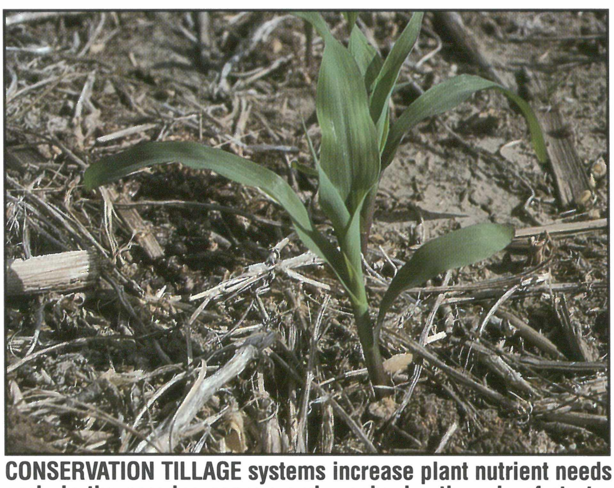
Starter Fertilizer and High Residue: A Profit-Building Combination

By Paul E. Fixen

Farmers are managing more crop residue on the soil surface as a result of less tillage and higher yields. There is a good case for starter fertilizer use under these conditions.

THE CONCEPT of starter fertilization hasn't changed for centuries, but our agriculture has. Modern high yields resulting from better management and improved varieties place increased nutritional demand on the crop's root system. Higher yielding crops produce more residue. Reduced tillage leaves more of that residue on the soil surface. Net effects are conditions that increase potential responses from starter fertilization . . . placement of nutrients in a concentrated band near the row.

Advances in planting equipment and banding attachments have reduced the inconvenience and time requirements of starter use. **Benefits of starters have increased while the agronomic costs have decreased.**



CONSERVATION TILLAGE systems increase plant nutrient needs early in the growing season and emphasize the role of starter fertilizer.

Starter Effects on Crops and Crop Management

Young root systems must have sufficient nutrients early in the growing season. Starter effects are most noticeable during this period. Starter fertilizer can:

- Enhance plant development, resulting in
  - earlier cultivation
  - increased competition with weeds
  - quicker soil cover, decreasing erosion potential
  - reduced heat stress during pollination
  - earlier harvest.
- Reduce grain moisture content at harvest.
- Improve nitrogen (N) use efficiency.
- Increase yield and crop quality.

Is Starter a Good Investment for Me?

Many factors influence responses to starters.

Residue level. High levels of residue on the soil surface from the previous crop result in larger and more frequent responses to starters **(Figure 1)**. Residues reduce surface evaporation and increase water

Dr. Fixen is Northcentral Director of the Potash & Phosphate Institute, Brookings, SD.

infiltration, leading to wetter, colder soils. This means increased response to starter fertilization. Surface concentrations of soil phosphorus (P) and potassium (K) that occur with limited tillage increase the potential for response to subsurface bands. Cool soil temperatures and a higher potential for N immobilization in crop residue can boost the need for starter N.

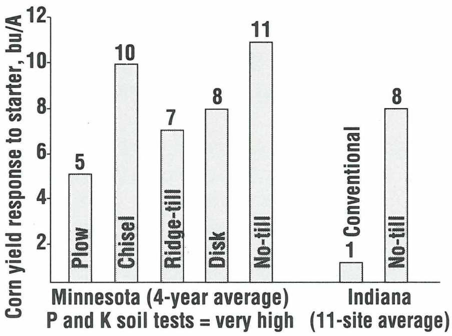


Figure 1. High residue farming increases the importance of starter fertilizer for corn.

Soil and weather conditions. Starter response is greatest when environmental conditions result in high plant nutrient demand relative to the root system's capacity to absorb nutrients. For example:

> **Cold soils** decrease root absorbing power, nutrient movement from roots to shoots, carbohydrate movement to roots and soil nutrient movement to root surfaces. Starter responses in **Figure 2** were caused, at least partially, by cold soils. Grain moisture at harvest was also reduced by as much as 10 percent with starter P.
>
> **Root growth restrictions** reduce the root system's ability to absorb nutrients. Factors include compaction (**Tables 1, 2**), soil acidity, high salinity and herbicide carryover.
>
> **High early season air temperatures and adequate soil water** increase shoot to root ratios and the amount of nutrient that must be absorbed per unit of root length. Starter responses in years with warm springs are often due to such effects.

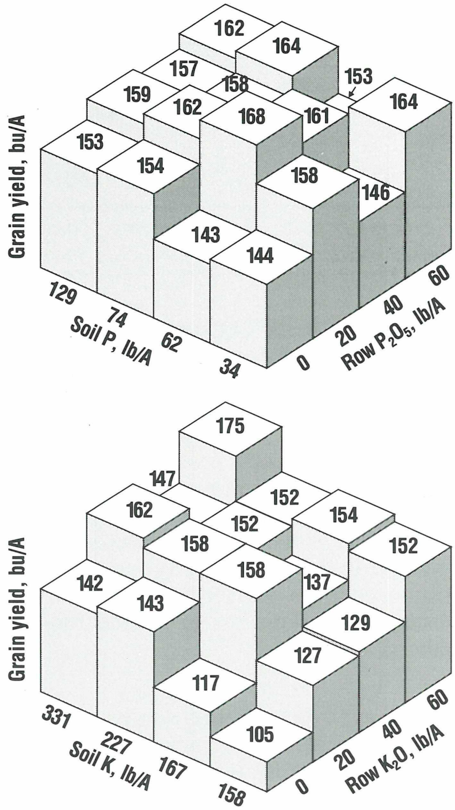


Figure 2. Corn grain yield increased with starter P and K, even on high testing soils. (Wisconsin)

Table 1. Higher soil bulk density (more compacted soil) leads to diminished P uptake by corn.

Soil texture	Bulk density, g/cm³	Shoot P, %
Silt loam	1.10	0.41
	1.35	0.35
	1.60	0.28

Ontario

Table 2. Soil compaction increases corn yield response to starter K.

	Row K_2O, lb/A	Corn yields, bu/A at compaction levels of (tons): <5	9	19
Year 1	0	132	114	111
	45	162	152	159
Year 2	0	169	168	147
	45	175	176	169

Soil test K = 204 lb/A — Wisconsin

HIGH SHOOT TO ROOT RATIOS, common in warm springs, place added stress on roots to take up nutrients early in the growing season. Starter responses are likely under such conditions.

Soil test levels. The need for starters is often expected to decrease as soil test levels increase **(Table 3, Figure 3)**. But many other factors influence starter response regardless of soil test level **(Figures 1, 2 and 4).** Substantial yield responses have occurred at soil test levels that are more than three times the level required to be classified as very high.

Table 3. Corn response to starter decreased as soil test P increased in Iowa (32-year average).

Broadcast[1] P_2O_5, lb/A	Response on two soil types, bu/A Primghar	Webster
0	12	17
46	4	9
92	2	4
138	1	7
Starter	6-23-12	6-23-23

[1]Applied once every three years.
Soil test levels: 0 P_2O_5 = very low; 138 lb/A P_2O_5 = medium.

Yield potential and cultural practices. Cultural practices can have a major influence on starter response. For example, a Nebraska study demonstrated a 33 bu/A response when irrigated corn was planted on May 8 and only a 7 bu/A response when planting was delayed to May 22. Generally, practices that lead to high yield potential increase the probability of response to starter. The full yield potential of corn growing in high yield environments cannot be achieved unless shoot P concentration at the 4 to 5 leaf stage approaches 0.5 percent. In many soils it is nearly impossible to attain that concentration without a starter band.

Local research and experience. There is no substitute for local experience with starter use. Interacting factors influence starter response and make prediction in specific situations difficult. However, the trends in crop production (conservation tillage, early planting, high yield hybrids) increase starter response probability.

Starter Effects on Profitability

Net returns. Net returns to starters can be impressive when weather conditions and cultural practices are both favorable for response. A cool, moist growing season combined with reduced tillage (spring disk) contributed to a \$48 net return to starter P on corn on a very high P testing soil **(Figure 4)**. Return at a nearby site with a soil test level more than twice as high was lower, but still substantial. Increased returns were due to higher yields and lower drying costs. A 3-year Wisconsin study with four planting dates

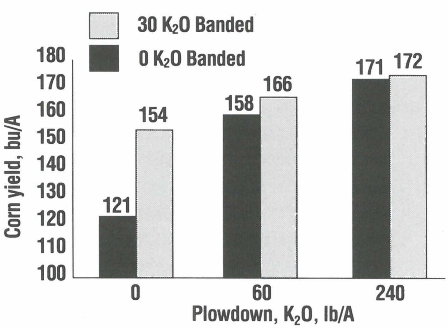


Figure 3. Responses to starter K decrease as soil test K increases. (Iowa)

and two tillage systems resulted in a profitable starter response in 19 of 24 comparisons, with an average increased net return of $12.00 per acre (data not shown).

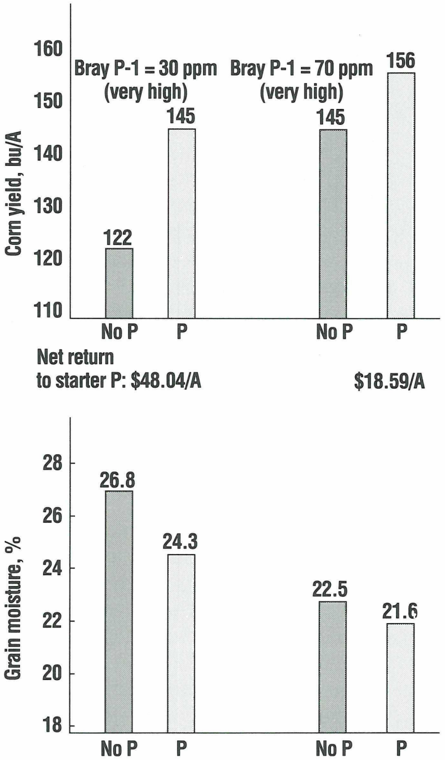


Figure 4. Cool, moist growing seasons amplify the importance of starter P even at very high soil test levels.

Data extracted with permission from the University of Minnesota Blue Book (A Report on Field Research in Soils, 1991, pp 313-316, John Moncrief, et al.)

Non-nutrient starter costs. Estimating net return to starters calculated solely on the cost of nutrients in the starter may not be appropriate if soil tests are near optimum and nutrients in the starter would have been applied, regardless of starter use, to maintain soil test levels. In such cases, the true cost of the starter involves the extra equipment required and any planting delays incurred due to starter use. These costs vary markedly and have to be determined on an individual basis.

Catastrophic crop loss. An entire crop can be lost if full season varieties are used where unusual weather has the potential to prevent crop maturity. Starter fertilizer can reduce the probability of such catastrophic crop loss by enhancing development during cool weather. Starter fertilization may also allow use of longer season varieties with higher yield potential.

Starter Placement and Equipment Alternatives

For maximum effectiveness, starter bands should not be placed more than about 3 inches to the side of the row and, preferably, below seed depth. When the normal growth angle of most roots originating from the seed is considered, the standard location of 2 inches to the side and 2 inches below the seed is nearly ideal for root interception. This usually places the band 3 to 4 inches below the soil surface, where soil moisture is likely to be favorable for nutrient uptake by roots. Placement with the seed for corn can give good early growth response, but the amount of N and K that can be safely applied is limited by the potential for salt injury. **Follow local guidelines on maximum rates for seed placement that are specific for crop and soil conditions.**

Great improvement in starter banding equipment has occurred in the last decade. Modern starter attachments offer options that are more durable, give more consistent performance, cause less soil disturbance, tolerate more residue, and frequently have lower power requirements than the conventional double disk opener of the past.

Starter Composition

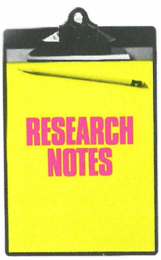
Phosphorus has been the nutrient emphasized in starter fertilizers, but evidence now supports use of a starter containing N, P, K, sulfur (S) and possibly other nutrients, depending on conditions. Studies have indicated that N, especially ammoniacal N, can enhance the response to P applied in bands. Soils with low levels of plant-available N near the surface are good candidates for high N starters.

Early growth response to starter S has also been observed in soils with low levels of S in the surface. Cold temperatures and winter precipitation may combine to cause low availability of S early in the season. Growth responses to starter zinc (Zn) are likely in soils testing low in Zn. Zinc requirements may be increased by banded P.

Environmental conditions that cause uptake problems for one nutrient, such as P, can also lead to problems for other nutrients. Starters should be tailored to the needs for specific situations. However, extra assurance of nutrient availability can be purchased at minimal costs by using a complete starter containing N, P and K, and, where soil conditions suggest, S and Zn.

Summary

A logical argument can be made that in high residue cropping systems, a portion of the maintenance nutrients should be applied in a starter band. When producers manage more surface residue, as a result of higher yields and less tillage, starter fertilizer is a best management practice that can help improve the potential benefits of modern residue management by increasing yields and profits . . . and providing better environmental protection. ■



Saskatchewan

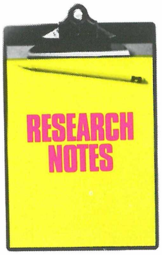
Yield Response of Canola to Nitrogen, Phosphorus, Precipitation and Temperature

IN THIS 16-year study, researchers measured the response of canola to nitrogen (N) and phosphorus (P) fertilization in relation to soil tests for these nutrients. Tests were conducted on a silty clay which had been previously cropped to spring wheat. Nitrogen was applied at rates of 40 and 120 lb/A in factorial combination with P_2O_5 rates of 0, 20, 40, 60 and 80 lb/A.

Both grain and straw responded to N and P fertilization, but the N by P interaction was not significant. The interaction effects of year by fertilization (both N and P) were significant. This indicates a wide range of response to fertilization because of precipitation, temperature and nutrient effects.

Researchers concluded that soil tests for N and P accounted for much of the variation in response to fertilization despite large yield differences among years. ■

Source: W.F. Nuttall, A.P. Moulin and L.J. Townley-Smith. Agron. J. 84:765-768 (1992).



North Carolina

Ranges in Soil Phosphorus Critical Levels with Time

THE AUTHOR points out that mathematical functions used to determine critical levels result in different soil test interpretations for phosphorus (P). Interpretations also differ because the critical soil P level may not be the same from year to year.

The long-term study from which the conclusions were drawn included nine years of crop production . . . corn (five crops), soybeans (four crops) and wheat (three crops). The soil was a Portsmouth, with a low P-fixing capacity. Yield responses to soil P were excellent. Two mathematical functions, as well as economic analysis, were used to interpret results.

Considerable ranges in critical soil P levels were formed with each crop and with each mathematical function. The author concluded that recognition of these ranges gives some justification for recommending P fertilizer on soils with P levels 50 percent greater than the average critical level for a crop grown on similar soils. ■

Source: Cox, F.R. 1992. Soil Sci. Soc. Am. J. 56:1504-1509.