Comparison of Organic and Conventional Crops at the Neely-Kinyon Long-term Agroecological Research (LTAR) Site, 2010

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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). A new rotation of Corn-Soybean-Corn-Oats/Alfalfa (C-SB-C-O/A) replaced the old S-W/RC rotation. On April 11, 2010, 'Spur' oats were underseeded with 'BR Goldfinch' alfalfa at a rate of 92 lbs/acre and 15 lb/acre, respectively. Following harvest of the organic corn plots in 2009, winter rye was no-till drilled at a rate of 75 lb/acre on November 6, 2009.

Conventional corn plots were injected with 28% UAN on May 24, 2010, at 140 lb N/acre. Conventional corn and soybean plots were broadcast with monoammonium phosphate at 112 lbs/acre on May 24. Hoop-house swine compost was applied to organic corn plots at a rate of 12 tons/acre on April 13 and 4 tons/acre to oat plots on April 11. Corn and soybean variety selection and planting methods in 2010 were as follows: Blue River 57H36 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 24, 2010. Blue River 29AR9 soybeans were planted at a depth of 2 in. in organic and conventional plots at a rate of 200,000 seeds/acre on May 25, 2010. Conventional corn plots were sprayed with a pre-emergence herbicide on May 28 with 1.5 oz/acre of Balance Pro, 1 lb/acre of atrazine and 32 oz/acre of WeatherMax. Conventional corn plots were sprayed with a post-emergence herbicide on June 24 with 0.75 oz/acre of Steadfast, 1.5 oz/acre of Callisto and 0.25 lbs/acre of atrazine. Conventional soybeans received an application of 1.5 oz/acre of Encompass on May 28 and 6 oz/acre of Fusilade on June 30 as a post-emergence herbicide.

Soil in corn plots was sampled on May 21, 2010, 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 October 13 for soil quality analysis.

All organic soybean plots were rotary hoed on May 28 before emergence and on June 4 and June 7. All organic soybean plots were cultivated on June 17, June 30 and July 10. Organic soybean plots were "walked" on July 22. Organic corn plots were rotary hoed on May 28, June 4, and June 7, and cultivated on June 17, and June 29. Corn and soybean stands were counted on June 24. Weed counts were enumerated in corn and soybean plots on June 24, using square meter quadrats at three randomly selected areas within a plot. Soybean plots were sampled for insects on July 21 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 September 27, and soybean cyst nematode sampling was completed on September 27. 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 1, June 29, August 1, and September 30. Oat plots were harvested on July 26 and baled on August 1. Soybean plots were harvested on October 6. Corn plots were harvested on October 16. 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 on June 24, 2010, plant populations were similar in the conventional C-S and organic rotations at 26,941 plants/acre (Table 1). Grass and broadleaf weed populations (9.5 and 7.9 weeds/sq. meter, respectively) were similar in corn plots in conventional and organic rotations (Table 2), except for higher number of weeds in the new rotation of C-S-C-O/A, which replaced the old S-W/RC rotation where weed populations became more of a problem over the years. In soybean plots (Table 2), the conventional rotation had the lowest amount of grass and broadleaf weeds (6.8 and 2.8 weeds/sq. meter, respectively), but the grass weeds in the organic C-S-O/A and C-S-O/A-A rotations were not significantly greater than the conventional C-S rotation, and broadleaf weeds in the C-S-O/A-A and C-S-C-O/A were not significantly greater than the conventional C-S rotation.

Late-spring nitrate levels averaged 2.5 ppm NO_3-N across conventional and organic plots, which is considered low compared to previous years but could be the result of high levels of rainfall (Table 1). Corn stalk nitrate levels at the end of the season were also low and were equivalent across all rotations, averaging 871 ppm nitrate–N (Table 1). Soybean plant stands, at 84,104 plants/acre, were quite reduced in 2010, but were equivalent across all rotations (Table 1).

Despite high levels of weeds and challenging weather (plots were under water for three weeks), organic corn yields averaged 141 bu/acre in 2010 and were equivalent across all rotations (Table 1). The C-S-O/A rotation produced numerically lower yields (119 bu/acre) compared to the four–year organic C-S-O/A-A rotation and the conventional C-S rotation yield (148 bu/acre). Organic soybean yields averaged 53 bushels/acre (Table 1), with the new rotation of C-S-C-O/A plots yielding lower (47 bu/acre) than the four–year organic C-S-O/A-A rotation (57 bu/acre). The organic three–year rotation and the conventional soybean yields at 54 bu/acre yields were statistically equivalent to both the new rotation and the higher-yielding organic C-S-O/A-A rotation. Small grain yields were impacted by extended periods of wet weather in 2010; oats yielded 74 bu/acre of grain in the organic C-S-O/A rotation and significantly higher (91 bu/acre) in the four–year rotation (Table 1). There were 1.2 tons/acre of oat straw, with no differences between oat rotations. Alfalfa yielded an average of 4.7 tons/acre.
Soybean cyst nematodes were low overall, averaging 100 eggs/100 cc of soil across all rotations, with no significant differences between rotations (Table 3).

Corn grain quality was affected by the poor weather conditions in 2010. Corn carbohydrate levels averaged 62% across all rotations, but the conventional corn was lower at 61.4% than the organic C-S-O/A rotation at 62.3% (Table 3). No significant difference was observed in corn grain oil content, averaging 3.6% across all rotations. Equivalent protein levels (6.4%) were found across all rotations (Table 3). Soybean carbohydrate levels (24.2%) and oil levels (17.5%) were similar across all rotations (Table 3). Protein levels were also equivalent among rotations at 35.5% (Table 3).

There were no significant differences in soybean pest and beneficial insect populations between rotations in 2010 (Table 4). Insect pests included aphids, bean leaf beetles, thrips, stinkbugs, and corn rootworms. Beneficial insects included minute pirate bugs, wasps and spiders. There was no damage from corn borer populations observed in 2010 and aphid numbers were very low, averaging 11 aphids per 20 sweeps (Table 4). Bean leaf beetle numbers were also low, similar to 2009, with populations averaging <1 beetle per 20 sweeps, compared to an average of 16 beetles per 20 sweeps in 2008.

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Table 1. Grain crop performance in Neely-Kinyon LTAR, 2010.

Rotation	Corn				Soybean		Oat		Alfalfa
	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 (tons/acre)
Conv. C-S [z]	148.7	29,333	2.25	1934.5	53.7ab	92,583	N/A	N/A	N/A
Org. C-S-O/A	118.9	27,333	2.00	29.25	54.2ab	85,889	74.0b	1.2	N/A
Org. C-S-O/A-A	147.6	25,933	3.25	1419.5	57.3a	86,778	90.7a	1.1	4.7
Org. C-S-C-O/A	149.7	25,166	2.50	100.5	47.1b	71,167	N/A	N/A	N/A
LSD $_{0.05}$	NS [y]	NS	NS	NS	7.8	NS	16.5	NS	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≥ 0.05 (Fisher's protected LSD test).

Table 2. Weed and nematode populations in Neely-Kinyon LTAR, 2010.

Rotation	Corn		Soybeans		
	June 24,2010		June 24,2010		SCN (Eggs/100cc)
	Grass	Broadleaves	Grass	Broadleaves	
Conv. C-S	0.8b	2.8b	6.8b	2.8b	75.0
Org. C-S-O/A	17.3b	11.6b	12.4ab	10.4a	87.5
Org. C-S-O/A-A	10.3b	9.4b	17.7ab	6.9ab	150.0
Org. C-S-C-O/A	109.5a	28.2a	26.7a	7.2ab	162.5
LSD $_{0.05}$	46.0 [z]	12.2	16.0	6.0	NS

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

Table 3. Grain quality in Neely-Kinyon LTAR, 2010.

Rotation	Corn					Soybean				
	Density	Starch	Oil	Protein	Moisture	Carbohydrates	Fiber	Oil	Protein	Moisture
Conv. C-S	1.3	61.4b	3.7	6.9	15.1	24.5	4.9	17.3	35.3	8.7b
Org. C-S-O/A	1.3	62.3a	3.6	5.9	16.0	24.3	4.9	17.3	35.6	9.2ab
Org. C-S-O/A-A	1.3	62.0ab	3.6	6.5	15.7	24.0	4.9	17.7	35.5	9.1ab
Org. C-S-C-O/A	1.3	61.9ab	3.6	6.4	15.4	24.0	4.9	17.6	35.5	9.8a
LSD $_{0.05}$	NS [z]	0.78	NS	NS	NS	NS	NS	NS	NS	0.90

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

Table 4. Insect populations (per 20 sweeps) in soybean plots in LTAR trial, Neely-Kinyon, 2010.

Treatment	Aphid population	BLB population	Thrips population	Corn rootworm	Stinkbug population	MPB [y] population	Spider population	Wasp population
Conv C-S	1.25	0.5	10.0	1.75	0.25	1,50	1.00	0.00
Org C-S-O/A	7.50	1.0	13.3	1.25	0.75	6.50	1.00	2.00
Org C-S-O/A-A	1.25	0.25	6.00	2.00	0.25	2.25	0.25	1.50
Org C-S-C-O/A	2.75	0.75	10.3	0.75	0.25	4.50	0.50	0.50
LSD 0.05	NS [z]	NS	NS	NS	NS	NS	NS	NS

[z] Means within a column are not significant (NS), or significant at p ≥ 0.05 (Fisher's protected LSD test
[y] MPB = minute pirate bug (predator).