Continuous Corn Production as Affected by Starter Fertilizers Containing N, P and S

Jeffrey Vetsch, Daniel Kaiser and Gyles Randall, Univ. of Minnesota

Introduction

Continuous corn production using conservation tillage often results in less uniform and smaller early season growth along with lower grain yields, especially on poorly drained soils in the northern Corn Belt. Research by Randall and Vetsch (unpublished) has shown many of the early growth and yield problems associated with corn after corn could be eliminated by moldboard plow tillage. Because of soil erosion concerns, the moldboard plow is not widely recommended. This research also showed a starter fertilizer containing N and P applied in-furrow or dribbled on the soil surface significantly increased early growth of corn by 13 to 43% and corn yield by 0.3 to 0.5 Mg ha^{-1}. Slow early growth and pale color of small corn plants are symptomatic of N and/or S deficiency. Corn yield responses to sulfur have been reported on medium and fine-textured soils in Minnesota (Randall and Vetsch, 2008 and Vetsch and Randall, 2010). The purpose of this study was to determine the optimum combination and placement of N, P and S starter fertilizers for corn.

Objective

To determine the effects of fluid starter fertilizer combinations and placements of ammonium polyphosphate (APP), urea ammonium nitrate (UAN), and ammonium thiosulfate (ATS) on continuous corn production in reduced tillage (chisel plow) high-residue conditions

Methods

Field experiments were conducted from 2010 through 2012 on clay loam (Typic Endoaquolls) and silt loam (Mollic Hapludalfs) soils in south-central (Waseca) and southeast (Rochester) Minnesota, respectively. Treatments consisted of a factorial arrangement of rates of three fluid starter fertilizers: 0 and 75 L ha^{-1} of UAN, 0 and 37 L ha^{-1} of APP and 0, 19, and 37 L ha^{-1} of ATS. The APP was applied in-furrow (IF) with the seed while UAN and ATS were applied as a surface band (SB) dribbled 5 cm from the row. Two additional treatments evaluated 37 L ha^{-1} of APP and 9 L ha^{-1} of ATS applied IF with and without UAN applied as a SB. Soil samples (0-15 cm depth) were taken to characterize each site. Generally, soil test P and K were at high to very high levels (Kaiser et al., 2011) except at Rochester in 2011, which required K fertilization. Corn was planted at 86,000 seeds ha^{-1} in late April or early May, except in 2011, when rain delayed planting until mid-May. At the V2-3 growth stage of corn, UAN was injected midway between the rows at various rates to give a total (at planting + V2-3) N rate of 224 kg ha^{-1} (202 kg ha^{-1} in 2010). At the V6-7 growth stage, total dry matter yield was determined by harvesting 8 random plants and extended leaf plant heights were measured from 10 random plants. Corn grain yields were taken from the center two rows with a research combine.

References

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Randall, G.W. and J.A. Vetsch. 2008. NPKS Starters improve profitability on high-testing soils. Fluid Journal. Winter 2008. p 17-19.

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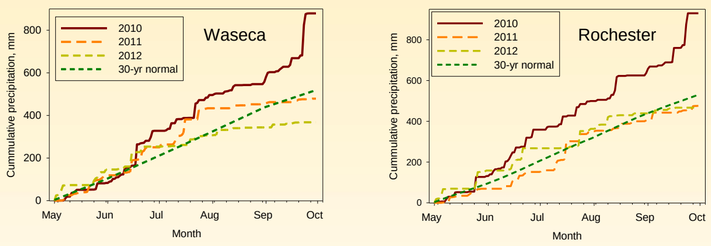

Fig. 1. Cumulative growing season precipitation during the study period at Waseca and Rochester.

Results: Waseca (clay loam soil)

Table 1. Three-year mean grain yield, grain moisture, whole plant dry matter yield, plant height and coefficient of variation of plant height as affected by starter fertilizer treatments at Waseca.

Rate and placement of starter fertilizers			Grain yield	Grain moisture	V6-7 Plant DM yield	V6-7 Plant height	CV of Plant heights
APP	UAN	ATS					
------ L ha^{-1} ------			Mg ha^{-1}	g kg^{-1}	g plant^{-1}	cm	%
0, IF	0, SB	0, SB	12.6	183	5.93	68.5	10.14
0, IF	0, SB	19, SB	13.0	180	6.80	71.3	10.60
0, IF	0, SB	37, SB	13.2	174	7.95	79.2	8.47
0, IF	75, SB	0, SB	13.2	175	8.73	81.8	5.95
0, IF	75, SB	19, SB	13.3	172	9.26	83.7	6.79
0, IF	75, SB	37, SB	12.9	175	9.47	84.4	6.31
37, IF	0, SB	0, SB	12.9	174	7.85	80.7	7.30
37, IF	0, SB	19, SB	13.2	172	9.27	84.4	7.12
37, IF	0, SB	37, SB	13.2	171	9.06	83.7	7.80
37, IF	75, SB	0, SB	12.9	173	9.35	85.1	7.40
37, IF	75, SB	19, SB	13.0	165	10.52	86.7	6.75
37, IF	75, SB	37, SB	13.1	167	10.49	88.4	5.54
37, IF	0, SB	9, IF	13.1	174	8.89	84.7	7.02
37, IF	75, SB	9, IF	12.6	171	9.41	83.6	7.57
		P > *F*:	0.478	0.584	<0.001	<0.001	0.008
		Avg LSD (0.10):	NS	NS	1.06	4.4	1.94
Treatment main effects							
APP applied in-furrow (IF)							
0 L ha^{-1}			13.0	177	8.03	78.1	8.04
37 L ha^{-1}			13.1	170	9.41	84.8	6.98
P > *F*:			0.860	0.007	0.034	0.015	0.015
UAN as surface band (SB)							
0 L ha^{-1}			13.0	176	7.80	78.0	8.57
75 L ha^{-1}			13.1	171	9.64	85.0	6.46
P > *F*:			0.891	0.153	0.107	0.118	0.118
ATS as surface band (SB)							
0 L ha^{-1}			12.9	176	7.98	79.0	7.70
19 L ha^{-1}			13.1	172	8.95	81.5	7.81
37 L ha^{-1}			13.1	172	9.23	83.9	7.03
P > *F*:			0.278	0.838	<0.001	0.019	0.229
Avg LSD (0.10):			NS	NS	0.48	2.5	NS
Treatment Interactions							
APP×UAN			0.269	0.753	0.065	0.003	0.005
APP×ATS			0.912	0.850	0.355	0.185	0.486
UAN×ATS			0.408	0.329	0.485	0.379	0.983
APP×UAN×ATS			0.414	0.372	0.499	0.078	0.078

Abbreviations: APP–ammonium polyphosphate, UAN–urea ammonium nitrate, ATS–ammonium thiosulfate, IF–in-furrow, SB–surface band, CV–coefficient of variation.

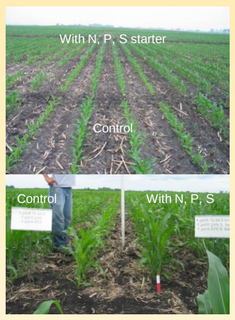

Fig. 2. Crop response to treatments at Waseca on June 20, 2011 (top) and June 21, 2010 (bottom).

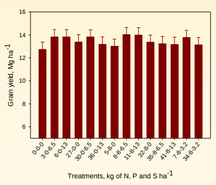

Fig 3. Grain yields at Waseca in 2010 as affected by fertilizer treatments.

Observations: Waseca (clay loam soil)

Three-yr average grain yields were not affected by N, P and S starter treatments.

In 2010, 6.5 kg S ha^{-1} increased yields 1 Mg ha^{-1} (Fig 3).

Drought conditions reduced yield potential and increased yield variability in both 2011 and 2012.

Grain moisture was reduced 7 g kg^{-1} by APP.

Generally, N, P and S starter fertilizers dramatically increased early growth of corn as measured by whole plant dry matter yield and plant height at V6-7.

APP reduced plant height CV, while UAN showed a trend (*p* value = 0.118) toward reduced CV.

Generally, significant interactions among main effects for plant height and CV of height showed starter N had a greater impact than did P or S.

Results: Rochester (silt loam soil)

Table 2. Three-year mean grain yield, grain moisture, whole plant dry matter yield, plant height and coefficient of variation of plant height as affected by starter fertilizer treatments at Rochester.

Rate and placement of starter fertilizers			Grain Yield	Grain moisture	V6-8 Plant DM yield	V6-8 Plant height	CV of Plant heights
APP	UAN	ATS					
------ L ha^{-1} ------			Mg ha^{-1}	g kg^{-1}	g plant^{-1}	cm	%
0, IF	0, SB	0, SB	13.4	190	9.2	73.9	7.92
0, IF	0, SB	19, SB	13.4	185	8.8	73.6	6.18
0, IF	0, SB	37, SB	13.6	183	9.3	75.0	6.85
0, IF	75, SB	0, SB	13.3	188	10.3	75.6	7.00
0, IF	75, SB	19, SB	13.5	179	10.9	79.1	6.41
0, IF	75, SB	37, SB	13.6	180	10.3	78.3	5.83
37, IF	0, SB	0, SB	13.4	175	12.6	81.1	6.04
37, IF	0, SB	19, SB	13.4	182	12.3	82.6	6.53
37, IF	0, SB	37, SB	13.6	172	13.1	83.4	6.47
37, IF	75, SB	0, SB	13.4	176	12.1	82.7	7.25
37, IF	75, SB	19, SB	13.6	173	13.4	83.3	5.92
37, IF	75, SB	37, SB	13.5	180	13.7	83.5	6.32
37, IF	0, SB	9, IF	13.4	179	12.5	82.4	6.38
37, IF	75, SB	9, IF	13.4	177	13.2	82.8	6.67
		P > *F*:	0.927	0.001	0.007	0.001	0.440
		Avg LSD (0.10):	NS	6	2.3	4.3	NS
Treatment main effects							
APP applied in-furrow (IF)							
0 L ha^{-1}			13.5	184	9.8	75.9	6.70
37 L ha^{-1}			13.5	176	12.8	82.8	6.42
P > *F*:			0.929	0.200	0.197	0.148	0.501
UAN as surface band (SB)							
0 L ha^{-1}			13.5	181	10.9	78.3	6.67
75 L ha^{-1}			13.5	179	11.8	80.4	6.46
P > *F*:			0.970	0.062	0.013	0.001	0.611
ATS as surface band (SB)							
0 L ha^{-1}			13.4	182	11.0	78.3	7.05
19 L ha^{-1}			13.5	180	11.3	79.7	6.26
37 L ha^{-1}			13.6	179	11.6	80.1	6.37
P > *F*:			0.460	0.068	0.519	0.222	0.051
Avg LSD (0.10):			NS	2	NS	NS	0.58
Treatment Interactions							
APP×UAN			0.914	0.062	0.177	0.038	0.389
APP×ATS			0.757	0.003	0.537	0.957	0.408
UAN×ATS			0.493	0.001	0.356	0.570	0.585
APP×UAN×ATS			0.895	0.047	0.750	0.320	0.103

Abbreviations: APP–ammonium polyphosphate, UAN–urea ammonium nitrate, ATS–ammonium thiosulfate, IF–in-furrow, SB–surface band, CV–coefficient of variation.

Observations: Rochester (silt loam soil)

Three-yr average grain yields were not affected by N, P and S starters.

In 2011, grain yields were increased 0.2 Mg ha^{-1} by APP and 0.8 Mg ha^{-1} by 37 L ha^{-1} of ATS (data not shown).

Grain moisture was reduced slightly by UAN and ATS application.

UAN increased early growth of corn as measured by whole plant dry matter yield and plant height at V6-8 while ATS reduced plant height CV.

Conclusions

Generally, APP, ATS and UAN applied as starter fertilizers increased early growth of continuous corn in reduced tillage on a poorly drained clay loam soil at Waseca, but yield responses where inconsistent. Only small differences in early growth were observed on the well drained silt loam soil at Rochester.

Acknowledgement

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