AGRONOMIC EVALUATION OF SEMIDWARF SUNFLOWER

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SUMMARY

The recent development of reduced height sunflower has necessitated basic agronomic studies to determine correct recommendations for maximum production. A series of field studies were conducted to compare performance and characteristics of a limited number of standard height and semidwarf sunflower. Results indicate there are few differences between the two plant types with the exception of plant height. The optimum plant population for maximum grain production is similar. Percent oil, yield, harvest index, stalk diameter, total water use, and water use efficiency were similar. The two plant types respond to differing row arrangements in a similar manner

Field studies to evaluate rooting depth of several reduced and standard height genotypes indicate that although differences among genotypes occur these differences are not consistent with differences in plant height. No correlation between maximum plant height and maximum rooting depth was found suggesting that rooting depth cannot be categorized by plant type. Although genetic variations for rooting patterns exist, it is important to remember that both root and top growth are very responsive to environment.

INTRODUCTION

Sunflower plant types grown in the United States are undergoing a diversification. Until 1984 all hybrids marketed were of a similar plant type that usually averaged between 1.5 to 2.1 m in height depending upon environmental conditions. In 1984 semidwarf (SD) genotypes which average between 1.2 to 1.5 m in height were introduced for commercial production. In 1986 an early maturing dwarf hybrid typically 0.8 to 1.2 m in height was marketed for the first time. Similar hybrids will probably be available in the future. Suggested advantages of the reduced height plant types include greater resistance to lodging and increased ease of cultivation and harvest. Information on the performance and agronomic characteristics of reduced height plant types under nonirrigated production environments, such as would occur in most of the U.S. is limited. Scientific data dealing with the agronomic potential and characteristics of the dwarf types are almost nonexistant but are being collected at this time. Information pertaining to the SD types has been collected since 1982 and is the subject of this paper.

MATERIALS AND METHODS

Recommended agronomic production practices were followed in all field studies. Fertilizer was applied according to need based on the results of soil tests (2). Chemical weed control in all instances consisted of an application of Trifluralin at 0.75 kg/ha. This was supplemented by hand weeding when necessary. Plant stage was determined using the method of Schneiter and Miller (12).

Studies were conducted from 1982-1984 at Fargo, Prosper and Carrington, ND to determine the response of two SD and two standard height (SH) sunflower hybrids, from different breeding programs but of similar maturity, to varying plant populations. The object of these studies was to determine if plant population recommendations for the commercial production of both plant types would be similar. Plots were established with populations of 32.1,

49.4, 66.7, 84.0, and 101.3 thousand plants/ha in rows spaced 0.76 m apart. Data were collected on several variables including yield, percent oil, harvest index, plant height, and stalk diameter.

Studies were conducted at Carrington and Prosper, North Dakota from 1984 to 1986 to evaluate the response of SH and SD to varying row arrangements and plant populations. One SD and one SH genotypes of similar maturity were sown at three row arrangements: (i) conventional rows spaced 0.76 m apart, (ii) solid seeding, (rows spaced 0.38 m apart), and (iii) twin rows, (two rows 0.19 m apart on 0.76 m center). All arrangements were evaluated at plant populations of 35.0, 50.0, and 65.0 thousand plant/ha.

Since most sunflower in North Dakota are grown on dryland with limited precipitation, one concern of reduced height sunflower was the possibility that reduced plant height may also result in reduced rooting depth. Studies were conducted at Prosper and Oakes, ND, during 1985 and 1986, to determine the water extraction pattern and depth of water utilization of two SD and two SH sunflower hybrids and a dwarf inbred. All genotypes were of similar maturity. Available water holding capacity of the soil at Prosper (180 mm m^{-1}) is twice that at Oakes (90 mm m^{-1}) (5). Soil water depletion was determined with a neutron probe at 0.30 m intervals to a depth of 2.7 m, every 10 days, beginning approximately 25 days after planting. Soil water status was monitored both within the row and between the rows which were spaced 0.76 m apart. Total water use (TWU) was determined using the formula TWU = SWD (Soil water depletion) + P (precipitation). Water use of sunflower from emergence until the first sampling date was calculated by application of the Jensen-Haise equation (13) and the amount was then added to the total.

RESULTS

Differences in yield and percent oil independent of plant type were observed among hybrids. Standard height and SD genotypes from one breeding program had similar but higher yields than both 894, a commonly grown SH hybrid, and a SD hybrid from another breeding program. Yield differences among hybrids were the consequence of differences in seed weight and seed/head. It was concluded that the SD hybrids evaluated did not possess any yield superiority when compared to the two SH sunflower hybrids. A plant population of 32,100 plants/ha resulted in the highest yield for hybrids representing both plant types. At plant populations above 32,100 plants/ha, yield, seed weight, seed per head, and head diameter decreased while percent oil increased. Semidwarf types tended to be less responsive to increasing plant populations than the SH types (yield of SD hybrids decreased less with increasing populations). SD and SH genotypes had similar total water use, water use efficiency, stalk diameter, and harvest index. Increasing plant population reduced HI, grain and biological yield/plant, stalk diameter, and increased plant height. Results of this study have been reported in greater detail (7).

Results comparing the yield of sunflower grown at different row arrangements indicated no statistical differences due to plant population, hybrids or between plant population and hybrids, hybrids and row arrangement or plant population and row arrangement. Significant difference among row arrangement treatments were found at 5 of the six environments. No arrangement evaluated, however, consistency yielded greater than the others.

The two years of the rooting depth study presented contrasts in precipitation and temperature patterns at each environment. Lower

precipitation in 1985 resulted in greater utilization of stored soil moisture while higher levels of precipitation in 1986 resulted in reduced stored soil water depletion. Total water use was not significantly ($p<0.05$) different among genotypes at any environments (Table 1). Approximately 75-80% of the seasonal TWU at Prosper in 1986 had occurred by the time the plants had reached R6, the completion of anthesis. Cumulative water use at this location, which is typical of other environments, is shown in Fig. 1.

Despite similar total water use among the genotypes evaluated, the depth soil water was extracted differed. Extraction patterns and maximum plant height for the 1985 and 1986 growing seasons at Prosper are shown in Fig. 2 where the vertical line represents initial soil water content and the horizontal bars represent changes in the initial soil water content. The majority of the water depletion occurred between the soil surface and a depth of 1.50 m, but the amount depleted from each depth was greater in 1985 than in 1986. In 1985, three of the genotypes (SH 8502, SD 208, and SD 8503) extracted available soil moisture to a depth of 1.80 m compared to only one genotype (SD 208) to this same depth in 1986. Maximum depth for root development appeared to be 1.80 m both years regardless of the amount of water depleted.

DISCUSSION

The studies which were conducted concerning the comparison of agronomic response of semidwarf and conventional or standard height sunflower indicate few differences except plant height exist. Variable response to differing plant populations in SH sunflower has been reported by several researchers (4, 8, 11, 14). Our results suggest that the SD hybrids tend to respond less to changes in plant population than do the SH types. This may be the result of reduced stalk breakage such as would occur with SH types grown at higher plant populations. Recommendations to producers for maximum grain production would be similar for both plant types.

Seeding of sunflower with a standard small grain drill has been an attractive alternative to producers that do not have row crop equipment. Results of our studies indicate SD and SH sunflower respond in a similar manner to single rows spaced either 0.76 or 0.38 m apart or to two rows spaced 0.19 m apart on a 0.76 m center. Differences in grain yield as a response to row arrangement were found at different enivronments. At Carrington, ND which is the drier of the two environments, production at rows spaced 0.38 m apart outyielded rows spaced 0.76 m apart, the current recommended production practice 2 of 3 years but yielded significantly less than the twin row arrangement the third year. At Prosper, ND no consistent response to planting patterns were evident.

Nonsignificant differences ($p<0.05$) were observed among genotypes for total water use (Table 1). Ennen (3) working with eight SH sunflower cultivars reported no differences in total water use.

Maertens and Bosc (6) studied sunflower rooting characteristics and reported that root length was at its maximum approximately 70 days after planting. This peak was followed by a decrease in both root length and weight. Sunflowers have been reported to have their greatest root mass at anthesis (10). As shown in Fig. 1 approximately 75-80% of the total water use occurred by the end of anthesis (stage R6). The high water uptake until stage R6 could be related to maximum root mass at anthesis. Beyond stage R6 water uptake continued at a decreased level and almost ceased by stage R8. Since maximum dry matter production is obtained near stage R8, limited water

uptake would be expected beyond this stage.

A relationship between root length and plant height has been reported (6). In these studies stem height and root length of sunflower reached maximum values at the same time. Even though the rate of plant height growth began to decrease approximately 55 days after planting, the elongation of the root continued at a similar rate until day 75. Our field results indicate no statistically significant correlation between maximum plant height and the maximum depth of soil water depletion at any of the four environments.

Moisture was more limited in 1985 than in 1986 and as a result depletion of stored soil water was greater (Fig 2). The amount of soil water depletion from the various depths was different among genotypes at both locations, both years. Inbred 291 extracted the majority of its total water from shallower depths than the SH and SD hybrids. This was evident throughout this study and can possibly be the result of a more vigorous root system produced by the hybrids. A similar response has been reported in sorghum (1). All genotypes extracted water from a depth of 1.20 m. Differentiation among genotypes occurred beyond this depth. Maximum depth for soil water depletion appeared to be 1.80 m at all environments although the amount of soil moisture absorbed beyond 1.50 m depth was relatively low.

Even though rooting characteristics are inherited, development of the root is influenced by environment and performance of the same genotype can differ among years and locations (9). In the sandy soil type with low water holding capacity at Oakes, SD inbred 291 extracted water from a greater soil depth than at Prosper. Depth of soil depletion among the genotypes evaluated in this study was not related to plant type. SD hybrids appear to have similar rooting depths as SH hybrids. These results are supported by other research.

CONCLUSIONS

Semidwarf (SD) and standard height (SH) sunflower generally respond in a similar manner to different agronomic practices. The SD type does appear to be more tolerant to increasing plant populations than the SH type. The recommended population for maximum yield of both types is similar. The two plant types respond in a similar manner to different planting patterns.

Total water utilization was similar among all genotypes at all environments. Soil water extraction patterns, however, differed among genotypes. In our field studies no relationships between plant height and depth of water extraction was evident. Depth of soil water extractions varied significantly among years and locations. In environments where adequate moisture was available in the form of precipitation, depth of water depletion was more shallow as a greater amount of water depletion occurred in the upper soil layers.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the assistance of B. Johnson and D. Neuville.

Table 1. Total water use (mm) of two standard height (SH) and three semidwarf (SD) sunflower genotypes during the 1985 and 1986 growing seasons at Prosper and Oakes, ND.

Genotypes	Prosper		Oakes	
	1985	1986	1985	1986
	mm			
SH8502 hybrid	425.1	438.2	161.3	382.9
SH894 hybrid	409.2	394.2	158.1	378.0
SD208 hybrid	395.9	405.1	159.6	368.5
SD8503 hybrid	391.9	376.6	163.1	372.8
SD291 inbred	329.4	383.4	169.4	361.4
LSD (0.05)	NS	NS	NS	NS

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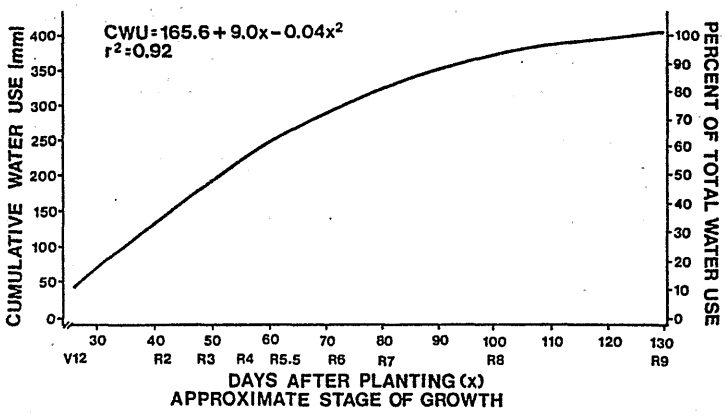

Fig. 1. Total and cumulative water use by five sunflower genotypes at Prosper, N.D. in 1986.

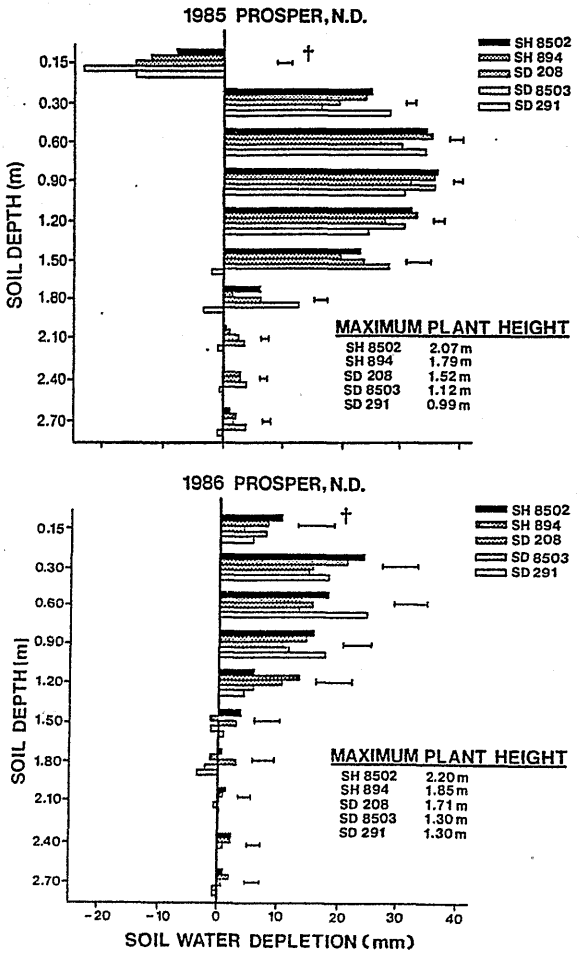

Fig. 2. Soil water depletion by standard height (SH) and semidwarf (SD) sunflower genotypes at various soil depths and maximum plant height (m) at Prosper, N.D. during 1985 and 1986.

† LSD among hybrids at 0.05 level.