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Timing of N and P Crucial In Achieving High Corn Yields

Inadequate N availability during first six weeks after planting can result in reduced yield potentials.

SUMMARY

Optimizing nitrogen (N) and phosphorus (P) availability to corn is fundamental to achieving high yields and maximizing nutrient–use efficiency (NUE). The corn plant requires N and P soon after germination to initiate the growth of stems, leaves, and ear structures. Inadequate N availability during the first six weeks after planting can result in reduced yield potentials. Phosphorus availability is equally critical during the early stages of plant growth, and movement of P to plant roots is reduced with cold soil temperatures, which are especially prevalent under no-till conditions. For these reasons, starter fertilizers most often have contained only the N that was supplied with the base P fertilizer plus small amounts of potassium (K), sulfur (S), and micronutrients as determined by soil test needs.

We conducted nine field experiments with corn to determine the optimum starter-band N rate in conjunction with the optimum sidedress N rate. Our research used blends of urea-ammonium nitrate (UAN at 30% N) solution as the N source and 10-34-0 as the P source. We varied N rates from 10 to 70 lbs/A placed in a 2 x 2 band. Soil test P levels in these studies were all high and the banded P rate of 34 lbs/A of P_2O_5 would be expected to provide for any P fertilizer needs. In addition, we conducted starter band P application rate studies of 0, 20, 40, and 60 lbs/A of P_2O_5 at each site to measure corn response to varying P application rates. Typical base starter fertilizers, in addition to those already mentioned, have had analyses such as 18-46-0, although in recent years 1:1 N:P starters such as 15-15-0 have been used in areas with higher soil test P levels. Since greater total amounts of N are needed by plants than P, we asked the question: why use 1:3 or even 1:1 N:P ratio starters?

Root growth response

The question in the preceding paragraph is especially relevant when it is clear that plants respond to zones of both N and P enrichment by increasing root growth in the zone of enrichment, so as to maximize nutrient uptake from the zone. Barley root growth in Figure 1 clearly

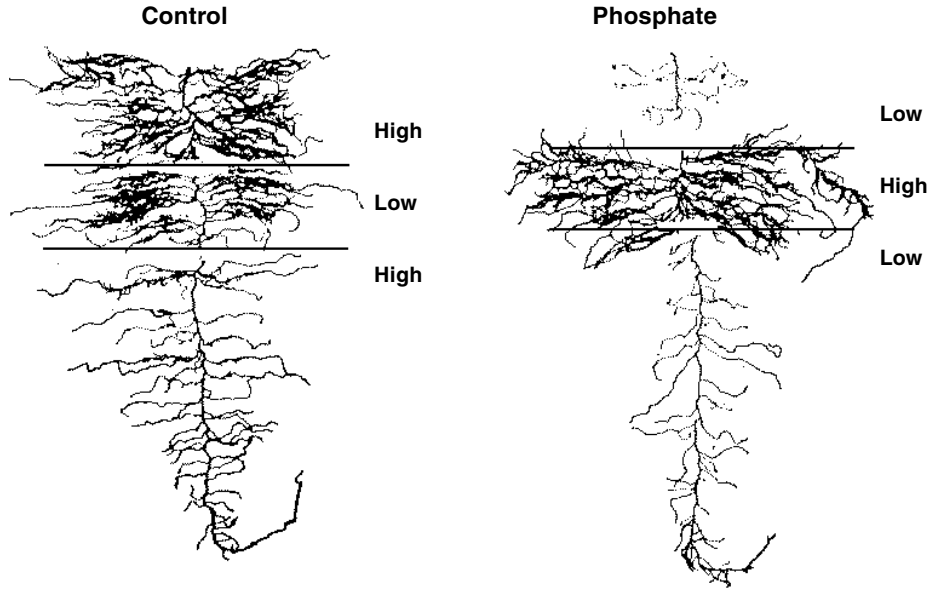


Figure 1. Barley root growth response to zones of nutrient enrichment, H.C. Drew.

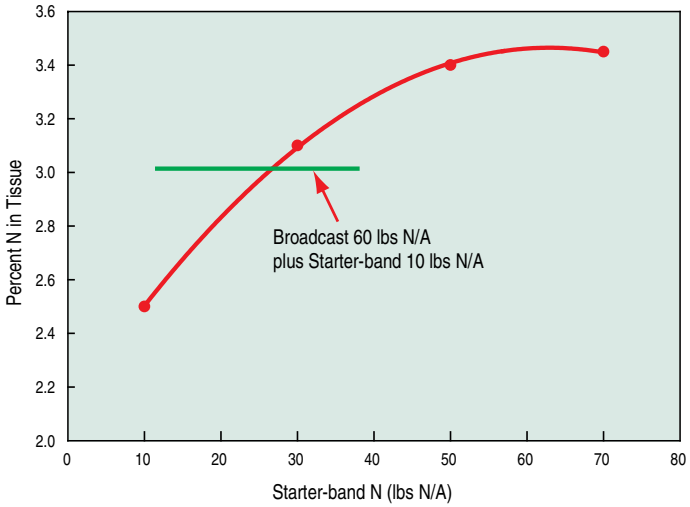


Figure 2. Percent N in whole corn plant (12- to 15-inch height) related to starter-band and broadcast N applications on a Slagle silt loam soil.

Table 1 Corn grain yield response to starter band-applied phosphorus applied at 0,20,40,60 lbs P_2O_5/acre.

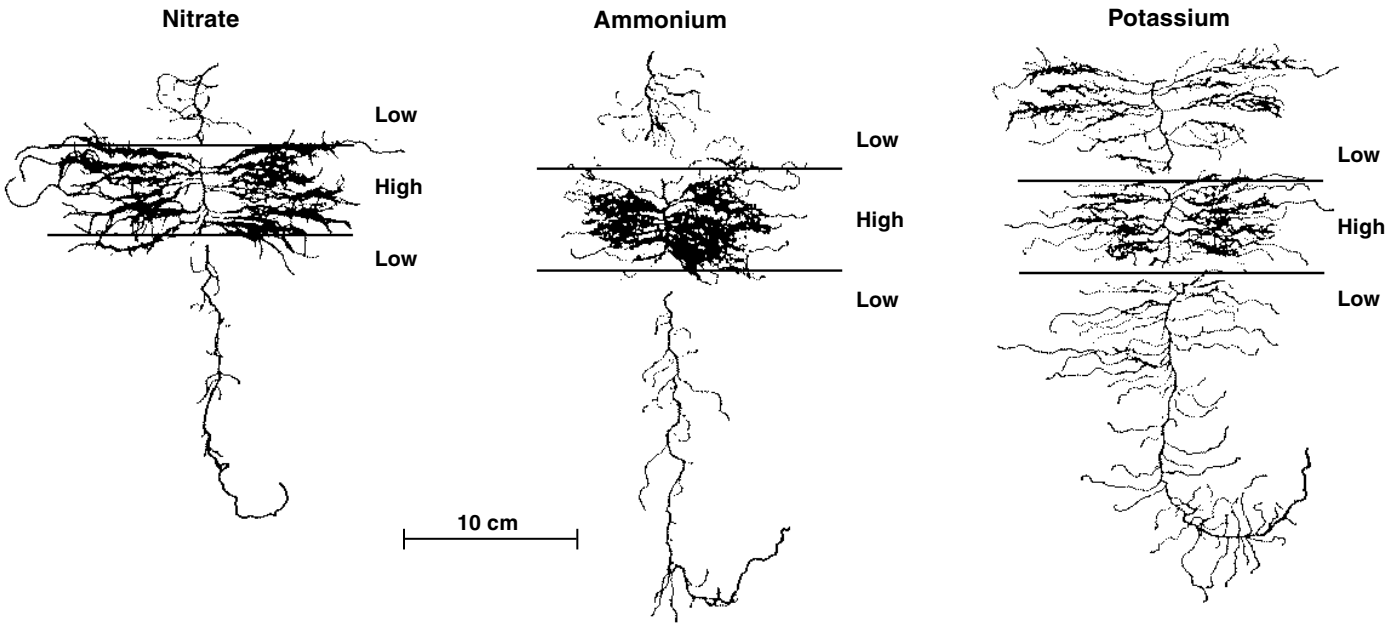
Soil Series	Mehlich I Available P (ppm)	P Calibration*	Yield Response	Average Test Yield (bu/A)
Pamunkey sil	7	Medium Plus	No	87
Slagle sil	41	High	No	149
Pamunkey fsl	22	High Minus	No	142
Slagle sl	16	Medium Plus	No	147
Turbeville sl	49	High Plus	No	95
Cullen l	8	Medium Minus	No	116
Eubanks sil	60	Very High	No	110
Ross l	17	Medium Plus	Yes	**
Pamunkey sil	12	Medium	No	143

*Mehlich I extractable P calibration used by Virginia Tech Soil Testing Laboratory.
**12 bu/A yield increase with 60 lbs P_2O_5/A.

shows the increased root growth associated with enriched levels of phosphate, nitrate, and ammonium. Response to K is limited. Although increased root growth normally has been associated with enhanced levels of P placed in starter fertilizer bands, these results illustrate that plant root growth is also increased with increased levels of ammonium and nitrate, as well as P.

Corn N response

Early-season nutrient availability is influenced by fertilizer placement. Germination and emergence of the corn seedling usually occur in six to ten days with reasonable temperatures and moisture. The corn seedling can be expected to develop two fully expanded leaves and a primary root system that obtains needed nutrients from the soil within seven days after emergence. The supply of nutrients in the seed will be exhausted by this time (seven days after emergence). The corn plant roots generally do not reach the middle of the rows until the corn plant has eight fully emerged leaves, which is about the time corn is knee-high. Therefore, during approximately the first six weeks



after planting, nutrients that are band-placed close to the corn row are more likely to be available for corn-plant uptake than if the same amount of nutrients were broadcast over the entire soil surface.

An example of enhanced N availability from starter band placement is shown in Figure 2. The percent N in whole corn plant tissue samples collected six weeks after planting (knee-high) was approximately the same with either starter band application of 30 lbs/A of N, or a surface broadcast application of 60 lbs/A of N plus 10 lbs/A of N in a starter band. The starter band N was more efficient in supplying N to the young corn plants.

Data from our studies show that optimum starter-band N rates ranged from 27 to 70 lbs/A of N for the nine experimental sites, all of which were no-till planted into wheat double-crop soybean residue. Optimum sidedress N rates ranged from 0 to 125 lbs/A of N as yield potential varied due to varying weather conditions for these mid-Atlantic Coastal Plain regional sites. Detailed analysis of the starter-band placement data demonstrated that essentially all the yield advantage for the higher starter-band N treatments could be obtained with a 50 lbs/A of N starter-band application. The 50 lbs/A of N starter-band application also reduced the potential for salt injury compared to 60 or 70 lbs/A application, and provides room in the starter fertilizer for additional K or other nutrients. The most important aspect of these data is that higher rates of starter band N are the most efficient way to apply early-season N.

Optimum sidedress N rates varied from 0 to 125 lbs/A of N in our experiments. These data are typical of Virginia conditions and result from two factors. First, large amounts of N can be released from sources such as manures and/or previous legume crop residues. When fields have a history of manure, or the corn crop is following a legume such as alfalfa, we recommend using an in-season test such as the pre-sidedress soil nitrate test (PSNT), a calibrated SPAD meter evaluation, or optical sensors to determine the sidedress N rate. Second, while drought stress will limit corn yield response to sidedress N applications in some cases, the starter band N applications of 50 lbs/A of N always ensure that early-season growth is not limited by lack of N availability.

Corn P response

Phosphorus fertilizer needs were also assessed and grain yield responses to starter P rates determined in nine field experiments.

Data in Table 1 illustrate that soil test calibrations of medium to very high are indicative of sites that show little response to added P fertilizer. This is expected as calibrations for high soil test levels mean that a low probability of yield response to applied fertilizer is expected. Only one grain yield response to applied P was found in these studies. However, as yield levels have increased with improved genetics in recent years, and more reduced tillage is being practiced, if any crop response is going to occur to applied P, it is most likely to be found in starter-band applications. Therefore, we recommend that all P be band-applied for no-till planted corn on soils testing medium or higher for plant-available P.

N:P ratios

Data from these trials clearly indicate that relatively high rates of N are needed in starter band fertilizers, and that P applications can be determined by soil testing. Our recommendations for corn are to apply 50 lbs/A of N in a 2 x 2 starter band in conjunction with needed P up to a rate of 50 lbs/A of P_2O_5 in the starter band. This rate of P covers the vast majority of soils used for corn production in the mid-Atlantic region. In most cases, either a 1:1 N:P ratio starter fertilizer such as 15-15-0 can be used, but on high-available P soils, starter fertilizers with ratios of 2:1 N:P, such as 20-10-0, are being used to maximize corn response to N, assure adequate early-season P, and optimize both N and P efficiency.

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