Comparison of Organic and Conventional Crops at the Neely-Kinyon Long-term Agroecological Research (LTAR) Site, 2007

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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 (S-W). 'Arapahoe' winter wheat was planted on October 25, 2006, at 85 lb/acre and 'Cardinal' red clover was frost-seeded into the wheat plots on March 15, 2007, at a rate of 12 lb/acre. On April 16, 2007, 'Kame' oats were underseeded with 'Bluebird' alfalfa at a rate of 110 lb/acre and 18 lb/acre, respectively. Following harvest of the organic corn plots in 2006, winter rye was no-till drilled at a rate of 70 lb/acre on November 8, 2006.

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 4. Manure was applied to organic soybean-wheat plots at 12 tons/acre on May 21, before the soybeans were replanted, to supply 300 lbs/acre of phosphorus, while the conventional corn-soybean plots received of 200 lbs/acre of 11-52-0 on May 21, providing 104 lbs/acre of phosphorus. To incorporate the fertility inputs, the conventional soybean plots and the soybeans in the organic soybean-wheat rotation were disked on May 21. Corn and soybean variety selection and planting methods in 2007 were as follows: Blue River 61R34 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, 2007. 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 22, 2007. Due to insufficient stands, soybeans in the organic soybean-wheat rotation were replanted to Blue River 34A7 soybeans on June 6, 2007, at the same initial rate. All soybean plots were cultivated on June 5.

Conventional corn plots were fertilized on May 17, 2007, with 32% nitrogen at 145 lbs N/acre along with 2.25 oz/acre of Balance Pro™ herbicide. Conventional corn was also sprayed on June 25 with 0.66 oz/acre of Accent, 1 pt/acre of Buctril, 4 oz/acre of NIS, and 1.5 lbs/acre of AMS. Conventional soybeans received an application of 1.44 oz/acre of Pursuit on June 21. Due to the high number of aphids present in late July and early August, NUFOS (Lorisban) at 2 pt/acre was applied to the conventional soybean plots, while Neemix 4.5 was applied to the organic soybean plots at 1 pt/acre on August 2-10.

Soil in corn plots was sampled on June 14, 2007, and analyzed for late-spring nitrate content by the Iowa State University Soil and Plant Analysis Laboratory, Ames, Iowa. Fall samples were taken on October 26 for soil quality analysis.

All organic soybean plots were rotary hoed on June 1 and 19; soybeans in the organic corn-soybean-oats/alfalfa and organic corn-soybean-oats/alfalfa-alfalfa were also rotary hoed on June 8, while the organic soybean-

wheat rotation was rotary hoed on June 14. Soybeans in the corn-soybean-oats/alfalfa and organic corn-soybean-oats/alfalfa-alfalfa were cultivated on June 12, while the organic soybean-wheat rotation was cultivated on June 20. All organic soybean plots were cultivated on June 26 and July 26. The organic soybean-wheat rotation was buffalo cultivated on July 11. Organic soybean and corn plots were "walked" on June 28 and July 12 at a rate of one acre per hour. Organic corn plots were rotary hoed on May 31. Organic corn plots were cultivated on June 5 and June 21. Corn stands were counted on June 5 and soybeans on June 11 in the conventional rotation and the organic corn-soybean-oats/alfalfa and organic corn-soybean-oats/alfalfa-alfalfa rotations, and on June 21 in the organic soybean-wheat rotation.

Weed counts were enumerated in corn plots on June 5 and 20, and in soybean plots on June 11 in the conventional rotation and the organic corn-soybean-oats/alfalfa and organic corn-soybean-oats/alfalfa-alfalfa rotations, and on June 21 in the organic soybean-wheat rotation, and in all soybean plots on June 27, 2007, 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 June 11, July 13 and August 6. Corn stalk nitrate samples were collected on September 21, and soybean cyst nematode sampling was completed on September 26. 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 6, July 9, August 14, and September 17. Wheat plots were harvested and baled on July 16, and oat plots were harvested on July 17 and baled on July 25. Soybean plots were harvested on October 26. Corn plots were harvested on October 29. 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, there were no differences between conventional C-S and organic stands in 2007 (Table 1). Weed populations were low in all corn plots throughout the season, and no significant differences were observed between rotations for grasses and broadleaves on the first and second sampling dates (Table 2). Late-spring nitrate levels in the C-S-O/A-A and C-S-O/A averaged 15.4 ppm NO_3-N, which is less than the recommended 25 ppm, compared with significantly greater levels at 53.6 ppm in the conventional plots (Table 1). Corn stalk nitrate levels at the end of the season were greater in the conventional C-S rotation compared to the organic rotations, although the organic rotations had sufficient N (over 2,000 ppm) (Table 1). Thus, some luxury N was present in corn from all rotations by the end of the season, despite early low late spring nitrate levels in the organic corn plots.

Soybean plant stands were significantly greater in the conventional C-S and organic S-W rotations in 2007, but the S-W rotation had been replanted (Table 1). Grass weeds were similar among rotations on June 11, but on June 27, grasses were higher in the conventional C-S and organic S-W plots (Table 2). Broadleaf weed counts were similar in conventional and organic plots on the first sampling date, but numbers were significantly greater in the organic S-W plots on June 27 (Table 2).

While the 2007 season was extremely dry mid-season, with low rainfall in June and early July, a 10-year high yield was obtained in the organic C-S-O/A-A rotation, where yields averaged 209 bu/acre (Table 1). Conventional C-S corn yields averaged 188

bu/acre and soybean yields averaged 61 bu/acre (Table 1). The organic C-S-O/A corn yield at 191 bu/acre was equivalent to the conventional C-S corn yield. The organic C-S-O/A soybean yield at 65 bu/acre and the conventional soybean yield of 61 bu/acre were greater than the other rotations, but the other organic soybean yields were also excellent, averaging 56 bu/acre. There were no significant yield differences between oat rotations, averaging 106 bu/acre of grain and 0.96 tons/acre of oat straw. Wheat yielded 47 bu/acre and 0.84 tons/acre straw. Alfalfa yielded 3.32 tons/acre (Table 1).

Pest populations were similar to 2005 levels, with less than 1% of corn ears exhibiting corn borer damage on July 5. Bean leaf beetle numbers were also lower than in 2006, with populations reaching 8 beetles per 20 sweeps at the peak period (Table 3). The organic S-W plots had the greatest number of beetles at the peak period. Beneficial insects were generally higher in the organic rotations although results were not significantly different (Table 3). Soybean cyst nematodes were low, with no significant differences among treatments (Table 3).

Soybean protein levels, averaging 34%; carbohydrate levels, averaging 25%; and oil levels, averaging 19%, were equivalent among all rotations in 2007 (Table 4). Corn starch levels were greater in the organic C-S-O/A-A and C-S-O/A rotations, while protein levels were greatest in the conventional C-S and organic C-S-O/A-A rotations, averaging 8.4%. No significant difference was observed in corn grain oil content. Wheat protein averaged 14% in 2007, 2% greater than 2006 levels.

The 2007 season represented the tenth cropping season of the LTAR. The strong competitiveness of the organic crops in the LTAR (with yields equal or greater than conventional counterparts) could not have occurred without the excellent management skills of farm manager, Bob Burcham, the N-K Farm staff and the Organic Ag program staff. The future performance of the LTAR will be dependent on continued support promised by the ISU Experiment Station.

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Table 1. Grain crop performance in N-K LTAR, 2007.

	Corn				Soybean		Oat		Wheat		Alfalfa
Rotation [z]	Yield Bu/acre	Population plants/acre	LSNT $\mu g \cdot g^{-1}$ $N\text{-}NO_3$	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	187.52b [y]	26,500	53.56a	5061.25a	61.31ab	115,750ab	N/A	N/A	N/A	N/A	N/A
Org. C-S-O/A	191.38b	26,250	14.63b	2456.00b	65.04a	92,500c	108.26	1.00	N/A	N/A	N/A
Org. C-S-O/A-A	209.35a	25,083	16.25b	3098.75b	58.59b	106,917b	104.26	0.91	N/A	N/A	3.32
Org. S-W	N/A	N/A	N/A	N/A	53.12c	123,000a	N/A	N/A	46.97	0.84	N/A
$LSD_{0.05}$	6.41	NS	11.65	1415.98	3.78	11.46	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 $p \geq 0.05$ (Fisher's protected LSD test).

Table 2. Weed populations in N-K LTAR, 2007.

	Corn				Soybean			
	June 5, 2007		June 20, 2007		June 11-21, 2007		June 27, 2007	
Treatment	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves	Grass	Broadleaves
Conv. C-S	0.00 [y]	0.25	0.58	0.58	0.17	3.33	4.92a	0.50b
Org. C-S-O/A	0.00	0.08	0.00	0.67	0.33	0.92	0.42b	0.00b
Org. C-S-O/A-A	0.08	0.83	0.00	0.58	0.17	2.75	0.17b	0.00b
Org. S-W	N/A	N/A	N/A	N/A	0.42	0.75	3.92a	59.75a
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS	1.92	9.95

[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).

Table 3. Insect populations in N-K LTAR, 2007.

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	1.50	3.00b	119.50	586.00	4.00	17.25
Org. C-S-O/A	0.17	0.00	1.85	2.25b	124.50	601.50	5.50	23.00
Org. C-S-O/A-A	0.08	25.00	1.50	1.50b	217.75	1,073.75	6.20	26.00
Org. S-W	N/A	0.00	1.55	7.50a	146.60	724.25	6.25	29.25
$LSD_{0.05}$	NS	NS	NS	4.24	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).

Table 4. Grain quality in N-K LTAR, 2007.

	Corn					Soybean					Wheat		
Treatment	Density	Starch	Oil	Protein	Moisture	Carbohydrates	Linolenic	Oil	Protein	Moisture	Protein	Moisture	Kettle Test Wt (kg hL^{-3})
Conv. C-S	1.28 [y]	60.11b	3.56	8.48a	17.85	24.95	8.20a	18.72	33.83	13.15b	N/A	N/A	N/A
Org. C-S-O/A	1.29	60.55a	3.55	8.10b	17.83	24.94	7.96ab	18.80	33.76	13.53ab	N/A	N/A	N/A
Org. C-S-O/A-A	1.29	60.43a	3.53	8.33ab	18.54	24.76	7.70c	18.58	34.16	13.70a	N/A	N/A	N/A
Org. S-W	N/A	N/A	N/A	N/A	N/A	25.25	7.92bc	18.87	33.38	13.17b	13.78	12.93	73.56
$LSD_{0.05}$	NS	0.29	NS	0.28	NS	NS	0.26	NS	NS	0.42	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 $p \geq 0.05$ (Fisher's protected LSD test).