Influence of Compost Application and Variety on Yield and Quality Variables of Organically Grown Lettuce, Popcorn, Potato and Processing Tomato

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Introduction

Organic vegetable farming is increasing in Ohio and the Midwest. To be successful, organic farmers must consistently select and manage varieties best suited to their production and market conditions. Research-based information regarding variety performance in the field and market can greatly assist farmers in this regard. This project was initiated to provide research-based information regarding crop and variety selection to organic farmers and to help improve the understanding of variety-x-compost interactions in organic vegetable systems.

Materials and Methods

Crops planted before and since the study began in 2004 and the target amount of N applied by compost to the subplots in 2005 are listed in Table 1.

Land used in the project was certified for organic production.

Plot Establishment and Maintenance. Crops were planted in separate fields or areas within each field and the separate and combined effects of compost application and variety on yield and crop quality variables were tested using a randomized complete block design with four replications per treatment (compost application-variety combination).

Soil amendment (composted dairy manure) was applied using a manure spreader and incorporated by light disking before planting in one-half of the plots of each crop, while remaining plots were unamended. The compost used in 2005 was approximately 2.7, 1.4 and 2.9 percent N, P and K by weight, respectively, and had a total C/N ratio of 11.8/1.

For transplanted crops (lettuce, processing tomato), organically-grown transplants were seeded in the spring, allowed to grow 6 weeks in a climate-controlled greenhouse, and hardened off before planting in the field.

Weed pressure was minimized with machine and hand cultivation. Disease and insect pressure were minimized by the use of organically-labeled crop protectants, if populations exceeded anticipated economic thresholds based on scouting. Tomato and lettuce were drip irrigated as needed, based on estimates of soil moisture using the hand-feel method.

Information for all crops planted in 2005, except edamame, is presented here. For all crops, harvest readiness was estimated for individual varieties from published maturity information and

examination of plots. Processing tomato varieties were harvested individually as they matured while all varieties of lettuce, popcorn and potato were harvested on the same day specific to the crop.

Statistical Analysis. Data reported here are subsets of those collected. Data presented here follow from analysis (ANOVA, LSD) of the effect of variety within compost application (+/-) and the effect of compost application within variety for each crop. The General Linear Model Procedure of Statistical Analysis System (SAS, version 8.2, Cary, N.C.) was employed and effects were considered significant if P # 0.05 (ANOVA). Alpha was set at 0.05 in completing Fisher's Least Significant Difference tests.

Lettuce

Plot Establishment. Fifteen varieties of leaf and romaine-type lettuce were transplanted to the field on May 26-27. The field was covered with black cloth ground cover soon after soil preparation in order to eliminate weed growth and transplants were set through holes cut in the cloth. Three-row plots were established by hand. Each row was 15 ft long with 12 in between rows and 10 in between transplants. Each row contained 18 transplants.

Data Collection. On June 30, nine mature, marketable heads were removed from the center 14 heads in each plot. Five of these were individually cut in half longitudinally and placed immediately at –20 C until further chemical analysis. Fresh weight was recorded from four consecutive heads. Leaves were separated from the stem of these four heads and both sample types were dried separately before dry weights were recorded (i.e., leaf and stem fresh and dry weight and percent moisture were recorded separately).

Popcorn

Plot Establishment. Six varieties of popcorn were machine-planted into four-row plots on May 18. Rows were 26 ft long, with 30 in between rows and 10 in between seed at planting.

Data Collection. On October 6 kernel moisture measured 12-16%; therefore, all ears were removed the same day from the center two rows of each plot. Husks were removed by hand and kernels were mechanically shelled and kernel moisture and weight for each row recorded. Yield is reported here. Popping tests are underway.

Potato

Plot Establishment. Seed for fourteen varieties were cut on May 20 and allowed to cure until being set into single-row plots with a one-row mechanical planter on June 1. Each row was 20 ft long with 38 in between rows and 1 ft between seed pieces.

Data Collection. Vines were mowed on September 21, although most vines had senesced naturally 2-3 weeks previously. Potatoes were field cured until mechanical harvest on October 5. After harvest, potatoes were placed in darkened storage at 7 ºC until sizing and grading on October 18 and November 9.

Processing Tomato

Plot Establishment. Twenty genotypes were transplanted by hand to the field on June 7. Single-row plots were 10 ft long, with 5 ft between rows and 15 in between transplants. Drip irrigation tape was placed within 6 in of the center of each row after transplanting and soil moisture was maintained at adequate levels through a combination of rainfall and irrigation.

Data Collection. At maturity, all fruit were hand-collected from all plants in each plot. Direct measures of total fruit weight were recorded for all genotypes. For eight genotypes (O 7983, OX 23, OX 325, U 2008, PS 696, H 9423, GEM 611, GEM 818), 33% by weight of all fruit were sub-sampled, sorted into healthy red, healthy green, immature and defected categories, and counted and weighed. Using the mean percent by weight of healthy red fruit from these eight genotypes, marketable yield was estimated for the remaining twelve genotypes. In addition, for all genotypes, 18 healthy-red fruit were retained for measures of Brix (% solids), pH, and acidity (not reported here).

Results

Variety within compost for each crop significantly affected all variables reported, except for percent leaf moisture in lettuce.

A total of thirty, six, forty-two, and forty tests (# varieties x # variables) of the effect of compost within each variety were completed for lettuce, popcorn, potato and processing tomato, respectively. Of these tests, sixteen (lettuce), two (popcorn), one (potato), and eighteen (processing tomato) were statistically significant ($\alpha = 0.05$). Lettuce head fresh weight and popcorn, potato and processing tomato yield tended to be higher in plots receiving compost compared to non-amended plots.

The data suggest that regardless crop and whether compost is used, variety selection is likely to affect yield. The data also suggest that compost application tends to increase yield in most varieties of the crops tests but to an extent depending on variety.

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Table 1. Crop rotation and the amount of N applied by compost to the subplots in 2005.

Year and Crop Planted		Target lb N/A applied via compost in 2005
2002/2003/2004	2005	
spelt/clover/potato-tomato/	lettuce-edamame	72
clover/potato/lettuce-edamame/	popcorn	150
soybean/spelt/cowpea/	potato-tomato	160 (potato); 130 (tomato)
potato/soybean/popcorn/	cowpea	0

Note: For all data tables to follow, values in boldface font within the compost-amended column are significantly greater than the value for the same variable within the non compost-amended column for the variety shown according to Fisher's Least Significant Difference test ($\alpha = 0.05$).

Table 2. Influence of compost application on (+/-) mean head fresh weight and percent leaf moisture for fifteen varieties of lettuce planted at the OARDC in Wooster, OH in 2005.

Variety	Type	Pre-Plant Compost Application: no — head fwt (g)	no — % leaf moisture	yes — head fwt (g)	yes — % leaf moisture
Jericho	romaine	209.9	95.2	**400.8**	**96.8**
Green Towers	romaine	182.7	95.3	**355.0**	**96.9**
Green Forest MTO	romaine	198.9	95.1	**341.4**	**96.0**
Brave Heart	romaine	196.2	95.4	**361.8**	**96.3**
LR 9071	red leaf	33.8	93.4	43.8	93.9
SVR 5636	red leaf	107.5	94.5	165.0	95.5
Mendoza	red leaf	70.0	94.4	87.1	94.6
Antigua	red leaf	375.7	96.2	**555.0**	96.8
Slobolt	green leaf	132.3	93.6	217.8	**97.5**
Marin	green leaf	173.8	95.3	**291.3**	**96.4**
Two Star MTO	green leaf	205.0	95.7	265.0	**96.5**
Red Cos	red romaine	181.6	94.9	199.1	95.5
Eruption MTO	red romaine	107.5	95.6	141.3	96.2
Freckles OG	speckled romaine	174.3	93.1	**307.7**	96.8
Forellenschluss	speckled romaine	146.9	94.1	**328.2**	**96.8**
	Pr > F	< 0.0001	0.2113	< 0.0001	< 0.0001
	L.S.D. $_{(0.05)}$	43.9	2.21	80.0	1.02

Table 3. Influence of compost application on (+/-) kernel yield (lb/A) of six varieties of popcorn planted at the OARDC in Wooster, OH in 2005.

Variety	Pre-Plant Compost Application: --- no ---	--- yes ---
Mahogany	2478.3	3245.8
Top Pop F1	4226.4	4598.7
Ruby Red	3965.9	4011.1
Shaman's Blue	4022.3	**4721.6**
Robust 128YH	3959.0	3993.3
Calico	3362.5	**4892.1**
Pr > F	< 0.0001	0.0034
L.S.D. $_{(0.05)}$	642.3	853.2

Table 4. Influence of compost application (+/-) on total, US #1 (marketable external quality, $ 1.88 in in diam.) and B-size (# 1.88 in diam.) yield for fourteen varieties of potato planted at the OARDC in Wooster, OH in 2005.

	Pre-Plant Compost Application					
	no			yes		
	yield (cwt/A)					
Variety	Total	US #1	B-size	Total	US #1	B-size
Adora	154.3	117.1	24.7	120.9	79.2	20.0
Alby's Gold	180.7	107.8	19.3	253.7	149.4	11.8
Bintje	194.3	81.6	41.9	245.5	95.1	61.7
Caribe	125.1	69.5	20.1	138.7	64.6	16.5
D.R. Norland	117.1	68.2	5.3	146.9	98.8	7.3
Desiree	214.9	133.9	21.8	254.1	156.2	18.1
Early Ohio	153.5	94.4	15.2	130.1	65.0	17.8
German Butterball	132.9	60.7	47.7	145.5	78.5	33.8
Irish Cobbler	146.3	85.9	21.0	160.1	101.7	11.6
Katahdin	216.9	155.2	12.2	221.7	124.9	5.0
Kennebec	281.6	200.5	8.5	189.9	**73.3**	6.7
Red LaSoda	178.9	113.8	5.9	189.3	103.6	5.7
Yellow Finn	168.3	98.7	19.0	239.7	123.8	22.0
Yukon Gold	141.1	71.0	10.2	155.3	108.0	4.8
Pr > F	0.0265	0.0026	< 0.0001	0.0030	0.0751	< 0.0001
$LSD_{(0.05)}$	85.1	62.6	14.1	80.2	61.7	12.5

Table 5. Influence of compost application (+/-) on total and marketable yield (ton/A) for twenty varieties of processing tomato planted at the OARDC in Wooster, OH in 2005.

	------ Pre-Plant Compost Application ------			
	--------- no ---------		--------- yes ---------	
Variety	total	healthy red	total	healthy red
03-6407	21.47	14.62	21.76	14.82
03-7264	18.61	12.67	19.32	13.16
02-7530	21.08	14.35	**27.49**	**18.72**
02-7536	20.36	13.86	**25.27**	**17.20**
O 9816	21.27	14.48	26.70	18.18
O 88119	17.66	12.02	**20.61**	**14.03**
O 7983	14.65	9.98	17.61	11.99
O 8245	21.44	14.60	**24.73**	**16.83**
OX 52	20.62	14.04	20.62	14.04
OX 23	18.96	12.91	**21.54**	**14.67**
OX 323	22.83	15.54	**31.04**	**21.13**
OX 325	23.11	15.73	**30.68**	**20.89**
U 2008	22.34	15.21	25.64	17.46
C 232	22.02	15.00	**28.23**	**19.22**
C 205	16.68	11.36	20.41	13.90
PS 696	19.91	13.56	24.67	16.80
H 9423	18.41	12.54	20.82	14.17
H 9704	21.17	14.41	25.98	17.69
GEM 611	17.94	12.21	20.69	14.09
GEM 818	14.73	10.03	**18.84**	**12.82**
Pr > F	0.0009	0.0009	< 0.0001	< 0.0001
$LSD_{(0.05)}$	4.13	2.85	4.61	3.14

Note: Direct measures of healthy red (i.e., marketable) fruit weight were taken on 33% by weight of all fruit removed from each plot of O 7983, OX 23, OX 325, U 2008, PS 696, H 9423, GEM 611, GEM 818. The grand mean percent by weight of healthy red fruit for these eight genotypes was calculated. Healthy red fruit yield for the remaining twelve genotypes is estimated using the direct measure of total yield for the genotype x mean percent of healthy red fruit recorded directly on eight genotypes.