Great Lakes Fruit, Vegetable & Farm Market EXPO
Michigan Greenhouse Growers Expo
December 8-10, 2009
DeVos Place Convention Center, Grand Rapids, MI

Tomato, Pepper, Eggplant

Tuesday morning 9:00 am

Where: Grand Gallery (lower level) Room E-F

Recertification credits: 1 (1B, PRIV OR COMM CORE)

CCA Credits: PM(1.0) CM(1.0)

9:00 a.m. Tunnel Production of Container-grown Tomatoes

- Ron Goldy, Senior Vegetable Education Educator, MSU Extension

9:30 a.m. Tools for Integrated Crop Management of Peppers

- Mark Bennett, Horticulture & Crop Science Dept., Ohio State Univ.

10:00 a.m. Overview of the SolCAP and Great Lakes Vegetable Working Group Tomato Heirloom Projects

- David Francis, OARDC, Ohio State Univ.

10:30 a.m. Preventing Late Blight on Tomatoes is Easier Than You Think

- Mary Hausbeck, Plant Pathology Dept., MSU

TUNNEL PRODUCTION OF CONTAINER GROWN TOMATOES

Dr. Ron Goldy, MSUE
1791 Hillandale Road
Benton Harbor, MI 49022
goldy@msu.edu

Summary: This is the second year of a trial designed to develop a system of growing tomatoes and cucumbers in a container system under high tunnels. It attempts to solve the crop rotation problem posed in high tunnel production by rotating soil rather than the crop, moving the tunnel or grafting the plants to resistant rootstocks. Nutrient deficiencies occurred both years despite different fertilization approaches, however, the 2009 trial was not as bad as in 2008. Water management was critical for both trials since the container system has little buffering capacity against water loss. The system continues to show promise providing nutrient deficiencies and other cultural practices can be overcome.

Introduction:

High tunnels continue to gain popularity among northern growers. They serve as season extenders and increase quality and yield of several fruit and vegetable crops. Tunnels also help organic producers since plants never get wet from rain or dew, greatly reducing incidence of some foliar diseases. However, soil borne diseases can become problems if the same or related crop is planted year after year - a serious concern for some growers. Tunnels can be moved every few years or some plants can be grafted onto resistant rootstocks, approaches that add to production costs. This report describes a two-year effort at the Southwest Michigan Research and Extension Center that investigates the possibility of growing plants in containers and rotating soil rather than rotating plants.

Materials and Methods:

Material and Methods of the 2008 trial will not be given since they were presented at the 2008 EXPO and can be seen at www.glexpo.com/abstracts/2008abstracts/high_tunnels.pdf.

2009 Trial:

Varieties: Cucumber: Jawell (mini-cucumber) and Dominica (long cucumber)
Tomato: Doloress (indeterminate, cluster) and Matias (indeterminate, single)
Cucumbers were direct seeded April 20, 2009 and tomatoes seeded in a greenhouse on March 11 and transplanted to the tunnels April 20, 2009.

Soil Mix: 301 Pro-Mix from Morgan's Composting, 4353 US 10, Sears, MI 49679 was placed into 5-gallon buckets with holes drilled in the bottom. Buckets were placed under the tunnels on ground covered with weed blocking landscape cloth.

Fertilizer: Compost Tea was made according to directions of Flowerfield Enterprises, 10332 Shaver Road, Portage, MI 49024 and made by placing 10-gallons of water in a 32-gallon plastic garbage container and suspending in the water one to two quarts of 301 compost in a paint strainer bag. Four ounces fish hydrolysate, 2 ounces humic acid and two teaspoons unsulfured molasses were also added to the water. Tea was aerated using an aquarium aerator for a minimum of 24 hours before it was used. Aeration continued if the tea was not used shortly after 24 hours. Tea was used within 96 hours of being made. Tea was injected through the drip system at a rate of 2.5 gallons/week into 438 buckets. An additional 50 ml was added directly into the top of half of the buckets. Tea applications began the week of April 27 and continued through August 31, 2009.

Irrigation: Plants were drip irrigated with one emitter per plant at a rate of one-half gallon per hour per emitter. Irrigation time changed as plants grew but started with 20 minutes twice a day and went up to 15 minutes eight times a day (1.0 gallon/plant). Water could not be applied for longer than 20 minutes at a time before it began to flow out the bottom.

Results and Discussion:

The 2008 trial had several shortcomings that were summarized in the 2008 Great Lakes Expo Proceedings found at www.glexpo.com/abstracts/2008abstracts/high_tunnels.pdf. The 2009 trial was a step in the right direction compared to 2008 but improvements to the system are still needed. The biggest drawbacks in 2009 were nutrient and water applications and learning how to raise greenhouse crops.

One of the problems in the 2008 trial was nutrient deficiencies, especially nitrogen and copper. Compost tea was chosen as the means of fertilizing in 2009 since it could be applied through out the season rather than a one-time application mixed in with the soil. The compost tea worked surprisingly well if it was added directly to the bucket. The tea did not work as well when applied only through the drip system. Several factors could contribute to this, including tea not being concentrated enough, dilution effect of going through the drip system or damage to microbes by being sucked through the injector. Also, 2.5 gallons for the 428 buckets in the trial is only 0.75 ounces per bucket per week and this may not have been enough. The idea behind compost tea is to increase microbial activity in the soil mix so it breaks down organic matter and liberates nutrients, making them available to the plants. If microbial population is not high enough, for whatever reason, this will not occur at a fast enough rate to furnish nutrients to the growing plants.

Table 1. Initial nutrient levels of 301 Pro Mix from Morgan's Compost.

PH:	6.4	
		LOW OPTIMUM HIGH
SOLUBLE SALTS		
(MMHO)	8.43	XXXXXXXXXXXXXXXXXXXXXXXXXX
PARTS PER MILLION OF:		
NITRATE-N	388	XXXXXXXXXXXXXXXXXXXXXXXXXX
PHOSPHORUS	24	XXXXXXXXXXXXXXXXXXXXXXXXX
POTASSIUM	630	XXXXXXXXXXXXXXXXXXXXXXXXXX
CALCIUM	840	XXXXXXXXXXXXXXXXXXXXXXXXXX
MAGNESIUM	316	XXXXXXXXXXXXXXXXXXXXXXXXXX
SODIUM	249	XXXXXXXXXXXXXXXXXXXXXXX
CHLORIDE	440	XXXXXXXXXXXXXXXXXXXXXXXXXXX
ZINC	1.5	
MANGANESE	1.0	
COPPER	0.7	
IRON	9.1	
PERCENT OF TOTAL SALTS:		
NITRATE	6.6	XXXXXXXX
POTASSIUM	10.7	XXXXXXXXXX
CALCIUM	14.2	XXXXXXXXXX
MAGNESIUM	5.4	XXXXXXXXXXX
		ACCEPTABLE EXCESSIVE
SODIUM	4.2	XXXXXXXXX
CHLORIDE	7.4	XXXXXXXXXXXX

Initial nutrient levels of 301 compost appear in Table 1. Most readings are at optimum to excessive, at least at the beginning of plant growth. Plant deficiency symptoms did not appear until two months after planting. Symptoms appeared first in cucumbers followed by tomatoes two weeks later. Cucumber symptoms were classic low nitrogen with general leaf yellowing. Tomato symptoms were somewhat different with leaves going green to purple/brown. Leaf nutrient analysis from tomato leaves taken June 22, 2009 found sufficient levels in all nutrients tested. August 6 tomato leaf samples revealed low nitrogen and zinc levels in those plants receiving tea only through the drip and low levels of potassium in plants receiving tea through the drip and the additional 50 ml in the top of the bucket. Nutrient deficiencies may be attributed to insufficient microbial activity in the soil mix, lower nutrient levels in the mix, or both.

Water management proved a critical factor. Buckets could only be watered for a maximum of 20 minutes before water began to flow through the holes in the bottom. Being separated from the soil, the system was not well buffered against water loss so it had to be watered often. At maximum water demand, plants were irrigated 15 minutes at a time, eight times a day. Unfortunately the automatic watering system malfunctioned and did not always deliver water as needed. Plants went through times of extreme water stress with leaf wilting and fruit shriveling. These circumstances critically affected plant growth and yield.

Some plants showed water stress while adjacent plants did not. Investigating the water delivery system revealed roots growing into the grooves of the arrow dripper, plugging it up. Arrow drippers should not be shoved deep into the soil but an inch or two of the top should be out of the soil so roots cannot grow into the grooves.

Cultivars were chosen because they were developed for greenhouse production and have higher yield potential than field-grown, determinate plants. The tomatoes were indeterminate and needed training to a string just as cucumbers needed training to a string. Pruning and training of greenhouse tomatoes and cucumbers is different than field-grown plants. To properly train plants requires training and experience of the person doing the work and this is still on going. Plants need attention almost on a daily basis to remove suckers, leaves, pinch off cluster tips, and attach plants to strings, harvest and other activities.

Buckets were placed in double rows as tightly as possible giving a plant spacing of approximately 14 inches in and between rows. This spacing was too close making it difficult to carry out cultural activities. A spacing of 18 to 20” in the row would have been more suitable.

Figure 1. Lettuce seeded late August, 2009 after removal of tomatoes. All plants received compost tea through the drip irrigation while plants on the right received an additional 50 ml directly into the top of the bucket.

Yields were taken on tomatoes and cucumbers. Comparisons can only be made between drip applied compost tea and those receiving 50 ml additional in the top of the bucket. ‘Dominica’ and ‘Jawall’ both had improved yield with the additional 50 ml (data not shown). However, this was not the case for the tomatoes. The reason for no differences in tomatoes was probably due to the over riding affects of moisture stress. Moisture stress was not as great for cucumbers because they were through with production before serious stress occurred. The effect of the 50 ml additional compost tea continued after the original cucumbers and tomatoes were taken out and replanted with more cucumbers (following cucumbers) or lettuce (following tomatoes) (Figure 1).

The 2010 trial will investigate different soil mixes, compost teas and tea rates and delivery systems.

TOOLS FOR INTEGRATED CROP MANAGEMENT OF PEPPERS (*Capsicum annuum*)

Mark A. Bennett
Professor
Dept of Horticulture and Crop Science
Ohio State University
Columbus, OH 43210

An integrated crop management (ICM) program for vegetable crop production is essentially the use of 'best management practices' for enhanced yields and efficient resource utilization. Cultural practices to consider for a pepper ICM program include the eight categories listed below.

- **Crop rotation**
  Frequently alter the habitat, type, and timing of food supply available to pests.

- **Sanitation**
  Remove habitat and inoculum by destroying crop residues, using clean seed and transplants, controlling weeds.

- **Timely tillage and cultivation**
  Bury pests, reduce overwintering sites, uproot weeds; use rye strips for wind protection and earlier warming on light-textured soils.

- **Crop and variety selection**
  Grow plants that can resist or tolerate expected pests; evaluate and identify successful practices and incorporate into next year's crop plan.

- **Crop timing**
  Plant or harvest to avoid known peaks in pest pressure; update field weed maps and use to make treatment decisions next season.

- **Crop health**
  Optimize fertility and irrigation to enhance crop's ability to cope with pests. Soil test and fertilize according to guidelines; desired soil pH is 6.0-6.8. Apply 2/3 of fertilizer preplant. High phosphorus is important to early flowering and yield.

- **Crop diversification**
  Plant several crops and/or several varieties to spread risk.

- **Modify crop environment**
  Suppress specific pests or disorders using mulches, row covers, raised beds, optimal plant populations, and other techniques.

An important factor in optimal pepper production is the effect of plant population per acre and plant spacing on insect and disease incidence, effectiveness of pesticide applications, and yield. Before examining research done recently in the Great Lakes region to determine the most economically advantageous plant population for currently used cultivars of peppers, key points of research from other states are summarized below.

- Batal and Smittle (1981 - Georgia) compared 27,000, 40,000 and 60,000 bell pepper plants/ha (~11,250, 16,670, and 25,000 plants/A). The biggest yield increase occurred when populations were increased to 16,670 plants/A, but yields decreased when plant populations were increased to 25,000 plants/A.
- Locascio and Stall (1994- Florida) compared 1, 2, and 3 rows on two bed widths (48" and 72" wide) and in-row plant spacing of 9 and 12" between plants. Highest yields were from single row orientation and wider in-row spacing. Best yields were achieved with fewer plants/row. The number of rows per bed and the overall raised bed width had more influence on yield than in-row spacing. Bell Pepper fruit yields per plant were also greater with the wider spaced in-row spacing. Two rows per bed versus 3 rows resulted in nonsignificant yield differences probably due to better light use. This is also confirmed with the three-row orientation where plants in the middle row produced the lowest yields compared to the outside rows on the same raised bed.
- Stoffella and Bryan (1988 - Florida) compared populations of plug-mix seeded bell peppers planted at 21,500 to 258,000 plants/ha (9,000 to 107,000 plants/A). Variable in-row spacings of 13, 25, 38 and 50 cm (5- 20 inches) were compared. As plant population increased, shoot:root ratios generally declined. This suggests that the decrease in shoot weight was greater than the decrease in root weight. At higher plant populations, the larger root system to shoot mass is perhaps required to improve water and nutrient absorption since root competition between plants is higher. Marketable pepper fruit number and weight generally decreased per plant and increased per hectre as plant populations increased.
- Decoteau and Graham (1994 – South Carolina) compared plant spacing of cayenne pepper for mechanical harvesting. Plants were arranged in single and double rows on raised beds at a plant spacing of 15 to 60 cm (6 to 24 inches) apart. As spacing increased from 15 to 60 cm, the total fruit weight and number per plant increased linearly. As in-row spacing increased total fruit production per hectare decreased. In row spacing effected plant growth and fruit production. Closer plant spacing generally produced more dry weight per plant, taller plants, thinner stem diameters and fewer fruit set per plant but more plants per hectre. Plants in double rows produced more fruit on the top of the plants compared to single rows where more fruit developed lower on the plant. The double row orientation may increase the probability of harvesting more fruit mechanically.
- Motsenbocker, et al., (1997 - Louisiana) evaluated the effect of in-row spacing on 2 cultivars of machine-harvested jalapeno peppers. Plants were spaced 4, 8, 12, and 16 inches apart in-row. Yields, in general, increased with reduced plant in-row spacing. This effect, however, may be cultivar dependent. One cultivar 'Jalapeno-M' had highest yields with 4 inches between plants vs. cultivar 'TAM Mild –1' that obtained the highest yields with a 12 inch in-row spacing, but was not significantly different from the 4 or 8 inch spacing. Closer in-row spacing may provide increased marketable yield of jalapeno peppers. Both cultivars had more plant lodging with increased in-row spacings.

Commercial practices in the Great Lakes region vary from staggered twin rows on raised beds with bed centers 5 feet apart, to single rows 3 to 4 feet apart without raised beds; in-row spacing ranges from 12 to 18 inches. Total populations range from 8,000 to 25,000 plants per acre. Hybrid pepper seed is expensive, particularly for processing peppers where profitability margins are relatively slim. Growers are seeking information to determine if plant populations can be adjusted to reduce hybrid seed costs, without significantly reducing yield, particularly if this is associated with better insect and disease control and thus fewer culls. Plant spacing affects the microclimate in the plant canopy that in turn may influence the incidence and severity of a number of diseases as well as the attractiveness for egg laying by European corn borer. No data are available on the effect of plant density on the epidemiology of anthracnose (*C. acutatum*) on peppers. However, plant spacing and microclimate are known to affect the severity of anthracnose disease on other crops (Boudreau & Madden 1995; Koech & Whitbread 2000).

Results are briefly summarized below for a 2005 field study near Fremont, OH (Table 1). Single row pepper plots with 10,500 to 14,000 plants/A equivalent provided best red pepper yields (cv. 'Socrates') and quality in general. First harvest red fruit yields from single row plots were twice those of twin rows. Sunscald was not different for single vs. twin or the 3 plant density comparisons (7, 10.5 or 14 K per acre). Single row plots produced more EBC damaged fruit and fruit with internal browning symptoms (Table 1). Cumulative red fruit harvest data showed significantly larger fruit from plots with plant densities of 7, or 10.5 K/A. Individual fruit fresh weights from plants in the 7 K plots were 15% heavier than those from plants in the 14 K/A plots (Table 1). End of season green fruit yields were also greater for plants in single row plots.

Literature Cited:

Batal, K.M. and D.A. Smittle. 1981. Response of bell pepper to irrigation, nitrogen, and plant population. J. Amer. Soc. Hort. Sci. 106(3):259-262.

Boudreau, M.A. and L.V. Madden. 1995. Effect of strawberry density on dispersal of *Colletotrichum actatum* by simulated rain. Phytopathology 85:934-941.

Decoteau, D.R. and H.A. Hatt Graham. 1994. Plant spatial arrangement affects growth, yield and pod distribution of cayenne peppers. HortScience 29(3):149-151.

Grubinger, V.P. 1999. Integrated pest management, pg. 140. In: NRAES Coop. Ext., Ithaca, NY. Sustainable Vegetable Production from Start-Up to Market. 268 pgs.

Koech, E.K. and R. Whitbread. 2000. Disease incidence and severity on beans in alleys between Leucaena hedgerows in Kenya. Agroforestry Stystems 49:85-101.

Locascio, S.J. and W.M. Stall. 1994. Bell pepper yield as influenced by plant spacing and row arrangement. J. Amer. Soc. Hort. Sci. 119(5):899-902.

Motsenbocker, C.E., B. Buckley, W.A. Mulkey, and J.E. Boudreaux. 1997. In-row spacing affects machine-harvested jalapeno pepper. HortTechnology 7(2):149-152.

Stoffella, P.J. and H.H. Bryan. 1988. Plant population influences growth and yields of bell pepper. J. Amer. Soc. Hort. Sci. 113(6):835-839.

Table 1. Bell pepper ('Socrates') plant density and row type interactions with yield and quality variables – Fremont, OH, 2005.

FIRST HARVEST RED FRUIT: --------------avg. # of fruit/plot------------------

Plant density	Variable	T/A	Clean%	Indiv. fr. wt (g)	ECB larva	End rot	Internal browning	Sunscald
Row type								
	Single	2.5a	44a	309a	1.3a	0.0a	4.6a	1.1a
	Twin	1.3b	48a	292a	0.3b	0.1a	1.3b	1.0a
Distance within row								
14 K	11 in.	2.2a	43a	277a	0.9a	0.0a	3.6a	1.3a
10.5 K	15 in.	2.2a	45a	310a	0.9a	0.1a	3.6a	0.8a
7 K	22 in.	1.6a	49a	314a	0.5b	0.0a	1.6b	1.0a

CUMULATIVE HARVEST RED FRUIT: --------------avg. # of fruit/plot------------------

Plant density	Variable	T/A	Clean%	Indiv. fr. wt (g)	ECB larva	End rot	Internal browning	Sunscald
Row type								
	Single	4.5a	48a	291a	2.2a	0.1a	5.2a	1.6a
	Twin	3.3a	56a	283a	0.8a	0.1a	1.6a	1.4a
Distance within row								
14 K	11 in.	5.3a	54a	264b	1.7a	0.1a	4.0a	2.2a
10.5 K	15 in.	4.4a	53a	292a	1.7a	0.1a	4.3a	1.2a
7 K	22 in.	2.6a	49a	304a	1.1a	0.0a	1.8a	1.3a

END OF SEASON GREEN FRUIT: --------------avg. # of fruit/plot------------------

Plant density	Variable	T/A	Clean%	Indiv. fr. wt (g)	ECB larva	End rot	Internal browning	Sunscald
Row type								
	Single	4.8a	88a	134a	1.3a	0.0a	0.1a	1.3a
	Twin	4.0b	85a	132a	0.8a	0.0a	0.0a	0.8a
Distance within row								
14 K	11 in.	4.5a	88a	129a	1.0a	0.0a	0.0a	0.8a
10.5 K	15 in.	4.3a	89a	134a	0.7a	0.0a	0.0a	1.3a
7 K	22 in.	4.9a	83a	135a	1.3a	0.0a	0.0a	1.0a

THE HEIRLOOM TOMATO PROJECT

David Francis, The Ohio State University, Wooster, OH; **Jim Jasinski**, Ohio State University Extension, Urbana, OH; **Hannah Stevens**, Macomb County Extension, Michigan State University; **Vicki Morrone,** C.S. Mott Group for Sustainable Food Systems, Michigan State University; **Meg McGrath**, Long Island Horticultural Research and Extension Center, Cornell University, **Joanne Labate**, USDA Plant Genetics Resource Unit, Geneva, NY; **Dilip Panthee**, Mountain Horticultural Crops Research & Extension Center, North Carolina State University; **Vince Fritz**, Southern Research and Outreach Center, University of Minnesota; **Bill Shoemaker**, St Charles Hort Research Center, University of Illinois; **Bronwyn Aly** & **Elizabeth Wahle**, Dixon Springs Agricultural Center, University of Illinois; **Brad Bergefurd** & **Thom Harker**, The Ohio State University South Center, Pikton, OH; **Elaine Grassbaugh**, Ohio State University, Columbus, OH; **Bob Precheur,** OSU Extension, Columbus, OH; **Hal Keen**, OSU Extension Meigs County, OH; **Liz Maynard** & **Ben Alkire**, Purdue University; **Alvin J. Bussan**, Department of Horticulture, University of Wisconsin-Madison; **Judson Reid**, Niagara County, Cornell University Extension, Barker, New York; Mike Orzolek, Pennsylvania State University.

A network of Extension Specialist who make up the Great Lakes Vegetable Working Group (GLVWG) and plant breeders associated with the Solanaceae Coordinated Agricultural Project (SolCAP) have teamed up to examine the "heirloom" tomato. What constitutes an "heirloom" tomato requires definition. Carolyn Male, in her definitive book "100 heirloom tomatoes for the American garden" (1999), notes that there are at least four types of heirloom, which paraphrased are: the family heirloom that has been handed down through the generations (for example, Brandywine, Quisenberry/Sudduth strain); the commercial heirloom (for example, any of Livingston's varieties); the created heirloom (a contemporary bred variety such as Green Zebra), and the mystery heirloom (a mutation or seed contamination appearing in another variety such as Annas Noire). Most definitions stipulate that an heirloom must be true breeding, not a hybrid. Often definitions come with an age requirement. These range from a fixed time point, such as prior to World War II and moving time points ranging from thirty to fifty years. In many senses a family heirloom variety is not so different than a landrace, a definition that refers to domesticated varieties adapted to the specific environment in which it was selected. When immigrants came to the United States they often brought landrace varieties with them.

Definitions aside, heirloom tomatoes are experiencing a rebirth as a new generation of gardeners and commercial producers have embraced the diversity of shape, size, colors, and flavors. Media watch groups have documented an over ten-fold increase in references to "heirloom tomato" over the last ten years (Black, 2009). Along with rising interest in the gardening, production and culinary heritage of the tomato, growers and gardeners are rediscovering some of the old problems associated with landrace, vintage or heirloom varieties.

Within the context of the SolCAP heirloom project, 82 landrace and vintage varieties were evaluated in Ohio, North Carolina, and New York. The top ten "favorites" from this group were evaluated in more detail at nine locations through the efforts of GLVWG team members. At each of the nine locations, Amish Paste, Brandywine (Sudduth/Quisenberry), Burbank, Cherokee Purple, Juane Flamme, Opalka, Livingston's Oxheart, Peron, Rutgers, and Tainan were evaluated. All heirloom varieties used in the GLVWG evaluation trial were indeterminate types except for Rutgers and Burbank, which are determinate. Tainan produced the most marketable fruits per plant, but the grape tomatoes were also the smallest fruit produced in the trial. Juane Flamme, an orange variety, produced the second most fruit which were also the second smallest by weight in the trial. In terms of total marketable fruit, Peron, Juane Flamme, and Livingston's Oxheart all produced over 16 lbs per plant. Results from the first year of the GLVWG evaluation will be available in the Midwest Variety Trial Report, published annually by Purdue University.

An issue that any growers of heirloom tomatoes will face relates to harvest management and fruit quality. Many heirloom varieties crack, badly. This tendency to crack affects storage and transportation. Cracking can be ameliorated under arid production or high tunnel production conditions by limiting irrigation as fruit ripen. Harvesting heirloom varieties before tomatoes are fully ripe will also help. Defining the best point to harvest is bit of an art. The first stage of ripening, "breaker stage" when tomatoes begin to show a flush of color is too early for full flavor development, and therefore too early for harvest. When they split, it's too late. The harvest window is past breaker but before fully ripe. If a rain event is forecast, tomatoes past breaker should probably be harvested. If you want to store the tomatoes for any length of time, the harvest window will need to be pushed toward the breaker stage.

The reason most cited for growing heirloom tomatoes is their taste. Is the perception that heirlooms taste better than contemporary varieties fact or myth? As part of the GLVWG study the team developed a score-card that incorporated ratings of smell, taste and texture and asked participants to rate the variety overall on a 1-9 scale (with 9 being excellent). The Michigan State University's Macomb County Extension center rated the heirlooms along side some hybrid varieties. Several other GLVWG sites also evaluated the varieties for flavor. In the MSU evaluation, the hybrids ranked well. Tainan, a grape type cherry rated well in Michigan, and across three GLVWG locations. The perception of some varieties differed dramatically between locations. For example Juane Flamme (also known as Flamme) ranked second among the heirlooms in Michigan, but was 8th across three locations. Peron and Brandywine ranked poorly in Michigan, but were second and third across three locations. Such variation could be due to the weather and soil conditions at each site, or expectations of the panelists. In Ohio, taste tests have suggested that some panelists prefer sweet, while others prefer more complex flavors.

References

Black, Jane. 2009. Snob Appeal: Won't someone knock heirloom tomatoes off their pedestal. Washington Post, August 12, 2009.

Borrell, Brendan. 2009. How to grow a better tomato: the case against heirloom tomatoes. Scientific American. March 30, 2009. http://www.scientificamerican.com/article.cfm?id=case-against-heirloom-tomatoes

Livinston, Alexander W. 1893. Livinngston and the tomato. Republished in 1998 with a forward by Andrew F. Smith. Ohio State University Press. Columbus, OH.

Male, Carolyn J. 1999. 100 heirloom tomatoes for the American garden. Workman Publishing Co., Inc. New York, NY (for Smith and Hawken)

Sim, Sung-Chur, Matthew D. Robbins, Charles Chilcott, Tong Zhu, and David Francis. 2009. Oligonucleotide array discovery of polymorphisms in cultivated tomato (*Solanum lycopersicum L.*) reveals patterns of SNP variation associated with breeding. *BMC Genomics* **10:**466 http://www.biomedcentral.com/1471-2164/10/466

Smith, Andrew F. 1994. The tomato in America: early history, culture and cookery. University of South Carolina Press, Columbia SC.

PREVENTING LATE BLIGHT ON TOMATOES IS EASIER THAN YOU THINK

Dr. Mary K. Hausbeck (517-355-4534)
Michigan State University, Department of Plant Pathology, East Lansing, MI

Late blight is a disease that most commonly affects potatoes, but can affect tomatoes when the weather is cool, rainy, and humid. The pathogen is called *Phytophthora infestans* and is well known to potato growers in the Northeast who suffered severe losses from this disease in 2008. Late blight was troublesome this season for tomato and potato growers in regions that had an especially wet spring followed by an unusually cool and wet summer. Late blight symptoms include blighting on all aboveground parts of the tomato plant. Lesions on leaves often appear dark and oily with production of sporangia (a.k.a., seeds of the pathogen) occurring on the undersides of the leaves resulting in a whitish/purplish appearance especially when conditions are wet and humid. These sporangia can be carried long distances from diseased plants to nearby healthy plants via wind currents and storm fronts. Blackened lesions on the stems also occur and are typical of late blight disease. Late blight affects green and ripe tomato fruit. The blighting on the fruit appears as dark, greasy areas that enlarge rapidly, encompassing the entire fruit. During wet and humid conditions, white masses (sporangia and threads) of the late blight pathogen can be seen on the diseased leaves and fruit.

Between cropping seasons, the fungus survives on volunteer and abandoned potatoes in cull piles. Control measures include eliminating all potato/tomato cull piles and destroying volunteer potato plants that grow from overwintered tubers. Infected potato plants established from diseased seed potatoes are another source of late blight. Most tomato varieties are susceptible to late blight. ‘Mountain Magic’ is a late blight resistant variety recently developed at North Carolina State University and is in low supply at present.

There are several highly effective fungicide sprays that can be used to protect tomato plants from late blight. Homeowners and organic growers had limited tools available and were not always able to hold the disease once it started. Conventional growers who use fungicides as part of their overall IPM program fared better as many of the fungicides used for *Alternaria*, *Septoria*, and Anthracnose (i.e., Bravo, Quadris, Pristine, Tanos, and Manzate) also provided some protection against late blight, especially early in the season. As the late blight disease increased in growing regions, and the weather continued to be cool and rainy, the addition of late blight specific fungicides to the spray program were helpful in controlling the disease, yet were not 100% effective.

For decades, late blight trials on potatoes have been conducted at the Muck Soils Research Farm of Michigan State University. This research farm has been the focus of potato late blight trials conducted annually by Dr. William Kirk (Department of Plant Pathology) and Dr. David Douches (Department of Crop and Soil Sciences) which are inoculated each year near the end of the growing season to assess fungicide efficacy and genetic resistance. For the last 11 years, my lab has conducted late blight trials on tomato after the potato researchers introduced the late blight pathogen to their nearby potato trials. This year, two tomato late blight fungicide trials were conducted at the Muck Soils Research Farm and one trial was established at the Plant Pathology Farm. The first late blight symptoms in our research plots were observed on August 24 and resulted from the pathogen's sporangia being carried on air currents from diseased plants in other regions.

One of our tomato late blight trials involved a comparison of single products (Table 1). Although growers should always alternate among fungicides based on their mode of action, it is valuable to know which products are most effective and therefore should be used during cool and rainy weather. When late blight threatens, it is best that late blight fungicides be applied preventively prior to the development of symptoms. In our research trial, fungicide sprays were applied after a trace (1-2%) of disease was detected in our research plot (August 24^{th}), using a CO_2 backpack sprayer equipped with three XR8003 nozzles. The sprays were reapplied every 7 days. The sprayer was operated at 50 psi at the boom and was calibrated to deliver 50 gal/A. Plots were evaluated after 4 weeks for foliar infection (%). Yields were taken from the inner 6 feet of row on 22 September. Data were analyzed using Sigma Stat version 3.1 (Systat Software Inc.) and treatments were compared using the Fisher LSD multiple comparison test.

Table 1. Fungicide products tested for the control of tomato late blight, MSU Plant Pathology Farm.

Product	Active ingredient	Registered for tomatoes
Bravo Weather Stik	chlorothalonil	yes
Forum/Acrobat	dimethomorph	yes
Manzate Pro Stik	mancozeb	yes
Phostrol	postassium phosphate	yes, *Phytophthora* spp.
Presidio	fluopicolide	yes
Previcur Flex	propamocarb	yes
Pristine	pyraclostrobin/boscalid	no
Quadris	azoxystrobin	yes
Ranman	cyazofamid	yes
Reason 500	fenamidone	yes
Revus 2.08SC	mandipropamid	yes
Ridomil Gold Bravo	mefenoxam/chlorothalonil	yes
Ridomil Gold MZ	mefenoxam/mancozeb	yes
Tanos	famoxadone/cymoxanil	yes

Plants that were not protected with fungicide were completely defoliated by the late blight pathogen. The fruit from the unprotected plants also became diseased and 84% showed blight (Figure 1). Most of the fungicides we included in this trial helped to limit the advance of late blight, but did not fully eradicate it. Reason and the new product Revus were the stand-out treatments of all fungicides tested in protecting both the foliage and fruit from disease. Using these new products, combined with other effective fungicides, can prevent the development of late blight. A number of other treatments were also impressive and included Pristine, Ranman, Ridomil Gold Bravo, Ridomil Gold MZ, Bravo Weather Stik, and Presidio. Keep in mind that other researchers have noted that this late blight strain is Ridomil-resistant so in the Ridomil Gold Bravo and Ridomil Gold MZ treatments, the Bravo and Mancozeb components, respectively, of those products may be the primary contributors to the late blight control. It is important to note that applications of Previcur Flex did not adequately protect the tomato foliage (35% infection) or the fruit (48% of the yield infected) from late blight. Similarly, Phostrol applications were not very helpful in limiting disease.

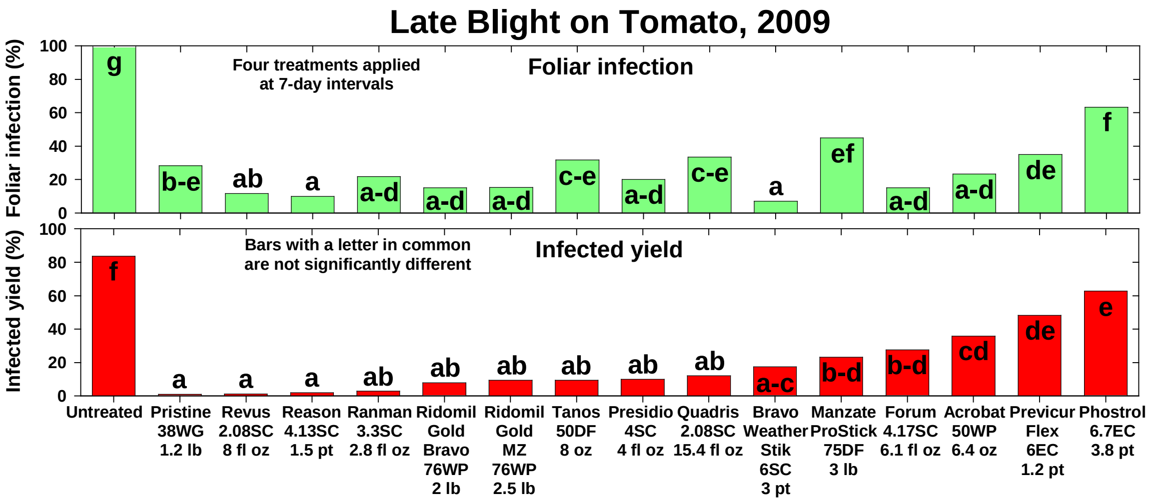

Figure 0. Tomato late blight trial conducted at MSU Plant Pathology Farm.