SDSU Extension

iGrow Corn

BEST MANAGEMENT PRACTICES

Chapter: 26

Starter, Banding, and Broadcasting Phosphorus Fertilizer for Profitable Corn Production

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The phosphorus (P) application methods used in corn production fields can impact yield and net profitability. The primary benefit from banding P is that it concentrates the P in a small zone near the plant, which can improve P availability. The objectives of this chapter are to: 1) discuss different P application methods, 2) summarize research comparing P application methods, 3) review the effect of band distance from the seed, 4) discuss safe amounts of P-containing fertilizers that can be placed with the seed, and 5) consider strengths and weaknesses of the application methods.

Introduction

Plant-available P moves slowly through the soil by diffusion to the root. Diffusion is the movement of ions from an area with high concentration to an area with low concentration. Factors that influence P diffusion are soil texture, water content, bulk density, pH, temperature and the distance between higher soil P concentrations zones such as bands and the root. P diffusion rates are higher for finer textured soil (clay), higher soil water content, lower soil bulk density, soil pH between 5.0 and 6.0, higher soil temperatures, and shorter distances from root to soil zones with higher P concentration (Bhadoria et al., 1991; Grierson et al., 1999; Olsen and Watanabe, 1963; Schachtman et al., 1998). Crops with finer root systems or those that have been colonized by arbuscular mycorrhizal fungi (AMF) may have higher P uptake efficiencies (Bittman et al, 2006). Adopting no-till practices that encourage fungi growth and development can encourage AMF colonization.

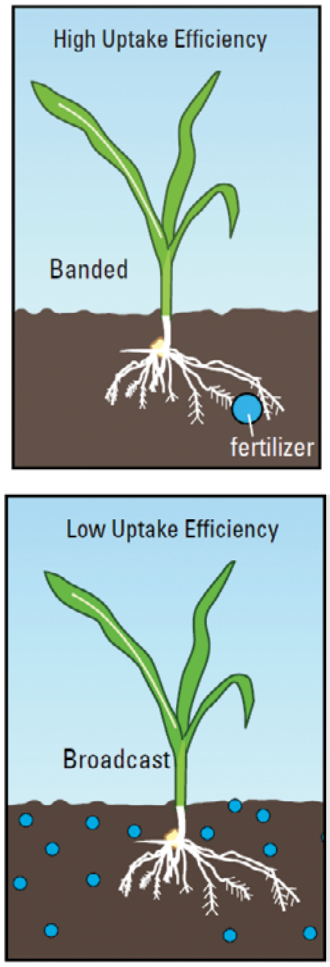

Figure 26.1 P applied as a broadcast or banded application. (Courtesy of Colorado State University, Clay et al., 2009)

Phosphorus fertilizer application methods include broadcast, banded, or band-applied with the seed (Fig. 26.1). Liquid or dry fertilizers are used with any of these placement options. Starter fertilizers, placed at planting, can be located to the side of the row or with the seed (pop-up). Usually, only a portion of the total recommended P rate for optimum corn yield is placed as a starter, unless the recommended P rate is low enough to enable full rate application. The balance of the P recommendation that is not applied as a starter needs to be applied with another method.

Concentrating fertilizer P in a band often improves P availability as there is less opportunity for the fertilizer P to be tied up in the soil, especially at very low or high soil pH. Rates can sometimes be reduced by one-third or more for band-applied P. However, reducing rates can result in a decline of soil test P over time, which can reduce yield potential (Chapters 23 and 29).

Phosphorus can be applied in a variety of forms ranging from liquid to solid products (Chapter 28) and the application technique will depend on your goals, your soil test value, and tillage and equipment options. Tillage system and equipment availability play an important role in determining what choice a corn grower makes when considering P placement. Equipping a very large planter with fertilizer application equipment can be less than desirable because the added weight can lead to higher soil compaction. Frequently asked questions regarding P placement for corn:

1. What P application method returns the greatest economic return?
2. What distance from the corn row should P bands be placed?
3. How much fertilizer can be placed with the seed at planting?

P Application Method Comparisons (band vs. broadcast)

Choosing the most appropriate P application method is complicated by the many factors that influence plant P uptake efficiency. Placing the P in a band near the seed may increase plant P uptake efficiency because it concentrates P in a zone easily reached by early root growth. In addition, P diffusion from the band to the root is high due to a large concentration gradient when compared with broadcast P application. However, when the bulk soil test P is high, the benefits of banded P are reduced. Therefore, knowing soil test P level is important when determining placement options. The optimal balance between P banding and broadcast application is difficult to achieve (Barber, 1974, 1985).

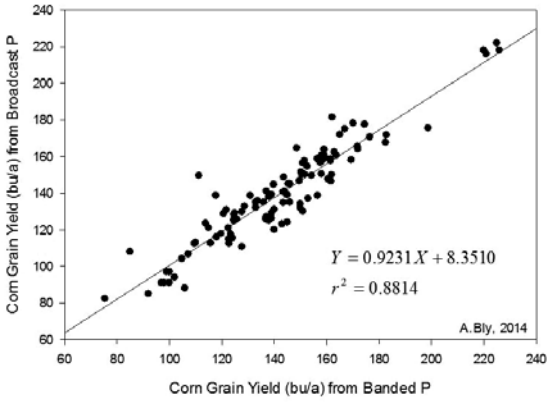

Figure 26.2 Band and broadcast P corn grain yield comparison from P placement literature review. (1970-2010)

Soil fertility researchers conducted research studies at several land-grant universities between 1970 and 2015 that compared banded and broadcast P applications (Fig. 26.2).

This research suggested that the benefit from banding P increased with yield potential. For example, at yield less than 100 bu/acre banding and broadcasting P had similar yields, whereas at 200 bu/acre, banding P had a 7.4 bu/acre yield advantage over broadcasting P. When the P rate was considered, the yield advantage from banding was higher when the P application rate was ≤ 40 lbs P_2O_5/acre (Fig. 26.3). Based on these findings, banding is recommended when yields are greater than 150 bu/acre, P rates < 40 lbs P_2O_5/acre, and soil test P is

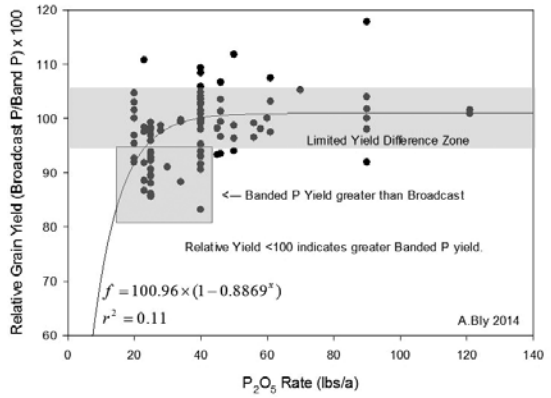

Figure 26.3 Band and broadcast P relative grain yield comparisons across P rates taken from literature review. (1970-2010)

at or below the medium category.

These recommendations are contrary to findings from Iowa, where banded and broadcast treatments had similar yields (Mallarino et al., 1999; 2004). Differences between South Dakota and Iowa may be attributed to differences in rainfall, length of growing season, and tillage.

Could higher soil moisture conditions in South Dakota no-till cornfields result in similar conclusions between banded and broadcast P? Phosphorus placement research projects were conducted in South Dakota between 1998 and 1999 at nine sites located in corn grower no-till fields. Phosphorus fertilizer was either placed as starter (2x2 band) or broadcast at 40 lbs P_2O_5/acre. Statistical comparison between the two treatments showed that site year was significant, which is indicative of a wide range of yield environments used in the project. The banded P treatment (134.1 bu/acre) grain yield average was greater than broadcast (130.8 bu/acre), but not statistically significant. A relative grain yield comparison of broadcast and banded P across Olsen P soil test levels showed that banded P resulted in greater yield at the 4-6 ppm soil test range and similar yields when the soil test value was ≥ 10 ppm (Fig. 26.4).

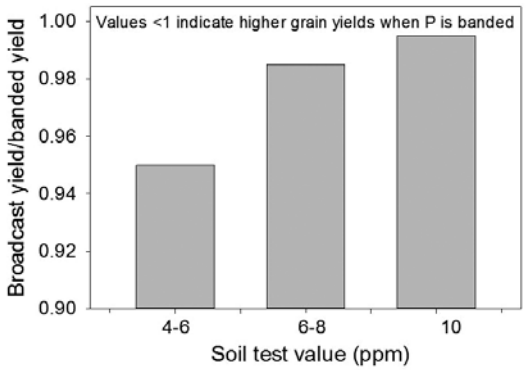

Figure 26.4 Relative no-till corn grain yield of broadcast and banded P comparisons at 9 locations in SD from 1998 to 1999.

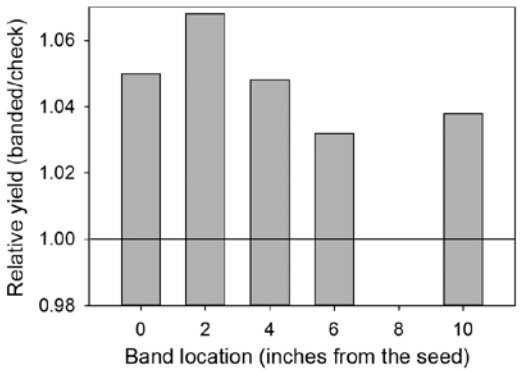

Figure 26.5 P band distance from corn seed furrow influence on relative grain yield at 4 locations in eastern South Dakota during 2004 and 2005.

Distance of P Band from the Seed

Phosphorus band distance from the crop root is another factor influencing P uptake efficiency. Few research studies have investigated the optimal P band distance because it requires specialized research equipment. Research conducted in 2004 and 2005 near Beresford, SD, and Brookings, SD, evaluated the effect of P band distance from the seed furrow on grain yield. This research showed that the greatest yield increase occurred when the P band was located 2 inches from the seed (Fig. 26.5).

Seed-placed Phosphorus

In some situation, placing the P fertilizer with the seed can improve P uptake efficiency. Triple super phosphate (0-46-0) was a very common P fertilizer material in the past and was very safe for seed application. However, for various reasons, this material is not produced to a great extent by the plant food industry. More recently developed P sources containing nitrogen include ammonium polyphosphate (10-34-0), monoammonium phosphate (MAP, 11-52-0), and diammonium phosphate (DAP, 18-46-0). A number of liquid P sources containing N, P, and K have been developed such as 7-21-7, 4-10-10, 3-18-18 and 9-18-9. In addition, numerous mixed fertilizers have been developed containing secondary and micronutrients as well. A pop-up fertilizer calculator has been developed for determining safe pop-up

Table 26.1 Allowable rates of 10-34-0 (ammonium polyphosphate) fertilizer applied with corn seed at planting for 30-inch rows and 5% germination reduction. *(Based on www.ipni.net calculator)*

Soil Texture	Soil Moisture at Planting		
	Dry	Borderline	Moist
	-------- *gallons/acre (lbs P_2O_5/acre)* --------		
Fine/Medium	5.8 (23)	7.8 (31)	11.7 (46)
Coarse	4.7 (19)	5.8 (23)	7.8 (31)

fertilizer rates (Gelderman, 2007). This calculator considers the fertilizer source, soil texture, soil moisture, row width, and risk adversity. The calculator was developed using laboratory method results that were well-correlated to field study data.

This calculator is available from the International Plant Nutrition Institute, www.ipni.net (search for Seed-placed Fertilizer Decision Aid). Table 26.1 was developed from this tool and shows the allowable rates of ammonium polyphosphate fertilizer (APP) with differing soil moisture and textures that can be applied with the corn seed planted in 30-inch rows using a 5% maximum seed germination reduction risk.

Summary

There are many different techniques that can be used to apply P to soils. Each application approach has strengths and weaknesses (Table 26.2). South Dakota has a frigid, semi-arid environment that may influence plant responses to P compared with other corn growing regions. In our soils and climatic conditions, management practices that encourage early growth may result in higher corn yields. Different outcomes may be found in more temperate environments. This paper contains several key summaries including:

1. Understanding soil phosphorus, the meaning of soil P test levels, and the factors influencing P movement (diffusion) to plant roots are very important for optimal P placement.
2. At lower P_2O_5 application rates (< 40 lbs/acre), band-placement grain yields were higher than broadcast and generally occurred at research sites with soil test P below the medium level.
3. In South Dakota no-till corn research, corn grain yield from fertilizer band (2x2) applications were higher than broadcast applications at soil test (Olsen) P levels less than 10 ppm.
4. P bands placed 4 inches or less from the seed furrow returned the highest grain yield.
5. P placement with the seed is a good management practice. However, special attention needs to be taken to understand how different fertilizer materials may reduce seed germination. The seed-placed fertilizer calculator, www.ipni.net, is a good tool to determine pop-up fertilizer limits.

Table 26.2 Strengths and weaknesses of P application methods.

	Strengths	Weaknesses
Pop-up	• Promotes early growth. • Can increase yields if soil test values are low. • Increases P uptake efficiency when soil test P is lower.	• Can reduce germination if the rate is too high. • Ammonia contained in the fertilizer can reduce germination. • Extra equipment for planter to carry. • Some liquids are more corrosive and can damage equipment over time. • Additional P fertilizer may have to be applied to get recommended P rate.
Broadcast	• Can be easily applied. • Will increase the bulk soil P level. • Will increase corn yields. • Could be as effective when compared with banding when rates > 40 lbs P_2O_5/acre.	• May be less effective than banding for low P rates. • May be less effective when soil test P levels are low.
Banded	• In high-yield environment can increase yields. • Most effective if the soil P level is in the low to medium level. • Bands should be placed less than 5 inches from the seed. • Increases P uptake efficiency when soil test P is lower.	• May not be effective for low-yield potentials. • May not be practical for high P rates. • Extra equipment for planter to carry. • Some liquids are more corrosive and can damage equipment over time. • Additional P fertilizer may have to be applied to get the recommended rate.

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