

SORGHUM PROFIT PROGRESS REPORT
PROPOSAL #21-9901
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Project Title: Narrow-row planting in grain sorghum: Technology transfer to farmers and continuing research to improve net returns

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Project Objectives

Long Term Objective:

To develop and deliver improved crop management technology to increase the profitability of grain sorghum production and secure the sustainability of the farming enterprise in the Coastal Bend region.

Specific Objective:

To formulate, evaluate, and deliver crop management technology involving narrow-row planting in grain sorghum.

Sub Objectives:

1. To evaluate the combined effects of narrow-row planting and planting densities on yield and yield components of grain sorghum grown under dryland and irrigated conditions.
2. To identify grain sorghum cultivars best adapted to narrow-row planting grown under dryland and irrigated conditions
3. To evaluate the economics of narrow- vs. normal-row planting in irrigated and dryland grain sorghum.
4. To deliver narrow-row planting technology to grain sorghum producers in the Coastal Bend region.

Methodology

Five experiments were conducted under specific objective 1. Two of these experiments were conducted at the TAMUAREC-Corpus Christi experimental farm, one under irrigation and the other under dryland conditions. Three other experiments were conducted at commercial farms; one at the Perry Foundation farm in Nueces Co. under dryland conditions, another at Robert Barlow Farm in San Patricio Co. also under dryland conditions, and another also in San Patricio Co. at Clarence Chopelas Farm under irrigation.

Dryland experiment at TAMUAREC-Corpus Christi.- A plant population and row spacing study was conducted evaluating the yield performance of Asgrow A459 CG at target populations of 50,000, 65,000, and 80,000 plants per acre planted in single rows 38" apart and in double rows 12" apart on beds 38" apart (12"/26" configuration). Experimental design was a randomized complete block with 4 replications. The experiment was planted with a four-row wide (8 units) Monosem NG Plus planter on 25 March 2000. Plots were 4x38" wide and 150 ft long. Fertilization, weed control and pest control practices were based on BMP. Rainfall received were as follows: emergence-panicle initiation 0.65 inches, panicle-initiation-flowering 4.1 inches, flowering-maturity 0.75 inches.

Irrigated experiment at TAMUAREC-Corpus Christi.- Experimental methodology was identical as for the dryland experiment except for slightly different target plant populations and applied irrigation. Plant populations used in this experiment were 60,000, 78,000, and 98,000 plants per acre. Irrigation applied was as follows: during panicle formation 4.8 inches and around flowering 1.7 inches. Irrigation schedule called for more irrigation around flowering and during late milk stage of grains. Low pressures in the city water main line (our water supply) prevented our automatic drip irrigation system to function.

Dryland experiment at Perry Foundation farm.- A plant population and row spacing study was conducted evaluating the yield performance of Pioneer 8313 CG at target populations of 60,000, 75,000, and 96,000 plants per acre planted in single rows 30" and 15" apart. Experimental design was a randomized complete block with 4 replications. The experiment was planted with a four-row wide (8 units) Monosem NG Plus planter on 3 March 2000. Soil moisture conditions were marginal. Plots were 16x30" wide and 535 ft long. Fertilization, weed control and pest control practices were based on BMP. Rainfall received were as follows: emergence-panicle initiation 0.83 inches, panicle-initiation-flowering 0.94 inches, flowering-maturity 2.6 inches.

Dryland experiment at Robert Barlow Farm and irrigated experiment at Clarence Chopelas farm.- Description of methodology for these two experiments were reported elsewhere (Profit progress report for proposal 05-9901 by R. Parker, C.J. Fernandez, and L.L. Falconer).

Specific objective 3. A partial-budget economic analysis was performed on data collected from experiments conducted at TAMUAREC-Corpus Christi and Perry Foundation.

Specific objectives 2 and 3.- These objectives will be executed on FY2 of this project.

Results and Discussion

Effects of single- and double-row spacing and planting population on dryland sorghum.

Under specific objective 1. Location: TAMUAREC-Corpus Christi, Nueces Co., TX.

Plant Population.- Measured plant populations were different from the target populations. With 38" row spacing, plants per acre were 6% and 9% lower at 50,000 and 80,000 plants per acre, respectively, but 6% higher at 65,000 plants per acre. With 12"/26" row spacing, measured plants per acre were 30%, 14%, and 10% higher than the target populations of 50,000, 65,000, and 80,000 plants per acre, respectively. These differences between measured and target populations, however, unlikely affected the validity of the experimental results.

Number of heads per acre.- The number of harvested heads per acre (first yield component) was significantly affected by plant population, but not by row spacing. Harvested heads per acre increased significantly with increasing plant population; 47,802, 60,011, 69,984 heads per acre across row spacing at target populations of 50,000, 65,000, and 80,000 plants per acre, respectively. Harvested heads per acre at target population of 80,000 plants per acre was, however, significantly higher (13%) in double rows than in single rows. The percent of heads per acre over measured plant populations early in the season was about 85% across all treatments. These data indicates that the number of grain-bearing heads per acre can be effectively controlled by planting rate.

Number of grains per head.- The number of grains per head (second yield component) were 1773, 1543, and 1360 for the target populations of 50,000, 65,000, and 80,000 plants per acre across row spacing, respectively. There was a marked trend indicating the inverse relationship between target plant population and head size (grains per head). Differences in head size among plant populations were significant in double rows, while head size differed significantly only between low and high plant populations in single rows. Across plant populations, head size in the double row configuration (12"/26") was 17% greater than in single rows (38"). Differences in head size between double row and single row depended on plant populations; 20%, 15%, and 14% at 50,000, 65,000, and 80,000 plants per acre, respectively. These differences were statistically significant at populations of 50,000 and 65,000 plants per acre, but only marginally significant at the highest plant population. These data suggest that competition among plants during panicle growth decreased with lower plant population and double row spacing.

Grain Weight.- Grain weight was not affected by plant population or row spacing. The average weight of 1000 grains was 24.7 g.

Bushel weight.- Bushel weight was not affected by plant population or row spacing. Average bushel weight in lbs/bushel was 53.8.

Grain Yield.- Grain yield was not affected by plant population in double row configuration; average grain yield in double rows was 5092 lbs/acre at 14% moisture. However, grain yield showed a marked tendency to increase with plant population in single rows, although only the difference between the low and high plant population was significant. Grain yield in single rows ranged from 3921 to 4820 lbs/acre, a 23% increase from 50,000 to 80,000 plants per acre (\$28.59/acre increase with sorghum valued at \$3.18/cwt, less \$5.18/acre to account for greater cost of Gaucho-treated seed). Grain yield across plant populations was 4433 lbs/acre in single rows and 5092 lbs/acre in double rows; 659 lbs/acre, a 15% increase (\$20.96/acre). Grain yield difference between single and double rows was significant at 50,000 plants per acre only; 1152 lbs/acre, a 30% increase (\$36.63/acre).

*Effects of single- and double-row spacing and planting population on irrigated sorghum.
Under specific objective 1. Location: TAMUAREC-Corpus Christi, Nueces Co., TX.*

Plant Population.-Measured plants per acre were higher than the target populations in the low and intermediate populations. With 38" row spacing, the over-planting was 13% and 7% greater at 60,000 and 78,000 plants per acre, respectively. With 12"/26" row spacing, the over-planting was 26%, and 11% at 60,000, and 78,000 plants per acre, respectively. Measured plant populations at the 98,000 plants per acre were close to the target, 4% lower with 38" row spacing and 3% higher with 12"/26" row spacing. These differences between measured and target populations, however, unlikely affected the validity of the experimental results.

Number of heads per acre.- The number of harvested heads per acre (first yield component) was significantly affected by plant population, but not by row spacing. Harvested heads per acre increased significantly with increasing plant population in both row spacing; 60,784, 73,423, and 87,780 heads per acre across row spacing at target populations of 60,000, 78,000, and 98,000 plants per acre. Harvested heads per acre were only slightly lower than the plant populations measured early in the season. The percent of heads per acre over measured plant populations were 85%, 86%, and 90% in the target populations of 60,000, 78,000, and 96,000 plants per acre, respectively. These data indicates that the number of grain-bearing heads per acre can be effectively controlled by planting rate.

Number of grains per head.- The number of grains per head (second yield component) were 1512, 1269, and 1049 for the target populations of 60,000, 78,000, and 98,000 plants per acre across row spacing, respectively. There was a marked trend indicating the inverse relationship between target plant population and head size (grains per head). Across plant populations, head size in the double row configuration (12"/26") was 13% greater than in single rows (38"). Differences in head size between double row and single row depended on plant populations; 18%, 11%, and 9% at 60,000, 78,000, and 98,000 plants per acre, respectively. However, only the difference at the lower plant population was statistically significant. These data suggest that competition among plants during panicle growth decreased with lower plant population and double row spacing.

Grain weight.- Grain weight was not affected by plant population, but it was affected significantly by row spacing. The weight of 1000 grains was 11% higher in single rows than in double rows; 26.3 g and 23.6 g, respectively. This difference in grain weight between row configurations was significant in all plant populations, and may have resulted from the greater number of grains per head in double rows than in single rows.

Bushel weight.- Bushel weight was not affected by plant population but was significantly affected by row spacing. Bushel weight in lbs/bushel was 3% higher in single rows than in double rows, 58.2 and 56.3 respectively.

Grain Yield.- Grain yield was not different among plant populations. Average grain yield across plant population was 4559 lbs/acre at 14% moisture. Grain yield across plant populations was significantly higher (8.5%, \$11.83/acre with sorghum valued at 3.18/cwt) in double row configuration than in single rows; 4373 and 4745 lbs/acre, respectively. This grain yield difference between row configurations resulted only from significant differences at the low and intermediate plant populations. At 50,000 plants per acre, double rows yield was 570 lbs/acre (13.3%, \$18.13/acre) higher in double rows than in single rows. At 65,000 plants per acre,

double rows yield was 572 lbs/acre (13.5%, \$18.19/acre) higher in double rows than in single rows.

*Effects of conventional- and narrow-row spacing and planting population on dryland sorghum.
Under specific objective 1. Location: Perry Foundation, Nueces Co., TX*

Plant Population.- Measured plant populations were greater than the targets in all treatments; 23% greater in the 60,000 plants per acre and 13% greater in the 75,000 and 96,000 plants per acre target populations. The over-planting was greater in the 15" than in the 30" row spacing; 11%, 18% and 7% greater at the target populations of 60,000, 75,000, and 96,000 plants per acre, respectively. These differences between measured and target populations, however, unlikely affected the validity of the experimental results.

Number of heads per acre.- The number of harvested heads per acre (first yield component) was significantly affected by plant population and row spacing. Harvested heads per acre increased significantly with increasing plant population in both row spacing; 66,211, 77,319, and 87,120 heads per acre with 30" row spacing, and 72,310, 86,685, and 103,673 heads per acre with 15" row spacing. Except for the highest plant population in 30" row spacing, the harvested heads per acre were only slightly lower than the plant populations measured early in the season. The percent of heads per acre over measured plant populations in the 60,000, 75,000, and 96,000 plants per acre treatments were 95%, 96%, and 83%, respectively, in the 30" row spacing, and 93%, 90%, and 93%, respectively in the 15" row spacing. The fewer heads/acre in the highest plant population at 30" row distance might have resulted from high competition among plants within rows. These data indicates that the number of grain-bearing heads per acre can be effectively controlled by planting rate.

Number of grains per head.- The number of grains per head (second yield component) was generally low ranging from 671 to 846, and this reflects the prevailing droughty environment that affected head growth. There was a marked trend indicating the inverse relationship between target plant population and head size (grains per head). However, when comparing values among plant populations, the decrease in head size was only significant with the highest plant population in both row spacing.

Grain weight.- Concomitant with the effect of plant population on head size, grain weight also decreased with increasing plant population. The weight of 1000 grains was 26.9 g, 26.1 g, and to 25.0 g for target populations of 60,000, 75,000, and 96,000 plants/acre across row spacing, respectively. Despite the clear trend, when grain weights were compared among plant populations, only grain weight difference between the lowest and the highest plant population at 30" row spacing was significant.

Bushel Weight.- Bushel weight averaged 60.1 lbs/bushel, and there were no statistical differences among treatments.

Grain Yield.- Under the droughty conditions prevailing during this experiment, and because of the counter-balancing effects between heads per acre and the other two yield components, namely grains per head and grain weight, we found no statistical differences in grain yield among plant populations or between row spacing treatments. Average grain yield at 14% moisture was 4045 lbs/acre.

Dryland experiment at Robert Barlow Farm and irrigated experiment at Clarence Chopelas Farm in San Patricio Co., TX.

Results and discussion for these two experiments were reported elsewhere (Profit progress report for proposal 05-9901 by R. Parker, C.J. Fernandez, and L.L. Falconer).

*Partial budget analysis of experiments. Under specific objective 3.
Location: TAMUAREC-Corpus Christi*

The partial budget economical analysis showed that the economic return per acre above seed, harvest, and drying cost with double-row planting was 11% and 17% higher than with single rows (\$111 vs. \$100 and \$107 vs. \$125) under irrigated and mild dryland conditions, respectively. Under severe dryland conditions, the economic return was generally lower, with no differences between row spacing, but with a 11% decrease by the high population compared to the low and intermediate populations (\$83 vs. \$94 per acre).

Preliminary Conclusions

- In all experiments reported here, the number of harvestable heads per acre (first component of yield) followed closely the targeted plant populations, which indicates that the planting rates were effective in obtaining the targeted number of productive plants or heads per acre at the range of populations evaluated.
- Head size (number of grains per head; second component of yield) decreased 10% to 17% from low to intermediate and from intermediate to high plant populations depending on soil water availability, the dryer the soil the smaller percentage of decrease. Also the better the soil water regime, the bigger the heads. Double rows increase head size about 17% over that of the single rows. In general, the more inter-plant competition the smaller the heads and viceversa.
- Grain weight (third component of yield) was not affected by plant population under irrigated conditions or under mild dryland conditions, but there was a clear tendency to decrease with increasing plant population under more severe droughty conditions. Narrow row spacing did not affect grain weight under dryland conditions but was 11% higher in single rows under irrigated conditions. This latter effect likely caused by more and bigger heads in double-row configuration that increased competition among heads (plants) and among grains within heads.
- Grain yield reflected the interacting effects of the three yield components, particularly the counter-acting effects between heads/acre and the other two components, head size, and grain weight, and between head size and grain weight. In all three experiments, yield was not affected by plant population, except in single row configuration under mild dryland conditions, where there was a 23% increase between low and high plant population. Yield of

double rows was 15% higher than single rows across plant populations under mild dryland conditions, with 30% increase (1152 lbs/acre) at the low plant population. Under irrigated conditions, double rows increased yields about 13% (570 lbs/acre) at the low and intermediate plant populations. Under severe dryland conditions, there were no effects of plant population or row spacing on yield.

- The partial budget economical analysis showed that the economic return per acre above seed, harvest, and drying cost with double-row planting was 11% and 17% higher than with single rows (\$111 vs. \$100 and \$107 vs. \$125) under irrigated and mild dryland conditions, respectively. Under severe dryland conditions, the economic return was generally lower, with no differences between row spacing, but with a 11% decrease by the high population compared to the low and intermediate populations (\$83 vs. \$94 per acre).

Summary

Grain sorghum is an economically important crop in the Coastal Bend region of Texas, contributing about 23% or 38% of the combined cotton-grain sorghum production gross income depending on whether a 1:1 or a 1:2 crop rotation system is used. An increased and more stable profitability of grain sorghum production is essential to improve and secure the sustainability of the farming industry in the region. Grain sorghum is commonly cultivated in rows 30 to 40 inches apart, but there is experimental evidence indicating that yields can be increased substantially by narrow-row planting. We have conducted experiments under irrigated, mild dryland, and severe dryland conditions to evaluate the interactive effects of populations ranging from 50,000 to 98,000 plants per acre in two row spacing, single rows vs. double rows 12" apart on 38" beds, and 30" vs. 15" rows. Our preliminary conclusions are as follows:

In all experiments reported here, the number of grain-bearing heads per acre (first component of yield) followed closely the targeted plant populations, which indicates that the planting rates were effective in obtaining the targeted number of productive plants or heads per acre at the range of populations evaluated.

Head size (number of grains per head; second component of yield) decreased 10% to 17% from low to intermediate and from intermediate to high plant populations depending on soil water availability, the dryer the soil the smaller percentage of decrease. Also the better the soil water regime, the bigger the heads. Double rows increase head size about 17% over that of the single rows. In general, the more inter-plant competition the smaller the heads and vice-versa.

Grain weight (third component of yield) was not affected by plant population under irrigated conditions or under mild dryland conditions, but there was a clear tendency to decrease with increasing plant population under more severe droughty conditions. Narrow row spacing did not affect grain weight under dryland conditions but was 11% higher in single rows under irrigated conditions. This latter effect likely caused by more and bigger heads in double-row configuration that increased competition among heads (plants) and among grains within heads.

In all three experiments, grain yield was not affected by plant population, except in single row configuration under mild dryland conditions, where there was a 23% increase between low and high plant population. Yield of double rows was 15% higher than single rows across plant populations under mild dryland conditions, with 30% increase (1152 lbs/acre) at the low plant population. Under irrigated conditions, double rows increased yields about 13% (570 lbs/acre) at the low and intermediate plant populations. Under severe dryland conditions, there were no effects of plant population or row spacing on yield.

The partial budget economical analysis showed that the economic return per acre above seed, harvest, and drying cost with double-row planting was 11% and 17% higher than with single rows (\$111 vs. \$100 and \$107 vs. \$125) under irrigated and mild dryland conditions, respectively. Under severe dryland conditions, the economic return was generally lower, with no differences between row spacing, but with a 11% decrease by the high population compared to the low and intermediate populations (\$83 vs. \$94 per acre).