ENHANCING CONTINUOUS CORN PRODUCTION UNDER HIGH-RESIDUE CONDITIONS WITH STARTER FLUID FERTILIZER COMBINATIONS AND PLACEMENTS

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ABSTRACT

Continuous corn production using conservation tillage systems often results in less uniform and smaller early season growth along with lower grain yields and profitability. This is especially true on fine-textured, and poorly drained soils in the northern part of the Corn Belt where decomposition of surface residues is slower and soil temps are colder. Consequently, farmers often choose to use moldboard plow tillage, where early season growth and yields are not reduced, but the erosion potential is increased. The purpose of this study was to determine the effects of fluid starter fertilizer (10-34-0 and 28-0-0, UAN) combinations and placements on second-year corn production under reduced tillage/high residue conditions. When averaged across the six starter fertilizer treatments, yields with moldboard plow tillage (180.0 bu/A) was significantly greater than for chisel/rip tillage (174.4 bu/A). Although, no starter fertilizer treatments yielded statistically greater than the no starter control, yields from the pop-up treatment and surface dribbled 10-34-0 + UAN tended to be highest under the warm and relatively dry spring conditions in 2007. Interactions between tillage and starter fertilizer treatment were not observed for any of the measured parameters.

INTRODUCTION

Crop rotations in the Midwest are changing markedly due to rapid expansion of the bio-fuel industry. Because of increased demand for corn to supply the ethanol industry and increasing insect and disease challenges facing soybean producers, farmers are switching to a corn-corn-soybean rotation and other corn intensive rotations. These rotations produce large amounts of biomass (corn stover) that often remain on the soil surface with present-day tillage systems.

Farmers who have switched to rotations where corn follows corn are concerned about yield reductions, especially when surface residue levels are high and soil temps are cooler with their current conservation tillage systems. Farmers are facing a dilemma – should they revert back to moldboard plow tillage, which greatly increases the potential for erosion but will lead to greater yields, or can they overcome the yield penalty associated with conservation tillage by using combinations of N & P fluid starter fertilizers?

The objectives of this research were to: (1) determine the effects of fluid starter fertilizer placement and combinations of 10-34-0 and 28-0-0 on second-year corn production under reduced tillage/high-residue conditions and (2) provide management guidelines on placement and rates of UAN and APP combinations for crop consultants, local advisors, and the fertilizer industry as they serve corn producers trying to meet the growing needs for corn grain by the ethanol industry and livestock producers.

EXPERIMENTAL PROCEDURES

A field experiment was established following first year corn on a Nicollet-Clarion clay loam soil complex at the Southern Research and Outreach Center, Waseca, MN in the fall of 2006. A split-plot design with four replications was used. Main plots (60' x 50') were tillage (moldboard plow vs. chisel plow) and the subplots (10' wide x 50' long) were combinations of placements and rates of fluid APP (10-34-0) and UAN (Table 1). The tillage was conducted on Nov. 9 by moldboard plowing about 9" deep and chisel-ripping about 9-10" deep with a DMI Model 2500 Disk Chisel with Tiger-point shanks. Soil tests (0-6") averaged pH = 5.2, OM = 5.8%, Bray P_1 = 25 ppm (VH) and exchangeable K = 203 ppm (VH).

Gypsum was broadcast applied at a rate of 20 lb S/A and incorporated by field cultivating on April 18. Corn (Dekalb 51-39) was planted at 33,000 seeds/A on April 26. Various combinations of APP and UAN were either applied in the furrow with the seed or dribbled on the soil surface within 2" of the seed row. Good weed control was obtained with a pre-emergence application of Harness + Callisto on April 28. Surface residue accumulation on May 11 averaged 15% and 50% for the moldboard plow and chisel-rip treatments, respectively. Stand counts were taken on the center two rows of each plots on May 18 and were thinned slightly on May 30 to give a uniform plant population across all plots (see Table 2). Supplemental N as UAN was sidedress-injected 3" deep midway between the rows on May 18 to give a total N rate of 180 lb/A on all plots. Roundup WeatherMax was applied on June 6 to eliminate weed escapes from the pre-emergence application. On June 14 (V7-8 stage) 10 random plants from each plot were cut at ground level, dried, weighed to determine dry matter, ground and submitted for N and P analyses. Plant heights of 10 random plants per plot were also taken on June 14. Grain yields and moisture content were determined on October 12 by a combine equipped with a weigh cell and moisture sensor system.

Growing conditions during the season were generally warm, especially in May when the growing degree units (GDUs) were 27% above normal. For the growing season (May through the first fall frost on Sept. 15), GDUs were 4% above normal. Although precipitation was 4.5" above normal for the May-September period, due primarily to 10.8" in August, dry conditions occurred during a 3-week period from July 10 through August 3. Rainfall totaled only 1.27" during this 24-day period. Available soil water in the top five feet was only 47% of a full soil profile with 77% below 36". Significant stress was visible during this critical silking/pollination period (R1 - R2), which limited yields below the superb yield potential shown early in July. Wet conditions causing significant denitrification and/or leaching did not occur in April-June.

RESULTS AND DISCUSSION

Early plant growth on June 14 (V7 stage) was affected by both tillage and starter fertilizer placement on this very high testing soil in this warm spring. (Table 1). Plant height, dry matter and uptake of N and P (due primarily to greater DM) were significantly greater for the moldboard plowed plots than for the chisel/ripped plots. Concentrations of N and P in the whole-plant tissue were not affected by tillage.

Plant height, dry matter, and uptake of N and P were greatest for the in-furrow placed pop-up treatment (5 gal 10-34-0/A) (Table 1). Dribbling 10-34-0 on the soil surface within 2" of the seed row did not increase plant height compared to the no-starter control. However, when 15 to 45 lb N/A was added to the surface-dribbled treatment, plant heights

were similar to the pop-up treatment. Dry matter production was not different between the control and the surface dribbled treatments that contained UAN. Although, N and P concentrations were not greatly different among the treatments, they were lowest for the pop-up treatment, probably due to dilution in the larger plants. Uptake of N and P tended to be greatest with the pop-up treatment and the surface-dribbled (2 x 0") placement that contained 45 lb N/A as UAN. Uptake of N and P was least with the surface-dribbled (2 x 0") treatment, containing no UAN. Interactions between tillage and the starter treatments were not significant ($P \leq 0.05$) for any of the early growth parameters.

Corn grain yield was affected significantly by tillage and the starter fertilizer treatments (Table 2). Yields were 5.6 bu/A greater for moldboard plow tillage compared to chisel/ripping. Yields were highest when 10-34-0 was applied in the seed furrow as a pop-up or when 10-34-0 plus 15 lb of N as UAN was surface dribbled 2" from the seed row. Lowest yields were found when 10-34-0 without supplemental N was dribbled on the surface 2" from the row. However, no yields were significantly different (LSD = 7.1) from the no starter, control treatment. A tillage x starter fertilizer interaction was not found.

Grain moisture at harvest was not affected by tillage or starter fertilizer (Table 2). Plant population was not affected meaningfully by either tillage or starter fertilizer placement.

CONCLUSIONS

The results obtained from this first-year study are not unexpected given the: a) very high soil test P (25 ppm Bray P_1), b) the warm soil conditions at the 2" depth in the 14-day period following planting (averaged 65ºF), and c) the relatively dry 14-day period after planting when five rain events totaled 0.73" (a maximum of 0.30" in one day). The primary conclusions are:

1) Early plant growth and uptake of N and P at the V7 stage were greater for moldboard plow tillage than for chisel/rip tillage.
2) Starter fertilizer (10-34-0) either placed in the seed furrow as a pop-up or combined with UAN and dribbled on the soil surface increased early plant growth and uptake of N and P.
3) Nitrogen and P concentrations in the small plants were not affected by tillage but were affected inconsistently by starter fertilizer (due to dilution).
4) Moldboard plowing produced grain yields 5.6 bu/A greater than did chisel/ripping.
5) Although none of the grain yields were significantly different from the no starter, control treatment, highest yields did occur for the pop-up treatment and when 15 lb N/A was combined with 10-34-0 and dribbled on the surface 2" from the seed rows. Higher rates of "starter N" did not produce greater yield.
6) Grain moisture at harvest and plant population were not affected by tillage or starter fertilizer.

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Table 1. Whole plant growth and nutrient uptake by corn at the V7 stage as affected by primary tillage and starter fertilizer placement and rate in 2007.

				Whole Plant Samples at V7 (June 14)					
	Starter Fertilizer Treatments			Plant	DM	Concentration		Uptake	
Tillage	Placement	10-34-0	28-0-0	height	yield	N	P	N	P
		gal/A	lb N/A	inch	T/A	%	%	--- lb P/A ---	
Chisel	None	0	0	32.0	0.375	3.62	0.377	27.3	2.82
Chisel	Pop-up	5	0	33.6	0.410	3.15	0.342	25.6	2.81
Chisel	2 x 0	5	0	30.0	0.319	3.59	0.388	22.9	2.48
Chisel	2 x 0	5	15	32.5	0.349	3.54	0.396	24.6	2.76
Chisel	2 x 0	5	30	33.7	0.297	3.55	0.382	21.0	2.28
Chisel	2 x 0	5	45	34.5	0.407	3.52	0.367	28.6	3.00
Moldboard	None	0	0	33.4	0.405	3.73	0.394	30.1	3.19
Moldboard	Pop-up	5	0	35.7	0.499	3.37	0.349	33.5	3.45
Moldboard	2 x 0	5	0	32.9	0.311	3.69	0.411	22.9	2.57
Moldboard	2 x 0	5	15	35.6	0.424	3.61	0.376	30.4	3.18
Moldboard	2 x 0	5	30	33.2	0.403	3.47	0.360	27.7	2.92
Moldboard	2 x 0	5	45	35.3	0.422	3.37	0.376	28.3	3.18
Stats for Split-Plot Design (All Treatments)									
Tillage									
Chisel				32.7	0.360	3.49	0.375	25.0	2.69
Moldboard				34.4	0.411	3.54	0.377	28.8	3.08
P > F:				0.103	0.009	0.490	0.829	0.010	0.002
Starter Treatments									
None				32.7	0.390	3.68	0.385	28.7	3.00
Popup: 5, 0				34.6	0.455	3.26	0.345	29.6	3.13
2 x 0: 5, 0				31.4	0.315	3.64	0.399	22.9	2.52
2 x 0: 5, 15				34.0	0.387	3.57	0.386	27.5	2.97
2 x 0: 5, 30				33.5	0.350	3.51	0.371	24.3	2.60
2 x 0: 5, 45				34.9	0.415	3.44	0.371	28.5	3.09
P > F:				0.001	0.001	0.001	0.030	0.002	0.034
LSD (0.10):				1.1	0.038	0.16	0.026	2.9	0.37
Interaction Tillage x Starter treatment									
P > F:				0.083	0.103	0.404	0.579	0.094	0.738
CV (%):				3.9	11.8	5.2	8.2	12.6	15.2

Table 2. Corn production as influenced by primary tillage and starter fertilizer placement and rate at Waseca in 2007.

	Starter Fertilizer Treatments			Grain		Initial Plant	Final Plant
Tillage	Placement	10-34-0	28-0-0	Yield	H_2O	Stand	Popl'n
		gal/A	lb N/A	bu/A	%	plants*10^3/A	
Chisel	None	0	0	174.9	16.1	31.3	30.9
Chisel	Pop-up	5	0	176.7	16.1	31.4	31.1
Chisel	2 x 0	5	0	166.7	16.3	31.9	31.4
Chisel	2 x 0	5	15	174.2	16.4	32.3	31.6
Chisel	2 x 0	5	30	175.8	16.2	31.7	31.3
Chisel	2 x 0	5	45	177.9	16.1	31.6	31.3
Moldboard	None	0	0	176.7	16.5	31.4	31.4
Moldboard	Pop-up	5	0	186.2	16.1	31.1	31.0
Moldboard	2 x 0	5	0	171.4	16.2	31.5	31.3
Moldboard	2 x 0	5	15	190.8	16.2	32.1	31.6
Moldboard	2 x 0	5	30	178.7	16.2	31.7	31.4
Moldboard	2 x 0	5	45	176.2	16.2	32.1	31.6
Stats for Split-Plot Design (All Treatments)							
Tillage							
Chisel				174.4	16.2	31.7	31.3
Moldboard				180.0	16.2	31.7	31.4
P > F:				0.043	0.514	0.817	0.397
Starter Treatments							
None				175.8	16.3	31.3	31.1
Popup: 5, 0				181.4	16.1	31.3	31.0
2 x 0: 5, 0				169.1	16.2	31.7	31.3
2 x 0: 5, 15				182.5	16.3	32.2	31.6
2 x 0: 5, 30				177.3	16.2	31.7	31.3
2 x 0: 5, 45				177.0	16.1	31.9	31.5
P > F:				0.044	0.601	0.012	0.036
LSD (0.10):				7.1	NS	0.4	0.3
Interaction Tillage x Starter treatment							
P > F:				0.330	0.397	0.615	0.537
CV (%):				4.7	1.6	1.6	1.1