2013

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

Kathleen Delate
*Iowa State University*, kdelate@iastate.edu

Ryan C. Rice
*Iowa State University*, rcrice29@iastate.edu

Ning Wang
*Iowa State University*

Kirk A. Schwarte
*Iowa State University*

Randy J. Breach
*Iowa State University*, rbreach@iastate.edu

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

**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 Corn-SoybeanCorn-Oats/Alfalfa (C-SB-C-O/A).

**Keywords**
RFR A1291, Horticulture, Agronomy

**Disciplines**
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Horticulture

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

**RFR-A1291**

Kathleen Delate, professor
Ryan Rice, research assistant
Ning Wang, research assistant
Departments of Horticulture and Agronomy
Kirk Schwarte and Randy Breach,
ag specialists

## 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 Corn-Soybean-Corn-Oats/Alfalfa (C-SB-C-O/A).

On March 27, 2012, Badger oats were underseeded with BR Goldfinch alfalfa at a rate of 90 lb/acre and 15 lb/acre, respectively. Following harvest of the organic corn plots in 2011, winter rye was no-till drilled at a rate of 75 lb/acre on October 29, 2011.

Conventional corn plots were injected with 32 percent UAN on May 16, 2012, at 140 lb N/acre. Chicken manure (S.W. Iowa Egg Cooperative, Massena, IA) was applied to organic corn plots at a rate of 4.6 tons/acre on April 4 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. Corn and soybean variety selection and planting methods in 2012 were as follows: Blue River 57H36 corn was planted at a depth of 2.5 in. as untreated seed at a rate of 35,000 seeds/acre in the organic plots and as treated seed in conventional plots, on May 16, 2012. Blue River 29AR9 soybeans were planted at a depth of 2 in. for organic and conventional plots at a rate of 175,000 seeds/acre on May 22, 2012. Conventional corn plots were sprayed with a pre-emergence herbicide on May 16 with 1.5 oz/acre of Balance Pro™, 1 lb/acre of atrazine, and 32 oz/acre of Roundup™. Conventional soybeans received an application of 2 oz/acre of Encompass™ and 32 oz/acre of Roundup™ on May 25, and 6 oz/acre of Intensity™ and 2 lbs/acre AMS and crop oil as a post-emergence herbicide on July 2, 2012.

All organic soybean plots were rotary hoed on June 1 before emergence and on June 8 and June 13. All organic soybean plots were cultivated on June 18, June 22, June 29, and July 13. Each organic soybean plot was "walked" (hand weeded) once for large weeds on July 24. Organic corn plots were rotary hoed on June 1 and June 8, and cultivated on June 13, June 18, and June 22. Corn and soybean stands were counted on June 25. Weed counts were enumerated in corn and soybean plots on June 25, using square meter quadrats at three randomly selected areas within a plot. Soybean plots were sampled for insects on July 19 and July 31 by sweeping plots 20 times with a 15-in. diameter net, placing contents in a Ziplock™ bag, and freezing until identification was completed. Corn stalk nitrate samples were collected on September 5, and soybean cyst nematode sampling was completed on September 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 April 26, June 22, July 2, and August 30. Oat grain was harvested on June 29, straw baled on July 3, and plots were mowed on August 30. Soybean plots were harvested on October 8. Corn plots were harvested on October 10. 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**

Corn populations were similar in the conventional C-S and organic rotations at 28,417 plants/acre (Table 1). Grass weed populations were higher in the organic C-S-C-O/A and C-S-O/A corn plots, but similar in the conventional and the organic C-S-O/A-A plots (Table 1). There were no statistical differences between broadleaf weed populations in the organic and conventional corn plots (Table 1). In the soybean plots, the conventional rotation had the highest amount of broadleaf weeds, with no difference in grass weeds in the organic and conventional plots (Table 1). This difference could be attributed to the drought and excellent weed management in the organic soybean plots.

The drought (rainfall: 8.5 in. below normal) and the heat (averaging 5°F above normal in July) severely affected corn yields, with conventional corn only reaching 91 bushels/acre and organic C-S-O/A-A and C-S-C-O/A corn statistically equivalent, at 89 bushels/acre (Table 2). The C-S-O/A corn yield was lower at 75 bushels/acre. The organic corn yields were 50 percent lower than the 14-year LTAR average.

Soybean plant stands averaged 140,167 plants/acre in conventional plots, but were lower in organic plots, averaging 122,750 plants/acre, possibly due to rotary hoeing operations (Table 1). Soybeans were more resilient than corn in the drought and heat, averaging 43 bushels/acre across both conventional and organic rotations (Table 3). Organic soybean yields averaged 42 bushels/acre (Table 3). There was no statistical difference in organic soybean yields between the three-year rotation and the four-year rotation. Small grain yields were impacted by extended periods of wet weather early in 2012; oats yielded 70 bushels/acre of grain across the organic rotations, with no significant differences between rotations (Table 4). The C-S-C-O/A rotation, however, had a numerically lower yield (60 bu/acre), similar to 2011. There was an average of 1.85 tons/acre of oat straw, with the organic rotation with two years of corn yielding significantly less straw (1.4 tons/acre) than the other two organic rotations. Alfalfa growth was also severely impacted by the drought, yielding an average of 0.77 tons/acre, down from 4.3 tons/acre in 2011.

Corn grain quality remained high despite the drought. Corn density averaged 1.28 percent across all rotations (Table 5). No significant difference was observed in corn oil content, averaging 4.2 percent across all rotations. Protein levels were equivalent between conventional and organic corn (averaging 10.4%, the highest protein in 14 years). Cornstarch averaged 70.7 percent across all rotations. Soybean carbohydrate levels (averaging 22.9%) were greater in the conventional and C-S-O/A-A rotations (averaging 23%). Oil levels (19.3%) were similar across all rotations (Table 6). Protein levels were also equivalent among rotations at 35 percent. Oat protein levels averaged 9.9 percent across both rotations.

Corn stalk nitrate levels were high at harvest, reflecting a crop with green leaves. The highest levels were in the organic C-S-O/A-A and C-S-O/A corn, averaging 7,108 ppm nitrate-N, compared with 1,704 ppm in the

conventional C-S and C-S-C-O/A rotations (Table 7).

Insect pest populations were low in 2012. There were no corn borers or corn borer damage when plants were sampled in the corn plots on July 19, 2012. Other corn and soybean insect pests included corn rootworms, aphids, bean leaf beetles, and thrips. Aphid numbers in soybean plots were very low on July 19 and August 22, averaging three and no aphids, respectively, per 20 sweeps (Tables 8 and 9), with no difference between rotations. Even though this is a soybean aphid-resistant variety, we monitor aphid numbers every year in the event of resistance development. Bean leaf beetle (BLB) numbers were also low in 2012, averaging three and no BLBs per 20 sweeps on the two sampling dates. These numbers were much higher in 2010 and 2009, with populations averaging 20 beetles/20 sweeps, compared with an average of one beetle/20 sweeps in 2011. Thrips were lower in organic plots in July, averaging 210 per 20 sweeps, compared with 544 in conventional plots, but similar across rotations in late August, averaging 19 thrips/20 sweeps. Corn rootworms (CRW) were observed on soybean plants in 2012 at low populations, averaging two beetles/20 sweeps in July and one CRW beetle/20 sweeps in August. Beneficial insects included minute pirate bugs (MPB) and spiders and were in larger numbers in 2011 than in 2010. Total beneficial insects averaged 20 per 20 sweeps with a trend towards higher numbers in the organic rotations, which averaged 23 per 20 sweeps. There were more MPBs in the conventional rotation, averaging 14 per 20 sweeps compared with four MPB in the organic soybean plots in July (Table 8), but there were no differences between rotations in August when MPBs averaged 4 per 20 sweeps. Spiders were also greater in the conventional plots in July, averaging 8 per 20 sweeps compared with three in the organic plots, but there were no differences between rotations in August when spiders averaged <1 per 20 sweeps. Soybean cyst nematodes remained low across all rotations, averaging 42 eggs/100 cc of soil.

**Acknowledgements**

We would like to thank the Leopold Center for Sustainable Agriculture for their support of the Neely-Kinyon LTAR site. We also thank the Wallace Foundation for their input and support. Thanks also go to Bernie Havlovic, Evan Duyvejonck, Neo Mazur, Jordan Garvey, Justin Kuzila, Bob Turnbull, Grace Wang, Andres Glasener, and Meaghan Daley for their help in production, data collection, and analytical aspects of this project. We also thank Charles Hurburgh and Glen Rippke of the ISU Grain Quality Lab, Kerry Culp of the ISU Soil and Plant Analysis Lab, and Blue River Hybrids for their support.

**Table 1. Corn and soybean plant and weed populations in the LTAR experiment, Neely-Kinyon Farm, 6/25/12.**

| | Corn | | | Soybean | | |
|---|---|---|---|---|---|---|
| **Rotation** | **Stand (plants/acre)** | **Grass (/acre)** | **Broadleaf (/acre)** | **Stands (plants/acre)** | **Grass (/acre)** | **Broadleaf (/acre)** |
| Conventional C-S[z] | 29,250 | 1,336b | 6,397 | 140,167a | 5,061 | 10,445a |
| Organic C-S-C-O/A | 26,833 | 18,543a | 12,470 | --- | --- | --- |
| Organic C-S-O/A | 28,917 | 11,457ab | 9,433 | 122,167b | 15,182 | 1,336b |
| Organic C-S-O/A-A | 28,667 | 2,348b | 6,397 | 123,333b | 19,919 | 3,036b |
| $LSD_{0.05}$ | NS[y] | 11,215 | NS | 6,985 | NS | 6,721 |

[z]C = corn, s = soybean, O = oat, and A = alfalfa.
[y]Means within a column with different letters are different at P ≥ 0.05 (Fisher's protected LSD test) or are not significant (NS).

**Table 2. Corn yield in the LTAR experiment, Neely-Kinyon Farm.**

| **Rotation** | **Yield (bu/acre)** |
|---|---|
| Conventional C-S | 91.7a |
| Organic C-S-C-O/A | 89.3a |
| Organic C-S-O/A | 74.7b |
| Organic C-S-O/A-A | 89.0a |
| $LSD_{0.05}$ | 9.73[z] |

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

**Table 3. Soybean yield in the LTAR experiment, Neely-Kinyon Farm.**

| **Rotation** | **Yield (bu/acre)** |
|---|---|
| Conventional C-S | 45.8 |
| Organic C-S-O/A | 39.3 |
| Organic C-S-O/A-A | 44.3 |
| $LSD_{0.05}$ | NS[z] |

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

**Table 4. Oat yield in the LTAR experiment, Neely-Kinyon Farm.**

| **Rotation** | **Yield (bu/acre)** | **Straw (tons/acre)** |
|---|---|---|
| Organic C-S-C-O/A | 60.4 | 1.44b |
| Organic C-S-O/A | 74.7 | 2.10a |
| Organic C-S-O/A-A | 75.9 | 2.00a |
| $LSD_{0.05}$ | NS[z] | 0.53 |

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

**Table 5. Corn grain quality in the LTAR experiment, Neely-Kinyon Farm.**

| Rotation | Protein (%) | Oil (%) | Starch (%) | Density (g/cc) | Ethanol yield (gal/bu) |
|---|---|---|---|---|---|
| Conventional C-S | 10.03 | 4.18 | 70.82 | 1.27 | 2.83 |
| Organic C-S-C-O/A | 10.37 | 4.19 | 70.65 | 1.28 | 2.81 |
| Organic C-S-O/A | 10.47 | 4.06 | 70.76 | 1.29 | 2.81 |
| Organic C-S-O/A-A | 10.72 | 4.18 | 70.35 | 1.28 | 2.80 |
| $LSD_{0.05}$ | NS[z] | NS | NS | NS | NS |

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

**Table 6. Soybean grain quality in the LTAR experiment, Neely-Kinyon Farm.**

| Rotation | Protein (%) | Oil (%) | Fiber (%) | Carbohydrates (%) |
|---|---|---|---|---|
| Conventional C-S | 34.85 | 19.18 | 4.77a | 23.21a |
| Organic C-S-O/A | 35.13 | 19.48 | 4.70b | 22.70b |
| Organic C-S-O/A-A | 35.00 | 19.13 | 4.76a | 23.12a |
| $LSD_{0.05}$ | NS[z] | NS | 0.05 | 0.35 |

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

**Table 7. Corn stalk nitrate in the LTAR experiment, Neely-Kinyon Farm, 9/11/12.**

| Rotation | $NO_3$-N (mg/kg) |
|---|---|
| Conventional C-SB | 1932.25b |
| Org. C-SB-C-O/A | 1476.25b |
| Org. C-SB-O/A | 8015.00a |
| Org. C-SB-O/A-A | 6200.00a |
| $LSD_{0.05}$ | 3563.23[z] |

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

**Table 8. Pest and beneficial insects in soybean plots, Neely-Kinyon LTAR, 7/19/12 (number per 20 sweeps).**

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn rootworms | Minute pirate bugs | Spiders |
|---|---|---|---|---|---|---|
| Conventional C-S | 4.00 | 5.00 | 544.25a | 2.00 | 14.33a | 7.50a |
| Org. C-S-O/A | 2.67 | 1.67 | 142.50b | 2.50 | 2.50b | 2.50b |
| Org. C-S-O/A-A | 3.00 | 1.00 | 277.67ab | 2.00 | 5.67b | 4.00b |
| $LSD_{0.05}$ | NS[z] | NS | 0.10 | NS | 0.02 | 0.002 |

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

**Table 9. Pest and beneficial insects in soybean plots, Neely-Kinyon LTAR, 8/22/12 (number per 20 sweeps).**

| Rotation | Aphids | Bean leaf beetles | Thrips | Corn Rootworms | Minute pirate bugs | Spiders |
|---|---|---|---|---|---|---|
| Conv. C-S | 0.00 | 0.00 | 19.25 | 0.75 | 3.25 | 1.00 |
| Org. C-S-O/A | 0.00 | 0.00 | 19.25 | 1.00 | 4.75 | 1.50 |
| Org. C-S-O/A-A | 0.00 | 0.00 | 18.5 | 1.25 | 4.75 | 0.00 |
| $LSD_{0.05}$ | NS[z] | NS | NS | NS | NS | NS |

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