

Compost Application and Variety Effects on Yield and Quality Variables of Organically Grown Edamame, Lettuce, Potato, Popcorn, 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. The Organic Vegetable Variety Evaluation, Selection and Management Project was initiated to provide research-based information regarding crop and variety selection to organic farmers to help improve the understanding of variety-x-compost interactions in organic vegetable systems.

Materials and Methods

Crops planted before and since this study began in 2004 and the target amount of N applied by compost to the subplots in 2006 are listed in Table 1.

Land use in this project was certified for organic production.

Plot Maintenance. Crops were planted in separate fields or areas within each field. 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). Planting date effects were also tested in lettuce.

Composted dairy manure was applied to sub-plots using a manure spreader and incorporated by disking before planting, while remaining sub-plots were not amended. The compost in 2006 was approximately 1.31, 0.71, and 3.94 percent N, P, and K by weight, respectively, and had a total C/N ratio of 12:1.

For transplanted crops (lettuce and 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.

For all crops, harvest readiness was estimated for individual varieties from published maturity information and visual examination of four plots per entry. Edamame and processing tomato varieties were harvested individually as they matured while lettuce, popcorn and potato plots were harvested once per planting.

Statistical Analysis. Data reported here are a subset of those collected. Analyses of variance (ANOVA) were performed to test compost and variety effects on dependent variables for each crop by using the General Linear Model Procedure of Statistical Analysis System (SAS, version 7, Carry, N.C.). Planting date effects were not tested in lettuce; instead, separate ANOVA were completed on data from the spring and summer plantings. For all tests, effects were considered significant if $P \leq 0.05$. After completing ANOVA, Fisher's LSD tests ($\alpha = 0.05$) were used to compare variety effects within the compost- and no compost-amendment groups and compost application (no, yes) effects within varieties. For Tables 2-6, values in boldface font within the compost-amended column significantly exceed the value for the same variable within the non compost-amended column for the variety shown.

Edamame

Plot Establishment. Eight edamame varieties were planted on May 31. Two-row plots of each variety were established with a four-row soybean planter. Each row was 16 ft long with 27 in between rows. The planter delivered 150 seed/row. Due to low germination, the number of plants in each row ranged from 3 to 52.

Data Collection. At maturity, data were collected from plants in the center 10 ft of one of the two rows of each plot. Pods were removed from the plants and weighed (total yield). Pods were then sorted into unmarketable and marketable groups, with marketable pods also sorted into those containing 2 beans or 3 or more beans. The weight of each group was recorded. The number of pods in an unsorted, 500-g sub-sample of marketable pods was also counted. And, the fresh weight (g) of 100 beans was recorded on the same sub-sample. Data for seven varieties are given here.

Lettuce

Plot Establishment. Fifteen varieties of leaf and romaine-type lettuce were planted on May 23 (spring planting) and again on September 5-7 (summer planting). Prior to the Spring planting, the field was covered with black cloth ground cover soon after soil preparation in order to eliminate weed growth with the cloth remaining in place until after the harvest of the Summer planting. 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. At maturity, nine marketable heads were removed from the center fourteen heads in each plot. Four of these heads were weighed intact and separated into leaf and stem portions. These portions were then weighed and placed in a drying oven before being re-weighed in order to calculate tissue moisture level. The remaining five heads were individually cut in half longitudinally. Half of each head was placed on ice and transferred within 3-4 hours of harvest to dark storage at -20 C . The fourth and fifth leaves were removed

from the remaining half-head with petiole sap nitrate level recorded on leaf number five and size recorded on leaf number four.

Potato

Plot Establishment. Seed for fourteen varieties were cut on May 11 and allowed to cure until planting on May 25, with a one-row mechanical planter. Each row was 25 ft long with 38 inches between rows and 1 ft between seed pieces.

Data Collection. Vines senesced naturally prior to harvest. Potatoes were field cured until mechanical harvest on October 9. After harvest, potatoes were placed in darkened storage at 7 C until sizing and grading on November 7.

Popcorn

Plot Establishment. Six varieties of popcorn were machine-planted into four-row plots on May 25. Rows were 26 ft long with 36 inches between rows and 10 inch between seed at planting.

Data Collection. Popcorn was harvested on October 6 and October 9. Husks were removed by hand. Kernels were removed with a mechanical sheller after ears had been allowed to dry until kernel moisture reached 12-16%. Kernel weight and moisture level were recorded at shelling. Yield data are reported here and popping tests are underway.

Processing Tomato

Plot Establishment. Twenty genotypes were planted on May 25. One row plots were established by hand. Each row was 10 ft long with 5 ft between rows and 12 in between transplants. Total and marketable yield were recorded for all genotypes.

Data Collection. At maturity, fruits were hand harvested from the center 5 plants of each plot. Direct measures of total fruit weight were recorded for all genotypes. Thereafter, a sub-sample (33% by weight of all fruit collected) was collected and sorted into healthy red, healthy green, immature and defected fruit and weighed. Five fruit from these groups (except defected) were retained for additional measures of size and shape. And, nine healthy red fruit were retained for measures of Brix (% solids), pH, and acidity (not reported here).

Results

A total of 35, 42, 45, 6, and 40 tests (# varieties x # variables) of the effect of compost within each variety were completed for edamame, potato, lettuce, popcorn, and processing tomato respectively. Of these tests, 6 (edamame), 32 (lettuce), 4 (popcorn), 8 (tomato), were statistically significant ($\alpha = 0.05$).

The data suggest that, regardless of crop and whether compost is used, variety selection is likely to affect yield. The data also suggests that compost application tends to increase yield

in most varieties of the crops tests but to an extend depending on variety.

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Table 1. Crop rotation and the amount of N applied by compost to the subplots in 2006.

2002/2003/2004/2005	2006	Target lbs N/A applied by compost in 2006
clover/potato/lettuce-edamame/popcorn	fallow	0
potato/soybean/popcorn/cowpea	potato-tomato	140 (pot.) - 110 (tom.)
soybean/spelt/cowpea/potato-tomato	lettuce-edamame	70 (let.) - 24 (eda.)
spelt/clover/potato-tomato/lettuce-edamame	popcorn	131

Table 2. Compost effects on total and marketable yield, number of pods in 500 g and fresh weight of 100 beans for seven varieties of edamame planted at the OARDC in Wooster, OH.

No Compost Applied					
Variety	---- Pod Yield ---- (fwt, g/plant)		number pods in 500 g	fresh wt (g) 100 beans	Harvest index (%)
	Total	Mkbl.			
AGS 381	54.1	39.1	168	46.6	36.0
BeSweet 2020	74.1	59.9	192	57.7	62.7
Butterbeans	11.5	90.0	221	50.2	55.3
Dawn	57.2	46.5	227	47.0	56.7
Envy	34.2	23.9	357	42.6	62.6
Gardensoy 31	39.3	28.5	285	37.6	32.3
HF-Black	60.7	46.3	216	58.5	51.0
Pr > F	0.0025	0.0042	<0.0001	<0.0001	<0.0001
LSD _(0.05)	33.9	30.5	29.0	7.1	4.7

Compost Applied					
AGS 381	61.0	48.3	182	51.3	34.8
BeSweet 2020	57.3	45.6	197	57.6	54.7
Butterbeans	109.1	72.7	252	44.5	48.6
Dawn	75.1	63.4	195	52.0	55.7
Envy	52.1	38.1	337	42.8	60.7
Gardensoy 31	39.3	28.1	277	40.7	30.6
HF-Black	81.1	61.0	210	61.3	46.2
Pr > F	0.081	0.0314	<0.0001	<0.0001	<0.0001
LSD _(0.05)	45.4	26.8	31.0	5.6	3.1

Table 3. Planting date and compost effects on mean head fresh weight and percent leaf moisture for fifteen varieties of lettuce planted at the OARDC in Wooster, OH.

		----- Pre-Plant Compost Application -----			
		----- no -----		----- yes -----	
Spring Planting		Head fwt (g)	Leaf moisture (%)	Head fwt (g)	Leaf moisture (%)
Variety	Type				
Jericho	romaine	175.3	93.7	400.1	94.9
Green Towers	romaine	132.4	92.4	271.3	94.5
Green Forest MTO	romaine	186.6	93.6	365.2	94.7
Brave Heart	romaine	142.8	93.7	281.9	94.6
LR 9071	red leaf	43.1	92.4	98.4	93.8
SVR 5636	red leaf	107.4	93.2	240.8	92.1
SVR 7998	red leaf	111.0	94.2	226.1	95.2
Antigua	iceberg	147.7	93.5	349.8	95.0
Slobolt	green leaf	150.1	93.9	261.4	95.0
Marin	green leaf	114.8	93.7	199.4	94.5
Two Star MTO	green leaf	164.1	94.0	311.8	94.9
Red Eyed Cos	red romaine	138.9	93.4	251.1	94.6
Eruption MTO	red romaine	113.8	95.2	182.1	95.2
Freckles OG	speckled romaine	148.1	91.6	232.1	95.0
Forellenschluss	speckled romaine	143.1	94.4	234.1	94.6
Pr > F		0.0011	0.2724	<0.0001	0.2150
LSD _(0.05)		54.0	2.3	85.9	2.0
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Summer Planting					
Jericho	romaine	101.0	NA	181.4	NA
Green Towers	romaine	68.3	NA	179.8	NA
Green Forest MTO	romaine	62.6	NA	234.2	NA
BraveHeart	romaine	108.6	NA	203.1	NA
LR 9071	red leaf	19.7	NA	48.3	NA
SVR 5636	red leaf	67.9	NA	104.0	NA
SVR 7998	red leaf	54.5	NA	120.0	NA
Antigua	iceberg	76.8	NA	107.8	NA
Slobolt	green leaf	67.5	NA	182.5	NA
Marin	green leaf	93.3	NA	176.1	NA
Two Star MTO	green leaf	83.8	NA	189.7	NA
Red Eyed Cos	red romaine	73.5	NA	128.0	NA
Eruption MTO	red romaine	49.4	NA	78.6	NA
Freckles OG	speckled romaine	78.9	NA	142.8	NA
Forellenschluss	speckled romaine	80.1	NA	159.3	NA

Pr > F	0.0003	NA	<0.0001	NA
LSD _(0.05)	32.1	NA	58.7	NA

Table 4. Compost effects on kernel yield of six varieties of popcorn planted at the OARDC in Wooster OH.

Variety	Pre-Plant Compost Application	
	no kernel yield (1b/A at 15% moisture)	yes
Calico	4557	6681
Mahogany	3003	5057
Robust 128Y	2968	7616
Ruby Red	5070	7952
Shaman's Blue	6091	9746
Top Pop F1	5015	5046
Pr > F	0.0071	0.0203
LSD _(0.05)	1721.4	2833

Table 5. Compost effects on total, US #1 (marketable external quality, ≥ 1.88 inches in diameter) and B-Size (≤ 1.88 inches in diameter) tuber yield for fourteen varieties of potato planted at the OARDC in Wooster, OH.

Variety	----- Pre-Plant Compost Application -----					
	----- no -----			----- yes -----		
	----- Yield (cwt/A) -----					
	Total	US#1	B-Size	Total	US#1	B-Size
Adora	89.0	42.8	13.4	67.4	33.7	8.8
Alby's Gold	148.5	76.4	14.6	148.5	59.1	20.3
Bintje	90.3	33.0	35.9	128.3	51.1	53.6
Caribe	106.5	25.4	15.0	157.5	69.7	18.5
D.R. Norland	103.1	62.3	20.7	121.3	80.0	15.3
Desiree	128.9	79.8	24.7	159.3	83.9	19.0
Early Rose	210.9	92.9	35.9	215.7	95.1	26.7
German Butterball	85.7	37.1	33.1	127.3	64.5	45.7
Irish Cobbler	126.9	62.4	17.5	122.9	57.7	19.5
Katahdin	106.2	59.2	7.1	152.5	107.1	8.6
Kennebec	180.1	72.7	7.5	204.1	120.9	9.3
Red LaSoda	121.7	53.6	8.6	174.7	87.9	6.6

Yellow Finn	62.0	31.5	13.8	105.5	48.0	22.0
Yukon Gold	49.6	18.1	4.0	59.4	22.5	1.4
Pr > F	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
LSD _(0.05)	37.3	22.3	7.0	40.5	30.7	9.7

Table 6. Compost effects on total and marketable yield (ton/A) for twenty varieties of processing tomato planted at the OARDC in Wooster, OH.

Variety	----- Pre-Plant Compost Application -----			
	----- no -----		----- yes -----	
	----- Yield (ton/A) -----			
	total	healthy red	total	healthy red
03-6407	8.7	3.9	14.9	6.7
03-7264	10.4	4.7	9.0	4.1
02-7530	8.1	3.7	12.3	5.5
02-7536	10.1	4.6	12.4	5.6
O 9816	7.3	3.3	11.0	5.0
O 88119	9.1	4.1	7.3	3.3
O 7983	7.4	3.3	10.8	4.9
O 8245	9.3	4.2	10.4	4.7
OX 52	7.7	3.5	11.6	5.3
OX 23	10.8	4.9	12.2	5.5
OX 323	7.8	3.5	14.7	6.7
OX 325	9.6	4.4	16.5	7.5
U 2008	12.0	5.4	12.2	5.5
C 232	10.9	4.9	12.1	5.5
C 205	7.3	3.3	15.9	7.2
PS 696	15.3	6.9	10.3	4.7
H 9423	8.8	4.0	11.6	5.3
H 9704	10.4	4.7	10.6	4.8
GEM 611	8.1	3.7	10.0	4.5
GEM 818	9.3	4.2	11.7	5.3
Pr > F	0.0417	0.0417	0.0415	0.0415
LSD _(0.05)	4.0	1.8	4.6	2.1