Comparison of Organic and Conventional Crops at the Neely-Kinyon Long-term Agroecological Research (LTAR) Site, 2009

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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 with a red clover frost-seeding (S-W/RC). 'Arapahoe' winter wheat was planted on November 19, 2008, at 85 lbs/acre and 'Cardinal' red clover was frost-seeded into the wheat plots on March 12, 2009, at a rate of 15.5 lb/acre. On April 16, 2009, 'Spur' oats were underseeded with 'BR Blue Jay' alfalfa at a rate of 90 lbs/acre and 16 lb/acre, respectively. Following harvest of the organic corn plots in 2008, winter rye was no-till drilled at a rate of 75 lb/acre on November 10, 2008.

Conventional corn plots were injected with 28% UAN on April 21, 2009, at 145 lbs N/acre. Hoop-house swine compost was applied to organic corn plots at a rate of 12 tons/acre on April 20 and 4 tons/acre to oat plots on April 15. Corn and soybean variety selection and planting methods in 2009 were as follows: Blue River 66H54 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, 2009. 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 21, 2009.

Conventional corn plots were sprayed with a pre-emergence herbicide on May 28 with 0.33 oz/acre of Basis, 1 lb/acre of Atrazine, 2 qts/100 gallons of COC, and 2.5 lbs/acre of AMS. Conventional soybeans received an application of 2 pts/acre of Pursuit on May 14.

Soil in corn plots was sampled on July 17, 2009, and analyzed for late-spring nitrate content by the Iowa State University Soil and Plant Analysis Laboratory, Ames, Iowa. Fall soil samples were taken on November 4 for soil quality analysis.

All organic soybean plots were rotary hoed on May 24 before emergence and on June 11; soybeans in the organic C-S-O/A-A plots were also rotary hoed on May 29. All organic soybean plots were cultivated on June 17, June 23, June 30, and July 13. Organic soybean plots were "walked" on July 16 and July 29.

Organic corn plots were rotary hoed on May 24, May 29, and June 11, and cultivated on June 17, June 23, and June 26. Corn stands were counted between June 11–19 and again on July 14; soybean stands were counted between June 11–16, and between July 17 –22. Weed counts were enumerated in corn plots between June 11–19, and again on July 20, and in all soybean plots between June 11–16, and again between July 17– July 22, 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 insects on August 12 by sweeping plots 20 times with a 15-inch diameter net, placing contents in a Ziplock™ bag, and freezing until identification was completed. Corn stalk nitrate samples were collected on October 6, and soybean cyst nematode sampling was completed on October

19. Corn stalk nitrate analysis was conducted at the Iowa State University Soil and Plant Analysis Laboratory, Ames, IA, and nematode analysis was conducted at the ISU Plant Disease Clinic (Ames, IA).

Alfalfa was baled on June 14, July 12, and August 11. Wheat plots were harvested on July 24 and baled on July 26, and oat plots were harvested on July 24 and baled on July 26. Soybean plots were harvested on October 28. Corn plots were harvested on November 5. Samples were collected from each corn and soybean plot for grain quality analysis, which was conducted at the ISU Grain Quality Laboratory, Ames, IA.

Results and Discussion

In the corn plots in 2009, plant populations were similar in the conventional C-S and organic C-S-O/A and C-S-O/A rotations at 28,445 plants/acre (Table 1). Weed populations were higher than average in organic corn plots throughout the season, particularly with greater broadleaf weeds in the three-year organic rotation (C-S-O/A) on the first sampling date (June 16), at 16 weeds/sq. meter. However, there were no significant differences in broadleaf weeds between conventional C-S and organic C-S-O/A-A rotations, which averaged 5 weeds/sq. meter (Table 2). Grass weeds, however, were similar, averaging 6 weeds/sq. meter, in all rotations on the first sampling date.

On the second sampling date, July 14, the C-S-O/A and the C-S-O/A-A plots had the lowest grass weed numbers, averaging 2 weeds/sq. meter, but grass weeds in the C-S and C-S-O/A rotations were similar. Broadleaf weed populations averaged 3 weeds/sq. meter across all rotations (Table 2).

Late-spring nitrate levels averaged 2.4 ppm NO_3-N across conventional and organic plots, which is considered low compared to previous years (Table 1). Corn stalk nitrate levels at the end of the season were also less than the recommended 2,000 ppm nitrate–N and were equivalent across all rotations, averaging 763 ppm nitrate–N (Table 1).

Soybean plant stands, at 135,833 plants/acre, were significantly greater in the conventional C-S plots in 2009, compared to the three– and four–year organic rotations, which averaged 84,542 plants/acre (Table 1). Soybean plant populations were significantly lower in the S-W/RC rotation compared to all other rotations (Table 1). Grass weed populations were high among organic rotations at the first sampling date, averaging 31 weeds/ sq. meter (Table 2). Broadleaf weed populations followed the same pattern as grass weeds, averaging 23 weeds/ sq. meter in organic plots compared to 1 weed/sq. meter where herbicides were used in conventional plots (Table 2). On the second sampling date, populations of grass weeds remained high in organic plots, averaging 10 weeds/sq. meter, but broadleaf weeds were reduced to an average of 3 weeds/sq. meter, equivalent to conventional soybean plots.

Despite high levels of weeds and challenging weather, organic corn yields averaged 196 bu/acre in 2009 (Table 1). The C-S-O/A rotation produced greater yields (198 bu/acre) than the four–year organic rotation (194 bu/acre), and was equivalent to the conventional C-S rotation. Organic soybean yields averaged 57 bushels/acre (Table 1), with the S-W/RC plots yielding lower at 48 bu/acre than the conventional (65 bu/acre) and four–year rotation (66 bu/acre). The organic three-year rotation soybean yields at 58 bu/acre were less numerically than soybean yields in the organic C-S-O/A-A and conventional plots, but statistically equivalent to these yields and to the organic S-W/RC yields. Small grain yields were impacted by extended periods of wet weather in 2009; oats yielded 73 bu/acre of grain and 1.14 tons/acre of oat straw, with no significant yield differences between oat rotations. Wheat yields

were extremely impacted by a poor stand, lack of snow cover, and a wet spring, averaging only 9 bu/acre and 1.34 tons/acre straw (Table 1). Alfalfa yielded an average of 3.9 tons/acre.

There was no damage from corn borer populations observed in 2009 (Table 2). Bean leaf beetle numbers were lower than in 2008, with populations averaging 2 beetles per 20 sweeps compared to an average of 16 beetles per 20 sweeps in 2008 (Table 4). There were no significant differences between rotations for beetle populations. Aphid populations averaged 32 beetles per 20 sweeps, with no significant differences between rotations. Total pest insect populations averaged 43 pest insects per 20 sweeps over the entire season (Table 4). Total beneficial insect populations averaged 13 beneficial insects per 20 sweeps over the entire season (Table 4). All insect counts showed no differences between conventional and organic rotations.

Stained soybeans averaged <1% stained soybeans in the C-S, C-S-O/A and C-S-O/A-A plots, but in S-W/RC plots, staining averaged 3.3%, which is considered a low level (Table 2). Soybean cyst nematodes were low overall, and despite levels reaching 38 eggs/100 cc of soil in the conventional soybean plots, there was no significant differences compared to organic plots where no eggs were recovered (Table 4).

Corn carbohydrate levels were equivalent among all rotations at 61.3% (Table 3). No significant difference was observed in corn grain oil content, averaging 4.1% across all rotations. Equivalent protein levels (8.4%) were found across all rotations (Table 3). Soybean carbohydrate levels (24%) and oil levels (18.6%) were similar across all rotations (Table 3). Protein levels were also equivalent among rotations at 34.6% (Table 3).

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Table 1. Grain crop performance in N-K LTAR, 2009.

	Corn				Soybean		Oat		Wheat		Alfalfa
Rotation[z]	Yield bu/acre	Population plants/acre	LSNT $\mu g \cdot g^{-1}$ N-NO_3	Stalk nitrate (ppm)	Yield bu/acre	Population plants/acre	Yield bu/acre	Straw tons/acre	Yield bu/acre	Straw tons/acre	Yield (tons/acre)
Conv. C-S	211.07a	27,000	2.175	936.00	65.21a	135,833a	N/A	N/A	N/A	N/A	N/A
Org. C-S-O/A	197.79ab	29,667	2.388	956.88	57.56ab	87,417b	71.81	1.03	N/A	N/A	N/A
Org. C-S-O/A-A	194.23b	28,667	2.775	397.00	66.07a	81,667b	73.62	1.24	N/A	N/A	3.87
Org. S-W	N/A	N/A	2.612	N/A	48.35b	50,417c	N/A	N/A	8.85	1.34	N/A
$LSD_{0.05}$	12.91	NS	NS	NS	10.00	13.05	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 significantly different (NS), or significantly different at $p \leq 0.05$ (Fisher's protected LSD test).

Table 2. Weed and insect populations in N-K LTAR, 2009.

	Corn					Soybeans					
	June 11-16, 2009 (weeds/sq. meter)		July 14, 2009 (weeds/sq. meter)		Corn borer damage	June 11-16, 2009 (weeds/sq. meter)		July 17-22, 2009 (weeds/sq. meter)		Stained soybeans (%)	Soybean cyst nematode (eggs per 100cc)
Rotation	Grass	Broadleaves	Grass	Broadleaves	(%)	Grass	Broadleaves	Grass	Broadleaves		
Conv. C-S	2.00b	5.50b	1.50b	1.33b	0.00	0.00b	1.25c	0.75b	1.33	0.80	37.50
Org. C-S-O/A	8.25a	16.75a	2.17b	6.00a	0.00	32.42a	29.83a	11.08a	2.42	0.83	0.00
Org. C-S-O/A-A	9.22a	4.67b	4.50a	2.97b	0.00	33.08a	17.17b	9.25a	2.17	0.60	0.00
Org. S-W	N/A	N/A	N/A	N/A	0.00	18.83a	16.17b	11.25a	3.17	3.30	0.00
$LSD_{0.05}$	5.91	6.57	2.31	2.37	NS	18.10	11.95	6.52	NS	NS	NS

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

Table 3. Grain quality in N-K LTAR, 2009.

	Corn					Soybean				
Rotation	Density	Starch	Oil	Protein	Moisture	Carbohydrates	Fiber	Oil	Protein	Moisture
Conv. C-S	1.24[z]	60.90	4.02	8.25	29.40	23.82	4.85	18.65	34.68	16.15b
Org. C-S-O/A	1.23	61.23	3.88	8.45	31.95	24.20	4.88	18.68	34.25	17.12b
Org. C-S-O/A-A	1.25	61.70	4.32	8.63	30.98	24.30	4.90	18.60	34.22	16.45b
Org. S-W	N/A	N/A	N/A	N/A	N/A	23.55	4.80	18.40	35.25	19.05a
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.49

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

Table 4. Insect populations in N-K LTAR, 2009.

Treatment	Bean leaf beetle population	Aphid population	Total pest insect population (seasonal average)	Total beneficial insect population (seasonal average)
	Insects/20 sweeps		Insects/20 sweeps	
Conv. C-S	1.75	30.75	38.75	10.00
Org. C-S-O/A	2.25	26.75	45.00	14.00
Org. C-S-O/A-A	2.00	27.25	30.25	7.50
Org. S-W	0.75	44.25	57.00	19.25
$LSD_{0.05}$	NS	NS	NS	NS

[z] C = corn, s = soybean, O = oat, and A = alfalfa.

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