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Interactive Effect of Nitrogen and Water Stress on Leaf Area of Sunflower (*Helianthus annuus* L.)

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Abstract: The interactive effect of nitrogen and water stress on leaf area of sunflower (*Helianthus annuus* L.) was studied in Pots. Nitrogen and sporadic stress was induced by a cycle of ten-days watering and ten-days stress period after 20, 30, 40 and 50 days of sowing. Data revealed that the sporadic stress and nitrogen had highly significant response. When either the stress period was increased or nitrogen level decreased, the leaf area significantly decreased. The highest leaf area values were recorded with full dose of nitrogen, intermediate with 1/3rd dose and the lowest with 1/8th dose of nitrogen at all sporadic stress levels.

Key words: Interactive effect, Nitrogen, Leaf area, Sunflower, Water stress

Introduction

Water stress is one of the severe conditions that affect crop productivity water stresses probably limits the plant production more than any other environmental factor. Water being an intergeral part of plant, plays a vital role in the maintenance of plant life. The deficiency of water modifies soil plant water relationship by lowering tissue water potential and impairing metabolic processes (Akhtar *et al.,* 1993). The effects of water stress on water status and growth of different plant species have been shown to depend upon the stage of growth when stress occurs. Several researchers have indicated that moisture stress experienced at any growth stage ultimately reduces crop yield (Monayeri *et al.,* 1984; Sarwar *et al.,* 1991). Similarly, Jamro and Larik (1991) pointed out that water stress during vegetative growth reduces leaf area and dry matter due to decrease in leaf water potential from less water uptake or more atmospheric demand, severely influences leaf expansion. The availability of nitrogen also has a strong effect on leaf area expansion (Palmer *et al.,* 1996). A general response to drought is accelerated senescence of leaves in lower parts of the shoot. Water stress also causes metabolic and compositional changes such as decline in Photosynthetic rate, increase in abscisic acid and ethylene concentrations, decrease in cytokinin levels and reduced protein synthesis (Wolfe *et al*., 1988).

The present investigation was undertaken to determine the influence of nitrogen fertilizer and sporadic water stress on leaf area of sunflower (*Helianthus annuus* L.).

Materials and Methods

The experiment was conducted in pots in the net house of Botanical garden, university of Agriculture Faisalabad during spring 1999. Seed of sunflower variety Gimsun-94 were obtained from the Ayub Agricultural Research Institute, Faisalabad. The seeds were sown in 120 pots and nitrogen fertilizer was added to each pot having 23 cm diameter and 9.5 kg soil in it. The soil analysis before experiment showed that it was deficient in nitrogen and organic matter with pH 8.0 and saturation percentage of 36%. One plant per pot was maintained. Urea as a nitrogen fertilizer was added to the pots.

1.	Full dose (normal)	:	75 kg/acre
2.	1/3rd dose (normal)	:	25 kg/acre
3.	1/8th dose (normal)	:	9.3 kg/acre

Four water stress levels and three urea treatments (as above) were used. The experiment was laid out in completely randomized design with eight replications. The number of pots per stress treatments was 24 where as the number of pots per nitrogen treatment was 8. Before application of nitrogen to all the 120 pots these were divided into five groups of 24 pots each. Group I pots having all three nitrogen levels were kept as control to which water was applied continuously. In rest of the four groups each having respective nitrogen level, sporadic drought was induced using a cycle of ten-days watering and a ten-day stress period at the following stages:

Control .....(S_0)
Drought started 20 days after sowing (DAS) (S_1)
Drought started 30 DAS (S_2)
Drought started 40 DAS (S_3)
Drought started 50 DAS (S_4)

Leaf area was measured just before flower initiation and mean of three plants was calculated for statistical analysis as reported by Carleton and Foote (1965).

Leaf area = Length x bread th x 0.75 (a constant)

The data were analyzed and significance was determined by Duncan's multiple range test (Steel and Torrie, 1980).

Results and Discussion

Table 1 showed a highly significant difference among fertilizer means with regard to leaf area just before flower initiation. Among the nitrogen levels applied the maximum significant leaf area was observed in full nitrogen concentration, while the minimum in $1/8^{th}$ concentration, indicating a highly significant decrease in leaf area with decrease in nitrogen concentration. The difference in leaf area was highly significant among all the stress treatments. Maximum significant value for leaf area was observed in zero stress and maximum significant decrease was observed in S_1. Intermediate values were observed with other stress treatments. These results indicate that with each successive increase in sporadic stress, the leaf area decreases significantly. The interaction between water stress and nitrogen levels, varied significantly. With full dose, $1/3^{rd}$ and $1/8^{th}$ nitrogen levels, leaf area deceased gradually with the increase of sporadic stress period. When full dose of nitrogen was applied, the maximum leaf area was observed in S_0, while the minimum in S_1 (stress 20 days after sowing). Similarly, with $1/8^{th}$ urea dose, the highest value of leaf area was noted in S_0 and lowest in S_1. These results indicated that all the sporadic stress levels including control (zero stress), the highest values for leaf area were obtained when full dose of nitrogen was applied.

It is, therefore, evident that both the sporadic water stress and varying nitrogen doses have highly significant effect on leaf area. When either the sporadic stress period is increased or nitrogen

Table 1: Leaf urea (cm^2) Just before flower initiation Doses of nitrogen used

Stress level	Full (1.41 g for each pot)	1/3rd (0.46 g for each pot)	1/8th (0.17 g for each pot)	Stress means
S_0 (zero stress)	51.15	49.65	41.00	47.27a
S_1 (stress started 20 days after sowing)	24.43	18.01	16.59	18.68e
S_2 started 30 days after sowing)	25.61	20.15	17.48	21.08d
S_3 started 40 days after sowing)	38.77	22.81	17.87	26.48c
S_4 started 50 days after sowing)	45.55	34.17	28.95	36.22b
Nitrogen means	36.50 A	34.99B	24.38C	

dose is decreased, the leaf area will significantly decrease. The adverse effect of water stress on leaf area in different crop plants has also been reported by different workers. Karamanos *et al.* (1982) recorded reduction in leaf size by reducing both the area at unfolding and the mean growth rate under water stress conditions in field bean (*Vicia faba* L.) Menzel *et al.* (1986) has recorded reduction in leaf area of passion fruit hybrids by soil moisture stress along with variation in other morphological. characteristics.

Conclusively, Leaf area decreased significantly with increase in sporadic stress period and progressive decrease in nitrogen doses.

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