

**WESTERN  
PHOSPHATE  
& SULFUR  
WORKGROUP**

**PROCEEDINGS**

**1990-91**

# 1990

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## RESPONSE OF WINTER WHEAT IN THE CENTRAL GREAT PLAINS TO HIGH RATES OF PHOSPHORUS FERTILIZER

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### ABSTRACT

Phosphorus (P) deficiency of winter wheat is common in the Central Great Plains. Acceptance of reduced and no-till systems for wheat production has made soil incorporation of broadcast P fertilizer more difficult. This field study evaluated the effectiveness of P placement methods on the response of no-till winter wheat to single applications of P fertilizer at rates of 0, 30, 60, 90, and 120 lb P/a (surface broadcast with and without incorporation and banded below seed zone), and at 25% of these rates (P placed directly with seed) with and without N fertilization. A loam soil with a  $\text{NaHCO}_3$ -extractable P level of 10 ppm and a pH of 7.8 was used. Grain yields increased curvilinearly with increasing P rate each crop year up to a P rate of 90 lb P/a for the broadcast and banded treatments. Grain yields of the seed-placed P treatments also increased with increasing P rates up to 15 lb P/a, with yields equalling those of equivalent P rates for the other placement methods when averaged over years. The cumulative three-year grain yields were equal for each P placement method when compared at the same level of applied P, except for the two highest rates for the seed-placed treatments which were lower. Straw yields generally increased with increasing P rate. The data from this study indicate that a broadcast application of P that is not incorporated under no-till conditions can effectively increase winter wheat yields on a P-deficient soil. When sufficient P is applied to correct P deficiency in winter wheat, method of placement has little effect.

### INTRODUCTION

Phosphorus deficiency in winter wheat is a common problem in the Central Great Plains. Banding of low rates of P fertilizer near the seed on soils testing low in available P has been shown to be more effective than broadcast applications of P fertilizer at the same rate during the first year of application (Leikam et al., 1983; Westfall et al., 1987). As the soil test P level increases from low to high, the yield difference between banding and broadcast applications is expected to decrease (Peterson et al., 1981).

On a long-term basis, a broadcast application of P fertilizer may be equally as effective as a band application at equal rates for wheat production (Roberts and Stewart, 1987; Wagar et al., 1986). Halvorson (1989) reported that irrigated winter wheat, grown annually on the same land, responded positively to residual fertilizer P under no-till conditions at Akron, Colorado.

Halvorson and Black (1985) suggested that a one-time, high-rate application of P fertilizer may be one way to satisfy the P needs of crops grown with reduced and no-till systems for several years. This study evaluates their suggestion, in addition to comparing the effects of placement method on the long-term effectiveness of residual P fertilizer with reduced tillage systems. The

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objectives of this study were to: (1) evaluate the efficiency of P placement methods for winter wheat production in reduced tillage systems, (2) determine the level of P fertilizer needed for optimum winter wheat yields with and without N fertilization, and (3) determine the residual P fertilizer effects over several years on cumulative dryland winter wheat yields. This paper summarizes the grain yield data from the first three winter wheat crops harvested from each of the P treatments.

#### MATERIALS AND METHODS

The study is located near Peetz, Colorado on a Rosebud-Escabosa loam soil with a pH of 7.8. The initial  $\text{NaHCO}_3$ -extractable soil P level (0 - 6 inch depth) was 10 ppm, a medium soil test P level in Colorado. A split-split plot, randomized block design was used with P placement method as main plots, P fertilizer rate as subplots, and N fertilizer rate as sub-subplots with four replications. Fertilizer P placement methods were: a) broadcast prior to planting with no incorporation (BCNI); b) broadcast prior to planting with shallow incorporation (3 inch depth) using a disk (BCI); c) banded below the seed at planting at about a 3 inch soil depth or 1.5 inches to the side and 1.5 inches below the seed (DB); and d) placed directly with seed (SP) at 25% of the established P rates each crop year. Fertilizer P (concentrated superphosphate) rates were 0, 30, 60, 90, and 120 lb P/a, except for the seed placed treatments which were 0, 7.5, 15, 22.5, and 30 lb P/a each crop year. We assumed that P placement directly with the seed would result in the most efficient P fertilizer use by winter wheat, and consequently, lower rates of P would result in yield potentials similar to those of the broadcast and banded treatments at higher rates. By mistake, the full P rates were reapplied to the DB treatments at planting of the 3rd wheat crop in the fall of 1989; consequently, the total P applied for the DB treatments are double those of the broadcast treatments. Fertilizer N rates were 50 lb N/a the first year and 75 lb N/a the second and third crop years, broadcast applied without incorporation prior to planting as ammonium nitrate.

Duplicate sets of treatments were established in adjacent plot areas, one set in the fall of 1985 and the other in fall of 1986 to allow harvest of winter wheat crops each year in a no-till winter wheat-fallow rotation. In this paper, the average grain yield represents two years of data for the 1st (1986-87) and 2nd (1988-89) wheat crops, and only one crop (1990) for the 3rd crop. A no-till drill (Haybuster model 8000)<sup>1</sup> with dual seed placement row openers on each shank (two rows 3 inches apart) with 12 inches between shanks was used to plant the winter wheat. Thus, the seed-placed P rates were split between two paired seed rows resulting in P rates equal to 12.5% of the BC and BD treatments directly in contact with the seed. Tam 105 winter wheat was grown in 1986 and Tam 107 from 1987 to 1990. A plot combine was used to obtain grain yields.

#### RESULTS AND DISCUSSION

Nitrogen fertilization increased winter wheat grain yields each crop year except for 1990, when yields were severely limited by lack of growing season

<sup>1</sup>Mention of trade names or manufacturer within the context of this article are used solely to provide specific information and does not constitute a guarantee or endorsement by the U.S. Department of Agriculture or Kansas State Univ.

precipitation. The interaction of N with P application rate was generally not significant for grain yield. Grain yields increased significantly with increasing rates of P fertilization for all placement methods each crop year. Grain yields were near or at maximum with the application of 90 lb P/a for the broadcast (BCI and BCNI) and band-below-seed (DB) placement methods. The SP treatments with lower P rates increased grain yields to levels comparable to those of equivalent P rates of the BCI, BCNI, and DB placement treatments for the first two crops. However, grain yields of the two highest P rates for the SP treatments had much lower yields for the third crop than for those of equivalent P rates for the BCI, BCNI and DB treatments.

Total cumulative grain yields in three crops above that of the check plot (no N or P added) for each P placement method as a function of rate of P applied is shown in Figure 1. Grain yields at each P rate were similar for the BCI, BCNI, and DB placement methods, with maximum cumulative yields occurring with the application of 90 lb P/a. The SP cumulative grain yields for the lower P rates ranged

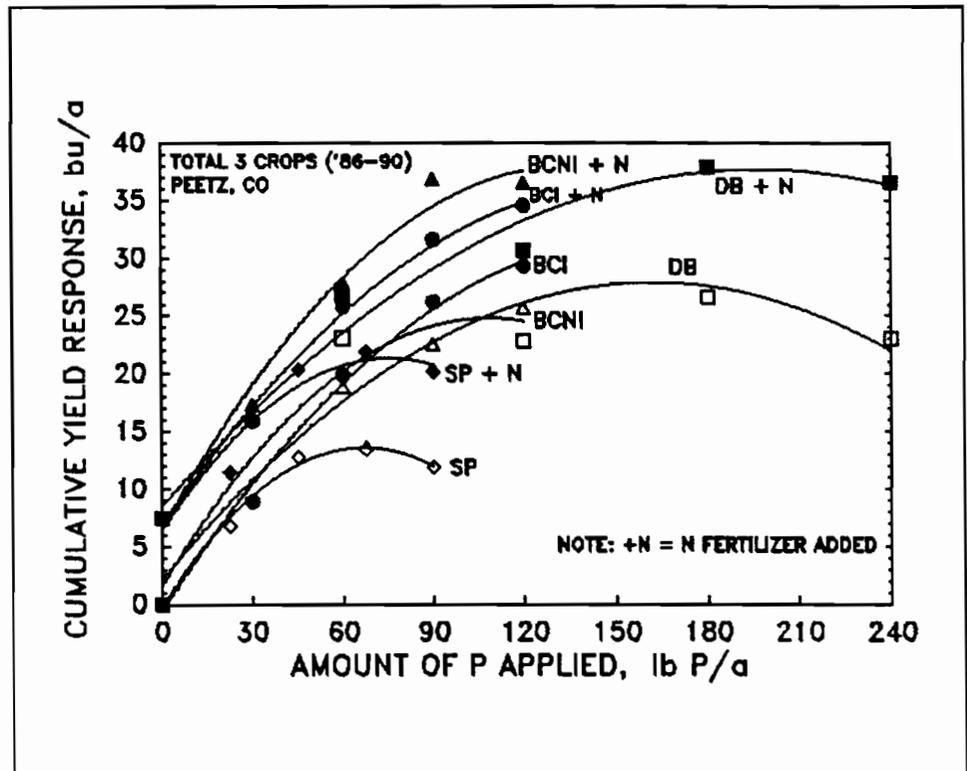


Figure 1. Total cumulative grain yield above check plot (no N or P) of three winter wheat crops as a function of P applied.

between those for the check (no P added) and the equivalent P rates of the other P placement methods. However, cumulative grain yields at the two highest SP rates of P tended to be lower than those of equivalent P rates for the other P placement methods. This yield difference was probably caused by the visually obvious lower plant stands for these P treatments. This visual difference in plant stand was very obvious during several crop years. Except for the SP treatments, P placement methods, when compared at equivalent P rates, had little influence on winter wheat grain yields in this study indicating that P applied BCNI will stimulate winter wheat yields under no-till conditions. The results also indicate that when sufficient P is applied to correct P deficiency for winter wheat, method of application may have little influence on grain yield. These data also suggest that P rates greater than those generally recommended (0-30 lb P/a) may be needed to correct P deficiency in winter wheat in the Central Great Plains. However, with only an average 8.9 bu/a increase in grain yield with application of 90 lb P/a the first crop year, this may not be an economical

venture during the first year of P application. Therefore, the residual value of the applied P will need to be considered over several years.

Application of N generally increased straw yields each crop year. In general, straw yields increased with increasing P rate for all methods of application. Because of the increased straw production with N and P fertilization, one might expect improved soil water relations and better protection from wind and water erosion with time. Thus, the beneficial effects of N and P fertilization are more than just increasing grain yield.

#### SUMMARY

The results of this study indicate that a nonincorporated, broadcast application of fertilizer P prior to planting under no-till conditions can be effective in increasing winter wheat grain yields on a soil with a medium soil test P level. The data also indicate that when sufficient P is applied to correct a P deficiency in winter wheat, method of application is not critical. Higher rates of P than those normally recommended may be needed to correct P deficiency of winter wheat grown on P-deficient soils supplied with adequate N; however, the problem of short-term economics may have to be solved. Thus, P fertilizer costs may have to be amortized over a longer time span than one year to adequately correct P deficiency in winter wheat in the Great Plains.

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