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Interaction of Seeding and Nitrogen Rate on Grain Sorghum Yield in Southwest Kansas

A. J. Foster

Kansas State University, anserdj@ksu.edu

A. Schlegel

Kansas State University, schlegel@ksu.edu

J. D. Holman

Kansas State University, jholman@ksu.edu

I. A. Ciampitti

Kansas State University, ciampitti@ksu.edu

See next page for additional authors

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Interaction of Seeding and Nitrogen Rate on Grain Sorghum Yield in Southwest Kansas

Abstract

This study compared drilled planted sorghum at four seeding rates to planted sorghum at three different nitrogen (N) fertility levels at two locations in southwest Kansas (Garden City and Tribune). At the Garden City location, no difference was observed in yield among the drilled seeded sorghum populations greater than 27,000 seeds/a compared to the standard planted sorghum (sorghum planted at 27,000 seeds/a with a planter at 30 in.-row spacing). At Tribune, there was no difference in yield between the drilled sorghum and the standard planted sorghum (sorghum planted at 40,000 seeds/a with a planter at 30 in.-row spacing) regardless of seeding rate. Nitrogen fertilizer did not interact with seeding rate or affect yield independently at either location. The use of normalized difference vegetation index (NDVI) to assess canopy coverage suggested that planted sorghum and drilled sorghum at population greater than 40,000 seeds/a may achieve canopy coverage at a faster rate. In general, nitrogen rate and seeding rates did not affect sorghum yield. However, we did observe that drilled planted sorghum was more at risk of irregular stand emergence and required a higher seeding rate to achieve canopy closure at a rate similar to that of planted sorghum.

Keywords

sorghum, narrow row, seeding rate, nitrogen fertilizer

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Authors

A. J. Foster, A. Schlegel, J. D. Holman, I. A. Ciampitti, C. Thompson, and D. Ruiz Diaz

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A.J. Foster, A.J. Schlegel, J. Holman, I. Ciampitti, C. Thompson, and D. Ruiz Diaz

Summary

This study compared drilled planted sorghum at four seeding rates to planted sorghum at three different nitrogen (N) fertility levels at two locations in southwest Kansas (Garden City and Tribune). At the Garden City location, no difference was observed in yield among the drilled seeded sorghum populations greater than 27,000 seeds/a compared to the standard planted sorghum (sorghum planted at 27,000 seeds/a with a planter at 30 in.-row spacing). At Tribune, there was no difference in yield between the drilled sorghum and the standard planted sorghum (sorghum planted at 40,000 seeds/a with a planter at 30 in.-row spacing) regardless of seeding rate. Nitrogen fertilizer did not interact with seeding rate or affect yield independently at either location. The use of normalized difference vegetation index (NDVI) to assess canopy coverage suggested that planted sorghum and drilled sorghum at population greater than 40,000 seeds/a may achieve canopy coverage at a faster rate. In general, nitrogen rate and seeding rates did not affect sorghum yield. However, we did observe that drilled planted sorghum was more at risk of irregular stand emergence and required a higher seeding rate to achieve canopy closure at a rate similar to that of planted sorghum.

Introduction

Drilled sorghum is normally done at super-high population at row spacing between 7.5 and 10 inches, compared to rows planted at spacing between 15 and 30 inches. Thompson (1983), growing super-thick sorghum at the Hays Research Station from 1974-1977, found that sorghum planted in narrow rows (12-18 in.) often produced higher yields than when planted in wide rows (24-40 in.). Norwood (1982) in Garden City repeated Thompson's work and also came to the conclusion that yield of high population narrow row sorghum could exceed that of low population wide row when subsoil moisture and precipitation were adequate. The conclusion from the work of Thompson and Norwood was that subsoil moisture and precipitation were big drivers for the high population, narrow-row sorghum to equal or exceed the yield of the low population wide row. Since then, most researchers have found yield response to plant population to be variable depending on environment. Overall, the general consensus is that under conditions of adequate moisture, yield of high population sorghum can continue to increase, but can decrease under dry conditions. Today moisture still remains the key for successful dryland sorghum production in southwest Kansas. Thus, the very familiar

saying, “moisture and fertility are joined at the hip.” Thompson’s and Norwood’s work did not evaluate narrow row at population under 25,000 seeds/a and at spacing below 10 in. We hypothesized that drilled sorghum at lower population could make better use of water resources and produce similar yields to drilled sorghum at higher population, and planted sorghum at the same population. Thus, the objective of this study is to evaluate drilled sorghum at different populations ranging from 20,000 to 80,000 seeds/a at row spacing of 10 in. or less at different nitrogen rates. Furthermore, most farmers in southwest Kansas own both a drill and a planter. Thus, it is not just an agronomic issue, but it is also about getting better value from a single piece of equipment in an already economically challenging wheat-sorghum-fallow production system.

Procedures

Experiments with small plots were conducted under dryland conditions at two locations in western Kansas (Southwest Research-Center in Garden City and Tribune) to determine interaction of seeding rate and nitrogen rate under narrow row sorghum in southwest Kansas.

Planting Dates and Plot Layout

Sorghum variety Dekalb 3707 was planted at both locations on June 2, 2016 in Garden City and June 7, 2016 in Tribune.

A randomized complete block design with a 5×3 factorial treatment arrangement with four replications was used at both locations. At Garden City, the five factors included four drilled seeding rates (27,000 (lowest amount recommended with the air seeder no-tillage planter) and 40,000, 54,000, and 68,000 seeds/a) and sorghum planted at 27,000 seeds/a with a planter at 30-in. row spacing. At Tribune, the five factors included four drilled seeding rates (20,000, 40,000, 60,000, and 80,000 seeds/a) and sorghum planted at 40,000 seeds/a with a planter at 30 in.-row spacing. The three factors included three nitrogen rates (0, 50, and 100 lb/a) at Tribune; (50, 75, and 100 lb/a) at Garden City.

At both locations, potassium (K) and phosphorus (P) were applied based on the soil test recommendations provided by the Kansas State University Soil and Plant Testing Laboratory. At Garden City, the drilled treatments were planted with a John Deere 1910 air seeder no-tillage drill and the planted with a John Deere 7300 planter. In Tribune, drilled treatments were planted with a John Deere 1590 no-tillage drill and the planted with a John Deere 1700 planter.

Herbicide management at Garden City was the application of Glyphosate at 1.25 qt/a + Harness at 2.5 pt/a + Starane Ultra at 0.75 pt/a applied pre-plant on June 1, 2016. At Tribune, Atrazine at 1 lb/a + Dicamba at 1 pt/a was applied early on March 10, 2016, followed by Degree Extra at 3 qt/a + Sharpen at 2 oz /a + Glyphosate at 0.75 lb a.e./a applied pre-emergence on June 8, 2016.

Data Collection and Analysis

Reducing plant density in narrow row planted sorghum could result in large areas of exposed soil. This exposed soil is subjected to wind and water erosion and weed infestation during the growing season and after harvest. However, the sorghum plant has an

extreme capability to compensate and utilize space by tillering. Normalized difference vegetation index (NDVI) measurements were collected during the growing season as a means of assessing exposed soil among the different plant population treatments. NDVI was measured using the GreenSeeker® hand-held device (NTech Industries Inc, Stillwater, OK). Measurement was collected from an approximately 80 ft² (2 ft GreenSeeker viewing area × 40 ft plot length) area at Garden City and a 100 ft² (2 ft GreenSeeker viewing area × 50 ft plot length) area in Tribune from each treatment plot.

The Garden City location was harvested using a 7.5 ft wide head plot combine and Tribune was harvested with a 5 ft wide head. Crop weights were adjusted to 13% moisture.

Data were analyzed using PROC GLM with SAS 9.4 (SAS Institute, Inc., Cary, NC) and a model statement appropriate for a factorial design. Treatment means were separated by Fisher's projected least significant difference test.

Results

Garden City

The emergence of drilled sorghum was more irregular compared to the standard planted (Figure 1). Emergence of the drilled sorghum was over a 3-15 day period compared to 3-5 days of the planted sorghum. This may have contributed to the large variation in yield observed among the treatments (least significant difference (LSD) = 24 bu/a). The 2016 results found no difference in yield among the three nitrogen rates (Figure 2), and drilled sorghum populations greater than 40,000 seeds/a and the standard planted sorghum (Figure 3). Grain yield of the standard planted sorghum was 31 bu/a greater than the drilled sorghum at 27,000 seeds/a. These results are in agreement with our initial hypothesis that drilled sorghum at lower population would not result in a yield penalty.

Tribune

The 2016 results found no difference in grain yield among the N rates (Figure 4) and for drilled sorghum at different populations and the standard planted sorghum (Figure 5). Similar to Garden City, the results are in agreement with our hypothesis that narrow sorghum could be planted at lower seeding rates without a yield penalty.

Assessing Canopy Coverage/Canopy Closure

Normalized difference vegetation index (NDVI) measured during the growing season was used to monitor the rate of change in green area among the different treatments throughout the growing season. The rate of change in green area was used to reflect the rate of canopy coverage over the plot area. Figure 6 shows that planted sorghum at 27,000 reached maximum green coverage or canopy closure at a faster rate compared to the drilled sorghum at the different populations at Garden City. At Tribune, the planted sorghum reached maximum green coverage at a similar rate to the higher drilled rates of 80,000 and 60,000 (Figure 6). Normalized difference vegetative index measurements starting at 23-29 days after planting showed lower readings for the lower drilled seeding rates throughout the growing season (Table 1). These results indicate that narrow row planted at lower seeding rates (20,000 – 40,000 seeds/a) reached canopy closure at a much slower rate. Based on field observation, the slower rate of canopy closure of the drilled sorghum at Garden City could be attributed to non-uniform emergence

that lasted over 10-15 days. This result indicates the importance of achieving a uniform emergence on the rate of canopy closure.

References

- Norwood, C. A. 1982. High population, narrow row dryland sorghum for southwest Kansas. Keeping up with research, 62. Kansas Agricultural Experiment Station. <http://krex.k-state.edu/dspace/handle/2097/16547>
- Thompson, C. 1983. Super-thick sorghum management. Kansas Agricultural Experiment Station Report of Progress, 437, 24.

Table 1. Normalized difference vegetation index (NDVI) measurements collected at different times after planting at five seeding rates across two locations in southwest Kansas

Seeding rate	Garden City				
	Days after planting				
	29	36	47	54	
seeds/a					
STAND_27 ¹	0.428	0.768	0.823	0.848	
67500	0.392	0.631	0.793	0.839	
54000	0.324	0.549	0.753	0.819	
40500	0.288	0.424	0.650	0.792	
27000	0.288	0.417	0.642	0.748	
LSD ³	0.077	0.110	0.100	0.063	
CV ⁴	26	15.6	6.4	3.6	
Seeding rate	Tribune				
	Days after planting				
	23	32	38	45	65
seeds/a					
STAND_40 ²	0.214	0.347	0.537	0.749	0.787
80000	0.223	0.411	0.634	0.796	0.803
60000	0.210	0.338	0.560	0.756	0.795
40000	0.209	0.285	0.520	0.689	0.771
20000	0.209	0.248	0.426	0.664	0.759
LSD	0.02	0.064	0.12	0.076	0.024
CV	6.3	15.9	12.04	7.16	2

¹Sorghum planted with a planter on 30 in.-row spacing at seeding rate of 27,000 seeds/a.

²Sorghum planted with a planter on 30 in.-row spacing at seeding rate of 40,000 seeds/a.

³LSD = least significant difference.

⁴CV = coefficient of variation.

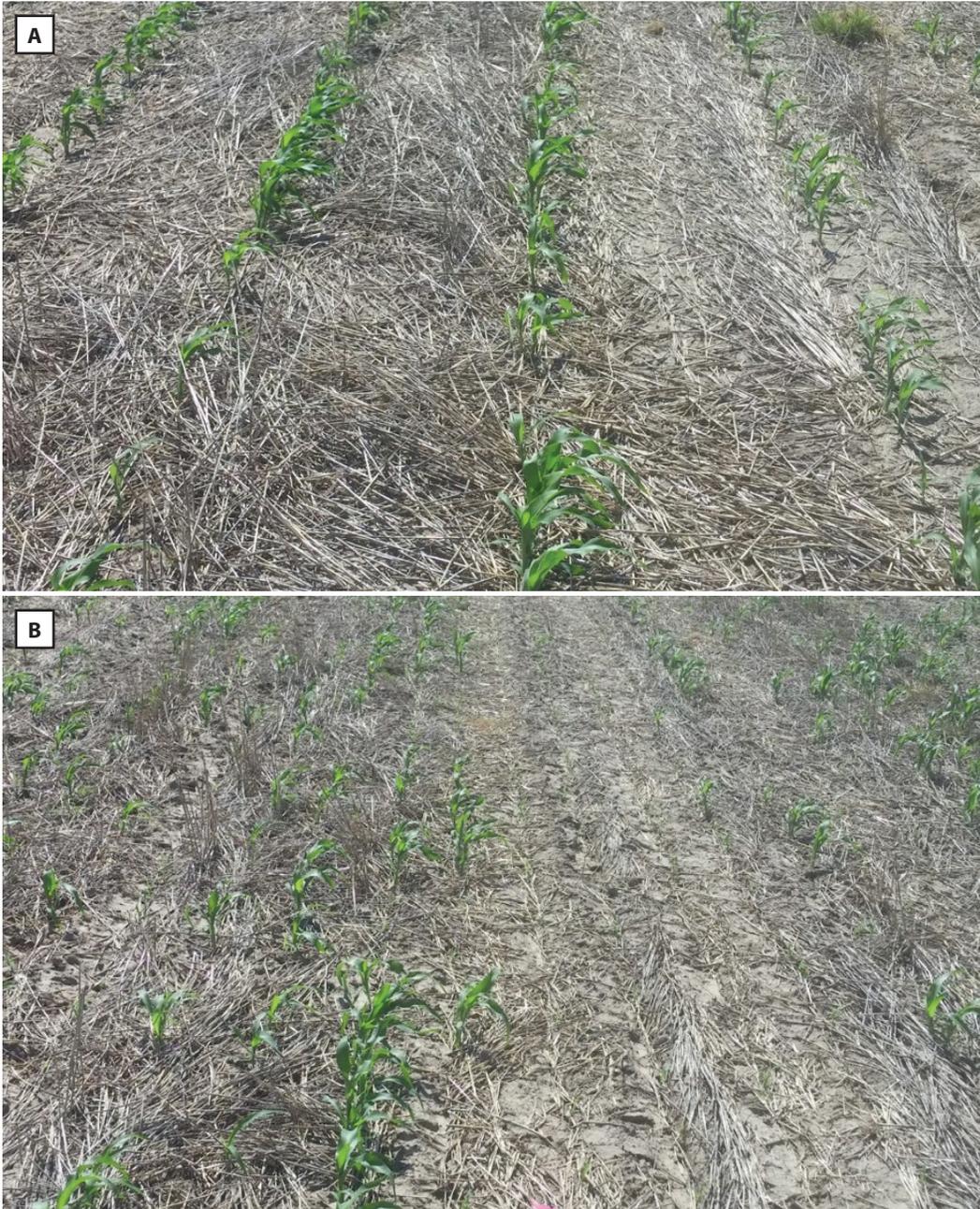


Figure 1. Emergence of drilled and planted sorghum. A) Sorghum planted using a standard 30 in. planter. B) Sorghum planted using a no-tillage air seeder drill.

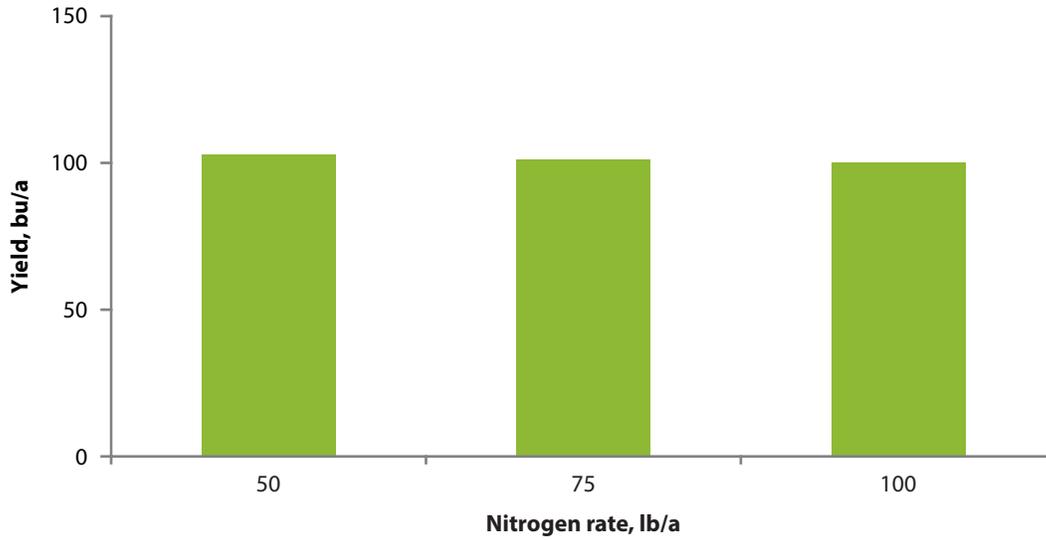


Figure 2. Grain sorghum yield affected by nitrogen rate under four drilled seeding rates and the standard planting rate in Garden City, KS (least significant difference = 6).

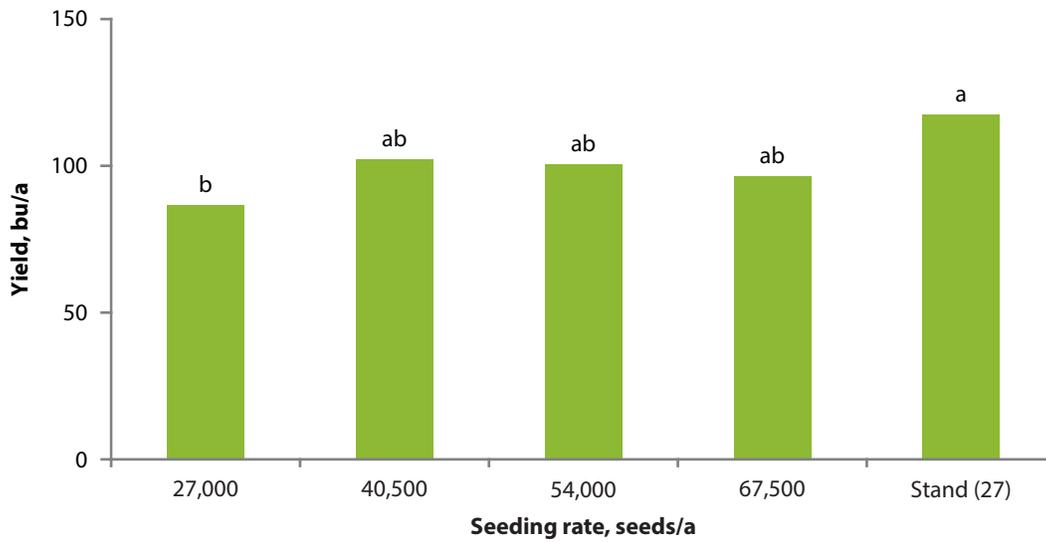


Figure 3. Grain sorghum yield affected by four drilled seeding rates and the standard planting rate at three different nitrogen rates in Garden City, KS.
^{ab}Means followed by same letter are not significantly different (least significant difference = 24).

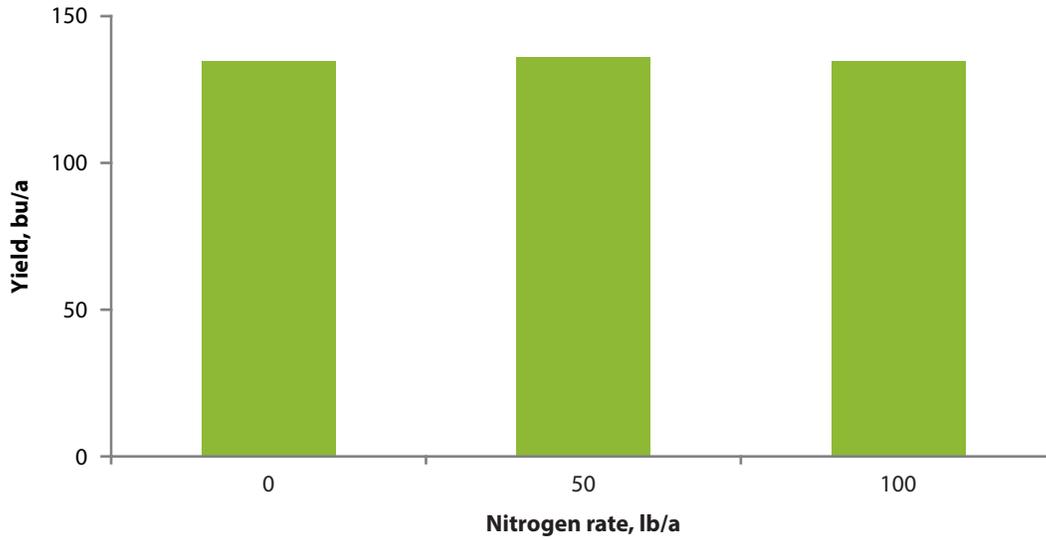


Figure 4. Grain sorghum yield affected by N rate under four drilled seeding rates and the standard planting rate in Tribune, KS (least significant difference = 4).

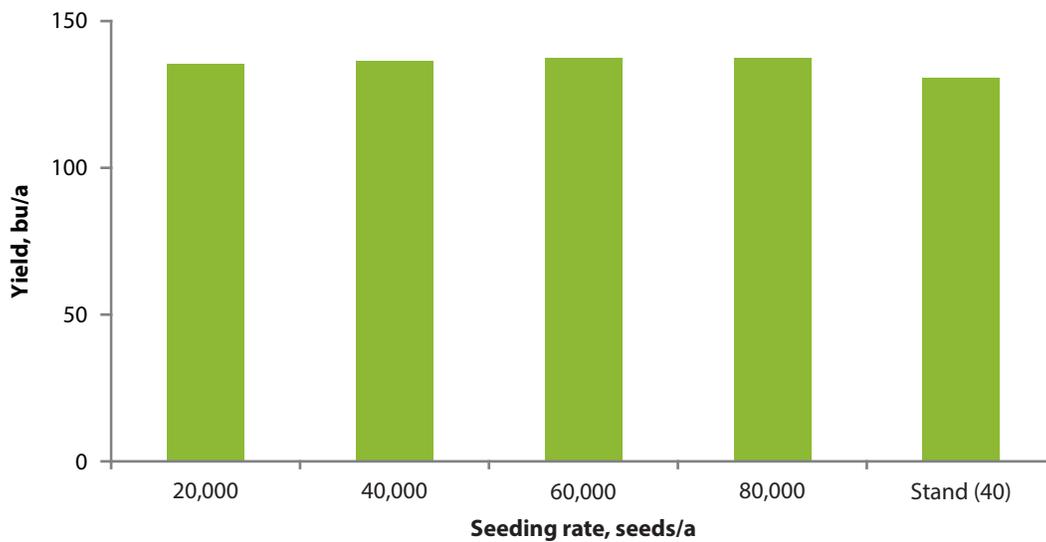


Figure 5. Grain sorghum yield affected by four drilled seeding rates and the standard planting rate averaged across three different N rates at Tribune, KS (least significant difference = 7).

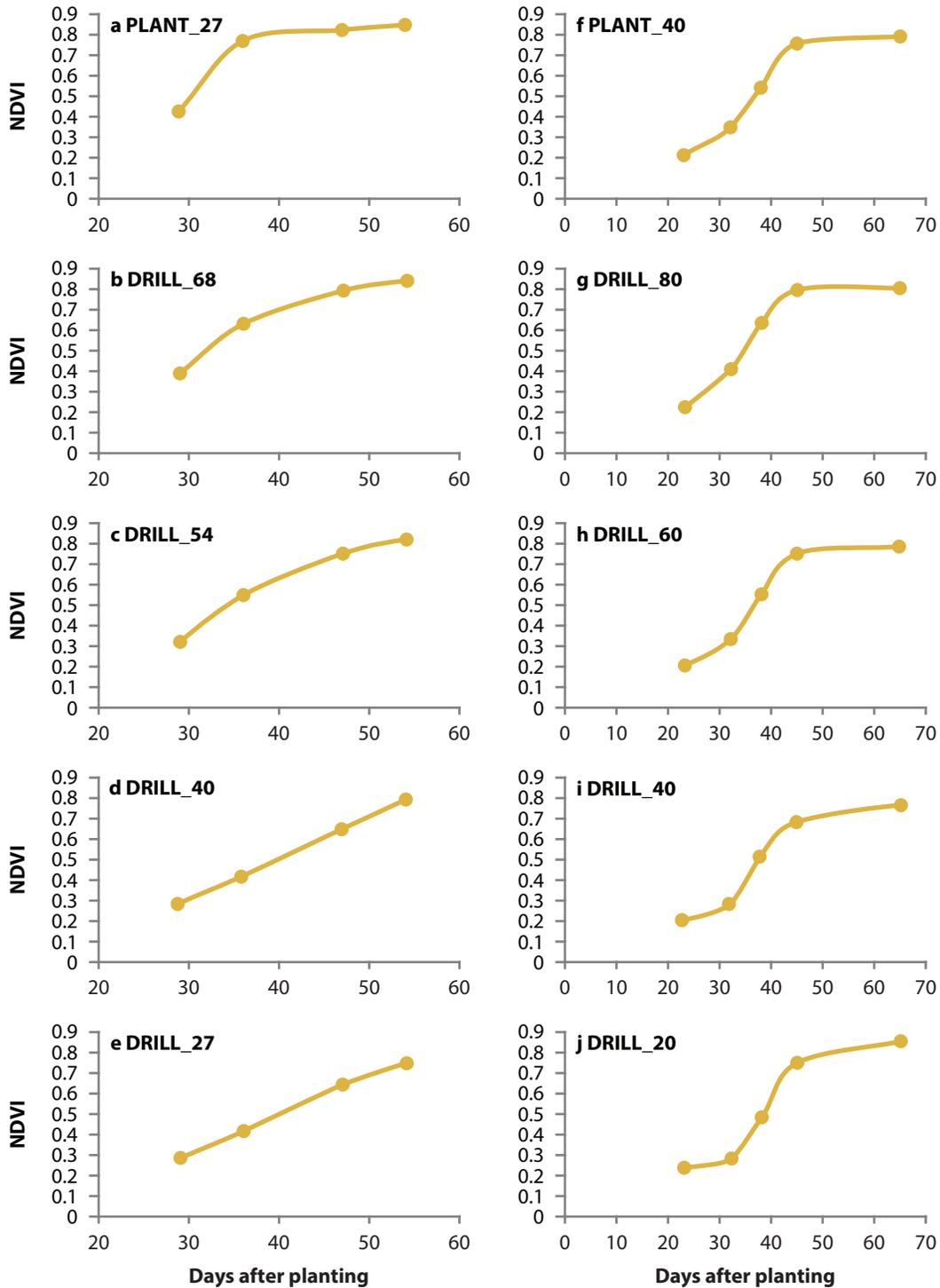


Figure 5. Normalized difference vegetation index and days after planting in relation to drilled vs. planted sorghum for both Garden City and Tribune locations used for determining the rate of canopy closure. Garden City: (a) planted sorghum at 27,000 seeds/a, (b) drilled at 67,500 seeds/a, (c) drilled at 54,000 seeds/a, (d) drilled at 40,500 seeds/a, and (e) drilled at 27,000 seeds/a. Tribune: (f) planted sorghum at 40,000 seeds/a, (g) drilled at 80,000 seeds/a, (h) drilled at 60,000 seeds/a, (i) drilled at 40,000 seeds/a, and (j) drilled at 20,000 seeds/a.