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

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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.

Materials and Methods

The study includes numerous varieties of edamame-type soybean, lettuce, potato, processing tomato and popcorn. 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. 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 untreated. The compost used in 2004 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. Crops planted before the study began in 2004 and the amounts of N applied by compost to the subplots in 2004 are listed in Table 1. Seed suppliers are listed in Table 2.

Land use in this project was certified for organic production.

Plot Maintenance. 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.

Statistical Analysis. Data reported here are subsets of those collected. In this analysis, treatment refers to individual combinations of variety x compost application (+/-). Analyses of variance (ANOVA) were performed to test amendment effects on dependent variables for each crop by using the General Linear Model Procedure of Statistical Analysis System (SAS, version 7, Carry, N.C.). Effects were considered significant if $P \leq 0.05$. After completing the ANOVA, Fisher's LSD test (α=0.05) was used to compare treatment mean values.

Information for all crops planted in 2004, except popcorn, are presented here. 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 into the field. For all crops, harvest readiness was estimated for individual varieties from published maturity information and visual examination of four plots per entry. Varieties were harvested individually as they matured.

Edamame

Plot Establishment. Eight edamame varieties were planted on May 12. Two-row plots of each variety were established with a four-row soybean planter. Each row was 20 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 10-112.

Data Collection. At maturity, data were collected from plants in the center 16 ft of the two center 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 and 3 or more beans. Yield was recorded on each group. Sub-samples of 2- and ≥-bean pods were collected and stored for further quality analysis and sensory evaluation. Samples for sensory evaluation were blanched before being placed at –20 C until analysis. Sub-samples (500 g) of unsorted marketable pods were taken and the number of pods counted. Fresh weight (g) of 100 beans was also recorded on the same sub-sample.

Lettuce

Plot Establishment. Fifteen varieties of leaf and romaine-type lettuce were planted on May 28. The field was covered with black cloth ground cover soon after soil preparation in order to eliminate weed growth. 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 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 placed in a drying oven for additional analyses after fresh weight was taken. Both leaf and stem fresh weight was taken before they were placed in the drying oven prior to measures of moisture content.

Processing Tomato

Plot Establishment. Twenty genotypes were planted on June 3, 2004. One row plots were established by hand. Each row was 10 ft long with 5 ft between rows and 15 in between transplants. Total yield was taken from twenty genotypes while marketable yield was recorded for thirteen genotypes.

Data Collection. At maturity, fruits were harvested from each replication. They were sorted and weighed as a group of healthy red, healthy green, immature and defected. Five individual

samples from these groups (except defected) were placed into a drying oven after individual weight was taken from them. Brix (% solids), pH, acidity from the healthy red fruits was recorded.

Potato

Plot Establishment. Seed for fourteen varieties were cut on May 17, 2004 and allowed to cure until planting on June 3, 2004, with a one-row mechanical planter. Each row was 10 ft long with 38 in between rows and 1 ft between seed pieces.

Data Collection. Vines were mowed on September 30 when most of the vines were dead in the field. Potatoes were field cured until mechanical harvest on October 6. After harvest, potatoes were placed in darkened storage at 7 ºC for approximately 21 days and then graded for size and external quality.

Results

Significant treatment effects on yield and quality were noted in all crops. Additional analyses will resolve the independent and interactive effects of variety and compost application.

Except for lettuce, higher yields of all crops were recorded in plots amended with compost. The yield of all potato and processing tomato and six of eight edamame varieties was greater in composted-amended than non-amended plots. Overall, marketable yield ranged from 30.3-176.9 g/plant, 1.2-4.0 kg/plant and 8-191 cwt/A in edamame, tomato and potato, respectively.

Contrary to other crops, lettuce head weight was generally lower in compost-amended than non-amended plots, although this was not the case for ‘Freckles’ and ‘SVR 5636’. The highest head weight (2.1 kg) was observed on ‘Green Forest’ grown without compost while the lowest head weight (0.3 kg) was recorded on Mendoza grown with compost.

In edamame, no clear trends were noted for treatment effects on the number of pods in 500 g or fresh weight of 100 beans.

Treatment effects were significant for processing tomato fruit pH, acidity and % solids (Brix).

Yield of B-size potatoes tended to be higher in plots amended with compost, compared to plots of the same variety grown without compost.

Table 1. Crop rotation and the amount of N applied by compost to the subplots in 2004.

2002/2003	2004	kg N/A applied by compost
clover-timothy/potato	edamame	14
clover-timothy/potato	lettuce	32
spelt/clover-timothy	potato	55
potato/soybean	popcorn	55
spelt/clover-timothy	processing tomato	41

Table 2. List of seed suppliers.

Supplier	Edamame	Lettuce	Potato	Processing Tomato
AVRDC[1]	x			
Coastal Valley Seeds		x		
FedCo		x		
Harris		x		
Harris Moran		x		
Johnny's Selected Seeds	x	x		
OPGA[2]			x	
OARDC[3]	x			x
Orsetti		x		
Rijk Zwaan		x		
Ronninger Seed Farm			x	
SeedEx	x			
Sunseeds	x			
Synergene		x		
Univ. of Illinois	x			
Wannamaker Seeds	x			

[1] Asian Vegetable Research and Development Center
[2] Ohio Potato Growers Association, with suppliers in Maine and Wisconsin
[3] Dr. Ron Fiorrito (edamame) and Dr. David Francis (processing tomato)

Table 3. Influence of compost application (+/-) on total and marketable yield, number of pods in 500 g and fresh weight of 100 beans for eight varieties of edamame planted May 12, 2004 at the Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH.

Variety	Compost Application	-----Pod Yield (g/plant) ----- Total	Marketable	No. pods in 500 g	Fresh weight of 100 beans
AGS 381	+	148.7	107.6	162.0	46.6
	-	239.8	176.9	153.5	58.5
Black Jack	+	64.6	56.3		
	-	53.3	32.0		
Butterbeans	+	81.5	60.8	201.3	54.6
	-	44.3	30.3	206.5	56.0
Dawn	+	62.8	46.6	161.8	70.2
	-	71.7	47.2	171.3	65.8
Envy	+	58.9	44.5	261.0	50.8
	-	54.8	42.3	258.7	46.7
Gardensoy 31	+	109.2	70.6	215.3	50.8
	-	81.6	60.5	213.0	49.6
HF-Black	+	91.7	66.6	181.3	66.5
	-	71.9	52.2	179.5	66.7
Kenko	+	114.5	92.3	166.7	81.3
	-	81.7	66.3	184.8	76.1
	Pr > F	**	**	**	**
	$LSD_{(0.05)}$	76.0	56.43	22.9	10.0

** denotes significance at alpha = 0.05.

Table 4. Influence of compost application on (+/-) head weight and percent leaf moisture for fifteen varieties of lettuce planted May 28, 2004 at the Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH.

Variety	Compost Application	Fresh Weight (kg) 4 heads
Antigua	+	0.9
	-	1.1
Brave Heart	+	1.7
	-	1.9
Eruption	+	0.5
	-	0.9
Forellenschluss	+	1.4
	-	1.8
Freckles	+	1.4
	-	1.1
Green Forest	+	1.8
	-	2.1
Green Towers	+	1.7
	-	1.8
Jericho	+	1.4
	-	2.0
LR 9071	+	0.3
	-	0.4
Marin	+	1.0
	-	1.8
Mendoza	+	0.3
	-	0.5
Red Cos	+	1.6
	-	1.3
Slobolt	+	1.4
	-	1.7
SVR 5636	+	1.1
	-	1.1
Two Star	+	0.8
	-	1.3
	Pr > F	**
	$LSD_{(0.05)}$	1.02

** denotes significance at alpha = 0.05.

Table 5. Influence of compost application (+/-) on total and marketable yield and fruit pH, acidity and Brix for thirteen varieties of processing tomato planted June 3, 2004 at the Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH.

Variety	Compost Application	------Yield (kg/plant)----- Total	Marketable	pH	Acidity	Brix
C 205	+	3.7	3.4	4.4	5.6	3.6
	-	3.1	2.7	4.2	6.0	3.6
C 232	+	4.6	4.0	4.3	6.2	3.6
	-	3.6	3.2	4.1	6.0	3.6
GEM 611	+	4.0	3.6	4.3	6.5	3.5
	-	2.3	2.7	4.3	6.0	3.6
GEM 818	+	3.6	3.4	4.2	7.0	3.6
	-	2.8	2.6	4.3	6.6	3.7
H 9423	+	3.5	3.1	4.0	7.2	4.0
	-	2.9	2.4	4.1	6.5	4.0
O 7983	+	3.4	2.9	4.0	7.7	3.7
	-	2.6	2.2	4.0	6.4	3.5
O 88119	+	2.5	1.6	4.2	5.6	3.2
	-	2.4	1.8	4.0	6.4	3.1
OX 23	+	2.8	2.0	4.0	7.0	3.2
	-	2.7	1.2	4.1	6.0	3.1
OX 52	+	3.6	3.2	4.1	7.4	3.5
	-	2.7	1.8	4.0	6.0	3.4
OX 323	+	3.4	3.1	4.2	7.3	3.6
	-	3.1	2.9	4.2	6.0	3.5
OX 325	+	3.3	2.9	4.2	6.7	3.6
	-	2.9	2.4	4.0	6.2	3.4
PS 696	+	4.0	3.7	4.2	6.5	3.4
	-	3.7	3.2	4.2	6.2	3.3
U 2008	+	3.6	3.3	4.2	5.8	3.6
	-	3.4	3.2	4.3	6.0	3.6
	Pr > F	**	**	**	**	**
	$LSD_{(0.05)}$	1.13	1.18	0.13	0.60	0.25

** denotes significance at alpha = 0.05.

Table 6. Influence of compost application (+/-) on total, US #1 and B size yield for fourteen varieties of potato planted May 17, 2004 at the Ohio Agricultural Research and Development Center (OARDC) in Wooster, OH.

Variety	Compost Application	Yield (cwt/A) Total	US #1	B size
Adora	+	93	60	11
	-	43	29	6
Alby's Gold	+	172	86	13
	-	106	43	10
Bintje	+	187	80	45
	-	160	68	41
Caribe	+	54	42	2
	-	44	27	8
D.R. Norland	+	144	113	9
	-	111	90	5
Desiree	+	136	69	15
	-	91	45	9
Early Ohio	+	52	34	6
	-	12	8	2
German Butterball	+	135	98	22
	-	89	57	17
Irish Cobbler	+	132	84	13
	-	127	77	18
Katahdin	+	177	129	7
	-	123	83	7
Kennebec	+	295	191	11
	-	220	146	16
Red LaSoda	+	176	102	9
	-	140	82	11
Yellow Finn	+	228	160	18
	-	148	99	12
Yukon Gold	+	78	54	3
	-	55	31	1
	Pr > F	**	**	**
	$LSD_{(0.05)}$	53.1	40.0	7.6

** denotes significance at alpha = 0.05.