Effect of Plant Density on Grain Sorghum Production in North Dakota

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Grain sorghum is grown extensively in the low rainfall areas of the Central Great Plains since it is relatively tolerant to drought compared to most other crops. Sorghum would seem a viable alternative crop for those areas of North Dakota where water is limiting or rainfall infrequent during the growing season. The crop is a major livestock feed grain in many areas of the United States. Grain sorghum produced by North Dakota farmers could be marketed as a cash grain or utilized on-farm by producers with livestock.

At present North Dakota has only limited grain sorghum production. The primary limitation to increased sorghum production has been the absence of grain sorghum hybrids which tolerate low temperatures and mature in our relatively short growing season. Recent genetic advances have resulted in grain sorghum genotypes which can set seed and mature with greater frequency in the Northern Plains (De La Soujeole, 1984). The availability of grain sorghum hybrids adapted to North Dakota will allow the crop to establish an acreage base from which its importance as an alternative crop may grow.

Since grain sorghum is less adapted than most traditional crops grown in the state, it is critical that producers practice good management to optimize production. Plant density selection to allow for expression of maximum grain yield is a management practice that would make sorghum production more economical. Considerable research has been conducted to evaluate the effect of plant population and row spacing on grain sorghum yield in the Great Plains states (Lawless, 1985; Meyer, 1974; Robinson et al., 1964). The results of this research are often inconsistent. Conflicting conclusions in the data are most often due to variations in moisture and temperature among trial locations.

The grain sorghum hybrids that may eventually become the standard in North Dakota differ morphologically from those evaluated in earlier research. The conventional grain sorghum hybrid grown in the Central Plains has about 16 to 17 leaves attached at an erect angle to a thick main stem. The "Northern hybrids" which possess cold tolerance and earlier maturity tend to produce a maximum of 13 leaves which are supported on narrow diameter stems at a low leaf angle. The objectives of this research were to determine the effect of plant population and row spacing on sorghum grain yield.

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METHODS

Field experiments were conducted at Carrington in 1985, 1986 and 1987 and at Prosper in 1985 and 1986. Trials were planted on June 7, June 4 and June 2 at Carrington in 1985, 1986 and 1987, respectively. Planting dates at Prosper were June 15 in 1985 and June 4 during the 1986 growing season. Data will not be reported from the experiments in 1985. Grain sorghum did not mature in 1985 due to growing season temperatures which were well below normal. In 1985, the Carrington area accumulated only 1,599 growing degree days compared to the long term average of 1,906. The experiments were harvested, and though the grain yields were low, the results were consistent with those reported.

Plantings were made at 15- and 30-inch row spacings. Seeding rate was adjusted to approximately four times the required viable seed needed to attain the desired plant population. At the three-leaf stage, stands were thinned to the desired plant populations of 30, 50, 70 and 90,000 plants per acre.

Experimental variables included two hybrids, two row spacings and four plant populations. Grain sorghum hybrids tested were 'DK-18', a commercial hybrid from Dekalb/ Phizer, and 'X3174', an experimental hybrid from Northrup King. The DK-18 hybrid is typical of those hybrids currently grown in the major sorghum-producing states. The experimental line X3174 has plant morphology typical of the "Northern sorghum" types. In 1987 only hybrid DK-18 was evaluated.

Table 1. Growing season weather data from Carrington 1986-1987 and Prosper 1986.

	May	June	July	Aug.	Sept.	
Precipitation						
Prosper '86	1.22	1.73	4.84	1.85	3.86	
Carrington '86	1.76	1.27	4.57	2.59	2.85	
Carrington '87	3.45	2.12	6.50	4.05	1.31	
Mean Temperature						
Prosper '86	57.2	67.8	70.9	64.4	56.5	
Carrington '86	55.3	65.0	65.6	63.4	52.9	
Carrington '87	60.1	68.0	69.1	62.9	56.3	
Growing Degree Days (50-86)						**Total**
Prosper '86	314	523	634	450	247	2168
Carrington '86	278	453	492	428	138	1789
Carrington '87	339	507	587	418	244	2095

RESULTS

Hybrid: Differences between hybrids were evident for some of the agronomic traits measured. These variations were expected based on previous performance test results. Hybrids evaluated responded similarly to changes in row spacing and plant population. The morphological differences between hybrids did not influence the response to variations in plant density.

Row Spacing: The traditional method of producing grain sorghum is in wide 30-inch, rows. This row width may facilitate weed control with cultivation; however, it may also limit grain yield. A significant yield increase with sorghum planted in narrow, 15-inch as compared to the 30-inch row spacings is indicated in Figure 1. Increases in grain yield associated with narrow rows ranged from 7 to 11 bushels per acre. Yield increases with narrow rows was consistent across locations. The yield advantage remained the same regardless of the yield level.

Sorghum is a crop which has an ability to produce tillers when growing conditions allow, particularly under cool temperatures. Grain yield from tillers is a significant component of total sorghum grain yield (Hedge et al., 1976; Stickler and Wearden, 1985). The data indicated that a similar number of tillers were produced at either narrow or wide row spacings. Since the number of panicles per plant was similar between row spacings, yield differences can not be attributed to this very compensatory yield component.

The major yield component responsible for the increase in yield of the narrow row system was grain yield per panicle. The yield per panicle of plants grown in narrow rows was significantly higher than those in wide rows at Carrington. The increased panicle grain yield was due to a greater number of seeds per panicle, as seed weights did not differ between row spacings. Increased plant spacing within the row associated with narrow row production would allow more efficient use of available sunlight, moisture and nutrients.

Agronomic traits such as plant maturity, stalk strength and height were influenced little by varying row spacing. There was evidence of increased plant height with plants in a wide row arrangement. This response could be due to increased inter-row competition associated with the greater number of plants per row in wide as compared to narrow row spacing within a given population.

Plant Population: Current recommendations for planting grain sorghum in the Northern Plains suggest the establishment of 30,000 to 50,000 plants per acre. This recommendation was derived from research conducted in surrounding regions and from sorghum's ability to compensate to diverse growing conditions.

The plant populations evaluated in these trials were found to have a significant influence on grain sorghum grain yield. Generally, grain yield increased with increasing plant population (Figure 2). Results indicate that recommended plant population should be increased in order to maximize grain yield in North Dakota.

The increase in grain yield with higher plant populations was the result of an increased number of panicles per unit area. The tendency of grass plants is for a reduction in tillering when plant densities increase. This response is due to the competitiveness of the stand and is normally associated with reduced weight of the inflorescence. In these experiments the number of panicles per plant did decrease with increasing plant population (Figure 3).

Grain yield per panicle was similar among populations. At two sites, panicle weights decreased significantly with increasing population, while at the other site panicle weights remained the same. In these trials an average of 19.5 grams of grain per panicle were produced. The greatest difference in panicle yield with a change in plant population at any site was 4 grams, while the average deviation was only 0.7 grams.

Plant population did influence both tillering and panicle weight. The greater densities did support fewer tillers per

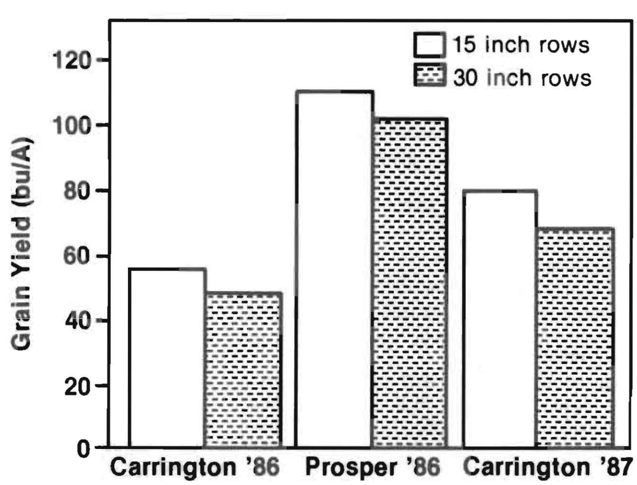

Figure 1. Mean grain yield of grain sorghum grown at two row spacings at Carrington and Prosper, N.D.

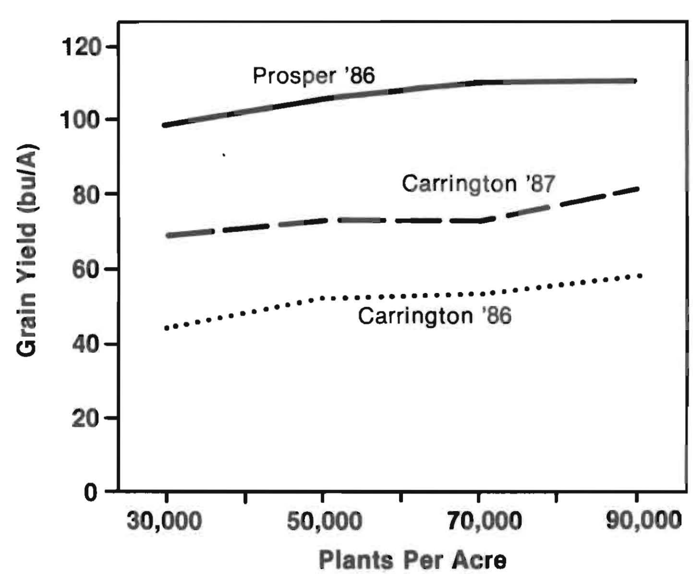

Figure 2. Mean grain yield of grain sorghum at four populations at Carrington and Prosper, N.D.

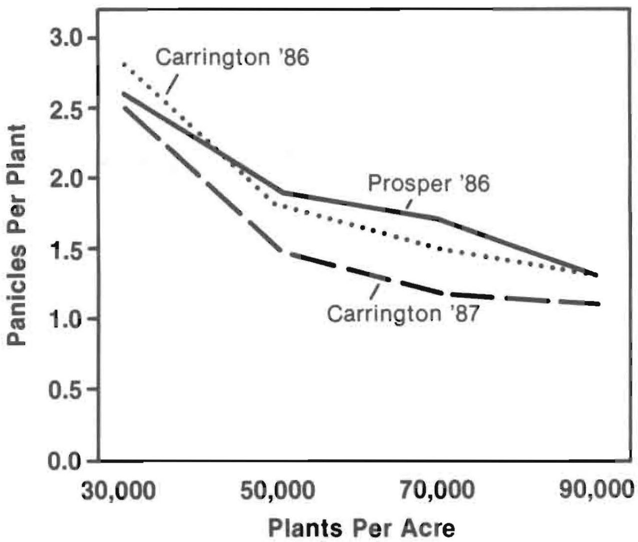

Figure 3. Mean number of panicles per plant from grain sorghum grown at four populations and two locations, Carrington and Prosper, N.D.

plant and the associated panicles tended to yield less grain. However, when one considers the increase in plant population and the corresponding tiller number the yield response can be better understood. An established stand of 30,000 plants produced a total of 79,000 panicles, while an established stand of 90,000 plants produced 111,000 panicles. This increase in the number of productive panicles per unit area and general stability in panicle yield explains the increased grain yield of sorghum at the higher plant populations.

Altering plant populations had only minor effects on other agronomic traits. There were small, though significant, increases in plant heights as populations increased. Plant population did significantly influence the total leaf area per plant. Plants grown at low densities had more tillers contributing to total leaf area than those plants at higher densities. Leaf area index (LAI) differences among populations were not significant. The possibility exists, however, that leaf area duration and the phenological stage at which maximum LAI occurred varied among populations.

SUMMARY

Results from these trials indicate that yields of grain sorghum can be improved by increasing the plant densities from the levels currently practiced. Data has shown that 15-inch row spacing consistently produced higher grain yields than standard 30-inch rows. Plant populations significantly influenced grain yields, as a trend for increased yields with increasing plant populations was observed. Highest grain yields can be expected with plant populations of 70,000 to 90,000 plants per acre planted in 15-inch row spacings. These results suggest a higher plant density than currently planted is necessary to optimize grain sorghum yield in North Dakota.

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