The Effect of Tillage on Organic Soybean Production Following CRP Land.

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Organic farming has increased to a $6 billion industry in the U.S. and continues to expand approximately 20% annually. In Iowa alone, organic acreage has increased from 13,000 in 1995 to 120,000 in 1998 (IDALS, 1998). 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 400% premium can be obtained compared to conventionally raised soybeans (Delate et al., 1999). Farmers are able to by-pass the three-year transition period between chemical and certified organic land if the CRP land has not been sprayed. CRP conversion to organic production and the issue of long- vs. short-term rotations continue to top the list of research needs for the Iowa organic farming community. Several options confront farmers interested in making the transition from CRP land to organic production, including fall plowing vs. spring plowing, and winter rye as a cover crop vs. no cover.

Both the CRP program and organic farming practices strive to preserve soil structure and quality on erodable lands, and protect waterways from silting and runoff. Compliance with soil conservation plans is mandatory in the development of ideal cropping systems (Phillips et al., 1997). Regulation of soil organic matter through additions of plant residues and proper crop rotations will determine the long-term sustainability of the system. Farmers interested in transitioning some or all of their CRP land into organic production require information on best management practices for these systems. Once the transition to sustainable systems is complete, comparable yields to conventional systems can be obtained if ideal management is followed (NRC, 1989).

CRP conversion will alter existing ecosystem processes, such as nutrient cycling and biological control. Tillage operations can impact soil structure and soil biological cycles (Hanna et al., 1994). The mineralization of soil organic matter in CRP land may lead to nutrient deficiencies in subsequent crops. Grassland herbivores may switch hosts and colonize agronomic species, impacting yields and subsequent cropping practices (Brenneman et al., 1985). Regarding effects of a rye cover crop on pest populations, varied impacts were reported, depending on insect species (Smith et al., 1988). While Hammond (1990) found increased damage from phytophagous insects with cover crops, Minton (1992) found that rye cover decreased feeding from pestiferous nematodes and increased yields in soybeans. Soybean yields were greatest following rye, barley, or wheat (LeMahieu and Brinkman, 1990). Liebel et al. (1992) employed a rye cover tilled two weeks prior to planting to provide a similar level (90%) of weed control as herbicides in soybean production; and Ateh and Doll (1996) reported that rye killed 45 days after soybean planting could provide adequate weed control without reducing soybean yields. Results were mixed, depending on weather, in dry bean production systems with rye (Liebman et al. 1995). Through this LCSA project, research has begun to evaluate methods to maintain soil organic matter, minimize nutrient loss in CRP-converted organic systems, and mitigate pests (insects, weeds, diseases, nematodes).

McNay Memorial Research Farm

In 1999, an experiment was initiated at the ISU McNay Research and Demonstration Farm in Chariton, Iowa, to evaluate the effect of four tillage methods for organic soybean production following CRP land.

Materials and Methods

The McNay Memorial Research Farm dedicated approximately two acres of a five-year old forage field (bromegrass and alfalfa) for this study. Bromegrass predominated in the field, as is typical of CRP land in this area of the state. The soils were sampled on this site in November 1997 in order to characterize the beginning soil conditions as shown in Table 1.

Table 1. Soil characteristics at the McNay Research and Demonstration Farm soybean following CRP site, 1997.

Soil Characteristics	Amount
Organic Matter	5.4%
pH	7.1
P	7.7 ppm
K	116 ppm

Experimental Design

Plots were laid out in a randomized complete block arrangement with four treatments and eight replications on September 30 and October 7, 1998. Thirty-two plots were established, measuring 30 x 60 ft. each. Treatments consisted of four tillage treatments: Treatment 1 = fall moldboard plow followed by spring disking and harrowing to finish the seedbed; Treatment 2 = fall plowing with a Kverneland® plow with a field cultivator for spring tillage; Treatment 3 = fall and spring tillage with a Howard Rotavator®; Treatment 4 = spring plowing with a moldboard plow and standard disking and harrowing for secondary tillage.

Tillage and Mechanical Operations

All fall tillage was accomplished on October 14, 1998. Winter rye was broadcast with a three-point mounted spreader on October 15, 1998, at a rate of one bushel per acre to serve as a ground cover to prevent erosion and mitigate weed populations in the spring. Manure was applied to all plots on May 4, 1999, at a rate of 4,000 lb/acre. The rye planting was disked on May 4 and 28, 1999. Plots were smoothed with a cultipak on May 28, 1999, prior to planting. Soybeans (IA 2034) were planted at a population of 175,000 plants/acre on May 28, 1999. Plots were rotary-hoed for weed control on June 6 and June 18. Row cultivation occurred on June 24, July 7 and 15., 1999. Soybeans were harvested with a combine on October 7, 1999.

Sampling

Soil samples (five random samples per plot) were taken on October 7, 1998, using methods described by Cambardella (1994) for the Neely-Kinyon LTAR site. Sampling for soil, plant performance, weeds, insects and nematodes followed methods developed for the Neely-Kinyon LTAR site (Delate 1999). Crop stand counts were taken on June 21, 1999. Weed counts were taken on June 21 and August 26, 1999. Post-harvest soil sampling occurred on November 17, 1999.

RESULTS AND DISCUSSION

Results from the first year trial at the McNay Farm were very encouraging. All organic soybean systems yielded well, averaging 49.3 bushels/acre. Plant populations were reduced significantly by tillage operations, but there were no significant differences among tillage treatments in stand counts at (Figure 1). Early weed counts demonstrated a significant increase in grass weeds in the rotavated plots (Figure 3) but no significant differences were detected with broadleaf weeds (Figure 3). Despite differences early in the season, there were no significant differences in weed populations at the end of the season (Figures 4 and 5). Yields were greatest in the spring-plowed plots (51.7 ± 3.02 bushels/acre), although differences among treatments were not significant (Figure 6). Soybean grain quality was also high in all systems (Figure 7). Protein content averaged 42.2% with soybeans from spring-plowed plots averaging 42.4 ± 0.46%. Oil and fiber content averaged 15.7 ± 0.16% and 4.5 ± 0.03%, respectively.

First year results demonstrated excellent production of high quality organic soybeans on land following CRP. We were pleased to obtain excellent yields and grain quality in soybean plots that were spring plowed as opposed to fall plowed. Spring plowing will allow for a vegetative cover during the winter and avoidance of soil erosion associated with fall plowing. Despite the lack of differences in plant and weed populations among tillage systems, it is recommended that fields be spring plowed for a more sustainable farming system.

Figure 1. Soybean stand counts at McNay CRP trial, 1999.

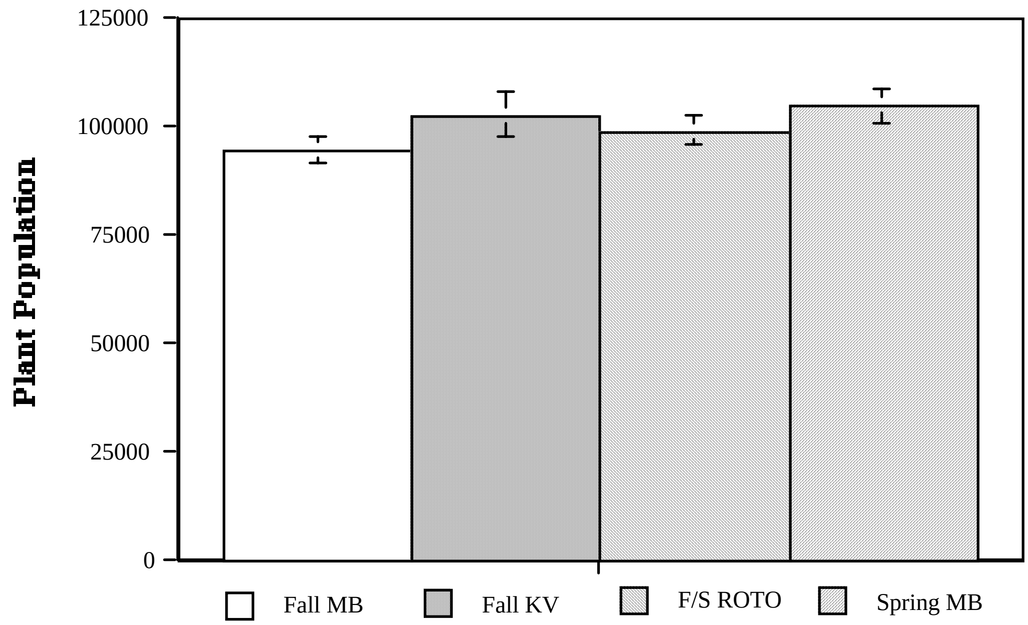


Figure 2. Early grass weed populations in soybean plots, McNay Farm, 1999.

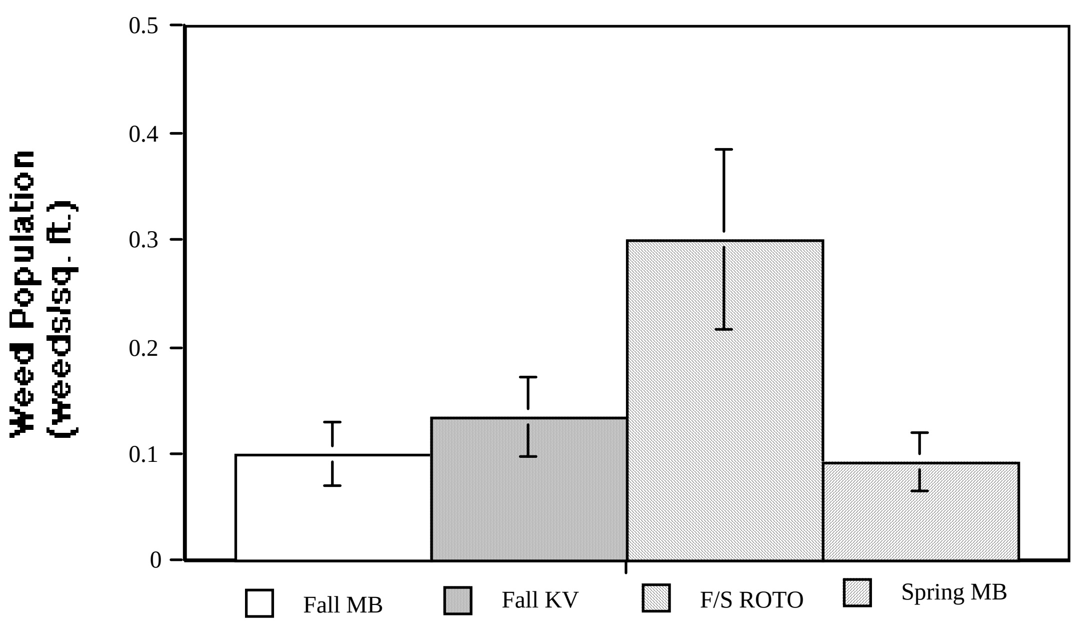


Figure 3. Early broadleaf weed poulations, McNay Farm, 1999.

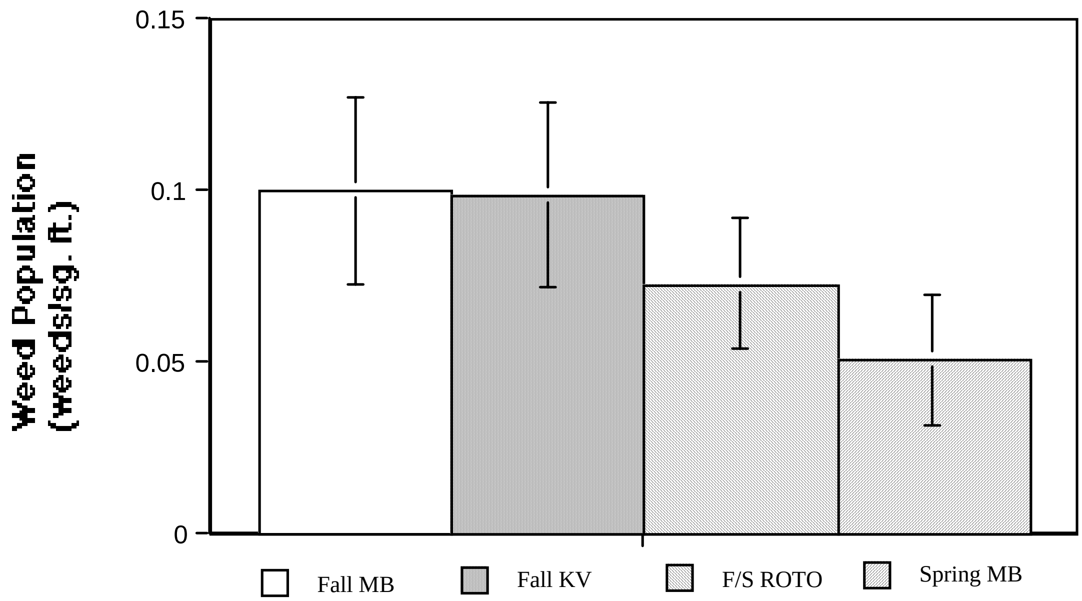


Figure 4. Late grass weed populations in soybean plots, McNay Farm, 1999.

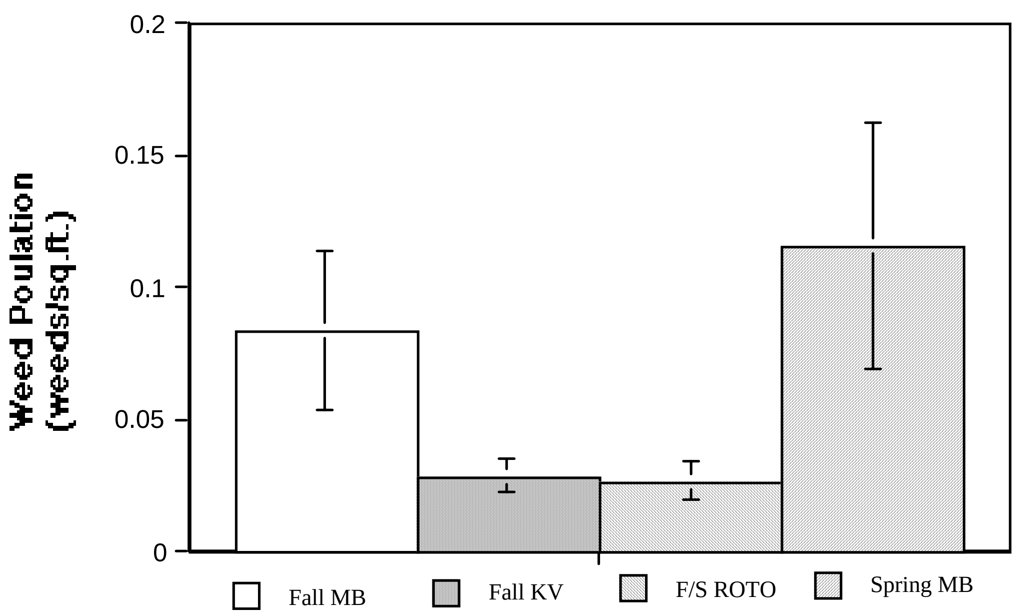


Figure 5. Late broadleaf weed populations in soybean plots, McNay Farm, 1999.

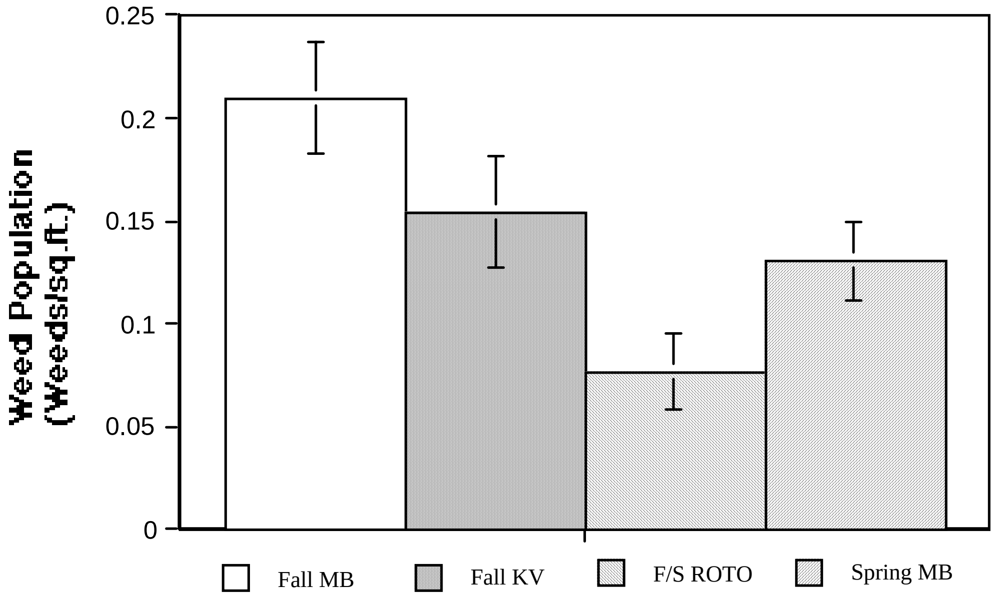


Figure 6. Soybean yields from McNay CRP trial, 1999.

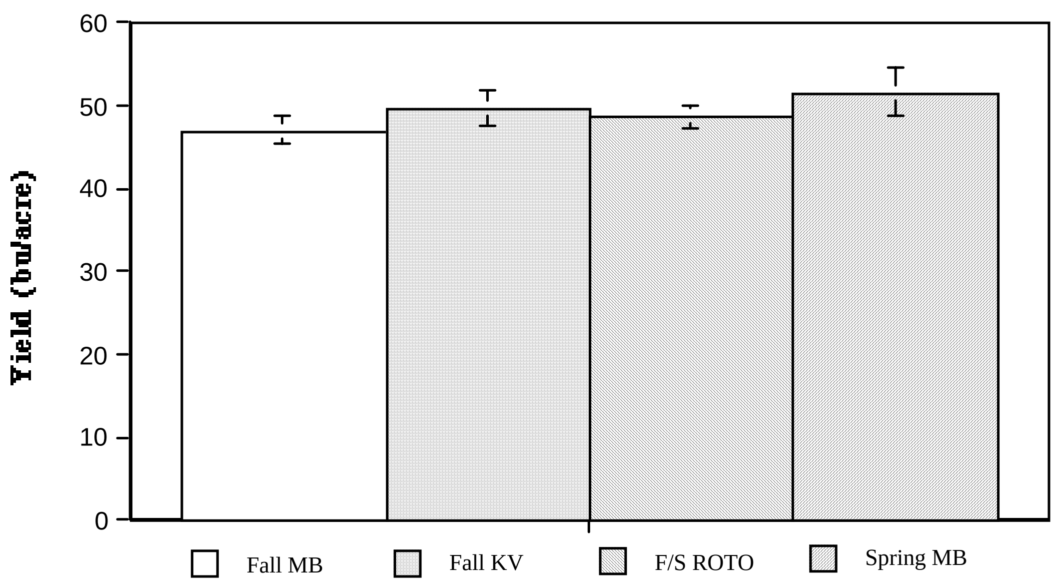
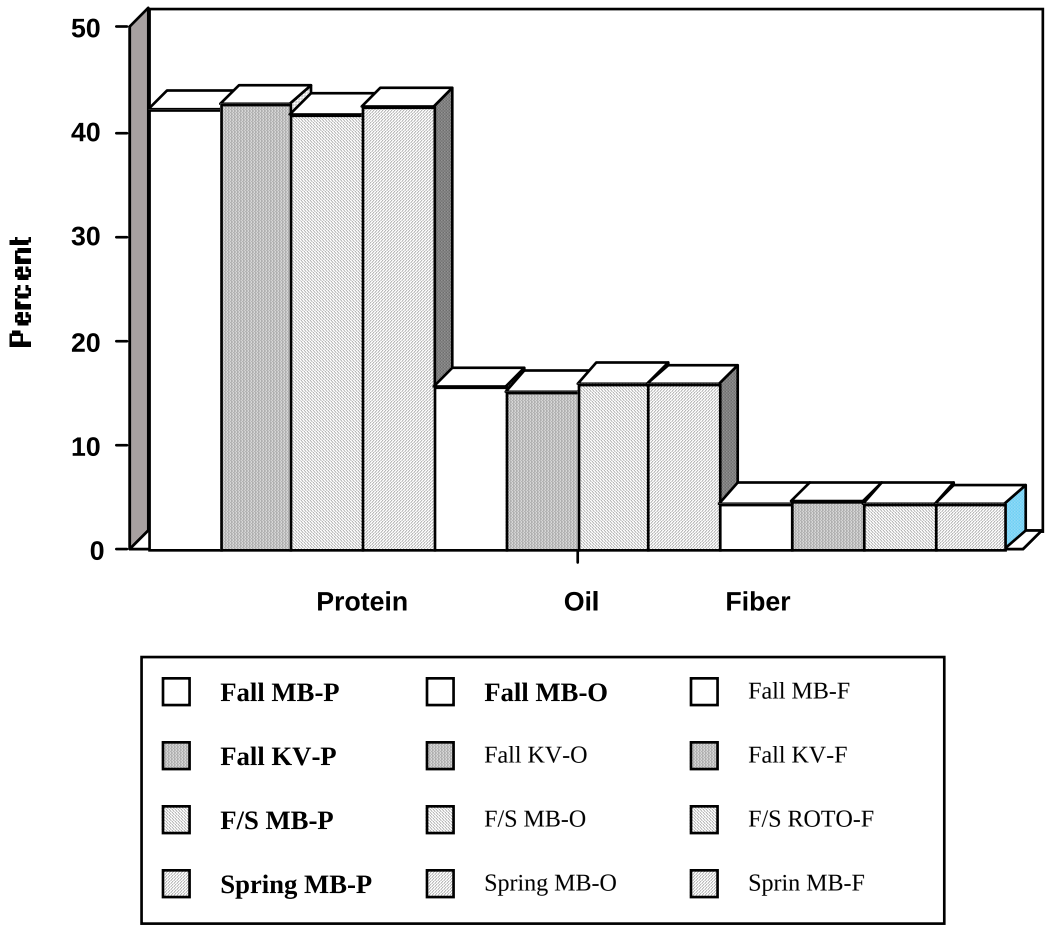


Figure 7. Soybean grain analysis, McNay Farm, 1999.



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