The role of legumes in conservation tillage systems

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with management. Thus, a better understanding of the effects of soil color on seedling establishment is needed to capitalize on potential benefits for conservation tillage, crop production, and resource management.

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White lupines as a rotation alternative with winter wheat in conservation tillage systems

Bohn D. Dunbar and David C. Nielsen

Lupines are an extremely diverse group of species, several of which have been adapted for agronomic use. Farmers have grown *Lupinus alba* in the Great Lakes region of the United States with some success. *Lupinus angustifolia* is grown extensively in Australia, with more than 1 million acres planted in some years. Lupine seed is high in protein with a content equivalent to soybeans at 30% to 40%. White lupine can be ground and fed directly to livestock without treatment because the lines of lupines available have been bred to keep toxic alkaloids out of the seeds.

A legume crop that could be added to the minimum tillage rotation with wheat and corn would be extremely desirable. Soybeans are marginal in this rotation except under irrigation. Lupines may be adapted to fit this role.

Scientists at the Central Great Plains Research Station have studied lupines since 1984. The results reported herein are some of the general findings of this 3-year study.

In April 1984 we planted 200 pounds of *Lupinus alba* (Ultra) on 1 acre under a solid-set-gradient irrigation system with a disk drill to observe its potential as a crop for the area. Treflan and Lorox were used singly and in combination on the area. The spring was wet and cold with normal precipitation during the rest of the season.

Yield on the nonirrigatied area was about 30 bushels/acre, with an increase up to 50 bushels/acre with full irrigation. Treflan stunted lupine root growth and noticeably reduced yield in the nonirrigated areas. Lorox did not appear to effect yield, but several species of weeds were not controlled.

With encouraging results in this preliminary trial, during the next winter we conducted herbicide screening trials in the greenhouse to determine the type and amount of herbicide that could be used on lupines. All of the triazines, in quantities that would control weeds, damaged or totally killed the lupine. We observed the same root stunting effect with Treflan. Lorox and Lasso did not appear to effect the lupines up to a 4-pound-per-acre rate. An experiment was designed with three varieties of lupines (Kiev, Ultra, and Multilupa), three planting dates determined by the first day that the ground temperature was 40°F and 7 and 14 days thereafter, and Lorox and Lasso alone or in combination at 1 quart/acre and 0.5 quart/acre, respectively. The spring of 1985 was extremely wet and the lupines germinated well, but the herbicide rates were not enough to control weeds. The entire experiment was abandoned after attempts to use postemergent herbicides failed. To date, nothing we have tried will kill weeds and not the lupines.

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In 1986 we conducted a similar but scaled-down experiment on two sites. The varieties 471, Kiev mutant, and 410 were added and Muliplupa was deleted. We planted three small plots to *Lupinus angustifolia* because only a few ounces of seed were available for the varieties available, Yandee and Illyarri. This was a dry spring and the lupines emerged poorly, resulting in a poor stand. The site with the best stand was completely hailed out in June. The yield on the one remaining site was reduced by a late-season infestation of sandbur. The early herbicide treatment, even with 2 pounds Lorox and 2 pounds of Lasso, did not control this grassy weed. The highest yield was 14 bushels/acre. The angustifolia did not set seeds and is apparently not adapted to grow in the 7.5 to 8 pH range soil in this area. It also is a winter annual and the vernal requirement may not have been met even with the early planting. This is not likely because this plant was grown in the greenhouse in 6 pH soil with no cold period and pod set was achieved.

David Nielsen has carried out other experiments in the same years at the Akron Station. He planted lupines in the spring of 1985 (Ultra) and 1986 (Gutwein 471). Plant populations were 219,700 plants/ha in 1985 and 387,350 plants/ha in 1986. Row spacing was 17.8 cm in 1985 and 38.1 cm in 1986. The plot area was not fertilized. The seed was inoculated before planting. Evapotranspiration was calculated by the water balance method from weekly measurements of soil water made with a neutron probe. Irrigations were applied via a line-source, gradient irrigation system. Irrigations in 1985 ranged from 0.7 to 9.6 cm. Irrigations in 1986 ranged from 0.0 to 12.6 cm. Precipitation was 23.4 cm in 1985 and 15.3 cm in 1986.

The lupines in both years responded well to supplemental, limited irrigation (Figure 1). The significantly lower slope of the yield-evapotranspiration relationship in 1985 probably was due to the lower plant population attributable to poor germination and emergence. The lower amount of vegetative cover resulting from the lower plant population probably caused lower interception of solar radiation, lower photosynthesis/unit ground area, higher solar radiation levels at the soil surface, and higher evaporative losses from the wet soil surface after an irrigation or precipitation event. This resulted in decreased water use efficiency (lower slope of the regression line) in 1985 than in 1986. Another explanation for the differences in slope may be due to variety differences in water use efficiency.

Although the lupines responded well to irrigation, yield levels were not high. Water application throughout the growing season may have been insufficient; pod-bearing branches were virtually nonexistant. The strong response of yield to irrigation indicates that these varieties of lupine are neither drought tolerant nor drought avoiding and, hence, may not be suitable as dryland crops for this region.

Analysis of water extraction patterns showed that root activity was limited primarily to the upper 90 cm of the soil profile. Wilting point appeared to be fairly high at about 12%. Hence, lupines may not be a good crop to follow another irrigated crop in a rotation to take advantage of stored soil water at lower soil depths that may result from excessive irrigations. This water would be unavailable to the lupine crop due to shallow rooting and high wilt point.

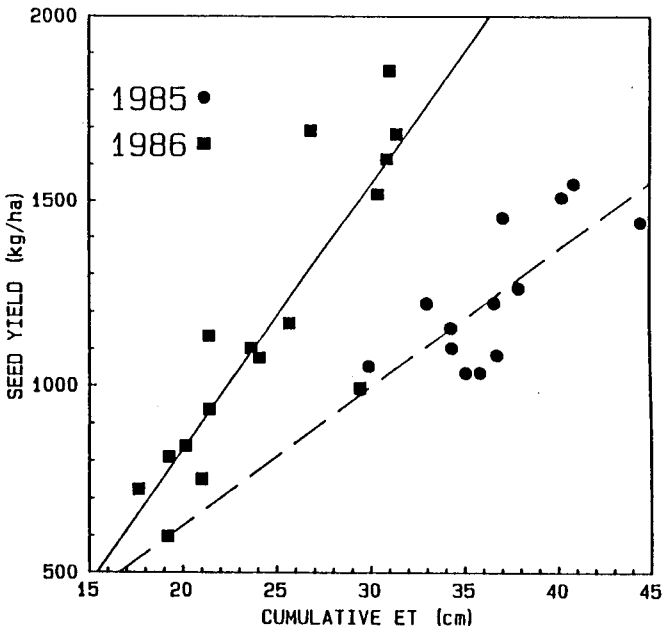

Figure 1. Lupine seed yield-cumulative evapotranspiration relationship.

Visual examination of roots for nodulation showed prolific, healthy nodules in both years.

The varieties of lupines grown in these studies were not well adapted to this, area and available herbicides are not adequate or economically feasible. Before abandoning this research, several other species of lupines will be evaluated and new herbicides screened.