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A Look at Starters on Corn

How is switching to reduced tillage affecting fertilizer placement in row crops?

It appears we once again have entered an era of increased interest in starter fertilization. Today's high yields translate into increased residue production and reduced tillage is leaving more of that residue on the surface, often resulting in nutrient stratification. Thus the increasing appeal of starter methodology that offers producers precise placement and high efficiency. Equipment manufacturers have also made great progress in offering planter banding equipment that is durable and can handle residue with a minimal increase in planting time.

Nutrient deficiency

One symptom we've been finding in today's high residue farming systems that stands out is inadequate early-season nutrition of corn, especially during years with cooler than normal springs. Such a year, for example, was 1992 in the upper Midwest. The results of a survey of 80 corn fields at approximately the V5 growth stage in Iowa, Minnesota, and eastern South Dakota are summarized in Table 1. Over 50 percent of the fields in the survey tested insufficient in P while 75 percent were insufficient in at least one nutrient. The fields selected represented a cross section of soil parent materials, soil test levels, tillage systems, and fertilizer use.

Best combinations

The question then becomes which are the best combinations of nutrients to use in planter-applied fertilizers? The relative importance of specific nutrients appears to vary with geography and cropping system, making summarizing generalizations difficult.

Best NP combinations in starters for corn found by Touchton12 in 1988 on the sandy Coastal Plain soils of Alabama, which tested very high in available P, were 40-20 or 60-0 (N-P2O5, lbs/A). Fertilizers were formulated from UAN, phosphoric acid, and water and mixed in the upper 2 to 4 inches of soil in the row area. In each of the four years, N improved early-season plant growth, while P added with N had a positive effect on early growth in only one year. Starter fertilizer increased corn yields by up to 39 bu/A when averaged over the four years.

In summarizing research on optimum N and P rates for starters in the Southeast, Zublena14 stated: 1) N and P rates in corn starters can affect grain yields, 2) starter N rates should be higher than the conventional use rate of around 10 lbs/A, 3) optimum N rate appears to be between 30 and 40 lbs/A, 4) on high P testing soils, starter P is less critical for yield, with optimum P rates around 10 lbs/A, and 5) on soils testing medium or low in P, higher starter P rates may be beneficial.

Corn response to N in starter fertilizer has also been common in the central Midwest. 1990 research in Indiana showed that N is the nutrient responsible for many responses to starter fertilizer in conservation tillage. However, Purdue University guidelines suggest that the amount of N + K2O in a 2 x 2 band for corn not exceed 40 lbs/A.

A three-year (1989-1991) cooperative research effort between the University of Nebraska and the University of Minnesota7,9,13 showed considerable flexibility exists in the N to P ratios of starters in these corn-producing states (Table 2). Some treatments were included at 7 site-years while others were included at 11 site-years. Fluid starters were applied in a 2 x 2 band in conservation tillage (not no-till or ridge-till) on soils testing low or medium in P. Yields of the no-starter checks ranged from 110 to 174 bu/A, with an average of 149 bu/A.

The greatest early growth enhancement occurred with the 1:1 N:P2O5 ratio. The 1:3, 1:2, and 1:1 ratios all had very similar effects and were essentially agronomically equal. The 2:1 and 3:1 ratios produced less early growth enhancement than the lower N starters. Grain yield increases were similar for all ratios, with the possible exception of the 3:1 ratio,

Table 1. Corn nutrient concentrations at the V5 growth stage in the upper Midwest in 1992.

Nutrient	Sufficiency Level (V5)	Measured Range	% of Fields Insufficient
N	3.40	1.60-4.70	23
P	0.35	0.14-0.63	53
K	2.70	1.00-6.30	26
S	0.16	0.11-0.29	31
Zn, ppm	20	16-46	8

80 fields tested: 35 in IA, 30 in MN, 15 in SD. In each field, 32 plants were collected from a 100-ft x 100-ft area of the major soil series.

which tended to be somewhat less effective. The average yield increase for the four lower N:P starter ratios was 9% or 13 bu/A.

Nebraska studies employing tagged N showed starter fertilizer N efficiency can be improved by a nitrification inhibitor3. Nitrate was leached from the young corn plant's rooting zone before it could be fully used. Ammonium nitrified rapidly and was also leached from the root zone. The nitrification inhibitor, dicyandiamide (DCD) increased crop uptake and microbial immobilization of the fertilizer N (Table 3). In other studies, the nitrification inhibitor N-Serve® has also increased yields and starter N efficiency.

2 x 2 is tops

Starter fertilizer placement studies in the Southeast have verified the superiority of the traditional 2 x 2 (2 inches to the side and 2 inches below the seed) placement for corn. Other placements were effective, but generally were not as consistent in stimulating early growth (Table 4).

High fertility response

Several Minnesota studies have demonstrated corn response to starters at high fertility levels if certain conditions exist10. Studies conducted in 1988, which included starter treatments, showed significant starter response at high fertility when cool, wet conditions followed planting.

Randall and Swan6 reported corn response to starters in Minnesota at very high soil test levels under conservation tillage (see under "Tillage/residue effects").

In South Dakota studies, corn response to starters appeared to be related to soil test P level in some years and not in others. Studies conducted in 1984-1986 resulted in crop response to starters regardless of tillage system or soil test level. In fact, at one location, yield response to starter in no-till corn appeared to increase as soil test P level increased. Indications were that the large early growth stimulation from starter use may have increased the importance of having an adequate level of available P in the non-band soil for late-season uptake. However, in 1987, in a different set of experiments that measured crop response to starters at 19 locations, the major factor influencing response was soil test P level1. All six yield responses measured occurred at Bray P1 levels below 16 ppm. Specific weather factors causing the differences between years were not identified.

Tillage/residue effects

Studies throughout the country have shown a marked increase in corn response to starters under reduced-tillage management systems, regardless of soil test levels5.

For example, a three-year research project at 11 Indiana sites reported yield increases from starter (2 x 2) at one site under conventional tillage and eight sites under no-till4. Average yield increases in response to starters across all 11 sites were 0.9 bu/A for conventional tillage and 7.8 bu/A for no-till. All sites in these studies were high fertility locations where starters would not have been recommended for conventional tillage.

A long-term study by Randall and Swan6 in Minnesota has shown similar tillage system effects on corn response to starters in a corn/soybean rotation. Corn response across four years for the four conservation tillage systems was an average yield increase of 9.1 bu/A, compared to 5.5 bu/A for the fall plow system (Figure 1). Soil test levels were

Table 2. Effect of 2 x 2 starter N:P ration on corn in Nebraska and Minnesota.

P_2O_5 rate lbs/acre	No. of site-years	Early Growth, N:P 1:3	1:2	1:1	2:1	3:1	Grain Yield, N:P 1:3	1:2	1:1	2:1	3:1
				%					%		
20	11	141		147	131		106		103	108	
40	11	155		162	137		112		111	111	
Avg		**148**		**155**	**134**		**109**		**107**	**110**	
20	7	143	129	148	130	122	107	105	106	107	103
40	7	147	157	159	131	111	110	110	110	112	108
Avg	**7**	**145**	**143**	**154**	**131**	**117**	**109**	**108**	**108**	**110**	**106**

100% = yield of no starter check. Summarized from progress reports by Wiese & Penas, 1989; Rehm et al., 1989, 1990; Rehm and Shapiro, 1991.

Table 3. Average percentage use by corn of ^{15}N applied in starter fertilizer at planting (Francis et al., 1993).

Growth Stage	1989 NO_3	1989 NO_4	1990 NO_3	1990 NO_3+DCD	1990 NH_4	1990 NH_4+DCD
	% Utilization					
V3	1.0	11.1	2.9	4.4	8.4	16.3
V8	10.1	20.6	51.5	49.7	61.2	62.6

Table 4. Effect of starter fertilizer placement on corn plant height. (Zublena, 1991)

Placement Method	Year 1985	1986	1987	1988
	Plant Height (inches)			
No Starter	—	13.9	14.4	10.0
2 x 2	12.9	17.1	27.3	18.3
2" below	12.5	16.8	22.5	14.4
4" below	12.4	16.5	19.7	12.8
6" below	11.4	15.3	17.3	10.8
14" surface band	—	14.3	22.0	12.6
Surface band	—	—	26.8	15.6
LSD (.05)	0.68	0.96	1.82	1.1

very high for both P and K. Starter used was 7-21-7, which delivers a lbs/A rate of 8+23+8 (N+P2O5+K2O).

Don't overlook hybrids

Recent Florida11 research on irrigated corn demonstrated large differences in the responsiveness of hybrids to starter fertilizers containing 40 lbs/A P2O5 as ammonium polyphosphate. In a three-year study of 21 hybrids, eight responded positively all three years, while responses of others varied by year. Range in average response was from 29 bu/A for a hybrid that responded positively each year to 14 bu/A for a hybrid that responded negatively each year. Additional greenhouse research revealed that hybrids that did not benefit from starter fertilization produced greater root mass than those that did.

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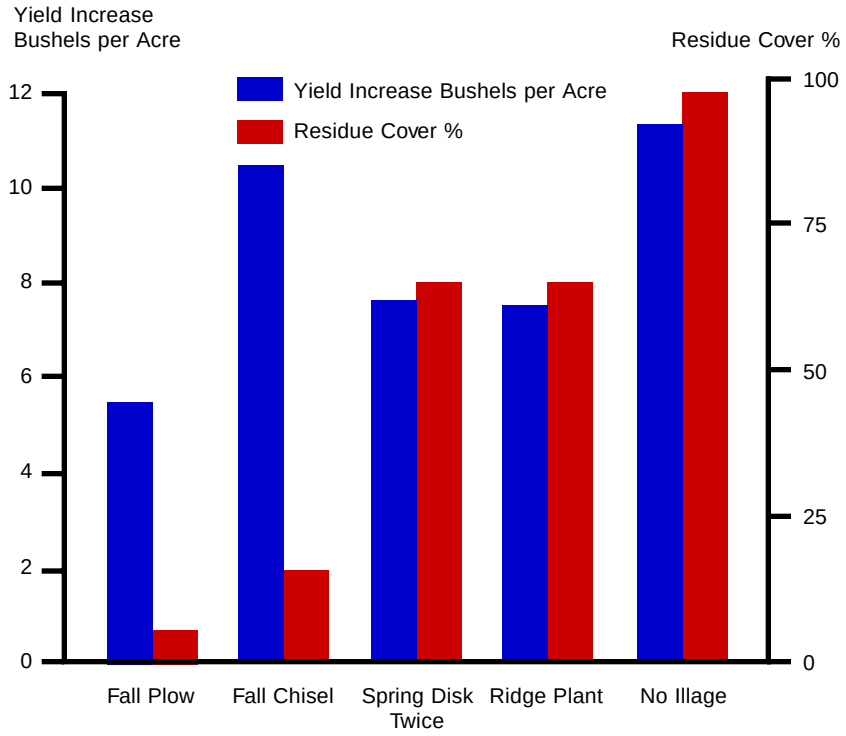

Figure 1. Influence of tillage system on corn response to starter fertilizer in southern Minnesota (Randall and Swan, 1990).

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