2007

Comparison of Organic and Conventional Crops, Long-Term Agroecological Research (LTAR) Site

Kathleen Delate
Iowa State University, kdelate@iastate.edu

Andrea McKern
Iowa State University

Cynthia A. Cambardella
USDA National Soil Tilth Lab, cindy.cambardella@ars.usda.gov

Robert Burcham
Iowa State University

Comparison of Organic and Conventional Crops, Long-Term Agroecological Research (LTAR) Site

Abstract
The Neely-Kinyon LTAR site was established in 1998 to study the long-term effects of organic production in Iowa. Treatments at the LTAR site, replicated four times in a randomized complete block design, included the following rotations: conventional Corn-Soybean (C-S), organic Corn-Soybean-Oats/Alfalfa (C-S-O/A), organic Corn-Soybean-Oats/Alfalfa-Alfalfa (CS-O/A-A), and Soybean-Wheat (S-W). Variety selection and planting methods in 2006 were as follows: Pioneer 34A15 corn was planted at a depth of 1.75 in. as untreated seed at a rate of 32,000 seeds/acre in the organic plots and as treated seed in conventional plots, on May 16, 2006. Schillinger 240F.Y soybeans were planted at a depth of 2 in. in organic and conventional plots at a rate of 165,000 seeds/acre on May 22, 2006.

Keywords
Horticulture, Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Horticulture

Comparison of Organic and Conventional Crops, Long-Term Agroecological Research (LTAR) Site

Kathleen Delate, associate professor
Andrea McKern, research assistant
Departments of Horticulture and Agronomy
Cynthia Cambardella, soil scientist
USDA National Soil Tilth Lab
Bob Burcham, ag specialist

Materials and Methods

The Neely-Kinyon LTAR site was established in 1998 to study the long-term effects of organic production in Iowa. Treatments at the LTAR site, replicated four times in a randomized complete block design, included the following rotations: conventional Corn-Soybean (C-S), organic Corn-Soybean-Oats/Alfalfa (C-S-O/A), organic Corn-Soybean-Oats/Alfalfa-Alfalfa (C-S-O/A-A), and Soybean-Wheat (S-W). Variety selection and planting methods in 2006 were as follows: Pioneer 34A15 corn was planted at a depth of 1.75 in. as untreated seed at a rate of 32,000 seeds/acre in the organic plots and as treated seed in conventional plots, on May 16, 2006. Schillinger 240F.Y soybeans were planted at a depth of 2 in. in organic and conventional plots at a rate of 165,000 seeds/acre on May 22, 2006. Due to insufficient stands, soybeans in the organic soybean-wheat rotation were replanted to Schillinger 240F.Y soybeans on June 2, 2006, at the same initial rate. Expedition winter wheat was planted on October 14, 2005, at 1.5 bushels/acre and Cherokee red clover was frost-seeded into the wheat plots on March 1, 2006, at a rate of 25 lb/acre. On April 13, 2006, Esker oats were underseeded with Bluebird alfalfa at a rate of 3.0 bushels/acre and 16 lb/acre, respectively. Following harvest of the organic corn plots in 2005, winter rye was no-till drilled at a rate of 70 lb/acre on October 19, 2005. Hoop-house swine compost was applied to organic corn plots at a rate of 12 tons/acre and 4 tons/acre to oat plots on April 6. Conventional corn plots were fertilized on April 27, 2006, with 32% nitrogen at 170 lb N/acre along with 3.0 oz/acre of Balance Pro™ herbicide. Corn plots were soil sampled on June 7, 2006 and analyzed for late-spring nitrate content by the Iowa State University Soil and Plant Analysis Laboratory, Ames, IA. Fall samples were taken for soil quality analysis. Conventional soybeans received an application of 22 oz/acre of Roundup WeatherMAX™ and 2 lb/acre of AMS on May 26, and an application of 5 oz/acre of Stellar®, 1.5 pt/acre of crop oil, and 2 lb/acre of AMS on June 27. Organic soybean plots were rotary hoed on June 1 and June 14, and cultivated on June 12 and June 27. Organic soybean plots were "walked" on June 29. Organic corn plots were rotary hoed on May 26 and June 1. Organic corn plots were cultivated on June 6 and June 19. Corn stands were counted on June 7 and soybeans June 14–22. Weed counts were enumerated in corn plots on June 7 and 22, and in soybean plots on June 14 and 26, 2006 using square meter quadrats at three randomly selected areas within a plot. Corn borer populations were monitored on July 5. Soybean plots were sampled for bean leaf beetles on July 20, August 3, and September 7. Corn stalk nitrate samples were collected on September 26, and soybean cyst nematode sampling was completed on September 27. Samples were collected from each corn and soybean plot for grain quality analysis, which was conducted at the ISU Grain Quality Laboratory, Ames, IA.

Alfalfa was baled on May 26, July 1, August 10, and September 17. Wheat plots were harvested and baled on July 6, and oat plots were harvested and baled on July 18. Soybean plots were harvested on October 24. Corn plots were harvested on November 1. Corn stalk nitrate analysis was conducted at the Iowa State

University Soil and Plant Analysis Laboratory, Ames, IA.

Results and Discussion

In the corn plots, conventional C-S and organic C-S-O/A-A corn stands were greater than those in the C-S-O/A rotation in 2006 (Table 1). Weed populations were low in all corn plots throughout the season, and no differences were observed between rotations for grasses and broadleaves on the first sampling date. On the second sampling date, June 22, the C-S-O/A plots had the lowest grass weed numbers, but there were no differences in broadleaves among rotations (Table 1). Late-spring nitrate levels in the C-S-O/A-A and C-S-O/A averaged 25.9 ppm NO_3-N, which is considered adequate, compared with greater levels at 39.9 ppm in the conventional plots (Table 1). Corn stalk nitrate levels at the end of the season were greater in the C-S-O/A-A rotation compared with the other two rotations, though the difference was not significant (Table 1). This rotation appeared to maintain adequate N levels through the season while the C-S-O/A and C-S rotations were lower than expected, based on early N levels.

Soybean plant stands were greater in the conventional C-S and organic S-W rotations in 2006, but the S-W rotation had been replanted (Table 2). Grass weeds were similar among rotations on June 14 and June 26 (Table 2). Broadleaf weed counts were similar in conventional and organic plots on June 14, but numbers were greater in the conventional C-S plots on June 26 (Table 2).

The 2006 season was extremely dry with less than average rain in June and July. Organic corn yields averaged 177.9 bushels/acre and organic soybean yields averaged 43 bushels/acre (Table 3). The conventional C-S corn yields of 176.9 bushels/acre were equivalent to the organic C-S-O/A-A corn yields of 188.3 bushels/acre and the C-S-O/A corn yield of 167.4 bushels/acre. The organic C-S-O/A soybean yields of 44.7 bushels/acre tended to be greater than the other rotations, but there was no difference between this rotation, the other organic rotations, and the conventional C-S yield of 42.6 bushels/acre. There were no yield differences between oat rotations, averaging 115.8 bushels/acre of grain and 0.92 tons/acre of oat straw. Wheat yielded 60.8 bushels/acre and 1.23 tons/acre straw (Table 3).

Pest populations were greater in 2006 compared with 2005, with up to 25% of corn ears exhibiting corn borer damage on July 5. Because of the high variability, however, there were no differences in damage levels among rotations. Bean leaf beetle numbers were also greater than in 2005, with populations reaching 15 beetles/20 sweeps on July 20 (Table 5), 110 beetles/20 sweeps on August 3 (Table 6), and up to 123 beetles/20 sweeps on September 7 (Table 7). July beetle populations were greater in organic C-S-O/A plots, but not statistically greater than those in the C-S-O/A-A, S-W and C-S plots. The S-W and the C-S rotations had lower bean leaf beetle populations in August, compared with the rotations with alfalfa (Table 6). In September, beetle populations were greater in organic rotations (Table 7). Beneficial insects were generally higher in the organic rotations although results were not statistically different (Tables 5–7). Soybean seed staining was also greater in 2006 than in previous years, with up to 8.4% of soybeans stained (Table 4). Soybean cyst nematodes were low, with no differences among treatments (Table 4).

Soybean protein and carbohydrate levels were equivalent among rotations, but oil content was greater in the C-S-O/A rotation (Table 8). Corn carbohydrate levels were greater in the C-S rotation, which was not greater than the organic C-S-O/A-A rotation (Table 8). No difference was observed in corn grain oil content. Higher protein levels in corn (8.5%) were found in the two organic rotations (Table 8). Wheat protein averaged 11.6%.

Acknowledgments

We would like to thank the Leopold Center for Sustainable Agriculture and the USDA-IFAFS program for their support of the Neely-Kinyon LTAR site. We also thank the Wallace Foundation, David Rosmann, Magda Marin Beltran, Kristin Brown, Mark Rosmann, Rita Tisinger, Christina Erickson, Greg Lilly, Bob Turnbull, Greg Tylka, Jerry DeWitt, John Kennicker, Kathy Rohrig and Deb Hall of Iowa State University; Charles Hurburgh and Glen Rippke of the ISU Grain Quality Lab, Kerry Culp of the ISU Soil and Plant Analysis Lab, John Schillinger and Corey Nikkel of Schillinger Seeds, Gary Hoard, Clive Holland, and Eric Gross of Pioneer Hi-Bred International, Maury Johnson of Blue River Hybrids, and Albert Lea Seed House for providing seed for this study.

Table 1. Corn stands and weed populations in corn plots at Neely-Kinyon LTAR, 2006.

Treatment	Corn stands plants/acre	Corn stalk Nitrate ppm NO_3-N	Late-spring Nitrate ppm NO_3-N	Corn weeds/m^2 June 7, 2006		Corn weeds/m^2 June 22, 2006	
				Grasses	Broadleaves	Grasses	Broadleaves
Conv. C-S	27,917a	358.25	39.89a	1.08	0.92	0.42b	2.50
Org. C-S-O/A	24,000b	292.50	23.13b	0.50	3.50	0.00a	1.17
Org. C-S-O/A-A	26,083ab	1,106.50	28.60b	0.25	2.08	0.08ab	2.00
LSD (0.05)	2,658	NS	5.87	NS	NS	0.35	NS

Means within columns followed by the same letter are not different.

Table 2. Soybean stands and weed populations in soybean plots at Neely-Kinyon LTAR, 2006.

Treatment	Soybean stands plants/acre	Soybean weeds/m^2 June 14, 2006[z]		Soybean weeds/m^2 June 26, 2006	
		Grasses	Broadleaves	Grasses	Broadleaves
Conv. C-S	113,417a	0.42	2.75	2.83	17.17b
Org. C-S-O/A	75,917b	0.75	1.00	0.42	6.00a
Org. C-S-O/A-A	86,000b	0.17	0.42	1.17	2.58a
Org. S-W	104,083a	1.25	2.50	0.42	3.75a
LSD (0.05)	15,159	NS	NS	NS	6.33

[z]Due to the replanting of the organic soybean-wheat rotation, weeds were enumerated for the first time on June 22, 2006.
Means within columns followed by the same letter are not different.

Table 3. Organic and conventional grain crop yields at Neely-Kinyon LTAR, 2006.

Treatment	Corn yield bu/acre	Soybean yield bu/acre	Oat yield bu/acre	Oat straw tons/acre	Wheat yield bu/acre	Wheat straw tons/acre
Conv. C-S	176.85ab	42.63	N/A	N/A	N/A	N/A
Org. C-S-O/A	167.44b	41.76	113.48	0.91	N/A	N/A
Org. C-S-O/A-A	188.33a	44.65	118.11	0.92	N/A	N/A
Org. S-W	N/A	42.65	N/A	N/A	60.84	1.23
LSD (0.05)	13.27	NS	NS	NS	N/A	N/A

Means within columns followed by the same letter are not different.

Table 4. Insect and nematode populations and stained soybeans at Neely-Kinyon LTAR, 2006.

Treatment	Corn borer damage	Stained soybean (%)	Soybean cyst nematode (eggs/ 100 cc)
Conv. C-S	25.0	6.58	37.50
Org. C-S-O/A	25.0	5.85	37.50
Org. C-S-O/A-A	0.0	8.40	25.00
Org. S-W	N/A	4.50	12.50
LSD (0.05)	NS	NS	NS

Table 5. Insect populations in soybeans at Neely-Kinyon LTAR, July 20, 2006.

Treatment	Beneficial insect population/ 20 sweeps	Pest population/ 20 sweeps	Bean leaf beetle population/ 20 sweeps
Conv. C-S	0.75	8.25a	6.25a
Org. C-S-O/A	1.50	18.50b	14.75b
Org. C-S-O/A-A	1.25	11.00ab	7.75ab
Org. S-W	0.75	5.75a	3.25a
LSD (0.05)	NS	8.16	7.05

Means within columns followed by the same letter are not different.

Table 6. Insect populations in soybeans at Neely-Kinyon LTAR, August 3, 2006.

Treatment	Beneficial insect population/ 20 sweeps	Pest population/ 20 sweeps	Bean leaf beetle population/ 20 sweeps
Conv. C-S	4.00	32.33a	24.00a
Org. C-S-O/A	3.33	120.33b	110.33b
Org. C-S-O/A-A	1.75	112.25b	103.50b
Org. S-W	3.75	23.75a	18.50a
LSD (0.05)	NS	42.55	41.88

Means within columns followed by the same letter are not different.

Table 7. Insect populations in soybeans at Neely-Kinyon LTAR, September 7, 2006.

Treatment	Beneficial insect population/ 20 sweeps	Pest population/ 20 sweeps	Bean leaf beetle population/ 20 sweeps
Conv. C-S	3.25	25.25a	16.25a
Org. C-S-O/A	3.50	136.75b	122.75b
Org. C-S-O/A-A	4.75	115.00b	100.25b
Org. S-W	2.75	118.75b	106.25b
LSD (0.05)	NS	48.26	48.82

Means within columns followed by the same letter are not different.

Table 8. Soybean and corn grain quality at Neely-Kinyon LTAR, 2006.

Treatment	Grain quality (%)							
	Carbohydrates		Oil		Protein		Moisture	
	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Conv. C-S	21.61	61.09b	16.61b	3.36	39.06	7.83b	14.13c	16.71b
Org. C-S-O/A	21.76	60.58a	17.18a	3.25	38.34	8.53a	14.41b	16.95b
Org. C-S-O/A-A	22.08	60.76ab	16.75ab	3.30	38.43	8.30a	14.30b	17.35a
Org. S-W	21.60	--	16.36b	--	39.35	--	14.61a	--
LSD (0.05)	NS	0.35	0.44	NS	NS	0.34	0.16	0.34

Means within columns followed by the same letter are not different.

Table 9. Wheat quality at Neely-Kinyon LTAR, 2006.

Treatment	Grain quality (%)		Kettle Test WT (lb/bu)
	Protein	Moisture	
Org. S-W	11.60	12.1	60.0