No-till Corn Response to Starter Fertilizer in Missouri

Peter Scharf, MU Agronomy Extension

Background

Early research on starter fertilizer showed that it usually increased early season crop growth, but in Missouri and adjacent states this only occasionally translated into a yield advantage. With widespread changes in tillage practices over the past twenty years, this conclusion may be changing. Recent starter fertilizer trials from other states are frequently showing corn yield responses in no-till systems. Dave Mengel at Purdue University found a yield response to starter in 8 of 11 no-till site-years, but only in 1 of 11 moldboard-plowed site-years (Mengel, 1992). These experiments were paired so the weather and soils were the same for both tillage systems. This yield response was primarily to the N component of the starter. Indiana is now recommending starter in no-till situations, but not when tillage is used.

Bob Hoeft and associates at the University of Illinois often found substantial yield responses to starter in no-till systems (Hoeft et al., 1995) and smaller responses in reduced-till systems (Ritchie et al., 1997). Their research broke the starter down into component nutrients, and they found that the main yield response was to the N in the starter. They may have had a response to P in starter as well.

No-till corn and sorghum in Kansas have frequently responded to starter fertilizer in experiments conducted by Barney Gordon and David Whitney. One set of experiments tried N-only, P-only, and combinations, and found clear responses to both the N and the P; also, 30 lb N/acre out-yielded 10 lb N/acre in starter (Gordon and Whitney, 1995). Their research has also established that some hybrids of both corn and sorghum consistently respond to starter fertilizer, while other hybrids do not (Gordon et al., 1997). They have found some evidence that later-maturing hybrids respond more.

Missouri experiments

These favorable results with starter for no-till corn in states adjacent to Missouri prompted the research reported here. Based on the Illinois and Kansas results, it was possible to focus in on a few specific treatments of interest and evaluate them in on-farm replicated strip trials. The core treatments are:

1) No starter
2) Typical low-N, high-P_2O_5 starter
3) Medium-N, medium-P_2O_5 starter
4) N-only starter

Experiments were planted in cooperation with producers who currently use starter fertilizer for no-till corn production. Details from each experiment are given in Table 1. Previous crop was no-till soybean at all locations except for Elliott 1998, which was in a field newly formed from two smaller fields, one in no-till corn and the other in no-till soybean the year before the experiment (strip plots ran across both old fields). The producers' equipment was used to plant and to apply the various starter fertilizer treatments, which are described in Table 2. All experiments used the basic four starter types listed above; several producers had additional treatments that they were

interested in looking at. All treatments at a location were replicated three or four times using a randomized complete-block design. Starter fertilizer materials were weighed before and after planting to determine the actual rates applied. Plots were 12 to 30 feet wide and 375 to 1290 feet long. Two of the cooperating producers used dry starter fertilizer and two used liquid. All starter materials were placed approximately 2-3" to the side of and 2" below the seed furrow. Plots were harvested using the producers' combines and grain was weighed in a weigh wagon.

Table 1. Details of on-farm starter fertilizer experiments.

Year	Cooperating management: producer	County	Soil type	Planting date	Hybrid	Seeding rate	Dimensions of one plot	Soil test P	Nitrogen Rate	Nitrogen Source	Nitrogen Timing
						Seeds/acre		lb Bray-1 P	lb N/acre		
1996	Earl Borgman	Lafayette	Marshall silt loam	23 April	Cargill 7997	22,000	12' x 375'	17	140	NH_3	sidedress
1997	Earl Borgman	Lafayette	Marshall silt loam	5 May	Burruss BX80	22,000	12' x 450'	43	148	NH_3	sidedress
1997	Richard & Jim Elliott	Morgan	Friendly & Glensted silt loam	6 May	Burruss 720	23,500	30' x 1425'	47	108	NH_3	sidedress
1998	Earl Borgman	Lafayette	Marshall silt loam	15 May	Cargill 7770	22,000	12' x 375'	22	136	NH_3	sidedress
1998	Richard & Jim Elliott	Morgan	Glensted silt loam	24 April	Burruss 720	23,500	30' x 1290'	136	100†	NH_3	sidedress
1998	Eddie & John Hoff	Cooper	Crestmeade silt loam	23 April	Pioneer 33G26	22,400	30' x 990'	51	80	NH_3	sidedress
1998	Jim & Jerry Klasing	Saline	Marshall silt loam	16 May	Pioneer 33A14 & 33V08*	28,500	30' x 1010'	20	105‡	UAN-knife	sidedress

*The planter was split between these two hybrids, six rows of each
†The plots with no starter received 106 lb N sidedressed
‡The plots with no starter received 135 lb N sidedressed

Table 2. Starter fertilizer treatments. All starter materials were placed 2" to the side and 2" below the seed furrow except as noted.

Year	Cooperating producer	fertilizer form	analysis applied for treatment category: low N /high P_2O_5	med N/ med P_2O_5	N only	other #1	other #2
			lb N-P_2O_5-K_2O/acre				
1996	Borgman	dry	11-44-44	24-24-24	40-0-0		
1997	Borgman	dry	10-42-42	26-26-26	30-0-0		
1997	Elliott	dry	22-57-57	28-28-28	36-0-0	22-57-57 + in-furrow*	22-57-57 + starch**
1998	Borgman	dry	12-47-47	25-25-25	32-0-0		
1998	Elliott	dry	15-39-39	33-33-33	40-0-0	15-39-39 + in-furrow*	
1998	Hoff	solution	13-43-0	22-22-0	34-0-0	19.8-15.5-0-2.9S-0.4Zn	17.6-13.8-0-5.8S-0.4Zn
1998	Klasing	solution	12-42-0	30-30-0-1Zn-0.5B	44-0-0		

*5 gallons/acre of 10-34-0 in-furrow = 5.5-18-0
**starch was mixed in with dry starter fertilizer

Results

In-field observations and measurements by me and by the producers consistently found increased growth and earlier tasseling due to applications of starter fertilizer. This was also visible in aerial photos of the experiments. In general, differences between plots with starter and plots with none were clear, but differences between plots with different types of starter were small or undetectable. The N-only starter plots appeared to have less growth than the N + P starter plots in an early-season aerial photo from the Borgman 1998 experiment (the N-only starter also yielded lower at this experiment).

Significant yield increases to starter fertilizer were found in six of the seven experiments, generally with no difference in yield between the different starters (see Table 3). A yield increase of at least 9 and up to 26 bu/acre was seen in each of these six experiments. Yield increases were smaller in 1998 than in 1996 or 1997. There were not any obvious weather differences between years that would have accounted for this difference in yield response.

Table 3. Yield results for on-farm starter fertilizer experiments in no-till corn.

		yield with starter treatment category:						
Year	Cooperating producer	no starter	low N/ high P_2O_5	med N/ med P_2O_5	N only	other #1*	other #2*	LSD**
		bu/acre						
1996	Borgman	170	190	189	184			6
1997	Borgman	137	150	154	155			12
1997	Elliott	106	132	127	132	130 †	128 ‡	13
1998	Borgman	130	140	139	134			9
1998	Elliott	141	138	149	150	143 †		5
1998	Hoff	130	140	138	137	140 §	139 ¶	6
1998	Klasing	166 ***	148	151	156			8
Average over 1st 6 sites		136	148	149	149			3

*all starter treatments listed as "other" had medium N & P_2O_5, plus additions as noted below (and in Table 2):
**least significant difference, statistically, at the 95% confidence level
† placed starter + 10-34-0 in-furrow
‡ starch mixed with starter fertilizer
§ plus about 3 lb S/acre
¶ plus about 6 lb S/acre
***yield loss to starter appears to be associated with late application of Basis Gold (see text)

In the seventh experiment, at the Klasings', plots with starter fertilizer yielded significantly **less** than plots with no starter by an average of about 15 bu/acre. This was probably due to a late application of Basis Gold. Basis Gold has a label restriction of 12" corn height because it can damage the embryonic ear which begins to form shortly after the corn passes 12" height. Basis Gold was applied in this field when the corn was about knee-high (18" to 20"); because the plants were larger in the starter fertilizer plots, developing ears were probably damaged more in these plots. This idea was confirmed by ear size measurements at harvest, which showed that ears were significantly larger in the plots that had not received starter fertilizer. The yields from this location were not used in calculating average treatment effect across all locations.

The only experiments in which N + P starter appeared to out-yield N-only starter were the Borgman 1996 and 1998 locations. These experiments were on rented ground that tested low in P. Using starter P may be worthwhile in this situation, but when soil test P was medium or higher there was no benefit to adding P. Overall, the N-only starter appears to be the most cost-effective alternative.

Averaged over six experiments, the N-only starter increased yield by 13 bu/acre. An average value for this yield increase might be 13 bu/acre x $2.50/bu = $32/acre. By comparison, the material cost for the N averaged about $9/acre at the rates used, and equipment cost for the starter attachments is about $3/acre if used at least 5 years over at least 300 acres. This gives an average net return to material and equipment of $32 - 9 - 3 = $20/acre for these six experiments. Slower planting is another cost associated with using starter fertilizer, but is very difficult to put a number on. On average, using starter slows the planting operation by about ten to fifteen percent. The value of this lost time depends on the individual farming operation.

There did not appear to be any yield benefit to using in-furrow starter in addition to placed starter, nor to the addition of starch, S, Zn, or B in the experiments where those materials were used. The starch treatment was tried because researchers in Idaho have reported yield gains from using row-placed starch for wheat.

Other recent experiments in Missouri

I know of eight other starter fertilizer experiments for no-till corn that have been conducted in Missouri since 1996. These have all been small-plot experiments, mostly at Bradford Research Farm near Columbia. Results are shown in Table 4. Average yield response to starter over these eight experiments was 8 bu/acre. This is not as large as the 12 or 13 bu/acre in the strip-plot experiments, but confirms that substantial yield responses to starter are often observed in Missouri conditions.

Table 4. Yield response of no-till corn to starter fertilizer in small-plot experiments.

Year	Researcher	Location	Yield Response
			Bu/ac
1996	Wiebold	Columbia	-2
1996	Blevins	Columbia	17
1996	Stecker	Columbia	4
1996	Stecker	Novelty	12
1996	Stecker	Corning	5
1997	Wiebold	Columbia	10
1997	Blevins	Columbia	0
1998	Wiebold	Columbia	15
Average			8

Summary

- Seven on-farm starter fertilizer experiments in no-till corn were conducted from 1996 to 1998 using large strip plots.
- The main treatments were no starter, low-N/high-P_2O_5 starter, medium-N/medium-P_2O_5 starter, and N-only starter.
- Averaged over six of these experiments (the seventh was omitted due to probable herbicide damage), all starter treatments gave statistically significant yield increases relative to the no starter treatment of 12 or 13 bu/acre.
- The N-only starter was best economically due to lower material cost. Average return to fertilizer and equipment for this treatment was about $20/acre at 1996-1998 prices.
- The cost of slower planting when starter fertilizer is used is difficult to put a number on, but should be subtracted from the $20/acre figure above to figure true return to starter.
- Eight small-plot experiments in Missouri over the last three years have shown an average yield response to starter of 8 bu/acre for no-till corn.
- Starter fertilizer for no-till corn in Missouri appears to be a profitable practice on average.

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Dr. Ed Lentz
Ohio State University Extension
952 Lima Avenue
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419/422-6106

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