Great Lakes Fruit, Vegetable & Farm Market EXPO
December 9-11, 2008
DeVo Place Convention Center, Grand Rapids, MI

Organic Vegetable Production

Thursday afternoon 1:00 pm

Where: Gallery Overlook (upper level) Room A-B

CCA Credits: NM(0.5) PM(1.5)

Moderator: Daniel Brainard, Horticulture Dept., MSU

1:00 p.m. Feed Your Soil and Bump Your Yield: Organic Tomato and Cucumber Production in the Great Lakes Region

- Mathieu Ngouajio, Horticulture Dept., MSU
- Ajay Nair, Horticulture Dept., MSU

1:30 p.m. Organic Insecticides for Vegetables: What Works and What Doesn't

- Galen Dively, Integrated Pest Management Specialist, Univ. of Maryland

2:00 p.m. Stop the Rot by Starting with Healthy Transplants

- Christine Smart, Plant Pathology Dept., Cornell Univ.

2:30 p.m. Managing Foliar Diseases Organically in Tomatoes and Cucurbits

- Margaret McGrath, Plant Pathology Dept., Cornell Univ.

FEED YOUR SOIL AND BUMP YOUR YIELD IN ORGANIC VEGETABLE PRODUCTION

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Introduction

With rising concerns on the impact of current agriculture practices on our environment, sustainable agriculture has emerged as a powerful tool in augmenting transition from a conventional to an organic farming system. Unpredictable weather conditions and a narrow seasonal window for producing vegetable crops in the Midwest have posed a commendable challenge for organic and transitional farmers in the region. Incorporation of cover crops, integrated nutrient and pest management bear paradigm importance in this context. The core objective of this study was to better understand and document changes, with relevance to crop yield, fruit quality and cover crop management under an organic cropping system. Using cover crops (cereal rye alone or in mixture with hairy vetch), dairy compost and polyculture (growing alternate rows of different cash crops) we intend to enhance soil management and biodiversity in an organic cucumber and tomato production system. Increased biodiversity promotes better soil quality, efficient nutrient cycling, reduced pest infestation and enhanced soil microbial activity. Our research aimed at addressing the following questions: (i) will a cover crop mixture of cereal rye (grass) and hairy vetch (legume) improve vegetable production when compared to cereal rye alone? (ii) does nutrient management through compost work synergistically with cover crops? (iii) does crop variety play any role when transitioning to an organic cropping system?

Methodology

The study was conducted at the Horticulture Teaching and Research Center of the Michigan State University at East Lansing, Michigan. Cover crops were sown in fall of 2007 and 2008. Rates of rye were 70 lb/A (rye only) and 35 lb/A (rye mixture with vetch). Hairy vetch was seeded at the rate of 25 lb/A in the rye + hairy vetch plots. Cover crops were plowed early spring and dairy compost was incorporated (only in the compost treatments) at the rate of 10 t/A. Tomato transplants were grown in the greenhouses starting mid April and transplanted into the field in the first week of June on raised beds with plastic mulch and drip irrigation (Teasdale and Abdul-Baki, 1997). Two tomato cultivars, ‘Mountain Fresh’ and ‘Big Beef’, were used. Transplants of two cucumber cultivars, ‘Cobra’ and ‘Dasher II’, were used.

Altogether there were 3 main treatments: (i) rye cover crop with cucumber or tomato monoculture, (ii) rye with polyculture (alternating rows of tomato and cucumber), (iii) rye + vetch cover crop mixture with polyculture. Absence or presence of compost was added as a factor to all the treatments for a total of six treatments. Each treatment was replicated four times and had five rows per treatment out of which the middle row was used as the data row. Each row had 12 plants. Plants were staked and all necessary cultural operations were undertaken when needed. Tobacco Horn Worm was the main insect pests on tomato and was controlled by two applications of Dipel® (Bt formulation). Incidence of Early Blight on tomato was observed and was kept under control by four applications of Sonata®, a biological fungicide. It is important to mention that cucumber beetle infestation was one of the main limiting factors for cucumber production in our study. Pyganic®, a botanical insecticide, was sprayed regularly throughout the growing season to keep the beetle population under check. However, beetles caused additional damage by vectoring and spreading bacterial wilt which significantly affected cucumber plants.

Results

a. Cucumber

Interesting results were obtained from the study in 2008. Yield is the primary concern for most farmers as it directly translates into economic returns. There was no significant interaction between cultivar and treatment for cucumber. Due to higher pressure of cucumber beetles and spread of bacterial wilt, plants in monoculture treatments were significantly affected. There were significant differences in the yield under different cropping systems. Cover cropping with rye + vetch combined with compost had the highest cucumber yield (18.8 kg/12 plants) (Fig. 1). Rye in a polyculture system with or without compost also performed well (17.5 to 16.1 kg marketable fruits/12 plants) as compared to monoculture rye alone with or without treatments (11.8 to 8.8 kg/12 plants). The cucumber monoculture system did not perform well, primary because of higher cucumber beetle infestations and disease incidence (bacterial wilt). This brings up the potential use of polyculture as a crop insurance tool against cucumber beetles and other pests that pose a phenomenal threat to organic cucumber production in our region.

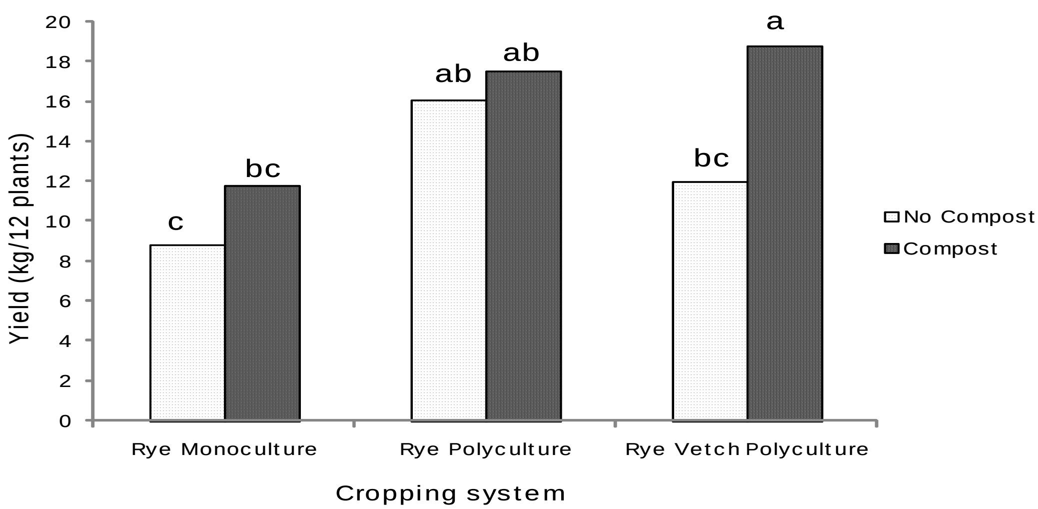

Figure 1. Effect of cropping system on marketable yield of cucumber grown under organic production system in 2008. The two cultivars 'Cobra' and 'Dasher II' had similar yield. Bars with similar alphabets are statistically equivalent by Fisher's LSD test (α=0.05).

Table 1. Differences in number and yield of marketable cucumber and tomato fruits as affected by cultivar when produced under an organic production system in 2008.

Cultivar	**Cucumber**	
	Marketable fruit number	Marketable fruit yield (kg/12 plants)
Cobra	37 a	13.8 a
Dasher	41 a	14.6 a
	Tomato	
Big Beef	208 a	45.0 a
Mountain Fresh	169 b	36.6 b

Mean separation within columns for each crop using Fisher's LSD for each crop. Values followed by the same letter are not statistically significant α=0.05.

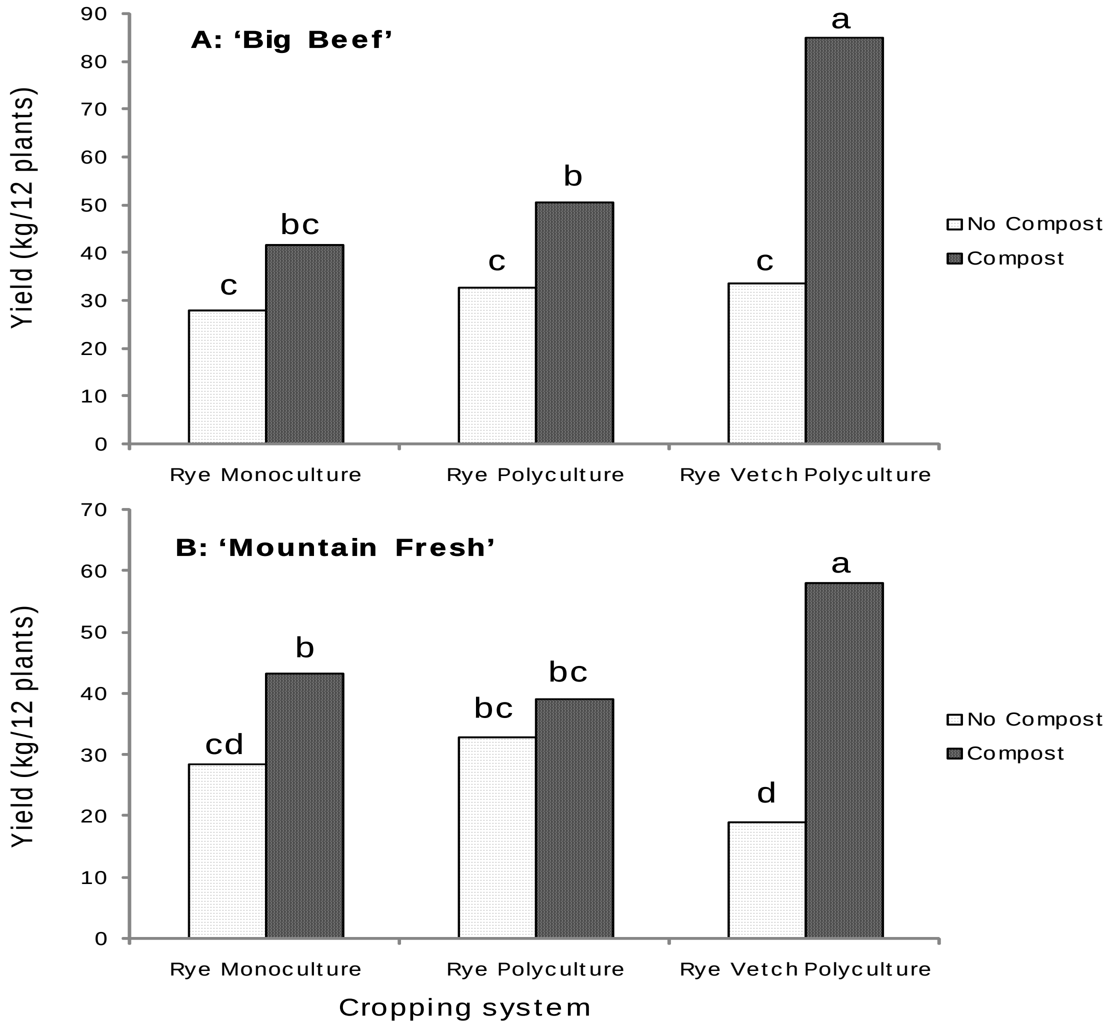

Figure 2. Effect of cropping system on marketable yield of two tomato ('Big Beef' and 'Mountain Fresh') cultivars grown under organic production system in 2008. The cultivars responded differently to the treatments. Bars with similar alphabets are statistically equivalent by Fisher's LSD test (α=0.05).

Rye + no compost treatment produced higher yield as compared to rye + vetch + no compost treatment. The yield decline in rye + vetch + no compost is potentially due to the poor vetch establishment as a result of adverse soil conditions (poor drainage) in many rye + vetch no compost treatments. This was due to the topography of the field and not to treatment effects. Additionally seeding rate of rye was half in rye + vetch plots when compared to rye only plots, contributing to reduced biomass production. Even though vetch did not contribute significantly in plots without compost, in the long run advantages of vetch cannot be discounted as it plays a key role in nitrogen fixation, stimulation of soil microbial population and improvement of soil health. There was no significant difference in terms of marketable yield between the two cultivars. 'Dasher II' and 'Cobra' produced 14.6 and 13.8 kg marketable fruits/12 plants respectively (Table1).

b. Tomato

In tomatoes, out of the six management systems tested best performances in terms of yield were obtained from rye + vetch + compost treatments. Data for both cultivars are shown separately as there were interactions between the cultivars and the treatments. Marketable yield for 'Big Beef' and 'Mountain Fresh' were 84.8 and 57.9 kg/12 plants (Fig. 2). For the cultivar 'Big Beef', monoculture and polyculture treatments treated with compost produced similar marketable yields. For ‘Mountain Fresh’, yields followed similar trend, with compost treatments producing higher yields (Fig. 2B). Lowest yields were recorded for rye + vetch + no compost treatments due to the poor soil conditions due to standing water in rye-vetch + no compost plots. With regard to varietal selection in tomatoes, ‘Big Beef’ produced higher marketable fruits as compared to ‘Mountain Fresh’ (Table 1). Same was the trend with the number of marketable fruits. We understand that selection of the cultivar depends largely on market demand, but transitional and organic growers should seriously consider varietal selection as it will directly reflect on the yield and the final output.

Conclusion

In most vegetable production systems, especially organic, addition of compost is critical as it not only adds to the nutrient pool in the soil but also improves soil structure and other soil properties like soil health, by stimulating microbial growth and enhancing microbial biomass in the soil. This study reinforces the above mentioned point and also advocates adopting polyculture as one of the tools when transitioning to organic production system as it could serve as a factor of crop insurance against crop failure (mainly in cucumber due to cucumber beetle attack). According to a study done in southern Michigan by Schultz et al. (1983), polyculture of cucumber and tomato had advantages in terms of Land Equivalent Ratio (LER) and per hectare dollar returns. Economics of the current study are yet to be determined.

Because of their ability to survive winter, both cereal rye and hairy vetch could easily fit into most vegetable cropping systems in the Great Lakes area (Hartwig and Ammon, 2002). Cover cropping with a combination of cereal rye and hairy vetch is an effective way to improve soil health and other soil attributes. The biggest challenge of using vetch in this study is related to the long growth cycle of tomato. Planting vetch after a tomato crop might not always allow enough biomass for the cover crop. Vetch would fit better after a cucumber crop. However, we waited until tomato was done so that we could plant the cover crop in the entire plot at once. Studies have shown advantages of using vetch because of its excellent nitrogen fixing and weed suppression qualities in various vegetable crop studies (Ngouajio and Mennan, 2005). Cover crops can reduce soil erosion, improve soil structure and increase organic carbon and nitrogen (Teasdale, 1996). This study showed significant yield improvement in systems where we optimally feed our soil (rye + vetch + compost). To conclude, farmers should give added consideration to varietal selection as it could help mitigate yield decline which is the major deterrent for transitioning to an organic production system.

References:

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STOP THE ROT BY STARTING WITH HEALTHY TRANSPLANTS

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It's well known that starting with healthy transplants is key to a successful growing season, but the best method for producing such transplants is not always so obvious. Certainly the most important factors are 1) start with disease-free seed 2) ensure that the greenhouse and all supplies used are either new or have been sanitized and 3) provide the proper environment for healthy growth. Each spring, our lab receives samples of transplants that have died due to damping-off, where the seedling has been killed by common soil-borne pathogens. The overwatering of seedlings is a common occurrence, and increases the likelihood of damping-off. Aeration in the starting medium is critical, and can be lost by overwatering, and saturation. Cultural practices that will reduce the chances of a disease outbreak are listed below.

Preseason Sanitation

- Clean and disinfect all greenhouse tables, benches, floors, hoses, flats, containers and anything else that could come into contact with the plants. It is important to do thorough cleaning **even if you had no disease last year**. Pathogens could still be present in the greenhouse and spread to healthy transplants under optimal environmental conditions. There are OMRI listed hydrogen peroxide-based disinfectants available for greenhouse cleaning. These products work well, but can be inactivated when in contact with organic material (soil or plant debris). The removal debris prior to sanitation is important.

Seed Selection and Planting

- Select resistant or tolerant varieties when possible. This is the best way to control diseases.
- Purchase seed that is certified disease free.
- Hot water seed treatments are recommended for some pathogens.
- If possible, use new flats to avoid carrying-over pathogens from the previous season. Alternatively, disinfect anything that was used the previous year.
- Use only sterilized soil or potting mix.

Management Strategies in the Greenhouse

- Do not overwater transplants.
- Keep the greenhouse weed-free. Many pathogens survive on weed hosts and then move to transplants in the greenhouse.
- Scout greenhouses weekly for any sign of disease. Remove diseased plants immediately. If a diseased plant is identified in a flat, remove the whole flat.
- Keep bedding plants and vegetables separate when possible. Some diseases including tomato spotted wilt virus, root rots, cucurbit powdery mildew, and tomato late blight can also infect bedding plants.
- Keep foliage as dry as possible. Pathogens love a moist environment. Water in the morning when possible so that foliage may dry during the day.
- Do not brush or trim wet plants. This will increase the chances of disease spread.

Many products that are said to enhance yield and/or control disease can be incorporated into the planting mix. These products contain living organisms (either bacteria or fungi) that survive on or near the roots of plants. These beneficial microbes are thought to increase yield by increasing the level of nutrients and minerals available for uptake by the plant. We have evaluated two products for use on vegetable transplants. We have tested BioYield, which contains two species of the *Bacillus* bacterium and also RootShield which contains the fungus *Trichoderma*, to determine the ability of the products to both control disease (bacterial speck of tomato) and enhance yield. The names, rates and manufacturers of the products used in this study are listed in Table 1.

Table 1. Products used in this study.

Product	**Rate**	**Manufacturer**
BioYield Concentrate standard rate	2 lb/cu yd planting mix	Gustafson (Bayer)
BioYield Concentrate high rate	4 lb/cu yd planting mix	Gustafson (Bayer)
Copper sulfate	2.5 lb/Acre	Cerexagri
RootShield Granular	1.2 lb/cu yd planting mix	Bioworks

The study has been done in two consecutive years in Geneva, NY. Weather conditions were remarkably different between the two seasons with the first year being cool and wet, while the second was hot and dry. For treatments containing BioYield or RootShield, the product was added to the planting mix prior to sowing the seed. Five-week-old tomato transplants, cultivar Sunchief VF, were planted in 20 plant plots on black plastic covered beds. Each treatment was replicated three times. Copper-based compounds were sprayed on as a foliar application every 7 days starting 2 weeks prior to inoculation with the bacterial speck pathogen (*Pseudomonas syringae* pv. *tomato*).

Results from the cool and wet first season show that both BioYield and RootShield had a larger average yield (in terms of both fruit number and weight) compared to untreated control plants. However, only the BioYield treatment was statistically significant (Table 2). Neither compound (when incorporated into the original planting mix) was able to control bacterial speck under the high disease pressure seen during this first season of the study.

Table 2. Disease severity (based on lesion number) and average yield (fruit number and weight) in the first season of the study.

Treatment	**Lesion no**[w]	**Fruit no**[x]	**Fruit wt (lb)**[y]
Control	34.0 bc[z]	103.33 c	34.10 c
RootShield	64.0 a	124.33 abc	41.45 abc
BioYield + RootShield	44.33 b	120.33 abc	41.86 abc
BioYield Standard Rate	41.33 b	145.33 a	48.70 a
Copper sulfate	4.33 d	111.33 bc	39.27 bc

[w]Mean number of lesions counted on 20 leaflets per plot
[x]Mean number of fruit on 5 plants per plot
[y]Mean fruit weight from 5 plants per plot
[z]Numbers followed by different letters are significantly different (*P*=0.05) based on Fisher's LSD.

Results from the second season were quite different from those of first. Yields, as determined by both total fruit weight and number of fruit on 5 plants per plot, were much larger due to excellent growing conditions. Surprisingly the control plants, which were not treated with any products to control bacterial diseases, had the largest yield although not statistically significant (Table 3). The hot and dry weather of the second season was not favorable for pathogen development and there was very little disease in any plots. All treatments were significantly better than the control plot (Table 3).

Table 3. Disease severity (based on lesion number) and average yield (fruit number and weight) from a 2005 tomato trial in New York.

Treatment	**Lesion no**[w]	**Fruit no**[x]	**Fruit wt (lb)**[y]
Control	15.87 a[z]	88.89 a	60.34 a
BioYield High rate	7.80 b	82.78 ab	58.73 ab
BioYield Standard rate	5.93 bc	73.00 b	50.30 b
Copper sulfate	3.77 c	76.89 ab	52.54 ab

[w]Mean number of lesions counted on 20 leaflets per plot
[x]Mean number of fruit on 5 plants per plot
[y]Mean fruit weight from 5 plants per plot
[z]Numbers followed by different letters are significantly different (P=0.05) based on Fisher's LSD.

Results from the two years of this study were quite different. Our hypothesis is that when plants are under stress, such as during the cool and wet seasen, activators that colonize the rhizosphere of the plant such as BioYield and RootShield will be more effective for yield enhancement. We also hypothesize that because disease pressure was very light during the second season (hot and dry), all control strategies were successful. Additionally, because plants had optimal growth conditions during the second season of the study, the effect of rhizosphere colonizing BioYield was not significant. We are continuing our research on these products and hope to identify and integrated disease control strategy that can utilize yield enhancing products.

Additionally we have tested bacteriaphage (also known as phage), which are bacterial viruses that infect and kill bacteria and are naturally occurring. The Utah-based company Omnilytics identifies and produces large quantities of phage that are specific to a bacterial pathogen. These phage can then be sprayed onto plants to kill the bacteria. They are used commercially in Florida and Georgia to control bacterial spot on tomato. In greenhouse trials aimed at controlling bacterial canker of tomato, we have not seen statistical differences between treated and untreated plants, however there does appear to be a reduction in the number of bacteria on plants. Additional studies will enable us to determine how phage can be utilized during transplant production to control bacterial diseases.