ABSTRACT BOOK

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## Looking toward the 21st Century

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# RESPONSE OF LUPIN TO SOIL pH AND RESIDUAL PHOSPHORUS

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**Abstract**

Field tests were conducted during 1991-1993 in the Coastal Plain of south Alabama (USA) to evaluate the response of white lupin (*Lupinus albus* L.) to soil pH and residual P when grown in rotation with tropical corn (*Zea mays* L; 1991.) or pearl millet (*Pennisetum glaucum* (L.) R. Br; 1992, 1993). Soils in this region are naturally acidic, highly weathered and frequently experience periods of short-term drought stress in summer months. All three crops should be well suited for these soil conditions. The test was conducted on a Benndale sandy loam (Typic Paleudults) and a Lucedale fine sandy loam (Rhodic Paleudults). The experimental sites had been part of a previous long-term study to evaluate crop response to soil pH and annual P rates. No P had been applied since 1980 and each site had a wide range in soil pH and soil test P. Heavy late season disease pressure severely limited grain yields in 1991. Lupin silage yields in 1991 averaged 14.3 Mg $ha^{-1}$ on the Benndale soil and 19.9 Mg $ha^{1}$ on the Lucedale soil. Highest silage yields were obtained at low pH ($\simeq$ 5.0) and tended to decrease as soil test P increased. These first year results were in contrast to grain and silage yields determined in 1992 and 1993. Lupin grain yields ranged from 437 to 1852 kg $ha^{-1}$ in 1992 and from 986 to 2138 kg $ha^{-1}$ in 1993 on the Benndale soil. In 1992, Lupin grain yields ranged from 972 to 1653 kg $ha^{-1}$ on the Lucedale soil. Silage yields ranged from 7.2 to 24.6 Mg $ha^{-1}$ in 1992 and from 13.4 to 31.2 Mg $ha^{-1}$ in 1993 on the Benndale soil. In 1992, lupin silage yields ranged from 14.2 to 20.7 Mg $ha^{-1}$ on the Lucedale soil. Disease pressure was less during 1992-93 and during these two years optimum soil pH for lupin grain and silage production was in the range of 5.5-6.5. Stand counts taken on the Benndale soil in February of 1992 and 1993 (early vegetative stage) showed that Lupin stand increased with increasing soil pH. Lupin responded to the level of soil test P up to a level that would be "high" according to the Auburn University Soil Testing Laboratory. Results of these tests suggest that a white lupin-grain pearl millet rotation would be a suitable cropping system . In contrast, a white lupin-tropical corn rotation would be less desirable (unless one of the two crops are harvested early for silage) due to overlapping of optimum planting and maturity dates of the two crops.

**Introduction**

White Lupin, tropical corn and pearl millet are examples of several crop species that are currently being evaluated as possible alternative crops in the Southeast. All three crops could easily fit into many crop rotations. Recent breeding efforts have resulted in the production of pearl millet hybrids that produce high yields of high quality grain. White lupin is a winter legume that produces high protein grain that could be utilized on-farm. Due to its

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late planting date, tropical corn could serve as an alternative summer crop in double-cropping systems.

Pearl millet and white lupin are reported to be tolerant of soil acidity and white lupin has been shown to grow very well on coarsely textured soils with low fertility. Both crops may be well suited for the Southeast since the soils in this region are naturally acidic, infertile and highly weathered. Tropical corn and pearl millet have been reported to be tolerant of drought stress. This aspect of both crops would be very desirable since the Southeastern U.S. frequently experiences periods of short term drought stress during the mid-late summer months.

In the Southeast there is little if any information available describing the response of white lupin, tropical corn or grain pearl millet to available soil P and soil acidity. This field test was conducted on sandy, coastal plain soils in Alabama to evaluate the response of white lupin to soil pH and residual soil P when grown in rotation with tropical corn and grain pearl millet.

## Materials and Methods

Field studies were conducted on experimental sites that were established in 1971 on a Benndale sandy loam (coarse-loamy, siliceous, thermic Typic Paleudult) and a Lucedale sandy loam (fine-loamy, siliceous, thermic Rhodic Paleudult). The original experiment included four soil pH levels and five annual rates of P (0 to 392 kg P $ha^{-1}$). Since 1980, K has been added according to soil test recommendations and agricultural limestone has been added to maintain a range in soil pH values. Each site currently has a range in soil pH and soil test P.

White Lupin ('Tifwhite 78' or 'Lunoble') was planted in the fall of 1990, 1991 and 1992. Silage yields were determined when the oldest pods were at physiological maturity (May) by harvesting 2, 3-m sections of row from each plot. Silage yields were corrected to 65% moisture. Grain yields of lupin were determined by mechanically harvesting the two center rows from each plot (June).

Tropical corn was planted during the summers (July) of 1990 (tropical hybrid Pioneer 304C) and 1991 (tropical hybrid Pioneer 3072). Severe insect damage prevented any harvestable yield in 1990. In November 1991, the two center rows of each plot were harvested for grain yield. Pearl millet (AgraTech Seeds Inc., hybrid 'HGM™100') was planted after the harvest of lupin for grain. At maturity in 1992 (September-October) the two center rows of each plot were picked mechanically. Due to bird damage, yields were estimated in 1993. Yields were estimated by covering 10 millet heads in each plot with paper bags at flowering and harvesting these protected heads by hand. Plot yields were estimated based on the average yield per head and the number of heads in a 3 m section of row in each plot.

## Results and Discussion

### *Lupins*

In 1991, heavy late season disease pressure resulted in no harvestable grain yields on the Benndale soil. On the Lucedale soil, grain yields ranged from 451 to 932 kg $ha^{-1}$. Disease pressure was less during 1992 and 1993. Lupin grain yields in 1992 ranged from 438 to 1852 kg $ha^{-1}$ on the Benndale soil (Fig. 1) and 972 to 1653 kg $ha^{-1}$ on the Lucedale soil (Fig. 2). In 1993, grain yields ranged from 986 to 2138 kg $ha^{-1}$ on the Benndale soil. On the Benndale soil a response to soil test P was observed at all but the lowest soil pH level. For the Benndale soil the highest yields were obtained at the highest pH level (6.4) with grain yields peaking at a soil test level of approximately 134 kg $ha^{-1}$. Lupin silage yields (65% moisture) (Fig. 3) showed a similar response to residual fertility throughout the three years of the test. Stand counts taken during the early vegetative stage in 1992 (Fig. 4) and 1993 showed that lupin stand decreased with increasing soil acidity.

Except for a general decrease in lupin grain yield with increasing soil test P (Fig. 2), there was not a consistent response of lupins to residual fertility treatments on the Lucedale soil during the three years of the test.

*Tropical Corn & Pearl Millet*

Due to too much overlap between harvest and optimum planting dates, we concluded that a tropical corn-lupin rotation would not be desirable if both crops are being grown for grain. For example, in 1991 tropical corn could not be planted until July and the corn grain could not be harvested until the middle of November which delayed the planting date of lupin. Even at this late date the tropical corn grain had a very high moisture content (20% Lucedale soil; 36% Benndale soil). The high moisture corn residue also presented a challenge to preparing a suitable seedbed for lupins. Relatively good yields of tropical corn were obtained on both the Benndale soil (1827 to 4552 kg $ha^{-1}$; Fig. 5) and Lucedale soil (3249 to 4552 kg $ha^{-1}$). In a tropical corn-lupin rotation, one of the crops should be harvested for silage in order to take advantage of optimum planting windows.

Millet grain yields in 1992 were low at both locations ranging from 792 to 2236 kg $ha^{-1}$. Low yields were attributed to pre-harvest bird damage. For the Benndale soil the best yields were obtained at pH 6.4, but there was no effect of pH on yields above pH 5. Except for the treatments at pH 4.7, millet yields increased with soil test P up to approximately 56-84 kg $ha^{-1}$.

For 1993, soil pH values were higher than 1992 due to fall applications of agricultural limestone. In 1993 yields on both soils were much higher as compared to 1992. Higher yields were attributed in part to a better protection of harvested heads from bird damage. Millet responded to soil test P at all three soil pH levels on the Benndale soil (Fig. 6). Yields were reduced somewhat when the pH was 5.2 as compared to 6.4. Lowest yields were obtained at pH 7.1.

On the Lucedale soil in 1992, yields increased with soil pH. At soil pH values of 5.5 and 5.1 grain yields tended to decrease with increasing soil test P. In 1993 millet grain yields ranged from 2200 to 3360 kg $ha^{-1}$. The response of millet to residual fertility treatments on the Lucedale soil in 1993 was inconsistent.

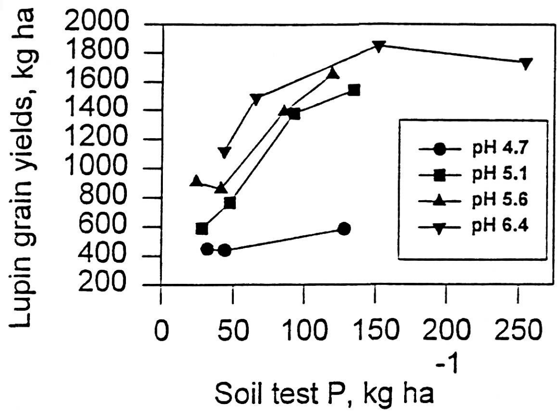


**Fig. 1. Lupin grain yields in 1992 on Benndale soil as affected by residual fertility.**

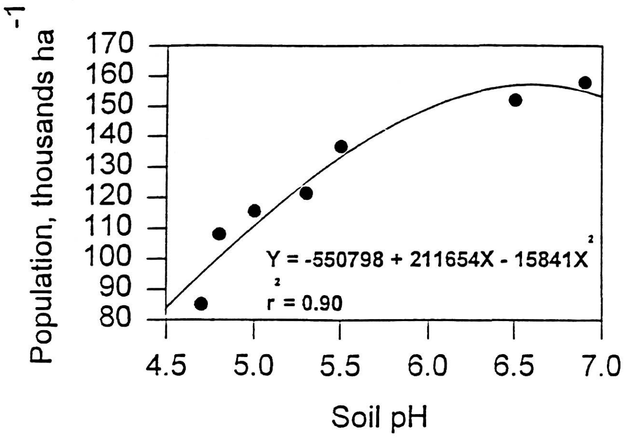


**Fig. 4. Lupin stand in 1992 on Benndale soil as affected by soil pH.**

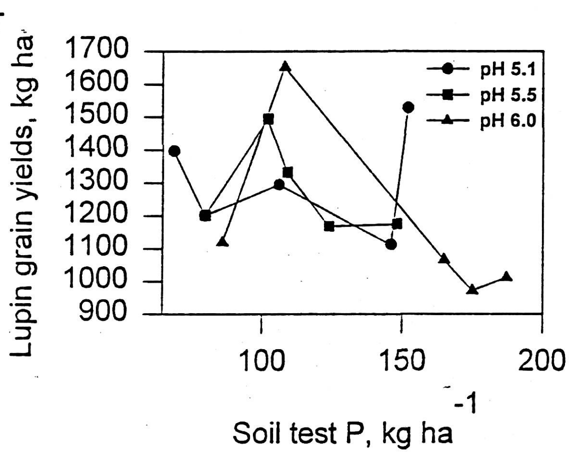


**Fig. 2. Lupin grain yields in 1992 on Lucedale soil as affected by residual fertility.**

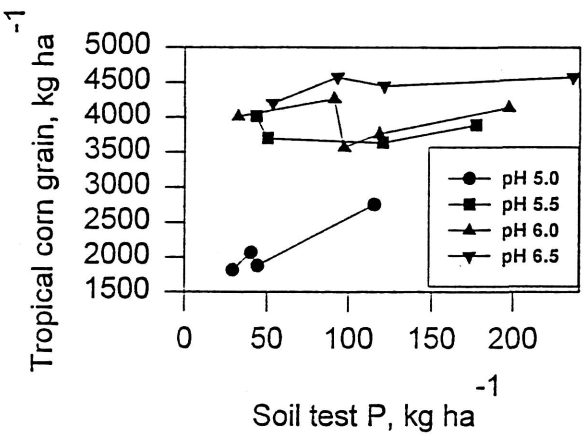


**Fig. 5. Tropical corn grain yields in 1991 on Benndale soil as affected by residual fertility.**

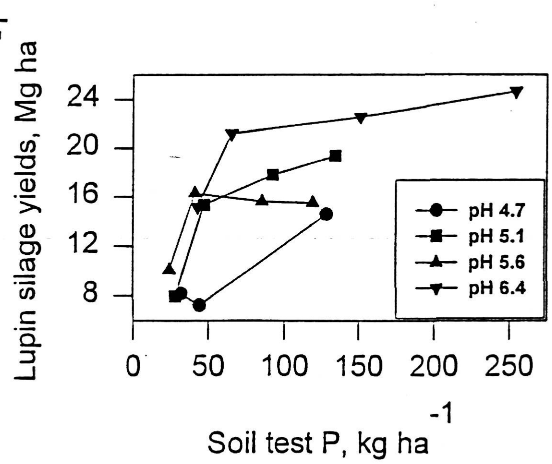


**Fig. 3. Lupin silage yields in 1992 on Benndale soil.**

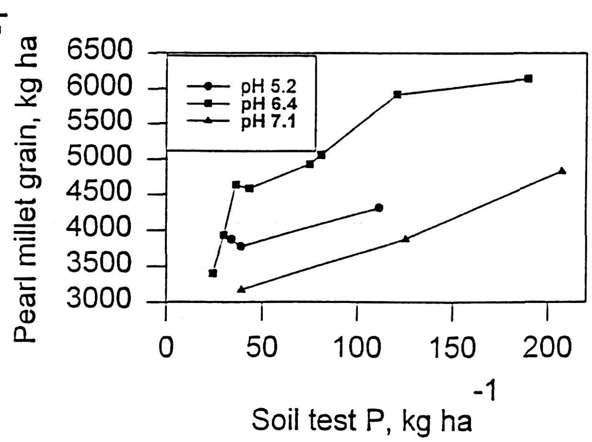


**Fig. 6. Pearl millet grain yields in 1993 on Benndale soil.**