Comments on the use of Starter P Fertilizer

The following are the full articles that were summarized for the two page handout on the use of starter P fertilizer on high P soils.

Corn and Soybean Digest January 28, 2010 Phosphorus at Planting?

Feb 1, 2008 12:00 PM, By Art Latham North Carolina State University

If your soils have ample phosphorus (P), you can skip the P in your pop-up corn fertilizer without sacrificing yield, according to new research by North Carolina State University.

"Overall, using only starter nitrogen (N) fertilizer would produce yields similar to those achieved with N and P starter fertilizer in soils that test very high for P," says Deanna Osmond, North Carolina State University Extension soil scientist, who led the research.

Corn starter fertilizers have been used successfully to increase early plant growth, nutrient uptake and yields in research trials and on the farm. They also promote earlier maturity, improve southern corn billbug control and help suppress weeds through earlier shading. Use of starter fertilizers is increasing in North Carolina and the southeastern U.S.

Most research in the southeast supports the practice of including N and P in corn starter fertilizers. Osmond, Research Associate Sheri Cahill and David Hardy of the North Carolina Agriculture and Consumer Services department (NCDA&CS) showed that "producers can reduce the cost of P fertilizer application and slowly decrease the amount of P in the soil by applying only N in their starter fertilizer," Osmond says.

"This will save money and help the environment at the same time," adds Osmond, a watershed, soil fertility and nutrient management specialist.

In 2003, nearly half of soil samples submitted to the NCA&CS soil-testing laboratory tested very high in soil P, she says. (Although 2003 data is the most recent available, soil test data tend to remain relatively stable over time.)

The problem: "As soil-test P increases, off-site P loss increases through erosion, soluble P runoff or leaching," Osmond says. Phosphorus can pollute drinking water supplies and surface waters and contributes to algae blooms.

The researchers studied North Carolina coastal plain, piedmont and mountain sites that contained very high soil-test P, according to 2007 state ag department soil testing records. The researchers sought to determine if, when used on very high P soils, starter P fertilizer would affect corn and cotton growth. The research was carried out at 38 locations for corn and 13 locations for cotton — 12 of those on the coastal plain.

Researchers treated one set of test plots with starter N and P fertilizers, using 32 lbs./acre N and 13.4 lbs./acre P (N+P). Comparison test plots received 32 lbs./acre of N fertilizer only. The nutrients were applied to the top of the soil in a band near the seed. The treatments were repeated four times at each location, and soil samples were taken from each site on planting day.

The researchers measured N and P concentration in early season plant tissue, and how many days it took for the corn to display silk and for the cotton to show earliest blooms. They also measured yields for both crops.

Corn yields were greater in the mountains than the coastal plain or piedmont, and cotton yields were greater in the coastal plain than in the piedmont. However, within each region there were no differences between the N-only and N+P corn and cotton treatments.

Moreover, the data indicated no yield differences resulted from the different treatments, Osmond and Cahill say.

http://cornandsoybeandigest.com/ag-issues/phosphorus-planting/

Nitrogen and Phosphorous Fertilization of Corn

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Phosphorus Fertilizer Recommendations

Phosphorus fertilizer recommendations are based on plant-available soil test P levels that have been established for many years. The use of soil tests such as the Mehlich I and Bray P1 tests is based on P being relatively immobile in soil, and on crop response to applied P fertilizer being related to the soil test P level. Tests such as the Mehlich I and the Bray P1 have been used successfully for many years. However, there is a legitimate concern that as corn yield levels increase, the soil test levels necessary to insure adequate P availability may need to be increased. We recently conducted several experiments to determine responses to P fertilization at Mehlich I soil test levels typical of Virginia soils.

Data from nine experiments are shown in Table 2. These experiments involved the application of starter-band P at rates of 0, 20, 40, and 60 lbs P2O5/acre with optimization of all other production factors to achieve highest possible yields. Mehlich I soil test levels ranged from 8 to 60 ppm available P. There was only one grain yield response to applied P in these experiments in which grain yield levels were reasonably high for the specific growing seasons. The conclusion from these data is that the current soil test calibration levels for plant-available P are adequate and do not need to be revised.

In summary, soil test P levels are adequate indicators of corn grain yield response to applied P. **The calibration of soil tests is such that no grain yield responses will be expected when soil test P levels are in the high (H) to very high (VH) range. All fields should be tested for plant-available P and applications made according to soil test levels.**

http://www.pubs.ext.vt.edu/424/424-027/424-027.html

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PHOSPHORUS MANAGEMENT

Response of Corn and Cotton to Starter Phosphorus on Soils Testing Very High in Phosphorus

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Abstract
Phosphorus from agricultural lands poses a problem in water resources. In 2003, more than 48% of soil samples submitted to the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) soil testing laboratory tested *very high* in soil P (>120 mg dm^{-3} P). As soil test P increases, off-site P loss increases, through erosion, soluble P runoff, or leaching. On soils testing above *high* soil test P (60–120 mg dm^{-3} P), studies from the northeast and midwest United States demonstrate that no corn (*Zea mays* L.) or cotton (*Gossypium* spp.) yield response from additional fertilizer is expected. However, there have been limited studies on the effects of starter-P fertilizer on soils with *very high* P status in North Carolina and the southeast. Therefore, we undertook a study in the three physiographic regions (coastal plain, piedmont, and mountains) of North Carolina to determine if the use of

starter-P fertilizer would affect the growth of corn and cotton on soils having *very high* soil test P. Treatments were starter N and P, and starter N only. Treatment differences were not observed for corn, while the N-only treatment had greater tissue N than the N- and P-starter treatment in Piedmont cotton. Additionally, the use of only starter-N is typically more cost effective than using both N and P starter fertilizer. For production, environmental, and economic reasons, starter-P fertilizer is not warranted on North Carolina fields with *very high* soil test P values.

http://agron.scijournals.org/cgi/reprint/100/3/537.pdf

REDUCING PHOSPHORUS FERTILIZER INPUTS FOR FIELD CORN PRODUCTION

PROJECT DIRECTOR: KETTERINGS, Q. M. CZYMMEK, K.

PERFORMING ORGANIZATION
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NON TECHNICAL SUMMARY: The addition of phosphorus fertilizer to soils testing high in P reduces farm profitability and increases the risk for P losses to the environment. In this project we implement P recommendations for corn on NY farms and research stations in different parts of the state. Through field days, winter meetings and extension articles, we aim to reach a large portion of NY corn growers and reduce the use of starter P fertilizer on farm fields where a response to P is very unlikely.
IMPACT: 2002-08-01 TO 2005-07-30 Over 350 corn producers were surveyed and according to this survey, the project convinced 17 percent of the corn producers surveyed to reduce starter P application. The actual reduction in P imports for farms that reduced starter P use in the past 5 years amounted to 377 tons of P2O5 (on almost 30,000 acres of corn land). Full impact of our activities in New York can only be assessed once the NYSDAM completes it annual fertilizer sales assessment for 2005. It is expected from the results of this survey that at least 18-50 percent of those newly aware of the New York Starter P Project results will make some reduction in their application of starter P based on this awareness, levels of manure use and the results of soil tests. Getting field research out on farms and working in collaboration with producers was highly valued (Quote: The idea of doing this type of research on farm is win-win for everybody. It gets me out on farms. Gets me involved in what they are doing in the field. The other thing is that the learning model that goes with this is one that works. You cannot make behavioral change by simply talking about it. We have county specific research now. And we are able to produce impacts far quicker than we have been able to do with traditional research). Quotes from a producer: It showed me that you can grow corn with less phosphorus in the starter and still get a good yield and spend a little less and be more environmentally friendly. The fertilizer industry reacted as well. FS Gromark made two new bulk fertilizer grades with low P levels available.

http://www.reeis.usda.gov/web/crisprojectpages/194185.html

Evaluation of Starter Fertilizers for Corn on Soils Testing High for Phosphorus

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Abstract

Many soils are testing in the above optimum range for phosphorus (P) in our region. The use of traditional starter fertilizers for corn (*Zea mays* L.) that supply 20-36 kg P ha^{-1} on these soils may not be desirable. The objective of this study was to evaluate the response of corn to starter fertilizers on typical high P soils and to investigate the need for nitrogen (N), P, potassium (K), or sulfur (S) as a component of starter fertilizers. A starter fertilizer evaluation study was conducted at four sites to evaluate the effects of six materials in no-till high P soils. The liquid starter fertilizers were formulated using UAN (Urea-Ammonium nitrate), APP (Ammonium Polyphosphate), AS (Ammonium Sulfate), and KCl (liquid KCl). Starter treatments (kg ha^{-1} N-P_2O_5-K_2O-S) consisted of none, 56-0-0 (UAN), 56-34-0 (UAN+APP), 34-34-0 (UAN+APP), 34-34-0-11S(UAN+APP+AS), 10-34-0 (APP), and 11-34-11 (APP+KCl) kg ha^{-1} N-P_2O_5-K_2O-S. In the starter fertilizer evaluation study, responses to starter were variable. Generally there was little benefit from the addition of P to the starter, but there were occasional benefits in early growth and yield from the addition of K, AS or N. Yields from the AS treatment were similar or superior to the conventional starter treatment, suggesting that AS may have a role as a low P starter fertilizer material on these soils.

Keywords: Maize; Corn; Starter fertilizer; Ammonium; Ammonium sulfate; Urea-ammonium nitrate; UAN; Fluid fertilizer; Ammonium polyphosphate

http://www.informaworld.com/smpp/content~db=all~content=a713624353

Agronomy Journal 94:1024-1033 (2002)

Yield and Early Growth Responses to Starter Fertilizer in No-Till Corn Assessed with Precision Agriculture Technologies

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Received for publication October 3, 2001. Starter fertilization often is recommended to complement broadcast fertilization. This study evaluated no-till corn (*Zea mays* L.) yield and early growth responses to starter fertilization using precision agriculture tools. Strip trials, yield monitors, intensive soil sampling, global positioning systems (GPS), and geographical information systems (GIS) were used to conduct 11 trials. Liquid N–P–K starter and no-starter treatments were applied to the seed furrow in nine fields and beside and below the seeds in two fields. Grain yield and early plant growth data were analyzed with analyses of variance (ANOVA) with or without accounting for spatial correlation with nearest-neighbor analysis

(NNA). Use of NNA reduced standard errors of treatment means. Starter fertilization increased yield in seven fields, reduced yield in one field (-231 kg ha^{-1}), and often increased early growth. Yield increases were large (200–671 kg ha^{-1}) in field areas with low soil-test P (STP) (<16 mg P kg^{-1}, Bray-P_1). Responses in areas with high STP were small (80–194 kg ha^{-1}) when the starter was applied in the furrow and larger (165–465 kg ha^{-1}) when it was applied beside and below the seeds at higher N rates (16.3–27.2 kg N ha^{-1}). Across fields, early growth response (32%) was linearly but poorly correlated (r = 0.44) with yield response (2.4%). The within-field variation in yield and growth responses was not consistently related with starter treatments, soils, or soil tests other than STP. Large yield responses of no-till corn to starter are likely when STP is below optimum or when preplant or sidedress N rates are deficient.

http://agron.scijournals.org/cgi/content/abstract/94/5/1024

Title: **Maize silage yield and quality response to starter phosphorus fertilizer in high phosphorus soils in New York.**

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Document Title: Journal of Food, Agriculture & Environment

Abstract:
Dairy producers are facing increasing pressure to reduce phosphorus (P) inputs in the form of concentrates and fertilizer. However, many producers are concerned about sacrificing maize (*Zea mays* L.) yield and quality if starter P applications are reduced or eliminated for fields testing beyond the agronomic critical level. A state-wide project was initiated in New York in 2001 targeting fields that tested high or very high in soil test P. Silage yield and quality were determined for maize grown in plots without starter fertilizer, without P in the starter band, or with P banded at two levels. Trials were conducted 2001-2003 on farms (62 trials) and research stations (9 trials). There was a significant yield response to a modest P application (P_2O_5<28 kg ha^{-1}) for soils testing high in P in only one out of three years. No yield benefits were obtained in the other two years or for maize grown on very high P soils. Planting

date and recent manure history did not affect the results and soil test P levels were not well correlated with dry matter yields. Forage quality was not impacted by the treatments. The average P concentration in the silage was 2.1 mg kg^{-1} in the research trials and 2.3 mg kg^{-1} in the on-farm trials. We conclude that on sites that test high in P and have no manure applications planned for the season, P starter applications can be reduced to less than 28 kg P_2O_5 ha^{-1} while on sites that test very high in P or when manure is applied to high testing sites, P could be eliminated from the starter without a yield or quality penalty.
http://www.cababstractsplus.org/abstracts/Abstract.aspx?AcNo=20053095107

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Deep and Shallow Banding of Phosphorus and Potassium as Alternatives to Broadcast Fertilization for No-Till Corn

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Proper P and K management for no-till crops is uncertain. Potential problems include inappropriate extrapolation of soil test interpretations and fertilizer recommendations from conventional tillage, inappropriate soil sampling techniques, and inefficient fertilizer placement. This study compared broadcast, deep-band, and planter-band P and K placements for no-till corn (*Zea mays* L.). Long-term P and K trials were established in 1994 at five Iowa research centers and were evaluated for 3 yr. Eleven short-term P-K trials were established in farmers' fields during the same period. Treatments were various P (0 to 56 kg P ha^{-1}) and K (0 to 132 kg K ha^{-1}) rates broadcast, banded with the planter 5 cm beside and below the seeds, and deep-banded at the 15- to 20-cm depth before planting. Soil samples were collected from the 0- to 7.5-cm and 7.5- to 15-cm depths prior to planting. Soiltest P (P_{ST}) at the 0- to 15-cm depth ranged from very low to very high across sites; soil-test K (K_{ST}) ranged from optimum to very high. There were grain yield responses to fertilization at several sites, but no significant differences between the P or K rates and no interactions between rates and placements. Phosphorus increased yields only in soils testing very low or low, and there was no response to P placement at any site. Potassium increased yields in several soils that tested optimum or higher in K_{ST}, and yields were higher when K was deepbanded. High rates of broadcast or planter-banded K did not offset the advantage of deep-banded K. Responses were better related with deficient rainfall in late spring and early summer than with K_{ST}. Current soil-test P interpretations and P fertilizer recommendations based on chisel-plow tillage are appropriate for most Iowa soils managed with no-tillage. Further work is needed to better characterize and predict responses to deep-banded K. Because yield response was small, the cost-effectiveness of deep-band K will be determined largely by application costs.

http://agron.scijournals.org/cgi/content/abstract/90/1/27

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No-Till Row Crop Response to Starter Fertilizer in Eastern Nebraska

II. Rainfed Grain Sorghum

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Received for publication January 10, 2005. Early grain sorghum [*Sorghum bicolor* (L.) Moench] plant growth is often slowed by cool soil temperatures in no-till production systems. This inhibitory effect may be reduced through use of starter fertilizer with a grain yield response. Twelve trials were conducted in southeastern Nebraska to determine sorghum response to different starter fertilizer nutrient combinations and placement methods at different topographic positions within locations. Soil orders at trial sites included Mollisols, Alfisols, and an Entisol. Placements of N + P and N + P + S in furrow, over the row, and 50 mm deep and 50 mm to the side of the seed (50 by 50 mm) were compared for effects on early growth, grain yield, and grain water content. Treatment by topographic position interaction effects occurred at one location for early growth and grain water content and at three locations for yield. The mean effect of starter fertilizer treatments was a 48% increase in early growth in five of seven trials with low soil test P (STP; Bray-P1 $\leq$15 mg kg^{-1}); however, yield and grain water content responses to starter were not related to STP. Including S in the starter fertilizer did not increase yield. Placement effects were not consistently significant. The frequency and magnitude of no-till grain sorghum response to starter fertilizer were not sufficient for starter fertilizer use to be profitable, irrespective of STP and topographic position.

Abbreviations: S_{as}, sulfur supplied from ammonium sulfate • S_{ats}, sulfur supplied with ammonium thio-sulfate • STP, soil test P by Bray-1 • 50 by 50 mm, starter fertilizer placed 50 mm deep and 50 mm to the side of the seed

http://agron.scijournals.org/cgi/content/abstract/98/1/187

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Starter Fertilizers for Corn Production

Corn starter fertilizers have been used successfully to increase early plant growth, nutrient uptake, and yields in research trials and on the farm. They also promote earlier maturity, improve southern corn billbug control, and help suppress weeds through earlier shading. Use of starter fertilizers is increasing in North Carolina and the southeastern United States. This fact sheet presents the principles of successful starter fertilizer use, research results relevant to North Carolina, and management suggestions for corn producers.

Why Use a Starter Fertilizer?

Cool air and soil slow corn plant and root growth in the spring. When root growth is restricted, corn plants often turn purple. Early season purpling varies with variety, but most often it is a symptom of an induced phosphorus (P) deficiency. The deficiency is described as induced because it may occur on soils that test high for phosphorus. It occurs because phosphorus moves slowly in the soil. If roots do not grow enough to reach soil phosphorus reserves, the plant begins to starve for that nutrient.

In most cases, phosphorus deficiencies are temporary, and symptoms disappear as soon as soil temperatures rise to a point where root growth is stimulated and the plant can reach more phosphorus. Grain yields are not reduced every year by root stunting, but yield losses can be significant in years when temperatures are low. Additional factors that limit root growth can also induce phosphorus deficiencies. Some common causes include soil compaction, herbicide injury, and insect or nematode damage to the root system.

Starter fertilizers may be used to overcome slow root growth and the potential for reduced nutrient uptake. Starter and "pop-up" fertilizers involve at-planting placement of a small supply of nutrients near the seed (for starter fertilizer) or in the seed furrow (for pop-up types) so seedling roots can rapidly reach the nutrient source. These fertilizers are not intended to supply all nutrients needed by the crop. Their primary purpose is to provide an accessible nutrient source for root and plant growth when adverse conditions occur soon after planting.

Starter Fertilizer Elements

A field's yield potential, soil nutrient reserves, and fertilizer management programs will dictate the best combination of nutrients for use in a corn starter fertilizer. It is best to fine tune your starter needs by comparing various nutrient combinations and starter rates on your own farm. The best tools for evaluating starter fertilizer performance are a comprehensive plant tissue analysis program and comparison of final yields.

Most research in the Southeast supports the practice of including nitrogen and phosphorus in corn starter fertilizers. Research in South Carolina compared several elements in corn starter fertilizers applied 2 inches below and 2 inches to the side of the seed position (known as a "2-by-2" placement) on coastal plain soils. The results showed that nitrogen in combination with phosphorus was superior to both broadcast and banded nitrogen alone.

Furthermore, the addition of micronutrients, potassium, or sulfur to the starter did not improve yields over the nitrogen-phosphorus combination. Soil tests at these experimental sites did not call for micronutrient applications. If soil tests, field history, or past tissue analyses predict a micronutrient deficiency, adding a suitable micronutrient source to the starter fertilizer may be warranted. Lower micronutrient rates are needed for banded starters than for broadcast applications. The most common micronutrients needed on corn are manganese and zinc. Recommended starter rates are 0.75 to 1 pound of actual manganese or zinc per acre

when soils are deficient. If boron is needed, do not exceed 0.5 pound per acre of boron in a 2-by-2 band.

Support for including both nitrogen and phosphorus in starter fertilizers has come from several southeastern states. Participants in a regional workshop on corn starter fertilizers observed positive yield responses to starter fertilizers in 78 percent of research and on-farm tests.

Conclusions from the workshop stated that, over time, positive responses to starter fertilizers appear to be more consistent for nitrogen alone than for phosphorous alone. However, combining nitrogen with phosphorus in a starter fertilizer is generally the most attractive option.

Optimum Nitrogen and Phosphorus Rates in Starter Fertilizers

Materials commonly used in starter fertilizers include diammonium phosphate (DAP 18-46-0), monoammonium phosphate (MAP 11-48-0), and ammonium polyphosphate (APP 10-34-0). All of these materials have higher phosphorus than nitrogen contents. In a preliminary study of starter materials, researchers compared two commercial liquid starter fertilizers with analyses of 10-34-0 (nitrogen, phosphate, and potash) and 3-18-18 to a blended 10-10-0 starter. The commercial starters were applied at a rate of 8 gallons per acre and the experimental blend at 30 gallons per acre. In that one-year study, the blended starter delivered 30 pounds of nitrogen and 30 pounds of phosphate per acre and produced yields 10 bushels per acre higher than the other materials.

Two later studies in South Carolina and Alabama examined nitrogen and phosphorus rates in corn starter fertilizers. Both programs were conducted on Norfolk soils with high to very high phosphorus levels. Results from six tests were similar for the two states. Corn responses to starter fertilizers were more consistent for nitrogen alone than for phosphorus alone, and yields were generally greater at all nitrogen rates with the addition of 10 to 20 pounds of phosphate (P_2O_5) per acre (Figure 1). From these studies, it appears that there is an advantage on high-phosphorus soils to decreasing the amount of phosphorus in the starter fertilizer and increasing the amount of nitrogen. Optimum levels in these studies were achieved with 10 to 20 pounds of P_2O_5 and 30 to 40 pounds of nitrogen per acre. At this increased concentration, the starter nitrogen can eliminate the need for all preplant broadcast applications of nitrogen.

This fertilization management scheme would improve nitrogen use efficiency, reduce potential nitrogen leaching losses, and provide a mechanism for reducing phosphorus application rates on soils that test high in phosphorus. The desired starter fertilizer analysis can be achieved by blending dry granular materials such as DAP with ammonium nitrate or urea. Another option is to use fluid starter fertilizers by blending products such as a 10-34-0 fertilizer with 30 percent urea ammonium nitrate (UAN) solution. In areas where sulfur is needed, ammonium sulfate can be used in dry blends and fluid sources such as S-25 can be substituted for 30 percent urea ammonium nitrate solution. Before large-scale mixing, always test fertilizer materials for compatibility.

On soils testing medium or low in phosphorus, higher phosphate rates may be needed in the starter fertilizer. On medium-phosphorus soils, adding 30 to 40 pounds per acre of phosphate should be adequate. As a rule of thumb, use about two-thirds of the recommended broadcast rate. On low-phosphorus soils, consider a combination of starter and broadcast phosphorus because the majority of the root zone is likely to be deficient in phosphorus.

For the rest of this article go to:

http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-29/

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Starter Fertilizers for Corn on Soils Testing High in Phosphorus in the Northeastern USA

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Starter fertilizers with a high P analysis are commonly used in the northeastern USA for corn (*Zea mays* L.) production, despite many soils testing above optimum (>50 mg P kg^{-1}). The objective of this study was to evaluate responses to high P starter fertilizers in a band 5 cm from the row compared to alternatives such as banded higher N or conventional and low-salt in-furrow fertilizers. Two studies were conducted during 2000 through 2003 in Pennsylvania. The first study was a 3-yr on-farm study conducted to evaluate an untreated check, $(NH_4)_2SO_4$ (AS), and 10–13–8.3 (N–P–K) as starters at 41 locations across Pennsylvania on high P testing soils. Early growth increased by 17% using 10–13–8.3 and 15% using AS compared to the check. Grain yields were 3.3% higher than the check for the AS treatment. Yields from the 10–13–8.3 were not different than the check but averaged 2.0% higher. A second 3-yr study consisted of an untreated check, five banded granular starter fertilizer blends (10–13–8.3, 21–0-0–24, 16–3.5–6.7–16, 16–3.5–6.7, and 16–0-6.7–16) applied at 202 kg ha^{-1}, and three liquid in-furrow treatments applied at 35 kg ha^{-1} (7–9.1–5.8, 7–7.4–2.5 and 7–7.8–7.5). Early growth and grain yield were significantly increased in 1 of 3 yr with some higher N starters. Eliminating starters, using higher N or in-furrow starters on high P soils all appear to be possible management alternatives to high P starters.

Abbreviations: AN, ammonium nitrate • AS, $(NH_4)_2SO_4$ or ammonium sulfate • RM, relative maturity • UAN, urea ammonium nitrate solution

http://agron.scijournals.org/cgi/content/full/98/4/1121