Drs. K. Girma, B. Raun, H. Zhang, J. Mosali

What About Foliar P On Corn and Winter Wheat?

Oklahoma studies show peak yields when P is foliar applied.

Summary: In our corn studies, phosphorus-use efficiency (PUE) was generally higher for foliar-applied than preplant-applied P. Our studies revealed that foliar P rate applied at the V8 growth stage resulted in higher PUE than the earlier or later applied foliar P rates. The lowest foliar P rate was more efficient than the higher rates. Over all winter wheat sites and years, PUE was as high as 86, 16, and 100 percent at Lake Carl Blackwell (2002), Lahoma (2002), and Lahoma (2003), respectively, when 4 lbs/A of P2O5 was foliar applied at post anthesis. On an average, PUE was higher when P was applied at stem elongation (39%) and post-anthesis (47%). However, it is preferable to apply at stem elongation since at this stage producers can simultaneously apply both N and P using the same equipment.

Foliar application of phosphorus (P) in corn and winter wheat is a potential option to improve P-use efficiency (PUE) and minimize environmental impacts. Foliar P fertilization research started in the late 1940s and early 1950s although it was limited to high-value horticultural crops and micronutrients. In many agricultural production systems, P has been identified as the most deficient essential nutrient after nitrogen (N). The release of P from the soil system for uptake by plants is influenced by several factors that result in poor synchronization of crop demand and soil supply. In addition, PUE averaged 8 percent when P was broadcast and incorporated, and 16 percent when P was either knifed with anhydrous ammonia or applied with the seed in winter wheat in the first year of application. This shows that it is necessary to assess methods for improving PUE. In such a case, it was surmised foliar supplement might be a good option.

The objectives of these experiments were to: 1) assess if corn or wheat responds to foliar P, 2) determine the appropriate time of application (growth stage) that improves both grain yield and PUE.

Response to foliar P

Corn. At the Perkins site in both 2002 and 2003, no response to foliar P was observed for grain yield. At the Guymon and Goodwell sites, however, some treatments were different. Test of the interaction of stage by foliar P rate as monopotassium phosphate (KH2PO4) at Guymon in 2002 revealed that grain yield was different among the three growth stages with the application of 4 lbs/A of P2O5. Grain yield reached its peak when foliar P was applied at the V8 growth stage, with increases of approximately 48 bu/A over that of the check (Figure 1). Luxurious vegetative growth due to excess supply of N might induce hidden P hunger and the foliar correction of this demand would likely improve yield. In 2003, yield differed among foliar P rates at Lake Carl Blackwell. Foliar P rates were significant for grain yield where 16 lbs/A of P2O5 resulted in significantly higher (34% more) yield than the lower rates and check combined, which were not significantly different among themselves.

PUE was generally higher for foliar applied than preplant applied P. The results obtained here also revealed that foliar P rate applied at the V8 growth stage resulted in higher PUE than the earlier or later applied foliar P rates. The lowest foliar P rate was more efficient than the higher rates. Interaction effects at the Guymon and Perkins experiments in 2002 revealed that applying 4 lbs/A of P_2O_5 at the V8 growth stage highly improved PUE. The decrease in efficiency with higher rates of foliar P could be due to several reasons that influence the actual amount of applied P that 1) comes in contact with the plant, 2) is retained on the corn leaf or stalk, and 3) is absorbed by leaves and translocated.

Winter wheat.

Trend analysis of mean grain yields, for foliar P applied at stem elongation with no preplant P, revealed a significant quadratic relationship between foliar P rates and grain yield at Lahoma in 2002. On the other hand, at a preplant rate of 62 lbs/A of P2O5, foliar P at stem elongation showed a linear trend.

In 2004 at this site a quadratic response was observed for foliar rates up to 16 lbs/A of P2O5 where maximum yields were achieved at 8 lbs/A of P2O5 (Figure 2). In plots treated with only foliar rates at stem elongation and flowering, there was an apparent response, which indicates that foliar P in wheat is still a potential option to manage P deficiency in wheat even under severe early P stress. The foliar rates considered in this study also showed apparent grain yield and PUE increases. The 2004 grain yield data revealed that an addition of foliar P in excess of 16 lbs/A of P2O5 did not improve grain yield. Foliar application of P at stem elongation was generally better than P applied at preflowering or post anthesis, in terms of grain yield. Our data suggest that increase in grain yield from foliar P generally took place when yield levels were lower, likely due to increased moisture stress. This would make sense since P uptake due to contact exchange would be less under moisture stress, thus enhancing the benefits of foliar P in these years. Foliar application seems to improve yields with or without the preplant P application on low soil test P soils.

Regardless of the method of P application, response to P fertilization should have been observed across all trials. This is because initial soil test P levels were all below 100 percent sufficiency. Despite this, only 50 percent of the trials showed significant response to applied P. The significant grain yield response to P at Lahoma can be explained by the fact that the soil had a relatively low level of initial soil P compared to the other two sites. This suggests that wheat grain yield can be improved by supplementing P in foliar form when the plant is in need.

Over all site and years, PUE was higher when P was foliar applied at 4 lbs/A of P_2O_5. PUE was as high as 86, 16, and 100 percent at Lake Carl Blackwell (2002), Lahoma (2002), and Lahoma (2003), respectively, when 4 lbs/A of P2O5 was foliar applied at post anthesis.

Dr. Girma is research associate, Dr. Raun is regents professor, Dr. Zhang is professor, Department of Plant and Soil Sciences, Oklahoma State University. Dr. Mosali is postdoctoral fellow, the Samuel Roberts Noble Foundation, Ardmore, Oklahoma.

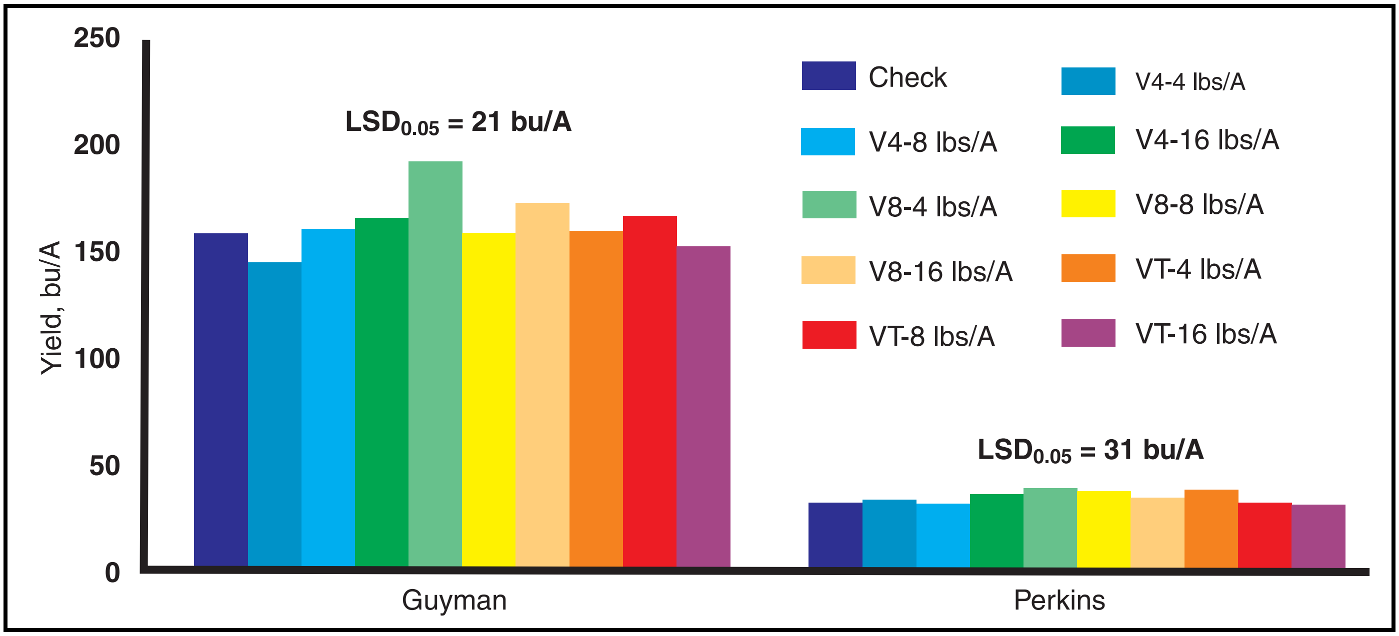

Figure 1. Mean corn grain yields (bu/A) for treatments at Guymon and Perkins, Oklahoma, 2002.

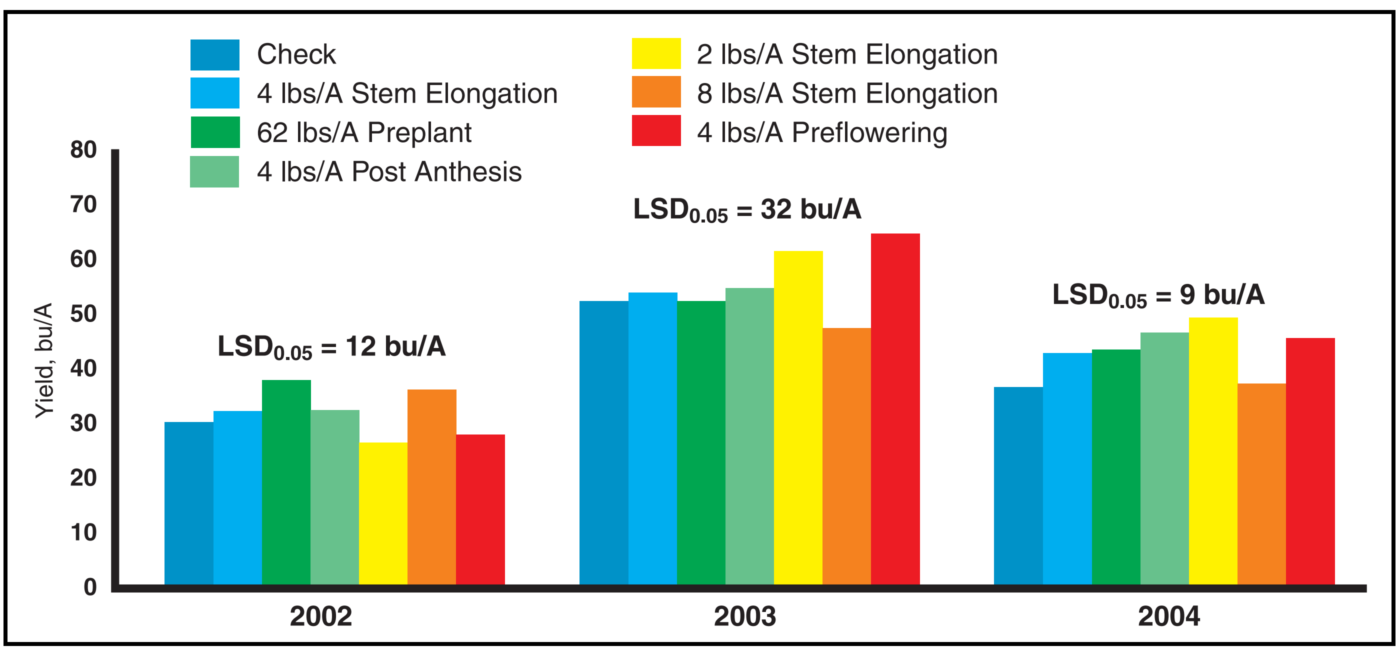

Figure 2. Mean wheat grain yields (bu/A) for treatments at Lahoma, Oklahoma, 2002-2004.