T E X A S

Deep Phosphorus Banding in Winter Wheat – A Risk Management Tool for the Southern Great Plains

By Travis D. Miller

Rainfall in the Southern Great Plains may range from 10 to 50 inches per year, and distribution of that rainfall may place a wheat crop in jeopardy of injury from both flood and drought conditions in one growing season.

In this region, wheat is a dual purpose crop, with winter pasture and grain production both being of great importance to farmers and ranchers. It is estimated that Texas wheat growers graze more than 70 per cent of the crop, and that 40 to 45 per cent is grazed the entire season with no grain harvested. Therefore, fertilizer management to enhance early forage production is of near equal importance to practices which optimize grain yield.

Reevaluating phosphorus (P) application technology may be one of the more important risk management tools that can be used by wheat farmers who rely on income from grazing and grain production in the Southern Great Plains.

Late August through early October is typically a high rainfall period, with accumulations of 3 to 4 inches per month. The October through March period tends to be a very dry time of the year, with normal averages below one inch per month, resulting in a deficit moisture condition. Wheat is planted early to optimize vegetative growth for winter grazing. This rapid early growth tends to deplete surface moisture. If we look at mobile fertilizer elements such as nitrogen (N), this does not pose a problem as active roots in the lower soil profile continue to supply the crop with N. With P, we begin to quickly see a yield limiting situation with conventional fertilizer application techniques.

Phosphorus deficiency caused by reduced tillage and surface application of P results from stratification of nutrients in the soil. When the surface 2 or 3 inches are moist, and wheat roots are active, this P is taken up and used by the crop to good effect. However,

TABLE 1. Response of wheat forage to fertilizer placement, Texas Rolling Plains.

Location	Year	Forage yield[1], lb/A			
		Deep P+N	Surface P+N	N only	Check
Runnels	1988	2,583a	1,595b	1,482b	—
Wichita	1995	2,357a	1,238b	1,257b	1,199b
Baylor	1994	2,552a	1,248b	1,568b	—
Baylor	1995	4,295a	3,757b	3,615b	3,607b
Abilene	1995	3,898b	4,770a	2,200c	—
Abilene	1997	580a	483a	477a	259b
Young	1997	1,050a	749bc	935b	598c
Wichita	1997	1,003a	929a	912a	—
Average		2,290	1,856	1,556	

[1]Yields in the same row followed by the same letter are not different according to LSD test at 95% level of confidence.

as the crop reaches deficit moisture conditions in the fall and winter, this P-enriched zone is too dry for active root uptake of fertilizer. Although the wheat continues to grow and make good use of water from lower in the soil profile, the crop is nutrient-deficient with respect to immobile nutrients concentrated in the surface 2 or 3 inches of soil.

Based upon studies reported in this article and numerous others, P is of great importance in establishing tillers, a deep, massive root system, and fall vegetative growth. These studies clearly indicate that when lack of fall moisture limits activity of roots near the surface, forage yields are greatly increased by deep P application. It is theorized that these dramatic responses in forage growth are related to better moisture availability associated with the location of the fertilizer band in the soil profile and the subsequent increased availability of fertilizer P over a greater percentage of the growing season. It is clear that lower wheat forage yields can be largely attributed to P deficiency, particularly early season P deficiency. Further, conventional P incorporation technology results in fertilizer which is not readily available during the dry fall weather common to much of the Southern Great Plains.

Beef cattle production is the largest agricultural enterprise in the Southern Great Plains. The potential for enhanced forage yields and the resultant increase carrying capacity under drought conditions have very large implications. Drought and the fear of drought weigh heavily in the management plans of most farmers and ranchers in this production region. In good (wet) conditions, properly managed wheat pastures can generate 3,000 to 4,500 lb/A dry weight forage. When judiciously grazed, it can result in 200 to 400 lb/A weight gain in light weight stocker calves. In dry years, forage yield might be realistically reduced to 750 to 1,500 lb of dry matter. In fields such as these, farmers may deem forage supplies inadequate to turn cattle into the fields. As wheat pasture is commonly leased on a gain basis, and $35/cwt gain is a widely used contract price, gross income from wheat pasture leases can vary from zero to $150/A.

Approximately 10 million acres of wheat are grazed annually in this production region. The economic potential for a system to improve yields in the high risk (dry) years is enormous with respect to farmers, ranchers, and the agricultural industry as a whole. Those years with zero return for fertilizer dollars invested are a great deterrent to further investment in fertilizer by farmers and certainly a drain on the financial bottom line. This article highlights research evaluating the effect of P fertility and its placement on wheat forage and grain yields. The results clearly indicate that P fertilizer is a key component of forage and grain yields in dry years in wheat production systems. Further, wheat farmers are at less risk of a crop failure due to drought when P is deep banded preplant than with conventional fertilizer application techniques or when no P fertilizer is applied.

Materials and Methods

In each trial, plots were planted early relative to the optimum date for grain production in winter wheat. This is common in the wheat-stocker cattle production system, as early heat units drive the forage production upon which the stocker cattle component of the system depends. The fertilizer applied was fluid ammonium polyphosphate (10-34-0) in all trials except those at Abilene. Trials at Abilene used 11-52-0 (MAP) banded at the 6-inch depth with an air seeder and compared to the same rate surface applied with an air boom and incorporated prior to planting. The Abilene trials used anhydrous ammonia (NH_3) at 80 lb N/A, while urea ammonium nitrate (UAN) was used on the other trials at a rate of 50 lb N/A. In other trials, banded applications were preplant injected on 10-inch centers at a depth of 8 inches at a rate of 50 lb N/A. Surface incorporated treatments were dribbled on the surface and then incorporated either with a disk or field cultivator. Rate of application was 40 lb/A P_2O_5, with the exception of the Abilene site where the rate was 50 lb/A. Wheat was planted on dates from mid-September to early October with a plot drill on 10-inch centers. Forage was hand clipped using a small frame, oven dried, and weighed. Grain yield was determined by using a Hege

TABLE 2. Response of wheat grain yield to fertilizer placement, Texas Rolling Plains.

Location	Year	Forage yield[1], lb/A			
		Deep P+N	Surface P+N	N only	Check
Runnels	1988	31.0a	25.8b	20.8c	—
Baylor	1994	46.0a	47.0a	35.0b	—
Baylor	1995	41.4a	39.2a	39.1a	27.9a
Wichita	1995	16.4a	5.1b	4.8b	3.5b
Abilene	1995	34.0b	48.5a	19.5c	—
Abilene	1996	22.0a	13.2b	12.2b	7.7d
Average		31.8	29.8	21.9	

[1]Yields in the same row followed by the same letter are not different according to LSD test at 95% level of confidence.

plot combine. Plot design was a randomized complete block with either 3 or 4 replications.

Results and Discussion

In these trials, forage dry matter yield response was greatest with deep banded P relative to surface incorporated P or the untreated check in dry years (**Table 1**). In five of eight site-year comparisons in the Texas Rolling Plains, deep banded P resulted in forage yields 50 percent greater (850 lb/A forage) than wheat treated with the same rate of surface incorporated P and 45 percent greater (796 lb/A forage) than wheat treated with the same rate of N but no P fertilizer. In four of the five sites, fall weather was abnormally dry while at the fifth site, weather was average. Two clear effects were noted: The first is that P placement significantly improved forage yield; the second is that P use efficiency with respect to forage yield with surface incorporated P in dry fall weather was nil.

In six trials where valid comparisons of grain yield were made between P placement techniques, three yielded significantly higher with deep placed P, with the yield average of deep banded P being 8.4 and 10.5 bu/A greater than the surface incorporated treatment and the untreated check, respectively (**Table 2**). This represents a yield increase of 57 and 83 percent under very dry growing conditions. In two trials, there was no difference between P placement techniques with respect to grain yield. In one trial during a very wet growing season, wheat fertilized with the surface incorporated P yielded more than the deep, banded P treatment. Averaged over six sites, deep banded P resulted in grain yields of 2.0 and 9.9 bu/A greater than the surface incorporated P and untreated check, respectively. In two sites (Wichita 1995 and Abilene 1996) where drought drastically limited grain yield, no response was obtained to N fertilizer alone or N fertilizer with surface incorporated P. Significant yield response was obtained with N and deep banded P.

Conclusions

There has been a widespread perception among wheat farmers that fertilizer applied in drought conditions is risky, and that fertilizer dollars are better spent elsewhere when the weather does not cooperate. This research proves the perception is correct and at the same time highly in error. When P fertilizer was applied in the traditional manner by surface application followed by incorporation, no effect was visible with respect to forage yield in average to dry fall weather, and in years where dry weather continued through grain fill, little effect was noted in grain yield. In two trials, neither grain nor forage yield was affected by P or N fertilizer when surface applied and shallow incorporated. However, in these same trials, significant and economic yield responses were observed in both grain and forage yield when P fertilizer was deep banded. BC

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