Comparison of Organic and Conventional Crops at the Neely-Kinyon Long-term Agroecological Research (LTAR) Site, 2008

Kathleen Delate, associate professor
Andrea McKern, research assistant
Departments of Horticulture and Agronomy
Cynthia Cambardella, soil scientist
USDA National Soil Tilth Lab
Jeff Butler and Randy Breach, ag specialists

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 completely randomized design, include 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). 'Arapahoe' winter wheat was planted on October 30, 2007, at 85 lb/acre and 'Cardinal' red clover was frost-seeded into the wheat plots on March 12, 2008, at a rate of 15.5 lb/acre. On April 21, 'Kame' oats were underseeded with 'Bluejay' alfalfa at a rate of 93 lb/acre and 16 lb/acre, respectively. Following harvest of the organic corn plots in 2007, 'AC Remington' winter rye was no-till drilled at a rate of 70 lb/acre on November 8, 2007.

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 21. Corn and soybean variety selection and planting methods in 2008 were as follows: Blue River 63H07 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 20, 2008. Blue River 34A7 soybeans were planted at a depth of 2 in. in organic and conventional plots at a rate of 200,000 seeds/acre on May 20, 2008. Three of four plots of soybeans in the organic soybean-wheat rotation were replanted on June 25, 2008, at the same initial rate, and because of this change in management, were not analyzed with the other treatments.

Conventional corn plots were fertilized on April 30, 2008, with 32% nitrogen (UAN) injected at 145 lbs N/acre. On May 21, the pre-emergence herbicides, Balance Pro™, RoundUp WeatherMax™ and atrazine were applied at 1.25 oz/acre, 16 oz/acre, and 0.75 lbs/acre, respectively. Conventional corn was also sprayed on June 23 with 0.75 oz/acre of Staedfast™, and 1.5 oz/acre of Callisto™. Conventional soybeans received an application of Encompass™ at 1 oz/acre, and RoundUp WeatherMax™ at 16 oz/acre on May 21. Post-emergent herbicides included Raptor™ at 4 oz/acre, Resource™ at 4 oz/acre, Flexstar™ at 1 pt/acre, and Fusilade™ at 8 oz/acre, applied on July 9.

Organic soybean plots were cultivated on June 22, and on July 2 and 7. Organic soybean plots were "walked" on August 1 and 14. Organic corn plots were rotary-hoed on June 2, and cultivated on June 17, 22, and July 2. Corn and soybean stands were counted on June 13, June 30-July 1, and July 21.

Weed counts were enumerated in corn and bean plots on June 13, June 30-July 1, and July 21 using square meter quadrats at three randomly selected areas within a plot. Corn borer populations were monitored on July 21. Soybean plots were sampled for insects on July 28 and September 4. Corn stalk nitrate samples were collected on October 14, and soybean cyst nematode sampling was completed on October 14. 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 June 22, July 23, and August 4. Wheat plots were sample harvested on July 31, 2008, and baled on August 4. Oat plots were sample harvested on July 30 and baled on August 4. Soybean plots were harvested on October 21. Corn plots were harvested on November 5. Corn stalk nitrate analysis was conducted at the Iowa State University Soil and Plant Analysis Laboratory, Ames, IA.

Soil in corn plots was sampled on June 18, 2008, and analyzed for late-spring nitrate content by the Iowa State University Soil and Plant Analysis Laboratory, Ames, Iowa. Fall samples were taken on November 4 for soil quality analysis.

Results and Discussion

There were many challenges in the 2008 season, including a change in management at the Neely-Kinyon Farm; a cool, wet spring with extended periods of flooding; and the latest corn harvest in the 11 years of the LTAR experiment. Conventional corn stands in the C-S rotation at 27,833 plants/acre were greater than the 24,417 plants/acre in the C-S-O/A-A rotation in 2008 (Table 1). Plant populations were intermediate in the C-S-O/A rotation at 27,833 plants/acre at 21 days after planting. Conventional soybean plant stands were significantly greater than the organic rotations by 12,199 plants/acre (Table 1). As a result of weather conditions and a change in management, LTAR plots did not receive the typical organic weed management followed in the previous 10 years of two rotary-hoeings in corn and soybean plots. Instead, corn plots were rotary hoed once and soybeans were never rotary hoed. As a result, weed populations were the highest in 11 years, with grass and broadleaf weeds significantly higher in organic plots compared to conventional corn and soybean plots (Table 2). As an example, with no weed management until 33 days after planting the organic soybeans (compared to the first rotary-hoeing 3 to7 DAP in previous years), broadleaf weeds averaged 37 plants/sq. meter over the two organic rotations compared to 3 weeds/sq. meter in the conventional plots. Grass weeds were extremely high (highest in 11 years) in organic corn plots that were not rotary-hoed until 13 DAP: populations in organic plots averaged 124 grass weeds/sq. meter compared to <1 weed/sq.meter in conventional plots. By the end of the season, after four tillage operations, weeds were reduced in organic corn plots but the damage from consistent competition throughout the growing season was severe enough to affect yields. Weed populations in organic soybean plots were higher than previous years, but by the end of the season, were lower than organic corn plots. Over three sampling periods in organic corn plots, there were no differences in grass and broadleaf weed populations in the 3– and 4–year rotations, except for less broadleaf weeds on two sampling periods in the 4–year rotation plots (Table 2). In organic soybean plots, grass weeds were lower in the 4–year rotation plots on two of three sampling periods compared to the 3–year rotation plots.

Late-spring soil nitrate levels in the C-S-O/A-A and C-S-O/A plots averaged 13 ppm NO_3-N, significantly lower than conventional corn plots (Table 1). This level was lower than all previous years and suggested inadequate distribution of N from composted manure applications, excessive leaching from flooding conditions, or a combination of both problems. Corn stalk nitrate levels at the end of the season were extremely low in the C-S-O/A rotation, but averaged 1136 $\mu g \cdot g^{-1}$ N-NO_3 in the C-S-O/A-A rotation (Table 1). The corn stalks in the C-S rotation, having received 145 lb/acre of synthetic N, had 2211 $\mu g \cdot g^{-1}$ N-NO_3 at the send of the season.

As a result of low levels of N and poor weed management, organic corn yields averaged 177 bu/acre compared to 202 bu/acre in conventional plots (Table 1). There was no difference between the conventional corn yield and the organic yield of 184 bu/acre in the 4–year rotation, however. The organic C-S-O/A corn yield at 169 bu/acre was equivalent to the organic C-S-O/A-A corn yield. With an average ear weight 215.7 grams/ear, ear weight from the C-S-O/A-A rotation at 233 grams was equivalent to the conventional ear weight, but greater than ears from the 3–year rotation (data not shown). Organic soybean yields averaged 54 bu/acre with significantly lower yields in the conventional C-S rotation at 48 bu/acre (Table 1). Contrary to previous years, soybeans in the 4–year rotation plots yielded greater than those in the 3–year rotation plots. There were no significant organic oat yield differences between rotations, averaging 109.2 bu/acre of grain in harvested samples, and 1.72 tons/acre of oat baleage. Wheat yielded 34.5 bu/acre and 698 lb/acre baleage (Table 1). Alfalfa plots yielded 4.1 tons/acre.

Pest populations were variable in 2008, with low corn borer damage and no differences in damage levels among rotations. Bean leaf beetle numbers were intermediate compared to previous years, with populations averaging 11 beetles per 20 sweeps (Table 3), and 16 beetles per 20 sweeps at peak populations. There were no differences between organic and conventional plots. Total pest insects (including aphids, BLBs and stink bugs) averaged 21 insects per 20 sweeps (Table 3), and 26 insects per 20 sweeps at peak populations, with no differences between organic and conventional plots. Beneficial insects averaged 6.3 insects per 20 sweeps with similar populations in organic and conventional plots. Soybean cyst nematodes were not found in any plots in 2008 (Table 3).

As a result of higher N in the C-S corn, higher protein levels (7.2%) were found compared to the two organic rotations (6.1%) (Table 4). Corn starch content at 62% was higher in the organic rotations. Soybean protein (33%), carbohydrate (26%) and oil (18%) content were equivalent among rotations (Table 4).

Acknowledgments

We would like to thank the Leopold Center for Sustainable Agriculture and the USDA-SARE program for their support of research at the Neely-Kinyon LTAR site. We also thank the Wallace Foundation for their input and support. Thanks also go to Mark Rosmann, Francisco Rosas, Bernardo Thompson, Chloe Poitral, Diego Viteri, Guillermo Cubas, 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; and Maury Johnson of Blue River Hybrids and Albert Lea Seed House for providing seed for this study.

Table 1. Grain crop performance in N-K LTAR, 2008.

	Corn				Soybean		Oat		Wheat		Alfalfa
Rotation [z]	Yield Bu/acre	Population 21 DAP plants/acre	LSNT $\mu g \cdot g^{-1}$ $N\text{-}NO_3$	Stalk nitrate (ppm)	Yield bu/acre	Population 21 DAP plants/acre	Yield Bu/acre	Baleage tons/acre	Yield bu/acre	Baleage tons/acre	Yield (tons/acre)
Conv. C-S	202.12a[y]	27,833a	33.04a	2211.25a	48.07c	135,583a	N/A	N/A	N/A	N/A	N/A
Org. C-S-O/A	169.44b	25,833ab	11.46b	20.00b	52.55b	93,250b	106.36	1.73	N/A	N/A	N/A
Org. C-S-O/A-A	184.18ab	24,417b	14.25b	1136.25ab	55.22a	93,778b	112.03	1.70	N/A	N/A	4.07
Org. S-W	N/A	N/A	N/A	N/A	N/A [x]	N/A	N/A	N/A	34.52	0.35	N/A
$LSD_{0.05}$	21.31	2,455	6.16	1359.74	2.06	12,199	NS	NS	N/A	N/A	N/A

[z] C = corn, s = soybean, O = oat, and A = alfalfa.
[y] Means within a column are not significant (NS), or significant at $p \leq 0.05$ (Fisher's protected LSD test).
[x] Data were not taken in the Organic Soybean-Wheat rotation due to flooding

Table 2. Weed populations in N-K LTAR, 2008.

	Corn						Soybean					
	June 13, 2008		June 30-July 1, 2008		July 21, 2008		June 13, 2008		June 30-July 1, 2008		July 21, 2008	
Treatment	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves
Conv. C-S	0.08b [y]	0.00b	0.17b	1.25	0.00b	0.47b	0.33b	2.50b	0.25b	5.83b	0.08	2.75b
Org. C-S-O/A	101.83a	60.75a	15.42a	11.08	29.42a	22.92a	2.67a	41.00a	1.50a	21.25a	4.92	8.50a
Org. C-S-O/A-A	145.00a	13.25b	11.83a	13.50	39.50a	4.58b	0.56b	33.33a	0.33b	21.33a	1.58	11.25a
Org. S-W	N/A	N/A	N/A	N/A	N/A	N/A	N/A [x]	N/A	N/A	N/A	N/A	N/A
$LSD_{0.05}$	50.18	27.18	7.95	NS	18.06	7.93	1.85	19.91	0.84	8.81	NS	3.16

[z] C = corn, s = soybean, O = oat, and A = alfalfa.
[y] Means within a column are not significant (NS), or significant at $p \leq 0.05$ (Fisher's protected LSD test).
[x] Data were not taken in the Organic Soybean-Wheat rotation due to flooding

Table 3. Insect populations in N-K LTAR, 2008.

Treatment	Corn borer Damage (%)	Soybean Cyst nematode (Eggs per 100 cc)	Bean leaf beetle population average	Bean leaf beetle peak population	Pest insect population average	Pest peak population	Beneficial insects population average	Beneficial insect peak population
			Insects/20 sweeps		Insects/20 sweeps		Insects/20 sweeps	
Conv. C-S	0.00 [y]	0.00	12.88	20.25	16.63	24.25	8.50	13.00a
Org. C-S-O/A	0.00	0.00	12.50	17.50	28.00	32.75	3.75	4.75b
Org. C-S-O/A-A	8.30	0.00	6.00	9.50	16.88	19.50	6.63	11.50a
Org. S-W	N/A	0.00	N/A [x]	N/A	N/A	N/A	N/A	N/A
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	5.84

[z] C = corn, s = soybean, O = oat, and A = alfalfa.
[y] Means within a column are not significant (NS), or significant at $p \leq 0.05$ (Fisher's protected LSD test).
[x] Data were not taken in the Organic Soybean-Wheat rotation due to flooding

Table 4. Grain quality in N-K LTAR, 2008.

	Corn					Soybean				
Treatment	Density	Starch	Oil	Protein	Moisture	Carbohydrates	Fiber	Oil	Protein	Moisture
Conv. C-S	1.27	61.35b	3.50	7.23a	14.78	25.75	5.08	18.23	32.95	12.00c
Org. C-S-O/A	1.28	62.34a	3.43	6.03b	13.71	25.90	5.05	18.35	32.70	12.53a
Org. C-S-O/A-A	1.26	62.20a	3.45	6.20b	16.23	25.74	5.05	18.49	32.73	12.36b
$LSD_{0.05}$	NS	0.63	NS	0.66	NS	NS	NS	NS	NS	0.16

[y] Means within a column are not significant (NS), or significant at $p \leq 0.05$ (Fisher's protected LSD test).