ORGANIC FARMING RESEARCH FOUNDATION

Project report submitted to the Organic Farming Research Foundation:

Project Title:

Aerated compost tea and other alternative treatments for disease control in pumpkins

FINAL PROJECT REPORT

Principal investigator:
Sarah Kelley
Farm to Table Initiative Coordinator
Earth Pledge
12 Highland Street
Natick, MA 01760

Co-investigator:
Nicole C. Mason, Farm to Table Initiative Coordinator, Earth Pledge, New York, NY
Leslie Hoffman, Executive Director, Earth Pledge
Stephen Storch, Green Thumb Farm/Natural Science Organics, Water Mill, NY
Margaret McGrath, Associate Professor, Dept. of Plant Pathology, Cornell University Long Island Horticultural Research and Extension Center

Funding provided by OFRF: $10,000, Fall 2003

Project period: 2004

Report submitted: December 20, 2004

Project Summary

Compost tea, a water-based compost extract containing high levels of beneficial microbes, is attracting increasing attention among growers and researchers for its apparent disease-suppressive abilities. Research into this technology began in the mid-1980's, but results from controlled and documented field trials are scarce. Most existing research results focus on non-aerated compost tea (NCT) production, but attention has recently shifted to aerated compost tea production (ACT). Compost tea holds promise against fungal diseases, making the pumpkin a particularly good test organism. Our test area on Long Island has porous soils, a fragile aquifer system, and a history of heavy pesticide use, making proven alternatives to chemical pesticides an essential research priority.

Our objectives in this experiment were first to investigate the effectiveness of compost tea in suppressing fungal diseases of pumpkins and thus promoting overall crop health and yields. Second, to investigate two relatively new and undocumented techniques involving the use of silica spray for plant disease suppression and a ground basalt soil amendment. Ultimately, we aimed to demonstrate that compost tea can be an effective tool for managing fungal diseases when used as part of an organic / non-chemical farming system.

We examined the disease-suppressing effectiveness of three different foliar sprays on Johnny's Kakai pumpkin: compost tea, an OMRI-approved copper-based fungicide (Bordeaux mixture), and an elemental-derived silica spray. A water spray control was included for comparison. Each of these four treatments was applied once a week with a 5-gallon backpack sprayer. Our experiment also examined the benefits of adding ground basaltic rock as a soil amendment on the performance of the pumpkin crop.

All marketable pumpkins were harvested from each plot, and pumpkin weight and total number of pumpkins were recorded and analyzed. During the growing season, plots were examined weekly for foliar symptoms of disease. When diseases appeared, assessments were made on the percent of plants affected in each plot. Additional criteria for assessing disease incidence such as percent of plant affected, types of diseases, and plant vigor were recorded. When symptoms were observed, leaves were collected and brought to the Long Island Horticultural Research and Extension Center (Riverhead, NY) for further analysis.

None of the treatments evaluated were documented to have a statistically significant benefit for suppressing any of the diseases that occurred nor did they affect the yield parameters measured. This may be due to the facts that the biodynamic treatment of the entire field in the spring had an overwhelming impact on disease severity and yield, weeds interfered with pumpkin growth and treatments, variables selected for measuring disease severity and yield did not capture differences that occurred, treatment timing was not adequate, and/or the treatments evaluated do not suppress the diseases that occurred. Vigor ratings made in September did document the visual differences evident among treatments that were not being captured by the disease assessments.

We disseminated information about this project through a field day after harvest with presentation of methods and results, as well as a presentation at a BioCycle conference during the growing season.

Introduction to Topic

In recent years, water-based compost extracts, more commonly known as compost teas, have begun to attract increasing attention from growers and researchers. Grower testimonials, field trials, and laboratory tests have indicated that these substances have the potential to suppress plant diseases, particularly fungal diseases. Scheuerell (2003) notes that this effect is attributed to the diverse microorganisms and soluble nutrients found in compost tea. Microorganisms in the tea are believed to fight disease by competing with pathogens for colonization sites and nutrient supplies, secreting antibiotic or anti-fungal substances, or directly parasitizing pathogens, while soluble nutrients improve plant health and bolster natural defense mechanisms. As fungal diseases have proven to be among the most difficult pest problems to control with non-chemical methods (Weltzien 1989,1991) and are among the most damaging crop problems, control through the use of compost teas has the potential to allow major advances in biological agricultural systems.

As noted by Merrill and McKeon (1998), potential for compost tea has been hampered by a lack of standard protocols for research, producing widely varied and often conflicting results for the research. This situation is due in part to the nature of the technology: the organic composts used as feedstock for compost tea are by their nature extremely varied, depending on the types of manure or plant substances used, the length of composting, and a host of other environmental factors. Further confusion has been introduced by the existence of two different “schools” of compost tea making: a non-aerated method that results in largely anaerobic conditions during tea brewing, and an aerated method that emphasizes the incorporation of maximum oxygen into the brewing tea. Scheuerell (2003) uses the terms nonaerated compost tea (NCT) and aerated compost tea (ACT) for these two methods.

Weltzien and Ketterer (1986) published the first experimental results using watery compost extracts on above-ground plant parts, and Weltzien continued to be a pioneer in this area in the late 1980’s and early 1990’s. These researchers focused primarily on nonaerated method of compost tea production during this period. However, in recent years attention has shifted to the ACT method (Scheuerell 2003). From a grower’s perspective, ACT has the distinct advantage that it can be prepared in 2-3 days, while NCT requires up to two weeks steeping time. This feature of ACT gives growers a greater ability to respond to weather forecasting services or other indications of disease outbreak (S. Storch, personal communication). ACT production also results in fewer odor problems than NCT, and some researchers have suggested that ACT greatly reduces the risk of contamination by human pathogens, as these are poorly competitive under aerobic conditions.

ACT technology has also come to dominate the commercial market for compost tea brewing devices. While NCT does not require any special technology beyond a steeping vessel, ACT requires constant stirring and aerating of large volumes of liquid; this choice is obvious from a marketing standpoint. At least seven companies currently sell compost tea makers designed to produce ACT in 18 to 48 hours (Scheuerell 2003). However, neither increased interest from growers nor increased commercial availability of ACT technology has been met by increased research and experimental results on ACT. As Scheuerell (2003) notes, “Research has shown that a variety of foliar plant pathogens and/or diseases have been suppressed by applications of NCT, while considerably fewer controlled studies have examined ACT.” Given the level of interest in and commercial activity around ACT, there is a pressing need for practical research results to determine whether the current emphasis on ACT is justified and will result in concrete benefits for growers.

Pumpkins are subject to severe disease pressure from a wide range of disease organisms, including powdery mildew (*Sphaerotheca fuliginea)*, downy mildew (*Pseudoperonospora cubensis)*, gummy stem blight/black rot (*Didymella bryoniae* and *Phoma cucurbitacearum)*, and Phythophthora fruit and crown rot (*Phytophthora capsici*) (Stivers 2000). Research by Margaret McGrath has demonstrated bacterial wilt (*Erwinia tracheiphila*), a disease spread by striped or spotted cucumber beetles that spread from leaves to vines and eventually causes plant death (Cornell University 2001).

In addition to their advantage in assuring disease pressure, pumpkins also fulfill a need for organic disease control methods as an important fresh-market crop for New York growers, ranking in the top five vegetable crops in crop value (Stivers 2000). Suffolk County ranks second in the state in pumpkin acres planted, with 517 acres in 1997 (USDA 1997). Pumpkins differ from the great majority of vegetable crops in that nearly all are grown for ornamental use. Stivers (2000) notes that an estimated 99% of the crop in New York State is used for decoration and never consumed; the remaining 1% is used for baking and pie filling. While this situation might seem to reduce the health risks of pesticide use in pumpkins, the popularity of pick-your-own pumpkin operations actually makes the need for non-chemical disease control options for pumpkins even more acute. With families and children coming in close contact with the crop, both customers and growers are very aware of the importance of organic disease control methods.

Currently, growers are heavily dependent on fungicides to control powdery mildew and other pumpkin diseases. Inoculum of powdery mildew is thought to be carried by wind from southern states each year, thus crop rotation is not an effective means of preventing the disease. Few resistant varieties are available, and these have resistance only to powdery mildew (Cornell University Vegetable MD Online, 2003). As Dr. McGrath (2003) reports, development of resistance to strobilurin fungicides is already a documented problem in New York State. Suffolk County's sandy porous soils are well suited to pumpkin cultivation but increase the risk of chemical runoff and contamination of Long Island's fragile aquifer system. As a result of these environmental concerns and the market demand for non-chemical alternatives for the pick-your-own pumpkin market, there is a need for research results testing alternative disease control methods such as compost tea.

Objectives Statement

a. To investigate the effectiveness of compost tea in suppressing fungal diseases of pumpkins and promoting overall crop health and yields; to demonstrate that compost tea can be an effective tool for managing fungal diseases when used as part of an organic / non-chemical farming system.

Modification: The proposal was originally written with potato as the test crop. This was changed to pumpkin to ensure disease presence.

b. To investigate two relatively new and undocumented techniques, soil amendment with ground basalt and silica sprays for plant disease suppression; to obtain some clear data and indications of the effectiveness of these treatments.

c. To effectively disseminate information about compost tea and our results through a mid-season evening field walk on our plots and a post-harvest grower field day. We are also hopeful that results obtained on the sandy soils of Long Island will be applicable to Maine, upstate NY, and elsewhere in the Northeast and Canada where sandy soils and cooler temperatures prevail.

Modification: We were not able to hold a mid-season evening field walk on the plots. We substituted this with a presentation at the BioCycle conference during the growing season.

Materials and Methods

a. Experimental Site

We used a 2-acre parcel of land located in Water Mill, NY on Long Island. The plot has remained uncultivated for the past two years, mowed approximately every two weeks by Stephen Storch for the past two growing seasons. He also applied compost tea to the plots approximately once a month. Prior to this, the plots hosted a small family vegetable garden of tomatoes and sunflowers. At the beginning of the 2004 growing season, Steve Storch spread biodynamically produced compost evenly over the experimental site.

b. Experimental Design

Our experimental design had two variables:

1) Two soil treatments:
   a. Soil amendment at the beginning of the season with ground basalt, or
   b. No soil amendment

2) Three different spray treatments with known or reputed fungicidal activity, and the control:
   a. Bordeaux mixture
   b. Compost tea produced by the ACT method
   c. A silica spray consisting of plant- and mineral-derived silica
   d. A water spray as a control

Row spacing: 6' Plant spacing: 2'		**C** ***32***	**R** **B** ***31***	**W** ***30***	**R** **S** ***29***	**B** ***28***	**R** **S** ***27***	**W** ***26***	**R** **C** ***25***
x x x x x x x x x x x x		**B** ***24***	**R** **C** ***23***	**S** ***22***	**R** **C** ***21***	**C** ***20***	**R** **W** ***19***	**B** ***18***	**R** **S** ***17***
Subplot Size 52' x 16' 6' rows = 9,152ft^2		**S** ***16***	**R** **W** ***15***	**C** ***14***	**R** **B** ***13***	**W** ***12***	**R** **C** ***11***	**S** ***10***	**R** **B** ***9***
52' **16'**	**6'**	**W** ***8***	**R** **S** ***7***	**B** ***6***	**R** **W** ***5***	**S** ***4***	**R** **B** ***3***	**C** ***2***	**R** **W** ***1***

232'

176'

Key:
R = basalt rock treatment
C = compost tea
S = silica spray
B = Bordeaux mixture
W = water

We replicated each treatment combination four times. Treatments were arranged in a randomized split plot design. Basalt rock treatment was the main plot treatment. Each spray was applied once a week with a 5-gallon backpack sprayer.

c. Planting Procedures

Field procedures followed recommendations for pumpkin cultivation in New York State. Pumpkins were direct seeded on June 27. Pumpkins used were Johnny's Kakai, a non-disease resistant variety known for their soft, hull-less seeds. Following recommended procedures (Stivers 2000), pumpkins were seeded in rows 6 feet apart with 2 feet between plants. Two seeds were planted per hill to ensure that at least one healthy plant would be available for harvest. Pumpkin rows were mechanically cultivated to control weeds until vine spread made this impossible.

d. Compost Tea Brewer Making Instructions:

To build an ACT compost tea brewer, Steve Storch uses a 55-gallon, food-grade drum (See Photograph 1). He places a 6" Air Stone (made out of heat-treated silica *not* glue and sand) in the bottom of the drum so that the air bubbles move up through the tea evenly (See Photograph 2). He attaches the Air Stone to the air compressor with 1/4" plastic tubing (see Photograph 3). He recommends using a 120-volt air compressor that pumps 150 liters/minute.

The Air Stone can be ordered from Aquatic Ecosystems (877.347.4788) for $12.00. The compressor, made by Gast Manufacturing, can be purchased for $1200. 1/4" plastic tubing is available at most hardware stores.

e. Treatments

i. Soil Amendment

The first experimental treatment was a mineral supplement added to the soil before planting. This supplement is a basalt rock powder containing high levels of magnesium, calcium, and iron. Basalt powder was obtained from Summa Minerals (Las Vegas, NV) and applied at the rate of 1000 pounds per acre.

ii. Spray Treatments

The second treatment, consisting of three different substances with known or reputed fungicidal effects and water, was applied as a foliar spray to the pumpkin crop once a week at a rate of 25 gallons/acre for 13 weeks (July 19 – Oct. 2).

(1) Compost Tea

The compost tea used in this experiment was ACT produced by Stephen Storch using a method developed over a number of years on his family's farm, Green Thumb Farm in Water Mill, NY, and in his business, Natural Science Organics. This method employs tea brewers that he constructed using materials and techniques originally designed for aquariums.

Compost tea production begins with creating high quality compost. Compost feedstock used for this experiment was cattle manure, straw and other bedding, and green materials from the farm operation. Feedstock was moved into piles of approximately 25 tons. Compost piles were amended with the basaltic mineral supplement described above, a microbial food source consisting of kelp powder, ground eggshells, and other micronutrient sources, a humic acid supplement produced by TeraVita (Lancaster, PA), and other biodynamic preparations. For a complete description of the basic biodynamic methods used to treat the compost piles, see Carpenter-Boggs (2000). Compost piles were matured for approximately 6 months, with additional sprays of valerian extract and compost tea over the decomposition period. Compost was turned 3-4 times over a 9-12 month maturing period.

Once the compost was fully matured, ten pounds of finished compost were used to make 500 gallons of compost tea. This compost was combined with a basalt mineral supplement, micronutrient supplement, additional humic acid solution and a horsetail extract (*Equisetum arvense* L.). These materials were combined with well water to total 500 gallons. The mixture was continually stirred and aerated in the brewer for 36 hours to allow maximum development of microbial populations.

Compost Tea ingredient list:

1 Unit	barrel compost (1/3 cup)
1/2 Unit	horn manure
3 Cups	powdered E*quisetum arvense*
2 Cups	2 year-old barrel compost
1/2 gallon	nettle manure tea (30 days old)

Compost tea was applied at a rate of 25 gallons per acre.

(2) Bordeaux mixture

Bordeaux mixture was prepared as described by Duval (1998): 10 lbs of copper sulfate and 5 lbs of hydrated lime mixed with 100 gallons of water, applied at 25 gallons per acre.

(3) Silica spray

The silica treatment consisted of a mixture of elemental silica and water at a ratio of 1lb:10gallons. It was applied at a rate of 25 gallons/acre.

(4) Control

Well water was used as a control to mimic the leaf contact and wetness effects of the other treatments. It was applied at a rate of 25 gallons per acre.

Spraying of all four treatments took place once a week. Spray equipment was a 5-gallon backpack sprayer. Spray equipment was rinsed between each treatment.

f. Disease monitoring

Disease monitoring was conducted once a week. Plots were examined for foliar symptoms of disease. When possible symptoms were seen, leaves were collected and brought to Dr. McGrath at the Long Island Horticultural Research and Extension Center

(Riverhead, NY). She identified the disease, using cultures when necessary. When diseases appeared, we assessed incidence as the percent of plants affected in each plot and severity as the number of leaves affected or the percentage of tissue affected. Vigor of plants in each plot was also assessed toward the end of the growing period (September 19 and 26) Vigor ratings were: weak, weak–good, good–moderate, good, good–plus, vigorous, and very vigorous. Photographs of disease in each plot were taken to document disease infestation and plant condition.

g. Harvest

Pumpkins were hand harvested on October 2, 2004. All marketable pumpkins from each test plot were counted, weighed, and recorded. In addition, the number of rotted pumpkins per plot were recorded.

h. Personnel

Sarah Kelley
Farm To Table Initiative Coordinator, Earth Pledge

Nicole C. Mason
Farm To Table Initiative Coordinator, Earth Pledge

Leslie Hoffman
Executive Director, Earth Pledge

Stephen Storch
Green Thumb Farm/Natural Science Organics

Margaret McGrath
Associate Professor, Department of Plant Pathology, Cornell University
Long Island Horticultural Research and Extension Center

Project Results

Bacterial wilt was the first disease occurring on the pumpkins in this project. Symptoms were first observed on July 27. This is a common disease on Long Island that varies greatly in occurrence and severity. The bacteria causing wilt are vectored by cucumber beetles and survive over winter in these beetles. Beetles were present when wilt symptoms were first seen. Beetles feed on pumpkin leaves, flowers, vines and fruit, depositing bacteria when they defecate. Bacteria enter the plants through wounds formed when the beetles feed. No statistically significant differences were detected among treatments in the percentage of hills with symptoms of wilt on August 10 or 17 (See Data Table).

Powdery mildew, the focus disease of this project, was first seen on August 7. The fungus causing this disease does not survive over winter in areas where its host plants do not survive; however, the fungus produces a spore that is easily dispersed long distances by wind and it does not require the leaf wetness periods that most other plant pathogenic fungi require to germinate and infect their host, consequently, this disease occurs every year on Long Island. No significant differences were detected among treatments in the number or percentage of leaves with symptoms (See Data Table). Severity of symptoms on leaves may have been a better measure, but it is more time consuming to complete.

Symptoms of downy mildew were found on August 17. This disease occurred much earlier than is typical throughout Long Island and it was quite severe in many pumpkin production fields. Like the fungus causing powdery mildew, the fungus causing downy mildew does not survive over winter in areas where its host plants do not survive. However, the downy mildew fungus evidently does not move as easily up the eastern US and it has more stringent requirements for infection than the powdery mildew fungus. Most years it is not observed until September if it occurs at all. Downy mildew can be more destructive than powdery mildew, as affected leaf tissue typically is killed more quickly. No significant differences were detected among treatments in the percentage of leaf tissue with symptoms (See Data Table).

On September 19, pumpkins that had not received the basalt rock soil amendment and were sprayed with water (no rock-water) were less vigorous than the other pumpkins. They were rated weak to good. The no rock-Bordeaux pumpkins and the no rock-silica pumpkins were rated good to good plus. One of the four no rock-compost tea pumpkin plots received a low rating of weak-good, but two plots received a high rating of vigorous, which is a higher rating than any other foliar treatment within the no rock treatment. Among the pumpkins that had received the basalt rock amendment, those receiving the water foliar spray were rated weak-good to good plus. These ratings are higher than the ratings of the no rock-water pumpkins, indicating a benefit of the basalt rock treatment. The rock-Bordeaux pumpkins were rated good-moderate to good plus, which was also higher than the ratings of the parallel treatment without basalt rock (no rock-Bordeaux). The rock-compost tea pumpkins exhibited a range in vigor from weak-good to very vigorous. The rock-silica pumpkins had the best ratings of all treatments: two plots were vigorous, one was good plus, and the other was good.

On September 26, pumpkins that had not received the basalt rock soil amendment and were sprayed with water (no rock-water) were still less vigorous than the other pumpkins. Three plots were rated weak-good while the other was good-moderate. The no rock-silica pumpkins, while more vigorous than the no rock-water pumpkins, were no longer as vigorous as the no rock-Bordeaux pumpkins: they were rated weak-good to good while the no rock-Bordeaux pumpkins were rated good to good-plus. The no rock-compost tea pumpkin plots received the same ratings as the no rock-Bordeaux pumpkins except for one slightly lower rating. Among the pumpkins that had received the basalt rock amendment, those receiving the water foliar spray were rated weak-good to good-moderate. The rock-Bordeaux pumpkins were rated good to good plus. The rock-compost tea pumpkins exhibited a range in vigor from weak to good plus. The rock-silica pumpkins were rated good to good-plus.

No significant differences were detected among treatments in the yield parameters measured (See Data Table).

Data Table.
Impact of amending soil with ground basalt rock before planting and impact of weekly foliar applications of compost tea, Bordeaux mixture, and silica on severity of three diseases and on yield of pumpkin.

	Bacterial Wilt		Powdery Mildew			Downy Mildew			
	Hills w/symptoms (%)		Leaves affected (#)	Leaves affected (%)		Tissue affected (%)		Yield	
Independent Variables	10-Aug	17-Aug	10-Aug	11-Sep	26-Sep	1-Sep	11-Sep	# fruit/hill	lb/fruit
Basalt Rock	25.0	31.4	1.4	21.3	20.0	20.3	20.9	1.6	5.2
No Rock	21.1	35.0	0.6	22.2	20.0	21.9	20.3	1.7	5.1
Water	20.4	36.5	1.4	23.1	21.3	20.0	20.0	1.7	5.2
Compost Tea	28.9	33.7	0.8	23.8	18.8	21.9	20.6	1.5	5.3
Bordeaux mixture	24.3	34.1	0.5	20.0	20.6	20.6	20.6	1.9	5.0
Silica	18.5	28.5	1.4	20.0	19.4	21.9	21.3	1.5	5.0
No Rock, Water	17.6	38.1	1.0	25.0	20.0	18.8	20.0	1.8	5.2
No Rock, Compost Tea	28.6	35.1	0.3	22.5	18.8	23.8	20.0	1.6	5.1
No Rock, Silica	19.6	29.5	0.8	21.3	20.0	23.8	21.3	1.7	5.1
No Rock, Bordeaux mixture	18.5	37.4	0.3	20.0	21.3	21.3	20.0	1.8	5.0
Basalt Rock, Water	23.2	35.0	1.8	21.3	22.5	21.3	20.0	1.6	5.2
Basalt Rock, Compost Tea	29.1	32.3	1.3	25.0	18.8	20.0	21.3	1.5	5.5
Basalt Rock, Silica	17.5	27.5	2.0	18.8	18.8	20.0	21.3	1.3	5.0
Basalt Rock, Bordeaux mixture	30.2	30.7	0.8	20.0	20.0	20.0	21.3	2.0	5.0
Source of Variance									
Replication	0.963	0.705	0.871	0.698	0.291	0.509	0.001	0.442	0.371
Main Plot Treatment	0.241	0.328	0.012	0.319	1.000	0.141	0.391	0.484	0.684
Replication * Main Plot Treatment	0.810	0.391	0.898	0.851	0.957	0.646	0.150	0.689	0.295
Sub Plot Treatment	0.448	0.325	0.251	0.203	0.676	0.509	0.295	0.489	0.588
Sub Plot * Main Plot Treatment	0.747	0.946	0.898	0.502	0.818	0.152	0.583	0.669	0.808

Conclusions and Discussion

None of the treatments evaluated were documented to have a statistically significant benefit for suppressing any of the diseases that occurred, nor did they affect the yield parameters measured. This may be due to the fact that the biodynamic treatment of the entire field in the spring had an overwhelming impact on disease severity and yield. Additionally, weeds may have interfered with pumpkin growth and treatments. Variables selected for measuring disease severity and yield may not have captured differences that occurred, as the measurement techniques used were number or percent of plants or leaves affected. However, determining percent of leaf tissue affected would have been more accurate but would have required more time. Furthermore, diseases and the treatments tested may have impacted fruit quality (e.g. sweetness, seed number and weight) rather than number and weight of fruit. It is also possible that treatment timing was not adequate and/or the treatments evaluated do not suppress the diseases that occurred. The focus disease, powdery mildew, was not the only disease of major importance as anticipated based on previous experiments conducted on Long Island. Vigor ratings made in September did document the visual differences evident among treatments that were not being captured by the disease assessments.

Although through this project we did not obtain conclusive data documenting the benefits of using ground basaltic rock as a soil amendment or of applying Bordeaux mixture, silica, or compost tea to foliage, we did obtain useful results because diseases did occur and the crop survived to produce yield. Additional research is needed to determine if measuring other variables will reveal benefits. Additional research also is needed to determine whether the farmer’s standard biodynamic treatments to the entire field had an impact on disease severity and to determine under what conditions, including crop and diseases, these treatments will provide benefits that are easy to document. Other farmers who use these treatments under similar conditions can anticipate obtaining similar results: possible benefits that are not easily detectable.

The main problem encountered during this project was achieving good weed control without expending more labor than would be acceptable for a farm operation. A research field necessitates open space between plots so that treatments can be made and the plants in plots can be kept separate. However, since this was an on-farm project, we did not want to manage weeds in a manner that would be unacceptable for a farm. An excessive amount of time spent weeding by hand, while common in research fields in university settings, was recognized as uneconomical in a farm setting.

We would like to conduct this experiment again with a different plot design to facilitate managing weeds. We feel we have gained valuable experience and now have a good weed management plan that would be reasonable for a farm operation. We propose to have long one-row plots rather than double-row plots. The single rows would be sufficiently separated to facilitate driving a tractor-cultivator between them. We would use transplants rather than direct seed and spread straw mulch around the plants immediately after transplanting. Spreading mulch after direct-seeded plants are established, as was done in the 2004 experiment, allows weeds to begin to grow.

Outreach

Information was disseminated at the June 2004 BioCycle conference in a presentation given by Sarah Kelley. An article was published in BioCycle magazine in the June 2004 edition highlighting the experimental design, progress and plans of he experiment in an article called "Building a Knowledge Base For Compost Tea." On October 30, Steve Storch, Leslie Hoffman, Nicole Mason, and Meg McGrath gave a presentation of the various parts of the experiment. This presentation was held in Water Mill, NY, a few miles from the experimental site. Our hope is to disseminate the final report to the public in both online and printed forms.

References

- Bowen, P., J. Menzies, D. Ehret, L. Samuels, and A.D.M. Glass. 1992. Soluble silicon sprays inhibit powdery mildew development on grape leaves. *Journal of the American Society of Horticultural Science* 117:906-912.
- Carpenter-Boggs, L., A.C. Kennedy, and J.P. Reaganold, 2000. Organic and Biodynamic management: Effects on Soil Biology. *Soil Science Society of America Journal* 64:1651-1659.
- Cornell University News Service. "Bacterial wilt that kills pumpkins, cucumbers, cantaloupes and squash found in parts of Midwest and Northeast, says Cornell plant pathologist." August 14, 2001. www.seedquest.com/News/releases/usa/Universities/n3724.htm
- Duval, J. 1998. Preventing Late blight in potatoes. Ecological Agriculture Projects No. 73. http://www.eap.mcgill.ca/Publications/EAP73.htm.
- Marschner, H. 1995. Mineral Nutrition of Higher Plants. London: Academic Press.
- McAvoy, R.J. and B.B. Bible. 1996. Silica sprays reduce the incidence and severity of bract necrosis in poinsettia. *HortScience* 31(7):1146-1149.
- McGrath, M.T. 2003. Occurrence of Strobilurin resistance and impact on managing powdery mildew of cucurbits. Cornell University Vegetable M.D. Online. http://vegetablemdonline.ppath.cornell.edu/NewsArticles/Cuc_Strob.htm
- Merrill, R. and J. McKeon. Organic teas from composts and manures. Organic Farming Research Foundation Project Report. http://www.ofrf.org/publications/Grant%20reports/97.40.10.Merrill.Fall97.IB9.pdf
- National Organic Standards Board. 2004. Compost Tea Task Force Report. http://www.ams.usda.gov/nosb/meetings/CompostTeaTaskForceFinalReport.pdf
- Rosato, C. 1992. Peach Brown Rot Control. Organic Farming Research Foundation Project Report. http://www.ofrf.org/publications/Grant%20reports/92.26.03.Rosato.Fall92.IB1.pdf.
- Scheuerell, S. 2003. Understanding how compost teas can control disease. *BioCycle* 44(2):20-30.
- Stivers, L. 2000. Crop Profile: Pumpkins in New York. Cornell Cooperative Extension, Rochester, NY. http://pmep.cce.cornell.edu/fqpa/crop-profiles/download/Pumpkin_Profile.PDF.
- United States Department of Agriculture, National Agricultural Statistics Service. 1997 Census of Agriculture: Geographic Area Series, Volume 1, 1A, 1B, 1C [machine-readable data file]. Washington, D.C.: National Agricultural Statistics Service. http://govinfo.library.orst.edu/php/agri/index.php.
- Weltzien, H.C. 1989. Some Effects of Composted Organic Materials on Plant

Health. *Agriculture, Ecosystems, and Environment* 27:439-446.

- Weltzien, H.C. 1991. Biocontrol of Foliar Fungal Disease with Compost Extracts. In J.H. Andrews and S. S. Hirano (eds.), Microbial Ecology of Leaves. New York: Springer Verlag. pp. 430-450.
- Weltzien, H.C. and N. Ketterer. 1986. Control of downy mildew, Plasmopara viticola (de Bary) Berlese et de Toni, on Grapevine Leaves through water extracts form composted organic wastes. *Journal of Phytopathology* 116: 186-188.