2012 REPORT FOR CERES PROJECT

PROJECT TITLE: Facilitating Improved Soil Quality on Organic Farms through Research and Training on No-Till Organic Vegetable Production in the Midwest

Introduction

U.S. agriculture is facing worldwide competition for petroleum and increased costs for fertility and weed management inputs, leaving producers to compete within the larger system or re-align their farming practices to allow participation in alternative markets, such as organic agriculture, to increase economic returns. Organic farmers are under increasing pressure–both internal and external–to reduce energy use in fertilization and pest management strategies, minimize nutrient leaching, reduce soil erosion, and build soil quality. In order to enter the expanding organic market and meet certified organic requirements, producers must implement a soil-building plan in accordance with sections 205.203 and 205.205 of the U.S. Dept. of Agriculture (USDA) National Organic Program (NOP) (USDA–AMS, 2010). At the heart of the regulations is the protection or enhancement of carbon and other nutrients in soil organic matter in order to maintain soil fertility and structure in sustainable systems (Manley et al., 2006). With inexpensive petroleum feedstocks declining, alternative sources of fertility, based on the ecological principles of biological nitrogen (N) fixation and nutrient recycling, as opposed to fossil fuel-based fertilization, must be developed for organic, as well as, conventional farms (Badgley et al., 2007). Removing carbon from the atmosphere and recycling it through plant-based systems may also mitigate the rate of global climate change. Through less reliance on carbon-intensive tillage systems, and increased use of strategies that enhance or sequester carbon in agricultural soils, the 'carbon footprint' of organic production also will be greatly reduced.

In addition to issues of soil fertility, some of the most critical needs of transitioning and certified organic growers are methods for maintaining effective, long-term soil fertility and managing weeds (Walz, 2004; Delate and DeWitt, 2004). Many organic and conventional vegetable farmers also are seeking alternatives to plastic mulch, which is expensive, difficult to dispose, and may have negative impacts on soil microbial activity (Rogers et al., 2004). Sources of carbon in organic systems include manure and plant residues from crop rotations and cover crops (Gaskell et al., 2000). Methods for terminating cover crops in organic systems include mowing, rolling, roll-chopping, undercutting, and roto-tilling (Carrera et al., 2004). Termination methods that are based on reduced tillage approaches offer the greatest potential for weed management and enhancement of soil quality. While the majority of cover crop studies have been reported from conventional systems using herbicide inputs, cover crop combinations and no-till methods developed in conventional systems can be of use in organic systems. However, because synthetic herbicides are disallowed in organic production, termination of cover crops through organic methods constitutes a major challenge for organic growers. Research is therefore needed that determines the impact of no-till organic farming on soil biological, chemical, and physical properties, in addition to the effect on weed management and yields. Also needed is documentation of any improvements in biodiversity conservation and wildlife habitat, soil erosion prevention, and protection of soil mycorrhizae and other beneficial soil organisms in these systems. Ultimately, organic no-till should be understood as one among a variety of methods for managing organic cropping systems for maximum environmental and economic benefit.

This multi-disciplinary project is designed to assist transitioning and certified organic producers by developing organic no-till strategies that would improve soil quality, reduce off-farm costs, and facilitate access to the projected growth in the organic industry. The long-term ***goals*** of this project are to maintain and enhance soil quality, crop health and food quality in organic systems by optimizing production inputs and systems design to improve nutrient cycling and soil biological processes and minimize environmental and economic costs. This project is driven by the ***hypothesis*** that organic vegetable systems with integrated management strategies including cover crops, crop rotations, and reduced tillage will lead to increased carbon sequestration, improved soil quality and crop health, and greater economic viability by reducing production costs. The ***Objectives*** to achieve these goals are to: (1) Develop organic cropping systems that improve soil health and carbon sequestration through cover crops and reduced tillage; (2) Enhance ecosystem services on organic farms by increasing biological management through suppression of pests (weeds, pest insects, nematodes, diseases) in cover crop-intensive systems; and (3) Enhance adoption and improve economic performance by training farmers, students, and agricultural professionals on organic vegetable production and marketing techniques.

Because the opportunity was presented to us to establish new organic plots in 2009, we began this research with a comparison of organic and conventional crops at the Iowa State University (ISU) Horticulture Research Station (HRS) in Gilbert, Iowa, using certified organic practices in the organic plots, to demonstrate best management practices for reduced tillage organic vegetable production. Soil quality, plant growth, yield, pest and postharvest quality data were analyzed to determine the effect of organic practices on crop productivity and quality. Results were presented in ISU Extension programs (Field Day and presentations) and at the PFI (Practical Farmers of Iowa) and MOSES conferences to facilitate producer involvement in self-development of soil quality enhancement techniques to improve organic farming in the Midwest.

Materials and Methods

A long-term crop rotation was established at the ISU-Horticulture Research Station (HRS) in 2010 to comply with certified organic rules. Separate blocks of vegetable (16 plots: 20 x 20 ft) and grain crop (16 plots: 20 x 50 ft) rotations were laid out in a randomized complete block design with 20-ft borders around each plot to comply with certified organic regulations.
The field operations in 2012 at the ISU HRS followed those outlined in Table 1.

Table 1. Field operations at the Horticulture Research Farm, Gilbert, Iowa, 2012.

Activity	**Date 2012**
Broccoli seeded in greenhouse	March 23
Squash seeded in greenhouse	April 19
Soil sampling	May 15-18, November 5-8
Organic fertilizer applied	May 22 and June 22 (Sq, B, C)
Plots tilled	Disked and field cultivated: May 21 Rotovation (2 passes): May 21 and 23
Squash and broccoli plants transplanted	May 23 and 24
Field corn planted	May 23
Soybeans planted	May 23

Conventional plots fertilized	May 21 (Urea-Sq): 60 lb N/acre May 21 (Urea-B): 80 lb N /acre
Side-dress organic fertilizer in organic plots	June 22 (Sq): 30 lb N/acre July 22 (B): 60 lb N/acre June 22 (C): 50 lb N/acre
Side-dress conventional fertilizer in conventional plots	June 19 (Urea-CC): 150 lbs N/acre
Organic plots row cultivated (C, SB)	June 27, July 10 (SB)
Herbicide applied in conventional plots	May 3 (Glyphosate) (CC, CSB, CSq, CB)
Organic pesticide applied in plots	June 11, 26, 30 (Bt) (B) July 11 and 30 (Pyganic™)-SB July 16, 22, 30 and Aug. 14 (Pyganic™)-Sq
Plant performance sampling	May 8, 11 (cover crop rating and biomass) June 7, July 9, 30 (Sq, B, C, SB) July 11 (Sq, B, C, SB)
Broccoli harvested	July 23, 30; August 1, 8, 14, 22
Squash harvested	July 25, 30; August 8, 14
Vegetable plots rotovated	May 21 and May 23 (2 passes) (OB, OSq, CB, CSq)
Field corn harvested	October 2
Soybeans harvested	October 2
Cover crop planted in organic vegetable plots in 2011	October 11
Cover crops planted on corn and soybean plots in 2011	October 11

Code: O=organic, C=conventional. Crops: Sq=Squash; B=Broccoli; C=Field Corn; SB=Soybean.

Broccoli (‘Belstar’, Johnny’s Seeds, Waterville, ME) seeds were planted at the Dept. of Horticulture greenhouse (Ames, IA) on March 23 in 72–cell trays containing organic–compliant media (Sunshine LC-1 Mix®, Sun-Gro Horticulture, Bellevue, Wash.). Squash (‘Honey Bear’, Johnny’s Seeds, Waterville, ME) were planted on April 19. The 6-inch plants were transplanted with a mechanical transplanter at the ISU HRS (Gilbert, Iowa) on May 23 and 24. Organic field corn (BR44R57, Blue River Hybrids, Kelley, IA) and organic soybeans (29AR9, Blue River Hybrids, Kelley, IA) were planted at a rate of 32,000 seeds/acre and 180,000 seeds/acre, respectively, on May 23. Conventional field corn (N53-WC, Syngenta, Slater, IA) and conventional soybeans (S27-C4, Syngenta, Slater, IA) were planted at a rate of 32,000 seeds/acre and 180,000 seeds/acre, respectively, on May 23. Organic fertilizer (4-3-5 N-P-K) (Midwest Bio-Ag, Blue Mounds, WI), which consisted of composted poultry manure and other organic-compliant ingredients, was applied in the organic treatments prior to vegetable planting at 80 lb N/acre based on nitrogen availability from the organic amendments, soil test results, and crop needs. Organic corn plots were also fertilized prior to planting at 100 lb N/acre. Conventional fertilizer (urea) was applied at a rate of 60 lb N/acre on May 21 to squash and 80 lb N/acre on broccoli. On June 19 urea was applied to conventional corn plots at a rate of 150 lb/acre. Organic fertilizer was side-dressed in organic squash and broccoli plots at rates of 30 lb N/acre and 60 lb N/acre, respectively, on June 22. Organic corn plots were also side dressed at 50 lb N/acre on June 22 to provide a total of 150 lb N/acre.

An extreme drought affected production in 2013, particularly corn and soybean crops. Vegetable crops were overhead-irrigated to provide one inch of water/week when no rainfall occurred. A one-time irrigation (providing one inch of water) was applied on July 20 to the corn and soybean crops to facilitate mineralization of the organic fertilizer, which, due to drought, had not dispersed from the soil surface. Additional problems that occurred in 2012 included poor plant establishment in organic corn and soybean crops due to ground squirrel attack; Japanese beetle attack on soybeans; herbicide drift from conventional plots damaging organic soybean leaves; high weed populations in organic corn and soybean plots; and deer damage at the end of the season.

<u>Data collection</u>: Cover crop plant performance was monitored on May 8 and 11. Weed populations were censused on July 11 and July 30 by counting weeds in three 1-m^2-quadrat areas in each plot, and separated into grasses and broadleaf species. Vegetable plant height was measured on June 7 and July 9. The number of broccoli and squash leaves per plant was counted on July 7 and July 9. Height and leaf number were measured on 4 randomly selected plants per plot.

Squash fruits were hand-harvested on July 25 and 30 and on August 8 and 14. Mature fruits were cut off the plant, leaving a 1–inch stem, and weighed in the field. Broccoli was harvested on July 23 and 30, and on August 1, 8, 14, and 22 by cutting heads off the plant with a knife, leaving a 6–inch stem. Ten heads per plot were used for a postharvest study (stored at 10 °C, 70% RH) in the ISU Horticulture Dept. and the remainder was used by the University of Iowa Dining Services for use in the Iowa Organic Conference meal.

All rows of each plot of field corn and soybeans were harvested with a combine on October 2. Grain samples were collected from each plot to be analyzed for grain quality at the ISU Grain Quality Lab (Ames, IA).

<u>Statistical Analysis:</u> Standard ANOVA was used to compare plant growth, weeds, yield and postharvest parameters among the different cropping system treatments (SAS, 2005).

RESULTS AND DISCUSSION

<u>Plant growth and weed populations</u>

When cover crops (hairy vetch and rye) were measured before rolling or disking, the rye height averaged 38 inches and hairy vetch averaged 26 inches, with no differences between all vegetable crop plots (Table 2). Rye predominated, averaging 61 stems/ft^2. The cover crop stand was excellent in 2012, with an average of 88% of the planted ground covered by cover crops. Weeds in cover crop plots averaged 1.5% cover, while bare ground was observed over an area covering only 10% of the plots. Cover crop biomass included an average of 7,770 lb/acre from the rye crop and 803 lb/acre from hairy vetch (Table 3).

On June 7, broccoli plant height was greater, at 5.3 inches, in the no-till organic plots compared to 4.5 inches in the tilled plots, while both treatments had a similar leaf number of 7 leaves/plant (Table 4). Organic squash height was similar in the no-till and tilled plots, at 9 inches, with a similar leaf number of 4 leaves/plant. On July 9, organic broccoli height averaged 17 inches, with no differences between tillage treatments (Table 5). Leaf number was also similar between tillage treatments and averaged 16 leaves/plant. There was no difference between tillage treatments in organic squash plots, where squash averaged 22 inches in height with 38 leaves/plant and 4 fruits/plant.

Weeds were well managed in the organic vegetable crop plots through the cover crop mulch and hand-weeding. Grass weeds averaged <2 weeds/ft^2 and broadleaf weeds averaged <1 weed/ ft^2 in broccoli plots, while both grass and broadleaf weeds averaged <2 weeds/ft^2 in organic squash plots (Table 6). On July 11, organic field corn populations averaged 25,959 plants/acre with no differences between tillage treatments (Table 7). There were no differences in soybean plant stands between tillage treatments either, averaging a very reduced 69,667 plants/acre, reflecting the ground squirrel attack, excess weeds, and drought effects. Grass weeds in the organic corn plots averaged 76,235 weeds/acre, while broadleaf weeds were less at 19,231 weeds/acre (Table 7). Grass weeds in the organic soybean plots averaged 26,766 weeds/acre, while broadleaf weeds were less at 21,593 weeds/acre. There were high populations of cucumber beetles in squash plants in 2012, and there were greater numbers of rogued squash plants due to a disease vectored by the beetles (bacterial wilt) in the conventional plots, although there were no significant differences in percentage of diseased plants between systems (Table 8).

<u>Yields</u>
Yields were greater in organic broccoli plots than conventional plots, averaging 6,184 lb/acre between both tillage treatments (Table 9). Similarly, organic squash yields were greater than conventional yields, averaging 14,967 lb/acre, with no differences between tillage treatments. Organic field corn yields suffered from ground squirrel attack, drought, excess weeds, and, at the end of the season, deer damage, averaging 98 bu/acre in the tilled organic plots and 49 bu/acre in the organic no-tilled plots (Table 10). The tilled organic corn yields were similar to the average conventional yield of 108 bu/acre. Organic soybeans in the tilled organic plots averaged 34 bu/acre, while organic no-tilled soybeans averaged 14 bu/acre (Table 10). Again, the tilled organic soybean yields were similar to the average conventional yield of 38 bu/acre. Organic soybeans, particularly in no-till plots, were affected by drought and herbicide drift from conventional plots.

<u>Soils</u>
Soil sampling occurred on May 15-18, prior to planting, tillage, and cover crop rolling. Soil sample measurements included pH, soil microbial biomass carbon, penetration resistance, bulk density, soil carbon, soil nitrogen, and soil aggregate stability. The most notable differences in 2012 include decreased bulk density in the organic agriculture treatments (Table 12). This is most likely due to the extensive, fibrous root systems of the winter cover crops contained in the organic treatments and not present in the conventional treatments. Bulk density is an indicator of voids or pore spaces calculated using the oven dry mass per given unit volume of a soil. The pore spaces are decreased through mechanical disruptions of soil such as tillage and compaction from wheel traffic, which consequently increases bulk density. There are no significant differences in pH between treatments, but pH generally decreases deeper in the soil profile among all

treatments because of basic, calcareous parent material of this site. Field saturated infiltration was greater in conventional vegetable treatments compared to organic vegetable treatments. This difference is likely attributed to presence of winter cover crops and abundance of fibrous root systems, which preserves the soil surface structure by intercepting rain and irrigation water drop impact. Unlike 2011 results, when soil under the organic treatments had higher microbial biomass carbon, there were no significant differences among treatments in 2012, although there was a trend towards numerically greater amounts under organic squash and organic soybean. There were no significant differences in soil compaction among treatments due to high variability between treatments and replications.

Postharvest Quality

Overall, postharvest weight loss was similar between organic and conventional broccoli (Table 13). Although there were a few differences during the study period, after 8 weeks in storage, weight loss in conventional broccoli was 2.8%, while in organic broccoli, weight loss was 3.3%, with no significant differences between treatments. There was a greater number of organic broccoli heads, however, at the end of the study, lasting 9 weeks, compared to only 10% of the conventional broccoli heads remaining in salable condition at 7 weeks of storage (Table 13).

DISSEMINATION OF RESULTS:

A Field Day was held at the ISU Horticulture Research Station on July 23, where organic practices were explained to 91 people. In addition, this project was highlighted in several Extension talks presented around the state, at the PFI annual conference, and will be discussed at the MOSES organic conference in LaCrosse, WI, in February 2013.

SUMMARY: Plant growth and yields in the organic no-till vegetables were excellent in 2012, demonstrating the potential for irrigated organic no-till crops. The cover crops of hairy vetch and rye performed very well through the winter and spring of 2011-2012 when rains were adequate. Mechanical operations during rolling/crimping the cover crops were excellent, allowing a flattened mulch to provide weed management and help improve soil quality, particularly in irrigated vegetable crops. Producers continue to express interest in reduced tillage methods in organic systems, and appreciate the Ceres Trust support of organic no-till research in Iowa and across the Midwest, where a network of organic no-till researchers has been established.

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Table 2. Cover crop height and ratings before rolling in CERES experiment, Horticulture farm, 2012.

Crop/Rotation	Rye height (inches)	Hairy vetch height (inches)	Cover crop (%)	Weed cover (%)	Bare ground (%)	Rye stems (Plants/ft^2)	White clover (%)
Broccoli							
No-till	36.93	27.07	83.33	5.17	11.50	63.08	31.25
Tilled	40.06	28.74	95.42	0.42	4.17	71.25	0.00
$LSD_{0.05}$	NS	NS	10.43	4.63	NS	NS	27.91
Squash							
No-till	37.29	23.90	90.67	0.33	9.00	54.58	8.33
Tilled	36.53	22.54	81.25	0.00	15.58	54.75	0.00
$LSD_{0.05}$	NS	NS	9.41	NS	NS	NS	NS
Corn							
No-till	36.04	27.00	84.92	1.75	13.33	58.58	17.50
Tilled	38.88	27.23	87.00	1.67	11.83	61.67	0.00
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS
Soybean							
No-till	24.80	17.06	60.00	0.56	39.44	41.89	0.00
Tilled	31.23	20.82	65.89	8.56	25.56	48.56	50.00
$LSD_{0.05}$	13.09	NS	NS	5.26	NS	NS	33.70

Table 3. Cover crop biomass in CERES experiment before rolling, Horticulture farm, 2012.

Crop/ Rotation	Rye (lb/acre)	Hairy vetch (lb/acre)	Weeds (lb/acre)
Broccoli			
No-till	8,641.08	1,028.52	2.88
Tilled	8,166.68	653.03	0.00
$LSD_{0.05}$	NS	NS	NS
Squash			
No-till	7,941.96	1,036.20	171.90
Tilled	6,328.60	495.53	47.06
$LSD_{0.05}$	NS	NS	NS
Corn			
No-till	5,811.94	545.47	0.00
Tilled	6,771.31	993.95	46.10
$LSD_{0.05}$	NS	405.26	NS
Soybean			
No-till	4,740.21	231.44	137.33
Tilled	3,443.76	230.48	11.52
$LSD_{0.05}$	NS	NS	NS

Table 4. Height and leaf number of vegetable crops in CERES experiment, Horticulture farm, 6/07/2012.

	Broccoli		Squash	
Rotation	Height (inches)	Leaf number	Height (inches)	Leaf number
Conventional				
No-till	4.78c	7.60a	7.45c	3.10b
Tilled	6.57a	7.95a	10.18a	4.50a
Organic				
No-till	5.25b	6.90b	8.95ab	3.50b
Tilled	4.46c	6.75b	8.23bc	3.70ab
Interaction P value	<0.0001*	0.2243	0.0002*	0.0717

Table 5. Height and leaf number of vegetable crops in CERES experiment, Horticulture farm, 7/09/2012.

	Broccoli		Squash		
Rotation	Height (inches)	Leaf number	Height (inches)	Leaf number	Fruit number
Conventional					
No-till	11.96b	11.33c	12.47b	22.11	0.89b
Tilled	18.29a	22.58a	21.23a	23.67	2.83ab
Organic					
No-till	17.60a	17.33b	22.95a	36.58	4.50a
Tilled	16.98a	14.50bc	21.49a	38.55	2.92ab
Interaction P value	<0.0001*	0.0002*	0.0071*	0.9723	0.0184*

Table 6. Weed populations in vegetable crops in CERES experiment, Horticulture farm, 7/30/2012.

Rotation	Broccoli Grass weeds/ft^2	Broccoli Broadleaf weeds/ft^2	Squash Grass weeds/ft^2	Squash Broadleaf weeds/ft^2
Conventional				
No-till	---	---	---	---
Tilled	---	---	---	---
Organic				
No-till	1.67	0.17	1.50	1.67
Tilled	1.33	0.50	1.67	1.33
Interaction P value	---	---	---	---

Table 7. Stand and weed populations in corn and soybean crops, Horticulture Farm, 7/11/2012.

Rotation	Corn Stand (plants/acre)	Corn Grass weeds (plants/acre)	Corn Broadleaf weeds (plants/acre)	Soybean Stand (plants/acre)	Soybean Grass weeds (plants/acre)	Soybean Broadleaf weeds (plants/acre)
Conventional						
No-till	20,167c	0b	7,085b	105,833ab	86,370	18,403ab
Tilled	23,416bc	324b	36,113a	114,083a	13,826	1,687b
Organic						
No-till	27,250a	64,089a	24,291ab	64,667c	31,939	35,425a
Tilled	24,667ab	88,381a	14,170b	74,667bc	21,592	7,760b
Interaction P value	0.0311*	0.5416	0.0086*	0.9410	0.2777	0.5290

Table 8. Diseased squash plants data in CERES experiment, Horticulture farm, 2012.

Rotation	Squash	
	Diseased plants (number)	Diseased plants %
Conventional	47	6.22
Organic	18	6.83
LSD $_{0.05}$	---	NS

Table 9. Vegetable yields in CERES experiment, Horticulture Farm, 2012.

Rotation	Broccoli Head yield (lb/acre)	Squash Fruit yield (lb/acre)
Conventional		
No-till	3082.13b	827.32b
Tilled	2923.14b	2966.66b
Organic		
No-till	6452.41a	15149.77a
Tilled	5915.90a	14784.63a
Interaction	NS	NS
P value	0.7026	0.4391

Table 10. Corn and soybean yields in CERES experiment, Horticulture Farm, 2012.

Rotation	Soybean Bu/acre	Corn Bu/acre
Conventional		
Tilled	38.10a	105.87a
No-till	37.50a	112.05a
$LSD_{0.05}$	NS	NS
Organic		
Tilled	33.93a	98.31a
No-till	14.23b	48.98b
$LSD_{0.05}$	8.08	37.47

Table 11. Corn stalk nitrate concentrations, Horticulture farm, 2012.

Rotation	NO_3-N (mg/kg)
Conventional	
No-till	41.75a
Tilled	99.50a
Organic	
No-till	25.25a
Tilled	27.00a
Interaction	NS
P value	0.5083

Table 12. Soil analysis from organic and conventional treatments, Horticulture Farm, Spring 2012.

Soil Depth Sampled (inches)	2012 Treatments							
	Organic				Conventional			
	Vegetable Crop		Grain Crop		Vegetable Crop		Grain Crop	
	Squash	Broccoli	Corn	Soybean	Squash	Broccoli	Corn	Soybean
pH								
(0-3)	6.68	6.49	6.13	6.33	6.68	6.25	6.14	6.21
(3-6)	6.78	6.72	6.27	6.34	6.78	6.48	6.28	6.22
(6-12)	6.78	6.88	6.34	6.48	6.62	6.60	6.57	6.28
(12-18)	6.48	6.97	6.45	6.54	6.80	6.62	6.98	6.53
(18-24)	7.44	7.56	6.48	6.84	7.11	7.30	6.78	6.90
Bulk Density (g/cm3)								
(0-3)	1.27	1.29	1.18	1.21	1.40	1.42	1.38	1.47
(3-6)	1.47	1.47	1.46	1.53	1.43	1.69	1.52	1.69
(6-12)	1.40	1.42	1.39	1.45	1.33	1.53	1.40	1.49
(12-18)	1.41	1.35	1.45	1.40	1.46	1.50	1.42	1.47
(18-24)	1.40	1.46	1.44	1.41	1.28	1.62	1.34	1.50
Soil Microbial Biomass (ug-C/ g-soil)	740.78	650.82	665.05	711.83	597.17	669.60	771.76	580.41
Penetration Resistance (kPa)								
(0-6)	1971	1262	1765	2429	2023	1426	1809	1961
(6-12)	1829	1591	1914	2786	1816	1850	2105	2316
Field Saturated Infiltration (cm/min)	0.324	0.285	0.236	0.242	0.184	0.211	0.264	0.245

Table 13. Broccoli postharvest weight loss with organic and conventional treatments, Horticulture Farm, 2012.

System	Weight loss after 1 week	Weight loss after 2 weeks	Weight loss after 3 weeks	Weight loss after 4 weeks	Weight loss after 5 weeks	Weight loss after 6 weeks	Weight loss after 7 weeks	Weight loss after 8 weeks	Weight loss after 9 weeks
			%						
Conventional	0.46	0.81b	1.06b	1.58	1.62	1.95	2.27	2.78	---[1]
Organic	0.56	1.03a	1.48a	1.88	2.10	2.47	2.74	3.30	4.13
$LSD_{0.05}$	NS	0.20	0.20	NS	NS	NS	NS	NS	---

[1] All conventional broccoli discarded in Week 8 as non-salable.

Percentage of discarded heads (due to rot or discoloration).

	After 1 week	After 2 weeks	After 3 weeks	After 4 weeks	After 5 weeks	After 6 weeks	After 7 weeks	After 8 weeks	After 9 weeks
Conventional	0.00%	0.00%	0.00%	0.00%	60.00%	80.00%	90.00%	100.00%	---
Organic	0.00%	0.00%	0.00%	0.00%	0.00%	10.00%	30.00%	30.00%	100%