by Dr. Paul E. Fixen

Starters Respond More Favorably in Reduced-Tillage Environments

Studies are showing crop responses in reduced-tillage systems outperform those in conventional-tillage.

Summary: *Multi-year studies have shown that crops respond more favorably to starter applications in a reduced tillage environment than in conventional systems. Crop yields are improved. Yield losses resulting from delayed planting are reduced. Fine tuning to achieve optimum efficiency in such a system involves 1) proper fertilizer rates, 2) proper placement, 3) proper hybrid selection, 4) proper fertilizer source, and 5) minimal leaching The fundamentals of a good management program cannot be overlooked.*

Studies throughout the country have shown a marked increase in starter response with tillage reduction, regardless of soil test levels.

The theory behind the starter concept is simple, but putting it into practice is not always easy. The idea is to get a concentrated band of nutrients near the seed at planting time. Concentration insulates the nutrients from tie-up by soil and biological activities. Placing nutrients close to the seed increases the chance for early uptake by seedlings.

The myriad of equipment available is a testimony to the challenge. Usually a knife and coulter delivers liquid fertilizer near the seed. Placement two inches beside and two inches below the seed puts the starter close enough to the seed to allow easy access by emerging seedlings and yet far enough away to provide an insulating barrier against unwanted salt effects.

The switch to no-till and ridge-till has placed some constraints on starter equipment. Some ridge-till planters have so much "iron" on them already that there is simply little room for another attachment. This and other reasons have revived interest in seed placement.

Starter is ordinarily used to power the plant out of the ground and provide a boost until the crop reaches its grand vegetative growth stage. It is not used to supply all the crop's nutrient needs, especially where nitrogen and potash requirements are high.

Putting to test

Indiana research at eleven corn sites across three years has shown how starter responses can vary in different tillage environments. In the study, responses to starters increased yields at only one site under conventional-till but at eight sites under no-till. Average yield increase across all eleven sites was 0.9 bu/A for conventional-till but 7.8 for no-till. All the sites in these studies were high fertility locations where starter fertilizer would not have been recommended for conventional-till.

Another long-term study in southern Minnesota showed similar tillage system effects on a starter (7-21-7) response in a corn/soybean rotation. P and K soil test levels were very high. Average yield increase in corn across four years for four conservation-till systems was 9.1 bu/A compared to 5.5 bu/A for the fall plow system (Figure 1). Average yield increase in soybeans across all five tillage systems, however, was only 0.5 bu/A, reflecting the tendency for soybeans to be less responsive to starter fertilization than corn. Most studies in the Midwest, in fact, have shown soybeans tend to be less responsive to starters than corn. The early-season inflow requirements for soybeans are considerably lower than for corn, and the physiologicaltraits of soybean roots make them less able to use nutrients in a concentrated band. Soybeans traditionally are planted later than corn when soil temperatures are more favorable for nutrient uptake. However, the increase in no-till drilled soybeans has created interest in the possibility of using starters to maintain soil phosphate levels and provide a boost to bean yields. Researchers postulate that only applying phosphate in the corn years and lack of mixing may deplete soil P levels in no-till corn/soybean rotations. Research is now being conducted to explore the effects of starters in no-till soybeans. Watch for future editions of the Fluid Journal for updates.

A three-year Wisconsin study has shown no-till may mitigate yield loss when planting dates are delayed. Corn response to starter P and K was measured in moldboard plow and no-till systems at four different planting dates varying from April to May 24. Averaged across three years, the largest starter response in the moldboard system was 16 bu/ A, occurring at the earliest planting date. In the no-till system, response averaged -2 bu/A for the earliest date and increased for each

planting date to a maximum of 20 bu/A for the latest date. Though yields were higher for the earlier dates, this study showed that use of starter fertilizer can reduce yield loss from delayed planting, especially in no-till systems.

While recent data suggest that less tillage may improve the chances for an economical starter response, differences among hybrids in responsiveness to banded K have been measured in the northern Corn Belt. Some of the differences may be attributed to rooting architecture or nutrient uptake pattern. Preliminary growth chamber studies have shown that the more responsive hybrids may have lower root to shoot ratios and less total root length than less responsive hybrids.

Florida research on irrigated corn has demonstrated large differences in the responsiveness of hybrids to fluid starter fertilizers containing 40 Ibs/A of phosphate asammonium polyphosphate. In a three-year study of 21 hybrids, 8 hybrids responded positively all three years while the response of the other hybrids varied year by year. The range in the 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 research revealed that hybrids that did not benefit from starter fertilization produced greater root mass than those that did benefit.

Fine tuning

Today's high-yielding systems are in many ways more forgiving than the older methods we used. Growers are producing remarkable yields even under adverse conditions. When all things are working together though, every detail counts. We cannot ignore the fundamentals of a good program. Starter fertilizer will not substitute for bad management. It is an enhancement to good management. Growers should not overlook the fundamentals.

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

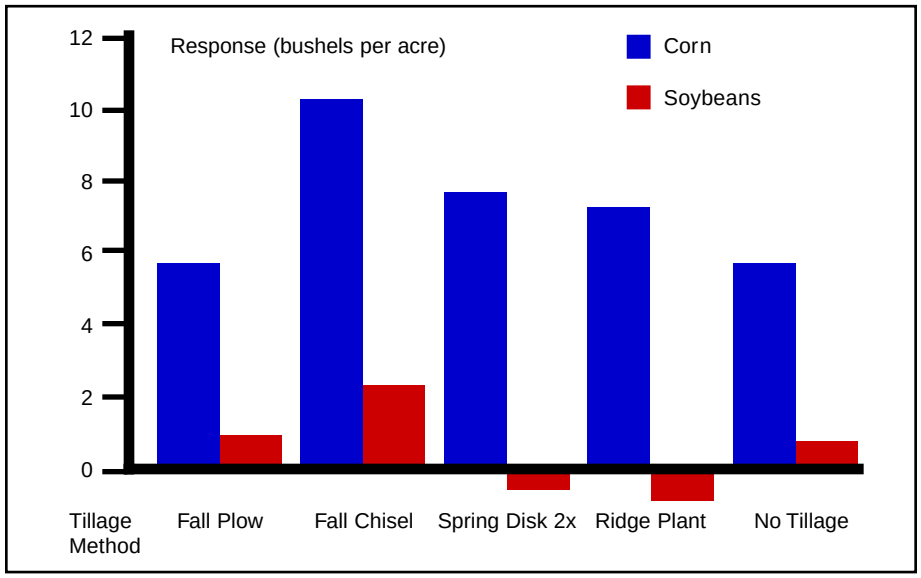

Table 1. Influence of starter source, placement, and rate on corn yields, grain moisture, and soil test P level in Wisconsin, Wolkowski and Kelling, 1985.

Source	Starter $N+P_2O_5+K_2O$ lbs/A	Placement	Three-Year Average Yield bu/A	Moisture %	Soil Test P lbs/A
None			125	26.9	44
Conv-liquid	3+7+3	Seed	133	29.7	33
UR+PA+KOH	3+7+3	Seed	128	29.6	29
Conv-liquid	6+24+24	2 x 2	139	28.3	36
Conv-dry	6+24+24	2 x 2	137	28.6	37
Conv-liquid	12+48+48	2 x 2	141	27.1	50
Conv-dry	12+48+48	2 x 2	138	27.7	52

Conv-liquid = conventional sources of urea, 10-34-0 and KCI.
UR + PA + KOH = Urea + phosphoric acid + potassium hydroxide.

Table 2. Effect of N:P ratio on 2x2 fluid starter response by corn in Nebraska and Minnesota, Wiese, Penas, Shapiro, Rehm et al.

P_2O_5 rate lbs/A	Number of site-years	Early growth, $N:P_2O_5$ 1:3	1:2	1:1	2:1	3:1	Grain yield, $N:P_2O_5$ 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	
Average	11	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
Average	7	145	143	154	131	117	109	108	108	110	106

* 100% = yield of no-starter check.

Adequate rates. Wisconsin research has shown that low rates of starters cannot substitute for more conventional

starter rates. High starter rates resulted in better yields and lower grain moisture. High starter rates maintained soil P levels while low rates resulted in soil test P declining below original levels, indicating; that soil fertility was being depleted (Table I)

Right N:P ratio. A cooperative effort between the University of Nebraska and University of Minnesota has shown considerable flexibility exists in the N to P ratio of starters of corn in these states (Table 2). Some treatments were included at seven site-years while others were included at all eleven site-years across the three years (1989-91). Fluid starters were used in a 2 by 2 placement in conservation-till (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 average early-growth enhancement occurred with the 1:1 (N:P2O5) ratio, but 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, which tended to be somewhat less effective. The average yield increase for the four lower N:P ratio starters was 9 percent or 13 bu/A.

Proper placement. Fertilizer placement on the seed is a common practice but it holds some pitfalls. It causes stress. It can reduce the number of seeds that germinate or delay germination if conditions are right. Dry soil can exacerbate the situation.

Fluid starters applied to one side and below the seed at planting provide a great opportunity to the reduced-till farmer. Unequaled fertilizer efficiency can be achieved. Uptake is increased because starters are in moist soil under the residue. Fixation loss (especially P) is reduced owing to the extremely high concentration of nutrients in a band. Less loss of nutrients means healthier young plants that can better withstand stress.

Right source. The debate of “ortho” versus “poly” is less important than application method and timing. Today’s high polyphosphates are easy to use and provide quality plant-available nutrients. In addition, the safest fertilizer may not be the most expensive (Table 3).

Minimal leaching. Nebraska studies employing isotopically tagged N have demonstrated that use of N from fluid starters can be improved by a nitrification inhibitor. N leaching is curbed as well as nitrification, increasing crop uptake and microbial immobilization of N. The end result: increased yields.

Table 3. Conductivity and salt ratios of various fertilizers, W.R. Raun et al., 1986.

Material	Conductivity mmhos	Conductivity per Unit of phosphate
9-18-9	582	32.3
10-34-0	670	19.7
7-21-7	705	33.6
7-21-7-T*	828	39.4

*Thiosulfate (12-0-0-26) to formulate up to 20 lbs/A salt rate.

Dr. Fixen is North Central director for the Potash & Phosphate Institute, Brookings, SD. ❑