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Abstract
The Neely-Kinyon Long-term Agroecological Research (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-SO/A), organic Corn-Soybean-Oats/AlfalfaAlfalfa (C-S-O/A-A), and organic CornSoybean-Corn-Oats/Alfalfa (C-SB-C-O/A).

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Comparison of Organic and Conventional Crops at the Neely-Kinyon Long-term Agroecological Research Site

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Materials and Methods

The Neely-Kinyon Long-term Agroecological Research (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 organic Corn-Soybean-Corn-Oats/Alfalfa (C-SB-C-O/A).

Oats/alfalfa plots were field cultivated twice on April 10, 2014. On April 12, Saber oats were underseeded with BR Raven alfalfa at a rate of 90 lb/acre and 15 lb/acre, respectively. Plots were cultipacked on April 12 after planting. Following harvest of the organic corn plots in 2013, winter rye was no-till drilled at a rate of 75 lb/acre on November 4, 2013.

Conventional corn plots were injected with 32 percent UAN on May 15, 2014 at 140 lb N/acre, disked on May 23, and field cultivated on May 29. Chicken manure (SW Iowa Egg Cooperative, Massena, IA) was applied to organic corn plots at a rate of 4.6 tons/acre on April 10 in the organic C-S-O/A and C-S-O/A-A plots, and at a reduced rate of 1.9 tons/acre in the C-S-C-O/A plots on the same day. Corn and soybean variety selection and planting methods in 2014 were as follows: Blue River 56M30 corn was planted at a depth of 2.5 in. as untreated seed at a rate of 33,600 seeds/acre in the organic plots and as treated seed in conventional plots, on May 30, 2014. Conventional soybean plots were disked on May 23 and field cultivated on May 29. Blue River 30C3 soybeans were planted at a depth of 2 in. in organic and conventional plots at a rate of 174,000 seeds/acre on May 30, 2014. Conventional corn plots were sprayed on May 30, 2014, with Lexar™ at 2 qt/acre and Round-Up™ at 1 qt/acre; and on June 25, with Status™ at 5 oz/acre and Chemsurf™ at 1 qt/acre. Conventional soybeans received applications of 1.3 pt/acre of Boundary™ and Round-Up™ at 1 qt/acre on May 30 and were sprayed again on June 25 with 5.5 oz/acre of Infinity™, 6 oz/acre of Choice™, and 2 qt/acre of crop oil. Conventional soybean plots were cultivated on July 9 and 16 to deal with weeds still emerging after herbicides.

The alfalfa and compost that was applied in the organic corn plots was plowed under April 22, 2014. Plots were disked May 17 and 23, and field cultivated May 29. Organic corn plots were rotary-hoed June 11 and 13, and row-cultivated June 24, which was two cultivations less than in 2013, due to wet weather.

Rye was disked in organic soybean plots May 21 and 23, and field cultivated May 29, before soybean planting May 30. All organic soybean plots were rotary hoed June 11 and June 13, and row-cultivated June 24, July 9, and July 16. The length of time between planting and the first rotary hoeing (10 days) due to wet weather was damaging to weed management, so considerable time was invested in "walking" each organic soybean plot for large weeds above the canopy on August 19 and 21. There was a problem of weeds in conventional plots in 2014, even after repeated herbicide applications, but these were not "walked" in keeping with the protocol of herbicide applications only in conventional plots.

Corn and soybean stands were counted on July 10, and weeds were counted within square meter quadrats at three randomly selected areas within a plot. Soil nitrate tests were not conducted until August 4, due to wet weather at the beginning of the season, by sampling at a 6-in. depth in three randomly selected areas in each plot in the corn row. Corn borer sampling was conducted July 10 by sampling the whorl of three randomly selected corn plants per plot and counting incidence and numbers of corn borers. Corn stalk nitrate samples were collected September 19. All crop and soil analyses were conducted at the Iowa State University Soil and Plant Analysis Laboratory, Ames, Iowa, and nematode analysis was conducted at the ISU Plant Disease Clinic, Ames, Iowa.

Alfalfa was baled June 13, July 21, and August 26. Oat grain was harvested July 22. Soybean plots were harvested October 26 and corn plots were not harvested until November 1. Grain samples were collected from each corn and soybean plot for grain quality analysis, which was conducted at the ISU Grain Quality Laboratory, Ames, Iowa.

Results and Discussion

The weather in 2014 was abnormally cool in May and 7 in. above normal rainfall in June. July was extremely dry, at 3 in. below normal rainfall. August was wet again, at 5 in. above normal rainfall. As a result of these extreme weather conditions, weed management and yields were affected in organic plots. Corn stands were similar between organic and conventional systems, averaging 34,768 plants/acre (Table 1). Organic soybean populations averaged 144,168 plants/acre, with no differences between systems. Grass weed populations were highest in the organic C-S-O/A and C-S-O/A-A corn plots, but similar in the C-S-C-O/A plots and the conventional plots (Table 1). The organic corn plots averaged 5 grass weeds/m^2 and the conventional plots averaged <1 weed/m^2. Broadleaf weeds in organic plots averaged 4 weeds/m^2, with significantly greater broadleaf weeds in the C-S-C-O/A rotation, averaging 6 weeds/m^2. In the soybean plots, the organic C-S-C-O/A rotation had a similar amount of grass weeds as conventional plots, but that weed population also was similar to the other organic rotations, averaging 3 grass weeds/m^2 (Table 1). Broadleaf weeds were not significantly different between organic and conventional soybean plots, averaging 2 weeds/m^2 across all rotations. Weeds in organic fields could be attributed to wet fields in spring, leading to a delay of 10 days between planting and the first rotary hoeing in corn and soybean plots. For good weed management in organic crops, the first rotary hoeing should occur within 2–3 days after planting.

The only plots where any corn borer damage was detected were in the C-S-O/A-A plots and averaged less than 1 percent of plants sampled (Table 2).

Although there was no statistical difference between soil nitrate levels, conventional corn plots averaged 2.3 ppm NO_3-N, and organic soils averaged 1.14 ppm NO_3-N (Table 3). Corn borers were again low in all fields. Corn stalk nitrate levels averaged 1,339 ppm nitrate-N in conventional corn, and 238 ppm nitrate-N in the organic corn, with no statistical differences (Table 4).

Oat yields averaged 96 bushels/acre (Table 5). There was no difference in oat yield between the three- and four-year rotations. Alfalfa growth was impacted by the wet spring followed by drought, but yielded an average of 4.64 tons/acre (Table 6), which was significantly higher than the 1.8 tons/acre yield of 2013, and similar to the 4.3 tons/acre yield in 2011.

Organic corn yields in the C-S-O/A-A rotation averaged 123 bushels/acre compared with conventional yields of 155 bushels/acre (Table 7). The excessive rains, which may have rapidly mineralized the compost N, or caused a poor release of N from the compost itself, impacted yields in organic plots. This was demonstrated by the lack of soil N in August (Table 3) and low stalk nitrate in September (Table 4), leading to a combined average organic yield of only 96.2 bushels/acre. Statistical differences were observed between conventional and organic corn yields, and between the C-S-O/A and C-S-C-O/A and the C-S-O/A-A corn yield. The compost will be analyzed in 2015 and a new source may be sought if it contains insufficient N. Despite insufficient mechanical weed management in organic soybean plots due to weather impacting field operations, the subsequent high weed populations in the organic soybeans were managed through manual removal ("walking") and yields were high, averaging 58 bushels/acre compared with 56 bushels/acre in the conventional plots, which received four different herbicides (Table 7). There were no statistical soybean yield differences between rotations in 2014.

Soybean moisture levels were not different between systems, averaging 12.2 percent (Table 8). Protein levels were equivalent among all rotations at 35.4 percent. Soybean carbohydrate levels averaged 23.9 percent, with no differences between systems. Oil levels (17.8%) also were similar across all rotations.

Corn grain quality remained acceptable for organic feed markets, despite the extreme weather. Protein levels were equivalent between conventional and organic corn, averaging 7.3 percent (Table 9). Corn density was equivalent, at 1.25 percent, in both systems. Moisture was high, averaging 16.7 percent at harvest, with the highest moisture in the conventional corn (18.3%). Corn starch was equivalent in both systems, averaging 73 percent. Corn oil content was greater, at 4.2 percent, in conventional corn compared with an average of 4.1 percent across all organic rotations.

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Table 1. Stand and weed populations in corn and soybean plots in the LTAR experiment, ISU Neely-Kinyon Farm, 7/10/14.

Rotation	Corn Plant population (plants/acre)	Corn Grass weeds[y] (plants/m^2)	Corn Broadleaf weeds[y] (plants/m^2)	Soybean Plant population (plants/acre)	Soybean Grass weeds[y] (plants/m^2)	Soybean Broadleaf weeds (plants/m^2)
Conventional C-SB[z]	35,330	0.42b	1.83b	149,000	0.00b	0.08
Org. C-SB-O/A	34,750	7.50a	2.92b	142,170	2.75a	2.67
Org. C-SB-O/A-A	34,070	6.13a	2.27b	147,330	3.83a	1.08
Org. C-SB-C-O/A	34,920	0.50b	5.67a	138,170	2.08ab	2.42
$LSD_{0.05}$	NS	1.45	1.10	NS	1.21	NS
p value ($\alpha = 0.05$)	0.454	0.019	0.029	0.129	0.037	0.152

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.
[y]Means followed by the same letter in the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 2. Corn borer damage and presence in the LTAR experiment, Neely-Kinyon Farm, 7/10/2014.

Rotation	Damage (%)	Presence (%)
Conventional C-SB[z]	0.00	0.00
Org. C-SB-O/A	0.00	0.00
Org. C-SB-O/A-A	0.07	0.00
Org. C-SB-C-O/A	0.00	0.00
$LSD_{0.05}$	NS	NS
p value ($\alpha = 0.05$)	0.506	-

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 3. Soil NO_3^--N analysis in the LTAR experiment, Neely-Kinyon Farm, 8/4/2014.

Rotation	NO_3^--N (mg/kg)
Conventional C-SB[z]	2.30
Org. C-SB-O/A	0.85
Org. C-SB-O/A-A	1.18
Org. C-SB-C-O/A	1.40
$LSD_{0.05}$	NS
p value ($\alpha = 0.05$)	0.090

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 4. Corn stalk nitrate in the LTAR experiment, Neely-Kinyon Farm, 9/19/14.

Rotation	NO_3 – N (mg/kg)
Conventional C-SB[z]	1,339.25
Org. C-SB-O/A	80.00
Org. C-SB-O/A-A	521.75
Org. C-SB-C-O/A	112.25
$LSD_{0.05}$	NS
p value ($\alpha = 0.05$)	0.120

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 5. Oat yields in the LTAR experiment, Neely-Kinyon Farm, 7/31/2014.

Rotation	Yield (bu/acre)
Org. C-SB-O/A[z]	102.43
Org. C-SB-O/A-A	89.65
$LSD_{0.05}$	NS
p value ($\alpha = 0.05$)	0.1789

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 6. Alfalfa yields in the C-SB-O/A-A[z] rotation in the LTAR experiment, Neely-Kinyon Farm, 2014.

Harvest date	Yield (tons/acre)
June 6	6.09
July 21	3.30
August 22	4.52
Total	13.91

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 7. Corn and soybean yields in the LTAR experiment, Neely-Kinyon Farm, 11/1/2014.

Rotation	Corn (bu/acre)[y]	Soybean (bu/acre)
Conventional C-SB[z]	155.0a	55.9
Org. C-SB-O/A	80.7c	56.6
Org. C-SB-O/A-A	122.9b	58.6
Org. C-SB-C-O/A	85.5c	58.4
$LSD_{0.05}$	12.1	NS
p value ($\alpha = 0.05$)	0.0001	0.384

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.
[y]Means followed by the same letter in the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD Test).

Table 8. Soybean grain quality analysis in the LTAR experiment, Neely-Kinyon Farm, 2014.

Rotation	Moisture (%)	Protein (%)	Oil (%)	Fiber (%)	Carbohydrates (%)	Sum (%)
Conventional C-SB[z]	11.95	35.38	17.68	4.88	24.07	53.05
Org. C-SB-O/A	12.34	35.19	17.93	4.88	24.01	53.11
Org. C-SB-O/A-A	12.28	35.44	17.86	4.85	23.85	53.30
Org. C-SB-C-O/A	12.24	35.49	17.83	4.85	23.84	53.31
$LSD_{0.05}$	NS[y]	NS	NS	NS	NS	NS
p value ($\alpha = 0.05$)	0.165	0.839	0.609	0.687	0.687	0.687

[z]C = corn, SB = soybeans, O = oats, A = alfalfa.

Table 9. Corn grain quality analysis in the LTAR experiment, Neely-Kinyon Farm, 2014.

Rotation	Moisture[y] (%)	Protein (%)	Oil[y] (%)	Starch (%)	Density (g/cc)	Ethanol yield (gal/bu)
Conventional C-SB[z]	18.33a	7.35	4.20a	72.58	1.25	2.76
Org. C-SB-O/A	15.93c	6.95	4.00c	73.13	1.24	2.79
Org. C-SB-O/A-A	16.64b	7.29	4.15b	72.59	1.25	2.76
Org. C-SB-C-O/A	16.01c	7.41	4.00c	72.55	1.24	2.76
$LSD_{0.05}$	0.47	NS	0.10	NS	NS	NS
p value ($\alpha = 0.05$)	0.0001	0.325	0.014	0.065	0.074	0.185

[z]C = corn, SB = soybean, O = oat, and A = alfalfa.
[y]Means followed by the same letter in the column are not significantly different at $P \leq 0.05$ (Fisher's Protected LSD test).