in the area of vegetable and tree fruit nutrition and later in berry crops. Recent research projects have included work on blueberry cultivar evaluation, blackberry cultivar evaluation and cold-hardiness, high tunnel production of strawberries, raspberries, and blackberries, and day-neutral strawberry production. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She happily lives in a rural area of Centre County, with husband Jeff, and sons Tim and Jeff.

Ultraviolet (UV) light (aka UV radiation, and "black light")

UV light consists of wavelengths shorter than visible ones, and is further broken down into UV-A, UV-B, and UV-C radiation, with UV-A being next in line from visible light. UV-C radiation, which is very dangerous to living organisms, is filtered out by our atmosphere. UV-A and UV-B wavelengths, as one can infer from sunscreen and sunglasses labelling, are the ones responsible for giving us sunburn and being tough on our retinas. These wavelengths also break down plastic, so plastics used for high tunnels and greenhouses contain UV stabilizers or blockers that minimize damage to the plastic. This is one of the main characteristics that sets greenhouse films apart from plastic sheeting that one might pick up at a local hardware store, which would become brittle within about a year if used on a tunnel

Infra-red (IR) radiation and near infra-red light

Infra-red wavelengths are sensed as heat, and thus are the ones responsible for heat build-up in a tunnel. Visible light and shorter wavelengths of infra-red light enter the tunnel during the daytime and are stored as heat in the soil and plants, but then are emitted back towards the plastic as longer IR wavelengths at night. Some plastics include an additive that reduces the amount of long-wave IR radiation passing through the plastic. These plastics are used to hold reflected heat (IR radiation) in the tunnel at night, and therefore are sold as thermal energy-saving films. Usually they are used in more northern locations, and are recommended for use as an "inside" layer of film with another layer overtop, with the space between the two being inflated with a blower.

Other films are capable of blocking IR radiation coming into the tunnel, and then have potential to keep the temperatures in the tunnel cooler than outside temperatures. Plastics intended to keep tunnel temperatures lower also diffuse light, which also helps with preventing heat build-up in the tunnel. Berry crops are especially sensitive to high temperatures, and given our extreme temperatures as of late, these plastics may be valuable in helping in keeping the plants cool. Tunnel height and venting of course, also plays a large role, so the cooling effect may not be as great in shorter tunnels.

Other plastic film characteristics

Anti-condensate or anti-drip additives

These additives are intended to discourage condensation, or when it does occur, to encourage water droplets to cling to the plastic and run down the tunnel sides rather than drip onto the plants, or to keep water-droplets small so they don't coalesce into larger drops that fall onto the plants. In some cases, the anti-condensate additive is a coating on the plastic, in which case the plastic will be marked as to which side needs to be facing inside. In other cases, the additive is incorporated into the plastic, and it doesn't matter which side is facing inward. When the anti-condensate additive is incorporated into the film, the additive gradually migrates to the surface so that it is replenished over time.

Anti-dust coatings

Some plastics have an additive to repel dust and dirt, thus maintaining good light transmission.

Differences in Costs vs. Benefits?

While many different plastics have been trialed over the years on an observational basis, and certainly growers may perceive that their plants perform better under one plastic than another, direct side-by-side comparisons are difficult to do because of the space and number of tunnels required to get reliable data.

However, over the past 2 years, 15 of the tunnels at Penn State's High Tunnel Research and Extension Facility have been refurbished and covered with 5 different plastics with a variety of characteristics, and raspberry and strawberry plants established. In additional, a low tunnel trial on raspberries that compares the same plastics, plus different plastic mulches (white, black, or no mulch) was established. First-year data produced some interesting results, but whether these differences will hold for other years with different weather conditions remains to be seen.

In a cost comparison of different brands and types of 6-mil plastic films, differences in price were mainly related to which distributor was selling the plastic film, and how much was being purchased, rather than being related to different plastic types. In most cases, shipping costs are likely to be the major factor determining where a plastic is purchased.

Over the next few years, economic analyses as part of the TunnelBerries project will be conducted to determine whether differences in yield or quality with different plastic types are sufficient to result in differences in profitability in raspberry and strawberry production.

Information on sources of available plastics can be found on the project website: www.tunnelberries.org

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BEST VARIETIES FOR HIGH TUNNELS TOMATOES, PEPPERS AND CUCUMBERS

Debra Deis, Seedway

TOMATOES

Round Red

The last time I spoke about high tunnel tomatoes, the mid-Atlantic region was focused on BHN 589 and Rocky Top. BHN 598 tastes great and Rocky Top looks great and tastes good. For determinate tomatoes we are seeing a change to varieties that don't necessarily look or taste as good, but have functional advantages- Fulvia leaf mold resistance, early maturity and reliable yield . The most common determinate variety now in use is Red Deuce, with Red Mountain gaining.

To back up, it's good to look at why some varieties work better than others in high tunnels. Varieties that work in the open field may not work in high tunnels, especially if you want to have production from early July through November. While we think of high tunnels for getting a jump start in cool weather, by the time the plants flower, it is often quite hot. Most tomatoes stop setting fruit at high temperatures, so, by trial and error, we find the varieties that can set at higher temperatures. This is not the same as truly "hot set", since those varieties will make too many small fruit when setting at "normal" temperatures.

Among indeterminate varieties, we have seen a big shift to Bigdena, the only truly large fruited greenhouse variety.

Why is big fruit so important? (I don't know.) In the grocery store, a large part of the tomato display will be "TOV" size, 6 -8 oz, sometimes in a cluster of 4. And Compari cocktail size, which is 2 – 3 oz, and, of course, grape and cherry tomatoes. So it doesn't make sense that high tunnel varieties should be large, but that remains the case.

We can't look at tomatoes without considering the consequences of not rotating. (You know who you are!). Options include moving the tunnels, growing in media, growing in soil bags, or, an interesting concept is rotating between media and bare ground. The longer you grow the more disease resistance you will need, particularly leaf mold. Grafting helps but not many growers have the patience to pair the right root stock with the right fruit. There is a lot of questions and trials but not a lot of answers. Then there is fumigation. Sally Miller has a plan for renewing high tunnels with fumigation with natural materials (molasses and rice hulls) exploding the bacteria by heating the soil (my translation). There is also mustard powder.

Determinate Varieties and why people like them

Primo Red – super early and less likely to point than it does in open field. Primo Red is preferred by growers who want to wrap up high tunnel production when the field varieties are ready. The plant is too small in the open field but bigger in a high tunnel. It has good flavor. In has observed resistance to Fulvia leaf mold.

Red Deuce – a nicely balanced plant that gives very good yield early and not prone to many problems. It has acceptable flavor. In has observed resistance to Fulvia leaf mold. Do not prune much other than suckers.

Red Mountain – although Fulvia mold resistance isn't claimed, this medium early variety does not get this common problem of high tunnels. This is also true of Red Morning but Red Mountain has better fruit size. Acceptable flavor.

Sunbrite This old variety remains popular in NJ and MD. It is somewhat early with good flavor.

Scarlet Red (temperamental) has some fans.

Debra Deis has been involved with in specialty vegetables and cold weather crops since 1980 when she worked in the test kitchen for Rodale Press - the organic gardening and farming publisher. During the next few years working at Johnny's Seeds in Maine she helped source and trial the specialty vegetables for which Johnny's is now known. She then moved to California, where she worked for Sakata Seed, the largest breeder-producer of brassica crops. After a detour working for wineries she returned to vegetable SEED in 2003, working at Seedway, in Hershey PA, where she is a product manager.

Indeterminate Round Red

Bigdena –it's a slam dunk, great yields supported by a great disease package including Ff (Fulvia). It yields relatively early in July and keeps going until it freezes and can also be grown in rockwool or coir.

Big Beef- If you can grow this without disease problems, and if it is early enough, you can't beat Big Beef for flavor and appearance. It is often used where it is possible to supplement with heat in spring.

There is still a little Trust and Arbason grown.

From Johnny', they like Climstar (cluster, 6 ounce, the TOV size), Frederik (7-9, compact plant, and good flavor),

HEIRLOOM and HEIRLOOM-LiKE TOMATOES

BHN 871- golden orange determinate that is better tasting and firmer than any other yellow tomato. It is really beautiful when cut open with excellent yields.

Pineapple or what we call Pineapple Premiere. Pineapple is an heirloom and there are some poor strains out there. We found the only way to deliver quality is through the Pineapple Premiere. It is relatively firm, with a unique and delicious flavor. It is also pretty early.

Brandywine Pink – this is very disease susceptible, but yields well in the beginning and end of the season. It will stop in heat but if it doesn't die, it will start up again.

Cherokee Purple is one of the earliest heirlooms but I find it stops and won't start again.

I asked Johnny's for their input: We have been getting a lot of calls from customers looking for greenhouse/high tunnel tomatoes that have good disease resistance, but at the same time still offer that great heirloom flavor. They are sometimes called 'hylooms'. Check out Marnero, Margold, and Marbonne for a good example of this. Note that these are more 'high tech' and suited to actual greenhouse growing versus high tunnel. Also even though this is more of a pink than a red, Pink Wonder is a great example of that-it has good yield and disease resistance, but also that heirloom-quality flavor. Pink Wonder (fancy but tender 7 – 10 oz. depending on fruit pruning) all with Fulvia mold resistance.

Less popular true heirlooms but really good-

Persimmon – very large and will out-yield a modern hybrid.

Riviera Cue di Bue (Oxheart) this Italian heirloom is very easy to grow with excellent yield. You can pay a lot more for greenhouse varieties… but why would you. This is a common style in mixes. The fruit is bland and a little puffy, but that is typical for the type.

I wish I had a good recommendation for a large pink heirloom-like variety but I don't. Mountain Rouge works but seed supply has been an issue.

Chocolate colored hybrids are popular. Paramount offers Espresso which I grew and liked this year. Black Velvet tastes great but you won't get much yield.

Cocktail size

If you prune Mountain Magic to one leader vine, that will do it but it does want to go smaller as the season goes on. The taste is unrivaled.

Cherry and Grape

Most hybrids will also work in the high tunnel… and many OP's won't. Give good space between plants and you should not have to prune hard.

Sweetheats and Smarty are the two grapes most likely to be used. Smarty has the better plant, Sweethearts better

flavor. Solid Gold is the standard yellow grape.

For Cherry, I haven't tried it, but I would recommend the new Braveheart. It is the only field tomato variety I know that claims Ff fulvia mold resistance and it works in low tech high tunnels. The beautiful deep red fruit will mostly ripen in a cluster.

Organic growers should try Sakura, with lovely flavor. It ripens in a cluster but maybe not 100% at once.

Sweet Treats Pink Cherry is my favorite. It is a large, very early dark pink cherry with amazing flavor. It ripens first of all tomatoes in my tunnel trials.

For yellow Cherry, it is hard to beat Sungold (Johnny's) for flavor and reliability.

CUCUMBER

Unless you use insects to pollinate, look for parthenocarpic varieties that set fruit without being pollinated. If you are using parthenocarpic varieties, do not mix with any variety that will have pollen and exclude insects with netting. If parthenocarpic cucumbers are pollinated, they can bend, get bitter or develop a large seed cavity. You can't wing it on nutrition for greenhouse cukes. Since they aren't putting any energy into making seeds, they will set more fruit than you can imagine, and drop more flowers than you can imagine if fed wrong. Build a big plant, and then feed increasing amounts as fruit set starts. Also experiment with pruning. Most cucumbers are grown in a media, coir or rockwool.

American Slicer : While I love true, thin skinned greenhouse type cucumbers, they can be a tough sell depending where you are growing. Lisboa looks like a regular American slicer and is a real workhorse in tunnels, with reasonable seed price to boot. It does "eat" better, with a small seed cavity unless it is pollinated. If it is pollinated it will still stay straight. You can get up to 80 cucumbers / plant. Have pots 16-18" apart and provide at least 5 foot trellis like field.

Mini- greenhouse: we like Picolino and other growers prefer Socrates from the same breeder.

Baby –greenhouse I LOVE Azamat. You cannot imagine how good this tastes so it is good for a situation where you can sample it. It keeps going very well despite yielding great.

Full-size English greenhouse – I honestly have not found one I like that rivals true, high tech, greenhouse.

Pickle – Excelsior this is the only "American Style" parthenocarpic pickle but the lack of competition doesn't matter because it is very good.

Tasty Green- theis curly Japanese "burpless" cucumber is not parthenocarpic so it shouldn't work but it does. Don't mix it with truly parthenocarpic varieties.

PEPPERS

Most pepper growers grow in soil and most use varieties that work in the field, but they don't usually need the same phytophthora and BLS resistance as field grown.

Abay for yellow bell

Milena for Orange bell. It is excellent and early and nearly every fruit is perfect but a tad small.

Green and Red is more of a challenge. Choosing from field varieties I like Tomcat and Hunter and many growers like Karisma. These are not early reds but make a nice red. They are great green. For an early red it is still the Socrates or Red Knight but they don't rival greenhouse peppers in quality. We have found a tie between cracking on the shoulders and Phytophthora resistance, so 1819 and Turnpike are not likely to work for red. Much of the new breeding for the field has very small plants. I am going to try Antebellum this year. The plant is decent with excellent foliage cover and the fruit quality is great. I will also try Mingun since it it the only new variety with a vigorous plant.

I have found the true protected culture varieties, Chesapeake and Sprinter to be touchy but they work for some (those who manage their nutrients carefully).

Snack peppers like Yummy and Oranos and Xanthi (longer carrot shaperd fruit) are excellent, and, bred for protected cropping although they are excellent outside.

Longer Italian sweet roasters are good. We offer Yellow Bardo and Sweet Delilah. Johnny's has a nice smaller "cornito" assortment. Cornito Rosso and Cornito Giallo.

I have **not** found hot peppers to do better than field grown other than the hybrid habaneros.

EGGPLANT

Eggplant is more sensitive to setting in heat and cold than other solenaceous plants so not all varieties will work.

Try our new A-1014, just keep it picked. You cannot do better for quality or earliness, plus it is splinelss and snaps easily from the plant. It will set well in cool weather but may take a break mid-summer.

For a striped eggplant Johnny's offers Angela.

The Sicilian eggplant Barbarella will work for an early start but not keep going too well.

Japanese and Chinese types, and many Indian eggplant do so well and so early outside I wouldn't give them tunnel space.

GRAFTING HIGH TUNNEL TOMATOES TO REDUCE YELLOW SHOULDERS

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High tunnels have allowed producers to extend the growing season and increase the production of tomatoes for fresh market sales. Many high tunnel producers utilize common varieties of tomatoes used in field or garden production. These varieties often have problems with fruit quality when grown in tunnels compared to greenhouse varieties. However, producers continue to prefer to use these varieties because of customer demand. The variety, 'Big Beef' is popular with fresh market and auction producers. 'Big Beef' produces an early large fruit that has excellent flavor. Customers often ask for the variety by name and pay more for the variety at the produce auction. The major problem with the variety 'Big Beef' is that it often develops yellow shoulders disorder (YSD) during the mid-part of the growing season.

YDS is a ripening disorder in which the top of the fruit remains green or turns yellow. The underlying tissue of the tomato is white, hard and poor tasting. The larger the yellowing on the top of the tomato indicates more severe damage to the fruit. Fruits with even moderate amounts of YSD cannot be sold for fresh market or packed at #1 or #2 fruit at the produce auction.

YSD is complex and while not completely understood the factors that are typically found in plants that have fruit with YSD is lower potassium levels in the plant. Lower plant potassium can be caused by high temperatures in the root zone which reduces potassium uptake. Increasing amounts of YSD can also be made worse by plants that have heavy fruit loads, plant disease, insects and too little water.

Grafting tomatoes and other fruiting vegetables has been practiced for several years around the world. The majority of the grafting has been to reduce soil disease problems on production. Only recently have researchers looked at the benefits of nutrient uptake on yield and fruit quality of plants grown in non-disease soil conditions. In 2007 and 2008, a group of researchers from North Carolina State University compared yields and nutrient uptake of grafted versus non-grafted indeterminate tomato plants grown in high tunnels. The nutrient content of leaf tissue was higher in grafted plants including potassium. In 2014, Jerry Brust, University of Maryland Vegetable Extension Specialist, conducted research on the heirloom variety 'Cherokee Purple' to compare the increased yield and quality in a non-diseased high tunnel. In his study he found that grafted plants had an average of 18% greater leaf tissue nutrient concentrations of nitrogen and potassium. Yields were increased by 25%, with 30% greater marketable fruit on grafted plants.

With research indicating that grafting tomato plants can increase nutrient uptake of the key nutrient potassium, a proposal was submitted to Northeast SARE to evaluate the value of grafting the variety 'Big Beef' onto a proven rootstock to increase yield and reduce the amount of YSD. The research was conducted in 2016 on five farms in Garrett County, Maryland in six different high tunnels. Producers were provided with 50 'Big Beef' tomato plants grafted on to 'Maxifort' root stock. The grafted plants were purchased from an experienced grower in Pennsylvania. The plants were received in 72 cell trays on March 25th and were transplanted into 4" round pots and grown in a greenhouse until being transplanted into the high tunnels between April 20th and May 5th. Growers planted two 25 plant blocks of grafted plants in their high tunnels in rows with 'Big Beef' non-grafted plants. Producers used their own production practices to raise the plants. Ten plants of both grafted and non-grafted plants in each of two locations were identified before the harvest season started for weighing and evaluation of YSD. Once the harvest began, producers harvested fruit on their typical harvest schedule. They weighed and counted the number of fruit from the twenty identified grafted plants and twenty non-grafted plants. The producers also evaluated each fruit for the YSD giving the fruit a rating of 0 (no evidence of YSD) to 4 (high degree of YSD) compared to a pictorial chart provided by the researcher.

Results: Grafted plants exceeded the yield of non-grafted plants in all six tunnels by an average of 5.15 pounds per plant which is a 26% increase in production. The variation in increased production ranged from 2.94 pounds per plant to 7.47 pounds per plant (Table 1).

Table 1 Increased Yield Per Plant

High Tunnel	Grafted lbs/ plant	Non-Grafted lbs/plant	Increase lbs/ plant	% Increase per plant
NY1	31.70	24.23	7.47	24%
NY2	29.58	23.59	5.99	20%
0LH	29.75	24.39	5.36	18%
FP	18.33	12.75	5.58	30%
MH	9.70	6.75	2.94	30%
LL	11.68	8.09	3.59	31%
AVG			5.15	26%

Due to large variations in increased yield, the difference between grafted and non-grafted plants was not statistically different.

When comparing the difference in YSD, the ratings were separated into fruit with a rating of 0, 1 & 2 which was considered marketable for fresh market tomatoes and a rating of 3 & 4 which was considered non-marketable as a fresh market tomato. Most producers sold the tomatoes rated as 3 or 4 as canning or juicing tomatoes. The results of the YSD was wide among both the grafted and non-grafted plants ranging from 98.7 % to 48.2% in the marketable category in grafted plant and 96.6% to 50.9% of marketable in the non-grafted plants. Five of the six high tunnels showed a higher percentage of marketable fruit in grafted plants. The average marketable fruit was 4.6% greater in the grafted versus non-grafted plants (Table 2).

Table 2 - Quality Difference Per High Tunnel

High Tunnel	% of Marketable Fruit Grafted Plants	% of Marketable Fruit Non-Grafted Plants	Difference
NY1	98.7%	96.6%	2.1%
NY2	98.8%	94.5%	4.2%
LH	79.7%	68.4%	11.3%
FP	97.3%	93.5%	3.8%
MH	48.2%	50.9%	-2.6%
LL	92.6%	75.5%	17.1%
Average	89.5%	84.9%	4.6%

Again due to large variations of the percent of fruit in the marketable category, the difference between grafted and non-grafted plants was not statistically different.

The bottom line for each of these farms is if the cost of using grafted plants is justified in additional yield and marketability of the fruit based on YSD. The additional cost of using grafted plants is based on the cost to purchase (including shipping) grafted plants. Grafted plants range in cost from just over $2.00 per plant to as much as nearly $4.00 per plant. Our plant cost was $2.25 per plant for the grafted plants and $.25 per plant for non-grafted plants. At a price of $1.50 per pound for marketable fruit, the grafted plants averaged a value of $29.38 per plant while the

non-grafted plants averaged $20.96 per plant for an increase value of $8.41 per plant for grafted plants (Table 3).

Table 3 Value of Marketable Fruit

	Grafted/ plant	Grafted/ plant	Change in Value
NY1	$ 46.92	$ 35.12	$ 11.80
NY2	$ 43.82	$ 33.45	$ 10.37
LH	$ 35.57	$ 25.04	$ 10.53
FP	$ 26.75	$ 17.89	$ 8.86
MH	$ 7.02	$ 5.15	$ 1.86
LL	$ 16.22	$ 9.17	$ 7.05
Average	$ 29.38	$ 20.97	$ 8.41

Five of the six tunnels exceeded the additional cost of $2.00 per plant for the grafted plants. It is also noteworthy in this year's research that the three tunnels with the highest production per plant had an average increased value of $10.90 per plant compared to the $5.93 for the three lower producing high tunnels. This might indicate that grafted tomato plants are profitable even at high production levels. Since the price of grafted tomato plants varies greatly among suppliers and the price of marketable tomatoes vary among producers, we looked at the profitability among six high tunnels with the price of grafted plants ranging from $4.00 to $1.50 per plant and the price of tomatoes ranging from $.75 per pound to $2.00 per pound. At the higher plant cost ($4.00 per plant) and the lowest marketable price ($.75) 4 of the 6 high tunnels showed increased profit from raising grafted tomato plants (Table 4).

Table 4 - Profit per Plant at Various Market Prices and Cost of Grafted Seedling

		Market price of Tomatoes/lb $ 0.75	Cost of Grafted Seedlings per plant			
			$ 4.00	$ 3.00	$ 2.00	$ 1.50
High Tunnel	Pounds Marketable Fruit per Plant - Grafted	Pounds Marketable Fruit Per Plant - Non-Grafted	Profit Per Plant			
NY1	31.28	23.41	$ 1.90	$ 2.90	$ 3.90	$ 4.40
NY2	29.21	22.30	$ 1.18	$ 2.18	$ 3.18	$ 3.68
LH	23.72	16.69	$ 1.27	$ 2.27	$ 3.27	$ 3.77
FP	17.83	11.92	$ 0.43	$ 1.43	$ 2.43	$ 2.93
MH	4.68	3.44	$ (3.07)	$ (2.07)	$ (1.07)	$ (0.57)
LL	10.81	6.11	$ (0.47)	$ 0.53	$ 1.53	$ 2.03

If the price of tomatoes is raised to $1.00 per pound or the cost of the grafted tomato plant seedlings is reduced to $3.00 five of the six high tunnels showed a profit above the cost of the grafted seedlings. For the high tunnel exhibiting the lowest increase in yield a market price of $2.00 per pound of fruit and a cost of $2.00 or less for grafted seedlings would be required to have an increased profitability with grafted tomato plants in this research. This does indicate that even with low marketability and low production that if a producer purchases grafted plants for a reasonable cost and has a high value market that grafted plants can be profitable.

This research has been funded by Northeast SARE for a two year study. We plan to repeat the study in 2017 in the same 6 high tunnels. We do plan to have smaller plot sizes and increased data points so that we can compare yields and YSD in each individual high tunnels.

PLUSSES AND MINUSES OF HIGH TUNNEL STRAWBERRY PRODUCTION

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The advantages of high tunnel production – a longer growing season, better control over growing conditions, and reduced disease and insect pressure – apply to strawberries as much as any crop. The high value of a strawberry crop coupled with significant potential for crop loss from poor weather conditions during harvest in the field, plus the susceptibility of strawberries to a number of disease and insect issues, are additional reasons why much of the world's strawberry production outside of the U.S. is under tunnels. However, in order for high tunnel strawberry production to be feasible, yield and prices obtained must justify the additional costs in funds and labor.

Grower survey results

A survey of high tunnel berry growers had been conducted in 2010 and 2011. Among the respondents, 36 had tried growing June-bearing strawberries and 35 had tried growing day-neutrals in high tunnels. About twice as many growers of June-bearers grew them in single-bay tunnels compared to multi-bay tunnels, and thus tended to have smaller acreages, whereas producers of day-neutrals were equally split between single-bay and multi-bay production. This is logical, since growers who had single-bay tunnels would have been able to keep them covered for the winter, so fall planting and spring production from June-bearers would be very-doable. With multi-bay tunnels, covering the tunnel from spring to fall, and then removing the plastic for the winter matches up well with the planting and production cycle for day-neutrals. It's also possible that day-neutral growers needed larger acreages if selling to wholesale markets.

The top reasons why growers of June-bearers used tunnels were to improve fruit appearance (56% of respondents), to allow harvest during rain (47%), and to increase yield, increase fruit size, and protect the crop from the rain (all at 41%).

The top reasons why day-neutral producers used tunnels were to improve fruit appearance (66% of respondents), to increase yield (56%), to extend the harvest later into the fall (54%), to protect the crop from the rain (51%), and to allow harvest during rain (49%).

Of the 36 growers who tried growing June-bearers in tunnels, 14 stopped growing them and switched to other crops, but of the 22 who were continuing with production, 9 planned to increase high tunnel strawberry acreage, 11 planned to keep it the same, and 2 planned to decrease it for future years. Of the 35 who tried day-neutrals, only 6 switched to other crops, and of the 29 who were continuing with production, 19 planned to increase high tunnel acreage, 7 planned to keep it the same, and 3 planned to decrease it. From these results, it appeared that growers felt that day-neutral production was more feasible than June-bearers production, but even some of the growers of June-bearers were satisfied enough to have plans to expand.

The reasons growers gave for discontinuing strawberry production were similar whether growing June-bearers or day-neutrals - most commonly that prices they could obtain did not justify tunnel costs, that they found more profitable crops to grow, or that it took too much labor to manage the tunnels. A few felt that field production was easier.

However, over half of the growers who were continuing production and who were also growing strawberries in the field, reported that they were able to obtain slightly higher prices (up to 25% higher) for their high tunnel than their field-grown strawberries, or that they were able to obtain higher prices for both after they started producing in tunnels.

Kathy Demchak has been at Penn State since 1983, working first in the area of vegetable and tree fruit nutrition and later in berry crops. Recent research projects have included work on blueberry cultivar evaluation, blackberry cultivar evaluation and cold-hardiness, high tunnel production of strawberries, raspberries, and blackberries, and day-neutral strawberry production. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She happily lives in a rural area of Centre County, with husband Jeff, and sons Tim and Jeff.

Other issues were cost of the building and maintaining the tunnels, temperature management, and spider mite management, but these applied to tunnel production in general rather than just high tunnel berry production.

The bottom line was the high tunnel strawberry production worked out well for some growers, and simply wasn't feasible for others. If high tunnel strawberry production is to be a viable option, reliable production methods must be in place that result in high enough yields and prices to justify the cost of the tunnel.

Plusses and Minuses of Production Options

June-bearers or day-neutrals?

The grower results discussed above indicated a generally better success rate when growing day-neutrals compared to June-bearers. There are probably certain instances, however, when June-bearers might work well, such as if plug plants are planted in the fall, fruited for a spring crop that captures high early season prices, and then are removed in time for planting a summer crop. Day-neutrals, on the other hand, can be planted in the spring from dormant stock, preferably as early as possible, and then fruited for the remainder of the growing season through the fall. The plants may take a break from production if temperatures get too high, though 'Albion' plants in our research tunnels fruited well throughout the summer. This currently seems to be the day-neutral cultivar of choice for growers in the northeastern U.S.

Single-bay or multi-bay tunnels (or low tunnels)?

Single-bay tunnels are more expensive per square foot of area than multi-bay tunnels - which are more frequently used for strawberry production elsewhere. In terms of efficiency of labor used for tunnel management, single bay tunnels are also fairly expensive. They are however, more manageable for small or diversified operations where only a small area of production is needed. Another option worth considering, which is outside of the area of this talk, is low tunnels, which are cheaper than high tunnels, but still require a fair amount of labor for management.

In-ground or containerized production?

Grower have been interested in containerized production for some time, and many have tried various systems including vertical ones while meeting with varying degrees of success. Containerized production adds another layer of costs to the operation, which vary depending on the containers and media used. It is of utility in situations where root diseases, nematodes, or poor soil quality are issues. Vertical systems make sense in that a greater number of plants can be planted per area, but root systems are then exposed to much greater temperature fluctuations since their temperature follows air temperature rather than being moderated by ground temperature. Though data on strawberry root temperature effects on strawberry growth are limited, it appears that both root survival and nutrient uptake can be negatively affected by very warm soil temperatures (mid 80's), which may explain some of the difficulties encountered in growing strawberries in vertical systems in our region, besides issues with shading of the lower plants in vertical systems.

Over the years, both June-bearing and day-neutral strawberries have been grown at Penn State's high tunnel facility in the ground in a plasticulture system, in permanent raised beds, in gutters, and more recently in gro-slabs and grow-bags. Of these, in-ground production in the plasticulture system was the easiest. Production in gutters was "fussy", and we had difficulties with maintaining the correct soil moisture levels, and avoiding micronutrient deficiencies during the summer, though these disappeared once we encountered cooler temperatures in the fall. Gro-slabs, which are white-on-black plastic sleeves, worked but because they are not very deep, are not very forgiving if the media is too porous or holds too much moisture. We are currently growing day-neutrals in 1-gallon grow bags, which has worked well.

In a comparison of 4 types of media (coir, Metromix 360, 2:1 peat:perlite, and 2:1:2 peat:perlite:coir) in gro-slabs, what worked best was the 2:1 mixture of peat:perlite. This provided a good combination of moisture holding capacity with excellent drainage. We mixed the media ourselves, since with our high bicarbonate-high pH well water at the site, felt that starting out with a media where the pH was a little low would be better than using a mix that

contained added lime. Going with the slightly deeper 1-gallon containers as opposed to gro-slabs has given us some "wiggle room" related to both drainage and water capacity. We use a soluble fertilizer that provides 100 ppm N and water whenever the media begins to dry out, and for a long enough time to allow some flushing of salts from the bags. Because of our high bicarbonate levels, we've used either of two different fertilizers made for high bicarbonate water (Peters pHLow 18-18-18 or Plant Marvel 20-7-20), which drop the pH of the irrigation water by about one unit, and kept nutrients from precipitating out.

Organic, conventional, or pesticide-free?

One of the questions to consider is… What do tunnels allow you to do that you can't do as well in the field? High tunnel production has a different set of pest problems from field production, but most are easy to control with beneficial predators or "soft materials" if the problems are caught early enough. The main pest issue growers identified in our survey was two-spotted spider mites, which can be relatively easy to control with predatory mites while populations are still low and if broad-spectrum insecticides are avoided. Disease issues have been minimal, with the exception of powdery mildew when the very susceptible cultivar 'Seascape' was grown. So, organic or pesticide-free production is quite feasible, and worth considering especially if a premium price for the berries can be obtained.

High Tunnel Production Elsewhere

In the introductory paragraph of this article, it was mentioned that tunnels are frequently used for strawberry production in much of world. Why is that the case in other locations but not in the U.S.? Just like here, it all comes down to economics. Most commonly, larger-scale tunnels are used that are relatively economical to build, thus being feasible for use even when relatively low (i.e., wholesale) prices are received - though often the berries produced in these scenarios are "off-season", such as for the winter market. In other situations where even high-cost greenhouse production is used, prices that consumers are willing to pay are also high – usually higher than prices obtained in the U.S.

For more information on production of berries in tunnels and research related to the project "Optimizing Protected Culture Environments for Berry Crops", visit www.tunnelberries.org

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SUMMER SQUASH PRODUCTION

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Introduction

Summer squashes (Curcurbita pepo) are warm-season cucurbits that are harvested when the fruits are immature. The most common summer squash types include yellow (crookneck and straightneck) and zucchini. Also included in the summer squash group are scallop squashes and cocozelle. Summer squashes grow on plants with a bush growth habit, rather than vining.

Marketing and Market Outlook

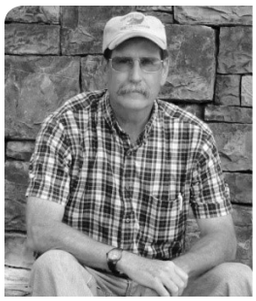
Marketing options for growers of summer squash include wholesale markets, farmers markets, community supported agriculture (CSA) subscriptions, and roadside stands. Squash is also a mainstay at local produce auctions. Sales to local retail markets, such as supermarkets, are also a viable option. Wholesale production is also possible and more profitable when producers are able to use season extension techniques to capture early or late markets. Although not as profitable as other summer produce, summer squash is an essential crop in a farmers market or roadside stand fresh vegetable mix. Some producers have discovered profitable niche markets selling edible squash blossoms to restaurants. Summer squash can also be utilized in value-added products such as breads and relishes.

Production Considerations

Summer squash cultivars differ in fruit characteristics (shape and color), growth habit (open or compact bush), earliness, and disease resistance. Crookneck squash typically have yellow skin with a crook or bend at the stem end, while straightneck are yellow squash that taper to the stem end but lack the crook. Zucchini squash usually are long and cylindrical, though there are some that tend more toward round, with skin that can be various shades of dark green. The cocozelle squash, often referred to as Italian zucchini, are green with lighter stripes. Scallop squash types, such as Patty Pan, are circular and flattened with scalloped edges; the skin may be green, white, or yellow. Because of this diversity among summer squashes, it is important to select those varieties with the qualities in demand by the intended market. In addition, growers should select well-adapted cultivars with disease resistance whenever possible.

Straightneck Squash

- **Cougar** -- smooth, well-proportioned neck to bulb, yellow hybrid, slight notch at stem end; "precocious yellow gene"; 40 to 45 days to harvest.
- **Enterprise** -- shiny, light yellow hybrid; smooth glossy skin; light green stem; short stem with long tapered bulbous end; 40 to 45 days after harvest.
- **Fortune** -- smooth, bright yellow hybrid; "precocious yellow gene"; average stem to bulb proportion; 40 to 45 days until harvest.



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- **Goldbar** -- very straight, uniform, golden yellow hybrid; easy to harvest; 47 to 50 days to harvest.
- **Lemon Drop L** -- creamy yellow hybrid; smooth glossy skin; early; 41 days to harvest.
- Liberator III -- creamy yellow hybrid; smooth glossy skin, early; Transgenic resistant to cucumber mosaic virus, watermelon mosaic virus and zucchini yellow mosaic virus; 40 to 45 days after harvest.
- **Lioness** -- shiny, light yellow hybrid; smooth glossy skin; green stem with tapered end; Resistance to cucumber mosaic, papaya ringspot, watermelon, and zucchini yellow mosaic viruses; very vigorous plant; 45 to 50 days to harvest.
- **Monet** -- short fruit; yellow hybrid; "precocious yellow gene;" resistant to cucumber mosaic and watermelon mosaic virus; 45 to 50 days to harvest
- **Multipik** -- yellow hybrid; "precocious yellow gene;" very prolific fruit set which may reduce fruit size and become too small under cool growing conditions; 50 days to harvest.
- **Seneca Prolific** -- creamy, yellow hybrid; high yielding; shape and color are very uniform; 47 to 50 days to harvest.
- **Superpik** -- yellow hybrid; "precocious yellow gene"; long fruit; 50 days to harvest.

Crookneck Squash

- **Destiny II** -- yellow hybrid; transgenic with cucumber mosaic and watermelon mosaic virus resistance; 40 to 45 days to harvest.
- **Dixie** -- leading bright yellow crookneck hybrid; early; yields well; 40 to 45 days to harvest.
- **Gentry** -- semi-crookneck, shiny, yellow hybrid; smooth glossy skin; short length handle with large bulbous end neck; small stem scar; 42 to 46 days after harvest.
- **Prelude II** -- smooth, dull yellow hybrid; green stem, average handle-length to bulb-size proportion; skinny, refined handle; transgenic with cucumber and watermelon mosaic virus resistance; 42 to 46 days to harvest.
- **Supersett** -- yellow, semi-crookneck; "precocious yellow gene"; 50 days to harvest.

Scallop

- **Early White Bush** -- most popular, scalloped type variety; flattened, uniformly white with a tinge of green; 47 days to harvest.
- **Peter Pan** -- excellent quality hybrid; good yield; light green; 52 days to harvest.

Zucchini

1. **Elite** -- dark-green hybrid; uniform color, shape and length; 47 to 50 days to harvest.
2. **Senator** -- hybrid; cylindrical fruit 5 to 7 inches long; early; glossy medium green; 40 to 45 days to harvest.
3. **Spineless Beauty** -- hybrid; cylindrical, medium-dark green, spineless stems; tendency to be short on first pick; 43 days to harvest.

Certain cultivars contain the precocious yellow gene, which results in clear yellow stems rather than traditional green stems. Cultivars with the precocious yellow gene will also retain their normal yellow coloring longer when infected with some virus(es) (precocious yellow stem types noted above). In addition to those cultivars containing the precocious yellow gene, improved disease-resistant squash cultivars are being developed in the laboratory by inserting genes with virus resistance. These virus-resistant (transgenic) varieties have been available to growers since the mid-1990s and may permit fall squash production in areas where viruses have been particularly troublesome.

Site Selection and Planting

Summer squash produces best in well-drained soils. This crop is usually grown for an early summer market or for an early fall market (harvested when prices begin to rise in September). Squash is a warm-season crop that should not be seeded until all danger of frost has passed. Black plastic on raised beds with drip irrigation will speed soil warming and can dramatically increase early and total summer squash yields. Seed or transplants can be planted directly through the plastic either by hand, with a waterwheel setter, or with machinery designed for direct seeding through plastic. Growers producing squash for the late summer/early fall market usually encounter serious virus disease problems and should plant either a variety with the precocious yellow trait that masks virus symptoms or one with virus resistance. If bees are not abundant in the field at flowering time, hives should be placed next to the field, with at least one hive per acre. The use of metallize silver mulch can aid in reducing the aphid population and thus reduce the virus on later season squash crops.

Pest Management

Potential disease problems include Choanephora fruit rot, scab, and Phytophthora blight. Viruses, downy mildew, and powdery mildew mainly cause losses in late summer and fall plantings. Diseases are managed with sequential planting, crop rotation, resistant varieties, sanitation, and fungicides. Cucumber beetles (striped and spotted), squash vine borer, spider mites, and squash bugs can become serious pests if not controlled. Scouting to monitor populations can help the grower determine when and how often insecticides should be applied. Special precautions should be taken with insecticide treatments during bloom to avoid damaging bee populations. Weed management options include herbicides, shallow cultivation, and/or the use of plastic mulch. Avoid planting in sites with a serious noxious perennial weed problem.

Harvest and Storage

Harvest summer squash at the proper size for your market and before the skin becomes tough and hard. The skin should still have a glossy appearance. Fruit will be ready for harvest two to five days after flowers have fully opened. Squash should be cut from the plant leaving a portion of the stem attached to the fruit. Fruit must be handled very gently to avoid scarring. Harvests may be required every other day or even daily. This crop is normally sold on the fresh, wholesale market in ½-bushel waxed cardboard cartons or bushel carton or wire bound crates. Squash in each crate or carton should be uniform in size to meet the produce buyer's count and weight requirements. Whenever possible, summer squash should be marketed quickly and not stored.

Labor Requirements

Labor needs per acre for summer squash grown on black plastic mulch with drip irrigation are approximately 25 hours for production, 130 hours for harvest, and 100 hours for packing/grading. An additional minimum of 10 hours per acre is needed for plastic removal following harvest. There are some options for recycling black plastic and drip tape such as "Ron the Bagman" www.ronthebagman.com so do not waste your plastic; a plastic roller that reels up the plastic and drip tape will speed the process and reduce the volume of material that needs to be disposed of.

Economic Considerations

Initial investments include land preparation and the purchase of seed or transplants. Additional start-up costs can include the installation of an irrigation system and plastic mulch. Production costs for plasticulture yellow crookneck summer squash are estimated at $1,590 per acre, with harvest and marketing costs at $4,250 per acre. Total expenses per acre, including both variable and fixed costs, can exceed $6,000 per acre.

TIPS FOR SUCCESSFUL DRIP IRRIGATION

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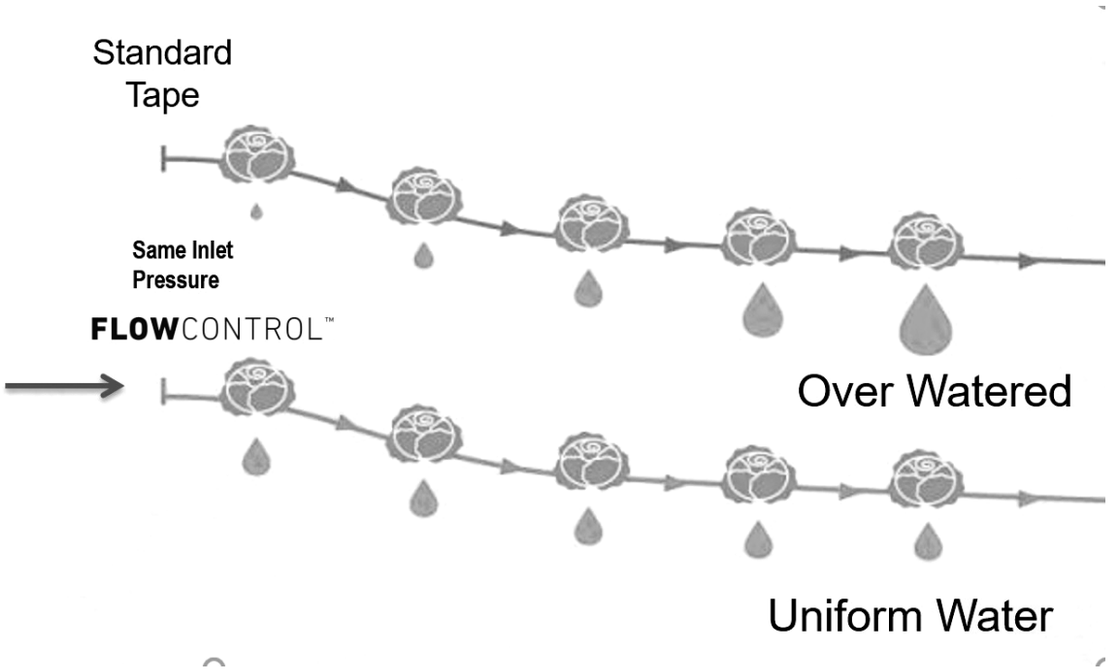
Success with drip irrigation, like success with anything, starts with planning. A good plan will help you avoid problems and wasted dollars such as planting high dollar crops in some areas that have disease, flood out or have other problems every year. To begin with, you determine what crops you plan on planting and where. Are you going to use drip irrigation with or without plastic mulch? What is the water source and volume available, with this can determine how much area you can water or how much water you can apply at one time? What are the water quality and what filtration is needed? Is treatment needed for algae, iron or other problems?

To help select the proper drip irrigation you need to know what is the soil type and plant spacing to help determine which drip tape spacing and flow to use. A minimum of 8 mil tape is typically used to minimize insect damage. Is the field flat or does it have over 6 to 8 feet of elevation change? If so you should consider a pressure compensating or moderating drip tape so you get a more uniform water and fertilizer application. When you have a lot of slope classic drip tapes put out more water at the bottom of the hill, overwatering and over-fertilizing the bottom while underwatering and under-fertilizing the top of the hill giving you less crop. This problem can be alleviated by using Aqua Traxx Flow Control pressure moderating drip tape or a pressure compensating drip tape. Remember the slope is not only down the row but across the rows.



Row length is important because you can only put so much water down a hose, tape or lateral and if you see strong plants at the beginning of the row and shorter or weak plants at the end of the row, your length of run is probably too long. You may need to feed water both ways from the middle or part way up the tape. Your local Supplier or Irrigation Manufacturer should be able to help you with this.

Bill Wolfram is District Sales Manager for Toro Micro Irrigation and has over 20 plus years working with drip irrigation, including 14 years as manager for a large tomato growing operation in Florida, Georgia, California and Virginia, growing over 500 acres per year. He is a Certified Irrigation Designer by the Irrigation Association. His responsibilities include training and sales for Dealers and Growers in the Northeast for Toro Micro Irrigation. He has a BS and MA in Agriculture from the University of Florida currently lives in Accomac, VA with his wife Sheila.

GENERAL VEGETABLES

Know how much water you are applying and how long it takes to apply the water you need.
Below find a chart that gives you approximate lengths of runs for various tapes. These charts are based on flow (Q-100), pressure, 10 psi, and diameter of the tape. Remember other factors affect the length of run as well such as undulating terrain, pressure variations, and a uniform manifold or header pressure.

AQUA-TRAXX®

Emitter Flow Part Number	Q-100 gpm/100 ft
0.07 gph emitter	
EAXxx0817	0.17
EAXxx1609	0.09
0.09 gph emitter	
EAXxx0822	0.22
EAXxx1611	0.11
0.10 gph emitter	
EAXxx0825	0.25
EAXxx1613	0.13
0.13 gph emitter	
EAXxx0467	0.67
EAXxx0644	0.44
EAXxx0834	0.34
EAXxx1222	0.22
EAXxx1617	0.17
EAXxx1814	0.14
EAXxx2411	0.11
0.15 gph emitter	
EAXxx0650	0.50
EAXxx1225	0.25
EAXxx1817	0.17
0.20 gph emitter	
EAXxx04100	1.00
EAXxx0667	0.67
EAXxx0850	0.50
EAXxx1234	0.34
EAXxx1625	0.25
EAXxx1822	0.22
EAXxx2417	0.17
0.27 gph emitter	
EAXxx04134	1.34
EAXxx0690	0.90
EAXxx0867	0.67
EAXxx1245	0.45
EAXxx1634	0.34
EAXxx1830	0.30
EAXxx2422	0.22
0.34 gph emitter	
EAXxx04168	1.68
EAXxx06112	1.12
EAXxx0884	0.84
EAXxx1256	0.56
EAXxx1642	0.42
EAXxx1838	0.38
EAXxx2428	0.28
0.53 gph emitter	
EAXxx04265	2.65
EAXxx08133	1.33
EAXxx1288	0.88
EAXxx1666	0.66
EAXxx2444	0.44
EAXxx3629	0.29

⅝" DIAMETER
Length of Run (ft) @ 10 psi for 90% EU

	Slopes				
Q-100	-2%	-1%	0%	+1%	+2%
0.09	240	456	1441	1874	318
0.11	259	481	1298	1719	368
0.13	237	442	1148	1523	337
0.14	256	462	1074	1424	1249
0.17	255	454	999	1324	1216
0.22	249	424	835	1095	1074
0.25	246	411	762	987	996
0.28	243	397	699	910	924
0.29	243	392	687	885	907
0.30	243	387	674	874	896
0.34	240	381	645	824	849
0.38	236	362	586	737	774
0.42	231	347	544	683	772
0.44	231	343	537	674	712
0.45	230	341	524	650	695
0.50	224	324	487	608	649
0.56	218	311	449	555	597
0.66	212	291	410	499	537
0.67	212	293	412	505	544
0.84	196	261	349	418	449
0.88	193	256	341	406	437
0.90	193	255	337	399	431
1.00	187	240	312	372	399
1.12	180	228	291	341	368
1.33	169	211	262	305	330
1.34	168	209	259	299	324
1.68	155	186	224	256	277
2.65	128	145	168	187	202

⅞" DIAMETER
Length of Run (ft) @ 10 psi for 90% EU

	Slopes				
Q-100	-2%	-1%	0%	+1%	+2%
0.09	240	474	2532	649	308
0.11	262	512	2276	774	343
0.13	240	473	2018	712	310
0.14	261	506	1899	2357	348
0.17	261	505	1763	2241	349
0.22	259	493	1468	1924	356
0.25	259	486	1340	1771	362
0.28	258	479	1233	1641	374
0.29	258	474	1207	1599	374
0.30	258	474	1191	1574	379
0.34	256	468	1134	1499	1244
0.38	256	456	1024	1365	1233
0.42	253	447	949	1263	1185
0.44	253	443	933	1224	1166
0.45	253	442	922	1216	1157
0.50	252	431	862	1132	1099
0.56	249	418	796	1037	1033
0.66	246	399	720	933	947
0.67	246	404	724	945	958
0.84	237	372	612	783	812
0.88	237	367	599	762	796
0.90	237	362	591	749	787
1.00	233	349	554	698	736
1.12	228	336	512	637	674
1.33	221	312	462	572	611
1.34	218	312	456	562	604
1.68	209	284	393	479	516
2.65	183	231	297	349	375

HOW TO DETERMINE LENGTH OF RUN

1. Find the Q-100 (gpm/100 ft) that corresponds to desired Emitter Flow Part Number.
2. Go to desired Tubing Diameter chart and match the Q-100 (identified above) with desired slope % (uphill = negative, downhill = positive) to find length of run in feet.

To help calculate how much water you need and how much you are applying I have attached two charts. The first determines Feet of Tape per acre and the Gallons per Acre Per Minute using the Q-100 and the spacing of the tapes in the row. A mature crop could take up to 1.5 to 2 inches of water per week at peak.

Row Spacing	Feet of Tape per Acre			(27154 Gallons) Gallons Per Minute Per Acre							
Inches	43,560	SQ. FT.	Q 100	0.17	0.22	0.25	0.34	0.45	0.50	0.67	1.00
12	43,560	FT / AC		74.1	95.8	108.9	148.1	196.0	217.8	291.9	435.6
24	21,780	FT / AC		37.0	47.9	54.5	74.1	98.0	108.9	145.9	217.8
30	17,424	FT / AC		29.6	38.3	43.6	59.2	78.4	87.1	116.7	174.2
36	14,520	FT / AC		24.7	31.9	36.3	49.4	65.3	72.6	97.3	145.2
42	12,446	FT / AC		21.2	27.4	31.1	42.3	56.0	62.2	83.4	124.5
48	10,890	FT / AC		18.5	24.0	27.2	37.0	49.0	54.5	73.0	108.9
54	9,680	FT / AC		16.5	21.3	24.2	32.9	43.6	48.4	64.9	96.8
60	8,712	FT / AC		14.8	19.2	21.8	29.6	39.2	43.6	58.4	87.1
66	7,920	FT / AC		13.5	17.4	19.8	26.9	35.6	39.6	53.1	79.2
72	7,260	FT / AC		12.3	16.0	18.2	24.7	32.7	36.3	48.6	72.6
78	6,702	FT / AC		11.4	14.7	16.8	22.8	30.2	33.5	44.9	67.0
84	6,223	FT / AC		10.6	13.7	15.6	21.2	28.0	31.1	41.7	62.2
96	5,445	FT / AC		9.3	12.0	13.6	18.5	24.5	27.2	36.5	54.5
120	4,356	FT / AC		7.4	9.6	10.9	14.8	19.6	21.8	29.2	43.6

Q-100 is the flow in gallons per min per 100 feet of lateral or tape.

Row Spacing	FT of Tape / AC			Run Time for 1 Acre Inch in Hours							
Inches	43,560	SQ. FT.	Q 100	0.17	0.22	0.25	0.34	0.45	0.50	0.67	1.00
12	43,560	FT / AC		6.11	4.72	4.16	3.06	2.31	2.08	1.55	1.04
24	21,780	FT / AC		12.22	9.45	8.31	6.11	4.62	4.16	3.10	2.08
30	17,424	FT / AC		15.28	11.81	10.39	7.64	5.77	5.19	3.88	2.60
36	14,520	FT / AC		18.33	14.17	12.47	9.17	6.93	6.23	4.65	3.12
42	12,446	FT / AC		21.39	16.53	14.55	10.70	8.08	7.27	5.43	3.64
48	10,890	FT / AC		24.45	18.89	16.62	12.22	9.24	8.31	6.20	4.16
54	9,680	FT / AC		27.50	21.25	18.70	13.75	10.39	9.35	6.98	4.68
60	8,712	FT / AC		30.56	23.61	20.78	15.28	11.54	10.39	7.75	5.19
66	7,920	FT / AC		33.61	25.97	22.86	16.81	12.70	11.43	8.53	5.71
72	7,260	FT / AC		36.67	28.34	24.93	18.33	13.85	12.47	9.30	6.23
78	6,702	FT / AC		39.72	30.70	27.01	19.86	15.01	13.51	10.08	6.75
84	6,223	FT / AC		42.78	33.06	29.09	21.39	16.16	14.55	10.85	7.27
96	5,445	FT / AC		48.89	37.78	33.25	24.45	18.47	16.62	12.41	8.31
120	4,356	FT / AC		61.11	47.23	41.56	30.56	23.09	20.78	15.51	10.39

Additional Tips for success include.

- It is also very important to understand the label and to keep a copy of the label for your records.
- Water frequently for short cycles in sandy soils or when beds are dry to wet them up and across.
- Water regularly and maintain moisture in your bed do not dry it out.
- Get an irrigation suitability test of your water.
- Check the pressure on your system to make sure it is designed correctly and working properly.
- Use Flow Control or other pressure compensating drip tape on slopes and undulating land. Elevation change is not just down the row but is across the row if on the same manifold/header.
- Flush and maintain your filter system as needed.
- Check filter disc's or screens or sand level in sand media filters.
- Check the ends of your system and flush your system as needed to help prevent clogging.
- Check and prepare you equipment before needed for the season.
- Check injection tubes for rust, burrs and wear.
- Open tape reels carefully so you do not cut through the sideboards/cardboard and cut the tape.
- When planting be aware of tape location and planter spike so as not to puncture the tape.
- If planting under clear plastic and using drip tape, make sure the drip tape is buried to prevent magnification or lens effect from sun burning the tape.

TRACEABILITY IN A GLOBAL MARKET

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The public's understanding of and appetite for food traceability information, fueled by recent food safety scandals, has never been greater. Traceability is a hot topic whether you are a fresh produce grower, shipper, packer, distributor, processor or retailer.

While most companies will never have food safety issues, it is imperative for all companies to be prepared.

In a 60 day period in 2016 the US Food & Drug Administration has posted details of 49 food related recalls, market withdrawals or food safety alerts. The reason for these recalls was varied and included problems such as; undeclared ingredients (18), presence of listeria (13), contaminants (6) and salmonella (6). Source: http://www.fda.gov/Safety/Recalls/

There is no magic way to predict when a food safety issue may arise, and businesses need to be prepared to have traceability data available at a moment's notice should a recall or market withdrawal be necessary. Business can prepare themselves by establishing, automating and maintaining a global audit trail.

Innovation and technology are always at the heart of problem solving. However, as with any system, procedures and accurate record keeping are critical for usability and success. A good mantra to follow is that even the best tracking and tracing systems become useless without real-time (as-it-happens) information. The use of technology to facilitate data capture removes duplication of effort or the need to re-key of data, thus eliminating errors and reducing labor. Electronic data, once captured, can be used repeatedly not only for traceability, but for business and operational planning.

In a recent Food Traceability Market (tracking technologies) Report, published by Allied Market Research the global market is expected to reach $14.1 billion by 2020, with RFID technology is expected to grow at the highest rate of 19.4% among all technologies of food traceability market.

The use of information technology coupled with industry specific business management or Enterprise Resource Planning (ERP) solutions gives producers and retailers the critical tools they need to accurately monitor produce from field to fork. This insightful and highly detailed information captured and delivered by this technology helps firms efficiently track and trace all aspects of a product's journey from planting and harvest, to raw material intake, production, and where it goes when it leaves the pack house or factory, including processes it's gone through along the way.

Robert (Rob) Frost is Founder Director at LINKFRESH. Since joining the company 1998 he has worked closely with the Board of Directors in realizing a new vision for the business. This has included moving the direction towards a progressive ERP consultancy business from its previous emphasis on hardware sales & support. Throughout this period the company has been successful in generating both profit growth & positive cash in all but one of the last nine years. LINKFRESH's headquarters is in Cambridge, UK. In 2010 the company began to evaluate international growth opportunities and has since established offices in California, USA, where Rob is based.

Rob is a LINKFRESH ERP evangelist and ambassador, working very closely with customers in the fresh produce industry ensuring that the LINKFRESH ERP solution exceeds expectations and delivers the forecasted benefits and efficiencies to the business. These benefits include increased supply chain visibility, full traceability, improved efficiencies, and reductions in waste as well as improved management reporting.

Between 1989 and 1998 Rob worked for Teleste, a Finnish Telcoms group that acquired his employer Labgear Cablevision Ltd. Rob was appointed business controller & company secretary of Teleste UK Ltd & was responsible in setting up this new company, building the foundations to facilitate rapid growth from £1Million to an annual turnover of £14 Million. He was responsible for contract negotiations with clients, including British Telecom and Cable & Wireless Communications. In addition he was responsible for all recruitment and had P & L responsibility and monthly reporting to HQ in Finland.

Robert's early career was in the finance departments of large organizations, notably the University of Cambridge & BUPA private healthcare provider.

In a manual, paper bound tracking process, the information is only available to people with access to the physical paperwork. With its electronic equivalent, the information can be shared immediately with the wider workforce to inform a number of business areas. This enables management to strategically manage business decisions and, when needed, to take rapid, pre-emptive actions to head off a potential customer relationship issue, such as a quality problem or order shortages. In addition, the information on produce origins and final destination essential to perform a comprehensive and efficient product recall procedure can be collated in minutes rather than the several hours taken to process the manual paper trail.

The ability to understand and comply with government regulations, such as the Produce Traceability Initiative (PTI), will require companies to invest in more sophisticated IT solutions to ensure they maintain accurate records. Modern ERP Solutions and remote mobile applications can provide the seamless integrated traceability back to the grower and grown location and field quality records, along with lot pack date.

However, at the moment the reality is that in most cases food safety monitoring or traceability processes still use manual, paper-based checks which are time consuming and carry a high risk of error and non-compliance compared with using an automated electronic data capture solution.

Global Audit Trails

Retailer audits are often perceived as a painful process to endure for food producers. To a certain extent this can be true, especially when reputations and processes are scrutinized as if under a microscope. However, aside from the obvious benefits of ensuring your business is equipped and ready to deal with any food safety issue or potential recall scenario, once a business embraces the critical need for a traceability audit trail and is confident in the processes and systems it has invested in, many business and competitive advantages can be realized.

Compliance and regulations are words commonly associated with traceability. However, a solid traceability audit capability offers significant benefits in other business areas, such as market development opportunities, better risk management, improved operational efficiencies and mitigation against food fraud.

Market development opportunities

Improved brand image and increased consumer confidence in your products opens up new market development opportunities to grow your market reach and customer base. An investment in a robust traceability audit system ensures that you are able to enter new markets with a competitive advantage. This can ease the process of overcoming barriers to market entry, including country specific, minimum track and trace regulatory requirements.

Risk Management

Traceability audits significantly reduce and potentially eliminate product recalls or emergency product withdrawals. As a result, associated costs or fines from any such recall or withdrawal also will be reduced.

In the event that a product recall or withdrawal does occur, the rapid availability of accurate traceability data ensures that only the affected goods are removed from sale and, more importantly, unaffected goods can confidently remain available for sale. This helps ensure a rapid recovery of normal business following a recall event. Additionally, it mitigates the impact of incorrectly halting production in a plant or production line, or incorrectly implicating a supplier.

Improved Operational Efficiencies

Any traceability system is underpinned by the accurate real-time collection of data on all stock movements and inventory levels. This ultimately allows a business to better manage its supply chain and more efficiently meet customer demand while rapidly reacting to last minute changes and ensuring more on-time-in-full deliveries. In addition, more accurate inventory management may result in reduced 'shrinkage' costs and less food waste.

Reduced Food Fraud

Improved traceability systems and processes help the industry eliminate illegal activities within the food supply chain. These may include supplier underpayments, operating without the correct certifications or licenses or ensuring the authenticity of raw materials at the point of supply. Traceability helps assure suppliers and customers

that what they are buying is legal, safe and fairly traded. Counterfeit or unfairly traded products threaten to cause a financial loss to legitimate businesses and carry a high risk of causing a food safety incidents, which could impact the entire industry.

Technology for Traceability

So, how can food supply chain technologies, such as enterprise resource planning (ERP) software, help establish a robust global audit trail and provide crucial visibility into your supply chain?

Many food organizations use ERP software, such as LINKFRESH. This real-time supply chain software provides the ability to track and trace all aspects of a product's manufacture from raw material intake, to production through its route and final destination after leaving the warehouse. Food industry ERP literally means you can follow the route of your ingredients and food products from farm to fork.

So how does it work? Each movement of an individual food product or ingredient through the supply chain is tracked using barcode scanning, providing a comprehensive traceability picture. This electronic data can be shared and analyzed to inform other critical business areas, such as Hazard Analysis and Critical Control Point (HACCP) policy requirements and quality assurance and supply chain audits. Additionally, the data provides real time business intelligence reporting on Key Performance Indicators (KPI's).

Technology brings new clarity and traceability to the global food supply chain, which will yield benefits to everyone from the producer to consumer. The ability to identify when, where, how and by whom foods products are sourced or produced means that suppliers and consumers alike can be more confident about the quality, safety and origins of their food. More importantly, companies can utilize the data to meet traceability, compliance, and consumer satisfaction, and to drive true competitive advantages, profitability and growth in the global marketplace. ERP systems will ensure the success of businesses in the food industry and the ability of companies along every step of the food supply chain to compete for years to come.

BIODEGRADABLE MULCH APPLICATIONS AND RESULTS

Dan Martens, Novamont

Since the 1960's agriculture has used a huge quantity of plastic products in short term, applications.

It has been estimated that consumption of plastic in agriculture in 2015 has been around 4 million of tons: 45 % for mulch film, 31 % for greenhouse and 24 % for silage.

Plastic films are essential tools in agriculture. They are used in various ways: for crop cycle extending, for increasing yield, to reduce chemical inputs and water use. The use of biodegradable plastic for mulching has steadily increased over the last decade.

Biodegradable mulch films, such the Mater-Bi® films, offer all the agronomical advantages of traditional plastic films and due to their biodegradability they can be left into the soil at the end of the crop cycle without Eco toxic effects. Thus eliminating the costs and time to remove film from the soil.

Data collected during 15 years of experimental and commercial activity show that biodegradable Mater-Bi® mulch films with different thickness can be used for several short, medium and long cycle crops like lettuce, melon, tomato, pepper, strawberry, grapevine and others. Trials comparing biodegradable films and traditional plastic films show on par performance in terms of yield, quality, and weed control.

This presentation will cover current applications in EU and North America. An overview of cost comparisons, performance and product grades will also be highlighted. Current North American research activity, and "other bio" alternatives will also be noted.

Dan Martens is the Commercial VP for Novamont North America. Novamont is the global leader in research and production of compostabile resins. Novamont is headquartered in Novara Italy with North American Headquarters in Shelton CT. Dan serves on the BPI board, the BPI Mulch Film workgroup and resides on SPI BioPlastics Division Steering Committee. Dan / Novamont is an advisory member to the North American SCRI Bio-mulch academic research group.

USING A RED CLOVER MULCH TO IMPROVE INSECT MANAGEMENT, YIELD AND ENVIRONMENTAL QUALITY IN PEPPERS AND CUCUMBERS

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Intensively managed vegetable systems often depend on pesticide and fertilizer applications to manage insect pests and provide adequate nutrients to plants. However, these applications can be harmful to beneficial arthropods and the environment, paradoxically sometimes leading to decreased profits and yields in the long-term. In light of declining global pollinator populations and increasing greenhouse gas emissions, it is necessary to identify alternative more sustainable production practices. We are researching the use of red clover as a living mulch to improve vegetable yields while maintaining environmental quality.

Figure 1: Cucumber inter-planted with red clover

Living mulches show promise in decreasing pest damage, Previous research has shown that living mulches can enhance natural enemies (Hinds & Hooks, 2013) and provide food (via pollen and nectar) for pollinators (Saunders, Luck, & Mayfield, 2013) when integrated into cropping systems. When red clover is interplanted into cash crops as a living mulch, and cash crop rows are strip tilled, less soil is disturbed, more soil is covered, and weeds in the inter-row areas are smothered by the clover. The added nitrogen from the strip-tilled clover adds natural fertilizer to the soil reducing the requirements of synthetic nitrogen. Previous research has suggested that these factors can reduce emissions of potent greenhouse gases, such as N20 and CO2. We sought to test whether red clover used as a living mulch can provide added benefits to vegetable cropping systems by promoting natural enemies, reducing pests, harboring pollinators, and reducing greenhouse gas emissions.

Red clover is a widely adaptable and durable cover crop that has the potential to grow in most climates. It has a longer growing season than annual clovers, and grows in relatively dense mass-flowering mattes. If mowed or cut, it rapidly regrows. Red clover's prized ability to provide fodder for livestock, add nitrogen to the soil, suppress weeds, and decrease erosion has already made red clover, along with other clovers, a popular cover crop. However, using red clover as an inter-planted living mulch is less common (Fig. 1). Yet, if allowed to grow continuously as a living mulch, then some of these benefits can be sustained over a longer time period.

For the summer of 2015, we compared green bell peppers inter-planted with red clover living mulch to bell peppers grown without a cover crop (monoculture) in Keedysville, Maryland at the Western Maryland Research and Education Center (WMREC). For the summer of 2016, we compared cucumbers inter-planted with red clover living mulch to cucumbers grown without a cover crop (monoculture) at WMREC and Upper Marlboro, Maryland at the Central Maryland Research and Education Center (CMREC). Throughout both summers, insect pest, natural enemy, and pollinator assemblages were monitored by weekly or biweekly visual observation of plants, collection with bee bowls, and sweep net samples. Yield data was collected by recording fruit quantity, weight, damage and quality (according to USDA standards). In 2016, sticky cards were used to help quantify cucumber beetle numbers and monitor their colonization of cucumber treatment plots. Additionally, N_2O and CO_2 greenhouse gas emissions were monitored and compared between treatments at CMREC.

Cerruti RR Hooks is an Associate Professor & Extension Specialists at the University of Maryland. He has a MS degree in Weed Science and PhD in Entomology. His areas of specialization are Conservation Biological Control, sustainable agriculture and Organic farming.

For both the 2015 and 2016 field seasons, we found that red clover living mulch reduced some economically important insect pests and increased natural enemies but had no effect on pollinator abundance or yield. In 2015, the major pests that caused damage to pepper fruits were various stink bugs (Family: Pentatomidae) and the European corn borer (*Ostrinia nubilalis*). While stink bug damage among harvested fruit was similiar among treatments, there was significantly more European corn borer damage and lower overall yield in the monoculture plots (Fig. 2). However, there was no significant difference between numbers of total herbivores, natural enemies, pollinators, and pepper quality between treatments. In 2016, the major pests that caused damage to cucumbers were striped cucumber beetles (*Acalymma vittatum*) and spotted cucumber beetles (*Diabrotica undecimpunctata*). There were less spotted cucumber beetles, more spiders, and less mis-shaped cucumbers in red clover plots, but there was no significant difference between treatments of striped cucumber beetles, pollinators, overall yield, or cucumber damage. The number of cucumber beetles on sticky cards and greenhouse gas emissions from the 2016 field season are currently being analyzed.

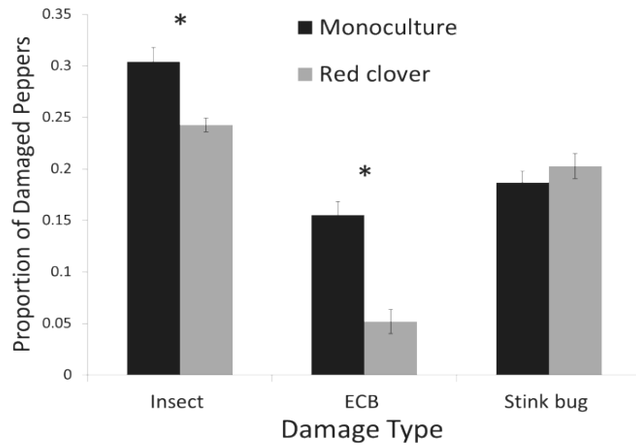

Figure 2. This graph shows the proportion of damaged peppers across damage type for the two treatments. The asterisks represents a significant difference at the $p<0.05$ level from chi-squared tests.

In conclusion, red clover living mulch can offer a wide range of benefits to vegetable systems. Red clover living mulch can decrease certain pest populations, increase spider populations, and improve the shape and overall yield of vegetables. Thus, the potential for red clover living mulch as a technique to manage pests and improve vegetable quality merits further research. Future research will continue to investigate how red clover living mulch impacts cucumber beetle colonization and greenhouse gas emissions.

References:

Bos, J.F.F.P., de Haan, J., Sukkel, W., Schils, R.L.M. (2014). Energy use and greenhouse gas emissions in organic and conventional farming systems in the Netherlands. Njas-Wagen. *J. Life Sci.,* 68, 61-70

Hinds, J., & Hooks, C. R. R. (2013). Population dynamics of arthropods in a sunn-hemp zucchini interplanting system. *Crop Protection*, *53*, 6–12. http://doi.org/10.1016/j.cropro.2013.06.003

Saunders, M. E., Luck, G. W., & Mayfield, M. M. (2013). Almond orchards with living ground cover host more wild insect pollinators. *Journal of Insect Conservation*, *17*(5), 1011–1025. http://doi.org/10.1007/s10841-013-9584-6

NEW HEATING TECHNOLOGY FOR HIGH TUNNELS

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Anglesea LLC

Please join us for an interactive look at a new infrared heating technology for high tunnels. One common area of agreement in the grower community seems to be the benefits of root zone heating. The benefits of elevating soil temperatures are well documented and include risk reduction through crop protection, expanded crop variety and time to maturity. This breakthrough technology will challenge the status quo by improving upon existing efficiencies, resulting in increased high tunnel productivity.

The presentation of this break-through technology will include a discussion on the science of infrared heating, an examination of materials currently deployed, grower testimony, and some early testing results. We appreciate the difficulty in assessing new tools without any reference point, so we have made materials available for growers to test independently. Little replaces your own feedback and grower needs vary by crop and climate, making hands-on experience invaluable. These solutions are modular, portable and scalable from a portion of a growing bed to an entire greenhouse.

For example, a trial now in its 3rd year deployed 4 rows of 5" tactical direct-soil heating to growing beds in a 30x36 high tunnel in Akron, OH. More marketable kale was produced at ½ the energy cost and 2 weeks earlier than the side by side tunnel heated with overhead forced air propane. Grower money goes where it belongs…directly into your product. Microgreen growers are also experiencing improved productivity in both time and energy expenditure, with the added benefits of a modular system.

Thank you for taking the time to hear about this truly innovative product solution. We look forward to hearing how we can be of service to your business.

SPRINGTIME DISEASES IN THE GREENHOUSE

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Spring is when everything is happening in the greenhouse—including, alas, the diseases. Fungi, water molds, bacteria and viruses all seem to be at their most active. Flower growers need to keep these problems in mind in order to prevent unpleasant surprises. The following are some of the key problems to strategize against.

Black Root Rot

One of the most persistent problems is black root rot, caused by Thielaviopsis basicola. This fungus can become established in greenhouses and return on crop after crop, year after year. It is primarily encountered on pansy, viola, vinca, petunia, and calibrachoa. Some other annuals and perennials are susceptible as well (e.g. bacopa last year). In the past, fuchsia and poinsettia were often troubled by black root rot. The main aboveground symptom is stunting, and this may be accompanied by yellowing or purpling of the foliage. It is easy to mistake black root rot for a nutritional problem. The root systems are also stunted, and if rinsed carefully the browning caused by accumulation of fungus structures (resting spores) may be visible: the roots are not softened, the way they are with Pythium root rot. Check incoming plugs for root health. Fungus gnats may play a major role in moving Thielaviopsis from pot to pot or up from the greenhouse floor into the crop, so keeping them managed is important for disease control. Biocontrols are helpful against fungus gnats, but are not especially valuable against the Thielaviopsis. Cultural controls can help: keep pH low to discourage the fungus (disease is greatest at pH 6.2 and higher), avoid poorly drained soil mix or cooler than desirable temperatures. Chemical control is achieved with thiophanate-methyl (3336, 6672, etc, in FRAC 1), rotated with fludioxonil (Medallion, FRAC 12), triflumizole (e.g. Terraguard, FRAC 3) and polyoxin-D (e.g. Affirm, FRAC 19). Sanitation is another key weapon against Thielaviopsis: if reusing packs and pots, they must be cleaned thoroughly to remove organic debris. Jets of water to remove debris followed by treatment in a disinfectant is desirable. Studies have shown sodium hypochlorite (dilute bleach) and hydrogen dioxide (e.g. ZeroTol) to be particularly effective at decontaminating surfaces after a black root rot outbreak.

Pythium Root Rot

Pythium root rot is different from Thielaviopsis root rot in almost every way except that the pathogens both like wet soil conditions. The different Pythium species that cause disease are not even true fungi, they are 'water molds', also known as oomycetes, more closely related to algae than to fungi. Their life cycle is tied to wetness, because they produce a swimming spore called a zoospore. The different species have different temperature preferences, so different species will plague your crops in spring than in summer. When Pythium attacks, plants look small, sickly, and wilty. Upon inspection, the root system is not full and white: the outer cortex of the root is discolored gray or brown, soft-rotted, and often pulls away as a wilted plant is lifted from the soil. Symptoms sometimes extend up from the root system into the lower stem to create "black leg". Most crops are susceptible to Pythium root rot under highly disease-favorable conditions, but some spring crops are notorious for the problem: geraniums, snapdragons and Easter lilies lead the list. Periodically, New Guinea impatiens are stunted and wilted by Pythium cryptoirregulare, which causes streaking in roots and a black discoloration of the vascular system extending up into the stem. Pythium produces oospores that allow it to survive well in plant debris, so greenhouse sanitation is important to keep problems with root rot from cycling year after year. Well-drained mixes and adequate soil temperature favor the crop and discourage the pathogen. Fewer chemical fungicides work against Pythium than against Phytophthora (which is, for example, more susceptible to strobilurins than is Pythium). The most reliable include etridiazole (found in Truban, Terrazole, Banrot, FRAC 14), cyazofamid (Segway, FRAC 21), and phosphorous acids (Alude, Aliette, etc FRAC 33). Mefenoxam (SubdueMAXX) is helpful within a rotation, but strains of Pythium with resistance are well established in the greenhouse industry so it should be used with awareness of this situation. Many growers today use biocontrols as protectants against Pythium, which are helpful if applied early in the life of the crop and used in conjunction with good sanitation and cultural practices. Biocontrols based on Bacillus spp. (Cease, Triathlon BA, Companion, etc),

Trichoderma spp. (Asperello, RootShield, etc.) and Streptomyces spp. (Mycostop, Actinovate, etc.) all have competitive effects against Pythium species.

Powdery Mildews

Powdery Mildews generally move in towards the latter part of the spring season. Powdery mildews are a group of fungi that are host-specialized, and prolific spore producers. They do well under normal greenhouse growing conditions, thriving on high humidity rather than excessive wetness (always keep humidity below 85%RH) Hydrangeas, roses, zinnias, gerberas, begonias, pansies, rosemary and petunias are among the crops where powdery mildew might be expected. Last year the most troublesome losses were seen in calibrachoas: flower symptoms reduced quality on crops where foliage symptoms were minor and overlooked. Flowers had a gray cast, and a shortened lifespan, lowering the visual quality of hanging baskets. Powdery mildew is the perfect disease to scout for: unless you see it, you do not need to treat for it—unless your experience has taught you that it is an annual problem for a particular crop. Because of their prolific sporulation, powdery mildews should be managed with careful attention to FRAC groups: as with downy mildew and Botrytis, resistant populations can be created by poor deployment of fungicides. Biocontrols (e.g. Cease, Actinovate, Triathlon BA) can be used in alternation with chemical fungicides. Many FRAC groups are available for rotation, including: Group 11 (strobilurins such as Compass, Pageant), FRAC 3 (DMIs such as Terraguard), FRAC 5 (piperalin, Pipron), FRAC 19 (polyoxin D, such as Affirm) and FRAC NC (bicarbonates, such as Milstop; plus oils; plus Reynoutria sachalinensis extract, Regalia). There are also a number of relatively new combination fungicides on the market that work well against powdery mildews. FRAC 9 + 12: Palladium (cyprodinil + fludioxonil); FRAC 11 + 3: Trigo (trifloxystrobin + triadimefon, previously found as Strike Plus) and Fame + T (fluoxastrobin + tebuconazole); FRAC 11 + 7: Orkestra (pyraclostrobin + fluxapyroxad) and Mural (azoxystrobin + benzovindiflupyr).

Bacterial Leaf Spot of Begonia

As impatiens have become more risky due to downy mildew, begonias have become more popular. Although Begonia semperflorens, the standard bedding plant, has very low susceptibility to Xanthomonas axonopodis pv. begoniae, other types of begonias, also popular, are much less resistant. Be especially vigilant with Rieger begonias, Rex begonias, NonStops and Begonia boliviensis hybrids. Lightly infected plants of some cultivars may show only a few round leaf spots, but highly susceptible cultivars will collapse during warm weather garden conditions. Disease can be spread by overhead irrigation, insects or handling. Watch for symptoms and discard infected plants. The remainder may be treated with a copper fungicide. Bacillus subtilis (e.g. Cease) applications also inhibit bacteria, and may be used in rotation with copper.

Impatiens Necrotic Spot Virus (INSV) and Tomato Spotted Wilt Virus (TSWV)

Impatiens necrotic spot virus (INSV) and Tomato spotted wilt virus (TSWV) will be problematic as long as Western flower thrips is problematic. Symptoms were seen in osteospermum, impatiens, begonias, Senettis, Montauk daisies and other crops last year. Remember that vegetables and herbs including tomato, pepper and basil are also susceptible. Constant monitoring for thrips populations and for virus-like symptoms is important during the spring, when rising temperatures lead to rising thrips populations that vector the viruses.

RESPIRATORY PROTECTIVE DEVICES FOR PESTICIDES

Tracey Harpster
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For many toxic pesticides, our breathing system (respiratory system) is the quickest and most direct route for these toxic chemicals to enter into our bloodstream. Of course, from there the chemical can be transported throughout the body. Don't forget that pesticides can damage by contact. The respirator gives extra protection for the nose, throat, and lungs.

Although the respiratory system does provide some filtration, very small particles of less then 10 microns can pass freely to the lungs. How big is 10 microns? It is roughly one-tenth the size of the thickness of a human hair. When exposed to large concentration of particles, your body's ability to filter any size particle is reduced. All these micron sizes are approximate as each item has a range of sizes.

The primary reason to wear a respirator is to protect your health. Some pesticides inhaled may cause temporary or permanent harmful health effects. Some could cause death.

If a label indicates the requirement to wear a respirator, you must meet that requirement. It is the law. You are legally required to follow all personal protective equipment (PPE) statements on the label.

Before wearing a respirator, you are required to have a medical evaluation. Breathing through a respirator is extra work. Respirators can be hazardous to people with heart and lung problems. This medical evaluation is required under the Worker Protection Standard as EPA has adopted the OSHA provisions when it comes to respirators. Some people are claustrophobic or simply find that wearing a respirator is uncomfortable. You must determine any personal limitations before using a respirator for a pesticide application. For example, facial hair makes it impossible to get the proper fit.

The key to preventing respiratory hazards associated with a pesticide is to wear a respirator. The proper respirator for the pesticide. In selecting respiratory protective device, first consider the degree of hazard associated with breathing the pesticide. Select a respirator that is designed for the intended use and always follow the manufacturer's instructions. For example, pesticide A requires XYZ respirator. Pesticide B may require TUV respirator. Only select respirators are approved by the NIOSH (National Institute of Occupational Safety and Health). The approved respirators will have numbers beginning with letters TC (tested and certified). Most pesticide labels indicate which TC cartridge provides the best protection for that product. The approval number in this case is TC-23C-74

Let's take a look at some of the types of respirators. Dust mask should not be confused with the particulate filter mask. The dust mask does not offer protection against pesticide vapors and particles. Particulate filter mask are designed to keep particulate matter out of the lungs. An example would be the fine sawdust from a sanding operation. Not intended for use with pesticides.

The approved respirators will have numbers beginning with letters TC (tested and certified). Most pesticide labels indicate which TC cartridge provides the best protection for that product. You will see other code letters: N, R, and

Tracey Harpster is an Extension Educator in the Penn State Pesticide Education Program. She has a BS and MS in Horticulture from Penn State. Tracey's background focuses on weed identification and control strategies in various planting and cropping situations. Her areas of expertise include curriculum development and Program Delivery.

P. These letters indicate if the particulate filter is resistant to oil. N is not resistant, R indicates resistant to oil for up to 8 hours. P is oil proof. The next column on this chart is the filter type designation. A number is included with the Code letter to indicate the minimum efficiency that we see in the last column on the right.

Let's take a look at some of the other types of respirators. Self-contained breathing apparatus are used by firefighters when the surrounding air is not fit to breathe. They carry with them the clean air supply. Dual cartridge respirator sometimes referred to as a partial face cartridge respirator is the most common type used with pesticides. Full face cartridge respirator have the same principle as the dual cartridge but the entire face is protected. Powered air-purifying respirator have a belt pack with the cartridges and motor/fan, worn on the back of the applicator, that brings the air into the helmet after it has passed through the cartridges.

Only the nuisance dust mask is not NIOSH approved. Particulate respirators are the simplest, least expensive, and least protective of the respirator types available. The particulate respirator has a filter and is rated by NIOSH. The dust mask does have either of these. In both cases air is inhaled through the filter and certain particles are kept out. In case of the dust mask the particles larger than 10 microns are filtered out. The particulate filter will keep out particles larger than 0.3 microns. Cartridge respirators use replaceable chemical cartridges to remove the contaminant from the air. Color coded to help you select the right cartridge. So as you breathe the air is drawn through the filter and the contaminants removed. Powered air-purifying respirator (PAPR) also falls within this group. They use a fan to draw air through the filter to the user. They use the same type of filters/cartridges as other air-purifying respirators. It is key to have the proper cartridge for the pesticide being used.

Whatever respirator you use, it must fit properly. Let's take a look at the steps to achieve the proper fit. The dual cartridge respirator will be used for our illustration. First, the quick release strap is aligned and placed on the clean hands of the applicator. This strap is the one that sustains the bottom of the face piece to the back of the neck of the applicator. For this reason, it is advisable that the applicator protect his or her skin by using a one piece disposable coverall with a hood that will keep pesticides from the absorbent straps of the respirator.

The applicator fastens the quick release bottom strap to the back of his or her neck. Then places the bottom of the mouthpiece to his or her chin. A clean shaven face or a light stubble is acceptable as long as the fit checks show that there are no leaks The applicator places the top strap on the crown of his or her head. Some respirators do not have a crown piece and may move around during the work task. Crown pieces on the top strap ensure that the respirator stays put in place even if the applicator is moving around substantially. The bottom straps are tightened. Be cautious of not over tightening because the respirator will be uncomfortable, the straps will wear prematurely, and the fit will not work appropriately. The top straps are tightened. Once again, be cautious of not over tightening the straps. Realign the respirator to your nose and chin. Crooked respirators do not protect your lungs! Place eye protection over the respirator. After placing your eye protection, use the hood of the coverall to protect the straps and the back of your head from pesticide exposures.

A positive pressure (breathe out while blocking the output) check can help the applicator verify that it is properly being worn. A negative pressure check (breathe in while blocking the input) can help the applicator verify that the respirator is protecting the lungs. Some cartridges have a lot of surface area to cover and a hand will not be enough. In these cases, a set of clean gloves can help cover the cartridges for a negative pressure quick fit check. Be sure to cover both filters.

Always remember to: 1) Clean mask after each use (remove cartridges before cleaning); 2) Store mask and cartridges in a sealed plastic bag (away from chemicals); 3) Replace respirators as suggested by manufacturer; and 4) Always check for damaged parts before placing the unit back into use.

Here is a summary of respirator requirements under the Worker Protection Standard.

- Medical evaluation is required to ensure the handler is physically able to safely wear the respirator.
- Handlers must have training in respirator use
- A fit test to ensure the respirator fits correctly
- Employer must keep records of these items for 2 years
- Handlers in enclosed cabs must wear label-specified respiratory protection with the exception if a dust/mist respirator is the only type required, then none needs to worn inside the enclosed cab

Under the WPS, replace particulate filters:

- When breathing becomes difficult
- When the filter is damaged or torn
- When the respirator or pesticide label requires it
- After 8 total hours of use (in the absence of any other instructions)

Under the WPS, replace particulate filters:

- When odor, taste, or irritation is noticed
- When the respirator or pesticide label requires it
- When breathing resistance becomes excessive
- After 8 total hours of use in the absence of any other instructions or indications of service life

APHIDS AND BIOCONTROL

Carol Glenister, Entomologist
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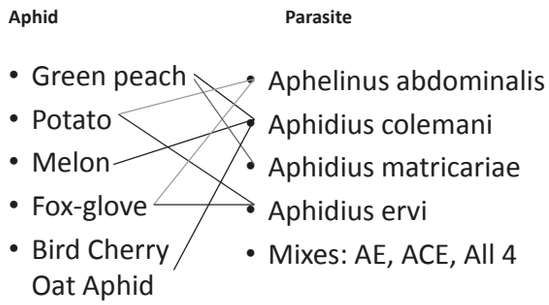
It often seems like aphids come out of nowhere. Or somehow, you can almost predict what week that they are going to show up based on when you start your crop. Why is this? How can hundreds or thousands of aphids suddenly appear? One way that scientists assess population increase is by assessing doubling time, the number of days that it takes a population to double. Doubling time is one of the tools in the study of population dynamics, or how population numbers move up or down.

Aphid doubling time can be as fast as 3 days, so for example if we have a population of 1000 aphids with a doubling time of 3 days, there will be 2000 aphids 3 days later and 4000 aphids 3 days after that. With very cold temperatures, aphids may take more than 7 days to double their populations.

If we are using biological controls, the easiest time to control aphids is early, before their populations really start cranking. It is the scout's job to detect the first sign of aphids and to determine what species you have so that you know if your aphid parasites are going to work. Because aphids can double quickly, weekly scouting is very important. If you wait 2 weeks to scout, aphid populations can actually multiply 10 to 16 times during the 14 days!

Aphid parasites are quite host specific, so aphid ID is important to help predict your control. These are are species of tiny wasps that lay an egg inside a young aphid. The wasp egg hatches into a tiny larva that grows up inside the aphid as the aphid grows up. Eventually, when the aphid's insides are all used up, the aphid dies and turns into a papery shell called an aphid mummy, which can be found glued to leaf undersides or stems.

Aphid Parasite Selection



Growers also use aphid predators which will attack most aphid species. The aphid midge, Aphidoletes aphidimyza, comes as a fly pupa which hatches into a tiny midge that senses and flies to aphid colonies. There the midge lays eggs which hatch into tiny orange larvae. These larvae are aphid-killing machines, killing many more than they eat. Aphidoletes is the only predator that will reproduce in the greenhouse (given long days and warm weather). Other commercially available predators for aphids include lady beetle adults and lacewing larvae.

Carol Glenister is founding president IPM Laboratories, Inc., a 35 year old company that supplies beneficial insects, mites and nematodes used for pest control in greenhouses, interiorscapes, landscapes, and agriculture. Her research focuses on creating supportive plant habitats for these natural enemies. She has a Masters Degree in Entomology from Cornell University. .

Three strategies are used with aphid biocontrols:

- Regular releases to assure constant presence of beneficials
- Inoculate and grow beneficials on site after one to three releases
- Set up alternate habitat for natural enemies to reproduce on their own (banker plants and guardian plants)

While regular releases assure constant presence, repeated charges for overnight freight can get expensive. But many people do favor this strategy because they are using the insects as their scouts. Inoculating and growing your own aphid parasites and Aphidoletes requires care and vigilance, but is practiced by many growers. One way to help assure that beneficials colonize the greenhouse is to create habitat for them, such as aphid banker plants, or habitat pots with flowers that offer nectar and pollen.

Aphid banker plants were first demonstrated in England before the turn of the century. The idea was to grow a grass-loving aphid on grain plants that could be used to feed beneficials, but would not attack broad-leaved plants. Today the aphid banker plants that are commercially available consist of barley and bird cherry oat aphids. Growers germinate more barley in (usually) hanging baskets, and grow more aphids in their greenhouses. These banker plants support the parasite, Aphidius colemani.

An added benefit of habitat pots is that they can attract in hover flies from the outside as soon as temperatures rise above 50° F. These predators are not yet available commercially. They will feed on nectar and pollen and lay eggs in aphid colonies. Hover fly larvae are voracious aphid predators. Sweet alyssum flowers are a favorite of hover flies.

It takes practice to master the use of these biocontrols, but every year's experiences will improve your ability to anticipate and detect that aphids, act in a timely manner, and improve the effectiveness of the biocontrols.

BEST OF THE PSU FLOWER TRIALS

Sinclair Adam, Penn State Extension

In 2016, over one thousand cultivars of flowering plants were tested in in Penn State Flower Trials. Plants were potted up in May and grown over the summer into early October. Three containers of the selection are potted up into five-gallon containers and placed on black plastic ground cloth at the Southeast Agricultural Research and Extension Center flower trials areas in Manheim, PA. Plants are rated for uniformity, flowering, foliar quality, and overall growth on a scale of one-five, and those rating numbers are averaged for a total score. Plants are rated four times during the growing season. Perennial plants that are to be tested in-ground for three successive winters to evaluate hardiness, are planted out into the Hagerstown soil in beds. This report reflects the best performing annual plants in the 2016 season. The complete data can be found at http://trialgardenspsu.com. 2016 was a hot year compared to the three preceding year's temperatures. Rainfall was less in the month of August and in early September. Some genera performed well under these conditions, some did not do as well as in previous years. Penn State Extension collaborates with three additional sites where sub-sets of the trials plants are tested in-ground. Collaborative sites are Hershey Gardens in Hershey, PA, North Park in Allegheny County, and at Ag. Progress Days, in Centre County. Total visitation at all sites by industry representatives and by the public, in 2016 was estimated to be over 250,000.

Best Performing Plants 2016:

Alternanthera 1 cultivar	Purple Prince PanAmerican Seed	5.0
Angelonia 13 cultivars		
Best performance:	Angelface Perfectly Pink Proven Winners	4.8
	Angelface Super Pink Proven Winners	4.8
	Archangel Pink Improved Ball FloraPlant	4.7
	Serenita Pink PanAmerican Seed	4.7
	Serenita Purple PanAmerican Seed	4.7
	Archangel Cherry Red Ball FloraPlant	4.6
	Archangel Raspberry Ball FloraPlant	4.6
	Angelface Super Blue Proven Winners	4.6
Argyranthemum 6 cultivars.		
Best performance:	Grandessa Yellow Suntory Flowers	4.2
Artemesia 1 cultivar	Quicksilver Proven Winners	4.9
Begonia 51 cultivars		
Best performance:	Unbelievable Tweetie Pie Dümmen Orange	5.0
	Unbelievable First Kiss Dümmen Orange	4.9
	Unbelievable Upright Apricot Dümmen Orange	4.9
	Big Green Leaf Red Ernst Benary of America	4.9

Sinclair Adam is a Penn State Extension Educator in Horticulture, and Penn State Flower Trials Director. He holds a B.S. in Plant and Soil Science from Univ. of Wyoming, and a M.S. in Plant and Soil Science from the Univ. of Vermont. Sinclair has been an Adjunct Professor at Univ. of Vermont, a Senior Lecturer at Temple University, a Research Fellow at Temple University, and has taught at the Barnes Foundation. Sinclair has also served in the horticultural industry for over 30 years, and holds 15 plant patents on Phlox, Tiarella, and Chrysanthemum selections.

Big Green Leaf Pink Ernst Benary of America		4.9
	Big Bronze Leaf Red Ernst Benary of N. America	4.9
	Unbelievable Miss Montreal Dümmen Orange	4.9
	Big Bronze leaf Rose Ernst Benary of America	4.9
	Unbelievable Double Apricot Dümmen Orange	4.9
	Unstoppable Upright Salmon Dümmen Orange	4.9
	Topspin Scarlet Syngenta Flowers	4.8
	Big Green Leaf Rose Ernst Benary of America	4.8
	Whopper Red Bronze Ball Ingenuity	4.8
	Whopper Experimental 1630-13T1 Ball Ingenuity	4.8
	Whopper Experimental 1630-5T2 Ball Ingenuity	4.8
	Topspin Pink Syngenta Flowers	4.8
Bidens 6 cultivars		
Best performance:	Blazing Glory Danziger Flower Farm	4.5
	Campfire Fireburst Proven Winners	4.4
Browallia 2 cultivars		
Best performance:	Endless Illumination Proven Winners	4.7
Caladium 9 cultivars		
Best performance:	Flatter Me Classic Caladiums	4.9
	Radiance Classic Caladiums	4.9
	Burning Heart Classic Caladiums	4.8
	Freckles Classic Caladiums	4.8
	Allure Classic Caladiums	4.8
	Posy Pink Classic Caladiums	4.8
	Chinook Classic Caladiums	4.8
Calibrachoa 93 cultivars		
Best performance:	Superbells Pomegranate Punch Proven Winners	4.9
	Aloha Hot Orange Dümmen Orange	4.9
	Bloomtastic Lavender 02 Dümmen Orange	4.8
	Superbells Lemon Slice Proven Winners	4.8
	Calipetite Mid Blue Sakata Seed America	4.8
	Calipetite White Sakata Seed America	4.8
	Cabaret White Ball FloraPlant	4.8
	Aloha Tiki Soft Pink Dümmen Orange	4.8
	Hula Appleblossom Dümmen Orange	4.8
	Superbells Coralina Proven Winners	4.8
	Superbells Yellow Improved Proven Winners	4.8
	Superbells Strawberry Punch Proven Winners	4.8
	MiniFamous Neo White + Yellow Eye Selecta First Class	4.8
	Aloha Blue Sky Dümmen Orange	4.8
	Superbells Tropical Sunrise Proven Winners	4.8
	Colibry Pink Lace Danziger Flower Farm	4.8
	Kabloom White PanAmerican/Kieft	4.8
	Bloomtastic Tiki Blue 05 Dümmen Orange	4.8

Celosia 10 cultivars:		
Best performance:	Kelos Fire Scarlet Improved Beekenkamp	5.0
	Kelos Atomic Neon Beekenkamp	4.8
	Kelos Atomic Purple Pink Beekenkamp	4.8
	Kelos Fire Yellow Beekenkamp	4.8
Cleome 4 cultivars		
Best performance:	Pequena Rosalita Proven Winners	4.7
Solenostemon (Coleus) 24 cultivars:		
Best performance:	Mainstreet Abbey Road Dümmen Orange	5.0
	ColorBlaze Apple Brandy proven Winners	5.0
	Vino Ball FloraPlant	4.9
	Wasabi Ball FloraPlant	4.9
	Mainstreet Riverwalk Dümmen Orange	4.9
	Under the Sea Pink Reef Hort Couture Plants	4.9
	Redhead Ball FloraPlant	4.9
	Inferno Ball FloraPlant	4.9
	Coleosaurus Ball FloraPlant	4.9
	Henna Ball FloraPlant	4.9
Solenostemon (Coleus) DWF 10 cultivars		
Best performance:	Terra Nova Macaw	5.0
	Terra Nova Quetzal	5.0
	Under the Sea Sea Urchin Red Hort Couture Plants	4.9
	Under the Sea Urchin Copper Hort Couture Plants	4.9
	Under the Sea Monkey Apricot Hort Couture Plants	4.9
Combinations 33 selections:		
Best performance:	MixMasters Feelin Lucky Ball FloraPlant	4.8
	MixMasters Summer Bouquet Ball FloraPlant	4.8
	Kwik Kombo #summerfun Syngenta Flowers	4.8
	MixMasters Summer Blues Ball FloraPlant	4.8
	Confetti Garden Trafalgar Square Dümmen Orange	4.8
	Kwik Kombo Grand Finale Syngenta Flowers	4.8
	Kwik Kombo Rocket's Red Glare Syngenta Flowers	4.7
Cuphea 1 cultivar	Vermillionaire Proven Winners	4.7
Cyperus 2 cultivars		
Best performance:	Graceful Grasses Prince Tut Proven Winners	4.8
Dahlia 35 cultivars:		
Best performance:	Labella Grande Purple Beekenkamp	4.5
	Labella Grande Orange Bicolor Beekenkamp	4.4
	Labella Grande Red Beekenkamp	4.4
	Labella Grande Rose Beekenkamp	4.3
	Labella Grande Yellow Beekenkamp	4.3
	Labella Grande Dark Pink Beekenkamp	4.3
Digitalis 7 cultivars		

Best performance:	Digiplexis Berry Canary Cultivaris	4.8
	Digiplexis Illumination Raspberry Improved Cultivaris	4.7
	Digiplexis Illumination Apricot Improved Cultivaris	4.7
Euphorbia 3 cultivars	Crystal White HF Michell/GreenFuse Botanicals	4.9
	Diamond Frost Proven Winners	4.8
Evolvulus 1 cultivar	Blue My Mind Proven Winners	4.7
Geranium (Pelargonium) Interspecific 13 cultivars		
Best performance:	Cumbanita Rose Splash Dümmen Orange	4.8
	Calliope Medium Pink Flame Syngenta Flowers	4.8
	Calliope Medium Crimson Flame Syngenta Flowers	4.7
Geranium (Pelargonium) Ivy 3 cultivars		
Best performance:	Caliente Fire Syngenta Flowers	4.5
Geranium (Pelargonium) Zonal 48 cultivars		
Best performance:	Mayflower J.P. Bartlett	4.8
	Brocade Fire Night Dümmen Orange	4.8
	05002 Pink J. P. Bartlett	4.8
	Anne J.P. Bartlett	4.7
	Samaritan J. P. Bartlett	4.7
	Brocade Salmon Night Dümmen Orange	4.7
	Brocade Cherry Night Dümmen Orange	4.7
Gerbera 10 cultivars		
Best performance:	Garvinia Sweet Glow Florist Holland	4.8
	Garvinia Sweet Memories Florist Holland	4.8
	Garvinia Sweet Smile Florist Holland	4.7
Gomphrena 3 cultivars		
Best performance:	Ping Pong White Sakata Seed America	4.8
Hibiscus 4 cultivars		
Best performance:	Little Zin Ball FloraPlant	4.8
Impatiens 40 cultivars		
Best performance:	Bounce Bright Coral Selecta First Class	4.9
	SunStanding Coral Aurora Dümmen Orange	4.9
	Big Bounce White Selecta First Class	4.8
	Bounce White Selecta First Class	4.8
	SunStanding White Cloud Dümmen Orange	4.8
	Big Bounce Lilac Selecta First Class	4.8
	Bounce Cherry Selecta First Class	4.8
	SunStanding Scarlet Dümmen Orange	4.8
	SunPatiens Compact Hot Coral Sakata Seed America	4.8
	SunPatiens Compact Electric Orange Sakata Seed America	4.8
	SunStanding Rose Aurora Dümmen Orange	4.8
	SunStanding Hot Pink Dümmen Orange	4.8
	SunStanding Neon Dümmen Orange	4.8

Impatiens NGI 19 cultivars		
Best performance:	Paradise Light Pink Kientzler North America	5.0
	Paradise Pure Beauty Light Pink Kientzler North America	4.9
	Experimental Timor Type 038 Kientzler North America	4.9
	Clockwork Orange Ball FloraPlant	4.9
	Clockwork Purple Ball FloraPlant	4.9
Ipomoea 12 cultivars		
Best performance:	Sweet Caroline Bewitched Green w/ Envy Proven Winners	4.9
	Sweet Caroline Sweetheart Lime Proven Winners	4.8
	Flora Mia Limon Dümmen Orange	4.7
	Sweet Caroline Sweetheart Jet Black Proven Winners	4.7
	Sweet Caroline Light Green Proven Winners	4.7
	SolarPower Black Ball FloraPlant	4.7
	Flora Mia Rosso Dümmen Orange	4.7
	Sweet Caroline Bewitched After Midnight proven Winners	4.7
Lantana 18 cultivars		
Best performance:	Lanscape Bandana Lemon Zest Syngenta Flowers	5.0
	Lucky White Ball FloraPlant	4.9
	Lucky Yellow Ball FloraPlant	4.9
	Little Lucky Pot of Gold Ball FloraPlant	4.9
	Luscious Citrus Blend Proven Winners	4.9
	Luscious Marmalade Proven Winners	4.9
Lobelia 11 cultivars		
Best performance:	Suntory Lobelia Trailing Sky Blue Suntory Flowers (Shade)	4.2
Lobularia 5 cultivars		
Best performance:	Snow Princess Proven Winners	4.6
	White Knight Proven Winners	4.6
	Deep Lavender Stream Danziger Flower Farm	4.5
Lophospermum 4 cultivars	Lofos Compact White Suntory Flowers	4.7
Melampodium 1 cultivar	Jackpot Gold American Takii	4.8

Ornamental Pepper 5 cultivars		
	Sangria PanAmerican Seed	4.9
	Sedona Sun PanAmerican Seed	4.9
	Hot Pops PanAmerican Seed	4.8
	Black Pearl PanAmerican Seed	4.8
	Chilly Chili PanAmerican Seed	4.8
Osteospermum 2 cultivars		
Best performance:	Blue Eyed Beauty Ball FloraPlant	4.6
Pentas 7 cultivars		
Best performance:	BeeBright Lipstick Syngenta Flowers	4.8
	BeeBright Pink Syngenta Flowers	4.8
	Starcluster Lavender Syngenta Flowers	4.8
	BeeBright Red Syngenta Flowers	4.8
Petchoa 8 cultivars		
Best performance:	SuperCal Cherry Improved Sakata Seed America	4.8
	SuperCal Blushing Pink Sakata Seed America	4.7
	SuperCal Pink Sakata Seed America	4.7
Petunia 103 cultivars		
Best performance:	Supertunia Sangria Charm Proven Winners	5.0
	Supertunia Vista Silverberry Proven Winners	4.9
	Supertunia Lavender Skies Proven Winners	4.9
	Supertunia Pink Star Charm Proven Winners	4.9
	Supertunia Vista Bubblegum Proven Winners	4.9
	Supertunia White Proven Winners	4.9
	Whispers Star Rose Syngenta Flowers	4.9
	ColorRush Pink Ball FloraPlant	4.9
	Supertunia Vista Fuchsia Improved Proven Winners	4.9
	Blanket Rose HF Michell/GreenFuse Botanicals	4.9
	Supertunia Morning Glory Charm Proven Winners	4.8
	Littletunia Pink Splash Danziger Flower Farm	4.8
	Surfina Sumo Sumo Pink Suntory Flowers	4.8
	Surfina Trailing Deep Red Suntory Flowers	4.8
	Cascadias Rim Fantasy Danziger Flower Farm	4.8
	Surfina Mounding Heart Beat Suntory Flowers	4.8
	Supertunia Picasso in Purple Proven Winners	4.8
	Supertunia Violet Star Charm Proven Winners	4.8
	Classic Blue Ray Danziger Flower Farm	4.8
	Tidal wave Red Velour PanAmerican Seed	4.8
	Sanguna White Improved Syngenta Flowers	4.8
	Tidal Wave Silver PanAmerican Seed	4.7
	Veranda Neon Kientzler North America	4.7
	Supertunia Bordeaux Proven Winners	4.7
	Supertunia Daybreak Charm Proven Winners	4.7
	Sanguna Patio Blue Vein Syngenta Flowers	4.7
	Veranda Hot Pink Kientzler North America	4.7

	Veranda Purple Kientzler North America	4.7
	Supertunia Indigo Charm Proven Winners	4.7
	Blanket Blue Star HF Michell/GreenFuse Botanicals	4.7
	Sanguna Patio Blue Morn Syngenta Flowers	4.7
	ColorRush Blue Ball FloraPlant	4.7
	Supertunia Latte Proven Winners	4.7
	Amore' Joy Danziger Flower Farm	4.7
Portulaca10 cultivars		
Best performance:	Pazzaz Orange Flare Danziger Flower Farm	4.8
Salvia 30 cultivars		
Best performance:	Playin' The Blues Proven Winners	4.8
	Magic Wand Danziger Flower Farm	4.6
	Summer Jewel Pink American Takii	4.8
	Summer Jewel White American Takii	4.8
	Summer Jewel Red American Takii	4.8
	Mirage Violet Darwin Perennials	4.8
	Mirage Cherry Red Darwin Perennials	4.8
	Grandstand Red HF Michell/Green Fuse Botanicals	4.9
	Grandstand Red Lipstick Pink HF Michell/GreenFuse	4.8
	Grandstand Salmon HF Michell/GreenFuse Botanicals	4.8
	Grandstand Lavender HF Michelle/GreenFuse Botanicals	4.8
	Grandstand Purple HF Michell/GreenFuse Botanicals	4.8
Scaevola 10 cultivars		
Best performance:	Surdiva White Improved Suntory Flowers	4.9
	Surdiva Classic Blue Suntory Flowers	4.9
	Bondi Blue Ball FloraPlant	4.8
	Surdiva Light Blue Suntory Flowers	4.8
	Bondi White Ball FloraPlant	4.7
Sutera (Bacopa) 8 cultivars		
Best performance:	MegaCopa White Ball FloraPlant	4.5
Verbena 34 cultivars		
Best performance:	EnduraScape Pink Bicolor Ball FloraPlant	4.7
	EnduraScape Red Ball FloraPlant	4.6
	Vepita White Kientzler North America	4.7
	Lanai Blue Eyes Syngenta Flowers	4.6
	Superbena Meteor Shower Proven Winners	4.6
	Superbena Whitecap Proven Winners	4.5
	Lanai Vintage Syngenta Flowers	4.5
	Lanai Twister Purple Improved Syngenta Flowers	4.5
	Lascar Magenta Selecta First Class	4.5
	EnduraScape Lavender Ball FloraPlant	4.5
	EnduraScape Purple Improved Ball FloraPlant	4.5
	Vepita Lavender Kientzler North America	4.5

Vinca (Catharanthus) 17 cultivars

Best performance:	Soiree Kawaii Pure White Suntory Flowers	5.0
	Soiree Kawaii Pink Suntory Flowers	4.9
	Soiree Kawaii Pink Peppermint Suntory Flowers	4.9
	Titan Really Red PanAmerican/Kieft	4.9
	Valiant Punch PanAmerican/Kieft	4.9
	Valiant Burgundy PanAmerican Kieft	4.8
	Valiant Pure White PanAmerican Kieft	4.8
	Titan Blush Improved PanAmerican Kieft	4.8
Zinnia 13 cultivars		
Best performance:	Zahara XL Pink PanAmerican/Kieft	4.8
	Zahara XL White PanAmerican Kieft	4.7
	Zahara XL Fire Improved PanAmerican/Kieft	4.7
	Profusion Double Fire Sakata Seed America	4.7
	Profusion Double Golden Sakata Seed America	4.7

LED COLORS MATTER TO FLOWERING

Qingwu (William) Meng

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Photoperiodic lighting

Many ornamental plants flower when their biological clock is in sync with daylength. Short-day and long-day plants, as their names indicate, flower most rapidly under short and long days, respectively. During natural short days (October to March), lighting at night can delay flowering of short-day plants to stimulate vegetative growth, or promote flowering of long-day plants to speed up production. Lighting at the end of the day (day extension) that creates a 16-hour day or in the middle of the night (night interruption) that operates for 4 hours can effectively control flowering (Figure 1).

Most incandescent light bulbs have been phased out because of their energy inefficiency. Compact fluorescent lamps have higher luminous efficacy, but are not as effective as incandescent lamps for some long-day plants. Light-emitting diodes (LEDs) are emerging as an alternative light source because of their greater energy efficiency and long life span.

Distinguishing among colors of light

Numerous LED lamps have been developed for commercial plant production during the past few years. However, not all LEDs are created equal; for example, some are better than others at regulating flowering. The key to regulation of flowering is in the spectrum, which refers to colors (or wavelengths) of light.

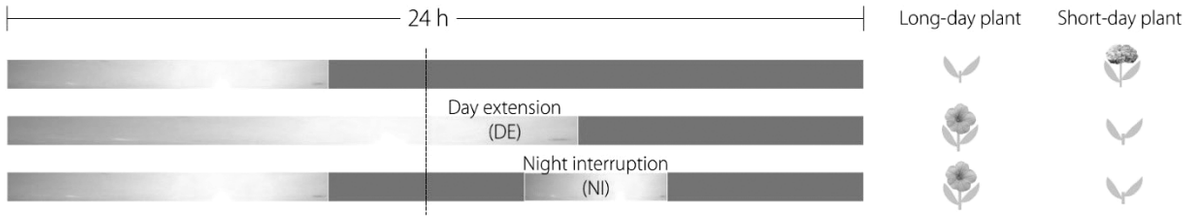
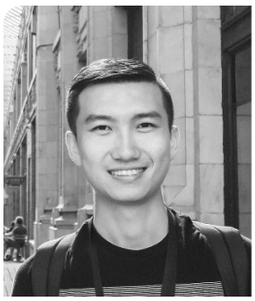


Figure 1. Lighting at the end of the day or during the middle of the night can promote flowering of long-day plants and inhibit flowering of short-day plants during short days. The dash line indicates the critical daylength of the photoperiodic crop.

For low-intensity (e.g., 2 $\mu mol \cdot m^{-2} \cdot s^{-1}$) lighting, a mixture of red (600 to 700 nm) and far-red (700 to 800 nm) light promotes flowering of long-day plants most effectively, whereas only red light is needed to inhibit flowering of short-day plants (Figure 2). Consistently, a coordinated grower trial we conducted reveals that red+far-red LEDs are similarly effective to conventional incandescent or high-pressure sodium lamps for regulation of flowering time. Adding far red to red+white light is critical for rapid flowering of some long-day plants (e.g., petunia and snapdragon), but not others, and its importance is more pronounced under a low photosynthetic daily light integral (DLI).

Blue light does not influence flowering at a low intensity, when delivered alone or added to red and/or far-red light (Figure 3). However, moderate-intensity (e.g., 30 $\mu mol \cdot m^{-2} \cdot s^{-1}$) blue light is effective by itself. White LEDs, which are really blue LEDs coated with a phosphor, cast a broad spectrum but emit little far-red light. At a low intensity, white LEDs are as effective as red LEDs at regulating flowering of both long-day plants and short-day plants. However,



Qingwu (William) Meng is a Ph.D. graduate research assistant in the Department of Horticulture at Michigan State University, under the guidance of Dr. Erik Runkle. His areas of expertise are horticultural lighting, indoor vertical farming, and photoperiodic lighting. He earned his Bachelor's in Agricultural Engineering at China Agricultural University in 2012, and his Master's in Horticulture at Michigan State University in 2014. He is also the creator of LightHort.com, a science website that communicates horticultural lighting research to the general public

flowering of some long-day plants can be delayed under white LEDs compared to red+white+far-red LEDs.

Collectively, these results have advanced our understanding of photoperiodic control of flowering and will ultimately facilitate the improvement of lighting products and applications to regulate flowering of commercial photoperiodic crops.

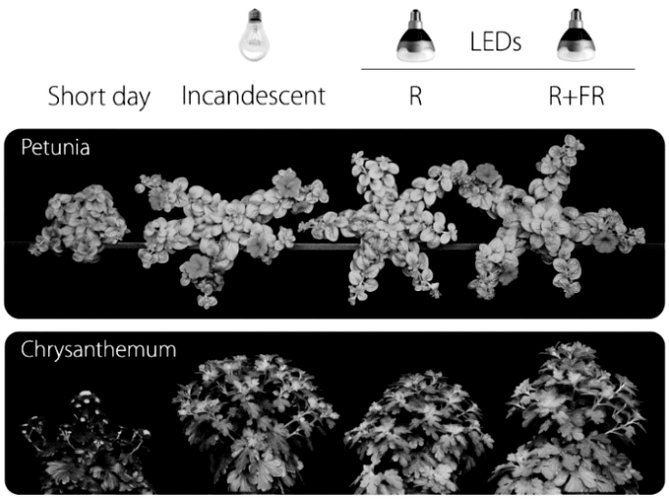


Figure 2. At a low intensity, LEDs emitting both red (R) and far-red (FR) light are as effective as incandescent lamps at accelerating flowering of long-day plants such as petunia. However, R light is sufficient to inhibit flowering of short-day plants such as chrysanthemum.

Figure 3. Blue (B) light is effective at controlling flowering of long-day plants (e.g., rudbeckia) and short-day plants (e.g., marigold) only at a sufficiently high intensity.

Choosing the right LEDs

Which LEDs to choose depends on several factors including what crops are grown and when. For short-day plants like chrysanthemum, lamps are generally effective if they emit red light. While the presence of red light is sufficient to promote flowering of long-day plants like rudbeckia, some long-day plants (e.g., snapdragon and petunia) need far-red light for the most rapid flowering, especially when grown during periods of low light. Therefore, lamps that emit both red and far-red light are most suitable for long-day plants. Aside from the spectrum, growers should also consider durability, cost, light output and uniformity, life time and warranty. Table 1 summarizes the efficacy of conventional lamps and LEDs commonly used for photoperiodic control.

Finally, don't confuse low-wattage "flowering" LED lamps with supplemental lighting. To regulate flowering, only a very low intensity (1 to 3 $\mu mol \cdot m^{-2} \cdot s^{-1}$) is needed. To increase growth (faster rooting, thicker stems, etc.), a much higher intensity is needed, and typically 40 to 60 $\mu mol \cdot m^{-2} \cdot s^{-1}$ is appropriate for ornamentals. Flowering LED lamps are suitable to extend the day or interrupt the night but provide no benefit when turned on during the day. Visit the MSU Floriculture webpage (http://flor.hrt.msu.edu/lighting) for more information on lighting.

Lamp type		Short-day plants	Long-day plants
Incandescent, halogen		✓	✓
Fluorescent (including CFLs)		✓	Some
HID (HPS, MH, mercury)		✓	✓
LEDs	Red	✓	Some
	Red + far-red	✓	✓
	Far-red	–	–
	Blue	–	–

Table 1. Summary of the efficacy of different lamp types at regulating flowering of photoperiodic crops when delivered during the night at a low intensity (1 to 3 $\mu mol \cdot m^{-2} \cdot s^{-1}$). ✓ generally effective; – generally not effective.

FERTILIZATION OF PERENNIALS AND MUMS

Krystal Snyder
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Feeding Perennials and Mums tends to be a big challenge among the growers I talk to. As always, you will want to look for the most efficient and cost effective fertilizer program that matches your water, crop, and end goal. Using the following tools will help you accomplish this.

Where to start:
The key to any successful fertilizer program is getting your water tested first. Having your water tested by a reputable horticulture lab in December or January will get you off on the right foot. Once you have a current water test, talk to a technical rep, fertilizer supplier, or extension agent about how to proceed. You will also need to think about your space and the needs of your crops. Remember, everyone's water is different. Just because a fertilizer works for your neighbor doesn't mean it will work for you.

Look at your water test for the following items: pH, alkalinity, calcium, magnesium, sodium and chloride. If you have low alkalinity water with little calcium and magnesium, a neutral or basic fertilizer is a better option. You will also need a fertilizer with some calcium and magnesium. If you have high alkalinity you will need an acidic fertilizer, also you depending on fertilizer delivered Calcium decreases. High alkalinity can cause a gradual increase in media pH, and you may need to consider acidification with a mineral acid. I like sulfuric acid, it is cost effective, easy to source, and adds much needed sulfur.

Mum Growing Strategy:
Mums are heavy feeders that respond well to additional magnesium, sulfur and iron. A fertilizer suited for mums has elevated levels of Chelated Iron and Magnesium, like Jack's Mum FeED 22-5-16, will give you the best results.

Growing On: Mums fertilizer schedule is the opposite of bedding plants. Start the Nitrogen High and reduce throughout the crop cycle. Let plant growth and laboratory tests determine the exact timing of rate change. At beginning of production cycle, CLF rate of 250-300 ppm for average container size. These rates will slightly decrease in 4 weeks to 200-250 ppm and then again in 4 more weeks to 150 ppm. The final reduction should coincide with first color. Mums are heavy feeders, after heavy rainfall make sure you apply any fertilizer they may have been washed out due to excess water in the root zone. Make sure you are feeding your plants using drip emitters or careful hand watering.

SUPPLEMENTS & FINISHING: Understanding your water quality is key in building a successful fertilizer plan. If your water source is low in calcium, it is advised to alternate a calcium nitrate formula like our Jack's Dark Weather 15-0-15, Jack's Cal Mag 15-5-15 or Jack's Cal-Trate 15-0-0, into the program and use these products as a finisher at the end of the crop cycle. Alternatively, you may also want to substitute a classic finisher formula like our Pot Mum Finisher 15-10-30 or our Jack's K-Trate 14-5-38. Both formulas are higher in Potassium (K) to give plants some strength and sturdiness for flower finish and shipping. A general supplement rate for CLF of the above Ca or K containing formulas are 200 ppm as determined by laboratory or EC analysis.

Krystal Snyder, the Technical Specialist at JR Peters, is only a phone call away to walk you through your laboratory results and provide you with answers about your mix or if you need help with another fix on the Jack's Professional line. Since she was young she considered herself a serious plant nerd, which led her to Delaware Valley College, where she made it official by earning a B.S. in Horticulture. When she is not helping customers fix their plants or creating her own outdoor oasis, Krystal can be found restoring her century old house in Easton, PA, with her handyman husband Justin, daughters Alexia & Lucy, and their two crazy Australian cattle dogs.

Jack's Professional 22-5-16 Mum Feed does contain an increased level of magnesium and sulfur, however, some mum crops benefit from extra applications of Epsom salts. Magnesium Sulfate– Epsom salts is used to prevent or treat magnesium deficiency. One ounce, by weight, of Magnesium Sulfate dissolved in 100 gallons of water supplies 7.2 ppm of magnesium. Use a rate of 4-6 oz. per 100 gallons, mixed right with the fertilizer concentrate as a once a month booster

Tips: Use a moderately high Phosphorus fertilizer like 20-10-20 or 20-20-20 for the first 2 weeks to give those cuttings a good head start in rooting. Early to mid-summer can have very hot days and high light levels, when plants are grown in dark containers and black plastic, the temperature in the root zone can soar! Avoid mid-day fertilizer application, especially if you tend to foliar feed more than root zone drench. If you are also adding a long-lasting fertilizer to the mix, like a CRF, be conservative in your rates. You will have more control over the availability of the fertilizer by delivering a constant liquid feed application. Monitoring the media pH and EC of all crops with either in house testing or through a horticultural lab will ensure crop success.

Perennial Growing Strategy:
It's best to think of perennials in 3 crop stages: Plug, Transplants, Finishing and also if it falls in the Low, moderate or high fertility category. Perennials tend to be low fertilizer users.

Plug Stage: the general recommendation is to use a water soluble fertilizer match to your water. Nitrate based fertilizers produce toned growth, whereas ammonia based ones produce quick growth, Urea is not recommended for this stage. For weeks 1-2 if you have planted in a charged media, fertilizers are not needed. Weeks 2-4 feed about 100 ppm N one time a week. From weeks 4 until transplant feed 125-150 PPM N once a week.

Transplant Stage: Continue feeding 150-175 PPM N until you are ready to start finishing.

Finishing Stage: Now is where you want to really push the growth of your plants. Depending on category this could be anywhere from 150 PPM N to 300 PPM N, on constant liquid feed. Let in house PourThru give you a good feel of container EC. If you will be shipping, feed mostly nitrate based fertilizers. A good reminder is that high fertility level can cause excess foliage and fewer flowers.

PROVEN NEW PERENNIALS

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Penn State University has been trialing flowers since 1933, and the trials were moved from State College PA to the PSU experiment station in Manheim PA in 1992.

Perennials were added to PSU Flower Trials in 2014, and planted in ground, to be tested for 3 years, at the PSU Southeast Agricultural Research and Extension Center (SEAREC) in Manheim PA. In year one (2014), plants were planted in ground in the fall after a season of container testing. Six plants per variety were planted out on two foot spacing, into soil amended with compost. Since 2014, perennials have been planted each year. Perennials have been submitted for in ground testing from American Takii, Darwin Perennials, Garden Genetics LLC, Star Roses & Plants/Conard Pyle, Terra Nova Nurseries, NE Thing Grows, Dummen Orange, Greenleaf Plants/Aris, North Creek Nurseries, Intrinsic Perennial Gardens, Cultivaris, H. F. Michell/Green Fuse Botanicals, HilverdaKooij, HGTV Home Plant Collection, Blooms of Bressingham, Plants Nouveau, Jelitto Perennials, Skagit Gardens, Proven Winners, Syngenta Flowers, and Walters Gardens. These firms have sent some excellent plants for testing, and a number of these cultivars have proved to be outstanding in the PSU Flower Trials. Visit the web pages for complete data on all plants at: http://trialgardenspsu.com.

Plants are rated on uniformity, flowering, foliar quality, and overall growth, four times per growing season. Results of the trials are published on the PSU Flower Trials Web pages at trialgardenspsu.com, and in articles, and printed reports. Information is also put up on the National Trials Database, housed at the University of Georgia.

Perennials with Excellent Performance 2014, 2015 and to date:

1) Achillea New Vintage Red	Darwin Perennials
2) Achillea New Vintage Rose	Darwin Perennials
3) Alstroemeria Indian Summer	HilverdaKooij
4) Aster Kickin Purple	Cultivaris
5) Brunnera Silver Heart	Plants Nouveau
6) Callisia rosea Morning Grace	North Creek Nurseries
7) Chrysanthemum Peaches and Cream	NE Thing Grows
8) Coreopsis Lil Bang Starlight	Skagit Gardens
9) Coreopsis Sylvester	Darwin Perennials
10) Dendranthema Icicle Igloo	Blooms of Bressingham
11) Dianthus Kohari	Dummen Orange
12) Echinacea Sombrero Adobe Orange	Darwin Perennials
13) Echinacea Dbl. Scoop Mandarin	Darwin Perennials
14) Echinacea Moodz In Love	HilverdaKooij

Sinclair Adam is a Penn State Extension Educator in Horticulture, and Penn State Flower Trials Director. He holds a B.S. in Plant and Soil Science from Univ. of Wyoming, and a M.S. in Plant and Soil Science from the Univ. of Vermont. Sinclair has been an Adjunct Professor at Univ. of Vermont, a Senior Lecturer at Temple University, a Research Fellow at Temple University, and has taught at the Barnes Foundation. Sinclair has also served in the horticultural industry for over 30 years, and holds 15 plant patents on Phlox, Tiarella, and Chrysanthemum selections

15) Echinacea Moodz Sympathy	HilverdaKooij
16) Echinacea Purple Emperor	Plants Nouveau
17) Festuca Cool as Ice	Intrinsic Perennial Gardens
18) Geranium Miss Heidi	Darwin Perennials
19) Helianthus Sunshine Daydream	North Creek Nurseries
20) Helleborus Winterbells	HilverdaKooij
21) Heuchera Carnival Coffee Bean	Darwin Perennials
22) Heuchera Carnival Fall Festival	Darwin Perennials
23) Heuchera Carnival Watermelon	Darwin Perennials
24) Heuchera Grape Soda	Terra Nova Nurseries
25) XHeucherella Cracked Ice	Blooms of Bressingham
26) Hibiscus Cordials Cherry Brandy	Green Leaf Plants/Aris
27) Kniphofia Fire Dance	Jelitto Perennials
28) Lagerstroemia EX-G2Y	Garden Genetics LLC
29) Lavandula Platinum Blonde	Skagit Gardens
30) Lavandula Super Blue	Darwin Perennials
31) Leucanthemum Snowbound	Terra Nova Nurseries
32) Monarda Balmy Pink	Darwin Perennials
33) Monarda Beebop	Garden Genetics LLC
34) Nepeta Junior Walker	Star Roses/ Conard Pyle
35) Panicum Cape Breeze	North Creek Nurseries
36) Penstemon Purple Rock Candy	Darwin Perennials
37) Penstemon Rose Quartz	Darwin Perennials
38) Penstemon Cha-Cha Lavender	Terra Nova Nurseries
39) Perovskia Caspian Blue	H. F. Michell/Green Fuse Botanicals
40) Phlox paniculata Jenna	North Creek Nurseries
41) Phlox Spring White	Dummen Orange
42) Salvia Lyrical Blues	Darwin Perennials
43) Salvia Lyrical Silvertone	Darwin Perennials
44) Schizachyrium Standing Ovation	North Creek Nurseries
45) Sedum Pillow Talk	Intrinsic Perennial Gardens
46) Tiarella F. M. Mooberry	Plants Nouveau
47) Veronica Spike	Intrinsic Perennial Gardens
48) Veronica Dark Blue Moody	Blues Star Roses/Conard Pyle
49) Veronica Light Blue Moody B	lues Star Roses/Conard Pyle
50) Veronica Vernique Rose	H. F. Michell Green Fuse Botanicals

ASSESSING THE QUALITY OF BIO-CONTROL AGENTS

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The first step when your box of beneficials arrives is to check the temperature of the contents and the ice pack. Today the easiest way to do this is with an infrared thermometer. Temperatures from an infrared thermometer give the clearest picture to your supplier. Lacking a quick read thermometer, you can always do a quick check with your hand. Is the ice pack still frozen? In the winter, this may be a bad sign, because the insects may have frozen as well. However, if it just froze recently, and cast off a lot of heat at the point of freezing, then the insects may still have survived. In the summer, there is a good chance that the ice pack thawed in transit. In this case, you want to know if the package had a phase where it got hot. A hot ice pack says, yes, the package got hot.

Another question is how many days has the product been in transit? Also check the batch codes or best by dates on the container. You do not want last week's product….it should be the product. If there is a problem, be sure to alert your supplier.

To assess the individual products takes a little time, but it is well worth the effort to know whether you got what you were supposed to get. You definitely want to know if the product is alive. This is easy for the moving adults and larvae. Are they moving? For eggs and pupae, you need to set aside some small samples to hatch.

Next, you want to get some idea of numbers. Did you get the thousand or 50,000 that you ordered? The most recent work on quality assessment for greenhouse growers is Grower Guide: Quality Assurance of Biocontrol Products. It was compiled by Rose Buitenhuis at the Vineland Research and Innovation Center in Ontario Canada. This can be found on-line at www.vinelandresearch.com/sites/default/files/grower_guide_pdf_final.pdf . It discusses quick methods to evaluate the quality of more than 27 species of beneficial insects, mites and nematodes.

Most but not all beneficials demonstrate vigor in the crop when you can observe them laying eggs and creating a second generation. This is easiest to observe on an infested crop plant or on a banker plant. Exceptions are those biocontrols that do not usually establish in a crop, like lacewings, lady beetles and nematodes.

Your supplier needs to know if there is a problem, so that they can fix it in the future. Continuous feedback feeds continuous improvement.

Overall, the variety and quality of beneficials has never been better and is constantly improving. With your help, biocontrol systems will continue to thrive and improve.

Carol Glenister is founding president IPM Laboratories, Inc., a 35 year old company that supplies beneficial insects, mites and nematodes used for pest control in greenhouses, interiorscapes, landscapes, and agriculture. Her research focuses on creating supportive plant habitats for these natural enemies. She has a Masters Degree in Entomology from Cornell University.

DOWNY MILDEW DISEASES ON FLOWER CROPS

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Cornell University Section of Plant Pathology and
Plant-Microbe Biology, LIHREC, Riverhead, NY

What is a downy mildew? Downy mildews are water molds (oomycetes), in the same grouping with Pythium and Phytophthora. They cause a number of often host-specific plant diseases, typically angular yellow leaf spots and/or systemic infection. The reason for the designation "downy" is that these mildews produce their spores (sporangia or conidia) on tiny "hat racks" that protrude through the stomates on the undersurface of the leaf. The accumulation of spore stalks and spores appears downy to the naked eye; the down varies from white (e.g. impatiens) to gray (e.g. coleus). Downy mildews are favored by high humidity, and most are favored by spring and fall temperatures typical to the Northeastern United States. Rose downy mildew, for example, is favored by 85% RH and 66°F.

Generic Downy Mildew Symptoms: Patches of yellow, red, brown or black on leaves; stunted and chlorotic new growth; leaf twisting, leaf drop, stunted leaves. These symptoms are usually accompanied by downy sporulation on the undersurface of the leaf. Downy mildew diseases are very hard for inexperienced growers to identify.

Roses: On roses, for example, there are scattered, irregularly-shaped spots on leaves, followed by leaf drop. The downy mildew causing disease on rose is called Peronospora sparsa for a very good reason: it rarely ever produces any spores. For rose downy mildew management, Chase Horticultural Research reported best results with Segway, Stature DM, Aliette, and SubdueMAXX. Low rates with strobilurins have not been effective, but Hausbeck (MSU) reported good control with Heritage at a 4 oz/100 gal rate; Daconil, although effective, can cause phytotoxicity to roses (as the label indicates).

Coleus: Coleus downy mildew was the new downy mildew before the dreaded impatiens downy mildew appeared on the scene. It causes spotting, leaf twisting on many coleus cultivars, and leaf drop on the most susceptible ones. It may be difficult to tell apart from Impatiens necrotic spot virus (INSV), which also produces brown spots on coleus leaves. With the downy mildew, however, there is often obvious downy mildew sporulation making the undersurface of the leaf appear "dirty". Agastache is susceptible to the same downy mildew, but the Peronospora species that causes the disease on coleus is different from the one that attacks basil. Sporulation in the greenhouse was shown at Michigan State Univ. to occur during a period of 95% RH, and spores were released when the humidity dropped. Their trials also showed that 59°F and 68°F promoted disease, whereas little infection or sporulation was seen at 77°F and none at 86°F. We conducted trials of a range of coleus cultivars in conjunction with Dr. Hausbeck's lab. In 2013, results showed no DM on Dark Star, Twist of Lime, Henna, Under the Sea Bone Fish, Under the Sea Electric Coral, Under the Sea Lime Shrimp, two experimental lines from the Univ. of Florida breeding program, Burgundy Lace, Cranberry Bog and The Whirlpool, under shaded conditions with overhead irrigation in which many other cultivars showed severe symptoms. Some of the most symptomatic cultivars, in contrast, were Chocolate Mint, Dark Chocolate, Kong Mosaic, Wizard Mosaic, Wizard Pineapple, and Wizard Velvet Red. Coleus that did well in a 2015 trial on seed-grown cultivars were Fairway Orange, Kong Lime Spritz, Kong Rose, Kong Salmon Pink, Superfine Multicolor Rainbow, Premium Sun Mighty Mosaic, and Wizard Jade. Disease control was good with Orvego, Pageant and the high rate of Stature DM. Higher rates and shorter interval were better for all materials tested. FenStop and a Subdue drench were effective in a Michigan trial. Phos acids have given weak control of coleus DM in our trials.

Basil: The downy mildew Peronospora belbahrii, noted in the US for the first time in Florida in 2007, causes a pernicious disease on basil that makes greenhouse production very difficult. Greenhouse humidity is generally high enough to favor sporulation, and the inoculum may be brought in at any time on contaminated seed, which is not uncommon. Purchasing steam-treated seed is one option for companies seeking to avoid downy mildew. Lighting crops at night will prevent sporulation on any part of the leaf surface that gets direct contact with light. Infected leaves will yellow if they are infected but humidity is not high enough for spore production. Plant breeders are working diligently to find new basil hybrids that are both resistant to the disease and delicious. Roguing out plants

with yellowing areas of foliage before sporulation is one key control. Fungicide treatments with phosphorous acid materials (KPhite, FosPhite, etc FRAC 33), mandipropamid (Revus, FRAC 40) and cyazofamid (Ranman, FRAC 21) may be used for management in greenhouses.

Sunflower: The downy mildew Plasmopara halstedii affects rudbeckias as well as sunflower, even though there are some genetic differences in the pathogens of the two crops. In the field, downy mildew infects through roots in areas of poor drainage. The diseased plants are stunted and orient their flowers abnormally. Later, leaf lesions can spread by wind-driven rain from plant to plant. The temperature for infection is 50-59° F and disease is inhibited by temperatures above 63° F.

Impatiens: Impatiens downy mildew, Plasmopara obducens, was new to the United States bedding plant industry in 2004, but the disease has been known on native impatiens (e.g. jewelweed, I. capensis) in the US since the 1800s. Infected plants stop flowering, show chlorotic leaves, drop leaves, keel over, and melt away into the soil—very different from their previously stellar performance. Our trials have shown that some other Impatiens species are susceptible, but that I. walleriana, the standard bedding plant, is exceptional in its high degree of vulnerability to downy mildew. Contrast this with I. balsamina, the balsam impatiens, which develops leaf spots but continues to flower and does not drop its leaves. Any impatiens type with I. walleriana in its parentage is very susceptible to downy mildew, but many other species tested show a high degree of resistance, which bodes well for an eventual cure through plant breeding efforts. In the fall of 2011, the downy mildew became established in bedding plants in the landscape for the first time, followed by widespread distribution and losses in 2012 and 2013. Currently growers continue to be pressured by their customers to grow more I. walleriana, as losses recently have not been as noticeable as they were in 2012-2013. Many fewer impatiens are being grown, and yet the disease is still being reported, so returning to impatiens is NOT risk-free. Mass outdoor plantings are still not recommended, particularly since the downy mildew is able to survive in the soil in the form of oospores for years. Sites with a history of downy mildew on impatiens are likely to see the disease return. The downy mildew may also be shipped north from frost-free areas.

Digitalis: The downy mildew of Digitalis (foxglove), Peronospora digitalidis, has now entered the plant production industry, and is in some cases not being properly identified. Treatment may be needed on this crop to prevent reddening and spotting of foliage.

Chemical Control of Downy Mildews: Fungicides in many FRAC groups are registered for use against ornamental downy mildews. Their effectiveness varies somewhat from one downy mildew to another. Mancozeb (FRAC M3) is the most effective contact-action material; copper is somewhat helpful. The effectiveness of biocontrols is limited against these diseases. Other FRAC groups that can be used in the rotations of treatment are FRAC 4 (e.g. Subdue MAXX, which must be tank-mixed with another material), FRAC 11 (e.g. Heritage), FRAC 19 (e.g. Affirm), FRAC 21 (e.g. Segway), FRAC 33 (e.g. Alude), FRAC 40 (e.g. Stature, Micora), FRAC 43 (e.g. Adorn, which must be tank-mixed) and the new FRAC U15 material, Segovis. Slow-release phosphorous acid formulations have shown strong promise against downy mildew in our trials.

For more info:
See the American Floral Endowment website for Final Research Reports on Studies Relating to coleus and rose downy mildew: http://endowment.org/afe-research-reports-disease-management/

See the Cornell Cooperative Extension of Suffolk County website for info on impatiens alternatives for shady gardens, impatiens downy mildew and coleus downy mildew: http://ccesuffolk.org/agriculture/floriculture

E-GRO: A COMPREHENSIVE ONLINE RESOURCE FOR THE GREENHOUSE INDUSTRY

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e-GRO (Electronic Grower Resources Online) is a collaborative effort of floriculture specialists from twelve land-grant universities, including Penn State, to freely share information about commercial greenhouse production. This comprehensive website houses a number of tools, videos, webinars and books, and also sends out pest and crop alerts to subscribers. If you are a commercial greenhouse operator Pennsylvania or surrounding states, you should look into this valuable resource.

Bringing together some of the leading specialists from universities around the US, e-GRO is a free resource and learning tool for anyone involved in greenhouse plant production. In fact, the American Society for Horticultural Science awarded e-GRO their "Top Extension Website" in 2013.

www.e-gro.org

What kinds of resources can be found on this website?

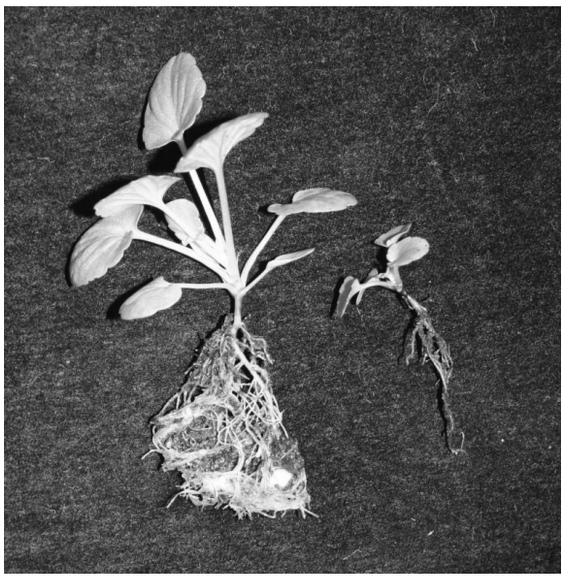
Pest and Crop Alerts. You can subscribe to email alerts to keep you updated on important pests, problems, tips and events occurring in the floriculture industry. These email alerts are timely, to the point, and easy to navigate. Here are a couple of examples of alerts from 2016:

E-GRO ALERT: BLACK ROOT ROT ON PANSY...KEEP LOOKING AT THOSE ROOTS!

Heidi Wollaeger,
Michigan State University Extension

Pansies (Viola spp.) are susceptible to black root rot. The symptoms of black root rot are: chlorotic lower foliage, poor rooting, lack of growth, and the blackening of the roots.

Read Now: e-GRO Alert 5.13 Black Root Rot on Pansy



Lee Stivers has been a horticulture educator with Penn State Extension in Washington County since 2001. She is a member of Penn State Extension's Statewide Horticulture Extension Team, specializing in vegetables, greenhouse production, and wine grapes. Prior to moving to Pennsylvania, Lee worked for Cornell Cooperative Extension and the University of California, Davis, where she received her Masters degree in 1989.

E-GRO ALERT: COLEUS DOWNY MILDEW UPDATE

Nora Catlin, Cornell Cooperative Extension of Suffolk County

Coleus downy mildew can cause leaf spots, necrotic lesions, leaf twisting, leaf drop, and/or stunt. Management options include using less susceptible cultivars, good air movement, low humidity, and fungicides.

Read Now: e-GRO Alert 5.14: Coleus Downy Mildew

Webinars and Videos. Go a little deeper into topics like plant nutrition, PGR calcluations, controlling plant growth, irrigation, and dosatron maintenance with live and recorded webinars and videos available on the site.

iBooks. A number of e-books are available for either direct download (free of charge) or for purchase through the iTunes iBookstore. For example, e-GRO's newest offering is Insect and Mite Pests of Floriculture Crops: Identification Guide. This is a free download from the website.

PGR MixMaster App. The PGR MixMaster app allows you to quickly calculate the amount of PGR product needed to mix specific concentrations for any volume.

e-GRO is sponsored by American Floral Endowment, Fine Americas, Philips, Griffin Greenhouse Supply, and the Fred C. Gloeckner Foundation. Collaborators include seven regional grower organizations.

GETTING MORE FROM YOUR COVER CROP WITH SPECIES MIXTURES

Charlie White, Mary Barbercheck, Tianna DuPont, Denise Finney, Abbe Hamilton, Dave Hartman, Mena Hautau, Jermaine Hinds, Mitch Hunter, Jason Kaye, Jim LaChance

The following is an excerpt from Penn State Extension Fact Sheet EE0166, available for download in full at http://extension.psu.edu/publications/ee0166/view

Cover crops can provide multiple benefits. For example they can improve soil health, supply nutrients to cash crops, suppress weeds, help manage insect pests, produce forage, support pollinators and beneficial insects, and reduce water and air pollution. However, not all cover crop species provide the same benefits. How can you best reap the multiple benefits of cover cropping with many species to choose from? Plant mixtures to multiply and diversify your cover crop benefits.

Cover crop strengths and weaknesses. Individual species of cover crops often excel at providing one or two functions, while also having specific drawbacks. For example, forage radish (Raphanus sativus var. longipinnatus) can suppress weeds and reduce compaction in the fall, but because it winter-kills, it does not provide a living root system or residue cover in the spring. Red clover (Trifolium pratense) captures nitrogen from the atmosphere, but may not suppress weeds when seeded in the heat of summer without a companion species. Cereal rye (Secale cereale) can stop nitrogen from leaching, but may deprive the following cash crop of nitrogen. Meeting multiple objectives while avoiding basic pitfalls may require combining several species. Tables 1 and 2 (available in the full PDF download) list many of the common cover crop species used in the Northeastern U.S., their relative ability to provide different services, known drawbacks, and recommended planting date windows.

Building a Complementary Mix

The success of a cover crop mixture depends upon each species in the mix providing the desired services in the appropriate balance with other species in the mix. Achieving this balance can be difficult because certain species are highly competitive, causing the desired services of the less competitive species to go unrealized. Often, these services are tied to a cover crop's biomass production or the density of certain plant parts, such as tap roots or flowers. For instance, legume cover crops with greater biomass and nitrogen content will supply more nitrogen, and a greater flower density in a cover crop stand will attract more pollinators. However, more is not always better. In some cases, excessive biomass production by species in a mixture can lead to challenges for cover crop termination and incorporation and for planting the following crop as well as reduce the efficacy of other species in the mix. Balancing the services provided by a mixture requires selecting species that are complementary in their growth periods, growth forms, nitrogen acquisition strategies, and resources for pollinators and beneficial insects.

Complementary growth periods. Different cover crop species can have a variety of temporal growth periods. Some species have narrow or restricted seeding windows in the fall to achieve successful establishment. Some species will winter-kill due to cold temperatures, while others will require termination early in the spring to avoid excessive growth, and others yet will require delaying termination later into spring to allow for sufficient growth. Navigating the maze of complementary growth periods is a sure way to hone down the list of cover crop species that will perform well together in a mix.

Begin by considering the date in the summer or fall when the cover crop can be planted. Generally, earlier planting dates will allow you to choose from more potential species. Then consider when you will terminate the cover crop, such as early, mid, or late spring, and select species that have similar optimum termination times. Tables 1 and 2 list recommended planting dates and optimum termination dates for each species.

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When the cover crop planting date is early enough to successfully establish winter-killed cover crop species, consider a mixture that includes both winter-killed and winter-hardy species. Rapid growth of the winter-killed species in the fall will increase nitrogen uptake, weed suppression, and erosion control in the fall. However, after winter-killing, some services provided by the cover crop begin to diminish. Without a living cover crop growing through the winter and into the spring, nitrogen scavenging and nitrogen fixation cease, and the opportunity to grow more cover crop biomass to build organic matter is lost. Having winter-hardy species in the mixture will help to maintain cover crop benefits throughout the winter and into the spring.

Complementary growth forms. Different species in a cover crop mixture can compete with each other for space and light, reducing the services provided by the less competitive species. Selecting species with complementary growth forms helps to alleviate competition between species. Cover crop growth forms can be divided into several categories, including tall open canopies, short dense canopies, and vining (See Tables 1 and 2). Species with similar growth forms are likely to compete with each other while species with differing growth forms are more likely to be complementary. Tall, open-canopied species are especially compatible with vining species as the tall canopied species creates a ladder on which the vining species can grow. It is important that species with tall, open canopies are not planted too densely, or they will shade out the understory species. It should also be noted that some cover crop species, such as cereal grains, will shift their growth form from a short dense canopy to a tall open canopy when maturing from vegetative to reproductive stages. One way to manage species that will compete with each other for space is to plant them in an alternating row configuration. This practice is described in more detail in the 'Methods to Establish Cover Crop Mixtures' section of this fact sheet.

Complementary nitrogen acquisition strategies. Legume cover crops can obtain nitrogen from both the soil and the atmosphere, while non-legume cover crops, such as grasses and brassicas, can only obtain nitrogen from the soil. Although legumes can take up soil nitrogen, they do so less aggressively than grasses and brassicas. Because low soil nitrogen levels can limit cover crop and cash crop growth, and excessive soil nitrogen levels can stimulate weed growth and contribute to nitrate leaching, the level of soil nitrogen availability should be taken into account when planning the cover crop mixture. Sometimes it is beneficial to pair species with different nitrogen acquisition strategies, while at other times only a single cover crop type may be necessary.

For soil with low nitrogen levels, legume cover crops that can satisfy their nitrogen demand from the atmosphere will be most effective. For soils with excessive nitrogen levels, non-legumes that are aggressive at scavenging soil nitrogen should be used. A legume cover crop planted in a soil with high nitrogen levels will grow well, but will be less competitive against nitrogen-hungry weeds and will not prevent nitrogen leaching as well as a non-legume would. Conversely, planting a non-legume into a soil with low nitrogen levels will result in sub-optimal biomass production due to nitrogen deficiency. In soils with moderate nitrogen levels, a mixture of a legume and non-legume can work well, as the non-legume will take up the soil nitrogen, protecting it against leaching, while the legume fixes nitrogen from the atmosphere, adding nitrogen to the plant-soil ecosystem. If the nitrogen level of a soil is not known, planting a cover crop mixture can be a useful strategy, as the performance of the mixture will adapt to the existing soil conditions. When large amounts of soil nitrogen are available, non-legumes will be favored and legumes may not flourish. With low soil nitrogen availability, legumes will be favored. This dynamic tradeoff between grasses and legumes allows the cover crop to adapt to the nitrogen management service needed most.

Complementary resources for beneficial insects and pollinators. Many beneficial insects, for example predators, parasitic wasps, and bees, can benefit from nectar and pollen provided by flowering cover crops. If providing resources for conserving pollinators and other beneficial insects is desired, differences in flower morphology such as shape, size, and color will influence the types of beneficial insects that are attracted to a particular cover crop. For example, cover crops with flat, open flowers allow pollen and nectar resources to be available to all shapes and sizes of bees as well as insect natural enemies. However, the narrow, closed flower morphology of legumes is typically difficult for small bees and beneficial insects, e.g., parasitic wasps, to enter to obtain pollen and nectar. Therefore, to provide resources to a diversity of beneficial insects, cover crops mixtures containing a variety of flower morphologies may be required.

Flower density has a significant influence on the number of bees and other beneficial insects that are attracted to a planting, with greatest beneficial insect visitation to plantings with the highest number of open blooms per area. Therefore, a monoculture of a flowering cover crop will be more attractive at peak flowering than a cover crop mixture that contains a lower density of open flowers. However, cover crop mixtures may contain species that flower at different times, extending the potential time that floral resources are available. Most importantly, to provide floral resources to beneficial insects, flowers must be open and available. Cover crop planting and termination windows may not allow for flowering species to bloom before the cover crop is terminated. If a crop rotation window does not allow the cover crop to flower before it must be terminated, then it may be feasible to leave strips of cover crops in the field for a few extra weeks to further support beneficial insects. However, management of the cover crop before seed set or a plan to manage "volunteer" cover crops resulting from those that set seed should be in place before allowing cover crops to flower.

Non-flowering cover crops can also provide resources for beneficial insects, such as extrafloral nectar, refuge and overwintering habitat, and alternate prey. These resources are all vital in supporting predatory and parasitic insects and spiders. The presence of these resources is important in facilitating early season colonization of fields by beneficial insects that can more easily respond to establishing pest populations. It is important to remember that cover crops can host crop pests, serving as a "green bridge" between cash crops. Therefore, it is critical to maintain a good crop rotation that takes into consideration the potential insect pest and disease-causing organisms that may be shared by the cover crops in a mixture and the subsequent cash crop in your rotation.

Too many? Too few? How many species are just right?

A central and yet unresolved question in the design of cover crop mixtures is "How many species should be in the mix?" In natural grasslands, it has frequently been observed that increasing the number of species in an area does enhance important ecosystem functions, but after a certain point, adding additional species no longer provides additional benefits. Applying this idea to cover crop mixtures, we expect that selecting a small number (3 to 5) of complementary species and managing them to achieve even biomass production in the mixture will provide multiple cover crop functions. Beyond a certain number of species the return on our investment is likely to diminish. In other words, a carefully planned mixture of a few complementary species may provide the same or more cover crop services than a mixture with many species.

A major challenge in pinpointing the "right" number of species is the fact that cover crops, like other crops, have good years and bad years due to weather or management decisions necessary to meet other production goals. This leads to year-to-year differences not only in overall biomass production, but also in the contribution of each species to a cover crop mixture. Such differences can impact the extent to which a mixture provides the desired cover crop services. One way to buffer against the loss of a desired service is to increase redundancy in the mix with additional species that perform the same functions or exhibit similar growth characteristics. The redundancy present in higher diversity mixtures increases the likelihood that at least one species selected to fill a certain role can thrive, a type of insurance policy to assure that the mix will provide the services for which it was designed.

In the online version of this extension fact sheet, we further describe methods to establish cover crop mixtures, including calculating seeding rates, considerations for terminating cover crop mixtures, and provide case studies of cover crop mixture management on farms in Pennsylvania.

Conclusions

The benefits of cover crops have been long recognized and in some cases using a cover crop mixture can enhance these benefits. By tailoring the selection of cover crop species to meet farm management objectives, understanding complementarity between species, and following some basic management guidelines, an endless array of cover crop mixtures can be designed and implemented in any farming system. As with any new endeavor, observing the results and making adjustments based on previous experiences are important keys to long-term success when using cover crop mixtures. Together, the collaboration of researchers and farmers can continue to unlock the potential of cover crop mixtures as a key tool for enhancing the multi-functionality, resiliency, and sustainability of cropping systems.

COVER CROPS FOR POLLINATORS

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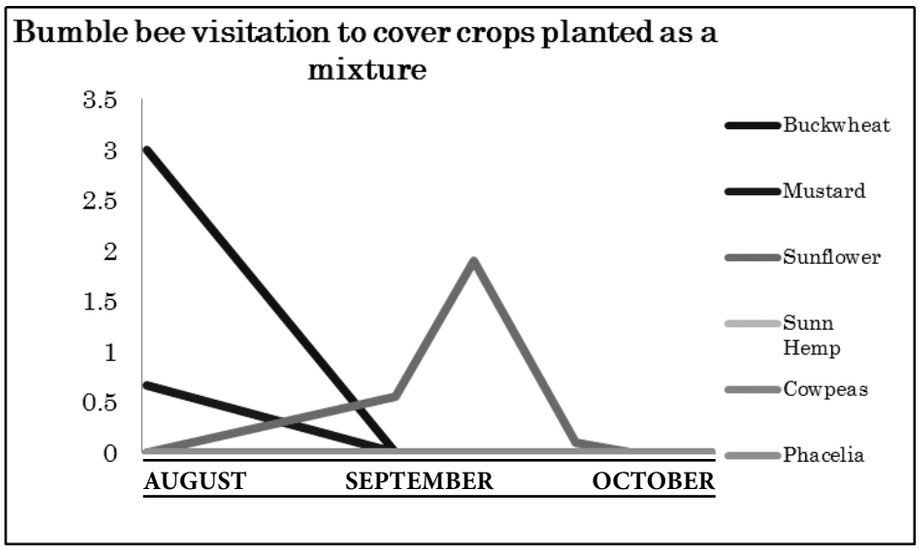
In the last decade, the decline of pollinators has been identified as a serious threat for both agricultural and natural ecosystems across North America. Habitat loss, and the resulting loss of valuable floral resources and nesting habitat, is one of the major threats to their populations. Augmentation of pollinator habitat and flowering resources has been proposed as a useful strategy to conserve pollinators in agricultural systems. This technique is commonly referred to as floral provisioning, and has been effective in a number of different agroecosystems, particularly vineyards, orchards, and non-rotational crops.

Due to the rotational system of certain crops, such as pumpkin, cover cropping as a method of floral provisioning can be utilized as a more effective method of supporting pollinators. Cover cropping is advantageous in this system as it not only allows for additional weed control (which has been problematic for establishing floral provisioning in agricultural systems) but it also allows for the grower to benefit from traditional and peripheral ecosystem services of cover crops. Species that flower annually can be chosen over the more commonly used perennial species in floral provisioning.



In Pennsylvania, we are trialing this within pumpkins. Research in our lab and from the surrounding region, including Virginia, West Virginia, Maryland, and New York has found that within the pumpkin cropping system, two wild species of pollinators are of importance, the bumble bee and the squash bee Bombus impatiens and Peponapis pruinosa. To support these pollinators, we are utilizing two stages of plantings across a growing season in Pennsylvania, with a spring and fall flowering planting. Although cover crops are typically seeded as monocultures, there is increasing interest in crop species mixtures. We are using a mixture of plant species in both the seeding dates in hopes of achieving a seasonal progression of floral resources. Some of the cover crop species we have trialed include: Phacelia, Hairy Vetch, Field Pea, Rye, Oats, Buckwheat, Sunflower, and Cowpea.

The spring blooming planting is seeded in the previous year, in early fall, with an intended planting date of September 15th, and blooms in the early spring, with the intention that this blooming period will synchronize with early emerging queens. We replaced the more commonly used rye with oats as a nurse crop, in the hopes of achieving suf-

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ficient resilience through the fall and winter, while also achieving winter-kill of oats, to enable more floral resource in the spring. The fall blooming planting will be seeded in early July, intended plant date being July 7th, and will bloom across September and October. This will provide flowering resources after pumpkin bloom for queens that are preparing to overwinter.

Understanding what pollinators are relevant to your system, their phenology, and what cover crops are relevant to your cropping system and region is imperative. To better streamline this process, the following questions should be asked when approaching this topic:

1.) What pollinators are the most relevant to my region and my crop?

   a. At what point in the season do these pollinators need additional flowering resources?

2.) What cover crop species meet the needs of my farm?

   a. Which species of cover crop do best in my region?

   b. Can I manage these species differently to better support pollinators?

   c. Can I add in additional species to fill in periods of no-bloom?

3.) Additional resources can be found using the following links:

   SARE.org
   Xerces.org
   www.kingsagriseeds.com
   Penn State Extension

Opportunities in Agriculture

CONTENTS

Available at: www.sare.org/cover-cropping-for-pollinators or order free hard copies at (301) 779-0007.

SARE
Sustainable Agriculture Research & Education

Cover Cropping for Pollinators and Beneficial Insects

Doug Crabtree uses many tools to make his Montana farm bee friendly. —Photo by Jennifer Hopwood. Phacelia is an attractive pollinator cover crop. —Photo by John Hayden. Clover fixes nitrogen and provides bee forage. —Photo by Jochen Reid

DOUG AND ANNA CRABTREE'S VILICUS FARM RESTS on more than 2,000 acres in northern Montana, and it is a model of how cover crops can be a foundation of pollinator and beneficial insect management. Like many farmers, their approach to cover cropping began with an interest in soil health and quickly grew to encompass much broader goals as they recognized the additional benefits cover crops could provide.

"We want to implement pollinator conservation at the field-level scale," Doug says. "Anyone can create a small wildflower strip, but as we scale up, we need conservation areas distributed across the entire operation."

While the Crabtrees have established permanent native wildflower strips around many of their fields to provide a skeleton of habitat throughout the farm, extensive cover crop rotations provide the muscle that makes their operation a rich landscape for bees and other beneficial insects.

This commitment to cover cropping is having clear and positive impacts. Flax, sunflower and safflower are just a few of the Crabtrees' regular crops that either require or strongly benefit from insect pollination. And, because of their commitment to integrating habitat for wild pollinators throughout their holdings, the Crabtrees have never needed to bring honey bee hives onto the farm for pollination. Instead, a walk through their fields quickly reveals an abundance of wild bumble bees, longhorn bees, sweat bees and more—all supported by the farm's habitat. A farm's ability to support its own pollinator community provides security, especially if managed honey bee hives become scarce or expensive.

In addition to supporting the pollinator community, cover crops have many traditional uses on a farm. These range from preventing erosion and improving soil health to managing weeds and serving as an additional source of income when part of a double-crop system. With cover

IMPACT OF COVER CROPS ON DISEASES OF VEGETABLE CROPS

Kathryne Everts, University of Maryland

I developed the following fact sheet as part of the Southern Cover Crop Conference in Mount Olive North Carolina following a talk titled Cover Crops and Disease Suppression. It was developed with support from the conference sponsor, the Southern Sustainable Agriculture Research and Education (Southern SARE) program, which is funded by the U.S. Department of Agriculture—National Institute of Food and Agriculture (USDA-NIFA). The fact sheet is reprinted here with the permission of the sponsor.

Cover crops provide several benefits to soil health such as improving soil structure, reducing the need for synthetic chemicals by decreasing weed biomass, increasing soil organic matter, contributing nutrients to the soil, retaining soil moisture, and decreasing soil erosion. In addition, the integration of cover crops into crop production often leads to soils that are suppressive to plant diseases (i.e. have less potential for disease development). Disease reductions may occur in fields where the cover crop is planted in the fall and tilled under in the spring as a green manure prior to planting the cash crop, as well as when the cover crop is killed and the residue is left on the soil surface as a mulch (FIG. 1).

FIG 1. No-till hairy vetch cover crops may reduce diseases caused by splash-dispersed pathogens such as anthracnose caused by Colletotrchum orbiculare. Photo—Xin-Gin Zhou, Texas A&M University.

Mechanisms of Disease Suppression

Mechanisms of cover crop-induced disease suppression are not yet fully understood. However, several common mechanisms are thought to be involved in the "general suppression" of soil-borne plant diseases. Disease may be suppressed due to an increase in the overall activity and diversity of the soil microbiota (microorganisms that inhabit the soil) that occurs with cover crop production. Greater microbial diversity and activity results in increased competition with plant pathogens for nutrients and release of more compounds that interfere with the ability of plant pathogens to grow and develop. Some cover crops impact plant pathogens directly by releasing fungitoxic compounds (compounds that are toxic and subsequently unfavorable to the growth of fungi). In addition to increasing competition with soil-borne plant pathogens, these changes may also impact diseases because decomposing organic matter may increase fungistasis. Fungistasis occurs when a soil-borne plant pathogen's growth and infection is inhibited, even under optimal soil conditions. Fungistasis results from the presence of volatile compounds and/or the reduction in organic carbon compounds and nutrients. One example of a cover crop that may trigger several of these impacts is mustard greens (Brassica juncea). Mustard greens contain high levels of glucosinulates, which are sulfur containing chemicals that have fungicidal and nematicidal properties. The glucosinulates in mustard greens induce high levels of biological activity (mostly antimicrobial) and successfully suppress the occurrence of Rhizoctonia on potatoes through the release of isothiocyanates into the soil. In addition to direct effects on

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plant pathogens, many cover crops impact plant pathogens indirectly by triggering the plants' host defense response (a plant's immune response that protects it from infection).

In addition to general suppression, cover crops may also induce specific suppression by enhancing individual beneficial organisms. An example of an organism that induces specific suppression is the fungus Trichoderma harzianum, which suppresses Pythium, Fusarium spp. and other soil-borne pathogens of beans, and many other vegetable crops. Suppression by T. harzianum is thought to be due to competition for nutrients. Trichoderma is able to colonize many cover crops including annual ryegrass (Lolium multiflorum), red clover (Trifolium pretense), hairy vetch (Vicia villosa), and winter wheat (Triticum aestivum). Its ability to survive at high populations and colonize a subsequent cash crop is related to the cover crop root mass, time of cover crop termination, and other factors. In one study, winter wheat and canola (Brassica napus) resulted in the best carry over of Trichoderma. Due to its ability to reduce some diseases, T. harzianum has been formulated into a commercial biocontrol product.

Mycorrhizae (fungi that live in association with plant roots and benefit the plant by aiding in water and nutrient absorption) may suppress individual pathogens. Cover crops influence the quantity and composition of mycorrhizae in soils and on the subsequent cash crop (FIG 2). Investigators have observed enhanced mycorrhizal populations in peach and tomato following a mycorrhizal cover crop. More recently, there was an increase in mycorrhizal colonization in watermelon grown after a hairy vetch or crimson clover (Trifolium incarnatum) cover crop. The cover crops improved mycorrhizal colonization of the watermelon roots and also reduced Fusarium wilt.

No-till and Disease Suppression

No-till cover crops provide many of the benefits just described and, additionally, provide a physical barrier that reduces the splash of soil and soil-borne pathogens onto foliage, stems, or fruit. The cover crop can also reduce the presence of free moisture on the plant because they reduce soil splash. Septoria leaf spot severity was reduced on tomatoes grown in a hairy vetch cover crop mulch due to reduced soil splash to the tomato leaves. Foliar and fruit rot diseases of pumpkin such as white fleck (caused by Plectosporium tabacinum) and black rot (caused by Didymella bryoniae) are often lower when the crop is grown on a no-till hairy vetch, cereal rye (Secale cereale), or hairy vetch plus cereal rye cover crop. The reduction may be due to the formation of a cover crop vegetative layer between the fruit and soil reducing soil splash and shortening the length of time the fruit remain wet throughout the day.

FIG 2. Crimson clover and other legumes cover crops support mycorrhizae populations that may increase colonization of this beneficial organism on the following cash crop. Photo credit—Kathryne Everts, University of Maryland.

FIG 3. Brassica spp. Cover crops suppress several diseases but have contributed to increases in Fusarium wilt diseases in some cases. Photo credit-Kathryne Everts, University of Maryland.

Cover Crop Management

Selection of a cover crop depends on many factors including its ability to suppress disease. In considering a cover crop for disease suppression, consider field history and what diseases have been observed in the past. In addition, consider future crops and their potential pathogens. Table 1 is a partial summary of specific cover crops that have successfully reduced diseases. Cautionary notes are also included.

TABLE 1. Selected cover crops that have suppressed vegetable diseases.

Cover Crop Amendment	Disease Suppression	Comments
Sudangrass (Sorghum sudanense)	Nematodes on many crops Bean root rot Verticillium wilt in potato	Suppression of nematodes is enhanced by the addition of poultry litter compost. (Sorghum spp. green manure has also reduced fungal diseases of lettuce and potato.)
Mustard (Brassicaceae spp.)	Root knot nematode Potato scab (Streptomyces scabies) Black scurf (Rhizoctonia solani) Verticillium wilt of tomato (Verticillium dahlia)	May reduce or increase Fusarium oxysporum. May suppress mycorrhizal populations in soil. Timely incorporation of the cover crop is important.
Hairy vetch (Vicia villosa)	Fusarium wilt of watermelon	Response is location dependent. Hairy vetch is a host of Root Knot Nematode (RKN) and therefore, not suitable for RKN infested areas. Use RKN resistant cv. Cahaba white.
Mixed forage species	Damping off tomatoes	Mix of tall fescue (Festuca arundinacea), orchard grass (Dactylis glomerata), timothy (Phleum pretense), red clover and alfalfa (Medicago sativa) suppressed Pythium.
No-till cover crop mulches: Hairy vetch Hairy vetch + cereal rye (Secale cereale)	Black rot (Didymella bryoniae) Anthracnose (Colletotrichum orbiculare) Plectosporium blight (P. tabicinum) on pumpkin Septoria leaf spot of tomato (Septoria lycopersici) Early blight (Alternaria tomatophila)	Provides a layer of plant material between soil and fruit, which reduces soil splash. Edema of pumpkin also was reduced some years on a no-till cover crop. Black plastic mulch also reduced disease in some years.
Sunnhemp (Crotolaria juncea)	Root knot nematode	
Crimson clover (Trifolium incarnatum)	Fusarium wilt on watermelon	Location dependent effect.
Cereal rye or oats (Avena sativa)	Verticillium wilt in potato	Not a good cover crop prior to corn production because it can host Fusarium graminearum, F. oxysporum and Pythium spp.

Cover crops, even those commonly associated with disease suppression, can under some circumstances increase other diseases (Table 1). In addition, timely incorporation of a cover crop is very important because incorporation that occurs too close to planting the cash crop may increase pathogens such as Pythium spp. It is important to maximize biomass of the cover crop, however the cover crop must be incorporated to insure enough time to breakdown, usually several weeks, prior to planting. Like all plants, cover crops get diseases and therefore can host plant pathogens, increasing the population present on the subsequent cash crop. For example, hairy vetch is a host of root knot nematode. White clover (Trifolium repens) and buckwheat (Fagopyrum esculentum) cover crops increased bean root rot where Fusarium, Pythium, and Rhizoctonia were present. Though brassica cover crops suppress many diseases, there also are reports of an increase in Fusarium disease severity following brassica cover crop incorporation FIG 3). This increase may have resulted because a Brassica cover crop decreases the mycorrhizal colonization of the succeeding cash crop. For example, when tomato was planted after a mustard (Allaria petiolata) cover crop the tomato roots had lower mycorrhizal colonization than in the absence of the cover crop.

The use of cover crop mixtures, timely incorporation of the cover crop into the soil or selection of a different cover crop can minimize these problems.

POST HARVEST MANAGEMENT OF ONIONS

Jeffrey Stoltzfus, Penn State Ext

Growing onions is a challenge in the best conditions. We battle bacterial diseases which can carry over in to storage if we aren't careful in grading our onions in the field at harvest. The biggest challenge after harvest is to control Black Mold in the bin.

Black mold is characterized by a fuzzy black mold that generally occurs just under the first and second skins. It usually starts around the neck of the onion but can progress to other parts of the onion.

Black mold can start in the field, but more often occurs in storage. Temperatures over 85 degrees can cause black mold to get started and progress rapidly. The key for us has been to dry the onions quickly and get them into a cooler below 70 degrees. The challenge we face is temperatures that can easily reach the mid 90's during harvest.

Drying starts in the field. We usually let the onions lay in the field for two to five days with the tops covering the bulbs to prevent sunburn. The onions are then topped and put in bins. There should 1.5 in. of top left on the onion to protect the bulb from bacteria. The bins are put on fans as quickly as possible. The fans are then run for five to seven days depending on the weather. We try to keep the drying room temps in the low 80's and keep the humidity down as well. Some years we have had good success in sheds with ambient air temperatures. Hot, wet years can be a challenge.

When the necks are paper dry and the outer skins come off easily when handled, then the onions are dry and ready to be cooled. If the necks have dried properly that will serve as a barrier for internal rot to move into the onions. Our onions are packed as they are shipped, so they go into a cooler until they are ready to pack. After packing the onions go back to a cooler to await shipment.

Surface rot can spread in the bin as well if the onions are not dried quickly and packed quickly after drying. Farmers are encouraged to keep onions with evidence of surface rot out of the bins at harvest. Center rot is harder to identify at harvest. It will progress in the onion during storage. However, since the center rot is internal it will generally not spread as quickly in the bin unless it gets bad. Internal rot can be identified at packing by a wet neck or a neck with black rings.

If sweet onions are harvested in good shape and handled properly they can keep 2-4 months without much storage loss.

Since last Spring, I have been working as the Farm Food Safety educator for Penn State Extension in Lancaster County. Prior to that I spent the past 23 years as a farmer educator working for the Eastern Lancaster County School District working primarily with vegetable farmers in Eastern Lancaster County. I assisted farmers in starting an onion growing cooperative and worked with them in areas of production and food safety. I live on a small farm where we grow strawberries, pumpkins, and beef cattle.

INSECT PESTS OF ONION: MANAGING THE OLD AND THE NEW

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A new invasive insect – the allium leafminer (*Phytomyza gymnostoma*) poses a threat to onions and their relatives (shallots, leeks, garlic, chives) in Pennsylvania and surrounding states. We are in the early stages of determining the behavior, ecology, and management of this pest in our agroecosystems. Concurrently, we are finding increased problems from a second fly species, the black onion fly (*Tritoxa flexa*). Little is known about this fly as well. These "new" pests need to be added to the pests growers often see: onion maggot, and onion thrips.

The allium leafminer has been expanding its geographic range throughout Europe during the last few decades, and was confirmed in February 2016 from samples collected in Lancaster Co. in December 2015. This is the first record of this invasive species in the US, and perhaps the western hemisphere. As of November 2016, surveys have confirmed its presence in 17 counties in PA, and 1 county in NJ. Damage to the spring onion crop in Lancaster Co. was significant, but it is unclear if there was much spillover into the bulb onion production. This species is expected to have a 1st generation spring flight, a summer aestivation (where it stays as a larval stage), followed by a late season fall 2nd generation flight. We've been able to compare behavioral responses to various sticky trap colors, and estimate timing of the 2nd generation flight, which started in the last week of September, and continued into mid-November, in southeastern PA in 2016 (Fig, 1). We've also gained an understanding of where we can expect to be able to conduct field work, and diagnostic characteristics for both the fly and damage symptoms. An understanding of flight timing and host preference may provide useful cultural control options, such as adjusting time of planting and harvest, trap cropping, and timing of row covers. Chemical controls labeled for leafminers in onions have been compiled and need to be evaluated. We've also confirmed feeding on wild alliums and ornamental alliums. Farms with a continuous supply of allium hosts, such as chives, leeks, maybe garlic, as well as weedy alliums, may be most at risk.

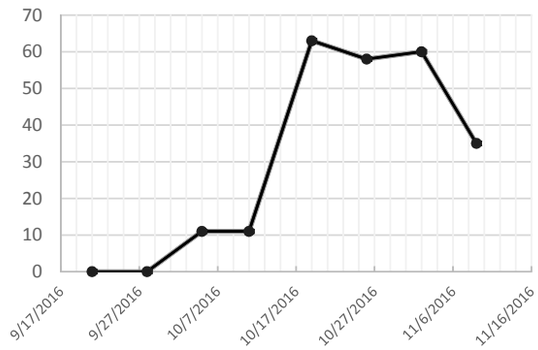

Fig. 1. Timing of fall (2nd generation) allium leafminer adult activity from one farm in PA, 2016. Data from an additional 7 farms are being collated.

The black onion fly (also sometimes called the onion bulb maggot) has been showing up in samples sent in that were suspected to be allium leafminer. Not much is known about black onion fly. Based on an old dissertation (Manis 1941), adults appeared in early May and were present season-long in Iowa. Often they were in adjacent grass or field margins, where they mate. There were 2-3 generations per year. The adults are easy to recognize due to colorful wing patterns that are probably used in mating rituals. Its large size suggests exclusion with row covers would be effective. Problems to date seem to be localized – we've seen black onion fly in north-central PA, and western PA. It has been causing significant damage to those farms where it occurs.

Onion thrips are probably the most commonly encountered pest in onions. Populations often start near field edges, and tend to increase following alfalfa or grain harvest. You need to pull back the leaves to find initial populations. New York suggests spray thresholds of 1 thrips/leaf. Reflective mulches tend to decrease thrips populations. Insecticide resistance is well documented from populations from large growing areas, such as the muck soils of New York. Fortunately, there are currently several modes-of-action among the insecticide options labeled for thrips con-

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trol in onion. These include neonicotinoids (Assail, Scorpion, Venom), cyazypyr (Exirel), abamectin (Agri-Mek), spirotetramat (Movento), and spinetoram (Radiant) – in addition to the older pyrethroids (lambda-cyhalothrin, permethrin) and carbamates (methomyl). A pre-mix of Agri-Mek and Exirel may be available in 2017. Some chemical options work best against larva, or need to be timed during early vegetative growth, or labelled for suppression only. Strategic choices among these can delay or avoid insecticide resistance.

Onion maggot overwinters as pupae. Adults that resemble small house flies emerge in April/May, and lay eggs at the base of plants. A second generation emerges is July, and a third in August. The Northeast Network for Environment and Weather Applications (NEWA) has an onion maggot model to estimate time of adult flight at http://newa.cornell.edu/index.php?page=onion-maggot. Select Jan 1 to current date and base 50 F for onion maggot. Compare your local growing degree days to projected first flights. Peak flight for is 450-540 for onion maggot (base 50). You can also see a map of GDD base 50F during the field season at http://apps.cei.psu.edu/proto/meteo/gdd50.html or http://pa-pipe.zedxinc.com/map/). Yellow traps can be used to monitor for flight activity, but you will need to be able to distinguish onion maggot adults from many other flies caught on yellow traps. Crop rotation is important to minimize pest pressure. Seed treated with FarMore FI500, FarMore OI100, or pelletized with cyromazine is effective when growing from true seed. Preplant (diazinon) or postplant soil drench (chlorpyrifos) are also chemical control options – but chlorpyriphos may be banned for food use soon, and both have not been effective in some trials. Although entomopathogenic nematodes seem to help with seedcorn maggot, efforts with onion maggot have not worked in recent trials. Postplant foliar sprays are difficult, at best, because adults are not in the fields, so contact is limited. Timing sprays well to coincide with adult flight and soaking soil can help. For the 3rd generation to survive, they need onions in the environment during August. Clean harvest and farm sanitation can help remove host material for that third generation, thus reducing pest pressure the following year.

Manis, R. C. 1941. Bionomics and morphology of the black onion fly, Tritoxa flexa (Wied.) (Diptera, Ortalidae). PhD. Dissertation. Iowa State University.

SWEET CORN WEED CONTROL: NEW HERBICIDES, NO-TILL ISSUES, AND OTHER CONSIDERATIONS

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Weed control continues to be a problem in sweet corn. However, over the past few years some newer herbicide products have been labeled for use in sweet corn that could provide effective control of problem weed species. Historically, weed control in sweet corn has primarily been limited to soil-applied materials. In addition to some newer preemergence herbicides, other postemergence products are also currently available. Products such as Acuron, Armezon PRO, Anthem, Liberty, Revulin Q, Solstice, Verdict, and Zidua now can be used in sweet corn production. These products have provided effective weed control and exhibited good crop safety in field corn, however there is limited research experience with them in sweet corn in Pennsylvania and the Mid-Atlantic region. It has been several years since an experiment evaluating competitive herbicide programs, especially those including newer products, has been conducted in our area. Also, with more weeds becoming herbicide resistant it is critical that growers use other effective modes of action to combat this problem. Some of these new products can help.

Newer GMO sweet corn varieties that are resistant to Roundup and Liberty are currently available for use. These varieties can be valuable since glyphosate and Liberty (glufosinate) provide broadspectrum weed control with no soil residual issues that could interfere with rotational crops. However, due to the increasing number of glyphosate resistant weed species we did not use Roundup Ready sweet corn varieties in this study. There were some treatments that include Liberty so a LibertyLink variety was used.

Field studies were conducted in 2016 at two locations, the Penn State Russell E. Larson Agricultural Research Farm in Centre County and at the University of Delaware Research and Extension Center in Sussex County to evaluate grass and broadleaf weed control programs in sweet corn (var. 'BC0805', tolerant to Liberty herbicide) using combinations of preemergence and/or pre & postemergence herbicides, including standard and new products. In order to obtain a wider range of weeds, soil types, and growing conditions, the studies were conducted at the Penn State research farm in Centre County and at the University of Delaware, Georgetown research farm. Results from the experiments are in Tables 1 & 2.

Dwight Lingenfelter is an extension agronomist/weed scientist in the Dept. of Plant Science at Penn State since 1994. He is responsible for developing various materials for Extension purposes, including revising portions of The Penn State Agronomy Guide, presenting practical information at county and statewide Extension meetings and field days, and generally contributing to other weed science Extension and research needs in mainly agronomic and some vegetable crops. He also coordinates the annual Penn State Agronomic Field Diagnostic Clinic and coaches the PSU collegiate weed science team and is a member of several professional societies and serves on various committees. He received BS and MS degrees in Agronomy from Penn State. He also worked for a period with a major ag chemical manufacturer and as a crop consultant. (2013)

Table 1. Effect of herbicides on weed control in sweet corn at Centre Co., PA, 2016***.

Herbicide(s)*	Rate/A	Applic. timing**	Gi. foxtail	L. crab-grass	Lambs-quarters	Velvet-leaf	C. rag-weed	Rr pig-weed	Cockle-bur
			% control						
Untreated	-	-	0	0	0	0	0	0	0
Lumax EZ	3 qt	PRE	98	95	99	99	98	99	86
Acuron	2.5 qt	PRE	96	95	99	99	99	99	83
Verdict + atrazine	15 oz + 1 qt	PRE	87	95	97	94	99	99	72
Zidua + atrazine	2.5 oz + 1 qt	PRE	86	95	99	94	99	99	57
Cinch ATZ fb Revulin Q	1 qt fb 4 oz	PRE fb MPOST	91	95	99	99	99	99	94
Bicep II Magnum fb Solstice + atrazine	1 qt fb 3 oz + 1 pt	PRE fb MPOST	85	95	99	99	99	99	99
Bicep II Magnum fb Impact + atrazine	1 qt fb 0.5 oz + 1 pt	PRE fb MPOST	90	95	98	96	99	98	94
Bicep II Magnum fb tolpyralate + atrzine	1 qt fb 1 oz + 1 pt	PRE fb MPOST	92	95	98	99	99	99	96
Bicep II Magnum fb Liberty	1 qt fb 20 fl oz	PRE fb MPOST	89	95	90	89	99	99	87
Prowl H2O fb Liberty	3 pt fb 20 fl oz	PRE fb MPOST	95	95	99	99	99	99	91
Zidua fb Armezon Pro	2 oz fb 16 fl oz	PRE fb MPOST	96	95	99	99	99	99	86
Anthem Maxx fb Solstice	3 fl oz fb 3 fl oz	PRE fb MPOST	90	95	99	99	99	98	92
Accent Q + Impact	0.5oz+0.75oz	MPOST	87	50	98	79	97	99	94
LSD (P=0.05)			7	-	4	7	2	1	21

* If necessary, rates will be adjusted depending on soil type at research location; and appropriate adjuvants will be included with the postemergence herbicide treatments

**abbreviations reference: fb – followed by; PRE – preemergence (; MPOST – mid postemergence

*** Late season ratings taken 8/5/2016

Table 2. Effect of herbicides on weed control and crop yield in sweet corn at Sussex Co., DE, 2016***.

Herbicide(s)*	Rate/A	Applic. timing**	L. crab-grass	Palmer amaranth	Annual morningglory	Yield (tons/A)
			% control			
Untreated	-	-	0	0	0	2.8
Lumax EZ	3 qt	PRE	98	100	53	3
Acuron	2.5 qt	PRE	99	100	90	3
Verdict + atrazine	15 oz + 1 qt	PRE	94	100	99	3.2
Zidua + atrazine	2.5 oz + 1 qt	PRE	97	100	0	2.6
Resicore + atrazine	2.25 qt + 1 qt		97	93	67	2.8

Cinch ATZ fb Revulin Q	1 qt fb 4 oz	PRE fb MPOST	98	100	98	3.1
Bicep II Magnum fb Solstice + atrazine	1 qt fb 3 oz + 1 pt	PRE fb MPOST	97	100	92	3.1
Bicep II Magnum fb Impact + atrazine	1 qt fb 0.5 oz + 1 pt	PRE fb MPOST	100	100	91	3.3
Bicep II Magnum fb Liberty	1 qt fb 20 fl oz	PRE fb MPOST	99	100	88	3.1
Prowl H2O fb Liberty	3 pt fb 20 fl oz	PRE fb MPOST	96	100	31	3.3
Zidua fb Armezon Pro	2 oz fb 16 fl oz	PRE fb MPOST	70	100	0	2.7
Anthem Maxx fb Solstice	3 fl oz fb 3 fl oz	PRE fb MPOST	99	100	92	2.4
Accent Q + Impact	0.5oz+0.75oz	MPOST	78	100	68	3
LSD (P=0.05)			30	5	45	0.6

* If necessary, rates will be adjusted depending on soil type at research location; and appropriate adjuvants will be included with the postemergence herbicide treatments

**abbreviations reference: fb – followed by; PRE – preemergence; MPOST – mid postemergence

*** Late season ratings taken 8/4/2016

Other issues in sweet corn production

As more producers are using no-till farming techniques for vegetable production, herbicide programs plays a key role in effective weed management. Yet many growers want to move to the next level and produce sweet corn in no-till setting and without the use of long residual herbicide such as atrazine. Atrazine continues to be a very effective yet economical herbicide for broadleaf weed control in sweet corn. Over half of the herbicides labeled for use in sweet corn contain atrazine or recommend atrazine as a tank-mix partner. Pennsylvania producers grew about 10,300 acres of fresh market sweet corn (NASS Ag Statistics, 2015) and likely a high percentage of those acres had atrazine applied to them. Despite its wide acceptance by producers, atrazine use in crop production systems is a controversial issue for various reasons including environmental issues and resistant weeds. In addition to these concerns, atrazine can cause problems with rotational crops, especially vegetables, and cover crops after sweet corn production. Many growers have inquired about herbicide programs that do not contain atrazine to potentially alleviate carryover problems with successional crops. Research evaluating non-atrazine herbicide programs in no-till sweet corn is very limited. With the introduction of Roundup Ready and LibertyLink sweet corn varieties, the possibility of successful weed control in no-till sweet corn production systems becomes more of a reality. LibertyLink sweet corn varieties are currently registered, allowing Liberty (glufosinate) herbicide to be applied over-the-top of some sweet corn hybrids. Liberty is a broadspectrum herbicide with limited residual and a short crop rotation interval. Currently, there are a few Roundup Ready varieties available that allow over-the-top application on Roundup (glyphosate) and are being sold in Pennsylvania and around the Northeast region.

In summary, there are some new herbicide products for sweet corn growers that can improve control of hard to control weeds. Although many are premixes of existing active ingredients labeled for corn, they have not been tested in this region for sweet corn safety. Another issue for mid-Atlantic farmers is getting the proper herbicide combinations and rates to not only provide effective weed control but also to account for potential carryover to rotation crops. Herbicides such as atrazine, mesotrione (Callisto), topramezone (Impact/Armezon), and pyroxasulfone (Zidua) potentially can leave residues causing injury to rotational crops. However, these can vary depending on use

rates, soil types, rainfall, and other environmental conditions. A proper understanding of herbicide characteristics, herbicide resistance management techniques, and management of rotational crops can help alleviate crop injury yet obtain good weed control and improved crop yields.

Atrazine does improve control of certain weed species (as is well documented through various research) and is still a very effective yet economical herbicide for broadleaf weed control in sweet corn, including no-till systems. However, depending on weed species present, reducing the rate of atrazine or eliminating it could be possible if there are concerns about carryover to rotational crops, especially vegetables, and cover crops following field or sweet corn production. Problems with atrazine residues causing injury to rotational crops varies depending on use rates, soil types, rainfall, and other environmental conditions. *However, simply replacing atrazine with another product such as an HPPD- or PPO-inhibiting herbicide (Acuron, Zemax, Callisto, Impact/Armezon, Laudis, Verdict) will not necessarily eliminate the aforementioned concerns.* Several of these types of products have stringent crop rotation restrictions as well. Only a few herbicides have short rotations for a multitude of crops. Liberty can have a good fit in sweet corn production in a LibertyLink sweet corn system. Roundup Ready varieties also can have a good fit as well. However, limited variety options, cost of these technologies (e.g., seed tech fees), resistant weed species (esp. glyphosate), and customer acceptance may limit their widespread use. Many of these herbicide programs (listed in the tables above) could provide effective weed control in no-till sweet corn. *Postemergence herbicides should only be used in sequence after a soil-applied herbicide.* Total-post weed control is not recommended because sweet corn seedlings are very non-competitive with weeds, and weather conditions that prevent postemergence herbicide application may delay weed control until it is too late to prevent loss. Having a soil-applied herbicide down improves overall weed control, provides additional herbicide modes of action for resistance management, and provides some insurance in case postemergence herbicides cannot be sprayed on time. In previous Penn State research, a two-pass system provided more effective weed control overall compared to a single application timing especially in no-till systems. Spray the post treatment when weeds are small (<3 inches tall). For best results, fields with heavy populations of annual grasses (foxtail, crabgrass, panicum) will require a PRE followed by POST herbicide program for consistent control. Depending on the program, common ragweed may require a two-pass program for adequate control. Also, control of annual morningglory and Palmer pigweed are two species that could be a problem depending on which herbicide program is used. Palmer amaranth and waterhemp are becoming a problem in PA. These noxious pigweeds are very aggressive and can be difficult to control in certain cropping systems. There are certain herbicides in sweet corn that provide control of Palmer and waterhemp including atrazine, acetochlor-products, Lumax, Zidua, Callisto, Impact/Armezon, Laudis, Liberty 280, 2,4-D and a few others. Again, two-pass systems work best with Palmer amaranth since it has a long germination period. And control of these weeds after sweet corn harvest may be necessary to stop seed production and additional spread.

(Funding for this research was provided in part by PA Vegetable Marketing and Research Program – PVGA)

RAISING EARLY SWEET CORN IN BIODEGRADABLE PLASTIC MULCH

Joseph Swann, Swann Farms

Sweet corn responds very well when seeded through plastic. The seeding units adapt to a well built plastic layer, making it a breeze in getting your corn crop in very fast and early.

Sweet corn can be very profitable for 3 big reasons:

1. Earlier yield, up to two weeks earlier.
2. A better stand and a bigger yield. Example, a variety that would normally yield 1200 dozen should yield at least 1800 dozen per acre because of the plastic.
3. A bigger ear for better marketing. Besides easier marketing, a better price can be received for earlier corn. As much as $1 more per dozen or $2000 more per acre. Even just with the yield difference,the gross should be at least $500 more an acre.

Sweet corn that matures before the general corn crop typically sells for $.50 to $1 more per dozen at farmers markets and on farm/roadside stands. An advantage for early sweet corn is that there is less market competition, making it easier to entice new buyers to purchase the product and possibly become long-term customers.

Corn covered with 0.5-ounce floating row cover can mature about 5 days earlier than uncovered corn. If care is taken when removing the fabric it can be re- used multiple years.

Three week old sweet corn transplants can mature about 10 days earlier than seeded corn. Transplanted corn is consistently shorter than seeded corn. Transplants do suffer more from cold weather and drought stress than seeded plants.

Estimated cost of practices :

- Plastic mulch = $250 per acre
- Transplanting corn = $3,000 per acre

Our farm primarily directs seeds into Eco-One Oxo-degradable plastic mulch (54”x9,000’..4 mil) for early sweetcorn. The equipment we use is a Buckeye Tractor Co. Pro-2133 plastic mulch layer and a Ferris Farm Poly-planter. We use seed varieties with different maturing dates to cover the entire early season without making multiple plantings.

Joe-Sam C. Swann, Owner/Operator of Swann Farms Operational, L.L.C.
2008 - Present Progressive Insurance - Team Leader
2001-2008 Towson University
Bachelor of Science, Social Science
I reside on my family farm with my wife Kelly, daughter Madeline and sons William, Benjamin, and Keller.
Swann Farms is a sixth generation family farm nestled on the shores of the Patuxent River in Southern Maryland. Historically a tobacco farm, we have transitioned into a fresh market fruit and vegetable farm. Our crops include white sweet corn, peaches, watermelons, cantaloupe, tomatoes, pumpkins, strawberries, blueberries, blackberries, and raspberries.

DOUBLE CROPPING PRACTICES BEHIND EARLY SEASON SWEET CORN

Eli H. Burkholder
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Growing sweet corn is one of my main vegetable crops and if I plant my first corn the beginning of April it's usually ready to pick by the end of June. So what will happen with that field after the sweet corn is done – do some double cropping, plant a cover crop, or let the weeds grow? To me it seems crazy to let the weeds grow because if weeds go to seed I just have to fight them the next year. So it seems sensible to do double crop after early sweet corn, then cover crop after later sweet corn.

So far the different crops I have tried after sweet corn are cabbages, cantaloupes and tomatoes. The cantaloupes I like to seed in the greenhouse in mid-June and have the transplants ready for the field by July 1st.

It can be tough at times to have the field ready by then because we transplant the sweet corn in green plastic. So we have to remove that, till the soil, go out and lay more plastic, and connect the drip irrigation before we've ready to plant.

The cantaloupes are ready to harvest by the middle to the end of September. We had a year with a dry September and had an excellent yield, but another year with a wet September gave poor quality fruit.

Tomatoes are another crop that fits in after sweet corn. It is just in time for the late tomato market when prices are often good.

In 2016, the only year I tried this, I was very impressed with how they turned out. We had dry, warm weather in September and October, which kept disease pressure at minimum levels.

I also tried cabbage one year. I used three different maturities and planted it in the same plastic we used for sweet corn in the spring. The early and mid-season did well, but the long season never matured due to an early freeze that year.

Eli Burkholder, the owner and manager of Breezy Valley Farm. I was born and raised on a vegetable farm and have been the manager for the past seven years. I now live on the home farm with my wife Edith and our two daughters, Janita Rose, age 4 and Kristina Beth, age 2.

WHAT IS BLACK ROOT ROT OF STRAWBERRY AND HOW DO WE MANAGE IT?

Annie M. Montes and Dr. Cassandra Swett
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Black root rot (BRR) is a root disease which weakens plants, reducing yields and daughter plant production, eventually leading to plant death. BRR is particularly problematic in matted row, two-year carryover, and in fields with repeated strawberry plantings. This disease is becoming increasingly problematic as land use intensity is increasing, reducing the number of years for strawberry rotation, and effective fumigants are simultaneously being phased out.

Fig. 1 Above: Black lesions on roots. Below: A stunted plant next to a healthy plant.

Diagnosis

In the field, BRR occurs in patches and affected plants can be stunted (Figs. 1 & 3). Pull up roots to look for blackening and decline of structural roots, dark spots (lesions) on roots, and dying feeder rootlets. Note that black roots alone are not a diagnostic feature because roots naturally darken with age (Fig. 1).

It is important to distinguish a BRR infection from other strawberry diseases and disorders. Strawberry crown rots and red stele can cause similar symptoms such as stunting and blackening of roots. If the crown is discolored, the plant is likely dying of crown rot. Cut open the crowns of affected plants to look for discoloration and rotting. If the stele of roots is red, the plant is affected by red stele. Cutting open affected roots long ways and looking for a red core can diagnose red stele (Fig. 2). In addition, plants can decline due to abiotic causes, such as flooding and poor soil quality.

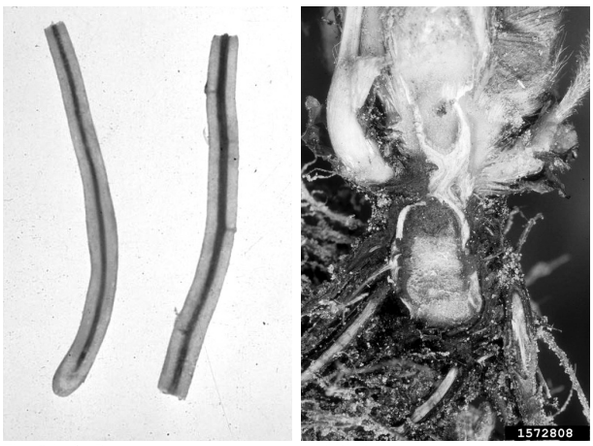

Fig. 2 Left: Red stele photo taken by SCRI-Dundee, Scottish Crop Research Institute.
Right: Crown rot photo taken by Gerald Holmes, California Polytechnic State University.

What causes black root rot?

Based on work in North Carolina and Virginia, BRR pathogens include several species of Pythium, Fusarium, Rhizoctonia, as well as Cylindrocarpon destructans; in addition, the root lesion nematode Pratylenchus penetrans is also commonly associated with BRR. It is thought that as the nematode feeds, it causes a layer of the strawberry roots to peel away, providing a wound that can be infected by other BRR pathogens such as Rhizoctonia fragariae.

Annie M. Montes
I am a master's student at the University of Maryland. I study plant pathology with Dr. Cassandra Swett in the small berry pathology lab. Prior to my work at UMD, I studied plant biology at UC Davis where I received my bachelor's degree. I grew up in Chico California, a college town in the northern valley. There I grew up spending much of my spare time marveling at the surrounding conifer forests and exploring riparian zones. After I receive my master's degree, I intend to join my partner, Dr. Greg Reynolds, at the plant inspection station in Linden, NJ.

All pathogens are soil inhabitants, which have survival structures that allow them to persist in the soil from months to several years. Because of this, BRR is worse in fields that are in strawberry production multiple years. These are all weak pathogens, and tend to only affect stressed plants. Disease is therefore more likely to develop when the plant is exposed to stressful environmental conditions such as drought, long-term flooding, freezing soils, soil compaction, and low organic matter. Silt-loam soils have also been correlated with BRR, likely because this soil type has poor drainage that creates an ideal environment for nematodes.

The Swett lab conducted a survey in 2015 and 2016 to determine which organisms are most commonly associated with disease in the mid-Atlantic, in order to provide more precise management recommendations. The most commonly recovered organisms included Fusarium oxysporum, Rhizoctonia solani, Rhizoctonia sp., Pythium irregulare, and Pythium sylvaticum. Pathogenicity tests indicated that Rhizoctonia solani, Rhizoctonia sp., and Pythium irregulare reproduced BRR symptoms in strawberry plants; Fusarium oxysporum did not.

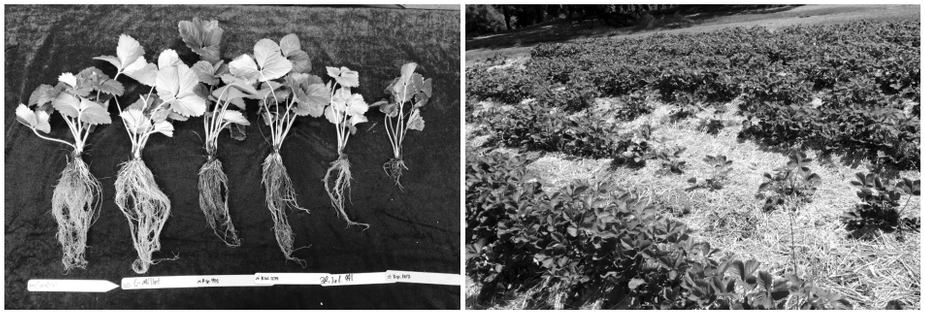

Fig. 3 Left: Degree of symptoms from left to right caused by four isolates of Rhizoctonia. The first two plants are healthy. Right: Characteristic patches occurring in a BRR affected field.

How to manage BRR

Crop rotation. To prevent buildup of pathogens in the soil, rotate out of strawberries for at least 3-5 years and avoid carryover.

Site Selection. Select a site with good drainage and high organic matter. Do not plant at the base of a hill. Additionally avoid silt-loam or other poorly draining soils.

Soil health management. BRR is associated with soil compaction and low organic matter. Legume cover crops can add nitrogen to the soil and be mowed over to increase organic matter. Additionally bark compost can suppress Rhizoctonia and Pythium species.

Fumigation and biofumigation. The fumigants Pic-Clor 60, Telone C-35, and Telone C-17 are effective at killing BRR pathogens in the soil. Mustard seed meal products like Biofence are also effective at eliminating soil pathogens and can supplement fertilization because of their high nitrogen, phosphorus, and potassium levels. Planting brassicas as a form of biofumigation can also reduce fungal and nematode pathogens in the soil.

Disease resistant cultivars. Research at Michigan State has shown that varieties with Lassen parentage, such as Cavendish, have some tolerance to BRR. However, results from these studies are yet to be replicated. The Swett lab is conducting studies comparing the short day variety Chandler to the day neutral variety Albion. These cultivars will be screened under varying soil moisture levels to determine resistance under conditions that predispose plants to BRR and evaluate physical traits associated with susceptibility.

IMPROVING FRUIT ROT MANAGEMENT BY PREVENTING FUNGICIDE RESISTANCE DEVELOPMENT

Johanna Del Castillo-Múnera and Cassandra L. Swett

Botrytis fruit rot is can be a devastating disease of both unripe and ripe fruit in the Mid-Atlantic. The pathogen, *Botrytis cinerea*, can come into the field on infected plant material (nursery stock), and is also common in the soil, on infected debris, and as fungal survival structures called sclerotia. The fungus infects strawberry flowers in the spring when there is high moisture and moderately cool temperatures; and the disease is favored if blooms are frost killed and plants are at a high density. Green fruit develop brown to black lesions; ripe fruit lesions are brown and soft. It is common to see fuzzy grey fungal growth on the lesions, when the fungus produces thousands of spores. These spores infect new ripe fruit, causing rapid secondary spread; about 90% of infections in a field are from secondary spread.

The best management practice to control Botrytis and avoid secondary spread is to prevent early season flower and fruit infections. Before planting, infected fruit should be removed during and after harvest. At planting, the use of plastic mulch can prevent soil inoculum from contacting fruit. Frost damage to flowers should be prevented using row covers, later blooming varieties, and wider spacing. In organic production, single row planting is recommended. In conventional production, fungicides are an effective way to protect blossom and fruit infections. Applications should start at 10% bloom, applying the most effective fungicides, such as Switch and Elevate, at bloom-time. Post bloom sprays can include Elevate, Kenja, Fontelis, Luna tranquility or Luna sensation. These can be tank mixed with Captan, Thiram or OSO/Tavano/PhD (polyoxin D) to enhance treatment efficacy. To prevent fungicide resistance from developing in the pathogen, it is critical to rotate fungicides with different modes of action (FRAC groups) and to avoid overuse of our best products, such as Switch. There are several fungicides which are consistently loosing efficacy across the region due to resistance development, including Topsin M, Pristine, and Elevate (Figure 1, courtesy of Guido Schnabel). Pristine is not currently recommended for Botrytis, due to resistance development.

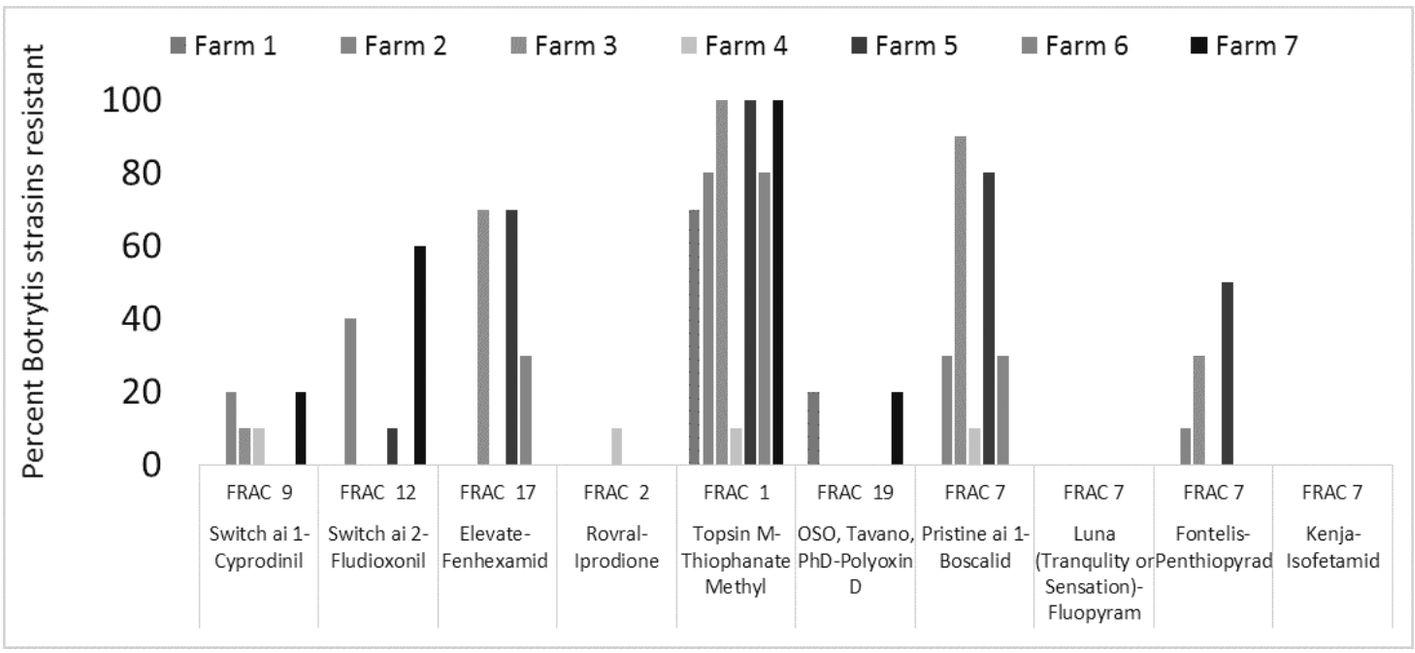

Figure 1. Fungicide resistant populations of Botrytis on Maryland farms, based on 2016 testing (Guido Schanbel).

Reducing the total number of fungicide applications can greatly assist in fungicide resistance management. Applications can be reduced by applying only when there is a disease risk, rather than on a calendar-based program. Disease risk can be determined based on weather conditions—the fungus will only infect the plant when it's above 55°F with at least 12 hours of leaf wetness. The Strawberry Advisory System (SAS) is a disease forecasting system for Botrytis and Anthracnose fruit rot developed in the Southeast—the system does not extend to the Mid-Atlantic, and efficacy in this region is unclear. In 2016, SAS was evaluated for efficacy on an experiment station in western Maryland. Chandler was planted on plastic mulch and disease was evaluated under three treatments: i) Cover: weekly Captan spray, ii) SAS: Captan spray based on risk, and iii) Water (no spray) control. SAS saved one out of six sprays in 2016, despite being an unusually wet spring. Botrytis and Anthracnose fruit rot were both controlled equally well in the SAS as the cover treatment, and there was no difference in the percent of fruit that were marketable (Figure 2). Fruit biomass was lower, but not significantly. Overall, SAS was a valuable informational tool that allowed us to adapt our fungicide program to continue to effectively protect fruit past the bloom period. In lower pressure years, SAS will likely result in greater spray reduction. This indicates potential to mitigate fungicide resistance development in the region; on-farm trials in 2017 will further establish efficacy of SAS as a disease control tool.

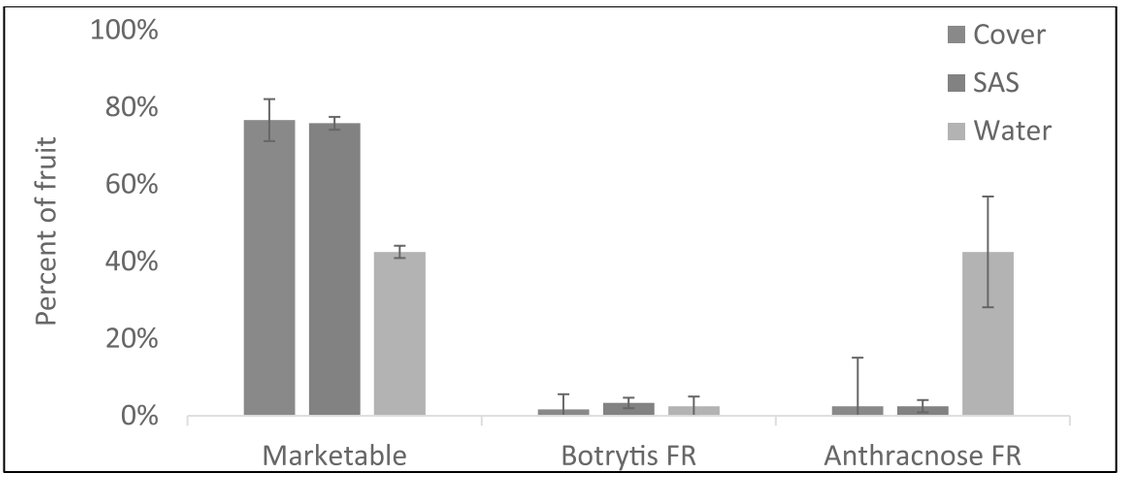

Figure 2. Percent of marketable fruit for Chandler under Cover: Captan weekly spray; SAS: Captan spray based on weather risk; and Water: no spray (control).

BLACK SHADOW ON BLUEBERRIES- WHAT IS IT AND WHY DOES IT MATTER?

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What is it? Black Shadow is a darkening of Blueberry (*Vaccinium corymbosum)* cuticle tissue caused by dark-colored fungal mycelia. This darkening occurs on first through third year stems in/on the epidermal and cuticular tissues, before disappearing with the development of the periderm around year three of the stem's life. Black Shadow is now officially referred to as Sooty Blotch *(not to be confused with Stem Blotch)* in the Compendium of Blueberry, Cranberry, and Lingonberry Diseases and Pests (Second edition, 2016) although many grower still refer to its acronym (BS) for undisclosed reasons. Typically, the term sooty blotch refers to conditions associated with epiphytic growth on fruits like the sooty blotch and flyspeck complex (SBFS) associated with apples and pears, which can cause late season **cosmetic** blemishes of fruit, reducing profitability dramatically in those crops, yet this observation has yet to be made to any deleterious degree in blueberries. New Jersey growers have noticed variable amounts of this condition from one farm to the next as well as variation within individual production areas leading to grower concerns.

The name Black Shadow refers to the complex of fungal genera and species' *mycelia (networks of hyphae from numerous individual species of fungi)*, pycnidia and other reproductive structures *(the vast majority of observed reproductive structures have been asexual including pycnidia, conidiophores, yeast budding, arthrospores (sections of vegetative hyphae that break into individual segments as a mode of dissemination/dispersal))* and novel spores that give the appearance of a *black shadow* on stems. The fungi isolated are typically dark brown to black on both growth media in culture and once reestablished on young/green blueberry tissue. Many of the isolates are members of *Dothideaceae*, which are collectively known as *The Black Yeasts*. These fungi can behave like yeast via asexual budding *(reproduction)* and as fibrous fungi, occasionally forming highly melanized dendritic *(tree like branching)* hyphae, hence the dark nature of these fungi. I have speculated that this high degree of melanin speaks to superficial growth on plant surfaces, *not in plant tissues*, necessitating protection from the sun's harmful ultraviolet light while on the surface of the plant.

Literature on Sooty Blotch (Black Shadow) affecting blueberry was virtually non-existent so fungal isolation was of utmost importance to begin this research. We first selected from forty symptomatic stems in an experimental block at the Phillip E. Marucci Rutgers Cranberry and Blueberry Research Center, Chatsworth, New Jersey. The cuticle

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Previous research has included Sooty Blotch (Black Shadow) isolation/sequencing/causality correlations, numerous fungicide efficacy trials, biological control of blueberry anthracnose, and biological control of cranberry fruit rot focusing on *Colletotrichum spp.*, *Phyllosticta spp.* and *Coleophoma empetri* as well as numerous other projects when assisting other researchers/students/summer-interns.
Interest: *Knife maker*, parrot trainer, musician and working with my two friends on their two farms.

from these infected/covered stems was surface scraped and plated onto growth medium amended with antibiotics. Through a series of isolations pure cultures were finally obtained. The four most common morphological *(growth)* types were further characterized, which included descriptions of morphological features/indicators as well as an ITS rDNA region genetic taxonomic position evaluation. Affiliations included *Pseudocercospora spp., Microcyclospora spp., Hormonema spp., Discostroma spp. and Rhizosphaera spp.* Each candidate isolate was evaluated on its ability to cause visible Sooty Blotch (Black Shadow) symptoms on surface sterilized young/green cane growth from first and second year stems, in order to complete Koch's postulates *(a well-established test to determine which pathogen causes a disease)*. Once stems had become visibly colonized, via droplet inoculations at the nodes *(where rainwater is caught in the field, described more below)*, the fungal material was re-isolated and cross-referenced with previously obtained morphological criteria, affirming causation of symptomology.

Of the isolates identified, some did have **relatives** *that do cause disease* including Needle Cast Disease of Conifers, Trembling Aspen dieback and Russet d'anjou pear, caused by the most ubiquitous of the black yeast *Auerobasidium pullulans.* Interestingly, these diseases attack perennial woody plants, implicated on conifers which surround many of the United States' blueberry production areas, especially those of the Pine Barrens.

In short, "it" is a complex composed of many different kinds of highly melanized *(black/brown)* **epiphytic** *(surface)* **fungi growing on/in the waxy surface of young/green blueberry canes.**

Why does it matter? Often the highest concentrations of Sooty Blotch (Black Shadow) are at the nodal sites and are the first to show symptoms. These areas the following spring can contain extremely dense populations of fungi and the plant anatomy of nodal site lends very well to colonization via wind driven water dispersal *(rainwater or overhead irrigation)*. This plant architecture gives rainwater-droplets *(that can contain prolific numbers of fungal bodies)* a place stop and adhere to the cuticle of the young blueberry stems in these crotches/nodes. These observations have led to concerns over the possible degradation of yield components, particularly the reduction in number of inflorescence/floral/fruit buds formed in areas of high fungal coverage, however this evidence is limited and should be further assessed. The most notable coverage is usually on the previous season's growth, as we believe the complex develops most rapidly during the fall, winter and early spring. Coinciding, fungal increased development with bud set and the highest concentrations of observable fungal coverage with the exact time flowers are starting to develop in the spring. As stated before the correlation between reduced bud set/formation to increased stem coverage of Sooty Blotch (Black Shadow) is weak but more research should be conducted in this arena.

The black fungal coverage is unsightly and worrisome but may actually be an indicator for other pest and cultural-practice problems in the blueberry production area if not a problem itself.

In short, there are limited data supporting the notion that Sooty Blotch (Black Shadow) "does" matter and can reduce yield components, but this may simply be a combination of plant architecture *(providing a landing site for rainwater containing fungal bodies)* **and *coincidence* of fungal growth optima preference and seasonal growth patterns of blueberries** *(fungal growth in fall through spring coinciding with bud set through floral development)* **that are leading to justified grower concerns.**

What can be done?

Overhead irrigation*?* As mentioned before this fungal complex is moved through the canopy via wind driven water, this could be rain or irrigation. Water movement allows for fungal movement and if production areas where overhead irrigation is commonplace and so too were dramatic Sooty Blotch (Black Shadow) coverage, moving over to drip irrigation would be a great starting place. Our research group was able to prove isolate causality *(Koch's postulates)* using methods that mimic rainwater movement onto nodes. The fungi that cause Sooty Blotch (Black Shadow) are not the only fungi moved by this mechanism. Many devastating pathogens including *Colletotrichum fioriniae,* causal agent of blueberry anthracnose, also moves by these means landing in these same nodes attacking inflorescences/flowers and developing fruit.

Movement away from overhead irrigation is a good practice in many agricultural systems from the standpoint of preventative plant pathology.

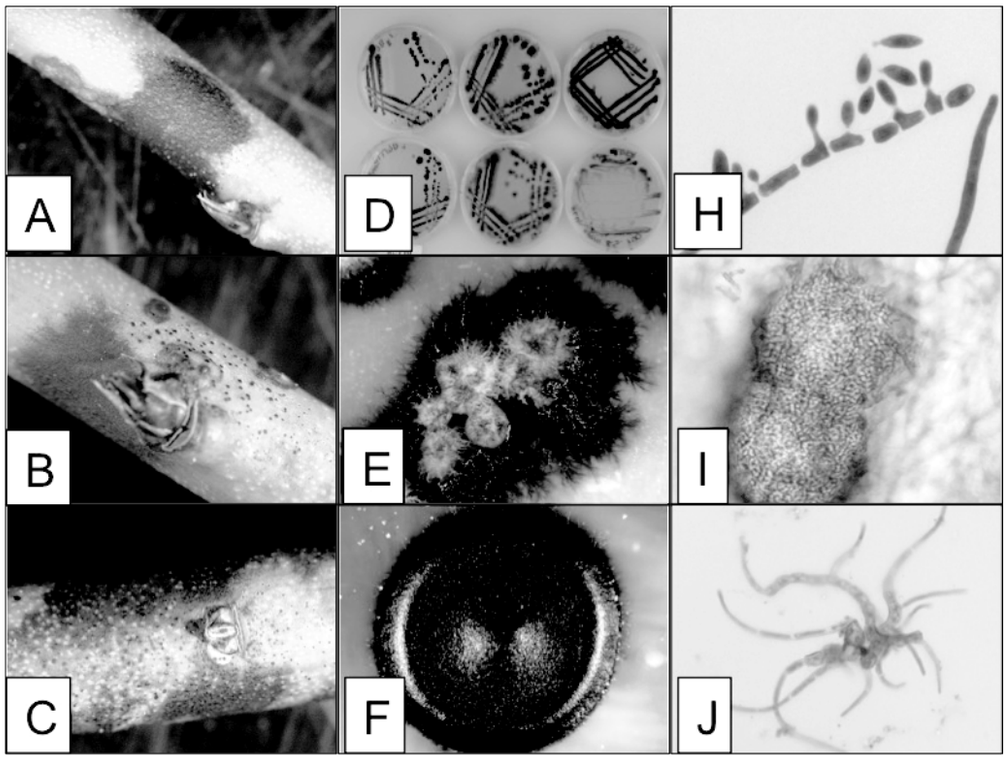
Sap-sucking insect infestations? In many systems affected by Sooty Mold *(first time mentioned in this text)* including blueberry, there are direct corollaries between honeydew secretions *(sugary, nutrient filled sap drawn out directly or via wounding)* caused by sap-sucking insect damage and increased prevalence of Sooty Mold. I strongly believe this phenomena could also be contributing to Sooty Blotch (Black Shadow) occurrence on blueberries, but have yet to explore this experimentally. Reason being, the fungi we have isolated do not live within the plant tissues, so we think, and they must be acquiring nourishment by some means. These fungi utilize, either directly or indirectly, sugars and other nutrients left over by these sap-sucking insects such as aphids and leaf-hoppers. Control measures for these pest would be a good approach if there is a known issue with this type of pest and dramatic Sooty Blotch (Black Shadow) coverage in the blueberry production area of interest.

Controlling sap-sucking insects will reduce a nutrient source *(honeydew)* for epiphytic fungi.

Chemical control. An interesting point to note, Sooty Blotch (Black Shadow) darkening symptoms can be completely removed by placing infected canes into 20% bleach solution for 5-10 minutes, they simply disappear, but since we cannot spray bleach in the field we are left with basically one alternative: Lime-sulfur. Applications can be made during plant dormancy to *help* control established Sooty Blotch (Black Shadow) colonies and can also act as a preventative prior to visible symptom development. Lime-sulfur is also recommended for some insect control measures including those for scale-insects.

Lime-sulfur is the chemical of choice for Sooty Blotch (Black Shadow) control. Make sure to adequately clean and maintain spray equipment after applications due to possible damaging effects of this compound on metal.

TYPICAL BLACK SHADOW OBSERVATIONS…



Typical observations of Sooty Blotch (Black Shadow). **A-C.** Darkening of young/green stems. **D-F.** Isolates on growth media, close ups. **H-J.** Microscopic observations; yeast budding, pycnidia, germination/fibrous mycelium.

TOWARDS AN IPM-BASED MANAGEMENT STRATEGY FOR SPOTTED WING DROSOPHILA IN BLUEBERRIES

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Since its introduction in 2008, spotted wing drosophila (SWD), *Drosophila suzukii* (Diptera: Drosophilidae), has become one of the biggest pest problems for small fruit growers in the United States. Highbush blueberries have been one of the most affected crops. Currently, management of this pest in the United States is driven by calendar-based insecticide applications. Therefore, the development of new, environmentally-safer, and effective tactics for managing SWD is necessary to achieve sustainable integrated pest management (IPM) programs. To reduce insecticide applications, we are testing the efficacy of "attract-and-kill" technologies such as attracticidal spheres (Fig. 1). This approach is based on a combination of visual cues, a killing agent (insecticide), and a phagostimulant (sugar). The present study evaluated the effectiveness of attracticidal spheres for managing SWD under field conditions.

Fig. 1. Attracticidal spheres

Material and Methods

A study was conducted in three commercial blueberry farms in Hammonton, New Jersey. The treatments consisted of: a) attracticidal spheres applied in a grid pattern ('Grid'), b) attracticidal spheres applied only to the field perimeter ('Perimeter'), and c) untreated controls without attracticidal spheres ('Control'). At each farm, three plots were randomly assigned to one of the treatments and all plots were of the late-season blueberry variety 'Elliott.' Plots were 50 m^2 (approximately 16-by-16 bushes). 'Control' plots were left untreated and received no insecticides but bushes were marked with flags for fruit collection. In the 'perimeter' plots, we deployed attracticidal spheres every other bush along the perimeter of the plot (total of 64 spheres per plot). For the 'grid' plots, we deployed attracticidal spheres every other bush in the entire plot (total of 256 spheres per plot). The experiment was a randomized complete block design, blocked by farm. Attracticidal spheres were deployed on 20 July 2016.

Fruit evaluation: Fruit samples were taken weekly for a total of three weeks after deployment of attracticidal spheres on 22 July, 30 July, and 8 August 2016. In each sampling date, we collected 1/4 pint fruit samples (~250 ml volume); a total of 24 samples were taken from each plot (12 from the plot interior and 12 from the plot perimeter). Fruit samples were then taken to the laboratory where they were weighed and placed in 0.5 L deli containers (~1000 ml) and incubated on a light bench under a 14L:10D photoperiod and 25-28°C for 10 days prior to evaluation. Larval infestation data were collected using the salt water extraction method consisting of submerging the berries in warm salt water (~1000 ml NaCl: 5 gal H_2O), which causes the SWD larvae to leave the fruit. SWD larvae and pupae caught by a 30 mesh sieve were counted and the number of larvae per fruit was calculated.

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Results

There were significant differences in SWD larval infestation among treatments (Fig. 2). 'Control' plots had higher SWD-infested fruit than the plots treated with attracticidal spheres ($F_{(2,636)}$=99.98 P<0.001); however, there were no differences between plots treated with attracticidal spheres either in a grid or perimeter pattern (Fig. 2).

In addition, we determined whether there were differences in SWD larval infestation among treatments depending on the location of the samples within plots (i.e., edge versus perimeter). We found no effects of location on fruit infestations ($F_{(1,636)}$=1.09, P= 0.296). There was also no interaction between treatment and location ($F_{(2,636)}$=1.37, P= 0.254), indicating that the effect of the treatment was similar regardless of location, edge or perimeter, within plots (Fig. 3).

In summary, there studies show the attracticidal spheres can reduce SWD infestation in blueberry fruit under field conditions. Further studies are needed to determine whether SWD abundance in fields affect the efficacy of attracticidal spheres. The integration of attracticidal spheres with current SWD management practices needs to be evaluated. Our study shows the potential of attract-and-kill technologies for suppressing fruit infestation by SWD in blueberry fields.

This project was previously funded by a USDA NE-IPM grant (No. 2013-34103-21468), and is currently being funded by a USDA Crop Protection and Pest Management grant (No. 2015-70006-24152).

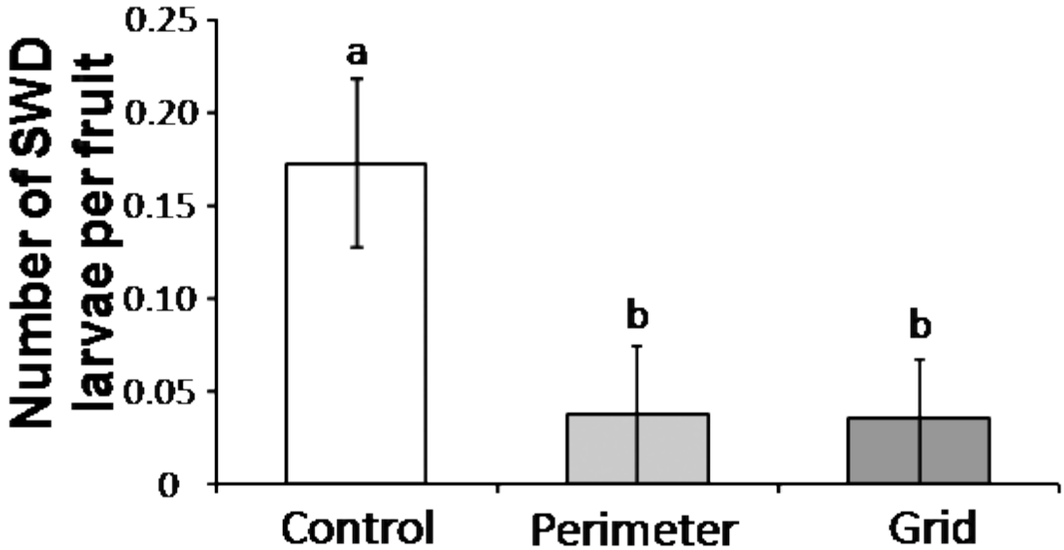

Fig 2. Mean (± SE) number of SWD larvae per fruit in blueberry plots treated with attracticidal spheres in a grid pattern ('GRID'), attracticidal spheres applied only to the field perimeter ('Perimeter'), and untreated controls without attracticidal spheres ('Control'). Different letters indicate significant differences among treatments.

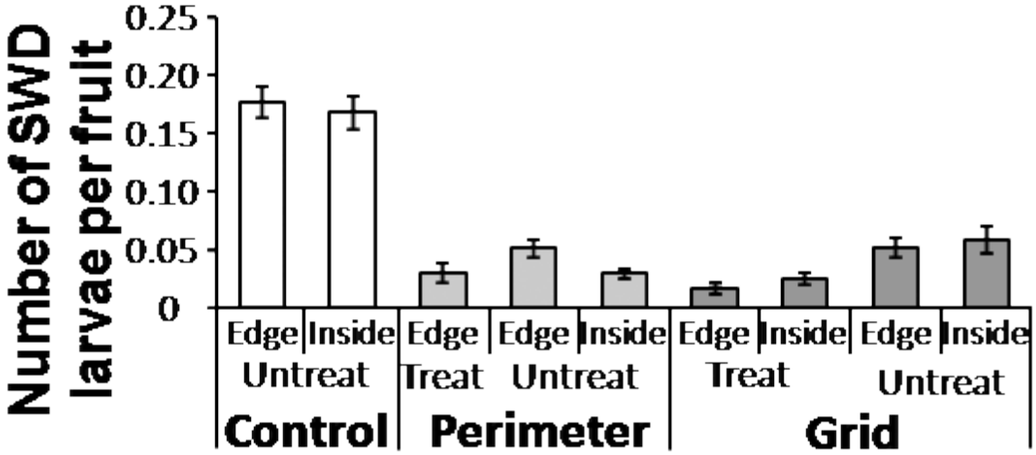

Fig 3. Mean (± SE) number of SWD larvae per fruit in blueberry plots treated with attracticidal spheres in a grid pattern ('GRID'), attracticidal spheres applied only to the field perimeter ('Perimeter'), and untreated controls without attracticidal spheres ('Control') and at two different locations (edge versus inside) of plots. 'Treat' indicates infestation of fruit from bushes treated with the attracticidal spheres; while 'Untreat' are bushes that received no attracticidal spheres within the treated plots.

GOOSEBERRIES, CURRANTS, AND WHITE PINE BLISTER RUST: A MODERN-DAY UNDERSTANDING

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Abstract
The recent breakdown of the Cr gene has stirred renewed controversy in the role of Ribes and infection of white pines with white pine blister rust (WPBR). Ribes is an intermediate host in the WPBR cycle, and removal of Ribes plants breaks the disease cycle. Ribes eradication programs in the US during the first half of the 20th century were implemented to control the spread of WPBR. They were discontinued by 1968 at the federal level when their effectiveness was questioned. The disease in cultivated plantings is easily controlled by the same fungicide programs that combat anthracnose and powdery mildew. Ecological studies by forest pathologists have offered control programs that are effective sustainable alternatives to eradication. They also illustrate natural disease control factors that exist in the environment.

INTRODUCTION

Ribes, is a group of berry crops including currants (red and black), and gooseberries that has been recently reintroduced to the Northeast US after losing favor due to prohibition of their cultivation in earlier years. When researchers discovered in the early 1900's that black currants, and some red currants and gooseberries are intermediate hosts for white pine blister rust (WPBR), USDA imposed a ban on growing the crops and began eradication programs to try and eliminate *Ribes spp* in the forest. Officials terminated the program by 1968, and left regulation up to the states when it was discovered that eradication was ineffective in eliminating the disease (and it was impossible to eliminate all the *Ribes spp* in the forest). There are now only seven states that maintain regulations due to efforts to relax regulations in the late 1990's and early 2000's. Renewed discussion of ribes restrictions has started since a mutated form of WPBR has been able to overcome immunity in ribes that had once been provided by the Cr gene.

The relationship between Ribes, pines, and WPBR became a classical illustration in basic college plant pathology courses and texts of a disease that requires the need for intermediate hosts to complete its life cycle. Further, if either the pines or the currants are eliminated, the disease life cycle is broken. Over time, this relationship has become ingrained in the training of many horticulturalists and accepted to the point that they believe **ribes=white pine blister rust=death to white pines.** Such a mindset leads plant pathologists to react to the disease without taking time to further understand the biology, ecology, and management options available to control the disease. It has also led to misinformation being published in WPBR articles which exaggerate the potential consequences of the disease. Plant pathologists working with the berry crops need to use the research forest pathologists have already completed and continue to improve recommendations for continued control of the disease.

DISCUSSION

Disease Life Cycle

This information is reprinted from a forestry publication written by Otis C. Maloy, Washington State University, Pullman, WA, and is useful in showing the points where management and control measures can be employed to deal with the disease.

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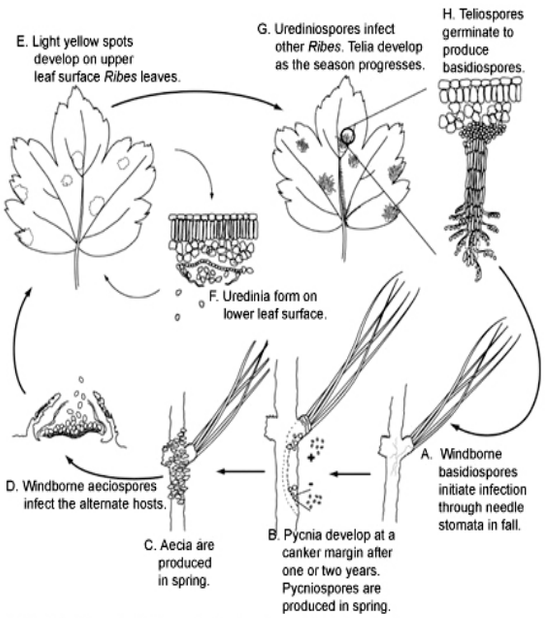
The blister rust cycle starts in the fall when pine needles are infected by basidiospores from the alternate host (*Ribes* spp.) (A). The basidiospores germinate, and the fungus mycelium enters the needles through stomata and grows down the needle into the branch. The fungus continues to develop between the cells of the inner bark, and nutrient absorbing haustoria penetrate into the phloem cells. The mycelial network continues to develop both lengthwise and laterally in a spindle-shaped pattern to produce a swollen canker (B). In the spring of the second year, pycnia are produced in the margins of the infected area. The following year aecia are produced and erupt through the bark where pycnia were produced the previous year (C). This disruption of the bark leads to drying and death of the inner bark and this dead area enlarges over several years to become a blister rust canker. The two or three year latent period between initial infection and appearance of symptoms or signs sometimes allows the disease to become established in a forest stand before it is detected. Aeciospores (D) can survive for several months and are wind-borne for long distances where they infect the alternate hosts (*Ribes* spp.)



White Pine Blister Rust Disease Cycle (Drawing by Vickie Brewster).

The two or three year latent The blister rust cycle starts in the fall when pine needles are infected by basidiospores from the alternate host (*Ribes* spp.) (A). The basidiospores germinate, and the fungus mycelium enters the needles through stomata and grows down the needle into the branch. The fungus continues to develop between the cells of the inner bark, and nutrient absorbing haustoria penetrate into the phloem cells. The mycelial network continues to develop both lengthwise and laterally in a spindle-shaped pattern to produce a swollen canker (B). In the spring of the second year, pycnia are produced in the margins of the infected area. The following year aecia are produced and erupt through the bark where pycnia were produced the previous year (C). This disruption of the bark leads to drying and death of the inner bark and this dead area enlarges over several years to become a blister rust canker. period between initial infection and appearance of symptoms or signs sometimes allows the disease to become established in a forest stand before it is detected. Aeciospores (D) can survive for several months and are wind-borne for long distances where they infect the alternate hosts (*Ribes* spp.)

A few weeks after the *Ribes* are infected, light yellow spots develop on the upper leaf surface (E) and uredinia (F) develop on the undersides of infected leaves. This is the repeating stage of the rust, and urediniospores infect other *Ribes* bushes in the general area as far as 1.6 km but normally no more than 305 m. Telial columns also develop on the underside of leaves (G), usually from uredinial pustules, and may start forming soon after the uredinia appear, increasing in number as the season progresses. The individual teliospores that make up the telial column germinate (H) to produce basidiospores that infect the pine hosts, completing the disease cycle.

Disease Ecology

Blister rust infection is favored by cool, moist conditions, and the disease tends to be more prevalent in low-lying areas such as creek bottoms, swampy depressions and openings in timber stands. Besides providing conditions favorable for infection, air currents carrying basidiospores are more likely to flow into and settle in these depressions. Studies in the Great Lakes Region and elsewhere have recognized rust hazard zones based on topography that are now used to formulate disease management systems in different areas.

Summer temperatures also determine the potential infection in the fall, since high temperatures greatly reduce or eliminate the fungus on ribes by "burning out" and destroying stages E-G in the life cycle. Thus in a hot or dry year, there is less potential for infection.

Another epidemiological factor is the relative susceptibility of the different pine species and of different age classes of the same species. Of the three commercial species, sugar pine (*Pinus lambertiana*) is the most susceptible, western

white pine (*P. monticola*) intermediate, and eastern white pine (*P. strobus*) least susceptible. Of all the white pines, whitebark pine (*P. albicaulis*) is most susceptible.

Young white pines, both saplings and pole size trees, are more severely infected and damaged than older trees for several reasons. On young trees the branches are closer to the ground, where conditions are more favorable for infection, and the needles are closer to the main trunk so that less time is needed for infections to get into the main stems and kill the trees. Mature trees can be infected, but these trees are not killed as rapidly and usually can be harvested before they die and deteriorate. Also, cankers seldom progress more than a foot back toward the trunk, and infected distal extremities of the branches normally die and are sloughed off before the canker reaches the trunk.

Factors important to development of wild *Ribes* include any soil disturbance, such as fire, logging, and snow and wind damage, which stimulates dormant *Ribes* seeds to germinate. Birds do not appear to be important in spreading *Ribes* seeds as they are for barberry, the alternate host of stem rust of wheat.

Consider that Ribes plants are present in the forest naturally, and the disease is not managed with horticultural practices such as in a commercial planting, where farmers want to maintain healthy plants for efficient production. Instead, natural selection in the forest will eliminate disease susceptible *Ribes spp* through summer defoliation, fall re-growth, and winter kill due to tender plant parts and weakened plants. Thus it could be argued that maintained commercial plantings of ribes are less of a threat to pines than the ever-present forest ribes.

Some additional factors to consider:

1. Fungus knats help to reduce fungus infections on ribes leaves by eating the fungus.
2. Aeciospores can travel over 600 km in dry conditions from infected pines to ribes, while the basidiospores that travel from ribes to pines normally travel no further than 305 m. Basidiospores are killed by strong light, or low humidity and heat. They need to contact moist pine needles or they will not develop. In low hazard zones, ribes plants can grow next to pine trees without danger of infection.
3. Pines are understory trees, and if seedlings are growing as understory trees, there is less possibility of free moisture on needles, and less possibility they can become infected.
4. 20% of white pines seedlings from seed from unselected sources will have natural immunity to WPBR.
5. WPBR does not overwinter in ribes. Ribes plants must be re-infected by pines each year.
6. Gooseberries are susceptible to gooseberry rust and appear to be more resistant to WPBR.

Management Practices

Management practices have been developed to allow safe cultivation for both pines and ribes. Letters have been placed that correspond to the points in the disease cycle where the cycle is broken.

1. Ribes Planting Management Practices

An understanding of the disease cycle and ecology allow ribes to be grown free of WPBR. Following are some suggestions:

1. Grow ribes in low hazard zones and areas designated as ribes growing areas. Planting in high hazard areas should be okay too since white pines should not be planted there. (A,E)
2. Separate ribes plantings with a buffer of about 305 m from young pines. Mature pines should be of little concern. (A)
3. Control infections of WPBR early so the fungus does not establish itself and become a potential problem for the whole season. WPBR will be controlled by sprays used for anthracnose and powdery mildew (for example, Rally). Anthracnose is a disease that is critical to control, and by doing so, you should not have to worry about WPBR. Remember that spores for WPBR can come in from as far as 600 km away. (E-G)

4. Use WPBR immune varieties as available. (E)

2. Forest Management Practices

1. Plant seedlings with an overstory. (A)
2. Plant immune seedlings. (A)
3. Make dense plantings that can be thinned (or will self thin through disease infection, deer, insects, pine weevils, etc.)
4. Prune lower branches and infected branches (which will result in higher quality trees). (A, B-D)
5. Plant in low hazard areas. (A)
6. Eradicate ribes plants (E)

3. Christmas Tree and Pine Nursery Management Practices

1. Plant resistant selections. (A)
2. Maintain a ribes-free buffer zone of at least 305 m. (A)
3. Plant in low hazard zones. (A)

CONCLUSIONS

By studying the life cycle and ecology of WPBR, it is possible to see that many management options exist for growing pines and ribes, even without immune ribes varieties. Commercial plantings of ribes are normally well cared for with immune varieties being chosen for planting, if available. Responsible spray programs can be employed to control the few disease problems that affect the crop which in turn eliminates WPBR for the year. Ribes plants in the forest will never be eliminated entirely, and they tend to be susceptible or resistant to WPBR. Obviously they are not sprayed or managed, so they would present more of a threat to five-needle pines than cultivated plants. With existing management practices developed by foresters, responsible spray programs, and the ever-present population of unmanaged susceptible plants in the forest, it makes no sense to prohibit cultivation of ribes as a method of "preventing" WPBR infections.

References

Maloy, O.C.. 2003. White pine blister rust. *The Plant Health Instructor.* DOI:10.1094/PHI-I-2003-0908-01 *Updated 2008.*

Maloy, O.C.. 2001. White pine blister rust. Online. *Plant Health Progress*. DOI: 10, 1094/PHP-2001-0924-01-MM

PLASTICULTURE AND MATTED ROW VARIETY TRIAL UPDATE

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Trial Establishment

Coordinated plasticulture and matted-row trials of strawberry cultivars had been established in 2014 and data from them was collected in 2015 and 2016. The plasticulture trial was conducted at Penn State's Southeast Research and Extension Center in Landisville while the matted-row trial was conducted at Penn State's Horticulture Research Farm at Rock Springs. Varieties included as standards in the plasticulture trial were 'Sweet Charlie' and 'Chandler' and in the matted-row trial were 'Earliglow' and 'Jewel'. Cultivars or advanced selections that were included in both experiments were 'Galletta', 'Sonata', 'Rubicon', 3 advanced selections from Rutgers University and 3 advanced selections from Cornell University. Additional varieties in the plasticulture experiment were 'Radiance', 'Daroyal', 'Donna', 'Earliglow', 'Flavorfest' and 'AC Wendy'. Additional varieties in the matted-row trial were 'Laurel', 'Herriot', 'Mayflower', 'Malwina' and a fourth advanced selection from Cornell.

Practices used for plant establishment and care followed recommended practices, with the exception that Rutgers selections were planted about a month later than the other varieties and selections at Landisville.

Crown Thinning Trial

Following harvest of the plasticulture planting at Landisville in 2015, half of the plants were thinned by removing approximately 50% of the crown by hand. The purpose was to determine whether there is a benefit to this practice when carrying over plasticulture plantings for a second harvest year.

Variety Performance in the Plasticulture System

The 2015 growing season in Landisville started wet and then turned dry before becoming wet again. The 2016 season was different in two ways – first – it was generally wet the entire harvest season (total rainfall 4.1 inches in 5 weeks) which necessitated use of a standard fungicide application program. In addition, the temperatures were well above normal with 15 consecutive days of 80°+ starting the second week of harvest and two 90°+ days in the last week of harvest. There were also some early flower losses because of the weather. High temperatures of 79° and 78° on April 1 and 2 were followed by low temperatures of 18° and 22° on April 6 and 10. Even under two rowcovers on these cold nights the most developed king blossoms were killed on the earliest varieties, particularly 'Sweet Charlie'.

Harvest started on May 13 with 'Chandler' and one of the Rutgers selections; 'Sweet Charlie', 'Daroyal' and a second Rutgers selection started on May 16; 'Earliglow', and 'Radiance' started May 18; 'Galletta' May 20; 'Rubicon', 'Wendy', two Cornell selections and the last Rutgers selection on May 23; 'Donna', 'Flavorfest', and 'Sonata' on May 25 and on May 27 the final Cornell selection started harvest.

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In 2016 we added a Bird Gard® electronic scare device to the planting because of the high level of bird damage to ripening fruit last season. While there was some reduction in the total amount of fruit damage this year, the number of berries damaged did not seem to change significantly, and individual berry size may have affected results. Often berries were still damaged by the birds but this year not as much of each individual fruit was eaten. It seemed that the birds would take a rapid mouthful or two of a fruit before being scared by the sounds from the Bird Gard® device.

The thinning treatment generally affected yield and the percentage of marketable fruit, but had no effect on berry size or brix (soluble solids) levels. Thus data presented below for yields and percentage marketable fruit are given for unthinned and thinned treatments respectively, but are averaged over thinning treatment for berry size and soluble solids.

'Chandler' performed about average this season with total yields of 12,230 and 9,611 lbs/acre in the non-thinned and thinned plots, respectively. The marketable percentages were 67 and 72%. 'Chandler' had one of the highest plant losses in the planting. A sample was sent to the PSU Plant Disease Lab and showed *Phytophthora* root rot on this variety. Average size of the marketable fruit was 12.9 g/berry with an average brix reading of 6.6. Overall performance of 'Chandler' in this study was not consistent with its position as the standard variety for plasticulture production in the SE part of PA.

'Sweet Charlie' yields were poor whether plants were non-thinned or thinned (8,139 and 7,366 lbs/acre, respectively) with marketable fruit percentages of 79 and 77% and average berry size of 12.1 g. As noted earlier, many early flowers were lost in the April sub-freezing temperatures.

'Daroyal' had good yields in the unthinned treatment (18,327 lbs/acre) but markedly lower yields when thinned (9,491 lbs/acre). Average marketable percentage increased from 56% to 73% with thinning and average fruit size was 12.0 g with a brix reading of 6.7. Flavor and appearance were good.

'Radiance' had total yields of 13,458 lbs/acre unthinned and 12,334 lbs/acre thinnned with marketable fruit percentages of 62 and 59%. Average berry size was 15.1 g/berry, brix level was 5.3 and while appearance was excellent, flavor was poor just as in 2015.

'Earliglow' had marketable percentages of 77 and 81% on yields of 11,567 and 11,699 lbs/acre. Flavor was excellent with an average brix of 7.9. Average size was 10.5 g/berry but we discarded any fruit weighing less than 9.0 g.

'Galletta' had very good yields (17,669 and 15,457 lbs/acre) and average fruit size (16.1 g/berry). Brix was 6.8 and marketable percent fruit was 67 in both treatments. Powdery mildew was again present on this variety.

'AC Wendy' was the 2nd highest yielding of the named varieties (18,891 and 17,665 lbs/acre) with marketable yields of 55 and 68%, an average brix of 5.9 and average berry size of 12.9 g. Flavor was poor.

'Rubicon' had yields of 10,446 and 14,273 lbs/acre, marketable percentages of 58 and 62%, brix of 6.8 and average fruit size of 12.9 g. Berries were very susceptible to softening in the high temperatures we had during harvest.

'Flavorfest' was the highest yielding of the named varieties this season with production of 17,977 and 20,599 lbs/acre. Average brix was 6.2, marketable percentages were 62 and 59, average berry size was 15.3 g. and flavor and appearance were good.

Kathy Demchak has been at Penn State since 1983, working first in the area of vegetable and tree fruit nutrition and later in berry crops. Recent research projects have included work on blueberry cultivar evaluation, blackberry cultivar evaluation and cold-hardiness, high tunnel production of strawberries, raspberries, and blackberries, and day-neutral strawberry production. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She happily lives in a rural area of Centre County, with husband Jeff, and sons Tim and Jeff.

'Sonata' had yields of 13,948 and 17,217 lbs/acre, average berry size of 11.0 g, marketable percentages of 55 and 66% and brix readings averaging 5.3. The fruit had average flavor. This variety is very vigorous and because of the dense foliage many berries rotted, which likely accounted for the improvement in the percentage of marketable fruit when thinned. In addition, the fruit was also susceptible to softening in the high temperatures during harvest.

'Donna' had yields of 13,946 and 12,532 lbs/acre and marketable percentages of 61 and 71%. The fruit had an average brix of 7.6 with good flavor and an average fruit size of 10.9 g. 'Donna' was another variety that had high plant losses in this planting.

The three Cornell selections each suffered from at least one major flaw such as low yields (< 10,000 lbs/acre), low percent marketable fruit (< 44), high plant losses or poor fruit quality. Two of these selections had higher plant losses in this study as well.

The three Rutgers selections performed better this year – perhaps because they had become better established, but yields were still low in two of these selections in the unthinned plots. Yields in the unthinned plots were 9,301, 9,890 and 20,675 lbs/acre and in the thinned plots were 12,456, 12,547 and 16,948 lbs/acre. One selection was the highest yielding in the trial this year. Brix readings were 8.1, 7.2 and 6.0; average fruit size was 14.1, 12.7 and 15.5 g and marketable percentages were between 58 and 78%.

Variety Performance in the Matted Row System

In 2015, the harvest season had been fairly wet and it seemed like the foliage almost never completely dried out, which affected gray mold incidence, followed by a hot spell in mid-June which probably had spurred on some anthracnose development. In 2016, conditions were interesting, in that a very warm spell in April resulted in us delaying straw removal to try to keep the plants cold so bloom wouldn't be advance too much. May and June were drier than usual so disease incidence was low overall. In order to be able to determine disease and insect susceptibilities, no fungicides or insecticides were applied in 2016. Unlike last year, when nearly all of the cultivars started to fruit at the same time except for 'Malwina', there was more of a spread in the harvest time of the varieties making it easier to divide the cultivars into early- vs. late-season ones.

'Earliglow' and 'Jewel', our early-season and mid-late season standards, respectively, continued to perform as expected with yields up relative to last year and fruit size dropping off a bit, as would also be expected. 'Earliglow' produced total yields of 9,900 lbs/acre with a mean berry weight of slightly less than last year at 9.0 g/berry (compared to 10.0 g/berry last year) while 'Jewel' produced 14,200 lbs/acre of fruit averaging 9.2 g/berry. 'Jewel' fruit size dropped off more markedly between years averaging 9.2 g/berry compared to 11.3 g/berry in 2015. Common leaf spot was quite noticeable on 'Jewel' leaves by the end of the harvest season. Only 54% of 'Earliglow' fruit was considered marketable, mainly due to small berry size for the remainder of the fruit. 'Jewel' had a greater percentage of marketable fruit, at 72% of the total, with the main reason for unmarketable fruit also being small size. The first significant harvest date (figured as at least 1 ripe king berry per 2' of row) was June 3 for 'Earliglow' and June 10 for 'Jewel'.

'Galletta' was the second variety to ripen, following 'Earliglow' by about 3 days. 'Galletta' was developed for plasticulture, but produced sufficient runners to fill the rows in very nicely after last year's renovation. 'Galletta' yield was about 50% higher than it was last year, but it was still a bit low-yielding, producing 7,000 lbs/acre. Fruit size was lower than last year but still nice-sized averaging 11.1 g/berry and it had a decent percentage of marketable fruit at 65%.

'Laurel' was another early-season variety and continued to perform well yielding 13,100 lbs/acre – 26% higher than last year - and berry size was acceptable, averaging 9.8 g/berry with 70% marketable fruit. Flavor was good, but not excellent. It was very resistant to foliar diseases. It is only available from Canadian nurseries at this time.

'Sonata' fruited in the mid-season, with first significant yield being June 8th and was the top-yielder mainly because of its high vigor, producing 18,800 lbs/acre of average-tasting fruit, averaging 9.3 g/berry, lower than the 10.5 g/berry size of last year's fruit. 71% of the fruit was marketable, up from 56% last year when much of the fruit was lost to gray mold presumably because of the plant's dense foliage.

'Rubicon' produced fruit at the same time as 'Sonata'. Yields were perfectly acceptable at 11,800 lbs/acre, but berries were on the small side averaging only 8.8 g/berry. The fruit were as tart as they were last year and still light-colored, but much less of the fruit was lost to gray mold with this variety as well, probably because we had a considerably drier harvest season this year. The percentage of marketable fruit was 63% this year compared to last year's 43%.

'Mayflower' fruited at about the same time as 'Jewel'. Its yield increased 50% over last year's yield, coming in at 11,900 lbs/acre. As happened last year, this cultivar had the highest percentage of marketable fruit compared to any other variety, at 75% marketable fruit. This is fairly impressive, especially considering that no fungicides or insecticides were applied to this plot this year. The flavor wasn't the best but seemed somewhat improved compared to last year when some unusual spicey and floral flavors were detected.

'Malwina' was again in a late harvest season all its own, not beginning to fruit until June 24 when only 'Jewel', 'Mayflower', and 'Rubicon' were still fruiting decently and continued to produce until July 13. The first year this variety had produced very few runners, so yields were very low in 2015. It renovated surprisingly well after the 2015 harvest though, so the beds filled in nicely bringing 2016 yields up by nearly 80% to 7700 lbs/acre – which still wasn't high for this trial – but was a significant improvement. Once again, a tiny percentage of the fruit (only a few berries) sprouted leaves, which is just a genetic disorder with this variety, and some of the caps looked like they were trying to mimic leaves.

Two of the four Cornell advanced selections had good total yields but fruit tended to be on the small side. Because of last year's high incidence of anthracnose fruit rot, disease resistance is a significant weakness of these selections. One of the three Rutgers advanced selections had amazing flavor later in the harvest season, and yields of all three were decent ranging from 7,100 to 10,000 lbs/acre, which was a significant improvement in yields compared to last year, which was probably a result of the small original plant size.

Disease and insect incidence was fairly low overall in 2016 with the main reason for unmarketable fruit being small berry size.

Crown-Thinning Effects in the Plasticulture System

The effects of thinning the crowns varied somewhat with variety, and depended on the vigor of the variety but overall, unthinned plots had a delay in the start of harvest. All of the varieties except for 'Sonata' and 'Rubicon' were average in vigor, and thinning the crowns after harvest resulted in lower, similar, or very slightly higher yields when compared to plants where the crowns were not thinned. Only 'Sonata' and 'Rubicon' showed a trend towards yield increases when the crowns were thinned, and 'Sonata' also showed a significant improvement in percentage marketable fruit when thinned. The conclusion was that there may be a benefit to crown-thinning only with varieties that demonstrate excessive vigor in their first production year. There were no consistent trends in effects on berry size.

Thanks to the Pennsylvania Vegetable Growers Association for funding these trials and to Rich Marini for his work on data analyses.

HOW TO KEEP YOUR BRAMBLES DISEASE FREE

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Production of good quality brambles (blackberry, raspberry, boysenberry etc.) for an extended period of time from a plantation largely depends on keeping them disease free. A wide range of disease problems can affect brambles and some of those diseases can quickly turn them unproductive or berry quality seriously deteriorated. In addition with environmental and nutritional disorders, a range of fungal and viral diseases are the major concerns that need to be managed preventatively. Knowing the susceptibility/resistance of bramble variety to major diseases help in developing a disease management plan. However, prevailing weather condition in many cases can alter the disease response of a variety. For example, a planting site that keeps morning dew longer on the leaves or canes or receives less sunlight due to its position near the wooded area will have higher fungal disease severity than normal.

Leaf and cane diseases:

Anthracnose, Spur blight and Cane blight are the common diseases that can attack most of the brambles. Anthracnose caused by fungal pathogen *Elsinoe veneta* is much more severe on black and purple raspberries than on red raspberries. On young canes, symptoms appear in the spring as small, purple spots that enlarge to about 1/8 inch in diameter, become sunken at the centers, and turn gray with a purple border. This disease is relatively easy to identify by looking at the sunken lesions. Infected leaves may show purple to brown spots that eventually take shot hole appearance. Spur Blight caused by *Didymella applanata* is usually a bigger problem on red raspberries than on black raspberries. In mid to late summer, chocolate brown to purple blotches appear around individual buds on canes. Spur blight when occur on leaves, the symptom appear as V shaped lesion from the apex of the leaf which can be identified very easily.

Cane blight Management:

Cane blight is a serious disease of brambles caused by *Leptosphaeria coniothyrium*, that infects all species of *Rubus* and also causes stem canker on roses and other ornamentals. Dark brown to purple cankers appear on main canes or branches that extend several inches along the cane and may include bud. However, it is not as confined to areas surrounding buds like spur blight. The fungus overwinters on dead tissue of old fruiting canes that serve as a ready source of infection for injured primocane tissues from the spring through the late summer. Black pimple like structures in the affected areas produce abundant spores during wet weather. The risk of cane blight is greatly increased when primocanes are injured or improperly pruned. Although pruning cuts provide a major infection site, insect damage, herbicide damage, freeze injury, or injury from farm machinery or other mechanical operations will likewise provide sites for infection. It was observed that most cane blights located at the base of the canes where they were wounded by old cane stubs. Once inocula are on the fruiting canes, it is necessary to spray fungicide to prevent infections of primocanes. However, established infections on fruiting canes can't be removed or cured by fungicide spray as most of these chemicals are primarily protective not curative, making the mechanical removal of infected canes an essential cultural practice during the growing season. Old, inappropriately pruned cane stubs were also found infected with cane blight fungus in more than 80% of the cases in the second year. Thus, proper removal of

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fruiting canes and application of effective chemicals together with facilitating quick drying and cultural operations that minimizes injury on canes will play an important role in managing the disease.

Fungicidal control: Fungicides that have been used previously (Captan, Pristine, Cabrio) by growers in the field were found ineffective in suppressing fungal growth indicating inefficacy or resistance. Few other new fungicides such as Quilt Xcel and Inspire XT were highly effective in vitro and in field trial. However, Inspire XT was not available from the company to label and for commercial use on brambles.

Table 1. Efficacy of fungicides in controlling cane blight in a field trial conducted near Morgantown, WV.

Treatment and rate/A	Days after first application	Cane blight incidence (%)*	Lesion length/cane (inches)**
Inspire XT 4.16EC 7 fl oz	0, 15, 30, 48, 60	25.5 c	2.8 c
Quilt Xcel 2.2SE 20 fl oz	0, 15, 30, 48, 60	35.6 c	2.6 c
Quadris Top 29.6SC 8 pt	0, 15, 30, 48, 60	40.5 b	3.7 b
Pristine 38WG 20 oz	0, 15, 30, 48, 60	59.5 a	6.3 a
Cabrio 20EG 14 oz	0, 15, 30, 48, 60	60.7 a	7.0 a
Captan 80WDG 2.5 lb	0, 15, 30, 48, 60	62.0 a	7.2 a
Non-treated	0, 15, 30, 48, 60	63.0 a	7.5 a

*Means within a column followed by the same letter are not significantly different as determined by Fisher's protected LSD test ($\alpha = 0.05$).
**Lesion length was averaged over all affected canes in a treatment.

The limited efficacy of Pristine and Cabrio was likely due to fungicide resistance in the fungal population, which is supported by results from an in-vitro assay. However, it is not clear why Captan was ineffective in controlling the disease.

Rust Diseases: Orange rust is the most important of several rust diseases that attack brambles particularly blackberries, dewberries, and black and purple raspberries. This is a systemic disease, once the plant is infected, the entire plant is infected for life. Stunted, deformed, and pale green or yellowish new leaves in the early spring is the diagnostic symptoms of orange rust. Undersides of the leaves may be covered with waxy blisters that later become bright orange and powdery.

Control of orange rust: Entire plant should be removed with root system as soon as symptoms of orange rust is detected. It is also necessary to remove and destroy all wild blackberries and raspberries in the area that might serve as a source of disease.

In addition, late leaf rust and cane and leaf rust may also occur on brambles that can be controlled in most cases with preventative spray programs.

Root diseases: Verticillium wilt and Phytophthora root rot are the two major root diseases of brambles, the latter being most common in heavy and poorly drained soil. The plant loses vigor because roots are rotted and uptake of water and nutrients is inhibited. Infected plants may be stunted; and lower one inch of the stem above the soil line may turn brown or black. Preventative application of phosphonate such as Agri-Fos together with improved drainage provided satisfactory disease control to some growers.

BROAD MITES IN PRIMOCANE-FRUITING BLACKBERRIES – ANOTHER NEW PEST?!

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Background: Broad mites (*Polyphagotarsonemus latus*) have historically been a pest of tropical and subtropical plants and greenhouse plants worldwide, but also can be present on a wide range of fruit crops including apples and grapes; vegetable crops including peppers, tomatoes, potatoes, beans, cantaloupes, and watermelon; and bedding plants such as impatiens and dahlias.

In recent years, broad mites have been found to cause damage on blackberries as well as other crops. In southeastern Pennsylvania, broad mites on blackberries were first noted on summer-bearing (i.e., floricane-fruiting) blackberries in 2013. Symptoms were present primarily on the leaves on the lower portions of the plants, which were distorted and resembled those on plants exposed to glyphosate or 2,4-D, or one emerging from canes that had been injured by cold temperatures. However, these causes were ruled out, and from a sample submitted to PSU's Dept. of Entomology's Insect ID lab, broad mites were determined to be the problem.

In 2015, broad mites caused a nearly total crop loss on primocane-fruiting blackberries. Samples were submitted to the PSU Plant Disease Clinic, as the plants looked like they had fire blight, but instead broad mites were identified as the cause. Symptoms had been present the year before, but were much more limited in scope. Meanwhile, broad mites as a pest of blackberry and their control was being investigated in Arkansas, as the pest problem had also been present there for a number of years. In 2016, broad mites were reported to be problematic on both floricane-fruiting and more commonly primocane-fruiting blackberries in at least 10 states.

Biology: On blackberries, it appears that broad mites can survive the winters with some slight degree of protection from cold, such as that afforded by high tunnels or row covers – basically any conditions which are mild enough to allow blackberry canes to survive appear to allow the broad mites to survive also. The life stages consist of eggs, larvae, nymphs, and adults. The life cycle can be completed in as little as a week. An interesting point regarding spread of broad mites is that they are small enough to be able to hitch a ride on whiteflies, which may look small to us, but apparently look taxi-sized to broad mites. Broad mites can also spread from plant-to-plant by cultural practices (pruning, tipping, and fruit harvest). In Arkansas, broad mites began increasing to damaging levels on primocane-fruiting blackberries from early-June and were present in damaging numbers until fall frost (Johnson and LeFors 2016).

Identification: Because of the tiny size of the various life stages (0.2 mm or less), a 20x hand lens is needed to be able to identify the pest itself. The adult mites seen in PA have been light peach in color, though apparently their color can vary from light yellow to dark green depending on their food source. The female has a crooked white stripe that looks somewhat like an hourglass down the center of her back, while the male does not. The most distinctive life stage is the egg. Eggs are nearly as large as the adults, oval in shape, and are clear with white bumps in a "polka dot" pattern on the surface.

Symptoms of damage: Growers in the region may already be familiar with some of the symptoms of broad mites, as this pest has been unusually problematic in the field for the last few years. With a wide range of crops, leaf distortion

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and cupping is often noted as well as a "strappy" leaf appearance. With bell peppers, the fruit develops a russeted surface, and the leaves may be smaller than normal and cupped downward. Symptoms are sometimes described as being similar to those that might be caused by systemic herbicides, boron deficiency, or cold damage. With blackberries, there is likely to be reduced or compressed terminal leaf growth, downward or upward curling or cupping of leaves which may appear somewhat bronze in color, compressed flower and fruit clusters, and/or dried-up blossoms. Symptoms on flower clusters may not show up until the second year of infestation. Symptoms similar to those from fire blight (leaf browning and death) may be present. Under a magnifying glass, young blackberry fruit may look like they were sprinkled with fine sand, but under higher magnification, it is apparent that the tiny specks on the forming drupelets are actually broad mite adults, nymphs and eggs.

Monitoring: Mites may be present at almost any time of the year, and though populations would be expected to increase as the season progresses, it is important to watch for them early when control is more likely to be successful. The populations are higher on the youngest foliage and terminal growth, unlike with two-spotted mites where populations begin on lower leaves and infestation slowly moves up the plant. Keep an eye out for symptoms of leaf bronzing or cupping of new growth, or dead leaves, and check these leaves and nearby ones for mite presence. Broad mites are most likely to be present on terminal growth and the undersides of terminal leaves, so these are the plant parts that should be checked. Scout whole planting weekly looking for plants with mite damage symptoms and use a 20X magnification lens to check for presence of active broad mites.

Management: If symptoms are present in only a few isolated locations in a planting, removal of the infested plants can assist greatly in preventing future spread. Several commercially available predatory mite species, including *Neosieulus fallacis*, feed on broad mites, but they must be released when broad mite populations are still low. Greenhouse trials in Canada found *Neoseiulus swirskii* and *Neoseiulus cucumeris* to have potential as biological control agents. Field releases in Arkansas found four predatory mite species with this potential: *Amblyseius andersoni, Neoseiulus swirskii, Neoseiulus cucumeris* and *Neoseiulus californicus* (Johnson and LeFors 2016). Some miticide products noted below have been found to have some efficacy.

Because broad mites are somewhat protected in there terminal growth, miticides with translaminar (penetrating the leaf) activity are more likely to be effective than miticides that have only contact activity. One such product is Agri-Mek SC, for which Syngenta has issued a 2(ee) label for broad mite control on caneberries in 7 states (AR, FL, IL, IN, NC, PA, and SC, effective from July 6, 2016 to July 6, 2020; (http://www.syngenta-us.com/special-label/agri-mek-sc/3486) in addition to a supplemental label that already was issued for spider mites on caneberries (http://www.syngenta-us.com/special-label/agri-mek-sc/3462). It should be noted that this is a restricted-use material. This is a useful addition, as the number of miticides labeled for use on blackberries is somewhat limited. Agri-Mek SC has a 7-day PHI, so the time to treat is either early before harvest starts (but ONLY if broad mites are present – don't just spray "in case"), or in the case of floricane-fruiting varieties, after harvest is over. Work conducted at the Univ. of Arkansas showed good efficacy of this material, but it was found that a second application may be needed to control mites that hatched after the first application. Apply Agri-Mek SC at rate of 3.5 fl oz/acre mixed with non-ionic (NIS) activator type wetting, spreading and/or penetrating spray adjuvant (read activator label, usually use 0.5% NIS v/v). Only 2 applications of Agri-Mek SC are allowed in a year, as resistance development to miticides is a serious concern with broad mites as well as other mites. Field treatments with Microthiol on 7 and 20 May delayed broad mite build-up by a couple weeks in Arkansas. Johnson and LeFors (2016) conducted laboratory bioassays where Agri-Mek, 1% or 2% M-Pede, 10 lbs or 15 lbs Microthiol and 2% JMS Stylet Oil all caused greater than 90% broad mite mortality within 72 hours of treatment. Future field treatments of these and other products will be conducted to determine where each may fit into a resistance management program for broad mites on blackberries or other crops.

For further reading:

Buitenhuise, R., L. Shipp and C. Scott. 2010. Greenhouse Canada. Biocontrols for broad mites. http://www.greenhousecanada.com/inputs/biocontrols/september-2010-2417

Cloyd, R.A. Pest Management: Broad Mites. FloriBytes. Oct. 2010. Online at http://www.oardc.ohio-state.edu/floriculture/images/10-10_Mites.pdf

Fasulo, T.R. 2000, revised August 2010. Broad Mite. Featured Creatures, Univ. of Florida. Online at: http://entnemdept.ufl.edu/creatures/orn/broad_mite.htm

Demchak, K. and D.T. Johnson. 2015. Broad mites on blackberries.

http://extension.psu.edu/plants/vegetable-fruit/news/2015/broad-mites-on-blackberries

Demchak, K. and D.T. Johnson. 2016. Broad mites on blackberries – a 2016 update. http://extension.psu.edu/plants/vegetable-fruit/news/2016/broad-mites-in-blackberries-a-2016-update

Johnson, D. 2014. Broad mites damaging blackberries. Arkansas Fruit and Nut News, Vol. 4, Issue 7, Sep. 5, 2014. Online at: http://comp.uark.edu/~dtjohnso/AR_News_5_Sep_2014.pdf

Johnson, D. 2015. Do you have broad mites on blackberry? Arkansas Fruit and Nut News, Vol. 5, Issue 5, June 8, 2015. Online at: http://comp.uark.edu/~dtjohnso/AR_News_8_June_2015.pdf

Johnson, D. and J. LeFors. 2016. Broad mite biology and management on blackberry. The Southern Region Small Fruit Consortium Progress Report Research Project 2016 R-07. Online: http://www.smallfruits.org/SRSFCReserch-Funding/Research16/2016R-07.pdf

Myers, M. and Bogash, S. 2015. Broad Mites in Fruiting Vegetables. Penn State Extension, posted June 22, 2015. Online at:

http://extension.psu.edu/plants/vegetable-fruit/news/2015/broad-mites-in-fruiting-vegetables

CHANGES IN THE WORKER PROTECTION STANDARD

James Harvey, Penn State University

The newly revised Worker Protection Standard will be enforced as of January 2017. If you do not have a complete understanding of this regulation get help now to get into compliance before you are inspected. Pennsylvania growers can get compliance assistance from Penn State University by calling Jim Harvey at 814-863-8656 or emailing him at jdh18@psu.edu

Highlights of the changes include:

- Safety Data Sheets (SDS) are now required at the central location for at least 30 days after the product has been used and must be kept at the facility for at least two years after it was used
- Annual WPS training for both Workers and Handlers
- No training grace period – workers must be trained prior to any work in treated areas. Handlers must be trained prior to doing any handling duties.
- Training must be documented and if an employee requests a copy of that documentation at least one copy must be provided free to that employee. Keep those training records at least 2 years.
- Handlers must have an eyewash system at the mix and load site that is capable of delivering .4 gallons of water per minutes for at least 15 minutes when the pesticide label requires eye protection or the pesticides are being loaded into a closed system operating under pressure. In addition, provide at least a pint of immediately available eyewash water during the actual application.
- Workers must have at least 1 gallons of water, soap and paper towels per worker within a quarter mile of the treated area.
- Handlers need at least 3 gallons, soap, paper towels and an emergency change of clothes within a quarter mile of the application area, at the mix and load site and where PPE is removed.
- Except for immediate family members Handlers and early entry workers must be at least 18 years old.
- The Application Exclusion Zone will take effect on the agricultural establishment as of 2017. In 2018 that application exclusion zone will also be enforced when it spills over onto neighboring property or roads.
- Handlers can still apply pesticides to their entire property but must suspend application if someone comes in that application exclusion zone during the application. High drift applications (such as air blast sprayers) require a 100 foot exclusion zone. Low drift applications are 25 foot exclusion zones.
- Employees can designate a representative to get pesticide records of past applications if the employee cannot do so.
- Handlers must be provided a medical evaluation, an annual fit test and respirator training if they are using pesticide products requiring respirators. Keep records of the medical evaluation, the actual fit test and respirator training for at least two years.
- Outdoor pesticide products with an REI (restricted entry interval) of greater than 48 hours will require posting do not enter signs. Enclosed space production applications require signage for REIs greater than 4 hours.

Jim Harvey has been the Worker Protection Standard (WPS)Specialist at Penn State's Pennsylvania Office of Rural Health since 2004. His position was created to help Pennsylvania growers understand and comply with the Worker Protection Standard. He spends most of his time visiting farms, orchards and greenhouses to go over the WPS with the employer. He is also involved with developing new training materials and speaking on the WPS. Prior to this position Jim worked as a regional farm safety extension educator for Penn State extension.

- The immediate family exemption has been expanded so that first cousins, aunts, uncles, grandchildren, grandparents and in- laws are now exempt from most of the Worker Protection Standard requirements. Everyone must still follow the pesticide label requirement including PPE and REIs.

There are two areas of this revision that are going to take some getting used to. These two areas are the Application Exclusion Zone (AEZ) and the respirator fit test.

Keep in mind that the Application Exclusion zone does not prevent you from spraying any parts of your crops. The AEZ does give you a specific amount of distance around the application equipment that no one is allowed in during application. It is a bubble that moves up and down the field with the application equipment. If someone comes within that bubble the Handler must suspend application until they leave. On your property that is fairly easy to control but in 2018 when it will be enforced off the property things can get difficult with cars speeding by or difficult neighbors. High drift applications such as air blast sprayers require a 100 foot bubble and low drift applications need a 25 foot bubble.

The respirator Fit test is the second area of concern. It basically requires 3 steps. Before you do the actual Fit test the Handler must pass a medical evaluation using the standard set of OSHA questions that EPA adopted for this. These questions must be reviewed by a licensed medical professional and the definition of a licensed medical professional is left to the states. The person performing the medical evaluation should inform you how many years the Handler should go between medical evaluations.

Once the medical evaluation is passed then the actual fit test can be done. Handlers can go to a contractor to have this done – at a price. The employer can also do the Fit test using a fit test kit available from safety suppliers or your local fire company might do it for a small donation since they should be experienced in doing this for their firefighters who must be fitted with their respirators.

If you have a beard or other facial hair that would create problems passing a fit test you have three options. The Handler can shave, you can use pesticide products that don't require respirators or you can invest in a loose fitting Powered Air Purifying Respirator (PAPR). A PAPR does not require a fit test although you are still required to get an initial medical evaluation.

Once the actual Fit test is given the Handler should be trained on proper use of a respirator.

Make sure each of these steps are properly documented and keep those documents for at least two years.

LOW TUNNEL STRAWBERRY PRODUCTION – PRODUCTION OPTIONS, ECONOMICS, AND GROWER DISCUSSION

Dr. Kim Lewers[1], Dr. David Conner[2], Kathleen Demchak[3]
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Strawberries are very popular in the US and internationally, ranking as the fifth most popular fresh-market fruit in the United States, with annual per capita consumption nearly doubling over the past 15 years to almost 8 pounds per person. Strawberries are highly perishable, and locally-grown strawberries are particularly valued by many consumers. While growers in California can produce strawberries year-round, with individual plantings of dayneutral varieties producing for six months or longer, most strawberry growers in the mid-Atlantic and northeastern part of the country utilize June-bearing varieties, harvesting fruit for only three to five weeks. When one compares consumption to the volume of strawberries produced in this region, it becomes apparent that even in "good years", local strawberry growers capture the sales of only 3 to 5% of the strawberries actually purchased by nearby consumers. Production of locally grown strawberries to fill this gap could provide additional grower income.

However, while producing more strawberries locally could be desirable, there are several differences between production in California and the mid-Atlantic that make this goal challenging. First, there is grower concern that "strawberry season" is perceived to consist of only late spring and early summer, and that consumers won't buy local strawberries outside of this season, believing that the berries are not truly local. However, whether this assumption applies or not depends on consumer education, locality and marketing method. Second, even if a switch is made from short-season June-bearing varieties to dayneutral varieties to allow harvest over a longer period, the region's growing season is still relatively short, and includes hot mid-summer temperatures which can cause an interruption in fruit production. Third, high humidity and frequent rainfall typically result in periods conducive to development of several different fruit rots, including botrytis and anthracnose, making it a challenge to maintain acceptable fruit quality. Production is currently dependent on cultivars with significant disease susceptibilities that become apparent under humid eastern growing conditions.

To help address these constraints, several US strawberry researchers have been working together to develop new ways to extend the production season from a few weeks to many months. A system that grows dayneutral strawberry varieties under "low tunnels" of various sorts seems to hold promise through addressing many of the above concerns. Major advantages of low tunnel use include an extended production season, high fruit quality, and reduced disease incidence. Major disadvantages include higher input costs, higher labor requirements, and a lack of locally-adapted dayneutral cultivars for this production system.

While this production system has appeal, there are a number of aspects to consider. Several designs of low tunnels are available for use, ranging from systems that growers can make themselves to commercially-available low tunnel kits. The cost of construction materials thus varies by location and system. Many other aspects of low-tunnel

Kim Lewers has been with the USDA's Agricultural Research Service at Beltsville, Maryland since 2001, conducting research on strawberry, blackberry, and raspberry. She serves as a Research Geneticist (Plants) developing improved cultivars of these valuable fruit crops while studying inheritance of important traits and developing molecular markers and genetic maps to help track these traits in breeding populations. Dr. Lewers earned all advanced degrees from Iowa State University in agronomy, integrated pest management, plant breeding, and genetics. Her husband also works with the USDA-ARS. She has two grown children: a son in the US Marine Corps, and a daughter who is an aerospace engineer with two daughters of her own. Dr. Lewers really loves being a grandma. Kim.Lewers@ars.udsa.gov

production can be optimized for local conditions. The ideal planting date will vary with location, as will the type of plastic which is best to cover the bed and the low tunnel, depending on the temperatures and light quality at different locations. Meanwhile, breeders in several states are working to develop locally-adapted dayneutral varieties that combine high yields and excellent quality with disease resistance. Fertilizer rates should be tuned to match crop needs while minimizing economic and environmental costs. Pest management strategies should be adjusted in response to the type and magnitude of problems, again while minimizing costs. Labor sources, marketing opportunities, and pricing also are key concerns when determining what break-even yields and pricing might be required to offset additional input costs and maximize long-term profits.

In this session, three researchers who have been working with low tunnel strawberry production will share their experiences to initiate a conversation with and among growers about the above aspects of low tunnel strawberry production. All three are involved in the "TunnelBerries" project (http://www.tunnelberries.org/), a large multi-state research project funded by the USDA's National Institute of Food and Agriculture, officially led by Dr. Eric Hanson of Michigan State University, and involving researchers in 9 states as well as the U.K. Kim Lewers is a strawberry breeder and geneticist working with the USDA - Agricultural Research Service in Beltsville, Maryland. She first used a low-tunnel summer-production system in an attempt to develop dayneutral strawberry varieties for the Mid-Atlantic. Kathy Demchak is an extension associate with Pennsylvania State University, has been involved with categorizing and testing different types of plastic as tunnel covers, and is conducting studies on plastic bed mulch and tunnel coverings for low tunnels. David Conner is an agricultural economist from Vermont, specializing in the economics of sustainable food systems. His involvement with the TunnelBerries project will help determine critical thresholds for various materials choices and production practices when growing berries in protected cultivation, including strawberries under low tunnels. Information on the project can be found on the project website: www.tunnelberries.org

The TunnelBerries project is based on research supported by the USDA National Institute of Food and Agriculture, Section 7311 of the Food, Conservation and Energy Act of 2008 (AREERA), Specialty Crops Research Initiative under Agreement 2014-51181-22380.

Thanks to the Pennsylvania Vegetable Growers Association for providing funds used towards a matching requirement for the TunnelBerries project.

David Conner grew up in central Pennsylvania and holds a PhD in Agricultural Economics from Cornell and Masters in Extension Education from UVM. His professional interests span the economics of sustainable food systems from farm to fork. David lives in Burlington with his three children. In his spare time he enjoys spending time with his family, especially hiking, making music and gardening.

Kathy Demchak has been at Penn State since 1983, working first in the area of vegetable and tree fruit nutrition and later in berry crops. Recent research projects have included work on blueberry cultivar evaluation, blackberry cultivar evaluation and cold-hardiness, high tunnel production of strawberries, raspberries, and blackberries, and day-neutral strawberry production. She earned a B.S. in Horticulture from Penn State and an M.S. in Horticulture from Virginia Tech. She happily lives in a rural area of Centre County, with husband Jeff, and sons Tim and Jeff.

HOW BIRTHDAY PARTIES CAN ENHANCE YOUR CURRENT AGRITOURISM BUSINESS

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Birthday parties are a great way to market your business in a very personal and unique way. It allows the opportunity for you to spend quality time with your guests and their children that they will remember for a lifetime. You can gain a customer for life just from them attending a successful party.

1. **Decide what you will offer with your party program**
   - How many children will be included? We allow up to 20 children. All adults are free
   - How many tables? We offer 6
   - Is the area covered? We provide covered areas
   - Will you provide an attendant to help? We provide 1 per party
   - What is the total party time? Our party is 2.5 hours from start to finish. This includes a 30-minute set up time.
   - What farm activities will be included? Example: Hayride, Train Rides, Inflatables. We include most of our play areas.
2. **Hiring the right staff**
   - Providing energetic upbeat staff who truly enjoys children to manage the party is very important. They will be spending several hours with a large group of your customers at the party. They will leave a lasting impression on them.
   - Consider your party staff attendants as ambassadors of your farm. Choose only the very best job applicants for this position.
   - The party attendant should be very knowledgeable of everything that is offered at your farm.
3. **What makes a party at your farm unique?**
   - Incorporate anything that is specific to your location into the party such as feeding the farm animals, visiting one of the food areas for a special treat such as your signature ice cream or homemade fudge.
   - Providing memory making photo ops that are farmed themed.
   - Most birthday party venues are overcrowded, indoors and not a pleasant experience for the invited guests. Choose a party location that uses the beautiful surroundings of your farm to provide a picturesque backdrop for the party.
4. **Birthday parties grow your customer base**
   - Offering parties at your agritourism business is a great way to gain new customers that may have never heard of you before being invited to attend a party at your farm. We have heard countless times "we were invited to a birthday party during the Spring/Summer" when asked how they learned about us.

John Hill is the owner of Hill Ridge Farms in Youngsville, N.C. He bought this farm in 1968 and it is adjacent to the farm he was raised on. John started out as a vegetable grower with seasonal crops and offered a pick-your-own vegetable store. Gradually, he started adding attractions and today has thousands of visitors per year. He has two daughters, Lisa and Jennifer. They both enjoy working with their dad and hope to keep the business growing for years to come.

- Each child that attends the party should be given a free return visit coupon to your farm. That is an easy way to generate repeat customers.
- Kids tell other kids about their fun experience at the birthday party and then those kids ask their parents to visit with you.

5. **Making your party guests VIP's**
   - Birthday parties are a high-ticket item for your business. Everyone attending should feel like hon ored guests during their visit.
   - Parties should be taken to the front of the line at main attractions such as the hayride and train ride.
   - Staff at these attractions should pay special attention to the birthday child such as announcing that it's their birthday.
   - The area should be very clean and comfortable for everyone attending the party. Pick shady areas in the summer and sunny areas in the cooler weather. Provide extra seating, when possible, for lager parties.
6. **Marketing your parties effectively**
   - Social media is the most effective and inexpensive way to market your parties. What do people do at parties? They take lots of pictures and share them!
   - Birthday party pictures will be shared over and over again, showcasing the very best of what your farm has to offer.
   - Party attendants can also ask permission to capture pictures of the children having a great time. You can then share them on your own business social media pages.
   - Proper signage throughout your farm showing that you offer parties is very important too.
   - Make sure your parties are held in an area that is very visible to your other customers. You want the area to be exclusively for your party guests but in a high traffic area so that other guests will notice that a birthday party is happening.
   - Party staff should specific party uniform shirts. While they are moving through your farm park other guests will realize you offer parties.
   - Offering repeat party discounts is another great way to encourage people to have their child's birth day at your farm each year. A 20% off discount is recommended.
   - Always mail the birthday child a thank you card for spending their birthday at your farm. Have the birthday attendant write it and mention something specific to the party such as a special gift, special guests or something memorable that happened. Another card inviting them back should be mailed the next year 6 weeks prior to their birthday.
7. **Making memories that last a lifetime**
   - Adding birthday parties to your agritourism business is a great way to market your farm and add profit to your bottom line, but it is MUCH more.
   - You are sharing in a once in a lifetime experience with your customer when they are celebrating their child's birthday.
   - You are making memories with them that they will cherish forever.
   - Your customers will now associate your location as being a special part of their family for years to come.

INNOVATIVE APPROACHES TO EXPAND LOCAL MARKETS

Rose Robson
Wrightstown, NJ
www.robsonsfarm.com

Set Yourself Up for Successful Expansion:

Quality business cards, social media, photography and signage 80/20 Rule

- 80% of your business is coming from 20% of your customers
- Seek free promotion by selling to restaurants, grocery stores and bakeries that highlight local products
- Pop Up shop
- Encourage hashtags and sharing

Looking for your New Market

- Pay close attention to what customers are responding to that you already do.
- Can you take it to the next level? How can it be enhanced? What value can be added.
- Be a voracious reader and listener
- But always be original!

No means "No right now" but it doesn't mean "no" tomorrow

- Have thoughtful persistance when trying to sell something new

Promote

- Videos are one of the most effective ways!
- Every door direct
- Social media

Targeting new groups of people to bring them to the farm

- Example philanthropic events (not necessary selling them anything but just getting them to the farm)

Get them to Return

- Coupon with expiration
- Upcoming event
- Get contact information (email or address)
- Make a meaningful connection

DIRECT FARM MARKETING AND AGRITOURISM, CONNECTING WITH YOUR ETHNIC CUSTOMERS

Stephen Specca
Specca Farms
Springfield, NJ

Our farm has been a Pick Your Own direct marketing operation since we ourselves, were immigrants from Italy. I have been helping my dad, Dave Specca on the farm all of my life. I have firsthand noticed a shift in some of the culture of our customers and that of New Jersey and the East coast. As a result of this shift, our farm has adapted our operation to appeal to other cultures. Besides, what is more distinctive of culture than food?

This discussion will present novel ideas other growers can use when trying to reach and connect to new customers of different ethnicities and cultures. Often many immigrants are looking for reminders of their cultures that often involve food.

Discussion points:

- Immigration chart to NJ
- Gross domestic product
- Using written language to appeal to a culture.
- Connectivity in a community.
- Creating loyal costumers
- Multi-cultural customer Cohesion
- The bartering system how to implement it.

Something you can feel good about. In a small way you are helping preserve a person's heritage and culture by offering them a connection to home.

Culturally different people are good costumers and can be yours.

PAY THE FARM MORTGAGE BY CHARGING ADMISSION

Kurt W. Alstede
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The costs associated with owning and operating a retail farm business in the Northeast are greater than ever. The goal of this session is to convince fellow farmers that they should be charging admission for their Pick Your Own activities and to give them the strategies, and the confidence, to do so.

As an industry, I believe that farmers do not charge enough for their pick your own crops or for the experience that they offer to the public.

- How many farm operations are making enough money and receiving returns on their investment comparable to other businesses?
- How many farmers are receiving wage and benefit packages comparable to outside employment?
- How many farmers are finding it more and more difficult to keep up with the rising costs of running their businesses?
- Are farmers in the Northeast prepared for a $15.00 minimum wage?
- How many farmers wish to expand their owned farm acreage but don't have the capital nor the cash flow to afford such a purchase?

How does one address these challenges?

The solution is simple: **Charge Admission to Pick Your Own and Increase PYO Prices!!!!**

The Grandson of German immigrants, Kurt Alstede grew up in a family owned service station business in New Jersey where he learned firsthand entrepreneurial and customer service skills from his father and grandfather. He began his career in agriculture in 1982 at the age of 18 when as a first generation farmer he began raising vegetables and doing custom work in his hometown of Chester, New Jersey while at the same time working for a neighboring farm.

An Eagle Scout, Kurt graduated as the Salutatorian from West Morris Central High School in Chester, New Jersey in 1982 and went on to earn a Bachelor of Science degree in Horticulture from Delaware Valley College of Science and Agriculture in 1985 where he also completed studies in Agronomy and Agribusiness.

Throughout his college tenure he continued to grow his farming business which eventually became to be known as Alstede Farms. Direct retailing to consumers began in a small farm stand in 1985 with Pick Your Own commencing in 1987. In 1990 the Farm Store that is used today was built and over time the business evolved from raising hay, grain, and wholesale vegetables to being an entirely retail based business raising nearly 450 acres of tree fruits, small fruits, vegetables, and flowers. Today 100% of the farm's output is sold through the on farm store, PYO, tailgate markets, and CSA. Agritourism also compliments the farm's retail offerings. The farm currently employs 23 fulltime year round staff members and seasonally up to 200 people in both the production and retail segments of the business. Kurt functions as the General Manager and is supported by a strong management team that includes his wife of 20 years, Barbara.

Kurt has been an active volunteer firefighter for nearly 35 years and has served or is currently serving in several different capacities of local, county, state, and federal government. He is also engaged in a variety of agricultural organizations and has served in church leadership roles. Kurt and Barbara have three children; all of whom are home schooled at the farm: Rebekah (15), Sarah (13), and Karl (9). All three children are active contributors to the family business during the busy harvest seasons.

When Kurt is not busy farming he enjoys stamp collecting, history, travel, and watching the New Jersey Devils play ice hockey. Kurt and his entire family are dedicated to the future of production agriculture, the responsible stewardship of God's natural resources, and to protecting and promoting rural American values.

For the Purpose of Discussion These Generalizations are Offered:

- Many farmers are afraid to charge higher prices!
- Farmers tend to undervalue their contributions to society and also undervalue the products that they raise.
- Farmers simply do not charge enough for the products and the experiences that they provide people.
- Farmers tend to fear that people will not pay a higher price for what they are offering.
- Farmers tend to love their work so much that they undervalue their worth.
  - Farmers accept that they are worth less in the work force despite good educations, strong management skills, and commitment to long work hours.
- Farmers often set prices based upon what they would want to pay rather than at a level that customers are willing to pay.
- Farmers often don't consider all of the expenses, and liability, associated with opening their farms to the public.
  - Insurance
  - Trash Collection
  - Rest Rooms
  - Extra Staff
  - Directional Signs
  - Landscaping
  - Shrinkage: Customers eating and taking products without paying.
  - Regulatory Compliance

Case Study #1: "What! Do you mean that you actually expect me to pay to come on to your farm to pick my own? Why that is outrageous! They let you on their farm down the road for free. I am going there and I am never coming back! You used to be such a great small family farm. Now you have become too commercialized and greedy!"

- We are selling experiences as well as the crop.
- Where can people go and experience what they can on a farm and not pay?
  - Even most parks require entry fees or annual passes
  - "Free" parks are supported by taxes…who is paying the taxes?
- It costs a lot of money to maintain the farm appearance for customers.
- One in the box, one in the mouth, one on the ground.
- Have you ever considered how much is being stolen from you?
  - It is unacceptable to sample at the grocery store produce department…why should people be allowed to do it in the fields?
  - In many instances people come to the farm for the sole purpose of eating your produce without paying for it.
- Many people today expect to pay…most are willing to pay.
  - How often do people call and say: "What is your admission cost?" or "Do you charge for parking?"
- No FREE adults! Where else can they go with their kids and get in for free?
- Just because people believe that they should be entitled to enter your farm…your private property…for FREE doesn't mean that you have to do it.

Case Study #2: "I can't believe that you are able to get the admission and pick your own prices that you do. I don't think that our customers would ever stand for that!"

- Don't fear charging.
- How long before your neighbors change their prices when they see that people are paying yours?
- We were the first to charge for hay wagon rides.
  - Now everyone in the region is charging for hay wagon rides.
- We were the first to charge admission onto the farm.
  - Most others have now adopted some sort of admission or prepayment system.
- Don't sweat the cheap guy.
  - You cannot afford to sell cheap and stay in business today.
- Why were we one of the pioneers and remain a leading advocate for charging higher prices and admission?
  - Because we want to purchase and own more farmland.
  - Because we have a lot of debt!
  - Because we refuse to work for nothing.
  - Because I want to pay our team members comparable wages and benefits to other careers.
  - Because we want to pass a financially stable business onto the next generation.

Case Study #3: "I can't believe that you are charging that much for Pick Your Own peaches! Why that is more than I pay in the grocery store! That's a rip off! I am never coming back and I am going to tell all of my friends! Plus, I am the President of my local PTA and I am going to tell everyone at school also! I am also going give you a bad review!"

- Don't sweat the threats!
  - Have you ever looked at Disney's reviews?
- If you no one complains about your prices then you are not charging enough.
- You cannot be everything to everyone.
  - Choose the base that you are seeking and set the prices accordingly.
  - The Waldorf-Astoria is not worried about attracting the customers that are sleeping at Hotel 8.
- The customer that you are losing is likely one that you never wanted anyway.
- Often these complaining customers come back because they cannot find what you are offering anywhere else.

Case Study #4: "No one goes there anymore. They are always too busy!"

- Admission pricing can be used as a marketing tool.
- Variable pricing can help direct customers to days that are less busy and that can absorb more growth.
- The busiest days are not necessarily the most profitable days. It costs a lot of money to staff up for busy.
  - Know when you are making your best profits.
- If you offer a beautiful farm, a good product, and a wholesome experience you will be busy.
- Would you rather serve less customers at a higher price, or serve more customers at a lower price?
  - Understand your margins. With the proper pricing you can net more money while serving less customers.

An Important Warning!!!: You must be prepared to offer your customers an *experience* and a *product* that is commensurate with what you are charging!

- Charging comes with the responsibility of performing.
- Customers will pay once…
  - It is easy to attract first time customers. The goal is to create a long term customer relationship.
- One must remain constantly diligent to details.

What We are Doing at Alstede Farms:

- All PYO customers pay admission for entry.
  - We charge $5.00 on weekdays and $6.99 on weekends.
  - Includes FREE hay wagon rides to all PYO areas 7 days a week 9 am to 7 pm each day.
  - Includes access to our Summer Sunflower Maze and Cider Mill Tours in Fall.
  - The Fall Corn Maze is added on for $6.00 per person.
- We are constantly reviewing, evaluating, and adjusting our admission pricing strategies.
  - Nothing is chiseled in stone.
- FREE PYO admission is offered every Monday through Thursday from 9 am until 12 noon.
- FREE PYO admission to all CSA customers.
- PYO admission is included with all daily and annual activity passes.
- Tickets can be purchases on line in advance at www.theticketbarn.com which is a site that we created and own.
- All PYO containers must be purchased.
  - No bags are allowed.
  - Containers from home may be my used but must be weighed first.
- No picnicking allowed in the PYO areas…no seating is provided.
- No eating and sampling of products is allowed until the produce has been paid for.
- Roving "Gator" security on weekends and busy days.
- We insure that there is always a wide variety of PYO options available.
- The farm is always mowed, well maintained, clean, and open.

Conclusion:

It is time for the entire industry to increase PYO prices, charge entry admission, and start getting paid for how hard everyone really works in agriculture!

REDUCING RISKS FOR YOUR DIRECT MARKETING FARM BUSINESS

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In recent years, there has been an influx of interest in farming that ranges from traditional, intergenerational farm families to nontraditional individuals seeking a fresh start in farming. However, significant barriers and risks exist for entry-level or beginning farmers as well as for established farmers looking to make significant changes in their crop production systems.

This discussion will provide an overview of ways to minimize risk and refine the control of capital expenses and cash flow. More specifically, ways to keep better production records, the importance of accurate field maps, and opportunities that are currently available for beginning, women, and minority farmers. This discussion will also introduce the USDA Noninsured Assistance Program (NAP) no-cost incentive for those specified groups of producers.

Since the 1930's, the United States Department of Agriculture (USDA) Farm Service Agency (FSA) has provided invaluable support to agricultural producers to enhance, expand, begin and maintain farming operations. In speaking with growers and FSA professionals, it has become clear that there may be a disconnect between the NAP program and growers who would apply. The NAP program provides financial assistance to producers of non-insurable crops when low yields, loss of inventory, or prevented planting occurs due to natural disasters. This discussion will explain how the NAP programs newly released county average direct market and organic prices can help provide farm businesses with a better financial safety net. A short video created by Rutgers Cooperative Extension will conclude the presentation by highlighting successful specialty crop growers within the program.

GRAFTING FOR THE FUTURE

By: Ben Hinson

- **What is vegetable grafting**
  - Grafting is the combination of any scion variety and rootstock variety.
  - Was first developed in East Asia (Japan, Korea, China).
  - Was introduced into Europe in the 20th century and later it was introduced in North America.
  - For commercial use, we are currently grafting Watermelons, Tomatoes, Peppers, Eggplant, and Pumpkins.
- **Why do we graft**
  - To overcome soil-borne diseases, soil pest, and to add extra vigor to plants for production increases.
  - We are expecting to see increase in vegetable grafting over the next 5 years, with the increase in pesticide reulation, increase in soil-borne pathogens, and a decrease in rotational land availability.
- **What are we grafting**
  - Watermelon
    - Rootstock = Interspecific Hybrid Squash (*C. Maxima X C. Muschata*).
    - Resistance to all races of Fusarium Wilt.
    - Increase in vigor and production while decreasing the total plant population.
    - One cotyledon grafting method
  - Tomatoes (Green House Applications)
    - Rootstock = Intraspecific Hybrid Tomato (Solanum lycopersicum), hybrid tomatoes (S. lycopersicum), and a wild relative to tomato (S. habrochaites) called interspecific hybrid.
    - Media = Peat based, Rockwool, or Coco fibers
    - Greenhouse grafted plants main goal is to increase production through the life of the crop.
    - Also, provides some disease resistance.
  - Tomatoes (Cold/High Tunnel Applications)
    - Different rootstocks are used based on your location, your end goal, and what diseases you are fighting.
    - Most Cold/High tunnel growers are using determinate scion varieties on vigorous tomato rootstocks to increase production.
  - Tomatoes (Open Filed Applications)
    - Rootstocks are chosen based on what disease pressures are in the field you are planting.

Benjamin Hinson – B.S.F.R (University of Georgia); Employer Reiter Affiliated Companies 2012 – 2014 as (Substrate Growing Manager); Employer TriEst AG/ Tri-Hishtil 2014 – Present (Sales Associate / Sales Coordinator)

- The majority of open field grafted tomato production is the fight the bacterium *Ralstonia* (*Pseudomonas*) *Solanacearum* or Bacterial Wilt.
- Mostly seen in the southeastern United States.

➢ **Background and General Information on Tri-Hishtil**

- Tri-Hishtil is a partnership between three different companies – TriEst AG (U.S.A), Hishtil (Israel), and Centro Seia (Italy).
- Located in Mills River, NC just outside of Asheville, NC
- This location was chosen because of its high light during the winter months, mild summers, and clean water.
- We currently have 2.5 acres of greenhouse with the option to expand later on to 26 acres of greenhouse.
- Every part of the growing/grafting process is completed at our facility.
- Will give a brief tour via pictures of the facility.

➢ **Conclusion and Q & A**

FRESH MARKET TOMATO VARIETY TRIAL – YEAR 1

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Introduction - Fresh market tomatoes are a very important crop in Pennsylvania. According to the USDA, in 2015 total harvested acreage was 2,200 with a crop value of over $33.2 million. Since there had been no evaluation of newly released varieties in the state in a replicated trial in recent years, this study was initiated in 2016 and plans are to repeat it again in 2017.

Materials and Methods - Twenty three round red tomato varieties (named and advanced selections) were evaluated using plasticulture and drip irrigation. In addition, six advanced selections from the Penn State tomato breeding program were included for observation. Seeds were started on April 26 and transplants were set in the field on May 31. There were four 10-plant replications per variety with an in-row spacing of 1.5 ft. Fertilizer was applied preplant according to soil test results and standard fertility and pest management practices were used during the growing season as found in the Commercial Vegetable Production Guide. Harvest started on August 1 and stopped on September 9. Fruit were graded into #1, #2 and cull and each group was counted and weighed.

Results and Discussion – Mountain Fresh Plus was used as the standard variety in this trial. Yields of #1 fruit and total marketable fruit (#1 + #2) were 6.5 and 12.0 lbs per plant (Tables 1 & 2). Varieties with similar yields of #1 fruit (+/- 0.3 lbs) were Red Bounty, Red Deuce, Rocky Top and Tribute. Varieties with higher yields of #1 (more than 0.3 lbs) were Red Morning, Red Mountain, STM 8005 and Volante. Varieties that had similar total marketable yields (+/- 0.5 lbs) were Bella Rosa, FTM 1135, Red Deuce, Rock Top, Tribute and Volante. Varieties with a total marketable yield 0.5 lbs per plant (or more) greater than Mountain Fresh Plus were Red Morning, Red Mountain and STM 8005.

Mountain Fresh Plus had a value of 80% for total marketable percent of harvested fruit. Varieties with similar total marketable percent of all fruit (+/- 5%) were Rally, Red Bounty, Red Deuce, Red Mountain, STM 8005, Tribute and Volante. Average marketable fruit size for Mountain Fresh Plus was 0.64 lbs; only 5 varieties had lower average fruit size. All varieties had acceptable average fruit size of over 0.5 lbs. No consistent differences in flavor were noted with informal tastings on selected harvests.

In the advanced selections from the Penn State breeding program PSFH 15-11 had similar yields of #1 fruit as Mountain Fresh Plus while PSFH 15-5, 15-8 and 15-28 had higher yields. All four of these selections had higher total yields. PSFH 15-8 and 15-11 had similar marketable percent as Mountain Fresh Plus while PSFH 15-28 was higher.

I would like to thank the PA Vegetable Marketing & Research Board for funding this trial.

Timothy Elkner is a regional horticulture educator based in Lancaster County, PA. His prime areas of responsibility are commercial vegetable and fruit production. He conducts applied research on vegetables and small fruit with an emphasis of variety evaluations. He has a B.S. degree in Agricultural Sciences from Cook College (Rutgers University) and an M.S. and Ph.D. in Horticulture from Clemson University and Virginia Tech, respectively.

Table 1. Yields of #1 and #2 fruit for 23 named/numbered varieties of round red tomato and six advanced selections from the Penn State tomato breeding program. All numbers are averages from four replications except as noted and are reported on a per-plant basis.

Variety	Number #1	Weight #1(lbs)	Number #2	Weight #2(lbs)
Bella Rosa	6.9	5.1	9.3	6.6
BHN 589	6.2	4.5	7.8	5.5
FTM 1127	3.8	3.0	6.4	5.5
FTM 1135	8.4	6.1	8.4	5.7
Mountain Fresh Plus	9.9	6.5	8.9	5.6
Mountain Majesty	5.4	4.3	5.3	4.3
Mountain Merit	5.8	3.5	6.9	4.5
Primo Red	7.2	5.4	8.3	6.2
Rally	9.1	5.6	9.3	5.4
Red Bounty	9.0	6.3	8.1	5.4
Red Delight	7.4	4.9	7.5	4.7
Red Deuce	7.5	6.6	6.4	5.7
Red Morning	9.5	7.6	7.0	5.3
Red Mountain	13.8	8.3	9.4	5.2
Red Rave	9.1	5.3	7.2	4.5
Redline	6.4	4.2	7.2	4.6
Resolute	7.3	4.4	8.7	5.4
Rocky Top	9.3	6.2	7.7	5.3
Scarlet Red	7.3	5.6	6.8	5.1
STM 8005	11.4	7.5	8.4	5.4
Summerpick	5.8	4.0	7.7	5.4
Tribute	9.7	6.3	7.8	5.1
Volante	10.4	7.1	7.7	5.0
PSFH 15-1[a]	7.8	4.9	9.2	5.4
PSFH 15-5[b]	12.0	7.1	10.8	6.0
PSFH 15-8[b]	14.1	9.1	7.9	5.0
PSFH 15-11[a]	10.7	6.9	9.8	6.7
PSFH 15-25[a]	7.1	5.2	5.5	4.1
PSFH 15-28[a]	15.5	9.5	6.9	4.3

[a] = one replicate
[b] = two replicates

Table 2. Total # and weight of marketable fruit, average weight and # culls for 23 named/numbered varieties of round red tomato and six advanced selections from the Penn State tomato breeding program. All numbers are averages from four replications except as noted and are reported on a per-plant basis.

Variety	Total Number Marketable	Total Marketable Wt.(lbs)	Average Marketable Wt.(lbs)	Number Culls
Bella Rosa	16.2	11.7	0.72	8.7
BHN 589	14.0	10.0	0.70	8.0
FTM 1127	10.2	8.5	0.83	8.6
FTM 1135	16.8	11.9	0.71	7.9
Mountain Fresh Plus	18.8	12.0	0.64	5.5
Mountain Majesty	10.7	8.6	0.82	5.4
Mountain Merit	12.7	7.9	0.63	8.4
Primo Red	15.5	11.6	0.75	9.2
Rally	18.4	11.0	0.60	6.2
Red Bounty	17.0	11.6	0.68	6.5
Red Delight	14.9	9.5	0.64	7.5
Red Deuce	13.9	12.3	0.89	4.3
Red Morning	16.5	12.9	0.79	6.8
Red Mountain	23.3	13.6	0.59	8.2
Red Rave	16.3	9.8	0.61	6.7
Redline	13.6	8.8	0.65	7.1
Resolute	16.0	9.7	0.61	6.0
Rocky Top	17.0	11.5	0.68	7.8
Scarlet Red	14.1	10.7	0.76	7.4
STM 8005	19.8	12.9	0.65	5.0
Summerpick	13.5	9.3	0.69	8.4
Tribute	17.6	11.5	0.66	6.2
Volante	18.1	12.1	0.67	7.1
PSFH 15-1[a]	17.0	10.3	0.60	7.3
PSFH 15-5[b]	22.8	13.1	0.58	8.5
PSFH 15-8[b]	22.0	14.0	0.64	4.7
PSFH 15-11[a]	20.5	13.6	0.66	6.2
PSFH 15-25[a]	12.6	9.3	0.74	8.7
PSFH 15-28[a]	22.4	13.8	0.62	4.2

[a] = one replicate

[b] = two replicates

Table 3. Total # and weight of harvested fruit, percent marketable and seed source for 23 named/numbered varieties of round red tomato and six advanced selections from the Penn State tomato breeding program. All numbers are averages from four replications except as noted and are reported on a per-plant basis.

Variety	Total Number Harvested	Total Weight Harv.(lbs)	Percent Marketable	Seed Source
Bella Rosa	24.9	17.3	68	CS
BHN 589	22.0	14.9	67	SW
FTM 1127	18.7	15.2	56	ST
FTM 1135	24.7	16.9	70	ST
Mountain Fresh Plus	24.3	15.0	80	HM
Mountain Majesty	16.1	12.7	68	HM
Mountain Merit	21.1	12.9	61	SW
Primo Red	24.8	17.9	65	HM
Rally	24.5	13.9	79	CS
Red Bounty	23.6	15.5	75	HM
Red Delight	22.3	14.0	68	CS
Red Deuce	18.2	15.8	78	HM
Red Morning	23.3	17.9	72	HM
Red Mountain	31.5	17.9	76	HM
Red Rave	23.0	13.4	73	SW
Redline	20.7	13.2	67	CS
Resolute	22.0	13.2	73	SW
Rocky Top	24.8	16.3	71	SW
Scarlet Red	21.4	16.2	66	SW
STM 8005	24.7	15.8	82	CS
Summerpick	21.8	14.5	64	CS
Tribute	23.7	15.0	77	CS
Volante	25.1	16.1	75	CS
PSFH 15-1[a]	24.3	14.1	73	PSU
PSFH 15-5[b]	31.2	17.7	74	PSU
PSFH 15-8[b]	26.7	16.6	84	PSU
PSFH 15-11[a]	26.7	17.3	79	PSU
PSFH 15-25[a]	21.3	15.0	62	PSU
PSFH 15-28[a]	26.6	15.8	87	PSU

[a] = one replicate, [b] = two replicates

CS = Clifton Seed, HM = Harris Moran, ST = Stokes, SW = SeedWay

PSU = Dr. Majid Foolad, Penn State

TOMATO BREEDING AT PENN STATE

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Objectives:
A primary objective of the Tomato Genetics and Breeding Program at Penn State is to develop breeding lines and F1 hybrid cultivars of fresh-market and processing tomato with disease resistance and other desirable horticultural characteristics suitable for production in PA.

Background Information:
Plant diseases are a major concern to the tomato industry in PA. Two most common and destructive diseases of tomato (*Solanum lycopersicum* L.) in PA are early blight and late blight. *Early blight* (EB), caused by *Alternaria solani* and A. *tomatophila*, is the most occurring disease of tomato in the Northeast of the United States. In PA, tomato growers experience EB almost every growing season. At present, few commercial cultivars of tomato exhibit acceptable level of resistance to EB, and the disease is commonly controlled via sanitation, long crop rotation, and frequent application of fungicides. Late blight (LB), caused by the oomycete *Phytophthora infestans*, occurs throughout tomato and potato (*Solanum tuberosum* L.) growing regions in the world with varying frequency, causing significant economic losses. In the U.S. Northeast, LB has become an annual concern for commercial tomato and potato growers (Fry et al. 2013). Currently, only a few tomato cultivars with LB resistance are available, and measures employed to control the disease involve the use of cultural practices and frequent use of fungicides. While application of preventative control measures such as mefenoxam or copper-based fungicides can be effective, frequent applications have financial and environmental consequences and may only prevent infection by certain genotypes of the pathogen (McGrath et al. 2013). Identifying new sources of LB resistance and incorporating resistance into elite breeding lines and hybrid cultivars is an effective strategy to counter new aggressive strains of P. *infestans* and reduce fungicide applications (Foolad et al. 2008; Nowicki et al. 2013). Previously, three major genes for LB resistance, including Ph-1, Ph-2 and Ph-3, were identified in tomato wild species, *Solanum pimpinellifolium* L. The Ph-1 resistance gene is no longer effective against the current race of P. *infestans* and is not used in tomato breeding anymore. The Ph-2 gene confers partial resistance to some P. *infestans* isolates and only provides a reduction in the rate of disease development. The Ph-3 gene confers incomplete-dominant resistance against a wide range of P. *infestans* isolates and is currently considered an effective resistance gene against tomato LB. However, there have been reports of new P. *infestans* isolates overcoming resistance conferred by *Ph-3* (Chunwongse et al. 2002; Foolad et al. 2008; Irzhansky and Cohen 2006), though a combination of *Ph-2* and *Ph-3* provides a much stronger resistance against tomato LB. Recently, a few LB-resistant fresh-market tomato hybrid cultivars have been released, including Plum Regal, Mountain Magic, Mountain Merit (Gardner and Panthee 2010; Gardner and Panthee 2012; Panthee and Gardner 2010) and Defiant PhR (http://www.johnnyseeds.com/p-8473-defiant-phr-f1.aspx). However, the presence of fungicide-resistant and more aggressive isolate of P. *infestans* necessitates identification, characterization and incorporation of additional sources of resistance in new tomato cultivars.

In addition to the appearance and taste of fruits and vegetables, consumer perceptions of fruit quality are now influenced by perceived health benefits. The red color is the most visible quality attribute of the mature tomato fruit for both fresh consumption and processing. The carotenoid lycopene is the red pigment in tomato, and a potent natural

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antioxidant that is increasing in demand. Fresh tomatoes and tomato products are the major sources of lycopene in the U.S. diet. The attention to lycopene is well deserved, as its antioxidant capacity is roughly twice that of β-carotene. Numerous epidemiological and intervention studies have demonstrated that dietary intake of lycopene is correlated with a decreased incidence of certain cancers and heart and eye diseases. Since humans acquire lycopene through the diet and obtain approximately 85% of their lycopene from tomato-based products, the availability of tomatoes that are higher in lycopene content is highly beneficial. The development of high-lycopene tomato cultivars is of major commercial significance to both fresh-market and processing tomato industries in PA and worldwide.

At Penn State we have been conducting research to 1) identify genetic sources of resistance to EB and LB, and high fruit quality within the related wild species of tomato, 2) discern the genetic basis of these traits, and 3) develop new tomato inbred lines and hybrid cultivars with improved characteristics for commercial production in PA. In this presentation, I will provide an update of our recent research progress, including the development of new experimental hybrids with improved disease resistance and other desirable horticultural characteristics.

Breeding Progress at Penn State:

Early Blight: We identified and characterized genetic sources of resistance to tomato EB within tomato related wild species, including *S. habrochaites* and *S. pimpinellifolium*. The resistant accessions were used for genetic studies, including identification and mapping of resistance genes (quantitative trait loci, QTLs), and breeding purposes. For example, we developed several interspecific populations segregating for EB resistance (Ashrafi et al. 2009; Foolad and Zhang 2015), studied the inheritance of resistance (Foolad and Ashrafi 2015) and identified and mapped several EB-resistance genes (QTLs) (Ashrafi and Foolad 2015). Simultaneously, the resistant accessions were used in backcross breeding programs leading to the development of processing and fresh-market (large round, plum, cherry and grape) tomato inbred lines with improved resistance to EB. During the past two years, we developed numerous experimental hybrids of tomatoes with EB resistance from crosses among our advanced breeding lines. For example, during the field season in 2015, 72 large round (slicer), 32 plum and 90 grape fresh-market tomato experimental hybrids were evaluated and their performances were compared with several commercial hybrid cultivars of tomato. Similarly, in 2016, 180 large size fresh-market tomato experimental hybrids were developed and evaluated under field conditions. Based on our own assessment and evaluation done by others, several hybrids were identified to be highly competitive when compared to commercial cultivars. To further evaluate select hybrids and some new hybrids, currently we are making crosses in the greenhouse to develop a total of 168 experimental hybrids, including 136 fresh-market (slicer) and 30 processing tomato experimental hybrids. These hybrids will be evaluated during the field season in 2017. Through our collaboration with seed companies, a select number of the experimental hybrids will also be grown and evaluated in several other locations in the U.S.

Late Blight: During the past several years, screening of a large collection of *S. pimpinellifolium* wild accessions for LB resistance under different growing conditions, including field, high tunnel, greenhouse and growth chamber, resulted in the identification of 16 accessions with strong LB resistance (Foolad et al. 2015; Foolad et al. 2014). Several of these accessions exhibited a resistance similar to breeding lines and hybrid cultivars with combined *Ph-2* + *Ph-3* LB-resistance genes. We have used five accessions for genetic studies and breeding purposes. Various genetic populations were developed from crosses between these five resistant accessions and LB-susceptible tomato breeding lines to study the inheritance of resistance. In most cases, it was determined that the LB-resistance from these accessions was highly heritable, with heritability values ranging from 0.6-0.9 (Merk and Foolad 2012; Ohlson and Foolad 2015, 2016). These studies demonstrated that LB resistance from these accessions could be transferred to the cultivated tomato via breeding and selection. Additional investigations, including molecular mapping of resistance genes, indicated that in most cases resistance was controlled by 1-few genes with major effects (Merk et al. 2012) (MR Foolad et al., unpublished). One of the genes identified in these accessions co-localized with the previously-identified resistance gene *Ph-2* on chromosome 10 (MR Foolad et al., unpublished). Whether the identified genes in the new accessions were allelic to *Ph-2*, or if they were separate genes closely linked to *Ph-2*, is unknown and requires further investigation. However, in the new accessions a few other genes (QTLs) were identified, which were at genomic positions other those of *Ph-2* and *Ph-3*. These genes might confer resistance to P. *infestans* isolates, which

have overcome the resistance conferred by *Ph-2* or *Ph-3*. Would this be proven to be the case, it might be possible to pyramid the various resistance genes in order to develop tomato inbred lines and hybrid cultivars with stronger and more durable resistance to LB.

In addition to the identification and characterization of new sources of LB resistance in tomato, we have been conducting breeding research to introduce LB resistance into Penn State tomato breeding lines and experimental F1 hybrids. Thus far, we have developed several inbred lines of processing and fresh-market tomatoes with LB resistance conferred either by a previously-known LB resistance gene, Ph-3, or by new LB resistance genes recently identified in a S. pimpinellifolium accession, PI 270443. During 2015 and 2016, LB resistance was confirmed in these breeding lines under greenhouse conditions, and they were further evaluated for other horticultural characteristics under field conditions. In winter/spring 2017, we are developing a total of 34 new experimental hybrids of fresh-market tomato with LB resistance, conferred from either Ph-3 or Ph-5. Additionally, we are developing one hybrid combining Ph-3 with Ph-5 genes to examine the level of combined resistance. The 35 experimental hybrids with LB resistance will be evaluated for horticultural characteristics during the field season in 2017.

Fruit Quality: At Penn State, we have been conducting basic and applied breeding research on tomato fruit quality characteristics, including color, firmness and physiological disorders. For example, we identified an accession (PSLP 125) of the red-fruited tomato wild species S. pimpinellifolium with exceptionally high fruit lycopene content. Extensive genetic studies resulted in the identification and mapping of two major genes (QTLs) on tomato chromosomes 7 (lyc7.1) and 12 (lyc12.1) contributing to high fruit lycopene content (Ashrafi et al. 2012). Subsequently, a marker-assisted backcross breeding program was undertaken, which resulted in fine mapping of one of the high-lycopene gene, lyc12.1 (Kinkade and Foolad 2013). Currently, through a collaborative research with Cornell University, we are dissecting the molecular basis of lyc12.1 to determine the gene(s) underpinning the high lycopene content. Simultaneously, we have been transferring the high lycopene trait from the S. pimpinellifolium accession PSLP 125 into Penn State tomato breeding lines. We have developed numerous advanced breeding lines of processing and fresh-market (large size, plum, grape and cherry) tomatoes with exceptionally high fruit lycopene content. During 2015 and 2016, we developed a large number of fresh-market experimental F1 hybrids, which were evaluated under field conditions. Several of the hybrids were also evaluated by one or more seed companies. Currently, we are making crosses in the greenhouse to develop some of the same and some additional experimental hybrids, which will be evaluate under field conditions in 2017.

References

Ashrafi H, Foolad MR (2015) Characterization of early blight resistance in a recombinant inbred line population of tomato: II. Identification of QTLs and their co-localization with candidate resistance genes. Advance Studies Biology 7:149-168

Ashrafi H, Kinkade M, Merk H, Foolad M (2012) Identification of novel quantitative trait loci for increased lycopene content and other fruit quality traits in a tomato recombinant inbred line population. Molecular breeding 30:549-567

Ashrafi H, Kinkade MP, Foolad MR (2009) A new genetic linkage map of tomato based on a *Solanum lycopersicum* × *S. pimpinellifolium* RIL population displaying locations of candidate resistance ESTs. Genome 52:935-956

Chunwongse J, Chunwongse C, Black L, Hanson P (2002) Molecular mapping of Ph-3 gene for late blight resistance in tomato. J Hort Sci Biotechnol 77:281-286

Foolad MR, Ashrafi H (2015) Characterization of early blight resistance in a recombinant inbred line population of tomato: I. Heritability and Trait Correlations. . Advance Studies Biology 7:131-148

Foolad MR, Merk HL, Ashrafi H (2008) Genetics, genomics and breeding of late blight and early blight resistance in tomato. Critic Rev Plant Sci 27:75-107

Foolad MR, Sullenberger MT, Ashrafi H (2015) Detached-leaflet evaluation of tomato germplasm for late blight resistance and its correspondence with field and greenhouse screenings. Plant Dis 99:718-722

Foolad MR, Sullenberger MT, Ohlson EW, Gugino BC (2014) Response of accessions within tomato wild species, *Solanum pimpinellifolium* to late blight. Plant Breed 133:401–411

Foolad MR, Zhang L (2015) A recombinant inbred line population of tomato and its genetic map constructed based on a *Solanum lycopersicum* × *S. pimpinellifolium* cross. Advance Studies Biology 7:441 – 471

Fry WE, McGrath MT, Seaman A, Zitter TA, McLeod A, Danies G, Small IM, Myers K, Everts K, Gevens AJ, Gugino BK, Johnson SB, Judelson H, Ristaino J, Roberts P, Secor G, Seebold K, Snover-Clift K, Wyenandt A, Grunwald NJ, Smart CD (2013) The 2009 Late Blight Pandemic in the Eastern United States ‚Äì Causes and Results. Plant Dis 97:296-306

Gardner RG, Panthee DR (2010) 'Plum Regal' Fresh-market plum tomato hybrid and its parents, NC 25P and NC 30P. HortScience 45:824-825

Gardner RG, Panthee DR (2012) Mountain Magic': An Early Blight and Late Blight-resistant Specialty Type F1 Hybrid Tomato. HortSci 47:299–300

Irzhansky I, Cohen Y (2006) Inheritance of resistance against *Phytophthora infestans* in *Lycopersicon pimpenellifolium* L3707. Euphytica 149:309-316

Kinkade MP, Foolad MR (2013) Validation and fine mapping of *lyc12.1*, a QTL for increased tomato fruit lycopene content. Theo Appl Genet 126:2163–2175

McGrath MT, Fry WE, Smart CD (2013) Recent Occurrences of Late Blight on Tomatoes in the Northeastern USA. Acta Hort (ISHS) 1069:321-326

Merk HL, Ashrafi H, Foolad MR (2012) Selective genotyping to identify late blight resistance genes in an accession of the tomato wild species *Solanum pimpinellifolium*. Euphytica 187:63-75

Merk HL, Foolad MR (2012) Parent-offspring correlation estimate of heritability for late blight resistance conferred by an accession of the tomato wild species *Solanum pimpinellifolium*. Plant Breed 131:203—210

Nowicki M, Kozik EU, Foolad MR (2013) The tomato late blight. In: Varshney RK, Tuberosa R (eds) Translational Genomics for Crop Breeding: Vol I, Biotic Stress, 1st edn. John Wiley & Sons, Inc., USA, pp 241-265

Ohlson EW, Foolad MR (2015) Heritability of late blight resistance conferred by *Solanum pimpinellifolium* accession PI 224710. Plant Breed 134:461–467

Ohlson EW, Foolad MR (2016) Genetic analysis of resistance to tomato late blight in *Solanum pimpinellifolium* accession PI 163245. Plant Breed 135:391-398

Panthee DR, Gardner RG (2010) 'Mountain Merit': A late blight-resistant large-fruited tomato hybrid. HortScience 45:1547-1548

GROWING LIST OF VIRUSES IMPACTING TOMATOES

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There is another new virus in the USA proving to be worthy of concern for tomato growers. *Tomato Chlorotic Spot Virus* (TCSV) has been causing substantial loss for growers in Florida. While viruses have generally been of minor importance in field tomato crops in the northeast, with the notable exception of when infection begins during greenhouse transplant production, the situation could change with a new virus or insect vectors becoming more numerous due to environmental conditions becoming more favorable with climate change and/or management becoming more difficult such as following development of insecticide resistance. Therefore it is prudent to be knowledgeable about viruses, understand that new ones periodically evolve, be on the look out for symptoms, and obtain a diagnosis of suspect symptoms. Two other new viruses are G*roundnut ring spot virus* (GRSV), first detected in Florida in 2009, and *Pepino mosaic virus* (PepMV). PepMV is a major problem in greenhouse tomatoes in the USA. Fortunately it is not expected to impact field tomatoes because symptom development is inversely affected by light intensity. These add to a very long list of viruses that can infect tomatoes: Alfalfa mosaic virus (AMV), Beet curly top virus (BCTV), Cucumber mosaic virus (CMV), Lettuce necrotic stunt virus (LNSV), Potato virus Y (PVY), Potato yellow vein virus (PYVV), Tobacco etch virus (TEV), Tobacco mosaic virus (TMV), Tomato apex necrosis virus (ToANV), Tomato marchitez virus (ToMarV), Tomato bushy stunt virus (TBSV), Tomato chlorosis virus (ToCV), Tomato chocolate spot virus (ToCSV), Tomato infectious chlorosis virus (TICV), Tomato mosaic virus (ToMV), Tomato mottle virus (ToMoV), Tomato spotted wilt virus (TSWV), Tomato torrado virus (ToTV), Tomato yellow leaf curl virus (TYLCV), and Tomato yellow mosaic virus (ToYMV).

***Tomato Chlorotic Spot Virus* (TCSV)**

While it has primarily been affecting tomatoes in south Florida, it has the potential to be moved elsewhere, it has a wide host range, and it can be very destructive. Florida growers have sustained great losses, thus this is an important disease to be aware of. TCSV was confirmed on tomato in a high tunnel in Ohio in 2013 and in field-grown tomato on Long Island in 2016, documenting its ability to affect crops outside of Florida.

TCSV is related to *Tomato Spotted Wilt Virus* (TSWV) and *Impatiens necrotic spot virus* (INSV), which already occur widely in the USA. All are tospoviruses and are spread by thrips. G*roundnut ring spot virus* (GRSV) is another new tospovirus. All three viruses occur in Florida; TCSV is now the dominant one. Western flower thrips have been increasing in occurrence in parts of the northeastern USA due to insecticide resistance, thus providing an opportunity for TCSV to be readily spread if it is introduced to the region. Common blossom thrips has also been confirmed to be an important vector of TCSV.

TCSV was first detected in the USA in Florida in 2012, but may have been present a few years earlier and mis-diagnosed as GRSV. Just two years later it was causing extensive plant loss with symptoms starting to develop only about three weeks after transplanting. Nearly all plants have been observed affected in a planting.

Symptoms. TCSV causes symptoms that are similar to those caused by TSWV. Both viruses cause upper leaves to develop brown (necrotic) tissue often in patterns as is typical with viruses. Chlorotic spots and ringspots as well as mosaic also develop sometimes with TCSV. This disease can progress rapidly causing bronzing, wilting, and deformation of leaves, and death of terminal leaves and stems. Necrotic rings develop on fruit rendering them

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unmarketable. When infection occurs before flowering, plants can be severely stunted and produce few if any flowers, and eventually die. Only fruit had symptoms during the outbreak in Ohio. Photographs are at http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Tomato_Chlorotic_Spot_Virus.html.

Long distance movement. TCSV could be moved to the northeast in tomato seedlings or another host plant produced where the virus is already established. Global movement of plants has become commonplace. Ornamental plants were also being produced in the high tunnel with affected tomato plants in Ohio and in the greenhouse where tomato transplants were grown on Long Island, and thrips were numerous in both cases. Another possible mechanism is shipment of infected tomato fruit with mild symptoms not affecting marketability.

Other Susceptible Plants. The name suggests TCSV is a disease of tomato; however, when a plant is specified in a virus name it is designating the first host identified for the virus. TCSV has also been detected in pepper (bell and chili), lettuce, long bean (*Vignaun guiculata*), weeds (jimsonweed), and ornamental plants including lisianthus, annual vinca (*Catharanthus roseus*), waxflower (*Hoya wayetii*), and Christmas cactus (*Schlumbergera truncate*). Tomatillo, tobacco, petunia, eggplant, escarole, beans, peanut, and impatiens were found to be susceptible as well when inoculated in a host range study.

TCSV Detection. Currently-available immunostrips for detecting TSWV, such as those marketed by Agdia Inc., will also give a positive result for a plant infected by TCSV or GRSV because these viruses are so closely related. Thus currently it is not possible to determine which of the three viruses is present with the immunostrips. Procedures have been developed to distinguish them as part of a national project on TCSV. Knowledge about occurrence of a new virus is critically important for management, thus testing is an important component of the project. There is funding for testing samples as part of a project underway through 2018. If you see symptoms that could be TCSV or TSWV, please report to Meg at mtm3@cornell.edu or to your local extension specialist.

Management. Plant viruses can be difficult to manage because insect vectors often transmit viruses quickly, limiting the usefulness of insecticides, and there are no pesticides that directly target viruses. An infected plant cannot be cured. Focus is on avoiding the virus when possible, thus the current emphasis on monitoring to obtain understanding of TCSV occurrence. Fortunately, tomato varieties bred to have the dominant *Sw-5* gene conferring resistance to TSWV have been found to also be resistant to TCSV as well as another new tospovirus, GRSV. See section below on TSWV for more information on resistant varieties.

Where Did TCSV Come From? New tospoviruses can be created when a plant is infected by more than one tospovirus as a result of these viruses being able to exchange segments of their genome (re-assortment). There are eight species recognized presently. TCSV was detected in Brazil and Argentina before Florida.

***Tomato Spotted Wilt Virus* (TSWV) and *Groundnut ring spot virus* (GRSV)**

TSWV has been occurring more commonly on Long Island recently in tomato as well as some other crops, including potato, pepper, and eggplant. So far impact has not been substantial except when symptoms began appearing on transplants. TSWV can stunt and kill plants when infection occurs early. Symptoms developing on fruit renders them unmarketable. GRSV was also detected in 2016 on Long Island. One sample tested positive for TCSV.

Western flower thrips (WFT), an important vector of tospoviruses, have been occurring more commonly on Long Island. Resistance to insecticides has made their control more difficult. WFT have developed resistance to pyrethroids, organophosphates, carbamates, and spinosad. There is some evidence that WFT are surviving over winter in some warmer areas of the northeast.

Several TSWV-resistant tomato varieties are now available. Most were developed for the southeastern region because TSWV has been a consistent constraint on production there. A list of TSWV-resistant varieties that have performed well in evaluations conducted in FL and GA is at http://www.tswvramp.org/management/index.html#role. In an evaluation of nine TSWV-resistant varieties conducted on Long Island by Sandy Menasha in 2015, the top performing varieties in terms of yield and taste (TSWV did not develop) were Primo Red (best), Red Morning, Red Mountain and Mountain Glory tied for third, and Red Defender and Red Bounty tied for fourth. Degree of resis-

tance can vary among varieties because performance of resistance genes can be affected by host plant background. There is concern about appearance of a new strain of TSWV able to overcome the resistance.

Managing tospoviruses: TSWV, GRSV, and TCSV

1. Select TSWV-resistant tomato varieties.
2. Grow transplants in a greenhouse that does not have ornamental plants. Separate rooms in the same greenhouse do not provide sufficient separation.
3. Monitor for thrips.
   In the greenhouse use yellow stickie cards and regularly inspect leaves for white flecking caused by their feeding.

   In the field look for injury on leaves and fruit (gold haloes around area where fruit were in contact). Also look for thrips in flowers by holding a piece of white paper underneath flower cluster, then tap the cluster by hand to dislodge thrips on to the paper.
4. Apply insecticides when thrips are present, but note that thrips are difficult to control partly due to resistance to many labeled products.
5. Scout for virus symptoms. Submit sample for virus identification.
6. Manage weeds in the greenhouse and field.

BIOSTIMULANTS IN TOMATO PRODUCTION

Steve Bogash, Vegetable Crops Advisor, ISP Technologies

2/2/17, 2:30 PM, Tomatoes Session

Properly applied foliarly and injected biostimulants can provide a large extra measure of production in tomatoes (and other fruits and vegetables) when applied as part of an overall plant nutrient program. They are especially helpful in managing plant stressors that can reduce fruit quality, size and yields.

Let's define a biostimulant:

- Mostly organic materials that when applied in small quantities, enhance plant growth and development.
- Plant reactions to biostimulants are above and beyond what could be expected with the application of plant nutrients (N, P, K, Ca, Mg….) alone.
- Many are hormonal in whole or part.
- There's a wide range of potential ingredients, but seaweed, seaweed extracts and humic acid are common in most if not all biostimulants. Other common ingredients include: vitamins, micronutrient chelates, amino acids, sugars, plant extracts, and Si.
- When applied with a complete nutritional package biostimulants can move yields and quality forward while providing a measure of environmental stress reduction.

Typical plant stressors include: high heat, drought, root saturation, insects, diseases, low temps, phytotoxic spray applications, and high humidity. Plants respond to these stresses by making free radicals / toxic oxygen species. These free radicals damage: plant pigments, mitochondria, and cell walls. Under extreme conditions this results in cell and plant death. Biostimulants help plants to create antioxidants and rebalance plant hormones.

A wide range of studies indicate that biostimulants have proven to help plants in weathering: drought, high salinity, heat, cold, fungal disease, intense UV, herbicide damage, and nematodes.

The addition of Silicone (Si) in plant available forms boosts biostimulant activity. Field observations from late summer 2016 indicate that adding Si materials such as SiMag58 (Si source: potassium silicate) to fungicide applications greatly enhanced powdery mildew management in winter squash and pumpkins.

Biostimulants will not reverse aging, nor bring back the dead, so it's good to have realistic expectations about their benefits. Much of the best research has been done on turf with some pretty significant results. Better plant color is often noted in research studies. Under ideal conditions, it's much tougher to tease out any benefit(s). There does seem to be some stimulant activity in aiding plants in recovering from an herbicide stress, but that is very dose dependent. Don't expect any biostimulant to fix plants that have been hit by high doses. Over application can create too many small fruit, therefore the timing of applications is a major factor in using these materials properly.

Steve is recently retired as a Horticulture Educator and Researcher, PSU Cooperative Extension. In his current position, Steve helps to develop new nutrient products and the recommendation to use thse products in vegetables, small fruit and flowers. He contines to do applied research in field and high tunnels on bell peppers, tomatoes, cucumbers and processing tomatoes seeking to improve yields and quality. .

Since 2008, Steve has been doing extensive trials on container-grown vegetables in addition to his high tunnel and field tomato evaluation program started in 2000. Evaluating more than 500 varieties of tomatoes for flavor, appearance, disease resistance and general usability has made Steve very opinionated when it comes to tomato varieties. Steve lives with his wife, Roberta and son, Joe in Newville, PA and is looking to create a vineyard and greenhouse business as a post-retirement form of entertainment.

When used properly, biostimulants will create a growth response with improved root and shoot growth, increased flowering and higher yields. They also stimulate specific biochemical pathways within plants that make them more resistant to insects and diseases. By upregulating specific genes, fruit nutritional quality is often increased. By upregulating the production of antioxidants, plants are better able to weather high salt levels, drought, and temperature extremes.

Let's look at 3 distinct types of biostimulants:

1) Regalia, Giant Knotweed Extract, Marrone, Bioinnovations: Primary mode of action is induced systemic resistance. This increases plant production of phytoalexins, phenolics, anti-oxidants, and PR proteins. Collectively this makes for tougher plants when dealing with diseases. Can be applied foliarly and injected. Combines well with many other pest management materials.

2) Stimplex, Ascophyllum nodusum, North Atlantic brown seaweed / algae, Acadian Seaplants: Active ingredient is cytokinen as kinetin which is a plant hormore largely responsible for increased flower set, but also stimulates many other biochemical pathways within plants. Also contains betains, sterols, micronutrients and other compounds that aid in biostiumulation.

3) Metabolik HV-1, multi component biostimulant, ISP Technologies: Contains humic acid, kinetin, vitamins, micros, and digested sugars. Blended materials such as this are where much of the industry is moving in order to create more situationally useful simulants. This combination reduces many negative effects of plant stressors, improves flower set, simulates soil biology……

Using these products in tomato production can provide a large measure of insurance for a successful crop. Tomato fruit set and fruit quality are often negatively impacted by the wide range of conditions during a typical growing season. Timely applications have proven to increase fruit set at the edges of good pollination conditions and improve fruit quantity and quality.

STINK BUGS AND APHIDS - WHAT'S NEW FOR CONTROLLING THESE PESTS

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Tomatoes are attacked by a number different insect pests. Some are chewing feeders that eat leaves and/or bore into fruit, while others have piercing sucking mouthparts that are used to feed on plant sap or fruit. Stink bugs and aphids are two of the most important pests that fall into the latter group.

Stink Bugs

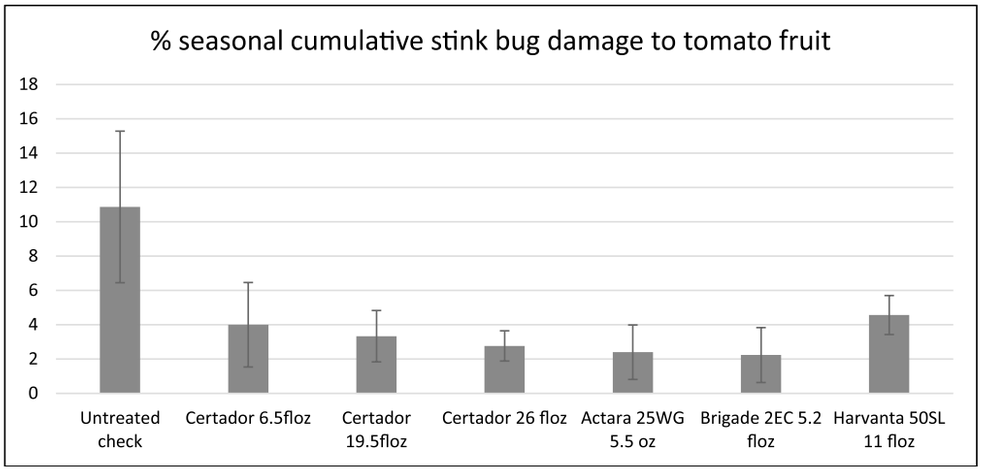
Tomatoes in the Mid-Atlantic U.S. are attacked by several different stink bug species, particularly the invasive brown marmorated stink bug (BMSB), Halyomorpha halys (Stål), which has become a serious pest species in many fields. Both nymph and adult stages of stink bugs feed on buds and developing and ripe fruit with their piercing-sucking stylet mouthparts. Feeding injury often appears as white or yellow starburst marks on the skin and spongy tissue damage internally where the feeding stylets were inserted into the fruit. In addition to direct damage, stink bugs can also transmit pathogens that cause fruit rot. Current control strategies for stink bugs rely on foliar applications of insecticides approximately weekly once fruit appear, and typically, the highest labeled rates of insecticide products are recommended for the most effective stink bug control. Some products that have performed well in previous field trials on peppers and tomatoes in Virginia include the pyrethroids: Bifenthrin (Brigade, Sniper); Permethrin; Baythroid XL; Warrior II; LambdaCy; MustangMax; and Hero EC; the neonicotinoids Venom, Scorpion; and Actara 25WDG; and the pyrethroid+neonic combination products Brigadier; Endigo; and Leverage 360.

In 2016, we evaluated a couple new insecticides for stink bug control in tomatoes in Virginia. Certador contains the neonicotinoid dinotefuran, which has been shown to be highly efficacious against BMSB. Harvanta contains cyclaniliprole, a new diamide insecticide with a broad spectrum of activity. Both products suppressed cumulative stink bug injury to tomato fruit.

2016 Stink bug insecticide efficacy test

Location:	Kentland Research Farm, Blacksburg, VA
Variety:	'Plum Regal' tomato
Transplant Date:	2 Jun 2016
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 30 GPA.
Experimental Design:	8 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft (6 ft. row centers).
Foliar Spray Dates:	11, 21, 26 Jul and 4, 15 and 22 Aug

Tom Kuhar is a Professor and Vegetable IPM Specialist in the Department of Entomology at Virginia Tech. Dr. Kuhar's research focuses on the ecology and integrated pest management of insect pests of potato and vegetable crops. He has published over 75 peer-reviewed papers and book chapters on insect pest management in agricultural crops and has given hundreds of presentations on the topic. He received his B.S. degree in biology from Towson, University, Towson, MD in 1992 and his Master's (1996) and Ph.D. (2000) degrees in entomology from Virginia Tech. He formerly worked as a postdoctoral research associate at Cornell University, Ithaca, NY researching alternative methods for managing vegetable pests. A native of Baltimore, MD, he and his wife, Stacey, who also works at Virginia Tech, have two children, Daniel (13) and Brianna (12). Outside of work, his passion is playing, watching, and coaching team sports like softball, basketball, and volleyball.



Aphids can also be problematic on tomatoes building up tremendous numbers on the undersides of leaves and producing sticky honeydew that can result in sooty mold growth on plants. Frequent use of pyrethroid insecticides can result in outbreaks of certain aphid species that are resistant to that class of insecticides. It is also important to utilize selective insecticides for aphid control that do not eliminate important natural enemies, which can keep pest populations in check. Several newer more IPM-friendly insecticides were evaluated for control of potato aphids in tomatoes on the Eastern Shore of Virginia. Effective control of aphids was achieved with Sivanto containing flupyridifurone, Movento containing spirotetramat, Closer containing sulfoxaflor, the diamide insecticides Exirel and Harvanta, and Requiem, which is a biological insecticide made from a unique synthesis of terpenes originally discovered in a Chenopodium plant, which causes degradation of soft insect cuticles (Table 1).

Control of potato aphids in fall tomatoes

Location:	Eastern Shore AREC, Painter, VA
Variety:	'BHN 602' medium round tomato
Transplant Date:	14 July 2014
Treatment Method:	All foliar treatments were applied with a 3-nozzle boom equipped with D3 spray tips and powered by a CO_2 backpack sprayer at 40psi delivering 38 GPA.
Experimental Design:	11 treatments arranged in a RCB design with 4 reps – 1 row x 20 ft on plastic mulch.
Foliar Treatment Date:	9 Oct

Table 1. Numbers of potato aphids on tomato leaves 1 and 2 weeks after application of various insecticides.

Treatment	Rate / Acre	Mean no. potato aphids / 10 compound leaves	
		16-Oct	21-Oct
Untreated check		39.5	12.8
Sivanto	7.5 fl. oz	1.5	1.8
Sivanto	10 fl. oz	2.0	0.0
Movento + Dynamic	5 fl. oz + 0.5% v/v	2.0	3.0
Closer + Dynamic	2 fl. oz + 0.5% v/v	0.3	2.5
Exirel + Dynamic	20.5 fl. oz + 0.5% v/v	2.3	0.0
Requiem	32 fl. oz	0.5	3.0
Harvanta 50SL	11 fl. oz	4.8	2.8
Harvanta 50SL	16.4 fl. oz	12.0	3.8

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

BEST USES OF BIOLOGICALS FOR INSECT AND MITE MANAGEMENT IN GREENHOUSES AND HIGH TUNNELS

Matthew S. Krause, PhD
Product Development Manager
BioWorks, Inc.
Victor, NY

Managing pests on edible crops in greenhouses and high tunnels is quite challenging. Growing environmental and food safety concerns, increasing resistance to chemical pesticides, and decreasing availability of effective chemistries continue to add more challenges. Fortunately, biologically based and less toxic tools and production practices have been developed in recent years that can help us to effectively address these challenges in conventional edible crop production.

This presentation will introduce biopesticides and how they you can use them with other tools (biological and chemical) and proactive approaches to build viable and effective insect and mite management programs. Among the concepts discussed will be:

- Types of biopesticide products and their modes of action
- Realistic expectations of biopesticides
- Compatibility and incompatibility
- Biopesticide best-use practices
- Developing your own *true* IPM programs with biopesticides.

BEST USES OF BIOLOGICALS FOR DISEASE MANAGEMENT IN GREENHOUSES AND HIGH TUNNELS

Matthew S. Krause, PhD
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Greenhouses and high tunnels are great environments for growing edible crops. These protected settings also offer ideal conditions for development and spread of pathogens that cause foliar, fruit and root diseases. Conventional chemistries continue to provide growers with effective means to manage plant diseases. However, growing concerns over food and environmental safety, development of fungicide-resistant or more-aggressive pathogens, and declining availability of safe and effective chemistries have made managing diseases on greenhouse and high-tunnel crops especially difficult. By taking a step back and approaching management of greenhouse and high-tunnel crop diseases from a more complete biological perspective, growers can integrate registered biological fungicides and best cultural practices into their existing programs to prevent major plant disease problems on their edible crops.

In this presentation, growers will learn about registered biologicals and how they can be used effectively with each other and with conventional chemistries against foliar, fruit and soilborne diseases in their operations. Concepts that will be discussed include:

- Types of registered biologicals and their modes of action
- Navigating the myths and realities of biologicals
- Strengths and limitations of biological disease-management products
- Best-use practices
- Developing proactive disease-management programs with biofungicides.

OBSERVATIONS FROM 2016 POTATO GROWING SEASON

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This is a brief summary of potato industry observations from 2016 with an update for potato growers to plan ahead for the 2017 growing season.

A Hot and Dry 2016 Growing Season! The major challenge of growing potatoes in Pennsylvania was the excessive heat that occurred during the past growing season. A combination of heat plus dry conditions in some areas was a double whammy at reducing tuber yield and quality. Potatoes are a cool season crop; ideal temperatures for crop growth are 65 to 80 during the day and 55 to 65 at night. Maximal tuber formation occurs at soil temperatures between 60° and 70°F. The tubers fail to form when the soil temperature reaches 80°F. If you look at daily high and low temperatures, much of Pennsylvania had night temperatures well above the 55 to 65 degree temperature range during June, July and August.

We also recognize maintaining uniform and adequate soil moisture is critical to producing an excellent potato crop. When a potato plant is stressed, even for only a few days, both yield and quality suffer. Heat and uneven soil moisture can cause serious problems for potato tubers. Second growth, tuber chaining, reduced specific gravity and reduced yield are some of the obvious disorders that show up in a year like 2016.

So how do we prepare for the 2017 potato growing season? Should we plant and harvest as early as possible in the season by growing an early season variety? Or do we plant as late as July and hope that growing conditions improve as temperatures begin to cool in the fall? Do we have enough water to meet the moisture needs of the potato plant as well as to provide some cooling of foliage and soil? These are difficult questions to answer. If our summers continue to heat up, we need to think about some of these options plus more to develop new cultural practices for growing potatoes in a warmer Pennsylvania.

Blackleg; is it *Dickeya dianthicola* or more? Most growers are familiar with blackleg, a bacterial disease that causes potato plant stems to rot from the seed piece up. During the last several growing seasons, some potato growers have seen symptoms in the field that seem to be more aggressive that the usual blackleg. Potato plants either failed to emerge or plants wilted because of stem rots, from the seed piece up. Yield losses were devastating in some fields and not at all present in other potato fields.

Understanding this bacterial pest is a high priority for the National Potato Council. Chris Ramage, a PhD. candidate in Penn State's Plant Pathology and Environmental Microbiology Department is focusing on identifying this complex of bacteria. Dr. Xinshun Qu, also in the same PSU Department, is working on identifying potato varieties that may have resistance to this disease. We will continue to collect suspect samples over the 2017 growing season to better understand and manage this pest.

More information can be obtained on this pest from Dr. Beth Gugino and her associates at: http://extension.psu.edu/plants/vegetable-fruit/news/2016/best-management-practices-for-soft-rot-associated-with-dickeya-in-potato-

Robert E. Leiby grew up on a Pennsylvania potato farm. After graduating from Delaware Valley College, he was hired by Penn State Cooperative Extension. He worked in Lehigh County as an agricultural agent and County Extension Director. Bob retired from Penn State Extension after 37 years of service. For the last four years he worked for Pennsylvania Co-Operative Potato Growers, Inc. as a potato crop consultant. He lives near Kutztown, PA, with his wife Jan Marie.

production-fields-in-the-northeast.

Potato growers purchasing certified seed potatoes for 2017 need to check with the supplier about the level of blackleg in the 2016 seed potato crop. Ask for the North American Certified Seed Potato Health Certificate in addition to the usual state certification tags and loading certificates that are provided with each lot of certified seed. This North American Certified Seed Potato Health Certificate will provide winter test reports and additional information to help determine your potential risk.

GMO Potatoes; Moving Ahead. Last year I talked about Simplot Innate Technology. Innate potatoes are genetically modified, however, they use only potato genes. There are no foreign or trans-species genes inserted into Innate potato DNA.

Innate 1.0 potatoes produce less black spot damage and have lower asparagine levels, as well as lower reducing sugars. Innate 2.0 features resistance to late blight and further reductions in both reducing sugars and asparagine levels.

Simplot will continue to work with select potato growers in 2017 to commercially grow Innate potatoes. Simplot is requiring growers to keep Innate potatoes segregated from conventional non-Innate potatoes. If you see the brand "White Russets" in the market place, those potatoes are the new Innate potatoes.

New technology is advancing rapidly and has potential to improve efficiencies and sustainability of potato production. Will consumers accept these potatoes in the marketplace? Wait and see. As consumers become more knowledgeable about this type of genetic engineering, I think they will accept it.

Par-Fry Potatoes; a Potential New Market for PA Potatoes. Fresh cut French fries have been growing in popularity in food service businesses. The par-fry process involves cutting tubers into fries, blanching them, slightly drying them, and partially frying them. These par-fried French fries are not frozen, but have a longer shelf life than fresh cut potatoes. PA Co-operative Potato Growers and Penn State worked together to screen and test potato varieties that have qualities that should perform well for par-frying. Norwis has performed fairly well for producing par-fry potatoes in Pennsylvania. We have identified several varieties that seem to perform well in this new category.

Easton, a long white processing potato developed by University of Maine, performed very well in northern Pennsylvania. In southeast Pennsylvania it does not produce a consistently uniform shaped tuber like we have seen in Erie County. We believe Easton has very good potential north of Interstate 80.

Dakota Trailblazer has been looking good in this category. It does not seem to do as well as Easton, but it may work for Pennsylvania growers looking for a russet-type potato. In 2016 PA Co-op Potato Growers and Penn State conducted some trials to study spacing and nitrogen rates on par fry varieties in PA. For more information contact rleiby@pacooppotatoes.com.

Creamers; More than Small Potatoes. While sales of fresh market potatoes have declined over the past few years, one category of potatoes has seen an uptick in sales; creamers. Creamers are potatoes that range from 3/4- inch to 1-5/8 inches in diameter.

Roadside marketers have noticed that these tiny tubers are popular and command a premium price. Creamers marketed in small packages or quart boxes are a popular choice for chefs and individuals who are looking for an attractive presentation on the plate. Reds, yellows, blues, fingerlings, small russets and even round whites are marketed in this category. Many commercial potato growers have ruled out trying to grow creamers since it is difficult to handle and harvest creamers without using hand labor or specialized harvesting equipment. Potato growers who want to use commercial harvesters would need to purchase specialized equipment to handle these miniature spuds. Growers who use potato diggers or lifters on small farms might find that creamers are a good source of extra income. A small, non-replicated, PA creamer trial in 2014 produced over 100 cwt. of creamers per acre in raised beds. Results of an expanded trial in 2015 produced closer to 200 cwt. per acre.

Creamers and specialty potatoes need to have bright, smooth skin with very little defects. Potatoes in this market

need to be nearly perfect. Consumers are buying a product that needs little preparation and looks beautiful on the dinner table. Red potatoes need to be bright red and not have dull gray silver scurf or Rhizoctonia. Appearance is more important than nearly any other factor when marketing these specialty potatoes.

Growing creamers in Pennsylvania requires a very different approach than normal potato production practices. Seed spacing is reduced to 5 or 6 inches between seed pieces. Nitrogen applications are reduced. The tops of the potato plants need to be killed while the potato plant is actively growing in the early part of the tuber bulking phase. Selecting a vine killing date is critical in harvesting a high-yielding creamer crop. Growers report there is only a 2 to 3 day vine killing window to produce a high yield and high quality creamer crop. It is important to select varieties that set a high number of tubers. This is in direct conflict with recent objectives of potato breeding programs which emphasized fewer larger tubers per plant.

PA Co-operative Potato Growers and Penn State are cooperating to continue research on specialty type potatoes. We hope to report some results at the 2018 Mid Atlantic Conference.

Potato Field Scouting. We now know that over 100 diseases may impact potatoes. Small critters like thrips, leafhoppers and aphids sometimes go undetected in potato fields. Frequent checking of potato fields can lead to discovering these pests and taking action before yield losses occur. In order to profitably grow high quality potatoes, growers need to ensure that their potato fields get scouted on a regular basis. Potatoes cannot be grown like other row crops that are planted, sprayed for weeds and then harvested. Careful management of pests plus irrigation management is critical to achieving a high quality, high yielding potato crop. If you have a crop consultant scouting your fields on a weekly basis, great. If not, designate an employee to learn how to recognize potato pests and check every field at least once a week.

Potato Rotations. Growers who have lengthened their potato crop rotations to more years out of potatoes see improved yield and quality. Growers who have land resources that allow potatoes to be grown on the same ground only once every five years are seeing improved tuber quality and yield. Swapping land with nearby farmers who don't grow potatoes can be a good way to plant potatoes on soil that has much less potato disease pressure that negatively impacts the potato crop.

Potato Trials. In 2016 a Potatoes USA/Snack Food Association chip potato variety trial was again planted at Benders Farms in Franklin County to compare some potential new chip varieties. Samples were evaluated for specific gravity and chip color at Utz Quality Foods and at Penn State's Chip Lab. You can request this chip potato variety research report by contacting rleiby@pacooppotatoes.com.

We continue to work closely with the Penn State Potato Program to identify new varieties that might work in Pennsylvania. Field testing continues on varieties that might chip, par-fry, or fit into table stock markets.

The *Pennsylvania Commercial Vegetable Guide* includes a list of recommended potato production practices and varieties. Limited space restricts me from including that list in this document. Potato variety trials conducted by Penn State's Xinshun Qu and Mike Peck provide an extremely valuable resource for potato growers. Pennsylvania potato growers should review the Pennsylvania Potato Research Report issued by these researchers each year. Review the information from multiple years to make sound variety selection decisions. At your request, I would be happy to forward you a copy of this report via email.

DICKEYA, AN EMERGING PATHOGEN ON POTATOES

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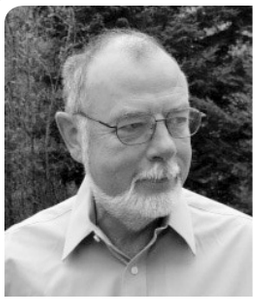
Severe stand losses and blackleg symptoms were present in number of states, including Maine, during the 2014, 2015, and again during the 2016 field season. Field symptoms included nonemergence, blackened stems, and plant wilting. Tuber breakdown in the field also occurs. Molecular analysis confirmed Dickeya dianthicola as the pathogen.

Dickeya dianthicola is a seed-transmitted pathogen and epidemics can initiate from very low inoculum levels, spread quickly and aggressively. Nonemergence is one symptom of Dickeya infection. Data from winter grow-out tests of potato seed lots showed an increase in nonemerged plants over recent years. It is probable Dickeya has been in the Maine seed system, albeit at low levels, for over 5 years. The pathogen may have been present and misidentified with symptoms attributed to unfavorable weather conditions. Warm conditions and excessive water favors the spread and development of Dickeya. One means of pathogen spread in seed lots may be physical transfer within and among seed lots during harvest. Without flushing infected seed lots, the disease will become an increasing problem to both potato seed growers and buyers.

Based on current research-based information, a set of best management practices for this emerging disease have been developed by Meg McGrath (Cornell) and Andy Wyenandt (Rutgers) with assistance from me, Kate Everts (University of Maryland), Beth Gugino (Penn State), and Nate Kleczewski (University of Delaware). They are as follows:

1. Select certified seed with negligible potential to be contaminated with Dickeya. This is best determined by talking with the seed grower about past occurrence on the farm and what is being done to manage it. There are growers who have not had Dickeya develop from their seed.
    a. Select seed from farms where the pathogen has not been detected and seed marketed in previous years was not associated with Dickeya developing where the seed was planted. Check Certificates before purchase to determine if the seed was increased in previous years on a farm where Dickeya has been detected and so is at risk for being contaminated.
    b. Select seed from farms where zero tolerance is being implemented.
    c. Select seed with zero blackleg levels reported on the North American Seed Potato Health Certificates or the Winter Grow Out Test results for presence of Dickeya in ANY seed lot from ANY source. Seed lots with field readings of blackleg present should have reports that suspect plant samples were taken for testing and found to be Dickeya free. Check Certificates before purchase and require a copy be provided for your records.
    d. Select seed that tested negative for Dickeya. Note that not detecting a pathogen in a sample of seed does not mean the pathogen is not present in the seedlot.
    e. Ask for 'references' to contact: potato growers who purchased their seed in 2016.



Dr. Steve Johnson is an Extension Professor and Extension Potato Specialist with the University of Maine where he has been employed for the past 28 years. Steve has a Ph.D. from the University of Florida, a M.S. degree from the University of Maine at Orono and a B.S. degree from the University of Wisconsin-Madison, all in plant pathology. His responsibilities in Maine are most aspects of potatoes with potato late blight occupying a major portion of his time. When the crop is not in the field, potato storage disorders are a focus of his efforts. Additionally, he works on garlic and barley.

f. Avoid seed lots that tested positive for Dickeya in previous years.

g. Avoid seed if its Certificate is unavailable. All certified seed has a Certificate.

h. Avoid seed from fields where symptoms of Dickeya were observed, even if affected plants were rogued out.

2. Request from supplier (directly from grower or broker) PCR testing for Dickeya dianthicola using an independent laboratory.

3. It is recommended that each truckload brought to a farm operation be sampled and re-tested for Dickeya once delivered. All results should be reported to your State Dept. of Agriculture or Potato Growers Association.

4. All equipment during seed piece cutting should be disinfested on a regular basis (at least daily), and also between lot numbers.

5. While it is recommended to rotate where potatoes are grown to manage most pathogens that can survive in unharvested tubers, this practice is not considered important for Dickeya because this pathogen does not readily spread in fields (thus a few tubers with Dickeya will not result in significant disease outbreak as can occur with late blight) and infected tubers are likely to rot while in soil.

6. Inspect fields for symptoms regularly, starting when skips and affected plants are readily visible. Examine the crop for unevenness (erratic growth) and plants that are unthrifty. Dickeya can be present in a plant affecting growth but not causing its typical blackleg symptom.

   Growers are encouraged to submit suspect samples for testing promptly to their local extension office in order to confirm Dickeya is the cause and to contribute to knowledge about Dickeya occurrence, and also to share their observations of Dickeya with the seed producer.

7. Avoid excess irrigation that results in standing water as Dickeya can move in this water. Note that surface irrigation water is not considered to be a possible source of Dickeya.

8. Do not apply copper or other fungicide for Dickeya. They are ineffective being unable to reach the pathogen, which is inside stems.

9. All growers are requested to share information about Dickeya occurrence and absence in their production fields. This information is needed to improve understanding about this disease. Include variety, lot number (North American Seed Certificate), field location, and testing results.

10. Dickeya has not been observed to continue developing in storage, which is as expected considering high temperatures are favorable, thus there are no management steps to implement after harvest for table-stock potatoes. However, it is prudent to make sure storages and pile temperatures remain cool, also reduce condensation and encourage airflow and exchange.

UPDATE ON INSECT MANAGEMENT IN POTATOES

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Wireworms

For potato growers in North America and Europe, wireworms can be very difficult pests to control. Wireworms are the subterranean larval stage of click beetles. In the Mid-Atlantic U.S., the cornfield wireworm, Melanotus communis, is the predominant species attacking potatoes. These insects can remain in the soil for several years attacking potato seed pieces or tubers or seeds and roots of other crops that are planted in the field. Wireworms can cause serious damage by tunneling into tubers, which reduces yield quality and creates entry points for certain plant pathogens that can rot the tuber. Wireworms are attracted to high moisture; and densities are often higher in low-lying portions of fields. Moreover, during extended hot, dry weather, wireworms may seek out the potato tubers for moisture in addition to food; exasperating the damage. Wireworm damage to potato tubers increases the longer tubers are left in the ground.

Because you are battling a subterranean insect that can remain in the soil for many years moving up and down in depth as the season progresses, the first step to controlling serious wireworm infestations is the use of a pre-plant or at-planting soil insecticide. Two organophosphates are stilled registered for control Mocap EC or 15G and Thimet 20G (in a LocknLoad) granular formulation. Other at-planting insecticide options for wireworms include Regent (fipronil), bifenthrin (Capture LFR, Bifenture, or Sniper), and any of the neonicotinoids (Admire Pro, Platinum, Belay, Brigadier) that are often applied preventatively to control Colorado potato beetle. All of these insecticides will reduce wireworm damage to tubers. Table 1 shows the results of an insecticide efficacy test that we conducted on the Eastern Shore of Virginia in 2016. In addition to controlling the main target, Colorado potato beetle, there was significantly less % wireworm damage to potato tubers as well from the at-planting applications of neonicotinoids such as Platinum, Brigadier, and Admire Pro.

Table 1. Summary of efficacy of at-planting neonicotinoid insecticides for the control of Colorado potato beetle and wireworms in potatoes; ESAREC, Painter, VA 2016

Treatment	Rate / acre	# CPB lrg larvae/10 stems 1 June (80 DAP)	% tubers at harvest (July) with wireworm or white grub damage
Untreated check		62.5	10.0 a
Brigadier (in furrow)	25.6 fl. oz	2.5	2.8 b
Platinum 75SG (in furrow)	2.67 oz	3.5	2.3 b
Admire Pro (in furrow)	8.7 fl. oz	10.8	3.5 b

All data were analyzed using analysis of variance procedures. Means were separated using Tukey's HSD at the 0.05 level of significance. Means followed by the same letter within a column are not significantly different (P>0.05).

Tom Kuhar is a Professor and Vegetable IPM Specialist in the Department of Entomology at Virginia Tech. Dr. Kuhar's research focuses on the ecology and integrated pest management of insect pests of potato and vegetable crops. He has published over 75 peer-reviewed papers and book chapters on insect pest management in agricultural crops and has given hundreds of presentations on the topic. He received his B.S. degree in biology from Towson, University, Towson, MD in 1992 and his Master's (1996) and Ph.D. (2000) degrees in entomology from Virginia Tech. He formerly worked as a postdoctoral research associate at Cornell University, Ithaca, NY researching alternative methods for managing vegetable pests. A native of Baltimore, MD, he and his wife, Stacey, who also works at Virginia Tech, have two children, Daniel (13) and Brianna (12). Outside of work, his passion is playing, watching, and coaching team sports like softball, basketball, and volleyball.

However, control failures may occur with any of those products under heavy pest pressure, or when wireworms do not move to seed-pieces early, but rather attack tubers late in the season. One strategy that has been proposed for supplemental (postplanting) control of wireworms is the use of foliar applications of the insecticide Movento, which is a two-way systemic insecticide that, when applied at flowering to potatoes @ 4-5 fl oz/A, has been shown to reduce wireworm damage to tubers in trials in the Pacific Northwest. We've been investigating this in Virginia over the past few years to determine if it is effective for control of our Melanotus wireworms.

On-farm trials with Movento foliar sprays for wireworm control

In 2013 and 2014 in eastern Virginia, we conducted on-farm trials. Growers applied their standard insecticides at-planting for the control of CPB and wireworms. On a 5 ac. section of a field, Movento + NIS @ 5 fl. oz /A was then applied as a foliar spray twice beginning at potato flowering. The remaining field was untreated. All fields were otherwise maintained according to standard commercial practices. At harvest, 500 tubers were collected in 5 areas of the untreated portion of the field and in 5 areas of the Movento-treated portion. All tubers were examined for wireworm and grub damage.

The experiment was conducted at 9 locations over the 2 years. We found that the Movento treatment significantly reduced wireworm damage in two of the seven fields. In one of the fields, the grower treated at planting with Platinum and had 17.8% tuber damage compared to 3% with Movento treatment. In the other field, under heavy wireworm pressure, the grower treated with both Mocap and Regent at planting and had 37% tuber damage compared to 1% in the Movento-treated potatoes. The remaining fields at very little damage, indicating that either the fields had low wireworm pressure or that the at-planting insecticide applications used by the growers were effective.

Potted potato plant Bioassay with Movento

- In Painter, VA in 2016, untreated 'Superior' potato plants close to flowering were dug from the field and placed in 5-gallon contractor buckets in a sand/soil mix on 20 May. A total of 6 buckets were set up (3 per treatment). Prior to treatments, 5 field-collected wireworms (Melatonus communis) were placed in each bucket and allowed to burrow into the soil.
- Beginning at flowering, half of the plants were treated and the other half were not. Movento 5 fl. oz / acre + Non-ionic surfactant @ 0.25% treatments were applied twice on 27 May and 10 Jun, and potato plants were placed outdoors and naturally irrigated. On 14 Jul, the number of tubers for each plant was recorded as well as total tuber weight in lbs. The number of wireworm damaged tubers was also recorded.
- There was a significant treatment effect. Each plant produced an average of 6 tubers in the buckets. Wireworm damage to tubers was reduced significantly with the foliar application of Movento +NIS.

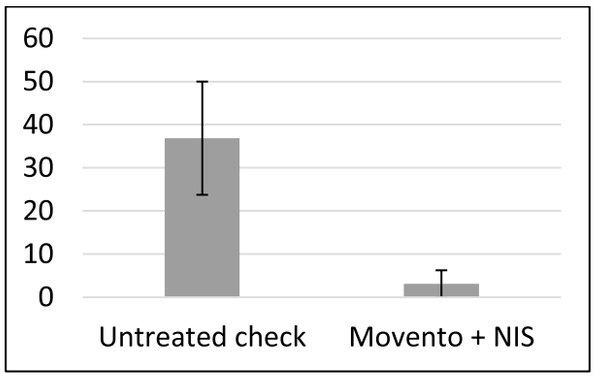

Fig. 1. Percentage of potato tubers with wireworm damage in a potted plant bioassay; Painter, VA 2016.

Alternatives to Neonicotinoids for Colorado potato beetle control

Colorado potato beetle remains the most important pest of potatoes in our region. Beetles emerge in the spring and seek out solanaceous plants like potato, eggplant, and tomato on which to feed and reproduce. Females deposit their bright yellow-colored egg masses on potato leaves beginning in May. The red-colored larvae that emerge from the

eggs can completely defoliate a potato plant if their densities are high enough or if the plant is small or not lush with growth. Since the mid-1990s, growers have primarily been using systemic neonicotinoid insecticides like imidacloprid (=Admire and Provado), thiamethoxam (Platinum & Actara), and others for control of this pest. However, insecticide resistance to neonicotinoids has appeared in various populations of CPB from the northeastern and North Central U.S. Managing neonicotinoid resistance in CPB through IPM practices and rotation of insecticide active ingredients is key to sustaining the long-term efficacy of these compounds for potato producers. Even on farms where CPB resistance to neonics has not been a problem, control of beetles later in the season is sometimes needed. In these instances, it is never good to follow an at-planting application of a neonic with a foliar application.

Fortunately, there are a number of effective non-neonicotinoid insecticides such as Verimark (cyazypyr), Radiant (spinetoram), Blackhawk (spinosad), Coragen (rynaypyr=chlorantraniliprole), Voliam Xpress (chlorantranilirpole + lambda-cyhalothrin), Rimon (novaluron), and Agri-Mek or AgriFlex (abamectin) that provide excellent control of CPB as well as other pests. Because small larvae are the easiest stage of CPB to kill, foliar insecticides should be targeted at about 25% egg hatch. In 2016 we evaluated the efficacy of the new product Trident, which contains the biological insecticide Btt and we evaluated the efficacy of Sivanto (flupyridifurone), a new insecticide subclass. All products significantly controlled CPB larvae (Table 1).

Table 1. Insecticide efficacy test conducted on 'Superior' potatoes planted in Painter, VA.

Treatment	Rate / acre	Mean # CPB larvae per 10 stems 2 June (9 DAT)
Untreated check	-	41.0 a
Trident	3 qts	0.0 b
Trident	6 qts	4.5 b
Blackhawk	3.3 oz	0.5 b
Sivanto	10.5 fl. oz	1.8 b
Sivanto	14 fl. oz	0.3 b

FERTILITY MANAGEMENT FOR POTATOES

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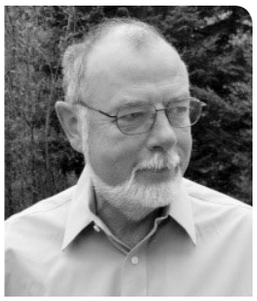
Nitrogen, potassium and phosphorus are essential macronutrients for potato growth. Triple 14 fertilizer contains N-P-K in the ratio of 14-14-14 on a percentage basis of N-P_2O_5-K_2O. Varieties vary, but a crop of 300 cwt of potato tubers and associated vines needs around 200 pounds of nitrogen, 30 to 45 pounds of P_2O_5, and up to 240 pounds of K_2O. Historic potato nutrient recommendations in Maine were designed to buildup soil cations. Target goals for the cation exchange capacity were 5% K, 15%, Mg, and 70% Ca. We have shifted to maintenance or crop removal based on economic efficiency. Potassium prices have significantly increased and research data from Maine showed no benefit to having more than 450 lbs/ac available K in the soil.

Nitrogen is an essential component of amino acids, which form proteins. Nitrogen is needed for chlorophyll synthesis, a component in energy systems. Nitrogen is either available or unavailable. The available portion of the nitrogen in soils is inorganic nitrogen. Mineralization is the process where microbial activity breaks down the organic nitrogen, making some of it available for plant growth. Immobilization is the process of inorganic nitrogen being converted to organic nitrogen. This effectively removes the nitrogen from available to unavailable status in the soil. Immobilization occurs when high carbon-to-nitrogen ratio crop residue is incorporated into the soil. If immobilization exceeds mineralization, there may be almost no nitrogen available for plant growth from the soil. If this occurs, there is a nitrogen depression period. Avoiding this is a main reason to have some starter fertilizer available near the plant roots. Incorporating plant residues well in advance to allow adequate decomposition will reduce the nitrogen depression period. The conversion of NH_4^+ to NO_3^- releases H^+ into the soil solution. This increases soil acidity. The NO_3^- ion is a factor associated with leaching of basic cations from the soil. As the NO_3^- ions leach, the Ca^{++}, Mg^{++} and K^+ move out, they are replaced with H^+, leading to increased soil acidity.

Some soils may contain a great deal of K^+ per acre. However, this does not mean that it is available to the plants. There is rarely more than five percent of the total K^+ that is plant available. In most soils, K^+ is available, slowly available, or most commonly, unavailable. Potassium is absorbed from the soil by plants in the form K^+. Potassium can be mobile in sandy soils or organic soils. Other than that, potassium is not very mobile in the soil solution, although water in the soil solution helps disperse potassium ions short distances. Proper placement of the started fertilizer is critical. If the roots don't grow into the potassium, it may not be available to the plant. With the root mass of potatoes contacting less than five percent of the soil, it is imperative to have the soil well supplied with potassium. Any reduction in root growth reduces potassium uptake.

Phosphorus plays a key role in energy transfer in plants. Energy storage and release through ATP (adenosine triphosphate) molecules requires phosphorus. Nucleic material, photosynthesis, and respiration require phosphorus. Cell division and expansion and other energy-intensive processes during growth require high concentrations of phosphorus. Soil phosphorus comes mainly from the weathering of apatite. As apatite breaks down, primary orthophosphate ion ($H_2PO_4^-$) and a secondary orthophosphate ion (HPO_4^{-2}) are formed. These ions are released into the soil solution and are absorbed by plant roots. The largest effect on soil phosphorus is soil pH. In acidic soils, phosphorus

Dr. Steve Johnson is an Extension Professor and Extension Potato Specialist with the University of Maine where he has been employed for the past 28 years. Steve has a Ph.D. from the University of Florida, a M.S. degree from the University of Maine at Orono and a B.S. degree from the University of Wisconsin-Madison, all in plant pathology. His responsibilities in Maine are most aspects of potatoes with potato late blight occupying a major portion of his time. When the crop is not in the field, potato storage disorders are a focus of his efforts. Additionally, he works on garlic and barley.



reacts with iron, manganese, or aluminum. This reaction fixes the phosphorus, making it unavailable to the plant. Most of these compounds formed are fixed or reverted and are not available to the plant. Clay will fix phosphorus so soils high in clay rapidly convert phosphorus to a form unavailable to plants. Anything that reduces aeration of soils, from compaction to excess water, reduces phosphorus availability in soils. Microbial breakdown of organic matter increases phosphorus to the soil solution. Ammonium (NH_4^+) in high concentrations slows phosphorus fixation reactions. In fact, Maine soils may have a half of ton of phosphorus per acre, almost all of it unavailable to plants. There is usually only about four pounds per acre of plant-available phosphorus in the soil solution at any one time. Obviously, the key to proper phosphorus fertilization is not the level of phosphorus in the soil, but the ability of the soil to replace the phosphorus the plant removes from the soil solution. This replacement may occur several times per day or hundreds of times during the growing season. In the plant, phosphorus is mobile, moving from older tissue to newer tissue. The highest levels of phosphorus are found in tissue at the growing point. Phosphorus is key in helping roots develop more rapidly and increase water use efficiency. Most phosphorus is absorbed by plants in the form of the primary orthophosphate ion ($H_2PO_4^-$) and, to a lesser extent, as the secondary orthophosphate ion (HPO_4^{-2}). In some cases, other forms of phosphorus are taken up, but to a much lesser extent than either of these two orthophosphate ions. Phosphorus is not mobile in soils. Little is lost to leaching. The majority of the phosphorus stays where it is put. Phosphorus moves by diffusion and is very dependent on soil moisture. It is very unlikely that phosphorus ¼ inch away from a potato root will move close enough to be taken up by the root. Phosphorus needs to be placed where the roots can intercept it. Soil erosion can remove phosphorus and has been a problem in some watersheds. Crop removal is the other major method of phosphorus removal from soils.

NEW IDEAS ON BRANDING AND MARKETING PA POTATOES

David Masser, Sterman Masser Potato Farms

The marketing of potatoes continues to advance along with many other items in the produce section. Potatoes have caught the attention of many foodies, as they are versatile, nutritious and a value meal choice. There are many areas that are rapidly changing in the potato category across the nation. We will discuss the category from an aggregate perspective based on relevant Nielsen data. Potato growers will need to continually invest in research for seed selection, varieties that meet the evolving consumer preference and grow well in Pennsylvania soils and climate.

Consumer preferences that are influencing the types of potatoes we market and promote include: red skinned varieties, russets, creamer size and convenience packaging for no hassle preparation. Additionally, external influences that are impacting the potato category include: the topic of food waste- consumers purchasing only what they need of for a meal; making multiple trips to buy fresh produce. Thus, smaller quantities of potatoes at a time. Food freedom- choosing to prepare potatoes differently (seasoning, preparation methods, etc), it is a trend in the food service industry, a great opportunity for the industry to demonstrate that potatoes can be used in lots of new and inspiring ways.

There is also a trend for smaller packaging. Some examples of new packaging, potato merchandising include various means to present the potato in eye catching packaging designs. These new design include steamables, flavorables and roastables. The packaging allows for consumer to see fresh potatoes, while at the same time providing convenience and easy in preparation. The potato category continues to be of interest and one of evolutionary change in the retail shelf space.

Dave Masser, President of Sterman Masser, Inc Dave is a native of the Tri-Valley region. He graduated from Tri-Valley High School in 1994, before attending Penn State University to earn a Bachelor of Science in Agricultural Systems Engineering. After leaving State College, Dave went to work for New Hollard North America as a test engineer. During this time, Sterman Masser underwent tremendous growth creating an opportunity for Dave to return to the family business in 1999. By joining the family business, Dave became the eight generation commitment to growing quality potatoes and feeding the world.

Dave is the President of Sterman Masser, Inc. Prior to this he served as Vice President of Sales and Marketing. Under this leadership the company has continued to grow and expand to meet the changing needs of the marketplace. He remains dedicated to the people, the community and customers served by focusing on the core values that have built the company.

Dave is a recognized leader in the produce industry. He currently serves as Chairman of the board for the Fresh Solutions Network; Vice-President of the Pennsylvania Potato Cooperative and President of the Tri-Valley Girls Softball Association.

Dave and his family live in Sacramento. He has two children Samantha and Maxwell. The family is active in their school, community and church. When Dave isn't spending time with family or friends, he can be found in the backyard trying out a new recipe on the grill.

WHAT'S NEW FROM CORNELL'S POTATO BREEDING PROGRAM?

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The Cornell potato breeding program seeks to serve the potato industry of NY and PA and neighboring states by developing new varieties that are adapted to the local environment and meet the evolving needs of growers, processors and consumers alike. The emphasis is to combine resistance to the golden nematode and scab with other attributes (e.g., yield, appearance, freedom from internal defects) needed in a successful variety. Primary market niches targeted by the program include round white varieties with resistance to low temperature sweetening and high dry matter for the chipping industry and round white and red-skinned cultivars for fresh market use.

Descriptions of our five most promising advanced clones follow below. Comments on the performance of these clones or any previously released Cornell varieties, or on desired attributes of future varieties are always welcome.

NY149 (F11-1) = Yukon Gold x Keuka Gold (2004). Mid-late season yellow-fleshed tablestock, with slightly-textured skin and pink eyes.

- In eleven Tompkins County, NY trials over five years, marketable yields averaged 84% of Atlantic.
- Wayne County, NY (muck soil) yield was 67% of Atlantic in 2011, 114% of Eva in 2015, and 100% of Eva in 2016.
- Yield on Long Island was 83% of Yukon Gold in 2011.
- Yield in PA was 118% of Atlantic in 2011 (1 trial) and 92% of Atlantic in 2015 (2 trials).

Tuber flesh color comparable to Yukon Gold, but tuber size is smaller. A low level of pickouts, mostly misshapes, have been observed. Generally free of internal defects. Low levels of hollow hear have been observed (much less than Yukon Gold). Specific gravity has averaged 0.012 less than Atlantic (11 trials). Moderately resistant to common scab. Tubers do not darken, and only exhibit slight sloughing, after boiling. Tuber dormancy is about 1 week longer than Atlantic. Resistant to race Ro1 of the golden nematode.

NY150 (F52-1) = NY121 x Jacqueline Lee (2004). Niche-market, early season tablestock. Produces many golf-ball sized tubers with bright white skin.

- In 17 Tompkins County, NY trials over the past seven years, yields of tubers between 1 and 1.875 inches averaged 167 cwt/acre, while yields of tubers between 1.875 and 2.5 inches in diameter averaged 149 cwt/acre. In the same trials yield of tubers greater than 2.5 inches averaged only 16 cwt/acre. For comparison, marketable yield of Atlantic (>1.875 inches) in the same trials averaged 400 cwt/acre.
- Yield in Wayne County, NY in 2014 was 128, 181 and 20 cwt/acre for the less than 2 inch, 2 to 3 inch, and greater than 3 inch size categories, respectively. Yield for the same size categories in a short 2015 season were 110, 35 and 0 cwt/acre. Yield in 2016 was 82, 18 and 0 cwt/acre, respectively.
- Yield on Long Island in 2014 was 63, 207 and 21 cwt/acre for the less than 2 inch, 2 to 2.5 inch, and greater than 2.5 inch size categories, respectively. Yield in 2015 was 75, 155 and 20 cwt/acre for the same size categories.

Walter De Jong is an Associate Professor in the Department of Plant Breeding and Genetics at Cornell University. At Cornell he oversees the applied potato breeding program and also conducts lab-based research aimed at identifying genes that control important potato traits. Prior to his arrival at Cornell in February 2000, Walter was a potato molecular geneticist at the Scottish Crop Research Institute in the UK. He received a PhD in Plant Pathology from the University of Wisconsin-Madison in 1994. He is a native of New Brunswick, Canada, where his father was a potato breeder with Agriculture and Agri-Food Canada. He is married to Darlene and has two daughters, Hannah and Amber.

- Yield in PA in 2013 averaged 143, 185 and 43 cwt/acre for the less than 1.875 inch, 1.875 to 2.5 inch, and greater than 2.5 inch size categories, respectively (2 trials). Yield in 2014 was 114, 159 and 93 cwt/acre for the same size categories. Yield in 2015 averaged 144, 150 and 26 cwt/acre (2 trials).

Few pickouts (mostly misshapes) or internal defects have been observed. Specific gravity has averaged 0.009 less than Atlantic (15 trials). Tubers do not darken or slough appreciably after boiling, and retain attractive appearance after long term storage. Very little skinning when harvested early (end of July). Tuber dormancy is about 2 weeks longer than Atlantic. Intermediate reaction to common scab. Resistant to potato virus Y. Exhibited some resistance to late blight in PA in 2012, 2013 and 2014. Resistant to race Ro1 of the golden nematode.

NY151 (G73-1) = NY121 x Salem (2005). Late season, white tablestock with uniform shape and relatively smooth skin.

- In 13 Tompkins County, NY trials over the past seven years, marketable yields averaged 104% of Atlantic.
- Yield in Wayne County, NY was 114% of Atlantic in 2014, 116% of Eva in 2015, and 106% of Eva in 2016.
- Yield on Long Island was 116% of Reba in 2011, 118% in 2012, 114% in 2014, 110% in 2015, and 121% of Reba in 2016.
- Yield in PA was 117% of Atlantic in 2011 (1 trial), 114% in 2012 (3 trials), 81% in 2014 (2 trials), and 105% of Atlantic in 2015 (1 trial).

In general, low levels of pickouts (mostly growth cracks) or internal defects (brown center) have been observed, although 23% brown center was observed in one trial in 2014. Specific gravity is low and has averaged 0.023 less than Atlantic (13 trials). Moderate resistance to common scab. Tubers do not darken or slough appreciably after boiling. Tuber dormancy is comparable to Atlantic. Resistant to race Ro1 of the golden nematode.

NY152 (H15-5) = B38-14 x Marcy (2006). Late season chipstock, excellent chip color. Slightly smaller than Snowden.

- In 11 Tompkins County trials over the past six years, marketable yields averaged 101% of Atlantic.
- Yield in PA was 106% of Atlantic in 2011 (1 trial).
- In trials in Wyoming and Steuben Counties, NY, yield averaged 97% of Atlantic in 2012, 133% in 2014, and 98% in 2015.
- Yield on Long Island was 164% of Reba in 2014.

Low levels of pickouts (growth cracks) and varying levels of hollow heart have been observed. Specific gravity has averaged 0.008 less than Atlantic (16 trials). Chip color from 44F storage in December, January and February (2011 crop season) averaged 3.0 compared to 4.0 for Snowden (lower is better). Chip color averaged 3.3 versus 3.7 for Snowden in 2012, 3.0 versus 4.7 for Snowden in 2013, 3.7 versus 4.0 for Snowden in 2014, and 3.2 vs 4.2 for Snowden in 2015. Moderate to good resistance to common scab. Tuber dormancy is about 4 weeks longer than Atlantic. May be resistant to potato virus Y. Susceptible to race Ro1 of the golden nematode.

NY157 (J105-10) = White Pearl x NY115 (2007). Mid-season chipstock.

- In nine Tompkins County, NY trials over the past five years, marketable yields averaged 92% of Atlantic.
- In trials in Wyoming and Steuben Counties, NY, yield averaged 100% of Atlantic in 2014, 87% of Atlantic in 2015, and 112% in 2016.
- On Long Island, yield was 114% of Reba in 2014, 88% of Reba in 2015, and 105% of Atlantic in 2016.
- Yield in Pennsylvania was 102% of Atlantic in 2015 (1 trial).

Low levels of pickouts (knobs, growth cracks) or internal defects (internal necrosis) have been observed. Specific gravity has averaged 0.006 less than Atlantic (15 trials). Chip color from 44F storage in December, January and February (2012 crop season) averaged 4.0 compared to 4.0 for Snowden (lower is better). Chip color averaged 3.7 vs 5.7 for Snowden in 2013, 3.0 versus 4.0 in 2014, and 3.2 vs 4.2 in 2015. Moderately resistant to common scab. Tuber dormancy is similar to Atlantic. Resistant to race Ro1 of the golden nematode.

COLORED POTATOES AND COLON CANCER

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Colon cancer kills over 50,000 Americans every year. Current chemopreventive/chemotherapeutic drugs have shown promising results against colon cancer, but these drugs carry significant negative side effects such as gastrointestinal toxicity. Hence there is a critical need to develop safe and efficacious alternatives. Emerging evidence suggests that naturally occurring anthocyanins, bright colored plant flavonoids, have chemopreventive effect against colon cancer in preclinical models and human studies. Large epidemiological studies conducted in Europe have shown that increased consumption of fruits and vegetables has been shown to be inversely associated with colon cancer risk. Additionally, a recent study in 2015 has shown that fruits and vegetable color groups rich in bioactive compounds is associated with lower risk of colon cancer. Thus, selecting staple crops where consumption is high and rich in color compounds – are ideal to develop food based cancer prevention strategies. Our studies demonstrated that anthocyanin-containing purple-fleshed potatoes (PP) can target colon cancer and reduce tumor incidence in an animal model of chemically-induced colon carcinogenesis. Our research group's goal for this research is that its successful completion can be expected to provide a strong evidence-based framework for future clinical evaluation of PP in colon cancer chemoprevention or treatment.

Importance of potatoes and consumption of colored potatoes

The year 2008 was declared as 'The International Year of the Potato' by United Nations in October 2007 to raise awareness of the potato in addressing nutritional issues of global concern, including hunger, poverty and threats to the environment (www.potato2008.org). The potato (*Solanum tuberosum* L.) is the world's 3rd largest food crop providing from 5% to 15% of dietary calories for various populations around the world. Potato is the leading vegetable crop in the United States with *per capita* consumption (predominantly white potatoes) of about 110 lbs annually. The high consumption makes potatoes as an attractive delivery vehicle for bioactive compounds because consumers are more likely to substitute white potatoes for color-fleshed potatoes with health benefits rather than replace potatoes in their diets. Moreover, color-fleshed potatoes are readily available and do not require any additional storage or processing conditions. The US Potato Board Report (2010), based on data from The NPD Group Inc. (formerly National Purchase Diary), stated that over the past ten years, while the consumption of traditional white potatoes (mashed, baked, fried, steamed, boiled and French fries) has been declining while specialty potato consumption increased by 17% – not including sweet potatoes.

Colon cancer

The colon tissue consists of thousands of "U" shaped crypts that carry out the function of absorbing water and minerals. In normal crypt, there is a balance between proliferation – cell division and apoptosis – cell death. However, when the cell genetics are changed – as a result of errors that occur as cells divide or because of damage to DNA caused by certain environmental exposures – it results in loss of this balance leading to increased proliferation (cell growth) and reduced apoptosis (cell death). When it comes to cancer it is not only proliferation and apoptosis but

Our previous work published have shown that even after processing colored potatoes retain anthocyanins and exhibits anti-cancer effect against early and advanced human colon cancer cell lines. Based on this evidence we conducted a study to determine whether supplementation of purple-fleshed potatoes in mice with colon cancer will lead to reduced tumors. Mice were fed with modified diet containing human relevant doses of purple-fleshed potatoes (20% w/w) for 4 weeks. Purple-fleshed potato reduced tumor number by more than 50% compared to mice that were not fed potatoes. PP was able to target multiple hallmarks of cancer. PP supplemented animals were more active, healthy had reduced toxicity compared to animals supplemented with chemotherapeutic drugs.

Venkata Charepalli is a doctoral student at the department of food science in Penn State University working under the supervision of Jairam K.P. Vanamala. He is originally from India and his research is primarily focused on developing food-based approaches for prevention of chronic diseases. He has his B.S., degree in Biotechnology from India and his M.S. in Biochemistry from the Colorado State University.

multiple pathways. Hence to simplify, the hallmarks of cancer was constituted for rationalizing the complexities of the disease. These include – uncontrolled division of cells, evading immune system, spreading to other sites, creating their own blood vessels. Current chemotherapies are designed to target only one or two of these hallmarks in some cases multiple combination of drugs are used. This results in significant toxicity. Additionally, these therapies are expensive costing approximately 150,000 per person per year. Hence there is a growing interest in a food based approach that targets multiple hallmarks and has no or little toxicity

Colored potatoes against colon cancer

Our previous work published have shown that even after processing colored potatoes retain anthocyanins and exhibits anti-cancer effect against early and advanced human colon cancer cell lines. Based on this evidence we conducted a study to determine whether supplementation of purple-fleshed potatoes in mice with colon cancer will lead to reduced tumors. Mice were fed with modified diet containing human relevant doses of purple-fleshed potatoes (20% w/w) for 4 weeks. Purple-fleshed potato reduced tumor number by more than 50% compared to mice that were not fed potatoes. PP was able to target multiple hallmarks of cancer. PP supplemented animals were more active, healthy had reduced toxicity compared to animals supplemented with chemotherapeutic drugs.

NUTRIENT MANAGEMENT AND FERTIGATION PROGRAMS FOR CUT FLOWERS

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Field grown cut flowers are gaining in popularity. As always, you will want to look for the most efficient and cost effective fertilizer program that matches your water, crop, and soil type. Using the following tools will give you an excellent crop, and save you time and money as well.

Where to start:
The key to any successful fertilizer program is getting your water tested first. Having your water tested by a reputable horticulture lab in December or January will get you off on the right foot. Once you have a current water test, talk to a technical rep, fertilizer supplier, or extension agent about how to proceed. You will also need to think about your space and the needs of your crops. Remember, everyone's water is different. Just because a fertilizer works for your neighbor doesn't mean it will work for you.

Look at your water test for the following items: pH, alkalinity, calcium, magnesium, sodium and chloride. If you have low alkalinity water with little calcium and magnesium, a neutral or basic fertilizer is a better option. You will also need a fertilizer with some calcium and magnesium. If you have high alkalinity you will need an acidic fertilizer, also you depending on fertilizer delivered Calcium decreases. High alkalinity can cause a gradual increase in media pH, and you may need to consider acidification with a mineral acid. I like sulfuric acid, it is cost effective, easy to source, and adds much needed sulfur.

In the case of field grown cut flowers, a soil test is imperative. You need to know what nutrients are lacking, so you can add back in what is needed and the correct amounts. Make sure you also get a pH reading, a soil pH to high or low can lock out nutrients to the plant. A pH between 5.8-6.2 will give you the best nutrient availability. If you need to increase your soil pH apply Dolomitic limestone, to decrease pH apply Elemental Sulfur.

Armed with these series of results you can then decide on a fertilizer program. A combo of pre-plant and drip delivered fertilizers will give you the best results. You can choose which way of application is best for your operation. These methods include row applications, broadcast, sidedress and using water soluble nutrients through drip lines.

Annual Crops
For annual cut flowers like snapdragons, zinnia, and sunflowers you will want to have nitrogen readily available to feed the vegetative growth of the plant. Each time you cut a stem, you will need to boost N to push more vegetative growth, before a new flower will form. Doing this with a water soluble fertilizer like a 25-5-15 or 20-10-20 through the drip line will deliver the nutrients need immediately to the plant

Perennial crops
For perennial cut flowers, like peonies, fertilizer must be available for early spring growth. Most growers will apply an application of a granular or slow release fertilizer after dormancy. Then the plant will have a reserve if fertilizer to pull from when it breaks dormancy. A second application can be applied after green-up.

Nutrient Requirements
There are three main groups of nutrient requirements based on amount of nitrogen needed.

Krystal Snyder, the Technical Specialist at JR Peters, is only a phone call away to walk you through your laboratory results and provide you with answers about your mix or if you need help with another fix on the Jack's Professional line. Since she was young she considered herself a serious plant nerd, which led her to Delaware Valley College, where she made it official by earning a B.S. in Horticulture. When she is not helping customers fix their plants or creating her own outdoor oasis, Krystal can be found restoring her century old house in Easton, PA, with her handyman husband Justin, daughters Alexia & Lucy, and their two crazy Australian cattle dogs.

Low Nitrogen (1.0-1.5 lbs/1000 sqft)	Medium Nitrogen (1.5-2.0 lbs/1000 sqft)	High Nitrogen (2.0-3.0 lbs/1000 sqft)
Allium	Ageratum	Alstromeria
Delphinum	Celosia	Chrysanthemum
Foxglove	Amaranth	Aster
Achiella	Dahlia	Gerbera
Aquilegia	Strawflower	Ranunculus
Cornflower	Lisianthus	Rudbeckia
Echinacea	Poppy	
Gladiolus	Scabiosa	
Lavender	Dianthus	
Veronica	German Statice	

SELLING SPECIALTY CUT FLOWERS TO FLORISTS

Dave Delbo
Dave's Flowers, 189 Southern Drive, Catawissa, PA 17820

Pros and cons

There are numerous pros and cons in selling flowers to florists. In my experience, the pros easily outweigh the cons. I have been extremely lucky and have dealt with florists that love locally grown flowers. In over 20 years, and probably close to 80 or more florists, I was only turned away from one florist who was not interested in purchasing flowers from me. In my opinion, some of the reasons to sell to florists are most of them are willing to pay for quality flowers. They have been receiving lower quality flowers from wholesale florists for so long that they really love locally grown flowers and will pay a fair price for them. Most shops are busy enough that you will have guaranteed sales every week if you have flowers. You can cut straight from the field and bunch in the field as long as you have high quality flowers. No additional time spent making mixed bouquets for farmer's market, plus this gives you another outlet to sell flowers besides the market.

Some of the cons in selling to florists include usually having to drive to the florist to deliver. This can sometimes be many miles and over an hour or more of your time. Also, florists are a dying industry. There just are not as many as there used to be and business is declining in many of the stores that are surviving. Also, florists require certain colored flowers for a specific date which may be hard for you to guarantee the florist that you will have them. Also, there are more people growing flowers and trying to sell to florists.

Before approaching a florist

Before approaching a retail florist, you should have a large supply and variety of flowers. You want to make a great impression when they first meet you. The flowers must be of the highest quality and preferably long stemmed. Do not let the flowers get to far open before cutting. Learn the proper stage to cut the flowers that you are growing. Sunflowers and lilies should be cut before they open to avoid damage to the petals, while stock and snapdragons need to be more open before they are cut. Most of the flowers will need to be bunched. But how? Some flowers are sold by the stem, some in bunches of 5, bunches of ten stems are used for many flowers, and even some things are sold by the "growers bunch", which is basically a handful.

How to approach florists

There is no "right" or "wrong" way to approach florists. Some growers try to meet the florist in the winter to gauge their interest and find out what to grow for them. Some send out emails or make phone calls to get orders and then deliver. I don't do that. I cut my flowers Sunday night, load the truck with fresh cut flowers, drive to the florist, ask to see the owner or manager and show them the truckload of flowers. The flowers will sell themselves. Another option is to take a large sampling of flowers into the florist the first time and just give them to the florist. They will see the quality is superior to shipped in material and buy from you the next week. If possible, go to larger cities. They will have more florists who are usually busier which equals more money for you.

How to keep them buying

Once you make that initial sale, you want to keep their business. To do this, you must prove to be reliable. Let them know that you will be back the same day the following week. Show up at approximately the same time every week. You will want to have a constant supply of flowers every week. Don't promise them a certain flower if you are not sure it will be blooming and ready to cut. Also, do not be pushy. Realize that the summer months are extremely slow for florists. And if you do receive a complaint, make it right even if it wasn't your fault.

Dave Delbo is co-owner of Dave's Flowers, located in Catawissa and Elysburg PA. He has been growing cut flowers for over 30 years. Dave's Flowers grows between 4 and 5 acres of specialty cut flowers selling to over 40 florists and 1 wholesale florist in eastern Pennsylvania. Dave lives in Catawissa, PA with his wife, Alicia, and two children, Greg, 19, and Jess, 15.

Invoicing and payment

I started out just using a carbon sales pad. Worked for many years. About 4 years ago, I bought a laptop, mobile printer and quickbooks. This is much easier for bookkeeping and tax time. Florists vary in their types of payment. Some may pay cash for small purchases, some will write a check every week. Some like to pay once a month. You will have to be flexible with payments. Be careful not to let any open balance get too high. You may even find a florist that would use a credit card. The square credit card reader is great for accepting credit cards. And make sure the florist fills out your states tax exemption form.

My top 10 selling flowers to florists

#1 Sunflowers

#2 Lilies

#3 Lisianthus

#4 Eucalyptus

#5 Celosia

#6 Statice

#7 Asters

#8 Gladiolus

#9 Snaps

#10 Sorghum/broomcorn

Other flowers

Other flowers that I sell to florists include calla lilies, larkspur, sweet William/dianthus, sedum, zinnias, stock, flowering cabbage, delphinium, to list just a few. There are many flowers that I do not grow that would be good sellers to florists. These include peonies, dahlias, sweet peas, willows, hydrangeas, ranunculus, anemones, and mums.

PERENNIALS AS SPECIALTY CUT FLOWERS-

Sinclair Adam saa19@psu.edu

Growers of specialty cut flowers have the opportunity to take advantage of local markets. The cut flower grower is responsible for the first stages of postharvest treatment, and should use the correct procedures for each species individually. Proper post-harvest physiology management puts a high quality product in the consumer's hands, and this will result in a positive perception by the consumer. Choices of cultivars should reflect the vase life quality as well as an appealing color selection. Growing realities should be attended to properly to attain a high quality product along with post harvest considerations. Yields should be tracked year to year with perennial species, as they are multi-year crops. If anything is below the standards for production, yield will be adversely affected. Such considerations as watering, fertility, and temperature, if not at optimum will affect yield. Plants that are over fertilized will have reduced vase life. Insect and disease pressures will also reduce yields. Some perennial species of flowers are better produced under cover, particularly a consideration with *Lillium* cultivars. Particular attention should be paid to harvesting the flowers. Planning should be scheduled to avoid temperature and moisture stress. Dark colored flowers can be ten degrees (F) warmer than lighter colors, most growers will harvest in the late afternoon, or early morning. In the morning, flower stems are fully hydrated, and temperatures are low. In the afternoon, the buildup of carbohydrates is highest from the day's photosynthetic production, but temperatures are higher. Considerations such as packing, grading, and shipping may dictate the time of day for optimum harvest, but each selection of species or cultivar may require an individual handling protocol. One of the most important considerations is temperature, and a cooler is required for many selections of cut flowers. Both water temperature and air temperature need to be managed by the grower for successful production. Ethylene sensitive plants need to be held in a cool well-ventilated area away from aging flowers.

Genus	Species	Harvest	Vase Life
1) *Achillea*	several	when pollen is visible	7-12
2) *Aconitum*	*napellus*	when 1-3 basal flowers open	7-10
3) *Agastache*	several	2/3 open	6-10
4) *Allium*	several	½ open	@14
5) *Alstroemeria*	several	pull stems @first flowers colored	10-14
6) *Anemone*	*coronaria*	cut at bud stage	4-6
7) *Artemesia*	several	when buds elongate (dried)	
8) *Asclepias*	*tuberosa*	½-2/3 open	8-10
9) *Aster*	several	¼ open	5-7
10) *Astilbe*	several	½-3/4 open	2-5
11) *Astrantia*	*major*	upper flowers open	5-7
12) *Baptesia*	*australis*	1/3 open	7-10
13) *Buddleia*	*davidii*	½ open	7-10
14) *Campanula*	several	1-2 flrs open/stem	8-16
15) *Centaurea*	several	½-3/4 open	7-10
16) *Coreopsis*	several	when starting to open	7-10

Sinclair Adam is a Penn State Extension Educator in Horticulture, and Penn State Flower Trials Director. He holds a B.S. in Plant and Soil Science from Univ. of Wyoming, and a M.S. in Plant and Soil Science from the Univ. of Vermont. Sinclair has been an Adjunct Professor at Univ. of Vermont, a Senior Lecturer at Temple University, a Research Fellow at Temple University, and has taught at the Barnes Foundation. Sinclair has also served in the horticultural industry for over 30 years, and holds 15 plant patents on Phlox, Tiarella, and Chrysanthemum selections.

Genus	Species	Harvest	Vase Life
17) *Crocosmia*	several	@first few flowers open	7-10
18) *Dahlia*	several	75% open	7-10
19) *Delphinium*	several	¼-1/3 open	6-8
20) *Dianthus*	several	10-20% open	7-10
21) *Digitalis*	several	2-3 lower flowers open	7
22) *Echinacea*	several	when petals expand	7-10
23) *Echinops*	*bannaticus*	½-3/4 color	6-12
24) *Eremurus*	several	bottom flowers colored	3 weeks
25) *Eryngium*	*planum*	when flower head turns blue	10-12
26) *Gypsophila*	*paniculata*	80% open-local 30%-shipping	3-5
27) *Helleborus*	*orientalis*	when stamens are visible	10-14
28) *Hypericum*	several	when fruit is colored	9-14
29) *Iris*	several	½" colored tip	3-6
30) *Kniphofia*	several	bottom florets open	6-8
31) *Liatris*	several	when 3-4 flowers open	7-12
32) *Lillium*	many	when flowers are colored	5-9
33) *Limonium*	several	80% open	10-14
34) *Lobelia*	several	1/3 open	8-10
35) *Monarda*	several	when colored	8-10
36) *Narcissus*	several	when still closed color showing	4-6
37) *Paeonia*	several	color showing	5-10
38) *Papaver*	*nudicaule*	colored bud stage	5-7
39) *Phlox*	*paniculata*	when 2 flowers open	5-7
40) *Physostegia*	*virginiana*	when spikes fully elongated	6-10
41) *Platycodon*	*grandiflorus*	2-3 flowers open	5-8
42) *Salvia*	*leucantha*	when petals emerge from calyx	7-8
43) *Scabiosa*	*caucasica*	when color appears	5-8
44) *Solidago*	several	½ open	5-6
45) *Thalictrum*	several	flowers mostly open	4-6
46) *Tiarella*	several	½ open	6-8
47) *Verbena*	*bonariensis*	when flowers mostly open	7-10
48) *Veronica*	several	1/3-1/2 open	7-8
49) *Veronicastrum*	*virginicum*	1/3 open	5-10
50) *Zantedeschia*	several	almost fully open	7-20

MAXIMIZING PROFIT IN DIRECT MARKETING WITH CUT FLOWERS

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Cut flowers can significantly increase farm income from a direct retail market. Flowers are attractive, colorful and draw customers closer to your booth, tent, display or store. It is a fact that customers will always pay more for what they want (e.g., flowers or alcohol) than what they need (e.g., vegetables or water). Therefore, the first step in maximizing profit in a direct market with cut flowers is knowing what the customer *wants*.

Following the Market

What are the trends in your market location? What types of things do your customers value the most? Which holidays do they celebrate? Do they seem to prefer large, showy displays, or are they more interested in a high-end, elegant style of product? What do they value? What do they want to get as a result of a flower purchase? Whatever the case, first identify what they are looking for and then look for ways to meet that demand in a way that is still economically feasible for you. Avoid trying to compete with the international cut flower market and their low prices. Chose flowers that will grow well in your region and that customers will identify as your local product.

Keep in mind that customers will not only be buying the product itself, but also the experience of buying the product. It is a possibility that this is the one product they will buy from you that they are planning to give away as a gift; and they may need more guidance in knowing what to choose. Anything you can do to assist them (in a time-efficient manner for you) can increase income. Consider posting signage with tips, such as a list of birth-month flowers if you grow some of the species, or even a color chart to help people choose which colors or flowers represent certain sentiments. Consider offering small cards they can write out. Educating the customer, even in small ways, will enhance their purchasing experience. The cut flower customer's experience should always include 1) high-quality customer service; 2) an attractive presentation and, 3) appropriate pricing for the value of both the product and experience.

Adding Value

You may see some farms selling flowers as single stems for the customer to arrange, others selling groupings of the same species (non-mixed bunches) and others selling mixed bouquets. Since a mixed bouquet is considered a value-added product and always leads to a more attractive display it is likely the best option for a retail farm market. This is true as long as the bouquet appears professional, fresh and clean. If no one in your business has experience creating mixed bouquets it is not hard to learn the basic principles. Even taking a half-day design class or watching a video can assist you in improving the appearance of a mixed bunch once the basic principles are followed. Selling single-stems will only work if the customer already knows well how to create their own bunch. Selling a grouping of one type of flower, such as 5 or 10 sunflowers, may be good enough, but will not set your display apart from your competition. Finishing touches, such as wrapping the product in a sleeve with a farm logo sticker and packet of floral preservative will increase perceived value.

Jenny Carleo, is a County Agent in the Department of Agriculture and Natural Resources, Rutgers Cooperative Extension. After receiving her Bachelor's in Agricultural Science and Master's in Plant Biology from Rutgers, Jenny began working for Rutgers Cooperative Extension in 2003. Since then her efforts have been concentrated in the areas of specialty crops and business management. Jenny's commercial experience with cut flowers began in 1995 while working for a florist. That experience enabled her to see cut flowers from a customer perspective when later growing them for a commercial farm and selling them at the Greenmarket in New York City. Jenny enjoys conducting field research on specialty crops such as flowers and small fruits that are important crops for local growers.

Post-Harvest Care

The freshness of a flower begins to decline the moment it is harvested. Flowers are extremely delicate, but there are some actions that can be taken in order to ensure your customer gets the most out of their purchase:

1) Cleanliness

   All harvest tools, buckets and water should be cleaned at least daily. This will prevent post-harvest bacteria and fungi from degrading the crop prematurely.

2) Maintaining a Cold-chain

   Keeping the flowers cool and out of sunlight will also help prolong their freshness. Cut flowers should be harvested very early in the morning but after dew dries. Field-heat should be removed immediately. Refrigeration when not on display can make a huge difference in flower quality in the 4-10 days post-harvest. Investigate the optimal post-harvest handling, temperature and storage methods for each species you intend to plant and follow the recommendations as closely as possible.

3) Processing Techniques

   Stripping the leaves off the lower portion of the stems will prevent decay from keeping them out of the water but will also reduce plant transpiration. Although a normal function of plants, once a stem is harvested transpiration will cause the crop to decline faster, as well as wilt or dehydrate if not kept to a minimum.

4) Using Preservative

   Floral preservative reduces bacterial and fungal pathogens in the harvest and holding water. It also prevents new pathogens from developing and provides a food source for the crop. There are many do-it-yourself recipes available for floral preservatives, but I do not recommend them since the professional ones are more consistent and highly effective.

Selling cut flowers in a retail setting can increase income from the flowers as well as enhance the appearance of your market to the customer which can increase sales of your other farm products. As for any crop, first knowing the market demands is key. By learning and following a few standard practices on flower harvesting and handling you will be able to comfortably stand by your product for many days after the customer brings it home or gives it to a friend.

MANAGING EXCESS OR SHORTAGE OF PRODUCE IN A CSA MARKETING OPERATION

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Introduction:
Community Supported Agriculture (CSA) markets can provide many benefits to both the farmer and consumer. On-farm direct marketing businesses contribute to and support the local economy. CSA's also develop a connection between farms and the local community members. Farmers can provide a fresh, affordable, nutritious and local food source. They also provide members with a sense of control over their family's food. This is a growing concern for many families due to food safety issues or personal preferences. In turn, members have the opportunity to learn about agricultural production. These interactions help to build stronger communities through farm and family connections. In order to keep connections strong, the farmer must be able to deliver what is promised. In some years, there is excess produce from the fields when all goes well. What can be done if there is a shortage or an excess? This topic will be discussed below.

Planning for the CSA Season:
Farming is a risky business. There are many factors that will determine yield outcome for the season. Proper planning is important and takes much thought, even for the experienced farmer. Knowing past yields, ordering seed and setting up field plans for the coming season can be calculated for the number of CSA customers the farm plans to accept. When setting up your membership contract, list the types, frequency and amounts of produce for each share to help manage customer expectations.

Shortage:
In some seasons, unexpected shortages may occur. Be sure to include a statement in the membership contract to address what will occur with shares when a shortage occurs. Be sure to stipulate what factors can cause a shortage. Members may be upset about not receiving what they expected, however if it is spelled out in the contract, they will be aware ahead of time.

Reasons for not being able to deliver enough produce could be from many factors. Generally, poor weather conditions that decrease yields, or even wipe out the entire crop can occur. Flooding rains, hail storms or damaging winds can devastate crops. Damaging weather generally also increases disease pressure to crops that survive the storms. Some storms that travel up the coast can also bring increased insect pressure that may hinder production. Additionally, every now and then a new insect pest is discovered that may or may not be controlled with current crop protection products. Besides insects, crops can be severely damaged or lost from deer, geese or other animal damage in the field. On some, but thankfully rare occasion, theft may take place and crops can be lost. Another unanticipated disaster could arise from fire or other accidents on the farm. Fire in buildings could destroy much needed production equipment, packing facilities or marketing areas. Accidents that result in farmer or worker injury would greatly disrupt the ability to produce, care for and harvest crops. Labor shortage is a reality in the agricultural industry, especially in the produce sector where skilled hand labor is a necessity.

Michelle Infante-Casella is an Agricultural Agent and Associate Professor, since 1996, with Rutgers NJ Agricultural Experiment Station, Cooperative Extension, in Gloucester County, NJ. She is responsible for vegetable production and marketing as well as field crops in Gloucester County. She is the chairperson of the Rutgers NJAES Agritourism Working Group. This group conducts education and research programs for farmers with on-farm direct marketing operations. Michelle is the NJ State PDP Coordinator for the U.S.D.A. Sustainable Agriculture Research and Education Program. She also serves on the National Association of County Agricultural Agents, Sustainable Agriculture National Committee. She has a Bachelors Degree in Horticulture from Delaware Valley University and a Masters in Plant Science from Virginia Tech. Originally from Monmouth County, NJ, Michelle and her husband Ben reside in Gloucester County, NJ and have two sons.

As the farm owner/operator what can you do to improve relations with members in times of produce shortage? First, before the shortage occurs, keep good communications with your members and make sure they fully understand the contract for shares. Educate members about how produce is grown on the farm. Make them aware of how rewarding it is to produce a successful crop, but also that some factors are beyond the control of the farmer. When factors prevent the crop from being available, explain the reasons why. Try to continue providing what is available to the membership; any surviving crops, or any value added products you included in shares. If supply is disrupted for only a short time, notify members when regular supply will become available. If economics allow, perhaps substituting some products from nearby farms may be an alternative. However, be sure to be honest with members about outsourcing products, and be sure to not lose more profit than is manageable.

Again addressing all the possible scenarios where shares would be reduced or unavailable due to unforeseen incidents, should be spelled out in the CSA membership contract. Since shortages are not planned and usually the result of factors not easily controlled, good communication, on a timely basis, will help to explain why members will not receive the anticipated shares.

Excess:
Having excess produce sounds like a much better situation than having a shortage. However, it still needs to be managed. Managing an excess of produce may be as easy as letting the field go and tilling the produce into the soil. However, if another option exists there may be a chance for profit or good will. In most cases, the excess produce may not be in great volume.

Remember selling your excess produce wholesale, even on a small scale, will require grading and packaging that may not be the norm for CSA shares. Local restaurants, other farm markets, "mom and pop" stores, or local tail gate markets may be an option for sales of extra supply. Most stores and restaurants could already have a steady and reliable supply of produce. Therefore, these markets may not be easy to enter on an infrequent basis. Also, remember your costs for harvest, grading, packaging and delivery to evaluate if these occasional sales are worth the effort.

One option that may not take much more effort is to offer the excess to your current CSA members. Consider the consequences before choosing this option. Was there a shortage at any time during the current season, and offering the excess would help make up for the past loss? If not, providing overages may "spoil" your members and make them accustom to expecting extra in the future. Think carefully about the outcomes of providing extra produce.

Extra produce can also be made into value-added products for future use. If the product would make for good jam, juice, sauces or other canned/frozen product, think about those options. Again, be sure to do a cost/profit analysis to see if this option is economical.

Another popular option, to utilize extra produce, is through donations to food banks or food pantries. Paying for labor to harvest for donation can be costly. However, utilizing a volunteer gleaning groups, and possibly the CSA members, can bring good will and community support to your business. Local churches, youth organizations, and even corporate businesses often have service groups looking to volunteer in the community. Setting up donation site contacts ahead of time, in order to make for timely actions when produce is of good quality for use, is important. Many times, charitable organizations will also provide a receipt that can be used as a tax deduction.

References:
Bamka, W. and S. Komar. 2012. Community Supported Agriculture: A Farmer's Overview. Rutgers NJAES Cooperative Extension Fact Sheet 1174. pp. 3. http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1174

INCORPORATING VALUE ADDED PRODUCTS FOR CSA MARKETING

Stephen Komar, Rutgers Cooperative Extension

Northeastern farmers are confronted with many challenges including high land prices, reduced farmland availability and increased production costs. In order to remain economically viable, some farmers have focused on producing high value agricultural commodities or adopting alternative marketing methods. Many farmers across the Northeast have focused their marketing efforts towards the increasing urban and suburban populations. One successful marketing technique is the Community Supported Agriculture (CSA) system. The CSA system has similarities to road side markets and farmer's markets, and therefore may be a practical transition to farmers with retail marketing experience.

Although several variations exist, the basic premise of a CSA is mutual risk taking and production support by both consumers and the farmer. In return for their investment or subscription CSA members receive a portion of the harvest during the growing season. On a weekly basis, or another arranged time line, members receive a diverse supply of fresh, quality produce. By participating in a CSA members also share the season's production risks such as insect pests, diseases and weather problems which could possibly reduce yields. Typically, a CSA farm will sell individual "shares" in the farming operation's harvest with yield being distributed on a per-share basis.

The concept of a CSA is believed to have been brought to the United States from Switzerland in 1984 and first implemented in the northeastern United States in 1986. While this strategy was designed to promote a relationship between the farming and non-farming communities, it is quickly becoming an economically viable alternative to traditional direct-marketing strategies.

There are many possible variations of the CSA model. However, CSAs generally fall into one of two distinct types based on the person or entity responsible for the management of the operation. These include; farmer (producer) managed and shareholder (consumer) managed CSA's. Each CSA farm sets prices, products to be grown, weekly delivery or pick up day and time. Example CSA types include:

Farmer Directed CSA: This CSA type places the management and organizational responsibilities on the farmer. The farmer is responsible for the day-to-day management decisions, as well as, promoting the CSA to potential customers, managing pick-up or delivery of the produce and communicating with shareholders. Managing a CSA properly can take considerable time and effort, often making it difficult for some farms to operate. As a result, a hybrid farmer directed CSA has been developed where multiple farms each contribute a portion of their products to the CSA. This arrangement, often called a cooperative CSA, provides the structure for multiple farms to share CSA responsibilities while providing more product diversity for the shareholders.

Shareholder CSA: This type of CSA places organizational responsibilities on a group of consumers rather than on the farmer. A shareholder CSA is often managed by a "core group" such as a non-profit or community organization who handles all of the organizational

responsibilities of the CSA. This group hires a farmer to produce the products that the shareholders want to be included in the shares and will have input into many of the farming decisions including; varieties, production methods and distribution. This type of CSA is popular with groups that share similar values such as organic production, grass-fed or specially fed livestock or locally grown production.

Stephen Komar, Associate Professor, County Agent II, Department of Agriculture and Resource Management. Komar provides education related to crop production, nutrient management and innovative agri-business ventures including value-added production and agritourism risk management. Prior to his employment with Rutgers, Komar worked as a cotton and peanut agronomist with The University of Georgia Cooperative Extension. He graduated from The University of Tennessee with degrees in Soil Science, Plant Science, and Crop Physiology and Post-Harvest Ecology.

Advantages to the farmer include:

- Since members purchase CSA shares at the beginning of the season, farmers have an assured market and income, enabling them to focus on producing high quality food and practicing good land stewardship
- Production risk is shared with CSA members
- Potential for up front capital to purchase seed, fertilizer and other inputs at the start of the growing season
- Opportunity to educate consumers about the risk factors and other issues related to food production
- Easier business planning since yield is not the primary factor in sales.

Variations on the CSA Model:

One of the most popular benefits of a CSA is the personal relationship that is developed between the consumer and farmer. Many CSA farms invite shareholders to visit the farm throughout the season to follow the crops progress or to participate in some of the day-to-day activities on the farm. These activities can provide a great educational opportunity for consumers and helps promote local agriculture.

CSAs offer a new alternative to consumers interested in supporting local agriculture. As this marketing alternative gains in popularity, more and more farms are offering CSAs in the region. In recent years, variations of the CSA model have been employed. On relatively new concept is the addition of value-added products to traditional CSA offerings. Products such as jellies and jams, value-added meat products, packaged bird seed and many others have all allowed producers the opportunity to further market their farms, while providing additional revenues, season extension and additional opportunities to promote the value-added offerings of local agricultural producers. This alternative model allows for greater product diversity and provides opportunities for collaboration and cross-marketing with other farming operations.

PRODUCT CONTACT SURFACE SANITATION FOR DIRECT MARKETERS

Meredith Melendez, County Agent
Rutgers NJAES Cooperative Extension

There are many ways that product contact surfaces can come to harbor human pathogens. Normal production of fresh produce involves the potential for contact with soil, farm workers, harvest and packing equipment, irrigation water and postharvest water to name a few. Once contaminated these items, considered food contact surfaces, can spread the pathogen onto the produce that it touches. Contact surfaces vary from farm to farm, the easiest way to identify them is to trace produce from the field to the sales location identifying each surface along the way. Direct marketers need to consider the potential risk with pick-your-own containers, product displays, and shopping containers and bags. Product contact surfaces must be washed, rinsed and sanitized regularly to reduce the likelihood of human pathogen contamination. Surfaces that come in contact with produce must be easy to assess for cleanliness, easy to clean and easy to sanitize. This may require you to take apart the equipment, particularly if conveyers, rollers or brushes are components.

Human pathogens, such as *E. coli*, Salmonella and Listeria, can grow on surfaces when the environmental conditions are appropriate. These pathogens thrive, and reproduce, in moist conditions. Smooth surfaces are much easier to clean than rough surfaces, and wood cannot be sanitized. Keep in mind that even stainless steel surfaces can harbor pathogens if not cleaned and sanitized properly. A regular cleaning schedule must be developed utilizing appropriate cleaners and sanitizers. Standard operating procedures (SOPs), or detailed instructions, must be written and posted describing how and when the cleaning and sanitizing produces will take place.

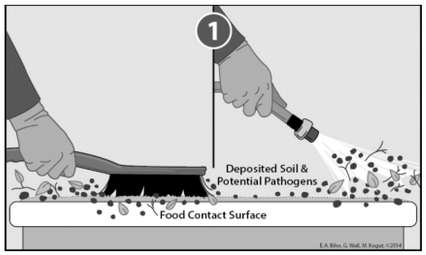
Picking a sanitize

There are many sanitizers available on the market for use, including approved for organic use sanitizers. Options include chlorine, peroxyacetic acid, quaternary ammonium, hydrogen peroxide and others. Using too little of a sanitizer is ineffective, and too much of a sanitizer can cause damage to the surface you are cleaning. Consideration should be given to compatibility of the surface to be sanitized with the sanitizer. Incompatibility can reduce the effectiveness of the sanitizer and degrade the surface. This is also true for the detergent used to clean the surface. Label instructions should give guidance on what detergents are acceptable for the sanitizer. Be sure to read labels of the sanitizers, often available online, prior to purchase. Each sanitizer will have its own instructions for use, which can vary considerably.

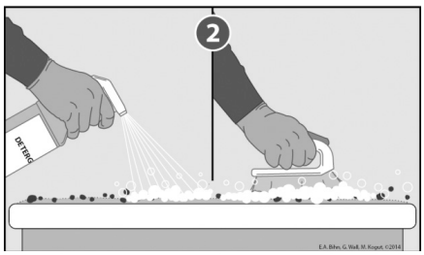
What is proper cleaning and sanitization of product contact surfaces?

Cleaning is the removal of dirt from surfaces which uses clean water and detergent. Sanitizing is the treatment of a cleaned surface to reduce or eliminate microorganisms. Dirty surfaces cannot be sanitized, the soil can render the sanitizer ineffective. Cleaning must take place before sanitization. Always use clean water that is free from generic *E. coli* for all cleaning and sanitizing steps.

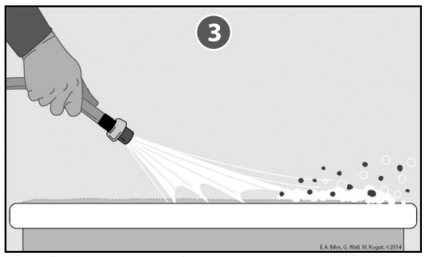
Meredith Melendez is the Agricultural Agent for Rutgers Cooperative Extension of Mercer County. She has worked for Rutgers Cooperative Extension since 2006, working with Mercer County agricultural producers since 2010. Meredith is responsible for agricultural edcuational outreach and research in Mercer County. Her research areas include beginning farmer outreach, organic production systems and on-farm food safety. Meredith is a member of the Rutgers On-Farm Food Safety Team, the New Jersey Food Safety Task Force, the Rutgers Vegetable Working Group, the NJAES Agritourism Working Group and Annie's Project NJ. She has a Bachelors Degree in Plant Science from Ferrum College and a Masters in Environmental Conservation Education from New York University. Originally from and residing in Burlington County, NJ Meredith and her husband Elias have two sons, Nathan and Mathew.



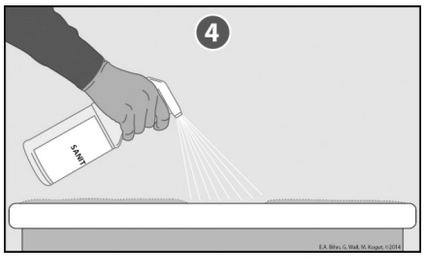
Step 1: Remove any obvious dirt and debris from the food contact surface.



2: Apply an appropriate detergent and scrub the surface.



Step 3: Rinse the surface with clean water, making sure to remove all of the detergent and soil



Step 4: Apply a sanitizer approved for use on food contact surfaces. Rinsing may be necessary Let the surface air dry

Critical points to consider:

- Only use sanitizers that are approved for food contact surfaces, and follow the label directions exactly.
- Develop a regular cleaning schedule with a written SOP detailing the products used, how they are used, and the steps involved in cleaning and sanitizing the surfaces. Daily sanitizing is best!
- Utilize smooth surfaces that cannot absorb water as your product contact surfaces, wood can be covered with linoleum or painted with food grade paint.
- Avoid cracks and crevices in your packing areas, these are difficult to clean and sanitize.
- Train workers annually on Worker Health and Hygiene, including proper handwashing.
- Train workers annually on the importance of sanitation and the farms developed SOPs.
- Workers must wear clean clothing daily.
- When gloves are used workers must be trained on how to use them so they do not become a contamination source.
- Remove surface moisture in the packinghouse/area whenever possible using squeegees and fans.
- Remove culls from the packing area daily so they do not become an attractant for wildlife.
- Utilize a pest control program in the packing and storage areas, focusing on rodents and other wildlife intrusions.
- Remove as much soil as possible from produce in the field, not in the packing area.
- Use new containers or containers that can be cleaned and/or sanitized to pack and display produce.
- Storage areas and coolers should be monitored for cleanliness, and be included in the rodent control program.

Resources:

Sanitation and Postharvest Handling. National Good Agricultural Practices Program, Cornell University. 2016. https://gaps.cornell.edu/educational-materials/decision-trees/sanitation-and-postharvest-handling

Small Scale Postharvest Handling Practices. University of California, Davis. 2003. http://ucce.ucdavis.edu/files/datastore/234-1450.pdf

*Photos curtesy of the Produce Safety Alliance

PROS AND CONS OF OPERATING A CSA AND MY EXPERIENCES

Robert Muth, Muth Family Farm

My Experience with CSA

My wife and I own and manage Muth Family Farm in Williamstown, NJ. Our farm totals 118 acres with 90 of them tillable. Thirty five acres have been certified organic since 2001. We ran a very successful organic CSA on that land for fifteen years. In 2016, we switched over to a farm stand, utilizing our existing customer base. Over the years we have continued to grow for the wholesale market with long established accounts in NJ, PA and New England.

Our venture with CSA started in 2001 with 25 members. We offered a simple boxed share at that time, with half of the members picking up at the farm and half at drop points. We discontinued the drop points after a couple of years and switched over to a mix and match system with pick up solely on the farm. Retention rates were much higher because members could pick out exactly what they wanted. We set limits when an item was in short supply or to make sure there would be enough to last throughout the day. Our membership increased to 400, with a waiting list, and we maintained that number for the next 12 years. Having a loyal, local customer base made the CSA experience very rewarding and positive.

CSA is frequently touted as the best marketing strategy for beginning or start-up farmers. I respectfully disagree. If you are a beginner, take time to answer the following questions:

1. Can you confidently grow 25 to 30 different crops, planting in succession for a 16 to 26 week season?
2. Is your land really ready to grow? Soil fertility and PH can be adjusted quickly and easily. Building organic matter will take much more time and effort. Bear in mind that good soil husbandry will allow you to grow good crops while others are experiencing failure.
3. Have you implemented steps to reduce weed and disease pressure via crop rotation and resting land?
4. Is your labor supply proficient and reliable?
5. Do you have water for irrigation? Both quantity and quality is important. You may have to grow solely with irrigation during an extended dry period.
6. Have you invested in weather protection such as tall tunnels to ward off damage due to hail and excessively wet weather?
7. When scouting, can you recognize pests, diseases and weeds at the very early stages so that controls can be applied in timely fashion?
8. Have you erected deer fencing? Can you trap wood chucks and raccoons at will?

Here are some other points that I've learned over the years:

Try to have at least 10-15 items each week. People will put up with less diversity for a week or two, but after that some will complain. You will be harvesting every week. You must plant every week, even during extended wet periods. Try to keep purchased products of things you don't grow. Display them on a separate table with signage that lets people know who grew them. People do really want to know who grew their food and whether it's from out-of-state. Don't run your CSA pick-up by treating people like cattle being herded down a chute. Give people time to converse and choose what they want. Meet & greet people are essential. Have people there to re-stock and keep an eye on things. Don't ever leave the pick-up area unattended! Unfortunately, there are people who will take advantage of the situation if you do. Harvesting for a mix and match system is always a guessing game. If you have under-harvested for one or more items, you need to pick more - fast! Members that pick up early in the day will talk with members that pick up later. Make sure there is enough to go around. If you over-harvest, move the surplus to the wholesale market or donate to charity. Display citations or awards from your charitable food donations or anything else you think may interest

your members. CSA's are either 100% organic or 100% conventional. Don't run a CSA that does both. It will lead to much confusion for your members. In my opinion, hail storms *do not* relieve you of your responsibility to grow. Shut the CSA down, clean up and replant; Offer to extend the season so members get what they paid for. Consumers nowadays are very savvy. You can fool most initially with a slick website with lots of "eye wash". So while an attractive website is good to have, it doesn't take the place of having good product. Ultimately, at the end of the season, your growing skills will be judged. Did you deliver on what you said you would grow? If you were constantly experiencing crop losses, many members will begin to look elsewhere. A successful CSA requires that you need to attract and retain a customer base. Retention rates lower than 50% should serve as a wake-up call!

SEED TO SALE: GROWER PANEL ON ALL-SEASON PLASTICULTURE LETTUCE PRODUCTION

Michael Brownback, Spiral Path Farm

Lettuce is one the most eaten vegetables and most households make weekly purchases. This creates an opportunity for growers who can overcome the challenges of the weather in our region to provide the market with consistent supply and quality. The use of plastic in lettuce production can help with our cold Spring, hot Summer and cool Fall weather.

Transplant production is the preferred method of starting lettuce for us. A potting soil with enough nutrition to get the transplants to maturity without supplemental feeding should be the goal. We usually figure about 4 weeks from seeding to transplanting with the earliest waves, late March to mid April for us needing to be hardened before being transplanted outside. As the season progresses and the greenhouse temperatures climb, lettuce can be more challenging to start. We use our germination chamber not for it's warmth but for the cooler temperature because of being totally shaded and insulated. The lettuce pops fairly rapidly this way. We find it essential to not hold these summer seeded plugs too long in their cells because longer days to transplanting hasten the bolting risk.

Transplanting in the field is accomplished on raised beds with a plastic type appropriate to the time of season. We start with green IRT plastic and transition to black and then white plastic as the season heats up. The holes are punched with a 3 hole punch spaced at 12 inches between holes with watered added. Drip tape must be placed to miss the punches and we use double drip most of the time We also use row covers for the earliest plantings in hopes of getting into the market earlier. Spring is the best and most consistent season for lettuce production. The leaf lettuces, Greenleaf, Red leaf, Romaine and Butter heads are much more reliable for us if we end the deal by the beginning of July. The new multi leaf varieties are more bolt resistant but the seed is expensive and the types are non traditional compared to the standard varieties. We use the multileaf types for cutting into a salad mix product. This requires a denser planting scheme 6 inch instead of 12 . There is also a need for washing and packing this lettuce and this increases the chance of retailers requiring food safety certification.

The standard leaf lettuce is cut and field packed when mature. We receive this lettuce at the pack house and promptly water the lettuce down thoroughly, palletize and then cool as rapidly as possible with forced air until the lettuce pulps at 35 degrees. We prefer to cut and ship to order.

Lettuce can be a profitable item for the grower who is able to provide their customers with a consistent supply.

Mike Brownback along with his wife, Terra, own and operate Spiral Path Farm - a certified organic vegetable farm in Perry County, PA since 1978. They are both first generation farmers. Today, two grown sons, Will and Lucas, both farm with the family on 255 certified organic acres; about 80 acres in produce, 4 acres under high tunnel vegetable production and 13,000 square feet of transplant production for on- farm use. Spiral Path Farm employs about 40 in peak of season. Organic Produce is marketed via wholesale, CSA Members, and Farmer's markets.

MUD, WATER, TUBS AND SANITIZERS: SAFE WASHING OF LEAFY GREENS

Lee Stivers
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This presentation is based on a new Penn State Extension farm food safety video series for fruit and vegetable growers seeking more detailed information on farm food safety of harvested crops. The "Using Sanitizers in Wash Water" series is designed for farmers and others involved in the post-harvest handling and washing of fresh produce. Developed by Dr. Luke LaBorde, Associate Professor of Food Science, and Lee Stivers, Extension Educator in Horticulture, the videos address food safety considerations for complying with the Food Safety Modernization Act (FSMA) and Good Agricultural Practices (GAP) standards. View the video series at:

http://extension.psu.edu/food/safety/farm/gaps/video-series-washwater-sanitation

Like the video series, this presentation will provide recommendations for best practices so that produce handlers understand the potential risks and how to minimize those risks through proper washing and use of wash water sanitizers. We will focus on how to use these best practices in the production, harvesting, and washing of leafy green vegetables.

Reasons for Washing Leafy Greens: Whether you are selling direct at farm markets, produce auctions or to a retail food store, you already know that your customers are more likely to buy fruits and vegetables that look clean, wholesome and nutritious. Leafy greens that are muddy or dusty will not do as well in the marketplace, so leafy greens growers frequently wash these vegetables before sending them to market. But does washing after harvest make leafy greens safer to eat? Only if you take the proper steps to ensure that they do not become contaminated or cross-contaminated with harmful microbes that can cause food-borne illnesses.

Safe, potable water (no detectable E. coli) must be used when washing any fresh produce. Proper washing steps for leafy greens include 1) removing visible soil deposits; 2) washing with water, and 3) drying. We wash with water to dislodge and carry away any soil on the surface of the leafy greens. Depending on the type of wash system used, we may need to add a sanitizer to the wash water. The purpose of adding sanitizer is not to surface sterilize each individual leaf; this is an impossible task. Instead, we add sanitizer to the water to kill any pathogenic microbes that may be washed off of a small number of contaminated leaves before they are able to cross-contaminate nearby leaves, especially when the leafy greens are immersed in a tank.

It is very important to dry produce after washing, especially leafy greens. If we don't remove most of the surface moisture from the leaves, then both harmful and spoilage microbes can grow, decreasing shelf-life and possibly making the vegetables unsafe to eat. A practical way to dry leafy greens after washing is to run them through a centrifuge—like a large salad spinner—to spin out extra moisture. Commercial centrifuges are available for purchase, and some innovative growers have even converted washing machines into leafy greens spinners.

For any type of washing system, it is critically important to clean and sanitize the wash tanks at the end of the day. Otherwise, a biofilm of bacterial growth can form on any of these surfaces, and become a source of harmful bacteria that may contaminate batches of leafy greens. After each washing, drain the tank, scrub it clean with a scrub brush, apply a sanitizer, and then let it air dry completely. The same applies to centrifuge buckets.

Lee Stivers has been a horticulture educator with Penn State Extension in Washington County since 2001. She is a member of Penn State Extension's Statewide Horticulture Extension Team, specializing in vegetables, greenhouse production, and wine grapes. Prior to moving to Pennsylvania, Lee worked for Cornell Cooperative Extension and the University of California, Davis, where she received her Masters degree in 1989.

Types of Wash Systems: Leafy greens are typically washed either using spray wash systems or immersion systems. In a spray wash system, produce is sprayed from water from above as it sits on a screen or moves along a belt. If the water passes over the produce only once, and then drains away, the risk of cross-contamination is low, and the use of sanitizer is optional. If the water is recirculated, for example to save water, then a sanitizer must be added to the wash water. Immersion systems include any kind of tank washing where the produce is submerged in the wash water. The tank may be as small as a plastic tub, or as large as a dump tank or flume. All immersion systems require the use of a sanitizer in the wash water, because of the risk of cross-contamination in the tank. Triple sink wash systems, commonly used for commercial ready-to-eat vegetables are a very effective method for cleaning leafy greens. These can be set up as a combination of spray wash (first sink) and immersion (second and third sink) systems. In this case, only the second and third sinks require the addition of sanitizer, and the lowest concentration can be used in the third sink to minimize any aromas or off-flavors in the final product.

Correct Use of Sanitizers: When using sanitizers in produce wash systems, you must only use sanitizer products that have been approved by EPA for washing fruits and vegetables. Check the label for an EPA registration number and directions for use. The most common wash water sanitizers are formulations of chlorine; chlorine dioxide; and peroxyacetic acid, alone or in combination with hydrogen peroxide. Each of these sanitizer types has different chemical and physical properties that are important to understand when choosing the right sanitizer for your operation. For example, chlorine is very sensitive to pH and to organic matter in the wash water. Monitoring chlorine activity and pH during the washing process assures that the sanitizer is still effective in killing microbes in the wash water.

More information can be found at the Penn State Farm Food Safety website:

http://extension.psu.edu/food/safety/farm

SPINACH PRODUCTION

Michael Brownback, Spiral Path Farm

Spinach is a crop in high demand and has the potential for high volume sales. However, Spinach also demands a lot from a grower's perspective and can be challenging to produce especially with the weather conditions we have in the mid Atlantic region. There are two types of Spinach that we currently grow on our farm. The first type is bunching Spinach and the other type is baby Spinach.

Bunching Spinach is a crop for us in south central Pa. that does best in early Spring. We focus on bunching Spinach as one of our earliest crops. There are two basic types of Spinach that are accepted and expected by the markets. One is Savoy, which has a more crinkly leaf and the other is Smooth leaf. There are also semi Savoy types that we have used with success. Spinach varieties are always changing so it's best to talk with your seed rep to find the most up to date variety. We seed the Spinach in the green house as early as late January in plug trays. We like 200 cell trays to save room and also to have a transplant that pulls within a short time in order to get the plants in the field as early as mid March. Spinach is very hardy and will come up with almost no supplemental heat but will germinate and emerge more uniformly and rapidly with 60 degree minimum heat. We have also had success laying flats out directly on the soil in unheated houses and covering with a row cover. The flats can freeze solid and we still get transplants. Spinach likes a high quality potting soil with adequate amounts of nitrogen. If transplants do not stay dark green, they probably need supplemental feeding or are being overwatered. By mid march with the unheated greenhouse method or sooner with heat the plugs should pull and be ready to plant outside. The ideal transplant should be short but pull and be more than able to take the wind. If a heated green house is used, hardening off the transplants is essential before the plants hit the reality of early Spring.

We use black plastic mulch on raised beds for the Spinach and punch 4 rows 6 inches apart. When transplanting this early, we rarely lay drip tape but punch the holes with water to make sure the transplants take. The Spinach will start slowly for a few weeks but as soon as the plants take, they usually grow rapidly. By early to mid May, the Spinach should be ready to harvest for bunching. Spinach has a distinct tap root and this should be cut with a knife right below the plant. Cut enough plants to make an appropriate bunch and either rubber band the bunch or use twist ties. Ties can be branded and also have the UPC and PLU numbers if being sold to a retailer. It is important to get the field heat out of the Spinach post harvest. We hydrate and top ice over paper all incoming Greens. Early bunching Spinach is a fairly easy and dependable crop but it must be harvested when ready. Spinach will bolt rapidly as the heat increases and needs an attentive grower. White plastic can help prolong the harvest season by a couple of weeks but on our farm we use Spinach as a quick hitter that starts the season until there are crops that are easier to harvest.

Baby Spinach is a crop with a large market opportunity but the degree of difficulty increases especially in the warmer seasons. We have grown baby spinach outside for years with inconsistent results and have not been able to become reasonably dependable growers until we started producing in high tunnels. We currently use 9 high tunnels that average 16,000 square feet each to grow a variety of baby greens, Spinach having the highest demand by far. I would not recommend producing baby Spinach without GAP certification as Spinach has a reputation of being risky from a food safety standpoint. In my opinion, the soil fertility methods used in growing baby greens have a major impact on the safety of the crop. We use compost made on our farm that contains no animal manure. We add fertilizer inputs based on soil tests and use a vegetable source of nitrogen. The tunnels also have a cover crop grown in the fallow season which for us is July and August.

The criteria for variety selection in baby Spinach is in my opinion, more important than for bunching Spinach.

Mike Brownback along with his wife, Terra, own and operate Spiral Path Farm - a certified organic vegetable farm in Perry County, PA since 1978. They are both first generation farmers. Today, two grown sons, Will and Lucas, both farm with the family on 255 certified organic acres; about 80 acres in produce, 4 acres under high tunnel vegetable production and 13,000 square feet of transplant production for on- farm use. Spiral Path Farm employs about 40 in peak of season. Organic Produce is marketed via wholesale, CSA Members, and Farmer's markets.

These stands are dense and the need for plants that stay upright for ease of harvest are critical to successful production. We build 6 raised beds per house that are about 4 foot wide. We seed using a Sutton electrical seeder that must be calibrated to achieve the desired stand. I hesitate to give a strong recommendation on population because we are always tweaking but the stand should be adequate to completely cover the bed at maturity and this takes some trial and error. We are currently using the variety Ashley from Seedway but it is being discontinued. It is imperative to do trials and find the varieties that work for you. Even when you have a good variety, you still need to trial. We seed about a quarter to a half inch deep in soil that needs to be not too dry and certainly not too wet. After seeding, we use an overhead watering system on a timer to get the moisture right for germination. We like just enough water to facilitate germination and then emergence and no more. One of the hardest parts of successful baby Spinach production is getting the water right. This why we have gone under cover in tunnels and why it is so difficult to consistently produce baby Spinach in our region. it rains normally. The cooler desert regions of the country have an advantage in this but we have proximity to major markets. As the Spinach grows, the importance of proper watering does not diminish and it doesn't take too many overwaterings to yellow and ruin a crop. Assuming the crop has matured to harvest age, approximately 30-35 days Spring and Fall it is time to harvest. We had harvested for years by hand with the gloves on but when we built the tunnels, we made the decision to go with a tractor mounted mechanical harvester. With a tractor driver and one harvester we can harvest a house of baby Spinach rapidly. We have a reefer truck cooled and ready to receive the crop and as soon as it reaches the packing shed, use fans to cool the Spinach down to the low 30's rapidly. The Spinach is inspected on a line before being washed and dried and then packed either for our CSA or clam shelled for the retail market.

We look at growing baby greens as a way to extend our season and thus providing cash flow for a longer part of the year. baby Spinach has become an important crop for us even though it requires perseverance.

GROCERY E-COMMERCE AND ONLINE SALES

George Latella
Professor of Food Marketing, Saint Joseph's University

"Bricks and Clicks" is a relatively new phenomenon that is affecting many of our lives directly and indirectly as consumers and stakeholders in the Food value chain. While e-commerce only represents a few percentage points of the overall food retail business, it is growing exponentially, especially with Millennials. However, everyone that has access to a smart phone, tablet, or laptop is impacting this business. For many years we have always said that "The Consumer is King" and now this is true. Consumer Behavior continues to change at a rapid pace.

Who we communicate with, When, Where, Why and How are all impacting operational and marketing decisions for companies. Because of this "connected" consumer, we need to be on "24/7, 365 days a year". Perception is Reality.

This presentation will examine this topic and provide some best in class examples of how large and small companies are taking advantage of technology. While larger companies still have scale on their side, smaller companies are able to compete by "looking" larger than they are. Digital technology is the great equalizer here. So there are advantages to "Operating Big and Thinking Small", as well as "Operating Small and Thinking Big".

The playing field is now level and the balance of power is shifting to those companies that understand who their consumer is and what problems they solve for their target market.

George Latella is a Visiting Professor in the Department of Food Marketing. He has taught in the food marketing program for 25 years at undergraduate and graduate levels, including classes in marketing strategy, customer and consumer behavior, communications, trade promotions, brand strategy, Sales, Supply Chain and Retail Food Marketing. He has received three Teaching Excellence awards. He was also recently voted the number one professor by students in the Haub School of Business at SJU. He has spoken at numerous conventions, and currently writes about Food Marketing Strategy for Heady Times.
He is Senior Vice President of Business Development for Beacon Marketing Group, which provides strategic solutions for companies through marketing planning, direct marketing, e-Commerce, and quantitative research.
He previously served with the Tasty Baking Company for 23 years, holding several director level positions in the company's sales and marketing executive departments under three different management teams. Over his career there, his responsibilities included: P&L responsibility for all chain accounts in all classes of trade; new business development, where he developed a "go to market" strategy for DSD; national sales accounts and new business development, which included expansion into Walmart and other leading retailers across the U.S.; customer relations and e-commerce, which included development of a sales planning model/B2C and B2B via the internet and direct marketing; and marketing, which touched on all day to day aspects of the company's marketing efforts.
Mr. Latella earned a BS in Marketing from Drexel University and an MBA in Marketing from Saint Joseph's University.
He can be reached at glatella@sju.edu or 610-660-2254.

GROWING RHUBARB BEST PRACTICES

Nate Nourse
Nourse Farms
41 River Road, South Deerfield Ma 01373

A staple vegetable in New England gardens and farms from Colonial times, the demand for the crop is as strong as ever. Rhubarb acreage has declined, plantings aren't being replaced. The fabled tough and resilient plant has difficulty getting established and is susceptible to Phytophthora root rot. We used to plant it on heavier soils that weren't well drained and it thrived. Heavier soils with high organic matter produced abundant crops for years. Now, it struggles on our best soils. The one part of rhubarb production that hasn't struggled is its price, $3-$5 per pound is common

The Fundamentals

Rhubarb likes cooler, well drained soils with a pH of 6-6.8, and afternoon shaded locations. It prefers summer temperatures below 75 degrees. It needs to be exposed to temperatures below 40 degrees to go dormant. The redder the variety gets, the harder it is to grow. Green Rhubarb yields range from 10-18 tons per acre, red varieties are about half the yield. Consumers will say they prefer the red color, but a blind taste test might reveal no significant difference. In our field trials, the greener the strain, the easier it is grow. Rhubarb leaves contain oxalic acid and should not be eaten.

In row plant spacing is generally 3 feet between plants and 5-6 feet between rows. While plants can be grown from seed, a stand with more uniformity is obtained from divided crowns. Commercially available crown size can vary from one shoot to three shoots per crown. Nourse Farms #1 graded divisions are 3 buds, #2 divisions are one bud.

Plan to plant Rhubarb on heavily composted soils. California recommendations are 15 tons of compost prior to planting. Rotate soils for 1-2 years into green manure crops without using any herbicides prior to planting. I've been recommending heavy mulch after planting for weed control and lowering soil temperatures. 3-4 inches applied every spring will keep out summer weeds, conserve moisture, and keep the soil temperature down. Drip irrigation is the easiest way to manage soil moisture, it will add to success and profits. Heavier yields and longer crop cycles can be realized.

Harvesting too soon after planting is one of the biggest mistakes. Allow rhubarb to establish for 3 years prior to harvest, developing 2 foot diameter crowns. Do not harvest the year after planting to allow for the plant to develop. Two years after planting, harvest lightly depending on the amount of growth in your field. Harvesting too much is the second biggest mistake. I recommend leaving a minimum of 25-30% for healthy regrowth. Other recommendations vary from leaving 2-3 stalks to 30-50%. Another rule of thumb is to end harvest when new stalks emerge thin or spindly. Flower stalks should be removed with a knife as they appear. Young plants can be uprooted if flower stalks or young stalks are pulled.

Pests and Diseases

Rhubarb is not immune to pests and disease. Slugs, Leafhoppers and Rhubarb Curculio need to be controlled early. Leaf spots, Ramularia and Ascochyta are also preventable with early intervention. Tank mixing insecticides with fungicides that need to begin to be applied in early May through the growing season. The prevalence of Phytophthora Root Rot justifies the preventative control in spring and fall. It will manifest itself in water logged and poorly drained situations and spread down the row.

Nate Nourse is the Sales Director at Nourse Farms since 2003. He has worked in the fruit and vegetable industry his entire life. After graduating from Penn State with a B.S. in Horticulture, he was a licensed Pest Control Advisor in central California. Nate currently works to improve berry production systems and helps growers adopt new practices for their specific goals.

Maintenance

Plan to replant every 6-8 years after reaching maturity. Plantings that are too old will have heavy growth that results in small sized petioles, reducing yield and increasing harvest costs. Regular division every 6-10 years and re-locating the field will add to crop yields. Growers should consider dividing 10-15% every year as an annual maintenance.

An annual schedule would include early spring herbicide application, prior to growing, to kill overwintering perennials and prevent seed germination. In late April, a straw application after plants begin to grow. Applying Gramoxone or other burn down material with a backpack sprayer to selectively kill any emergent weeds should occur every other week through most of the season. This crop will benefit when long residual herbicides aren't used. Irrigate 2-3 times per week. Two inches per week will sustain the crop, three to four inches will help it flourish before and during harvest. Maintain good soil moisture for your soil type.

Fertilizer Schedule

Spring apply 200-250 pounds of 20-10-20 three times, adjust N-P-K levels according to your soil test. Application intervals are before growth begins, before harvest, and after harvest. Remember to consider add micro nutrients and slow release products. The total pounds nitrogen applied should be reduced according to compost quantity. Apply 15-30 tons of compost in early November, ¾-1 ½ pounds per sq/ft. Account for any nitrogen in the compost and decrease the spring application accordingly.

Varieties have special requirements and their own personalities. Mac Donald's downside of greenish stalks is offset by its vigor. It is easy to grow and is consistent producer. Cawood Delight is my favorite it fills the red color requirement. The plant is compact with very thick stems. Flavor isn't as much of an issue as tenderness. Harvesting too late in the season will result in tougher and mealy stalks.

Forcing

Forcing can be accomplished in two ways. Potting divisions in large containers, rhubarb can be forced in a greenhouse. After harvest, the pots would move outside until the following spring. Remember they won't like hot spots or black ground covers. Regular division would occur after 3-4 years of harvest.

In the field, row covers can be applied to a few rows. As temperatures exceed 70 degrees, remove the covers. The goal is to realize harvest 1-2 weeks early. Pay attention to weeds and killing frosts! Remove the covers are weed every two weeks. Cover during frost nights, 2 covers may be necessary some nights.

*Information used to write this article can be found in The Rhubarb Compendium online. http://www.rhubarbinfo.com/

SNACK PEPPERS 2017

Debra Deis
Seedway in Elizabethtown PA www.seedway.com ddeis@seedway.com

Background and Varieties

Also called Mini Sweets, these 2"-3" peppers have medium-thin flesh and nearly no seeds. They keep well and children (may) love them. They are great fun to eat. I find it surprising how much consumers like "no waste" and very little chopping, and for this market segment, snack peppers are perfect.

The original small sweet, nearly seedless, peppers are called Tribelli, bred by Enza, and available only to several greenhouse growers in Spain. Some of the fanciest snack peppers in the US are grown by Pero Family Farms and these varieties are also not available to others growers. The websites, however, have great recipes and selling ideas. www.Tribelli.com and http://www.perofamilyfarms.com/

In 2007, Seedway became the first retail seed company to offer a snack pepper, **Yummy**, which only came in **Orange** the first few years. I found Yummy through a Czech friend of Ralph Cramer's. Regardless of the variety name or series, the orange color always tastes best and usually yields best. The Yummy Orange breeders have not yet come up with a red or yellow. Seedway now offers a red and yellow Yummy but these are from a different breeder. The Red is too small and the Yellow is lobed. Even though the Orange is just about perfect, a single color is hard to sell. For this reason we pack Yummy Mix 40% orange and 25% each Red and Yellow.

For 2017 (10 years after original Yummy) we are introducing the **Sweetie** series. The Sweeties are better matched in size and shape. The Red plant is a little wild, but the Yellow and Orange plants are tidy, bushy and cone-shaped. The Yellow and Red Sweetie yield better than the Yummy Red and Yellow. The Sweeties cost more, but are worth it in yield and quality. For me, I would stay with Yummy Orange and it will be a nice match to Sweetie Red and Yellow. The Sweetie breeder, however, has compared them in the field and finds a yield advantage with Sweetie Orange. We are hoping to offer Purple Sweetie in March. There will not be enough Sweetie seed for this year, so we will likely have to offer both Sweetie and Yummy.

We also offer "Sweety with a 'Y'". Some customers use this instead of Yummy Red because it is bigger. It does not, however, have the great taste of Yummy and it is seedy.

Johnny's offers Lunchbox snack peppers. These are organic seed. If fruit size matching is really important, and small size is OK, this is a good choice.

We have trialed many other varieties of snack pepper without finding any advantage. We have sold some intended for greenhouse and have not had reorders.

Growing Small Snack Peppers

GROWING AND SELLING

These peppers have great consumer value with flavor, shelf life and a convenient small size… but they are not fun to pick and there are NO varieties with any disease resistance. They are very sensitive to 24D drift.

In open field in Pennsylvania, the first colored fruit matures the first week in August. Sadly for the people picking them, there will be only 1 or 2 colored fruit per plant. Yield builds through the end of September, when you can pick 30 to 40 fruit per plant. Size goes down then, until frost. The Sweeties have a little better early yield than do the Yummies.

Debra Deis has been involved with in specialty vegetables and cold weather crops since 1980 when she worked in the test kitchen for Rodale Press - the organic gardening and farming publisher. During the next few years working at Johnny's Seeds in Maine she helped source and trial the specialty vegetables for which Johnny's is now known. She then moved to California, where she worked for Sakata Seed, the largest breeder-producer of brassica crops. After a detour working for wineries she returned to vegetable SEED in 2003, working at Seedway, in Hershey PA, where she is a product manager.

These peppers grow great in high tunnels, but you do need to fertilize for peppers, not tomatoes. You can use rock-wool blocks or soil bags if your rotation isn't good.

In glass-houses in Ontario, the Sweeties grow for a full year with some pruning and leaf pruning.

Thanks to Mark Dellinger of Tozer for yield data below based on the new Sweeties.

Yield - A lot depends on the grower, with better production in the north than the south! Mark attributes this to the longer days in the north accelerating growth. Florida has two seasons but neither works well for extended harvest as is needed to get good yield from the snack peppers. It should be possible to get 40,000 lbs per acre in the field, but 25-30,000 is more likely for Sweetie as customers learn how to grow it. Mark reports lower yields for the Yummy Series of 18 – 20,000 (I question this for Orange but believe it for Red and Yellow). On a small scale Mark says anything over a pound per square foot is good over 6 to 8 picks.

This is based on a high plant population of 18,000 to the acre (double row with 2.3 plants per square foot). At our farm, we have gone to growing all pepper in a single row at 12 inches apart in row, and anyone serious about growing snack peppers should experiment with plant population.

In low light in the south the flowers can drop without setting. The same thing is true in the north in high tunnels, with diminished light causing flower drop. I asked Mark how growers are tweaking their programs to increase yield and he said the big difference in feeding… feed light until first set, then feed heavy.

Most snack peppers are sold in berry boxes or clam shells. In grocery stores you see them bulk and in sealed bags. Recently a new product of redi-cut sliced and bagged snack peppers is available. CSA customers appreciate the snack peppers.

With my "Assigned Topic" covered, I will show photo of other small specialty colored peppers as time allows.

SMALL "CONE" PEPPERS

Oranos and **Xanthi** are two larger, carrot shaped varieties that share the eating quality of the mini snack peppers. There is no red that matches well. Oranos, is particular, yields like crazy. For anyone that wants the same flavor of Yummy but better yield, you should look at Oranos. Yield is so good the plants look like they are on fire with orange fruit.

MINI BELLS

Bella Fina is a brand name and is only available to a few growers, such as Bailey Farms. These are by far the best mini-bells, with very good flavor, perfect shape and uniformity between colors. I have not seen a comparable variety that match within colors AND taste good.

Orange Blaze is as long as a bell pepper but shares the same quality as the Mini Bell, with thinner, sweet flesh.

Johnny's offers Eros, Aura and Glow, all from organic seed.

In between a snack pepper and a mini-bell is Yellow Sparkler. It's very nice but stand-alone in size and color.

COLORED SWEET CHERRIES

Harris Seeds offers Right on Red, Orange you Right and Yes to Yellow. These are the only multicolored sweet cherries I have found that are good tasting; most others have tough skins and some are bitter. Like all cherry peppers, they are packed solid with seeds.

CHEESES PEPPERS

Rounding out the colored pepper selection (literally) is Topepo Rosso and other heirloom cheese peppers. These are fluted and rounded and a little smaller than a bell pepper. They are a good choice for those who have a market for heirlooms.

2016 EGGPLANT VARIETY TRIAL

M. D. Orzolek
PSU Horticulture Research Farm Rock Springs, PA

Seeded in greenhouse on March 23, 2016.

Date transplanted in field: May 18, 2016

Dates harvested: July 5 through August 30, 2016 (a total of 10 harvests)

Production system: Raised beds covered with black plastic mulch and drip tape 2 inches in the soil.

Design: Randomized Complete Block with 3 replications.

Sample size: 8 plants/variety/rep

Variety	Source	Fruit shape
Fond May*(OT)	Twilley Seed	Cylindrical-10″
Rhapsody*(P)	Twilley Seed	Oblong-4″x8″
San Marino* Campana Negra*	NE Seed NE Seed	Oval elongated Large bell
Long Purple (OT) Tucci*	NE Seed NE Seed	Cylindrical-12″ Elongated
Nubia* Santana*	Seedway Seedway	Med size teardrop Large teardrop
Megal* Slim Purple (OT)	Seedway Seedway	Long tapered-7″-9″ Cylindrical-8″-12″
Little Fingers Piccola*(P)	Genesis Seeds Genesis Seeds	Cylindrical – 3″-6″ Oval – 3″x4″
Michal*(P) Bianca White	Genesis Seeds Genesis Seeds	Teardrop Elongated-2.5″x7″

- *Signifies Hybrid
- (OT) – oriental type
- (P) – parthenocarpic (no seeds)

Michael D. Orzolek is Professor Emeritus of Vegetable Crops, Department of Plant Science, The Pennsylvania State University. He came to Penn State in 1981 with a three-way appointment – 60% Extension, 22% Research and 18% Teaching. Since his retirement in July, 2012, he has kept active conducting applied field research and moving his office to the Horticulture Research Farm, Rock Springs, PA. He has done extensive research on stand establishment, plastic mulches, high tunnels, weed management and tillage systems. Mike is still the current Director of the Penn State Center for Plasticulture and the CP High Tunnel Research and Education Facility at Rock Springs, PA..
Dr. Orzolek formerly was Extension Vegetable Specialist at the University of Delaware (1974-81). He received his B.S. in Biology from Alliance College, his M.S. in Horticulture from West Virginia University, and his Ph.D. in Horticulture/Botany from the University of Maryland.

Comments:
After transplanting the eggplant varieties in May, they did not develop very rapidly for about 3 weeks. In the interim, the eggplants began to show symptoms of Verticillium Wilt and loose a few leaves. Because of the hot and dry weather that occurred in late June through September and a very aggressive fertilizer/plant growth regulators injection program for several months, the eggplants resumed normal plant growth and development without and additional symptoms of Verticillium. Even though I stopped taking yield data after August 30, 2016, there was approximately 25% of mature fruit still left on the plants until October 4, 2016. The best oriental type eggplant variety was Fond May especially for fruit color and size (Table 1). Long Purple produced the highest number of fruit per plant. Most of the large fruited (greater than 9.0 oz/fruit) eggplant varieties were very similar in yield and quality characteristics.

Other varieties that have been evaluated in the past and are worth looking at include: A1014 – Seedway – 55 day, medium-sized, smooth teardrop shape, purple/black color, spineless calyx and compact plant.

Nadia – Johnny's – 67 days, black Italian type, teardrop shape, tall plants can set fruit under cool conditions.

Dancer – Johnny's – 65 days, deep pink Italian type, semi-cylindrical fruits, mild and nonbitter.

Clara – Johnny's – 65 days, large white Italian type, teardrop shape, high yielding and early maturity.

Table 1. The marketable yield and fruit size of 14 eggplant varieties grown at the Horticulture Research, Rock Springs, PA – 2016.

Variety	Total Fruit No.	Avg. wt. – oz.	#fruit/plant
Fond May*(OT)	152.7	3.1	19.1
Rhapsody*(P)	95.3	9.2	11.9
San Marino*	90.3	9.6	11.3
Campana Negra*	150.0	5.2	17.0
Long Purple (OT)	288.9	2.2	36.1
Tucci*	138.7	5.6	17.3
Nubia*	84.3	9.9	10.5
Santana*	85.3	9.5	10.7
Megal*	120.7	6.2	15.1
Slim Purple (OT)	166.0	2.4	20.8
Little Fingers	211.3	2.2	26.4
Piccola*(P)	148.0	4.2	18.5
Michal*(P)	76.7	9.1	9.6
Bianca White	136.3	3.7	17.0

Table 2. Verticillium ratings and Japanese Beetle damage for 14 eggplant varieties grown at the Horticulture Research, Rock Springs, PA – 2016.

Variety	% verticillium Wilt symptoms	Japanese Beetle damage to plants
Fond May*(OT)	62.5	No damage
Rhapsody*(P)	75.0	No damage
San Marino*	29.2	No damage
Campana Negra*	37.5	No damage
Long Purple (OT)	45.8	Moderate damage –beetles
Tucci*	45.8	Moderate damage
Nubia*	45.8	Moderate damage -beetles
Santana*	41.7	Moderate damage
Megal*	33.3	Moderate damage
Slim Purple (OT)	37.5	No damage
Little Fingers	50.0	No damage
Piccola*(P)	66.7	No damage
Michal*(P)	75.0	No damage
Bianca White	41.7	Moderate damage

Verticillium ratings based on visual symptoms (total or partially yellow, slightly wilted leaves on one side of the plant) on plants recorded on July 6, 2016.

Japanese Beetle damage recorded on June 29, 2016. Varieties with beetles noted after damage had considerable number of live beetles on the leaves on the date data was recorded.

SWEET POTATOES IN PA & THE NE: CHALLENGES & OPPORTUNITIES

Presenter: Luis Duque, PhD. Department of Plant Science, Penn State University

Abstract:
Sweetpotato (Ipomoea batatas) is usually grown for fresh market consumption, particularly in developed nations, but it is increasingly being utilized for value-added alternative markets such as processed foods (french fries and chips) and industrial products (starch, flour, food dyes) among others. Traditionally, commercial production of sweetpotatoes has concentrated in southern US states with NC, CA, AL and MS fulfilling over 94% of total area planted for 2016. The Northeast accounts for ~1300 acres harvested with PA accounting for ~4% of this area. Sweetpotato in the NE has not been widely adopted due to several reasons, such as shorter growing seasons, average milder temperatures, types of soil, inadequate farm infrastructure, post harvest handling and market opportunities. Albeit, increased consumer preferences for more nutritious foods, novel marketing strategies and breeding, sweetpotato has now increased its importance nationally and is now ranked as the most nutritious vegetable. Potential sweetpotato research possibilities for PA will be discussed such as, cold hardiness, weed suppression and specialty market sweetpotato.

Dr. Luis Duque storage root crop physiologist and faculty member of the Department of Plant Science at Penn State University. He received his Master's, PhD and post-doctoral training from Cornell University. Dr. Duque's research focuses on a better understanding of the influence of abiotic stresses on crop growth, development and yield of storage root crops, mainly Cassava (Manihot esculenta Crantz) and Sweetpotato (Ipomoea batatas Lam.). In cassava, he has focused his attention in carbohydrate storage and remobilization and stress hormone fluxes during periods of prolonged water stress. In sweetpotato, he has examined plant-water relations, phenotypic plasticity, sink-source relations, and root system architecture, as well as root quality traits through the use of near-infrared spectometry. At North Carolina State University, he worked as a project manager for a multimillion dollar breeding project with McCain Foods Inc. developing novel sweetpotato lines for the french fry industry. Dr. Duque has been a research member in several internationally funded grants, namely, Generation Challenge Programme (GCP), BMGF funded Next Generation Cassava Breeding Project and the BMGF funded Genomic Tools for Sweet Potato Improvement (GT4SP). Ultimately, his research goals are to accelerate breeding efforts through the use of physiological attributes to improve crop performance and seek ways to alleviate famine and achieve food security

PennState Extension

Food Safety Modernization Act (FSMA) Produce Grower Certification Training

JAN 30

FSMA Produce Grower Certification Training
When: Monday, January 30, 2017, 9:00 AM - 5:15 PM
Where: Hershey Lodge and Convention Center
325 University Drive, Hershey, PA
(Held in conjunction with the Mid-Atlantic Fruit and Vegetable Convention)

For more information and registration, visit:
http://www.mafvc.org/site/other/MAFVCWkshpFSMAFoodSafety.pdf
or call 717-694-3596

FEB 21

FSMA Produce Grower Certification Training
When: Tuesday, February 21, 2017, 8:30 AM - 5:00 PM
Where: Butler County, PA -- The Atrium, 1031 New Castle Road, Prospect, PA
To register, please visit www.extension.psu.edu/fsma or call 814-445-8911

MAR 24

FSMA Produce Grower Certification Training
When: Friday, March 24, 2017, 8:30 AM - 5:00 PM
Where: Bedford County, PA -- Travelodge Bedford, 4517 Business 220, Bedford, PA
To register, please visit www.extension.psu.edu/fsma or call 814-445-8911

Who should attend?

The FSMA Grower Certification Course is accepted by the Food & Drug Administration to satisfy the FSMA Produce Safety Rule requirement outlined in § 112.22(c) that requires "At least one supervisor from the farm must complete food safety training at least equivalent to the standardized curriculum recognized by the FDA." After attending the entire course, participants will be eligible to receive a certificate from the Association of Food and Drug Officials (AFDO) that verifies completion of the training course.

To receive an AFDO certificate, a participant must be present for the entire training and submit the appropriate paperwork to their trainer at the end of the course.

What can I expect?

Penn State Extension trainers will spend approximately seven hours of instruction time covering content contained in these seven modules:

- **Introduction to Produce Safety**
- **Worker Health, Hygiene, and Training**
- **Soil Amendments**
- **Wildlife, Domesticated Animals, and Land Use**
- **Agricultural Water**
- **Postharvest Handling and Sanitation**
- **How to Develop a Farm Food Safety Plan**

In addition to learning about produce safety best practices, key parts of the FSMA Produce Safety Rule requirements are outlined within each module. There will be time for questions and discussion.

What is the cost?

The registration fee is $50 for Pennsylvania resident growers and $150 for others. Lunch is included and registration is limited.

The discounted rate for PA growers is provided with support of the PA Ag Resource Centers, a partnership of Penn State's College of Agricultural Sciences and the PA Department of Agriculture.

Participants will be asked to participate in a brief survey during the training session.

For more information and resources, visit www.extension.psu.edu/fsma

PennState Extension

Developing a Farm Food Safety Plan

A Plan Writing Workshop

FEB 9

Developing a Farm Food Safety Plan
When: Thursday, February 9, 2017, 9:00 AM - 3:00 PM
Where: Lebanon County -- Lebanon County Extension Office, 2120 Cornwall Road, Lebanon, PA
To register, please visit www.extension.psu.edu/fsma or call 814-445-8911

MAR 7

Developing a Farm Food Safety Plan
When: Tuesday, March 7, 2017, 8:30 AM - 4:00 PM
Where: Butler County -- The Atrium, 1031 New Castle Road, Prospect, PA
To register, please visit www.extension.psu.edu/fsma or call 814-445-8911

MAR 31

Developing a Farm Food Safety Plan
When: Friday, March 31, 2017, 8:30 AM - 4:00 PM
Where: Bedford County -- Travelodge Bedford, 4517 Business 220, Bedford, PA
To register, please visit www.extension.psu.edu/fsma or call 814-445-8911

Who should attend?

This course is designed to help growers prepare for a USDA Harmonized GAP, or other farm food safety audit, that requires a written plan.

What can I expect?

Prior to attending this course, it is helpful, but not necessary, to have attended the FSMA Produce Grower Certification Training or another introductory GAPs course that covers farm practices and food safety risks.

This workshop will review basic concepts, but it is designed as a level-two course for farmers writing a food safety plan. It is also designed for farmers who are considering, or are required, to have a third party audit.

Participation in this course leaves you better prepared for third party audits. Previous participants have left the course with a started, if not mostly completed, farm food safety plan in hand.

What is the cost?

The cost to attend this training is $60 per individual.

Lunch and resource materials will be provided.

**Note - If you have a personal laptop on which you intend to develop your Farm Food Safety Plan, you may choose to bring it with you.*

Critical Updates for the 2017 Mid-Atlantic Vegetable Recommendations Guide 01/09/17

Entomology

1. EPA **cancelled all registrations** of the insecticide **Flubendiamide** (found in the products Belt and Vetica for use in the U.S. due to potential toxicity concerns for certain aquatic organisms.
2. Label change for the insecticide/miticide abamectin: Agri-Mek SC label contains revised use instructions and restrictions as well as new labeled crops (**including dry and succulent beans, soybeans and sweet corn**). Be sure to read the label before making an application for use rates and all restrictions including, but not limited to adjuvant requirement that must be followed to avoid illegal residues. NOTE – this is the only labeled formulation of abamectin available for use on dry and succulent beans, soybeans and sweet corn for spider mite control http://www.cdms.net/ldat/ld9NL020.pdf
3. Allium leafminer: New serious pest of onions and garlic in the mid-Atlantic region.

Allium leafminer (*Phytomyza gymnostoma*) is an invasive species first confirmed in southeastern Pennsylvania in 2016. Information is at http://ento.psu.edu/extension/vegetables/pest-alert-allium-leafminer and http://www.agriculture.pa.gov/Protect/PlantIndustry/Pages/ALLIUM-LEAFMINER.aspx. Adults appear to be active in the spring (March-May) and fall (October-November). Management includes row covers or insecticides during the time of adult activity. Although efficacy trials have not been conducted, the following insecticides labelled for leafminers that may be effective against allium leafminer**.** Labeled crops noted with days to harvest (DTH)

Crop subgroups with listed crops taken from labels and also found at
http://ir4.rutgers.edu/other/CropGroup.htm

Trigard (cyromazine): for leafminers *Not for use in Nassau and Suffolk Counties, NY*
Bulb Vegetables crop group (7 DTH)
Some of the crops in this group are: garlic, great-headed (elephant) garlic, leek, dry bulb onion, green onion, potato onion, tree onion, Welsh onion, rakkyo, and shallot.

Scorpion (dinotefuran): for leafminers and others *Not for use in NY State*
Onion, bulb and green (subgroups 3-07A and 3-07B) (1 DTH)
Bulb onion, includes: Daylily, bulb; Fritillaria, bulb; Garlic, bulb; Garlic, Great- headed, bulb; Garlic, serpent, bulb; Lily, bulb; Onion, bulb; Onion, Chinese, bulb; Onion; pearl Onion; potato, bulb; Shallot, bulb; Cultivars, varieties and/or, hybrids of these
Green onion, includes:
Chive, fresh leaves; Chive, Chinese, fresh leaves; Elegans hosta; Fritillaria leaves; Kurrat; Leady's leek; Leek; Leek, wild; Onion, Beltsville bunching; Onion, fresh; Onion, green; Onion, macrostem; Onion, tree, tops; Onion, Welsh tops; Shallot, fresh leaves; Cultivars, varieties and/or hybrids of these

Radiant SC (spinetoram): for dipteran leafminers and others
Bulb Vegetables (Crop Group 3) (1 DTH)
Bulb vegetables: bulb onion, garlic, great-headed (elephant) garlic, green onion, leek, shallot, Welsh onion
Herbs (Subgroup 19A) (1 DTH)
Includes: chive, chive (Chinese)

Mustang, Mustang Maxx (and OLF) (zeta-cypermethrin): for leafminers (adults)
Bulb Vegetables (Allium spp.) (7 day PHI)
Including: Garlic; Garlic, Great-Headed (elephant); Green Eschalots; Japanese Bunching Onions; Leeks; Onion, Dry Bulb and Green; Onion, Welch; Shallots, Dry Bulb and Green; Spring Onion or Scallions

Warrior II (and OLF) (lambda-cyhalothrin): for leafminer species (adults)
Onion (bulb) and Garlic (14 DTH)

For Organic Growers

Aza-Direct (and OLF) (azadirachtin): for leafminers
verify label crops and uses – some variation among products and some may not be organic-compatible
Bulb Vegetables (0 DTH)
Such as: Garlic, Leek, Onion (dry bulb, green and Welch), Shallot

Entrust SC (spinosad): organic-compatible, for dipteran leafminers and others
Bulb Vegetables (Crop Group 3) (1 DTH)
Bulb vegetables: dry bulb onion, garlic, great-headed (elephant) garlic, green onion, leek, shallot, welch onion
Herbs (Subgroup 19A) (Insect Suppression) (1 DTH)
Includes: chive, chive (Chinese)

Products not specifically labeled for Phytomyza gymnostoma but may be effective

Agri-Mek SC (or OLF) (abamectin): for *Liriomyza* leafminers and thrips. Include adjuvant per label
Herb Crop Subgroup (Crop Subgroup 19A) (7 DTH)
Including Chives, Chives (Chinese)
Onion, Bulb (Crop Subgroup 3-07A) (30 DTH)
Crops in this group are: onion, bulb including daylily, bulb; fritillaria, bulb; garlic, bulb; garlic, great-headed, bulb; garlic, serpent, bulb; lily, bulb; onion, Chinese, bulb; onion, pearl; onion, potato, bulb; shallot, bulb; cultivars, varieties, and/or hybrids of these.

Exirel (cyantraniliprole): for Leafminer (*Liriomyza* spp.) and thrips. Include adjuvant per label
Bulb Vegetables, (EPA Crop Group 3-07) (1 DTH)
Chive, fresh leaves; Chive, Chinese, fresh leaves; Daylilly, bulb (edible);
Elegans hosta (edible); Fritillaria, leaves (edible);
Garlic, bulb; Garlic, great headed, bulb; Garlic, serpent, bulb;
Kurrat; Lady's leek; Leek; Leek, wild; Lily, bulb; Onion, Beltsville bunching; Onion, bulb; Onion, Chinese, bulb; Onion, fresh; Onion, green; Onion, macrostem; Onion, pearl; Onion, potato, bulb; Onion, tree, tops; Onion, Welsh, tops; Shallot, bulb; Shallot, fresh leaves

Assail (acetamiprid): for thrips
Onions and other Bulb Vegetables, (EPA Crop Group 3-07) (7 DTH)
Chive, fresh leaves; Chive, Chinese, fresh leaves; Daylilly, bulb;
Elegans hosta; Fritillaria, leaves and bulbs;
Garlic, bulb; Garlic, great headed, bulb; Garlic, serpent, bulb;
Kurrat; Lady's leek; Leek; Leek, wild; Lily, bulb; Onion, Beltsville bunching; Onion, bulb; Onion, Chinese, bulb; Onion, fresh; Onion, green; Onion, macrostem; Onion, pearl; Onion, potato, bulb; Onion, tree, tops; Onion, Welsh, tops; Shallot, bulb; Shallot, fresh leaves

Compiled by Dan Gilrein, Cornell Cooperative Extension of Suffolk County, Riverhead, NY 3/31/2016

Critical Updates for the 2017 Mid-Atlantic Vegetable Recommendations Guide
01/09/17

Weed Management

Cole Crops

Reflex	24c registrations also include Virginia. See label for rates, instructions and restrictions

Cucumbers

Sandea	Pre-harvest interval has been reduced 14 days (24c registration; expires 5/31/2018)

Lettuce

Kerb	Label has been expanded to include leaf lettuce as well as head lettuce.

Pepper

Reflex	24c registrations also include Virginia. See label for rates, instructions and restrictions

Sweet Corn

- Recently labeled herbicides include:

Herbicide	Comments
Acuron	Pre-packaged mixture of Dual, atrazine, Callisto, and bicyclopyrone. Applications can be made pre-plant or preemergence. Broad spectrum control
Acuron Flexi	Similar to Acuron, but without atrazine
Armezon Pro	Pre-packaged mixture of Armezon plus Outlook for postemergence applications. Outlook may provide additional residual control for grasses and some small-seeded broadleaf weeds
Verdict	Pre-packaged mixture of Outlook and Sharpen. Applications can be made pre-plant or preemergence.

Watermelon

Reflex	24c registrations also include Virginia. See label for rates, instructions and restrictions

Changes to Labels Affecting Crop Rotations:

Reflex has new crop rotation planting restrictions for the following crops:
- Lima bean: 4 months instead of 10 months
- Pumpkin: 10 months instead of 18 months
- Cucumber: 12 months instead of 18 months
- Transplanted pepper/tomato: 10 months instead of 18 months
- Direct seeded pepper/tomato: 12 months instead of 18 months
- Squash: 12 months instead of 18 months

Flexstar and Flexstar GT have new crop rotation planting restrictions for the following crops:
- Lima bean: 4 months instead of 12 months
- Squash : 12 months instead of 18 months

Critical Updates for the 2017 Mid-Atlantic Vegetable Recommendations Guide
01/09/17

Pathology

Presidio (fluopicolide, 43) is not labelled for use in potato.

SoilGard (*Trichoderma virens*) and Double Nickel (*Bacillus amyloliquefaciens* strain D747) are labelled for use on greenhouse transplants.

Orondis Opti (oxathiapiprolin + chlorothanonil, U15 + M5) is now labeled for use on multiple crops for fungal leaf spots and downy mildew control.

Orondis Ultra (oxathiapiprolin + mandipropamid, U15 + 40) is now labeled for use on multiple crops for downy mildew and Phytophthora blight control

Orondis Gold (oxathiapiprolin + mefenoxam, U15 + 4) is now labeled for use on multiple crops for damping-off and Phytophthora blight control.

SEE LABEL FOR SPECIFIC CROPS AND USE RATES