DR. GYLES RANDALL AND JEFF VETSCH

NPKS Starters Improve Profitability On High-Testing Soils

Studies conducted at Southern Research and Outreach Center in Waseca, Minnesota.

Historically, starter fertilizers have not been commonly recommended for corn production on high or very high P-testing soils due to poor yield response even though early growth responses may be seen. However, we've seen renewed interest in starter (band-placed) fertilizers as 1) corn yields continue to increase, 2) tillage intensity tends to decrease, and 3) corn planting comes earlier. With this renewed interest, questions have been raised regarding the inclusion of K and S in the fluid starter, as well as about optimum placement (in-row with seed vs. bands 2 inches from the seed or bands dribbled on the soil surface). Objectives of the research in this report were:

• Determine the effect of various combinations and rates of N, P, K and S as starter fertilizers for improving corn production and profitability on high P- and K-testing soils

• Evaluate starter placement positions for NPKS fluid fertilizers for corn grown on high P- and K-testing soils

• Provide to corn producers, crop advisors, and the fertilizer industry management guidelines on fluid starter fertilizer rates and placements for corn grown on high P- and K-testing soils with reduced tillage.

Concentration

Concentrations of N, P, K, and S in the whole small plant at the V6 stage were inconsistently affected by NPKS treatments (Table 1). This was particularly true for N and P where statistically significant differences were found but there was no clear effect of rate or placement and no interaction between rate and placement. Whole-plant K concentrations were not affected by starter P and K treatments. Whole-plant S concentration was increased by the 2 x 2 and 2 x 0 treatments that received S. Concentrations of NPKS were similar between 2 x 0 and 2 x 2 placement.

Dry matter

Dry matter accumulation at V6 was affected by the starter P

treatments on this high P-testing soil (Table 2). Dry matter was increased over the control by all starter treatments. Largest plants were obtained with treatments that received 10 lbs/A of K_2O and S. Dry matter accumulation was similar for both 2 x 0 and 2 x 2 placements.

Uptake

Early growth differences resulted in significant differences in NKS uptake among treatments. In general, greatest NPKS uptake occurred with the treatments receiving 10 lbs/A of K_2O and S. Placement (2 x 0 vs. 2 x 2) showed no difference in effects on NPKS uptake.

SUMMARY

This study was conducted in 2006 to determine if combinations of nitrogen (N), phosphorus (P), potassium (K) and sulfur (S) in fluid starter fertilizers and various placements (in row with seed; surface dribble, 2 x 0; and injected, 2 x 2) would increase yield and profitability on high P-testing clay loam soils in Minnesota. Plant populations were generally not affected by any of the starter treatments except for a minimal 4 percent reduction when a 6 + 20 + 6 + 4 starter mix (using KTS) was placed in-furrow as a popup placement. Concentrations of N, P, and K at the V6 stage were generally not affected by the starter treatments. Starter treatments (2 x 0 and 2 by 2) containing S increased S concentrations in the whole plants at V6. Uptake of N, P, K, and S at the V6 stage was affected by the starter treatments due to large effects of the treatments on dry matter yield. Corn yield increases of 5 to 22 bu/A were obtained with NPKS fluid starters. Greatest responses occurred when treatments contained 10 lbs/A of K_2O and S. Including S in the starter increased yields an average of 18 bu/A, while adding K to NPS had little effect on yield. NPKS placement (2 x 2 vs. 2 x 0 dribble) had no effect on grain yield.

Table 1. Concentration of N, P, K, and S in the whole small corn plant (V6) as influenced by rate, placement, and source of starter fertilizer at Waseca, in 2006.

Starter Treatments				Concentrations			
Trt	Rate	Placement	Sources	N	P	K	S
	lbs/A $N+P_2O_5+K_2O+S$			%			
1	0+0+0+0	None	None	4.39	0.465	4.12	0.230
2	6+20+0+0	Popup	APP	4.26	0.475	4.25	0.243
3	6+20+6+4	Popup	APP + KTS	4.30	0.463	4.09	0.235
4	20+20+6+4	2 x 0	APP+UAN+KTS	4.45	0.440	3.99	0.270
5	20+20+6+4	2 x 2	APP+UAN+KTS	4.44	0.483	4.33	0.248
6	20+20+0+4	2 x 0	APP+UAN+KTS	4.45	0.493	4.32	0.270
7	20+20+0+4	2 x 2	APP+UAN+KTS	4.38	0.483	3.97	0.278
8	20+20+6+0	2 x 0	UAN+7-21-7	4.30	0.475	4.51	0.245
9	20+20+6+0	2 x 2	UAN+7-21-7	4.47	0.460	4.14	0.253
10	20+20+10+10	2 x 0	APP+UAN+KTS+ATS	4.42	0.450	4.44	0.258
11	20+20+10+10	2 x 2	APP+UAN+KTS+ATS	4.38	0.448	4.28	0.278
12	20+40+10+10	2 x 0	APP+UAN+KTS+ATS	4.38	0.475	4.46	0.288
13	40+40+10+10	2 x 0	APP+UAN+KTS+ATS	4.56	0.443	4.24	0.273

Grain yield

Grain yield was increased significantly on this high P-testing soil over the no-starter control in six of the starter treatments (Table 3). The starter NPKS treatments that contained 10 lbs/A of K_2O and S consistently produced the greatest yields. When 20 lbs/A of N and P were applied, the inclusion of S gave an average yield increase of 18 bu/A compared to where S was excluded. The presence of K in starter did not appear to affect yield. Placements (2 x 0 or 2 x 2) were equally effective in increasing yield and there was no interaction between starter rate and placement.

Grain moisture

Grain moisture at harvest was not affected materially by any of the starter fertilizer rates or placement (Table 3).

Population

Initial plant population was affected slightly by the starter treatments (Table 3). Three treatments (popup placed 6 + 20 +0 +0 and 6 + 20 + 6 + 4, and 2 x 0 placed 20 + 20 + 0 +4) had populations significantly lower (1,000 to 1,200 plants/A) than the control. The latter was likely an aberration since 20 + 20 + 6 + 4 placed 2 x 0 had no effect on population nor did 40 + 40 + 10 + 10 placed 2 x 0. It is interesting to note that the popup 6 + 20 + 6 + 4 treatment, which reduced plant population 30 percent in 2005 (a cold May), reduced population by only

4 percent in 2006 when the time between planting and emergence was only 10 days.

Conclusions

In a warm year with cool early May conditions, a significant plant growth response was found for all of the starter fertilizer treatments on this high P-testing soil. Largest growth (50 percent and 65 percent larger than the control) was obtained with the treatments that received 20 or 40 lbs/A of N and P and 10 lbs/A of K and S applied in 2 x 0 or 2 x 2 bands. Similar results have been reported in Kansas (Gordon).

Plant population was reduced only 4 percent by the 6 + 20 + 6 + 4 popup treatment. Plant population was not affected by the 2 x 0 or 2 x 2 P placement or NPKS rates.

Concentrations of N, P, and K were not greatly different among any of the treatments at the V6 stage. Sulfur concentration was increased by the 2 x 0 or 2 x 2 treatments containing S. Uptake of N, K and S was greatly increased by starter due to the large effect of starter fertilizer on early growth.

Corn grain yields were increased over the no-starter control by half of the starter treatments. Greatest yields were produced by the NPKS treatments that contained 10 lbs/A of K_2O and S. Yields were increased an average of 18 bu/A when S was included in the starter, but the inclusion of K had little effect on yield. Grain yields were similar for the surface dribble (2 x 0) and sidebanded (2 x 2) placements.

Grain moisture at harvest was not materially affected by any of the starter fertilizer treatments.

Dr. Randall is soil scientist/professor and Mr. Vetsch is assistant scientist at the Southern Research and Outreach Center, University of Minnesota.

Table 2. Dry matter accumulation and uptake of N, P, K, and S in the whole small corn plant (V6) as influenced by rate, placement, and source of starter, at Waseca, in 2006.

					Whole plant samples at V6 on June 17			
Starter Treatments					Uptake			
Trt	Rate	Placement	Sources	Yield	N	P	K	S
	lbs/A $N+P_2O_5+K_2O+S$				lbs/A			
1	0+0+0+0	None	None	262	11.5	1.22	10.9	0.61
2	6+20+0+0	Popup	APP	356	15.2	1.71	15.2	0.89
3	6+20+6+4	Popup	APP+KTS	356	15.3	1.66	14.7	0.83
4	20+20+6+4	2 x 0	APP+UAN+KTS	370	16.5	1.63	14.8	0.99
5	20+20+6+4	2 x 2	APP+UAN+KTS	388	17.3	1.88	16.8	1.00
6	20+20+0+4	2 x 0	APP+UAN+KTS	338	15.0	1.66	14.6	0.92
7	20+20+0+4	2 x 2	APP+UAN+KTS	342	15.0	1.65	13.6	0.96
8	20+20+6+0	2 x 0	UAN+7-21-7	342	14.7	1.63	15.5	0.84
9	20+20+6+0	2 x 2	UAN+7-21-7	352	15.7	1.64	14.8	0.88
10	20+20+10+10	2 x 0	APP+UAN+KTS+ATS	432	19.2	1.95	19.3	1.11
11	20+20+10+10	2 x 2	APP+UAN+KTS+ATS	392	17.2	1.76	16.9	1.09
12	20+40+10+10	2 x 0	APP+UAN+KTS+ATS	396	17.3	1.89	17.9	1.12
13	40+40+10+10	2 x 0	APP+UAN+KTS+ATS	428	19.5	1.90	18.2	1.15

Table 3. Grain yield, grain moisture, and plant population as influenced by rate, placement, and source of starter at Waseca in 2006.

Starter Treatments				Grain yield	Grain H_2O	Initial plant popl'n	Final plant popl'n
Trt	Rate	Placement	Sources				
	lbs/A $N+P_2O_5+K_2O+S$			bu/A	%	P x 10^3/A	
1	0+0+0+0	None	None	209.2	20.2	34.1	33.1
2	6+20+0+0	Popup	APP	214.8	20.7	33.1	32.7
3	6+20+6+4	Popup	APP+KTS	215.4	20.5	32.9	32.7
4	20+20+6+4	2 x 0	APP+UAN+KTS	233.0	18.9	34.5	33.1
5	20+20+6+4	2 x 2	APP+UAN+KTS	221.0	20.0	34.3	33.1
6	20+20+0+4	2 x 0	APP+UAN+KTS	215.5	19.7	33.0	32.5
7	20+20+0+4	2 x 2	APP+UAN+KTS	229.0	19.4	34.2	33.1
8	20+20+6+0	2 x 0	UAN+7-21-7	206.3	19.8	33.8	32.6
9	20+20+6+0	2 x 2	UAN+7-21-7	208.5	20.9	34.5	33.1
10	20+20+10+10	2 x 0	APP+UAN+KTS+ATS	231.1	19.3	34.2	33.1
11	20+20+10+10	2 x 2	APP+UAN+KTS+ATS	223.5	19.2	34.5	33.0
12	20+40+10+10	2 x 0	APP+UAN+KTS+ATS	223.8	18.9	34.4	33.1
13	40+40+10+10	2 x 0	APP+UAN+KTS+ATS	226.2	19.5	34.5	33.0