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EFFECT OF PLANTING GEOMETRY AND WATER STRESS ON SEED YIELD AND QUALITY OF SPRING PLANTED SUNFLOWER *(HELIANTHUS ANNUUS* L.)

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Effect of planting geometry and water stress on the seed yield and quality of spring planted sunflower hybrid "SF 100" was studied under field conditions. Crop grown without water stress (five irrigations) resulted in the maximum seed yield of 32.7 q ha^{-1} while water stress at seed setting gave the lowest seed yield of 22.8 q ha^{-1}. Sunflower grown with water stress at cup formation (foral primordia) and flowering gave the seed yield of 27.2 and 25.8 q ha^{-1}, respectively. Crop grown in 90 cm spaced double row strips exhibited significantly higher seed yield (29.1 q ha^{-1}) than that grown in 60 cm spaced single rows (25.2 q ha^{-1}). Interactive effect of water stress and planting geometry was significant only on seed yield. The highest yield of 36.6 q ha^{-1} was obtained in crop receiving 5-irrigations and planted in 90 cm apart double-row strips. Sunflower grown without water stress exhibited the maximum seed oil content (41.3%) while that subjected to water stress at seed setting gave the lowest seed oil content (35%).

INTRODUCTION

Water stress is one of the most serious and severe conditions affecting crop productivity. Water being an integral part of plant plays a vital role in the maintenance of plant life. Its deficiency modifies soil-plant water relationships by lowering tissue water potential and impairing metabolic processes. Planting geometry determines the plant distribution in the field and thereby affects competition among crop plants for mineral nutrients and other essentials for growth.

Sunflower being a short duration crop can be fitted well in our present cropping system without bringing any major change in our present cropping pattern. However, before recommending it for general cultivation, it is necessary to develop suitable agro-technology for its cultivation. There are many yield constraints, out of which proper use of irrigation water and maintenance of suitable soil moisture regime during the growing period of the crop are of great significance. Moreover, proper distribution of crop plants over the field is also very important to facilitate aeration and light penetration into the crop canopy.

In the light of above, the present study was designed to determine the effect of planting geometry and water stress on seed yield and oil content of sunflower under the irrigated conditions of Faisalabad.

MATERIALS AND METHODS

Effect of planting geometry and water stress at various growth stages on the seed yield and quality of spring planted sunflower was investigated at the Agronomic Research Area, University of Agriculture, Faisalabad in 1991. The experiment was sown in the last

week of January and was laid out in Split Plot Design with four replications. The net plot measured 3.60 x 6.00 m. The experimental treatments comprised the sunflower hybrid "SF 100" sowing in either 90 cm apart double row strips with 30 cm distance between the paired rows or 60 cm apart single rows (subplot treatments) and water stress at cup formation (flower primordia development), flowering or seed setting including control (no water stress) were randomised in the main plot treatments.

The crop was sown on a well prepared seed bed with the help of single row hand drill. A basal dose of fertilizer @ 100 kg each of N and P as urea and SSP, respectively was applied. Whole of the phosphorus and half of the nitrogen was applied at the time of sowing while remaining half of nitrogen was top dressed with second irrigation. The crop was thinned at 2-4 leaf stage in order to maintain a plant to plant distance of 30 cm. The crop was harvested in early June 1991. The data on plant height, head diameter, total number of seeds head^{-1}, filled seeds head^{-1}, seed weight head^{-1}, 1000-seed weight, seed yield ha^{-1} and seed protein contents were collected. The data collected were analysed statistically by using Fisher's analysis of variance technique (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Both the planting geometry and water stress had a significant effect on seed yield and quality of sunflower (Table 1). However, the interaction between planting geometry and water stress was significant only on seed yield. Plant height was not affected significantly both by the planting geometry and water stress. Similar plant height at various stress stages might be due to delayed imposition and by that time the plant had almost attained the maximum vegetative growth. However, crop grown without water stress produced the tallest plants (167.3 cm) as against the minimum plant height of 162.9 cm recorded in plants receiving water stress at cup formation stage.

Sunflower grown in 90 cm spaced double row strips produced larger heads than that grown in 60 cm apart single rows. This is probably due to reason that 90 cm strips between paired rows resulted in better aeration and light penetration providing environmental condition conducive to better head development. Water stress had a significant effect on head diameter. Plants grown without water stress produced heads with the maximum diameter (25.4 cm) but were statistically at par with those subjected to water stress at cup formation. The minimum head diameter (23.2 cm) was formed in plants stressed at seed setting. These findings are in line with those of Jana *et al.* (1982) who reported that irrigation increased head diameter. Likewise, El-Wakil and Gaafar (1981) observed that a decrease in available soil moisture resulted in reduced head diameter.

The plants grown in double row strips produced significantly more number of seeds head^{-1} (1501) than those in 30 cm apart single rows (1456). Plants grown without water stress produced maximum number of seeds head^{-1} (1551) which were, however, at par with those given water stress at cup formation. Plants stressed at flowering as well as seed setting produced the minimum number of seeds head^{-1} (1440-1430) suggesting that water stress at these growth stages was crucial and hampered the plant metabolism. Similar results were reported by Jana *et al.* (1982).

Number of filled seeds head^{-1} is a better indicator of crop productivity than total number of seeds head^{-1}. Plants grown in double row strips as a result of better aera-

Table 1. Effect of planting geometry and water stress on the growth, seed yield and quality of spring planted sunflower hybrid 'SF 100'

Treatments	Plant height (cm)	Head diameter (cm)	Number of seeds head^{-1}	Number of filled seeds head^{-1}	Seed weight head^{-1} (g)	1000-seed weight (g)	Seed yield (q ha^{-1})	Seed oil content (%)
a. Planting geometry								
1. 90 cm apart double row strips	164.4^{NS}	24.2^{NS}	1501 a	1423 a	86.1 a	54.8^{NS}	29.1 a	39.2 a
2. 60 cm spaced single rows	166.2	23.9	1456 b	1376 b	83.5 b	54.6	25.2 b	38.2 b
S.E.	-	-	8.56	8.32	0.40	-	0.59	0.32
b. Water stress								
1. Control (Normal irrigation)	167.3^{NS}	25.4 a	1551 a	1494 a	89.7 a	57.9 a	32.7 a	41.3 a
2. Water stress at cup formation	162.9	24.2 a	1530 a	1470 a	87.6 b	57.2 ab	27.2 b	40.0 a
3. Water stress at flowering	163.4	23.4 b	1430 b	1369 b	85.3 c	55.7 b	25.8 b	38.6 b
4. Water stress at seed setting	165.9	23.2 b	1404 b	1265 c	76.6 d	47.8 c	22.8 c	35.0 c
S.E.	-	0.42	15.10	15.04	0.52	0.61	0.73	0.66

NS = Non-significant.
Treatments not sharing a letter in each column differ significantly at 5% probability level.

tion and light interception between strips produced significantly higher number of filled seeds head^{-1} (1423) than those grown in single rows (1376). Likewise, water stress during seed setting exhibited the minimum number of filled seeds head^{-1} (1265) followed by those receiving water stress at flowering and cup formation. The later treatment was, however, at par with the control plots.

Sunflower grown in 90 cm spaced double row strips produced significantly higher seed weight head^{-1} (86.1 g) than that in 60 cm spaced single rows (83.5 g). This suggests that strips provided an environment that was conducive to better seed and head development. Water stress during seed setting produced the lowest seed weight head^{-1} (76.4 g) and differed significantly with water stress at flowering and cup formation which resulted in 85.3 and 87.6 g seed weight head^{-1}, respectively. The highest seed weight head^{-1} (89.7 g) was recorded in sunflower grown without any water stress.

Water stress during seed setting exhibited the minimum 1000-seed weight (47.8 g). In contrast, sunflower grown without water stress produced maximum 1000-seed weight (57.9 g) and was at par with the treatment in which water stress was given at cup formation. Similarly, difference between the latter treatment and water stress at flowering was non-significant. These results are supported by the findings of Osman and Talha (1975).

Water stress during seed setting produced the minimum seed yield of 22.8 q ha^{-1} and was followed by water stress at cup formation and flowering where seed yields were 27.2 and 25.8 q ha^{-1}, respectively. Sunflower grown without water stress produced the highest seed yield of 32.7 q ha^{-1}. This could be attributed to water stress at floral primordia initiation and flowering which affected adversely the fertilization, resulting in poor seed setting. Similarly, water stress

at seed setting could have caused hindrance in the transport of metabolites, causing serious reduction in grain yield. These results are in agreement with the findings of D'Amato *et al.* (1990). Sunflower planted in 90 cm apart double row strips produced significantly higher seed yield (29.1 q ha^{-1}) than that grown in 60 cm apart single rows (25.2 q ha^{-1}). Similar results were reported by Ali *et al.* (1988). Crop grown in 90 cm apart double row strips without any water stress exhibited the maximum seed yield (36.6 q ha^{-1}) while that in 60 cm apart single rows and subjected to water stress produced at seed setting gave the minimum seed yield of 22.4 q ha^{-1}. Crop grown without water stress produced seeds with the highest oil content (41.3%) but was statistically at par with the water stress at cup formation (40%). Water stress at seed setting produced the lowest seed oil content (35%) followed by water stress at flowering that gave 38.6% seed oil content. The results are in conformity with those of Hang and Evans (1985). Sunflower grown in double row strips gave significantly higher seed oil content (39.2%) than that planted in single rows (38.2%).

The above results suggest that water stress at any of the developmental stages of sunflower adversely affects its seed yield and stress at seed setting is the most critical. Similarly, sunflower grown in 90 cm apart double row strips can give higher seed yield than the conventional single row planting by providing environmental conditions conductive to better plant growth and seed development.

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