

Starter Fertilizer and Row Cleaning Did Not Affect Yield of Early-Planted, No-Till Grain Sorghum

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Abstract

Cool soil temperatures in no-till production systems often slow early grain sorghum [*Sorghum bicolor* (L.) Moench] plant growth. This inhibitory effect may be reduced through use of starter fertilizer, nitrogen band-applied over the crop row, or removal of crop residues from the row before or at planting time to increase soil temperature. Six trials were conducted in 2004 and 2005 in eastern Nebraska with early-planted grain sorghum under continuous no-till conditions. Soil organic matter was 30 mg/kg or more and Bray-P1 ranged from 19 to 46 mg/kg in the top 5 cm of soil and from 6 to 11 mg/kg for the 5- to 20-cm depth. Application of N at 30 kg/ha in a band over the row at planting time, in-furrow application of starter fertilizer containing N+P or N+P+S, and row cleaning before or at planting all resulted in earlier flowering of sorghum. Grain water content was slightly reduced with row cleaning. However, none of these practices individually or in combination affected kernel size, panicle number or grain yield for early-planted grain sorghum grown in no-till conditions.

Introduction

No-till sorghum production is common in southern Nebraska. Heavy residue cover, often prevalent in no-till production systems, typically keeps soil temperatures cooler than conventionally prepared seedbeds. This may slow germination, early shoot and root growth, and early nutrient uptake, and thereby reduce yield.

Studies have shown that using starter fertilizer in high residue environments typically increases the rate of early plant growth that may (5) or may not (7,15) translate to increased grain yield of sorghum. No-till grain sorghum yield was not affected by starter fertilizer use in southeastern Nebraska when trials were planted between 19 and 26 May, which is the typical planting time for sorghum in that environment (15). Corn (*Zea mays* L.) yield response to starter fertilizer has often been profitable for no-till conditions (10,11,12,13), but not always (1,2,3,14). Increasing N supply to young seedlings by band application of some N over the row rather than all N applied pre-plant increased irrigated ridge-tilled corn yield (6). The inconsistencies are not well understood although corn yield increase was more frequent with low available soil P and adequate soil water throughout the season (14).

Removing crop residues from the row area, such as in a 15-cm wide band, increases soil exposure to solar radiation. Row cleaning may result in increased soil temperature and enhanced early plant growth (13).

The objective of this research was to evaluate the effects of in-furrow starter fertilizer, over-the-row band application of N, and row cleaning on the yield performance of early planted, no-till grain sorghum.

Site Characteristics

Trials were conducted on silt loam or silty clay loam alluvial (Nodaway and Kennebec), colluvial (Judson), and loess (Wymore and Sharpsburg) soils in

2004 and 2005 at Rogers Memorial Farm located 16 km east of Lincoln, NE (Table 1). The previous crop was always soybean [*Glycine max* L. (Merr.)] and the crop preceding soybean was either corn or wheat (*Triticum aestivum* L.).

Table 1. Site information for six grain sorghum trials conducted in 2004 and 2005 at Rogers Memorial Farm in southeastern Nebraska.

Previous crops ^x	Soil series ^y	Yield ^z (Mg /ha)	RC (%)	pH		SOM (g/kg)		Bray-P1 (mg/kg)		K	
				Soil depth (cm)							
				0-5	5-20	0-5	5-20	0-5	5-20	0-5	5-20
Planted 5 May 2004											
WH-SB	Sharpsburg	8.65	79	6.7	5.8	37	31	44.1	5.8	587	332
C-SB	Judson	8.80	45	7.0	5.4	30	28	25.8	11.4	539	277
C-SB	Nodaway	8.15	63	7.1	6.2	35	31	46.3	11.4	524	250
Planted 6 May 2005											
WH-SB	Wymore	8.83	82	6.8	6.6	33	29	18.9	7.6	477	389
WH-SB	Sharpsburg	8.50	84	7.4	5.9	34	27	53.1	11.3	579	293
C-SB	Kennebec	8.94	86	7.2	5.4	36	34	29.4	9.1	446	193

^x C = corn; SB = soybean; WH = wheat.

^y Soils were silty clay loams or silt loams. The corresponding great soil groups were: Judson, Cumulic Hapludolls; Kennebec, Cumulic Hapludolls; Nodaway, Mollic Udifluvents; Sharpsburg, Typic Argiudolls; Wymore, Aquertic Argiudolls.

^z Yield = the mean yield for the trial; RC = percent ground cover by crop residue; SOM = soil organic matter.

Surface soil samples (0 to 5 and 5 to 20 cm) were taken at all experimental sites before planting. One sample of 10 cores of 17.5-mm diameter was collected from two replications and another sample from the other two replications. Soil test P levels were stratified as is typical under continuous no-till (Table 1) (1). Bray-P1 was low to medium below the 5-cm depth but very high in the surface 5-cm depth with the exception of the Wymore soil in 2005 (4).

Crop residue cover of the soil was measured after planting using a line intersect method with two 30-m opposite diagonal measurements per trial and counting crop residue intersections at 100 points per diagonal (12). Crop residues covered a mean of 75% of the soil surface (Table 1).

Soil temperature was monitored at the 10-cm depth for three weeks after planting in 2004 (Optic StowAway Temp, Onset Computer Corporation, Bourne, MA) as soil temperature differences were expected to affect root extension and nutrient availability during this period. Two sensors each were placed immediately after planting in the row area for a row-cleaning and a no-row-cleaning treatment. Mean soil temperatures during the first week and the 3-week period after planting were 17.6°C and 19.1°C, respectively, with only 0.1°C higher mean temperature with row cleaning. These temperatures were above the minimum 16°C cardinal temperature for sorghum germination (8) while mean temperatures were likely higher at shallower depths. Due to the very small effect of row cleaning on soil temperature in 2004, these observations were not repeated in 2005.

Treatments and Experimental Design

Ten treatments comprised two complete factorials. The factors included surface application of a band of N, starter fertilizer, and row cleaning. The starter fertilizer × N band factorial was comprised of three starter fertilizer treatments and two N band rates. The starter fertilizer × row-cleaning factorial was comprised of the starter fertilizer treatments and three row-cleaning treatments.

The rates for the N band factor were 0 and 30 kg of N per ha dribbled over the row during planting as dissolved ammonium nitrate solution. The starter

fertilizer levels were: no starter fertilizer applied; 6.4 kg of N plus 9.5 kg of P per ha as ammonium polyphosphate; and a mixture of ammonium polyphosphate and dissolved ammonium sulfate that supplied 12.1, 9.5, and 6.5 kg of N, P and S, respectively, per ha. Potassium was not included in the starter fertilizer as soil test K was always very high (> 250 mg/kg) (4). Starter fertilizer was applied in the seed furrow during planting.

The row-cleaning treatments were no row cleaning, row cleaning before planting, and row cleaning during planting. Row-cleaning units (Case IH, Racine, WI) were set to clean crop residue from a 15-cm band with minimal disturbance of the soil.

The trials had four replications in a randomized complete-block design. Plot size was 4.5 m by 15.0 m. An area of 1.5 m × 6.1 m was harvested for grain yield determination.

Crop Management

In 2004, 155 kg of N per ha was injected at least two weeks before planting as anhydrous ammonia over the whole trial area. In 2005, ammonium nitrate was surface applied before planting at the rate of 60 and 80 kg of N per ha in plots where the N band treatment was and was not applied, respectively. The 2004 N rate did not fully account for N credits and exceeded crop needs, but was not so high as to have a negative effect on crop performance (4). The 2004 N rate may have affected response to the N band treatment but was not likely to affect other treatments. The pre-planting row-cleaning operations occurred on 19 April 2004 and 29 April 2005. The trials were planted on 5 May 2004 and 6 May 2005 which is two to three weeks earlier than normal for this area. The 6-row planter was equipped for row cleaning and for in-furrow and over-the-row fertilizer application. The row spacing was 76 cm and the planting rate was about 190,000 seed/ha. The grain sorghum hybrid was NC+7R37E (NC+ Hybrids, Lincoln, NE).

Data Collection and Analysis

Data were collected for days to 50% flower, panicle number, 100-kernel weight, grain yield, and, in 2005, grain water content. Panicle number and grain yield were determined by harvesting a 6-m length of the center two rows. Trials were harvested by hand after reaching physiological maturity in 2004 and panicles were threshed after drying. In 2005, a plot combine was used for harvest. Grain yield was adjusted to 155 mg/kg grain water content.

Combined analyses of variance were conducted for the three trials of each year using Statistix 8.0 (Analytical Software, Tallahassee, FL). The combined analysis was not extended to years because of differing N application rates. The 2-way interaction effects for starter fertilizer × N band and for starter fertilizer by row cleaning were tested using the appropriate sub-sets of data for each factorial. Treatment effects were considered to be statistically significant at $P < 0.05$.

Effects on Crop Performance

The starter fertilizer by N band treatment interaction was significant in 2004 due to late flowering with the treatment that received neither starter fertilizer nor band applied N compared with the treatment with band applied N but no starter fertilizer (Table 2). Flowering was about 79 days after planting for the band application of N, starter fertilizer, and row-cleaning treatments, but 83 days for the control treatment.

Table 2. Starter fertilizer and row-cleaning main factor effects on grain sorghum performance under no-till conditions in six trials in southeastern Nebraska.

Treatments	Days to 50% bloom		Panicles per m ² ^x		Grain yield (Mg/ha)		Grain water (g/kg)
	2004	2005	2004	2005	2004	2005	2005
Control	83.6	76.0	20.0	14.6	8.52	8.60	15.4
Surface band application of N	79.7	74.1	20.3	15.2	8.60	8.80	15.5
Starter N+P fertilizer	79.5	73.8	20.2	15.0	8.63	8.83	15.6
Starter N+P+S fertilizer	79.2	74.5	20.1	15.0	8.88	8.72	15.5
Row cleaning before planting	80.4	73.7	19.0	14.8	8.35	8.72	14.9
Row cleaning during planting	80.1	73.5	19.4	14.9	8.10	8.94	14.9
Starter N+P, plus row cleaning	79.0	73.1	19.3	14.9	8.36	8.97	14.9
Treatment	***	***	NS	NS	NS	NS	*
Trial × treatment	NS	NS	NS	NS	NS	NS	*y
Starter × N band	*	NS	NS	NS	NS	NS	NS
Starter × row cleaning	NS	NS	NS	NS	NS	NS	NS
CV	1.6	1.3	6.6	7.4	8.2	7.7	4.9

NS, *, *** not significant and significant at 0.05 and 0.001, respectively.

^x The means for 100-kernel weight are not included here as there were no treatment effects. The mean weight was 2.67 g/100 seeds.

^y The trial × treatment interaction was significant due to a decrease in grain water content in one trial while there was no effect in the other two trials.

The mean grain yields were above 8 Mg/ha for all trials (Table 1). The two-way interactions of band application of N × starter fertilizer and of row cleaning × starter fertilizer did not have a significant effect on any of the measured traits in either year except for an interaction effect on days to flower in 2004 (Table 2). The main effects of band application of N, starter fertilizer application, and row cleaning also did not affect grain yield, panicle number, or 100-kernel weight in either year. Mean grain water content at harvest in 2005 was less with row cleaning than with all other treatments, but this effect occurred in only one of the three trials. Treatment effects for the three trials conducted in 2004 were consistent with effects for the three trials conducted in 2005, as indicated by the lack of treatment by trial interaction effects, despite the different blanket N application rates.

The results for the starter fertilizer treatments are consistent with other findings (7,15) but contrast with the results of Gordon and Whitney (5) where soil test P was higher and soil organic matter was lower than in these trials. The difference in soil organic matter may account for the contrasting results suggesting a greater probability of response to starter fertilizer when soil organic matter is relatively low, such as less than 27 g/kg soil. If so, soil organic matter level may be an important determinant of yield response to banded N application and row cleaning as well.

Treatment effects on yield are even less likely at typical planting times for grain sorghum which are two to three weeks later than the planting dates for these trials as seedling exposure to low temperature soil would be less. Different placement of the starter fertilizer is not likely to result in a yield increase (8,14,15). Exceptional cases may occur where the enhanced early growth or earlier flowering may contribute to increased grain yield, but this did not occur in these six trials and in 12 other trials conducted in southeastern Nebraska (15).

Conclusion

Grain yield of early planted no-till sorghum was not increased in southern Nebraska by applying a band of N over the row relative to applying all N pre-

plant, nor by starter fertilizer application, row cleaning, or by a combination of these practices. Considering the results of this and other research (15), starter fertilizer and row cleaning are not productive practices for no-till grain sorghum production in this environment unless increased early growth is valued for reasons other than effects on yield.

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Literature Cited

1. Bermudez, M., and Mallarino, A. P. 2004. Corn response to starter fertilizer and tillage across and within fields having no-till management histories. *Agron. J.* 96:776–785.
2. Borges, R., and Mallarino, A. P. 2000. Grain yield, early growth and nutrient uptake of no-till soybean as affected by phosphorus and nutrient placement. *Agron. J.* 92:380-388
3. Bundy, L. G., and Andraski, T. W. 1999. Site specific factors affecting corn response to starter fertilizer. *J. Prod. Agric.* 12:664–670.
4. Ferguson, R. B. 2000. Grain and silage sorghum. Pages 97-103 in: *Nutrient management for agronomic crops in Nebraska*. R. B. Ferguson, ed. Univ. of Nebraska Coop. Ext. EC 01-155-S, Lincoln, NE.
5. Gordon, W. B., and Whitney, D. A. 1995. No-tillage grain sorghum response to starter nitrogen-phosphorus combinations. *J. Prod. Agric.* 8:369-373.
6. Gordon, W. B., and Whitney, D. A. 2002. Effects of application method and composition of starter fertilizer on irrigated ridge-tilled corn. *Kansas Fertilizer Res. 2002, Prog. Rep. No. 903*, Kansas State Univ.
7. Khosla, R., Alley, M. M., and Davis, P. H. 2000. Nitrogen management in no-till grain sorghum production: Rate and time of application. *Agron. J.* 92:321-328.
8. Mallarino, A. P., Bordoli, J. M., and Borges, R. 1999. Phosphorus and potassium placement effects on early growth and nutrient uptake on no-till corn and relationships with grain yield. *Agron. J.* 91:37-45.
9. Martin, J. H., and Leonard, W. H. 1967. *Principles of Crop Production*. 2 nd ed. The Macmillan Co., New York.
10. Riedell, W. E., Beck, D. L., and Schumacher, T. E. 2000. Corn response to fertilizer placement treatments in irrigated no-till systems. *Agron. J.* 92:316–320.
11. Scharf, P. C. 1999. On-farm starter fertilizer response in no-till corn. *J. Prod. Agric.* 112:692–695.
12. Shelton, D. P., Kanable, R., and Jasa, P. J. 1993. Estimating percent crop residue cover using the line-transect method. Online. Univ. of Nebraska G93-1133.
13. Vetsch, J. A., and Randall, G. W. 2000. Enhancing no-tillage systems for corn with starter fertilizers, row cleaners, and nitrogen placement methods. *Agron. J.* 92:309-315.
14. Wortmann, C. S., Xerinda, S. A., Mamo, M. and Shapiro, C. A. No-till row crop response to starter fertilizer in eastern Nebraska: I. irrigated and rainfed corn. *Agron. J.* 98:156-162.
15. Wortmann, C. S., Xerinda, S. A., and Mamo, M. 2006. No-till row crop response to starter fertilizer in eastern Nebraska: II. rainfed grain sorghum. *Agron. J.* 98:187-193.