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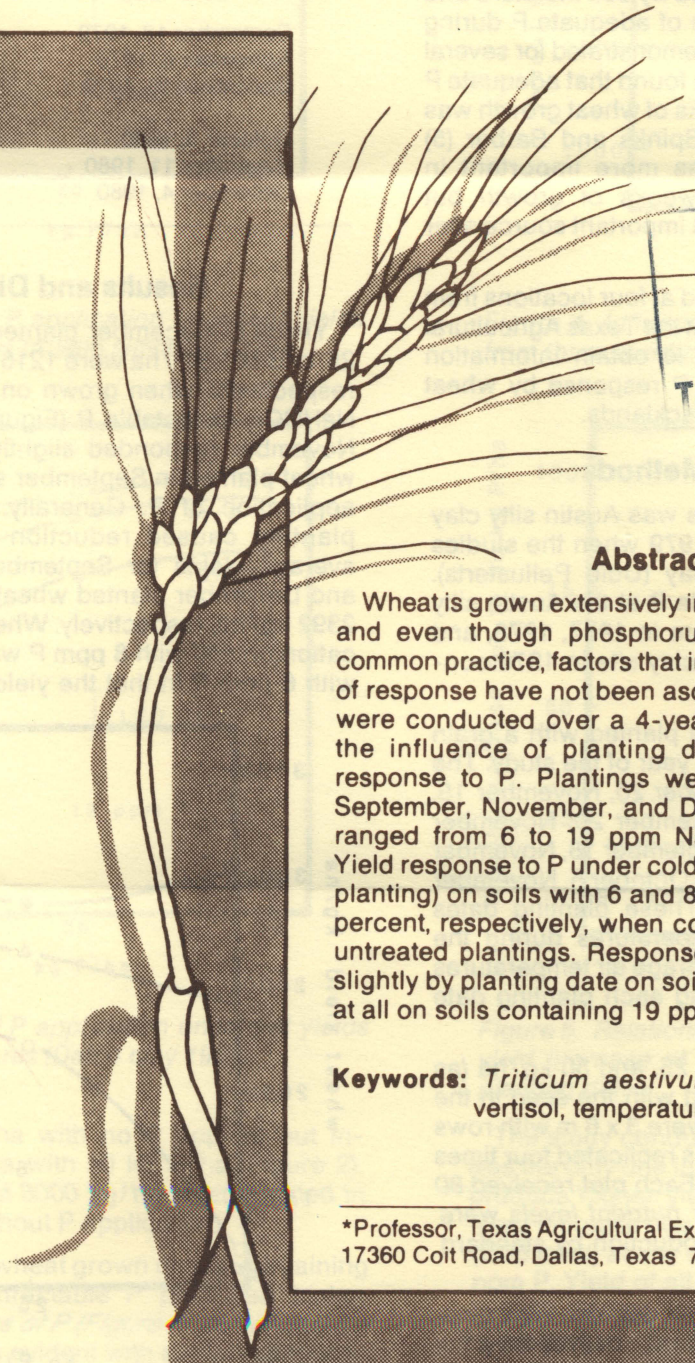
Influence of Planting Date on Response of Winter Wheat to Phosphorus

Billy W. Hipp*



Abstract

Wheat is grown extensively in the Texas Blacklands, and even though phosphorus (P) fertilization is a common practice, factors that influence the magnitude of response have not been ascertained. Field studies were conducted over a 4-year period to determine the influence of planting date on winter wheat response to P. Plantings were generally made in September, November, and December on soils that ranged from 6 to 19 ppm $NaHCO_3$ extractable P. Yield response to P under cold conditions (December planting) on soils with 6 and 8 ppm P was 86 and 60 percent, respectively, when compared to yields from untreated plantings. Response to P was influenced slightly by planting date on soils with 13 ppm and not at all on soils containing 19 ppm P.

Keywords: *Triticum aestivum* L., Blackland soil, vertisol, temperature, fertilizer.

*Professor, Texas Agricultural Experiment Station at Dallas, 17360 Coit Road, Dallas, Texas 75252

THE TEXAS AGRICULTURAL EXPERIMENT STATION/Neville P. Clarke, Director/The Texas A&M University System/College Station, Texas

Introduction

Wheat (*Triticum aestivum* L.) is the major crop grown in the northern portion of the Blackland Prairie of Texas. It is planted in the fall or early winter and harvested the following June. Applications of P fertilizer are generally made but response has been erratic. Research conducted in the area has shown that P fertilizer is required for optimum yields (3, 4), but all factors influencing the magnitude of P response have not been determined. In Montana (1), P response by spring wheat was influenced by soil moisture and planting date. The importance of adequate P during early growth stages has been demonstrated for several crops. Boatwright and Viets (2) found that adequate P supplied during the first 5 weeks of wheat growth was enough for maximum yield. Spinks and Barber (5) indicated that applied P was more important in nutrition during the first 4 weeks of growth but indigenous soil P was the most important source after 4 weeks.

Field studies were conducted at four locations from September 1977 to June 1981 at the Texas Agricultural Experiment Station at Dallas to obtain information regarding factors influencing P response by wheat grown on soils of the Texas Blacklands.

Materials and Methods

Soil at the experimental sites was Austin silty clay (Entic Haplustolls), except in 1979 when the studies were conducted on Dalco clay (Udic Pellusterts). Sodium bicarbonate extractable P at the Austin silty clay sites was 6, 8, and 19 ppm in 1977, 1978, and 1980, respectively. The Dalco clay site in 1979 contained 13 ppm P.

Wheat (cultivar 'Sturdy') was planted with a grain drill at three dates during each year of the study. The dates of planting were September 20, November 15, and December 15, 1977; September 20, November 15, and December 18, 1978; September 18, November 6, and December 10, 1979; and October 5, November 11, and December 4, 1980. These planting dates allowed a wide range of temperatures during the early stages of plant growth. Average air temperatures for the 5-week period following each planting date are given in Table 1.

Phosphorus treatments of 0, 25, and 50 kg/ha (as 0-46-0 or 0-20-0) were applied with the seed in the furrow at each planting. Plots were 3 x 6 m with rows 20 cm apart. Each treatment was replicated four times in a randomized block design. Each plot received 80 kg N/ha as NH_4NO_3. All other nutrient levels were deemed adequate for wheat production by standard testing procedures for the area.

Yield estimates (based on 14 percent moisture) were made by cutting 2 m^2 (1.3 m^2 in 1978) from the center of each plot, threshing with a plot thresher, and weighing grain. No yield data were obtained from the November 1978 planting because of poor stands.

Table 1. Air temperature for the 5-week period follov each date of planting (average of maximum and minimu

Planting date	°C
September 20, 1977	21.9
November 15, 1977	11.2
December 15, 1977	4.3
September 20, 1978	21.1
December 18, 1978	3.4
September 18, 1979	21.3
November 6, 1979	9.6
December 10, 1979	6.7
October 5, 1980	17.6
November 11, 1980	9.3
December 4, 1980	7.2

Results and Discussion

Yields of December planted wheat treated with 0, 25, and 50 kg P/ha were 1216, 2224, and 2330 kg/ha, respectively, when grown on soil containing 6 ppm $NaHCO_3$ extractable P (Figure 1). Wheat planted in November responded slightly to P application but wheat planted in September showed no response to application of P. Generally, delaying the time of planting caused reduction in wheat yields. The average yields for September-October, November, and December planted wheat were 2900, 2747, and 2392 kg/ha, respectively. Wheat response to P application on soil with 8 ppm P was similar to that of soil with 6 ppm P in that the yield of December planted

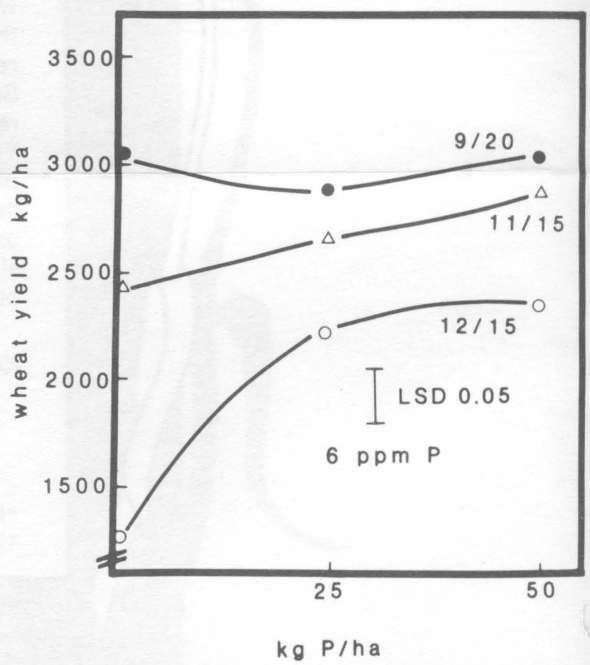


Figure 1. Influence of P application on wheat yields from three planting dates (Austin silty clay soil 1978).

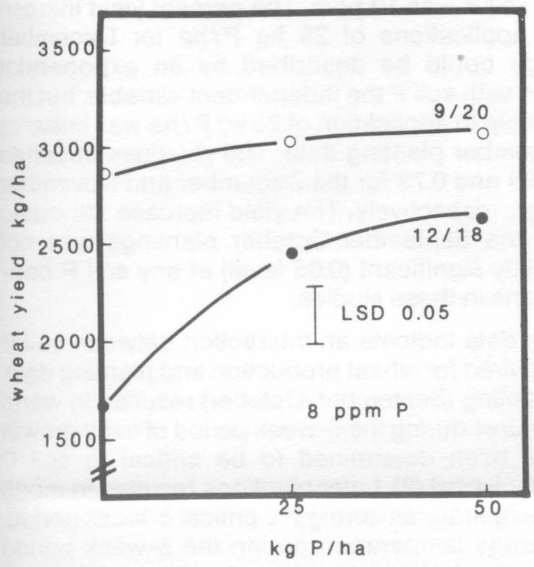


Figure 2. Influence of P application on wheat yields from two planting dates (Austin silty clay 1979).

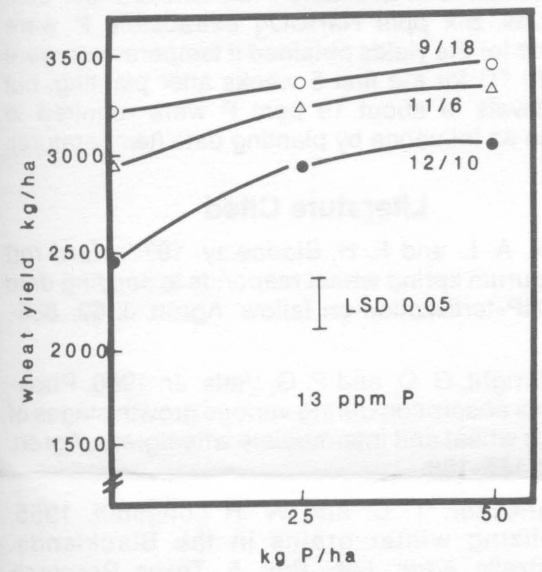


Figure 3. Influence of P application on wheat yields from three planting dates (Dalco clay 1980).

wheat was 1670 kg/ha with no P applied but increased to 2610 kg/ha with 50 kg P/ha (Figure 2). Wheat produced about 3000 kg/ha when planted in September with or without P application.

When planted late, wheat grown on soil containing 13 ppm $NaHCO_3$ extractable P produced higher yields with applications of P (Figure 3), but response of wheat to P was less evident with earlier plantings. Yields decreased with later plantings at all P levels, but P fertilization partially offset yield loss due to late planting.

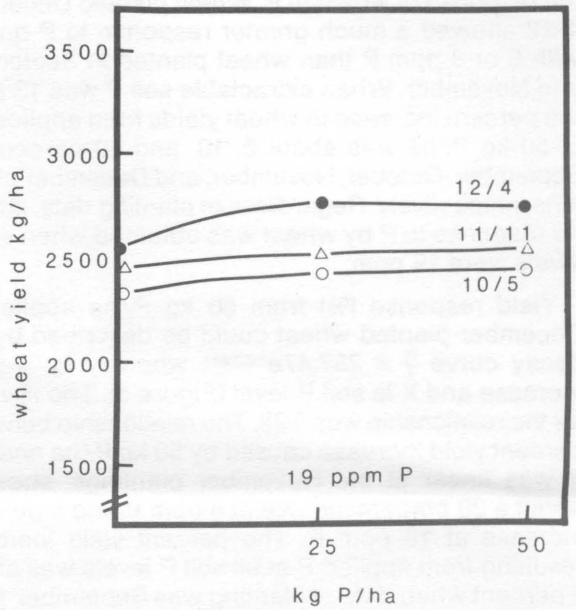


Figure 4. Influence of P application on wheat yields from three planting dates (Austin silty clay 1981).

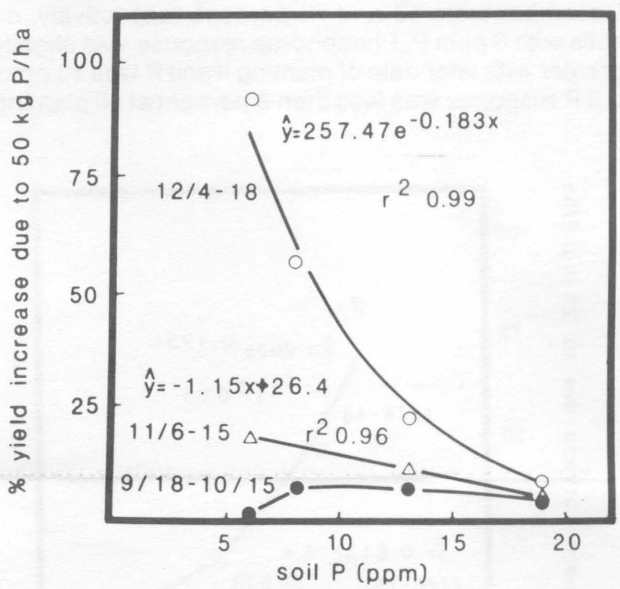


Figure 5. Relationship between soil P level and wheat yield increase at the 50 kg P/ha rate and various planting dates.

The study conducted in 1980-81 on 19 ppm P soil was the only one in which early planted wheat did not produce higher yields than late plantings (Figure 4). Yield increase due to P application was not significant (0.05 level) at any of the planting dates on soil with 19 ppm P. Yield of all wheat grown throughout the area in 1980-81 was decreased because of lodging caused by prolonged spring rains.

The relationship between soil P and percent yield increase (over no P) from 50 kg P/ha (Figure 5) indicates that date of planting is an important factor in

the response of wheat to P. Wheat planted December 4-18 showed a much greater response to P on soil with 6 or 8 ppm P than wheat planted in September and November. When extractable soil P was 13 ppm, the percent increase in wheat yields from application of 50 kg P/ha was about 5, 10, and 20 percent for September-October, November, and December plantings, respectively. Regardless of planting date, little or no response to P by wheat was obtained when soil P levels were 19 ppm.

Yield response (%) from 50 kg P/ha applied to December planted wheat could be described by the decay curve $\hat{y} = 257.47e^{-0.183X}$ where $\hat{y}$ is % yield increase and X is soil P level (Figure 5). The r^2 value for the relationship was 0.99. The relationship between percent yield increase caused by 50 kg P/ha and soil P was linear at the November plantings, showing about a 20 percent increse at 6 ppm P and 5 percent increase at 19 ppm P. The percent yield increase resulting from applied P at all soil P levels was about 5 percent when date of planting was September 18 to October 15. Similar relationships were obtained when 25 kg P/ha was applied (Fig. 6), but the magnitude of the P response was less than with 50 kg P/ha. The yield increases from 25 kg P/ha in November and December were 13 and 78 percent, respectively, on soils with 6 ppm P. Phosphorus response was slightly greater with later date of planting if soil P was 13 ppm, but P response was less than 8 percent at all planting dates if soil P was 19 ppm. The percent yield increse due to applications of 25 kg P/ha for December plantings could be described by an exponential equation with soil P the independent variable, but the relationship to application of 25 kg P/ha was linear at the November planting date. The r^2 values obtained were 0.98 and 0.73 for the December and November plantings, respectively. The yield increase attributed to P at the September-October plantings was not statistically significant (0.05 level) at any soil P concentrations in these studies.

These data indicate an interaction between soil P level required for wheat production and planting date. Early planting (September-October) resulted in warm temperatures during the 5-week period of early growth that has been determined to be critical in soil P uptake by wheat (2). Later plantings resulted in much colder temperatures during the critical 5-week period. The average temperature during the 5-week period following each date of planting is given in Table 1. Temperatures for 5 weeks after the September plantings ranged from 21.9 to 17.6 °C; in contrast, temperatures after the late plantings (December) ranged from 3.4 to 7.2 °C. These data indicate a need for higher amounts of available P for wheat under cold conditions. Six ppm $NaHCO_3$ extractable P were adequate for the yields obtained if temperatures were about 20 °C for the first 5 weeks after planting, but soil P levels of about 19 ppm P were required to preclude an influence by planting date (temperature).

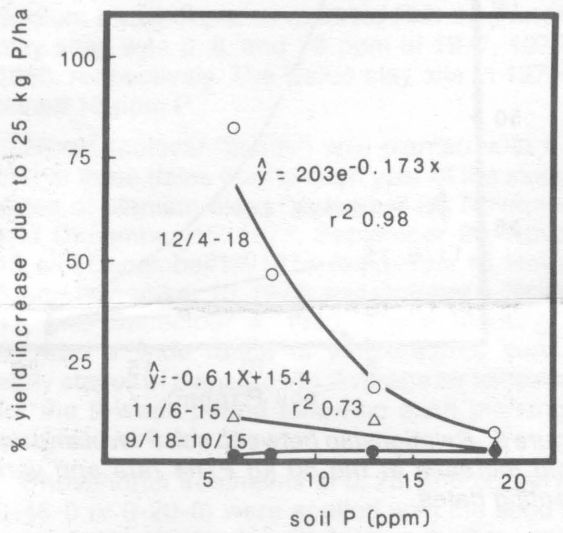


Figure 6. Relationship between soil P level and wheat yield increase at the 25 kg P/ha rate and various planting dates.

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