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2014 MID-ATLANTIC
FRUIT AND VEGETABLE CONVENTION

Proceedings
FOR THE
VEGETABLE, POTATO, GREENHOUSE, SMALL FRUIT & GENERAL SESSIONS

January 28 to January 30, 2014

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Hershey, Pennsylvania

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FARM TO WORKPLACE: EMERGING TRENDS IN CSA'S

Lindsay Gilmour and Sonja Claxton
Common Market Philadelphia

The Delaware Valley Farm Share (DVFS) is a farm to office community supported agriculture (CSA) program for institutions in Greater Philadelphia. DVFS is a year-round program that delivers farm-fresh produce direct to employers, schools, and faith institutions in the region. Piloted in the summer of 2011 by Common Market Philadelphia and Farm to City, DVFS has grown from 125 members to over 900 members in close to 30 different institutions in 2013.

Common Market Philadelphia is a nonprofit distributor of local foods that serves and connects our region's communities with local, sustainably grown farm food. Common Market delivers food from about 75 regional growers and food processors to over 200 public and private institutions 6 days a week. These institutions include but are not limited to schools, hospitals, workplaces, retail and cooperative grocers, restaurants, and faith institutions.

Farm to City is a Philadelphia-based program whose goal is to unite communities, families, and farmers year-round through good locally grown food. A local food pioneer since 2001, Farm to City runs 19 farmer's markets in and around Philadelphia and provides year round access to local food for close to 1000 households through their Winter Harvest Buying Club.

DVFS is designed for those who have never participated in a typical CSA nor frequented farmer's markets. Each delivery includes fruit, vegetables and a dozen cage-free eggs, typically considered a half share. In the winter, when produce is more limited, value-added pantry staples supplement the share. Having access to multiple suppliers, Common Market is able to provide a good variety of products throughout the year. The shares are designed to give customers a

balanced mix of staples and specialty items. Customer feedback is critical to help us continuously improve the service and the product while serving a very diverse membership.

Common Market's mission is to strengthen regional farms while making the local bounty accessible to communities and the institutions that serve them. The DVFS price is lower than a typical CSA, multiple payment options are available and payment for the entire season is not required up front, allowing more participants access to the program. To keep labor cost down, the food is delivered with minimal repackaging.

All the farms Common Market works with are family farms, most of them on less than 50 acres of land. Through relationships with Common Market, farmers are able to access new markets without having to do their own sales, distribution, or CSA administration. Common Market also ensures that farms receive timely payments for their goods. As the Common Market orders increase, most farms notice a decrease in their production costs.

For participants of the DVFS, the benefits of receiving farm fresh produce go beyond the initial health benefits. Many note the program fits seamlessly into already existing employee engagement, wellness and sustainability programs. And moreover, once every other week, people get to congregate around good food, swap recipes, and connect.

Lindsay Gilmour is works on Farmer Outreach and Product Development for Common Market Philadelphia, a values-driven wholesale distributor of food produced in the Philadelphia region. The goal of Common Market is to support local agriculture while making local food affordable and accessible to urban communities. Common Market purchases direct from farmers and distributes to schools, hospitals, universities, and retailers in the Tri-State area. By providing distribution infrastructure, Common Market is helping to rebuild wholesale markets for family farmers, and bring local food to a broad audience. Lindsay seeks out new growers and products and works with farmers to meet the demands of larger wholesale customers. Lindsay Gilmour has over 30 years experience in all areas of the food industry and is a chef, cooking instructor, and the owner of Organic Planet Handcrafted Foods. Lindsay is a long time local food systems advocate and was formerly manager of the Fair Food Farm to Institution and Farmer Outreach Programs. Lindsay serves as board chair for Fair Food Philadelphia, and is a co-founder and former board chair of both the Sustainable Business Network of Greater Philadelphia and Good Company Group.

As the Organizational Wellness Manager for Common Market, **Sonja Claxton**, helps workplaces engage their employees around healthy and sustainable lifestyles. Sonja manages the Delaware Valley Farm Share (DVFS) program, a farm-to-office program that provides farm-fresh produce direct to employees in PA, NJ, and DE. Piloted in 2011, the DVFS is a year-round program that during the peak of the summer feeds over 900 families through almost 30 locations. Before joining Common Market to support the Delaware Valley Farm Share program, Sonja spent three years at Bracket, a pharmaceutical services company trying to create the perfect workplace. Sonja led the charge for creating Bracket's Health and Wellness Committee and co-founded the Sustainability Awareness Group. Sonja introduced Bracket to the Delaware Valley Farm Share in 2011. For close to two seasons, Sonja coordinated the efforts of the farm share at Bracket. Graduated from Temple University's Fox School of Business with a Bachelors in Business Administration. Born and raised in West Philadelphia, Pennsylvania. Mother to one awesome kindergartener.

EFFICACY OF INSECTICIDES ON CUCURBIT CROPS

Thomas P. Kuhar
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In the mid-Atlantic U.S., cucurbit crops including cucumbers, melons, squash and pumpkins can be attacked by several insect pests that can jeopardize the quantity and quality of the crop. The key pests include: cucumber beetles (striped and spotted), which can destroy seedlings with their leaf feeding. These beetles also can transmit bacterial wilt, which can be deadly to susceptible cultivars. They also can feed on the rinds of fruit, especially when foliage is scarce late in the season. Squash bugs are another key pest that can build up in high densities and wilt the leaves of squash and pumpkin. Melon aphids can also be quite abundant on squash and pumpkin, especially after repeated applications of pyrethroid insecticides. A number of new insecticides have been registered in recent years that provide effective control of these insect pests. However, minimizing nontarget effects on bees and other pollinators should be a concern when using any pesticides. Many of the newer insecticides are less toxic to bees than the older broadspectrum chemicals, applications of any product should not be made during peak bee activity when flowers are pollinating. The results of several insecticide efficacy tests conducted on cucurbit vine crops are presented below.

**CONTROL OF CUCUMBER BEETLES & APHIDS IN 'BLUE HUBBARD' SQUASH
PLANTED 22 JULY –FOLIAR SPRAYS ON 10 AND 21 AUG - BLACKSBURG, VA**

		Mean no. cucumber beetles / 5 plants			Mean no. aphids / 10 leaves	
Treatment	**Rate / acre**	**14-Aug**	**19-Aug**	**26-Aug**	**26-Aug**	**5-Sep**
Untreated Control		7.3 ab	10.5 a	1.8	71.5	23.0
Hero EC	5.12 fl. oz	0.0 c	0.3 b	0.0	70.3	57.0
Mustang Max	4 fl. oz	0.0 c	0.8 b	0.0	29.0	176.8
Gladiator	18 fl. oz	0.8 c	3.3 b	0.3	165.0	30.8
Beleaf 50SG	2.8 oz	6.5 ab	9.5 a	3.8	0.0	0.3
Triple Crown	4.5 fl. oz	0.0 c	2.8 b	0.3	0.0	8.3
Venom 70SG	2 oz	7.5 a	8.5 a	2.3	0.5	0.8
Voliam Flexi 40WDG	4 oz	3.5 bc	2.8 b	1.3	1.0	1.0
Assail 30SG + Lambda-cy 1E	4 oz + 2.56 fl. oz	0.8 c	1.0 b	0.0	0.5	7.8
P-Value from Anova		0.0001	<0.0001	ns	ns	ns

CONTROL OF MELON APHIDS IN 'PAYROLL' SUMMER SQUASH
PLANTED 18 JUL, 2013 –FOLIAR SPRAYS 14, 21 & 28 AUG – VIRGINIA BEACH

		Mean no. melon aphids / 10 leaves	
Treatment	**Rate / acre**	**28-Aug**	**5-Sep**
Untreated Control		184.5 bc	47.0 bc
Fastac (BASF)	3.8 fl. oz	494.8 a	116.2 ab
Hero	5.12 fl. oz	506.7 ab	140.7 ab
Mustang Max	4 fl. oz	423.8 ab	186.5 ab
Gladiator	18 fl. oz	283.8 abc	139.5 ab
Beleaf	2.8 oz	5.5 c	0.0 c
Triple Crown	4.5 fl. oz	116.8 c	31.8 bc
Venom	2 oz	7.5 c	2.3 c
Voliam Flexi	4 fl. oz	5.3 c	0.3 c
P-Value from Anova		0.0017	0.0086

CONTROL OF SQUASH BUGS IN 'GENTRY' SUMMER SQUASH
PLANTED 11 JUN 2012 –FOLIAR SPRAYS ON 17 JUL, 2, 9 AND 15 AUG - PAINTER, VA

		Mean no. squash bugs / 5 plants				
Treatment	**Rate / acre**	**Egg mass (9 Aug)**	**Nymphs (9 Aug)**	**Egg mass (15 Aug)**	**Nymphs (15 Aug)**	**Adults (15 Aug)**
Untreated Control		2.5 a	18.0 a	18.8 a	30.3	4.3 a
Assail 30SG	4 oz	11.5 a	1.8 b	9.0 b	8.0	2.8 a
Lambda-cy 1E	3.84 fl. oz	2.0 b	0.3 b	4.0 c	0.0	0.0 b
Assail 30SG + Lambda-cy 1E	4 oz + 2.56 fl. oz	3.8 b	0.0 b	0.3 c	0.3	0.3 b
Assail 30SG + Lambda-cy 1E	4 oz + 3.84 fl. oz	0.8 b	0.0 b	0.8 c	0.0	0.3 b
Assail 30SG + Bifenture 2EC	4 oz + 5 fl. oz	1.8 b	0.0 b	0.5 c	0.0	0.0 b
Endigo EZ	4.5 fl. oz	1.5 b	0.0 b	0.8 c	0.0	0.5 b
Endigo ZCX	4.5 fl. oz	2.8 b	0.0 b	0.0 c	0.0	0.0 b
Besiege	9 fl. oz	2.5 b	0.0 b	1.3 c	0.0	0.3 b
P-Value from Anova		0.0095	0.0045	0.0000	ns	0.0001

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

CONTROL OF CUCUMBER BEETLE IN ‘APHRODITE’ CANTALOUPES PLANTED 4 JUN 2012 – ONE FOLIAR SPRAY ON 29 JUN - BLACKSBURG, VA

		Mean no. live cucumber beetles / 5 plants		
Treatment	**Rate / acre**	**2-Jul**	**5-Jul**	**11-Jul**
1. Untreated Control		1.0	7.3 a	4.5
2. Assail 30SG	4 oz	0.3	1.5 b	1.5
3. Lambda-cy 1E	3.84 fl. oz	0.3	1.0 b	0.5
4. Assail 30SG + Lambda-cy 1E	4 oz + 2.56 fl. oz	0.5	1.5 b	1.8
5. Assail 30SG + Lambda-cy 1E	4 oz + 3.84 fl. oz	0.3	1.5 b	0.3
6. Assail 30SG + Bifenture 2EC	4 oz + 5 fl. oz	0.0	0.5 b	0.8
7. Endigo EZ	4.5 fl. oz	0.0	0.3 b	0.5
P-Value from Anova		ns	0.0009	ns

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

CONTROL OF SQUASH BUG IN ‘PAYROLL’ SUMMER SQUASH VIA DRIP CHEMIGATION OF INSECTICIDES PLANTED 28 MAY, 2012 – INJECTION ON 17 JUN AND 15 JUL - PAINTER, VA

Treatment	Rate/acre	No. squash bug nymphs per 10 leaves				
		6-Jul	**15-Jul**	**23-Jul**	**28-Jul**	**2-Aug**
Untreated Control		13.8 a	13.8	24.5 a	20.8	39.5 a
Scorpion 35SL	9 fl. oz	0.0 b	0.0	0.0 b	0.0	1.5 b
Scorpion 35SL	10.5 fl. oz	0.0 b	0.0	0.0 b	0.0	1.3 b
Admire Pro	10.5 fl. oz	7.8 ab	0.0	0.0 b	0.0	0.3 b
P-Value from Anova		0.012	ns	0.0000	ns	0.0000

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

FIELD AND HIGH TUNNEL CUCUMBER VARIETY TRIALS

Steve Bogash, Horticulture Educator, Penn State Cooperative Extension

Session: 1/28/14, Vine Crops at 9:45 AM

For the past two years, the researcher has been evaluating cucumber varieties at the Penn State Southeast Agricultural Research and Extension Center (SEAREC). These projects were supported by Pennsylvania Vegetable Research Marketing Program (PVMRP) funds The field variety comments are from the 2012 and 2013 growing season. The High tunnel variety comments are from growing cucumbers in succession using two high tunnels, but are only for 2013. The complete reports with yield data will be published by the PVMRP in its' annual report and / or the PVGA newsletter.

Field Variety Trial Comments

Marketmore 76: This non-hybrid variety has been around for a very long time, yet still compares well with many much newer hybrids. The fruit are largely on the smaller (less than 8") size, but the cull rate was low and the overall quality high. Yields were among the lowest for this trial. Minimal infection with either PM or DM under a standard preventative program. Monoecious.

Cobra: High yields and reasonable packouts with most fruit ripening at 7-9". Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

Sweet Slice: The highest yields of the greatest percentage of long fruit (10-12"). Very low cull rate for these long fruit (12%). Dark and thin skinned. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

Cutter: High yields of short, blocky fruit, but one of the highest cull rates of the trial. These plants did perform well as the season got hotter. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Sweet Success: The highest percentage of 10" plus fruit of any variety. Many fruit were over 12". High yields of thin skinned, low seed fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecous, parthenocarpic. Probably useful in high tunnel or greenhouse production.

Darlington: High yields and reasonable packouts with most fruit ripening at 7-9". Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Rockingham: High yields and with some of the largest fruit ripening at greater than 9". Disappointing cull rate that could have been tied to the high heat of the 2012 growing season. Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

Gold Standard: Very light colored cucumber reported to have high beta carotene. Lower yields, but a low cull rate. Good spread of fruit between 7 and 9". Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Fanfare: High yields on very compact vines. This 1994 All-America Selections Winner does well in both containers and under field conditions. High quality, dark green fruit. Very low cull rate. Minimal infection with either PM or DM under a standard preventative program.

Sweeter Yet: Among the highest yields of longer fruit with some pushing 12". Very good yields of thin skinned fruit with few seeds. Reported to have both PM and DM resistance. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

Corinto: Lower yields than most with relatively high cull rate. Probably better in a high tunnel or greenhouse which is where it will be trialed in 2013. Very nice looking fruit. Gynoecious and Parthenocarpic

Python: High yields and with some of the largest fruit ripening at greater than 9”. Very consistent harvests throughout the hottest part of the season. Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Talledega: Higher early yields that tailed off as the season got hotter. Good fruit quality early. Reported to have good PM resistance. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

SVR14763462: This and SVR14784719 are some of the first varieties of cucumbers bred with DM resistance. While the yields were moderate, the fruit quality was good, the cull rate low and the harvests consistent. No PM or DM noted. Gynoecious

Intimidator: Relatively low yields, but one of the highest percentages of large fruit in the trial. Very consistent yields of larger fruit. Fruit are a bit lighter in color, but still dark enough for most markets. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Boa: Highest yields in the trial with most of the fruit ripening at 7- 9”. Reasonable cull rate even at very high yields. Very consistent harvests. Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

SVR14784719: This and SVR14763462 are some of the first varieties of cucumbers bred with DM resistance. While the yields were moderate, the fruit quality was good, the cull rate low and the harvests consistent. Slightly higher yields than SVR14763462. No PM or DM noted. Gynoecious

Speedway: Moderate yields and reasonable packouts with most fruit ripening at 7-9”. Very low cull rate. Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious.

General Lee: Very high yields, good fruit quality and consistent harvests with excellent looking fruit. Very low cull rate. This variety performed very well in the high heat of 2012. Gynoecious.

Dasher II: Among the higher yields in the trial with most of the fruit ripening at 7- 9”. Very low cull rate even at very high yields. Very consistent harvests. Good looking dark green fruit. Minimal infection with either PM or DM under a standard preventative program. Gynoecious

Summertop: Very high yields of 10-12” fruit. Reported to have both PM and Dm resistance. Minimal infection with either PM or DM under a standard preventative program. Monoeicous

Tamazula: Moderate to low yields, but high quality fruit. This greenhouse variety performed poorly in the field. Minimal infection with either PM or DM under a standard preventative program.

Seed Sources: Johnny’s Seeds, Seedway Seeds, Ball Seeds, and Burpee Seeds.

High Tunnel Variety Trial Comments

Corinto: This slicer was bred specifically for the greenhouse environment which partially explains its superior performance, flavor, and durability. Skin is an attractive deep, smooth, green. Producing the second most fruit by count and the most by weight, Corinto is a very good option for a grower looking for a relatively disease resistant cucumber with high yields and relative disease resistance.

Diva: As displayed in the data, Diva performed the poorest in all evaluations of yield. Despite its prolific vegetative growth, Diva failed to produce fruit until nearly three weeks after the other varieties. These results were consistent throughout all three production runs in this program.

Excelsior: A cucumber performing moderately well, with good yields. What set excelsior apart was its consistent production of high quality fruit, having the lowest cull percentage, 0.97%. The single pickling type cucumber in this program.

Katrina: Like Picolino, Katrina started yielding earlier than most others. However, it also faded quickly, so would require about a 4 week replant schedule to maintain consistent harvests.

Lisboa: Reasonable yields of very large fruit (0.71 lbs./fruit, third highest) characterizes this multipurpose variety. Management became an issue half way through the growing period as the plants became extremely tall (taller than other varieties) with much branching. Possibly using a different trellis system would help this problem. Skin is an attractive dark green but flesh leaves more to be desired.

Picolino: The highest producing in terms of number of fruit, Picolino cucumbers ripen small, 4-5", and have a very desirable, mild flavor. Very early yielding with consistent harvest over the entire program run.

Rocky: An oddly shaped, stout cucumber, Rocky produced tasty, attractive fruit that are somewhat blocky in appearance. Acclaimed by some as a good farmers market variety.

Socrates: Socrates consistently produced high-quality fruit in moderately large quantities. Yield was fairly high and fruit was sweet with a moderately attractive dark green flesh.

USAC0330: Nondescript and typical was USAC0330. Low yields and high cull rates plagued this dark skinned variety, This variety did not perform well in this program.

USACX0329: Out of all the varieties from US Agriseeds, this variety performed the best. It had high yields (both weight and number of fruit), but also had a high cull rate at 13.7%. Superior in both flavor and appearance.

USACX08835: Similar to its relative, USAC0330, USACX8835 had excellent flavor but had mediocre performance with low yields and high cull rates.

Note on Powdery and Downy Mildew: PM only appeared on high tunnels plants as they started to senesce and had been harvested for 3 or more weeks. Downy mildew was a short term challenge as there were only about 3 or 4 weeks this past growing season when DM on cucumbers was an issue. We alternated crops between the SEAREC / Landisville Farm 17' x 48' high tunnel and the same house at the Franklin County Horticulture Center, Chambersburg, PA with three crops total (spring into early summer and fall at SEAREC and one summer crop in Chambersburg).

Special thanks to Elizabeth Lesko, Ian Gallo and Will Brandenburg who did much of the sweat work and data collection on these trials.

Steve is currently a Horticulture Educator serving Pennsylvania out of the Cumberland County office in Carlisle. He covers vegetables, small fruit, cut flowers, greenhouse vegetables, and specialty marketing as his primary areas of responsibility. Tomatoes, bell peppers, container vegetables, cucumbers, and other specialty crops are regular items in the trial gardens under Steve's management.

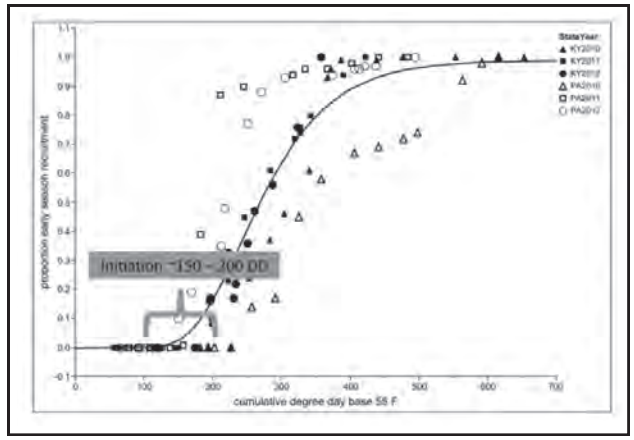
Since 2008, Steve has been doing extensive trials on container-grown vegetables in addition to his high tunnel and field tomato evaluation program started in 2000. Evaluating more than 400 varieties of tomatoes for flavor, appearance, disease resistance and general usability has made Steve very opinionated 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.

CUCUMBER BEETLE AND SQUASH BUG PHENOLOGY

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

Phenology means the timing of biological events. Both cucumber beetles and squash bugs overwinter as adults. Information about when to expect these adults to immigrate into your fields, when the immature stages will develop into the next generation of adults, and how many generations to expect, can help with management. As part of a project funded by the Organic Research and Education Initiative, we collaborated with researchers in Iowa and Kentucky to advance our understanding of cucurbit pest phenology.

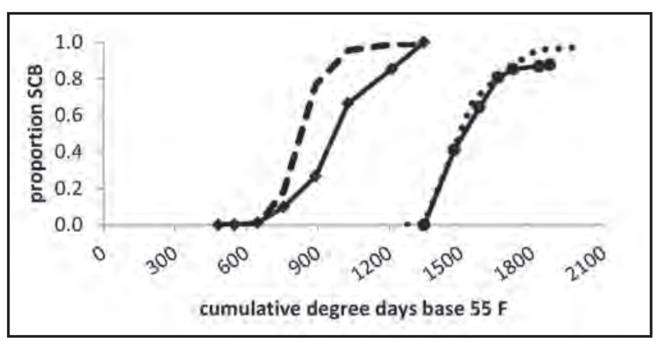
Immigration of cucumber beetle adults: Immigration of cucumber beetle adults: We used flats of transplants as insect traps, setting them out early in the season, and checking them daily for immigration. The literature suggests that males are the first to arrive. A combination of a male-produced aggregation pheromone, volatiles from plants that have feeding damage, and frass from the beetles rapidly attract additional overwintered adults. The cumulative numbers of immigrants can be graphed as an S-shaped curve over time. We graphed this cumulative immigration as a function of degree days, using data from 2 states and 3 years, to generate an range of degree-days to expect early activity of overwintered adult striped cucumber beetles. The time frame of 150-200 degree-days, base 55 F, provided a good fit for when this S-shaped curve first starts to increase.



Initiation of early season recruitment of cucumber beetles to trap flats at 150-200 degree days. Data from 2 states, 3 years.

There are management implications for this type of immigration. It is not uncommon to see variation in beetle density among groups of fields in a farmscape, or among plants started at different planting dates. In the first case, the earliest-planted fields often show the first influx of beetles. If the beetles are well-controlled in these early plantings, late-planted fields may see lower pest pressure, or a slower immigration process. Similarly, transplants set out early, and surrounding a field, can be used as a trap crop. This strategy is called "Perimeter-Trap-Crop" or PTC. PTC with highly attractive, larger cucurbits, such as various gourd species, can serve as a trap crop by using a systemic or other insecticide on those early transplants, reducing the pest pressure on the later-planted crops placed in the rest of the field.

Degree-day models for beetles and bugs. Entomologists often use degree-day models to estimate when an immature stage will develop to a more advanced stage, or to an adult. These models are generated in lab settings, under constant temperatures, and lab-models exist for both cucumber beetles and squash bug. We tested these models for use in field settings, again using data from 3 states. We tracked the time of arrival of both species in small field plots, and assumed that egg-laying started when adults first arrived. We were surprised at how early squash bugs were appearing in fields. We compared the degree-day modeled estimate of when to expect the next generation to the field-measured observations. For both striped cucumber beetles, the models fit the data reasonably well in 3 of 5 datasets. This suggests that we can provide advance warning of when to expect emergence of 2nd and 3rd generation adults. Often, these emergences of adults results in a strong increase in pest density. Knowing when this is expected to occur can help time management



Observed (solid line) and modeled (dotted line) of the proportion of the cucumber beetle density for 1st and 2nd generation. Example from 2011.

efforts for that field and for neighboring fields which is where some of these new adults will disperse to. We are hoping to use these results to create a website that growers could easily use to estimate when to expect this adult emergence, based on when they first see adults moving into their fields, for both cucumber beetles and squash bugs.

Voltinism: number of generations per year for beetles and bugs. For both pest species, egg-laying will end as the adults enter diapause (a physiological condition that enables them to overwinter). The photoperiod that induces diapause is known for only one species, the squash bug (between 14:10 and 14.5:9.5 hours of light/dark, Nechols 1988). In all 3 states almost all of the new squash bug adults were emerging after the time that decreasing photoperiod is expected to induce diapause, thus these new adults are not expected to lay eggs, resulting in only 1 new generation per year. For beetles, we estimated the number of generations per year based on graphs of population dynamics.

Squash vine borer: Much less is known about the phenology of squash vine borer. We used pheromone traps in our 3 states to estimate the calendar day and cumulative degree day for first capture, and found it to be approximately day 170 (+ 5 or 6) days, or 1080 (+ 151) degree days base 50-degrees F, in our locations.

In summary, we are able to make reasonable predictions of when beetles, bugs, and borers are first showing spring activity near fields, and once they begin to lay eggs in a field, predict when the next generation will emerge. More research will help refine these predictions, and web sites should be developed that enable growers to utilize these predictions. The high rates of movement of these insects will always limit the accuracy of these predictions, because movement among fields is not being modeled. However, there are useful management implications, especially at the farmscape level, for developing these phenology models for pests of cucurbit crops.

Table 1. Summary of life history parameters for Cucurbit pests from the literature (see footnotes) and this study (*). Table modified from Bachmann, A. 2012. Using population structure and phenology to advance insect management in diversified vegetable agroecosystems. Ph.D. dissertation, Penn State University.

	Striped Cucumber Beetle	*Squash Bug*	*Squash Vine Borer*
Spring life stage	Adult	Adult	Late stage pupae
Degree-day base	55 F	60 F	50 F
Degree days to first detection	132.9 +/- 17.3*	141.7 +/- 9.0*	745.2 DD [1]
Egg to Adult Development Time (Fahrenheit DD)	793.6 DD [2]	725.1 DD [3]	1687.5 DD [1]
Preoviposition Period	204.8 DD [2]	140 – 200 DD [4]	--

[1] Canhilal et al 2006 [2] Ellers-Kirk and Fleischer 2006 [3] Fargo and Bonjour 1988 [4] Nechols 1987

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THE OLD AND THE NEW: YELLOW VINE DECLINE AND UPDATE ON THE MILDEWS

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CUCURBIT YELLOW VINE DECLINE (CYVD) This past summer cucurbit yellow vine decline, a relatively new disease in the Northeast region, was confirmed in a pumpkin trial at one of the Penn State research farms as well as in a commercial pumpkin field in Pennsylvania. This disease was first detected in Oklahoma and Texas in 1988 and has sense been confirmed in the Southeast region of the U.S. In the Northeast, it was confirmed in Massachusetts in 2003 but has not been seen since and has also suspected in Ohio. Although previously suspected in PA, this is the first confirmation of the disease statewide.

Fig. 1. Symptoms of CYVD on pumpkin.

This disease is caused by the bacteria, *Serratia marcescens*, which is vectored by the squash bug (*Anasa tristis*). The symptoms are similar to bacterial wilt which is transmitted by the cucumber beetle but disease progression is much more rapid (Fig. 1.). The plants can wilt and turn yellow almost overnight usually 10 to 14 days before the fruit is mature. Cross-sectioning of the crown can reveal discoloration of the phloem tissue which has become colonized by the bacteria.

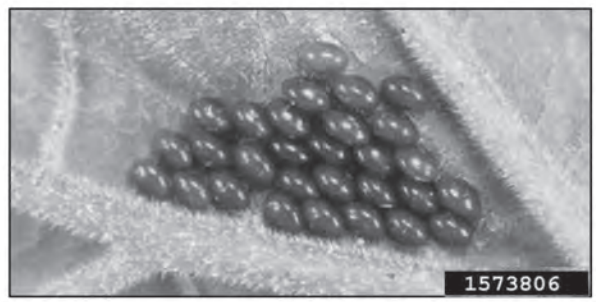

Fig. 2. Bronze colored squash bug eggs on the underside of a cucurbit leaf (Photo: Gerald Holmes, Valent USA Corporation, bugwood.org).

The key to managing CYVD is early detection and management of the squash bug in the nymphal stages. Similar to bacterial wilt, once the bacteria are inside the plant there is little that can be done to prevent the plant from dying. The squash bugs themselves can also cause direct damage by using the piercing-sucking mouthparts to suck the sap out of the leaves causing them to wilt and collapse. Intense feeding can cause the entire leaf to collapse. Although the squash bug is considered a pest on all cucurbits, it prefers squash and pumpkins and CYVD is primarily a problem on these cucurbit crops as well.

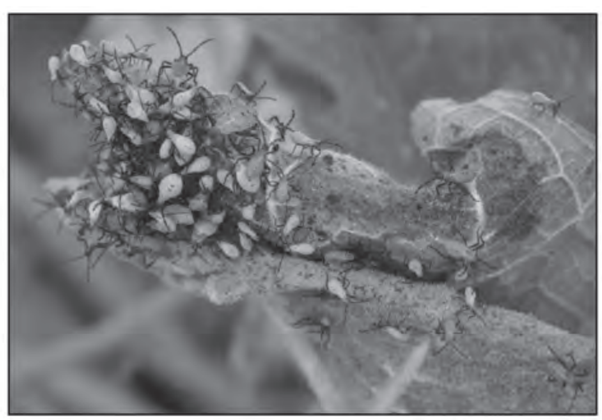

Fig. 3. Various squash bug nymph life stages on a pumpkin leaf.

It is important to scout for squash bug early by looking for the iridescent bronze colored eggs on the lower leaf surface (Fig. 2.). The egg masses are laid in a diamond or V-shaped pattern and can consist of up to 20 eggs. The eggs will hatch in one to two weeks and then take an additional four to six weeks to go through five instars to become adults. All life stages may be found on the same plant because the female lays eggs over a long period of time (Fig. 3.). The unmated adults will overwinter in plant debris or along edges of fields also harboring the bacteria overwinter. The next season these adults move into the crop and transmit the bacteria.

The action threshold for squash bug is one egg mass per plant during flowering. It is important to manage them early in the season before the populations are large and there are a greater proportion of adults which are more difficult to manage. Also as the crop becomes larger it can be more difficult to get foliar insecticides into the crop canopy. The two most critical points for the host is at the young seedling stage and at flowering. Chemical treatments should be directed towards the nymph stages and application coverage is critical since they tend to hide.

Mowing weeds and managing vegetation around field edges will reduce potential overwintering sites for the squash bugs. Maintaining a healthy actively growing crop through optimal fertilizing and irrigating will also help reduce squash bug feeding. Rotate cucurbit fields as far apart as possible.

POWDERY AND DOWNY MILDEW UPDATE. Powdery and downy mildews continue to be an annual concern for cucurbit production. Since neither of these pathogens overwinter in the Northeast and mid-Atlantic regions, the asexsually produced spores move into our production fields from other nearby sources typically from the Southeast moving up along the east coast.

Although not as effective as prior to 2004, cucumber varieties with resistance to downy mildew still offer a slight bit more disease suppression than those that have not been bread with resistance. Last season Seminis released a couple of slicing cucumber varieties (SV3462CS and SV4719CS) with intermediate resistance which delayed disease development slightly creating a larger window for the application of a fungicide compared to more susceptible varieties. Despite this advancement, fungicides are still the primary tool for downy mildew management and an important resource for timing their application is the NCSU Cucurbit Downy Mildew Forecasting (CDM ipmPIPE) website (http://cdm.ipmpipe.org). Expand your fungicide program to include downy mildew specific fungicides when the crops are considered at high risk due to combination of favorable environmental conditions and the pathogen has been detected in the region. Reporting outbreaks of downy mildew is important to aid in disease management not just on a local but on a regional level.

The list of powdery mildew resistant varieties continues to increase. For pumpkins, the resistance is most effective when it is from both parents (homozygous resistance). Depending on the seed catalogue, these are typically categorized as highly resistant vs intermediately resistant (heterozygous resistance from one parent). Host resistance coupled with a good fungicide program can be used to successfully manage powdery mildew. It is also much easier to manage powdery mildew organically using both microbial biopesticides and biochemical biopesticides than downy mildew. Regardless of the products being used, scouting is a critical component of management. One powdery mildew lesion on 50 leaves is enough to trigger a fungicide program. Remember for every lesion that is visible, there are numerous lesion not yet visible to the naked eye.

Last season, the fungicide efficacy table for cucurbit powdery and downy mildew was updated to reflect shifts in product efficacy as well as expanded to included newly registered products. For both diseases, fungicide resistance continues to be serious concern and can greatly affect your bottom line through increased input costs as well as crop loss. Alternating between products based on FRAC codes and tank mixing with a broad spectrum protectant continues to be a highly recommended practice

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2013 Fungicide Resistance Management Guidelines for Cucurbit Downy Mildew and Powdery Mildew Control in the Mid-Atlantic & Northeast regions of the United States

Fungicide	Active Ingredient(s)	FRAC Code*	Risk Rating**	Management Required***	Powdery Mildew	Downy Mildew	General Fungicide Resistance Management Guidelines****
Kocide 3000 or OLF	fixed copper(s)	M1	L	N	+		FRAC code M fungicides are low risk, protectant fungicides. Use alone, or tank mix with high-risk fungicides to improve control
Microthiol or OLF	sulfur	M2	L	N	++		
Manzate, Dithane or OLF	EBDC	M3	L	N		++	
Gavel	zoxamide + mancozeb	M3 + 22	L - M	N		++	
Bravo, Echo or OLF	chlorothalonil	M5	L	N	++	++	
Topsin M	thiophanate methyl	1	H^R	Y	+		Select fungicides with at least ++ rating. Rotate among fungicides with different FRAC codes. Tank mix high risk fungicides with FRAC code M product if the product is not formulated with a FRAC code M fungicide.
Rally	myclobutanil	3	M^R	Y	++		
Procure	triflumizole	3	M^R	Y	++		
Folicur	tebuconazole	3	M	Y	++		
Inspire Super	difenconazole + cyprodinil	3 + 9	H	Y	++		
Ridomil Gold Copper	mefenoxam + copper	4 + M1	H^R + L	Y		+	
Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	H^R + L	Y		+	
Fontelis	penthiopyrad	7	M - H	Y	++		When resistance is qualitative (FRAC code 1 and 11 fungicides), resistant pathogen strains are completely insensitive and cannot be controlled with the fungicide.
Luna Experience[a]	fluopyram + tebuconazole	7 + 3	M	Y	+++		
Luna Sensation[a]	fluopyram + trifloxystrobin	7 + 11	M	Y	+++		
Pristine	boscalid + pyraclostrobin	7 + 11	H^R	Y	++	+	
Quadris	azoxystrobin	11	H^R	Y	+	+	
Cabrio	pyraclostrobin	11	H^R	Y	+	+	
Flint	trifloxystrobin	11	H^R	Y	+		With quantitative resistance (FRAC Code 3 fungicides), pathogen strains exhibit range in fungicide sensitive and efficacy depends on level of insensitivity. Better control can be obtained with high label rates and tight spray intervals.
Reason	fenamidone	11	H	Y		+	
Pristine	pyraclostrobin + boscalid	11 + 7	H^R	Y	++	+	
Tanos	famoxadone + cymoxanil	11 + 27	L - M	Y		+	
Quintec	quinoxyfen	13	H	Y	+++++		
Ranman	cyazofamid	21	M - H	Y		+++	
Gavel	zoxamide + mancozeb	22 + M3	M + L	Y		++	
Curzate	cymoxanil	27	L - M	Y		++	
Previcur Flex	propamocarb HCL	28	L - M	Y		+++	
Alliete	aluminum tris	33	L	Y		+	[a]Luna fungicides are labeled for watermelon only.
Phosphonates	phosphorous acid salts	33	L	Y		+	
Forum	dimethomorph	40	L - M	Y		+++	
Revus[b]	mandipropamid	40	L - M	Y		+/+++	[b]Revus is poor on cucumber. Presidio has exhibited poor control when the pathogen originated from the southeast.
Presidio[b]	fluopicolide	43	H	Y		+/++++	
Zampro	ametoctradin + dimethomorph	45 + 40	M	Y		++++	
Torino	cyflufenamid	U6	M	Y	+++++		

Efficacy Ratings: + = poor (not recommended), ++ = poor to good, +++ = good, ++++ = very good, +++++ = excellent

* FRAC code: M = multi-site mode of action (MOA), numbered groups = fungicides with similar MOA

** Risk Ratings: L = low risk, M = moderate risk or H = high risk for fungicide resistance to develop

*** Risk management required according to fungicide label

**** See fungicide label for specific crops, rates and instructions on use

[R] = resistance known; (+ boxes shaded gray) control failures detected in the mid-Atlantic and Northeast regions
Fungicides with the same color belong to the same FRAC code

Trade or Brand Names Disclaimer: The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement by the Rutgers Cooperative Extension is implied. Furthermore, in some instances the same compound may be sold under different names, which may vary as to label clearances.

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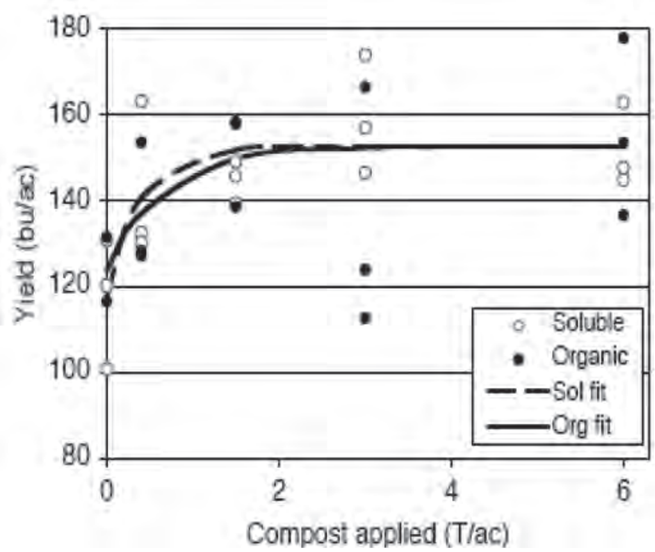
LINKING NUTRIENT MANAGEMENT TO WEED PROBLEMS

Brian Caldwell, Cornell Organic Cropping Systems Project

It is tricky to manage soil fertility in organic production systems. Varying nutrient contents of amendments and release regulated by soil biology are just two aspects to consider. Restrictions on what can be applied and days to harvest restrictions are others. It is tempting under those circumstances to apply extra, just to be sure. In addition, amendments like compost and manure have positive effects on soil health. So, is there any reason not to apply more than crops need?

For field crop producers, the cost of fertility amendments can be a large part of overall expenses, so applying only what is needed is a high priority. However, for vegetable growers, the value of a good yield can more than cover an increased outlay on fertility inputs. Livestock farmers may purchase considerable feed, and thus return more nutrients to their land in manure than they remove in crops. For these reasons, fertility applications may be high on some organic farms.

Figure 1. Corn yields vs. compost rate



There may be a negative consequence for over-fertilizing beyond unnecessary expense or even possible water degradation from runoff, erosion, or leaching. Years ago when I cleaned out my neighbor's winter pack beef manure to put on my vegetable fields, he invariably said, "Now that will make the weeds grow!" It turns out, as was often the case, that he was right.

Dr. Chuck Mohler at Cornell has done several field studies indicating that weeds respond to higher levels of compost additions than do crops. That is, above a certain level, crop yields level off, but weed growth and seed production continue to increase.

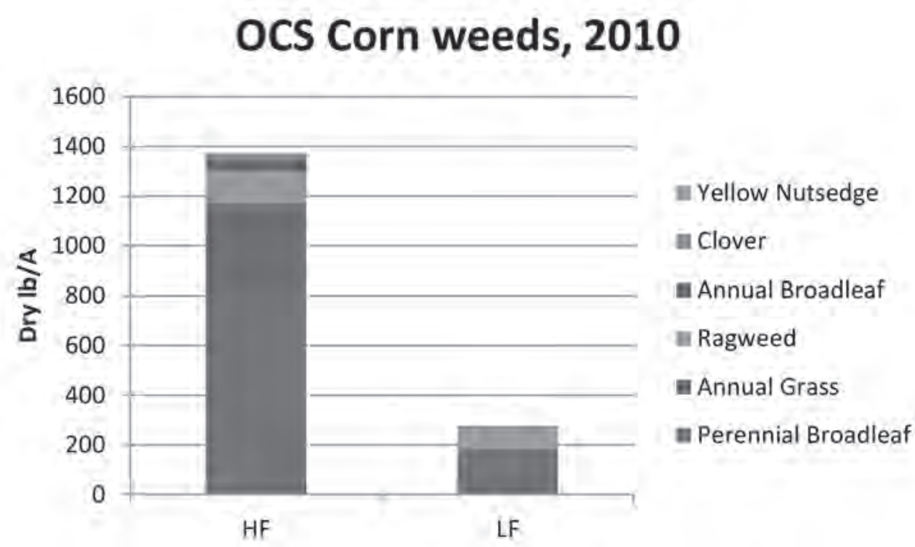
For instance, in one study directed at finding the optimal rates of chicken manure compost applications in a grain rotation, corn yields maxed out at about 1 ton per acre. However, the heights of foxtail, ragweed, and lambsquarters continued to increase at twice that application rate. Furthermore, even after the trial was over, weeds grew bigger in the areas that had received more compost (but corn did not respond).

In another example from the Cornell Organic Cropping Systems Project (OCS), four organic grain systems are compared over time. In particular, one system received regular, though moderate, compost applications while another had only a light application of corn starter in each 3-year rotation. Thus every 3 years the high fertility (HF) system got 125-167-54 (NPK) while the low fertility (LF) system received only 8-15-8. Besides a grass cover crop underseeded in HF at last cultivation, that was the only difference between the two systems. In both systems, a red clover green manure crop was plowed in before the corn. After 6 years, corn weed biomass was significantly higher in the HF system. The surprising thing was that corn yields in the two systems were the same, and above County averages in the second rotation. In this case, extra fertility additions meant more weeds but the same yields.

What is it about compost that makes weeds so happy? Trials were conducted to determine which component of the compost was responsible for increased weed growth. Most weeds did not respond to elevated levels of nitrogen or potassium. We attempted to supply phosphorus (P) by applying bone char, the organic source which carried the least other confounding nutrients. However, due to low availability of phosphorus from this source, we could not raise soil or tissue levels, so results were ambiguous. Phosphorus is strongly implicated, but not proven to be the culprit.

Our suggestions at this point are to refrain from applying more compost or P than you need for good yields. See Penn State's pamphlet, Using Organic Nutrient Sources for guidance. If soil P is low, by all means add compost. But if it is already high, use legume green manures to add nitrogen to your rotation whenever possible in place of compost additions. Be sure to plant legumes at the proper times to allow for heavy biomass production. A small or light green manure crop will not produce the nitrogen your cash crops need. Use green manures lavishly, and compost sparingly like the precious stuff it is, to grow big crops and small weeds!

Figure 2. OCS corn weed biomass in high and low fertility systems



MANAGING BROWN MARMORATED STINK BUG ORGANICALLY

Gladis M. Zinati
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Brown marmorated stink bug, BMSB, (*Halyomorpha halys*, Stal) is an agricultural pest and homeowner nuisance. Native to Japan, South Korea, and China, it was introduced into the Allentown, PA sometime around 1996. Damage extent, control methods and host plants were not known until 2003, when Karen Bernhard at PSU Cooperative Extension reported populations in Allentown, PA. Between 2003 and 2005, BMSB population was significantly higher than endemic species and had numerous host plants including ornamental and specialty crops. In 2006, BMSB caused severe damage in fruit trees in NJ and PA and high numbers were found in soybeans and ornamentals. Due to diverse host plants, the insect threatens an estimated $21 billion worth of crops in the United States alone.

Identifying BMSB

BMSB adults are relatively large compared to other stink bugs, measuring 1/2 - 2/3" long and 5/16" wide. They are easily identified by the two white bands on the antennae and the black and white banding on the abdomen beyond the wings, the smooth shoulder and the mottled brown legs. They suck juices from fruits and seeds creating pockmarks and distortions that make fruits and vegetables unmarketable and lay barrel-shaped white eggs in clusters. Young BMSB nymphs have an orange abdomen with brown rectangular markings. As the nymphs get older, they show banded antennae and legs with rust-colored abdomen with broad brown markings.

BMSB Biology

In the spring, BMSB adults emerge from overwintering sites (houses, barns, storage buildings, and dead trees) and become active on nearby trees, shrubs, and crops during warm sunny days. Adults can fly more than a mile and some flight over 31 miles. In the spring and throughout the summer, BMSB feed, mate, and lay eggs. They lay egg masses on the underside of leaves. It takes about 35 days to develop from egg to adult with 538 degree day (DD) (57.2 oF). The BMSB female can lay 4-10 egg masses in her lifetime each with 28 eggs. Thus, you could expect 1-2 generations per year, with first generation extends between June and late August and the second one starts sometime in late August through October.

Nympal stages and adults can be seen on a wide range of plant species that bear buds, pods, and fruiting bodies. At particular times during the growing season, BMSB prefer plant species that provide habitat and nutrition (soybean, sunflower, cayenne pepper, tree of heaven, eggplant, tomato, Swiss chard, corn, cherry, moth orchid, mimosa, mulberry, crabapple).

Monitoring and Management Tactics

The high number of host plants that this pest feeds on, its high mobility, and lack of natural enemies make monitoring of this pest in both conventional and organic agricultural systems a challenging task. In October 2012, Dr. Anne Nielsen, an Extension Entomologist at Rutgers University, and collaborating institutions including Rodale Institute were awarded a grant for Organic Management of BMSB Using a Whole-Farm Approach. At Rodale Institute, we investigated the dispersal behavior to understand temporal and spatial movement of BMSB and native pentatomids and their aggregation in order to identify potential organic pest management strategies such as aggregation traps, trap crops, and barriers.

Overwintering structures and fabrics

In November of 2012, we **surveyed all structures** such as buildings, offices, attics, sheds, greenhouses, barns, and garages at Rodale Institute for overwintering BMSBs and recorded the number of dead and live adults per structure.

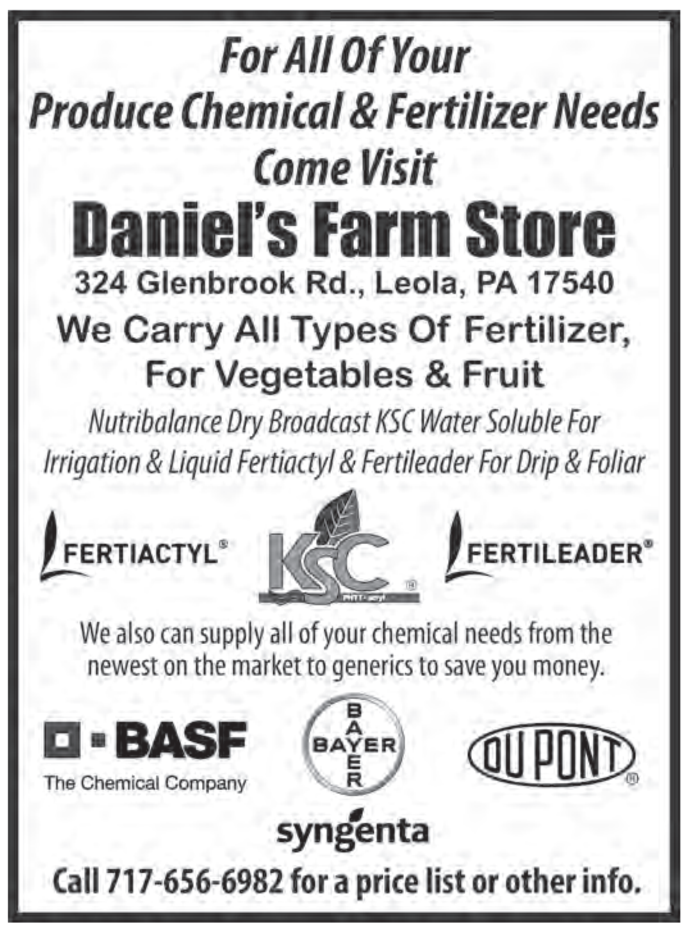
We identified three structures (the book store, the house, and the pavilion) that had live adult BMSBs overwintering. We also identified **fabrics** in which BMSBs preferred to hide and overwinter. Live BMSB adults were found hiding in dark-colored rain coats and black fabric Grow Bags.

Cone traps

To monitor the temporal and spatial dispersal of BMSB adults from the overwintering structures to nearby outdoor areas, we set up four **cones traps each attached to black wooden pyramids** around the house, which is also close to the pavilion and the woods. Each was placed at each side of the building (four cardinal points) in spring 2013. In these cones we placed pheromone #10 and a compound called "A". Between April 18 and June 10 we collected and recoded bugs trapped in these cones twice a week. The first sign of BMSB adults (four females) were seen in the west cone on May 20 and four and 10 days later, two male adults in the west side cone trap. By June, more males and females were seen in the east and south cones. In addition to BMSBs, we also saw caterpillars, small beetles, and spiders in the cone traps. Spider webs were seen on the pyramids.

Trap Crops

Early June of 2013, we tested five different **trap crops** (admiral pea, sorghum, sunflowers, okra, and millet) to document attractiveness of BMSB to these crops and record population and life stages of BMSBs per crop. The trap crops including were planted in Latin square design. A total of 25 plots each of 20 ft x 10 ft. Admiral pea flowered and died pretty quickly before BMSB monitoring started. We monitored weekly and we did not see any BMSB egg masses, nymphs or adults until August 21. The first spined-soldier adult stink bug (a natural enemy) was observed on millet, sunflower, okra, and sorghum towards the south of plots, near the woods. Not until September 4th when first BMSB adult and nymphs were seen on fruit heads of sunflower, millet, and sorghum. During September we recorded male



BMSB adults on sunflowers and on the east and west sides of sorghum. Native stink bugs were also observed on sorghum. As the sunflowers started senescing and temperatures started to drop into the lower 40's, few BMSBs were seen on sunflower leaves. Later in September, BMSBs were seen on the south side of sorghum along the native stink bugs. The last scouting was done on October 2nd on a slightly humid, sunny day where one BMSB adult was seen on the east side of sorghum in plots close to the wooded area. Plants were defoliating: okra, sunflower, and sorghum heads had turned orange and brown as seeds became hard. It is important to note that **natural enemies** such as katydid, spiders, lady bugs, praying mantis, and wasps were also found where BMSB adults and nymphs were feeding.

Trap houses

We deployed **trap houses** at two Rodale Institute structures, the pavilion and the Siegfried House on September 16. These two structures are bordered with wooded area and crops. We placed four trap houses outside and four inside the two selected structures to monitor BMSB adult preference to shelter location from cold weather. Trap houses were made of wood, coated with white weather proof paint and stuffed with used row cover pieces. The idea was to use material that commonly found on farms. On November 8, we checked and counted BMSBs in trap houses. At the pavilion we found female adults in outdoor houses concentrated in the east side, followed by the south and west side. We found one male adult in the north side. We found male adults in indoor houses in the south and east side, and female adults in the north and west houses. At the Siegfried House, we did not see any BMSB adults in either the outdoor or indoor trap houses.

Our first year's project results showed that BMSB population was very low and much below the expected level when compared to previous years. Among the trap crops, sunflower and red sorghum seemed to be potential crops to attract and manage BMSB. These two crops are tall, brightly colored, and have seeds that are good protein source. Thus, planting any of these two crops around cash crops will reduce BMSB population and percent injury on cash crops. These crops also attract natural enemies (good predatory insects) that serve well in reducing total BMSB population. These insects include: katydid, lady beetle, and wasps.

In conclusion, because the brown marmorated stink bugs feed on a diverse array of crops, farmers may experience damage on various fruits and vegetables. Economic losses due to this pest would depend on pest pressure and climate conditions. For example, these pests may increase in population with food availability, warmer climate, sunnier days, and absence of natural enemies. At this time, there is limited number of organic insecticides available that are effective on BMSB adults and nymphs without harming the natural enemies. Organic farmers could use scouting during the fall/winter season to discover overwintering sites for BMSB adults and set up the pheromone cone traps to monitor the first appearance of adults. Typically, BMSBs feed (suck) on green plants to nourish themselves and mate after an overwintering period in spring. They then move to sweet crops such as sweet corn and peach, then to berries, tomatoes, and peppers, then to apples and field crops. Thus, the integration of management tactics such as planting plants that attract natural enemies and setting up trap crops near cash crops, to attract these pests, are likely to be the best management strategies an organic or conventional farmer could use to reduce crop losses. We are continuing our efforts in developing effective strategies to manage BMSB population in organic cropping system and increase marketability of produce.

Gladis Zinati is an Interim Research Director at Rodale Institute, Kutztown, PA. She conducts basic and applied research in compost formulations, carbon sequestration, soil fertility, and pest management to improve organic crop production and quality. 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 formerly worked as an Extension Specialist in Nursery Crops for Rutgers University in NJ.

EFFICIENT INTERCROPPING FOR BIOLOGICAL CONTROL OF APHIDS IN ORGANIC LETTUCE

Eric B. Brennan

Lettuce is the most economically important vegetable grown in Salinas valley on the central coast of California, with an annual production value of nearly $1.3 billion in 2012. This is the major production region for lettuce in the U.S. and is often called the 'Salad Bowl of America'. This presentation will share lessons learned during 10 years of research at the USDA Agricultural Research Service in Salinas, California, on more efficient ways that farmers can intercrop lettuce with alyssum for biological control of aphids. This research occurred in a commercial scale in a long-term organic systems experiment that was partially funded by the sale of lettuce from the experiment. The research was motivated by a desire to maximize the marketable yields and the efficiency of the lettuce production.

The most important insect pest of lettuce in California is the currant-lettuce aphid (*Nasonovia ribisnigri*). Intercropping or interplanting lettuce with plants that flower quickly like alyssum is a common and effective strategy that organic farmers in this region often use to control aphids. Alyssum is referred to as an 'insectary plant' because when it is intercropped with lettuce, it attracts naturally occurring beneficial insects like hoverflies into the field. Alyssum flowers provide adult hoverflies with a source of energy (from the nectar) and protein (from the pollen). The females hover flies lay eggs on lettuce plants with aphids and the larvae that hatch from the eggs in a few days, eat aphids.

In highly disturbed agricultural landscapes such as those used for vegetable production in Salinas Valley, the presence of hedgerows around farms and the frequent use of annual cover crops help to protect and maintain populations of beneficial insects year round. These habitats and the use of insectary intercrops, like alyssum, enhance the ability of beneficial insects to control economically important pests like aphids. We refer to this pest management strategy as Conservation Biological Control.

Lettuce management. A GPS guided tractor was used to form beds that were 40 inches wide and into which preplant organic fertilizer (≈ 50 lbs of nitrogen per acre) was injected. The lettuce was transplanted in two lines, 12 inches apart, with 11 to 12 inches between plants within each line. The transplants were approximately 30 to 35 days old at transplanting. The lettuce varieties were either 'Triton' or 'Sunbelt' depending on the year. The alyssum variety was 'Sweet'; this variety is much more vigorous than typical ornamental varieties used as bedding plants. Transplanting was usually was during the first 10 days of May except during the year 3 when rains delayed it until late May. Sprinkle irrigation was used as needed to establish the transplants, but drip irrigation was used for most of the season. During most years liquid organic fertilizers (≈ 15 lbs of nitrogen per acre) were injected through the drip tape approximately 30 days after transplanting. Weeds were controlled by tractor cultivation and by hand weeding once during each crop. And the lettuce was harvested at maturity 39 to 49 days after transplanting. The alyssum insectary plants were concentrated in 8 of the 48 total beds in the field.

Intercropping Changes. There were 3 changes in how lettuce was intercropped with alyssum during 9 years. The first change involved switching from direct seeding alyssum to using transplants to establish the insectary beds. The change was done to simplify weed control and hasten flowering of alyssum. Hand weeding dense lines of direct-seeded alyssum was extremely difficult. Furthermore, direct seeded alyssum required about 30 days of growth before flowering began. The last two intercropping changes were 2 approaches to reduce the field area that was displaced by insectary plantings (Figure 1). The 8 full beds devoted to alyssum during the first 4 years were effective for aphid control, but they also reduced the area for lettuce by 17%. This displacement of lettuce for insectary plants is a major concern for farmers in Salinas where the land rents are high (i.e., $ 1500 to 3000 per acre per year). The reductions in area devoted to alyssum during years 5 to 9 provided excellent aphid control and increased lettuce yields because lettuce densities increased these latter years. The most efficient and recommended approach to intercropping transplanted lettuce with alyssum involved additive intercropping. In additive intercropping, lettuce is transplanted over the entire field at the standard density, and then alyssum transplants are then inserted by hand between the lettuce plants within the line (Figure 2). Based on the experience at the USDA-ARS in Salinas, the additive intercropping approach with approximately 500 to 1000 alyssum transplants per acre appears adequate to provide excellent biological control of aphids. Ongoing efforts to develop more efficient approaches to intercrop direct-seeded lettuces with alyssum by mixing various percentages of pelleted alyssum seed with pelleted lettuce seed will be discussed.

Figure 1. Change in the percentage of lettuce displaced by alyssum over 9 years of research at the USDA, Agricultural Research Service in Salinas, California. During all years the alyssum was concentrated in 8 of 48 total beds in the field. During years 1 to 4, there were 8 full beds of alyssum. During years 5 to 7 there were 8 half beds of alyssum. During the last two years, alyssum did not replace any lettuce in the field, but instead was one alyssum transplants was inserted between every 3 to 5 lettuce plants in the 8 insectary beds during years 8 and 9, respectively. The first two patterns are called replacement intercropping because alyssum replaced lettuce, and the last pattern is called additive intercropping because alyssum is inserted between lettuce plants at a standard spacing.

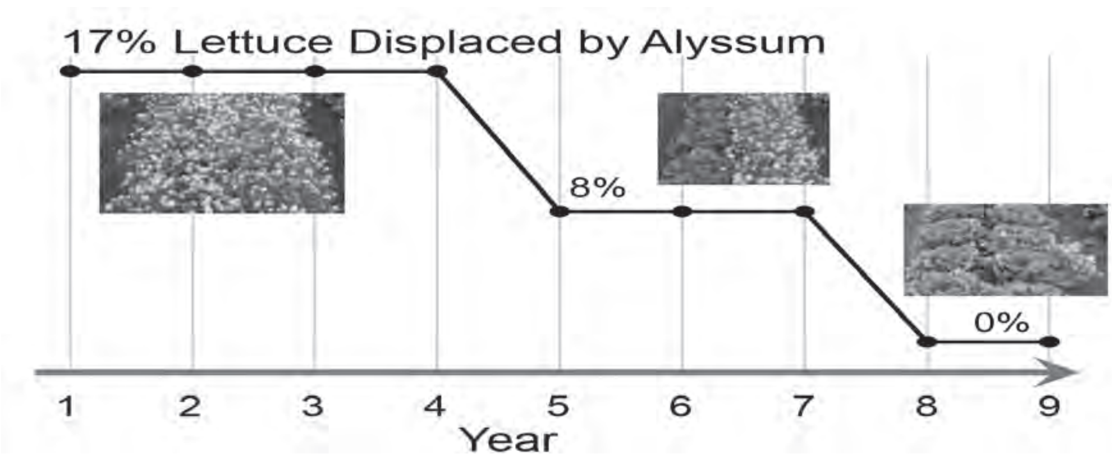
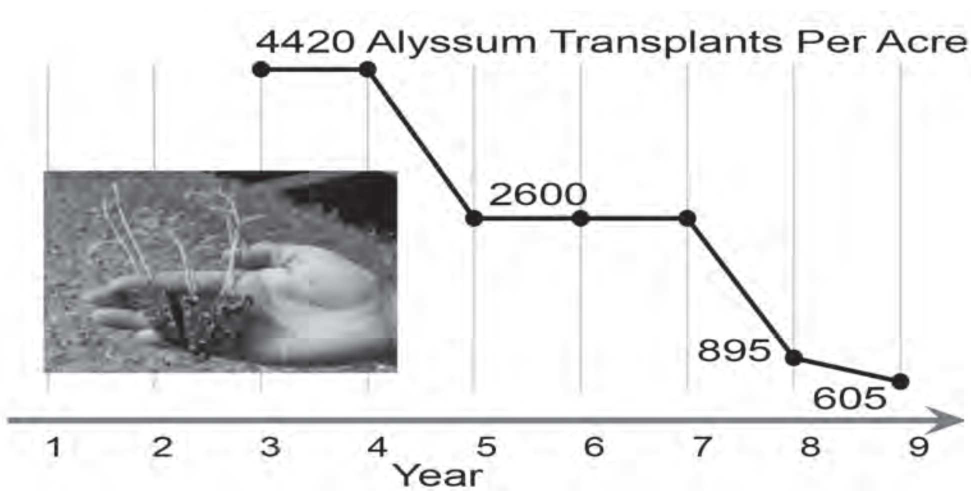


Figure 2. Change in the number of alyssum transplants per acre over 9 years of research at the USDA, Agricultural Research Service in Salinas, California. Data are not shown for the first two years because alyssum transplants were only used during years 3 to 9.



POTTING MIXES AND FERTILIZERS FOR ORGANIC VEGETABLES AND HERB TRANSPLANT PRODUCTION

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In the Cornell greenhouse program we have been studying the characteristics that make up good quality potting mixes for production of vegetable seedlings and transplants. Both conventional and organic potting mixes have been studied. In our most recent work which we will describe here our objectives were to compare different commercially or locally available organic substrates and fertilizers for use in organic production. We have noticed an increased interest in organic production methods and locally prepared potting mixes. However as compared to conventional mixes, organic mixes can be more challenging to manage fertility, pH, and salts. Managing the fertility of an organic crop is often one of the most difficult aspects. Organic fertilizers have low levels of plant available nutrients with slow release rates. Conventional growers have more options to correct the problems in fertility, ph and alkalinity. Many organic potting mixes have enough fertility to support sufficient plant growth for about the first 4 weeks; these mixes seem to be preferred by organic growers to avoid the expense and labor of supplementing with additional fertility. Therefore in our trial we did not add additional fertilizers. If necessary, additional fertility could be added by top-dressing with granular materials or using liquid products. We have had success with many organic fertilizers in other trials.

The mixes trialed in this study included: Sun Gro Sunshine Natural & Organic #1 (Sun 1) and #4 (Sun 4), Sun Gro Metro-Mix Natural & Organic PX-2, a Cornell vermicompost mix (COR), an Ithaca locally formulated mix (ITH), Vermont Compost Fort Lite (VFL) and Fort Vee (VFV), and McEnroe Organic Premium Lite (MOPL). All these mixes were acceptable for certified organic production. The Cornell vermicompost mix was, by volume, 70% peat, 35% coarse perlite and 5% vermicompost (Worm Power LLC, Avon, NY). To this we added 2.5 lbs/yd^3 dolomitic limestone (more can be used if the irrigation water is low in alkalinity), 5 lbs/yd^3 each of green sand and rock phosphate and 3.5 5 lbs./yd^3. The ITH mix was formulated by a local grower in Ithaca New York and was made of compost, peat, coconut coir, perlite and other aggregates and a poultry litter fertilizer. All plants were grown in a glass greenhouse at Cornell University at 70 °F average daily temperature.

In the seedling germination trial seeds of tomato (‘Celebrity’ untreated) and pepper (‘Declaration’ untreated) were sown on the 200 cell trays with 3 replications per substrate treatment. After 4 weeks the experiment was terminated. Germination percentage was determined and the dry weight of 10 combined representative seedlings from a tray was measured. Germination of pepper was significantly reduced and very poor from the ITH substrate. This appears to be due to high salts and immature compost in that mix. Germination and growth of peppers seems to be negatively affected by high pH of mixes (>6.5) and high EC. Tomato has heavier fertilizer requirements and appears to be less affected by substrate pH and high ammonium in fresh compost.

For the transplant experiment plugs (well-rooted 4-5 week old seedlings) of (‘Celebrity’ untreated) and pepper (‘Declaration’ untreated) were transplanted into 4-inch containers. There were 10 replicate plants for each substrate treatment. Each week leachate samples were taken from 5 randomly selected containers from each substrate treatment and sampled for pH and EC (electrical conductivity, i.e. soluble salts - a measure of fertilizer and non-fertilizer salts). After 4 weeks the experiment was terminated. Plant height and dry weights were determined. Many of the substrates had pH levels above the desirable range during the 4 week production period (optimum during production is 5.5-6.5). Substrate pH increased over time due to our moderately alkaline irrigation water at Cornell University. By three weeks after experiment initiation EC levels of containers had all dropped indicating that nutrients were being consumed by the plant or leached out of the substrate. For pepper, plant size was similar for the VFL, VFV, MOPL, ITH and COR mixes. For tomato, plant size was greatest for the ITH mix, and was significantly smaller with Sun 1, Sun 2, and PX-2 – these mixes had much lighter starter nutrient charge than the other mixes. For optimal plant growth additional organic fertility will need to be added soon after transplanting when using these mixes; while the other mixes tested appear to be suitable for pepper and tomato transplant growth in 4-inch containers for at least 4 weeks. When comparing the seedling to the container trials, the seedlings were more sensitive to mixes high in EC whereas the 4-inch transplants were able to take advantage of the added fertility in these high EC mixes.

To follow up the 4-inch transplant experiment we wanted to see if we could use a granular organic fertilizer to improve the plant performance of a low fertility mix. Organic supplied nutrients are primarily slow release and depend on biological processes to convert organically bound nutrients into a plant available form. Conditions that promote microbial activity include warm temperatures, a well-aerated root-zone and a balanced pH. Therefore nutrient release rates of a given fertilizer will vary from operation to operation based on their growing conditions. A trial was conducted to compare the performance of several different granular organic fertilizers on 4-inch tomato transplant growth at average daily temperatures of 50, 60, and 70 °F. We used a peat perlite mix with no added fertility as the base substrate for the trial. The organic fertilizers used included sustane, vermicompost (WormPower, LLC.), Verdanta, and Microstart. Osmocote was used as a conventional fertilizer comparison as was a constant liquid fertilizer. The granular fertilizers were incorporated prior to planting. The pots were placed into a growth chamber set at 50, 60, or 70 °F. No additional fertilizer was applied throughout the trial. Our results indicate that these fertilizers perform well (with some minor differences) at 60 and 70 °F, but plant growth and nutrient availability was very reduced at 50 °F. The trial was terminated after 6 weeks and height and dry weight were measured (Table 4).

Table 1. Analysis of substrates using the saturated media extract method. Preferred range is as reported by the J.R. Peters laboratory.

	pH	Soluble Salts (mmhos/cm)	NO3-N	NH4-N	P	K	Ca	Mg	Na	Cl
			ppm							
Sun 1	6.6	0.43	15	13	5	15	27	17	17	44
Sun 4	6.7	0.52	16	19	10	27	25	15	28	52
PX-2	5.5	1.97	32	18	35	239	112	77	28	58
COR	5.2	0.48	9	27	13	38	9	5	28	52
ITH	7.1	1.37	2	41	68	215	18	6	77	172
VFL	5.3	3.7	270	3	30	315	347	91	210	180
VFF	5.9	3.37	263	2	21	293	282	71	180	179
MOPL	5.7	3.8	277	1	35	331	390	168	87	120
Preferred Range	5.2-6.3	0.75-3.5	35-180	0-20	5-50	35-300	40-200	20-100	N/A	N/A

Table 2. Plant height and dry weight of tomato transplants grown in 4-inch containers in response to different organic or conventional fertilizers applied as granules or a conventional fertilizer applied as a constant liquid

feed (clf). The plants were subjected to one of three different temperatures. Within each column, values followed by the same letter are not significantly different from each other.

Fertilizer	Temp (°F)	Height		Dry weight	
Wormpower	70	25.2	ABCD	2.342	CDE
Microstart	70	28.6	ABC	3.674	BC
Verdanta	70	34.4	A	3.568	BC
Sustane	70	23.6	BCD	4.23	B
Osmocote	70	30	AB	4.26	B
Clf	70	22	BCD	5.726	A
Wormpower	60	15.8	DEFGH	1.306	DEF
Microstart	60	17.4	DEFG	3.076	BC
Verdanta	60	19	DEF	2.382	CD
Sustane	60	19.8	CDE	3.536	BC
Osmocote	60	21.6	BCD	3.91	B
Clf	60	19.6	CDE	3.408	BC
Wormpower	50	9.8	FGHI	0.56	F
Microstart	50	8.4	GHI	0.456	F
Verdanta	50	6.75	HI	0.225	F
Sustane	50	6.2	I	0.256	F
Osmocote	50	10.4	EFGHI	1.104	DEF
Clf	50	9.6	FGHI	0.898	EF

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EFFECTS OF TILLAGE SYSTEMS ON SOIL NITROGEN AND WEED DYNAMICS, GREENHOUSE GAS EMISSIONS, AND YIELD IN ORGANIC VEGETABLE PRODUCTIONS

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Background

Tillage has been used for millennia to suppress weeds, loosen soils, and incorporate plant residue and fertilizer into the soil. However, in the past several decades, conservational tillage and no-till practices have been successfully incorporated into field crop production systems to conserve soil, water and air quality. Yet, these tillage systems have not been practiced much for vegetable systems, especially those grown organically. Moreover, cultivation for weeds control finds its limits because while weeds between crop rows can be managed by cultivation in some cropping systems, weeds within crop rows generally escape cultivation. Therefore, more effective and sustainable practices for organic vegetable productions are needed.

Crop rotation provides an important tool for maintaining long-term soil productivity and environmental quality. Including cover crops in crop rotation systems has been found to provide multiple benefits such as increasing soil fertility, reducing soil erosion and water pollution, and enhancing crop growth. Adding plant flora in an agroecosystem can increase the biodiversity of beneficial arthropods and microorganisms, which could help suppress crop pests and improve marketable yield. Conservational tillage has been reported also to reduce weed seed bank population and thus has a potential to reduce weed pressure in the long term. The objectives of this study was to evaluate the influences of four tillage practices integrated with a cover crop mixture on soil nitrogen and weed dynamics, N2O gas emissions, and crop yield of vegetables transitioning to organic productions.

Materials and Methods

The experiment was located at the University of Maryland Research and Education Center in Upper Marlboro, Maryland. For field trial 1, a mixture of forage radish (FR, *Raphanus sativus*) and crimson clover (CC, *Trifolium incarnatum* L.) cover crops were no-till drilled at seeding rates of 4 and 11 lb/A, respectively on September 19, 2011. Volunteer rye (*Secale cereal*) was also present in the field. For field trial 2, a mixture of three cover crop species was planted at seeding rates of 4, 11, and 60 lb/A for FR, CC and rye, respectively, on September 5, 2012.

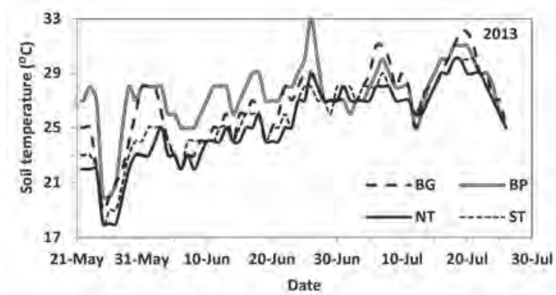
The four tillage treatments for both trials were conventional tillage with bare-ground (BG), conventional tillage with black plastic mulch (BP), strip-till (ST) and no-till (NT). Forage radish was frost killed in January and the remaining cover crop mixture was flail-mowed in early May in BG and BP treatment plots, one week prior to tillage (rototill in 2012 and chisel-plowing in 2013), and in mid- May in the NT and ST plots in 2012 and 2013. Surface disking was performed in BG and BP plots and black plastic was laid in BP plots one week after tillage and just prior to planting/transplanting. The plot dimension was 40 ft by 40 ft, consisting of 12 rows with 3-ft row space in the BG, NT and ST plots, and six rows (double row) with 6-ft row space in the BP plots. This allowed a similar number of plants to exist in all treatment plots.

In 2012 (trial 1), eggplant (*Solanum melongena*) seedlings were transplanted on May 24 at 16″ plant spacing. In 2013 (trial 2), sweet corn (*Zea mays*, cv. Luscious) was direct seeded at 9″ plant spacing on May 20 and reseeded on June 11 and 19 because of poor seed germination. The fertilization rate was 120 N lb/A for both crops. As cover crops provided about 45 N lb/A each year, organic fertilizers (chicken manure -3:2:3, feather meal-7:2:2, or blood meal-12:0:0) were applied to provide 75 N lb/A. The type of fertilizers was chosen based on the soil P level in order not to exceed the optimum level. Fertilizers were applied at 40 N lb/A at pre-planting and 35 N lb/A as side-dress in BG, NT and ST plots, and at 75 N lb/A at pre-planting in BP plots. Pre-plant fertilizer applications were soil incorporated in BG, BP and ST plots. All fertilizers were applied by hand along the crop rows. The BG and BP plots were cultivated and ST and NT plots hand weeded on June 7 and 19, 2012, respectively. Hand-weeding was used in 2013 for all treatment plots on June 20 and July 15, respectively. Surface drip irrigation was used in both years.

Results and Discussion

1. Soil temperature and moisture conditions and plant growth rate

Figure 1 represents soil temperature at 4-6 ″ depth in the plant rows in 2013. Soil temperature was the highest in the BP plots during most of the growing season though it was also high in BG plots during several periods. Temperatures in the NT and ST plots were lowest. This might be due to the mulch effect of cover crop residue.

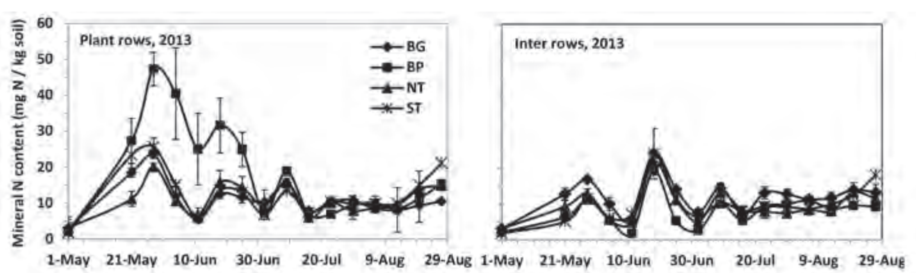


Soils were marginally moister in BG plots than in other treatment plots during the early growing season, though soils in all plots were soundly moist because of high precipitation from May to July. Soils were slightly drier in BP than other treatment plots in early and mid- July because no irrigation was applied. Tillage treatments had a limited impact on soil moisture.

The higher soil temperature in BP plots is believed to have increased the growth rate of eggplant plants (e.g., height and canopy) during the early growth stage. However, plant growth rate in ST plots increased rapidly from the mid- growing season and had the greatest canopy cover but there was no differences in plant height among treatments. However, higher soil temperatures in BP plots did not affect corn plant growth rate in 2013. Corn plants were tallest in ST plots, shortest in BG plots, and intermediate in BP and NT plots.

2. Soil mineral nitrogen content and plant nitrogen uptake

Figure 2 represents soil mineral nitrogen content (NH4+ - N and NO3- - N) at 0-6 ″ depth within the plant and inter- row areas, in 2013. A similar trend was found during the 2012 trial. Mineral nitrogen content in plant rows was greatest in BP plots and lowest in NT plots; mineral nitrogen content in inter row areas was slightly higher in BG plots and lowest in BP plots for several sampling events. The greater mineral nitrogen content in BP plots was probably due to warmer soil temperature, greater initial fertilizer input, and the presence of the plastic mulch that reduced potential N loss during rainfall events. Lower mineral nitrogen content in NT plots was attributed to lower soil temperature and no fertilizer incorporation. Though soil mineral nitrogen content differed among the four treatments, symptoms of plant nitrogen deficiency were not observed in NT plots, and plant leaf SPAD (leaf chlorophyll content) measurements showed no difference in plant nitrogen levels within the plant foliage during both trials.



3. Weed population density

Overall weed densities during the first and second sampling dates were much less in 2013 than in 2012, the exception being within the plant rows of BP plots. On the first sampling date, weed density within plant rows was greater in BG and ST plots than in NT and BP, and was not different between BG and ST (BG = ST > NT = BP) in 2012, and greater in BG than ST, greater in ST than NT and BP, and not different between NT and BP (BG > ST > NT = BP) in 2013; weed density in the inter row areas was greater in BG and BP plots than in ST and NT plots and not different between BG and BP and between ST and NT plots (BG = BP = > ST = NT) in 2012, and was greater in BG than BP, greater in BP than NT and ST plots, and not different between NT and ST plots (BG > BP > NT = ST) in 2013. In both years, weed suppression within plant row areas in NT and BP plots was similar; the BG plots contained the greatest weed density. This was anticipated as these plots did not have any surface mulch and the soil was disturbed by tillage. The within plant row areas of ST and BG plots had similar greatest weed density in 2012 and the ST plots had the second greatest weed density in 2013 due to soil disturbance. The difference of weed suppression in 2012 and 2013 is believed to have contributed to the greater Carbon to Nitrogen (C/N) ratio of cover crop residue in 2013 (30.6:1) than 2012 (21.4:1). The greater the C/N ratio, the longer the period of time that plant residue will remain and weed suppression will persist. There may be other unknown factors that reduced weed germination in 2013 because weed seed population density was not different in the two years (data not shown).

Table 1. Weed population density during growing seasons of 2012 and 2013 in the plant and inter rows.

year	date	Plant row (weeds m^{-2})				Inter row Plant row (weeds m^{-2})			
		BG	BP	NT	ST	BG	BP	NT	ST
2012	Jun. 07	627 (74)*	86 (14)	91 (22)	804 (131)	1728 (183)	1502 (162)	138 (34)	164 (33)
	Jul. 03	96 (26)	8 (3)	10 (3)	210 (59)	304 (50)	457 (74)	33 (13)	418 (180)
2013	Jun. 17	178 (19)	6 (1)	7 (2)	88 (12)	189 (23)	97 (10)	12 (5)	5 (2)
	Jul. 09	61 (7)	4 (1)	11 (2)	24 (4)	54 (6)	47 (9)	7 (1)	17 (5)

* Values inside parentheses are standard errors.

4. Greenhouse gas (N2O) emissions during the growing seasons

Nitrous oxide emissions during the growth seasons in both years followed the same trend for each treatment. N2O emissions were greatest in the plant rows of BP plots, followed by plant rows of ST plots and the plant and inter row areas of BG plots. N2O emissions in the plant rows of NT plots was lower, and the lowest in the inter row areas of BP, NT and ST plots. Overall N2O emissions were in the order of BP > BG > ST > NT. The greater N2O emissions were associated with greater mineral nitrogen content and warmer soil temperature.

Table 2. N2O gas emissions (g N2O-N ha-1) during growing seasons in 2012 (123 days) and 2013 (115 days)

Treatment	BG		BP		NT		ST	
	Plant row	Inter row	Plant row	Inter row	Plant row	Inter row	Plant row	Inter row
	2919 (349)	2918 (676)	5841 (983)	1215 (185)	2114 (287)	1206 (353)	3220 (653)	1345 (256)
average	2919 (367)		3528 (768)		1660 (249)		2282 (416)	

* Values inside parentheses are standard errors.

4. Vegetable yield and quality

In 2012, the total marketable and first marketable yields of eggplant fruits were greater in plots of BG, BP, and ST than in the NT. However, the total insect damage and cull of eggplant were fewer in the plots of NT and ST treatments. Among the four treatments, the ST did the best in terms of fruit yield and quality.

Table 3. Fruit yield and insect damage in 2012 and 2013

Treatment	2012 eggplant yield (US tons /A)				2013 Sweet corn yield (1,000 ears / A)		
	1st Marketable	2nd Marketable	Insect damage	Cull	Total ears	Marketable ears	% Insect damage
BG	16.1 (1.18)	0.9 (0.13)	0.9 (0.13)	0.9 (0.09)	12.19 (0.39)	4.06 (0.22)	55.7
BP	16.8 (0.92)	1.0 (0.12)	1.0 (0.12)	0.8 (0.11)	12.77 (0.44)	3.40 (0.25)	62.6
NT	13.1 (0.92)	0.3 (0.05)	0.3 (0.05)	0.2 (0.05)	12.80 (0.34)	4.29 (0.28)	50.2
ST	16.5 (0.57)	0.2 (0.05)	0.2 (0.05)	0.3 (0.06)	14.22 (0.41)	4.42 (0.20)	62.8

* Values inside parentheses are standard errors.

In 2013, total harvested corn ears were greatest in ST plots but not different among BG, BP and NT treatments. However, marketable ear numbers did not differ among BG, NT and ST treatments and were greater in these treatments than in BP plots. This was due to greater percentage of insect damaged ears in BP and ST plots which was lowest in NT plots. Corn seed germination rate was lower in the BP and NT plots after the first planting (May 20, 2013) because of wet and cool soil conditions caused by rainfall events. Corn had the highest plant establishment in ST compared to other treatment plots. This may be associated with the highest total ears in ST plots.

Conclusion

Soil mineral nitrogen content (or nitrogen mineralization rate) was the greatest in BP plots, followed by BG and ST plots, and lowest in NT plots. Tillage tasks that incorporates fertilizers with soils and black plastic mulch that increases soil temperature will help speed up nitrogen mineralization. With the help of cover crop residue mulch, the best overall weed control was achieved in NT plots and the inter row areas of ST plots. However, the black plastic did successfully control weeds within plant rows. In terms of reducing N2O gas emissions, the priority should be in the order of NT, ST, BG, and BP. In both trials, marketable yield in the ST plots were ranked the highest among the four treatments. The complete picture favored the ST treatment. Therefore, in combining the effects on nitrogen availability, weeds control, reduction of N2O gas emissions, and yield quantity and quality, strip-tillage appears to be a promising option for organic vegetable productions.

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DON'T GET "BROAD-SIDED" BY BROAD MITES

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Broad mite, *Polyphagotarsonemus latus* is a mite species that may be encountered in greenhouses during production. Broad mite is classified as a tarsonemid mite and feeds on a wide variety of horticultural crops including African violet, begonia, browallia, chrysanthemum, cissus, cucumber, dahlia, delphinium, eggplant, English ivy, exacum, fuchsia, impatiens, New Guinea impatiens, pepper, snapdragon, strawberry, tomato, and zinnia. Broad mites are typically a problem when temperatures are between 60ºF and 70ºF (15ºC to 21ºC) and the relative humidity is 60% to 80%, which is conducive for development and reproduction. Broad mites tend to avoid lights. All life stages including the egg, larva, nymph, and adult may be present simultaneously during the growing season. Broad mites feed on young leaves and flower parts, and may even feed on flower buds thus retarding growth and preventing flowers from fully-developing. They reside and feed on the meristematic tissues of plants, requiring tender living tissue that provides an ideal food source for development. Broad mites are typically detected when plant injury becomes noticeable, as the mites are rarely themselves, if ever, detected.

Identification, Biology, and Damage

Broad mite adults are approximately 0.0009 inches (0.25 mm) in length, shiny, amber to dark-green in color, and oval. There are four distinct life stages: egg, larva, nymph, and adult. Development from egg to adult takes 5 to 6 days at 70ºF to 80ºF (21ºC to 26ºC), and 7 to 10 days at 50ºF to 65ºF (10ºC to 18ºC). Females can lay up to 40 eggs during their lifespan; however, this is dependent on temperature and relative humidity. Unmated females only produce male offspring. Eggs are oval, white, and covered with bumps or protrusions. Six-legged larvae emerge from eggs, which transition into eight-legged nymphs, and then eventually adults. Males are usually smaller than females. Broad mites feed in groups, primarily on the underside of young leaves and in flowers, where females lay eggs. Broad mites are cell-feeders using their piercing-sucking mouthparts to feed on the epidermis of young leaves. This causes leaf margins to curl and become brittle, puckered, and shriveled. They may also inject toxins during feeding. When broad mite populations are extensive then individuals may move and feed on the upper leaf surface resulting in severe distortion. In addition, lower leaf surfaces may appear bronzed. Broad mite feeding damages the meristematic tissue of the growing tip or apical shoot, which may inhibit growth, decrease leaf number, leaf size and area, and reduce plant height. Leaves may increase in firmness and appear darker green than normal. Damage may resemble exposure to a phenoxy-based herbicide such as 2,4-D, a virus, or nutritional imbalances (e.g., magnesium deficiency). Broad mites can spread among greenhouse-grown crops via air currents, leaves of adjacent plants contacting each other, and by workers handling infested plant material and then touching non-infested plants. Broad mite females have been shown to attach to the legs and antennae of adult greenhouse whitefly (*Trialeurodes vaporariorum*) and/or sweet potato whitefly B-biotype (Bemisia tabaci); thus resulting in another means of dispersal. Furthermore, male broad mites may transport female nymphs, eggs and adult females to new leaves.

Management

Broad mites require a food source for survival, so implementing sanitation practices such as cleaning greenhouses before introducing new plant material and disinfecting benches, will alleviate problems with broad mite populations. Broad mite populations are difficult to regulate with contact miticides because the mites are located in the meristematic tissues. Miticides with translaminar activity may be more effective, and typically broad mite is listed on the label of many miticides that are translaminar. Translaminar means that after a foliar application, the material penetrates leaf tissues and new terminal growth, forming a reservoir of active ingredient within the leaf or new growing points.

Therefore, these miticides are more likely to come-into-contact with broad mites feeding in the meristematic tissues. Miticides labeled for regulation of broad mite populations include abamectin (Avid), chlorfenapyr (Pylon), fenpyroximate (Akari), pyridaben (Sanmite), spiromesifen (Judo), and spirotetramat (Kontos). Those miticides with translaminar activity are abamectin (Avid), chlorfenapyr (Pylon), spiromesifen (Judo), and spirotetramat (Kontos). Preventative applications may be required; particularly on highly susceptible crops because once damage is evident it is too late to initiate practices that may regulate populations of broad mites. As such, it is recommended to remove and immediately dispose of plants exhibiting symptoms, and even those adjacent to symptomatic plants in order to prevent broad mite populations from spreading.

Biological control of broad mites on greenhouse-grown horticultural crops is a management option that involves the use of commercially available predatory mites including *Neoseiulus californicus*, *N. cucumeris*, or *Amblyseius swirskii*. It is important to apply predatory mites early in the crop production cycle before broad mites become established.

Change In Plant Protection Practices: Why Broad Mites Are More Problematic?

In general, there has been an increase in broad mite populations on many greenhouse-grown horticultural crops, even those that were not initially considered susceptible. This may be a response to the extensive use or reliance on the neonicotinoid insecticides including imidacloprid (Marathon), thiamethoxam (Flagship), acetamiprid (TriStar), and dinotefuran (Safari). These insecticides have systemic activity and are commonly applied as a drench or granules to the growing medium (with the exception of acetamiprid or TriStar) to regulate populations of phloem-feeding insect pests such as aphids, whiteflies, and mealybugs; however, they have no activity on mites. Before the introduction of the neonicotinoid insecticides, greenhouse producers typically applied broad-spectrum insecticides (with miticidal activity) to regulate the diversity of insect and mite pests (e.g., thrips, whiteflies, aphids, and spider mites). In addition to regulating populations of the target insect or mite pests, applications likely indirectly maintained broad mite populations below damaging levels, thus preventing outbreaks. Therefore, the reliance on neonicotinoid insecticides may have allowed broad mite populations to escape exposure and build-up to damaging levels.

For more detailed information on broad mites consult the following extension publication:

Cloyd, R. A. 2010. Broad mite and cyclamen mite management in greenhouses and nurseries. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2938. Kansas State University, Manhattan, KS. 4 pages.

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THE LATEST, BEST, MOST WONDERFUL PERENNIAL FLOWERS THAT EVERY GREENHOUSE NEEDS TO GROW AND SELL

Sinclair Adams, Penn State Extension

Perennial plants are known as the backbone of the garden, and provide interest and change over the course of the season. Many new selections have been introduced to the greenhouse and nursery industry recently, but which ones are the ones to grow in your operation? Simply because a plant is new does not necessarily mean it is good, it is just new. Learn which new plants are good new plants that will grow successfully, and sell well from your nursery or greenhouse operation. A series of great plants from a wide range of breeders will be presented, described, and their attributes elaborated. Their performance in the mid-Atlantic region has been tested, and these selections will be an asset to your business.

Sinclair has received a BS from the Univ. of Wyoming in Plant and Soil Science 1983, and a MS from the Univ. of Vermont in Plant and Soil Science 1988. He has been in education at Univ. of Vermont (Adjunct) 2013, Temple University (Adjunct & Senior Lecturer) 2000-2006, & Research Fellow 2002-2006. Also serving at The Barnes Foundation as an Instructor 1995-1997. Sinclair has over 30 years industry experience: Recently, as Plant Scientist, for Vermont Organics Reclamation, and owner, of Dunvegan Nursery from 1989-2009. He was a Range Manager Greenleaf Enterprises 1988-1989, and Assistant Horticulturalist at The Brandywine Conservancy. Sinclair has been published in research on plant propagation, nitrogen nutrition of perennial plants, germplasm releases from 1990-2006 in the Journal of Environ Hort, HortScience, Perennial Plant Assn. Journal, Daylily journal, IPPS proceedings, and American Nurseryman). He has been an invited speaker at the VT Flower Show, Univ. of VT, Solar Fest, PPA, Northern New England Nursery Conference, Millersville Native Plant Conf., US Nat'l Arb. Lahr Conference, Delaware Extension Meeting, New England Greenhouse Conference, and IPPS. Holder of 15 plant patents, Sinclair has developed Tiarella, Chrysanthemum, and Phlox selections for industry, and is a member of ASHS, PPA, Pi Alpha Xi, & the Hardy Plant Society.

HARD TO RESIST: UNDERSTANDING ISSUES ASSOCIATED WITH RESISTANCE IN INSECT POPULATIONS—PARTS 1 AND 2

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Insect (and mite) pests of greenhouse-grown horticultural crop production systems are primarily managed with pesticides, in this case insecticides (and miticides). However, many insect pests possess the inherent ability to evolve (or adapt) to various environmental and human disturbance factors such as pesticide applications. Therefore, continual reliance on pesticides eventually leads to resistance, which is the genetic ability of some individuals in an insect pest population to survive pesticide exposure. In other words, the pesticide(s) no longer kills a sufficient number of individuals in the insect pest population to be considered effective.

Resistance is an international concern with expanding global trade of plant material that not only can spread insect pests, but may also spread resistance genes that insect pests harbor. Resistance is an inherited trait. Evolution of resistance in a population depends on existing genetic variability that permits survival of some individuals when exposed to a pesticide. Surviving individuals transfer traits (genetically) to the next generation thus enriching the gene pool with resistant genes. The "selection pressure," or proportion of the population killed by a pesticide, is the main factor, along with genetic variation in the insect pest population responsible for susceptibility to the pesticide, which influences the evolution of resistance. Every time an insect pest population is exposed to a pesticide, this potentially results in selection for resistance; thus increasing the frequency or proportion of resistant genes within an insect pest population

The speed of resistance developing in an insect pest population is dependent mainly on two biological factors: short generation time and high female reproduction. In addition, some pests, including the twospotted spider mite (*Tetranychus urticae*) and the western flower thrips (*Frankliniella occidentalis*), have haplo-diploid breeding systems that accelerate the rate of resistance development. Genes associated with resistance are fully-expressed in haploid (single set of chromosomes) males in haplo-diploid species, whereas with entirely diploid (double set of chromosomes) species, resistance may be partially hidden as recessive or co-dominant traits.

An individual does not become resistant, but due to frequent applications of a given pesticide over multiple generations, susceptible individuals are removed from the population and resistant individuals remain to breed and reproduce. This results in an insect pest population that may no longer be controlled with a given pesticide. Resistance may also develop due to the movement of insect pests within and into greenhouses. There are three ways that pest immigration enhances resistance. First, migration from other crops within the greenhouse, or between greenhouses increases the likelihood that the insect pest population has been exposed to additional pesticide applications. Second, receiving plants from a distributor with insect pests that have been previously exposed to pesticides may enhance the prospect of resistance developing, as a large percentage of these insect pests may already possess genes for resistance. Finally, insect pests that enter greenhouses from field or vegetable-grown crops may have been exposed to agricultural pesticides that are similar to those used in greenhouses.

Different mechanisms may confer resistance in various populations of the same species of an insect pest, and multiple resistance mechanisms may co-exist in the population. The mechanisms of resistance are 1) metabolic, 2) physiological, 3) physical, 4) behavioral, and 5) natural. **Metabolic resistance** is the breakdown of the active ingredient by the insect pest. When the pesticide enters the body, enzymes attack and detoxify or convert the active ingredient into a non-toxic form. Detoxifying enzymes convert insecticides (which are hydrophobic or "water-hating") to more hydrophilic ("water-loving") and less biologically active compounds that are eliminated via excretion. A number of enzymes may be involved including hydrolases (e.g., carboxylesterases), glutathione S-transferases, and cytochrome

P450 mono-oxygenases (also called mixed function oxidases). **Physiological resistance** is also referred to as target site insensitivity. The interaction between the pesticide and its target is similar to a key (the toxin) fitting into a lock (the target site). Decreased binding associated with physiological resistance is analogous to the lock having been changed so that the key no longer fits, and consequently the pesticide is no longer effective. Examples of this kind of resistance occur in the organophosphate, carbamate, and pyrethroid chemical classes. Insects may evolve different means to decrease susceptibility to organophosphate and carbamate insecticides including reduced sensitivity of acetylcholinesterase or AChE (this is an enzyme in the central nervous system that is inhibited by insecticides in the organophosphate and carbamate chemical classes), increased activity of AChE, or overproduction of AChE. Additionally, insects may possess what is known as "knockdown resistance" or "kdr." In this case, the nervous system of insects has reduced sensitivity to pyrethroid insecticides (e.g., bifenthrin, cyfluthrin, permethrin, fenpropathrin, fluvalinate, and lambda-cyhalothrin) due to modifications of the sodium channels associated with nerve axons, which are the target site for pyrethroid insecticides. **Physical resistance** is a change or alteration in the cuticle (skin) that reduces or delays penetration of the pesticide. Delayed penetration through the cuticle or integument reduces the concentration of insecticide at the target site, and prevents overloading the insects' detoxification system. **Behavioral resistance** is when insect pests avoid contact with a pesticide. One behavior is hiding in locations such as the terminal growing points, which may be difficult for the pesticide to penetrate. **Natural resistance** is a term used to describe the lack of susceptibility to a toxin that is pre-existing and does not result from repeated exposure of an insect pest population to a pesticide. This may be due to any of the previously described metabolic, physiological, physical, or behavioral traits including life stages not susceptible to a pesticide. For example, most contact and systemic insecticides and/or miticides are not effective against the egg and pupae.

Factors that may influence the rate of resistance development in insect pest populations can be divided into operational factors, which are under the control of greenhouse producers, and biological factors that are intrinsic to the insect pest population. These are presented below:

Operational Factors

- Length of exposure to a single pesticide (pesticide residue characteristics).
- Frequency of pesticide applications.
- Dosage (use rate) of pesticide applied.
- Spray coverage (non-uniform deposition on leaves).
- Level of mortality (proportion of insect pest population killed).
- Applying pesticides when the most susceptible life stage(s) such as larva, nymph, and adult are absent.
- Previous history of pesticide use.
- Relatedness of a pesticide to those that have previously been applied.
- Presence or absence of refuge sites or hiding places.

Biological Factors

- Time to complete one generation (egg to adult).
- Numbers of offspring produced per generation.
- Insect pest mobility (winged adults disperse to mate and/or feed in protected habitats).
- Host range (a wide range of plant hosts pre-adapts insect pests to detoxify pesticides).
- Mobility of individuals.

- Genetic system (parthenogenesis, haplo-diploid, or sexual reproduction).
- Expression of resistance trait (mono- vs. polygenic).

Greenhouse conditions can increase the rate of resistance developing in an insect pest population. Environmental parameters such as temperature and relative humidity are typically conducive for rapid insect pest development and reproduction. The greenhouse generally encloses insect pests and restricts susceptible individuals from migrating into the population. Therefore, resistant individuals within an insect pest population are dominant and remain in the greenhouse to breed, whereas susceptible individuals from areas not treated with a pesticide are unable to enter and breed with resistant insect pests. Furthermore, biological control agents or natural enemies such as parasitoids and predators are often absent, and may not be able to immigrate into greenhouses. Finally, intensive year around production in many greenhouses provides a continuous food supply for insect pests often resulting in multiple generations per year and frequent exposure to pesticide applications.

Resistance Management

Resistance management (or more appropriately—mitigation) is a strategy designed to preserve or sustain the effectiveness of currently existing pesticides. This primarily involves judicious selection and accurate application of pesticides, and their integration with other plant protection strategies consistent with basic pest management philosophy. This is the most effective way of avoiding resistance. Because resistance is genetically based, it is the frequency of resistance in an insect pest population that a greenhouse producer attempts to mitigate in a resistance management program. Below are generalized guidelines to help minimize insect pest populations from developing resistance to any pesticide:

- Scout crops regularly to appropriately time applications of pesticides so as to target the most susceptible life stage (larvae and adults).
- Implement proper cultural (water and fertility) and sanitation (weed removal) practices.
- If feasible, screen greenhouse openings so as to prevent migrations of insect pests into greenhouses.
- Implement the use of biological control agents or natural enemies.
- Use synergists when applying pesticides to inhibit enzymes involved in detoxification (be sure to read the label to determine if a synergist has already been incorporated into the formulation). However, because insect pests may counteract the presence of synergists through enzyme induction, the effects of synergists may only be temporary. Certain insecticides may also be used as synergists when mixed together. For example, organophosphate insecticides block carboxylesterase enzymes that sometimes metabolize certain pyrethroid insecticides.
- Rotate pesticides with different modes of action.
- Use pesticides with broad modes of activity such as insect growth regulators, insecticidal soap (potassium salts of fatty acids), horticultural oils (petroleum-based), selective feeding blockers, beneficial bacteria and fungi, and microorganisms.

When developing a resistance management program it is important to rotate common names (active ingredients)—not trade or brand names. For example, Azatin®, Ornazin®, Molt-X®, and AzaGuard™ despite having different trade names, contain the same active ingredient—azadirachtin. Furthermore, in order to alleviate the possibility of an insect pest population developing resistance, it is important to design rotation programs that involve using pesticides with different modes of activity not just active ingredients or even chemical classes. The reason for this is that some chemical classes have similar modes of activity. Mode of action or mode of activity refers to how a pesticide affects the metabolic or physiological processes in an insect (e.g., sodium channel of the nerve axon, oxidative phosporylation, or juvenile hormone). For example, organophosphates and carbamates, despite being different chemical classes, both have identical modes of activity. These chemical classes block the action of acetylcholinesterase (AChE), an enzyme that deactivates the neurotransmitter acetylcholine (ACh) thus allowing nerve signals to halt, which results in the total loss of nerve functions. So, for example, using acephate (Orthene) for two consecutive spray applications during a generation and then switching to methiocarb (Mesurol) does not constitute a proper rotation program. Similarly, although acequinocyl (Shuttle), pyridaben (Sanmite), fenpyroximate (Akari), bifenazate (Floramite), tolfenpyrad (Hachi-Hachi), and fenazaquin (Magus) are in different chemical classes all are active on the mitochondria electron transport system (responsible for energy production) by inhibiting nicotinamide adenine dinucleotide hydride (NADH) dehydrogenase (complex I), acting on the NADH-CoQ reductase site, or binding to the Qo center or cytochrome bc1 (complex III) in the mitochondria electron transport chain resulting in blockage of ATP (adenosine triphosphate) production. Therefore, these compounds should never be used in succession. The neonicotinoid chemical class contains a number of insecticides including imidacloprid (Marathon), thiamethoxam (Flagship), acetamiprid (TriStar), and dinotefuran (Safari). All the neonicotinoid insecticides have similar modes of action, which involves the active ingredient binding to the post-synaptic nicotinergic acetylcholine receptors causing irreversible blockage. Therefore, it is essential to avoid using these insecticides in succession as this may increase "selection pressure" resulting in resistance to this class of insecticides. It is recommended to use an insecticide with a different mode of activity either before or prior to using a neonicotinoid insecticide.

Another important strategy is to rotate pesticides with specific modes of activity with those having non-specific, multiple, or broad modes of activity such as insect growth regulators, insecticidal soaps, horticultural oils, selective feeding inhibitors, beneficial bacteria and fungi, and microorganisms. This will minimize the possibility of an insect pest population developing resistance. However, it is also important to rotate insect growth regulators with different modes of action since certain insect pests have demonstrated to be resistant to a number of insect growth regulators.

In general, rotate different modes of activity every two to three weeks, or within one to two insect pest population generations. However, this will depend on the time of year as temperature influences the duration of the life cycle (egg to adult). High temperatures that typically occur during the summer months shorten the developmental time of the major insect (e.g., aphids, thrips, whiteflies, mealybugs, caterpillars, and beetles) and mite (e.g., twospotted spider mite) pests associated with greenhouses. This often leads to overlapping generations with variable age structures (eggs, larvae/nymphs, pupae, and/or adults) present simultaneously. Therefore, more frequent pesticide applications are required and rotations must be conducted more often. In contrast, during the winter months, the development time of greenhouse insect pests is extended due to the cooler temperatures and shorter daylengths; thus pesticides may not have to be rotated as frequently. Furthermore, tank mixing or combining pesticides with different modes of action may delay resistance developing within insect pest populations because the mechanisms required to resist pesticide mixtures may not be wide-spread or exist in insect pest populations, and it may be difficult for individuals in the insect pest population to develop resistance to several modes of action simultaneously. Insect pests in the population resistant to one or more pesticides would likely succumb to the other pesticide in the mixture. However, this approach risks selecting for detoxification mechanisms that may permit survival to both pesticides.

Below are examples of rotation programs associated with pesticides, based on the active ingredient (and trade name), that have dissimilar modes of activity against various insect and mite pests:

- *Aphids:* Pymetrozine (Endeavor)->Imidacloprid (Marathon)->Petroleum oil (Ultra-Pure Oil)->Acephate (Orthene)
- *Thrips:* Spinosad (Conserve)->Chlorfenapyr (Pylon)->Abamectin (Avid)->Pyridalyl (Overture)
- *Twospotted Spider Mite:* Bifenazate (Floramite)->Chlorfenapyr (Pylon)->Pyridaben (Sanmite)->Etoxazole (TetraSan)
- *Whiteflies:* Dinotefuran (Safari)->Pyriproxyfen (Distance)->Spiromesifen (Judo)->Buprofezin (Talus)
- *Mealybugs:* Acetamiprid (TriStar)->Acephate (Orthene)->Potassium salts of fatty acids (M-Pede)->Kinoprene (Enstar AQ)

- *Fungus Gnats:* Pyriproxyfen (Distance)->Cyromazine (Citation)->Chlorfenapyr (Pylon)->Diflubenzuron (Adept)
- *Scales:* Potassium salts of fatty acids (M-Pede)->Petroleum oil (Ultra-Pure Oil)->Acetamiprid (TriStar)->Acephate (Orthene)

The rotation of pesticides will only be effective in delaying the development of resistance if the pesticides used select for different resistance mechanisms (described above). For example, metabolic resistance may confer resistance to pesticides in different chemical classes that have different modes of action. As such, rotation programs should encompass as many pesticides with different modes of action as possible.

Combining Resistance Management and Pest Management

The key to converting from a "pesticide management" to a "pest management" or "plant protection" approach usually requires greater reliance on biological control and substantially reducing the use of broad-spectrum pesticides (especially organophosphates, carbamates, and pyrethroids). Careful use of selective pesticides may work in concert with naturally occurring or introduced parasitoids and/or predators to maintain insect pest populations at non-damaging levels. Horticultural crops grown in greenhouses often have very dense canopies, which makes complete spray coverage difficult. This may lead to a situation where the outer part of the plant canopy is thoroughly sprayed, but a refuge remains unsprayed in the plant interior allowing insect pests to recolonize the outer foliage. When selective pesticides are used, natural enemies are preserved, which allows them to deal with the remaining insect pest population in the un-sprayed refuges. This avoids pesticide resistance among insect pest populations by eliminating any survivors through parasitism or predation. As such, effective insect pest regulation may be achieved without the need to ensure complete spray coverage. Unfortunately, this system cannot be established under circumstances where long residual, broad-spectrum pesticides have previously been applied, as these pesticides are generally more toxic to natural enemies than insect pests. However, applying systemic insecticides, which are taken-up by plant roots and distributed throughout the plant, may sometimes be used in conjunction with natural enemies, because residues are internal to the plant thus limiting direct exposure of natural enemies to the insecticide.

For more detailed information on resistance and resistance management consult the following extension publication:

Cloyd, R. A., and R. S. Cowles. 2009. Resistance management: resistance, mode of action, and pesticide rotation. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2905. Kansas State University, Manhattan, KS. 8 pages.

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FERTILIZING PETUNIAS AND CALIBRACHOA: EFFECTIVE NUTRIENT MANAGEMENT FOR TODAY'S VARITIES

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Petunias and calibrachoa are a staple in today's bedding plant market. Many growers either start theirs from seed or buy in plugs and liners. Problems tend to arise later in the season when media pH climbs and iron becomes available. Using the following tools will give you an excellent crop, and save you time and money as well.

Starting strong:

One of the main parts of growing is knowing your water quality. Having your water tested by a reputable horticulture lab in December or January will get you off on the right foot. A grower with a low alkalinity source will need a different program than one with a high alkalinity water. If you have a source with low alkalinity and pH, I generally recommend 20-3-19 Petunia FeED with an occasional booster of a Cal-Mag product. Growers on the opposite side of the spectrum should only use 20-3-19 Petunia FeED and possibly an additional of a sulfuric acid. Your growing media should be a peat-lite mix or a peat-bark mix with a high starter charge. The media pH should be in the 5.4-5.8 range.

Growing:

Petunias are classified as a heavy feeder. The best course of action is to have a constant liquid feed program. The program is as follows; plug stage 100 ppm of Nitrogen, growing on 200 ppm of Nitrogen, then about 2-3 weeks before sale bump this rate to 250 ppm for a strong finish. To do this most effectively use formula exclusively designed for growing petunias and calibrachoa, like a 20-3-19 with 3 forms of chelated iron and added magnesium. By using this feed you will eliminate the need for additions of chelated iron and magnesium sulfate to a general purposed feed like 20-10-20 or 25-5-15. This will also eliminate user error of remembering to add these additions. A bag petunia feed is about a dollar more a bag than a general purpose, but the cost savings of not adding in Epsom salts and chelated iron are quite high. See chart for cost breakdown.

Cost analysis per 100 gallons at 200ppm of Nitrogen

Formula	Cost per 100 gallons
20-10-20	$0.95
25-5-15	$0.76
20-3-19	$1.00
Epsom Salts	$1.28
Iron Chelate 11%	$2.58

Petunia FeED	20-10-20 + Epsom Salts+Iron	25-5-15+ Epsom Salts+Iron
$1.00 per 100 gallons	4.81 per 100 gallons	4.62 per 100 gallons

Troubleshooting:

Growers should be monitoring the media pH and EC of all crops with either in house testing or through a horticultural lab. For the petunia group a pH between 5.4-5.8 and EC levels should fall between 1.3-2.0 mS/cm. Watching the pH will likely keep iron unavailability at bay. Other deficiencies to look out for include boron, calcium and magnesium, especially if you are using a water source lacking in these elements.

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USING BIOFUNGICIDES IN THE GREENHOUSE

Steve Bogash, Horticulture Educator, Penn State Cooperative Extension

Session: Greenhouse Ornamentals, 1/28/14 at 4:00 PM

Proactive growers that pay careful attention to fine details can effectively manage most greenhouse diseases using a largely biologically-based fungicide program. This disease management requires the coupling of good sanitation practices and active management of ventilation as well as other BMP's along with the biological fungicides in order make this work. Diseases like Late blight may require specific systemic materials that are outside of those considered to be biological. The practices described in this article are largely based on growing vegetable transplants in greenhouses as well as producing fruiting tomatoes, peppers and cucumbers under high tunnel conditions. Most of these biological materials have broad enough labels or specific formulations that enable them to be applicable in ornamental greenhouse production.

Direct application of beneficial fungi and/or bacteria to soil, potting media, and plant foliage is a relatively recent practice which is rapidly catching on with producers. The methods and philosophy of using biofungicides such as Actinovate AG and Root Shield are distinct from our past practices of starting with "sterile" media and fighting to keep it clean. We've typically fought the plant disease wars through the application of various chemical fungicides in rotation as we attempt to slow the development of resistance. With materials such as Actinovate and RootShield, application is required prior to any suspected infection as these materials boost plants abilities to prevent infection.

Standard chemical fungicides fall into two main categories: protectant and systemic. Protectant materials such as chlorothalonil (Bravo, Daconil, Equus, and many other trade names) provide fungal disease protection by creating a chemical barrier to disease penetration. Systemic materials such as Azoxystrobin (Quadris, Heritage, and other trade names) move into plant tissue to provide disease management from within. Protectants' do not manage diseases once a plant is infected and systemic materials provide only a measure of "clean-up" disease control activity. The mindset of relying completely on non-biological materials assumes that growers take a long series of "fall back" positions as there are always new strains of disease causing organisms as well as diseases that get missed until our crops have received serious damage.

The application of beneficial organisms (biofungicides) is another tool to add to our arsenal in managing diseases in the greenhouse and field. These materials have unique modes of action (MOA) that can provide levels of disease management not possible with our traditional fungicides. Since these are living organisms, their application requires strict adherence to the labeled application instructions. Often pH, tank mixing, and surfactant instructions are very precise in order to reach reasonable levels of efficacy. Even with these challenges, field experience has proven that these biological materials can provide disease management in situations where traditional chemistries have failed to do so. Also, since they are living materials, many of these biological materials have short storage lives and specific storage instructions.

How biological fungicides work (modes of action):

Direct Competition: Before infection can occur, the pathogen must gain access to the root zone, then penetrate plant tissue. An effective biofungicide will grow faster than the pathogen and out compete it for nutrients and space.

Antibiosis: Some biological materials produce chemical compounds such as antibiotics and toxins that kill or inhibit pathogen growth. These compounds can prevent germination of fungal spores or restrict growth.

Predation and or Parasitism: Some materials such as Actinovate AG, Root Shield, RootShield Plus and SoilGard 12G claim that their materials actively seek out pathogens and destroy them.

Induced Resistance: While plants do not have immune systems like animals, they do have defense mechanisms. Certain biological controls will induce plants to produce defensive compounds such as salicylic acid (similar to aspirin). Salicylic acid can travel throughout the plant and stimulate the plants own defense mechanisms prior to infection.

As mentioned previously, biological fungicides require application before the plant becomes infected with a pathogen. Most commonly, a producer will drench containers, transplants or cuttings either just before or during the planting process. Products like SoilGard 12G are incorporated directly into potting media. Those with foliar activity are applied (as a foliar spray) in much the same manner as protectant fungicides such as Chlorthalonil. These living materials colonize the root zone (rhizosphere) and surface of leaves (phylosphere), fruit and flowers. For those growers using fumigants, it is very important to inoculate soil with a beneficial organism immediately after fumigation in order to have the desired organism (biological fungicide) dominate. Most fumigants require a waiting period before planting so that the fumigant can do its' job and move out of the soil or breakdown. Talk to your fumigant supplier's technical support for advice on when to apply a biofungicide after treatment.

Materials:

-Regalia: (extract of Reynoutria sachalinensis). Considered my MOA to 'boost plants defense systems'. This material has become the base for the authors high tunnel and greenhouse protective programs. Tank mixes well with coppers for greatly enhanced efficacy.

-Actinovate AG: (ai: Streptomyces lydicus) The label claims efficacy on Fusarium, Rhizoctonia, Pythium, Phytophthora, and Verticillium. Used as both a root drench and foliar material. Very effective in control of specific root-borne diseases.

-Stimplex: (extract of North American seaweed, listed AI is kinetin, a source of cytokinens) Research indicates that Stimplex and other seaweed extracts have the potential to initiate plant defense systems as well as provide a source of cytokinens, a hormone that can boost the initiation of blossoms.

-Bacillus subtillus strains: (Cease, Companion, Rhapsidy and others) These bacteria infect the epidermis of the root and support healthy plant functions by protecting the root and assisting in the uptake of nutrients. Some researchers report that the combination of this inoculant with fungal products such as Actinovate or RootShield will enhance preventative activity.

-RootShield Plus: (Trichoderma harzianum strain T-22, and T. virens) Excellent preplant inoculant. These specific fungus develops a symbiotic relationship with plant roots and will continue to grow with the plant. Preventative for Rhizoctonia, Pythium and Fusarium. Some researchers report that the combination of this inoculant with bacteria such as B. subtillus will enhance preventative activity.

-Coppers: (Champ, Kocide, Badger…….) Coppers have long been used as a fungicides and bactericides and are an important component of any disease management program. Of these formulations, few have an OMRI label. The

primary drawback of coppers is the tendency to stain leaves and flowers. Also, increasingly bacterial diseases demonstrate a resistance to coppers.

-Neem Oil(s): (emulsified, near raw) oils in general work on diseases by smothering the spores, protecting leaf surfaces and dissolving through protective layers on spores and fungal mycelia. Overuse and use during high light and heat levels can result in phytotoxic damage to leaf and fruit.

-Insecticidal Soaps: (M-Pede and others) potassium salt of fatty acids, same AI as Safer soaps, warning label, 12 hour REI (mucous membrane irritant), works by perforating fungal membranes. Some Powdery mildew control, but not very helpful after either or both inculant pressure reaches high levels, and the moisture and temperature conditions are near ideal for disease development. Also, be careful of overapplication as soap can damage leaf and stem cuticle.

-Curzate: (cymaxanil). This is an excellent Late blight and Downy mildew specific material that has a 12 hour REI and 3 day PHI interval. It has worked well when we've had Late blight challenges using Regalia as the protectant part of the tank mix.

-Tanos: (tank mix of cymananil and famaxadone). Another excellent Late blight and Downy mildew specific material that has a 12 hour REI and 3 day PHI interval. It has worked well when we've had Late blight challenges using Regalia as the protectant part of the tank mix.

Our basic protectant program consists of drenching the roots of transplants with either RootShield Plus or Actinovate AG with either Companion or Cease. Once plants are in place at planting, Regalia is applied foliarly followed by Actinovate AG, then Stimplex on a five day schedule. This program works well as a basic protectant disease program that also fits within OMRI standards. It meets our criteria of short REI's and PHI's, low phytotoxicity potential while still providing a good measure of protection. Organic growers will want to switch to Regalia plus copper, then Actinovate plus Stimplex on a 7 day schedule in the case of Late blight or Downy mildew infections. Conventional growers can include Curzate or Tanos (or several other Oomycete materials) tank mixed with the Regalia in the case of Downy mildew, DM or Late blight, LB. Be sure to rotate FRAC groups when battling DM and LB so as to help prevent the development of resistance to these materials.

Steve is currently a Horticulture Educator serving Pennsylvania out of the Cumberland County office in Carlisle. He covers vegetables, small fruit, cut flowers, greenhouse vegetables, and specialty marketing as his primary areas of responsibility. Tomatoes, bell peppers, container vegetables, cucumbers, and other specialty crops are regular items in the trial gardens under Steve's management.

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 400 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.

STATUS OF THE GREENHOUSE VEGETABLE INDUSTRY IN PENNSYLVANIA

Thomas G. Ford, Commercial Horticulture Educator, Penn State Extension
Phone: 814-472-7986
E-Mail: tgf2@psu.edu

Vegetable production under protected culture is growing rapidly within the Mid-Atlantic and Northeastern states. This growth is being fueled by a strong demand for local vegetables that can be produced in an environment that may limit pest pressure, pesticide usage, and exposure to bacterial contaminants. A secondary factor that is fueling the expansion of the greenhouse vegetable industry is the decline in bedding plant and floral sales across the U.S. This drop in floriculture sales is being attributed to an aging baby boomer population and to disinterested Generation X and Y consumers. As a result, Floriculture growers that have both the expertise and available infrastructure are quickly trying to exploit local and regional marketing opportunities for fresh produce.

Data obtained from the Update on the North American Greenhouse Vegetable Industry report from Farm Credit Canada indicates that greenhouse tomatoes account for approximately 22% of the U.S. tomato market, greenhouse cucumbers approximately 7% of the U.S. cucumber market, and greenhouse peppers approximately 20% of the U.S. pepper market. This report also indicated that the change in greenhouse imports from the period 2006-2011 into the U.S. was +107% tomatoes, +85% cucumbers, and +75% peppers. While the overall market is growing for produce grown in protected culture systems, the price for specific commodities has stayed the same or dropped as a result of the over-supply in the marketplace. The change in greenhouse import value for the U.S. from the period 2006-2011 revealed that the value of greenhouse tomatoes rose +6%, the value of greenhouse cucumbers dropped -14%, and the value of greenhouse pepper imports dropped -17%.

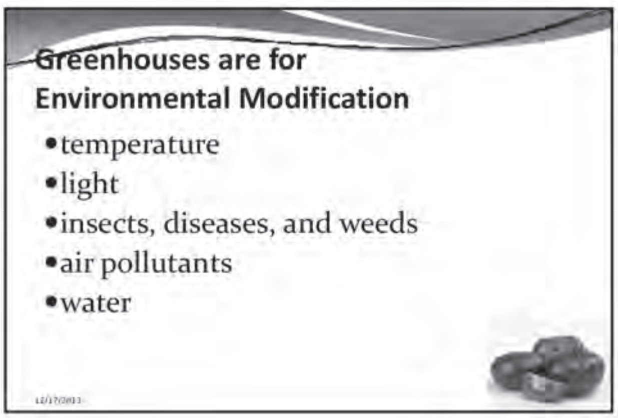
The supply of fresh greenhouse grown produce on the market is primarily being fueled by imports from Canada and Mexico into the U.S. market. Growers wishing to expand into greenhouse and/or high tunnel vegetables should consider looking for niche or ethnic crops that are not currently being marketed into the U.S. by Canadian and/or Mexican growers. Local growers in the Mid-Atlantic States have distinct market advantages for greenhouse vegetables because of lower shipping costs due to market proximity, pyschographics like “native chauvinism” and consumer perception, and harvest maturity indices which allow for growers to harvest more mature fruits.

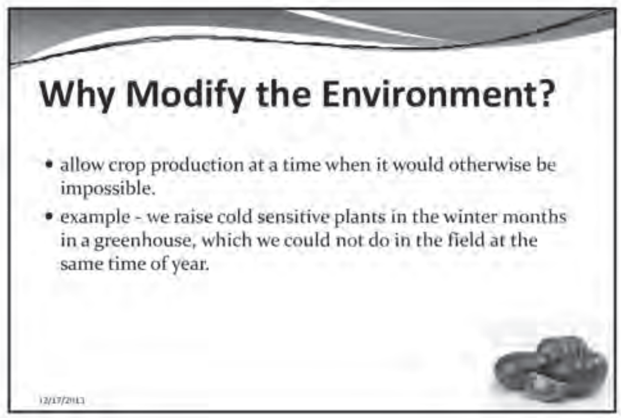
Pennsylvania, New York, Ohio, West Virginia, and to a lesser extent Maryland should also see lower natural gas prices because of the Marcellus and Utica Shale plays. As natural gas prices drop, entrepreneurs should see the opportunities for food production in protective culture systems to expand. Innovations like LED lighting should also increase the amount of off-season or winter production in this corridor. In summary innovation, native chauvinism, and lower natural gas prices should fuel a dramatic increase in the growth and development of the greenhouse vegetable industry in the Mid-Atlantic and Northeastern States despite continued market pressure from Mexico and Canada.

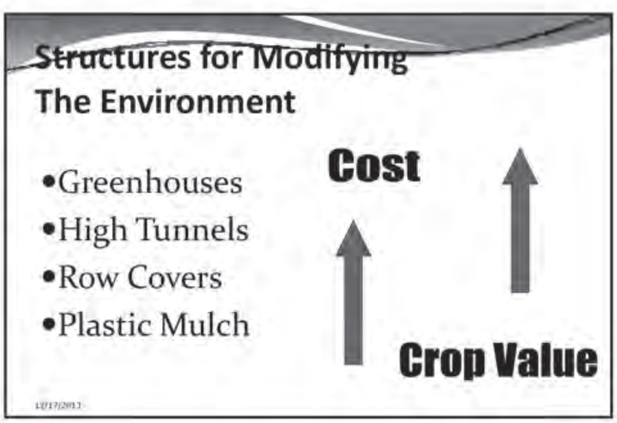
Tom Ford currently serves as a multi-county Commercial Horticulture Extension Educator with Penn State Cooperative Extension. He is part of the State Horticulture Team with Penn State Extension and is the lead educator for Commercial Horticulture in Blair, Bedford, Cambria, and Somerset Counties. He has worked for Cooperative Extension for 31 years with service time in Maryland, North Carolina, and Pennsylvania. Tom has a B.S. degree in Ornamental Horticulture from the University of Maryland and a MBA from Frostburg State University. He is a native of Westminster, MD and resides with his wife, Laura and four sons in Duncansville, PA. (2014)

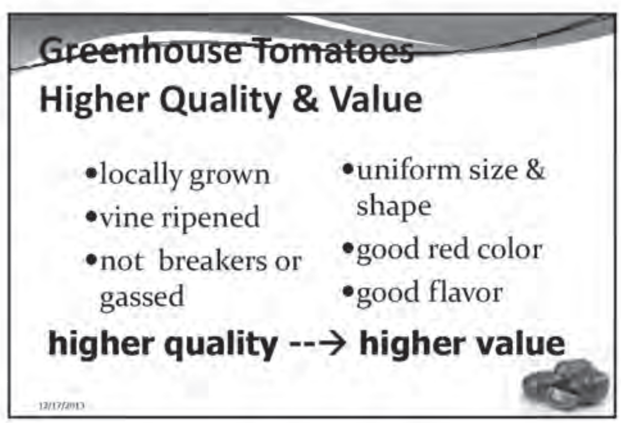
GROWING GREENHOUSE TOMATOES A - Z

Dr. Richard G. Snyder, Mississippi State University
Rick.Snyder@msstate.edu

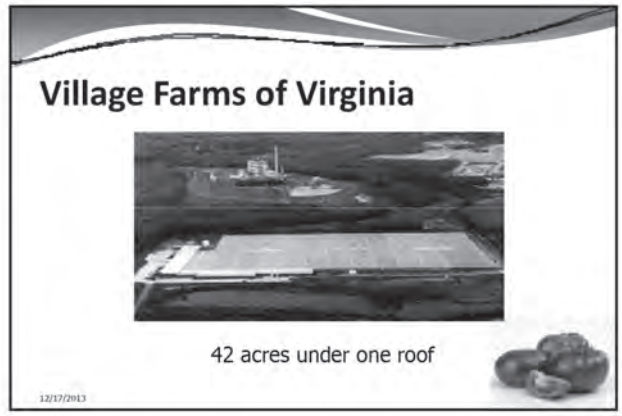


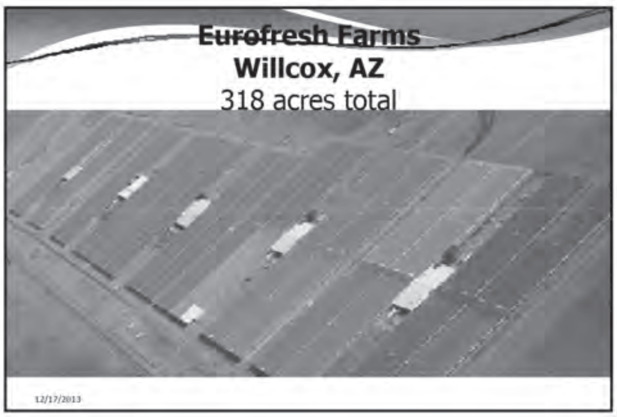




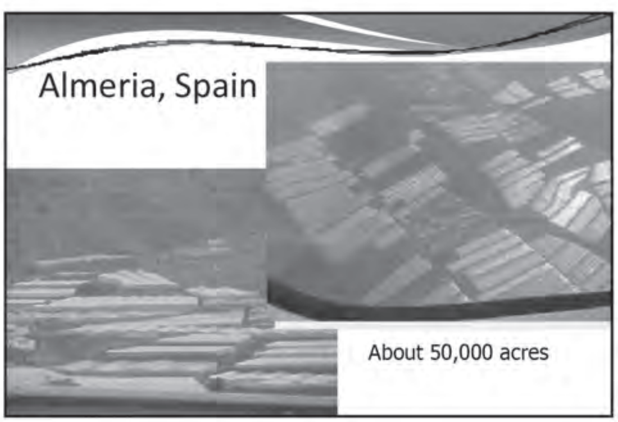


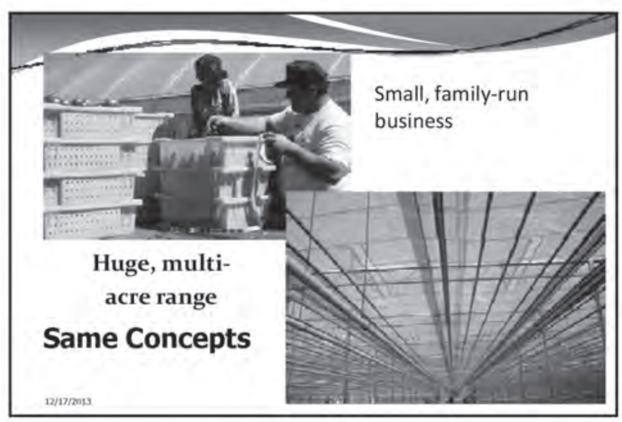

Looks easy?
Lot to learn
12/17/2013


Village Farms of Virginia
42 acres under one roof
12/17/2013


Eurofresh Farms
Willcox, AZ
318 acres total
12/17/2013


Almeria, Spain
"sea of plastic"
12/17/2013
Photo source: Wikipedia


Almeria, Spain
About 50,000 acres


Small, family-run business
Huge, multi-acre range
Same Concepts
12/17/2013

Grow, then Sell Tomatoes

- Don't even think about growing greenhouse tomatoes unless you have a market to sell them.
- Small grower?
  Sell locally.
- Have alternative buyers.

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Get Educated

- Conferences and Workshops like this one
- Greenhouse Tomato Short Course
- Extension publications
- Books
- Newsletters
- Visit growers
- Internet

12/17/2013

Get a Greenhouse

- See vendor list in Greenhouse Tomato Handbook.
- Determine size.
- Site location.
- Sales on site?
- Plan for drainage.
  - 1-2% slope.

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Learn The Language

- See the Greenhouse Tomato Growers' Glossary
- Learn the terminology
- Feel free to suggest words to add if you find other terms you don't know

Peduncle? EC? Cluster? PPM? Calyx? Internode? Truss? IPM?


Greenhouse Tomato
Growers' Glossary

12/17/2013

Start Small

"Well you said start small..."

- 1 or 2 bays
- Not 6
- Not 12
- Not 5 acres

12/17/2013

Who will do all the work?

- Labor – yes there is work to do
- Average 20 hours per week per bay over the life of the crop
  - Do it all by yourself?
  - Family labor?
  - Hire part time labor?
  - Hire full time labor?
- Be sure labor is available when you need it

12/17/2013

Temperature Control

is it working correctly?

- Heaters (64° F min)
- Fans (keep it under 90° F)
- Vents
- HAF
- Shade Materials?
- Pad & Fan system?
- Fogging?

high/low thermometer ➔

12/17/2013

How Many Plants?

- Plant Population
- 5 square feet per plant
  - Length X width / 5 = number of plants
  - 24 X 96 ➔ 460 plants
- 3 or 4 plants for 2 cubic foot lay-flat bag
- 2 plants per 5 or 7 ½ gallon upright bag or 5 gallon nursery bucket

12/17/2013

Variety Selection

- Choose a good variety.
- Pick a greenhouse variety.
- Look for
  - Good yield & size
  - Red color
  - Excellent disease resistance
  - Free of physiological disorders

12/17/2013

Types of Tomato Plants

- Determinate
  - Height is genetically determined – short plant
  - Top of plant ends with a flower cluster
  - Earlier first harvest
  - Will produce for short season
- Indeterminate
  - Height is NOT genetically determined – tall plant
  - Top of plant is vegetative shoot
  - Will grow and produce over long season
  - Higher total yield

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Tomato Types – use, color, size, age

- Canning
- Slicing
- Pickling

- Beefsteak
- Cherry
- Roma
- Grape
- Cluster (TOV)

- Red
- Pink
- Yellow
- Orange
- Green

➢Heirloom
➢Open pollinated
➢Hybrid

12/17/2013

Photo source: Wikipedia

12/17/2013

For Greenhouse Production

In most cases ....

- Red
- Indeterminate
- Beefsteak, or smaller types if good market exists.
- Greenhouse variety – not field or home garden type which are not well adapted to greenhouse conditions.

- ***Can deviate from this based on market demands.***

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Greenhouse Tomato Varieties

- Trust (De Ruiter / Seminis / Monsanto)
- Big Dena (Syngenta)
- Geronimo (De Ruiter / Seminis / Monsanto)
- Torero (De Ruiter / Seminis / Monsanto)
- Heritage (Rijk Zwaan)
- Starbuck (De Ruiter / Seminis / Monsanto)
- Match, Blitz, Quest, Matrix, Clarance, Ambiance, Tresco - all *discontinued* after the last merger
- Cluster types – Success, Tradiro
- OLD – Caruso, Laura, Tropic, etc.

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Choose a good growing medium

- Pine bark (composted fines)
- Perlite
- Coconut coir
- Rockwool
- Peat-lite mixes
- Soil
- Sand
- Newer Alternatives

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Tools of the trade

- Pollinator or bumblebee hive
  - (Class A, B, C)
- pH meter
- EC meter
- High/low thermometer

Design A Good Irrigation System

- Not as simple as it sounds.
- Get help from an irrigation engineer.
- Choose proper emitters.
- Use filters.
- Plan for fertigation.
  - Bulk tank
  - Injector

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Good Quality Water

- Get your water tested
  - In Mississippi – Mississippi State Chemical Laboratory
  - 1 Gallon in CLEAN jug (not from milk!) i.e. from bottled water
- Not all water is created equal
- Water quality can change over time
  - Especially community water

Greenhouse Tomatoes 201, Dr. Richard G. Snyder, Mississippi State University, Rick.Snyder@msstate.edu


Greenhouse Tomatoes 201, Dr.
Richard G. Snyder, Mississippi
State University,
Rick.Snyder@msstate.edu
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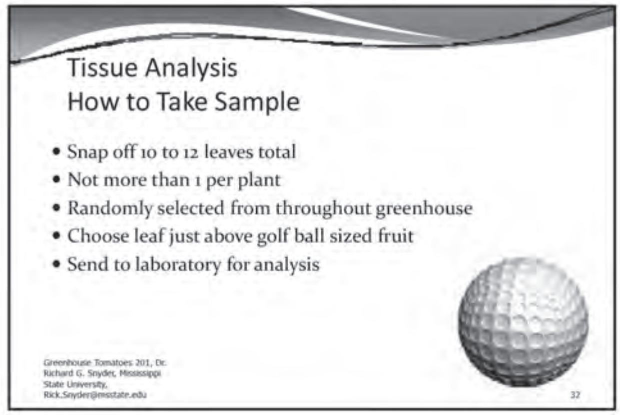
Tissue Analysis
How to Take Sample
• Snap off 10 to 12 leaves total
• Not more than 1 per plant
• Randomly selected from throughout greenhouse
• Choose leaf just above golf ball sized fruit
• Send to laboratory for analysis
Greenhouse Tomatoes 201, Dr.
Richard G. Snyder, Mississippi
State University,
Rick.Snyder@msstate.edu
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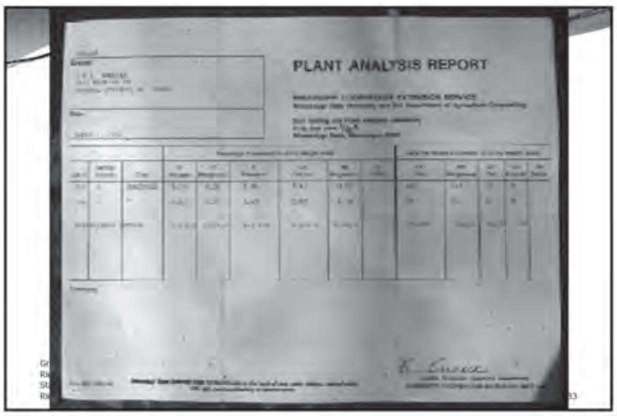
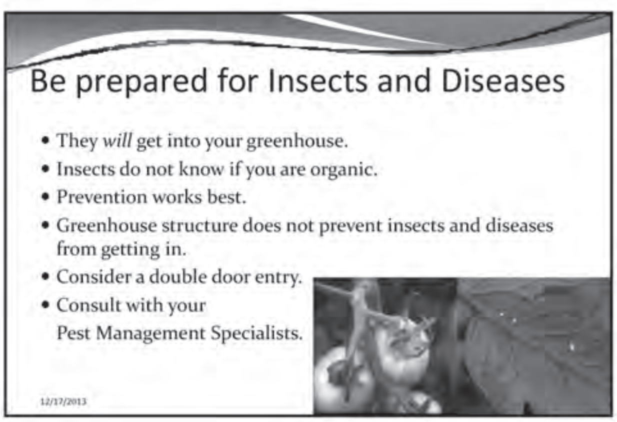

PLANT ANALYSIS REPORT
33


Be prepared for Insects and Diseases
• They *will* get into your greenhouse.
• Insects do not know if you are organic.
• Prevention works best.
• Greenhouse structure does not prevent insects and diseases from getting in.
• Consider a double door entry.
• Consult with your Pest Management Specialists.
12/17/2013


Maintain your equipment
• Heaters
• Should be ready in advance of need.
• Fans
• Vents
• Emitters
• Injectors
• Pumps
12/17/2013

Worry!

- Check your work.
- Use pH and EC meter to check nutrient solution daily and after mixing.
- Use a gallon jug to check volume per day.
- Walk the greenhouse every day.
  - Look for wilting plants.
  - Look for critters.

12/17/2013

Publication Resources

- Greenhouse Tomato Handbook
- Greenhouse Tomato Growers' Glossary
- Environmental Control for Greenhouse Tomatoes
- Greenhouse Tomatoes - Pest Management in Mississippi
- Budget For Greenhouse Tomatoes
- A Spreadsheet Approach to Fertilization Management for Greenhouse Tomatoes

12/17/2013

All are on the web site.

Greenhouse Tomato Handbook

Also available in Spanish

12/17/2013

Internet Resources

- **Greenhouse Tomato FAQ:**
  www.msucares.com/crops/comhort/greenhouse.html
- **Greenhouse Tomato Short Course:**
  www.greenhousetomatosc.com

12/17/2013

Greenhouse Tomato Short Course

www.greenhousetomatosc.com

- Jackson, Mississippi area
- March 4 & 5, 2014
- Expert Speakers
- Educational Materials
- Growers from 20+ states
- Meals Included
- Exhibitors

Greenhouse Tomato short course

Thanks for coming.

Questions?

Dr. Richard G. Snyder has been working as a Professor and Extension Vegetable Specialist at Mississippi State University since 1988. His position involves research in field and greenhouse vegetables as well as assisting growers with production problems associated with field and greenhouse vegetable crops. His main areas of work have included the culture of hydroponic greenhouse tomatoes and other vegetables - growing media, nutrition, heating systems, variety evaluation, pollination and biological control. In the field, Snyder has worked primarily with vegetable variety evaluations, triploid (seedless) watermelons, specialty vegetables, plastic mulch, degradable mulch/trickle irrigation and fertigation production systems for tomatoes, watermelons and summer squash.

Some of his Extension projects include the annual Greenhouse Tomato Short Course (http://www.greenhousetomatosc.com) held in Jackson, Mississippi each March, which is a national conference for greenhouse growers (participants from 25 states and several countries each year), numerous publications on greenhouse tomatoes, including the Greenhouse Tomato Handbook, and coordinating the annual Fall Flower & Garden Fest (http://msucares.com/fallfest) at the Experiment Station each October (attendance 5,000 adults and 3,000 school children).

Originally from Connecticut, Dr. Snyder earned his B.S. degree in Horticulture at the University of Connecticut, M.S. in Greenhouse Vegetables at Ohio State University, and Ph.D. in Vegetable Crops at Cornell University. He also served in a Post Doctoral research position at Purdue University before taking employment with Mississippi State University.

Snyder has served as Secretary / Treasurer of the American Greenhouse Vegetable Growers Association, on the Board of Directors of the American Society for Plasticulture, and coordinated Greenhouse Tomato Seminars in Montreal (1995), Denver (1996), San Juan, Puerto Rico (2003), and Trinidad (2010). He has been an invited speaker in 21 states as well as in Mexico, and has served as the greenhouse vegetable columnist for American Vegetable Grower Magazine since 1998, a gardening columnist for Mississippi Gardener magazine since 2005, and a Vegetable Judge for All-America Selections since 1990. In both 2010 and 2011, he was a recipient of the MSU College of Agriculture and Life Sciences State Pride Award for outstanding faculty.

HYDROPONIC LETTUCE PRODUCTION

A.J. Both
Associate Extension Specialist, Department of Environmental Sciences, Rutgers University,
14 College Farm Road, New Brunswick, NJ 08901. E-mail: both@aesop.rutgers.edu

A hydroponic growing system is just one of several different growing techniques that growers can use to produce a variety of crops. Except for warmer climates, hydroponic systems are typically used in indoor cropping systems such as greenhouses. While growing crops indoors is often more expensive compared to field production, it does allow for extended-season or year-round growing and most if not all growing conditions can be optimized for maximum crop production. The main advantage of the hydroponic system is that an inert (soilless) rooting medium is used that does not interact with the plant nutrients that are supplied with the irrigation water.

Hydroponic growing systems include aeroponics (plant roots are be placed in air and sprayed periodically), the nutrient film technique (NFT; a thin film of water is constantly flowing by the roots), or floating hydroponics (the roots are continuously submerged in a layer of water). Other hydroponic systems use conventional irrigation systems (e.g., drip or ebb and flood) while growing plants in soilless media. Typically for hydroponics, a small amount of inert rooting medium (e.g., rockwool), is used to anchor the first roots immediately after germination and the subsequent early growth stages of the plant. The lack of a buffering capacity for nutrients is a main difference for hydroponic systems compared to soil-based growing systems. Hydroponic systems allow for better control of nutrient uptake and improved temperature and oxygen management of the root zone compared to traditional soil-based production systems. On the other hand, as the complexity of control systems increases, the chance for errors also increases. For example, a malfunction of the water and nutrient supply system can easily result in crop damage if not corrected before the roots dry out. But because hydroponic systems generally allow for improved control, crop yields are often higher compared to soil-based systems.

Floating hydroponics or the NFT system are common growing systems for the greenhouse production of lettuce (Lactuca sativa L.). The floating system allows for easy transport of floating trays filled with plant material, but requires aeration of the nutrient solution due to reduced diffusion of oxygen into the (covered) liquid volume. The NFT system is often a little more expensive to install, and does not provide much buffer capacity in case of a failure of the circulation system. Nevertheless, both systems can be used effectively to grow hydroponic lettuce and the choice of grwoing system is often determined by grower preferences.

Compared to other crops (e.g., tomato), lettuce plants are compact, short and develop into harvestable sizes in a relatively short amount of time (weeks). Only vegetative growth is desirable (flowering changes the taste significantly) and plants can be harvested at the seedling stage (baby lettuce) or at a mature stage (fully developed heads).

In the Northeastern US, the winter growing season is often accompanied by low sunlight conditions. As a result, in order to maintain sufficient crop production, supplemental lighting is needed. Supplemental light intensities required for adequate crop production are relatively high (approximately 150-200 µmol/(m2s)) and as a result signifant amounts of electric energy are needed. Therefore, proper management of the supplemental lighting system is needed for these production systems to be economical. During the wintertime, greenhouse carbon dioxide concentration can become depleted (because of limited ventilation rates needed for temperature control), and as a result, enrichment with carbon dioxide might be needed. Under certain conditions it is possible to ‘trade’ carbon dioxide enrichment for supplemental lighting and maintain acceptable growth rates. Carbon dioxide enrichment is usually less expensive compared to adding supplemental light. The details of this approach will be discussed in the presentation.

Research has demonstrated a predictable relationship between the amount of light received and the resulting growth rate (Figure 1). Other useful relationships will be presented (e.g., between dry and fresh mass, between total leaf mass and area, and between root and shoot mass).

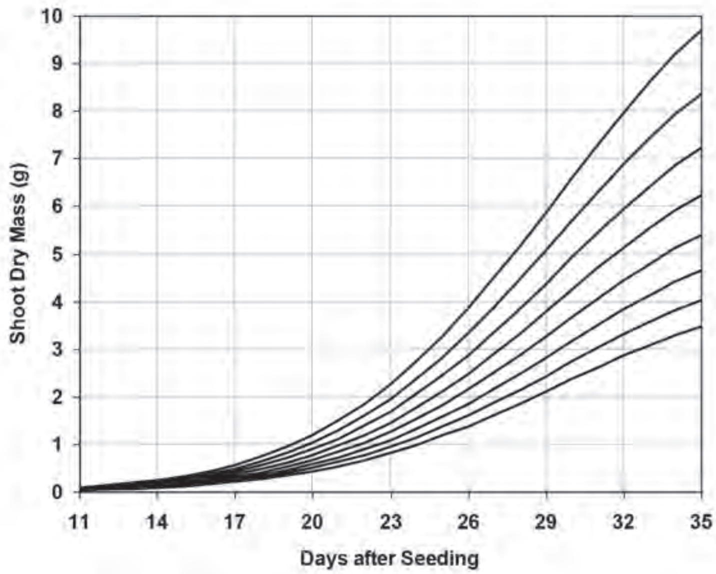


Figure 1. Fitted growth curves for butterhead lettuce (cultivar Ostinata) based on the daily integrated light level maintained during the production cycle (35 days). The curves represent lettuce growth for daily light integrals of 8, 10, 12, 14, 16, 18, 20, and 22 mol/(m2d) (from bottom to top).

When growing lettuce in controlled environment greenhouses, under certain conditions, the uptake and distribution of nutrients can not always keep up with the high growth rates. As a result tipburn can occur. Tipburn is a physiological disorder caused by calcium deficiency in the rapidly growing tips of developing leaves. By increasing the rate of plant transpiration, an increase in the transport of calcium from the roots to the developing lettuce leaves can be accomplished. Tipburn needs to be avoided since its presence will significantly reduce the salability of the crop. Plant transpiration rates can be increased by installing overhead fans that blow air vertically down onto the lettuce plants. This process will be further discussed during the presentation.

The marketability of greenhouse hydroponic lettuce is often impacted by lettuce grown in the field (that is sometimes transported over significant distances). Thus, for greenhouse lettuce producers to be successful, they have to develop sound marketing strategies. In addition, contigency measures (in case of pests, diseases, or equipment failures) are needed to ensure long-term financial stability of the business. These issues will be further addressed during the presentation.

Dr. A.J. Both was appointed as Extension Specialist in Controlled Environment Engineering at Rutgers University in January 2000. Prior to joining Rutgers University, he was a student, Post Doc and research associate at Cornell University. He received his Ph.D. degree from Cornell University in Agricultural and Biological Engineering in 1995. He received his M.S. and B.S. degrees from the Agricultural University in Wageningen, the Netherlands, majoring in Agricultural Engineering.

Dr. Both's research focuses on controlled environment agriculture and includes engineering and crop production projects in growth chambers, and greenhouses. His research interests include greenhouse environment control, hydroponic vegetable production, supplemental lighting, and energy systems.

INSECT PEST MANAGEMENT IN GREENHOUSE VEGETABLES: A PROCESS OF ELIMINATION

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661 Spear Street, Burlington, VT 05405-0105

Greenhouse production by design is an artificial environment designed to support and benefit plant growth. Conditions favoring plants also encourage reproduction of insect and mite pests. Unlike field cultivation where a diverse group of crops is grown, in greenhouse vegetable production, monocultures are generally created, which promote pest outbreaks. Whereas many checks and balances exist in nature to hold down pest populations, these are often lacking in greenhouses, especially in the winter when temperatures are cool and day length is short. This can lead to an unchecked increase in pest populations and a significant reduction in crop quality and yield. Traditionally growers tend to have a low tolerance for pests in their greenhouse crops, considering them an unnatural plague to be completely eliminated. However, key components of integrated pest management (IPM) are sometimes overlooked by growers during this time of year, leading to unexpected outbreaks that are difficult to bring under control.

With expanded commercial availability of a broad range of natural enemies and biological control products, growers have an opportunity to encourage a more diverse ecosystem in their greenhouses that better simulates the eclectic natural world. A sterile pest-free greenhouse environment is virtually impossible to attain, but an approach that strives for balance, a give and take between the plants, the pests and their natural enemies can achieve greater crop success and peace of mind.

There are many species of insects and mites that threaten the health and productivity of a greenhouse crop—too many to review in detail here. Therefore, for this presentation, the focus is on the IPM process to maintain a balance among the good, the bad and the ugly to attain ecological and economical production of vegetables in greenhouses. There is no one way to deal with a pest, no set cookbook recipe to follow. Even if there were, it wouldn't work for everyone. Each operation is a bit different, and ultimately it is the grower, armed with accurate information and years of experience, who can figure out what works best for his/her situation. However, to do this a grower must follow some basic steps to successfully achieve balance.

"Keep your friends close and your enemies closer." This was said by Sun-tzu, a Chinese general from 400 BC. He was a brilliant military strategist, and would have been a great greenhouse vegetable grower had he followed this advice. To effectively manage (not control) a pest, there are two things a grower must know:

What is it? That means, what species is it, NOT what family or general group it belongs to?

What is its biology? That is, what does it do, where it does it, and how often?

These sound like such simple, basic questions. They seem so obvious, but surprisingly, too often answers to these questions are overlooked by growers and pest specialists when developing a management strategy. Aphid pest management provides an excellent example of the importance of using this process. Several different species of aphids can infest greenhouse-grown vegetables, in particular, tomatoes. To the unaided eye they all look pretty much alike. They are pear-shaped, often greenish, or sometimes pinkish. They have long antennae and two cornicles that look like tailpipes coming off their rump. Sometimes they have wings and sometimes they don't. In fact several different aphid species can infest greenhouse vegetables and knowing which species you have in your crop is critical for determining what to do about them.

What is it? Growers often use the color of the aphid to identify the species. If it is pinkish it must be green peach aphid, *Myzus persicae* (GPA, for short). In fact aphids have an uncanny ability to change color depending on what they are feeding on and the density of the population. Another aphid commonly infesting tomatoes and other vegetables is the potato aphid, *Macrosiphum euphorbia* (PA). PA also can come in colors ranging from green to pink. It tends to be a bit larger than GPA, but that is hard to gauge if you don't have them side by side. So the lesson is, get it identified by a professional. Why is this so important? The species of parasitic wasp that works against GPA does not necessarily work against PA. Before investing in releasing a biological control agent, it is critical to know the aphid species.

What is its biology? Whereas some groups of closely related insects may share similarities in their biology, the biology of an aphid can vary significantly among species. That is why this second question is so important. The rate of reproduction and location on the plant may differ among aphid species. For example GPA tends to occur on the succulent upper parts of the plant, whereas PA is more commonly found on lower leaves, particularly when the population is low. This is critical information when scouting for the pest. PA also tends to reproduce faster than GPA, and tolerates cool temperatures. These factors favor the rapid increase in PA populations in greenhouse tomatoes in the winter and early spring. Growers have a sense for when a pest population is high enough to warrant treatment. However, the decision for when to take action must consider the pest species and its rate of reproduction as well as that of the biological control agent. Because the reproductive rate of GPA tends to be less than PA, the grower can perhaps wait awhile before treating for GPA, whereas an infestation of PA must be monitored carefully and treated proactively to avoid a large scale outbreak.

In biological control one size does not fit all. This is another reason why knowing the species of an pest is essential. *Aphidius colemani* is a parasitic wasp commonly used to manage aphids. While it is extremely effective against GPA, it does not work for PA, which is a larger aphid and can fend off the attack of the parasite. A predatory midge, *Aphidoletes aphidimyza*, is very effective against both GPA and PA, but its reproduction is slow when day length is short. For this reason, without supplemental light, this predator cannot be relied upon in the winter to manage an aphid infestation.

Growers know they must plan ahead for the pest battles that are bound to surface over the growing season. A worksheet has been developed to guide growers in their efforts to collect the critical knowledge they need to manage their pests in advance of the season. Sun-tzu said "Every battle is won BEFORE it is fought." This is a sound approach to follow for greenhouse production to maximize on crop yield and quality while minimizing production costs. So whereas "Elimination" of pests in greenhouse vegetables is unrealistic, when growers follow a "Process", using basic IPM principles, including knowing the pest and its biology and regularly scouting the crop, a successful truce is attainable.

Dr. Margaret Skinner, a native Vermonter, is a Research Professor and Extension Entomologist, at the University of Vermont, Entomology Research Laboratory, where she has worked for 29 years, conducting research on management of a wide array of insect pests in forests, vegetable crops and greenhouse ornamentals. Her target pests include western flower thrips, hemlock woolly adelgid, Asian longhorned beetle, gypsy moth, conifer root aphid and tarnished plant bug. Much of her work has included development of strategies to maximize on the potential of insect-killing fungi. For 20 years she has also held a partial appointment as the Extension Entomologist, assisting greenhouse growers, landscapers and homeowners. She coordinates a regional interdisciplinary greenhouse IPM program, linking specialists from ME, NH and VT, which has resulted in a significant increase in growers' use of non-chemical IPM approaches. Prior to pursuing advanced degrees in entomology at the University of Vermont she worked for over 12 years in sociology and human services.

Integrated Pest Management Worksheet

Date:_______________ Crop:__________________________

Damage (When, Where, What type):____

____

Pest Identification: ____

Common Name: ____

Pest Life Cycle:

How many generations/year?_______________

How many eggs laid/female? _______________

How long to complete one generation?____

What are the ideal conditions? ____

Other key information on the biology:____

____

Recommended Management: ____

____

Threshold for Action:____

Cultural Control:

Biological Control:

Natural Enemies (naturally occurring or commercially available):

Chemical Control:

Future Prevention:

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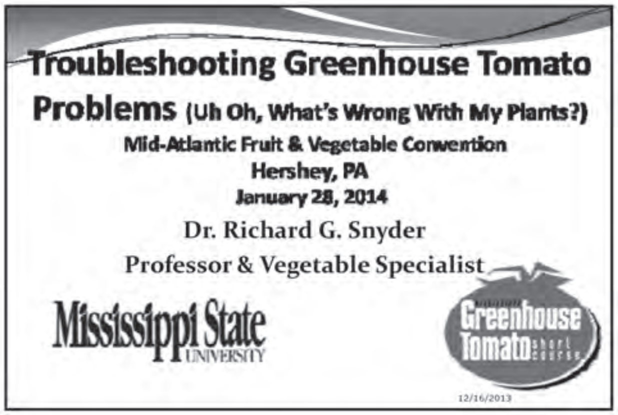
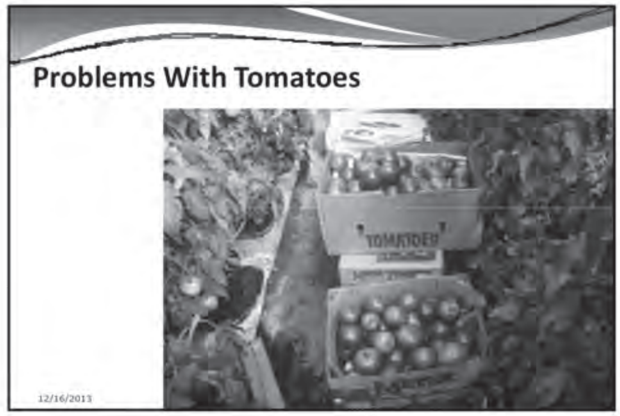
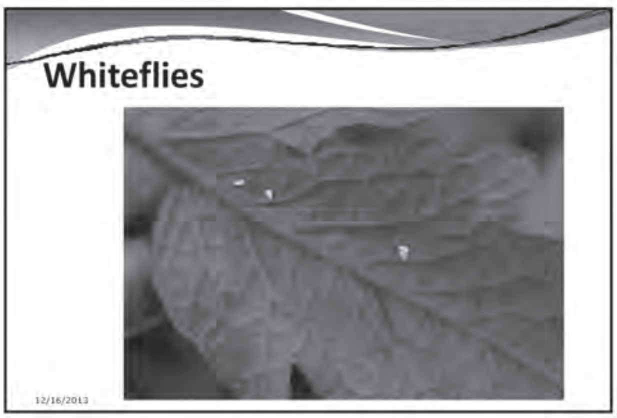
University of Vermont, Entomology Research Laboratory, Burlington, VT

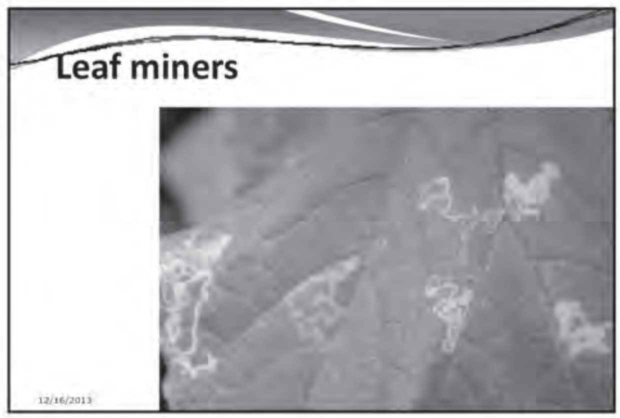
TROUBLESHOOTING GREENHOUSE TOMATO PROBLEMS (UH OH, WHAT'S WRONG WITH MY PLANTS?)

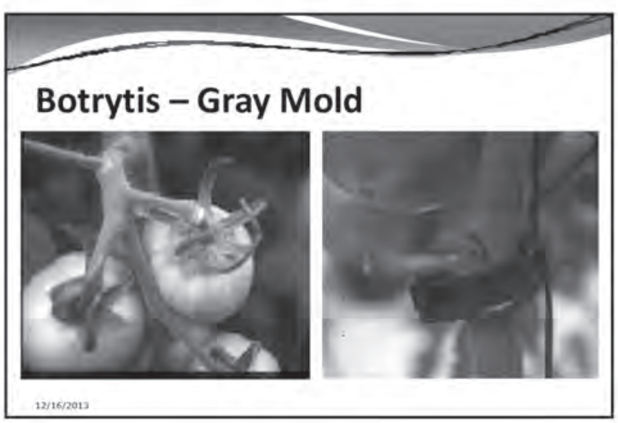
Dr. Richard G. Snyder, Mississippi State University
Rick.Snyder@msstate.edu

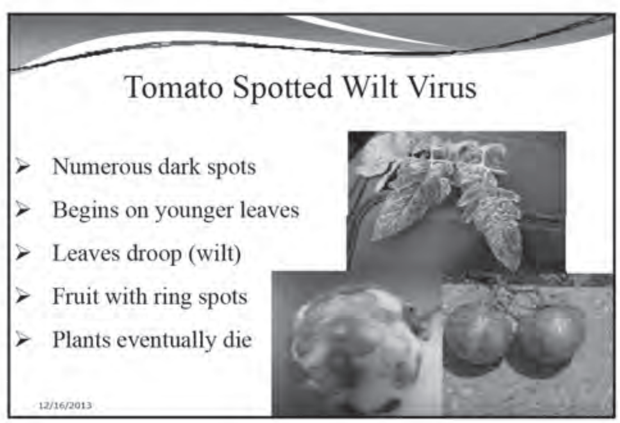






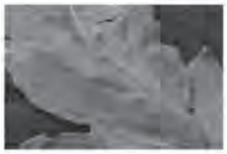






Target Spot / Early Blight

- Leaf lesions appear like a target (bull's eye).
- Starts on lower leaves.



12/16/2013

~~Disease Management in the~~ Greenhouse Environment

- Environment is hot and humid.
- Moist leaf surfaces promote disease development.
- Maximize ventilation!
- Cooling and drying will avoid disease and cure it faster.
- Remove lower leaves to improve air movement.

12/16/2013

What is it?

12/16/2013

Blossom-End Rot

- Blossom-end brown to black, dry, sunken, leathery
- Lack of calcium *in the fruit*
- Keep calcium level up in fertilizer (150 to 200 ppm)
- If water source is high in Ca, use less from fertilizer.
- *Nitrogen*
  - *Do not overfertilize with nitrogen.*
  - *Do not use too much ammonium.*
- Avoid uneven water (dry periods)
- Don't let plants wilt.
- *Need young, actively growing roots for calcium uptake.*

12/16/2013

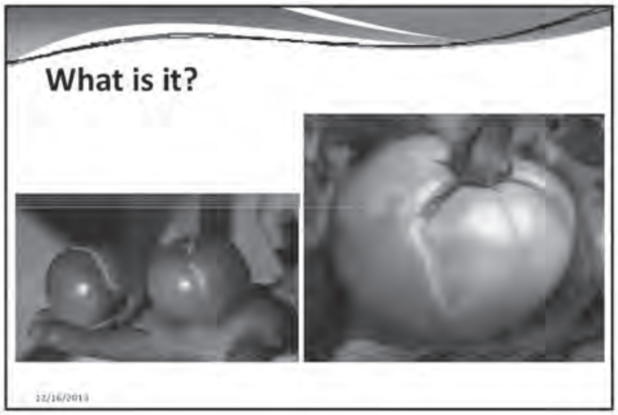
What is it?

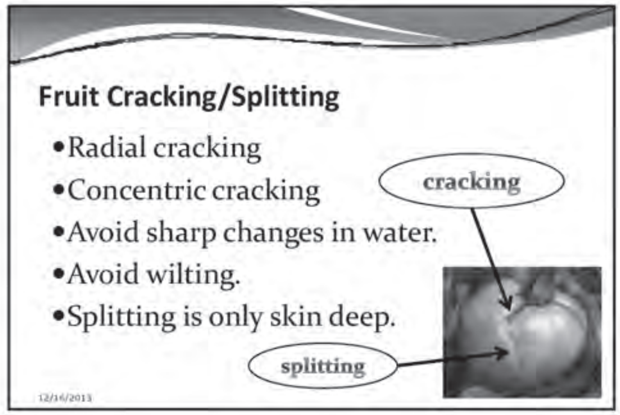
12/16/2013

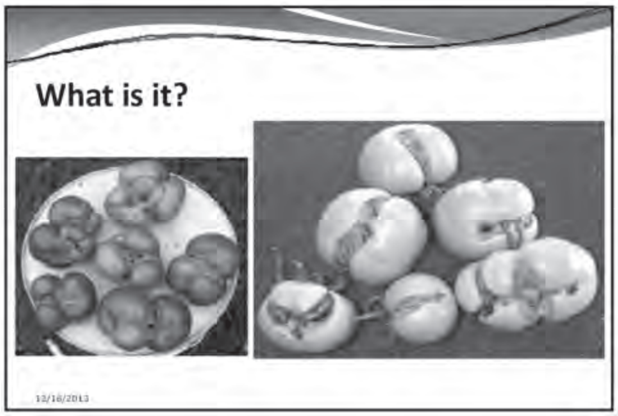
No Calcium

- Tomatoes require calcium
- Blossom-end rot
- Death of the terminal
  - Weak, brown,
  - then black
- End of crop

12/16/2013


What is it?
12/16/2013


Fruit Cracking/Splitting
•Radial cracking
•Concentric cracking
•Avoid sharp changes in water.
•Avoid wilting.
•Splitting is only skin deep.
cracking
splitting
12/16/2013


What is it?
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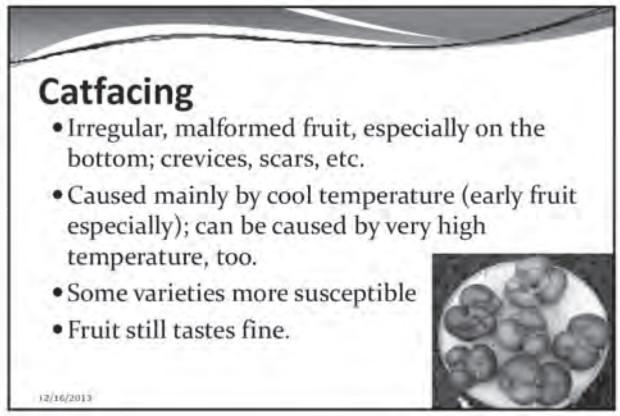
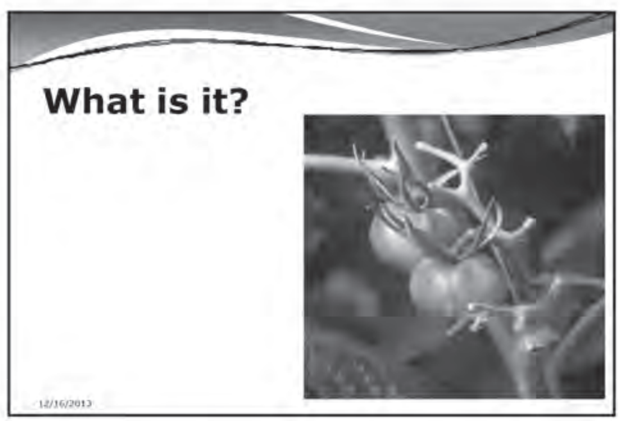

Catfacing
• Irregular, malformed fruit, especially on the bottom; crevices, scars, etc.
• Caused mainly by cool temperature (early fruit especially); can be caused by very high temperature, too.
• Some varieties more susceptible
• Fruit still tastes fine.
12/16/2013


Leaf Roll
• Often starts at the bottom and moves up.
• This is *not* a disease; it is physiological.
• Usually occurs with wet soils, high fertility.
• Looks bad, but does not reduce yield or fruit quality.
12/16/2013

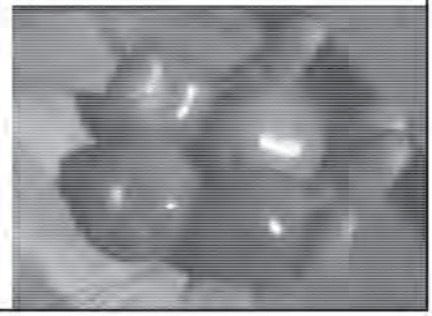

What is it?
12/16/2013

Blossom Drop

- Flowers fall off --> reduces yield.
- Temperature too high or too low.
  - Day temp above 90° or night temp above 75°F interferes with fruit set.
  - Night temp above 64°F is ideal in greenhouse.
- High humidity.
- Too much or too little nitrogen.
- Any stress can cause flower drop.

12/16/2013

Why So Small?



12/16/2013

Small Tomatoes

- Fertility?
- Water?
- Poor Pollination?
  - Slice fruit transversely.
  - Check for seed numbers.
  - Other symptoms: angular, flat-sided fruit.

12/16/2013

What is it?

12/16/2013

Leaf Yellowing – Interveinal

- Upper Leaves
  - Iron deficiency – starts at base of leaflets.
  - Manganese deficiency – starts at tips of leaflets.
- Lower Leaves (or mid range)
  - Magnesium deficiency is most common culprit, especially at or after 4th cluster set.

12/16/2013

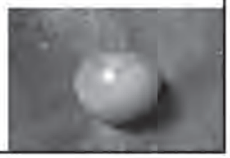
Leaf Yellowing – Not Interveinal

- Nitrogen deficiency – general yellowing.
- Senescence – bottom leaves turn yellow.
  - Natural death, promoted by aging and shade.
- Disease
  - Most often Early Blight / Target Spot.
    - First, small brown circles on lower leaves.
    - Then, larger brown circles.
    - Then, yellow leaves.
    - Leaf drop.
    - Finally, it progresses up the plant.

12/16/2013

Uneven Ripening

- Green stripes, streaks, blotches, stars, shoulders, etc.
- May be caused by high fertility (N), low potassium, high temperature (lycopene killed), viruses, white flies.
- Maintain correct fertilizer.



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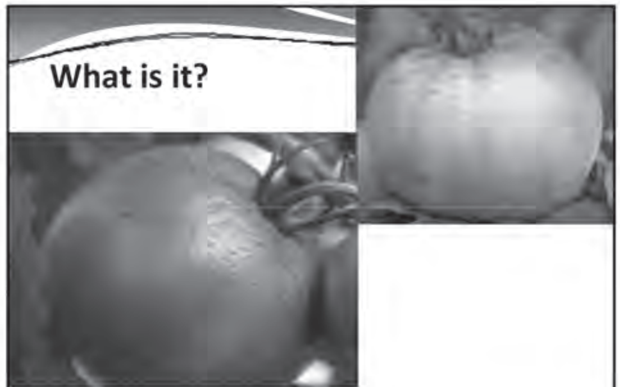
What is it?



12/16/2013

Russetting

- Many, very fine cracks on fruit surface.
- Causes water loss; poor shelf life.
- Believed to be due to
  - Moisture on fruit surface.
  - Topping plant along with all suckers.
- Use HAF fans.
- Leave 2 leaves above highest cluster at topping.

12/16/2013

Sun Scald

- White blistered area on fruit.
- Can turn leathery, can be invaded.
- From fruit exposed to the sun.
- Keep good leaf cover.
- Do not prune too heavily.
- When topping, leave 2 leaves at top.

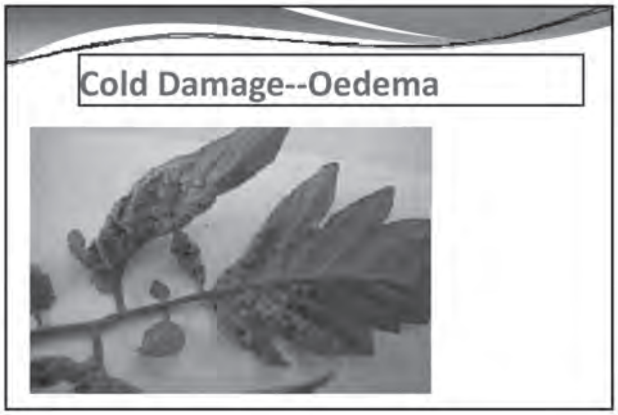
12/16/2013

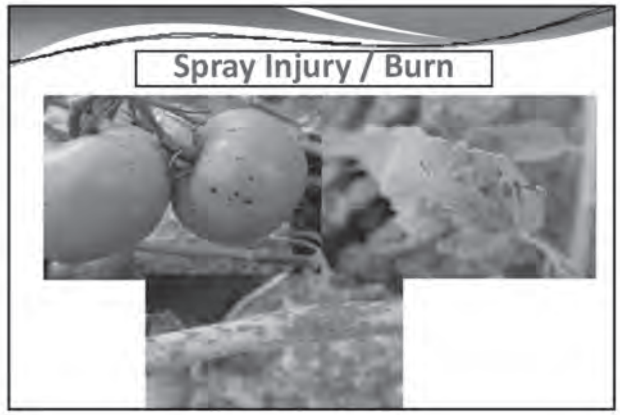
Wilting – several possible causes

Abiotic (physical damage)

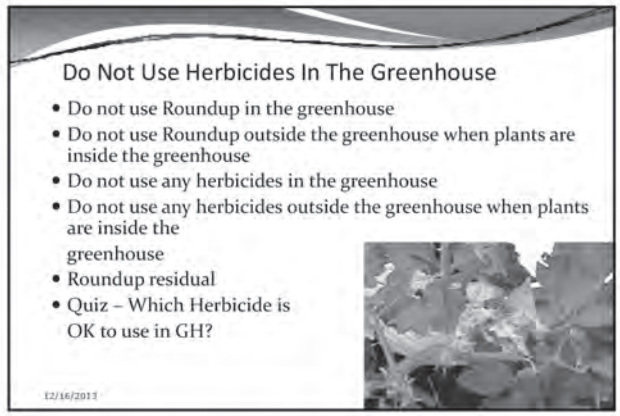
Biotic (disease)

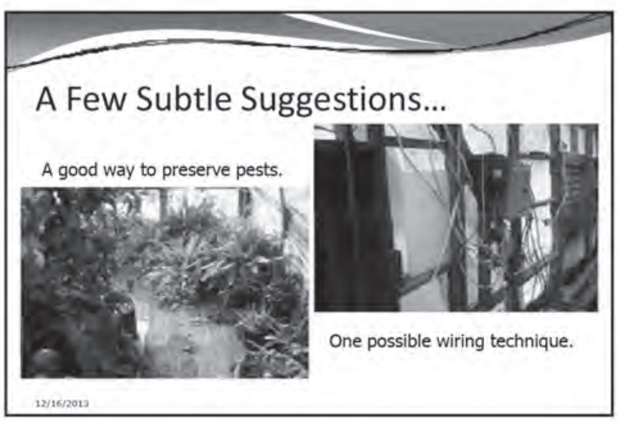
Carbon Monoxide / Ethylene

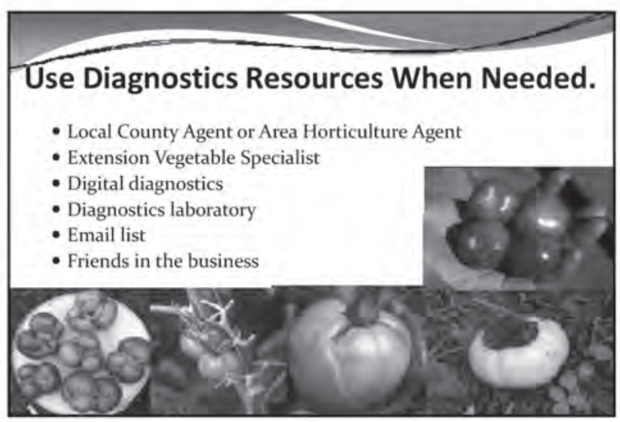

Cold Damage--Oedema

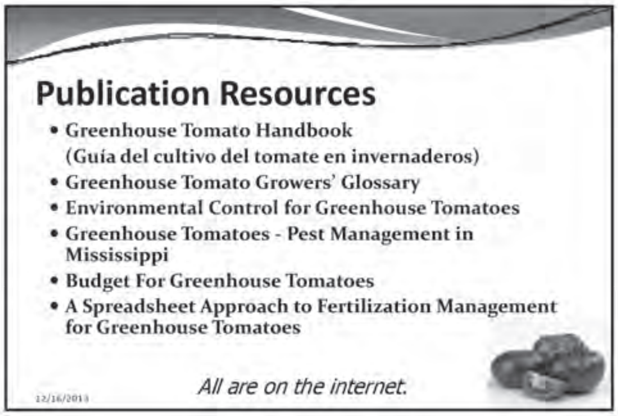

Spray Injury / Burn


What is it?


Do Not Use Herbicides In The Greenhouse
• Do not use Roundup in the greenhouse
• Do not use Roundup outside the greenhouse when plants are inside the greenhouse
• Do not use any herbicides in the greenhouse
• Do not use any herbicides outside the greenhouse when plants are inside the
greenhouse
• Roundup residual
• Quiz – Which Herbicide is OK to use in GH?
12/16/2013

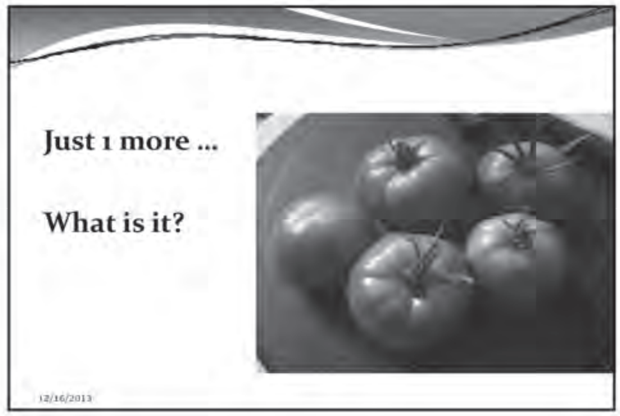

A Few Subtle Suggestions…
A good way to preserve pests.
One possible wiring technique.
12/16/2013


Use Diagnostics Resources When Needed.
• Local County Agent or Area Horticulture Agent
• Extension Vegetable Specialist
• Digital diagnostics
• Diagnostics laboratory
• Email list
• Friends in the business


Publication Resources
• Greenhouse Tomato Handbook
(Guía del cultivo del tomate en invernaderos)
• Greenhouse Tomato Growers' Glossary
• Environmental Control for Greenhouse Tomatoes
• Greenhouse Tomatoes - Pest Management in Mississippi
• Budget For Greenhouse Tomatoes
• A Spreadsheet Approach to Fertilization Management for Greenhouse Tomatoes
All are on the internet.


Internet Resources
•Greenhouse Tomato FAQ:
www.msucares.com/crops/comhort/greenhouse.html
•Greenhouse Tomato Short Course:
www.greenhousetomatosc.com


Greenhouse Tomato Short Course
www.greenhousetomatosc.com
➢Jackson, Mississippi area
➢March 4 & 5, 2014
➢Expert Speakers
➢Educational Materials
➢Growers from 20+ states
➢Meals Included
➢Exhibitors
Greenhouse Tomato short course


Just 1 more ...
What is it?


Questions?
Thanks for coming.

Dr. Richard G. Snyder has been working as a Professor and Extension Vegetable Specialist at Mississippi State University since 1988. His position involves research in field and greenhouse vegetables as well as assisting growers with production problems associated with field and greenhouse vegetable crops. His main areas of work have included the culture of hydroponic greenhouse tomatoes and other vegetables - growing media, nutrition, heating systems, variety evaluation, pollination and biological control. In the field, Snyder has worked primarily with vegetable variety evaluations, triploid (seedless) watermelons, specialty vegetables, plastic mulch, degradable mulch/ trickle irrigation and fertigation production systems for tomatoes, watermelons and summer squash.

Some of his Extension projects include the annual Greenhouse Tomato Short Course (http://www.greenhousetomatosc.com) held in Jackson, Mississippi each March, which is a national conference for greenhouse growers (participants from 25 states and several countries each year), numerous publications on greenhouse tomatoes, including the Greenhouse Tomato Handbook, and coordinating the annual Fall Flower & Garden Fest (http://msucares.com/fallfest) at the Experiment Station each October (attendance 5,000 adults and 3,000 school children).

Originally from Connecticut, Dr. Snyder earned his B.S. degree in Horticulture at the University of Connecticut, M.S. in Greenhouse Vegetables at Ohio State University, and Ph.D. in Vegetable Crops at Cornell University. He also served in a Post Doctoral research position at Purdue University before taking employment with Mississippi State University.

Snyder has served as Secretary / Treasurer of the American Greenhouse Vegetable Growers Association, on the Board of Directors of the American Society for Plasticulture, and coordinated Greenhouse Tomato Seminars in Montreal (1995), Denver (1996), San Juan, Puerto Rico (2003), and Trinidad (2010). He has been an invited speaker in 21 states as well as in Mexico, and has served as the greenhouse vegetable columnist for American Vegetable Grower Magazine since 1998, a gardening columnist for Mississippi Gardener magazine since 2005, and a Vegetable Judge for All-America Selections since 1990. In both 2010 and 2011, he was a recipient of the MSU College of Agriculture and Life Sciences State Pride Award for outstanding faculty.

GREENHOUSE VEGETABLE DISEASES AND CONTROL MEASURES

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University of Maryland's Lower Eastern Shore Research and Education Center
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Vegetable disease management in the greenhouse requires a different approach than disease management in the field. The main difference is that the use of disease free soil, exclusion of pathogens, and modification of the environment, are the main lines of defense against disease. These tactics are combined with the use of host resistance, biological control, and conventional fungicides. In general, managing disease in the greenhouse involves three steps, 1) prevention of disease by avoiding initial pathogen inoculum where possible, 2) use of sanitation to minimize initial inoculum, and 3) reducing the rate of disease progress.

While many aspects of greenhouse production are beneficial to plant growth and development, greenhouse production may place stress on plants that can predispose them to disease. For example, too much or too little water, temperature extremes, nutritional deficiencies or toxicities, nutritional imbalance, salinity, and the partition of assimilates to fruit development, may stress plants. Excessive pesticide use also results in plant stress. Greenhouses tend to have lower light intensity than open fields, which favors diseases like tomato leaf mold (*Fulvia fulva*).

The site location of a greenhouse should be carefully considered before construction. Placement should be conducive to good air movement around the house and into the house. Ideally the greenhouse should be oriented in the direction of prevailing winds to promote air movement. A weed free area around the greenhouse or high tunnel of 10 meters (33 feet) will minimize pathogens entering the greenhouse. Also, many pathogens, including *Phytophthora infestans* (late blight), *Pseudoperonospora cubensis* (downy mildew on cucurbits), and *Sclerotinia sclerotiorum* (white mold and other diseases) are easily transported from nearby plantings to greenhouse crops. Therefore be aware of the crops that may be planted in adjacent fields. If a greenhouse will have ground beds, the surrounding area should slope away from the structure so that pathogens such as *Phytophthora* spp. or *Pythium* are not carried into the greenhouse when rainfall is heavy.

Sanitation is especially critical for disease management to reduce initial inoculum. Placing foot trays of disinfectants at each doorway will help reduce bringing new pathogens in on boots. Growers should scout plants regularly and discard plants that show signs of disease. Eliminate cull piles outside a greenhouse structure. Once a pathogen is present in low numbers, sanitation can be relatively effective for diseases that increase slowly (such as Fusarium wilt or root knot nematodes). Sanitation is less effective for diseases with short life cycles that increase exponentially, such as late blight or powdery mildew.

Reducing foliar diseases in protected environments, such as greenhouses, is made easier when water on the foliage can be controlled (by using drip irrigation, etc.). However, greenhouse environments without modification tend to be wind free and prone to high humidity. Reducing humidity is critical to reducing disease. This is most easily accomplished by ventilation in greenhouses. Air flow can be increased by fans that move air around the structure, particularly around vegetable foliage and fruit. Improved air movement will also reduce the temperature of the foliage as water is transpired. Removing unproductive leaves at the base of plants and trellising are two methods to alter the plant architecture resulting in improved air flow within the foliage.

The soil environment also can be modified to favor plant growth and development and limit disease. For example, soil in clay pots will maintain cooler temperatures than plastic pots. Raised beds will result in a warmer root zone and lead to better drainage.

Pathogen inoculum should be eliminated from potting media with the use of sterile or disease free soil or soilless mixes. How and where the mixtures are prepared should be evaluated for cleanliness. If a disease free mix cannot be purchased, such as in the case of ground beds, soil should be sterilized. First remove plants from the soil, including the roots. Till the soil to break up dirt clods and to further incorporate plant residue. Steam, fumigation, and soil solarization all will reduce pathogens in soil, but each has disadvantages. Steam may result in phytotoxic manganese or ammonia residue. Fumigants must be used with care by trained personnel, and soil solarization requires a month or more out of production during warm weather. In addition once the sterilization is conducted, special care should be used in replanting so that diseases are not reintroduced into an environment where few beneficial organisms (and therefore little competition) exist.

Composts, while not sterile, may be suppressive to disease development. Plant pathology researchers found that some hardwood bark composts were suppressive to *Phytophthora* spp. However, not all composts are suppressive. Be cautious about the source of the compost and be wary of unverified claims of suppression.

Elimination of all inoculum sources is difficult because pathogens survive in many places. Sclerotia of *S. sclerotiorum* and *S. rolfsii* are long-lived in soil. The nematode *Meloidogyne incognita* can survive deep in soil in ground beds and is difficult to eliminate. Bacteria survive on crop debris and on twine, stakes, and wire. Weeds in or near the greenhouse can harbor viruses and some plants serve as symptomless hosts of pathogens such as *Fusarium oxysporum* spp. and *Verticillium.*

Because all inoculum sources cannot be eliminated, measures should be taken to minimize the presence of disease. Use Greenshield or another disinfectant to clean tools, stakes, benches and walls. Avoid having ornamental plants in the vegetable production greenhouse. Also, launder work clothes frequently. Pathogens are easily spread through the activities of people, on hands, clothing, and tools. Irrigation can also spread pathogens; use of drip tape or the practice of watering at the base of plants, will minimize spread. Finally, pets and birds may bring pathogens inside a greenhouse structure or spread them from a diseased section of a greenhouse to a non-diseased area.

Additional techniques have been very useful in reducing disease in greenhouse environments. Grafting is widely used in many countries to manage Fusarium wilt on tomato and watermelon crops. This approach is highly effective for reducing losses due to soilborne disease such as Fusarium wilt, but does add extra cost to production.

Fungicides and biorational pesticides are often used on greenhouse vegetables. Several fungicides are labelled specifically for greenhouse use and a partial list is available in the Commercial Vegetable Production Guide published through Extension in the mid-Atlantic region. One important consideration in using fungicides is that the potential for fungicide resistance development in pathogens is high in the greenhouse environment. Therefore, the use of some fungicides is strictly prohibited. Judicious use of pesticides and biorationals by trained personnel in combination with manipulation of the environment to disfavor disease will help in the production of a healthy greenhouse vegetable crop.

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NEW AND PROMISING ASPARAGUS VARIETIES FOR THE 21ST CENTURY

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Asparagus is a dioecious plant, meaning that it has both male and female reproductive structures (flowers) on separate plants. Seed made from female plants while in the fern growth stage fall to the ground and become seedling asparagus weeds. Female plants expend energy to produce the seed. As a result, spear yield from a female plant is about one-half the yield of a male plant, which does not expend energy to produce seeds. For this reason, superior varieties were bred to obtain all male plants, with no female plants produced.

In the early 1980's, Dr. Howard Ellison, asparagus plant breeder at Rutgers University, observed that although asparagus is dioecious, about one in 500 male plants will produce male flowers and a few flowers with functional male and female parts. By selfing flowers on one of these plants, called "hermaphrodites", Ellison produced his first male hybrid. These male hybrids have tolerance to asparagus rust and Fusarium crown rot, two major fungus diseases that affect asparagus. The New Jersey male hybrids have wide geographic adaptability and have yielded well in several variety trials across the U.S.

The New Jersey male hybrids that yield well in North Carolina include Jersey Giant, Jersey Supreme, and Jersey King.

Guelph Millennium is a male hybrid from Ontario, Canada, which is yielding about the same as Jersey Giant in North Carolina.

The California Hybrids, which are not male hybrids, are dioecious. They have been bred to survive the warm and arid climates. The attributes of the California Hybrids enable the grower in a warmer climate to harvest a taller spear (8-9") without the tip of the spear opening up or "ferning out" under warm temperature conditions (above 70 degrees F.)

and still be tender. The New Jersey male hybrids and Guelph Millennium will fern out at a much shorter spear height (5-6”) above 70 degrees F.

In North Carolina, yields of the California Hybrids have out-yielded the New Jersey hybrids and Guelph Millennium initially, but yields have dropped in succeeding years, probably due to the California Hybrid crowns not being able to survive cold winter temperatures, leaving Guelph Millennium, Jersey Giant, Jersey King, and Jersey Supreme performing the best in the trial, with the exception of Grande, a California Hybrid, which is currently in 3rd place in the trial with the highest 7 year total yield. It will be closely followed to see if that trend continues.

Viola, or Purple Passion is dioecious, and until 2013, yielded poorly in the trial. In 2013, it moved into first place for the first time. It will be interesting to see if this trend will continue. Purple Passion has a purple spear that is higher in sugar content than green asparagus. When cooked, the purple pigment is destroyed, reverting back to green.

Yields of asparagus in lbs. per acre and how they have ranked each year can be seen in the tables below:

Asparagus Yield Totals and Rankings in lbs./Acre in Roxboro, NC

Cultivar	‘07 Yield[1]	‘08 Yield	‘09 Yield	‘10 Yield	‘11 Yield	‘12 Yield	’13 Yield	7 Year Total	7 Year Rank
UC 157	1155a	2385abc	3848abc	4397a	4897ab	5278ab	3507a	25467	7
Jersey Giant	944ab	2737ab	4494abc	5304a	6021ab	5390ab	4601a	29491	3
Jersey King	883abc	2458abc	3937abc	3992a	4902ab	5701ab	4233a	26106	6
Jersey Supreme	860abc	2485abc	4211abc	4759a	5696ab	6273ab	4794a	29078	4
UC 115	821abc	2314abc	3175c	4204a	5102ab	4154b	3138a	22908	10
Jersey Gem	734bcd	2071bc	3442abc	3712a	3770b	4575ab	4178a	22482	11
Atlas	717bcd	2523abc	3987abc	4716a	5630ab	5846ab	4336a	27755	5
Grande	703bcd	3030a	4935a	5195a	6654a	6621a	4926a	32064	1
Apollo	555cd	1781c	3550abc	4204a	4220ab	4160b	3594a	22064	12
Jersey Knight	456de	1604c	3233bc	3821a	4233ab	5189ab	4514a	23050	9
Purple Passion	151ef	1915bc	3287bc	3884a	4436ab	5280ab	5251a	24204	8
Guelph Millennium	86f	2332abc	4868ab	6029a	6560ab	5293ab	5212a	30380	2

[1]Cultivars with the same letter within columns are not statistically significant, Duncan’s Multiple Range Test, .05 level. Trial was established by planting 12-week-old seedling transplants in May 2005. First harvest was taken in 2007.

Yearly Asparagus Cultivar Ranking in Numerical Order, Roxboro, NC

This table shows how each asparagus cultivar ranked in numerical order each year from highest yielding (1) to lowest yielding (12).

Cultivar	’07	’08	’09	’10	’11	‘12	‘13
UC 157	1	6	7	6	8	8	11
Jer. Giant	2	2	3	2	3	5	5
Jer. King	3	5	6	9	7	4	8
J. Supreme	4	4	4	4	4	2	4
UC 115	5	8	12	7	6	12	12
Jer. Gem	6	9	9	12	12	10	9
Atlas	7	3	5	5	5	3	7
Grande	8	1	1	3	1	1	3
Apollo	9	11	8	8	11	11	10
Jer. Knight	10	12	11	11	10	9	6
P. Passion	11	10	10	10	9	7	1
Millennium	12	7	2	1	2	6	2

ASPARAGUS

White (blanched) asparagus is produced in the absence of sunlight. It is commonly grown in Asia and Europe. However, fresh white asparagus is rare even in major U.S. markets and supports a price structure of two to three times that of green asparagus. White asparagus is easily grown, and there seems to be a demand for it. The traditional growing method was to mound up soil over the plant row to an 8 to 10 inch height just before spears start to grow in spring. Once the tip of the soil mound started to crack above the emerging spear, the asparagus knife was thrust into the mound, cutting the spear before it was exposed to light. This growing method is very labor intensive.

An easier method is to use clean, opaque, food-grade, 55-gallon drums that are sawed in half longitudinally. The halves are then placed over the row and are butted up against each other. When harvesting, the half-drum can be lifted off the row very easily and then put back in place when finished. After the harvest season is over, remove the drum halves and let the spears turn green and allow them to change into ferns, just like the rest of the field.

White asparagus is lower in phenolics (bitter components), Vitamin C, and protein, but higher in simple sugars. Fiber content is similar. Green asparagus contains higher concentrations of mineral nutrients which decrease from the spear tip to the base.

Green asparagus is high in folic acid (prevents birth defects and is important for the formation of blood cells, and DNA) and one serving provides 60% of the U.S. Recommended Daily Allowance of folic acid.

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MAXIMIZING ASPARAGUS YIELDS AND PROFITS

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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 would reduce 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.

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.

ASPARAGUS

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. 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 delays 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 larger 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.

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 either Lorox or Karmex 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.

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

During the second year, about 3 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 early 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. Judge when to stop harvesting by looking at the spear diameter. When 3/4ths of the spears are pencil sized in diameter, it’s best to stop harvesting, even though you might not have finished harvesting for the specified number of weeks. This will take some experience in growing the crop to determine when to stop harvesting.

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. Do not store asparagus immersed in water in a refrigerator. Fungi can grow in the water, which will promote premature spoilage. Water droplets from drained asparagus put into plastic bags does not cause any problems, however.

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.

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.

Rust spores are blown in the spring (aeciospores) and infect spears in the first growing season when no harvest is taken. The aeciospores change into brownish-red colored spores called urediospores, which attack the fern, and then overwinter on the fern as teliospores that are black in color.

During the second growing season, when asparagus is harvested for the first time, the aeciospores do not infect the spears, because they are harvested before the spores can form lesions on the spears. The urediospores are then produced on the fern growth after harvest is finished.

ASPARAGUS

Alternating sprays of Mancozeb and Chlorothalonil fungicides are needed to control asparagus rust when the brownish-red urediospores are first noticed and then spray every other week until the end of September.

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.

Alternating sprays of Mancozeb and Chlorothalonil fungicides are needed to control Cercospora when reddish-brown football-shaped lesions on the fern stalks are first noticed. Spray once every 7-10 days until the end of September. Neglecting to spray will reduce spear yield by 40% next year. Burning the old ferns off instead of mowing them off and letting the residue remain on the ground will not plants from becoming infected with Cercospora. 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 damage to spears
- waterlogged soil
- insect, disease, and weed pressures

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.

Glyphosate herbicide is labeled for applying immediately after picking the field clean after the last harvest and removing any spears that are sticking up above the soil surface. This will kill any existing weeds. Lorox or Karmex can be applied at the same time to take care of any weeds that are germinating to give weed control until the fern canopy covers the between-row space.

While the plants are in the fern growth stage, Poast can be applied to actively growing grasses and will not harm the asparagus fern since it is in the lily family. The amine salt formulation of 2,4-D broadleaf weed killer can be sprayed at the base of the fern stalks to control broadleaved weeds that are actively growing. Do not spray 2,4-D on the fern or serious injury will result.

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POSTHARVEST HANDLING OF HERBS

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a) Introduction

- In 2009 there were 323 fresh herb operations in the U.S. using protected culture. A significant amount of herbs are also field-grown.
- Herbs are high-value crops, fetching as much as $50/pound.
- The number of culinary herbs grown in the U.S. and Canada are too numerous to discuss here due to the many preferences for ethnic foods. This presentation will focus on the more commonly grown species.

Popular Fresh Herbs

Sold clipped, bare-rooted or as living plants.

Arugula	Garlic Chives	Perilla (Japanese basil, shiso)
Basil, Purple Basil, Thai Basil	Italian Parsley	Rosemary
Bay Leaves	Kaffir Lime Leaves	Sage
Chervil, Parsley	Lemon Grass	Savory
Chives	Lemon Thyme	Sorrel
Cilantro	Marjoram	Tarragon
Dill	Mint	Thyme
Edible Flowers*	Oregano	

Source: Shenandoah Growers, Harrisonburg VA. www.shenandoahgrowers.com

*See Iowa State University reference.

Popular Microgreens

Most of the above can be harvested as sprouts - your imagination is the limit! Other popular items include*:

Amaranth (red)	Celery	Mustard (mizuna, red giant)
Beet	Kale	Onion
Broccoli	Kohlrabi	Pea (shoots, tendrils)
Cabbage	Lettuce (red, green)	Radish (daikon, purple sakura)

Source: Cahaba Club Herbal Outpost, Odessa FL. www.cahabaclub.com

*See University of Florida reference.

b) Fresh herb types and storage recommendations

- Perishability
  - o As immature, leafy plants (either intact or cut), fresh herbs are very perishable; if not properly handled, they can become unmarketable in a matter of hours.

   - Symptoms of quality loss include: wilting, leading to drying; darkening at cut ends and on leaf margins; loss of color intensity; development of decay at cut surfaces or where damaged (e.g., folded or crushed leaves and stems).

- Optimal storage conditions:
   - Temperature-sensitive herbs:
      - Basil types; shiso: Keep above 50oF (10oC) at 95% relative humidity.
      - Squash flowers: Hold at 38-41oF (2.5-5.0oC), 95% RH.
   - All other herbs: Keep above 32oF (0oC), 95% RH.
   - Ethylene-sensitive: All of these crops are very sensitive to exposure to ethylene gas – it accelerates yellowing, wilting and drying. Do not store with fruits and other crops that produce ethylene gas.
   - Maintain these conditions during transport and handling.

c) Harvest, Handling and Packaging Considerations

- These crops are very sensitive to damage. Most are snipped and either packed in the field or greenhouse or packed in a refrigerated room located nearby.

- Rigid, plastic “clamshell”-type containers provide better protection than bags.

- Many growers successfully ship fresh herbs in foam cases with cold gel packs.

d) Cooling Methods

- Herbs should be cooled quickly. Room cooling is generally used after packing to minimize water loss.

- Leaves and sprouts are very sensitive to wilting and should be kept out of areas with high velocity air.

e) Sanitation

- Follow recommendations throughout all operations:
   - Preharvest operations: Good Agricultural Practices (GAPs).
   - Harvest and postharvest operations: Good Manufacturing Practices (GMPs).

f) For Further Information

- University of Florida Extension – EDIS. Microgreens.
https://edis.ifas.ufl.edu/pdffiles/HS/HS116400.pdf

- Pennsylvania State University Extension. Herbs.
http://extension.psu.edu/plants/gardening/herbs

- Iowa State University Extension. Edible Flowers.
http://www.extension.iastate.edu/publications/rg302.pdf

- University of California, Davis. Postharvest Technology Center. Herbs.
http://postharvest.ucdavis.edu/pfvegetable/Herbs/

- U.S.D.A. Census of Agriculture – Census of Horticultural Specialties.
http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Census_of_Horticulture_Specialties/index.php

BASIL DOWNY MILDEW

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Downy mildew of basil is a new, destructive disease that appears to be here to stay. It was first reported in the USA in south FL in October 2007. In 2008 downy mildew was confirmed in both field- and greenhouse-grown basil crops, as well as home gardens, in several states including the northeast (PA, NJ, NY, and MA). It has occurred in this region every year since. It has been reported throughout the USA including HI and AL. Complete crop loss has occurred because leaves with any injury are unmarketable.

Reports of downy mildew began a few years earlier in Europe, where the disease is now considered endemic. It was observed in greenhouses in Switzerland in 2001, Italy in 2003, and Belgium plus France in 2004. Basil downy mildew has also been detected recently for the first time in Israel, New Zealand, Iran and several African countries: Cameroon in 2007, South Africa in 2005, plus Benin and Tanzania.

So where did this new scourge come from? Prior to all these recent outbreaks, basil downy mildew had only been reported in Uganda and that was in 1933. One possibility is that a more aggressive pathogen strain evolved in Uganda that is responsible for the recent outbreaks. The pathogen (*Peronospora belbahrii*) can be seed-borne, as well as dispersed via its air-borne spores. Unknowingly distributing contaminated seed is a plausible way that it has been spread long distances between geographically-separated areas, including in to the USA. Basil growers may recall with frustration a similar situation years ago with another new disease: Fusarium wilt. In just a few years, as the cause of this wilt was being identified, the pathogen became endemic most likely as the result of marketing of contaminated seed. It also is possible that spread of the basil downy mildew pathogen occurred through marketing of infected, basil leaves that were asymptomatic during shipment. Basil in the US has become the leading culinary herb and is available year round. An estimated 20% of the total basil sold is imported from other countries. The pathogen found in FL has been shown to be genetically the same as that in Switzerland (100% homology in their genetic sequences). Once downy mildew has begun to develop in one crop, the pathogen can readily spread via the easily wind-dispersed spores that it produces abundantly. This is likely the main way it has spread throughout the eastern USA every summer since 2008, similar to its well-known relative, the cucurbit downy mildew fungus.

Downy mildew also was observed recently on ornamental plants related to basil, in particular coleus and salvia. These plants all belong to the Lamiaceae family. Fortunately, the coleus and basil downy mildew pathogens have now been demonstrated to be genetically different; therefore, these ornamental plants are no longer considered potential alternative hosts. However, there are many ornamental types of basils that are also hosts to the pathogen affecting basil grown for use as an herb.

Monitoring program. In 2009 a program was started to obtain information on where basil downy mildew occurs and to try to determine whether the pathogen could move northward through the eastern USA, now that it is considered established in FL, as occurs with the cucurbit downy mildew pathogen, and whether a monitoring program can assist growers to be prepared for downy mildew occurrence in their basil crop. Monitoring also will assist with determining whether seed is becoming a less important source, as expected. Each year a spreadsheet accessible by anyone has been set-up in Google Docs. In addition to date and location of the occurrence, growers and gardeners making reports have often included information about the occurrence and management experience, all adding to knowledge about this new disease. Growers are encouraged to report occurrences to assist the effort to develop a forecasting program and to contribute to knowledge about this disease. Links to current and past pages are at: http://vegetablemdonline.ppath.cornell.edu/News-

Articles/BasilDowny.html *. Some past reports have been from outside the USA, including Mexico, Baja California, Costa Rico, Puerto Rico, Jamaica, Quebec, Ontario, and British Columbia.

Symptoms. Typically affected leaves initially have yellow banding because major veins block growth of the pathogen inside leaves. As the disease progresses, yellowing becomes more widespread and resembles a nutritional deficiency. The characteristic dark, downy-appearing sporulation of the pathogen almost always only develops on lower leaf surfaces below yellowing. Affected leaf tissue turns brown and dies. Plants are susceptible from emergence. Photographs are posted at: http://www.longislandhort.cornell.edu/vegpath/photos/downymildew_basil.htm *

* both websites can be found by searching 'basil downy mildew' on the internet.

Management. Using seed not infested with the basil downy mildew pathogen, selecting a less susceptible variety, and applying fungicides are the primary management practices for downy mildew. Minimizing leaf wetness and reducing humidity to obtain conditions unfavorable for disease development may suppress downy mildew, especially in greenhouses. While effective, treating basil seed with hot water is problematic because the seed exudes a gel.

Seed Tests. Recent efforts to develop a seed test have resulted in a genetic-based procedure specifically for *Peronospora belbahrii* that is now being validated (contact mtm3@cornell.edu for information on seed testing). Eurofins STA Laboratories in CO (http://www.eurofinsus.com/stalabs/products-services-seed-health.html) now tests basil seed for *Peronospora* spp. It is sufficient to test only at the genus level with this pathogen since it is the only species of *Peronospora* that would be associated with basil seed.

Varieties. Research is being conducted to determine if there are inherent differences in susceptibility among varieties and species of basil, and to identify sources of genetic resistance. Commonly grown sweet basil (*Ocimum basilicum*) has been shown to be more susceptible than some of the other exotic, spice, and ornamental basils such as *Ocimum citriodorum* and *Ocimum americanum*. All sweet basil varieties evaluated have been found to be very susceptible. Other basil varieties with fewer symptoms in evaluations include red types (including 'Red Leaf' and 'Red Rubin'), Thai basil (Queenette'), lemon basil ('Lemon', 'Lemon Mrs. Burns', 'Sweet Dani Lemon Basil'), lime basil ('Lime'), and spice types ('Spice', 'Blue Spice', 'Blue Spice Fil', 'Cinnamon'). Fewer symptoms were observed only on those basils that are different from sweet basil being distinct in visual appearance, aroma and flavor, and which have quite limited markets. The challenge in breeding for resistance to basil downy mildew is to develop improved resistant varieties that still look, taste, grow and pack-out as a traditional high quality sweet basil. However, progress is being made. Without resistant sweet basil varieties, growers will need to rely on alternative strategies to control this disease.

Fungicides. Applying fungicides frequently and starting before first symptoms are considered necessary to control downy mildew effectively. Many of the fungicides currently labeled for this new disease, plus others not registered yet, have provided limited suppression in fungicide evaluations, demonstrating the difficulty in controlling this disease, especially in a research setting with applications made with a backpack sprayer, and thus the importance of starting before disease onset. Part of the challenge of controlling downy mildew is the need for blemish-free herbs when marketed as fresh sprigs.

<u>Organic.</u> Actinovate AG (active ingredient is *Streptomyces lydicus*), Double Nickel 55 (*Bacillus amyloliquefaciens*), MilStop (potassium bicarbonate), Regalia (extract of *Reynoutria sachalinensis*), Trilogy (neem oil), and OxiDate (hydrogen dioxide) are OMRI-listed fungicides labeled for use on herbs and for suppressing foliar diseases including downy mildew. MilStop, Regalia, and OxiDate are labeled for use outdoors and in greenhouses. The Actinovate, Double Nickel and Trilogy labels do not have a statement prohibiting use in greenhouses. Double Nickel label has directions for greenhouse use for soil-borne pathogens. OxiDate has limited residual activity and thus if used should be combined with or followed by another product.

<u>Conventional.</u> Ranman (cyazofamid), Quadris (azoxystrobin), Armicarb (potassium bicarbonate), and phosphorous acid fungicides can be used in conventional production of basil, in addition to the fungicides listed above. Quadris is the only one of these that is not permitted to be used in a greenhouse. Ranman is the first product labeled with targeted activity for oomycetes, the group of pathogens that includes those causing downy mildews. There are several phosphorous acid

(phosphanate) fungicides labeled for this disease, including ProPhyt, Fosphite, Fungi-Phite, Rampart, pHorsepHite, and K-Phite. This chemistry as well as Ranman was documented to be among the most effective in some university fungicide evaluations. Quadris is labeled for use on basil but not specifically for downy mildew; it also has been shown to be effective for this downy mildew. In states like NY where the target disease is required to be specified on the label, Quadris cannot be used without an approved FIFRA 2(ee) recommendation, which the applicator must possess when using (the one for NY can be downloaded at http://magritte.psur.cornell.edu/pims/current/). Other fungicides are expected to be labeled for basil downy mildew in the future as a result of work by the IR-4 program, which identified this as a top priority and supported fungicide evaluations. Ranman is the first fungicide registered as a result of IR-4 work.

There are additional fungicides that can be used in select states under Section 18 or 24(c) registrations. These include Subdue MAXX (mefenoxam) applied to transplants grown in AL, CA, and MI for re-sale to consumers under a 24(c) Special Local Needs Label. Heritage (azoxystrobin) is similarly labeled in AL, CA, and FL.

To determine when to initiate a fungicide program and also when it is warranted to consider harvesting early to avoid losses to downy mildew, growers should not only routinely check the on-line spreadsheet to determine when downy mildew is occurring on basil nearby, but also regularly inspect their crop for symptoms. The cucurbit downy mildew forecasting web site (http://cdm.ipmpipe.org) might be useful for predicting when conditions are favorable for basil downy mildew since both pathogens likely have similar requirements for successful wind dispersal long distances (e.g. overcast skies) and subsequent infection (e.g. wet leaves or high humidity). Summer is not a time to forget about this disease: unlike most other downy mildew pathogens, e.g. the ones affecting lettuce and cruciferous crops, which stop developing in summer, the basil downy mildew pathogen seems to develop best under moderate to warm temperatures while also tolerating cool temperatures. Report occurrence of downy mildew as soon as possible at the monitoring page or via e-mail to mtm3@cornell.edu.

Other Practices. Practices that minimize leaf wetness and reduce humidity can contribute to control. These include planting where there is full sunlight and good air movement with rows parallel to the prevailing wind direction, maximizing plant spacing, and using drip irrigation. Humidity can be lowered in greenhouses by using circulating fans and lights and by increasing temperature. Observations of downy mildew occurrence in field and greenhouse basil plantings suggest that environmental conditions might significantly affect severity of downy mildew.

Illuminating either leaf surface of plants growing under protected and field conditions during nighttime was shown to effectively suppress downy mildew by inhibiting spore production through a study conducted in Israel. In the field, light was supplied with 20W Day Light fluorescent bulbs each equipped with a white metal reflector (30 cm diameter), with 1 bulb per meter row. Red light was shown to be the most inhibitory under protected conditions.

Basil crops should be disked under or otherwise destroyed as soon as possible after last harvest, or when abandoned because of disease, to eliminate this source of inoculum for other plantings. A sunny day is the best time to physically destroy an affected crop because the disturbed spores will be killed by UV radiation.

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.

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HARD LABOR MADE EASY – THE SOLUTION TO BENDING & STOOPING

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Labor and worker safety & health are major concerns to industries that rely on manual labor. As growers we depend heavily on manual labor, we need good people who are not afraid of hard work and we count on them each and every day throughout the demanding season. In order to remain competitive and profitable we must closely match our laborers to the work load, so being down by one employee due to an injury or backache can put us in a difficult situation, that may result in missed deadlines or broken commitments, leaving you with a dissatisfied customer. You work hard to get and keep your customers. You also work hard to keep your productive workers and keep them going strong all day, every day. The CropCare electric self propelled picking assistant can help you with both of these challenges.

Worker Comfort

Worker comfort is achieved with carefully located and adjustable canvas covered cushions that are designed to distribute the workers body weight properly. The travel speed is controlled by a foot activated switch keeping the hands free for picking. Steering is easily controlled with the workers left hand by adjusting the conveniently located steering bar. The canvas top with roll down sides provides protection from the sun and rain.

Worker Safety

Lying down to harvest or maintain high density crops eliminates the stresses of bending and stooping that can result in a reduction of worker back injuries and potential workman compensation claims. It also provides opportunities to utilize a wider age range of workers, or workers who's physical limitations or impairments may normally prevent them from working in these applications.

Efficiency

Keeping both hands free for picking and added endurance resulting from increased comfort enables the Picking Assistant to improve productivity by 21%. This is according to a study that was performed by a large producer of strawberries on plastic mulch, The Francois Gosselin Farm, located at Ile d'Orleans, Quebec. However, the speed of picking is not the only efficiency gained. The workers will also finish the day less exhausted. The Quality of of the fruit and produce can be increased as well due to more gentle handling. In addition to the picking tray there is a large storage tray located at the back of the machine for the storage of picking supplies and picked product.

Harvesting Applications

- Strawberries
- Green beans
- Asparagus
- Greens
- Baby Lettuce
- Others?

Other Applications

- Pruning strawberry runners
- Setting onions and garlic
- Transplanting
- Weeding / bed maintenance
- Pruning nursery stock
- Others?

Versatility

Nearly every component of the machine is adjustable, allowing it to be used with a wide range of bed widths, crop heights & types and tailored to meet each individual worker's preferences and achieve a comfortable operating position for people of all sizes.

Value

The CropCare picking assistant's simple design is it's strength. There is little to go wrong and minimal maintenance required. It is an economical, long lasting machine that quickly pays for it's self by reducing labor requirements, reducing the amount of time that is needed to harvest and increasing the care of the crop which results in extended shelf life.

Steve Zook is sales manager for CropCare located in Lititz Pennsylvania. As a native of PA he grew up on a crop and dairy farm where he developed a love for agriculture that remains strong today. Steve has formerly managed organic vegetable production in Denver PA. He and his wife Carita have four children and enjoy the outdoors & gardening.

INNOVATIVE EQUIPMENT AT DICKINSON COLLEGE FARM

Matt Steiman, Production Manager

About the Dickinson College Farm: The Dickinson College Farm (DCF) is both an educational program and a working production farm. We raise certified organic produce on 15 acres of limestone ground near Boiling Springs, Cumberland County PA. The entire property currently under college farm management is about 50 acres, including a one acre compost area and 20 acres of pasture for grass-fed cattle and sheep. Produce raised at the farm is sold to the College dining hall, the Farmers on the Square market in Carlisle, and through a 130 family CSA program.

The educational side of the operation involves classes, labs, and tours for students from many disciplines, including the obvious (Environmental Studies, Biology, Earth Science) and the not so obvious (Fine Arts, Religion, Computer Science, Business). Some students and faculty also use the farm for independent research projects and internships. Dickinson College does not have a formal agriculture education program per se, but instead uses the working farm as a living lab for expanding on the liberal arts curriculum. We also teach students who are interested the basics of small scale direct market farming in a hands-on fashion. At any given time about 20 students are involved in production related labor, as full-time apprentices or paid and volunteer part time workers. While needless to say this abundant supply of enthusiastic labor creates some unusual flexibility in the farm's bottom line, we do our best to keep it real by pushing the crew to work hard, fast, and smart. A central goal of the DCF student farmer program is to educate the next generation of sustainable direct market growers, and we are proud that after seven years we have several graduates who are becoming just that.

Equipment at Dickinson College Farm

Electric Vehicles:

THE SOLAR WHEELER PROJECT: The Solar Wheeler is a solar powered heavy duty golf cart that we use for daily operations, including transport of produce, tools, and people around the farm. The project began with a lucky find at a local auction – a beat up 1996 Cushman Titan IV utility vehicle that we bought for $200. The Titan IV is a heavy duty two wheel drive electric "truck" that is most likely designed for use on a factory floor or industrial campus. In our experience, the Titan IV can haul about 500 lbs of produce, or five or six people plus a dog and some odds and ends. The Titan IV handles moderate hills and off-roading on grass pretty well, though it will get stuck in ditches or holes. Essentially it works well for moderate duty on farm lanes and has served its purpose at our farm admirably since 2009.

In 2009, through an internal grant from the College and some equipment donations, we secured funding to support a student to develop an on-board solar charging system for the Titan IV. Renamed the Solar Wheeler, in honor of the student who did the conversion (Sam Wheeler), the golf car is now equipped with 495 watts of solar panels mounted on a sturdy steel frame that also provides shade to the drivers and produce. East Penn / DEKA batteries donated a new 48 volt battery bank, and BP Solar donated three 165 watt photovoltaic modules to the project. To complete the job we sized up a weather tight MPPT charge controller from Solar Converters Inc and a disconnect box from Midnite Solar.

The entire job was pretty straightforward for anyone familiar with DC wiring and the basics of solar charging systems. Essentially the charge controller, breakers and wiring are sized to match the current and voltage output of the solar array, which are all fed into the terminals of the 48 volt battery bank. The Titan IV was already equipped with an on-board 110Volt AC charger, which we use when the sun is not doing the job of keeping the batteries charged. Finally, a DC battery voltage gauge for the dashboard is handy for keeping track of the energy stored in the battery bank.

In practice the Solar Wheeler is an effective project. If we park the cart in the sun, we get about 30 minutes of total drive time per day and rarely need to plug it in. If we use the cart heavily for several days during cloudy weather, we do need to supplement with some AC charging. While 30 minutes may not seem like much, in fact most of the time our cart is working in the field, it is parked and waiting to be loaded. We typically drive for a minute or two between work stations, then park the cart while we harvest, weed, etc. After several years of operation, we've found that we only need to plug in the cart a handful of times each season, and otherwise we are running on free, clean energy from the sun.

Without donations or grants, the total cost of the Solar Wheeler project with off-the-shelf parts would be between \$2000 and \$4000, plus the cart itself. We've had no problems with any of the solar components, but have suffered standard electric vehicle challenges of corroded battery terminals. Some good Non Corrosive Paste(NOCO NCP-2) and good battery maintenance and hygiene have helped keep the Wheeler on the road. Learn more at http://solarwheeler.wordpress.com/

ELECTRIC ALLIS CHALMERS G CONVERSION: Our second venture into the electric vehicle world came in 2012, when we purchased an antique Allis Chalmers G cultivating tractor with a blown gas motor. After reading Ron Kholsa's web postings about his "Electric G" conversion innovations, we got some students involved and decided to give it a try. For a full set of instructions please read Ron's web tutorial at http://www.flyingbeet.com/electricg/ .

Following Ron's instructions, the job was very straightforward. Between myself, two dedicated students, and a student's father with exceptional shop skills, we pulled the conversion off in about 100 hours. We bought key custom conversion pieces (motor mount & clutch conversion plate) from Niekamp Tool Company: http://niekampinc.com/tractor-gallery/ and our components package from the Electric Vehicle Association : http://www.evamerica.com/ . Cost of the basic kit was around \$2000 for components, plus another \$1000 for the 48 volt battery bank. Other odds and ends we fabricated from farm scrap or were donated by Bruns Brothers Process Equipment http://www.brunsbros.com/. Used Allis G tractors go for around \$3000 at auction depending on their condition. Hillside Cultivator Company http://www.hillsidecultivator.com/ carries a modern gas version of the G for about \$10000 new off the shelf (with working motor).

After one year of operation, we are very happy with the addition of the Electric G to the farm fleet. The G is our go-to tool for close in weeding on 3 row beds of salad, carrots, lettuce, and more. As soon as we made our first pass, it was easy to see why the G, with its great crop visibility due to high clearance and rear mounted motor, is the tool of choice for many small vegetable farms. We built our own belly mount tool bar with Danish tine shanks and some custom guards for the three row beds. The electric motor only draws about 20 to 30 amps when under load - at this rate we can run the tractor for about three hours before it needs to be recharged. In practice we never cultivate for much more than an hour per session, so for our scale the electric G has plenty of energy storage between charging. The high torque 10HP motor is super quiet, and can run at creeper speeds if needed while we get the feel for spacing adjustments on the cultivating tools. The best part is the quiet operation… it is no problem to take a cell phone call while running the tractor. The only thing we have added to Ron's design is a removable key switch to prevent accidental start by the kids who tend to gravitate to the nifty orange tractor during farm events.

ROLLER CRIMPER FOR NO-TILL ORGANIC VEGETABLES: In 2013 the DCF was the granted the use of a Roller Crimper through the "Park the Plow" program of Capital RC&D. We used the I & J brand roller crimper as seen at http://www.croproller.com/ - ours is a rear mounted 3-point hitch 8 foot version that is easily pulled by our 68 HP Kubota tractor. The tool is filled with water for extra weight and must be drained annually for winter storage.

A roller crimper is designed to kill live cover crops without mowing or incorporation tillage. It is equipped with heavy duty 3/8" steel fins about every six inches around the circumference of its central barrel. In 2013 we used our roller crimper to kill two fields of winter rye / hairy vetch cover crops that we had planted the previous fall. The cover crop was rolled down when the rye had made seed heads, but the grains were still very soft, and vetch was mostly in flower. Repeated crimping by the heavy steel fins along the length of the rye stem result in very effective kill and a significant surface mulch. In 2013 we found hairy vetch to be more problematic in that it did not reliably die and required subsequent weedwacking in spots. We might fix this in future years by reducing the seeding rate of vetch in the total cover crop mixture. After rolling down the cover crop, our crew ran a single drip line on each bed and used periodic ground staples to keep the drip lines straight. The drip was run for a few hours to soften the ground, and then tomato, pepper, and cucurbit seedlings were transplanted into the softened ground using hand trowels – this part of the job was labor intensive compared to mechanical transplanting, but it was offset by later reductions in weeding due to the surface mulch of the cover crop.

Despite some early concern for seedling establishment, we had near 100% survival of pepper and tomato seedlings and went on to have some of our best yields of high quality tomatoes. A few weeks after establishment, cucurbit seedlings suffered from undiagnosed damage at the base of the stem and we lost about 30% of them – they just melted in the field in a matter of days - perhaps due to insect damage or increased rot activity in the heavy mulch. Those cucurbits that survived yielded normally in comparison to our conventional plantings.

Weed pressure was reduced considerably in the rolled down fields. We ran through each field once with a quick hand-pull crew, and then periodically revisited the fields with a weedwacker – mostly to knock back hairy vetch or a few surviving annual weeds. In a previous year's experiment, we found that fields with existing perennial weed pressure (thistle and bindweed) were less successful, and that slug damage can be a problem in wet seasons. In both our 2013 study and our previous trial, we found much higher soil worm counts in the untilled fields compared with conventionally tilled tomato and cucurbits. We really like the idea of giving the fields a full year off from tillage, while still producing a marketable crop – in the case of our 2013 tomato crop it was the best of three fields.

Areas needing further adjustment for our farm include finding the best seeding rate and dates for rye and vetch that will be used for subsequent roll-down and no till vegetables. We also plan to incorporate mineral soil amendments according to our soil test at fall cover crop seeding time, since they cannot be added in the cropping year. See http://mysare.sare.org/mySARE/ProjectReport.aspx?do=viewProj&pn=FNE02-442 for more details on our 2003 trial.

Other tools covered in this talk:

Undercutter bar for carrot, garlic, and sweet potato harvest: From Market Farm Implement www.marketfarm.com

Barrel Washer for root crops: http://www.grindstonefarm.com/ordering/root-crop-washer/

One-row potato harvester: http://ussmallfarm.com/

Contact:

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FARM SUCCESSION LAW ISSUES

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For most individuals involved in farming who are contemplating retirement, the most important issue they face is how to transition the farm to the next owner. These transitions are governed by a number of documents, some of which are traditional estate planning documents such as wills and trusts. However, when trying to develop a comprehensive succession plan many farm owners fail to look at other key business documents and how they are titled. That is a mistake, because in order to effectively transition a farm all of these factors need to be considered together.

What follows is a chart that provides general guidance as to how assets will be transferred for a farm owner when the owner dies:

Asset	How Titled or Transferred	Recipient at Owner's Death
Car, truck, CDs, personal property	In the owner's name alone	Controlled by owner's Will or Law[1] (probate assets)
Real estate	Jointly with others	Other owners named in Deed[1] or Will[2]
Life insurance, annuities, IRA	In the owner's name with a beneficiary designated	Named beneficiary (if none, becomes probate asset)
Business interests of the farm owner	Based on a business agreement or buy-sell agreement in place	Purchaser or recipient under business agreements

[1]If the owner has no Will
[2]Real estate can either pass based on the exact words in the Deed or via Will - depends on how the property is held

From an estate perspective, there are certain documents that are, or can be, key to a well thought out succession plan. These documents include:

Financial Powers of Attorney

A financial power of attorney allows another individual to manage the owner's property in the event he or she is unavailable or incapacitated. The named agent (a spouse or child) has the authority to manage the owner's property. It can come into effect at signing or upon the happening of a specific event (like incapacity). This permits the owner's agent to act with respect to the owner's property without receiving permission from a local court. A financial power of attorney lapses at the owner's death.

Wills

The owner's Will can serve multiple functions to transfer assets after death. It allows the owner's executor to carry out his or her wishes for disposition of property in the owner's name alone, gives the owner the ability to name a guardian for minor children (if there are any), and permits the owner to control the age at which children or grandchildren receive their inheritance.

Revocable Living Trust

Revocable living trusts are set up while the owner is alive, and typically the owner has the ability to terminate (revoke) them during the owner's lifetime. A revocable living trust can allow the owner to control joint assets upon death (wills may only control assets in the decedent's name alone). It may also allow the owner to control the distribution of retirement accounts or life insurance, as those amounts can be designated to flow through the trust. A revocable living trust may be helpful for individuals that live in one state but own property in another state, as having property in the trust may avoid having to open an estate in an ancillary jurisdiction.

Transferring the Farm During the Owner's Lifetime

Transferring the farm through an estate plan may not be ideal. Children who are active on the farm may be forced to share an interest in the farm with siblings who have no interest or "sweat equity" in the farm. There may not be enough liquid assets to treat the children equally without providing all beneficiaries with an interest in the farm. Planning before death may allow these issues to be lessened or alleviated by leaving non-farm assets to children who are not active on the farm (for example, life insurance proceeds, non-farm real estate or CDs).

Another option is to have farmland owned by a business entity. With respect to the various business forms that are available, the basic options are outlined below:

Legal Form	Ease of transferring a partial interest to children during owner's life	Ease of business continuation upon owner's death
Sole Proprietorship	Not possible to transfer a partial interest	Ends at owner's death
Partnership (general or limited)	Transfer can be done by admitting new partners	Continues according to terms of Partnership Agreement
Limited Liability Co. (LLC)	Transfer can be done by admitting new members	Continues according to terms of the LLC Operating Agreement
Corporation	Transfer can be done by transferring stock certificates to new shareholders. Can also maximize continuing control by transferring non-voting stock	Continues according to terms of a Shareholder Agreement

The best legal form for any given owner is something that he or she should discuss with professional advisors, but all of these entities potentially have value depending on the owner's goals or concerns. Possible concerns are ease of transfer, potential liability associated with the operation of the farm, and the ability of future owners to purchase the business interest during the life or after the death of the primary owner, or both.

Buy-Sell Agreements

There are several advantages to a buy-sell agreement. The first benefit is that it can allow the owner to maintain a "right of first refusal" if any other owner wants to sell an interest in the business. It also may require the owners to buy an interest in the event one of the other owners die or are disabled. The buy-sell can also establish either a fixed price to purchase the business interest, or a fixed method for determining the value of the ownership interest. It can be triggered by the owner's death, disability, retirement or termination of employment. Business documents for partnerships, LLCs and corporations can and in nearly all cases should contain buy-sell provisions.

Tax Considerations

There are tax considerations associated with farm transfers that should be taken into account. The key provisions from a federal tax perspective are the annual gift exclusion - in 2013, $14,000 can be given to any number of people without reducing the lifetime exemption amount - and the unified gift and estate lifetime exclusion amount of $5.25 million (that is the 2013 value; the exclusion is indexed annually for inflation). The maximum gift and estate tax rate for assets above the lifetime exclusion amount is 40%, so avoiding federal estate tax if at all possible is advisable. Relatively recent changes permit "portability", which allows any unused exemption amount of the first spouse's estate to be transferred to the surviving spouse. This is a significant benefit for farm owners.

If farmland is owned by a business entity, such as an LLC or a partnership, gifts of these ownership interests can be made instead of cash. Certain discounts for fractional and minority ownership may be considered when determining the value of the ownership gifts.

From a state tax perspective, changes in 2013 also will have a very positive effect for farmers. Act 85 exempts from state inheritance tax any real estate "devoted to the business of agriculture" that is transferred by the death of the owner to family members (or business entities owned by the family) if the farm was directly and principally used for agricultural purposes. Until the passage of Act 85, an inheritance tax of either 4.5 percent or 12 percent was owed in many cases when family farms were transferred after death to either children of the decedent or siblings of the decedent.

Act 85 requires that for the inheritance tax exemption to be used the farm must continue to be devoted to agriculture for seven years after the owner's death and must generate a yearly gross income from agriculture of at least $2,000 during that same period.

The second notable change for farmers under Act 85 is a modification in the realty transfer tax (RTT). Under the new law, farm property is exempt from RTT if it is part of a reorganization of a family owned farm business to a business entity managed by (primarily) the same family. More specifically, to qualify for an RTT exemption as a family farm business, at least seventy-five percent of the ownership interest in the business must be held by members of the same family and at least seventy-five percent of the business assets must be devoted to the business of agriculture. This change essentially gives family farm businesses more leeway to plan during the owner's lifetime without incurring negative tax consequences.

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MARKET DESIGN & LAYOUT SUMMARY

Caleb Torrice Tabora Farms

Market design and layout is something that many of us focus on without even realizing we are doing it. For us, we focused on design and layout for two simple reasons; increase sales, and to increase a security/theft prevention. What we found we got was much more.

Here are some helpful hints that have helped us increase sales in a down economy.

1. Establish a clear line of sight. No shelving units in the middle of the store that are higher than your belly button. Keep all tall displays against walls and perimeters.
2. Place your most profitable items as soon as a customer enters your store before they are mentally feeling the increasing bill.
3. Use the front porch to establish the feeling of your market so a customer already has a sense of quality or price before they enter.
4. Sample product as soon as they walk in. Help them to establish all of their senses.
5. Allow circle space around your displays so your product can be seen from every angle, not just from the front.
6. Create a shopping "u" with your displays encouraging your customers to enter the display.
7. Mix it up. Slightly change your displays or layout to create a fresh feeling.
8. Use your behind the scenes area to sell your product. For example, large bakery windows or production areas behind your deli counter.
9. Light the room. Older customers will not feel as comfortable in an area with shadows or dim lights.
10. Create a separate area for returns or complaints. Don't let other customers hear that something is bad.
11. Keep your high demand items in low traffic areas and your low demand items in high traffic areas to balance out your sales.
12. Complimentary items should be placed near one another.
13. Use directional signage to move traffic through your store.
14. Focus on impulse sales. For us, load the front area by the registers with items that are under two dollars.
15. Focus on the window displays. Use them not for customers to see into the store, but to see showcased items.
16. Take product out of boxes for your displays. Help customers see your product with nice colors.
17. Make destination displays that customers will walk to because it is impressive from a distance.
18. Use objects that would be found on your farm for your displays.
19. Clean your store. Sounds simple but often it is hard for an owner to see the trees through the forest. Walk through your store and see it as a customer would.
20. Have displays large enough so employees are forced to constantly restock. If it is a high selling item, place it near the stock room.

21. Quantity equals quality. Build false bottoms on displays or strategic stacking.

22. Greeting area for customers. Walmart example.

We will go into further detail on these topics and have many photos of examples.

WHAT'S NEW WITH BLACKBERRY VARIETIES AND ARKANSAS BLACKBERRY BREEDING UPDATE: NEW DEVELOPMENTS READY OR ON THE HORIZON

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Blackberry breeding is progressing well at the University of Arkansas Division of Agriculture. The breeding program concluded its 50th year of work in 2013. The years 2012 and 2013 provided for good program progress, with many selections made, hundreds of thousands of hybrid seeds produced, and substantial seedling populations established in the field. As most know, the program focuses on floricane- and primocane-fruiting varieties, primarily thornless, with commercial shipping potential, good flavor, and high quality as top priorities. I want to highlight two recent releases from the program.

'Osage'

The latest thornless, floricane-fruiting variety released is 'Osage' in 2012. 'Osage' is the thirteenth release from the program. An enhanced effort in the improvement of flavor in blackberries has been underway in the Arkansas program for a number of years, and 'Osage' was developed with the intention of advancing flavor to a higher level in a thornless blackberry cultivar. 'Osage' ripens mid-early, slightly before 'Ouachita' and just after 'Natchez'. 'Osage' produces medium-sized berries, smaller than that of 'Natchez' but comparable to that of 'Ouachita'. 'Osage' has excellent postharvest quality for the shipping market in addition to local markets. It is expected that 'Osage' will complement 'Ouachita' in the mid-early to mid-season harvest period. Key highlights:

Ripe date: Average first harvest date for 'Osage' is June 10th, 5 days after 'Natchez', 3 days before 'Ouachita', at Clarksville, AR.

Berry characteristics: Average weight usually 6-7 g; soluble solids (sweetness) 11%; mostly round shape similar to 'Ouachita'; very firm; excellent flavor; glossy; white drupelets not observed.

Plant characteristics: Yield comparable to higher than 'Ouachita'; chilling requirement not verified, likely near that of 'Ouachita' or possibly lower; hardiness comparable to hardiest Arkansas varieties but not tested in severe environments; very erect canes and consistently healthy plants.

Post-harvest handling: 'Osage' demonstrated excellent storage potential, comparable to 'Ouachita', 'Natchez' and 'Prime-Ark® 45' and exceeding that of 'Tupy'. Development of red drupes on berries was very low in most years for 'Osage', 0 to 1% except for 2008 where this value was higher for 'Osage' along with most other cultivars. 'Osage' is expected to perform well in commercial shipping use based on this comparison.

'Prime-Ark® Freedom'

It is very exciting to announce the first thornless, primocane-fruiting blackberry, 'Prime-Ark® Freedom'. It is intended primarily as a home garden or local-market plant. In addition to having thornless canes, this new introduction has very large fruits with good flavor, and is very early ripening on floricanes, the earliest of all Arkansas blackberry varieties. Fruit of 'Prime-Ark® Freedom' does not exhibit exceptional postharvest storage potential, therefore 'Prime-Ark® Freedom' is not recommended for the shipping market. Key highlights:

Ripe date: Floricane first harvest date for 'Prime-Ark® Freedom' is very early, up to 9-11 days earlier than the early ripening 'Natchez', and 16-18 days before 'Ouachita'. This exceptionally early floricane harvest date should make this cultivar very attractive to homeowners and local marketers as it provides very early fruit, earlier than any prior Arkansas thornless blackberry cultivars. Primocane first ripe fruit date has been difficult to fully determine for 'Prime-Ark®

Freedom' in Arkansas. Observations indicated that first ripe fruit was 10-20 of July on tipped primocanes, although amount of fruit can be limited, depending on summer heat. Floricane yields of 'Prime-Ark® Freedom' have ranged from less than to comparable to 'Prime-Ark® 45', and can be substantial if the plants do not have much primocane fruit the prior year.

Berry characteristics: 'Prime-Ark® Freedom' floricane berries average 9 g in Arkansas, larger than other named varieties including 'Natchez'. For primocane berries, weight in Arkansas was slightly less for 'Prime-Ark® Freedom' compared to the floricane fruits of the same cultivar, but was significantly larger than that for 'Prime-Ark® 45'. Soluble solids concentration averaged 10.4% for 'Prime-Ark® Freedom', slightly lower than 'Prime-Ark® 45' (11.4%) and similar to 'Natchez'. Flavor ratings for 'Prime-Ark® Freedom' averaged 7.8 (on a 10-point scale, with 10 as best), the same as for 'Prime-Ark® 45', higher than for 'Natchez (7.0) but lower than 'Ouachita' (8.8) and 'Osage' (8.3).

Plant characteristics: Canes of 'Prime-Ark® Freedom' are thornless and very erect, similar to 'Ouachita' and more erect than 'Natchez'. Vigor of 'Prime-Ark®' has usually been rated good, but not excessively vigorous. This variety has not been tested in colder climates than Arkansas, so it is not known if it is as hardy as other Arkansas developments.

Postharvest handling: 'Prime-Ark® Freedom' had lower overall ratings compared to 'Prime-Ark® 45', indicating limited shipping potential. Berry leakage was the primary variable that 'Prime-Ark® Freedom' had poor ratings for, with some concerns for soft berries. However, 'Prime-Ark® Freedom' should be acceptable for pick-your-own operations or possibly local marketing where 7-day or longer storage potential is not required.

As far as prior releases from the program, the top sellers in the last few years have been led by 'Ouachita', 'Prime-Ark® 45', and 'Natchez'. These three varieties accounted for over 4.2 million plants sold in recent years. 'Ouachita' has proven to be a reliable producer coast to coast. 'Natchez' was released several years after 'Ouachita' and has been a favorite of some growers due to its large fruit that ripens early. Negatives of 'Natchez' include less erect canes, tart fruit flavor at some harvest dates, and reduced primocane numbers. Likely a key to growing 'Natchez' is crop control, as it has been observed to fruit heavily resulting in reduced sweetness in berries, and reducing subsequent primocane emergence. 'Prime-Ark® 45' has been planted quite heavily since its release in 2009, with the most successful plantings near the coast of California. The moderate temperatures in that region provide conditions for tremendous yields of high-quality berries from mid-August until November (or when it either gets cold, folks get tired of picking, or Mexican imports enter the market). Some production of 'Prime-Ark® 45' has been carried out in the eastern US, and more moderate temperatures in summer of 2013 provided for improved primocane yields. However, the floricane crop has been valuable to some growers also, as it ripens early (with 'Natchez') and has excellent quality.

New developments should continue from the program. Substantial interest has been focused on other early selections to complement 'Natchez' with more uniform flavor and improved cane erectness. Enhanced firmness (some describe as crispy) has been incorporated into thornless selections, and improvements in plant yields are a major focus with this berry type. Primocane-fruiting selections with enhanced fruit quality are getting a close look, and one may be in hand for potential release.

The future is bright for new blackberry developments to provide for expansion of both shipping and local markets. This is an exciting time for blackberries!

John R. Clark is a university professor of horticulture at the University of Arkansas. His research responsibilities are his primary appointment, where he directs the University's Division of Agriculture fruit breeding program and teaches in the areas of fruit production and plant breeding. Crops he works with include blackberries, table grapes, muscadine grapes, blueberries, and peaches/nectarines. His research activities are carried out in Arkansas, several US states, and various countries in the world. A native of Mississippi, he has BS and MS degrees from Mississippi State Univ. and a PhD from the Univ. of Arkansas.

BLACK RASPBERRIES: NEW INTEREST IN AN OLD CROP

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Background

Canada, and became a commonly cultivated crop during the early 1800's. By the 1860's, there were at least 11 cultivars of black raspberries grown in the East, including an everbearing selection that was named and introduced around 1832, though this source of the everbearing trait was subsequently lost. By the 1880's, several thousand acres of black raspberries were being cultivated in New York State alone.

Since that time, production acreage in the East has decreased. Currently the state with the most production is Oregon, where according to the 2012 USDA-NASS Noncitrus Fruits and Nuts Summary, 900 acres were grown, producing 2.4 million pounds of berries almost entirely for the processing industry. Interestingly, the most widely-grown cultivar for this industry has been 'Munger', a cultivar introduced from Ohio in 1890. USDA statistics on black raspberry production for states other than Oregon are not available.

In the East, interest in the fresh-market black raspberry crop varies with locality, with the perception being that rural consumers, perhaps because they are accustomed to black raspberries, prefer black raspberries over red raspberries, while urban and suburban consumers generally prefer red raspberries. This preference for red raspberries was noted during the 1800's and was ascribed to greater familiarity of the population with the European red raspberry of their homelands. However, whether the majority of current consumers truly prefer red raspberries over black raspberries, or are simply more familiar with red raspberries due to their wider availability is unclear. What is clear is that individual consumers often have a strong preference for one type of raspberry over the other.

Currently, the majority of black raspberries in the East are grown in small plots, typically one-half acre or less, on diversified farms. However, several farms that specialize in growing berries grow much greater amounts of black raspberries, the largest in the eastern U.S. being Stokes Berry Farm in Ohio with 40 acres of black raspberries.

The relatively low overall acreage of black raspberries in the East is likely due to a number of reasons, one important one being the crop's short harvest season and concentrated ripening. This means that in order to get the crop harvested in pick-your-own operations, customers must be made aware of when the crop is available. The short harvest season and concentrated ripening period is, however, an advantage for machine-harvest. A second challenge is that black raspberry productivity is relatively low, typically averaging less than 2500 pounds per acre. Third, the black raspberry fruit is small, so labor requirements per pound of harvested berries is relatively high. This combination of factors means that fresh-market production is limited to mainly pick-your-own operations with a large customer base, farms where there is otherwise sufficient labor to harvest the berries, and locations where a high price can be obtained to cover costs. Finally, although black raspberries are fairly easy to grow, maximizing production and fruit quality can be challenging.

Increased Interest

Consumers. Recently, there has been an upsurge in consumer interest in the crop. The health benefits of black raspberries and their value in both preventing and fighting certain types of cancer have been discovered and received considerable attention over the last decade. This publicity has also had the side benefit of increasing consumer awareness of the crop's existence. Interestingly, the fact that consumers are sometimes unaware of the difference between black raspberries and blackberries means that growers may need to do some customer education.

Growers. Within grower ranks, there is always interest in growing crops with a strong market. However, the arrival of spotted wing drosophila is also increasing grower interest in berry crops with an early fruiting season; in this regard, the early and short harvest season of black raspberries may be an advantage, as harvest has been essentially over in the mid-Atlantic region and northward by the time that spotted wing drosophila populations become troublesome.

Breeding Efforts. Renewed interest in breeding with black raspberries is occurring in several venues. It had been long-assumed that because there is little variation in traits among current cultivars of black raspberries, little improvement would be obtained from additional efforts. However, recent studies using molecular techniques are finding more genetic diversity in wild germplasm than was expected, and there is potential to incorporate traits from a western close relative, whitebark raspberry, *Rubus leucodermis.* Besides attributes such an improved yields or flavor, other traits such as resistance to botrytis, improved firmness, and resistance to raspberry bush dwarf virus have potential to be incorporated into new varieties of both red and black raspberries from wild black raspberry germplasm. Furthermore, concentrations of bio-active compounds have been found to vary widely in wild germplasm, and thus improvements may be made in this area. Perhaps one of the traits that has the most potential to change the landscape of black raspberry production is the re-introduction of the long-lost trait of primocane-fruiting ability through the work of Peter Tallman. Use of varieties with this trait could increase the potential length of the harvest season and total yields.

Production Basics

There are several points of interest for producers establishing or expanding their plantings of black raspberries.

Site considerations. The black raspberry plant is tolerant of a wide range of soil types and pH, but is slightly more cold-tender than red raspberry and is not adapted to hot growing conditions. Thus, black raspberry production tends to be the most successful in areas with moderate temperatures. As with other small fruits, a well-drained site is needed. Black raspberries are somewhat susceptible to phytophthora root rot, though not to the extent that red raspberries are, but are very susceptible to verticillium wilt and thus should not follow tomatoes, potatoes, and others solanaceous crops. Wild raspberry and blackberry plants in the vicinity should be removed to the extent possible before establishing the planting, and distance from wild plants should otherwise be maximized.

Irrigation. Trickle irrigation is a necessity for ensuring that berries will reach full size.

Varieties. Only a few varieties – 'Bristol', 'Jewel', and 'Mac Black' - are currently widely-available for fresh-market production. Of these, 'Mac Black' extends the production slightly longer, adding about a week to harvest. Testing of various varieties from nursery suppliers has shown the above 3 varieties are generally correctly labeled; however, many other varieties, especially older ones, may not be what they were thought to be. The primocane-fruiting trait is now in existence in 'Niwot', which is expected to be available in the near future.

Trellising and training. A major difference between black raspberries and red raspberries is that black raspberries will arch over and tip root where they touch the ground. This is true for both standard floricane-fruiting plants, and also ones with the primocane-fruiting trait. Thus, vegetative canes of floricane-fruiting types must be tipped (i.e., the top 2-3 inches of growth removed) during their first summer to avoid this problem and also encourage lateral formation. Plants with the primocane-fruiting trait should be trellised, but best methods of management to maximize yields have yet to be investigated.

Insects. Aphids and thrips can be vectors of viruses to which black raspberries are very susceptible and thus should be controlled. Plantings should not be established where other fruit crops were grown due to the likely presence of dagger nematodes which are the vector of tomato ringspot virus. In northern areas, spotted wing drosophila populations are generally too low to be of concern until the end of the summer black raspberry harvest season. However, in areas with mild winters, spotted wing drosophila presence should be monitored to determine when sprays are needed.

Diseases. The widespread presence of wild black raspberries and blackberries in many wooded edges, roadsides, and fencerows means that growers need to be vigilant to protect their cultivated plants from systemic diseases such as orange rust and viruses, to which black raspberries are extremely susceptible. Though 500 feet is often mentioned as the distance for removal of wild plants, there is no precise distance that ensures safety, so plantings should be monitored for appearance of orange rust symptoms – specifically, weak spindly olive-green growth in the spring, followed by the appearance of orange pustules on the leaf undersides of infected plants. Protective fungicides should be applied, and infected plants should be dug out, taking measures to minimize spores being disseminated. Growth of surrounding plants should be monitored. Since orange rust is systemic, any plant parts that are left behind will still be infected and may resume growth.

Plants should also be monitored for symptoms of viruses, and as mentioned above under site considerations and insects, steps should be taken to minimize exposure of plants to vectors. As always, plants should be purchased from a reputable source.

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NIWOT DOUBLE-CROPPING BLACK RASPBERRY

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My presentation is about my new primocane-fruiting black raspberry named Niwot.

My work with primocane-fruiting black raspberries started with the discovery in 1986 of a wild black raspberry plant that was ripening fruit in October. Years of breeding from this start produced an initial candidate for commercialization, the Explorer black raspberry, distributed for trials in 2004-2006.

While the evaluation trials for Explorer were ongoing, I made another selection, recently called PT-2A4, that looked promising, with bigger berries and more productive compared to Explorer. PT2A4 was clearly a better selection than Explorer, showing good crops on both floricane and primocane crops, but, in 2006 when the new selection was made, I did not want to disturb the Explorer commercialization project, so I kept the new selection, PT2A4, in my back pocket for possible use later.

In spite of high hopes for Explorer, it was discovered in 2008 during evaluation trials that Explorer was not self fruitful and required an outside source of pollen. At that point, work to commercialize Explorer was terminated. Careful testing of PT2A4 in 2008 showed that it was indeed self-fruitful, which was a great relief, so PT2A4 became my new candidate for commercialization. The selection has been named 'Niwot' after a village in the vicinity of my garden, and a plant patent has been filed.

The Niwot floricane crop, at least for me in summer 2013, was one week earlier than Jewel and more productive. The comparison was made on Niwot plants that had been planted from green plugs (albeit with a bit of extra head-start under lights) in 2012. The Jewel comparison plants were planted as bare root stock at the same time in 2012. In my experience, the Niwot floricane crop per plant was larger than the Jewel crop per plant, although the Niwot floricane berries are slightly smaller than Jewel. Niwot also continued to ripen berries for several days after Jewel had finished its season.

The Niwot primocane crop starts in late August or early September, the schedule being very much dependent on the growing conditions earlier in the year, particularly in spring. My primocane crop for 2013 started about three weeks later than the primocane crop for 2012. Berries of the Niwot primocane crop tend to be larger than Jewel floricane berries. The 2013 primocane crop was even more productive than the 2013 floricane crop.

Because of the quality of cropping in both the floricane season and primocane season, I consider Niwot to be more than just primocane-fruiting, so I call it a double-cropping black raspberry.

Two pruning options are available to optimize Niwot growth to the grower's wishes: tip pruning or not tip pruning the primocanes and retaining or not retaining floricanes. Further information on pruning primocane-fruiting black raspberries is in a file that can be found by doing a web search on: Pete Tallman raspberry pruning.

Hardiness and disease resistance for Niwot are not fully known yet. We have seen good results for Niwot in USDA hardiness zones 5 to 7. One of the cooperating testers claims that the canes survived over a USDA Zone 3 winter, with canes surviving the winter to produce floricane berries. However, compared to something like Pequot, Niwot is probably not the best candidate. There is little disease pressure in my Colorado garden, and few observations of resistance or susceptibility are available.

Propagation of Niwot is being ramped up, and plants are expected to be available in some form from Nourse Farms for 2015 spring planting; these are likely to be dormant tissue-culture plugs. There are a few plants available in 2014, but not in commercial quantities.

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U.S. Plant Patent 17,727 gives details and background of the Explorer black raspberry.

An article in the NABGA conference proceedings for 2007 gives more background of my primocane-fruiting black raspberry breeding project and Explorer.

Web page, search on: Pete Tallman Raspberries

Pete Tallman is an amateur, backyard raspberry breeder. Pete grew up in central New Hampshire, surrounded by all manner of wild fruits, including blueberries, blackberries, and red and black raspberries, along with the apples and pears his parents had planted. He spent a long career in computer design engineering in the Hudson Valley, New York. Outside of work, his hobby was vegetable and fruit growing, which served as an antidote to the nanosecond world of computer engineering. In the summer he would spend hours gathering black raspberries from the local roadsides to stock the freezer for the winter. His black raspberry breeding activity started with the 1986 discovery near his home of an unusual wild black raspberry plant that was ripening fruit in October. In 1993, Pete relocated to Colorado for a job change, still in computer design, and he took the black raspberry project to Colorado with him. Pete retired in 2003 and lives just outside Boulder, Colorado with his wife Ellen on a fruit-filled acre of apples, pears, cherries, grapes, blueberries, and raspberries. Nearby live their daughter Kate, her husband, and their two lovely girls ages 1 and 4. Their son Michael lives in Salt Lake City with his wife and their handsome 2-year-old son, who is already being groomed for a future position on the US Ski Team.

Winter 2014
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Spotted wing drosophila (*Drosophila suzukii*) Caneberry update

What is the current status spotted wing drosophila (SWD)?

Spotted wing drosophila (*Drosophila suzukii*), an invasive pest of soft skinned fruits including blackberries, blueberries, cherries, grapes, raspberries, and strawberries, has been detected in 40 states throughout the continental United States and at least 14 countries outside its home range of eastern and central Asia since 2008. Female SWD preferentially lay their eggs in ripe and ripening fruit, unlike nearly all other *Drosophila* species. The resulting larvae feed on the fruit, causing direct damage, and may also be present at harvest, contaminating the product. Caneberries (blackberries and raspberries) have been among the crops most severally impacted by *D. suzukii.* In North Carolina alone, caneberries produced a crop valued at an estimated $14.3 million during the 2012 growing season, and *D. suzukii* damage alone was estimated to have caused 15% crop loss and an estimated $163/acre increase in production costs, resulting in $2.14 million in monetary losses. For more information on impacts of *D. suzukii* in the eastern US, see http://bit.ly/1cMYfP9.

Key 2013 findings

1. *D. suzukii* infestation rates vary between caneberry varieties in field when they are grown in mixed variety plantings (Figure 1). However, no blackberry or raspberry variety has been demonstrated to be resistant to *D. suzukii* infestation, and we have not observed similar infestation differences between blueberry or day neutral strawberry varieties.

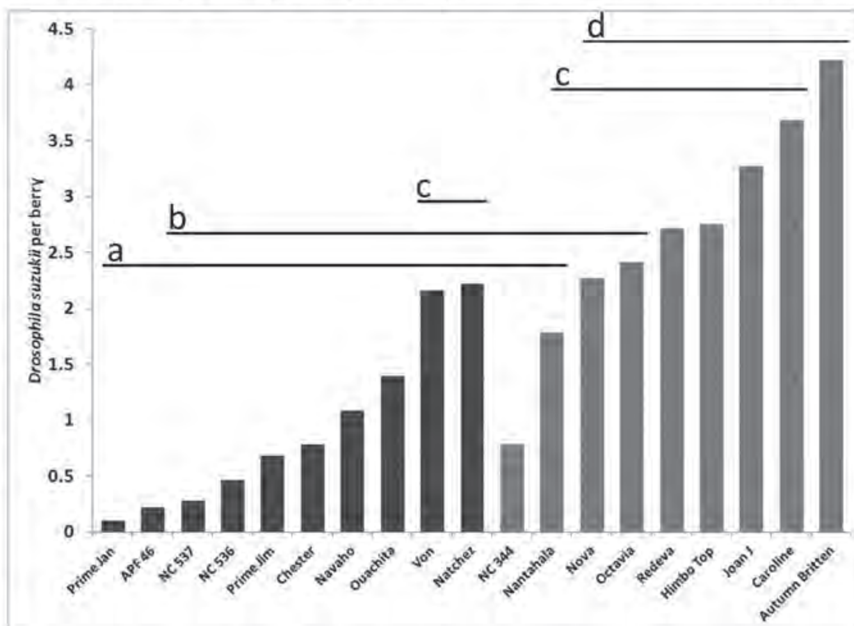

Figure 1. *D. suzukii* infestation rates (larvae per berry) in blacberry (purple) and raspberry (red) varieties. See http://bit.ly/1gdPtJ4 for more information.

2. While adult *D. suzukii* trap captures may be higher in field margins and non crop habitat, this does not necessarily relate to fruit infestation patterns. Further, fruit infestation can build from very low levels to near total infestation in as little as a week.

3. Apple cider vinegar is not the most attractive *D. suzukii* bait, and caught flies later than all other baits or lures compared in a ten state trapping experiment. However, all baits and lures tested caught as many or more native *Drosophila* flies as *D. suzukii.*

Spotted wing drosophila (*Drosophila suzukii*) caneberry update

Key 2013 findings, continued

4. Storing fruit at cold temperatures (less than 41°F) post harvest stops egg or larval development, but this does not necessarily kill immature *D. suzukii.* Eggs and newly hatched first instar larvae appear to be the most sensitive to cold temperatures. More eggs and larvae survive in fruit than in artificial diets at cold temperatures.

2014 Management Recommendations

Monitoring

Fruit samples should be collected and assessed for infestation at each harvest. A separate sample should be collected for each variety for each production unit. If adult traps are used, use a bait or lure other than apple cider vinegar and be prepared to distinguish *D. suzukii* from other *Drosophila* species. A commercial lure may be available in 2014.

Cultural strategies

Harvest as frequently and thoroughly as feasible. This both shortens the time that ripe fruit are exposed to egg laying *D. suzukii* and reduces the number of fruit which can support developing flies. Remove unmarketable fruit from the field or destroy it in a way which kills *D. suzukii* larvae, including freezing, "baking" in clear plastic bags under the sun for several days, or crushing and drying fruit. Fine mesh "no-see-um" netting has been demonstrated to prevent *D. suzukii* infestation in blueberries in Japan.

Insecticide options

Insecticide treatments should begin when fruit start to ripen and should be repeated weekly. Effective classes of insecticides include spinosyns, pyrethroids, and organophophates. Consult your local cooperative extension personnel for specific recommendations. Some new active ingredients have also shown promise but will not be available in caneberries during 2014. Be sure to rotate between at least two modes of action for resistance management.

Read us @ entomology.ces.ncsu.edu
Follow us @NCSmallFruitIPM on Twitter
Like us @ http://www.facebook.com/NCSmallFruitIPM

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GETTING THE MOST OUT OF SWD CONTROL MEASURES

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In 2011, the first adults of the spotted wing drosophila (SWD) were found in the Northeastern United States. Since then, this insect has become a serious pest of blueberries, strawberries, raspberries, and blackberries in our region. To control this pest, we are currently evaluating various insecticides with different modes of action. In 2013, we conducted studies to: a) determine the efficacy of various insecticides with and without a phagostimulant against adult SWD, and b) determine the efficacy of these insecticides against SWD larvae inside the fruit (curative control).

Efficacy of insecticides with and without a phagostimulant against adult SWD

An experiment was conducted to compare the efficacy of Exirel (a diamide), Danitol (a pyrethroid), Delegate (a spinosyn), Assail 30SG (a neonicotinoid), Bifenture (a pyrethroid), Movento (a tetramic acid derivative), Malathion (an organophosphate), and Imidan (an organophosphate) against SWD in highbush blueberries in New Jersey. Insecticides were applied with and without sugar as a phagostimulant at 2 lbs. per 100 gallons. The experiment was conducted in the mid-season cultivar 'Bluecrop,' located at the P.E. Marucci Blueberry/Cranberry Center in Chatsworth, New Jersey. Treatments were applied to single bushes and were replicated four times. Applications were made with an R&D CO2 backpack sprayer, using a 0.5 liter plastic bottle. The sprayer was calibrated to deliver 50 gallons of volume per acre at 35 psi, using a single ConeJet TXVS 4 nozzle, yielding 5.29 fl oz per bush. Treatments were applied on 30 June. A single cluster of ripe blueberries with an 8-10 cm stem attached was taken from each treated bush 1 and 3 DAT on 1 July and 3 July. The clusters were placed in a 32 oz deli container with a hole cut in the bottom in which a florists water pick fit tightly, with stems watered, and the number of ripe/ripening berries counted. A total of ten spotted wing drosophila adults (5 females and 5 males) were removed from a laboratory colony and kept in rearing tubes in a 25°C incubator for 2-3 h before being released into the containers. Flies were 1-3 days old at the time of use to ensure sexual maturity and were anesthetized with small puffs of CO2 injected into the tubes prior to placing them in the containers. The containers were then placed on a light bench in the laboratory under a 14:10 L:D photoperiod, and were kept at 25-28°C during the 7 days of observation. Adult fly mortality data were collected on day 1 and 3. Data on fruit infestation were collected 5-9 days after the last adult mortality observation via a salt water extraction method and then counting larvae and/or pupal cases that exited the fruit. The salt water extraction method consisted of submerging fruit samples in warm salt water approx 1000 ml of salt to 5 gal water. Number of larvae per 100 berries was calculated from the number of larvae and ripe/ripening fruit in the cluster. Data were analyzed using ANOVA and means separation by Tukey tests at $P = 0.05$. Percent mortality data were arcsine square-root transformed. Count data were natural log (x+0.5) transformed prior to analysis. Exirel, Assail, Imidan, Malathion, Bifenture, and Delegate provided the best control 1 DAT (see Figure 1). The efficacy of Exirel, Assail, Imidan, Bifenture, Danitol, and Delegate increased when sugar was added. All treatments, except for Movento, reduced the number of larvae in fruit (see Figure 2).

Figure 1. Effect of various insecticides with and without sugar (sucrose) on SWD mortality

Figure 2. Effect of various insecticides with and without sugar (sucrose) on SWD larvae in fruit

Efficacy of various insecticides against SWD larvae inside the fruit (curative control)

This experiment tested the efficacy of Exirel, Assail, Imidan, Malathion, Bifenture, Danitol, Delegate, and Movento for curing existing SWD infestation in blueberries. On 6 July, 3600 ripe undamaged berries were obtained from an untreated field of the mid-season blueberry cv. 'Bluecrop' located at the Rutgers P.E. Marucci Center in Chatsworth, New Jersey. Picked berries were divided up into eight groups of 450 berries each and each group was spread in a single layer on each of eight clear polypropylene trays. Four of the trays were placed in a 15°C incubator for later exposure. The remaining four trays were placed in 1 ft cube cages and exposed to >500 spotted wing drosophila adults (mixed sexes) in each cage. Flies were approx. 4-9 days old, and were from a laboratory colony kept at the P.E. Marucci Center. Berries were left in cages for two days (from 3 July until 5 July for the 4-5 day old group and from 6 July until 8 July for the 0-2 day old group). Cages were kept on lab shelves at 25°C, under lights on a 15:9 L:D cycle. At 48 hours, trays were removed from the cages and any flies remaining on the berries were aspirated off to stop oviposition. The four exposed trays were then placed in a 22°C incubator until the treatment date. On 6 July, the remaining four trays were moved from the 15°C incubator and given an hour to warm to room temperature before being placed in the same exposure cages. Berries were left in cages for two days as was done with the first set of berries. On the day of treatment, berries from the 4-5 day old group were degraded too far to be able to handle them, and were not able to be treated. On 10 July, berries from all four trays from the 0-2 day old group were evenly divided into 36 groups (9 treatments x 4 replicates), of 50 berries each for treatment that day. On the day of treatment, 10 July, each group of berries (36) was spread out on a 12”x12” wire-mesh tray formed from 1/4”gap hardware-cloth prior to treatment. Applications were made with R&D CO2 backpack sprayer, using a 1-liter plastic bottle. The sprayer was calibrated to deliver 4.3 mL/sec at 30 psi with a single ConeJet TXVS 4 nozzle. Trays were gently shaken during application to cause berries to roll and be coated on all sides. Application took 3-4 seconds yielding 12.9-17.2 mL per group. Treated berries were left on trays for 3 hours to dry. Larvae in berries were to be allowed to develop and emerge before evaluation, so each group of treated berries were placed in a 16 oz clear plastic deli container over approx. 1 cm of clean dry playsand. All cups were capped with ventilated lids and kept on trays in a 24°C incubator on a 15:9 L:D cycle to allow any surviving larvae to develop. Samples were evaluated at 10 days post-treatment on 18 July. Fruit was allowed to incubate for 10 days to allow most surviving larvae enough time to develop and exit the berries, at which point larval data were collected using the salt water extraction method (salt water extraction method = submerging sample in warm salt water approx 1000 ml of salt to 5 gal water causing any larvae to leave fruit). Larvae and pupae floating to surface were removed and counted, and the remaining berries were then dissected to ensure no developed larvae/pupae were overlooked. The number of larvae per 50 berries was totaled for each sample. Data were analyzed using ANOVA and means separation by Tukey test at P≤0.05. Count data were ln-transformed prior to analysis [ln(x+0.5)]. All insecticides provided > 90% curative control. Exirel and delegate provided 100% control. Movento provided the weakest curative control of all insecticides tested.

Table 1. Curative control

Treatment	Rate	No. Larvae / 50 fruit (Mean ± SE)	% Curative Control
Exirel (10SE)*	20.5 floz/ac	0.00 ± 0.00 d	(100.0)
Assail 30SG	5.3 oz/ac	0.75 ± 0.48 cd	(99.7)
Imidan (liquid formulation)	32 floz/ac	0.25 ± 0.25 cd	(99.9)
Malathion 8Aquamol	2.5 pt/ac	0.25 ± 0.25 cd	(99.9)
Bifenture 10DF	16 oz/ac	4.00 ± 1.41 c	(98.6)
Danitol 2.4EC*	10.7 floz/ac	2.25 ± 1.03 cd	(99.2)
Delegate 30WG	6 oz/ac	0.00 ± 0.00 d	(100.0)
Movento 240SC**	10 floz/ac	23.75 ± 5.23 b	(92.0)
Control	-	295.75 ± 25.09 a	0.0

*Adjuvant=0.25% Dynamic, **Adjuvant=0.25% MSO

Means within a column followed by different letters are significantly different (Tukey test, P≤0.05)

Count data were ln(x+0.5) transformed prior to analysis

% Curative Control = [1-(No. Larvae in insecticide-treatment / No. larvae in control)]*100

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THERE ARE WORMS IN MY JELLY!

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Many customers say that they can sense friendly, customer-oriented produce staff almost from the time they walk into the market. But it isn't always just the way the employees notice them.

The cleanliness and readiness for business of the department, and the care and beauty that the merchandising of the department conveys, all contribute to that sense of welcome and comfort that is communicated to the customer. And all are an integral part to customer service.

Customer Complaints

The professional produce clerk not only welcomes requests for information, but uses customer complaints as an excellent opportunity to help win over customers.

Handling complaints well requires application of the basic techniques of good customer service. In most cases, the anger or frustrations of a dis-satisfied customer will be diffused by being treated in a way that shows you care about the customer and their problem.

When a customer approaches you, greet them with a friendly smile. Listen attentively and sympathetically while the customer describes their problem, and don't interrupt until they have let out all frustration. Ask questions (if necessary) so that you can find out exactly what happened.

When you understand the problem, apologize sincerely and then provide a solution or alternative, using your product knowledge. Avoid any sense that you are being critical of mis-handled or mis-stored product.

An excellent way to provide this kind of information is just to begin by saying: "Next time…," and then proceed to give the correct or missing information. Your manager will explain your policy on replacing product. Call your manager immediately if you cannot handle the situation.

Don't forget that it's harder to satisfy a customer who has a complaint, or who has had a bad experience. But when you do, you have created a loyal customer, one who will continue to shop your department not only because of the quality of your merchandise, but because you care about your customers as individuals.

Opportunity

- Care/compassion
- Smile
- Listen

Once you understand

- Apologize
- Offer solution
- Alternatives

A simple "sorry" is not enough. A satisfying apology, in this case, should include the following:

Take responsibility. Sometimes we shrink from doing this. Instead, we try to downplay or dismiss the problem. When I found a beetle in my salad once, the waitress airily responded: "What do you expect? It's organic." In fact, according to one study, people are less likely to be litigious if the wrongdoer offers a full apology.

Empathize. I found "a small, gray, very wriggly worm" on a piece of lettuce that accompanied a takeout burger. I took the burger back to the restaurant, but the worm had disappeared. "People looked at me like I was crazy. Then someone saw it on my sleeve." Nonetheless, I still patronize the restaurant, because the manager called me at home and offered a "distraught" apology. "His tone won me over. He sounded very upset."

Identify the source. Show you taking steps to find the source of the problem and fix it. The customer wants to know it won't happen again." If the market can pinpoint the source, it reassures the customer, proving the entire business isn't filthy and infested. I once ordered a Manhattan that was "swimming with ants." Eventually, the bartender discovered that the ants were in the vermouth. "I was weirdly satisfied. … Once the mystery was solved, I could relax."

Obviously, I shouldn't pay for the tainted product. And most likely I won't want another one, even if it's free. But I should be compensated for my distress by giving me something else. This offer might be a bottle of wine or a gift voucher. Whatever our offer is, let's be certain we surprise the customer with something they consider valuable. This makes economic sense. A repeat customer is far less expensive than a new one. Then I would apologize again. That way, however traumatic my event was, it ends on a sweet note.

John Berry works for Penn State in the 8 counties of the southeast region. Half of his time is spent working on marketing issues with commodity growers. The other half is spent on educational programs for direct-to-consumer retail farm marketers. Mr. Berry has a BS from Tennessee Tech University and an MBA from Kutztown University. He lives with his family in Emmaus, PA. He and his wife Maureen have three children Jill, Chris, and Kyle

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 hybrid cultivars of tomato with resistance to tomato diseases common in PA, improved fruit quality, high yield, and adaptation to PA conditions.

Background Information:

Plant diseases are a major concern to the tomato industry in PA. Two most 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 one of the most common diseases of tomato in the Midwest, East and Northeast of the United States. In PA, tomato growers experience EB almost every single year. 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 routine 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). The pathogen is best known for its role in the Irish potato famine, where it caused the loss of more than a million lives (Andrivon 1996). Until the late 1970s, tomato LB was relatively well controlled through the use of cultural practices and heavy use of fungicides. However, the occurrence of both A1 and A2 mating types of *P. infestans* during the past few decades (Hu et al. 2012) has created the opportunity for sexual reproduction and creation of new and more aggressive isolates, many of which are resistant to LB-specific systemic fungicides. Currently, few tomato cultivars with LB resistance are available, and measures employed to control the disease involve the use of cultural practices and heavy use of fungicides. However, the variability in fungicide resistance among different clonal lineages of *P. infestans* and the realization that heavy reliance on fungicides for disease control is not sustainable, nor practical in organic production, has made genetic resistance more appealing. 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 not effective against the current race (T-1) 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. Recently, a few LB-resistant fresh-market tomato hybrid cultivars were released, including Plum Regal, Mountain Magic, and Mountain Merit (Gardner and Panthee 2010; Panthee and Gardner 2010; Gardner and Panthee 2012), and Defiant PhR (http://www.johnnyseeds.com/p-8473-defiant-phr-f1.aspx). 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; R.G. Gardner; *pers. commun.*), necessitating 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 (LYC) is the red pigment in tomato, and a potent natural antioxidant that is increasing in demand. Fresh tomatoes and tomato products are the major sources of LYC in the U.S. diet. The attention to LYC is well deserved, as its antioxidant capacity is roughly twice that of b-carotene. Numerous epidemiological and intervention studies have demonstrated that dietary intake of lycopene is correlated with a decreased incidence of certain cancers (e.g. prostate, lung, mouth, and colon), coronary heart diseases, and cataracts (Jatoi et al. 2007; Kucuk 2002; Suresh Kumar et al. 2003; Wu et al. 2004). Furthermore, since humans can only acquire lycopene through the diet and obtain approximately 85% of their lycopene from tomato-based foods, the availability of tomatoes that are higher in lycopene content would be highly beneficial to consumers as well as the tomato industry. The development of high-lycopene tomato cultivars is of major commercial significance to both fresh-market and processing tomato industries, as well as pharmaceutical and nutraceutical companies.

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 controls 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: Genetic sources of resistance to EB were identified within tomato wild species *S. pimpinellifolium* and *S. habrochaites.* The wild germplasms were used for genetic studies, including identification and mapping of resistance genes (quantitative trait loci, QTLs), and breeding purposes. We have developed processing and fresh-market (large round, plum, cherry and grape) tomato inbred lines with improved resistance to EB. We also have developed experimental hybrids from crosses among advanced breeding lines, which were evaluated under field conditions in 2013 and compared with current commercial cultivars. Several hybrids exhibited strong EB resistance (Fig. 1), and currently are being evaluated by a few seed companies for commercial use.


Figure 1. Select pictures of FM tomato hybrids from the 2013 field trial conducted at the Russell E. Larson Research and Education Center at Rock Springs, PA. These hybrids exhibited high level of resistance to EB.

Late Blight: Screening of a large collection of *S. pimpinellifolium* wild accessions for LB resistance under field, high tunnel, greenhouse and growth chamber conditions resulted in the identification of over a dozen accessions with strong resistance. Several of these accessions exhibited a LB-resistance similar to breeding lines and hybrid cultivars with combined *Ph-2* + *Ph-3* resistance genes (Table 1). We have used 5 accessions for genetic studies and breeding purposes. In one accession (PSLP 153), using a parent-offspring (F_2:F_3) regression analysis, heritability of LB-resistance was estimated to be 0.86, suggesting that resistance was highly heritable and could be transferred to the cultivated tomato via phenotypic selection. Using a selective genotyping approach two genomic locations on tomato chromosomes 1 and 10 were identified, which contributed to LB resistance. These two genomic locations (genes) have been tentatively denoted as *Ph-5-1* and *Ph-5-2.* Resistance from this accession as well as that conferred by the previously-known resistance gene, *Ph-3*, have been incorporated into Penn State tomato breeding lines. These new lines exhibit high level of resistance to LB (Fig. 2). Currently, breeding activities are underway to improve these breeding lines for other desirable horticultural characteristics. Furthermore, research in underway investigating the genetic basis of LB resistance in four other *S. pimpinellifolium* accessions, including PSLP 142, PSLP 144, PSLP 150 and PSLP 151 (Table 1).

Figure 2. Select pictures of tomato breeding lines developed at Penn State with LB resistance. In each panel, at the left side are control susceptible lines.

Fruit Quality: From screening of ~300 accessions of the red-fruited tomato wild species *S. pimpinellifolium*, one accession was identified with exceptionally high fruit lycopene content. Extensive genetic studies, using segregating populations derived from crosses with the high-lycopene accession, resulted in the identification and mapping of QTLs on tomato chromosomes 7 (*lyc7.1*) and 12 (*lyc12.1*) contributing to high fruit lycopene content (Ashrafi et al. 2012). Subsequently, to validate the phenotypic effect of these QTLs, a marker-assisted backcross program was undertaken and produced near-isogenic lines (NILs) segregating for *lyc12.1*. Lycopene contents from *lyc12.1* homozygous and heterozygous recombinants in this population were measured and *lyc12.1* was localized to a 1.5 cM region (Kinkade and Foolad 2013). Simultaneously, we have been transferring the high lycopene trait from the *S. pimpinellifolium* accession 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. Recently, we have developed experimental F_1 hybrids of fresh market tomatoes, which were grown and evaluated during the 2013 field season. In addition to high fruit quality, several of these hybrids exhibit other desirable horticultural characteristics, including high yield and disease resistance (Fig. 3).

Table 1. Late blight disease rating (% disease severity) of tomato germplasm under field and greenhouse condition

		Field Exp. I	Field Exp. II	GH Exp. I	GH Exp. II	GH Exp. III	GH Exp. IV	All Exps.
S. pimpinellifolium								
PSLP	117	80.0	95.3 ± 11.5	98.0	91.0 ± 1.4	88.8 ± 2.5	70.0 ± 14.1	87.2 ± 10.5
PSLP	166	70.0	80.7 ± 4.6	85.0	76.0 ± 15.6	95.0 ± 0.0	25.0 ± 7.1	71.9 ± 24.5
PSLP	163	60.0	66.7 ± 5.8	50.0	78.5 ± 12.0	87.5 ± 2.9	27.5 ± 3.5	61.7 ± 21.4
PSLP	135	40.0	100.0 ± 16.2	97.0	87.5 ± 10.6	8.5 ± 4.4	20.0 ± 7.1	58.8 ± 40.9
PSLP	125	20.0	80.0 ± 8.7	70.0	52.5 ± 3.5	57.5 ± 5.0	50.0 ± 49.5	55.0 ± 20.6
PSLP	141	40.0	88.3 ± 1.7	15.0	55.0 ± 7.1	38.8 ± 16.5	47.5 ± 10.6	47.4 ± 24.1
PSLP	143	50.0	65.0 ± 7.5	20.0	37.5 ± 10.6	43.8 ± 4.8	17.5 ± 3.5	39.0 ± 18.1
PSLP	122	20.0	46.7 ± 2.9	35.0	25.0 ± 14.1	43.8 ± 2.5	37.5 ± 3.5	34.7 ± 10.4
PSLP	139	40.0	30.3 ± 14.4	20.0	25.0 ± 0.0	8.0 ± 2.4	35.0 ± 7.1	26.4 ± 11.5
PSLP	144	30.0	7.0 ± 0.3	15.0	9.5 ± 3.5	10.5 ± 4.9	10.0 ± 0.0	13.7 ± 8.4
PSLP	142	20.0	0.5 ± 0.0	5.0	20.0 ± 7.1	7.5 ± 2.9	17.5 ± 3.5	11.8 ± 8.5
PSLP	147	10.0	0.7 ± 0.0	7.0	5.0 ± 0.0	1.3 ± 0.5	7.5 ± 3.5	5.2 ± 3.7
PSLP	153	10.0	0.3 ± 0.0	10.0	0.0 ± 0.0	2.8 ± 1.7	6.0 ± 1.4	4.8 ± 4.5
PSLP	150	0.0	0.3 ± 0.0	12.0	7.0 ± 0.0	3.3 ± 1.3	6.0 ± 1.4	4.8 ± 4.5
PSLP	152	10.0	0.3 ± 0.3	5.0	0.0 ± 0.0	1.1 ± 0.6	6.0 ± 1.4	3.7 ± 4.0
PSLP	151	10.0	0.3 ± 0.0	3.0	0.0 ± 0.0	0.6 ± 0.3	4.0 ± 1.4	3.0 ± 3.8
PSLP	155	0.0	0.3 ± 0.0	6.0	1.5 ± 2.1	5.0 ± 1.6	4.0 ± 1.4	2.8 ± 2.5
PSLP	161	0.0	0.5 ± 0.0	3.0	0.0 ± 0.0	2.5 ± 1.3	5.0 ± 0.0	1.8 ± 2.0
Control genotypes								
NC84173 (susc.)				92.0	91.5 ± 9.2	73.8 ± 8.5	87.5 ± 6.5	86.2 ± 8.5
New Yorker (*Ph-1*)				95.0	98.0 ± 0.0	68.8 ± 26.6	72.5 ± 26.0	83.6 ± 15.1
NC63EB (*Ph-2*)				25.0	7.5 ± 3.5	20.0 ± 13.5	20.0 ± 10.0	18.1 ± 7.5
NC870 (*Ph-3*)				3.0	10.0 ± 0.0	18.8 ± 2.5	12.5 ± 6.5	11.1 ± 6.5
NC03220 (*Ph-2+Ph-3*)				1.0	4.0 ± 1.4	8.8 ± 14.2	5.5 ± 3.3	4.8 ± 3.2
Mean ± SD		28.3 ± 24.6	36.9 ± 40.0	33.6 ± 36.1	34.0 ± 36.0	30.3 ± 32.7	25.8 ± 24.5	32.1 ± 30.5
LSD (0.05)			12.4		24.9	9.8	30.3	16.7

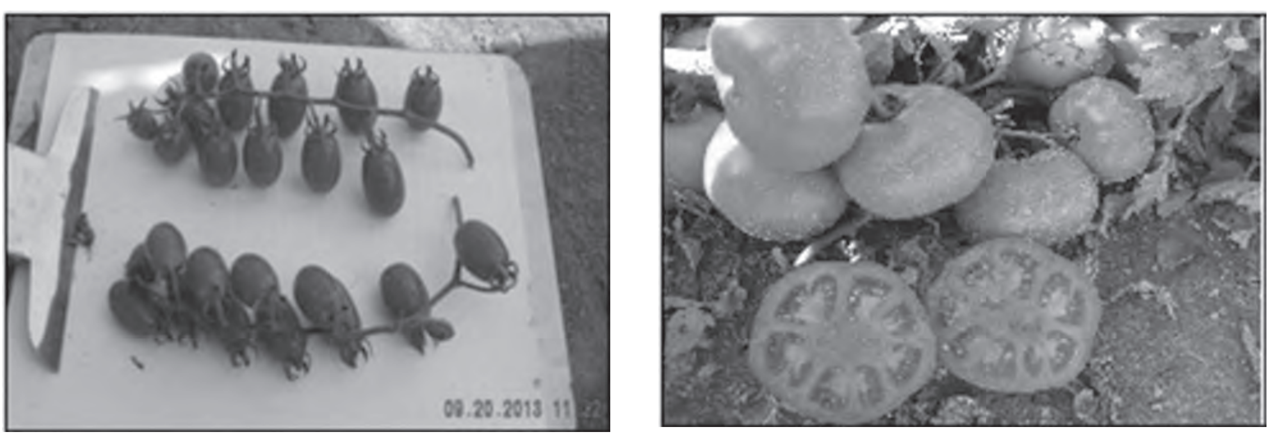

Figure 3. Select pictures of high lycopene FM tomato hybrids from the 2013 field trial conducted at the Russell E. Larson Research and Education Center at Rock Springs, PA.

TOMATOES

Several lines and experimental hybrids with improved disease resistance and high fruit quality are currently being evaluated by seed companies for commercial utilization. In 2014, we will trial several of our newly developed experimental F_1 hybrids side-by-side with commercial hybrid cultivars. We will organize a field day in early September where tomato growers and other interested parties could visit and observe the new Penn State hybrids.

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GOING BEYOND N, P, AND K; SOLVING OTHER NUTRIENT ISSUES

Steve Bogash, Horticulture Educator

One of the great misconceptions among growers is in the understanding of the importance of micronutrients in creating a great tomato harvest. While the required amounts of these nutrients are very low in comparison to the levels of macronutrients, their importance is still very high. Typically major nutrients or macronutrients can be measured expressed as a percentage of dry matter in plant tissue while the much smaller micronutrient levels are expressed as PPM (parts per million). These smaller amounts lead many to believe that they are less important. However, plant health and fruit quality suffers greatly when there are insufficient amounts of these micronutrients as they are important in cell division, development of flavor compounds, cell wall formation, fruit set and other plant biochemical processes.

Major nutrients include Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Phosphorus (P), and Potassium (K). Of these, C, H, & O are classed as structural elements and are extracted by plants from the air and water and make up 85-90% of plant tissue. N, P, and K are commonly considered as the macronutrients, make up much of the remaining plant tissue and are the 3 numbers expressed as percentages on fertilizer bags (occasionally a fourth number with Ca or S is on some labels). Required in lesser amounts as critical micronutrients by plants are Calcium (Ca) and Magnesium (Mg) followed by Sulfur(S), Boron (B), Chlorine (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), and Zinc (Zn). Of great interest in our industry at this time as well as receiving a lot of research are the elements Silicon (Si), Sodium (Na), Vanadium (V) and Nickel (Ni). So far these last four elements are not considered critical nutrients, but research indicates that they may be beneficial in the right circumstances.

We will consider the list of currently considered “critical” micronutrients for our region. Mo, Mn, and Cl have been left out of this section as they are seldom a problem. All of the tissue levels are based on samples of whole leaves collected as “Most Recently Mature.” On a typical tomato plant, this is the fourth or fifth whole leaf down from the growing point. This leaf will be fully expanded and no longer yellow in appearance.

Calcium (Ca): Calcium is critical in cell wall formation. Plant Ca deficiencies include Blossom End Rot (BER) along with many variations of skin cracking. Calcium deficiencies are typically part of a series of problems including uneven watering, low pH, moisture stresses, and imbalances with the nutrients K, Mg and N. Ca tomato tissue levels at fruiting should be near 3%. Calcium Nitrate and Calcium chelates are typically applied through irrigation or foliarly to increase available calcium. Irrigation must be managed properly to solve a Ca deficiency.

Magnesium (Mg): The comments for Mg are very similar to Ca as these elements must be in balance with each other. Like Ca, severe Mg deficiency can cause BER. Mg tomato tissue levels at fruiting should be near .9%. Field observations indicate that a ratio of 3/4 parts Ca to 1 part Mg assuming that both are near the peak of sufficiency produces excellent fruit with strong skins and minimal cracking. Magnesium sulfate, Sul-Po-Mag, Magnesion Chelates, and Magnesium Oxides are common sources of additional Mg.

Sulfur (S): Sulfur is especially important in the creation of the complex of organic compounds that make up the odor and flavor profiles of vegetable fruit. Tissue sulfur levels at fruiting should be between .8 and 1.2%. Potassium sulfate, Sul-Po-Mag, Magnesium sulfate and Ammonium sulfate are all common sources of sulfur. Since these are common materials used in blending fertilizers, S is seldom a limiting nutrient.

Boron (B): Boron is extremely important to growers in our region as this element is often deficient in our soils. B deficiency is often expressed as poor development or death of the growing point since it is very important in many cellular division processes. Borax and Solubor are often applied foliarly at #1/2 -1 / Acre annually. B tissue levels should be between 50 and 75ppm. Bringing B tissue levels to 75 ppm can increase fruit quality by reducing cracking and uneven ripening.

Copper (Cu): Although copper deficiency is seldom seen in the field, observations indicate that keeping Cu levels near 20ppm will enhance plant growth and aid in the plants ability to resist diseases. Most copper bactericides / fungicides supply sufficient amounts of Cu when used in rotation as part of an overall disease management program.

Iron (Fe): Iron is very important in the plants ability to utilize N and S. Many plant biochemical processes require small amounts of Fe. Recommended tissue levels are 100-300ppm. Iron deficient plants have interveinal chlorosis and yellowing of younger leaves. High pH soils or irrigation water can cause Fe deficiency. Iron chelate and Ferrous sulfate are good sources of additional Fe. Tomatoes benefit greatly from the management of irrigation water to a pH of 6.2-6.5. This increases Fe and K availability.

Zinc (Zn): Zn deficiency can appear as poor growth and/or poor fruit set and often appear very similar to Fe deficiency. The only way to identify this problem is by tissue testing. Zn levels should be between 20 and 50ppm. Zinc chelates, sulfate and oxides are common sources of additional Zn.

The best method to avoid micronutrient deficiencies as well as produce the largest crop with the greatest packout is to regularly soil test and tissue test plants at critical points. Always test a tomato field prior to planting and apply nutrients as recommended. Then submit plant tissue for analysis at first blossom, 6-8mm green fruit, first fruit color (pink) and again at first harvest if you are planning on keeping the plants fruiting. If you need information on collecting proper plant tissue for analysis, please contact the author.

Steve is currently a Horticulture Educator serving Pennsylvania out of the Cumberland County office in Carlisle. He covers vegetables, small fruit, cut flowers, greenhouse vegetables, and specialty marketing as his primary areas of responsibility. Tomatoes, bell peppers, container vegetables, cucumbers, and other specialty crops are regular items in the trial gardens under Steve's management.

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 400 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.

THE INTEGRATED MANAGEMENT OF LATE BLIGHT ON TOMATO

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Late blight, caused by the pathogen *Phytophthora infestans*, was a disease once considered sporadic, but is now an annual concern for tomato and potato growers. Symptoms on tomato can develop on leaves, stems, branches and fruit at any growth stage. On leaves, pale green to brown lesions will develop on the upper leaf surface and have pale green or water soaked margins. The lesions may enlarge rapidly until entire leaflets are killed. Under conditions of high relative humidity, grayish white sporulation will develop on the lower leaf surface opposite to the lesions. Stem lesions are chocolate brown in color and can girdle causing them to break. Greasy-brown lesions can develop on both immature and mature fruit and the fruit typically remain firm unless infected by secondary soft-rotting organisms. Disease development and spread is favored by temperatures between 65 and 70°F with high relative humidity (RH) near 100%. Survival of the spores is greatly reduced when the RH is below 95%; at 80% RH they can survive only five hours. Once the spores have landed on the plant, a film of water must be present to initiate infection. Infection can occur in a matter of hours under ideal conditions and visible symptoms are evident in the field after 5 to 7 days.

Once again in 2013 late blight was widespread across the Northeast and mid-Atlantic regions. In PA, samples were collected throughout the season from 14 July when the first report was confirmed through the end of September for a total of 23 confirmed reports (22 from tomato and 1 from potato) that were entered into the USAblight.org website. The majority of the samples were submitted to Dr. Bill Fry at Cornell University for genotyping (typically one sample per county per host). All samples except for the one potato sample (US8) were determined to be clonal lineage US23, same one that predominated in 2012. A similar distribution was observed in the eastern U.S. with approx. 90% of the 195 samples submitted for genotyping being determined to be US23. US23 is characterized as the A1 mating type and is aggressive on both tomato and potato; however it produces many more spores on tomato. US23 is also characterized as sensitive to the systemic fungicide mefenoxam which was again effectively used in several potato fields early in the season to manage the disease outbreak. Knowledge of the pathogen population structure is an important component of an integrated disease management program and helps growers make informed in-season disease management decisions.

Until recently, late blight management has focused on the frequent use of fungicides, especially under favorable conditions however, as more cultivars are released with resistance to late blight, host resistance becomes an important and more feasible component of an IPM program. To-date, three major late blight resistance genes (*Ph-1*, *Ph-2* and *Ph-3*) have been identified in the red-fruited tomato wild species *Solanum pimpinellifolium* and transferred through conventional breeding into the cultivated tomato (*S. lycopersicum*). Unfortunately, the pathogen population is constantly adapting has already overcome *Ph-1*, rendering it no longer effective. More recently, *Ph-2* and *Ph-3* have been introgressed into a few commercial cultivars in both the heterozygous and homozygous state (e.g. Mountain Magic, Mountain Merit, Plum Regal and Defiant). Currently, commercially available cultivars that contain both *Ph-2* and *Ph-3* (e.g. Mountain Merit and Mountain Magic) are considered most effective against the current genotypes of late blight. Work in the Foolad lab at Penn State is on-going to identify new late blight resistance genes (e.g. *Ph-5*) in the wild species *S. pimpinellifolium*. The goal is to combine multiple resistance genes to increase the strength and durability of resistance. Molecular markers and marker-assisted selection (MAS) technology is used to facilitate this process.

In 2013, two field trials were conducted at the Russell E. Larson Research and Extension Center in Centre Co. and the Southeast Research and Education Center in Lancaster Co. to evaluate the susceptibility of 11 fresh market tomato breeding lines and hybrid cultivars with various combinations of late blight resistance genes identified by North Carolina State and Penn State breeding programs to late blight, and in combination with several fungicide programs. As was observed in identical trials conducted in 2012, fresh market tomato breeding lines and hybrid cultivars containing various combinations of LB resistance genes (*Ph-2*, *Ph-3* and *Ph-5*) in the homozygous or heterozygous state, exhibited a high degree of resistance to late blight in the absence of fungicides. Breeding lines and cultivars containing both *Ph-2* and *Ph-3* (Mountain Magic, Mountain Merit and NC1 CELBR) exhibited the highest level of resistance across the trials. Late blight was observed on Plum Regal (heterozygous *Ph-3*) in both trials as well as in other locations across the Northeast. Under very high disease pressure (95% of the foliage in Mountain Fresh Plus plots showing symptoms) and in the absence of fungicides, the PSU breeding lines containing *Ph-3* or *Ph-5* resistance genes developed very few, if any, late blight foliar or fruit lesions making them prime candidates for the development of late blight resistant commercial hybrids.

Another set of replicated trials in the same two locations were conducted to more specifically evaluate the use of the Cornell late blight decision support system (DSS) for managing late blight on tomato in PA. In PA, growers have utilized Blitecast to help time fungicide applications based on accumulated environmental conditions. Historically this model was run using weather data collected from in-field weather stations and more recently using real-time mesoscale weather data from Zed X., Inc. and disseminated via the Pennsylvania Pest Information Platform for Extension and Education (PA-PIPE). A more comprehensive decision support system has been developed by Cornell that builds-upon use of the traditional forecasting program and incorporates information about host resistance, fungicide use and pathogen traits. The system is composed of four components that include 1) location specific weather data; 2) disease forecasting models Blitecast and SimCast; 3) late blight disease simulator; and 4) an alert system. The grower sets-up a free account and inputs information regarding location, cultivar, and planting date. This information is saved and can be accessed when logged-in during subsequent sessions when information about fungicides applications is entered. The report provides information regarding past and forecasted temperatures, relative humidity and precipitation as well as both accumulated and forecasted disease severity values based on Blitecast. The first fungicide application is based on blight units (disease severity values) and then subsequent applications are made based on the SimCast thresholds that take into account fungicide residue levels which decline between applications.

Two tomato cultivars (Mountain Fresh Plus and Plum Regal), selected for their differing susceptibility to late blight, were managed for late blight using either the protectant fungicide chlorothalonil (2.0 pt/A) or copper hydroxide (4.0 lb/A) applied following 7-day schedule, using the Cornell decision support system run using environmental data from an in-field weather station, Blitecast run using interpolated weather (RMTA) data through ZedX, Inc. and the PA-PIPE or remained untreated (no fungicide control). Not surprisingly, there was a significant difference in foliar disease severity and fruit incidence between the Mountain Fresh Plus (susceptible) and Plum Regal (heterozygous *Ph-3*). Late blight moved very quickly through the trial at Rock Springs resulting in nine weekly fungicide applications compared to 12 at Landisville (Table 1) before the trials were terminated. Also, chlorothalonil was more effective than copper at managing foliar late blight on Mountain Fresh Plus while both were equally effective on Plum Regal.

Across both trials, fungicide applications based on the forecasting models resulted in a reduction in the number of sprays by 11 to 16% for Blitecast across both cultivars since it does not take into account host resistance and 41 to 44% for the Mountain Fresh Plus sprayed according to the Cornell DSS, compared to a 7-day weekly program. The Cornell DSS classified Plum Regal as resistant and did not recommend any fungicide applications during the season (Table 1). As a result, disease severity was significantly higher in the Plum Regal following the Cornell DSS compared to Blitecast and a 7-day program at Rock Springs (Figure 2). This difference was not observed in the Landisville trial where disease pressure was lower. As stated previously, although Plum Regal contains the late blight resistance gene, *Ph-3*, it has been observed in this trial as well as in other variety trials in the eastern U.S. to develop foliar late blight symptoms under high disease pressure from US23. Within the Cornell DSS, Plum Regal has now been reclassified as moderately resistant rather than resistant.

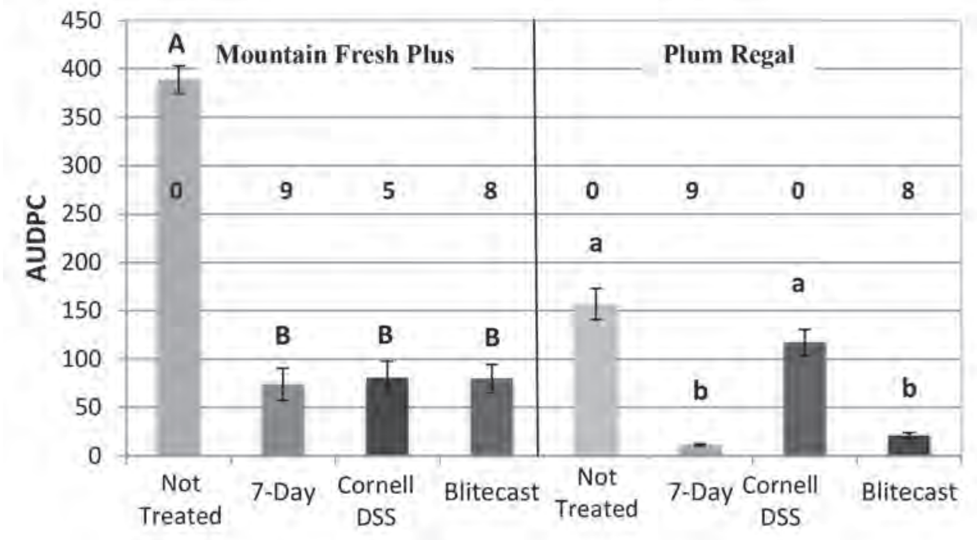
Table 1. Number of fungicide applications made based on the late blight disease forecasting programs over the course of the season.

Fungicide application timing	Number of fungicide applications	
	Rock Springs	Landisville
Untreated control	0	0
7-day weekly	9	12
Blitecast (both cultivars) [a]	8	10
Cornell DSS (Mountain Fresh Plus) [b]	5	7
Cornell DSS (Plum Regal) [b]	0	0

[a] Blitecast does not account for differences in host susceptibility so both cultivars were sprayed the same.

[b] The Cornell DSS accounts for host susceptibility and classified Plum Regal as resistant and therefore did not recommend any fungicide applications during the season

Figure 2. Effect of the fungicide timing programs on late blight disease development over the course of the season



(AUDPC) at Rock Springs. The higher the AUDPC value the more disease developed during the season. The numbers indicate the number of fungicide applications made. No fungicides were applied to the Plum Regal plots sprayed according to the Cornell DSS because it was classified as resistant. Differing letters above the bars indicate that treatments were significantly different from each other within each cultivar based on Tukey's HSD ($P<0.05$).

Management of late blight requires an integrated approach that is initiated prior to late blight developing in the field. This starts by preventing the introduction of late blight through planting certified potato seed and visibly healthy tomato transplants. Selecting less susceptible cultivars with host resistance can reduce your reliance on fungicides and provide more flexibility in the timing of application, especially when you are delayed getting into the field to spray. In addition to the resistant cultivars, less susceptible cultivars based on field observations include Matt's Wild Cherry, Sun Gold Cherry, Big Rainbow, Tigerella and Red Pearl. Once detected in the region, continue to scout your crop carefully and, at the very least, initiate a protectant fungicide program depending on the forecasted weather conditions. Be sure to have products available and on-hand and know how to apply them appropriately to maximize their efficacy. Under favorable conditions, late blight can devastate a crop in as few as 5 to 7 days if left unmanaged. Incorporation of a disease forecasting program to help time fungicide applications can optimize the timing of their application thus reducing input and labor costs when conditions are not favorable for disease development.

Please contact me or your local Penn State Extension office if you suspect late blight on either tomatoes or potatoes. We would like to continue to collect as many samples as possible during the upcoming 2014 season. Understanding more about the pathogen population structure, not just in Pennsylvania but across the U.S., helps us develop better tools to manage this disease more cost-effectively. For the latest information regarding outbreaks of late blight visit the Penn State Extension Vegetable and Small Fruit Production website (http://extension.psu.edu/plants/vegetable-fruit) or the USAblight website (http://usablight.org). You can sign-up to receive email and text message at both websites and the later website also has additional information about the Cornell DSS. Portions of the research reported here were supported by the Agriculture and Food Research Initiative Competitive Grants Program 2011-68004-30104 from the USDA National Institute of Food and Agriculture as well as the Pest Management Alternatives Program 2011-34381-30770 and the Pennsylvania Vegetable Growers Association and PA Vegetable Marketing and Research Program.

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CONTROLLING WEEDS BETWEEN RAISED BEDS WITH PLASTIC MULCH

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Producing fruiting vegetables (tomatoes, peppers, eggplant) and melons with plasticulture for fresh market has become the standard practice in Delaware and other regions of the mid-Atlantic States. Based on the 2009 USDA Ag Statistics, there are over 16,000 A of fresh market tomatoes, peppers, and eggplant in the region, and an additional 9,000 A of melons. Plasticulture provides many benefits to the grower, including moisture conservation, cleaner produce, better diseases resistance, and better weed control in the crop row. Weed control between the rows of plasticulture vegetables and melon crops can be challenging due to the limitation of some "tools". For instance, the plastic does not allow for close cultivation, forming the beds prevents using cover crop and mulches for weed control, and wide rows limit the benefit of crop canopy for shading out late emerging weeds. As a result most growers have relied on chemical weed control. Herbicide options are limited for effective full-season weed control, furthermore incorporating additional herbicide mode of action would be very beneficial.

Curbit, Sandea, Dual Magnum, Command, Devrinol, metribuzin, Prowl are labeled for providing residual control between the rows of plastic in melons and/or fruiting vegetables. But many of these products are limited in the spectrum of weeds that they will control. Also, many will limit which vegetables can be planted in the field the following year. These products are typically applied in combination with paraquat, using hooded (shielded) applicators. Two new herbicides may have potential for weed control in row middles, Chateau and Sharpen. Both are PPO-inhibiting herbicides (Group 14) which are not typically used in vegetables and can bring a different mode of action for resistance management. Both can be used at rates significantly higher than typically used in field crops, which will improve their performance and longevity in the soil. However, there are no crop rotational restrictions after six months if the soil is tilled prior to planting the rotational crop. Valent, the manufacturer of Chateau, has granted special local needs labeling (24c SLN) for use in fruiting vegetables and melons to some states. Recent field studies examined Chateau for potential for labeling in PA and provide additional information on its benefits. Sharpen, is not labeled for the proposed uses, but it is being evaluated to determine its appropriateness in this region.

Objectives of the studies:

1. Evaluate effectiveness of various herbicides for weed control in row middles for plasticulture
2. Evaluate potential herbicides for use in plasticulture
3. Evaluate crop safety of various crops for herbicides that could be registered in PA

Field Study Methods and Materials:

Two trials were conducted, the first focused on weed control, and the second examined crop safety. The first study was conducted with watermelon and muskmelon and examined Chateau at 3 and 4 oz/A, and Sharpen at 3 and 5 oz/A. Chateau/Valor is used in soybeans at 2 oz/A and Sharpen is used at 1 to 2 oz/A in corn and soybeans. In addition, a standard treatment of Strategy (Curbit plus Command) plus Sandea was evaluated. This study was done both in DE and PA.

The second study examined crop safety. Plots consisted of multiple crop species that were evaluated for response to Chateau or Sharpen. Tomatoes, peppers, eggplant, and watermelons were planted in each plot. Chateau at 4 oz/A and Sharpen at 5 oz/A was applied prior to transplanting or 10 days after transplanting to examine crop safety. This study was only conducted in DE.

All applications were made with a hooded (shielded) sprayer to prevent/minimize herbicide contact with crop foliage.

Field studies were conducted from 2011 to 2013 at two locations, Georgetown, Delaware (DE) with Dr. Mark Van-Gessel and Rock Springs, Pennsylvania (PA) to examine various potential herbicide programs for row-middle weed control and crop injury in watermelon (var. '7187HQ' and 'Top Gun') and muskmelon (var. 'Aphrodite' and 'Athena') in black plastic. PRE and POST-directed programs were evaluated. Herbicides included: Strategy (2 pt/A); Curbit (24 fl oz); Sandea (0.67 oz); Chateau (3 and 4 oz); Sharpen (3 and 5 fl oz); Reflex (1.5 pt); Sinbar (4 oz); Dual Magnum (1.3 pt); and Gramoxone (3 pt). Visual weed control evaluations were taken periodically throughout the growing period. Crop yield data and phytotoxicity ratings were also collected. Small-plot studies were arranged in a randomized complete block design with three replications. The purpose of conducting research at multiple locations is to evaluate these herbicide programs under different growing and climatic conditions, including different soil types and broader range of weed species.

Results:

Potential herbicide programs study (PA and DE): Chateau and Sharpen have potential to be labeled for weed control in row-middles. These herbicides in combination with Curbit were compared to a PRE standard of Strategy plus Curbit plus Sandea and a POST program of the same mixture plus Gramoxone. In PA, late season ratings revealed that the PRE Strategy tank mixture program provided 88 to 96% control of common purslane, common lambsquarters, redroot pigweed, and hairy galinsoga, while the POST Strategy mixture with Gramoxone provided 97-98% control of the weeds. Both rates of Chateau and Sharpen provided 94-99% and 77-89% control, respectively, of the same species. Across all the treatments, ladysthumb control ranged from 78-86% control. None of the treatments resulted in significant crop injury or yield decreases. In DE, none of the treatments resulted in stunting significantly different than the untreated check for both watermelon and muskmelon. Due to flooding in mid-season the plots were not taken to yield. Late season ratings for common lambsquarters control was excellent (>97%) and morningglory control was >79% for all treatments except Strategy plus Curbit plus Sandea. Fall panicum control was similar for all treatments (averaging 82%), except Sharpen which provided <40% control.

Crop injury study in DE: When melon vines were 18-21 inches long herbicide treatments were applied with a hooded sprayer. Residual herbicides (Reflex, Chateau, Dual, Sandea in all three years; and Sinbar and Sharpen in 2011 and 2012) were applied in combination with Gramoxone and a surfactant. In 2011, results were quite variable and no significant differences in treatment were detected. However, watermelon stunting at 8 DAT was 18 and 21 for Chateau and Sharpen, respectively. Although no yield differences were detected, plots treated with Chateau and Dual yield at least 15% less than the untreated check. For muskmelon at 8 DAT, Sharpen, Chateau, and Dual all caused 40, 32, and 20% stunting, respectively. Yield was not significantly different, but Chateau, Dual, Sharpen, and Sinbar all resulted in >15% reduction in yield. In 2012, no treatment was rated significantly different than the untreated check for either watermelon or muskmelon. In 2013 in watermelon, only Reflex had an injury rating (14%) significantly different than the untreated check. No difference in yield was detected. For muskmelon, all treatments resulted in ≥10% stunting at 9 DAT and Reflex, Chateau and Dual treatments were still rated ≥10% stunting 24 DAT. Despite no significant differences for yield, Chateau, Dual and Sharpen treatments resulted in >25% reduction in harvested yield. In this trial, Chateau has the potential to cause stunting to both crops if the spray drift is allowed to injure young plants. Furthermore, muskmelon appears to be more sensitive to Sharpen, Chateau, and Dual than watermelon.

RETRACTABLE ROOF PRODUCTION SYSTEMS

Benjamin Martin
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The Retractable Roof Production System ™ (RRPS) is a hybrid production system that allows growers in warm or hot climates to use the retractable roofs and walls to maximize the profitability of food crops by increasing revenues through higher yields and quality with an extended harvest season while simultaneously lowering fixed production costs.

This is accomplished simply by taking advantage of the benefits of growing in the natural outdoors by installing a "retractable roof over a field" with the benefits of conventional structures and avoiding production losses due to excessive cold, heat, wind, hail, snow and rain. Growers can react in minutes to daily and seasonal changes in outside weather conditions and create the best possible growing conditions simply by having the computer automatically adjust the roof and wall positions to create an open field, a greenhouse or a shade house environment.

The RRPS differs from the open field and the conventional greenhouse in that the goal of the system is to let nature do the work when conditions are optimal because it is less costly to utilize nature than to try to re-create it inside.

To fully understand the power of this hybrid system, a conventional greenhouse grower needs to be willing to think outside of the box, or outside of the greenhouse.

For outdoor farmers who are willing to explore the RRPS, they will soon realize that it actually is very logical and easy to use, especially if they utilize the control strategies that have been developed specifically for the retractable roof. Monitoring outdoor weather conditions and deploying a roof and walls is much easier than managing an artificial greenhouse growing environment.

While the RRPS may be new to some people, it is not new. Retractable roofs have been in use for decades helping to produce better bedding plants, perennials, shrubs, trees, cut flowers, and for over 15 years vegetables and most recently production of tree fruit and berries.

When growers were first exposed to the RRPS, they were excited about the possibilities. However they were also nervous and in many cases skeptical about making the change to the RRPS since they had no experience with the RRPS and they were concerned especially about the management of insects, best practices for operating roof & walls to steer the crop, and the ability to compare profitability of the various production systems. Growers could easily access many books and research data on crop production in the open field, or in conventional net houses or greenhouses. The good news is that today with reliable and quick information exchange the revolution towards this type of growing by Cravo, developer of this technology, and is continually being documented supported by an over 30 year track record and installations on 5 continents.

Crop benefits are realized by managing weather to optimize crop environment with computer automation of the roof & walls for better plant growth.

Increases in yields, quality and timing for fruit & vegetables crops is as result of creating optimal plant temperatures, transpiration rates, C02 and light levels.

With the environmental tool of the retractable roof & walls, crops can be steered to develop the right balance between vegetative and generative growth which corresponds to better plant health and natural defense against losses from pest & disease.

A controlled outdoor environment will lessen the degree of pressure and/or acceleration of foliar (fungus, mold, mildew) & pest (virus) incidence and facilitate natural pollination.

Fruits and vegetables tend to be larger in size, higher in brix, and with longer shelf life over those of open field or conventional low tech structures.

There are different structural designs of retractable roof greenhouses & shade houses to support a wide range of crops grown and relative to the crop cultural needs and the geography of the farm.

Regardless of the design, an entire farm can be fully covered or retracted in minutes.

Choosing the right structure for the application will determine the investment cost which can range from $2 to $10 dollars per square foot. Growers presently utilizing a retractable roof greenhouse experience a quick payback and are seeing their return on investment (ROI) generally between 2 to 5 years.

In most cases, the improved quality and yields and avoiding risk from damaging weather events is not sufficient to achieve an acceptable ROI, as such more considerations must be part of the business case study to give the required return and improve profitability of the farm.

It is important for growers to work with the structure supplier because there are developed investment calculators to compare the RRPS with the existing farm system.

Many identified benefits of the RRPS have been documented which improve the company balance sheet and income statement. All said these many factors need to be realized to increase profits and return rates and can include strategies such as extending the harvest season or speeding up or slowing down harvest timing to meet premium prices at the shoulders of the sales season.

Reductions in operating costs from producing on smaller acreages or growing higher valued (varietal or organic) crops that are at greater risk with other production systems.

While the high tech crop management system in conventional greenhouses is absolutely necessary when producing in cold and low light climates, the high investment and complexity of the production system is what prevents many open field growers in warm or hot climates from making the transition out of the field. For those that make the transition out of the field, the complex crop management frequently results in many production problems causing new greenhouse ventures to be unprofitable.

The RRPS is not going to be ideal for all crops and in all locations, but for growers of high value multiple harvested crops in warm and hot climates this could be the solution for growers to the meet the profit challenge of today's time and create the new model of the farm of the future.

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FINE TUNING YOUR IRRIGATION AND NUTRIENT MANAGEMENT PROGRAM

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Introduction

Most vegetable growers in the Suwannee Basin region of North Florida are small to mid-sized growers (one to 300 acres), many who have adopted drip irrigation and plastic mulch cultural practices since the late 1980s to produce vegetable such as tomato, bell pepper, eggplant, cucumber, muskmelon, and watermelon. Soils in the area are sandy with low water holding capacity (<10%) and low organic matter content (<1.5%). Hence, vegetable production in northeastern Florida requires intense irrigation and fertilization management. The recommendations of University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) for irrigation management for vegetable crops include using a combination of target irrigation volume, a measure of soil moisture to adjust this volume based on crop age and weather conditions, a knowledge of how much water the root zone can hold, and an assessment of how rainfall contributes to replenishing soil moisture.

Previous educational efforts in northeastern Florida have focused on plant establishment and fertilizer management. The recent development and adoption of statewide Best Management Practices in Florida in rule 5M-8 of the Florida Administrative Code (Florida Department of Agriculture and Consumer Services Office of Ag Water Policy) and the increase in production costs, have emphasized the need for improved irrigation practices and a better understanding of water movement in mulched beds. Growers' understanding of the interdependence between fertilization, irrigation, and nutrient leaching below the root zone was increased through a targeted effort of on-farm projects.

UF/IFAS county extension agents and specialists have been working with Suwannee Valley's vegetable growers who use plastic mulch and drip irrigation to refine their management of the technology since it was introduced to the region in the late 1980s. The emphasis of the educational programs after the turn of the century has been to improve efficiency of water and nutrient management. County extension agents and specialists have coordinated several projects at the regional UF/IFAS Center, Suwannee Valley Agricultural Extension Center, near Live Oak, FL. The educational approach was to first demonstration the new technology at the Center via field days and workshops, then follow-up by demonstrating that technology on leading grower's fields throughout the region.

Materials and Methods

The Extension mission of the University of Florida is to take the latest research findings to the citizens of Florida. In this case, Extension specialists and county extension agents developed outreach programs to take the latest findings regarding water and nutrient management in plasticulture to the farmers in Suwannee Valley.

The first programs included demonstrating soil moisture sensors such as tensiometers, granular matrix sensors, and time domain reflectometry (TDR) devices. Each can help growers to determine when to irrigate and for how long. This program has been taken to dozens of farms in nine counties since the late 1990s. The growers learned they were likely to over water in the first month of the season and underwater thereafter. Early season over watering is important to change because they learned the greatest risk of leaching nutrients is during this early season period. Growers adopted changes in their early season irrigation management based on the information from these various soil moisture sensors. The remainder of the season water use was changed very little; however, the improved irrigation efficiency early in the season led to reduced fertilizer applications.

A second specific program to help continue to teach growers water and nutrient management was the initiation of the Florida Drip Irrigation School. The first such school was held at the Suwannee Valley Agricultural Extension Center in 2001 and was so popular it was adopted statewide as a UF/IFAS program and over 25 such schools have been held in Florida since 2001. The school is an intensive hands-on training for growers to learn to better manage their drip irrigation systems for the delivery of water and fertilizer. Presentations were delivered by University faculty and representatives from the allied industry. Well over 500 growers have attended these trainings at the Suwannee Valley's Center and other locations and learned several practices including: using soil moisture sensors, cleaning the system, proper design and maintenance, calculating fertilizer rates, selecting drip tape, and determining proper lengths of irrigation events, etc.

Plant nutrient status can be determined in the field by squeezing plant sap onto meters (Cardy) that measure either nitrogen or potassium. This gives a grower an instant result to guide their fertilizer program week to week. The Cardy meters have been used and demonstrated by several county extension agents in the area over the last 15 years. Most County Extension agents in the Suwannee Valley area of Florida are proficient in running petiole sap tests and a few growers and industry representatives have also learned to run this test. Over 90% of the Suwannee Valley watermelon acreage has benefited from this program. Currently research is being conducted to refine petiole sap guidelines for seeded and seedless cultivars separately.

The most recent and perhaps most popular demonstration being taken to farms is the use of blue dye injected into the irrigation system to see how quickly the water moves downward in the soil in their field. This has been demonstrated on at least 25 farms from 2004 to 2013 after demonstrations began at the Center in 2001. The blue dye is used to be able to actually visualize the wetting pattern of the soil profile under the drip tape. After injection of the blue dye growers followed their normal irrigation schedules for one week and then a cross section of the soil profile under the mulch was dug to measure how far the water and nutrients moved.

Results and Discussion

The growers showed great interest in using new technology such as moisture sensors and Cardy meters, and seeing the movement of dye on the "digging" visits. It was very common for growers to make immediate changes in irrigation schedules, especially irrigation event durations early in the season based on what they observed. The greatest challenge in managing the leaching from over irrigation occurred in the early part of the season, weeks 1-5 after planting. Most growers apply a portion of the total fertilizer program to the soil prior to bedding and mulching. This fertilizer is especially vulnerable to being leached early in the season before the root system and crop become well developed. It was shown that single irrigation events of more than one hour in sandy soils can move the blue dye more than a foot deep. This can move fertilizer below the root zone in the early part of the season. Many growers have reduced the preplant fertilizer as a result of these programs.

The blue dye tests conducted on these farms and also at the Center near Live Oak, Florida have provided a very good estimate of movement of the dye in sandy soils. Each grower involved in these demonstrations made adjustments based on the visualization of the movement of the dye. Area growers and Extension agents began to coin the phrase "The blue dye don't lie", showing the undeniable lessons learned in watching the results of the blue dye demonstrations. The changes were immediate, short term changes to their management. The longer term changes leading to actual adoption are those make from one year to the next based on these educational experiences. The on-farm trials, in addition to other educational programs, such as the Drip Irrigation School and various field days have resulted in significant changes on several farms. Growers involved with the dye demonstrations and other events for three years or more have adopted long term changes. One of the main changes has come in the fertilizer program by reducing the total nitrogen rate applied prior to bedding and mulching. Pre-plant N rate for watermelon has been typically reduced from 100-150 down to 25-50 pounds per acre since the beginning of these programs. The remaining N is now applied via the drip system over the season. This part of the fertility program, where fertigation is used, has not dramatically changed over that period of time. Therefore, a total reduction of 75 to 100 pounds of N per acre per year has resulted directly from these demonstrations without affecting yield or quality. The final resulting N and water management programs on this farm are accepted Best Management Practices for growing watermelon using plasticulture.

In summary, combining these several educational programs in the Suwannee Valley watermelon growing area has made a great impact toward adopting BMPs voluntarily. During this long term effort, 50 growers saw and learn from one or more demonstration on their own farm and they often served as early adopters which helped Extension agents teach other plasticulture growers how to adopt the BMPs. These programs integrated together have resulted in growers:

- Reducing early season irrigation events by over 50% saving water and reducing nutrient leaching.
- Improving early season irrigation efficiencies, growers reduced preplant fertilizer rates. Most growers have reduced preplant nitrogen rates by 20-50%.
- Suwannee Valley watermelon and other vegetable growers using plasticulture techniques have adopted several BMPs including: irrigation sensors, petiole-sap testing, and refining fertilization rates; resulting in adoption of UF/IFAS nutrient recommendations on nearly 90% of the area watermelon acreage.

Conclusions

Increased concern over the impact of agricultural practices on water quality in Florida has resulted in the grower's need to adopt Best Management Practices (BMPs). The successful adoption of BMPs in plasticulture production of vegetables in North Florida has been greatly facilitated by Extension programs in conjunction with industry and other agency involvement. Growers are more likely to adopt BMPs when they can evaluate them on their own farm. Long term educational program efforts including hands-on teaching workshops at a research facility combined with on-farm demonstrations proved to be a very effective strategy in helping vegetable growers using plasticulture improve water and nutrient management practices on well over 5,000 acres.

Robert (Bob) Hochmuth is a Multi-county Extension Agent with the University of Florida. His position is 50% multi-county in nature supporting commercial vegetable Extension programs in nine counties in the Suwannee Valley area of Florida, centered around the Suwannee Valley Agricultural Extension Center (SVAEC) near Live Oak, Florida. The overall responsibility is the development and implementation of educational programs for commercial field and greenhouse vegetable producers that will increase their knowledge of production, incorporating principles of efficiencies, profitability, and environmental awareness. The position's other 50% of responsibility is to serve as the statewide co-coordinator for educational programs in the area of small farms, including leadership in the Small Farms and Alternative Enterprises Conference, the Small Farms Web Site, UF Small Farms Academy, Regional Small Farms Conferences, and County Extension Agent In-Service Trainings. Bob was raised on a vegetable farm on the Eastern Shore of Maryland and received a BS degree in Extension Education and MS degree in Entomology; both from the University of Maryland. He also served as an Extension Agent in Kent County Delaware from 1982 to 1988. Bob and his wife Terri raised twin boys, Scott and Lee who are both married and pharmacists in Florida.

DRIP IRRIGATION-WHY DO I NEED IT?

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You need drip irrigation because it is a very efficient method of watering certain vegetable crops while conserving water and nutrients. Drip (trickle) irrigation was pioneered in the 1940s but not until the advent of polyethylene plastics in the 1960s did field application of this efficient watering method become widespread. Drip irrigation is a method of applying small amounts of water, often on a daily basis, to the plant's root zone.

A drip irrigation system has four major components and two options.

Major Components

- Delivery system: emitters or line source drip tubing
- Filters: sand, disk, or screen
- Pressure regulators: spring or valve
- Valves: hand-operated, hydraulic, or electrical

Options

- Controller: simple electric clock or computer
- Fertigation system: electric pumps, hydraulic pumps, venturi systems, etc.

How you put these components together, and which options you choose, will depend on the size of the system, the water source, the crop, and the degree of sophistication you desire.

Advantages and Disadvantages

Although many advantages favor installation of a drip system, there are some limitations as well.

Advantages

1. Smaller water sources can be used, as trickle irrigation may require less than half of the water needed for sprinkler irrigation.
2. Lower pressures mean reduced energy for pumping.
3. High levels of water management are achieved because plants can be supplied with precise amounts of water.
4. Diseases may be lessened because foliage remains dry.
5. Labor and operating costs are generally less, and extensive automation is possible.
6. Water applications are precisely targeted. No applications are made between rows or other non-productive areas.
7. Field operations can continue during irrigation because the areas between rows remain dry, resulting in better weed control and lower production costs.

8. Fertilizers can be applied efficiently to roots through the drip system.
9. Watering can be done on varied terrains and in varied soil conditions.
10. Soil erosion and nutrient leaching can be reduced.

Disadvantages or problems

1. Initial investment costs may be more on a per acre basis than other irrigation options.
2. Management requirements are high. A critical delay in operation decisions may cause irreversible damage to crops.
3. Frost protection that can be achieved by sprinkler systems is not possible with drip systems.
4. Rodent, insect, or human damage to drip tubes may cause leaks.
5. Filtration of water for trickle irrigation is necessary to prevent clogging of the small openings in the trickle line.
6. Water distribution in the soil is restricted.

Specific Adaptations to Vegetables

Because vegetables are usually planted in rows, a drip tubing with prepunched emitter holes, called a line source emitter, is used to wet a continuous strip along the row. Also, because most vegetables are considered annuals and are grown for only one season, a thin-walled disposable tubing (4 or 8 mil thick) generally is used for only one season. Less emphasis is usually placed on buried mainlines and sub-mainlines to allow the system to be dismantled and moved from season to season. Costs may be high, so a goal should be to develop an inexpensive yet functional system that allows maximum production with minimal costs. You may purchase an entire system from an irrigation dealer or adapt your own components. Assistance in design from an irrigation dealer or professional can be very helpful in avoiding problems later on.

Dr. William J. Lamont Jr. is a Professor and Extension Vegetable Crops Specialist in the Department of Plant Science at Penn State University. He was born and raised in rural Pennsylvania and obtained two undergraduate degrees, one in Economics and Business from Lebanon Valley College and one in Horticulture from Delaware Valley College. He earned his M.S. and Ph.D. degrees from Cornell University. Dr. Lamont has an extensive background in research, extension and teaching. In his current extension position Dr. Lamont is responsible for the culture and management of vegetable crops. He has worked at North Carolina State University and Kansas State University prior to coming to Penn State in 1997. He and his wife Phyllis reside on 28 acres of land near McAlevy's Fort, PA.

HOW LONG CAN I KEEP MY SEEDS?

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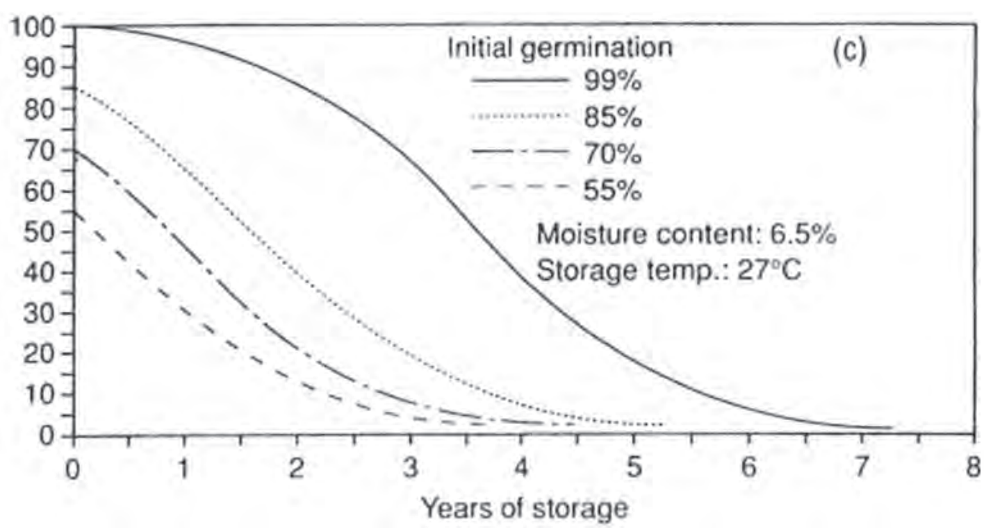
Seeds attain their highest seed quality on the mother plant prior to seed harvesting. Seed quality starts to decline after harvesting and in time all seeds will die in storage. It is important for growers to maintain the germination and vigor of a seed lot until the time of sowing. There are three major factors that will be addressed to achieve and maintain high seed quality 1) start with high quality seeds, 2) seed storage temperature and 3) seed storage relative humidity.

Start with High Quality Seeds

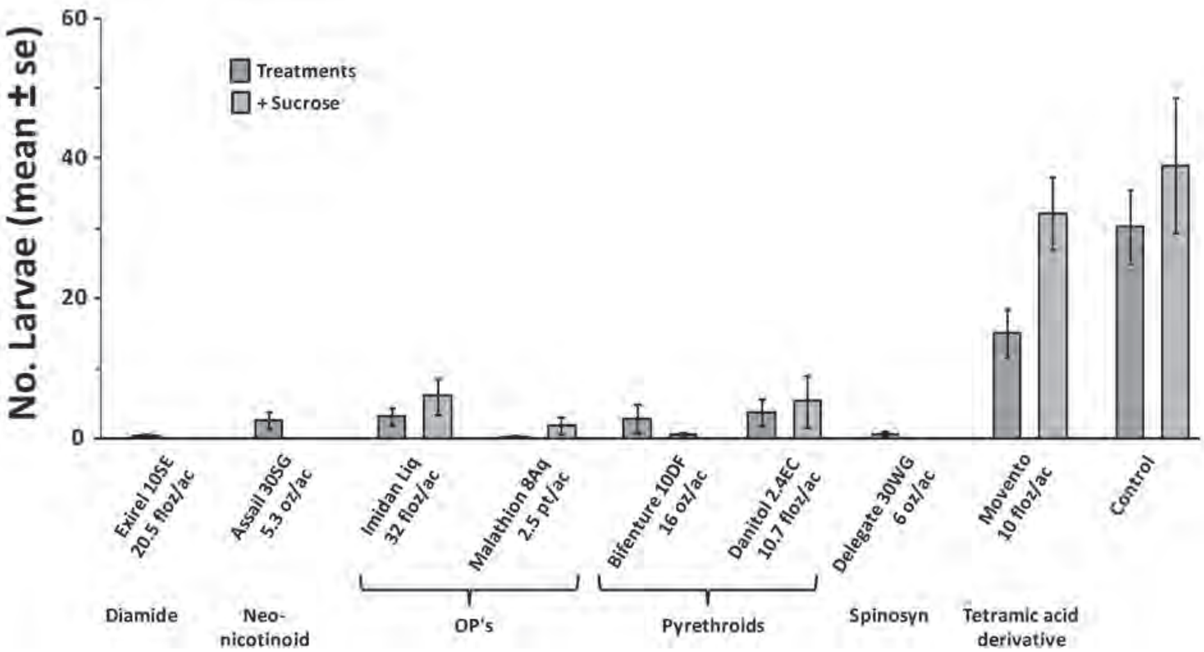
The germination of seeds will only decline with storage time. Therefore, it is most important to start with high quality seeds at the beginning. This is true if you produce your own seeds or if you buy seeds from a seed company. The figure below shows that starting with seeds with nearly 100% germination that the seeds maintain this high germination for a period of time before declining. However, starting with seeds with lower quality, the germination decreases rapidly in storage.



There are two key aspects of the environment that are responsible for storing seeds: temperature and relative humidity. Each parameter will be described separately, but in the real world it is the combination of each that ultimately affects how long seeds may be kept.

Seed Storage Temperature

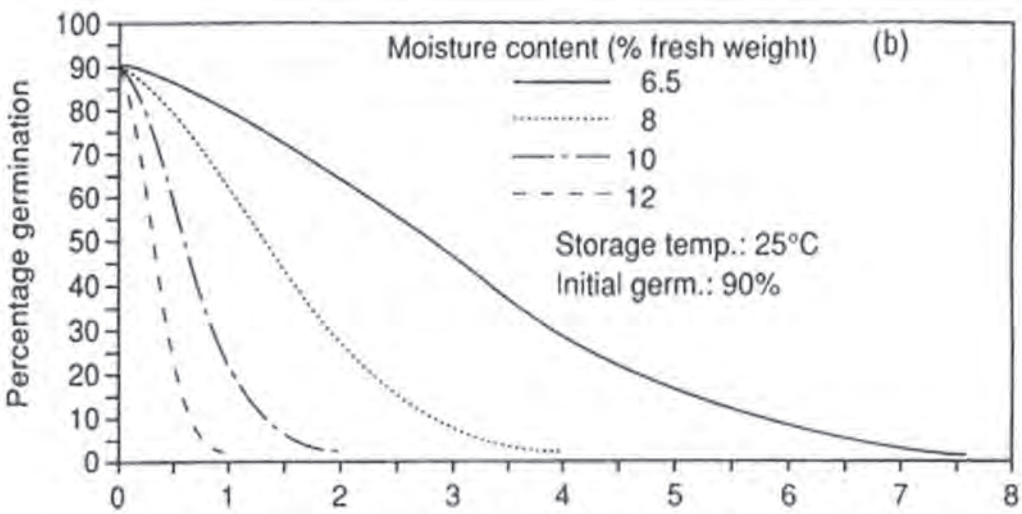
Seeds keep better at lower temperatures than higher temperatures. The graph on the next page shows the effect of storage temperature at 15, 20, 25 and 30˚C (59, 68, 77 or 86˚F) on germination over time. The data reveals that the shelf life of the seeds double for each 5˚C (9˚F) decrease in temperature. For example, the germination is 70% after 1 year of storage at 20 ˚C compared to two years of storage at 15 ˚C. In this example, the seed moisture was held the same at 9.5%.



Years of Storage

Seed Storage Relative Humidity

The relative humidity is most important as it directly influences the seed moisture content. The seed moisture content increases as the relative humidity increases. Moreover, as seed moisture content decreases the life of the seed increases. The graph below shows the effect of storing seeds at 6.5, 8, 10 or 12 % moisture content. Only a slight decrease in seed moisture content dramatically increases the life of seeds.



Years of Storage

Safe Storage and Practical Considerations

The graphs on the previous page illustrates that separately decreasing storage temperature or decreasing seed moisture increases how long seeds can be kept. However, it is the combination of temperature and seed moisture content that ultimately determines the storage life, so both need to be considered in storing your seeds. Starting with the relative humidity, if you are producing your own seeds, seeds need to be dried in air with low relative humidity. Then place the dried seeds in a moisture proof container. For example, small quantities of seed can be stored in glass canning jars with good lids that will seal. For large quantities of seeds, 5 gallon plastic buckets can be used with a lid that will seal. The key is to keep seeds dry in a moisture proof container. If you are purchasing seeds, they will probably have a moisture barrier in the packaging. Open the seed container only when you need to remove seeds for planting and then reseal if there are any remaining seeds. The bottom line is to keep seeds dry and not allow moisture to get to the seeds. Now that you have seeds with low moisture content and are in a moisture proof container, then you need to store at low temperatures. For small containers, keep seed in a refrigerator. If a refrigerator is not available, keep seeds in a cool or air-conditioned room, especially during the summer. Avoid seeds being exposed to heat and direct sunlight

The realistic goal is to keep seeds for one year. Therefore, if you purchase seeds for vegetable crop production in year one, then storing seeds properly should result in good quality seeds for year two. Follow the guidelines described in this paper of keeping low moisture content seeds and storing them at low temperatures.

All the graphs in this article use onion seeds to illustrate seed aging in storage. This data and other information were taken from my book chapter:

Taylor, A. G. Seed storage, germination and quality. 1997. In: Wien, H.C. ed., The Physiology of Vegetable Crops CAB International. Wallingford, UK. p 1-36.

Alan Taylor is a Professor of Seed Science and Technology at the New York State Agricultural Experiment Station, Cornell University, Geneva campus. His responsiblities are 80% research, 10% teaching and 10% administration of the New York Seed Testing Lab. His research is focused on vegetable, biofuel, other crop and weed seeds with emphasis on seed quality, and seed treatments. He received his BS from Heidelberg College in Tiffin, OH, his MS in Horticulture at Michigan State University and his PhD at Oklahoma State University. He has two sons (Ryan and Andrew) and two grandchildren (Ayden and Jaxson).

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THE COLORADO POTATO CULTIVAR DEVELOPMENT PROGRAM

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Introduction: The Colorado State University Potato Development Program at the San Luis Valley Research Center consists of five core programs. These programs include breeding and selection, pathology, crop management, postharvest physiology, and seed certification. This interdisciplinary program focuses on potato research and related activities that are crucial to the development of new potato cultivars. The central mission of this program is Ato develop cultivars that will assure that the Colorado potato industry remains productive, competitive, and sustainable and to develop cultivars that provide the consumer with improved nutrition and quality.@

Potato Breeding and Selection Program - David G. Holm, Ph.D. and Caroline P. Gray, M.S.

The major objectives of the Colorado Potato Breeding and Selection Program are:

1. to develop new potato cultivars (russets, reds, specialties, and chippers) with increased yield, improved quality, enhanced nutritional and health characteristics, resistance to diseases and pests, and tolerance to environmental stresses;
2. to collaborate with growers, shippers, processors, and research/extension personnel to assess the production, adaptability, marketability, and other characteristics of advanced selections from the Colorado program;
3. to provide a basic seed source of selections to growers for seed increase and commercial testing; and
4. to evaluate promising selections for possible export (interstate and international).

Besides the major objectives outlined above, specific breeding emphasis is being placed on identifying germplasm and developing cultivars that have: (1) early vine maturity and early tuber bulking; (2) immunity to PVY; resistance to (3) late blight (foliar and tuber); (4) storage rots [dry rot (*Fusarium* and early blight) and bacterial soft rot]; (5) pink rot; (6) nematodes; (7) powdery scab; (8) corky ringspot; and (9) that have improved nutritional quality, health attributes, and other consumer desired characteristics such as improved red skin color retention and improved shelf life. Continued emphasis is placed on breeding/selecting for low input cultivars, primarily for reduced nitrogen and fungicide input, for improved postharvest and processing qualities such as a lengthened dormancy. The long-term process of potato breeding and cultivar development fosters collaborations between research and extension personnel as well as growers, shippers, and processors.

Potato Pathology Program - Robert D. Davidson, Ph.D. and Andrew Houser, M.S.

The major objectives of the Potato Pathology Program are:

1. to develop control/management strategies and best management guidelines for primary disease issues in the potato crop in Colorado;
2. to conduct trials on new and promising chemistries for the control of major potato diseases; and
3. to work with the Potato Cultivar Development Program by evaluating new germplasm for specific disease reactions to various pathogens.

The focus of the Potato Pathology Program efforts with the Potato Cultivar Development Program includes studying the timing of disease and symptom expression for advanced selections in the Potato Breeding and Selection Program.

This has resulted in identifying resistance to some key disease issues in Colorado. A good example of this is the identification of advanced selections and new cultivars with excellent resistance to powdery scab (both in the root galling phase where soil inoculum can build up rapidly without the grower's knowledge and in the tuber phase where grade standards can make the potatoes unmarketable).

Several advanced selections are evaluated for disease symptom expression screening trials in Colorado each year. These disease trials include bacterial ring rot, potato leafroll virus, PVY, powdery scab, and corky ringspot.

Potato Crop Management and Field Physiology Program - Samuel Y. C. Essah, Ph. D.

The Potato Crop Management and Field Physiology Program emphasizes cultural management, field physiology, and soil-nutrient-plant interactions. Significant emphasis is placed on studies related to advanced selections and new potato cultivars.

The specific objectives of this project are:

1. to develop optimum nitrogen management guidelines;
2. to develop optimum in-row seed spacing;
3. to define appropriate vine kill timing for optimum tuber yield, tuber size distribution, and tuber quality;
4. to define water requirements for optimum production;
5. to evaluate the effect of cut and single drop seed, seed size, and seed reconditioning on tuber performance; and
6. to evaluate tuber yield, tuber size distribution, and quality of advanced potato selections on grower farms.

On-farm trials provide an opportunity for a grower evaluation process to assist in the development of management guidelines, detect unforeseen problems, and determine the predictability of performance of each new cultivar that is developed.

Potato Postharvest Physiology Program - Sastry S. Jayanty, Ph.D.

The potato is the most significant vegetable and staple food consumed worldwide. Research in storage management and improvements in nutrition potentially adds value to the crop and impacts growers and consumers. Potatoes are grown in the summer months, harvested in the fall, and stored up to six to nine months based on market demand. Successful long-term storage of potatoes for fresh market distribution requires proper postharvest storage management.

The Potato Postharvest Physiology Program at the San Luis Valley Research Center focuses on three areas:

1. to maintain the quality of tubers in long term potato storage by developing pre- and postharvest methods to reduce shrinkage, pressure bruise and other storage related physiological disorders;
2. to develop methods to screen advanced selections for storage disorders; and
3. to study nutritional aspects of advanced potato selections and potato cultivars and provide feedback to the Breeding and Selection Program.

Potato Certification Service - Kent P. Sather, M.S.

The Potato Certification Service (PCS) is a cooperative program of seed improvement and inspection carried on by Colorado State University and the Colorado Certified Potato Growers= Association, Inc. (CCPGA). The PCS is responsible for inspecting potatoes while growing in the field and again after harvest. After this process the potatoes become certified by the PCS as provided for in the Rules and Regulations approved by the Board of Governors of the CSU System.

The PCS manages inspections and documentation of seed lots for Colorado, the third largest certified seed producing state. Seed is shipped across the United States and exported into other countries that request cultivars that Colorado seed growers produce. Several international agreements with potato companies desiring Colorado cultivars have been established. The PCS staff work to make available proper documentation and high quality plant material needed for local, national, and international growers.

The PCS staff has a very close working relationship with the Colorado Potato Breeding and Selection Program and other research programs located at the San Luis Valley Research Center.

Once an advanced selection is identified for increase, tubers are submitted to the PCS tissue culture laboratory for pathogen testing and establishment into test tubes. These are increased and provided to interested growers as the PCS staff aides them in managing new selections for seed increase through the certification scheme. The PCS staff work closely with growers encouraging optimum management as prescribed by data generated by the Colorado Potato Cultivar Development research faculty.

Advanced selections and new cultivars are inspected, paying particular attention to disease symptom expression. This data is shared directly with the research faculty and with current and potential growers of these clones.

Acknowledgments:

- Caroline Gray - Colorado Potato Breeding and Selection Program
- Rob Davidson, Andrew Houser, and Kent Sather - Disease Screening and Evaluation and Seed Certification
- Samuel Essah - Production Management
- Sastry Jayanty - Postharvest Physiology

Dr. Holm was born in Southeast Idaho and raised on a family farm near Shelley in Bingham County. Potatoes, grain, and alfalfa were the primary crops raised. He credits his Dad and Grandfather with instilling in him an interest in potatoes, and his 7th grade science teacher with helping him decide on a career in science when he challenged the class to start thinking about the future and what they wanted to do for a living. Dr. Holm received his B.S. (1972) and M.S. (1974) from the University of Idaho and his Ph.D. from the University of Minnesota (1977). Dave began his professional career and is currently a Professor in the Department of Horticulture at Colorado State University located at the San Luis Valley Research Center, where he served as Superintendent from 1983B1997. Dave=s principal research responsibilities include the breeding and selection of new potato cultivars through traditional hybridization methods. Development of seed stocks of advanced selections for grower evaluation and seed increase is also an integral part of his program. He maintains close interaction with various research, extension, and production segments of the potato industry in Colorado and other major potato production areas of the US. He considers these relationships critical to the release and successful adoption of new cultivars. In 1979, he initiated the Colorado Potato Breeding and Selection Program, which previously had been solely a selection program receiving seedling tubers from other programs. During Dave=s tenure, 18 cultivars have been released. He has cooperated with other universities, the USDA-ARS, and Agriculture & Agri-Food Canada in the release of another 11 cultivars. He also has developed five clonal selections of Sangre and Russet Norkotah.

INSECT PESTS OF POTATOES AND THEIR CONTROL

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Colorado potato beetle, potato leafhopper, and wireworms remain the most important insect pest of potatoes in the mid-Atlantic U.S. The biology and management of each of these pests will be discussed. In 1996 the first neonicotinoid insecticide, imidacloprid (=Admire) was registered for use on potatoes in the U.S., and a few years later, other neonicotinoids, including thiamethoxam, acetamiprid, dinotefuran, and clothianidin would be registered. Since that period, neonicotinoids have been the most commonly-used insecticides on potatoes for control of Colorado potato beetle (CPB) as well as other pests such as potato leafhoppers, aphids, and flea beetles. Although they are effective as contact foliar insecticides, it is the ability of these chemicals to translocate from the soil into leaves as systemic insecticides that has been one of the primary reasons for their popularity. Most commercial potato growers apply these chemicals at planting (such as Admire Pro, Platinum, Belay, Scorpion, Venom, or Brigadier) or as a pre-planting treatment to seed pieces (such as Cruiser, Gaucho, or Admire Pro). Both application methods have been shown to provide long-term (> 60 days) systemic protection to the potato plant against CPB and potato leafhopper. Most neonicotinoid insecticides also provide significant suppression of wireworms that attack the potato seed piece.

However, insecticide resistance to neonicotinoids has appeared in numerous populations of CPB from the northeastern and Midwestern U.S. Managing neonicotinoid resistance in CPB through integrated pest management practices and rotation of insecticide active ingredients is key to sustaining the long-term efficacy of these compounds for potato producers.

Fortunately there are a wide range of registered insecticides today including Radiant (spinetoram), Blackhawk (spinosad), Coragen (rynaypyr=chlorantranilirpole), Voliam Xpress (chlorantranilirpole + lambda-cyhalothrin), Rimon (novaluron), and Agri-Mek (abamectin) that provide excellent control of CPB as well as other pests. In addition, many of the alternative chemicals are more IPM-friendly control options than the more traditional broadspectrum organophosphates, carbamates, or pyrethroids. Results of some recent efficacy trials with these products as well as some soon-to-be-registered new insecticides in Virginia will be presented (see Tables 1 and 2).

Table 1. Summary of insecticide efficacy test conducted on 'Superior' potatoes in Painter, VA, 2013; each of the foliar insecticide treatments were applied twice (20 and 30 May). The Admire Pro treatment was applied in-furrow at-planting (11 April) and evaluated a very low rate of that product.

		Mean no. Colorado potato beetles / 10 stems						% defoliation 11-Jun
		29-May		5-Jun		14-Jun		
Treatment	Rate / Acre	Small larvae	Large larvae	Small larvae	Large larvae	Large larvae	Adult	
Untreated Control		102.5 a	66.3 a	23.3 a	107.0 a	1.3 ab	55.0 a	67.5 a
Coragen 20SC	5 fl. oz	13.5 b	2.0 b	0.0 b	0.5 b	0.0 c	0.8 b	2.5 bc
Blackhawk	3.2 fl. oz	28.8 b	1.8 b	0.5 b	1.8 b	1.0 ab	2.8 b	0.0 c
Benevia 10OD (cyazypyr)	5 fl. oz	10.8 b	0.0 b	0.3 b	0.0 b	0.5 bc	3.0 b	0.0 c
Benevia 10SE (cyazypyr)	6.75 fl. oz	4.0 b	0.0 b	0.0 b	0.0 b	0.0 c	0.3 b	0.0 c
Admire Pro (in-furrow)	1.3 fl. oz	50.8 ab	3.8 b	7.3 b	5.0 b	1.8 a	3.8 b	3.8 b
P-Value from ANOVA		0.0111	0.0039	0.0065	<0.001	0.0015	0.024	<0.001

Table 2. Summary of insecticide efficacy test conducted on 'Superior' potatoes in Painter, VA, 2013; each of the foliar insecticide treatments were applied twice (24 and 31 May).

		Mean no. Colorado potato beetles / 10 stems					% defoliation	
Treatment	Rate / Acre	31-May		10-Jun		14-Jun		
		Small larvae	Large larvae	Large larvae	Adult	Adult	11-Jun	26-Jun
Untreated Control		97.0 a	103.8 a	11.5	5.0	15.5	100.0 a	100.0 a
Leverage 360	2.8 fl. oz	4.8 bc	6.8 bc	20.3	1.5	38.8	1.3 c	62.5 b
Endigo ZCX 2.71ZC	4 fl. oz	1.5 bc	0.8 bc	3.5	3.8	14.3	0.0 c	18.8 c
Actara 25WG	3 oz	5.3 bc	8.8 b	16.8	3.5	15.5	3.8 b	70.0 b
Besiege 1.25ZC	9 fl. oz	6.0 b	3.0 bc	0.3	1.0	4.3	0.0 c	1.3 c
Agri-Flex 1.55SC	6 fl. oz	0.0 c	0.0 c	0.0	0.0	5.0	0.0 c	3.8 c
P-Value from Anova		0.0001	0.0001	ns	ns	ns	0.0001	0.0001

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 60 peer-reviewed papers and 4 book chapters on insect pest management in agricultural crops. 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 (11) and Brianna (10).

NEW POTATO CULTIVARS IMPROVE SUSTAINABILITY AND ENHANCE PROFITS

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Historically a major portion of agricultural research had been devoted to production agriculture. This has generally resulted in an indirect benefit to the consumer through an abundance of relatively inexpensive agricultural food products. More recently consumers has taken on a more prominent role in the agricultural research agenda strengthened by fewer and larger food retailers. This has resulted in the development of an integrated approach or what may be referred to as an integrated agricultural production-consumer research system. This integrated research system has fostered the concept of sustainability in agriculture.

Sustainability has various meanings to individuals. For the purposes of this presentation it is defined as follows:

The term ''sustainable agriculture'' (U.S. Code Title 7, Section 3103) means an integrated system of plant and animal production practices having a site-specific application that will over the long-term:

- Satisfy human food and fiber needs.
- Enhance environmental quality and the natural resource base upon which the agriculture economy depends.
- Make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls.
- Sustain the economic viability of farm operations.
- Enhance the quality of life for farmers and society as a whole.

The mission of the Colorado Potato Breeding and Selection Program also embraces and supports tenets of sustainability, i.e. to develop cultivars that will help assure that the Colorado potato industry remains productive, competitive, and sustainable and to develop cultivars that provide the consumer with improved nutrition and quality.

Relevant Research Initiatives

The efficient breeding, production, and marketing of relevant new potato cultivars is dependant on identifying superior progenies from crosses with economically important characteristics. These characteristics may relate to production, disease management, and postharvest storage management. Consumer attributes such as appearance, flavor, nutritional and health-promoting properties, and other quality factors are also critically important. Current concepts and research in these areas will be discussed below.

Production Management

Development of Production Management Guidelines. To improve sustainability and enhance profits it is important to develop management guidelines for new potato cultivars. Without this information, grower experiences with new cultivars may not be successful because of improper fertilization resulting in negative impacts on yield, quality and production costs. Optimum nitrogen management guidelines for new cultivars have helped to improve their performance and adoption.

No two potato cultivars are alike and crop management strategies need to be customized for each. Performance can also vary with location and field conditions. Management practices are designed to take these differences into account and are established to optimize yield and quality of the crop while minimizing cultivar weaknesses.

From a practical standpoint, growers should always consult various sources to obtain information on the characteristics of a new cultivar they are interested in growing. The grower should consider each aspect of their field production, storage, and disease management and how a new cultivar fits in that system. When growing the new cultivar the producer, should follow the more or less concept for various inputs. Management practices should be evaluated and revised annually making appropriate adjustments. Since new cultivars have inherent risks associated with growing them, growers should evaluate new cultivars on a limited scale.

In Colorado, shifting production to Russet Norkotah Selection 3 resulted in an increase in grower returns of approximately $700/A due to yield and grade improvements. Shifting from production of Russet Norkotah Selection 3 to Rio Grande Russet added another $600/A to grower returns. Overall grower returns have increased about $1,3060/A by moving acreage from the standard Russet Norkotah to Rio Grande Russet. Additionally, during a high fertilizer cost year, fertilizer costs could be reduced by approximately $0.20 per hundredweight by growing Rio Grande Russet instead of the standard Russet Norkotah.

In many instances growers have now reduced their nitrogen application rate by 30 to 40%, and have increased tuber yield by 30 to 40% in some cases with new cultivars. A reduction of nitrogen application of 80 lbs/acre, from 240 to 160 lbs N/acre, results in a savings of $40.00 based on a cost of $0.50/lb of N. Based on estimates of 55,000 acres in the San Luis Valley, this translates to a nitrogen savings of about $2 million annually.

Storage Management

Storage Related Physiological Disorders. Pressure bruise/flattening accounts for a substantial portion of the $298 million loss attributed to potato bruising each storage year. Pressure bruise is a physiological disorder affecting both the fresh and processing industry. Increasing potato pile depth can result in flattened or compressed areas on the surface of the tuber and discoloration of associated internal tuber tissues.

Research has led to the discovery of a pre-harvest test that can identify which storage bins of potatoes are more prone to pressure bruise. This would allow storage managers to identify bins that should be marketed first, thereby avoiding losses due to pressure bruise. One commercial potato shipper commented that with this test “Colorado potatoes will have improved appearance.” This test could also be adapted to screening advanced selections for resistance to pressure bruising.

Disease Management

Disease Screening Using Molecular Methods - Powdery Scab. Colorado is known for its specialty cultivars that are rich in antioxidants and health promoting compounds. These smooth skinned cultivars are highly susceptible to powdery scab disease which can cause significant losses. Our studies have resulted in a soil screening test using a PCR method to determine how many spore balls are in the soil. This has helped potato growers to decide which potato cultivars should be planted in fields to reduce disease incidence.

The goal is to develop an enzyme based test to screen selections and cultivars for powdery scab susceptibility. This will help the Potato Breeding and Cultivar Development Program to identify and select for disease resistant material.

Nutritional Characteristics and Health Attributes

The production and partial purification of specific health modulating bioactive components in potato would also provide a new, stable and potentially more profitable market for potato growers.

Selenium and Antioxidant Studies. Selenium is an essential micronutrient. Our studies have shown that certain cultivars tend to accumulate more selenium in the tubers compared to other cultivars and they also exhibited greater antioxidant activity. There is a potential market for these cultivars in some countries where selenium rich potato are produced hydroponically and marketed at a premium price.

Acrylamide. Acrylamide is a potential neurotoxin formed in carbohydrate rich foods when cooked at high temperatures. A blanching method was developed to reduce acrylamide formation in French fries and chips. The blanching treatment that was developed also acts as nutritional supplement for Type-2 diabetics.

Flavor. Studies have shown that improvement in flavor results in repeat customers and commands higher prices. Tests are ongoing to identify and quantify some of the unique flavor compounds found in cooked potatoes. These studies will help in developing breeding strategies for developing more flavorful potato cultivars.

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- Rob Davidson, Andrew Houser, and Kent Sather - Disease Screening and Evaluation and Seed Certification

Dr. Holm was born in Southeast Idaho and raised on a family farm near Shelley in Bingham County. Potatoes, grain, and alfalfa were the primary crops raised. He credits his Dad and Grandfather with instilling in him an interest in potatoes, and his 7th grade science teacher with helping him decide on a career in science when he challenged the class to start thinking about the future and what they wanted to do for a living. Dr. Holm received his B.S. (1972) and M.S. (1974) from the University of Idaho and his Ph.D. from the University of Minnesota (1977). Dave began his professional career and is currently a Professor in the Department of Horticulture at Colorado State University located at the San Luis Valley Research Center, where he served as Superintendent from 1983B1997. Dave=s principal research responsibilities include the breeding and selection of new potato cultivars through traditional hybridization methods. Development of seed stocks of advanced selections for grower evaluation and seed increase is also an integral part of his program. He maintains close interaction with various research, extension, and production segments of the potato industry in Colorado and other major potato production areas of the US. He considers these relationships critical to the release and successful adoption of new cultivars. In 1979, he initiated the Colorado Potato Breeding and Selection Program, which previously had been solely a selection program receiving seedling tubers from other programs. During Dave=s tenure, 18 cultivars have been released. He has cooperated with other universities, the USDA-ARS, and Agriculture & Agri-Food Canada in the release of another 11 cultivars. He also has developed five clonal selections of Sangre and Russet Norkotah.

POTATO VARIETIES FOR PENNSYLVANIA

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Selecting an appropriate potato variety is an important management decision for potato growers. It is worth mentioning that the most common potato variety planted in the US is Russet Burbank. This variety was reported by Luther Burbank in 1914 as being a chimera selected from the variety Burbank by a potato grower in Colorado. Considering the technological advances made in modern agriculture, one might think that the potato industry is slow to change. It is unheard of to commercially grow varieties of most other crops that have been around for 100 years.

There are thousands of potato varieties. Potato growing conditions and soils are extremely variable throughout Pennsylvania. If you are considering a new potato variety, plant it in a small trial to test how well it performs before you grow it on a commercial scale.

Potato growers need to select varieties that they know they can sell. Buyers have become more selective and may not accept some varieties depending on the end use. Select varieties to meet your market needs.

Chip Varieties. Atlantic and Snowden have been the standards for Pennsylvania chip growers for more than 20 years.. Atlantic is typically harvested and immediately sent to the chip plant. Snowden is typically harvested and stored for several months before chipped. Several new varieties are being considered. Waneta is in high demand this year as it has gotten off to a good start since its release from the NY breeding program. Waneta produces an oblong tuber that has been equal or better than Snowden for out of storage chip color. Plus Waneta can be marketed as a table stock variety. Lamoka is another recently introduced chip variety with an uncertain future.

In 2013 a Snack Food chip potato variety trial was planted at Jim Hite's farm in Cambria County to compare some potential new chip varieties. After harvest tuber samples were placed in Kelly Hite's storage and later evaluated for specific gravity and chip color at Snyder's of Berlin. You can request this chip potato variety research report by contacting rleiby@pacooppotatoes.com.

Early Round White Potatoes. Superior has been a long-time choice as an early season round white potato. Over the past few years Envol has become a popular replacement for Superior in Pennsylvania. Envol stores well and is good for boiling. Expect to pay a premium price for Envol seed.

Round White Potatoes. Reba seems to be the most popular round white variety in Pennsylvania. Eva is known for attractive bright white skin. Norwis is a good yielder but has a creamy, light yellow flesh.

Red Potatoes. Red Norland and Dark Red Norland are early varieties that are best suited for the grower who needs an early red potato for summer roadside and fresh markets. We continue to evaluate red skin varieties that PA growers might store while successfully maintaining an acceptable red color. Unfortunately, many of our red varieties are susceptible to silver scurf which can turn a bright red skin at harvest to a bland gray-red unmarketable potato in just a few weeks. We have only one year experience looking at Dark Red Chieftain which might become a promising red variety for Pennsylvania growers.

Yellow Flesh Potatoes. The popularity of Yukon Gold has increased demand for yellow flesh potatoes. Lehigh is the leader among Pennsylvania grown yellow fleshed varieties. It is a good yielder, fries well and holds well in storage. Nearly 500 acres of Lehigh were grown in Pennsylvania in 2013.

Russet Potatoes. Most Pennsylvania growers are fully aware of the difficulty growing russet potatoes. Russet Burbank is next to impossible to grow in Pennsylvania without producing lots of knobby and misshapen tubers. If you must grow a russet potato in Pennsylvania look at Russet Norkota and its improved strains. This variety was released by USDA and has been accepted as one of the best russet in the Northeast US. Water management is especially important when growing russets in Pennsylvania.

Processing Potatoes. As market opportunities develop for fresh cut and processing varieties in Pennsylvania, several varieties are being evaluated. AF 3001-6 seems to have the best potential especially in the northern Pennsylvania potato growing regions. We are continuing to seek out other varieties to fit in this emerging market.

Specialty Potatoes. A number of blue, purple and fingerling potatoes have become more popular in recent years. Adirondack Red, Adirondack Blue, Purple Majesty, and Michigan Purple have all been successfully grown in Pennsylvania. Avoid All Blue.

It takes a long time for a new potato cross to develop into a commercially acceptable variety. Consider the recently introduced variety Lehigh. The original cross was made early in 1994 in New York. By 2006 Penn State tested NY126 (as it was known before it was named Lehigh) in its trials for 6 years. In 2007 NY126 was officially named Lehigh and was released. During the last six years commercial potato seed growers have gradually increased Lehigh seed supplies. In 2013 Maine and New York state seed certification programs inspected over 150 acres of Lehigh seed potatoes.

The Pennsylvania Commercial Vegetable guide includes a list of recommended potato varieties. Limited space restricts me from including that list in this document. Potato variety trials conducted by Penn State University's Barb Christ, Xinshun Qu, and Mike Peck provide an extremely valuable resource for potato growers. All 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.

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 and now works for Pennsylvania Co-Operative Potato Growers, Inc. as a potato crop consultant. He lives near Kutztown, PA with his wife Jan Marie.

PROPER DESIGN FOR POTATO STORAGES

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A potato storage, whether box or bulk, uses the same equipment and design parameters except for the air delivery system.

TO DESIGN A STORAGE WE NEED TO KNOW THE FOLLOWING:

- Total CWT of the storage
- Dimensions of storage
- CFM/CWT the owner wants
- Equipment selected to size of fan static pressure

THE EQUIPMENT REQUIREMENTS OF A STORAGE

- Computer panel with temperature and relative humidity sensor
- Therma Door with heated frames
- Direct drive fans designed for system S.P.
- Humidification – humidicell or humidifier
- Exhaust louvers on doors
- Variable frequency drives for fans

A BRIEF SUMMARY OF THE EQUIPMENT

The computer panel is the heart and brains of all the equipment, taking temperature and humidity readings to tell the equipment when to run based on the parameters we input. It directs the starting and stopping of fans, humidification equipment and intake air door operations to give you the proper temperature and humidity for the storage.

We have multiple temperature sensors in the pile or the boxes to precisely measure the temperature to maintain the proper supply air temperature to the pile.

The computer compares tuber temperature to outdoor temperature and if it is cooler outside than the tuber temperature, the system will automatically adjust to give the proper air temperature to the storage. This is the most critical part of storage management; to know precisely what the tuber temperature is, and what is happening inside the storage.

The Therma door or intake door is designed for the proper velocity and CFM requirements of air in the storage. It is an insulated door with stainless steel hinges and a heated frame. In case of high humidity and low ambient temperatures, the heater frame prevents door freeze-ups.

POTATOES

The fans in a storage are designed to deliver 1 CFM of air/CWT of potatoes. Some owners want more CFM/CWT depending on their particular harvesting times and soil conditions. Depending on equipment selection the fan is sized for 1" to 1-1/2" static pressure. We do not use belt drive fans – too many problems with belt slippage and controlling CFM.

The Humidicell will supply the proper humidity with no free water on the tubers. The Humidicell will also give you evaporative, free cooling if the conditions are correct.

Humidifiers should have a water particle discharge of 5 microns. At this size you can create a fog that will move through the storage. A larger water particle size will drop out of the airflow and not get to the tubers.

Exhaust louvers and doors are needed in the system to relieve storage building pressurization. When we bring outside air into a storage, we pressurize the storage. If we can't relieve the pressure, no more cool outside air can enter the storage. We do not use exhaust fans in a storage because a building under pressure will maintain a much more uniform temperature in the storage.

Variable frequency drives allow you to run a 3-phase motor on single or 3-phase power and to vary the speed up or down depending on the CFM needs of the storage. There is a great energy savings by controlling motor speed.

The main fault I see when I enter an existing storage is the air distribution system. The air ducts are too small, too far apart, and hole sizes in the lateral ducts are too large. The air distribution system has to be properly sized for the correct air velocity and CFM to get an even airflow through the storage. We need the proper air velocity to balance the air flow in the duct system.

In a Bulk Storage, sizing of the main plenum and lateral ducting (whether in-floor or pipes on the floor), and hole spacing in the lateral ducts is critical to achieving even air distribution throughout the potato pile. The lateral duct spacing should be 8 ft. on center.

The following parameters are used in **Bulk Storages** for sizing the air distribution system.

- Main plenum – 800 ft/min velocity
- Lateral ducts – 8' on center – 1000 ft/min
- Hole sizing in lateral ducts – 1400 ft/min
- Return duct – 1000 ft/min
- Therma door – 1400 ft/min
- Humidicell – 625 ft/min

Example: Storage has 30,000 CWT = 30,000 CFM @ 1.0" S.P.
Main air plenum = 30,000/1,000 = 30 sq. ft

The following parameters are used in Box Storages for sizing the air distribution system:

- Main supply plenum – 800 ft/min velocity
- Main return plenum – 1000 ft/min velocity
- Supply air holes on plenum wall – 1400-1450 ft/min
- Return air plenum slot – 1200 ft/min

- Therma door – 1400 ft/min
- Humidicell – 625 ft/min

In a Box Storage we have a plenum wall against which the boxes are set. The plenum wall has continuous slots that line up with the fork lift slots in the boxes. The slot size is designed according to the CFM while maintaining 1400-1450 ft/min airflow.

The most critical part of a Box Storage is the return air duct system. Without it, the storage will not work properly. Air takes the path of least resistance, and as the pallet boxes do not fit perfectly together, there are air gaps. The forklift slots on the last row of boxes from the plenum wall must be sealed to force the air up through the boxes. The return slot and duct is on the opposite side of the storage from the supply air wall. This guarantees the air will flow evenly through the boxes to the return duct. It is much more difficult to control the temperature, humidity, and to sprout inhibit because of the irregularities of the boxes. As a result, around 95% of potato storages in the US are Bulk Storages.

To properly manage a storage you have to have the correctly sized equipment and air distribution system. The most critical part of the storage is an even and uniform temperature. The computer measures temperature within .1 deg F. there are temperature probes in the pile measuring and recording temperature and recording and comparing pile temperature to outside temperature. The system can start and run automatically supplying supply air temperature within .1 deg F of set point.

The computer system in the storage is only a tool to work with. You still must make the storage decisions based on crop and harvest time. And a storage isn't a hospital...it can't make a bad potato into a good one.

Michael Mager is Co-Owner of Arctic Refrigeration Co. of Batavia, Inc. Arctic Refrigeration is a family owned business serving agriculture for over 60 years. He received his potato storage training at the University of Idaho at Pocatello and Industrial Ventilation Inc. (IVI). IVI are the inventors of the modern control systems for potato storages. We have currently completed storages in 8 states. He is a technical and field advisor for Bohn – Heat Craft Co. – one of the largest refrigeration equipment manufacturers in the country. He has spoken at numerous conferences and meetings including Cornell University and Penn State

GOING WITH THE FLOW - HELPING CUSTOMERS HAVE A GOOD TIME, VIA SIGNAGE, PRICING, FARM ORIENTATION

Russell Holmberg

Holmberg Orchards is 4th generation fruit farm located in southeastern Connecticut. Over the last 25 years, we have made the transition from a primarily wholesale apple orchard to a diversified, retail operation. We grow approximately 50 fifty acres of fruit; including apples, peaches, pears, small fruits and wine grapes, as well as several acres of vegetables and ornamentals. Ninety-five percent of the crops we grow are marketed on site, either through our year round farm market or our seasonal pick your own operation. In 2006, we established a farm winery where we produce hard ciders, table and grape wines. These products are marketed at the farm market and our seasonal tasting room on the farm.

Our business has witnessed a dramatic increase in customers and sales volume in the last ten years. During our peak months of September and October, we handle between four and eight thousand visitors per weekend. This represents a three-fold increase the customer volume since 2004. We attribute these changes to several factors including: the addition of the winery, the rise in interest in local agriculture, increased marketing efforts, and our increased attention to the customer experience. The last point listed will be the focus of this presentation. Although we are a fruit farm, any of all of these points should translate to other areas of agritainment - from corn mazes to on-farm catering and beyond.

As we adapted to a broader customer base, a few concepts emerged that have greatly improved our customers experience and our farm management. The first is constantly evaluating the customer experience as if it we the first time you have ever been on a farm. As farmers, we spend a lot of time on our property and our perspective gets skewed. We know where to drive, where to park and the difference between an equipment shed and a packinghouse. But if it were your first time on the farm, would you? A fresh set of eyes with honest feedback might reveal gaping holes in your operation. An example from our operation: we received feedback that the farm appeared well maintained, but you have to walk by old, broken down equipment on the way in. It was the first thing this customer noticed. The old broken down equipment was actually tractors that we use daily. They were pulled neatly into a stall barn and in fine working order. It looked okay to us, but it did not meet the customer's expectation.

The second concept is that you can't have too many signs. Perhaps the best improvement we have made to our operation was hiring a sign maker and redoing all our signs. Having plenty of professional signage establishes a professional report with the customers. Our goal with signage is to have clear, uniform signage that makes the farm as self-serviceable as possible. For every step in the customer's experience, we want a sign to be in place guiding them. This starts with clear directions getting to the farm and parking. An arriving customer is greeted by an employee but also with a large welcome sign. This sign has information about what we are picking, prices, rules, and map of the orchard showing the picking location for that day. Each row of fruit in the picking area is clearly marked with the variety, and ropes that are marked "area closed" define the picking area. This has eliminated the problem of pickers making honest mistakes and picking the wrong fruit. It also gives us authority when we have to pursue people in closed areas because they had to work to get there.

The third concept is that there is no substitute for a well-trained employee. After a year of making the farm look perfect, all can be lost by a customer having a poor interaction with an employee. We struggle with the challenge of getting employees proficient as soon as possible. Most of our seasonal help is starting work right before our busiest time. Working with them one on one is ideal, but impractical. Our solution has been to create training materials so that we are not reinventing the wheel year after year. We pair new hires with managers and provide them with a detailed employee manual. This manual details their work responsibilities and also provides a framework for each of the pick your own positions – greeter, field supervisor, checkout clerk, etc. For each of these key positions, the employee has details about the job, frequently asked questions, and scripts of what to say to customers. The scripts give them a few examples of a typical interaction with function words in italics. E.g. “Welcome to Holmberg Orchards. Is this your first time visiting our farm?” or “Welcome, how are you? Can I help you find anything today?”

Our final theme that emerged was the importance of well-defined areas for each activity on the farm. As the crowds got larger, crowd control became much easier as we separated parking, picking, checkout, picnicking and production activities. It seems obvious, but there is a lot of infrastructure that changed as we worked towards this goal. Our big challenge was that we started as production farm that had to adapt to being a public space. Clear, simple delineation between public and private areas was the first big step. We use ropes, painted lines, and movable signs to exclude the wandering public from our packing house, tractor sheds, private residences, etc.

In addition, we have found to very useful to create defined areas within the farm for various activities other than apple picking. For example, apple picking happens here, picnicking over there, wine tasting over there, etc. By separating other activities from fruit picking we are trying to address the problem of people who want to be at the farm, but don’t really want to pick apples. This gives us the ability to redirect a group that wants pictures and a gallon of cider. Instead of heading out to the orchard, they can go to the checkout and photo area, where they’ll do less damage than in the orchard.

These four concepts have greatly reduced the challenges of crowd control at our operation and have facilitated much larger volumes of people with out chaos. In fact, as our crowds have increased in size, the operation appears less busy because there are fewer lines and little confusion.

FRECON'S PICKFEST: BRINGING MUSIC AND ARTS TO THE ORCHARD

Henry Frecon, Frecon Orchards
Fun on the Farm: Agritainment session.

Pickfest: Free Range, Local Homegrown Bluegrass, Live in Frecon's Orchard! Bringing together the wonderful worlds of agriculture & music for a one of a kind fall harvest & bluegrass festival like no other! PICKFEST has been a Frecon tradition for 7 years and features some of the region's best bluegrass acts, pick your own fruit, carriage rides, hayrides, hard cider & wine garden, kids games & more...

Over the years, the Frecon Farms Pickfest has grown from being a small local festival to now being a boutique regional festival. In this presentation we will explore the growth, management, financials, and future evolution of the Frecon Pickfest. Most importantly we will explore the reasons for its existence.

The original festival started out with a single Bluegrass act known as the Manatawny Creek Ramblers. In the second year, the Ramblers played host to two other bands with a total of three. As the years mounted, the number of bands playing at Pickfest can be anywhere from 6 to 8 bands. As the number of bands increased so did the number of activities and participating businesses. Activities have bloomed in what is now called the Kidz Zone. These include but are not limited to; kids sing along, arts and craft sessions, apple smash, and face painting. Also offered is a round the clock hayride that is included with the price of admission.

Pickfest attendees range from infants to the elderly and everyone in between. There are entrance fee discounts for kids a full price entrance fees for adults. There are shuttles that offer round the clock service to get people from and to their cars. There are sponsorships to other affiliated businesses as a way of creating advertising opportunities for them and additional revenue streams. Pickfest offfers local vendors a location to sell other related craft products. Pickfest features five food and beverage vendors. The products featured include, apple wood smoked BBQ, apple wood fired brick oven pizza, coffee, hard and sweet apple cider, apple wine, and fruit meads. There is even an onsite 18th century brewing demonstration that ends up using some the wild yeast in our orchard to kick off the fermentation.

The Frecon's original goal of Pickfest was structured so that it would hit on two key aspects surrounding all of the Frecon lines of business.

1. To give the Frecon's a general marketing platform to promote for the fall season. Having Pickfest as a story to tell brings the affiliated Frecon lines of business recognition through this story. This story is told through media outlets, posters, social media, fliers, and word of mouth. All the while re-enforcing the affiliated brands to Frecon's potential consumers.

2. To create a BIG sales day for the affiliated lines of business. At the retail store the Frecon's are looking for sales to increase across all of the products being sold at that time of the year and at the Pickfest location we are looking for big returns on Pick Your Own, sales of our Hard and Sweet Cider and finally sales that evening at our Brewery.

From a financial perspective Pickfest was initially modeled as a promotional only event and thus a promotional expenditure along with other seasonal events at that time. As the festival grew, it moved into its own profit and loss model with the goal being to make sure that the festival at least pays for itself. In the most recent years of Pickfest the Frecon's have focused Pickfest on turning a profit. This is because the associated expenses have increased as the number of people attending have increased, thus the overall risk has increased.

Operationally the Frecon's Orchard is nestled snuggly in the rolling hills of Berks County Pennsylvania, and thus managing large volumes of people for a festival often proves challenging. Further, the Frecon Farms retail store, the Frecon's Cidery, and their affiliated Brewery are located in disparate locations not connected to the main farm. With the lines of business being as spread out as they are, creating a fluid traffic model and managing a large amount of traffic requires creative thinking and tactical organizational management in order to execute. We will explore how the Frecon's have overcome this and turned it into an advantage.

Finally, we will review what has become our most recent challenge with the festival and how we plan to over come it. In the past the initial beneficiaries were primarily our retail store and our Pick Your Own operation. In recent years with the emergence of our Cidery, they two have seen huge benefits. However, as the festival has grown in size our Pick Your Own and our retail sales have gone down for that day, while the Cidery's continue to move north. The future of Pickfest is still a story to be written, but it is likely that it will move in its time of the year. We will explore the logic behind this and what will be our new plan of attack.

In summary, this presentation will review all of the aspects required for the undertaking of a festival like this; from promotions, organization of resources, the financials, and labor which draws on a combination of family members, business partners, volunteers, and even the local the fire police. Hopefully at the end of this presentation audience members will walk away with fresh ideas in growing their own events or festivals, learn important operational requirements to execute their own festival, and better understand the dynamics associated with a festival or events growth.

PRICING PICK YOUR OWN (PYO) AND CHARGING ADMISSION

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The goal of this session is to convince fellow farmers that they should be charging more money for their products and their agritourism 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 products 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?

How does one address these challenges?

The solution is simple: **Charge Higher Prices!!!!**

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
    - Staff
    - Directional Signs
    - Landscaping
    - Shrinkage: Customers eating and taking products without paying.

Case Study #1: How much did you pay for the bottle of water that you purchased at the last Devils game?

- Why is it that farmers are willing to pay $4.50 for a bottle of water when they go to a sporting event…but are only willing to charge $1.25 for that same bottle when they sell it at their farm to their customers?
  - o Understand your customer base.
  - o Are they buying groceries for home or are they out for an experience?
  - o People are willing to pay more for an experience…and expect to.
  - o Don't base prices on what you think is fair! Base prices on what your customers are willing to pay.
  - o Higher margin items can help cover many of the hidden expenses of your retail business.

Case Study #2: "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!

- Don't sweat the threats!

- If you no one complains about your prices then you are not charging enough.

- You cannot be everything to everyone.
  - o Choose the base that you are seeking and set the prices accordingly.
  - o 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 #3: "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!"

- We are selling experiences as well as the crop.

- Where can people go and experience what they can on a farm and not pay?
  - o Even most parks require entry fees or annual passes
  - o "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?
  - o It is unacceptable to sample at the grocery store produce department…why should people be allowed to do it in the fields?
  - o 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.
  - o 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 #4: "Can you believe it? He is actually charging people admission to go and pick their own! And people are paying it! I don't think that our customers would ever stand for that!"

- 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.
  - You will see others following suit in short order.

- Don't sweat the cheap guy.
  - You cannot afford to sell cheap and stay in business today.

- Why were we one of the pioneers for charging higher prices and admission?
  - Because we have a lot of debt!
  - Because we refuse to work for nothing!
  - Because I want to pay our team members comparable wages to other careers.
  - Because we want to pass a financially stable business onto the next generation.

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…
  - Our goal is to get them to pay a second, third, and fourth time each year.

- One must remain constantly diligent to details.

What We are Doing at Alstede Farms:

- All PYO customers pay $5.00 admission for entry.
  - Includes FREE hay wagon rides to all PYO areas 7 days a week 9 am to 7 pm each day.
  - Includes a $2.00 coupon that they can apply only towards their PYO purchase.

- The coupon never expires.

- Change is never given if entire coupon amount is not used.

- FREE PYO admission is offered every Tuesday and Wednesday from 9 am until 1 pm.

- 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 you…and the entire industry… to increase PYO prices, charge entry admission, and start getting paid for how hard everyone really works in agriculture!

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 300 acres of tree fruits, small fruits, vegetables, and flowers. Today the farm's entire output is sold through the on farm store, PYO, tailgate markets, and CSA. Agritourism also compliments the farm's retail offerings. The farm today employs 18 full-time year round staff members and seasonally up to 165 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 17 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. Kurt and Barbara have three children; all of whom are home schooled at the farm: Rebekah (13), Sarah (10), and Karl (7). 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 win Stanley Cups. 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.

TIMING IS EVERYTHING – USING SOCIAL MEDIA TO LET CUSTOMERS KNOW WHAT IS HAPPENING ON THE FARM

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The number of ways you can reach your customer is vast (print newspaper, cable and local TV, radio, in store, social media, sponsorships) and the number of social media tools you can use to reach customers is even greater (Facebook, YouTube, Twitter, Google Plus, LinkedIn, Pinterest, Instagram…). As overwhelming as it might be, social media is great for reaching consumers. You can tweet about which fruits are in season, post YouTube videos about how to determine if a fruit is ripe, or share Pinterest images of engagement or wedding photos couples took at your farm, all of which help you build relationships with your customers.

So, which networks might you focus on and how might you use them?

Facebook

Available to the public since 2006, Facebook is used by 64% of US adults. Facebook business pages allow administrators to indicate hours of operation, type of parking available near the business, and directions, as well as announce events. Consider these fan pages as more of an advertising and promotional tool where content is not restricted to only those who choose to "like" the page; rather, these pages are public and can be accessed by anyone, even those who don't have a Facebook account.

After you create your Facebook business page, start personalizing it by posting images of the business, employees and customers (with their permission), updates about new product offerings, and so on. One way to begin building an audience is to invite those who you've "friended" via your personal page to "like" your business's Facebook page. Additionally, encourage those who like your page to suggest the page to their friends.

Facebook has quite a bit of utility for business owners, allowing them to:

- Create ads to target consumers
- Develop offers that can be redeemed online or in a retail outlet
- Download apps to create event announcements
- Develop forms for visitors to sign up for email lists or loyalty programs
- Create a survey
- Sell products on their Facebook page
- Provide another outlet for Twitter feeds, blog postings, and YouTube videos
- Allow visitors to purchase products without leaving Facebook

As with your website, you need to keep your business page up-to-date and provide visitors with a reason to return again and again. Stagnant pages will likely see the numbers of visitors decrease over time. Simply adding a news item, a set of pictures, and other information on a regular basis will encourage repeat visits.

Twitter

Twitter is a simple tool that can be used to quickly share information with people interested in your company, gather real-time market intelligence and feedback, and build relationships with customers, partners, and other people who care about your business.

With each tweet, 140 characters or less, users can post links to images, websites, and other electronic documents.

Like Facebook, Twitter users can:

- Create a profile and upload a profile image
- Publish their name and business location
- Add a URL for a website
- Create a short bio
- Choose a background theme for their home page (where all the tweets they receive appear)
- Receive an email when others "follow" them, send them a direct massage (a private tweet that the user sends to another Twitter user), retweet their tweet, and so forth
- Update followers about the progress of an event, such as hour-by-hour activities at an open house

Pinterest

Pinterest can be best described as an electronic bulletin board on which users "pin" electronic images or video they upload or find on the Internet based on keywords of their choosing (e.g., apple pie recipes). Other Pinterest users can then "like" the image, "repin" it to their own Pinterest board, or comment on the image or video.

Images and video that are pinned from the Internet are often tied to a URL. Consider how this could benefit your business. Pinterest users pin an image you have on your website to one of their boards. When Pinterest members click on the picture, they will be taken to your business's website, where they can learn more about your products and services. If you upload an image to your Pinterest board that is not tied to a URL—for example, you take a picture with your phone using the Pinterest app and pin it to a board—make sure to add the URL to your website when you label the image and add a description. Again, this will direct interested Pinterest users to where they can learn more.

Also consider using Pinterest to host contests. Several small business as well as national and international businesses are using the site for this purpose. One example of a Pinterest contest involves asking customers to submit a picture of a recipe they created using apples, pears, peaches, etc., and then invite other Pinterest users to vote on their favorite image by liking it. The contest winner would then win a fall-themed container garden or similar prize. Search for "contest" or "contest ideas" on Pinterest to see several examples you can use as inspiration.

Location- or Geolocation-Based Social Media

Geolocation-based social media includes Foursquare, Gowalla, SCVNGR, Whrrl, and others, each of which has a smartphone app component. Consider this type of social media as one that has a "game" component. In general, users create an account and "check in" at locations using the GPS on their smartphones. One benefit is that retailers can offer discounts or rewards to customers who visit their business and check in. It is certainly a creative way to reward both first-time visitors and repeat customers since there are a number of different types of discounts the business can offer: first time check-ins, discounts that are activated when "x" number of people check in, discounts for their most loyal customer (referred to as the mayor), and so forth.

These programs provide not only a game/discount component but also a social element. Users can rate businesses, post pictures they take at the business, provide tips (e.g., "friendliest staff," "best tasting and freshest apples"), and read tips that others have posted. Users can link these accounts to their Facebook, Twitter, email, and other accounts so that a picture, check-in, or post can be shared on multiple social media outlets, thus increasing their, and your, reach.

YouTube

YouTube can serve as a marketing and customer relationship tool for retail businesses. Videos can vary from less than a minute to over an hour in length. Since many people are "visual," this tool may better help convey benefits and features of your goods and services compared to "still" images that are just two dimensional.

Whether videos are created to promote a business, new products for the season, helpful tips, or how-tos, posting videos on YouTube is just another creative way to reach current and potential customers and inform, remind, and persuade them to purchase your goods and services. Allowing consumers to view videos you produce adds another dimension to your website or emails. Encourage viewers to send the link to others who might be interested in the content. For example, you could post a video about how to select and store peaches, and at the end of the video, as well as within the written description that accompanies it, mention that the information is applicable to everyone and that the viewer should do their friends and family a favor by forwarding the video link to them

As with other social networking sites, it is necessary to post frequently, though the number of videos produced may increase and/or decrease based on the seasonality of the business. To tie in with other social networking tools you may be using, consider posting a video based on content posted in a blog or on Facebook, Twitter, or other social network. Don't forget to let consumers know when a new video is available by sending them emails, placing an announcement on your website, putting a sign in your retail outlet, and posting on your other social networks.

Excerpts reprinted from Kelley, K. 2012. Social media strategies for horticultural businesses. OFA Bulletin, (phone:) November/December 2012, Number 936.

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CONTROLLING INSECT DAMAGE AND DISEASE TRANSMISSION WITH GMOS

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Currently transgenic technologies provide options for pest management in squash and zucchini, for controlling several aphid-transmitted viruses, and in sweet corn for controlling lepidopteran ("worm") pests. They involve very different approaches of using transgenic technologies.

Controlling Disease Transmission: In the case of squash, the ability to control aphid-transmitted viruses occurs through gene silencing. Genes that code for the coat protein of a virus were introduced into the plant, so that the plant can make these coat proteins. The National Research Council (2010) describes this as "transcription of a transgene [which] induces degradation of an invading virus". Although aphids can introduce a virus, that virus can no longer successfully replicate and cause disease. The presence of the coat protein prevents the biochemical processes required for viral replication to occur. This coat protein was viewed as a natural part of our food system, because the virus itself is a natural part of our food system. This approach, sometimes called "pathogen-derived resistance", was first developed for commercial food crops for papaya in Hawaii, by Dr. Gonsalves and colleagues, in the mid-1990s, to control papaya ringspot virus (PRSV). Transgenic cultivars have been credited with saving the papaya industry in Hawaii.

Today, growers of yellow squash and zucchini can use this same technology for controlling one or more viruses, including Watermelon Mosaic Virus (WMV), zucchini yellow mosaic virus (ZYMV), cucumber mosaic virus (CMV), and papaya ringspot virus (PRSV). Adoption rates are difficult to estimate, but the National Research Council estimated that these types of transgenic cultivars represented 12% of the crop in 2005, with most of the acreage in 5 states (NJ, FL, GA, SC, and TN). As of late 2012, yellow squash cultivars with this technology include XPT1832 III, Conqueror III, Prelude II; and zucchini cultivars include Independence II, Judgement III, Justice III, and new introductions (ZGNEHH 6009 and ZGNEHH 6014). These cultivars are available through Seminis and their distributors.

The viruses targeted in all these cases are often called "non-persistant" viruses, because they do not persist in the insect vector. Yet they can be rapidly spread, and can be quite damaging where they occur. They are spread by aphids ingesting sap that contains the virions, which then attach to specific proteins in the thin straw-like mouthparts of the aphid, and then the aphid ejecting them in the next one or several feeding bouts. It is like being transmitted by flying hypodermic needles. Aphid choice behavior among plants can facilitate transmission, by being attracted to plants during the early time after infection. Management with insecticides is often not very effective, because transmission can easily occur quicker than an insecticide can kill the aphid. Various cultural control options are necessary, and, for those who wish to use it, one of these cultural options is use of host-resistance developed through plant breeding with transgenic technology. There are additional crops for which this approach has been developed, although not commercialized. In our geographic area, one of interest is for controlling plum pox virus in stone fruit.

Controlling Insect Damage: In the case of sweet corn, the ability to manage several lepidopteran pests occurs through the plant expression of cry genes from various strains of the soil bacterium Bacillus thuringiensis. There are over 250 insecticidal proteins currently recognized from this bacterium. They include crystalline proteins ("Cry" proteins) produced during sporulation, and some strains also produce insecticidal proteins during vegetative growth (vegetative insecticide proteins, or "VIPs"). The Cry proteins are classified according to their amino acid sequence (Cry1 through Cry67, with subcategories defined by a sequence of letters and numbers). The genes that code for these were moved into maize using transgenic technologies, and later moved into commercially relevant sweet corn cultivars through traditional plant breeding.

When companies successfully breed a cultivar that includes cry genes, which codes for Cry proteins and/or VIPs, they refer to the particular genetic construct as an "event". That event is what is being marketed. That event might code for a single protein, or it might code for multiple proteins. If the event codes for multiple proteins targeting the same insect, it is called a pyramided event. If the event codes for multiple proteins that target totally different organisms (for example, different insect species, or herbicide tolerance and insect control), then it is called a stacked event. Both pyramided and stacked options are now available for pest management in sweet corn.

Commercially relevant lines have been available since about 1996, now known as the Attribute sweet corns available through Syngenta/Rogers and their distributors. These code for the protein Cry1Ab, using the Bt11 event, and are extremely effective in controlling European corn borer. There are many commercial cultivars now – for example, BC0805, which is similar to 'Providence' except that it includes the host plant resistance gene. I estimate at least 8 such cultivars from catalogues on the web in late 2012. Silk and ear expression may be higher than field corn, and under pest and plant conditions in central and southeast Pennsylvania, multiple trials have demonstrated that these cultivars achieved sufficient control of European corn borer and other worm pests so as to reduce the need to spray sweet corn for worms to zero, or very few applications. This level of control, however, was not always achieved in other nearby locations to the south, perhaps because of higher pest pressure, or different expression rates by the plant, or a combination of these factors. Also, these Attribute lines are hemizygous. Following open pollination and gene segregation in the ear, on average 75% of the kernels will express the Cry protein at some level, but 25% will not.

More recently, Seminis introduced the Performance Series of sweet corn cultivars, with at least 6 cultivar options. These cultivars all include stacked events. As of 2012, the cultivars included either the MON88017 event, or the MON89034 event, which are the same events found in GenuityR VT Triple PRO field corn. The MON88017 is aimed at corn rootworms (via CryBb1 proteins), and is stacked with CP4, which provides tolerance to glyphosate. The MON89034 event codes for Cry1A.105, which is effective against European corn borer and has some activity against corn earworm and fall armyworm, and Cry2Ab, which also controls European corn borer, and adds stronger efficacy against corn earworm and fall armyworm.

Soon, Syngenta/Rogers plans to introduce stacked events that include the Bt11 event discussed above, but stacked with the MIR162 event, which codes for a vegetative insecticidal protein, VIP3A. In addition, it will be stacked with herbicide tolerance to both glyphosate and glufosinate. Trials from Maryland and Minnesota have documented excellent control of corn borer, earworm, and fall armyworm. These resistant traits are not linked, so when they segregate in the production of the kernels on the ear, a higher percentage (94%) will express some form of resistance (Dively 2013).

Both of these newer options (the Seminis Performance Series and the Syngenta stack with the MIR162 event) showed greater efficacy against multiple worm pests in multiple states (Burkness et al. 2010, Shelton et al. 2013).

Finally, when it comes to considering how GMOs are affecting insect control in sweet corn, it is important to consider how adoption patterns in surrounding acreages of field corn have affected pest populations. The affects have been dramatic, and continue to change. Affects include reductions in regional densities of some species, and perhaps the beginning of the development of resistance in some species. In addition to the explaining cultivar choice options for vegetable growers, this talk will briefly consider these regional affects.

And remember, **scout your crop!** Silk feeding by sap beetles, Japanese beetles, or adult Western corn rootworms, and damage from Brown Marmorated Stink Bug or aphids, is NOT controlled by any of these transgenes. Sprays may be needed to control for these pest species, or under conditions of higher pest pressure from the worm species.

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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 over 20 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.

HERBICIDE-RESISTANT CROPS, RESISTANT WEEDS, AND HERBICIDE DRIFT

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New herbicide-resistance traits in corn and soybean may bring new management challenges for fruit and vegetable growers in the Mid-Atlantic region.

Herbicide-resistant crops are an important weed management technology in row crop agriculture that allow growers to apply an herbicide to control weeds without harming their crop. Glyphosate-resistant crops (i.e. Roundup Ready) have been the most commercially successful herbicide-resistant crops, and these varieties been planted over millions of acres, including much of the soybean acreage in the Mid-Atlantic. Over-reliance on the herbicide glyphosate in these crops has resulted in the evolution of difficult to control glyphosate-resistant weeds. In the Mid-Atlantic, glyphosate-resistant horseweed (or marestail, *Conyza canadensis*) is the most problematic species and is prevalent throughout the DelMarVa area and southeastern Pennsylvania. Glyphosate-resistant Palmer pigweed (*Amaranthus palmeri*) was also recently identified in Delaware and Pennsylvania and could become a serious problem.

Biotechnology companies are developing crops with resistance to additional herbicides as a partial solution to challenges with glyphosate-resistant weeds. For instance, Dow AgroSciences is developing corn and soybean varieties with combined resistance to glyphosate, glufosinate, and 2,4-D. The Monsanto Company is developing soybean with combined resistance to glyphosate and dicamba. These varieties could be on the marketplace as early as 2015 and may become very popular with soybean growers dealing with glyphosate resistant weeds. Both dicamba and 2,4-D are in the synthetic-auxin class of herbicides. These compounds can be prone to drifting off crop fields and are frequently cited in incidents of herbicide damage to non-target vegetation.

Horticulture crops (especially grapes, tomatoes, peppers, cucurbits, and snap beans) are sensitive to dicamba and/or 2,4-D at the low doses typical of herbicide drift. When exposed to synthetic-auxin herbicide drift, injury on horticulture crops can be easily recognized by symptoms including leaf cupping and twisting stems. Plant response to these herbicides can vary based on a number of factors including plant growth stage and environmental conditions at the time of exposure. Plants exposed to dicamba or 2,4-D drift during early vegetative stages can often fully recover from seemingly serious injury symptoms, especially during favorable growing conditions. Exposures during flowering or fruit set are often more serious and can result in substantial yield loss. Herbicide drift can also damage ornamental plants, and wildflowers exposed to synthetic-auxin drift may show reduced production of flowers that support pollinators and other beneficial insects.

Row crop producers and herbicide applicators have numerous options to prevent herbicide drift. Herbicide drift can be effectively reduced by using drift-reducing spray nozzles, limiting the speed of application vehicles, applying herbicides only under appropriate low-wind conditions, and using low-volatility herbicide formulations. Horticulture producers can minimize risks from herbicide drift by talking with neighbors that may be using synthetic-auxin herbicides, learning to recognize injury symptoms, and reporting a significant injury event as soon as it is spotted.

J. Franklin Egan is a research ecologist with the U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS). He is currently leading a research project assessing the land use footprint of the dairy industry in the Northeast region. Before joining the ARS, Dr. Egan completed his Ph.D. studies in Ecology at the Pennsylvania State University. His dissertation research examined agronomic and environmental risks from second-generation herbicide-resistant that are genetically modified to be resistant to the herbicides 2,4-D and dicamba. He lives in Lemont, Pennsylvania, with his wife Glenna Malcolm.

BUSTING THE MYTHS: THE TRUTH ABOUT GENETICALLY ENGINEERED FOODS

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Are genetically engineered foods as risky as some people believe? Do genetically engineered crops harm the environment? Do only seed companies benefit from genetically engineered (GE) seeds? Will genetically engineered plants and animals reduce hunger and food insecurity? These are just some of the many questions that surround the heated rhetoric and discourse that follows genetically engineered crops and the foods made from them. In this talk, some of the myths perpetuated by both the proponents and opponents of engineered crops and animals will be dispelled with the facts that exist today.

The myths and reality behind those myths are as follows:

Myth 1 – Creating new crop varieties in the laboratory is a recent phenomenon.

Reality – Scientists have been manipulating agricultural plants and animals in the laboratory for decades using techniques such as chemical mutagenesis, irradiation, and cloning.

Myth 2 – Monsanto and other seed developers are the primary beneficiaries of engineered crops.

Reality – While the biotech seed developers clearly benefit from the sale of engineered seeds, there are many other benefits, although they vary depending on the crop and the environment where they are grown. Some farmers have benefitted through increased yields, increased farm income, and reduced farmer poisonings. Some non-GE farmers have benefitted from the overall reduction in pest populations from neighbors who planted GE crops with a built in pesticide. Also, there have been benefits to the environment from the reduction in the use of some harmful pesticides.

Myth 3 -- Foods made with genetically engineered ingredients are harmful to eat.

Reality – While each genetically engineered crop and animal variety needs to be thoroughly tested beforehand to ensure no food safety risk, the engineered crop varieties currently grown by farmers have no documented food safety risks. The U.S. Food and Drug Administration (FDA), the National Academy of Sciences, the European Food Safety Agency, and many other scientific bodies have reached that same conclusion.

Myth 4 – FDA approves GE foods and ingredients before we eat them.

Reality – FDA regulates foods under the Federal Food, Drug and Cosmetic Act, which was written decades before the development of genetically engineered crops and animals. Only "food additives" receive mandatory pre-market approval before they enter our food supply and engineered foods so far have not been deemed "food additives." To date, engineered crops receive a voluntary review by FDA but FDA does not provide an approval or safety determination.

Myth 5 – GE crops are environmentally sustainable.

Reality – Extensive use of herbicide tolerant GE crops has led to the development of more than 10 herbicide tolerant weed species that are estimated to cover 7 to 10 million acres of farmland in 22 states. Similarly, the use of GE crops that produce their own pesticide is leading to the development of resistant pest populations. Continued use of those crops without incorporating integrated weed and pest management systems will quickly make those crops unsustainable.

Myth 6 – GE animals are dangerous to humans and the environment.

Reality – There are only two commercial GE animals, the GloFish (a pet) and the Atryn goats (goats that produce a biologic in their mammary glands). These animals are not dangerous but future GE animals may expose humans and the environment to risks unless they are properly regulated by the federal government.

Myth 7 – GE is the best way to increase farm productivity and reduce world hunger.

Reality – Under proper conditions, GE crops could help developing country farmers increase production. However, farmers need GE varieties of the crops they grow, education about their proper use, and credit to purchase fertilizer and other products that maximize productivity. Meanwhile, providing conventional technologies, such as irrigation equipment, quality seeds, and post-harvest storage facilities, could greatly increase developing farmer income.

While dispelling those myths and providing truthful information is one way to lessen the rancorous debate about GE crops, greater consumer acceptance will involve several different actions. First, FDA needs to be more involved in insuring the safety of GE crops, primarily through a mandatory pre-market approval process. Second, there must be greater transparency about GE crops and where they end up in our food supply. If GE crops and ingredients remain hidden to consumers, they will continue to wonder why that is. Finally, consumers will continue to ask what benefit do they receive from genetically engineered crops. That is why both public and private developers need to develop crops that have direct consumers benefits. Products in the pipeline that may meet this criteria could include GE apples, oranges, potatoes, rice, and eggplant, each of which will be briefly discussed in the talk.

Gregory Jaffe is the Director of the Biotechnology Project at the Center for Science in the Public Interest (CSPI), a non-Profit consumer organization located in Washington, DC. Before coming to CSPI, Greg worked as a lawyer for both the US Department of Justice and the US Environmental Protection Agency. He received his B.A. from Wesleyan University in Biology and Government in 1984 and his J.D. from Harvard Law School in 1988. Greg is a native of New Jersey and presently lives in Virginia with his wife Margaret and his three children, Seth, Naomi, and Rachel.

AN UPDATE ON THE NATIONAL STRAWBERRY SUSTAINABILITY INITATIVE

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In February 2013 the Walmart Foundation University donated $3 million the University of Arkansas System Division of Agriculture's Center for Agricultural and Rural Sustainability (CARS) with the goal of making U.S. strawberries a more sustainable crop for farmers and consumers. CARS created a competitive grants program with the grant which attracted 56 proposals from agricultural research and extension personnel at land-grant public universities in 29 states.

The purpose of the program is to move sustainable production forward through innovation, application of new technology, demonstration, outreach/extension, and education, ultimately resulting in increased sustainable production and supply of strawberries to American consumers.

The following projects and team leaders were selected for grant funding support and this presentation will provide an update of some of the activities and outcomes of these projects to date:

- Brian Whipker, North Carolina State University, "Strawberry Diagnostics: A Problem Solving Tool." The project will create a web-based interactive diagnostic key that strawberry growers can access via their computer, tablet or smart phone.
- Michelle Schroeder-Moreno, North Carolina State University, "Sustainable Soil Management Practices for Strawberries: Evaluation of Individual and Integrated Approaches." The project will generate information regarding the impact of compost, cover crops, and soil inoculants on strawberry production.
- Chieri Kubota, University of Arizona, "Sustainable Off-Season Production of High-Quality Hydroponic Strawberry in Desert Southwest." The project's goal is to establish sustainable off-season hydroponic strawberry production in the desert Southwest where there is practically no commercial production of strawberries, but there are strong greenhouse industries.
- Ganti Murthy, Oregon State University, "Creating Life Cycle Inventory Datasets to Support Meaningful and Constructive Strawberry Production Sustainability Metrics." The project's results will have lasting impacts on the industry by disseminating environmental data and metrics that can be used for continuous improvement in strawberry production and ensuring international market access for strawberry products with information that fairly and accurately represents United States agriculture.
- Ruijun Qin, University of California, "Optimizing Fumigation Rate, Application Depth, and Plastic Mulch Use for Strawberry Production in Raised-Bed Systems." The goal of the project is to develop effective field fumigation strategies including application depths and rates under three films for increased fumigation efficiency, improved pest control, high strawberry yield and reduced fumigant input.
- Ellen Paparozzi, University of Nebraska-Lincoln, "Winter Production of Nebraska Strawberries: An Idea Whose Time Has Come." The university's strawberry team has developed low cost, sustainable methods for growers to produce strawberries in a winter greenhouse.
- Suping Zhou, Tennessee State University, "Developing the Logistics for Producing Human Pathogen-free Organic Strawberries in the State of Tennessee." Outcomes of this project include promoting organic strawberry production by setting up demonstration farms in four major strawberry counties in Middle Tennessee, developing a safe production and consumption environment for fresh strawberries by defining the status of potential human pathogen contamination, and developing an easy-to-use tool to detect human pathogens on fresh strawberries.

STRAWBERRIES

- Cary Rivard, Kansas State University, "Development and Adoption of Annual, Plasticulture Strawberry Production in the Great Plains." The project's goal is to design a production system that is less prone to crop failures, provides a more stable income stream, and encourages new growers to enter the industry.
- Jeffrey Brecht, University of Florida, "Reducing Strawberry Waste and Losses in the Postharvest Supply Chain via Intelligent Distribution Management." The team will conduct in-store consumer evaluations to document how likely consumers will be to purchase strawberries from various lot and handling scenarios.
- Oleg Daugovish, University of California Cooperative Extension, "Placement of Additional Drip Lines to Enhance Soil Fumigation and Irrigation Efficiency and Minimize Environmental Impacts." The team will demonstrate how drip line management can save water, reduce fumigant use, prevent runoff, decrease pollution, and improve pathogen and weed management.
- Thomas Gordon, University of California at Davis, "Sustainable Strawberry Production in the Absence of Soil Fumigation." The purpose of this project is to evaluate a wide range of strawberry cultivars and the use of compost in non-fumigated soil in three different California geographic regions.
- Emily Hoover, University of Minnesota, "Development of a Comprehensive, Engaging E-Learning Tool for Strawberry Farmers." The team plans to develop an e-learning tool that will expand strawberry production using interactive multimedia to educate farmers on season extension and the use of June-bearing cultivars. The team will introduce innovative marketing techniques and resources to ensure locally-grown strawberries reach as many consumers as possible.
- Elena Garcia, University of Arkansas System Division of Agriculture Cooperative Extension Service, "Revitalizing Strawberry Production in Arkansas and the Surrounding Region via Extended Season Production Systems." The project team will demonstrate the practical application of technologies and methods in three Arkansas locations and conduct outreach activities for commercial and potential growers, county extension agents, agricultural professionals and Master Gardeners.
- Peter Nitzsche, Rutgers Cooperative Extension, "Improved Variety Selection and Sustainability of Strawberries for the Eastern United States." This project will test larger scale propagation and distribution of advanced selections, with goals of increasing production, improving profitability of local farms, and increasing the availability of high quality fruit.
- Jeremy Pattison, North Carolina State University, "Strawberry Grower Education and Adoption of Research Innovations: Technology Transfer of Production Recommendations." The team has developed a fall growing degree day (GDD) model that is ready for industry transfer to be used by strawberry growers to maximize yields and stabilize variation across years and locations.
- Carlene Chase, University of Florida, "Organic Open-field and High Tunnel Strawberry Cropping Systems for Long-term Viability of the Southeastern Industry." The project will develop open-field and high tunnel organic strawberry cropping systems that are more environmentally and economically sustainable and are resilient to weeds, pests, and diseases.
- Russell Wallace, Texas A&M AgriLife Extension, "Revitalization of Texas Strawberry Industry Through Identification of Production Constraints and Introduction of New Technologies." The project will launch a statewide collaborative effort to address grower, retailer and consumer concerns through extension programming and a series of surveys and research.
- Leonard Githinji, University of Arkansas at Pine Bluff, "Establishing and Expanding Sustainable Strawberry Production in Eastern Arkansas and Surrounding Areas." Extensive outreach and education including hands-on

exercises and demonstrations on sustainable strawberry production will be conducted across the Delta region of Arkansas.

Additional information about the projects is available at the National Strawberry Sustainability Initiative website at http://strawberry.uark.edu.

RHIZOCTONIA FRAGARIAE IN STRAWBERRY BLACK ROOT ROT: FRIEND OR FOE?

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Black root rot (BRR) is a disease complex in strawberry plants that results in blackening and death of roots and ultimately leads to planting decline. Many factors are implicated in this disease complex such as root-rotting fungi (*Rhizoctonia*, *Pythium*, and others), lesion nematode feeding, and abiotic factors including cultural or environmental stresses. Declining plants show signs of brown to black spreading lesions on roots and root death while above ground symptoms may include a general stunting of growth and limited berry production. Research at Penn State was conducted to develop a better understanding of the fungi involved with this complex and the environmental and cultural factors associated with BRR development that may negatively affect root growth and health. Several experiments were performed during 2011 and 2012 to further investigate the role of herbicides, environmental factors, and *Rhizoctonia fragariae* in the black root rot complex.

Rhizoctonia fragariae. Black root rot (BRR) continues to be a concern for Pennsylvania strawberry growers as well as growers in other states. In PA, strawberry plants showing symptoms of BRR were identified and sampled from six PA farms in Erie, Centre, Lycoming, Luzerne, Cambria, and Lancaster counties from August 2010 to October 2011. Plants were thoroughly washed and roots were examined for the presence of black root rot symptoms. Multiple fungi including *Rhizoctonia fragariae, Pythium* spp., *Fusarium* spp., and *Trichoderma* spp. were isolated and identified from the symptomatic strawberry root tissue.

Our experiments focused on *R. fragariae* as the causal agent of black root rot. To determine which fungal AG groups were present in Pennsylvania, sampled roots were cut into 5mm segments and placed on a *Rhizoctonia* selective agar growing media. Fungal isolates of *R. fragariae* were identified using conventional staining methods and DNA sequencing. *R. fragariae* isolates belonging to three anastomosis groups were isolated from strawberry plants collected from commercial fields in PA. Samples from Cambria and Lycoming counties contained the fungal strain AG-A, samples from Lancaster and Centre counties contained the fungal strain AG-G, and samples from Erie and Luzerne counties contained the fungal strain AG-I. An uncharacterized strain of *R. fragariae*, not previously reported, was also isolated from the strawberry plants grown in Centre County.

For this disease to develop, the pathogen must interact with a susceptible host under environmental conditions that favor the pathogen. Further understanding of how cultural and environmental factors impact the ability of different AG groups to cause disease would be valuable for understanding potential disease problems in strawberry production systems and may lead to the development of management strategies that are tailored to the specific AG group(s) present.

Sinbar (terbacil) and *Rhizoctonia fragariae.* In previous studies, repeated applications of Sinbar 80WP (terbacil) at planting year rates or a single application at higher labeled rates decreased new root growth. The mode of action of terbacil results in the inhibition of photosynthesis in plants. Photosynthesis is the biochemical process where light energy is used to convert carbon dioxide in the atmosphere to carbohydrates (mostly sugar) that are used for plant growth. Sinbar application specifically reduced photosynthesis in young strawberry leaves. A reduction in photosynthesis could lead to limited production of photosynthate, reduced root growth, and suppressed plant defenses against black root rot pathogens. A New York grower survey reported a correlation between application of terbacil and a reduction in healthy feeder roots; however, further investigation is needed to understand this possible interaction between Sinbar application and *R. fragariae*.

In May 2012, a commonly grown strawberry variety, 'Jewel', was used in an experiment to observe the effect of Sinbar application and *R. fragariae* inoculation on plant growth and black root rot development. Plant roots were inoculated with each of four strains of *R. fragariae* isolated from PA fields. A control group of plants was also included which were not inoculated. Plants were grown in the greenhouse for eight weeks at which time Sinbar 80WP was sprayed using a small hand sprayer at rates equivalent to 0 or 1 oz. per acre in 30 gallons of water.

Plants were harvested at 13 weeks after planting and leaf, crown, and runner numbers were recorded. Roots were washed, and dry weights of leaves, crowns, and roots were measured. Results showed that leaf, crown, root, and total plant dry weight were not significantly affected by Sinbar application or inoculation; however, inoculation did affect runner production. Plants inoculated with AG-G and AG-A had reduced runner production. Plants inoculated with AG-I also had reduced runner production but only when terbacil was applied. The uncharacterized strain had no effect on plant growth. When Sinbar was applied at the rate of 1 oz. per acre, about 4% of leaves developed phytotoxicity. Interestingly, 12% of leaves developed phytotoxicity when plants were inoculated with AG-A which could have a significant impact on leaf function. Although Sinbar application had minimal effects on plant growth in this experiment, the extent to which plants are affected by Sinbar may be in response to the anastomosis group present in the root system.

Sinbar application, environmental factors, and *Rhizoctonia fragariae*. In two experiments, the effect of Sinbar application was studied in combination with select soil temperature and soil moisture levels. Strawberry plants of the variety 'Jewel' were used in both experiments and were inoculated with AG-A or AG-G. Some plants were not inoculated and served as the control. In the soil temperature experiment, plants were grown in the greenhouse in pots with average soil temperatures of 65˚F, 80˚F, and 90˚F. Twelve weeks after planting, Sinbar was applied at rates equivalent to 0 or 1 oz. per acre in 30 gallons of water. Plants were harvested at 20 weeks after planting, and leaf, crown, and runner numbers were recorded. Roots were washed, and dry weights of leaves, crowns, and roots were measured.

Sinbar application and soil temperature had few effects on total plant growth; however, when plants were grown at 65˚F, fewer runners were produced when terbacil was applied. Inoculation treatments did impact plant growth, and plants inoculated with AG-A had significantly more primary roots and higher crown and root dry weight when compared to control plants. The number of symptomatic primary roots was also determined, and the percentage of roots with lesions was compared across treatments. Plants inoculated with AG-A had a higher percentage of primary roots with lesions than other treatments where 44% of primary roots had lesion development. Inoculation with AG-G did not have any effects on plant growth or lesion development that differed from control plants. These results suggest that the presence of some isolates of *R. fragariae* may cause lesion development, but could also benefit the plant by increasing plant growth and negating any harm caused by low levels of lesion development.

In the soil moisture experiment, strawberry plants were inoculated and grown in the greenhouse with supplemental lighting. After seven weeks, plants were subjected to three water treatments of sufficient water, drought, and waterlogged for 10 days to emulate a water stress event. Twelve weeks after planting, Sinbar was applied at rates equivalent to 0 or 1oz. per acre in 30 gallons of water. Plants were harvested at 20 weeks after planting, and leaf, crown, and runner numbers were recorded. Roots were washed, and dry weights of leaves, crowns, and roots were measured. Sinbar application and moisture treatment had no affect on plant growth or lesion development. Inoculation treatments also had minimal effects; however, when Sinbar was applied, plants inoculated with AG-A had significantly higher total dry mass than other inoculation treatments. These results suggest that strawberry plants may be fairly tolerant to short term water stress, and Sinbar application is not synergistic with water stress. These results also suggest that inoculation with *R. fragariae* AG-A may help plants compensate for short term water stress.

Environmental factors and *Rhizoctonia fragariae*. The effects of soil type and inoculation with *R. fragariae* were also explored. In this experiment, strawberry plants of the variety 'Jewel' were inoculated with *R. fragariae* AG-A isolates from

Connecticut (CT-A) and Pennsylvania (PA-A). After plants were inoculated, they were planted in pots with different soil types collected from PA: low fertility clay loam, high fertility clay loam, and sandy loam. Plants were grown in the greenhouse for seven weeks, plants were harvested, and roots were washed. Final leaf number, crown number, and primary root number were recorded. Lesion development was also recorded.

Plants grown in the low fertility clay loam had significantly less plant development and total dry weight than plants grown in the high fertility clay loam. Plants grown in the sandy loam had intermediate growth compared to other treatments. Plants inoculated with both isolates of *R. fragariae* had significantly more leaves than control plants and had greater total plant dry weight. The percentage of primary roots with lesions was not different among inoculation treatments; however, plants grown in the sandy loam had almost 45 to 55% fewer roots with lesions than plants grown in the clay loam soils. These results suggest that soil type may have a larger impact on overall plant health and development and black root rot than *R. fragariae.*

Minimizing plant stress during the growing season is always recommended to help reduce potential planting decline and black root rot in strawberry plantings. Applying Sinbar at low field rates more frequently may be necessary to minimize phytotoxicity and maintain effective weed management. Soil type may have a larger impact on black root rot development over time than soil temperature, soil moisture, and the presence of *R. fragariae*. Growers select fields with beneficial soil characteristics such as good drainage, high fertility, and high organic matter. These characteristics may help suppress populations of pathogenic organisms. The presence of *R. fragariae* may have a minimal impact on black root rot development. Although lesions were present on roots of inoculated plants, the presence of *R. fragariae* often resulted in increased strawberry plant growth. This suggests that other pathogens such as *Fusarium* spp. and *Pythium* spp. should be studied to determine if they have a greater impact on lesion development and black root rot than *Rhizoctonia fragariae* in PA strawberry production systems.

Emily Lavely is currently a Master's student in the Department of Horticulture at Penn State University. She is advised by committee members: Dr. Rich Marini, Kathy Demchak, and Dr. Beth Gugino. Her research focus is black root rot in strawberry in Pennsylvania, and she is studying fungal interactions with plants and the influence of herbicides on photosynthesis as possible contributors to the black root rot complex. Emily received her undergraduate degree at Purdue University where she met her husband who is also currently a Penn State graduate student in Aerospace Engineering. She is originally from Rome City, IN.

NEW TABLE GRAPE DEVELOPMENTS FROM THE UNIV. OF ARKANSAS

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Grape breeding at the University of Arkansas was begun in 1964, and the year 2013 was the 50th year of this effort. In 2012, four new table grape varieties were released, ‘Faith’, ‘Hope’, ‘Joy’, and ‘Gratitude’. These releases expand options for table grape growers for local markets in the United States. All four cultivars have non-slipskin flesh with good skin quality, fruit cracking resistance, good vine health and winter hardiness (in the upper South, where testing was done). However, they have not been well tested in the Mid-Atlantic region for winter hardiness, so this should be noted when considering these new developments. These cultivars, in addition to prior releases from the program (including ‘Mars’, ‘Jupiter’, and ‘Neptune’) provide for a range of dates of harvest along with choices of fruit colors, shapes, textures, and flavors for local-market growers.

‘Faith’ (A-2412) is a blue, non-slipskin, seedless grape that ripens early, late July to early August in Arkansas. It has a largely neutral flavor with slight fruity flavor in some observations. Berries average 4 g, and cluster weight ranges from 150 to 250 g, medium in size. Soluble solids content averages 19% and skin is edible. Fruit cracking was usually not found after summer rainfall during ripening or at maturity for ‘Faith’. Vines usually have moderate vigor and yield and exhibit good hardiness in Arkansas. This new variety should complement ‘Jupiter’ for the early local market for table grapes. Negative aspects include uneven set of berries in some years resulting in reduced cluster fill, occasional seed traces that can harden in some years, and a slight skin astringency noted occasionally.

‘Hope’ (A-2053) is a white (green) seedless grape with a fruity flavor and high yields. Berries average 3 g. Seed traces are seldom seen with Hope. Soluble solids content averages 19%, and berries are non-slipskin. Texture is soft. Only slight fruit cracking was seen following rainfall. Harvest of ‘Hope’ was usually August 20th. Clusters are usually very tight and range from 300 to 330 g. Yields were usually 35 to 50 lb/vine. Vines are moderate in vigor. Negative observations have included excessively tight clusters and a moderately thick skin.

‘Joy’ (A-2494) is a blue, non-slipskin, seedless grape with exceptional fruity flavor. The skin is very thin, likely the thinnest of any Arkansas-developed grape. Fruit cracking during rainy periods near or at harvest has rarely been seen. Berry weight averages 3 g and cluster weight is usually near 300 g. Average harvest date is August 11th in Arkansas. Vine yield is usually moderate to high, and vines have moderate vigor along with consistently good vine health. Shortcomings include a very soft texture, occasional variable berry set resulting in some “shot” berries, and shatter of ripe berries at maturity noted in some years. Occasional hard seed traces were seen with ‘Joy’.

‘Gratitude’ (A-2505) has an exceptional crisp texture with seedless, white (green) berries. Berry weight averages 3.5 g and clusters can weigh up to 500 g. Skin is very thin and in most years no seed traces were found. Soluble solids content averages 19%, and flavor is neutral, similar to most *Vitis vinifera* table grapes. Fruit cracking was not observed, an exceptional characteristic for a crisp, thin-skinned variety grown in an area with rainfall near maturity and harvest. Clusters are usually very tight. Productivity is moderate. Negative characteristics for ‘Gratitude’ include occasional winter injury to vines and tight cluster fill.

Vines are available in the commercial marketplace, and the suggested nursery for the Mid-Atlantic region is:

Double A Vineyards, Inc.
10277 Christy Road
Fredonia, NY 14063
Phone: 716-672-8493
Website: www.doubleavineyards.com
Email: sue.rak@doubleavineyards.com

Pictured above, right to left, are ‘Faith’, ‘Hope’, ‘Joy’, and ‘Gratitude’ table grapes.

John R. Clark is a university professor of horticulture at the University of Arkansas. His research responsibilities are his primary appointment, where he directs the University’s Division of Agriculture fruit breeding program and teaches in the areas of fruit production and plant breeding. Crops he works with include blackberries, table grapes, muscadine grapes, blueberries, and peaches/nectarines. His research activities are carried out in Arkansas, several US states, and various countries in the world. A native of Mississippi, he has BS and MS degrees from Mississippi State Univ. and a PhD from the Univ. of Arkansas.

WHAT'S HAPPENING IN HIGH TUNNELS IN WEST VIRGINIA

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High tunnels are becoming widely adopted in West Virginia with specialty crop growers. In 2007, there were approximately 15 high tunnels in operation. In 2013, West Virginia has over 150 high tunnels producing a wide diversity of food crops. While over 60 specialty crops are grown in West Virginia, high tunnel production has centered on crops which have consistently high yield, demand and value such as tomatoes, peppers, squash, cucumbers, root vegetables and leafy salad greens.

The high tunnel research and outreach program has focused on several factors associated with high tunnel production and marketing of high tunnel crops. I have evaluated several cropping systems including Asian vegetables, beans, blackberries, carrots, chard, celery, cover crops, cucumbers, (diverse leafy greens) lettuce, melons, strawberries, and tomatoes. Superior varieties or genotypes of vegetables have been screened throughout the year to determine which varieties perform best in West Virginia. Head lettuce can be grown throughout the year using high tunnels in West Virginia. Production cycles vary from 60 days to 120 days depending on the season of the year.

Scheduling crop production within high tunnels is critical for success. For growers who are participating in the Farm-to-School program, it's important to have a relatively consistent supply of produce throughout the school year. I have developed crop schedules (Table 1) and profitability rankings (Table 2) of specialty crops based on research results which may help new growers in developing a plan for high tunnel production. For maximum profitability, high tunnels must be used for four-season production. Cover crops can be successfully integrated into rotation schemes for high tunnel growers. Growers must monitor soil health carefully. Both soil-based and soilless production systems can be used in the high tunnel for crop production.

Figure 1. Over 150 high tunnels are being used in West Virginia for specialty crop production.

Generally speaking, high tunnels allow for 4-8 week earlier or later planting and harvest of most crops in West Virginia. Minimal heating (i.e., supplemental heating) can be used to grow winter and early spring crops. The minimum air temperature at night is held approximately to the physiological base temperature of the crop (50°F warm season crops and 35°F cool season crops).

Table 1. Relative planting and harvest schedule for freestanding high tunnel vegetable crop production in West Virginia[z].

Crop	Planting Method[y]	Days from planting to first harvest	High Tunnel Planting Date	High Tunnel Harvest Date
Beet	TRP or DS	55	February-April; August-October15	October-May
Bean (snap)	TRP or DS	65	April-September 1	June-October
Bok Choi	TRP or DS	40	February-November	Year-round
Broccoli*	TRP or DS	72	March-April; August	May-June; October-November
Cabbage*(green)	TRP or DS	78	March 15-May15 August 1-15	May-December
Cabbage (Chinese)	TRP or DS	68	February15-April 15	April-June; October-December 10
Carrot	DS	65	February 1-April 15 August-October	March-June November-December
Cauliflower*	TRP or DS	70	March 15-April 15 August	May-June October-December 10
Chard	TRP or DS	60	Year-round	Year-round
Cucumber	TRP or DS	55	April-September 1	May-October
Eggplant	TRP	78	April 15-August 15	July-October
Garlic	DS	120	October-November	June-August
Kale	TRP or DS	60	January-April 15 August-October 15	February-June September-January
Kohlrabi	TRP or DS	55	August	October-December
Leek	TRP or DS	100	February 15-November 1	Year-round-
Lettuce	TRP or DS	25-65	February 1-October 15	February-December 15
Onion (bunching green)	TRP or DS	60	October-December February-June	March-December
Pea	TRP or DS	60	February 14-April 15 August-September 10	May-June October-November
Pepper (bell)	TRP	65-80	April-July 20	June-November
Potato (Irish)	DS		February 14-March 15 August	May-June October-November
Radish	DS	20-25	February-April October-December	February-May November-January
Spinach	DS		January 1-May 1 August-December	January-May October-December
Summer Squash	TRP or DS	45	April-May	May-June
Tomato	TRP	70-80	March 25-July 15	June 15-December 1
Turnip	DS	25-65	February-April September-December	February-May October-January

[z]This table is intended for reference.

[y]**TRP=**Transplant; **DS=**Direct Seeded Transplanting is recommended for early harvest.

*Not recommended for high tunnel production (See Table 2).

Table 2. Summary of yield and total revenue of annual high tunnel crops.

Crop	Ft^2/plant	Yield/ft^2 (lbs.)	Price/lb^y.	Total Revenue ($)^z	Time in the high tunnel (days)	$/$ft^2$/day	Rank
Beans (bush)	0.1	0.5	2.00	1800	65	28.00	10
Beets	0.2	1.25	2.50	5625	75	75.00	7
Broccoli	1.5	0.4	2.50	1800	80	21.00	15
Carrots	0.2	1.3	3.00	7020	75	94.00	6
Chinese Napa Cabbage	1.5	2	1.65	2700	70	39.00	9
Cucumbers	4.0	2.5	3.00	13500	65	208.00	1
Eggplants	6.0	0.7	2.00	2520	100	25.00	12
Kale	0.6	1.0	6.00	10800	60	180.00	2
Lettuce	0.2	1.0	6.00	10800	65	166.00	3
Melons	8.0	1.5	0.50	1350	120	14.00	16
Peas	0.1	0.5	2.00	1800	75	24.00	13
Spinach	0.2	1.0	4.00	7200	65	111.00	5
Squash (Summer)	8.0	0.6	1.00	1080	70	15.00	16
Raspberries	10.0	0.5	8.00	7200	365	27.60	11
Strawberries	2.0	0.8	3.00	4320	200	22.00	14
Peppers	4.0	2.0	1.00	3600	100	42.00	8
Tomatoes	8.0	2.5	2.50	11250	100	113.00	4

zAssumes 1800 ft2 bed space within a commercial high tunnel.

yEstimated price. Prices will vary with location.

Lewis Jett is Associate Professor and State Extension Commercial Horticulture Specialist at West Virginia University. He is a native of West Virginia, and conducts research and extension projects with a wide diversity of specialty crops.

HIGH TUNNEL LETTUCE VARIETY TRIALS

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High tunnels have been proven to extend the growing season, which can allow growers to have the ability to generate more profits, but only when growing high value crops. Lettuce is a high value crop and is the second most important vegetable crop (after tomatoes) for high tunnel growers. Growers need cultivars that perform well in the high tunnel environment and also have excellent quality for the marketplace.

In 2013 we evaluated in both the spring and fall, sixteen cultivars of lettuce grown in a 17 ft by 36 ft high tunnel at the Penn State High Tunnel Research and Education Facility located at the Horticulture Research Farm in Rock Springs, Pennsylvania to determine which are best suited for a spring and fall crop in high tunnels. We evaluated yield, crop uniformity, maturity, color, habit, and susceptibility to insect/disease/stress.

The high tunnel had three raised wooden beds. The outer two beds being 3 foot wide and the center bed being 4 foot wide. The length of the beds was 30 feet. The two outer beds were planted with 3 rows of 3 transplants across for a total of 9 plants of lettuce per cultivar while the center bed was planted with 3 rows of 4 transplants across for a total of 12 plants per cultivar. The spacing between the rows was 7.5 inches and 12 inches between plants in the row. Drip irrigation system was used to maintain adequate soil moisture in the beds. Weeds were managed by hand hoeing. The only pest experienced was some aphids and white fly late in the fall crop.

For each cultivar the entire 9 heads from the outer beds were harvested while 9 heads from the center bed were harvested leaving three plants to observe for bolting, etc. Harvesting date for the cultivars was determined by referring to the days to maturity listed for the cultivar and by the appearance of the cultivar. The individual heads were then weighed and the diameter of the heads recorded.

The spring crop of lettuce was seeded on March 15, 2013 in 1.25-inch diameter cells in a 98-count cell tray with two cultivars per tray or 49 plants per cultivar in the tray. The spring crop was transplanted on May 3, 2013. Fertilizer (.6 lbs. of 10-10-10) was applied and lightly incorporated into the beds prior to transplanting. Harvest for the spring crop commenced May 24, 2013. The lettuce was seeded on August 6, 2013 for fall trial as before. Fertilizer was applied at the rate of (.6 lbs. of 10-10-10-10) and lightly incorporated into the beds prior to transplanting the lettuce. Drip irrigation was used to maintain adequate soil moisture. The lettuce was transplanted on September 13, 2013. The first harvest of lettuce commenced on October 21, 2013.

The data was analyzed using analysis of variance (PROC MIXED) and means will be separated using Tukey's Least Significance Difference test ($P > 0.05$).

Table 1. Lettuce cultivar, type, seed source, days to maturity and organic or non-treated seed for high tunnel spring and fall cultivar trial.

Cultivar	Type	Seed Source	Maturity	Organic Seed
True Heart	Romaine (narrow pointed, dense head)	Syngenta		NT
Rio Bravo	Romaine (large, v-shaped head)	Syngenta		NT
Red Zin	Romaine (triple red, medium thick, waxy leaf)	Syngenta		NT
Camino Verde	Romaine (open head)	Syngenta		NT
Skyphos MTO	Red Butterhead	Johnny's	47	NT
Two Star MTO	Green Leaf	Johnny's	51	Yes
Red Cross MTO	Red Butterhead	Johnny's	48	NT
Concept MTO	Green Summer Crisp	Johnny's	51	Yes
Mottistone MTO	Red Summer Crisp	Johnny's	55	NT
New Red Fire MTO	Red Leaf	Johnny's	55	Yes
Panisse MTO	Green Oakleaf	Johnny's	48	NT
Cherokee MTO	Red Summer Crisp	Johnny's	48	NT
Adriana MTO	Green Butterhead	Johnny's	48	NT
Rouxai MTO	Red Oakleaf	Johnny's	47	NT
Nevada MTO	Green Summer Crisp	Johnny's	48	NT
Nancy MTO	Green Butterhead	Johnny's	52	Yes

Table 2. Head weight (lb) and diameter (in) of 16 lettuce cultivars grown for a spring and fall crop in a 17 foot by 36 foot high tunnel located at the Penn State High Tunnel Research and Education Facility, Rock Springs, Pa.; in 2013

Cultivar	Spring Crop		Fall Crop	
	Head Weight (lb)	Head Diameter (in)	Head Weight (lb)	Head Diameter (in)
Rio Bravo	1.574a[z]	14.69a	0.550b	12.24b
True Heart	1.499a	14.27a	0.676a	12.49b
Camino Verde	1.308b	13.91abc	0.668a	12.47b
Adriana	0.649c	13.77abc	0.377de	11.16c
Nancy	0.624c	14.04ab	0.387d	12.92b
Skyphos	0.619c	14.15ab	0.366def	12.28b
Concept	0.463d	13.25bcd	0.479b	12.94b
Nevada	0.412de	11.51e	0.468c	10.56cde
Red Cross	0.349def	11.59e	0.300fgh	12.64b
New Red Fire	0.329ef	12.71d	0.369def	14.19a
Panisse	0.259fg	9.92fg	0.406cd	12.30b
Two Star	0.258fg	13.01cd	0.369def	12.40b
Mottistone	0.243fg	8.37h	0.265ghi	10.12de
Rouxai	0.202g	9.35g	0.220i	10.83c
Red Zin	0.194g	10.01fg	0.226hi	10.04e
Cherokee	0.180g	10.48f	0.305efg	10.77cd

[z]Values are the mean of 3 replications; values followed by different letters within a column are significantly different using Tukey's multiple comparison test at the 5% level

Table 3. Harvest dates and cultivars harvested.

Cultivar	Spring Crop Harvest Date	Cultivar	Fall Crop Harvest Date
Two Star	May 24	Two Star	October 21
Cherokee		Panisse	October 24
Panisse		Red Cross	
Red Cross	May 29	Mottistone	
Mottistone		New Red Fire	
New Red Fire		Nancy	
Rouxai		Red Zin	
Nevada	May 30	Rouxai	October 31
Concept		Cherokee	
Red Zin		Adriana	
Nancy	June 4	Skyphos	
Adriana		Rio Bravo	November 7
Skyphos		Camino Verde	
Rio Bravo	June 22	True Heart	
Camino Verde		Nevada	
True Heart		Concept	

Overall all lettuces that were trialed proved acceptable and were of excellent quality. The various color of the lettuces were extremely attractive and would be good for the local roadside stands or farmers markets. The eating quality of the varieties was excellent. I believe that the selection would dependent of one's market and how responsive the consumer would be to some of the varieties such as Mottistone, which has a unique speckling on the leaves, which we found to be very acceptable but others may find not as attractive. We have photos of all the varieties, which we will present at the Mid-Atlantic Fruit and Vegetable Conference in the High Tunnel Session when discussing the results of the lettuce trial.

Dr. William J. Lamont Jr. is a Professor and Extension Vegetable Crops Specialist in the Department of Plant Science at Penn State University. He was born and raised in rural Pennsylvania and obtained two undergraduate degrees, one in Economics and Business from Lebanon Valley College and one in Horticulture from Delaware Valley College. He earned his M.S. and Ph.D. degrees from Cornell University. Dr. Lamont has an extensive background in research, extension and teaching. In his current extension position Dr. Lamont is responsible for the culture and management of vegetable crops. He has worked at North Carolina State University and Kansas State University prior to coming to Penn State in 1997. He and his wife Phyllis reside on 28 acres of land near McAlevy's Fort, PA.

BANKER PLANTS FOR HIGH TUNNELS FOR VEGETABLE IPM: A NEW HOPE

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Growing vegetables in high tunnels is a burgeoning production strategy. They represent a **new hope** for Northeastern diversified farmers, offering opportunities for extending the growing season and generating greater revenues by producing cold-tolerant crops (eg., spinach, lettuce and leafy cole varieties) at times of the year when cold temperatures prevent field production. Construction of high tunnels continues to expand, and new pest challenges are surfacing. Growers can maximize on their production with the adoption of innovative integrated pest management (IPM) tools.

Plant production is a balancing act. Growers must create conditions that favor the crop, but these often encourage pests and diseases. Growers commonly report that they have lost their entire crop in their high tunnel to cutworms, armyworms or more often aphids. Because most high tunnels lack a heat source, temperature is difficult to control. Depending on the time of year, generally it is cooler in high tunnels than in greenhouses. This slows the survival, reproduction and searching ability of many natural enemies. Unlike field cultivation, in high tunnels, crop diversity is limited and the natural enemies that are supported outdoors are generally lacking. Growers need to adopt strategies to augment and sustain the biological control complex in the protected high tunnel environment.

Aphids are a common pest problem for growers in high tunnels. Because they give birth to living young, their life cycle is shorter than many other pests, and a few adult aphids can quickly multiply into an outbreak if allowed to reproduce unchecked. Often, by the time a grower notices there are aphids in the crop it is too late to release biological control agents. It takes time for a natural enemy population to build up to a high enough level to adequately contain the pest. The key to success with biological control of aphids is to establish natural enemies in the high tunnel when pest populations are low or apparently absent. However growers are hesitant to invest in releasing parasites or predators when there is no sign of the pest. Banker plants enable growers to produce a sustained source of parasites or predators in the absence of the target pest, in anticipation of a future outbreak. Banker plants are a self-contained sustainable system that supplies a non-pest prey species to support a continual source of natural enemies that disperse into the crop in search of the target pest. Essentially they are a mini-rearing system for the natural enemy. The prey may be a plant pest, but generally does not attack the crop that is being protected.

Several species of aphids attack vegetables that are produced in high tunnels. Some can be managed with parasitic wasps using an aphid banker plant system. For this system, the bird cherry oat aphid, *Rhopalosiphum padi*, a cereal grass pest that doesn't attack most plants grown in high tunnels, is raised on barley, wheat or oat plants. *Aphidius colemani* is a parasite commonly used to manage green peach aphid (*Myzus persicae*) and cotton or melon aphid (*Aphis gossypii*) and other aphid pest species found in high tunnels and greenhouses. This parasite can be released onto the banker plant when the population of the cereal aphid is high enough to sustain the parasite population. Over time, the parasite population will increase sufficiently so that it disperses into the crop in search of the target pest aphids. The banker plant will continue to produce more parasites as long as there are cereal aphids. To be effective, fresh banker plants must be produced to provide an ongoing source of parasites for the crop over the growing season.

A full description of the step by step procedure to produce aphid banker plants can be found at: http://www.uvm.edu/~entlab/Greenhouse%20IPM/Pests&Beneficials/IncreasingBiocontrolSuccess/AphidBankerPlantSystem-April2013.pdf. Supplies for producing aphid banker plants are available at IPM Labs (http://www.ipmlabs.com/).

Aphid banker plants offer several advantages for growers:

They are an inexpensive way to produce a continual source of aphid parasites, avoiding the expense of multiple shipments during the season, and the associated shipping costs;

They eliminate the lag time between detecting an aphid infestation and receiving the natural enemies from the supplier;

The parasites (*A. colemani*) produced are not negatively affected by short days and tolerate cool temperatures, and because they are produced fresh in the crop, they are better acclimated to the conditions;

They are relatively easy to produce and require minimal time and effort.

Aphid banker plants are effective for most spring bedding plants and vegetables such as tomatoes and cucumbers, particularly those that are dicotyledonous plants. These are not susceptible to infestation by the bird cherry oat aphid. Aphid banker plants should not be used in high tunnels where monocotyledon plants are grown. These include Easter lilies, Alstroemria, ornamental grasses, day lilies, irises, spring bulbs (tulips, daffodils), palms, sweet corn, onions and garlic. Research in Canada has shown that if less than 10% of the crop in a greenhouse is a plant that could be susceptible to the bird cherry oat aphid, it is unlikely that they will infest the crop.

The general recommendation is to start with one or two banker plants per high tunnel. Each week or two one more banker plant should be added so there is a continual supply of aphids for the parasite to prey upon. Banker plants are used as a preventative IPM tool and should be put into high tunnels as soon as they are opened up and crop plants are established. It takes at least 3-4 weeks before a banker plant is producing adult parasites. If a grower waits until the first aphids are found in the crop to start banker plants, it is TOO LATE.

It should be noted that *Aphidius colemani* is not effective against all aphid species though. For example the potato aphid, *Macrosiphum euphorbiae*, which sometimes attacks crops grown in high tunnels, is a large species and is able to fend off a parasite attack. Aphid banker plants should be destroyed at the end of the season to avoid the buildup of hyperparasites. Hyperparasites are tiny wasps that lay their egg within the *A. colemani* which has parasitized an aphid. They can completely wipe out the beneficial parasite population in a short time, rendering the banker plant useless.

Research is needed to fully evaluate the potential and drawbacks of banker plants for aphid management in high tunnel vegetables. However, until that work can be done, growers can begin to experiment themselves to determine how to maximize on this novel, cost-effective management strategy.

Dr. Margaret Skinner, a native Vermonter, is a Research Professor and Extension Entomologist, at the University of Vermont, Entomology Research Laboratory, where she has worked for 29 years, conducting research on management of a wide array of insect pests in forests, vegetable crops and greenhouse ornamentals. Her target pests include western flower thrips, hemlock woolly adelgid, Asian longhorned beetle, gypsy moth, conifer root aphid and tarnished plant bug. Much of her work has included development of strategies to maximize on the potential of insect-killing fungi. For 20 years she has also held a partial appointment as the Extension Entomologist, assisting greenhouse growers, landscapers and homeowners. She coordinates a regional interdisciplinary greenhouse IPM program, linking specialists from ME, NH and VT, which has resulted in a significant increase in growers' use of non-chemical IPM approaches. Prior to pursuing advanced degrees in entomology at the University of Vermont she worked for over 12 years in sociology and human services.

PENNSYLVANIA HIGH TUNNEL GROWERS NETWORK – A NEW INITIATIVE

Adam Dellinger
Capital Resource Conservation & Development Council, 401 E. Louther St, Ste. 307, Carlisle, PA 17013

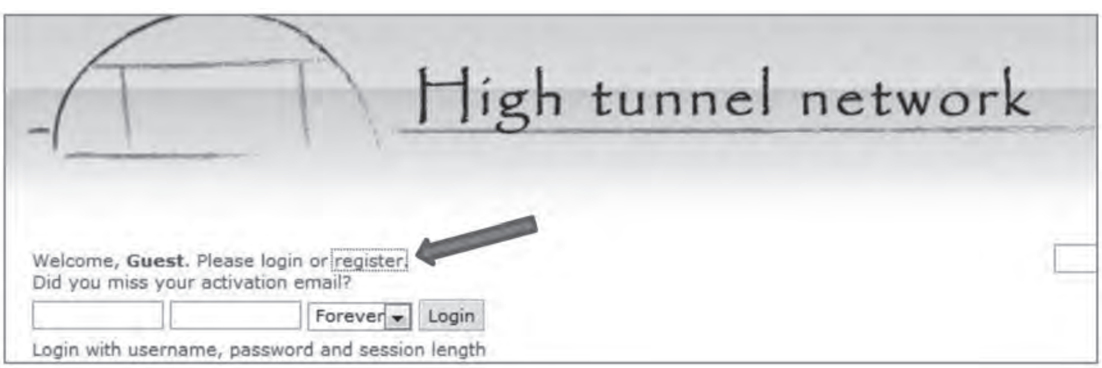
Producers have found that high tunnels are a cost effective structure to increase crop quality and provide season extension. Growers with a wide range of farm sizes and agricultural backgrounds have been increasingly adopting high tunnel use over the last several years. In fact, surveys shows that the majority of PA high tunnel growers have been producing agricultural products in high tunnels for less than 6 years. It's a relatively new approach for growing anything from tomatoes to gooseberries, which brings with it a unique set of challenges and opportunities to learn about and potentially overcome.

Feedback indicates that producers receive the majority of their information and advice from local meetings and their peers. To respond to this need, the Capital Resource Conservation & Development Council (Capital RC&D) has started an initiative to bring producers together both online and in person to provide education and support for this popular agricultural tool. Capital RC&D will be hosting a series of in-person meetings throughout Pennsylvania during 2014, and the details of these meetings will be reviewed at the meeting. In addition, we are excited to offer a brand new online discussion forum that will host online conversations, announcements, and Q&A about anything related to high tunnels and other forms of plasticulture.

During this presentation, we will discuss how to use the website to its full potential. The forum not only offers a platform for convenient online discussion for a broad variety of topics, but also features a classifieds section for buying or selling used equipment, a library of resources for research, and a calendar for high tunnel related events. For those not familiar with how to use an online discussion forum, we will cover some of the basics, such as registering as a user and making your first post. In addition, we will take questions or topics of discussion directly from the audience and post them to the forum in real time. Participants can check back on the website after the meeting to review responses to the posts and engage in the conversation from their home computer.

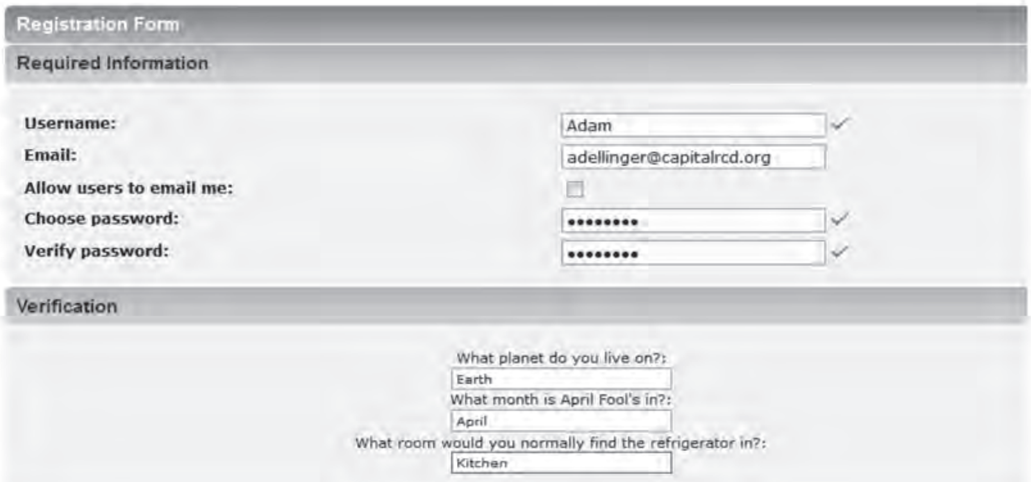
An excerpt of the essential "how-to register" portion of the presentation is covered below. Anyone can register to use the forum and start doing research or posting comments and questions within minutes.

1. Point your browser to www.hightunnelnetwork.org and then click on the red letters **"Enter the Discussion Forum"**.
2. Click on the link to **Register** as a user, then scroll down to read the registration agreement and click to **Accept the terms of the agreement**



3. Select a username, enter your email address, choose a password that's at least 8 characters, and enter the 3 anti-spam questions (these are simple questions designed to defeat spam-bots and make sure only real humans are

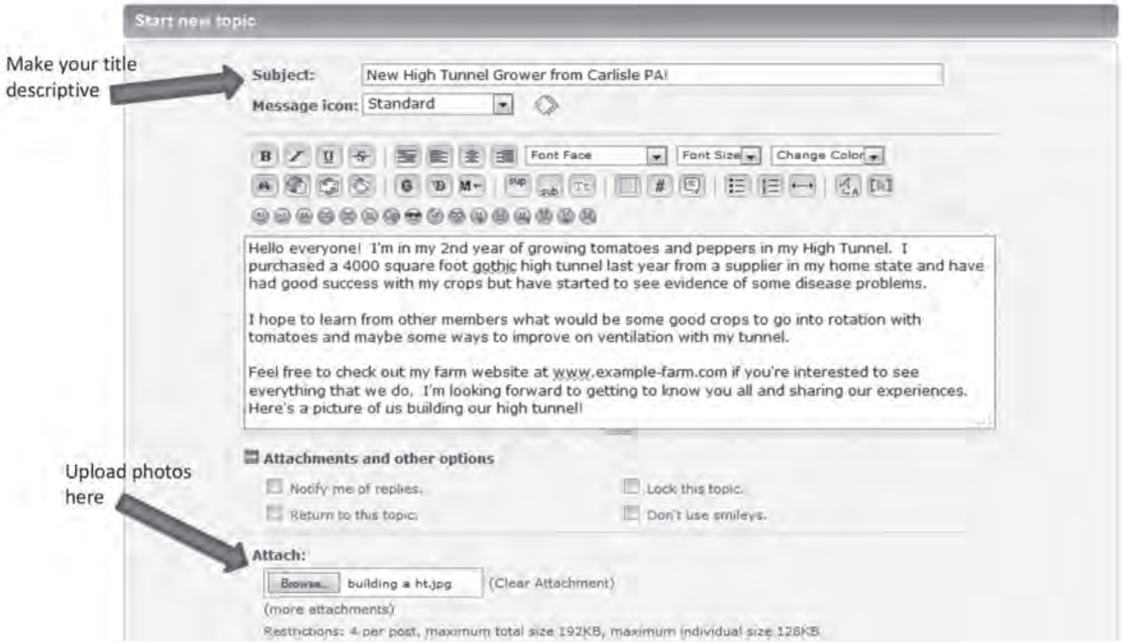
registering to use the forum). Check the box if you want to allow other forum members to email you. Even if you check this option, your email address will not be publicly visible on the forum.



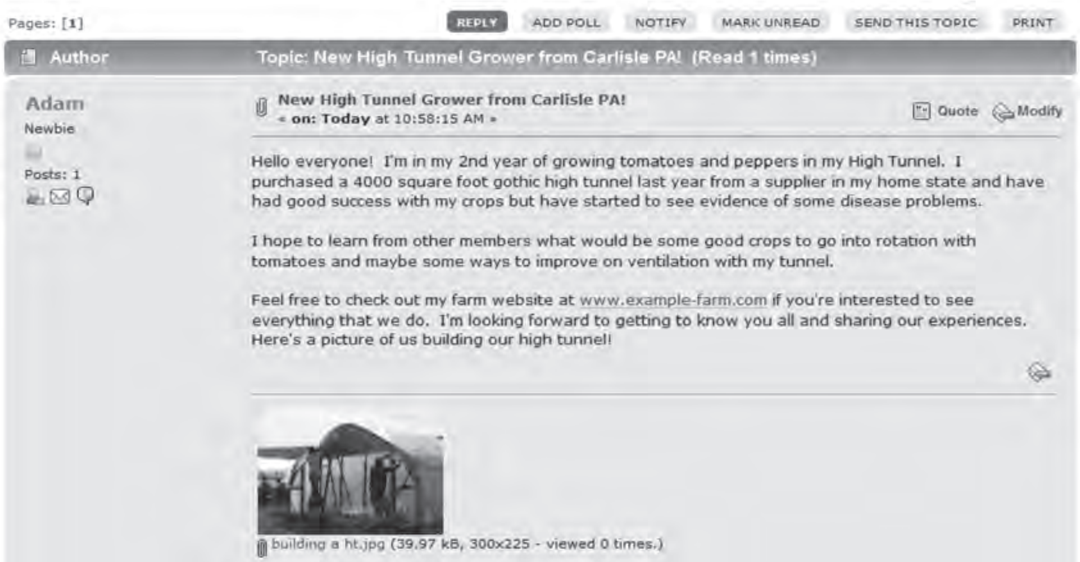
4. Next you will receive an activation email in the email inbox you entered in the step above. Check your email, read over the introductory information and click the link to activate your membership. Next you will be asked to reenter your password to proceed. Once you enter this, you will be brought to the main screen and you can start posting as a member.

5. Make your first post an introductory post about yourself and your goals in the **Meet and Greet** section! Once you click on the Meet and Greet Section, you will see a screen similar to the one shown below. Just click on **New Topic** to get started!

6. Take this opportunity to talk a little bit about yourself, your farm, and what you hope to achieve by being a member of the forum. Don't forget to include your location because you never know if someone with lots of experience might be your neighbor and willing to help stop over and help you out. Use the Attach: section to upload pictures you want to share!



7. Click **Post** and your finished post should look something like the picture below. At this point you're all set up and ready to go!



8. If you have any questions about the high tunnel forum or 2014 in-person meetings, please contact Capital RC&D at 717-241-4361 or webnotification@capitalrcd.org.

Adam Dellinger is the Natural Resource Specialist for the Capital Resource Conservation & Development Council (Capital RC&D) in Carlisle, PA. He provides project management and technical assistance to agricultural producers in the South Central PA region. He has a B.S. degree in Geoenvironmental Studies from Shippensburg University and an M.S. in Soil Science from Penn State University. He formally worked for the USDA-NRCS as a Soil Conservationist and RC&D Coordinator.

TWO YEARS OF SWEET CORN CULTIVAR EVALUATIONS

Elsa Sánchez and Bill Lamont, Penn State Plant Science
Tim Elkner, Tom Butzler, Steve Bogash, Lee Stivers and Bob Pollock, Penn State Extension

To provide growers with information for successful, region specific cultivar selection, in 2012-13, we evaluated 25 cultivars of bicolor and white synergistic sweet corn grown in a conventional system across the state. Evaluations were located in southwestern Pennsylvania at Schramm Farms in Harrison City, Westmoreland County, in central Pennsylvania at the Russell E. Larson Research and Education Center in Rock Springs, and in southeastern Pennsylvania at the Southeast Research and Extension Center in Landisville.

The cultivars and year(s) evaluated and company from which seed were acquired from are listed below. The standard used was 'Temptation'.

Synergistic Sweet Corn Varieties for Statewide Trial; 2012-13

Cultivar	Year(s) Evaluated	Seed Company
Bicolor		
Allure	2012-13	Rupp Seeds, Wauseon, OH
BC 0805	2012-13	SeedWay, Elizabethtown, PA
Bicolor 1102	2012-13	Seminis Vegetable Seeds, Oxnard, CA
Cuppa Joe	2012-13	Rupp Seeds
Espresso	2012-13	Rupp Seeds
Jackie	2012-13	Harris Moran Seed Co., Modesto, CA
Ka-Ching	2012-13	SeedWay
Kristine	2012-13	Seigers/Crookham Seed Co., Holland, MI
Montauk	2012-13	Harris Moran Seed Co.
Primus	2012-13	SeedWay
Paydirt	2012-13	SeedWay
Profit	2012-13	SeedWay
Providence	2012-13	SeedWay
1273	2012	Seigers Seed Co.
1274	2012	Seigers Seed Co.
Synergy	2012-13	Seigers Seed Co.
Temptation*	2012-13	Seigers Seed Co.
Temptation II	2012-13	Seminis Vegetable Seeds
SV 9014	2013	Seminis Vegetable Seeds
White		
Avalon	2012-13	SeedWay
Captivate	2012-13	Rupp Seeds
Edelweiss	2012-13	Harris Moran Seed Co.
Illusion	2012-13	Rupp Seeds
Mattapoisett	2012-13	SeedWay
Silver Duchess	2012-13	Seigers Seed Co.
Whiteout	2012-13	SeedWay

*se heterozygous (standard)

At all locations sweet corn was direct seeded with 8-10 inches between plants in a row. In the southwestern location 38 inch spacing was used between rows and in central and southeastern locations 30 inch spacing was used. Planting took place on 6 June 2012 and 21 May 2013 in southwestern Pennsylvania, 1 June 2012 and 2013 in central Pennsylvania, and 21 May 2012 and 30 May 2013 in southeastern Pennsylvania.

At the southwestern site, in 2012, 144.5 lb/acre N, 117 lb/acre P and 87 lb/acre K were applied as follows: 57 lb N, 57 lb P and 57 lb K per acre were broadcast preplant, 30 lb N, 60 lb P and 30 lb K per acre were banded at planting and 57.5 lb/acre N was sidedressed. In 2013 200 lb of 19-19-19 per acre was applied. Plants were irrigated during periods of limited rainfall. Weeds were managed with pre-emergent herbicides: atrazine (1 Q/acre atrazine; Syngenta Crop Protection LLC, Wilmington, DE) and metolachlor (1.5 Qt/acre Dual II Magnum; Syngenta Crop Protection LLC, Wilmington, DE). Insects were managed with four applications of methomyl (1.5 pt/acre Lannate LV; DuPont Crop Protection, Wilmington, DE) plus lambda-cyhalothrin (1.5 oz/acre Warrior II; Syngenta Crop Protection LLC, Wilmington, DE).

At the central site, in 2012, 50 lb/acre N and 45 lb/acre phosphate were broadcast preplant. Based on soil levels, K was not added. In 2013 50 lb/acre N was broadcast preplant. Weeds were managed with a preplant application of mesotrione (3 oz/acre Callisto; Syngenta Crop Protection LLC, Wilmington, DE) and atrazine and metolachlor (1.5 pt/acre Bicep II Magnum; Syngenta Crop Protection LLC, Wilmington, DE). Insect pests and diseases were left unmanaged. Supplemental water was provided through a drip irrigation (T-Tape model 508-12-450; John Deere, Moline, IL) system to reach 1-1.5 acre-inch water per week.

At the southeast site, in 2012 150 lb/acre N, 50 lb/acre P and 50 lb/acre K were broadcast preplant. In 2013 100 lb/acre N, 160 lb/acre P and 160 lb/acre K were applied preplant. Weeds were managed in both years with preplant applications of glyphosate (2 qt/acre Credit 41; Nufarm Inc., Burr Ridge, IL), metolachlor (1.2 pt/acre Dual II Magnum; Syngenta Crop Protection Inc., Greensboro, NC) and atrazine (1 qt/acre; Makhteshim Agan of North America, Inc., Raleigh, NC). Insects were controlled with weekly applications of lambda-cyhalothrin (3 oz/acre Warrior; Syngenta Crop Protection Inc., Greensboro, NC) starting at silk in both years.

Ears from 10-15 plants were harvested when all plants of an individual cultivar reached maturity. Data to estimate the work involved in hand harvest was recorded. Ears were categorized as marketable or unmarketable, counted and weighed. Ear quality from a subset of 10 ears per plot was also determined.

Husked ear appearance, unhusked ear appearance, the extent to which the husk covered the ear tip (tip cover), kernels filling the tip of the ear (tip fill), and the relative level of work involved in snapping the ear from the culm (picking ease) were rated using a 5 point scale. For husked ear appearance and unhusked ear appearance 1= poor and 5 = good; tip cover 1= exposed ear tip, 2 = husk cover less than 0.75 in past ear tip, 3 = 0.75 to 1.24 in, 4 = 1.25 to 2 in, 5 = greater than 2 in; tip fill 5 = kernels filled to tip of ear, 4 = greater than 0.5 in unfilled, 3 = 1 to 1.5 in, 2 = 1.6 to 2 in, 1 = greater than 2 inches; and picking ease 1 = difficult, 5 = easy.

All data were subjected to analysis of variance (ANOVA) using the GLM procedure in SAS (version 9.2; SAS Institute, Cary, NC). When P values were less than or equal to 0.05, means were separated using Duncan's multiple comparison test.

Statewide Results

In determining whether a cultivar was suited for statewide recommendation, the criterion was that it must have produced comparable or superior yields to 'Temptation' in a minimum of two of the evaluation sites over both trial years.

Estimating the work involved in hand harvesting

The distance from the soil line to the base of the primary ear and picking ease were collected as an indication of the work involved in hand harvesting.

With the exception of ‘Synergy’, all cultivar met the criterion above for distance from the soil line to the primary ear. For the following cultivars picking ease rating met the criterion above: Mattapoisette, Primus, Edelweiss, Avalon, Temptation II, Montauk, Cuppa Joe, Jackie, Allure, Bicolor 1102, Illusion, Silver Duchess, Profit, Espresso, Kristine and Paydirt.

Yields

Based on marketable yield results all cultivars met the criterion above for number of ears. With the exception of ‘Paydirt’, all cultivars met the criterion above for weight of marketable ears.

Ear Quality

Ear quality is just as important as marketable yield in making profits. Consumers are first attracted to the appearance of the ear, while taste can result in repeat purchases. In most US markets, consumers prefer an 8-9 in ear with a dark green husk, long and dark green flag leaf, and 16 straight rows of small deep and sweet kernels filled to the tip of the ear (Tracy, 2001).

In terms of ear length all cultivars met the criterion. For ear diameter ‘BC 0805’, ‘Espresso’ and ‘Cuppa Joe’ did not meet the criterion while the remaining cultivars were comparable or superior to ‘Temptation’. For husked and un-husked appearance all cultivars met the criterion. All ears were completely covered by the husk; however, ‘Cuppa Joe’ and ‘Jackie’ did not meet the criterion above while all other cultivars did. Regarding tip fill, ‘Cuppa Joe’, and ‘Profit’ did not meet the criterion above while all other cultivars did.

The number of rows was only evaluated in more than one location in one year of the study. Based on the criterion of producing comparable or superior results to ‘Temptation’ in a minimum of two evaluation sites, the number of rows for all cultivars except ‘Paydirt’ and ‘Illusion’ were not different or superior to ‘Temptation’.

Brix levels were only evaluated in one year of the study. Based on the criterion of producing comparable or superior results to ‘Temptation’ in a minimum of two evaluation sites, all cultivars had brix levels not different than or superior to ‘Temptation’.

Literature Cited

“Sweet Corn” by W.F. Tracy, In: Specialty Corns, 2nd ed., 2001, A.R. Hallauer, ed.

POSTHARVEST HANDLING AND FOOD SAFETY FOR SWEET CORN

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a) Importance of Sweet Corn
- U.S. produced about 1/3 of world's total for sweet corn in 2008.
- U.S. production for fresh market valued $836 million in 2009.
- Sweet corn accounted for about 6% of farm gate total for vegetables ($14.2 billion) in 2010.
- U.S. fresh market sector produced about 44% of that sold for processing; however the price received for the fresh market crop was roughly 2.5 times higher.
- Mid-Atlantic States produced about 7% of U.S. total.

U.S. Ranking	Fresh-Market Production (millions cwt)	Price ($, millions)
Florida	6.68	227.1
California	4.48	111.2
Georgia	3.25	85.2
Washington	2.16	81.1
New York	2.15	58.3
Mid-Atlantic States		
Pennsylvania	.979	35.5
New Jersey	.781	22.8
Maryland	.261	8.4
Virginia	.102	2.6
U.S. Total	**28.4**	**$835.8**

Source: U.S. Sweet Corn Statistics. Fresh Market Production by State (1960-2009). 2010.

b) Sweet Corn Types and Storage Recommendations
- Perishability: ranks among the most perishable of crops.
- Typically harvested during hot weather, leading to:
  - Losses in quality: moisture loss (denting), sweetness, kernel pericarp toughening (more fibrous), dried and/or yellowed husks.
  - Shortened shelf life: is time/temperature dependent.
- Main types: sugary, sugary enhanced, shrunken-2.
  - Each has different quality characteristics that affect postharvest quality and shelf life.
- Optimal storage conditions: 32oF (0oC) at 95% relative humidity during transport and warehousing.
- Food safety

c) Harvest, Handling and Packaging Considerations
- Mechanical harvest vs. hand harvest.
- Field pack vs. packing line.
- Bulk vs. crate.
- Intact ear vs. value-added pack.
- Food safety

d) Cooling Methods
- Principles of cooling.
  - o The 3 T's: time, temperature, turbulence.
  - o 7/8 Cooling – what is it?
- Hydrocooling, package ice (slush ice), vacuum cooling.
- Food safety

e) For Further Information
- University of Florida Extension – EDIS.
  http://edis.ifas.ufl.edu/
- U.S.D.A. Agriculture Handbook 66.
  http://www.ba.ars.usda.gov/hb66/131sweetcorn.pdf
- University of California, Davis. Postharvest Technology Center.
  http://postharvest.ucdavis.edu/pfvegetable/CornSweet/
- U.S.D.A. Food Safety Portal.
  http://www.usda.gov/wps/portal/usda/usdahome?navid=FOOD_SAFETY
- National GAPS Program.
  http://www.gaps.cornell.edu/indexhighspeed.html
- U.S.D.A. Economic Research Service.
  http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1564

Steven A. Sargent is a professor in the Horticultural Sciences Department at the University of Florida in Gainesville, where he has been an Extension Postharvest Specialist since 1987. From 2006 to 2012 he served as Assistant Chair and Graduate Coordinator in his department, and from 2012-2013 as interim chair.

A native of Michigan, he studied at Michigan State University where completed his undergraduate and M.S. studies in the Horticulture Department, and doctoral studies in the Agricultural Engineering Department in 1984.

The goal of his integrated extension/research/teaching program at the University of Florida is to develop pertinent information to reduce losses in postharvest quality during harvest, handling and shipping operations. Focal areas include study of high-value, promising crops such as tropical fruits, temperate fruits grown in subtropical climates, greenhouse-grown vegetables and fresh-cut produce. This interdisciplinary program evaluates the relevance of new technologies and methods, including handling methods, cooling methods, packaging and food safety. Training of graduate students and visiting scientists compose a significant part of this program. Each spring he conducts the Postharvest Horticulture Industry Tour in Florida.

Over the years Sargent's international interests have led to extensive collaborative efforts with colleagues at research institutions and universities throughout Brazil, and he has lectured on postharvest technology throughout the U.S., and in Canada, Central America, Thailand, China and Korea. In 2010 he received an honorary professorship in food technology at the Universidad Del Santa, Huacho, Peru. He is currently co-P.I. on the Trilateral Collaboration Project, the first USAID project to be conducted between three country partners, U.S. (Univ. of Florida), Brazil and Mozambique.

He and his wife Suzana they have three daughters.

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This program is coordinated by Dr. Steven Sargent and Dr. Mark Ritenour, specialists in the area of postharvest technology at the University of Florida-IFAS. The tour is designed for produce industry professionals, educators, researchers and students in such diverse areas as field and packinghouse management, transportation, wholesale and retail sales, and import/export. The group will visit large and small-scale operations, compare cooling technologies, visit a fresh-cut processor and a major supermarket distribution center.

Sponsored by the Horticultural Sciences Department and the University of Florida-IFAS Cooperative Extension Service

For more information and to register, go to: http://postharvest2014.eventbrite.com/

WEEDS: CONTROLLING ANNUAL GRASSES, RESISTANT SPECIES, AND PALMER AMARANTH

Dwight Lingenfelter
Penn State University, Dept. of Plant Science, 116 ASI Building, University Park, PA 16802

Sweet corn growers have many more weed management tools at their disposal now, compared to 10-15 years ago. Although more products are now available, weed control in sweet corn can still be a challenge. Sweet corn is generally planted at lower plant populations than field corn, and is also slower growing, shorter, and produces less dense canopy. This allows more light to penetrate to the soil surface and lower canopy, which can favor weed growth. These factors make sweet corn less competitive with weeds than field corn, and thus more susceptible to losses due to weeds. Weeds may also interfere with the operation of mechanical pickers. This article will cover specific issues related to annual grass control, the increase of resistant weed species and a new weed to our area, Palmer amaranth.

Problem annual grasses.

Annual grasses such as foxtails, crabgrass, fall panicum, and shattercane can be common problem weeds in sweet corn. They can be very competitive with the crop and difficult to control postemergence. Crop rotation usually helps to reduce the weed seedbank in the soil. Herbicides like Dual II Magnum, Lumax, Harness, Outlook, Impact, Accent Q, and Option will control most annual grasses. Keep in mind, crabgrass, yellow foxtail, and fall panicum especially can be difficult to control postemergence. In general, two-pass systems (i.e., those that include a soil residual followed by a postemergence application) provide the best and most consistent control of annual grasses. Below is a table that shows the efficacy of selected herbicides on some common annual grassy weeds.

Weeds	Bicep II Mag	Lumax	Zidua	Impact	Laudis	Accent Q	Option
Barnyardgrass	**9**	**9**	**8+**	7	8	**8+**	**9**
Giant foxtail	**9**	**9**	**8+**	7	8	**9**	**9**
Lg. crabgrass	**9**	**9**	**9**	8	8	7	7
Fall panicum	**9**	**9**	**8+**	8	6	**9**	**8+**
Shattercane	6	**8+**	6	7	7	6	7+

Resistant weed issues

Aside from triazine-resistant weeds, others are become more prevalent in our region. Here are some of the weed species that have become resistant to certain herbicides: Triazine resistant (herbicides such as atrazine, simazine, metribuzin) – lambsquarters, pigweed, giant foxtail, common ragweed; ALS resistant (herbicides such as Accent Q, Option, Sandea) – pigweed, shattercane, giant foxtail, ragweeds, chickweed; and Glyphosate resistant (herbicides like Roundup, Touchdown, Credit, Gly Star, Rattler, etc.) – horseweed, ragweeds, lambsquarters, pigweeds. 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 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.

Two-pass herbicide programs are also good for managing resistant species. 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. 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 can not be sprayed on time. In Penn State research a two-pass system provided more effective weed control overall compared to a single application timing. If spraying a post treatment, for best results, apply when the weeds are small (<3 inches tall).

Palmer amaranth is now in PA

Over the last several months, there have been a number of potential Palmer amaranth *(Amaranthus palmeri)* infestations in PA. These have ranged from one or more soybean fields with severe infestations to a small number of plants that are relatively isolated. Currently, 6 or 7 sites have been documented mostly in the southeast, but also a small population in the south central region that have Palmer amaranth, but many more are likely out there unrecognized. Waterhemp is another pigweed species that is creeping into our region. It was assumed that the introduction of Palmer amaranth to Pennsylvania was recent, but The Plants of Pennsylvania website lists both Palmer amaranth and waterhemp as “present” in Pennsylvania although not yet widespread. This new outbreak in PA could likely be predicted with the problems to the south and west with these two species. It is uncertain how Palmer amaranth was introduced to some of our farms, but equipment, hay, feed (corn, cotton seed, etc.), and manure are all suspected. Paying close attention to feed quality, origin, and potential pigweed seed contamination could really be important in preventing the introduction of these two weeds in our region. Like other pigweeds, Palmer amaranth and waterhemp seeds are very small, round, and black in color. Keep in mind that glyphosate and ALS-resistant Palmer amaranth is widespread from southern Delaware through the cotton belt west to Kansas. Waterhemp is a common pigweed in the central Corn Belt.

Palmer amaranth or pigweed is extremely aggressive and some common identifying features include:

- smooth stems
- rosette pattern; leaf architecture around stem resembles a poinsettia
- singular hair in tip of leaf notch when it is small (<6” tall)
- long petiole (stalk that attaches leaf to stem); with Palmer, the petioles will be as long as or longer than the leaf blade
- “watermark” or chevron pattern on some leaves (not necessarily on every plant)
- male and female plants and long seed heads; Palmer amaranth is dioecious meaning that male and female flowers are on separate plants (compared to monecious like redroot or smooth where they are both on the same plant). Male and female flowers are quite different from one another and distinctive. The mature inflorescence spikes are 6 to 36 inches long for both male and females with the main terminal seed head being the longest. The female has flower bracts that are prickly and painful to the touch; males are not painful and have anthers and pollen rather than these painful bracts. These female bracts are not spines or modified leaves like spiny amaranth, but rather part of the female flower.
- Thick “root crown”; lower stalks of Palmer can be 2 to 5 inches in diameter

Management

There are certain herbicides in sweet corn that provide control of Palmer including atrazine, acetochlor-products, Prowl, Lumax, Zidua, Callisto, Impact, Laudis, Liberty 280, 2,4-D and a few others. Again, two-pass systems work best with Palmer since it has a long germination period.

If you encounter a suspected Palmer amaranth or waterhemp infestation, please contact your local county extension educator or Bill Curran (wcurran@psu.edu) and/or Dwight Lingenfelter (dwight@psu.edu) at Penn State University to help us track this potential problem. Also, if possible collect and record the following information to help document the problem.

Documentation:

1. Suspected pigweed species:
2. Location of fields or farm. Please provide as much information as possible and include farm, township, county, and GPS coordinates if you can.
3. Crops infested: soybean, corn, other:
4. Describe infestation or the problem. How many plants, size of infestation (few plants, 10 to 100 plants, 100 to 1000 plants, more than 1000 plants, one field, multiple fields, acres infested, etc.)
5. Did plants survive herbicide management? If so what herbicides?
6. Describe level of plant maturity upon discovery. Juvenile, vegetative, early flowering, late flowering, mature seed present, post-harvest, etc.
7. How was infestation managed? Not managed, plants removed by hand, mowed or destroyed, harvested with crop, etc.
8. Did plants produce mature seed prior to destruction or harvest?
9. Was infestation contained or did it likely spread?
10. Management plan next year if applicable (e.g. will plant corn and manage aggressively).
11. Document infestation/problem with numerous digital photos of stems, leaves, and flowers if applicable.

IMPORTANT: Do not transport seed containing plants away from infested fields. Destroy plants by either burying or burning near infested field.

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.

MY EXPERIENCES WITH DRIP IRRIGATION IN SWEET CORN

We use drip irrigation on all of our 25-30 acres of sweet corn production. Plantings are put in from the end of March until the end of July. Using drip irrigation allows us to meet our goal of picking a fresh harvest every day from the beginning of July until frost. We don't have to worry about gaps in plantings because of the lack of rain. We retail 80% of our crop at our farm market.

We use a Monesom two row planter set on a 21 inch spacing. We lay down I line of the drip tape in between the two rows of corn. In the early years we used a 10 mil drip. This was so that the drip could be put out multiple years. However, this proved to be more costly than buying new 8 mil every year because of too much time spent on labor. We use a low flow and the longest run is about 650 feet. Once the corn is 6 leaf or bigger, we put the drip out. Weed control must be done before if using cultivation.

A well is our source of water. Underground mains are installed with the ability to irrigate up to 50 acres of ground. A 10 hp submersible pump supplies 60-80gal/min. This will cover about three acres at a time. After the drip is laid out it is hooked up to headers. The first time the water is run, the lines need to be stretched out to avoid kinks in the lines.

The work is almost over now. When the irrigation is needed, the only thing left to do is adjust the right valves and observe that it is running correctly. We can irrigate during the day with very little evaporation. After the harvest the headers are wrapped up to be re-used. The drip tape is pulled out and thrown away.

James Stahl, with his wife Laura and their seven children, farm in partnership with his dad in central Lancaster County operating a diversified farm on 250 acres. He oversees the production of fruits and vegetables for their retail farm market, Harvest Lane Farm.

BOOM SPRAYER CALIBRATION

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As stated on the pesticide label – the sprayer needs to be calibrated before you spray!

Proper calibration of sprayer equipment is the only way to ensure spray applications are effective, efficient, and economical. Poor spray coverage is the primary cause of reduced spray product performance. Regular care and maintenance will ensure the sprayer is residue-free and serviceable when needed.

A sprayer should never be operated without first checking the calibration for the following reasons:

1. To determine the precise rate of material applied per acre.
2. To ensure each nozzle tip is operating at the manufacturer's specification.
3. To compensate for equipment changes, crop staging, and environmental conditions.

Calibration Factors Affecting Application Rate

- Ground Speed

A uniform ground speed is necessary to maintain even spray application. The spray application per acre varies inversely with the ground speed of the sprayer. If the ground speed is doubled the application rate is cut in half and as the ground speed is reduced to half, the spray application is doubled. Rate controllers can only compensate for this within certain limits and can sometimes have a negative impact on spray quality.

- Nozzle Flow Rate

The flow rate through the nozzle varies with the tip size, the pressure applied, and the condition of the tip.

Calibration Notes

Recording your sprayer calibration calculations for future use is important and can be useful the next time you check the calibration. By having a record, you can compare your sprayer calibration calculations from calibration to calibration. This recordkeeping is also due-diligence and is important to have on hand if ever a question arises about product residue, pesticide drift, or any other spray complaint.

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Boom Sprayer Calibration Worksheet

Retain the following information for your records:

Date ____________________

Farm ____________________ Operator ____________________ Phone ____________________

Address ____________________ Town ____________________ State _____ Zip code ________

Sprayer and Tractor Identification Sprayer ____________________ Tractor ____________________

Calibration

1. Drive the tractor with sprayer (half full of water) over a given distance and note the exact time in seconds it takes to pass the end points. Make a return pass and check the time again. If the time differs by no more than 1 second, average the two times. Repeat if the time differs by 1 second or more. Note the engine RPM and gear that were used to make the passes.

Tractor RPM__________________ Gear______________________ Travel Distance______________

Time in seconds – down___________ time in seconds – back___________ Average Time in seconds______________

Miles per Hour [MPH] $= \dfrac{\text{distance in feet} \times 60}{\text{time in seconds} \times 88} = \dfrac{(\quad\text{feet}) \times 60}{(\quad\text{seconds}) \times 88} =$ ________ = ________ MPH

2. With the tractor in a stationary position set the same engine RPM used in Step 1. Set the application pressure (30-40 psi) that you normally use and spray water through the broom. Collect spray at the nozzles when all the nozzles appear to have a uniform delivery at the desired psi. The container(s) should be quickly placed under the nozzle(s) for the exact same number seconds for each nozzle.

Pressure _________PSI

Number of Nozzles on Boom _______

Type of Nozzle ________________

Size of Tip ____________________

Distance of Nozzle from Target _____

New Nozzle Tip's Output ______ GPM

Nozzle Output			Nozzle Output		
Nozzle #	Tip Size	Output in Fluid Ounces	Nozzle #	Tip Size	Output in Fluid Ounces
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		
	Output			Output	
				Total Output for ____ Seconds	
				Convert to Total Output per Minute	

(Looking at the sprayer from behind, #1 nozzle is on left side)

Average output $= \dfrac{\text{Total Output in fluid ounces}}{\text{Total number of nozzles}} = \dfrac{(\qquad)\text{ fluid ounces}}{(\qquad)\text{ nozzles}} =$ __________fluid ounces (Average Output)

Minimum Output = 0.95 × ________ Average Output = ________ Fluid ounces

Maximum Output = 1.05 × ________ Average Output = ________ Fluid ounces

Replace nozzles if output is greater than 10% variation between nozzles.

Replace all nozzles if average output is 15% more than a new nozzle's output (from manufacturer's chart or discharge test).

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Crop: ___________________

Block (#__________________) **Spray Swath Width __________ft.**

Calculate: Number of Linear Feet of Row per Acre

Linear Feet of Row per Acre = $\frac{43{,}560}{\text{Spray Swath Width}}$ = $\frac{43{,}560}{(\quad)}$ = (__________) Feet per Acre

Calculate: Sprayer Speed in Feet per Minute [FPM]

Speed in Feet per Minute = MPH × 88 = (_____) MPH × 88 = (______) Feet per Minute

Calculate: The Number of Minutes to Spray One Acre [MPA]

Block (#______) Minutes/Acre = $\frac{\text{Linear Feet Row per Acre}}{\text{Feet per Minute}}$ = $\frac{(\_\_\_\_\_\_\_\_)}{(\quad)}$ = (_______) MPA [Minutes per Acre]

Calculate: Gallons per Minute [GPM] that Sprayer is Applying at the Current Settings

Gallons per Minute = $\frac{\text{fluid ounces}}{\text{Seconds}} \times \frac{\text{60 seconds/minute}}{\text{128 fluid ounces/gallon}}$ = GPM [Gallons per Minute]

$\frac{(\_\_\_\_)\text{ fluid ounces}}{(\_\_\_\_)\text{ seconds}} \times \frac{\text{60 seconds/minute}}{\text{128 fluid ounces/gallon}} = \frac{(\_\_\_\_\_\_)}{(\quad)}$ = (______) GPM [Gallons per Minute]

Calculate: Sprayer Output in Gallons Per Acre [GPA] Appied

Output - Gallons per Acre = GPM × MPA = (_______) GPM × (_______) MPA = (_______) GPA

NOTES:

128 fluid ounces per one gallon

88 feet per minute per one mile per hour

43560 square feet per one acre

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NEW CUT FLOWER VARIETIES

Alicain S. Carlson and John M. Dole
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Every year the NCSU Cut Flower Program, coordinated by Dr. John Dole, trials 30-60 new cultivars for their production and postharvest qualities for the Association of Specialty Cut Flower Growers (ASCFG) Cut Flower Trials. This year annual, perennial, and woody species were trialed. Top performers are put through a basic postharvest test, which includes 4 treatment solutions: hydrator only, holding preservative only, hydrator and holding, and deionized (DI) water only. Flowers are held in hydrating solutions for 4 hours and in holding solutions for 2 days before being put into jars of DI water until they die. Some notable species from this year's trials:

Annuals:

Amaranthus 'Elephant Head' – about 2 weeks vase life with holding solution.
Eggplant 'Pumpkin on a Stick' – 36 day vase life, a must grow for fall seasonal sales.
Experimental pepper varieties – Many different pepper shapes and colors, use holding solutions for about 2 weeks vase life. Foliage will not stay hydrated so be prepared to remove it if you want to utilize the peppers for longer.
Lisianthus 'Arena II Blue Flash,' 'Arena II Light Pink,' and 'Arena III Baby Pink' – Two weeks vase life with holding solution.
Snapdragon 'Chantilly Velvet', 'Purple Twist', 'Pink Trumpet' – Weeks vase life with holding solution. As weather warms 'Purple Twist' loses its purple specks.

Herbaceous Perennials:

Asclepias 'Oro' – One week vase life. No milky sap.
Astilbe 'Fanal' – One week vase life in holding solution.
Eucomis 'Megaru' and 'Tugela Gem' and 'Tugela Jewel' – One month vase life in tap water. Do not use preservatives.

More species to be highlighted in the presentation.

Results from all the research over the years have led to particular conclusions for the use of hydrating and holding solutions. Hydrating solutions should be used for those species that need them (uncommon), otherwise use good clean water (common). Holding solutions (overnight or longer) should be used for most flowers, unless you see a problem (uncommon). All of our trial information can be found online (http://cutflowers.ces.ncsu.edu/) or in every Winter issue of the ASCFG Cut Flower Quarterly publication (www.ascfg.org).

Alicain Carlson is a graduate research assistant at North Carolina State University (NCSU) studying various aspects of production and postharvest of specialty cut flowers under Dr. John Dole. She received her MS degree from NCSU in 2010 and is currently finishing up her PhD. Her research interests include: effects of bacteria on vase life of cut flowers, water quality considerations for extended postharvest life of cut flowers, and evaluating new cut flower introductions, notably Eucomis. She completed her BS degree in Biological Sciences at Virginia Tech in 2008. Alicain is an Army brat who has travelled the country, but her familial roots are in Northern PA.

John Dole is a professor and Dept. Head of Horticultural Science at NCSU where he conducts research on production and postharvest handling of cut flowers, unrooted cuttings, and bedding plants. John received a PhD from the University of Minnesota and a BS from Michigan State University in Horticulture.

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BIORATIONAL INSECT AND ARTHROPOD CONTROL IN CUT FLOWERS

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"Biorational" is a term coined to describe insecticides and/or miticides that are often viewed as "soft". These products are either derived from soaps, oils, naturally derived substances, synthetic substances that mimic natural compounds, entomopathogenic nematodes, and microbially based-products. Often, these insecticide/miticide products are employed in IPM programs because they typically have limited residues and less potential of adverse impact to humans and beneficial organisms in the environment. A partial listing of the most commonly used biorational insecticides are listed in the table below:

Biorational Insecticides for Use on Cut Flowers

Classification	Active Ingredient	Product(s)	Labeled Pests
Mycoinsecticide	*Beauveria bassiana*	Botanigard 22 WP, Naturalis-O	Aphids, Caterpillars, Leafhoppers, Thrips, Whiteflies
Mycoinsecticide	*Metarhizium anisopliae* Strain F52	Met52	Thrips pupae, Aphids, Whiteflies, Weevils
Spinosyns	Spinosad	Entrust	Beetles, Caterpillars, Leafminers, Thrips
Botanical/IGR	Azadirachtin	Aza-Direct, AzaGurad, Azatin XL, Molt-X	Aphids, Beetles, Caterpillars, Leafhoppers, Leafminers, Tarnished Plantbugs, Two Spotted Spider mites, Stinkbugs, Thrips, Whiteflies
Botanical	Pyrethrum	Pyganic Crop Protection EC 5.0	Aphids, Beetles, Caterpillars, Leafhoppers, Leafminers, Tarnished Plantbugs, Two Spotted Spider mites, Stinkbugs, Thrips, Whiteflies
Refined Petroleum Oil	Horticultural Oil	PureSpray Green, Suffoil -X	Aphids, Leafhoppers, Plant Bugs, Scale Insects, Thrips, Spider Mites, Whiteflies
Potassium salts of fatty acids	Insecticidal soap	M-Pede	Aphids, Leafhoppers, Plant Bugs, Scale Insects, Thrips, Spider Mites, Whiteflies
Entompathogenic nematodes	Beneficial Nematodes	Nemasys G	White Grubs
Bacterial	*Bacillus thuringiensis* subsp. *kurstaki*	Dipel Pro DF	Caterpillars

Tom Ford currently serves as a multi-county Commercial Horticulture Extension Educator with Penn State Cooperative Extension. He is part of the State Horticulture Team with Penn State Extension and is the lead educator for Commercial Horticulture in Blair, Bedford, Cambria, and Somerset Counties. He has worked for Cooperative Extension for 31 years with service time in Maryland, North Carolina, and Pennsylvania. Tom has a B.S. degree in Ornamental Horticulture from the University of Maryland and a MBA from Frostburg State University. He is a native of Westminster, MD and resides with his wife, Laura and four sons in Duncansville, PA. (2014)

MAXIMIZING STEM LENGTH AND POSTHARVEST LIFE OF CUT FLOWERS

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Maximizing Stem Length

There are so many species of plants out there that have beautiful flowers, high productivity, and long vase life, but sometimes they are just too short! Besides changing cultivars, there are a few things you might be able to do about it by changing how you grow the plant, including: manipulating environmental conditions, altering production methods, and applying plant growth regulators (PGRs).

Production in the field, high tunnel, hoop house, and greenhouse are going to results in different plant qualities based on the varying levels of environmental controls in each location. Key plant growth factors that can be manipulated are temperature, light, nutrition, water, and air movement.

Temperatures should be optimal for the species you are growing to allow maximum plant growth and vary by species. When temperatures are too warm plants are generally shorter, have thinner stems, less branching, and are more susceptible to insects and diseases. Night temperatures are in general more important to control than day temperatures. A concept called DIF, which is the DIFference between day and night temperatures can be used to control stem elongation in some species such as Lilium. The greater the DIF, the greater the stem elongation.

Light intensity, quality, and duration are also important for controlling stem length. Decreasing light intensity by using shade cloth or other shade structures increases stem elongation as the plants stretch to reach the light source above. The quality of light or the ratio of red:far-red light effects stem elongation. If you reduce plant spacing (increase the number of plants per bed), you will increase stem length by increasing red:far-red light ratio and decreasing the amount of light each plant receives, but this may also decrease stem quality (thinner/weaker stems) and increase disease from reduced air flow. Manipulating light duration can help control plants that are photoperiod sensitive (photoperiodic). Plants can be classified as either short day (SD), long day (LD), day neutral, or a combination of photoperiodic types. You can increase stem length by increasing the time between non-inductive photoperiod and inductive photoperiod. For example, with a SD plant, grow under LD longer before putting under SD to increase vegetative growth before it flowers and stem elongation ceases.

Nutrition can also be manipulated. Increasing the nutrients available in the soil/media will increase plant growth, but soluble salt (EC) levels in the media that are too high can also stunt plant growth just like low EC can. Increasing ammonium nitrogen tends to increase stem elongation and leaf size compared to nitrate nitrogens.

Any water stress may reduce cell elongation and plant height so increase irrigation frequency as needed to increase growth/prevent a loss in growth. More water isn't always better; be careful of root rots/"wet feet". The point is just to not have the plants severely wilt and stressed.

Air movement not only affects disease incidence, but also stem length. Reduced air movement increases stem length, which is one reason why stems are usually longer in high tunnels, hoop houses, and greenhouses. Wind breaks can be used in the field.

Other production methods can also have effects on stem length. Direct seeding versus transplanting, pinching versus straight up/single stem, and lateral bud removal all alter stem length. Gibberellic acid can also be applied as a plant growth regulator (PGR) to increase stem elongation for some species, including Dianthus, Yarrow, Celosia, and Zinnia, but may have other negative effects on flower size, stem strength, flowering time, and vase life.

Maximizing Postharvest Life

Many factors effect cut flower postharvest, i.e. how long flowers last in the vase, including: flower quality, cultivar, harvest practices, temperature, ethylene, and preservative solutions. Only high quality flowers should be harvested and sold because poor quality product declines faster. There is a wide variation in vase life and the optimal postharvest treatments between cultivars of the same species. All flowers have an optimal developmental stage at which they should be harvested in order to maximize vase life and this stage also varies with the market the product is to be sold in (retail versus wholesale).

Warm temperatures have negative effects on cut flowers and they should be kept cool as much as possible (34°F is best for most species). Warm temperatures increase the rate at which flowers use up their carbohydrate (sugar) energy storage, make bacteria in the vase solution grow faster (clog up the stem preventing water uptake), and cause more stems to bend after storage reducing the quality of the product.

Ethylene is a natural ripening hormone in the form of a gas that is produced in some flowers themselves and also given off by fruits and vegetables, as well as many other sources. Ethylene sensitive flowers should never be stored with fruits and vegetables, as the ethylene given off by the fruits and vegetables will speed the senescence of the flowers. Anti-ethylene postharvest treatments exist for cut flowers such as 1-MCP (Ethylbloc) and STS that will reduce the harmful effects of the gas. Sanitation is the key to maximizing cut flower postharvest.

Buckets, clippers, tables, choppers, coolers, etc. should be routinely sanitized with a cleaner that has a residual effect in order to minimize the number of stem clogging bacteria that come in contact with the flowers. Water quality, including pH and electrical conductivity (EC), can also have effects on vase life. Acidic pH is beneficial and the effects of EC vary with the species. Another key postharvest practice is using appropriate floral preservatives, including hydrating, holding and vase solutions, as well as many other species specific solutions that provide sugars and control microbes. There are species and cultivar specific recommendations for each product.

Alicain Carlson is a graduate research assistant at North Carolina State University (NCSU) studying various aspects of production and postharvest of specialty cut flowers under Dr. John Dole. She received her MS degree from NCSU in 2010 and is currently finishing up her PhD. Her research interests include: effects of bacteria on vase life of cut flowers, water quality considerations for extended postharvest life of cut flowers, and evaluating new cut flower introductions, notably Eucomis. She completed her BS degree in Biological Sciences at Virginia Tech in 2008. Alicain is an Army brat who has travelled the country, but her familial roots are in Northern PA.

John Dole is a professor and Dept. Head of Horticultural Science at NCSU where he conducts research on production and postharvest handling of cut flowers, unrooted cuttings, and bedding plants. John received a PhD from the University of Minnesota and a BS from Michigan State University in Horticulture.

PEONIES AND BULBS - NEW AND OLD

Juergen Steininger, Bulb Trading Company

PEONIES AND BULBS NEW AND OLD

BOTANICAL TRADING COMPANY LLC
PIONEER GARDENS, INC/HOLLINGSWORTH PEONIES
JUERGEN STEININGER

MID-ATLANTIC
fruit & vegetable convention
30 January 2014
Hershey, PA

BULBS AND BARE ROOTS traditionally have been an important segment in greenhouse production. The height of this development was perhaps the early 1900s for peony production and the 1950s through 1970s for forcing bulbs, bare roots, and cut flower production.

Following this, customer demand for bulb crops steadily declined, and consequently production methods and assortment changed. In recent decades the focusing was on the apparently ever increasing demand for summer annuals, and growing methods were developed for cheap mass production from plugs. Most all American operations changed thus creating an ever increasing supply of cheap summer annuals. Meanwhile growers forgot how to work with bulbs and bare roots, although recently it appears consumer taste and demand again shifted.

Meanwhile plant breeders continued their work, introducing many new varieties of peonies and bulbs, many of which are promising favor with the consumer. A new and exciting assortments of plants is ready for growers to learn about, providing perhaps for the competitive edge many are looking for. The following is a brief overview of some important bulb crops, especially daffodils and peonies.

TOPICS

- **TITLE PAGE**
- **SYNOPSIS**
- **INTRODUCTION**
  - Who Are We?
  - Our Goals
- **REVIEW**
  - Peonies, Narcissus, & Bulbs
- **PROGRAMS AND CULTIVARS**
  - Peonies
  - Daffodils
  - Lilies, Callas, and others (if time allows)
- **HOW TO GROW**
  - Cut Flower Culture
  - Pot Culture

INTRODUCTION

PIONEER GARDENS/BOTANICAL TRADING CO.

- **Botanical Trading Company** markets and sells, perennial plugs, bare roots, and bulbs
- **Pioneer Gardens** is the grower of quality field-grown bare roots and greenhouse plugs
- **Hollingsworth Peonies** is a subsidiary of Botanical Trading Co. that grows high quality peonies

Product assessment, development, and production occurs in 5 locations: Massachusetts, Michigan, Missouri, Oregon, and Wisconsin

OUR GOALS

DEVELOP & PRODUCE SUPERIOR PLANTS FOR THE AMERICAN MARKET

REVIEW

PEONIES AND BULBS

- Bulbous plants
- Herbaceous perennials
- Fast to flower – short bench time
- Suitable for forcing programs
- Relatively tough plants, tolerant to various and sometimes challenging environmental conditions
- Brought product assortment
- Excellent consumer recognition

REVIEW

PEONIES

A peony program?

- Sold as bare roots
  - Domestic production
  - Problems with imported material
- Standard Programs and Applications
  - Direct retail (similar to dry bulb sale)
  - Container production (2 gallon, 3 gallon, and 5 gallon pots)
  - Cut flower production

REVIEW

BULBS

A bulb program?

- Sold as dry bulbs
  - Domestic production
  - Problems with imported material
- Standard Programs and Applications
  - Direct retail (dry bulb sale)
  - Container production
  - Cut flower production

PROGRAMS AND CULTIVARS

PEONIES

Container Production

Pros
- Many suitable cultivars
- Excellent consumer recognition
- Relatively limited production – limited competition
- Good prices

Cons
- Relatively expensive roots
- Bench time
- More involved culture
- Requires large pots/containers

PROGRAMS AND CULTIVARS

PEONIES FOR POTS

- Choose compact cultivars
- Pot varieties are available as double, semi-double, and single flower forms
- Pot culture of peonies can be challenging
  - Water management
  - Proper potting media
  - Protect from excessive sun
  - Protect from excessive wind
  - Requires vernalization

PROGRAMS AND CULTIVARS

PEONIES FOR POTS

PROGRAMS AND CULTIVARS

PEONIES

Cut Flower Production

Pros
- Many suitable cultivars
- Excellent consumer recognition
- Relatively limited competition
- Excellent prices
- Relatively simple culture
- Robust plants
- Wedding flower

Cons
- Relatively expensive start up
- Short season for cut flowers
- Weather depended - frost
- Space commitment

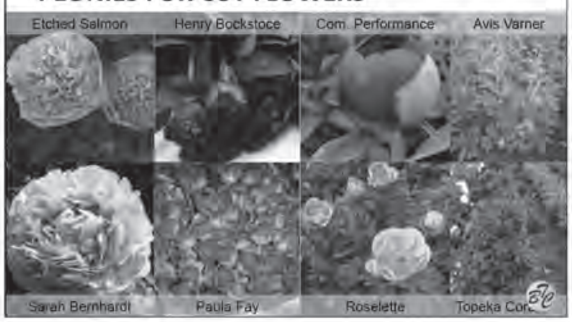
PROGRAMS AND CULTIVARS

PEONIES FOR CUT

- Choose tall cultivars with strong stems and few side buds
- Cut varieties are available as double, semi-double, and single flower forms
- Many colors and fragrance
- Cut culture of peonies
  - Field production
  - Tunnels optional
  - Protect from excessive sun
  - Protect from excessive wind
  - Requires vernalization

PROGRAMS AND CULTIVARS

PEONIES FOR CUT FLOWERS



PROGRAMS AND CULTIVARS

PEONIES FOR CUT FLOWER - FAVORITES

'Allan Rogers'

Culture **NEW**
- Pure White Flowers
- Multi Purpose (Cut and Pot)
- Fragrant
- Excellent habit
- Good for forcing program
- Strong Stems – 24 to 30 inch
- Large flowers
- High performing and robust plant
- Mid-season bloom
- Excellent vase life
- Holds up in storage

PROGRAMS AND CULTIVARS

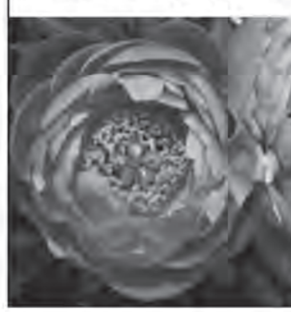
PEONIES FOR CUT FLOWER - FAVORITES

'Sarah Bernhardt'

Culture **OLD**
- Pink Flowers
- Fragrant
- Excellent habit
- Good for forcing program
- Strong Stems – 36 inch
- Large flowers
- High performing and robust plant
- Mid-season bloom
- Excellent vase life
- Holds up in storage

PROGRAMS AND CULTIVARS

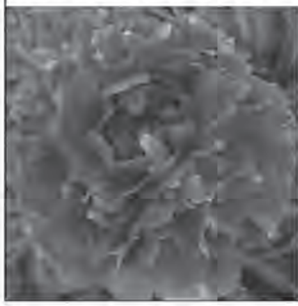
PEONIES FOR CUT FLOWER - FAVORITES



'Coral Charm'

Culture
- Coral Flowers
- Semi-double flower
- Excellent habit
- Good for forcing program
- Strong Stems – 30 inch
- Medium to Large flowers
- High performing and robust plant
- Mid-season bloom
- Excellent vase life
- Holds up in storage

PROGRAMS AND CULTIVARS
PEONIES FOR CUT FLOWER - FAVORITES



'Felix Supreme'

Culture
- Ruby red Flowers
- Double flower
- Excellent habit
- Suitable for forcing program
- Strong Stems – 30 inch
- Large flowers
- High performing and robust plant
- Late-season bloom
- Excellent vase life
- Holds up in storage

PROGRAMS AND CULTIVARS
BULBS

Container Production
Cut Flower Production

Pros
- Many suitable cultivars
- Excellent consumer recognition
- Relatively limited production – limited competition
- Good prices
- Affordable investment cost

Cons
- Weather dependent sales
- Short sales window
- Relatively short season
- Problems with imported material – quality and availability

PROGRAMS AND CULTIVARS
BULBS - NARCISSUS

Container Production

Pros
- New cultivars
- Added value for customers
  - Deer resistant
  - Perennial
  - Durable
- Many suitable cultivars
- Excellent consumer recognition
- Relatively limited production – limited competition
- Good prices

Cons
- Coolers
- More involved culture

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

'Early Sensation'

Culture
- Standard Yellow Trumpet
- Vernalization 10 to 12 wks
- Bench time 10 to 20 days
- Very early forcing program – January through March
- Compact habit
- Strong Stems
- Medium size flower which is in proportion to the size of the plant
- PGR optional – satisfactory height with cultural practices is possible

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

'Holland Sensation'

Culture
- Standard White Yellow Trumpet
- Vernalization 12 to 14 wks
- Bench time 20 to 30 days
- Early forcing program – February through March
- Compact habit
- Strong Stems
- Medium size flower which is in proportion to the size of the plant
- PGR optional – satisfactory height with cultural practices is possible

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

'Tete a Tete'

Culture
- Yellow Flowers
- Vernalization 12 to 14 wks
- Bench time 14 to 21 days
- Early forcing program – January through March
- Compact habit
- Strong Stems
- Small flowers, several per stem
- PGR optional – satisfactory height with cultural practices is possible

PROGRAMS AND CULTIVARS
BULBS - NARCISSUS

Cut Flower Production

Pros
- Several new cultivars
- Extensive selection of cultivars
- Excellent consumer recognition
- Relatively limited production – limited competition
- Locally grown program

Cons
- Weather
- Not recognized as a cut flower
- Short season

PROGRAMS AND CULTIVARS
NARCISSUS FOR CUT

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

'Popeye'

Culture
- Standard double white yellow
- Field production
- Needs vernalization
- Suitable for forcing
- Mid Season
- Excellent habit
- Strong tall stems
- Large size flower
- Unusual shape and color combination

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

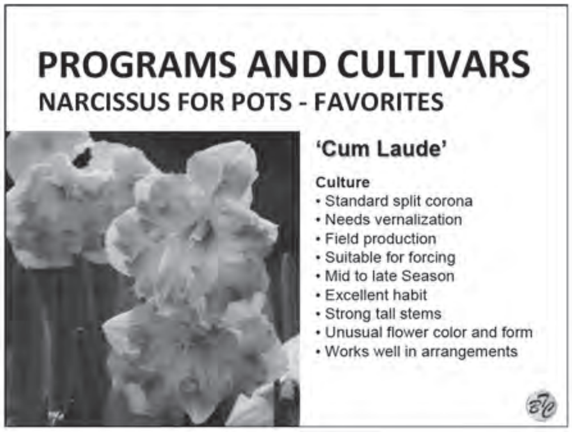
'Strong Gold'

Culture
- Standard yellow trumpet
- Needs vernalization
- Field production
- Suitable for forcing
- Mid to late Season
- Excellent habit
- Strong tall stems
- Large size flower
- Traditional look but improved genetics

PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES

'Bridal Crown'

Culture
- Standard white double
- Needs vernalization
- Field production
- Suitable for forcing
- Mid Season
- Excellent habit
- Fragrant
- Strong tall stems
- Multiple flowers per stem
- Works well in arrangements


PROGRAMS AND CULTIVARS
NARCISSUS FOR POTS - FAVORITES
'Cum Laude'
Culture
• Standard split corona
• Needs vernalization
• Field production
• Suitable for forcing
• Mid to late Season
• Excellent habit
• Strong tall stems
• Unusual flower color and form
• Works well in arrangements


FLOATING THROUGH MORE BULBS


MORE BULBS
ALLIUMS –
CUT FLOWERS


MORE BULBS
CALLA –
CUT FLOWERS &
POT PLANT


MORE BULBS
CALLA –
CUT FLOWERS &
POT PLANT


MORE BULBS
EREMURUS –
CUT FLOWERS


MORE BULBS
FREESIA –
CUT FLOWERS &
POT PLANT


MORE BULBS
A VARIETY –
CUT FLOWERS &
POT PLANT


THANK YOU FOR YOUR TIME!
QUESTIONS?

INNOVATIVE CUT FLOWERS

Joan Mazat
Ball Seed Company, 622 Town Rd., West Chicago, IL. 60185

Each year our customers ask us "what's new"? To set yourself apart from your competitors, it is important to keep your product mix fresh. There are two significant new releases that are sure to peak their interest- Green Ball Dianthus and Flare Lisianthus.

Green Ball Dianthus was released a few years ago but was not readily available due to stock issues which are now resolved. Green Ball is a dianthus that never opens and creates a large green ball head 3" in diameter. Vase life for the consumer is at least two weeks adding great value. Used as a filler or a focal flower, it is extremely versatile. Green Ball is trendy, fitting in well with today's fashion- "green" is a color!

I have included the cultural sheet. Keep in mind these key points:

- 13 week crop time from plant to harvest
- Suggested for one flush use
  - If kept for multiple flushes, the stems are weaker and the heads are smaller in subsequent cuts and are then called 'Green Trick'.
- Soft pinch 3-4 weeks after planting leaving 2-3 sets of leaves
- Keep constant moisture
- Harvest when 100% open
- Place immediately in STS for 4 hours after cut
- Extremely long vase life- approximately two weeks

Green Ball is Available from Ball Tagawa Growers in Arroyo Grande, CA available as a 207 or 102 tray year round.

Another new innovation in cut flower breeding is Flare Lisianthus. This is a true breeding breakthrough in lisianthus as it opens up the possibility of using lisianthus in a bouquet which has not been financially feasible in the past. More flowers open in a short window of time on top giving more of a spray appearance. Flare has medium size flowers and many of them per stem. In tests, bouquet manufacture using flare took 1/3 less time due to using one less stem per bouquet resulting in the same appearance. Flare lisianthus is available as a plug from Ball Tagawa in Arroyo Grande, CA in a 288 Deep or a 384 tray. It is available in three colors currently as Deep Blue, Deep Rose, and White. The white is the shortest of the three colors.

As the official release of Flare is not until May of 2014, a cultural sheet has not yet been written but the same crop culture applies as ABC Lisianthus. A few key notes:

- Speed 2- Can be flowered year round
- Flowering speed/quality is influenced by temperature, day length & light intensity, flower fastest under high temperatures, long days and high light intensities.
- Crop time is dependent on time of year, temperature, use of supplemental lighting and greenhouse conditions, anywhere from 13-16 weeks.

Important harvest notes:

- Harvest Lisianthus when one or more flowers are open in the morning.
- Remove field heat by transferring harvested bunches to coolers to optimize post-harvest life.
- Always use clean buckets with fresh cool water.
- Do not ship flowers that have not had field heat removed.

Bringing innovative products to market is a must. Green Ball and Flare can give you the edge in your business that you are looking for.

Joan Mazat is the Business Manager for the Ball Seed Company for Cut Flowers, Geraniums, and Poinsettias. In addition she is the lead of the Container Solutions Committee. She is a graduate of the Du Page Horticultural School and formerly was a greenhouse grower/production manager in Northern WI. An Illinois native, Joan and her fiancé Shawn have a son John Henry.

THE SOIL FOOD WEB AND PEST MANAGEMENT

Dr. Mary Barbercheck
Penn State University, 501 ASI Bldg., University Park, PA 16802. meb34@psu.edu

What is soil?

Soil is a complex ecosystem composed of organisms living within a complex matrix of mineral and organic particles, gases, water, nutrients, and other chemical elements. In addition to providing mechanical support for growing plants, a healthy soil absorbs, holds, and releases water; exchanges gases; cycles nutrients and converts nutrients tied up in organic matter into plant-available nutrients; assimilates carbon into humus; resists erosion; suppresses insect pests and plant pathogens, and sustains biodiversity.

Soil Quality and Soil Health

In an agricultural system, soil health or soil quality refers to the ability of the soil to sustain productivity and protect environmental resources. Soil quality refers to the ability of soil to function for a specific purpose, such as for agriculture or as an engineering material, and can take into account inherent soil properties such as texture or landscape position. Soil health is an assessment of the state of soil functioning in relation to subjective goals or a desired optimum condition and primarily considers properties of soil that can be changed through management. A healthy soil provides many functions that support plant growth, including nutrient cycling, biological control of plant pests, and regulation of water and air supply. Physical, chemical, and biological properties of soil all interact to influence soil functioning. Soil organic matter plays an especially important role in soil health, as it regulates many key physical, chemical, and biological properties of soil.

The Soil Food Web

Soil is home to a complex community of organisms that interact to significantly impact both above-ground and below-ground processes. The soil food web is the community of organisms living all or part of their lives in the soil. Soil-dwelling organisms play key roles in soil function, providing the foundation for such critical processes as soil structure development, decomposition and nutrient cycling, bioremediation, and promotion of plant health and diversity. Soil life ranges in size from microscopic to easily observable with the unaided eye, and include

- Microbes, including bacteria, fungi, and protozoa, are the primary decomposers of soil organic matter. They contribute to nutrient cycling and breakdown of organic material to release plant-available nutrients from organic residues. Microbes in the soil that reduce plant disease are called antagonists. Antagonistic microorganisms can affect a plant pathogen by physical contact and destruction or consumption of the plant-pathogenic organism; by the secretion of antibiotic materials, enzymes or other compounds; by competing for space on the surface of roots; or by the induction of plant host defenses through biochemical changes that enhance resistance of the plant against infection by pathogens or to attack from plant-feeding insects. This phenomenon is called *induced systemic resistance.*
- Larger organisms, for example, free-living nematodes and small arthropods help to mediate the breakdown of plant and other organic residues, and the mineralization of plant nutrients from those residues by breaking apart relatively large fragments of organic residues to smaller pieces with increased moisture and surface area for the primary microbial decomposers to act on. Some common insects and related organisms that play an active role in decomposition in agricultural systems are millipedes, springtails, mites, fly larvae, and burying beetles. An additional benefit of a healthy, biologically active soil that is of particular interest in agricultural systems is the control of arthropod pests. Agricultural soil communities typically include a wide range of predators, parasites and pathogens that contribute to the suppression of agricultural pests.

What do beneficial soil organisms need?

Soil organisms need the same resources as all other living beings: *space, air, water, and food.* The way that we manage soil impacts the resources available to soil organisms and to their functioning.

- *Space:* Soil particles are grouped together in the soil formation processes to create structural pieces called aggregates. Clay, organic matter, root hairs, organic compounds from bacteria and fungi, and fungal hyphae help "glue" soil aggregates together. The significance of soil aggregation is that it creates soil pores or voids that are the living spaces for most soil organisms, and they hold air and water. Therefore, a healthy soil is similar to a sponge – consisting of a network of pores, channels, and solid material. Many beneficial soil organisms are too small to move soil, and live in the existing pores and channels in well-aggregated soil. Some soil organisms are capable of moving soil and creating macropores and channels in the soil. These organisms, sometimes called ecosystem engineers, include termites, ants, dung beetles, and earthworms. Earthworms are probably the best-known soil organism that contributes to the development and maintenance of soil structure.

- *Air and water:* Water and air are held in the pore space between soil particles and soil aggregates. Larger pores, known as macropores, are important to promote good aeration and rapid infiltration of rainfall. Smaller pores, known as micropores, are important for absorbing and holding water. To maintain both adequate aeration and water supply for optimum plant growth, it is necessary to have both macro- and micropores in the soil.

- *Food:* Organic matter in soil plays an important role in integrating many aspects of soil health. Soil organic matter is the base fuel that supports a healthy food web and provides nutrients used by plants and other organisms. Soil organic matter includes all the organic substances in or on the soil, including plant- and animal-derived material, in various stages of decay. The quantity of organic matter in a given soil is also the result of a balance between organic matter inputs, such as crop residues, manure, and compost, and the rate of organic matter decomposition. Both organic matter inputs and the rate of decomposition can be influenced by soil management practices. The quantity of labile organic matter generally responds to changes in soil management practices more quickly than the quantity of stable soil organic matter, so changes in labile organic matter levels can serve as a leading indicator of long-term trends in total organic matter levels. Reduction of tillage frequency or intensity, growth of overwintering cover crops, crops with fibrous roots such as small grains, and returning crop residues to soil can help increase labile organic matter in soil.

Management for a healthy soil

- **Avoid compaction.** The wetter the soil, the easier it is to compact the soil. As the structural units are broken down when a soil is compacted, the pore space is reduced. Reduced pore space reduces aeration in the soils necessary for root growth and biological activity. Don't walk or drive on wet soils and never till wet soils.

- **Plant cover crops.** Green manures, or cover crops, such as annual rye, ryegrass are planted in the fall for incorporation in spring. Cover cropping provides additional organic matter, holds nutrients that might have been lost over the winter, and helps reduce erosion and loss of topsoil. Legume cover crops, such as red clover, crimson clover, or hairy vetch can increase the amount of nitrogen in the soil and reduce fertilizer needs.

- **Increase organic matter inputs.** Regularly adding manures, compost, cover crops, and other organic materials can raise the soil's nutrient level and physical quality, thus reducing the need for synthetic fertilizers. A desirable soil health does not come about with the single addition of organic material, or even several additions; it requires a serious soil-building program.

- **Reduce frequency and intensity of tillage.** Tillage increases oxygen in the soil, stimulating microbial activity, and results in the decomposition of organic matter. If additions of organic matter are not sufficient to counteract the losses from decomposition, organic matter levels will decline over time, reducing soil health. Inversion tillage can have profound effects on the biological properties of soil. Compaction and removal of surface residue may contribute to reduction in soil moisture and living space for soil-dwelling organisms. Diversity and abundance of arthropod predators associated with the soil surface can be greater under reduced-tillage management in comparison to conventional tillage, and natural control of pest insects in soil may be enhanced in reduced tillage systems. Beneficial insects associated with the soil are more likely to survive in fields where reduced tillage is used and surface residues are maintained. In comparison with inversion tillage practices, non-inversion tillage causes less soil disturbance and thus, less direct mortality, of beneficial soil organisms. Some tillage is still a necessary practice in some production systems, especially in organic systems which do not use herbicides for weed control. When tillage is used it is important to offset the increased rate of organic matter decomposition with increased inputs of organic matter through crop residues, manure, and compost.

- **Reduce pesticide use and provide habitat for beneficial organisms.** The application of broad-spectrum insecticides can kill beneficial insects, like ground beetles, directly, or indirectly, by interfering with the reproductive development or behavior of the organism. Practices to increase and manage biodiversity with the goal of increasing the presence of beneficial organisms include the use of insectary plants, hedgerows, cover crops, and water reservoirs to attract and support populations of beneficial organisms such as insects, spiders, amphibians, reptiles, bats, and birds that parasitize or prey upon insect pests. Natural areas placed in contours between fields, steep ditches, or places that are easily eroded gives stability to the soil. Natural areas can also be used as a filter strip to prevent water runoff and soil erosion.

- **Rotate crops.** Diverse crop rotations help to break up soil-borne pest and disease life cycles, improving plant health. Rotations can also assist in managing weeds. By growing diverse crops in time and space, pests that thrive within a certain crop are not given a chance to build their population over time. Rotating crops can also help to reduce nutrient excesses.

- **Manage soil fertility carefully.** Planning the timing, application method, and quantity of manure, compost, and other fertilizers will allow you to meet crop nutrient demands and minimize nutrient excesses. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, over-fertilizing crops can increase pest problems. Increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage. Maintaining a soil pH appropriate for the crop to be grown will improve nutrient availability and reduce toxicity. Maintaining adequate calcium levels will help earthworms thrive and improve soil aggregation. Using diverse nutrient sources can help to maintain soil health. There is some evidence that synthetic nitrogen fertilizers reduce soil organic matter. Manure and compost add organic matter as well as an array of nutrients, but using just compost or manure to meet the nitrogen needs of the crop every year can result in excessive phosphorus levels in the soil.

Mary Barbercheck is a Professor of Entomology at Penn State. Her appointment includes research in sustainable agriculture and extension in pasture and forages. Her research focus is on the biological aspect of soil quality and it’s role in pest suppression, and the effects of agricultural management systems on beneficial soil organisms. Originally from the northwestern corner of Indiana, she has a B.A. in Environmental Biology for the University of California at Santa Barbara, and a Master’s degree in Plant Protection and Pest Management and a Ph.D. in Entomology from the University of California at Davis. Before joining the faculty at Penn State in 2002, she held a faculty position as soil entomologist in the Dept. of Entomology at North Carolina State University from 1990 – 2002.

HOW TO READ SOIL AND FOLIAR NUTRIENT ANALYSIS REPORTS

Elsa Sánchez, esanchez@psu.edu, Penn State Plant Science

Soil test and foliar nutrient analysis reports contain information that can be very useful to consider when making decisions for nutrient and soil management. A step-by-step explanation of the information on soil test reports and foliar nutrient analysis reports will be presented in this presentation.

Soil Test Report Interpretation

The soil test report below from Penn State's Agricultural Analytical Services Laboratory will be used as an example.

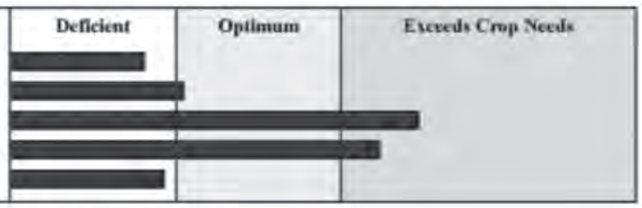
PENNSTATE

(814) 863-0841 Fax (814) 863-4540
Agricultural Analytical Services Laboratory
The Pennsylvania State University
University Park PA 16802
www.aasl.psu.edu

SOIL TEST REPORT FOR:	ADDITIONAL COPY TO:
ELSA SANCHEZ 202 TYSON UNIVERSITY PARK PA 16802	

DATE	LAB #	SERIAL #	COUNTY	ACRES	FIELD ID	SOIL
04/16/2012	S11-42262		Centre	1	Hort43	

SOIL NUTRIENT LEVELS			
Soil pH		6.1	
Phosphate	(P_2O_5)	183	lb/A
Potash	(K_2O)	418	lb/A
Magnesium	(MgO)	601	lb/A
Calcium	(CaO)	3101	lb/A



Recommendations For: *SWEET CORN (FRESH MARKET)*

Limestone and Magnesium:

Calcitic Limestone (calcium carbonate equivalent): 2000 lb/A **Magnesium (Mg):** NONE

Plant Nutrient Needs:

Nitrogen (N):	Phosphate (P_2O_5):	Potash (K_2O):
50 lb/A	45 lb/A	NONE

MESSAGES

Apply above fertilizer in bands 2 inches to the side and 2 inches below the seed. Double the above amounts of nitrogen-phosphate-potash if you wish to broadcast the fertilizer. To maintain good husk and flag-leaf color, sidedress with 30 lb/acre of nitrogen when corn is 12 to 18 inches tall.

For early plantings in cool soils, apply 50 lb/A of 0-20-0 or 25 lb/A of 0-46-0 down the spout with the seed.

For additional information, see back messages 1,2,6,7,8,9 and 12.

Commercial fruit and vegetable-1

LABORATORY RESULTS:										Optional Tests:		
[1]pH	[2]P lb/A	Exchangeable Cations (meq/100g)					% Saturation of the CEC			Organic Matter %	Nitrate-N ppm	Soluble salts mmhos/cm
		[3]Acidity	[2]K	[2]Mg	[2]Ca	[4]CEC	K	Mg	Ca			
6.1	80	2.8	0.4	1.5	5.6	10.3	4.3	14.6	54.0			

Test Methods: [1]1:1 soil:water pH, [2]Mehlich 3 (ICP), [3]Mehlich Buffer pH, [4]Summation of Cations

3964

In the Soil Nutrient Levels section (top of the report)

Penn State's Agricultural Analytical Services Laboratory and other commonly used laboratories in our area including A&L Eastern Laboratories and Logan Labs, LLC use the Mehlich III method to estimate available phosphorus (P), potassium (K), magnesium (Mg) and calcium (Ca).

The soil test categories for soil pH, phosphate (P_2O_5), potash (K_2O), magnesium oxide (MgO) and calcium oxide (CaO) levels are: *deficient, optimum* and *exceeds crop needs*. The goal of nutrient management is to maintain soil pH and nutrient levels in the *optimum* category. One exception is that for cold soils (early in the spring) a starter fertilizer high in P_2O_5 may be used even when available soil P levels are high.

Recommendations (middle of the report)

Soil pH: pH affects plant nutrient availability, soil microbe activity and root growth. High soil pH is seldom a problem in vegetable crop production. pH can reach up to 7.5 or higher before crop production declines. Low pH which can negatively affect crop production is much more common. Over time the pH of soils used for agriculture tend to acidify. For this reason it is important to monitor soil pH. Test soil pH every 1-3 years. If the pH of a soil is too low, soil test reports provide liming recommendations to raise it. Recommendations are expressed as the calcium carbonate equivalent or CCE. The CCE of pure calcium carbonate is 100%. Other liming materials have different CCE values relative to calcium carbonate. The CCE of a liming material can be found on its label.

Phosphate, potash, magnesium, calcium: Various crops require different amounts of nutrients and recommendations are specific for each vegetable crop. Generally, vegetable crops that produce large yields of harvestable material will remove large amounts of nutrients from the soil and will have a higher nutrient recommendation. When P_2O_5, K_2O, MgO and/or CaO levels are in the *deficient* category the recommendation provided indicates how much of each nutrient to apply. When a nutrient level is in the *deficient* category, the nutrient recommendation is designed to achieve full crop yield potential and to increase nutrient levels into the *optimum* range over time. If the nutrient level already in the optimum range the recommendation is indicates how much of the nutrient to apply to replace the amount removed by the crop to maintain optimum fertility. No nutrient application is recommended when the soil test category exceeds crop needs. Soil nutrient levels *exceeding crop needs* can be as bad as deficient levels. High soil levels not only might represent an economic loss, but they may also result in crop, animal or environmental problems. Use best management practices to avoid increasing nutrient levels that are in the *exceed crop needs* category.

Nitrogen recommendations: Nitrogen (N) is recommended based on crop needs. Adjust the N recommendation based on soil type, previous management (use of manure, legume cover crops, compost, etc.), amount of rainfall and plant growth. If vine growth has been excessive, apply less N.

In the Laboratory Results section (bottom line of the soil test report)

Soil pH: This is a measure of whether the soil is acidic or alkaline. Most vegetables produced in the field or high tunnel grow optimally when soil pH is between 6.2 and 6.8.

P lb/A: This is the pounds of available phosphorus per acre. It is used to calculate the soil phosphate level indicated at the top of the report (part of the bar graph): Pounds per acre (lb/acre) P_2O_5 is equal to 2.3 x lb/acre P.

Acidity: The acidity value is used to determine the lime requirement, if needed. Different soils can have the same soil pH and a different acidity value. In this case, different amounts of lime are needed to adjust soil pH to be within the optimal range. The following calculations are used to estimate the lime requirement for incorporation in the top 8 inches of soil based on the target pH range and the acidity value:

Target pH Range	Lime Requirement (lb/acre)
6.5-7.0	1000 x acidity index
6.0-6.5	840 x acidity index
5.5-6.0	684 x acidity index
5.0-5.5	514 x acidity index

Exchangeable cations: These values are the concentration of hydrogen (H; acidity value), K, magnesium (Mg) and calcium (Ca) expressed as milliequivalents per 100 grams of soil. CEC or cation exchange capacity is a measure of the ability of a soil to hold or store H, K, Mg, ammonium, sodium and Ca (cations). In Pennsylvania soils cations dominating the CEC are H, K, Mg and Ca. Therefore CEC is calculated by adding the amount of H, K, Mg and Ca. For the example soil report 2.8 (acidity value) + 0.4 (K meq/100 g) + 1.5 (Mg meq/100 g) + 5.6 (Ca meq/100 g) = CEC of 10.3. Soils high in clay and/or organic matter have high CEC values, while sandy soils have low CEC values.

% Saturation of the CEC: This is the concentration of K, Mg and Ca expressed as a percent of the CEC. A general desired balance between these elements is 3-5% K, 10-15% Mg and 60-80% Ca.

Foliar Nutrient Analysis Report Interpretation

The foliar nutrient analysis report on the following page from Penn State's Agricultural Analytical Services Laboratory will be used as an example.

Foliar nutrient analysis reports indicate the concentration, expressed as percent dry weight, of N, P, K, Ca, Mg, sulfur, manganese, iron, copper, boron and zinc in plant tissue.

Nutrient concentrations fall into the categories of *deficient, low, normal, high* and *excessive*. The range for nutrient concentrations in each category is crop specific. The *normal* category indicates that the tissue has sufficient concentration of the nutrients and no corrective measure is needed. A *high* concentration usually does not affect plant growth or yield, but can lead to a problem if it reaches the *excessive* category. When a nutrient concentration is in the *excessive* category the nutrient may have reached toxic levels and plant growth, yield and/or quality will generally be reduced. Concentrations in the *deficient* or *low* categories indicate that the nutrient is below sufficient concentrations and very likely is limiting crop potential by resulting in reduced growth, yield and/or quality. Crop response to adding a nutrient in the *low* category is medium and in the *deficient* category high.

It is important to determine the cause before taking corrective action when concentrations are in a category other than *normal*. Looking over a soil test report provides important information. If soil pH is out of the optimal range soil nutrient availability is affected and can result in *deficient/low* or *high/excessive* nutrient concentrations in plant tissue. Nutrient imbalances and soil nutrient levels in the *deficient* or *exceeds crop needs* category can also result in plant tissue nutrient concentrations out of the *normal* category. Additionally, applying certain pesticides such as those containing sulfur or copper can result in concentrations of these nutrients in the *high/excessive* categories. Very wet or dry soils, low or high soil and air temperatures and heavy fruit loads can result in nutrient concentrations in the *deficient/low* categories. Once the cause is determined, corrective actions should be taken.

PENNSTATE

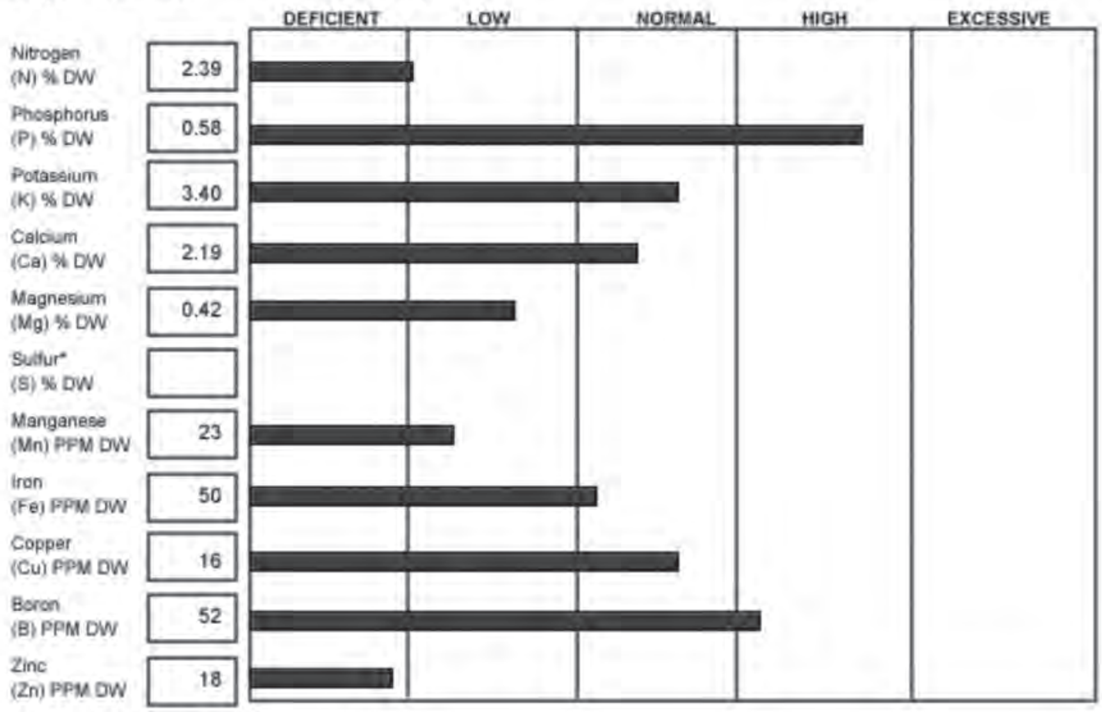
(814) 863-0841 Fax (814) 863-4540

Agricultural Analytical Services Laboratory
The Pennsylvania State University
University Park PA 16802

PLANT TISSUE ANALYSIS FOR:	ADDITIONAL COPY TO:
Jane Doe Doe Farms RR 1 Box 4 Wysox PA 11111	

KIT ID	LAB ID	FIELD NAME	HOUSE	BENCH	RECEIVED	COMPLETED	COUNTY
	PK15080	Garden			8/22/2011	9/5/2011	Adams

Crop: Tomato **Variety:** Any



*Sulfur analysis is available upon request.

Elsa Sánchez is an Associate Professor of Horticultural Systems Management in the Department of Plant Science at Penn State University. Her responsibilities are 60% extension and 40% 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. Currently, she and her husband, Chris, live in State College, PA with their daughters Laurel and Lilly.

ROBERT MARVEL PLASTIC MULCH, LLC

BioTELO AGRI

The original biodegradable mulching film!

BioTelo Agri is a revolutionary film for mulching that is completely biodegradable.
BioTelo Agri is composed of Mater-Bi, a corn-starch based, thermoplastic material made of raw materials from renewable resources that have not been genetically modified. BioTelo Agri breaks down into the soil where microorganisms convert it to water, carbon dioxide and biomass.

Benefits of BioTelo Agri:

- Leaves no residue in the soil, significantly minimizing its environmental impact.
- Biodegrades completely without polluting the soil or accumulating over time.
- Has the same strength, elasticity and effectiveness of traditional plastic mulch film.
- Does not need to be removed from the soil or disposed of at the end of the growing season.
- Can be laid with conventional mulch laying machines.
- Can be used for any crop traditionally grown with plastic mulch film.
- Provides the same effectiveness of weed suppression as plastic mulch film. Testing has shown that the quality and productivity of the crops grown using BioTelo Agri are identical to those grown with plastic mulch film.

How Long will BioTelo Agri Last?

Degradation of BioTelo Agri depends largely on climatic and environmental conditions such as temperature, humidity and soil microbial activity, allowing for a field life of at least three to four months and up to five to seven months.

What is BioTelo Agri made from?

BioTelo Agri is wholly composed of Mater-Bi, a corn-starch based material whose complete biodegradability has been certified by The Belgian Institute of Organic Waste System as part of the certification program “OK Compost”, “OK Biodegradable Soil”, as well as other international institutions such as AIB Vincotte (Belgium), Dincertco (Germany), and IIP Italy.

And remember, if the label on the roll does not say BioTelo Agri, it's not

BioTELO AGRI

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UTILIZING COVER CROP MIXES IN VEGETABLE PRODUCTION SYSTEMS

Tianna Dupont, Charlie White, Jason Kaye, Mena Hautau, Dave Hartman; Penn State Extension

On-farm cover crop experiments are an important component of our research into the multifunctionality of cover crop mixtures. To complement a 30 acre experiment at Penn State's Rock Springs research station, three on-farm experiments in different regions of Pennsylvania allow us to broaden the scope and outreach of our project. Each on-farm experiment is hosted by a collaborating farmer on land that has been managed organically for at least 10 years. At each site the farmer planted one cover crop monoculture, a custom three species mix, and a four species mix that was common across the three on-farm sites and was also present in the research station experiment. The cover crops were planted in August 2012 in a fallow period of the crop rotation typically available between small grain harvest in mid-summer of one year and corn planting in late-spring the next year. After the cover crops were terminated in May 2013, corn was planted over the experimental plots. The collaborating farmers managed all field operations including tillage for seedbed preparation, seeding, and cultivation in the corn using the practices and equipment typical of their organic farming systems. Below are some of the key preliminary findings from these experiments.

- Biomass and nitrogen uptake in cover crop mixtures was dominated by non-legumes such as cereal rye and canola.
- Cover crop monocultures and mixtures containing only legume species tended to be weedy.
- Soil nitrogen uptake by non-legume cover crops and weeds reduced nitrate leaching into the subsoil.
- The highest amount of nitrate leaching across the three sites (48 lbs N /ac) was observed under a frost-seeded red clover monoculture where weed growth was suppressed by mowing.
- The second highest amount of nitrate leaching across the sites (30 lbs N/ac) was observed under a cover crop mixture that contained 81 lbs N/ac in the biomass of a winterkilled Austrian winter pea despite the presence of a winterhardy grass in the mixture.
- The third highest amount of nitrate leaching across the sites (18 lbs N/ac) was observed under a red clover monoculture.
- Other mixes and monocultures maintained leaching below (12 lbs N/ac).
- Soil nitrate concentrations in late June 2013 were not different between cover crop treatments at each site.

More detailed results from each site are available in the following pages.

The on-farm research in this report was designed and conducted by Charlie White, Tianna DuPont, Dave Hartman, Mena Hautau, and Jason Kaye of the Pennsylvania State University with cooperating farmers Bucky Ziegler, Dan DeTurk and Wade Esbenshade. **Funding for the work is from the USDA Organic Agriculture Research and Extension Initiative.**

Tianna DuPont is an Educator in Sustainable Agriculture for Penn State Cooperative Extension in Northampton and Lehigh Counties working with organics, soil health, cover crops, reduced tillage, grazing and new farmers. She has a B.S. in Environmental Studies from Whitman College of Washington and an M.S. in Integrated Pest Management from the University of California at Davis where she conducted her research using nematodes as indicators of soil health in organic cropping systems. She worked formerly with the Rodale Institute and the Land Institute in Salina, Kansas.

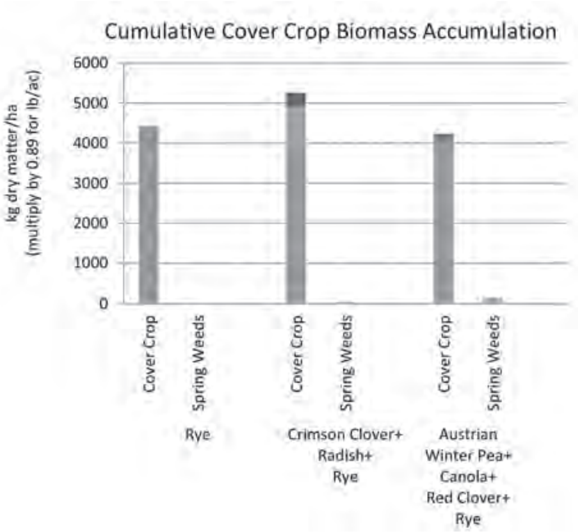
On-Farm Cover Crop Mixture Experiment 2012-13

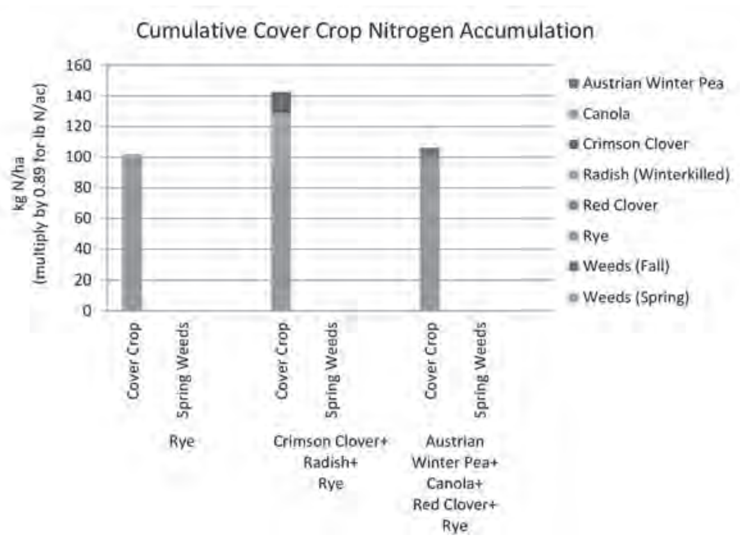
Farmer Collaborator: Dan DeTurk

Previous Crop: Alfalfa (4yrs)
Cover Crop Planting Date: August 31, 2012
Cover Crop Treatments (seeding rates in lbs/ac):

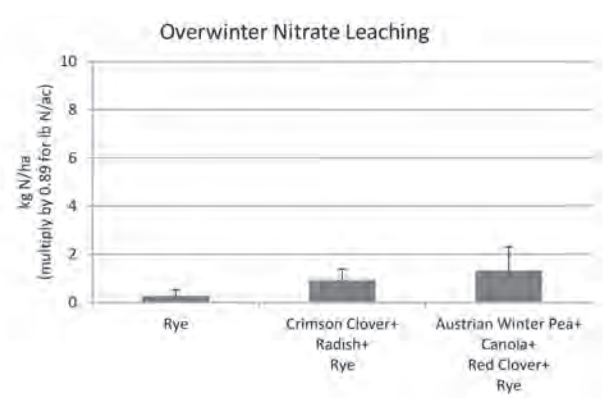
Cereal Rye (150)
Crimson Clover (17) + Forage Radish (3) + Rye (60)
Austrian Winter Pea (39) + Canola (6) + Red Clover (6) + Rye (25)

Cover Crop Establishment Methods: Molboard plowed to terminate and incorporate alfalfa and then disked, harrowed and cultipacked. Cover crops were planted with a Case IH 5100 drill. For each treatment, cover crop seeds were separated into different drill boxes with cereal rye and peas placed in the large box and clovers, canola, and radish placed in the small seedbox. The large seedbox delivered seeds to double disk openers planting at 1” depth. The small seedbox dribbled seeds onto the soil surface in front of the disk openers. After cover crops were seeded, a cultipackers was used to firm the seedbed.





Cumulative cover crop biomass and nitrogen accumulation. Values are for a late-April sampling date except for winterkilled species and fall weeds, for which values are for an early-November sampling date. Values are means of four replicates.



Nitrate leaching into the subsoil (below 30cm/12 inch depth) between late-September and late-April. Differences between treatments were not statistically significant.

	+N	-N
Canola+Pea+Red Clover+Rye	10.5	8.6
Rye+Crimson Clover+Radish	10.9	0.9
Rye	10.6	8.2

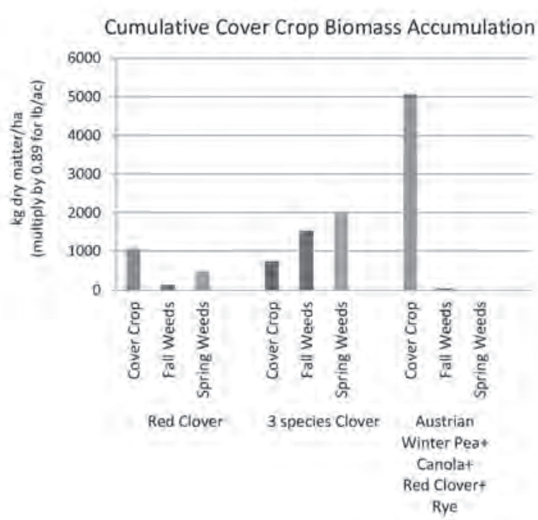
Average of dry grain weight Mg/Ha

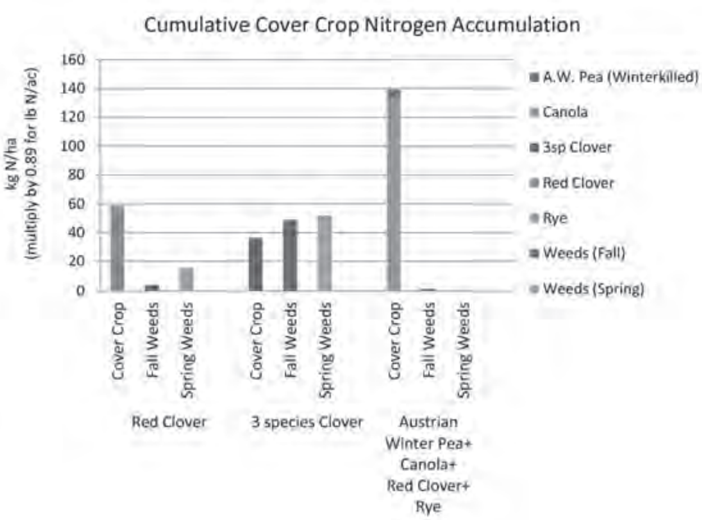
On-Farm Cover Crop Mixture Experiment 2012-13

Farmer Collaborator: Wade Esbenshade

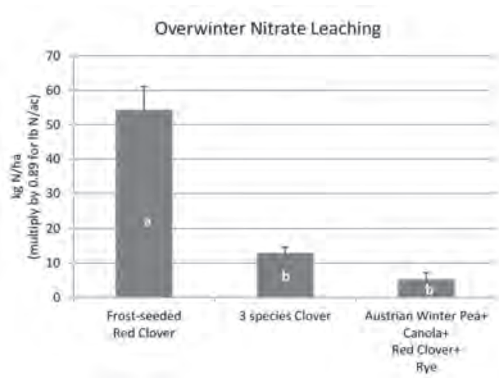
Previous Crop: Spelt
Cover Crop Planting Date: February 27, 2012 and August 23, 2012
Cover Crop Treatments (seeding rates in lbs/ac):
Red Clover (13)
3 species Clover – red + ladino+ yellow blossom sweet (13)
Austrian Winter Pea (39) + Canola (6) + Red Clover (6) + Rye (25)

Cover Crop Establishment Methods: The red clover and 3 species clover treatments were both frost seeded into spelt in late February. Establishment of these treatments was evaluated in August and the 3 species clover establishment was deemed insufficient. Therefore, plots of the 3 species clover were chisel plowed, disked 3 times, and reseeded on August 25, 2012. The Austrian winter pea + canola + red clover + rye treatment was seeded on August 23, 2012 following chisel plowing and 3 passes of a disk. The frost seeded cover crops were spun onto the soil surface with a spinner spreader. For the seedings in August, rye and pea seed were mixed in the large seedbox of a Case IH 5100 drill and planted through double disk openers to a depth of 1". Red clover, canola, and the pre-mixed 3spCl seed were dribbled on the soil surface with a brillion seeder and firmed in with a cultipacker. On August 24, 2012, the frost seeded red clover treatment was mowed twice with a rotary mower to a height of 6 inches to suppress weeds.





Cumulative cover crop biomass and nitrogen accumulation. Values are for a late-April sampling date except for winterkilled species and fall weeds, for which values are for an early-November sampling date. Values are means of four replicates.



Nitrate leaching into the subsoil (below 30cm/12 inch depth) between late-September and late-April. Treatments with different letters are significantly different.

Average of Yield	N Rate	
Cover Crop	+N	-N
3 Species Clover	194	192
Canola+Pea+Red Clover+Rye	190	193
Red Clover	188	189

Average of dry grain weight bu/A.

MARKETING TO THE MOBILE CONSUMER

Kathy Kelley
Pennsylvania State University, Department of Plant Science,
University Park, Pennsylvania 16802

Consumer use of mobile technology has become more of a norm than an exception. In 2013, 56% of consumers in the US owned a smartphone (http://bit.ly/1cgMfCT) and 43% of consumers, age 16 years and older, owned a tablet or an e-reader (http://bit.ly/1cgMfCT). There is plenty of data that indicates certain demographic groups are more likely to be "mobile" users. For example, the age ranges with the greatest percentage of smartphone users are: age 18 to 24 (79% own a smartphone), age 25 to 34 (81%), and age 35 to 44 (69%). As would be expected, income also has an impact on smartphone ownership; however, this has less of an influence on consumers age 18 to 29 years (http://bit.ly/1elAV8a).

How consumers use their smartphones and tablets do differ – just because both are mobile their purposes are not considered interchangeable, even when used in the home. Though accessing email is the primary function owners perform on both types of devices, tablets are more likely to be used for reading news (50%), shopping (44%), and researching restaurants (30%; http://bit.ly/1elAV8a).

What might your mobile marketing strategy include? A few, of the almost endless options, include:

- Create or enhance your Facebook page to best appeal to consumers with information about your business, products, hints and tips. Fifty-eight percent of smartphone owners and 61% of tablet owners use their devices to access this social network (http://bit.ly/1elAV8a).
- Develop coupons that can be "redeemed" by mobile users. Consider how you will distribute them and whether you will limit usage or allow recipients to share them.
- Develop a policy for price matching. Consumers will continue to use their devices for "showrooming" and searching online for prices competitors are charging.
- Create QR codes (Quick Response codes) that, when scanned by a mobile device, lead the user to specific websites for product or processing information.
- Have a mobile ready website and view the site on all types of devices. How it looks on an iPhone might look quite different on an iPad or Android phone or tablet.
- "Claim" and enhance your page on Foursquare, Yelp.com, and TripAdvisor. Ensure that the information that is posted is correct, add images, consider using the site to offer promotions, and respond to all customer reviews – good and bad.

How else can you "interact" with the mobile consumer? By allowing them to make payments with their mobile device. Several options exist:

- Consumers download apps to their device and then "tap" their phone against a near field communication (NFC) reader/credit card terminal (e.g. Google Wallet) to make a purchase.
- Consumers download an app to their smartphone and either pay using the app or they pay by typing in a phone number and PIN associated with their account (e.g. PayPal) at credit card processing terminals.
- Consumers use their "face" to pay for purchases. Instead of matching customers' signatures with that on the back of their credit cards to verify purchases, "merchants use FaceCash to verify that [the customer's] real face

matches a digital image linked to [his or her] account" or the cashier can scan a code on the user's smartphone (www.facecash.com).

These are just a few of the options that require consumers to either download an app, sign up for an account, or perform some other action before they make a purchase. Other systems require the retailer to have smartphones or tablets and purchase a reader for swiping cards, called a "dongle," that plugs into either the headphone jack on a mobile device (e.g., Square) or the charger port for iPhones and iPads (e.g., Eventbrite). Other companies use a wrap-around style card swiper (e.g. Mophie and Chase Paymentech).

An advantage of using a mobile payment system is that businesses can process payments in remote locations. Consider situations where you have been in the process of selling your goods or services and credit card users were not able to make a purchase because you only had cash available to make transactions.

Aside from flexibility these systems provide for your customers, your business may also benefit:

- These systems capture a fair amount of customer information, which can help businesses create (or take the place of existing) loyalty programs.
- Funds are transferred to the business more quickly, reducing the transaction time from days to hours.
- Most mobile payment companies do not charge a setup fee or a monthly fee to use their system.
- There may be little or no requirement to purchase equipment (if you already own the required smartphones/tablets).
- Though percentage processing fees, ranging from 1.74 to 3.7 percent, are applied to each transaction, some companies have eliminated the per-transaction charge, which can range from $0.10 to $0.30.

Before deciding on how, when, and even if mobile planning, payment, and other tasks are appropriate for your business – it is critical to gather data on mobile device ownership and usage, especially as they relate to your own customers.

Kathy Kelley is a Horticultural Marketing and Business Management Extension Specialist at The Pennsylvania State University. She teaches Retail Horticultural Business Management and co-teaches Issues in Landscape Contracting. Her research interests include studying consumer attitudes and behaviors for various horticultural goods and services. She also has extension responsibilities that include developing business and marketing educational programs for horticultural crop producers and retailers.

SOCIAL MEDIA: BEYOND FACEBOOK

Rachel VanDuzer of VanDuzer Design & Marketing

VanDuzer Design & Marketing is a small-scale marketing agency specializing in promoting locally produced foods through traditional marketing, public relations, online marketing and social media. We currently work with two farm markets (Weaver's Orchard and Wolff's Apple House), one farmer's market (The Farmers' Market at Elverson), a cattle farm (Lone Star Farm Beef) and a dairy farm (Conebella Farm Cheese). We publish 2-3 blog posts per week for all of these clients, manage their social media and email marketing. Visit www.VanDuzerDesign.com for information on marketing and www.RachelsFarmTable.com for recipes, farm stories and photography tips.

Table of Contents:

I. Overview of social media marketing

Social media marketing is the process of creating brand awareness and gaining website traffic through social media sites such as Facebook, Twitter, Pinterest, Google+, Tumbler and Instagram. Social media marketing programs typically try to create "viral" content that attracts attention and encourages followers to comment, like and share content with a broader audience. Since it is essentially word of mouth marketing for the Internet, it has greater impact that pure advertising alone. When followers share a company's message or photo, other social media users are more likely to resonate with the message endorsed from a trusted third party follower (their friends or other companies they trust) rather than from the company itself.

II. Twitter

About: Twitter is a text-based social network where each "tweet" is limited to 140 characters.

Users: Twitter has 500 million+ users who generate 58 million tweets daily (9,100 every second!)

Benefits: Twitter is a powerful tool to leverage traffic to your website and help your search engine optimization (SEO) efforts. Search engines index all tweets, querying 2.8 million tweets every day. Using keywords and adjectives in tweets (such as *strawberry picking* farm, *pick-your-own* peaches, *locally grown Maryland* pears, *New Jersey* blueberries or the best apple cider in the Mid-Atlantic region) will be helpful as people search for those keywords on search engines. Since Twitter has a high volume of traffic, any links shared back to your website will help overall SEO efforts since search engines want to send traffic to reputable websites.

Considerations: Each tweet is limited to 140 characters. The Twitter feed is constant, so you need to create short, quality content often.

Tips:

- **Retweet** what other people are saying if it is relevant to your audience.
- **Tag (@)** other users in your tweets (especially news publications and vendors if you are a farmers' market/farm market with vendors).
- **Shorten links** (using either with goo.gl, tinyurl.com or shortcodes on Wordpress).

- **Follow others** based on similar companies/organizations to generate re-follows.
- **Use hashtags** (#) before keywords to help people find what you are talking about - for example: #locallygrown-produce helps people find tweets about this topic. Limit to 2 hashtags per tweet.
- **Do** link Twitter with your other social networks (to and from).
- **Do** keep most Facebook posts to 140 characters if Facebook auto feeds to Twitter.
- If you do nothing else with Twitter, at least link it to Facebook so all updates come to Twitter.

III. Google+

About: Google+ is a text and image based social network similar to Facebook.

Users: Google+ has 300 million monthly active users, plus an additional 200 million members who use it for YouTube comments and Gmail.

Benefits

- Users can easily post updates, upload photos and create "circles" of friends.
- Google+ (Places) lists a summary of your Google+ page (photos, hours, reviews, etc.) on the side of the search results page.
- Regular updates will improve SEO. Google is the largest search engine, so it is essential to at least have a page for the Google+/Places benefits.

Considerations:

- It is currently not possible to link a Facebook or Twitter page to post *to* Google+, however you can use a third party (Hootsuite.com) to do this or you can post *from* Google+.
- The actual popularity/activity and engagement level of Google + users is debated.
- If you do nothing else, at least set up a page for the benefits of having a Google Places page.

Tips:

- To post to Google + without signing in, post from Hootsuite.com: this allows you to post to Facebook, Twitter and Google+ all at once.
- **Tag people** with the @ sign like you would on other social media
- For more tips, visit http://www.blogtyrant.com/google-plus-tips/

IV. Pinterest

About: Pinterest is an image-based social network based on the concept of "pinning" photos to a board, reminiscent of a physical corkboard. Users follow other "pinners" based on their interests (food, recipes fashion, furniture, decorations, crafts, weddings, etc.) and pin photos from any website or re-pin from within Pinterest. Each time a user pins something, all of their followers see their pin on their feed and on the other social networks to which they have granted permission.

Users: Pinterest has 70 million users, 80% of whom are women. Users spend an average of 14.2 minutes on Pinterest per visit.

Benefits: Social media (especially Pinterest) is a powerful tool to gain traffic for your website, especially if it is a new website. 35% of traffic to Rachel's Farm Table blog comes from Pinterest and 50% (350,000 hits per month) of food blog Pinch of Yum's traffic comes from Pinterest.

- Using social media to reference back to your website helps search engines build confidence in your website. Even with my clients who do not actively use Pinterest, it remains a major traffic source since other people pin from their blogs.

Considerations:

- You can't pin to Pinterest from other social media, but pins can be posted from Pinterest to Twitter, boards can be shared on Facebook and it may be possible to pin from Instagram.
- Good photography is a must, and photos have to be on your website/blog/microblog (you cannot pin a photo that was shared on Facebook).
- Start using Pinterest now before settings inevitably change. Promoted pins just started, so their algorithm may change like Facebook's did, requiring you to pay to reach your whole audience.

Tips:

- **Set up a business account**, or convert your current page to a business account: http://business.pinterest.com/
- **Add a "Pin It" button** by each photo you want people to pin from your website. Do this with a plug in if you use Wordpress or on this page: http://business.pinterest.com/widget-builder/#do_pin_it_button. Pre-populate the description exactly as you want people to pin it.
- **Curate boards** with things other people share seasonally (about 1/3 should be your products, 2/3 other people's. It's against Pinterest's rules to only post from your website). Include boards with recipes for all your crops, plus add boards with recipes for each holiday.
- **Make pins search-friendly** using keywords in a relevant way, being sure to pre-populate this from your pin it button.

V. Instagram

About: Instagram is an image based photo and video sharing social network that allows people to apply unique digital filters to their photos and then share them on a variety of social networks.

Users: Instagram has 150 million active users; 40% of Fortune 500 companies use Instagram.

Benefits: Instagram is a great way to share photos of "human interest" activities and then post to other social networks. Ideas: planting, harvesting, kids enjoying time on the farm, family life, etc.

Considerations:

- It is an app, so photos have to be shared on a smart phone, tablet or third party desktop app.
- Instagram is another platform that you share from, not to.

Tips:

- **Take photos in diffused natural light** (on a cloudy day, indoors with windows or on a porch) for the best photo quality. (Morning and late afternoon is best for lighting).
- **Add depth** by adding items into the foreground or background and use different angles.
- **Follow others** based on similar companies/organizations, local people to generate follows.
- **In the captions**, add **links to your website/blog**, use **#hashtags** and **@tag people**.

VI. Blogs

About: A blog is a page on your website or a blogging platform where you can write articles about relevant topics (farming practices, recipes, life on the farm etc.). It shouldn't sound like a sales pitch, but rather should stir people up to want to support your farm.

Benefits: Your blog is where you build your brand's personality and establish credibility. It provides great content to share on social media.

Considerations:

- Have your web developer integrate your blog into your website so that you get the SEO benefits from frequent updates & keywords. (www.example.com/blog instead of example.wordpress.com).
- You must have good quality photos (Instagram photos taken in natural light may suffice).
- Add a teaser for your latest blog post on your email newsletter. Allow users to sign up for just blog posts if desired (using Mailchimp: http://mailchimp.com/resources/guides/mailchimp-for-bloggers/html/ or Feedburner.com)

VII. Linking Your Social Media Efforts Together & General Tips

- **Add social media apps** to Facebook (Pinterest, Google+, Instagram, Twitter etc.) https://apps.facebook.com/pinterest-tab/?fb_source=fbpage
- **Help customers find you** on all social media: post social media links on your website, blog, other social media and include social media icons on ads/flyers. Have a Facebook/Twitter feed on your website. Take screen shots of your Pinterest boards for your e-newsletter/social media.
- **Engage with your followers.** Like, comment on and re-pin their pins (Pinterest), Retweet their relevant tweets/photos (Twitter/Instagram), like, comment & share things posted on your timeline (Google+ Facebook).
- **Post questions, relevant articles, share about charities, fundraisers, school events, races**, etc. you are supporting. Remember that social media is a conversation, not a megaphone.
- **"Viral" content** will reach the most people on all social media platforms. Good quality photos will always do better than simply links or text-based updates.

VIII. Social Media Action Items

1. **Learn photography basics and consider investing in an easy-to-use DSLR camera.** Visit www.RachelsFarmTable.com/food-photography/ for tips, insights and camera reviews.

2. **Twitter:** Have social media filter INTO Twitter; sign in/use Hootsuite to engage with followers.

3. **Google+:** Set up an account and post text/photos from here or use Hootsuite.

4. **Pinterest:** Set up or convert your account to a business account: http://business.pinterest.com/ Add a customized pin it button to each photo on your blog: http://business.pinterest.com/widget-builder/#do_pin_it_button. **Publish pins to Twitter, install Pinterest App for Facebook (in VII)**.

5. **Instagram:** Set up an Instagram account and experiment with getting quality photos, build your following and share “human interest” photos. **Share on Twitter, Facebook & other social networks using Instagram’s built-in tools**.

6. **Blog:** Set up a blog (having it integrated into your website is absolutely best but free options through Tumblr, Wordpress.com or Blogspot are a good start). Come up with a plan and schedule for posts. Assign writers to cover topics. Use quality photos. Pin and post articles to all social media. Keep in mind that a photo with a link will do better than just the link feature on Facebook.

7. **Use Hootsuite.com** (free) to post to and manage **Facebook, Twitter & Google+** all at once.

8. **Schedule social media posts and blog articles ahead of time.**

9. Finally, **HAVE FUN** with it! If you’re having fun, it will shine through to your followers!

HARDWARE AND DEVICES FOR DIGITAL MARKETING

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Americans are connected with technology now more than ever. Research from the Pew Internet & American Life Project in May 2013 reported that 85% of American adults use the internet at least occasionally. The same group reported in April 2012 that 55% of American adults access the internet from their mobile devices. With all this technology adoption among the general population, businesses have turned to using technology to not only communicate with their consumers, but more importantly engage technology to assist in the financial management their business. Two business sectors, agricultural and small businesses, have been slow to achieve the same rate of adoption. The benefits to incorporating technology into the financial management of the business outweigh the tribulations they may present.

Financial Management Use

Only 1 out of 2 agricultural and small businesses use technology for financial management of their business. Yodle reported in their first “Small Business Sentiment Survey” (August 2013) 51% of small business owners use technology for accounting purposes. This percent decreases to less than 30% when dealing with customer management or marketing.

For agricultural operations, technology use with finances has been on a slow trend upward. Computer accesses has seen decent growth over the past decade, but use of the computer for farm business has only increased by 10%, and remains below half of ag businesses (National Ag Statistics Service, August 2013). That trend is even lower for ag. businesses within PA. PA computer access has hovered between 50-60% since 2001, and use of computer for the farm business remains around 35%. Essentially a half of U.S. and two-thirds of PA ag. businesses are not directly engaging technology to assist in business management.

Consumer connectivity

Agricultural businesses are facing greater challenges to engage a local consumer. A recent report cited that nearly half of all American adults use their smartphones and tablets to get local news and information (Purcell et al., 2011). Software like Facebook, Twitter, and various news and software platforms are the sources of connectivity. Usage is skewed toward the younger generations. Understanding your clientele’s demographics and software tendencies will enhance the selection of appropriate platforms.

Constant Hardware evolution

Within hours of purchase, any new computer, tablet, smartphone, or other technologies could be considered outdated. Selecting hardware that can give you ready access to the appropriate operating systems and software needs for your business are critical. The number one smartphone and tablet operating system is Android, followed by iOS. In the computer (desktop/laptop) market, Microsoft remains a primary operating system followed by iOS. Regardless of hardware and operating system, selecting equipment upon identified business needs and user skill level remains the most critical component in satisfactory technology integration into the agricultural business. Regardless of which system is ultimately chosen, there are many benefits to utilizing a technology. These include, but are not limited to the following:

- Ease of backing up vital information.
- Reduced time of data entry (after initial training on system-specific use).
- Collection of multi-year information in one location.

- Improved accuracy of information, easier correction for incorrect information.
- Simplified analysis of information and trends.
- Greater access of information to key employees.

The 'Whats' to Consider

Choosing the right computing system for your agricultural enterprise can be a daunting task. If you are not sure where to start, try answering some of these tips below to determine what features may best fit your operation.

- What are the main tasks the equipment is used for?
  - o Will it be able to serve multiple business needs?
- Will additional training be needed?
  - o Will multiple people need access to the equipment?
- What will the system cost me?
  - o Money counts, so make sure when you are investigating any equipment you've taken into consideration any additional add-on updates, support costs, upgrade/licensing fees, there may be for the given program so you have the whole picture.
- What features are going to be used? Are there features not needed?
  - o Don't spend more money on features you won't use. Evaluate how and what you plan to utilize for to dete mine if features not included in the base system will be needed.
- Will it run what I want, or do I need to upgrade?
- What did I think of the demonstration product(s)?
  - o Most, if not all, technology has some form of demonstration equipment or video available. It is a good decision to take some time and evaluate these packages or videos to determine what program(s) will make the best fit into the operation. Make sure all people apart of the operation that will utilize the program have a chance to evaluate and make comments.

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WHAT DO YOU WANT IN A BLUEBERRY VARIETY? NEW CHOICES AND SOME TIME-TESTED ONES

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(+ = best bets)

Early Season

Bluetta - Bush is compact, low growing, and of medium vigor. Fruit is medium-sized, soft, and blue-black with fair flavor. Stem scars tend to be broad; fruit can hang for a long time. Consistent production may be a problem. Winters well and does not break dormancy too early. Moderately resistant to mummy berry disease; highly susceptible to anthracnose and red ringspot virus.

+ Duke - A vigorous, upright bush bearing medium-sized, light-blue, firm fruit with a small dry scar. Blooms late, avoiding early frosts, but ripens relatively early. Plant has numerous canes that are stocky and moderately branched. Precocious. Buds and wood tolerate fluctuating winter temperatures well. Harvest can be completed in two or three pickings. Flavor is mild but is said to improve in storage. Moderately resistant to anthracnose; good resistance to mummy blight (primary shoot infection); moderately susceptible to mummy berry fruit infection; stem blight problems have been documented.

Hannah's Choice - Vigorous, upright bush. Fruit has superior firmness, sweetness, and flavor with peachy overtones. Large first-pick berries, with some size decrease in later picks. Relatively resistant to anthracnose; average resistance to both phases of mummy berry. Less productive in some areas than others.

Early Midseason

Bluehaven - Bush is upright and productive, but not sufficiently hardy for northern areas. Berry is large, light blue, and exceptionally flavorful. Scar is small and dry. Relatively resistant to anthracnose; highly susceptible to mummy berry blight; average resistance to mummy berry fruit infection

Bluejay - Bush is vigorous, upright, and open. Berries are long stemmed and hang in loose clusters; they hold on to the bush without losing their quality and until most are ripe. Fruit is of medium size. Berries are firm and light blue with a small stem scar. Wood and buds are resistant to low winter temperatures. Flowers are less resistant to frost than Bluecrop. Average resistance to anthracnose; resistant to both phases of mummy berry; field resistant to shoestring virus. Production is sometimes erratic.

Blueray - Plant is vigorous and propagates easily. Fruit is borne on small, tight clusters and canes tend to bend over, making it difficult to harvest mechanically; tight clusters can cause berries to drop, especially in hot weather. Berries are large, dark blue, and firm with medium scar and excellent flavor. Consistently productive, but may overproduce if not pruned properly. Upright habit; very hardy. Highly susceptible to mummy berry disease and anthracnose; also susceptible to red ringspot virus.

Ivanhoe - Vigorous, upright bush with numerous stocky, moderately branched canes. Medium-sized light-blue fruit with good to excellent flavor. Buds and wood tolerate fluctuating winter temperatures well. Moderately resistant to anthracnose; good resistance to mummy blight (primary shoot infection); moderately susceptible to mummy berry fruit infection. Consistent yields in small-scale New Jersey test plot.

Patriot - Plant is upright and vigorous, though only medium in height. Fruit is large and firm with a small dry scar and excellent flavor. Developed in Maine and has excellent cold hardiness, but blooms early and is subject to frost.

Resistant to root rot. Average resistance to anthracnose; average resistance to mummy berry blight, relatively resistant to mummy berry fruit infection.

Spartan - Plants are vigorous, upright, and open. Fruits are large, firm, light blue, and highly flavored. Plant performs poorly on amended upland soils. Blooms late, but harvests relatively early; late bloom date helps prevent frost injury. Relatively susceptible to anthracnose; average resistance to both phases of mummy berry.

+ Draper - Released in 2004 from the breeding program at Michigan State. Ripens slightly later than Duke, but with better flavor. Relatively susceptible to mummy berry blight.

+ Reka - From New Zealand. Upright, very vigorous habit that has been very productive where grown. Trial results in PA indicate potential for high yields. Berries are small and deep blue with a spicy flavor. This cultivar's outstanding characteristic is that it appears to be very adaptable to a wide range of soil types. Average resistance to anthracnose, relatively resistant to both phases of mummy berry.

Midseason

+ Bluecrop - Best midseason variety. Bush is vigorous and upright, but canes tend to be slender and whippy, which may make fruit difficult to harvest mechanically. Is slow to send up new canes on upland soils. Fruit is medium and numerous, firm, with small scars, and good flavored, and is resistant to cracking. Consistently high production and good winter hardiness; season tends to be prolonged, requiring several harvests. Field resistant to shoestring and red ringspot virus; moderately resistant to mummy berry and powdery mildew; susceptible to anthracnose.

Bluegold - Very productive and cold hardy within the region. Has a very vigorous bushy growth habit. Ripening is concentrated. Below-average to very good flavor, depending on location. Primary downside to cultivar is that the stem is sometimes retained when fruit is picked and/or the skin tears when stem is removed. Entire clusters may come off at one time. Highly susceptible to mummy berry blight; relatively resistant to mummy berry fruit infection. Average resistance to anthracnose,

Cara's Choice - Released as a specialty cultivar for exceptional fruit quality. Low- to moderate-sized spreading plants. Exceptionally firm, sweet, and flavorful. Medium-sized fruit. Moderate yield; about half that of Bluecrop. Moderately susceptible to anthracnose; resistant to mummy blight; average for mummy fruit infection.

+ Legacy - Has some *V. darrowii* in its background and holds its leaves through much of the winter, so it is less winter hardy than pure highbush. Outstanding characteristic is extremely high yields due to a long harvest season while maintaining superior flavor and quality. Medium to large fruit. For trial in milder or protected locations. Resistant to anthracnose, average resistance to both phases of mummy berry.

Puru - Purported to have excellent flavor and fruit quality. Upright, moderately vigorous bushes with light-blue, medium to large fruit. Winter hardiness is uncertain. Average resistance to anthracnose and both phases of mummy berry

Toro - Vigorous, upright bush that is consistently productive. Fruit is large with small, dry scars and good color and flavor. Begins ripening with Bluecrop but has a concentrated ripening, and harvest can be completed in two pickings. Tolerates fluctuating winter temperatures well. Not very self-fertile, so should be planted with another cultivar. Relatively resistant to mummy berry blight; average resistance to anthracnose and mummy berry fruit infection.

Mid to Late Season

Brigitta Blue - Upright, vigorous, cold-hardy bush with moderate productivity. Fruit is large, very light blue, and firm with a small dry scar. Plant with other cultivars to ensure good pollination. Clusters are loose and ripening is concentrated. Excellent fruit quality and shelf life. Slow to "shut down" in the fall, so don't fertilize after early season. Resistant to anthracnose and both phases of mummy berry.

Nelson - A vigorous, upright bush. Fruit is large, of size similar to Spartan, firm, and light blue with very good flavor. Initial tests show it to tolerate cold temperatures well. Test-plot yields in New Jersey and Michigan have been high. Average resistance to anthracnose and both phases of mummy berry

Ozarkblue - Very late flowering (may avoid frosts). Slow to produce new canes. Quality is similar to that of Bluecrop. Average resistance to anthracnose and both phases of mummy berry

Sierra - A vigorous, upright, productive bush. Fruit is medium sized with a small dry scar, good color, and excellent flavor and firmness. Because Sierra is an interspecific hybrid of four species, its cold hardiness is unknown. Average resistance to anthracnose; relatively susceptible to both phases of mummy berry.

Late Season

+ Liberty - Released in 2004 from the breeding program at Michigan State. In PA trial, is producing more foliage than fruit. Berries are nice size in PA; concerns about fruit size in NJ. Ripens with Elliott, but with better flavor than Elliott. Likely to have good resistance to anthracnose and both phases of mummy berry based on parentage.

+ Elliott - Amongst last to fruit of all standard cultivars. Bush is vigorous and upright; plants very productive, and hardy. Berry size is small and berries are light blue with firm flesh and only fair flavor. Fruit can be tart and berry can be fully blue when not fully ripe, so fruit should be allowed to remain on bush after coloring. Interplanting with another late-blooming variety has provided cross-pollination and improved size and flavor. Stores well. Resistant to anthracnose and mummy berry blight; relatively susceptible to mummy berry fruit infection.

Aurora - Released in 2004 from the breeding program at Michigan State. Ripens very late; slightly later than Elliott. Huge berries with excellent flavor. Likely to have good resistance to anthracnose and both phases of mummy berry based on parentage.

New Varieties (so new they are, as yet, under-evaluated)

Early season

Huron – In 2013, we only have some small plants of 'Huron', so I haven't been able to judge them sufficiently. Below are a few notes from the plant patent (with my highlights and comments).

"It is **exceptionally late flowering** and was one of the few early to mid-season genotypes to survive a late (spring) frost in the mid-1990s. 'Huron' also has **excellent winter hardiness**, as it has routinely been challenged with mid-winter temperatures below -20 C."

"In the trials conducted in Michigan at Grand Junction, 'Huron' was consistently one of the top rated advanced selections. It had among the **highest fruit load** of any of the early to midseason cultivars and the best flavor. The average date of first harvest was **5d before 'Draper' and 6d after 'Duke'**. The fruit of 'Huron' was slightly softer than 'Draper' and much firmer than 'Bluecrop'. 'Huron's fruit were smaller than 'Draper', but larger than 'Duke' and 'Bluecrop'. Its fruit color was similar to 'Duke', but a little darker than 'Bluecrop' and 'Draper'. 'Huron' fruit had a storage life as long as 'Draper', which was several weeks longer than 'Duke' and 'Bluecrop'. 'Huron' had the second highest levels of soluble solids next to 'Draper' and the second lowest acidity next to 'Duke'."

"Blueberry growers in Michigan and the cooler production regions across the USA, Europe, and Canada will find 'Huron' desirable as a new early northern highbush variety. However, some fruit **pedicels of 'Huron' fruit remain attached in very hot weather.** The fruit of 'Huron' also **develops sugar slowly and if picked too early can be very tart.** In addition, the fruit **clusters of 'Huron' are relatively tight**, which may reduce picking efficiency."

The patent gave no indications regarding disease resistance.

Sweetheart – Sweetheart is an early variety, with perhaps the best flavor in early-season fruit, and flavor that holds up in storage. Sweetheart needs to develop into a large plant before its yielding ability is fully apparent. Many people will probably judge this plant too early and dismiss it. Even after the plant "sizes-up" it will need good cross-pollination and assertive pruning to maintain fruit size. It's too early to know if it performs equally well in all locales. It is not precocious like Duke. It has a low level of fall-fruiting.

Some Traditional Varieties

Mid to Late Season (these are a few varieties I include because people always seem to want to know about them)

Coville - Bush has very vigorous spreading habit. Has open fruit clusters; excellent for machine harvest. Needs high bee concentration for best pollination. Berry is large, medium blue, highly aromatic, and rated highly for strong blueberry flavor. Does not set fruit well on occasion, which can limit its productivity. Narrow soil adaptation and produces only moderately. Fruit is relatively susceptible to anthracnose; average resistance to both phases of mummy berry.

Elizabeth - Extremely flavorful, with medium to large berries. No longer commercially important because of inconsistent productivity, but of interest to home gardeners because of excellent flavor. Resistant to anthracnose, relatively resistant to mummy berry blight, relatively susceptible to mummy berry fruit infection.

Herbert – large, dark soft, fruit with a unique sweet flavor. Relatively susceptible to anthracnose, relatively susceptible to mummy berry blight, relatively resistant to mummy berry fruit infection.

Jersey - Bush is vigorous and erect with open fruit clusters. Medium-sized, firm fruit with good color and good flavor. May have fruit set problems; tends to set fruit without undergoing pollination, so fruit does not size. Considered by some to have the sweetest flavor. Relatively resistant to anthracnose; resistant to mummy berry blight, average resistance to mummy berry fruit infection.

Rabbiteye – (a southern species; I include these for those who wish to experiment; most rabbiteye are considerably less cold-hardy, seedier, and, overall, less flavorful than highbush, but **<u>are</u>** later ripening, and thus can extend the fresh fruit season).

Coastal – An older variety. Dark and soft, but more flavorful than many other rabbiteye. Good productivity in NJ.

Montgomery – A North Carolina release. More flavorful than many other rabbiteyes, with flowery overtones. Moderately productive in NJ.

Yadkin – A North Carolina release. More flavorful than many other rabbiteyes, with flowery overtones; similar to Montgomery. Moderately productive in NJ.

Tifblue – Vigorous and productive. Relatively small fruit. Average quality.

Powderblue – Vigorous and productive. Average quality. Probably the latest-ripening rabbiteye variety with relatively consistent production in the NJ/PA area.

Specials (ornamentals and flavor notables)

Nocturne - A winter-hardy rabbiteye-type with orange/black ornamental fruit and superior quality. Origin: U.S. Department of Agriculture, Agricultural Research Service. Ripe fruit is dark (gunmetal black) and sweet (~13 brix) with an interesting flavor, like neither highbush nor rabbiteye. Ripens late-midseason to late season; fair scar; average firmness; fair storage quality; unripe fruit vivid, red-orange. Intermediate-type plant with glossy green foliage; winter hardiness comparable to northern highbush cultivars; late flowering; reliably productive under NJ conditions; probable RRSV resistance. Available in a couple more years.

Pink Lemonade - a pink-fruited specialty variety. Half highbush, half rabbiteye, therefore more southern-adapted.

Pink Champagne - a pink-fruited specialty variety. More northern-adapted than Pink Lemonade. Soon to be distributed.

Razz – a sibling of Bluecrop; a midseason variety with raspberry overtones; relatively soft fruit, mainly for home garden and PYO.

Fall Creek Farm and Nursery Varieties (commercially produced varieties, just becoming available; these comments come from nursery documents, not from public evaluations; they are available wholesale, it is unknown if they will be sub-licensed for retail sale)

Blue Ribbon - high yielding early/midseason northern highbush blueberry intended for the fresh market; ripens between Duke and Draper.

Cargo - high yielding mid to late season northern highbush blueberry; fruit releases well; high yielding; ripens Liberty season; recommended for machine harvest.

Clockwork - mid-season northern highbush blueberry for the processed fruit market; concentrated ripening; Draper season.

Last Call – high-yielding very-late-season northern highbush blueberry for the fresh market; large fruit; light blue; ripens with Aurora and Elliott.

Overtime - late season rabbiteye blueberry with excellent flavor; very little grittiness or seediness for a rabbiteye.

Top shelf - mid-season, mid-chill, jumbo blueberry intended primarily for the fresh market; very firm; strong tropical flavors and juicy texture; Draper season.

Ventura - early season southern highbush blueberry intended for hand harvest fresh markets; fruit releases easily; good machine harvest potential.

Tips for growing your own small-scale blueberries (if you don't already) – 1) raised beds 1:1 peat/sand (pH ~4.5), **2)** sunny location, **3)** good water supply, **4)** ammonium fertilizer, **5)** two varieties for cross pollination. **Bonus tip –** bird netting

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INTEGRATED MANAGEMENT OF INSECT PESTS IN BLUEBERRIES

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Here are some basic answers to common questions for implementing insect pest management (IPM) practices in highbush blueberries for the Mid-Atlantic region.

What Should I Look For?

The insect pest complex on blueberries is extensive, attacking all parts of the plant. In New Jersey, blueberries are host to over 17 species of insect pests. It is worth noting, however, that not all insects are considered pests. For example, many insects are beneficial to plants such as ladybeetles and pollinators. Becoming familiarized with different insect pests and their life histories is critical to properly monitor and control them. For instance, it is important to know the pest's feeding habits. Pests can be classified depending on where they feed as direct and indirect pests. A direct pest is one that feeds on flowers, buds, and/or fruit and can potentially reduce blueberry yield. *Direct pests* can cost severe losses if unmanaged. Examples of direct pests in blueberries include **spotted wing drosophila**, **blueberry maggot**, **plum curculio, cranberry weevil, cranberry fruitworm, and Japanese beetle**. The spotted wing drosophila is an invasive pest from Asia that has spread in the past two years from California to Oregon, Washington, British Columbia, North Carolina, South Carolina, Michigan, Virginia, Florida, and throughout the northeastern states. The greatest potential impact is expected to be in blueberries, cherries, strawberries, raspberries, and blackberries because soft-fleshed fruit are easier for the flies to lay eggs in and for larvae to develop. This pest has also been reared out of other fruit crops, and from berries of wild plants. Blueberry maggot damages the fruit. Historically, this insect has been the most important blueberry pest in New Jersey (as well as in several other blueberry-growing states in the US) because there is zero tolerance for maggot-infested fruit that is exported to Canada. Plum curculio has become an increasing problem in blueberries. This insect feeds and oviposits on young unripe fruit. Cranberry weevil adults feed and oviposit on flower buds; whereas cranberry fruitworm adults oviposit in young fruit and larvae feed inside the fruit, damaging several fruit within a cluster. Japanese beetles feed on blueberry leaves and fruit, becoming a problem due to potential contamination of harvested fruit, especially when cover crops (grasses) are planted between rows of blueberries. *Indirect pests* feed on leaves, stems, or roots and can also have some impact on yield by reducing the plant vigor or by the transmission of diseases. Examples of indirect pests include **oriental beetle**, **leafrollers, spanworms, gypsy moth, aphids**, and **sharp-nosed leafhoppers**. Oriental beetle grubs feed on blueberry roots, reducing nutrient uptake. Leafrollers, spanworms, and gypsy moth feed mainly on young shoots and leaves, but can also feed on flower clusters. Aphids are vectors of the blueberry scorch virus. Sharp-nosed leafhoppers transmit blueberry stunt disease caused by a phytoplasma. Other blueberry pests usually considered minor in New Jersey include thrips, scales, mites, blueberry leafminer, and blueberry gall midge.

You may find information on how to identify these pests and their biology and life cycles in:

- A Pocket Guide to IPM Scouting in Highbush Blueberries. 2004. Compiled and edited by: A. Schilder, R. Isaacs, E. Hanson, and B. Cline. Michigan State University Extension Bulletin E-2928.
- Blueberries For Growers, Gardeners, Promoters. 2006. N. F. Childers and P. M. Lyrene, editors. Dr. Norman F. Childers Publications.
- The Mid-Atlantic Berry Guide. 2008. K. Demchak, Coordinator. The Pennsylvania State University.

When and How Should I Scout?

Highbush blueberries can suffer major yield losses due to insect pests. Thus, understanding the insect pest's activity is key for making appropriate management decisions. Different pests are present in blueberries at different times of the plant's growth. Thus, it is important to scout your blueberry farm throughout the entire growing season. *Growers (or IPM scouts) need to visit their farm on a regular basis to monitor pest populations*. Here I provide the times, based on plant phenology, when most important blueberry insect pests are expected in commercial farms

(Table 1). The intention of this table is to give blueberry growers an idea on when to scout (in grey) and when to treat (in black), if pest populations exceed the economic threshold, for the different pests. This table *should not* be used as a guide on when to treat in a calendar basis. A scouting guide is also provided in this article (Table 2). This scouting guide provides information on how to monitor for the most important insect pests in blueberries.

What Should I Do?

In case a pest exceeds the economic threshold, treatment is recommended. Since passage of the Food Quality Protection Act (FQPA) in 1996, environmental risks associated with the use of non-selective broad-spectrum insecticides have been a major concern among pesticide regulators. As a consequence, several broad-spectrum insecticides have been cancelled, scheduled for cancellation, or being restricted for use in blueberries. This tolerance reassessment will likely impact the blueberry industry more than others because of its specialty crop status. On the bright side, more reduced-risk insecticides and organophosphate alternatives are becoming registered for use in blueberries. For a list of recommended reduced-risk insecticides and organophosphate alternatives for insect pest management in blueberries please see our recommendations at https://njaes.rutgers.edu/pubs/publication.asp?pid=e265. Reduced-risk insecticides are those insecticides with low impact on human health, low toxicity to non-target organisms, low potential for groundwater contamination, low use rates, low pest resistance potential, and of high compatibility with integrated pest management practices (http://www.epa.gov/opprd001/workplan/reducedrisk.html). Consult a county agent or an extension specialist about best treatment options for particular pests.

Table 1. Activity Periods of Blueberry Insect Pests in New Jersey

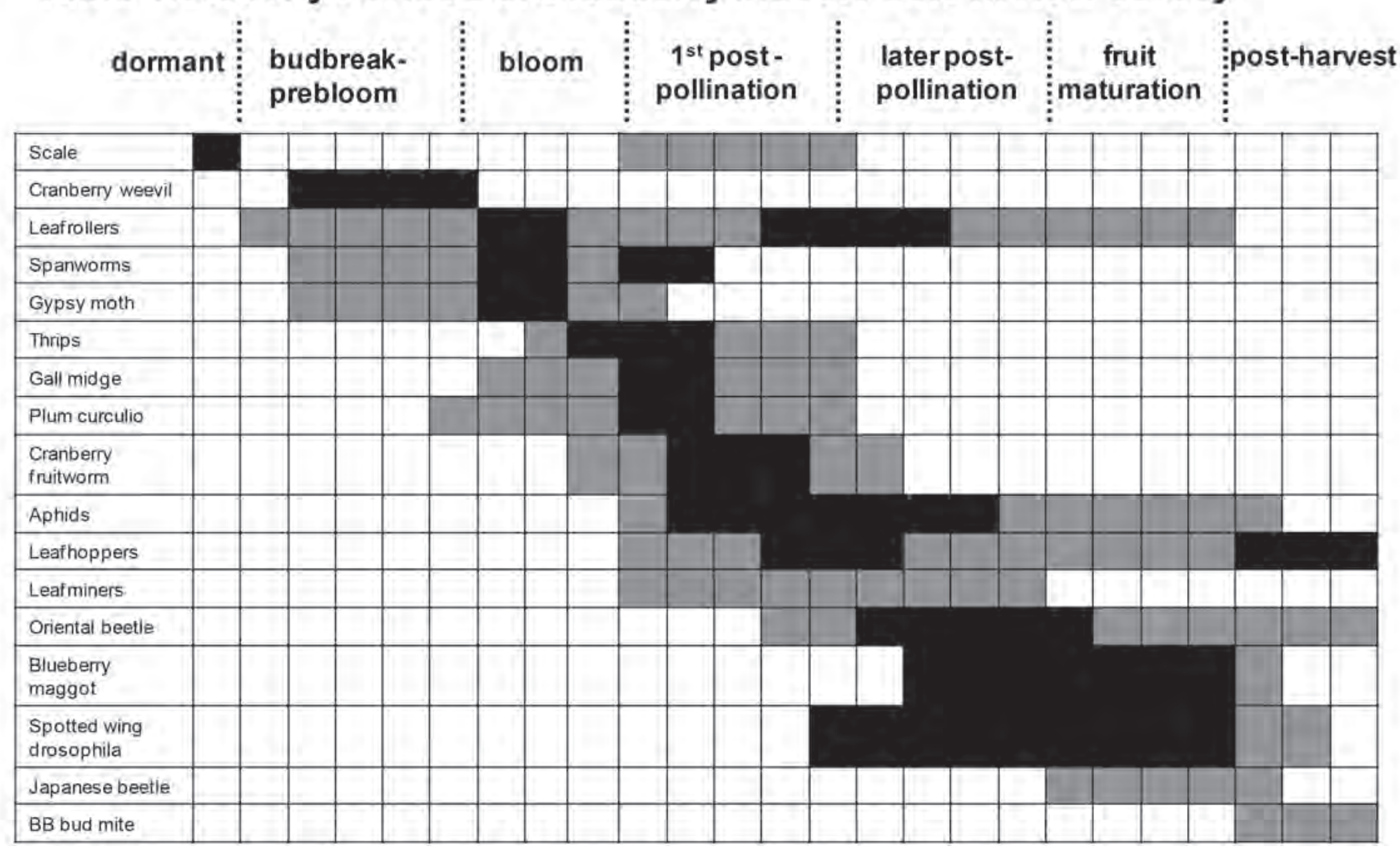

Table 2. Scouting Guide for Monitoring Blueberry Pests

Sampling Time	Pest	Method of Detection	Sampling Method	Threshold per MPA[1]
Dormant & Pre-bloom	Scales	Visual examination	10 bushes	None Available
	Cranberry weevil	Beating Tray Sampling Visual examination	10 bushes 100 VC & FC[2]	≥ 5 weevils / bush ≥ 20 % of clusters damaged
	Leafrollers, Spanworms, Gypsy moth	Visual examination	100 VC & FC[2]	1 larva / 100 clusters (combine all 3 pests)
Bloom	Thrips	Visual examination Sticky white traps	100 VC & FC[2] -	Avg 1 per cluster Timing
	Cranberry fruitworm	Pheromone trap	-	Timing
Post-bloom	Plum curculio	% injured fruit (scars)	-	None available
	Blueberry Aphid	Lower shoots	100 CS[3]	None available
	Blueberry Maggot	Baited Pherocon AM Traps Boil Test	Canada Protocol 2 Liters	1 adult Zero Tolerance
	Oriental beetle	Pheromone traps	-	Timing

1. MPA = monitored production area
2. 100 VC & FC = 10 clusters (vegetative and flower) of each from 10 bushes
3. 100 CS = 10 new cane shoots from 10 bushes

Cesar Rodriguez-Saona is the Extension Specialist in Blueberry and Cranberry Entomology at Rutgers PE Marucci Center for Blueberry & Cranberry Research & Extension, Chatsworth NJ. He conducts applied research on the development and implementation of cost-effective reduced-risk insect pest management practices and delivers educational information to growers. He received his M.S. degree in Entomology (Biological Control) from Oregon State University and his Ph.D. in Entomology (Integrated Pest Management) from the University of California, Riverside. Prior to joining Rutgers University, he worked for the USDA-ARS in Phoenix, AZ, University of Toronto in Ontario, Canada, and Michigan State University in East Lansing, MI. He is native of Lima, Peru. He and his wife Corinne have two sons Renzo and Marcello.

SEASON EXTENSION & HIGH TUNNEL USE IN PHILADELPHIA

Ryan Witmer

In the past decade Philadelphia has seen a significant increase in urban farm activities. Most of these farms are small by nature, one acre or less, and are designed to provide positive influence to the neighborhood they reside in as well as the kids they educate. Their broader role in agriculture acts as a gateway to agriculture's largest consumers and agrarian processes, allowing urban individuals to observe and engage with food production. While many farms in Philadelphia exist under this capacity there are a few small but profitable specialty farms. These include CSAs, contract growing for restaurants, and cut flower production. Many sites, regardless of the mission, now have high tunnels for the many benefits they bring. These have allowed the profit farms to become more profitable and educational farms to diversify their production styles. My speech will be covering the different farms residing in Philadelphia while also discussing their mission, production capabilities and influence on the City of Brotherly Love.

Ryan grew up farming in Ohio and later graduated from Messiah College with a degree in Environmental Studies and Public Policy. In 2008 he conducted research in Havana, Cuba, through the University of British Colombia, on the policy and formation of Cuba's urban agriculture; and in 2009 he was awarded the Murray Library Research Grant to investigate 'The Viability of Urban Agriculture in a Developed Capitalistic Country' at International Development and Research Center in Ottawa, Canada.

CAPTURING MARKET DEMAND WITH PROTECTED CULTURE

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Introduction

The importance of using various types of protected agriculture for crop culture in Florida has recently increased. Prior to the turn of the century, hydroponic culture in Florida was done inside a greenhouse structure, but now hydroponic production has expanded to several other types of protected ag structures. In addition to greenhouses, production now exists in high tunnels, insect screens or net houses, and open-shade covered structures. In southern parts of Florida, outdoor hydroponic systems without any structure are becoming much more common with an estimated 100 acres of unprotected outdoor hydroponic systems, mostly vertical systems. In those cases, many operations are prepared to use a polypropylene cover for freeze protection. Diversifying structures stems from growers' desires to extend the season to meet consumer demand for a longer time period. Most protected agriculture structures in Florida are used to extend the season in the coldest part of the year. Structures used during the cooler part of the year include traditional greenhouses, both passively and fan and pad cooled types; and unheated high tunnels. An estimated 200-300 acres of these types of structures are being used for the production of fresh fruits, vegetables, and herbs. In attempts to extend the growing season into warmer weather, shade structures have become more popular. Florida's extremely high summer temperatures make production inside greenhouses or high tunnels very difficult, even with fully operational ventilation systems. In attempts to extend the season, small growers began using open-shade covered structures to combat the summer heat. Research trials at the Suwannee Valley Agricultural Extension Center near Live Oak, Florida have been successfully conducted since 2003 to evaluate various crops and cultivars as well as production systems under an open-shade structure.

Many growers considering diversified crops and protected culture also take part in direct marketing avenues. Providing product year round is essential for maintaining customer relationships in the marketing environment. The risk-management advantage that comes with diversifying available products is equally important. For example, if the market price is not desirable or if one crop fails but others perform above average, this lessens the operation's risk, depending on volumes. Diversifying crops also allows growers to assort products into "value-added" offerings. Ultimately, the entrepreneurial grower can reap marketing and risk-management advantages when he or she diversifies crops and extends the season. The eye appealing combinations of size, color and shapes among fruits, vegetables, and herbs at local market displays make traditional and non-traditional crops popular among consumers. Many small operations have been successful with a crop diversification approach when selling directly to consumers at farmer's markets or other retail markets. High quality greenhouse tomato, cucumber, or pepper accompanied with lettuce, cut flowers, baby squash, strawberries, herbs, and specialty leafy greens and other vegetables can make a great crop mix at a local market for a small, but talented greenhouse grower. For additional reading on many of these crops being researched and grown in Florida greenhouses, see the following links: http://smallfarms.ifas.ufl.edu/crops/hydroponics/index.html.

Most of the recent expansion of protected ag in Florida and in most other eastern US states has been for smaller growers who choose to market their products directly to the consumer. Most small farmers, in fact are direct marketers. Direct marketing refers to selling that is based on a personal, one-to-one relationship that ties farmers and consumers together. Many times this relationship is face-to-face, like at farmers' markets. Other times, the consumer and farmer may not actually meet, for example, on Internet sales. This section of this report is taken from An Overview of Small Farm Direct Marketing (http://edis.ifas.ufl.edu/fy597).

How is direct marketing different from traditional (commodity) marketing?

The goal of traditional marketing is to sell a commodity. Direct marketing focuses on marketing product differences. This mindset shift to direct from traditional marketing is the fundamental difference between these marketing strategies. Commodity products are treated as if there is no difference between them: all No. 1 watermelons are the same. Because there is not much product differentiation, commodity items are sold on a price basis. On the other hand, instead of ignoring product differences, direct marketing relies on differentiation. The idea is that neither products nor consumers are identical; products vary with consumers' unique tastes and preferences. Farmers who are successful at direct marketing profit from these differences (niches), rather than compete solely on price.

How can small scale, protected agriculture, farmers use direct marketing to their advantage?

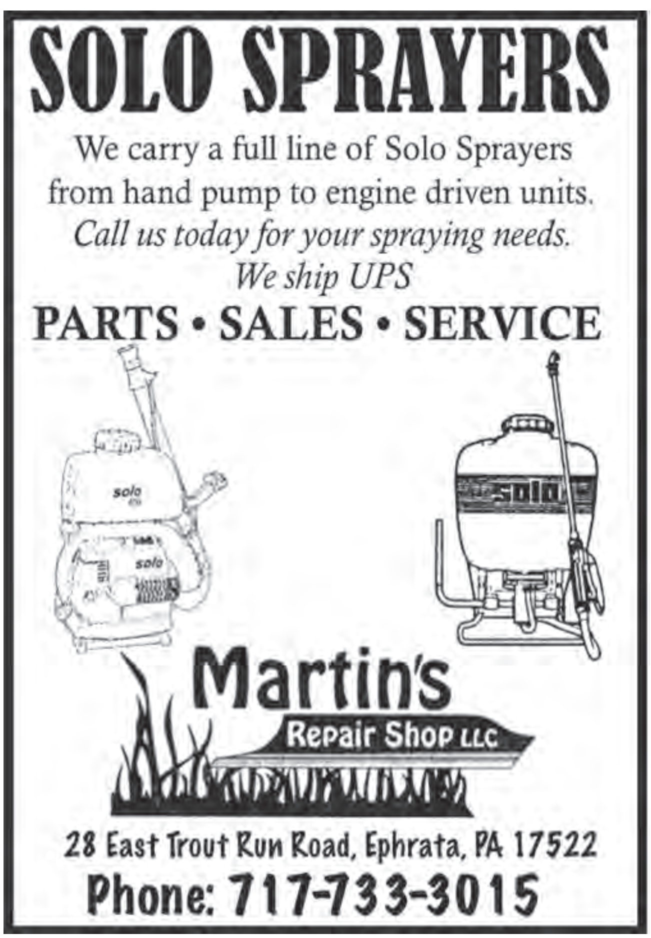
Competing solely on price is rarely feasible for small scale farmers. Farmers who accept the lowest price for their products must have the lowest costs. Larger farms can almost always produce high volume, uniform products more cheaply than smaller farms. While small farmers cannot effectively compete with large scale operations on price, their businesses are uniquely positioned to compete on other, non-price factors. Competing on non-price factors means that farmers must offer their customers something they want but cannot buy at the grocery store, or anywhere else. Differences can include freshness, convenience, flavor, variety, and novelty. Protected ag offers other advantages in that growers can: be a more consistent supplier for a longer period of time, offer local products at a time when those products are not available in the open field, and provide unique products in a geographic area where they are not normally grown at all.

What are some examples of direct marketing alternatives suitable for small farmers?

There are a variety of ways that small scale farmers reach their customers with direct marketing. Some may be more suited to your farm and products than others. For many farmers, a combination of several marketing outlets is effective. Specific examples of direct marketing strategies include:

- U-pick
- Roadside stands
- Farmers' markets
- Community markets
- Retail outlets
- Chefs and restaurants
- Internet or mail order
- Cooperative marketing
- Auction markets
- Agri-tainment or agri-tourism
- Community Supported Agriculture (CSA) or subscription
- Institutional sales

Robert (Bob) Hochmuth is a Multi-county Extension Agent with the University of Florida. His position is 50% multi-county in nature supporting commercial vegetable Extension programs in nine counties in the Suwannee Valley area of Florida, centered around the Suwannee Valley Agricultural Extension Center (SVAEC) near Live Oak, Florida. The overall responsibility is the development and implementation of educational programs for commercial field and greenhouse vegetable producers that will increase their knowledge of production, incorporating principles of efficiencies, profitability, and environmental awareness. The position's other 50% of responsibility is to serve as the statewide co-coordinator for educational programs in the area of small farms, including leadership in the Small Farms and Alternative Enterprises Conference, the Small Farms Web Site, UF Small Farms Academy, Regional Small Farms Conferences, and County Extension Agent In-Service Trainings. Bob was raised on a vegetable farm on the Eastern Shore of Maryland and received a BS degree in Extension Education and MS degree in Entomology; both from the University of Maryland. He also served as an Extension Agent in Kent County Delaware from 1982 to 1988. Bob and his wife Terri raised twin boys, Scott and Lee who are both married and pharmacists in Florida.



EXTENDING VEGETABLE HARVEST AND SALES USING TUNNELS, ROW COVERS AND WINTER STORAGE

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In response to increasing demand for local vegetables through the winter months, growers are expanding the use and diversity of protective growing structures, as well as increasing production and storage of root vegetables. From 2010 to the present, UMass Vegetable Program has partnered with Univ. of New Hampshire Cooperative Extension and two buy-local marketing organizations, CISA and Seacoast Eat Local, to investigate and support production and marketing during the months of December through April.

Row Covers are used in fall and spring to raise air and soil temperatures, and to protect from frost and winds. In the fall, crops gain additional weeks to reach harvest or remain marketable, starting with frost sensitive crops such as eggplant or pepper and ending with hardier lettuce, broccoli, bok choy, spinach, and sometimes root crops. In spring, row covers without hoops are frequently used on salad mix, lettuce, and early Brassicas to provide heat as well as insect protection. With hoops and plastic, summer squash and zucchini transplants can go out in late April or early May depending on the season; and eggplant, pepper, or tomato can get an early start. Row cover weights are generally 0.55 oz/sq yd or slightly heavier. Less often, wide sheets of heavier covers are used for overwintering hardy crops such as carrots or spinach for early spring growth.

Low Tunnels are temporary, small (4-8 ft tall, 5-10 ft wide) unheated structures with hoops made of PVC or metal conduit, covered with various materials. While low tunnels afford less winter protection than high tunnels and access is limited after snowfall, they can be erected for $0.50-$1.00 per square foot, estimated to be 5% of the cost of a 4-season greenhouse or 15-30% of the cost of an unheated high tunnel. They are easily moved, simplifying rotation of winter production areas. While these may be used for late fall harvests (November and December) they also are designed to carry snow and provide protection through the winter for regrowth in March and April, targeting an April–June harvest depending on the crop. They need to be in place before the ground freezes, as the most reliable way to secure the plastic is soil mounded along the edge. Over the past 4 years, UMass has partnered with UNH to test various coverings, crops, varieties and plant dates for optimal spring harvest. Our studies found that an inner layer of heavy (1.25 oz/sq yd) row cover with outer layer of 0.6 ml IR greenhouse plastic (RCGH) gives greater protection from cold than a row cover with perforated plastic or double row cover. In studies of tunnels from central NH and western MA to southern RI, the winter minimum temperature in the RCGH tunnels ranged from 20 to >40°F higher than outdoor temperatures, and soil T rarely dropped below freezing. This combination also provides flexibility in spring when sun returns and T can rapidly exceed 95ºF. Removing the plastic while leaving the row cover layer gives the protection needed for tender new growth that burns easily in dry, cold spring winds, and can also get the crop through cold spells or snowfall in March. As a general rule, crops tend to bolt more rapidly in spring if planted too early, but yield less if planted too late. Onions, seeded in August or September and transplanted in October and grown on to be harvested green or as early bulb onions are one of our most successful low tunnel crops. Spinach and kale, both Winterboror Siberian kale types also do very well. *Brassica rapa* type greens (bok choy, mizuna) bolt too quickly when overwintered in low tunnels and beets do not survive well so neither are recommended for low tunnels. Carrots are very promising(cv Napoli is often used) ; in 2012-13 UMass trials an early October seeding date gave us the best yield of fresh spring bunching carrots, but the best date will depend on your location and the season.

Caterpillar Tunnels are temporary, movable structures using steel or PVC bows set in or over ground posts, creating 10 to 15 ft wide space that covers 1 to 3 growing beds. Bows are generally 6-8 ft apart and 20 ft long. Diagonally crossed ropes linked to tie-downs bolted into the base of the ground posts, and plastic gathered tightly and staked at each end are key to structural integrity. Cost per sq ft is under $1.00, cheaper than high tunnels with excellent net income potential. They are typically used in spring, summer and fall but more recently in New England are being used to carry crops through the winter. They allow for 2 to 4 succession crops per season, moving from cold hardy greens or roots to heat-loving crops (fruiting vegetables, flowers), or the reverse, as the season progresses. Black plastic, inner row covers and use of transplants give additional boost to survival and growth. Ventilation and access are accomplished by raising the sides. Yields and quality are enhanced as is winter survival. Advantages over low tunnels are winter access and more heat and cold buffering; these tunnels can however suffer from wind and snow damage and require more attention to structural integrity for winter use.

High Tunnels, which typically have no permanent furnace or end-wall fans, use passive ventilation through roll-up sides and end or peak vent, and grow crops in the ground, are well known in the mid-Atlantic region. They are used widely to gain an early start or continue later in the fall with summer crops. For winter production, a gothic shape with high vertical sides is needed to shed snow and diagonal bracing is key to handling a snow load. A double inflated plastic system protects the plastic and adds insulation. An interior row cover (one or more layers) 18-30 inches above the crop, supported by hoops or rails, helps hold in the heat that builds up during sunny days and moderates cold nights but is opened on all but the coldest, cloudy days. Ventilation in winter is through end vents. Often growers build up their supply of greens in the fall, then pick them down during the December and January 'dead zone' of shortest days and lowest light. Growth rates pick up by the beginning of February for overwintered and newly seeded crops. Crops that can handle the repeated freezing of a winter high tunnel include spinach, Siberian kale, bok choy, Tatsoi, and chard. Movable tunnels provide options for crop rotation and succession plantings making best use of the protective cover; for example, keeping fall tomatoes covered longer, while greens get started in the open or under row cover.

Storage. Good postharvest handling (including curing) and proper storage conditions make it possible to store and sell root crops that can only be grown in the summer months. Ideally, farms should have four storage units, each with specific temperature and RH conditions (see Figure 1) for crop groups. The 'cold moist' group also includes cabbage, Brussels sprouts, celeriac, turnips, and rutabaga. It is important to manage RH as well as T. Growers who are scaling up their winter sales often start with smaller, more basic storages and build better infrastructure over time. Ambient air can be used for cooling, especially with thermostatically controlled intake fans, but may not provide the rapid cooling needed in fall and the steady cold needed in spring for best crop quality. We have found that a 'good enough' storage (eg 34-38 ºF for the 'cold moist' group can carry crops till February or March while ideal conditions will take crops till May or June. For sweet potato and winter squash, preventing cold injury by keeping temperatures above 50 to 55 ºF is critical.

Carrots, beets	Cold Moist	32-34°F and 98-100% RH.
potatoes	Cool moist	40-45°F and 95% RH
squash, sw potato	Warm, dry	55-60°G and 50-70% RH.
onion, garlic	Cold Dry	32°F and 65-70% RH

Figure 1. Storage Conditions Needed for Vegetable Crop Groups

Summary. To meet the demands of winter CSA's and farmers markets and year-round wholesale, New England farmers are putting together a fairly complex system of growing structures and storage units. Meeting the needs of winter markets requires changing your planting schedules, labor force, and and your way of thinking about the six month period from October to March. Winter production and sales is not for everyone, but for some growers it provides a chance for the farm to expand, an increased winter income, a year round labor force, and a more balanced yearly workload.

This work was supported in part by Northeast SARE Project No. LNE10-297. More information can be found at http://extension.umass.edu/vegetable/projects/winter-production-storage-sales

See also articles by Becky Sidemann, including
http://extension.unh.edu/resources/files/Resource003239_Rep4688.pdf

Ruth V. Hazzard works for University of Massachusetts Extension as an Extension educator and researcher in ecological pest management and vegetable cropping systems. She grew up in upstate New York and earned her BA from Goddard College in 1979. Since getting her MS from UMass Amherst in Entomology in 1989, she has worked with both organic and conventional farmers throughout New England on integrated pest management strategies in vegetable crops. Her focus in recent years has included production systems for winter harvest and sales of vegetable crops, including experiments with fall carrots, storage systems, and low tunnels. She started the year-round Student Farming Enterprise program, now in its 8th year, which gives UMass students practical experience in growing and marketing organic vegetables. She and her husband have four grown children, and recently built a home next to the North Amherst Community Farm in Amherst where they are establishing fruit and vegetable gardens and a high tunnel.

MAXIMIZING YIELD THROUGH USE OF PROPER IRRIGATION MANAGEMENT

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Yes, even in Pennsylvania where we do get rain, timely irrigation is extremely important to maximize the production of Cole crops such as, broccoli, Brussels sprouts, cabbage, cauliflower, collards, kale, and kohlrabi. Why? Because there are periods when we do not get timely rain and need to supplement Mother Nature with some irrigation. These are considered cool-season vegetables that prefer 60° to 70°F temperatures for optimal growth and can withstand light frosts without injury. All these crops certainly need consistent water during their entire life span, especially during head or root development.

If we look at the production of broccoli and cabbage, we can see that it can be grown successfully on bare ground with overhead irrigation, bare ground with drip irrigation or using black plastic mulch and drip irrigation. Either system can provide excellent results but the drip irrigation system will certainly reduce the amount of water used and lessen the disease pressure on the crop. The use of plastic mulch and drip irrigation certainly conserves moisture and uses it most effectively by application of precise quantity of water directly to the root zone of the crop at right time. Irrigation efficiency with drip systems ranges from 75-95% compared to; 70-80% solid set sprinklers and 65-75% for portable sprinkler systems.

Broccoli for instance is a succulent plant, which requires continuous, rapid growth for high yields and good quality. Uneven soil moisture will adversely affect growth. Therefore it is important to irrigate with overhead or drip irrigation to maintain a constant supply of moisture.

That could mean supplying 1 to 1.5 inches of water per week. Using an overhead irrigation system to apply an inch of water to an acre of crop would mean applying 27,560 gallons of water. If using a drip irrigation system with the following considerations that a double row of broccoli or cabbage on 30 inch wide raised beds spaced 6 feet apart with one drip line buried 3 inches down the center of the bed between the double rows similar to peppers the amount of water to apply an inch would be 13,780 gallons. The water saving is obvious. Plus if using a tightly dome shaped head of broccoli even if natural rainfall is available the water will be shed off the head. That is why it is best to avoid flat shape heads that will trap water on the indentation at the center of the head.

As an example, I will assume that one will be using drip irrigation with or without plastic mulch when talking about broccoli production. Many factors influence appropriate drip irrigation management, including system design, soil characteristics, crop and growth stage, environmental conditions, etc. The influences of these factors can be integrated into a practical, efficient scheduling system, which determines quantity and timing of drip irrigation. This system combines direct soil moisture measurement with a water budget approach using evapotranspiration estimates and crop coefficients.

The advantage of drip irrigation is that it offers the potential for precise water management and divorces irrigation from the engineering and cultural constraints that complicate sprinkler irrigation. It also provides the ideal vehicle to deliver nutrients in a timely and efficient manner. However, achieving high water- and nutrient-use efficiency while maximizing crop productivity requires intensive management. Central to that management is appropriate irrigation scheduling, both in terms of timing and volume applied. A further discussion will focus on the practical aspects of drip irrigation management for commercial cole crop production.

There are two basic approaches to scheduling drip irrigation: soil-moisture-based scheduling and a water-budget-based approach that estimates crop evapotranspiration. There are limitations to both methods, but when used together they are a reliable way to determine both quantity and timing of drip irrigation.

Accounting for non-uniformity

The estimate of irrigation requirement must be increased to account for the non-uniformity of the drip system; no system delivers water with complete uniformity, and irrigation should be geared to meet the crop need in the driest part of the field. In general, the basic irrigation calculation should be increased by 10-20% to compensate for non-uniformity of the system. If distribution uniformity of the system is less than 80% the cause of the non-uniformity (emitter plugging, design flaws, etc.) should be addressed rather than simply increasing the volume of water applied, since over irrigation in the high flow area can be as damaging as deficit irrigation.

Irrigation frequency

A water budget scheduling system estimates the volume of water required, but it does not suggest with what frequency it should be applied. It is difficult to generalize about drip irrigation frequency, because there are a plethora of factors to consider (crop, root depth and distribution, soil water holding characteristics, drip wetting pattern, degree of automation, etc.). However, two basic rules can simplify the issue:

1. Deplete no more than 20-40% of available soil moisture in the most active root zone.
2. Limit individual applications to approximately 0.5 inches or less. This limits the degree of root zone saturation after application and minimizes the amount of applied water likely to drain below the active root zone.

Irrigation frequency will vary, depending on crop growth stage and site-specific variables. Typically, frequency may be once every 5-7 days early in the season, increasing to daily or every other day during peak water demand.

- Using low beds that minimize the depth of the drip lines.
- Forming tightly pressed beds, which improves capillary water movement.
- Irrigating often, using high-flow tape or tubing if possible. It is particularly important on heavy soils not to let the soil above the drip line dry out, because reestablishing capillary wetting is difficult.

Use of plastic mulch

Drip irrigation is commonly used in conjunction with polyethylene bed mulch. Significant effects of mulch on irrigation demand are relatively modest and generally confined to the early weeks of a growing season, before the plant canopy covers the wetted soil surface, if any (with buried drip systems the wetting pattern may or may not reach the surface). Scheduling early-season irrigation based on soil moisture depletion will work equally well for mulched or bare-soil cropping systems. Once a substantial crop canopy is established, mulch effects on crop water demand will be negligible. However, the use of plastic mulch can change the wetted area of the bed. By nearly eliminating evaporation from the soil, and by trapping condensate, mulch tends to keep the surface soil moist; by comparison, with buried drip systems on bare soil beds, the top 2-4 inches of soil may dry over time, even though crop water demands are being met. This has implications for fertilizer management because the surface soil is generally the richest in P and K availability.

Direct soil moisture monitoring

There can be several significant sources of error in the irrigation scheduling system previously described. Each site, soil type, and season is unique. Direct soil moisture measurement is the essential safeguard to avoid over- or under-watering, both of which can compromise the benefits of drip irrigation. Of the common soil moisture monitoring techniques available, the use of tensiometers is one of the best for monitoring drip irrigation. Despite substantial cost and the need for maintenance, tensiometers can provide crucial information.

The first consideration is tensiometer placement. One set of instruments should be placed in the zone of most active root uptake. Depth will depend on the crop; shallow-rooted crops like celery or lettuce should be monitored at 8-10 inches, whereas tomato and vine crops are evaluated best at 12-15 inches. It is also important to understand what is happening to soil moisture at lower depths; another set of instruments installed 8-12 inches below the shallow set will provide this information. To be sure that representative readings are obtained, tensiometers at each depth should be installed at several locations in a field, because no irrigation system is totally uniform, nor are field soils homogeneous.

Correct interpretation of tensiometer readings is critical. To understand exactly what the readings mean, one would need to know the soil moisture release curve for each field being monitored. Few growers have access to that information, so generalizations must be used. Optimum soil moisture usually is assumed to be near field capacity (the maximum amount of water a soil can hold against the force of gravity). In most sandy soils, soil matric potential at field capacity is between 7-12 centibars (cb), in loam soils between 12-20 cb. In coarse- to medium-textured soils, tensiometer readings at 20% available moisture depletion are 10-15 cb higher than at field capacity; this means that for stress-sensitive crops, irrigation should commence before tensiometers exceed 17-22 cb in sandy soil or 22-30 cb in loam or clay loam soil. Some studies suggest that in sandy soil, optimal drip irrigation management requires maintenance of soil moisture tension near field capacity.

Shallow tensiometers indicate the moisture status of the active root zone; the deeper instruments indicate whether the amount of water applied is correct. After an irrigation, deep tensiometer readings should go down near, or even below, field capacity. If they do not, it means the application was too light. Between irrigations the deep tensiometer readings should come back up near, or slightly above, field capacity, indicating that deep roots are not permanently saturated. Failure of deep tensiometers to rebound between irrigations means that either the application is too heavy, too frequent, or there is restricted drainage, which is preventing movement of gravitational water.

Another useful soil moisture monitoring tool is the portable soil capacitance probe. It works by emitting a radio frequency wave and measuring the attenuation of the wave by the soil around the probe tip. This instrument is best suited to compare the relative water content of different areas or soil depths, identifying under- or over-irrigated areas. It is a tool to augment, not replace, tensiometers. The major advantages of the soil capacitance probe are its portability and quick response time. A major limitation is that it can be difficult to insert the instrument deeper than 12 inches in many field situations, particularly in multiple crop drip installations where deep tillage is not practiced routinely.

Dr. William J. Lamont Jr. is a Professor and Extension Vegetable Crops Specialist in the Department of Plant Science at Penn State University. He was born and raised in rural Pennsylvania and obtained two undergraduate degrees, one in Economics and Business from Lebanon Valley College and one in Horticulture from Delaware Valley College. He earned his M.S. and Ph.D. degrees from Cornell University. Dr. Lamont has an extensive background in research, extension and teaching. In his current extension position Dr. Lamont is responsible for the culture and management of vegetable crops. He has worked at North Carolina State University and Kansas State University prior to coming to Penn State in 1997. He and his wife Phyllis reside on 28 acres of land near McAlevy's Fort, PA.

COLE CROP DISEASE MANAGEMENT 101: DOWNY MILDEW AND BLACK ROT

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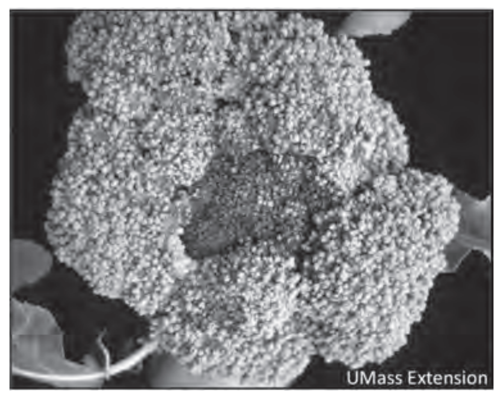
As cole crop acreage continues to increase across the region so has the incidence and severity of the two potentially devastating diseases, downy mildew and black rot. Both these diseases affect a wide range of cole crops (also known a brassicas) including broccoli, Brussels sprouts, cabbage, cauliflower, turnips, mustards, etc. There is some degree of resistance or tolerance to these diseases in some cole crops. See the 2014 Commercial Vegetable Production Recommendations for an updated list of recommended varieties for our production region. Below is specific information on the identification and management of each of these diseases.

DOWNY MILDEW on cole crops is caused by the oomycete pathogen *Hyaloperonospora brassicae* (formerly known as *Peronsopora parasitica*). This pathogen can infect many plants in the brassica family. Similar to downy mildew on other vegetable crops, this pathogen favors cool wet weather (optimal temperatures are 50 to 59°F and daytime temperatures below 75°F) which is common early in spring when early plantings are young and later in the growing season on mature fall crops. On the leaves, purple to yellowish-brown spots/lesions will develop on the upper leaf surface and under favorable conditions, grayish-white sporulation will become visible on the lower leaf surface. Younger leaves may yellow and drop-off while older leaves may become tan and leathery. Stems can also become infected and develop lesions on the surface and brown streaking internally in the vascular system. Downy mildew can outright kill young plants and can infect the heads causing small, dark sunken spots which then become perfect points of entry for bacterial pathogens to cause soft rots.



The pathogen survives overwinter as mycelium on crop residue and as thick-walled oospores in the crop debris. The spores that are produced on the lower leaf surface can be carried between plants or longer distances (similar to cucurbit downy mildew) by the wind or are splash dispersed by rain. There is some evidence that the pathogen may be seed borne but it is currently not thought to be an important source of the pathogen.

Manage this disease by practicing a 3-year rotation out of cole crops and manage weeds especially mustards both in and around the field. Disc under crop residue to facilitate rapid decomposition thus, reducing the ability of the pathogen to survive. Manage downy mildew on transplants by improving air circulation, minimizing overhead irrigation and leaf wetness and using fungicides. Scout regularly and rogue out the initial symptomatic plants to reduce the spread of secondary inoculum. Fungicides recommended for downy mildew on other hosts including Presidio, Revus, and Zampro are also recommended on broccoli and other cole crops. In addition, FRAC code 11 fungicides like Cabrio and Quadris are recommended because the pathogen has not developed fungicide resistance like with cucurbit downy mildew. Actigard, which functions to boost the defense response in the plant, is also recommended but should be applied preventatively or tank-mixed with another effective fungicide with the onset of symptoms.

BLACK ROT on cole crops is caused by the bacterial pathogen *Xanthomonas campestris* pv. *campestris* and has been a common problem for growers for over 100 years. It is primarily a disease of the above ground portion of the

plant however, the bacteria can enter through the roots and move systemically within the plant. Plants can become infected at any stage of growth. Typically symptoms initially appear at the margin of the leaves where the bacteria enter into the hydathodes (natural opening) located along the leaf edge. However, the bacteria can also enter through wounds following heavy rain, hail, insect feeding or mechanical injury. Depending on the weather conditions, symptoms may be visible within 8 to 12 days or it may take up to 40 days for symptom expression. Foliar lesions are usually yellow and V-shaped from the leaf margin towards the mid-rib. As the disease progresses, the veins in the yellow tissue will become dark in color and can extend from the leaves into the main vein. Optimal conditions for disease development are higher temperatures from 77 to 86°F and free moisture either from rain, fog, dew or irrigation. Extended periods of warm wet weather favor rapid pathogen spread and disease development.

The bacterial pathogen can survive from season to season in crop residue, cruciferous weeds and on seed. The bacteria are not thought to survive long in the soil in the absence of host tissue. The bacteria associated with the seed will infect the cotyledon leaves (first leaves following germination) and then the first true leaves through the hydathodes. As the bacteria multiply inside the leaf they move through the xylem (water conducting tissue) towards the stem. During the growing season, the bacteria are moved between plants through rain or irrigation splashing, blowing of detached leaves, insects, cultivation equipment or people working in the field especially when the plants are wet.

Since seed can be an important source of the pathogen, it is important to plant high quality, pathogen-free seed. As few as 2 or 3 infected seeds in 10,000 are enough to cause a serious epidemic. Hot water seed treatment can help eliminate bacteria from the surface of the seed and under the seed coat (broccoli and cauliflower at 122°F for 20 min) however, cole crop seed is prone to seed coat splitting and needs to be planting promptly. Also keep in mind that many seed companies to a grower out of 50,000 seed per lot to screen for bacterial diseases like black rot and that treating the seed will void any agreements made with the seed company regarding seed performance. Surface disinfesting the seed with sodium hypochlorite will help minimize bacteria on the surface of the seed but not under the seed coat.

Once planted in the field, copper is the primary management tool and provides minimal efficacy when conditions are favorable so the emphasis needs to be placed on management prior to planting. Scout transplants and rogue symptomatic ones as well as those in the surrounding flats which are likely infected but not yet showing symptoms. Keep the transplant production area clean and disinfest transplant trays and other equipment between uses. Harden plants off by reducing water and fertilizer rather than by topping them mechanically. If you are not growing your own transplants talk with your supplier to understand what measures he/she has in place to manage black rot. In the field, rotate a minimum of three years between cole crops to allow the crop residue to thoroughly decompose and eliminate cruciferous weeds in and around the field which can harbor the bacteria. Implement practices that reduce potential leaf wetness and water splash during the season and avoid field activities when the plants are wet. As will bacterial disease on other vegetable crops, fixed copper will help slow disease spread in the field from splash dispersed bacteria but will not help manage disease development once the bacteria are inside the plant.

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FOOD AND CULINARY TRENDS THAT VALUE-ADDED PRODUCERS SHOULD CAPITALIZE ON

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The palate of the American consumer is always evolving and changing. Value-added producers need to scan the horizon daily looking for emerging food and culinary trends that they can capitalize on in the marketplace. In some cases emerging food trends may be short-lived which serves to limit the engagement of the entrepreneur in the market because of risk. In some cases, the trend evolves more quickly than the supply which leads to value-based pricing in the marketplace. When value-based price exists, the value-added entrepreneur can reap large profits until the product/supply catches up with consumer demand.

Each year food and beverage consultants, market researchers, and chefs affiliated with the American Culinary Federation publish a listing of the food and culinary trends that they expect to be "hot" for the New Year. While there is a great deal of research that goes into developing these trend-lists, there are sometimes major disconnects between the researchers and the American consumer. As an entrepreneur, it usually good to be the first at something, but if you guess wrong and the market doesn't develop as forecasted, it could lead to serious financial consequences for the farm business.

Here is a listing of some of the 2014 anticipated culinary trends and my analysis of how a value-added entrepreneur may capitalize on this particular trend.

Trend	How to Implement
Health Halo	Focus on products that are natural, chemically free, gluten-free, and antibiotic free. Consider value-added products that have elevated anti-oxidant levels.
Farm or Estate Branded	American consumers are socially conscious and are distrustful of large corporations. Consumers want locally sourced products from environmentally sustainable farms. Farm/ Estate Branded products appeals to the belief structure of the Generation Y consumer.
Non-wheat noodles/ pasta and ethnic flours	Consider utilizing quinoa, rice, buckwheat, Khorasan wheat (Kamut), peanut, millet, rice, spelt, amaranth, barley, fufu, teff, and cassava/yucca as a flour source. Many of these "exotic" grains may appeal to ethnic segments of the market and to customers focused on the health halo.
Ethnic condiments	America remains a melting pot and Generation Y is one of the most culturally diverse generations that we have witnessed yet. The appeal of various ethnic condiments can be tied to our ethnic diversity and a global society that travels widely.
Pickled vegetables	American consumers want sustainable farms and locally grown products. Pickling prolongs the shelf life of the local produce and insures a healthy alternative to produce being produced out of season. Many farm–to-table restaurants feature a wide range of pickled vegetables on their menus throughout the year.
Natural sweeteners	Honey, concentrated fruit juice, sorghum syrup, and maple syrup are welcome alternatives to cane sugar or corn syrup. Entrepreneurs should emphasize the usage of whole fruit in jams and jellies and other fruit-based products.
Fruits- Exotic, Super, & Heirloom	American consumers interested in the "health halo" want fruits with high anti-oxidant levels. Some consumers have a somewhat romanticized view of heirloom fruit varieties. Essentially these consumers want a non-GMO fruit that connects them to their past. Multi-culturalism, international travel, and our global economy fuel demand for exotic fruits in the market.

FSMA AND ITS IMPACT ON VALUE-ADDED FARM PROCESSORS

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Introduction

Mid-Atlantic agriculture is experiencing increases in smaller agriculture enterprises, such as vegetable, fruit, greenhouse, and other production operations. As this trend of increasingly diverse agricultural production continues producers are finding new ways to add value to their products. This is critically important to be able to sustain their farms.

Penn State Extension is providing business, marketing, and other important management skills training to assist the agriculture entrepreneur start new businesses or expand existing ones. Understanding safe food processing and the impact of the Food Safety Modernization Act (FSMA) is another very important aspect to these entrepreneurial activities and will be highlighted in this presentation.

What is FSMA?

High-profile outbreaks of foodborne illness over the last decade and data showing that such illnesses strike one in six Americans each year have caused a widespread recognition that a food safety system that prevents food safety problems in the first place - not a system that just reacts once they happen. FSMA was signed into law on January 4, 2011, to better protect public health by helping to ensure the safety and security of the food supply.

FSMA is the first major update of federal food safety laws since 1938. FSMA gives the Food and Drug Administration (FDA) broad new powers to prevent food safety problems, detect and respond to food safety issues, and improve the safety of imported foods. The signed Act covers food safety from farm to fork with 19 key provisions.

Proposed Rules with Most Impact on Farms

For the first time, FDA has a legislative mandate to require comprehensive, science-based preventive controls across the food supply. Among the many rules FDA has proposed since January 2013, the two with the most impact on value-added farm production are **Produce Safety Standards** and **Preventative Controls of Human Food**. The Produce Safety Standards Rule establishes science-based standards for growing, harvesting, packing and holding produce on domestic and foreign farms. The focus of this presentation will be on how the proposed Preventative Controls rule may affect farm processors.

The proposed **Rule on Preventative Controls for Human Food** focuses on preventing problems that can cause foodborne illness. This would apply to many domestic and foreign firms that manufacture, process, pack or hold human food. These firms would be required to have written plans that identify potential hazards, specify the steps that will be put in place to minimize or prevent those hazards, identify monitoring procedures and record monitoring results and specify what actions will be taken to correct problems that arise. FDA would evaluate the plans and continue to inspect facilities to make sure the plans are being implemented properly.

Who would be affected?

Facilities that manufacture, process, pack or hold human food. In general, with some exceptions, the new preventive control provisions would apply to facilities that are required to register with FDA under FDA's current food facility registration regulations, i.e. manufacturers, processors, warehouses, storage tanks, grain elevators and some, but not all, on-farm processing.

What would be the proposed requirements?

Each covered facility would be required to prepare and implement a written food safety plan that includes what FDA collectively terms as "Hazard Analysis and Risk-based Preventive Controls" (HA/PC). The HA/PC Plan would include the following:

- A hazard analysis
- Written preventive controls plan that includes process, sanitation, and allergen controls
- Monitoring procedures
- Corrective actions
- Verification activities
- Recordkeeping

I have a Farm – Does the Proposed Preventative Controls Rule Affect Me?

The answer to this question begins with determining if you have a "farm", which is exempt from FDA's food facility registration, or a farm "mixed-type facility", which is required to register. Facilities that do not have to register with FDA, such as farms, retail food establishments, and restaurants, are not subject to the requirements for Hazard Analysis and Risk-based Preventive Controls (HA/PC) in the Proposed Preventive Controls Rule for Human Food.

Definition of a Farm

A farm is defined as a facility in one general location devoted to the growing and harvesting of crops, the raising of animals (including, seafood) or both. The term "farm" includes:

1. Facilities that pack or hold food, provided that all food used in such activities is grown, raised or consumed on that farm or another farm under the same ownership, and
2. Facilities that manufacture/process food, provided that all food used in such activities is consumed on that farm or another farm under the same ownership.

Definition of a Farm Mixed-Type Facility

A farm mixed-type facility is an establishment that grows and harvests crops or raises animals and may conduct other activities within the farm definition, but also conducts activities that require the enterprise to be registered with FDA. Because of a number of exemptions, some farm-mixed type facilities are subject to the HA/PC requirements, and some are not. Examples of manufacturing/processing activities carried out by mixed-type facilities that would be subject to the Preventive Controls requirements (unless your facility is subject to one of the exemptions mentioned below), including:

- Cutting/ chopping/slicing produce
- Freezing produce
- Canning acid or acidified foods
- Drying that creates a distinct commodity, such as drying grapes to make raisins

Exemptions and Limitations

There are a number of limitations and exemptions that are likely to apply to many farm mixed-type facilities. First, activities within the definition of “farm,” including farm activities that are covered by the Proposed Rule on Produce Safety, are not subject to the Proposed Rule on Preventive Controls for Human Food. So even though a farm mixed-type facility must register, the activities it conducts within the farm definition would not be subject to the HA/PC requirements even if other activities are.

Next, there is a proposed exemption form HA/PC requirements if you are a small or very small enterprise and the only activities your farm mixed-type facility conducts are certain on-farm low-risk manufacturing/processing activities on specific foods, e.g. jams, jellies and preserves from acidic fruits, making maple syrup, and shelling peanuts and tree nuts. FDA defines a small enterprise as one employing fewer than 500 persons. Three options are currently being considered for the definition of a very small business—less than $250,000, less than $500,000 or less than $1 million in total annual food sales. There is also a proposed exemption if the only activity the farm mixed-type facility does is storage of non-fruit or vegetable raw agricultural commodities that are intended for further distribution or processing, e.g. storage of grain or unpasteurized milk.

If the farm mixed-type facility is a “qualified facility,” then it would be subject to modified requirements. A qualified facility is one of the following:

- A very small enterprise
- A facility that on average over the previous three years has less than $500,000 in annual value of food sold AND the majority of the food is sold directly to “qualified end users.” (These are consumers in any location or a restaurant or retail food establishment in the same state or within 275 miles of your farm mixed-type facility.)

“Qualified facilities” would be required to submit certain documentation and, in certain instances, may need to provide notification to consumers of their complete business address. More details need to be provided by the FDA.

Farmer’s Markets and Community Supported Agriculture Programs

These programs are currently proposed as exempt from the rule because are considered retail food establishments. Indications are that FDA intends to clarify.

For more Information and Food Safety Training Opportunities:

Penn State Food Science
http://foodsafety. psu.edu

Penn State Food Entrepreneur Web Site
http://extension.psu.edu/food-safety/entrepreneurs

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PRODUCT PACKAGING- WHY WE BUY

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What this presentation DOES address:

1. Functions of Packaging
2. The Components that add power to your package
3. Packaging as your primary visual marketing tool

What this presentation DOES NOT address:

1. Nutritional labeling
2. Allergens
3. UPC Codes

These are important components of your label and detailed information about their content and application are readily available on the Internet. Some materials used in this presentation from Penn State Extension's "Food for Profit" program that I coordinate in Maryland.

Packaging functions include:

Physical protection - The food enclosed in the package may require protection from, among other things, shock, vibration, compression, temperature, etc.

Barrier protection - A barrier from oxygen, water vapor, dust, etc., is often required. Extending shelf life is a primary function.

Containment or agglomeration - Small items are typically grouped together in one package to allow efficient handling. Liquids, powders, and granular materials need containment.

Information transmission - Packages and labels communicate how to use or dispose of the package or product. Some types of information are required by governments.

Marketing - The packaging and labels can be used by marketers to encourage potential buyers to purchase the product.

Security - Packaging can play an important role in reducing the security risks of shipment. Packages also can include anti-theft devices, such as dye-packs, RFID tags, or electronic article surveillance tags that can be activated or detected by devices at exit points.

Convenience - Packages can have features which add convenience in distribution, handling, stacking, display, sale, opening, reclosing, use, and reuse.

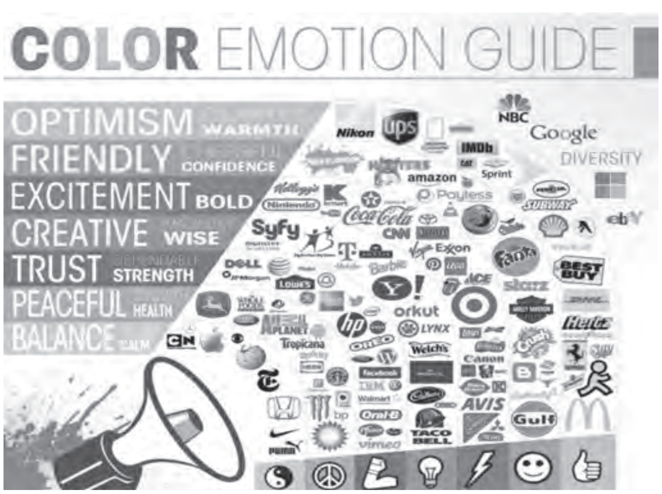
Portion control - Single serving packaging has a precise amount of contents to control usage. It also aids the control of inventory: selling sealed one-liter-bottles of milk, rather than having people bring their own bottles to fill themselves

Packaging should communicate positioning, identity and values. Package design essentials apply to both service and physical product companies and must do all of the following:

1. reflect the business positioning;
2. communicate graphic identity; and
3. reflect target buyer values.

One of your biggest marketing decisions will be the look of the container and the label.

- Package design communicates product ownership, brand, visual image, statement of business principles, and objectives.
- Predesign homework – research the target consumer's mind for influencing variables, such as: consumer age, color combinations, sustainability, shelf position, affordability, inferred health.
- Packaging Can Attract a Customers Who Wants to Support a Cause or Specific Values such as fighting breast cancer or farmland preservation.



Packaging costs comprise about 8 percent of total food costs, and they increased almost 40 percent in the 1990s. This increase is a function of the cost of paper and plastics and the demand for more conveniently packaged foods. Package design changes and packages that can be used directly for cooking and for eating or drinking increase the cost of packaging relative to the basic food. Convenience is a major product differentiator that is fought and won on the store shelves as consumers increasingly make buying decisions based not only on product quality, but how they will use the product again and again at home.

In summary, your packaging should differentiate, motivate, protect, and promote your product.

Ginger Myers the Ag Marketing Specialist for the University of Maryland Extension. She is also the Director of the Maryland Rural Enterprise Development Center, a virtual rural business development center. She brings over 30 years of experience in production agriculture, agri-business and consulting to this position. In her current position works with agricultural entrepreneurs, develops new markets and networking opportunities, works with new and beginning farmers, and assists with business development and business planning. She also publishes the “Master Marketing” Newsletter, has authored Extension peer reviewed publications, maintains two websites, and is a regular contributor to the agricultural press.

Her professional affiliations include:

- Former member of the Maryland Agricultural Commission which advises the Governor on agricultural issues
- A founding member of Maryland’s Agricultural Marketing Professionals (AMPs) Working Group
- A graduate of LEAD Maryland, the State’s agricultural leadership training program,
- Former member of Administrative Council for USDA’s Northeast Sustainable Agriculture Research and Education Program.
- Serves as adjunct instructor for Agriculturally-based marketing and business development classes at Carroll Community College.
- Board of Director with the Future Harvest, a farmer-member organization supporting sustainable agriculture in the Chesapeake watershed.

A graduate of Penn State University, Ginger lives with her husband John in Westminster, Maryland, on a 21 acre diversified livestock farm. They have two grown children.

EGGPLANT PRODUCTION

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Types Grown

Eggplant is a member of the nightshade family and is related to tomato, pepper, and white potato. Among this group eggplant is more sensitive to cold. The majority of the varieties grown are the large dark purple skin with a light to dark green calyx, teardrop to oblong shape "American or Harris type." There is some production of white teardrop shape eggplant; Italian slender, purple skin with a dark green calyx types; Japanese slender with a dark purple to black tender skin; and Chinese long cylindrical purple to green with a green calyx eggplants. With the increased ethnic population, there is a growing demand for 'non-traditional types.'

Transplant production

Eggplants are a warm season crop that does not tolerate frost. Plants are started in greenhouses in January through March for transplanting in May through early July depending on the variety. Growers like sturdy plants and will start seeds in large trays such as 72 cell trays and move them to 18, 24 or 36 cell trays as they grow. Plants are grown using a standard soilless mix (i.e. Promix) and the fertility level is supplemented with two to three applications of a complete liquid fertilizer. Plants are hardened off by withholding water before setting in the field. Height control is a problem if transplants are started too early.

Field Planting

Most eggplant is set into black plastic with drip irrigation for early production. Late plantings are set into white plastic for better temperature control. Eggplants are planted one row per bed at either 5 or 6 ft interrow spacing with most plantings at 6 ft. Within row spacing varies between 30 and 36 inches. Some growers still plant on flat ground without plastic or drip irrigation. These plants are irrigated with solid set irrigation or cannon type equipment.

Transplants are set with a water wheel, mechanical transplanter or by hand depending on the size of the plants. Growers take care when transplanting to set the plants straight in the transplant plant hole to avoid stem burn if the plastic becomes too hot. Also, some growers fill the hole around the plastic with soil to reduce the chance of water collecting around the plant leading to disease. Early varieties are ready to harvest in 50 to 55 days and harvest continues until frost (early October). Late varieties are ready to harvest in 70 to 80 days.

Most of the eggplant grown on plastic is staked to increase yields and improve fruit quality. Eggplant is staked using a modified Florida Weave system. Stakes are placed at every or every other plant and strings are weaved around them. Four or five strings are needed to support the fruit load throughout the season.

Land preparation

Eggplant does best on well-drained sandy-loam and loamy sand soils with a pH of 6.0-6.5. Some fields are fumigated in the fall before planting a cover crop. The main fumigant used is Metam-sodium at the rate of 45 to 70 gal/A. The fumigant is applied using a shank applicator and the soil is sealed behind. If the fumigant is not applied in the fall, it is injected just before lying plastic in the spring. A cover crop (wheat or rye) is planted the year before for the early eggplants. Growers prefer wheat since it does not hold as much moisture plus grain rye may get tall making it difficult to incorporate. In the spring, the cover crop is plowed down using either a moldboard or chisel plow. Beds are made; irrigation tape applied and plastic laid using either Kennco or Rain-Flo equipment.

Some growers apply herbicides prior to bed making and laying plastic as a broadcast application. Others will lay the plastic without any herbicide then band apply between the rows before transplanting.

Harvesting

Eggplants are hand harvested as they approach marketable size, but before the seeds start to turn color by cutting the fruit from the plant above the calyx. Fruit that are allowed to stay on the plant too long will reduce total yield. Fruit should be moved as soon as possible to the packinghouse. If left in the field the fruit will easily sunburn. Fruit are picked in plastic bushel containers and transported to packing sheds where they are washed, graded into No.1, No.2 and field run and packed in 11/9 bushel waxed cardboard cartons.

Insects Pests

Colorado Potato Beetle (CPB) has been one of the main insect pests on eggplant. Adults and larval attack foliage, flowers and young fruit. CPB occur every year and have at least two generations a year. CPB feed on solanceous crops such as tomato, potato, eggplant and tomatillo and have the potential to defoliate these crops each year unless controlled.

Fields can be monitored for overwintering adult populations by checking field edges closest to where a host crop was grown the previous year. The insect will move over or through another crop to infest eggplant. Field edges should be checked weekly after planting. It is recommended to treat hot spots when 15 CPB are found on 10 plants.

Potato flea beetle and Eggplant flea beetle attack plants right after setting in the field. They are not a problem every year or with every planting. Shiny black adults approximately 1/8 long overwinter and feed on young plants in the spring. The larvae feed on the roots, but do little noticeable damage. The beetles are first found on field edges or weedy areas. They are hard to monitor since they are shy, jumping when approached. Shot hole damage is the easily identifiable symptom. Monitoring is generally necessary for the first few weeks, but may be necessary up to flowering.

Two Spotted Spider Mite infestations generally begin around field margins and grassy areas especially if the field edges are mowed during dry periods. Observe plants near field edges, especially next to dusty roads. A 10X hand lens or shaking leaves over white paper helps in identification. Field should be monitored weekly especially during dry periods. Rate infestations as absent, light, moderate or heavy. Early season thresholds are 10-15% of crown leaves and late season 50% of terminal leaves infested. Mites can be spread through the field on clothing, but overhead irrigation helps retard outbreaks. Also, beneficial organism help keep populations under control. Continuous use of certain insecticides especially pyrethroids can exacerbate mite problems.

Diseases

Phytophthora Blight attacks plants anytime during production. Look for wilted plants in the field, especially in low spots and at ends of rows where water can collect after rain or irrigation. When wilted plants are found remove them from the field. For plastic mulch culture remove at least a 2-foot section of mulch between infected and healthy plants to allow the soil to dry. Planting on ridges or raised domes shaped beds reduce the treat of Phytophthora.

Verticillium Wilt is a sporadic disease where good rotations are observed. Plants are stunted with interveinal yellowing, wilting and drying of leaves. Older leaves are affected first with the symptoms progressing up the plant. Symptoms often appear on one side of the leaf or plant. The presence of root know/root lesion nematodes may increase severity and there are no rescue treatments. Fields should be monitored weekly and plants removed if infected. Good crop rotation and tolerant or resistant varieties are the only controls.

Bacterial Soft Rot is a post harvest problem associated with harvesting during warm, rainy periods and inadequate chlorination when washing fruit after harvest. The bacteria enter fruit through cuts, breaks, insect damage and abrasions. Look for discolored areas on the stem or fruits or a slimy rot on stems and fruit. Avoid harvesting when plants are wet or planting after potatoes and cabbage.

Phomopsis Blight is a sporadic disease that affects all stages of the eggplant. Leaf spots are clearly defined, circular up to 1 inch in diameter, brown to gray with narrow dark brown margin and black specks in lesion centers. Spots generally appear first on seedling stems or leaves. Spots may girdle seedling stems, killing the plant. The disease overwinters on diseased plants. Wet weather and high temperatures promote Phomopsis blight. Good rotation helps reduce the spread.

Blossom End Rot (BER) can be a problem if the plants are under water stress (too little or too much) when the fruit is developing. BER is a lack of calcium in the fruit, but there may be sufficient calcium in the soil, but the plant cannot take it up at the rate the fruit need to prevent BER. The disorder can be external where you see the black area at the bottom of the fruit or internal where it is difficult to notice the symptom until the fruit is cut. If internal BER is suspected, look for sunken or soft areas on the fruit.

Wesley Kline has been an agricultural agent for Rutgers Cooperative Extension in Cumberland County since 1996. He is responsible for the commercial vegetable and herb program with special interest in integrated pest management, nutrient management and food safety. Prior to joining Rutgers Cooperative Extension, Dr. Kline worked in Central America as a private consultant with the United States Agency for International Development, a private research foundation, and independent growers. Born and raised on a dairy farm in Clearfield County, Pennsylvania, he received his B.A. from Salem College, Salem, West Virginia and M.S. and Ph.D. from Cornell University. He and his wife Shirley live in Stow Creek, New Jersey.

UPDATE ON INSECTICIDES FOR PEPPER/EGGPLANT AND PEST PROBLEMS IN 2013

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In the mid-Atlantic U.S., peppers and eggplant are attacked by a wide range of arthropod pests including lepidopteran larvae ("worms"), aphids, Colorado potato beetles, thrips, and spider mites. However, in recent years, the invasive brown marmorated stink bug (BMSB) has become one of the most damaging pests of these crops. The bugs typically infest the peppers and eggplant during fruiting stages from mid-July to late September. Both nymphs and adults insert their piercing mouthparts into fruiting stages, stems or leaves, which can result in scarring, necrosis, fruit abortion, or fruit rot if pathogens enter the feeding site. Under heavy BMSB pest pressure, significant crop loss can occur to the aforementioned vegetables. Based on assessments of untreated plots of these crops in Maryland, Delaware and Virginia over the past three years, approximately 25-30% of fruit will suffer damage from BMSB each year.

At Virginia Tech from 2011-13, selected insecticides were evaluated using green bean dip bioassays on brown marmorated stink bug nymphs and adults, as well as field efficacy trials on bell peppers. For the green bean dip bioassays, insecticide solutions were mixed based on the highest labeled rate and 100 gal /acre output. Green bean (*Phaseolus vulgaris*) pods were: dipped in solution for 5 sec, allowed to dry for ≈½ hr under a fume hood, then placed in a 9-cm Petri dish with filter paper and either 5 stink bug adults or 5 nymphs (2^{nd}-3^{rd} instars) per dish. There were 4 Petri dishes per treatment for a total of 20 insects tested each bout. Bioassays were repeated Mortality (dead + intoxicated bugs) was assessed after 72 hr. For the field efficacy trials, 'Aristotle' bell peppers were established on black plastic mulch at the Virginia Tech Kentland Research near Blacksburg, VA. Small plot experiments were arranged in a randomized complete block with 4 reps. At fruiting stage, four weekly spray applications were made using a backpack sprayer, and % stink bug injury to pepper fruit was assessed on three post-spray harvest dates (in Aug). Percentage control was calculated as a reduction in stink bug damage averaged over the three harvest dates.

Table 1 ranks the insecticides based on their average performance across the nymph green bean dip bioassays, the adult green bean dip assays, and the pepper field experiments. Results indicate that a wide range of insecticide products can provide high levels of brown marmorated stink bug control. Additional research on the residual efficacy of these insecticides needs to be conducted. As is always the case when applying pesticides, please read the label carefully to ensure that the product is labeled for the specific target and crop.

Table 1. Performance of Insecticides on Brown Marmorated Stink Bug on Vegetables in VA

Product (active ingredient)	Rate oz/Acre	% mortality in bean dip bioassays*		% control in pepper field tests**		Avg. % control from all four experiments
		Nymphs	Adults	2011	2012	
Scorpion 3.24 (dinotefuran)	7.7	76.7	90.0	85.4	67.0	79.8
Permethrin 3.2EC (permethrin)	8	97.5	98.8	60.6	58.4	78.8
Baythroid XL (β-Cyfluthrin)	2.8	92.5	88.2	52.8	67.8	75.3
Endigo ZC (λ-cyhalothrin + thiamethoxam)	4.5	75.0	98.7	49.2	78.3	75.3
Bifenture 10DF (bifenthrin)	12.8	100.0	81.9	56.3	60.3	74.6
Belay (clothianidin)	4	75.0	67.5	66.7	78.3	71.9
Lannate LV (methomyl)	40	66.7	75.3	79.8	62.2	71.0
Leverage 360 (imidacloprid + β-Cyfluthrin)	2.8 [a]	97.3	74.5	49.9	60.2	70.5
Hero EC (ζ-cypermethrin)	10.3	91.7	50.0	72.8	66.6	70.3
Brigadier (imidacloprid + bifenthrin)	9.85	76.7	70.0	69.9	62.8	69.9
Venom 70 (dinotefuran)	4	100.0	80.0	46.0	52.8	69.7
MustangMAX (ζ-cypermethrin)	4	100.0	35.0	72.8	69.2	69.2
Acephate 97UP (acephate)	16	100.0	51.8	70.4	52.8	68.7
Trebon (etofenprox)	8	100.0	100.0	36.5	34.9	67.9
Vydate L (oxamyl)	48	85.0	47.0	79.7	47.1	64.7
Assail 30SG (acetamiprid)	4	90.0	32.8	70.4	NA	64.4
Warrior II (λ-cyhalothrin)	2.5	100.0	72.8	38.0	42.5	63.3
Danitol (fenpropathrin)	16	93.3	42.5	60.3	55.6	62.9
Actara 50WG (thiamethoxam)	5.5	66.7	81.0	60.3	42.5	62.6
Lambda-cy (λ-cyhalothrin)	3.84	86.0	32.3	62.0	NA	60.1
Asana XL (esfenvalerate)	9	35.0	27.5	76.4	NA	46.3
Beleaf 50SG (flonicamid)	2.8	28.5	17.5	27.2	71.8	36.3

* Mortality refers to the percentage of dead + moribund individuals after 72 hrs of exposure.
** Based on reduction in stink bug injury to pepper fruit from three harvests.
[a] Not the highest labeled rate for all vegetables.

For many conventional growers, synthetic pyrethroids are a popular tool because they provide "the best bang for your buck". Pyrethroids are registered on the most vegetables crops, kill the broadest spectrum of pests, and are generally the cheapest insecticides on the market with a variety of generic formulations. The most commonly-used pyrethroids in the mid-Atlantic U.S. include: permethrin, bifenthrin (Sniper, Capture), lambda-cyhalothrin (Warrior), zeta-cypermethrin (MustangMaxx), cyfluthrin (Tombstone), beta-cyfluthrin (Baythroid XL), and esfenvalerate (Asana XL). However, repeated use of these insecticides has led to resistance problems in several key pests including Colorado potato beetle, diamondback moth, two-spotted spider mite, beet armyworm, green peach aphid, melon aphid, western flower thrips, cabbage looper, and corn earworm. Use of pyrethroids also destroys natural enemies, which can lead to resurgences of secondary pests (see Table 2). Thus, it is important that vegetable growers avoid complete reliance on these chemicals for pest management. Implementing IPM practices through pest scouting and minimizing the impact on natural control agents is clearly a more sound and sustainable approach. Today there are many IPM-friendly insecticides that provide effective control of their target pests on vegetables in the U.S. (Table 3). We have evaluated the efficacy of most these insecticides over the past decade in Virginia.

Table 2: Densities of green peach aphids in bell peppers after three weekly applications of various insecticides; Blacksburg, Virginia

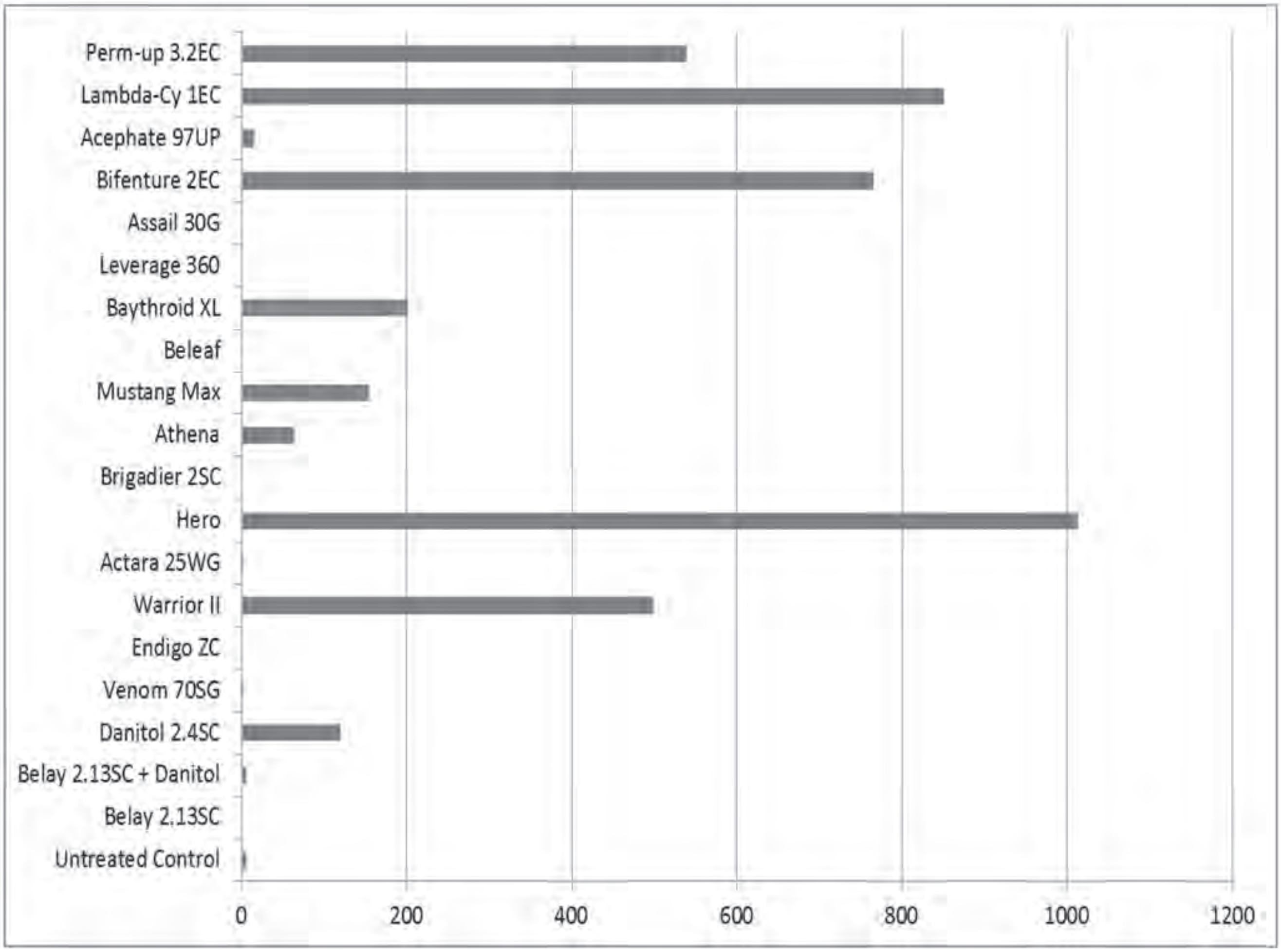
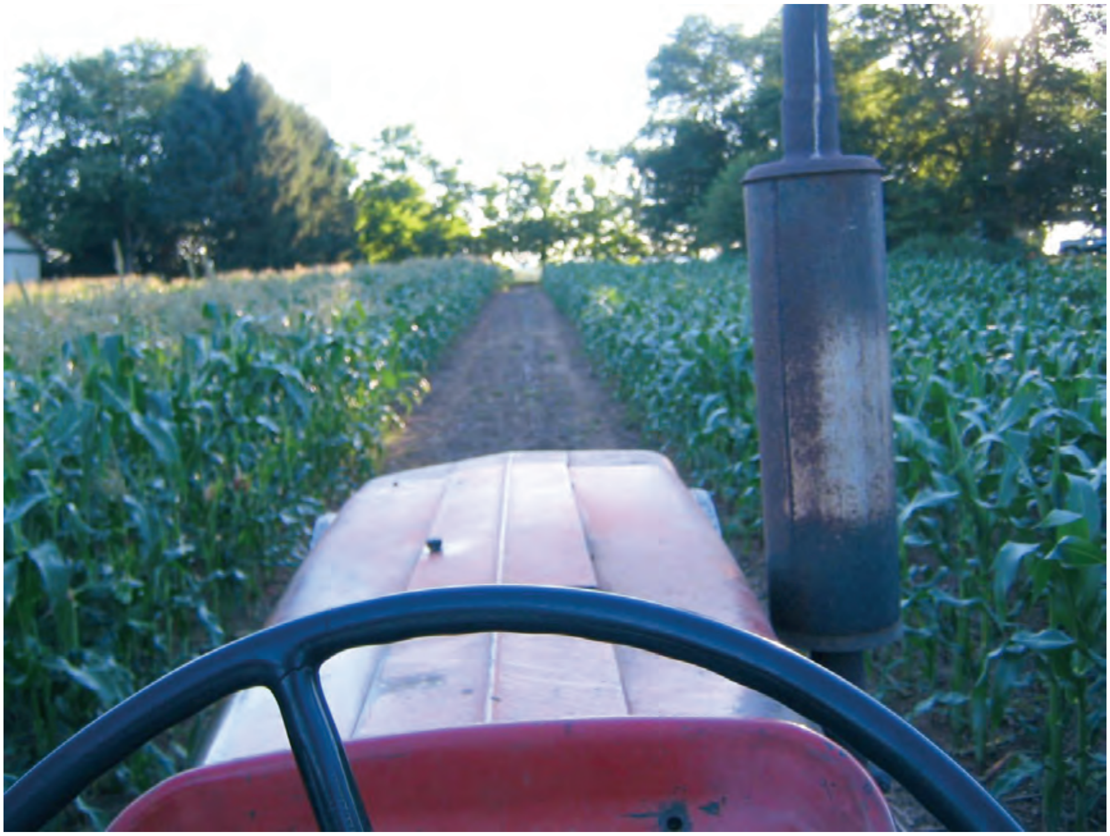


Table 3. Some IPM-friendly insecticide options for key pests of vegetables in the U.S.

Product (company)	Insecticide (AI)	Some of the major veg groups labeled						
		Brassicas	Beans	Cucurbits	Leafy veggies	Sweet corn	Tomato/ Pepper	Potato
Lepidopteran larvae (caterpillars)								
Aza-Direct (Gowan)	azadirachtins	x	x	x	x		x	x
Belt (Bayer)	flubendiamide		x	x	x	x	x	x
Blackhawk (Dow)	spinosad	x	x	x	x	x	x	x
Bt products (several)	*Bacillus thuringiensis* sbsp. kurstaki, aizawai	x	x	x	x	x	x	x
Coragen (Dupont)	chlorantraniliprole	x	x	x	x	x	x	x
Durivo (Syngenta)	chlorantraniliprole + thiamethoxam	x		x	x	x	x	x
Intrepid (Dow)	methoxyfenozide	x	x	x	x	x	x	
Neemix (Certis)	azadirachtins	x	x	x	x		x	x
Proclaim (Syngenta)	emamectin benzoate	x			x		x	
Radiant (Dow)	spinetoram	x	x	x	x	x	x	x
Rimon (Chemtura)	novaluron	x	x	x	x		x	x
Vetica (Nichino)	flubendiamide + buprofezin	x			x		x	
VoliamFlexi (Syngenta)	chlorantraniliprole + thiamethoxam	x		x	x		x	x
Product (company)	Insecticide (AI)	Some of the major veg groups labeled						
		Brassicas	Beans	Cucurbits	Leafy veggies	Sweet corn	Tomato/ Pepper	Potato
Aphids								
Beleaf (FMC)	flonicamid	x		x	x		x	x
Fulfill (Syngenta)	pymetrozine	x		x	x		x	x
Movento (Bayer)	spirotetrmat	x	x		x		x	x
Thrips								
Blackhawk (Dow)	spinosad	x	x	x	x	x	x	x
Radiant (Dow)	spinetoram	x	x	x	x	x	x	x
Spider mites								
Acramite (Chemtura)	bifenazate			x			x	
Oberon (Bayer)	spiromesifen	x		x	x	x	x	x
Portal (Nichino)	fenpyroximate			melons			x	
Zeal (Valent)	etoxazole			x			pepper	
Stink bugs								
Belay (Valent)	clothianidin	x		x	x		x	x
Scorpion (Gowan)	dinotefuran	x		x	x		x	x
Venom (Valent)	dinotefuran	x		x	x		x	x
Colorado potato beetles								
Aza-Direct (Gowan)	azadirachtins	x	x	x	x		x	x
Blackhawk (Dow)	spinosad	x	x	x	x	x	x	x
Coragen (Dupont)	chlorantraniliprole	x	x	x	x	x	x	x
Durivo (Syngenta)	chlorantraniliprole + thiamethoxam	x		x	x	x	x	x
Radiant (Dow)	spinetoram	x	x	x	x	x	x	x
Rimon (Chemtura)	novaluron	x	x	x	x		x	x



Where Is the Pennsylvania Vegetable Industry Headed? And Who's Driving the Tractor?

The Pennsylvania Vegetable Marketing and Research Program and the Pennsylvania Vegetable Growers Association are organizing a series of strategic planning sessions for the Pennsylvania vegetable industry during the first two weeks of February 2014.

The goal of this strategic planning initiative is to gather all segments of the industry together to strategically plan how the different organizations, segments and partners in the industry can work together to collectively strengthen and advance the industry.

A series of regional facilitated strategic planning sessions with growers, allied industry personnel, board members of the Program and PVGA, university staff and faculty, extension educators, and Pennsylvania Department of Agriculture personnel will be held during the first two weeks of February to discuss what these groups can and should be doing to foster the growth and profitability of the vegetable industry.

YOU ARE INVITED! We Need Your Input and Ideas

The regional meetings are open to all growers and vegetable industry members (although reservations are required). The sessions will start at 10:00 a.m. and conclude by 3:00 p.m. Lunch will be provided. The dates and locations are as follows:

* South Central Pennsylvania – February 4 – Penn State Extension Office in Chambersburg
* Southeastern Pennsylvania –February 10 – Yoder's Restaurant in New Holland
* Northeastern Pennsylvania – February 12 – Penn State Extension Office in Bloomsburg
* Western Pennsylvania – February 13 – Soergels' Orchard in Wexford

After the regional meetings have been conducted, a statewide all-day meeting especially for the board members of the Association and the Marketing and Research Program as well as key industry, extension and university personnel will be conducted on March 5.

This effort will only be successful if growers and industry members take some time to look at the "big picture" of the vegetable industry and provide some well-thought out input.

Call us at 717-694-3596 or email us at pvmrp@embarqmail.com to reserve your seat at the table.

Please plan to be a part of this process.
Your participation is essential to the success of this effort.