ALTERNATIVE MANAGEMENT FOR WINTER ANNUAL WEEDS AND IMPROVED SOIL QUALITY. Robert J. Kremer, Microbiologist, USDA-ARS, Cropping Systems & Water Quality Research Unit, Columbia, MO 65211.

The widespread adoption of glyphosate-resistant crops in no-tillage crop production systems has contributed to extensive infestations of winter annual weeds. Dense infestations of winter annual weeds may adversely affect subsequent crops in a crop rotation by lowering soil temperatures and soil water content in the spring; disrupting planting operations; serving as hosts for pests including detrimental insects and the soybean cyst nematode; and producing copious amounts of seeds that replenish the seedbank. Because glyphosate applied during the crop-growing season has no residual soil activity on winter annual weeds that establish after crop harvest, additional herbicide management strategies to control these weeds have been proposed. Establishment of cover crops into standing soybean or corn is an alternative to additional herbicide inputs, which increase production costs and impact environmental quality. In the Midwest USA, selected cover crops can be established prior to crop harvest for adequate vegetative production to suppress winter annual weed growth, provide surface residue cover, and enhance soil quality before a killing frost. The objectives of this research were to determine winter annual weed suppression and biomass production of selected cover crops overseeded into soybean or corn prior to harvest, and to determine the effects of these cover crops on selected soil quality indicators.

A soybean-corn rotation was established in spring 2001 on a Mexico silt loam (fine, smectitic, mesic, Aeric Vertic Epiaqualfs) on Sanborn Field, University of Missouri-Columbia. The existing cool-season grasses were killed with glyphosate and no-till soybean was planted; no-till corn was planted in 2002, and this crop rotation was continued throughout the study (2001-2005). A completely random design with three replicates of three treatments consisted of plots 3.1 m wide and 9.2 m long, which were planted with the rotational crop at 0.76 m row widths. Cover crop treatments were a control (weedy check), spring oat (VNS), and canola ('Victoria'). Cover crops were overseeded into soybean or corn in late-August to mid-September with a hand-crank seeder at 170 kg $ha^{-1}$ (oat) or 100 kg $ha^{-1}$ (canola). Cover crop and weed above-ground biomass was harvested in late November to early December (fall sampling) and in April to early May (spring sampling) by clipping all growth at the soil surface within a 0.1 $m^2$ quadrat. Biomass samples were separated into cover crop and weed components and dried at 105°C for 48 h for dry weight determination. Soil samples were collected from the upper 0-8 cm in late fall and early spring. Total organic carbon (TOC) and total nitrogen contents were determined by dry combustion using a C/N analyzer. Soil microbial activity was assessed using the fluorescein diacetate (FDA) hydrolysis and dehydrogenase enzyme assays (Kremer and Li. 2003. Soil Till. Res. 72:193-202). Soil aggregate stability was determined for aggregates ≥250-μm using a wet-sieving method (Kremer and Li 2003). All data were subjected to one-way analysis of variance and, where F-values were significant and $p<0.05$, means were compared by using Fisher's protected least significance differences (LSD) test.

Common chickweed, henbit, and purple deadnettle were the predominant winter annual weeds that produced 260-450 g biomass $m^2$. Spring oat had the greatest cover crop biomass accumulation and suppressed weed growth by 77-94% and 75-100% in the fall and spring, respectively. Canola accumulated an average of 400 g biomass $m^2$ but suppressed <80% of winter annual weed growth regardless of sampling period. Spring oat was winter-killed by freezing temperatures and provided a dense mulch on the soil surface. Canola growth was suspended by winter conditions but re-grew in spring that required mowing to mulch the soil surface. Canola also often sprouted new shoots after mowing, which interfered with corn and soybean growth. For these reasons, canola was not evaluated as a cover crop after the 2003 season. Soils under 4 yr of no-tillage with spring oat as a cover crop had ~ 10% greater TOC compared to weedy check soils. The resulting increased soil organic matter levels likely contributed to improved soil structure and microbial activity, and increased carbon sequestration. The spring oat cover crop had ~ 3 times greater water-stable aggregation compared to the weedy check soils. The highest microbial activity (FDA hydrolysis and dehydrogenase) was also associated with the spring oat cover crop. Thus, the improved soil structure that developed under spring oat cover cropping provided optimum soil aeration and water availability for increased microbial activity. Corn yields under spring oat cover cropping were not different from or were higher than yields in the check plots in which winter annual weeds were controlled with glyphosate.

In summary, adoption of an overseeded, spring oat cover crop in a no-tillage system can significantly decrease winter annual weed infestations in a corn-soybean crop rotation. The advantages of spring oat seeded in late summer include the accumulation of sufficient cover crop biomass to suppress winter annual weed establishment in fall, and the vulnerability of spring oat to winter-kill that provides a mulch that maintains weed growth suppression into the spring, which eliminates the need for herbicide treatment. Further, the spring oat cover cropping system can improve soil biological activity, soil structure, and promote carbon sequestration. The results presented here support previous conclusions (Reicosky and Forcella. 1998. J. Soil Water Convervat. 53:224-229) regarding the critical role of cover crops in maintaining environmental quality at both the field and ecosystem levels.