Legume Green Fallow Effect on Soil Water Content at Wheat Planting and Wheat Yield

David C. Nielsen* and Merle F. Vigil

ABSTRACT

Growing a legume cover crop in place of fallow in a winter wheat (Triticum aestivum L.)-fallow system can provide protection against erosion while adding N to the soil. However, water use by legumes may reduce subsequent wheat yield. This study was conducted to quantify the effect of varying legume termination dates on available soil water content at wheat planting and subsequent wheat yield in the central Great Plains. Four legumes (Astragalus lentiliformis L., subsp. cuneatus var. arenarius (L.) Fenzl; spring field pea, P. sativum L.; black lentil, Lens culinaris Medikus; hairy vetch, Vicia villosa Roth.) were grown at Akron, CO, as spring crops from 1994 to 1999. Legumes were planted in early April and terminated at 2-wk intervals (four termination dates), generally starting in early June. Wheat was planted in September in the terminated legume plots, and yields were compared with wheat yields from conventional till wheat-fallow. Generally there were no significant differences in available soil water at wheat planting due to legume type. Soil water at wheat planting was reduced by 55 mm when legumes were terminated early and by 134 mm when legumes were terminated late, compared with soil water in fallowed plots that were conventionally tilled. Average wheat yield was linearly correlated with average available soil water at wheat planting, with the relationship varying from year to year depending on evaporative demand and precipitation in April, May, and June. The cost in water use by legumes and subsequent decrease in wheat yield may be too great to justify use of legumes as fallow cover crops in wheat-fallow systems in semiarid environments.

THE LIMITS and highly variable precipitation of the semiarid central Great Plains resulted in the traditional winter wheat-fallow crop production system used to stabilize yields (Hase et al., 1974; Himle and Smika, 1983). That system, especially with the use of tillage to control weeds during the fallow period, leaves the soil surface vulnerable to soil loss and degradation by wind erosion and has low precipitation storage efficiency (Tanaka and Aase, 1987; Black and Bauer, 1988; Steiner, 1988; Farahani et al., 1998). The introduction of no-till, chemical fallow has reduced the potential for wind erosion and organic matter loss (Bowman et al., 1999), and increased stored soil water available for crop production (Peterson et al., 1996; Nielsen et al., 2002), but has introduced the potential for development of herbicide-resistant weeds when the same herbicide is continuously used in the system (Westra, 2004).

A possible solution is the use of legume cover crops during the fallow period, which could protect the soil from erosion while providing organic matter and fixing N to maintain soil quality (Biederbeck et al., 1988). Such a system has been referred to as green fallow (Gardner et al., 1993). These systems have sometimes been successful in the cooler regions of the northern Great Plains (Zentner et al., 2001). Zentner et al. (2004) reported that early legume planting and termination dates as well as effective snow catch before spring wheat planting were essential for success with a legume green fallow system in southwestern Saskatchewan. In Montana, lentil grown to fall bloom did not reduce subsequent spring profile water compared with tilled or chemical fallow. However, wheat yields in the lentil-spring wheat system were lower than in the wheat-fallow system during the first three cycles of the system due to low available N following lentil (Cochran and Kolberg, 2002). In other studies wheat yields following the green fallow period have been decreased due to lower soil water content at wheat planting (Zentner et al., 1996; Schlegel and Havlin, 1997) or due to N deficiency (Pikul et al., 1997). Under the higher temperature, higher evaporative demand environmental conditions of the central Great Plains, the positive economic trade-off between water used by the legumes and their favorable rotation and N fixing effects have not been observed (Vigil and Nielsen, 1998). The objectives of this study were (i) to determine the effect of legume termination date (using four legume species) on available soil water content at winter wheat planting and subsequent wheat yield in a central Great Plains environment, and (ii) to verify the conclusions of Vigil and Nielsen (1998) using a longer study period (6 vs. 2 yr).

MATERIALS AND METHODS

This study was conducted at the USDA Central Great Plains Research Station, 6.4 km east of Akron, CO (40°9' N lat, 103° 09' W long, 1384 m). The soil type was a Weld silt loam (fine, smectitic, mesic Aridic Argiustolls). The experiment was established in 1994 on a site that had been in a dryland winter wheat-fallow (Triticum aestivum L.)-summer fallow rotation the previous 3 yr. Before planting the first legume crop, the corn stalks from the 1993 crop were mowed with a flail mower, raked, and removed as bales.

The experiment was arranged in a randomized split block design with each block replicated four times. Two adjacent areas were alternated each year between legume green fallow/conventional fallow plots and the following winter wheat plots (i.e., both the fallow phase and the wheat phase of the experiment appeared each year). A replication consisted of four main plots, 9.1 m wide and 19.5 m long. The four main-plot treatments consisted of three legume species and a traditional summer fallow treatment. Four legume species were investigated in this study, but only three were tested in any given year (Table 1). In preliminary work (Vigil and Nielsen, 1998), lentil was found to produce less biomass than the same amount of water use as the other legumes, and was therefore replaced.
wheat yield from temperature and rainfall. In 2004 Agromony abstracts [CD-ROM], ASA, Madison, WI.


wheat yield from temperature and rainfall. In 2004 Agromony abstracts [CD-ROM], ASA, Madison, WI.


wheat yield from temperature and rainfall. In 2004 Agromony abstracts [CD-ROM], ASA, Madison, WI.


