EVALUATION OF STARTER FERTILIZER FORMULATIONS AND PLACEMENTS FOR CONSERVATION TILLAGE PRODUCTION SYSTEMS

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Abstract

With the interest in and importance of the use of starter fertilizers in conservation tillage production systems, research was continued to evaluate higher rates of N in starter fertilizers and different starter fertilizer placements. The use of starter fertilizer containing N, P and K significantly increased corn yields compared to a N only program, even though soil P and K levels were high. Increasing N rates in direct seed placed starter did not increase yields and significantly reduced plant population at both sites. Results confirm that higher N rates can be safely applied in starter fertilizers when placed away from the seed (over the row or 2x2), however, increasing N rates above 15-20 lb/a did not increase yields further. The addition of 10 lb S/a in starter fertilizer significantly increased early season corn growth and grain yield. With the cool, wet soil conditions encountered with early planting and heavy residue cover in conservation tillage production systems, the use of starter fertilizers is a sound, efficient, and profitable management practice.

Introduction

Conservation tillage systems are characterized by at least a 30% residue cover at planting time. University research over the past several years has emphasized the importance of starter fertilizers in conservation tillage crops. Conservation tillage crops are subjected to several early season stresses, which limit the plants' ability to take up nutrients early in the season. Low soil temperature and soil compaction combined with early dates of planting for long-season hybrids particularly contribute to these stresses (Johnson and Lowery, 1985; MacKay and Barber, 1984). These stresses can be partially alleviated by use of starter fertilizers even when soil test values for nutrients such as phosphorus (P) and potassium (K) are high. Research has also shown that manipulation of starter fertilizer formulations in regard to concentrations of various nutrients can have substantial influence upon their effectiveness (Farber and Fixen, 1986; Lamond and Whitney, 1991; Reeves et al., 1986; Touchton and Karim, 1986).

Some producers are very interested in applying their total nutrient program at planting in order to reduce trips and the concept of high nitrogen (N) starters has continued to develop over the past 10 years. Research has clearly shown that yield advantages accrue from higher N:P_2O_5 ratios in starter fertilizers than can be produced by normal manufacturing processes. The advantages of higher N concentrations include providing additional N supplies early in the growing season, allowing additional flexibility in timing of supplemental N applications, beneficial effects of soil P fixation reactions and enhanced P absorption even on high P-testing soils. University research has underscored the advantages in terms of higher crop yields (Zublena, 1991; Rehm et al., 1991; Gordon and Whitney, 1995).

Production of high N liquid starter fertilizers necessarily requires blending of nitrogen solution (UAN) with other starter formulations. Since half the N in UAN is urea, banding higher concentrations of N close to the seed provides opportunity for the presence of free ammonia in close proximity to the germinating seed. Crops are sensitive to free ammonia even on a very short-term basis and express that sensitivity in lowered seedling vigor and final stands.

Some observations have suggested the possibility of corn population decline with banding of high N starters close to the seed row despite the advantages these formulations have demonstrated. Grower interest in higher rates of N placed beside the row at planting under adequate rainfall or irrigated conditions combined with dryland producer interest in applying all nutrients at planting in the Central Great Plains points to the need for evaluation of techniques to avoid this germination effect and to make a proven practice even more effective. With increasing seed costs from genetic engineering, protection of seedlings and maximizing populations would be additional benefits.

With all these ideas in mind, research was conducted evaluating starter fertilizer management in conservation tillage production systems, applying higher N rates in starters, and different placements to reduce the risk of germination damage associated with higher N rates in starter fertilizers.

Materials and Methods

Studies were conducted at the North Agronomy Farm (Manhattan, dryland) and the North Central Experiment Field (Scandia, irrigated) to evaluate placements of starter fertilizers. At Manhattan on continuous no-till corn, placements included in-furrow, 2x2 and over the row (surface band); while at Scandia, on irrigated ridge-till corn, in-furrow, 2x2, over the row, and surface band 2 inches to the side of the row were evaluated. Different N rates in the starter were also evaluated. Starter P and K were included in the starter fertilizers even though both sites had high soil test levels of P and K. Starter solutions were formulated with UAN, 7-21-7 (Manhattan), 10-34-0 and potassium thiosulfate (Scandia) and ammonium thiosulfate (Manhattan). Total N was balanced on all treatments at 150 lb/a (Manhattan) and 220 lb/a (Scandia).

At both sites, final plant populations were determined, V6 dry matter yields were measured, and leaf samples were retained for analysis. Tassel-stage leaf samples also were taken for analysis. Grain yields and grain protein levels were determined.

At Manhattan, corn was planted on April 7, 2000 and April 14, 2001 while at Scandia the planting date was April 12, 2000.

Results and Discussion

Grain yields were good to excellent in 2000 while yields at Manhattan in 2001 were average due to hot, dry conditions during pollination, and the use of starter fertilizers significantly increased corn yields grown in conservation tillage production systems (Tables 1-3).

Manhattan

The use of starter fertilizer either in direct seed contact, dribbled over the row, or in a 2x2 placement increased yields compared to broadcast N only (Tables 1 and 2). Increasing N rates in the starter above 10 lb/a did not increase yields further and final plant populations were significantly reduced at the 40 and 50 lb/a N rates when placed in-furrow. Starter N rates up to 50 lb N/a placed over the row and 120 lb N/a placed 2x2 had no effect on plant populations. These results suggest that when higher N rates in a starter are used, the starter fertilizer should be placed over the row or 2x2. In the 2x2 study at Manhattan, inclusion of 10 lb S/a in the starter increased yields by 13 bu/a in 2000 and 5 bu/a in 2001. These results are somewhat unexpected as the soil is a productive silt loam with 3.1% organic matter. Apparently, the cool, wet soil conditions encountered with early planting and heavy residue cover slow S release from organic matter mineralization early in the growing season.

Scandia

When starter fertilizer was applied in-furrow with the seed, plant populations were reduced by over 7,500 plants/a when compared with the other application methods (Table 3). Corn yield was 34 bu/a lower when starter fertilizer was applied in-furrow with the seed than when applied 2 in. beside and 2 in. below the seed. Dribble application of starter fertilizer in a narrow surface band 2 in. to the side of the seed row resulted in yields equal to the 2x2 applied starter. In this year, surface band application was equal to sub-surface starter placement. The band over the row treatment resulted in yields greater than the in-furrow treatment but less than the 2x2 or surface band treatments. Grain yield and V-6 dry matter accumulation was lower in the starter treatment that only included 5 lb N/a.

Summary

The use of starter fertilizer containing N, P and K significantly increased no-till corn grain yields compared to a broadcast N-only program, even though soil P and K levels were high. Application of more than 20 lb N/a in a starter placed in-furrow reduced plant populations and reduced yields. Over-the-row (surface-band) and 2x2 placements are viable options for starter placement if higher N rates in the starter are desired, however, this research indicated that increasing N rates above 20 lb/a in a starter did not further increase yields. Including S in starter fertilizer appears to be a good management practice for early planting in no-till production systems.

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Table 1. Evaluation of starter fertilizer formulation and placement on no-till dryland corn, North Agronomy Farm, Manhattan, KS.

B'cast	Starter Fertilizer				Plant Population		V-6 Dry Wt.		Grain Yield	
N[1]	N	P_2O_5	K_2O	Placement	2000	2001	2000	2001	2000	2001
lb/a	- - lb/a - -				1000 plants/a		- - lb/a - -		- - bu/a - -	
150	0	0	0	--	20.7	24.8	163	247	105	72
140	10	15	5	In-furrow	19.7	23.5	210	294	127	82
130	20	15	5	In-furrow	19.7	24.5	163	333	122	83
110	40	15	5	In-furrow	17.3	21.6	173	281	127	90
100	50	15	5	In-furrow	15.9	16.3	120	307	111	76
140	10	15	5	Over Row	20.2	24.3	209	452	133	96
130	20	15	5	Over Row	20.7	24.5	214	384	133	92
110	40	15	5	Over Row	19.2	24.8	173	367	126	93
100	50	15	5	Over Row	20.5	25.1	161	341	128	89
LSD(0.10)					2.8	2.9	NS	65	21	11
Mean Values:										
Starter	10				20.0	23.9	209	373	130	89
N	20				20.2	24.5	189	358	127	88
	40				18.3	23.2	173	324	127	91
	50				18.2	20.7	141	324	119	82
LSD (0.10)					NS	1.8	38	NS	NS	NS
Placement	In-furrow				18.2	21.5	166	304	121	83
	Over Row				20.2	24.7	189	386	130	92
LSD (0.10)					1.5	1.3	NS	35	NS	6

[1] Broadcast N applied as ammonium nitrate after planting

Table 2. Evaluation of starter fertilizer placed 2x2 on no-till dryland corn, North Agronomy Farm, Manhattan, KS.

B'cast	Starter Fertilizer[2]				Plant Population		V-6 Dry Wt.		Grain Yield	
N[1]	N	P_2O_5	K_2O	S	2000	2001	2000	2001	2000	2001
lb/a	- - - - - lb/a - - - - -				1000 plants/a		- - - lb/a - - -		- - - bu/a - - -	
150	0	0	0	0	20.7	23.7	163	247	105	72
120	30	30	10	0	17.9	22.7	209	316	119	86
120	30	30	10	10	18.0	23.7	201	499	132	91
90	60	30	10	0	20.1	23.2	152	316	120	83
60	90	30	10	0	20.8	22.5	178	301	142	85
30	120	30	10	0	20.3	22.7	121	308	128	88
LSD(0.10)					1.5	NS	NS	91	15	6

[1] Broadcast N applied as ammonium nitrate after planting
[2] Starter was placed 2 inches below and 2 inches to the side of seed row at planting

Table 3. Effects of starter application method and composition on corn grain yield, plant population and dry whole-plant dry matter at the V-6 stage, Experiment Field, Scandia, KS, 2000.

Application method	Starter	Yield	Population	V-6 Dry Matter
	lb/a	bu/a	plants/a	lb/a
	Check 0-0-0	136.0	30,884	230
In-furrow	5-15-5	139.6	24,260	309
	15-15-5	156.5	23,142	321
	30-15-5	147.1	23,307	327
	45-15-5	147.8	23,197	326
	60-15-5	138.7	22,747	331
2x2	5-15-5	169.2	31,266	402
	15-15-5	171.7	30,729	403
	30-15-5	187.3	31,266	470
	45-15-5	184.8	30,976	549
	60-15-5	184.8	30,686	570
Dribble 2x	5-15-5	167.2	31,170	357
	15-15-5	175.0	31,655	429
	30-15-5	180.3	30,492	482
	45-15-5	181.9	30,392	446
	60-15-5	182.8	30,613	474
Row band	5-15-5	149.5	31,266	329
	15-15-5	154.4	31,557	345
	30-15-5	154.5	30,589	459
	45-15-5	165.1	30,492	456
	60-15-5	180.0	30,298	460
Method Means				
In-furrow		146.0	23,330	323
2x2		179.6	30,985	479
Dribble 2x		177.4	30,864	438
Row band		160.7	30,840	410
LSD (0.05)		10.9	840	32
Starter Means				
5-15-5		156.4	31,266	349
15-15-5		164.4	31,557	375
30-15-5		167.3	30,589	435
45-15-5		169.9	30,492	444
60-15-5		171.5	30,298	459
LSD (0.05)		10.2	849	33

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