Drs. W.B. Gordon and D.A. Whitney

What About P Placement and Rate on Furrow Irrigated, Ridge-Tilled Grain Sorghum?

Three-year Kansas study shows broadcasting not as effective as banding, plus higher P rates improved yields.

Summary: *On low-test P soil, sub-surface banding P increased grain sorghum yield by 20.3 bu/A compared to broadcasting. Placing N and P in a single starter band 2 inches to the side and 2 inches below the seed was as effective as placing a band on each side of the row Knifing N and P in row centers was not as effective as placement beside the row Single-banded starter in N:P_2O_5 ratios of 1:1 or 3:1 consistently increased yields and nutrient uptake and shortened the time to mid-bloom as compared to the single-banded starter that provided only 10 lbs/A of N. Over the three-year study, 1:1 and 3:1 N:P_2O_5 starters were clearly superior to other treatments.*

Use of conservation tillage systems has increased greatly in recent years because of their effectiveness in conserving soil and water. Interest in ridge-till is also growing. This involves planting a crop on a raised bed that is formed by cultivation during the preceding growing season. Ridges 6-8 inches high are built by cultivation when the crop is approximately 15-18 inches tall. Tillage prior to planting is confined to a narrow strip on top of the ridge.

Advantages of ridge-till over other conservation tillage methods are: 1) it maintains warmer soil temperatures because of the ridge configuration and removes residue from the seed zone during planting, and 2) it is one of the most economical tillage systems currently used.

A major disadvantage of ridge-till is limitation on nutrient placement options owing to a lack of primary tillage operations. Ridge-till may also alter a crop's rooting pattern and nutrient uptake.

Some researchers have shown that broadcasting P is not as effective as sub-surface banding, while others have found no response to P placement in no-till systems. Reports from 1980 research showed an increase in P uptake as volume fraction of soil treated with P decreased, largely because P stimulated root growth in the fertilized portion of soil.

Other research has demonstrated that because soils differ in their adsorption capacity of P, the volume fraction of soil to fertilizer for maximum P uptake varies with soil and rate of P applied. Therefore, P application can be over-localized.

Stimulation of P uptake by N placed in fertilizer bands has been observed by many researchers. Research in Kansas found that no-till grain sorghum yield on high soil-testing P was improved with starter fertilizer applied in either a 1:1 or 3:1 N:P_2O_5 ratio compared to the typical 1:3 ratio.

Although many studies have examined placement in no-till situations, little information is available about optimum P placement for grain sorghum grown in ridge-till systems. Thus, objective of this experiment was to investigate the effects of P rate and placement method on irrigated grain sorghum grown in a ridge-till system on a low-P available soil. The three-year study was initiated in 1993.

Climate

Growing conditions were abnormal in 1993. Rainfall in July exceeded the average by nearly 14 inches, but

Table 1. Growing season weather information. Scandia, KS.

	Rainfall				Avg Daily Temperature			
Month	1993	1994	1995	30-yr avg	1993	1994	1995	30-yr avg
	- - - - - - - inches - - - - - - -				- - - - - - - F° - - - - - - -			
April	3.38	2.00	1.69	2.52	49.8	51.8	47.8	53.6
May	4.41	1.50	9.41	4.02	61.7	65.5	56.8	64.0
June	6.61	8.50	1.61	4.61	70.7	74.7	69.6	73.9
July	17.79	5.59	3.11	3.82	76.1	73.6	77.7	79.0
Aug	5.59	0.59	4.68	3.71	74.7	74.7	79.5	77.0
Sept	2.91	0.98	2.60	3.90	61.7	67.6	64.8	66.9
Oct	1.69	1.42	0.71	2.01	52.9	55.8	53.8	55.9
Total	**42.40**	**20.59**	**23.82**	**24.67**				

temperatures were below normal (Table I). An early frost also was recorded in mid-September of 1993 that affected yields of some treatments.

Seasonal rainfall in 1994 and 1995 was below the long-term averages. Below normal temperatures in September of 1995 also may have affected grain fill and yield.

Yields up

North Central Kansas. Applied P treatments on a producer's field near our North Central Kansas Experiment Field significantly improved grain yields over those of no-P check plots in all three years of the experiment (Figure 1). Orthogonal contrasts were used to compare rate and placement effects.

When averaged over three years, applied P compared to no P improved grain yields by 40 bu/A. Surface broadcasting P_2O_5 at 40 lbs/A increased yields by 9 bu/A when compared to the 20 lbs/A rate of P_2O_5.

On the low soil testing P soil, however, banding P proved to be more effective than broadcasting. Comparison of all band treatments showed that 20 lbs/A of P_2O_5 was just as effective as 40 lbs/A.

Previous studies report P placed in a soil volume intermediate between a small fraction with a row-placed band and a large fraction broadcast, gave higher P recovery and greater yields than either banding or broadcasting. However, on this Can sandy loam soil a single band beside the row was just as effective as bands placed on either side of the row.

Broadcasting half of the P and placing half as a single starter band was as effective as a single starter band.

Knifing P in the center of the row middle was not as effective as placing P in a band beside the row.

Nitrogen and P applied in either a 1:1 or 3:1 ratio produced the greatest 3-year average yields. The 1:1 N:P_2O_5 (40 lbs/A of N and 40 lbs/A of P_2O_5) ratio applied as a single band starter increased yields by 16 bu/A over the single band that provided only 10 lbs/A of N.

Higher N starter treatments resulted in consistently greater grain yields. The

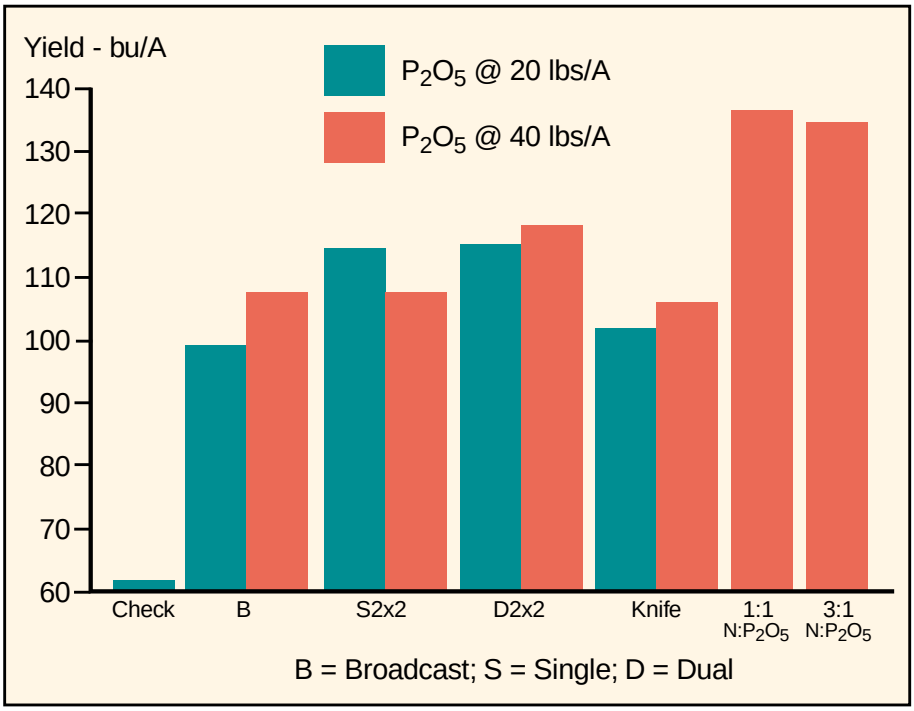

Figure 1. Effects of NP application method and rate on grain sorghum yield, all N rates at 10 lbs/A, except 40 lbs/A (1:1) and 120 lbs/A (3:1), Gordon, et al., KSU, Scandia, 1993.

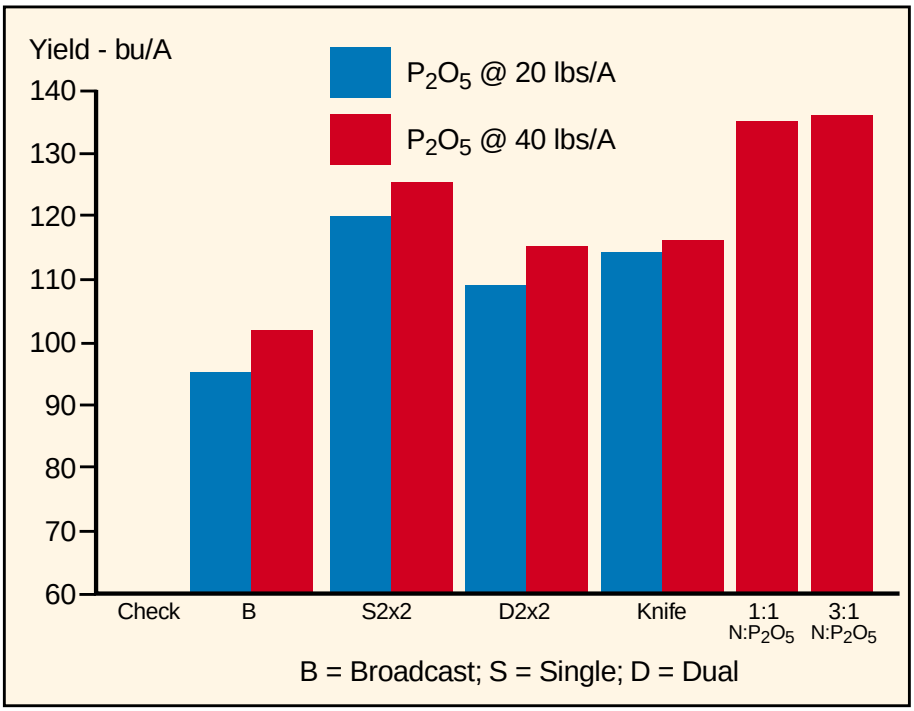

Figure 2. Effects of P application method and rate on grain sorghum yield, N rates of 40 lbs/A (1:1) and 120 lbs/A (3:1), Gordon, et al., KSU, Scandia, 1993.

1:1 and 3:1 N:P_2O_5 ratio starters were equally effective.

Scandia, Kansas. Broadcasting P on a producer's field near Scandia, Kansas, improved yield of grain sorghum compared to no-P check plot, but was not as effective as banding (Figure 2). Single degree of freedom contrasts (P>0.04) show that 40 lbs/A of P_2O_5 was superior to 20 lbs/A on a soil testing low in P.

Broadcast plus starter treatment produced yields that were equal to those achieved with a banded starter of 40 lbs/A of P_2O_5. Greatest yields resulted from banding starters in ratios of 1:1 or 3:1.

Uptake

When averaged over three years, broad-casting 20 lbs/A P_2O_5 increased P uptake by 32 percent compared to the no-P check. However, banded starter was more effective than broadcasting. Greatest P uptake occurred when banded starter was applied in a 1:1 or 3:1 N:P_2O_5 ratio.

Previous research has shown that when P is banded, N also is needed in the band for stimulation of P uptake. Banded starters that supplied 10 lbs/A of N were not as effective as treatments that supplied 40 lbs/A of N. N uptake at the V8 stage of growth also was maximized in banded starters, with N and P applied in either a 1:1 or 3:1 ratio.

Surface broadcasting P increased leaf P above critical levels, and those at 40 lbs/A of P_2O_5 were statistically equal to those with banded starters that supplied 10 lbs/A of N with 20 or 40 lbs/A of P_2O_5. Leaf P concentration was maximized by banded starter applied either at a 1:1 or 3:1 N:P_2O_5 ratio. The three-year average leaf N concentration was greatest when N and P were placed in a starter band in a 1:1 or 3:1 N:P_2O_5 ratio.

Methodology

Soil was a Can sandy loam with a pH of 6.9, organic matter content of 1.5 percent, and Bray-1 P in the low soil test category.

Tillage. The experimental area had been in ridge-tillage corn for three years prior to establishment of this study.

Design. Experimental design was a randomized complete block replicated four times. Plots consisted of four rows, 30 feet long and 30 inches apart.

Population. Dekalb 40Y was planted each year at 90,000 seeds/A.

Planting dates were in the latter part of May in all years.

Irrigation. In 1994 and 1995, plots were irrigated twice, once at boot stage and again 10-14 days later. A total of 3 inches of water was applied at each irrigation. Since rainfall in July of 1993 was much above average, plots were irrigated only once in mid-August. All irrigation water was applied in-furrow.

Dr. Gordon is professor at the North Central Kansas Experimental Fields, KSU, and Dr. Whitney is professor of Extension Agronomy, KSU.