Influence of Summer Grass and Legume Crops on Winter-Grown Wheat and Lupin

P. J. Wiatrak*, D. L. Wright, D. W. Reeves, J. A. Pudelko, and B. Kidd

ABSTRACT

This research was conducted during 1994 and 1995 on a Dothan sandy loam (fine, loamy siliceous, thermic Plinthic Kandiudults) located at the North Florida Research and Education Center (NFREC), Quincy, FL. The objective of this research was to evaluate the influence of summer grass and legume crops on winter-grown wheat and lupin. Winter wheat (*Triticum aestivum* L.) (var. Coker 9835) and white lupin (*Lupinus albus* L.) (var. "Lunoble") followed tropical corn (*Zea mays* L.), pearl millet [*Pennisetum glaucum* (L.) R. Br., HGM™ 100] and soybean [*Glycine max* (L.) Merr.]. Four nitrogen rates (0, 67, 134 and 202 kg ha^{-1}) were applied to tropical corn and pearl millet. Higher yields of wheat silage [35% dry matter (DM)] in 1994 were obtained after tropical corn (14.3 t ha^{-1}) and soybean (13.3 t ha^{-1}) than after pearl millet (12.9 t ha^{-1}) but, in 1995, wheat silage (35% DM) yields were higher after soybean and pearl millet (15.3 t ha^{-1} and 14.4 t ha^{-1}, respectively). The N content of wheat silage in 1994 increased with previous N fertilization on rotation crops. Highest wheat grain yield (2.3 t ha^{-1}) in 1994 occurred after both tropical corn and soybean. In 1995, grain yields of wheat were generally lower than in 1994 and without significant effects from previous crops. The grain yield of wheat after tropical corn in 1994 was a linear function of N rate applied to tropical corn (0 to 202 kg N ha^{-1}). The N content of wheat grain in 1994 following tropical corn was highest at 125 kg N ha^{-1}. Nitrogen fertilization of previous rotation crops did not affect wheat grain yields in 1995. The 4.4 t ha^{-1} silage yield of white lupin in 1994 after soybean was higher than after tropical corn or pearl millet. In 1995 the highest yield of lupin silage (5.2 t ha^{-1}) was obtained after soybean. In 1994, the highest grain yield (1134 kg ha^{-1}) of white lupin was obtained after tropical corn, but in 1995 the previous-crop influence was not significant.

INTRODUCTION

White lupin is a high protein grain legume grown during the winter in the southern USA. Human food products such as pasta and flour are made from lupin (Ayisi et al., 1992). Fuentes et al. (1988) reported that the environment influenced lupin pod number and seed weight, but not seed number per pod. Perry and Poole (1975) reported that drought stress reduced the number of pods per plant. Farmers have used legume cover crops for many years as a green manure source for cultivated cropping systems (Hoyt, 1989) to increase qualities of biologically-fixed N and to recycle other plant-essential nutrients (P, K, Ca, Mg) in the soil.

Growth of legume cover crops depends upon geographic locations and climatic conditions (Hoyt and Hargrove, 1986). Cropping sequence also plays a major role in biomass and nutrient accumulation.

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Different crops can have different effects on soil structure (Reid and Goss, 1981). For example, soybean (*Glycine max* L.) tends to leave the soil more susceptible to wind and water erosion than corn (*Zea mays*) (Bathke and Blake, 1984). They concluded that different effects of soybean and corn on soil could be related to the effect either of the growing plants or of their remains on soil structure. Reeves et al. (1984) reported that differences between soils after wheat and those after a lupin crop with regard to soil water-stable aggregates and bulk densities were small and inconsistent.

A soybean/wheat double crop system consistently produced excellent wheat yields during the early years of study, but the yields of continuous systems have declined in recent years, probably as a result of disease buildup in the crops (Boquet and Coco, 1994). A cropping sequence in which wheat is planted every other year (1989, 1991, 1993) has yielded an average of 1.2 t ha^{-1} (18 bu acre^{-1}) higher than continuously cropped wheat. The double-crop soybean/wheat rotation also increased soil organic matter levels 19% higher than continuously cropped soybean.

The objective of this experiment was to study the influence of tropical corn, pearl millet and soybean (with different N rates on the tropical corn and pearl millet) on grain and silage yields of white lupin and wheat, and on N content in grain and silage of winter-grown crops.

MATERIALS AND METHODS

These studies were conducted on a Dothan sandy loam (fine, loamy siliceous, thermic Plinthic Kandiudults) located on the NFREC, Quincy, FL from 1993 to 1995. The soil has a compacted layer located 20 to 36 cm below the surface. The experiment was conducted for two years following cropping of tropical corn, pearl millet and soybean. The experimental design was a split-plot (main plots followed previous crops and sub-plots followed N fertilizer rates for the previous crops) with four replications. Wheat (var. Coker 9835) and lupin (var. "Lunoble") were used in this study. Preplant cultivation included s-tine chisel plowing, plowing (with switch-plow) and s-tine harrowing. Prior to planting, the wheat was fertilized with 672 kg ha^{-1} of 5-10-15 (N P K) material, and lupin was fertilized with 146 kg ha^{-1} of 0-46-0 (N P K) material and 168 kg ha^{-1} of 0-0-60 (N P K) material. The fertilizer was incorporated into the soil with an s-tine harrow.

Wheat was seeded at 101 kg ha^{-1} with an H & N cone drill (13 cm row width) and lupin was seeded at 78 kg ha^{-1} on 22 Nov. 1993 and 1994 with a KMC planter (91 cm row width). A rolling-cultivator was used to cultivate the middle of the rows in the lupin plots for weed control on 24 Jan. 1994 and 31 Jan. 1995. The wheat sections were sprayed with 2,4 D @ 1.8 L ha^{-1} on 27 Jan. 1994 and 22 Feb. 1995. On 4 Feb. 1994 and 3 Feb. 1995, wheat was

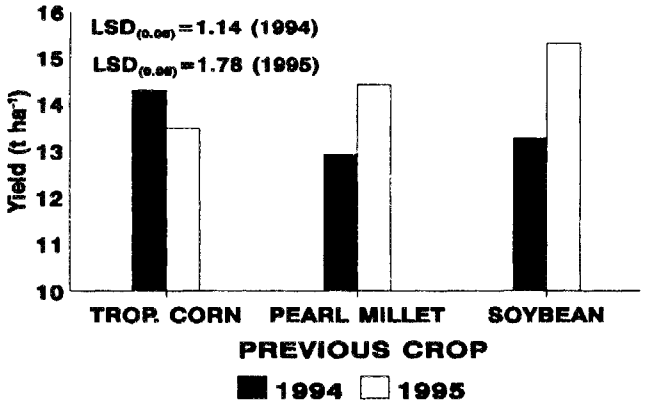

Fig. 1. Influence of previous crop on silage yield of wheat.

fertilized with 78 kg N ha^{-1} (34 0 0 N P K material) using a Gandy fertilizer spreader. Lupin and wheat were cut for silage on 6 May 1994 and 28 Apr. 1995. Wheat was harvested for grain on 23 May and lupin for grain on 10 June 1994 and on 19 May and 14 June 1995, respectively, using a Gleaner E combine.

Results of the experiment were analyzed statistically using SAS (SAS, 1989) by analysis of variance, and means were separated using Fisher's Least Significant Difference Test at the 5% probability level.

RESULTS AND DISCUSSION

The analyzed features were significantly different between 1994 and 1995; therefore, the data were not combined. The highest yield of 35% dry matter (DM) wheat silage (Fig. 1) in 1994 was obtained after tropical corn (14.3 t ha^{-1}), second highest after soybean (13.3 t ha^{-1}) and lowest after pearl millet (12.9 t ha^{-1}) but, in 1995, the trend was reversed with highest yield after soybean and second highest after pearl millet (15.3 and 14.4 t ha^{-1}, respectively). Percent N in wheat silage in 1994 was not significant with respect to a crop effect after tropical corn and pearl millet (Fig. 2); therefore, the data were combined. There was a positive linear response of % N in the wheat silage in 1994 to N rates on previous crops (0 to 202 kg N ha^{-1}). In 1995, the % N in

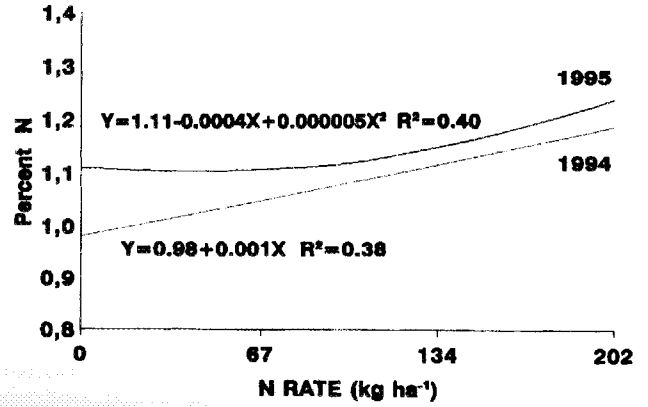

Fig. 2. Influence of N fertilization of tropical corn and pearl millet on N in wheat silage during 1994 and 1995.

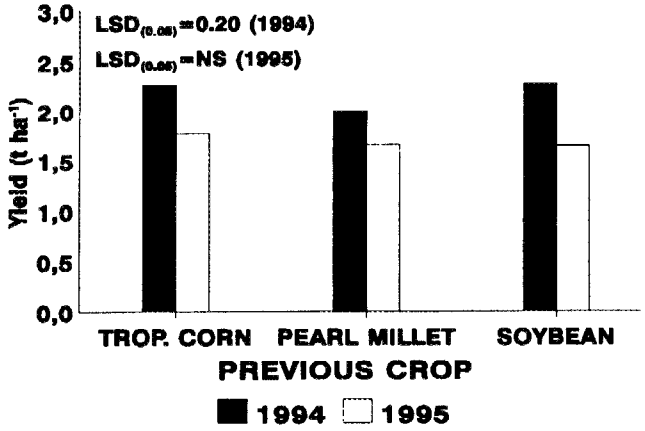

Fig. 3. Influence of previous crop on grain yield of wheat.

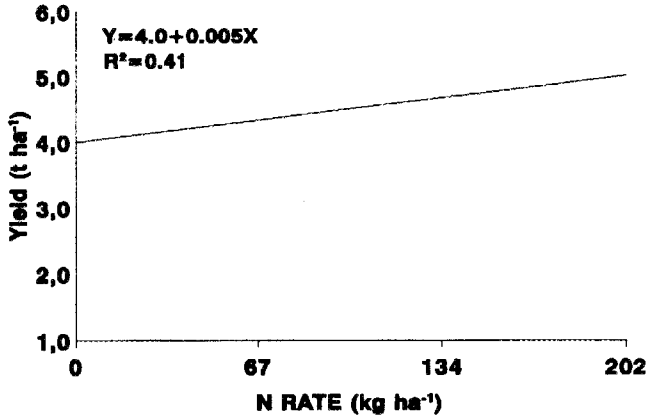

Fig. 4. Influence of N fertilization of tropical corn on grain yield of wheat during 1994.

wheat silage (Fig. 2) was not significantly different between tropical corn and pearl millet. The only increase in % N for wheat silage in 1995 was between the previous crop N rates of 134 kg ha^{-1} and 202 kg ha^{-1}.

The grain yield of wheat in 1994 (Fig. 3) was the same after tropical corn as after soybean (2.3 t ha^{-1}), but significantly higher than after pearl millet (2.0 t ha^{-1}). In 1995 (Fig. 3), the grain yields of wheat were lower than

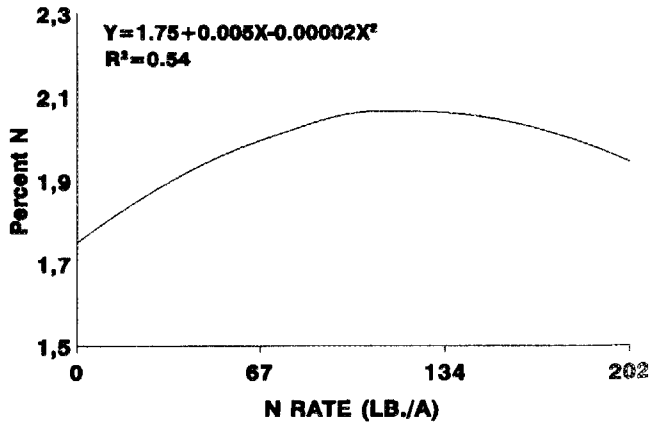

Fig. 5. Influence of N fertilization of tropical corn on N in wheat grain during 1994.

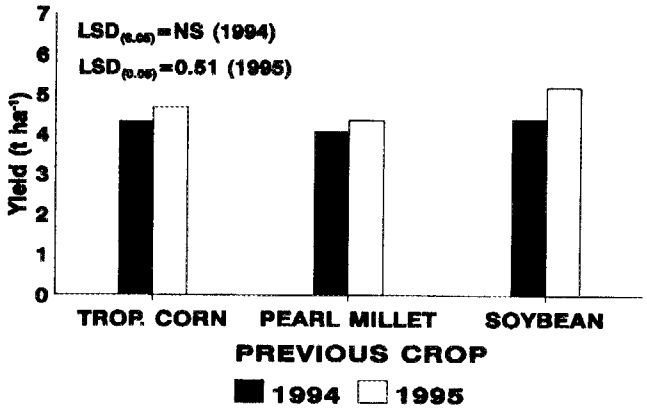

Fig. 6. Influence of previous crop on silage yield of white lupin.

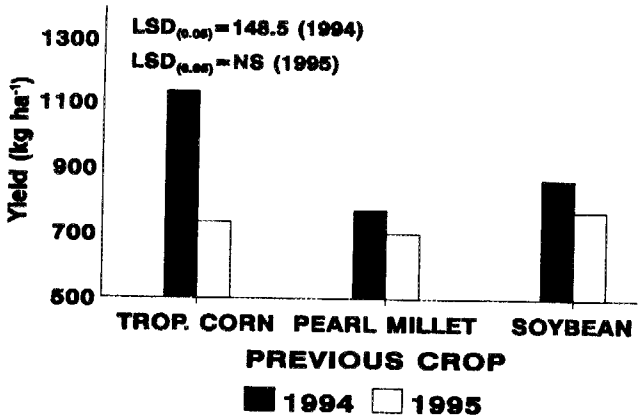

Fig. 7. Influence of previous crop on grain yield of white lupin.

in 1994 and without significant previous-crop effects on grain yield of wheat. The grain yield of wheat after tropical corn in 1994 (Fig. 4) was a positive linear function of N applied to the previous crop (over the range 0 to 202 kg N ha^{-1}).

The % N in wheat grain of wheat in 1994 after tropical corn (Fig. 5) was highest at 125 kg N ha^{-1} applied to the previous crop and lowest at 0 kg N ha^{-1}. There was not a significant difference for % N in wheat grain between different previous crops for 1995. The silage yield of white lupin in 1994 (Fig. 6) was not significantly different between previous crops. In 1995 (Fig. 6), the significantly highest yield of lupin silage was obtained after soybean (5.2 t ha^{-1}).

In 1994, the highest grain yield of white lupin (Fig. 7) was obtained after tropical corn (1134 kg ha^{-1}), but in 1995 the previous-crop effect was not significantly different. Higher rainfall in 1994 than in 1995 may have contributed to differences in wheat and lupin data between years.

In conclusion, increasing rates of N applied to previous crops generally increased silage and grain yield of wheat, and no previous summer crop stood out as superior prior to growth of wheat or lupin.

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