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IMPACT OF VARIABLE DROUGHT STRESS AND NITROGEN LEVELS ON PLANT HEIGHT, ROOT LENGTH AND GRAIN NUMBERS PER PLANT IN A SUNFLOWER *(HELIANTHUS ANNUUS* L.) VARIETY "SHMAS"

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A pot experimentwas conducted to evaluate the impact of variable drought stress and nitrogen levels on plant height, root length and grain numbers per plant in sunflower *IHelianthus annuus* L.) variety "Shmas'tThree levels of nitrogen were applied at the time of sowing and sporadic drought stress was induced by a cycle of ten-day watering and ten-day stress period after 20, 30, 40 and 50 days of sowing. It was laid out in a completely randomized design with eight replications. Plant height, root length and number of grains per plant were significantly affected both by sporadic drought and nitrogen levels. The values of these parameters decreased significantly by lowering the nitrogen level or increasing the sporadic stress.
Key words: drought stress, nitrogen levels, sunflower

INTRODUCTION

Sunflower *(Helianthus annuus* L.) is the most important oilseed crop of the world due to its wide range of adaptability and very high seed oil content, ranging from 40-50% and 23% protein (Hatim and Abbasi, 1994). It is a newly introduced oilseed crop in Pakistan. The major acreage of oilseed crops is under cotton which contributes 71.4% to local edible oil production. Next to cotton, rapeseed and mustard are the major oilseed crops which contribute 21.8% to local oil production. Groundnut is another source of vegetable oil which contributes only 6.8% to local oil production. Of these crops, sunflower seems to play a vital role in supplementing our local oilseed production (Saleem et al., 1998). Sunflower is a short duration crop (90-110 days) and can be grown twice a year successfully. Its cultivation is increasing every year due to its high edible oil content (Ahmad et al,, 1988). Edible oil is an important component of human diet. The domestic production of edible oil meets only 35% of the total requirement (Aslam et al., 1989). The per capita availability of edible oil in Pakistan is 9.78 kg/annum, which is much less than the recommended fat intake (Anonymous, 1990-91). In Pakistan, oilseed crops were grown on 523000 hectares during 1991-92, while the edible oil requirement of the country was 1262 thousand tonnes and domestic production was only 338 thousand tonnes which was 30% of the total requirement (Anonymous, 1992). Pakistan imported edible oils worth Rs. 10025.2 million during 1991-92 (Hatim and Abbasi, 1994). As the import is increasing gradually, it is expected to reach 1.7 million tonnes by this year (2000). Thus there is an imperative need to enhance domestic production of edible oil. New and non-conventional sources of edible oil are sunflower, safflower and soybean; the seeds of these crops are rich in oil contents and contribute 7.80% to the local production (Rana et al., 1988).

Akhter et al. (1993) reported that water stress at any of the development stages of sunflower adversely affects its seed yield. Palmer et al. (1996) found that availability of nitrate has a strong effect on leaf expansion in sunflower. Ahmad and Ibrar (1998) determined that sunflower/summer legumes intercropping under rainfed condition showed similar trends for leaf areas and dry matter accumulation, Meo (1999) observed that sporadic drought stress and urea fertilizer have highly significant effect on leaf area of sunflower. Bakhsh et al. (1999) reported that yield components of sunflower were significantly affected by different irrigation levels and six irrigations were found optimum for obtaining good yield of sunflower. Khan et al. (1999) worked on the performance of six sunflower hybrids and revealed that Hysun-33 gave maximum plant height and number of leaves. The present study was undertaken to study the impact of variable drought stress and nitrogen levels on plant height, root length and grain numbers per plant of a sunflower variety "Shmas".

MATERIALS AND METHODS

An experiment was conducted in pots on a sunflower variety "Shmas" in the net-house of botanical garden, University of Agriculture, Faisalabad. The soil in each pot was 9.5 kg and the diameter of each pot was 23 cm. The seeds were sown in 120 pots and urea as nitrogen fertilizer was added to each pot. The soil analysis before experiment showed that it was deficient in nitrogen (0.036%) and organic matter (0.73%)with pH 8.0 and saturation percentage of 36.

The experiment involved three nitrogen levels i.e. 75, 25 and 9.37 kg/acre as urea in full, 1/3rd and 1/8th dose and four sporadic drought treatments with control (So), The experiment was laid out in a completely randomized design with eight replications. The number of pots per stress treatment was 24, whereas the number of pots per nitrogen treatment was 8. Before application of urea to 120 pots, these were divided into five groups of 24 pots each as follows: Group I having all the three nitrogen levels as control in which water was applied continuously. In the remaining four groups of each nitrogen level, drought was induced by a cycle of ten days watering and ten days stress period during the following stages: control (So); 20 days after sowing (SI); 30 days after sowing (S2); 40 days after sowing (Sa) and 50 days after sowing (S4)' The data for plant height and root length were recorded before flower initiation and number of grains per plant was calculated at the time of maturity. The data were analyzed statistically and Duncan's new multiple range test was employed to compare the treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Plant Height: Table 1 showed a highly significant difference among fertilizer means with regard to plant height before flower initiation. Among the three nitrogen levels, the maximum plant height (71.63 cm) was observed in full urea concentration and the minimum (52.57 cm) in 1/8th concentration, indicating a highly significant decrease in plant height with decrease in urea concentration. In stress treatment means, the difference in plant height was highly significant. The maximum value (74.41 cm) for plant height was observed in So (Control) and significantly the maximum decrease (51.11 cm) was observed in SI (stress 20 days after sowing). These results revealed that with the successive increase in sporadic water stress, the plant height decreased significantly. The interaction between stress and fertilizer means differed non-significantly. With full dose, 1/3rd and 1/8th urea level, the plant height decreased gradually due to increase in sporadic stress period. When full dose of urea fertilizer was applied, the maximum plant height (83.83 cm) was observed in So, while the minimum (58.53 cm) in SI' In 1I3rd urea, the maximum value (74.63 cm) was found in Soand minimum (52.70 cm) in SI' Similarly, with 1/8th urea level, the highest value (64.76 cm) of plant height was found in So and the lowest (42.10 cm) in SI' It is evident that height of the plant w~s significantly affected by urea levels and sporadic stress. When either stress period is increased or urea level is decreased, the plant height is significantly decreased. These results are in conformity with those ofYousaf et al. (1998) and Bakhsh et al. (1999).

Table 1. Plant height before flower initiation

Water stress level	Fertilizer level			Means
	F_I	F_2	Fa	
So	83.83	74.63	64.76	74.41 a
SI	58.53	52.70	42.10	51.11 e
S2	64.57	56.17 '	47.08	55.94 d
Sa	72.93	62.73	49.87	61.84 c
S4	78.27	71.20	59.03	69.50 b
Means	71.63 A	63.49 B	52.57 C	

Root Length: Table 2 revealed highly significant differences among fertilizer means with regard to length of root before flower initiation. Significantly the maximum root length (10.52 cm) was recorded in full urea concentration, while the minimum (6.57 cm) in 1/8th concentration. In stress treatments, the difference in root length was highly significant. The maximum value (11.07 cm) was observed in So (control), while significant decrease (6.20 cm) was recorded in SI (stress after 20 days). The interaction between stress and fertilizer means was non-significant. When full dose of urea. was applied, the maximum root length (13.27 cm) was recorded in So and the minimum (7.33 cm) in SI' The same trend was observed in 1/3rd urea application. Similarly, with 1/8th urea level, the highest root length (8.87 cm) was recorded in Soand the lowest (4.73 cm) in SI' These results indicated that both urea levels and sporadic stress period had highly significant effect on length of root. When either the stress period was increased or urea level decreased, the root length significantly decreased. These results are in agreement with those of Marta and Fraschina (1986) who reported that root elongation took place in few hours after imposition of drought and ceased thereafter.

Grain Number: Table 3 showed highly significant differences among nitrogen levels with regard to number of grains per plant at maturity. The maximum number of grains (291.76) was recorded in full dose while significant decrease (218.76) in 1/8th urea level, indicating a highly significant decrease in

number of grains with the decrease in urea concentration. In stress treatments, the differences in grain numbers were highly significant. Significantly the maximum value (349.53) was recorded in So and significant decrease (162.53) was noted in SI' Intermediate values were found for treatments stressed after 30, 40 and 50 days after sowing. The interaction between stress and fertilizer was non-significant. When full dose of urea was applied, the maximum number of grains (406.40) was observed in So, while the minimum (189.80) in SI' At 1/3rd urea level, the same trend was noted. Similarly, in 1/8th urea, the highest value (311.40) for grain numbers was noted in So and the lowest (127.40) in SI' These results are in agreement with those of Mehar (1989)

Table 2. Root length before flower initiation

Water stress level	Fertilizer level			
	FI	F_2	F_S	Means
So	13.27	11.07	8.87	11.07 a
SI	'7.33	6.53	4.73	6.20d
S2	9.60	6.77	5.90	7.42 c
Ss	10.90	9.63	6.42	9.00b
S4	11.47	10.63	6.87	9.66 b
Means	10.51 A	8.93 B	6.57 C	

Table 3. Number of grains per plant

Water stress level	Fertilizer level			
	F_I	F_2	F_S	Means
So	40.6.40	330.80	311.40	349.53 a
SI	189.80	170.40	127.40	162.53 e
S2	261.20	201.40	191.60	221.06 d
Ss	291.40	225.00	189.20	235.20 c
S4	310.00	297.40	274.20	293.87 b
Means	291.76A	246.80B	218.76C	

who recorded higher number of grains per disc by giving six irrigations to sunflower. Similar results were reported by Khalil et al. (1998) who reported that number of cobs and grains in corn *(Zea mays* L.) was affected significantly by nitrogen and planting density. These results are also in conformity with those of Bakhsh et al. (1999) who reported that number of grains per head was significantly affected by different irrigation levels.

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