

AGRONOMIC CHARACTERISTICS AND FIELD PERFORMANCE OF DWARF SUNFLOWER HYBRIDS

G. N. Fick, J. J. Caroline, G. E. Auwarter and P. M. Duhigg
SIGCO Research, Inc., Breckenridge, MN 56520, U.S.A.

ABSTRACT

Dwarf sunflower hybrids produced using lines with a partially dominant gene(s) for short plant height were evaluated in experimental plots and on-the-farm tests throughout the northern sunflower production area of the U.S. Plant height of the dwarf hybrids was reduced by approximately 30 percent compared to SIGCO 894A and other conventional height hybrids. Seed yields averaged 1387 kg/ha compared to 1430 kg/ha for SIGCO 894A, and ranged from 75 to 140 percent of the average yield of the conventional height hybrid in individual tests. Ease of harvest and improved tolerance to stalk breakage and lodging were considered the main advantages of the dwarf hybrids over the conventional height cultivars. Commercial production of dwarf hybrids is expected to increase rapidly within the next few years, especially in areas with good management practices and favorable growing conditions.

INTRODUCTION

Seed yields of sunflower (*Helianthus annuus* L.) in the U.S. are frequently reduced because of stalk breakage and/or root lodging caused by strong winds and storms during the growing season. In preliminary studies we observed that certain dwarf hybrids that grew only about one meter tall had good resistance to lodging, were easy to harvest, and produced relatively high yields. In 1980, following severe storm damage to our breeding nursery, an experimental dwarf hybrid showed four percent lodging and yielded 1373 kg/ha as compared to over 50 percent lodging and 730 kg/ha for conventional height hybrids.

In this paper we present results of our breeding efforts to develop dwarf hybrids for commercial production, and of the performance of dwarf and conventional height hybrids in experimental plots and on-the-farm trials.

MATERIALS AND METHODS

More than 100 experimental dwarf sunflower hybrids produced using parent lines with a partially dominant gene(s) for short plant height were evaluated in replicated tests at Breckenridge, MN and Carrington, ND in 1981-1984. Data from three or more trials were collected for plant height, percent lodging, number of leaves, days to flower, stem diameter, head diameter, seed yield, 1000-seed weight and oil percentage. One of the dwarf hybrids, designated SIGCO Dwarf 1, was included in plant population, row spacing, and depth of planting studies to determine if different production techniques might be required for dwarf as compared to conventional height hybrids. SIGCO Dwarf 1 is related to the widely grown hybrid 894, the major difference being the occurrence of the dwarfing gene(s) in the female parent. Plots in the plant

population studies were oversown and thinned back to populations ranging from 30,000 to 100,000 plants per hectare during the early seedling stage.

SIGCO Dwarf 1 also was grown in 77 on-the-farm trials throughout the Dakotas and Minnesota in 1983 in comparison with numerous conventional height hybrids. Variable plant populations, row spacings, fertilizer treatments and other production techniques were utilized depending on the management practices that were common to a particular area or farmer conducting the test. In most trials an area of at least 0.2 hectares per hybrid was harvested. A conventional height check hybrid was grown in an adjacent plot or as every other entry which allowed for yield adjustments to be made for field variation.

RESULTS AND DISCUSSION

Plant height of the dwarf hybrids was generally reduced by approximately 30 percent compared to conventional height hybrids. SIGCO Dwarf 1 when compared to SIGCO 894A (Table 1) was 51 cm shorter and had a similar number of leaves, indicating reduced height was due to a shortening of the internodes rather than a reduced number of internodes. Days to flower, stem diameter, head diameter, seed weight, and percent oil were similar for the two hybrids.

Table 1. Plant and seed characteristics of SIGCO Dwarf 1 and 894A sunflower hybrids

Hybrid	Plant Height cm	Days to Flower	Stem Diameter cm	No. Leaves	Head Diameter cm	Seed Weight gm/1000	% Oil
SIGCO Dwarf 1	114	72	2.6	30	18.5	41	44.8
SIGCO 894A	165	70	2.5	28	17.8	38	44.0
LSD .05	12	2	0.2	2	1.2	3	0.6

In 1981, SIGCO Dwarf 1 and the conventional height hybrid SIGCO 454 were compared in a row spacing (38- and 76-cm rows) and plant population study (50,000 and 75,000 plants/ha) at Breckenridge, MN (Table 2). SIGCO Dwarf 1 was about 2/3 the plant height of SIGCO 454 although precise information was not obtained for each row spacing or population that was studied. Percent lodged plants averaged over all row spacings and plant populations was 7.7 for the dwarf hybrid and 11.1 for SIGCO 454. Seed yields of SIGCO Dwarf 1 and SIGCO 454 were not significantly different at 50,000 plants/ha in either the 38- or 76-cm rows. However, at the high plant population of 75,000 plants/ha, and where the percentage of lodged plants was higher, the dwarf hybrid produced 399 kg/ha more than SIGCO 454 in 38-cm rows and 371 kg/ha more in 76-cm rows.

Table 2. Seed yield and percent lodging of SIGCO Dwarf 1 and SIGCO 454 sunflower hybrids in a row spacing x plant population study at Breckenridge, MN in 1981.

Row Spacing cm	Plant Population p/ha	Hybrid	Lodging %	Seed Yield kg/ha
76	50,000	SIGCO Dwarf 1	5.8	2174
		SIGCO 454	6.3	1989
	75,000	SIGCO Dwarf 1	6.4	2156
		SIGCO 454	13.4	1785
38	50,000	SIGCO Dwarf 1	6.2	2186
		SIGCO 454	9.0	1948
	75,000	SIGCO Dwarf 1	12.5	1946
		SIGCO 454	15.8	1547
LSD .05			7.9	347

Subsequent studies indicated that seed yields of both SIGCO Dwarf 1 and conventional height hybrids were generally reduced at high plant populations, and confirmed that the dwarf hybrid performed relatively better at high populations than the conventional hybrids. In ten comparisons at plant populations ranging from 30,000 to 60,000 plants/hectare SIGCO Dwarf 1 yielded 1612 kg/ha which was three percent less than the yield of conventional height hybrids. In twelve comparisons at plant populations ranging from 65,000 to 100,000 plants/hectare the dwarf yielded 1438 kg/ha which was about four percent more than the yield of the conventional hybrids. These results indicated the potential yield advantage of the dwarf hybrids in environments where high plant populations may have advantages.

Results from four row spacing studies involving plant populations ranging from 50,000 to 75,000 plants/hectare suggested that SIGCO Dwarf 1 produced slightly higher yields in 38-cm as compared to 76-cm row spacing (1545 vs. 1510 kg/ha) whereas the reverse was suggested for conventional height hybrids (1466 vs. 1488 kg/ha). Because of large plot to plot variability, however, the differences were not statistically significant.

In 1983, SIGCO Dwarf 1 was grown in 77 on-the-farm trials throughout the Dakotas and Minnesota to determine its adaptation across a wide range of environments. Trials were conducted primarily in 76-cm or wider row spacings, plant populations of 40,000 to 50,000 plants/hectare, and other management practices common to sunflower production in the area. Seed yield of the dwarf hybrid averaged 1387 kg/ha as compared to 1430 kg/ha for SIGCO 894A, a difference of 3.1 percent. These results agree with the plant population studies mentioned previously. Seed yields in individual tests ranged from 75 to 140 percent of the average yield of the conventional height hybrids with the highest yield advantage occurring primarily in environments where lodging caused by strong winds and storms was a problem.

SIGCO Dwarf 1 did not appear to show an advantage in tests where lodging and stalk breakage was caused by damage from the stem weevil (Cylindrocopterus adspersus LeC.) or phoma black stem (Phoma oleracea var. helianthi-tuberosi Sacc.).

Regression of seed yields of SIGCO Dwarf 1 on location mean yields ($b = 0.86$) confirmed that the dwarf hybrid performed relatively well in low yield environments, such as might occur as a result of storm damage. It was apparent from the data, however, that the dwarf hybrid also yielded relatively well in low yield environments where drought or other stress was a contributing factor. Recent data suggest that water use to a depth of two meters and water use efficiency of SIGCO Dwarf 1 were as good or better than SIGCO 894A (personal communication, A. A. Schmeiter, Agronomy Department, North Dakota State University, Fargo, ND). Although additional studies are required these results alleviate some of the concern about shallow rooting depth of dwarf hybrids and possible poor performance under drought conditions.

Semidwarf varieties of wheat and certain other crops often show reduced seedling emergence when compared to standard-height varieties, especially when deep plantings are necessary to insure seeds reach moisture. To determine if this was a potential problem with dwarf sunflower hybrids we planted SIGCO Dwarf 1 and a conventional height hybrid at four planting depths ranging from 2 to 8 cm deep at three locations in North Dakota in 1982-83. Percent seedling emergence of the dwarf hybrid was reduced by 5, 8, 18, and 50 percent compared to the conventional height hybrid when planted at depths of approximately 2.5, 5.7, 7.0 and 8.3 cm, respectively. Thus it appears that adequate stands of dwarf sunflower hybrids can be obtained at normal planting depths of 5 to 6 cm. At deeper depths growers may need increased seeding rates or alternatively plant a conventional height hybrid in order to insure proper plant populations.

The performance of SIGCO Dwarf 1 and other dwarf hybrids in our program support the concept that short statured sunflower hybrids can be developed that combine improved tolerance to lodging and stalk breakage with high yield potential. Additional studies are necessary to determine specific areas of adaptation, although it is expected that the dwarfs will be best suited to highly productive environments and to crop management practices that include relatively high plant populations and narrow row spacings. Limited commercial production of a dwarf hybrid was grown in 1984, and production of dwarfs is expected to increase rapidly within the next few years.