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Evaluation of Tillage and Crop-Rotation Effects in Certified Organic Production--McNay Trial, 2002

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Abstract
Organic farming has increased to an $8 billion industry in the U.S. and continues to expand approximately 20% annually. In Iowa alone, organic acreage has increased from 13,000 acres in 1995 to 150,000 acres in 2000. Across the North Central region, there has been a great interest in planting organic soybeans on Conservation Reserve Program (CRP) land, where up to a 300% premium can be obtained compared with conventionally raised soybeans. Regulation of soil organic matter through additions of plant residues and proper crop rotations will determine the long-term sustainability of the system. The objectives of this research and educational program included the following: (1) establish plots dedicated to organic farming research on CRP land, (2) implement production and management regimes for opening CRP land and for weed control in organic systems on CRP land, (3) evaluate the biological and economic outcomes of the different systems, and (4) promulgate technology transfer through demonstrations/field days and publications for area farmers and agricultural professionals.

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Horticulture, Agronomy

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Introduction

Organic farming has increased to an $8 billion industry in the U.S. and continues to expand approximately 20% annually. In Iowa alone, organic acreage has increased from 13,000 acres in 1995 to 150,000 acres in 2000. Across the North Central region, there has been a great interest in planting organic soybeans on Conservation Reserve Program (CRP) land, where up to a 300% premium can be obtained compared with conventionally raised soybeans. Regulation of soil organic matter through additions of plant residues and proper crop rotations will determine the long-term sustainability of the system. The objectives of this research and educational program included the following: (1) establish plots dedicated to organic farming research on CRP land, (2) implement production and management regimes for opening CRP land and for weed control in organic systems on CRP land, (3) evaluate the biological and economic outcomes of the different systems, and (4) promulgate technology transfer through demonstrations/field days and publications for area farmers and agricultural professionals.

Materials and Methods

This project involved the establishment of a long-term agroecological research (LTAR) site in southeast Iowa. The McNay Memorial Research Farm dedicated approximately two acres of a five-year-old forage field (bromegrass and alfalfa) for this long-term project in 1999. Bromegrass predominated in the field, as is typical of CRP land in this area of the state.

Experimental Design. Forty-eight plots (four tillage treatments, three crops, and four replications) measuring 30 × 60 ft each, were laid out in a randomized complete block design in September 1999. The initial plowing of the CRP land, in the fall of 1999 and spring 2000, consisted of the following treatments: Treatment 1 = fall moldboard plowing, 2 = spring moldboard plowing, 3 = Kverneland® plowing (fall), and 4 = Howard Rotavator® (fall and spring). In 2000, a rotation of corn-soybean-oats underseeded with red clover was initiated to meet certified organic requirements. Each crop of the rotation was planted each year beginning in 2000.

Tillage and Mechanical Operations. Plots that were fall plowed in 1999 (fall moldboard and Kverneland®-plowed) were retained as fall plowed plots in 2000, 2001, and 2002. Fall tillage for the 2002 season was accomplished by November 30, 2001. Winter rye was broadcast on corn plots with a three-point mounted spreader on November 9, 2001, at a rate of one bushel/acre to serve as a ground cover to prevent erosion and to mitigate weed populations in 2002 soybean plots. Spring plowing was completed on March 18, 2002, and the rye in soybean plots was disked on April 3. Manure was applied to all plots going to corn at a rate of 5,000 lb/acre on April 16, 2002. 'Blaze' oats and 'Star Fire' red clover were planted on April 13, 2002, at a rate of 2 bushels/acre and 12 lb/acre, respectively. Soybeans (Pioneer 9305) were planted at a population of 175,000 plants/acre on May 24. The corn variety Pioneer 34M94 was initially planted on May 10, at a rate of 31,000 plants/acre, but was replanted on June 7 due to a poor stand. Corn was rotary-hoed on

June 18 and cultivated on June 25. Soybeans were rotary-hoed on June 7 then cultivated on June 18 and 25. Soybean plots were "walked" (large weeds removed by hand) on August 14, per local organic practices to remove any potentially staining weeds prior to harvest. Oats were harvested on July 18, 2002. Corn was harvested on October 16 and soybeans were harvested on October 11, 2002.

Sampling. Post-harvest soil samples (five random samples/plot) were taken on November 16, 2002, at depths of 0–4" and 4–8." Sampling for soil, plant performance, weeds, insects, and nematodes was also conducted. Corn and soybean crop stand counts were taken on June 20 (14 and 27 DAP, respectively). Weed counts (3 square meter quadrants/plot) were taken on June 20 and July 18. Bean leaf beetles, which are associated with the soybean staining disease complex, were sampled in soybean plots on July 18, 2002, by sweeping 20 times/plot with a 15-inch diameter net. Corn borer populations were sampled by removing 3 randomly selected corn whorls/plot, and recording the number of corn borer feeding holes and actual larvae on July 18. Soybean cyst nematodes were analyzed by sampling 5- to 6-inch soil cores per soybean plot for the presence of eggs on September 24. Corn stalks were collected on September 24 for stalk nitrate analysis. Corn and soybeans were analyzed for protein, carbohydrates, fiber, and oil through the Iowa State University Grain Quality Laboratory in the Department of Food Science. A 250-gram sample of harvested soybeans was analyzed from each plot for percentage of stained soybeans (soybeans with a tan, brown, or mottled appearance).

Results and Discussion

Both corn and soybean plots yielded very well in 2002, although oat yields were impacted by lodging, due to winds and rain. There were no significant differences among the tillage treatments in corn plant populations (avg. 24,062 ± 303) or in soybean stand counts (avg. 111,375 ± 3,149). Broadleaf and grass weed populations in corn and soybean plots were not significantly different on June 20 nor on July 18.

No significant yield differences were determined among treatments in oat, corn, or soybean plots. Corn yields averaged 186 ± 6 bushels/acre with a trend towards higher yields in plots that were fall-plowed. Soybean yields were not significantly different, ranging from 43.7–49.7 bushels/acre. Organic oats averaged 80 ± 5 bushels/acre.

No corn borers were detected on July 18. Bean leaf beetle populations were lower on July 18 than on September 10, and at harvest, seed staining averaged 13.4%. There were no significant differences among treatments in corn or soybean grain quality in 2002. Corn stalk nitrate results were not significantly different, but corn stalks from fall-plowed plots tended to retain more stalk nitrate than spring-plowed plots. Soybean cyst nematode egg populations remained below the economic threshold level. Overall, 2002 organic crop yields at the McNay LTAR site were among the highest organic crop yields in the state.

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