Effects of Water Stress on Plant Growth and Reproduction of Sunflower (*Helianthus annus L.*)

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Abstract

Sunflower *(Helianthus annus L.)* productivity is strongly regulated by availability of water. In the present study we observed the growth and reproduction of sunflower due to 10 day water stress at different growth stages; vegetative, flowering and at maturity. The study consisted with a control, with continuous water supply one time in each day during every growth stages. Experiments were analyzed using Complete Randomized Design (CRD) with five replicates and repeated two times. Plant height, plant shoot length, plant root length, number of flowers, head diameter, seed wet weight and seed dry weight were significantly affected by the water stress. Plant shoot length of the control (163.4 cm) was significantly higher compared to other treatments. Water stress at vegetative stage significantly increased the number of flowers (8.4 flowers/plant) compared to the water stress at flowering stage (2.4flowers/plant) which observed with least number of flowers. The highest root length was observed (18.92 cm) at vegetative stage due to water stress and it was significantly different compared to maturity stage (11.8 cm) and the control (11.5 cm). Furthermore, water stress at flowering stage significantly reduced the head diameter of flowers (11.2 cm) and it lead to the reduction of final seed yield. However highest head diameter (17.9 cm) and seed wet weight (9.79g/plant) were recorded in control compared to all other treatments. It is concluded that water stress at different growth stages; vegetative, flowering and maturity stage have significant effects on the growth and reproduction of sunflower in different ways. Results also indicated that drought at flowering stage should be avoided to increase seed production of Sunflower.

Key words: Sunflower *(Helianthus annus)*, water stress, Vegetative stage, Flowering stage,

Introduction

Sunflower *(Helianthus annus L.)* belongs to family Asteraceae and is an important oil seed crop in the World. Drought condition is one of the most important and wide spread environmental stress which limits the production efficiency of agricultural products. Productivity of sunflower is strongly regulated by the availability of water. It is categorized as a low to medium drought sensitive crop (Stone et al, 1996; Turhan and Baser, 2004). The water deficit conditions during the sunflower growing season, adversely affect its vegetative as well as reproductive growth in addition to deterioration the quality of its oil content (Jones, 1984). Drought stress during the yield formation period of sunflower reduced yields when compared to full irrigation but the reduction was much less than when stress occurred during flowering period. (Stone et al. 1996). Sunflower is the most susceptible to soil water deficiency at flowering, fertilization and grain fill, whereas at the start and end of the growing period the sensitivity is not so evident (Jana et al. 1982; Stone et al. 1996).

Present study was conducted to find the responses of sunflower to water stress/drought stress at different growth stages. The main objective of the research was to determine whether and how water deficit environment at different growth stages effect on yield and yield components of sunflower.

Materials and Methods

Seeds of Sunflower *(Helianthus annus L.)* were planted in plastic pots containing coir dust/topsoil/cow dung/compost (1:1:1:1) under greenhouse condition. Sunflower seeds were soaked overnight and applied recommended basal dressing before planting. Five seeds per pot were allowed to grow under normal growth conditions and plants were thinned out to have two plants per pot at two to three leaf stage.

There were four treatments according to Complete Randomized Design (CRD) with five replicates. The control (T_1) was full irrigated at all growth stages. The other treatments were; water cut at vegetative growth stage (T_2), water cut at flowering stage (T_3), water cut

at maturity stage (T_4). Water cut was done for 10 days period in each stage.

Plants were re-watered after stress period (water cut) and plant height (shoot length and root length), number of flowers/plant, head diameter, seed wet weight, seed dry weight were measured one week after recovering from stress.

Analysis of variance was carried out with the use of Statistical Analysis Systems (SAS Portable) software and Duncan's multiple range tests were applied to compare the treatment means.

Results and Discussion

In present study water cut at three different growth stages; vegetative, flowering, mature and the control; continuously watered one time in each day during every growth stages, were used to examine the effects of drought stress on Sunflower. Six different parameters were measured and analysis of variance show traits influenced water stress significantly at different growth stages.

There was a significant difference between control plants and water stressed plants for average shoot length (Figure 1). Increasing drought stress resulted in decreasing plant height. The highest plant shoot length (163.4cm) was recorded in control treatment. However, Riahi (2003) also got the same results with sunflower, cotton, bean and maize. Higher plant height was obtained from higher irrigation frequency; meaningful irrigation applied at all growth stages (Kaya and Kolsarici, 2011).

The average highest root length (18.92 cm) was observed when water stress at vegetative stage and when plants were with insufficient water (Figure 1). It was significantly different from values of control treatment and treatment values at mature stage. Furthermore, maximum number of flowers recorded during water stress at vegetative stage (8.4 flowers/plant). It might induce formation of flower buds when at water stress during vegetative stage. That value was

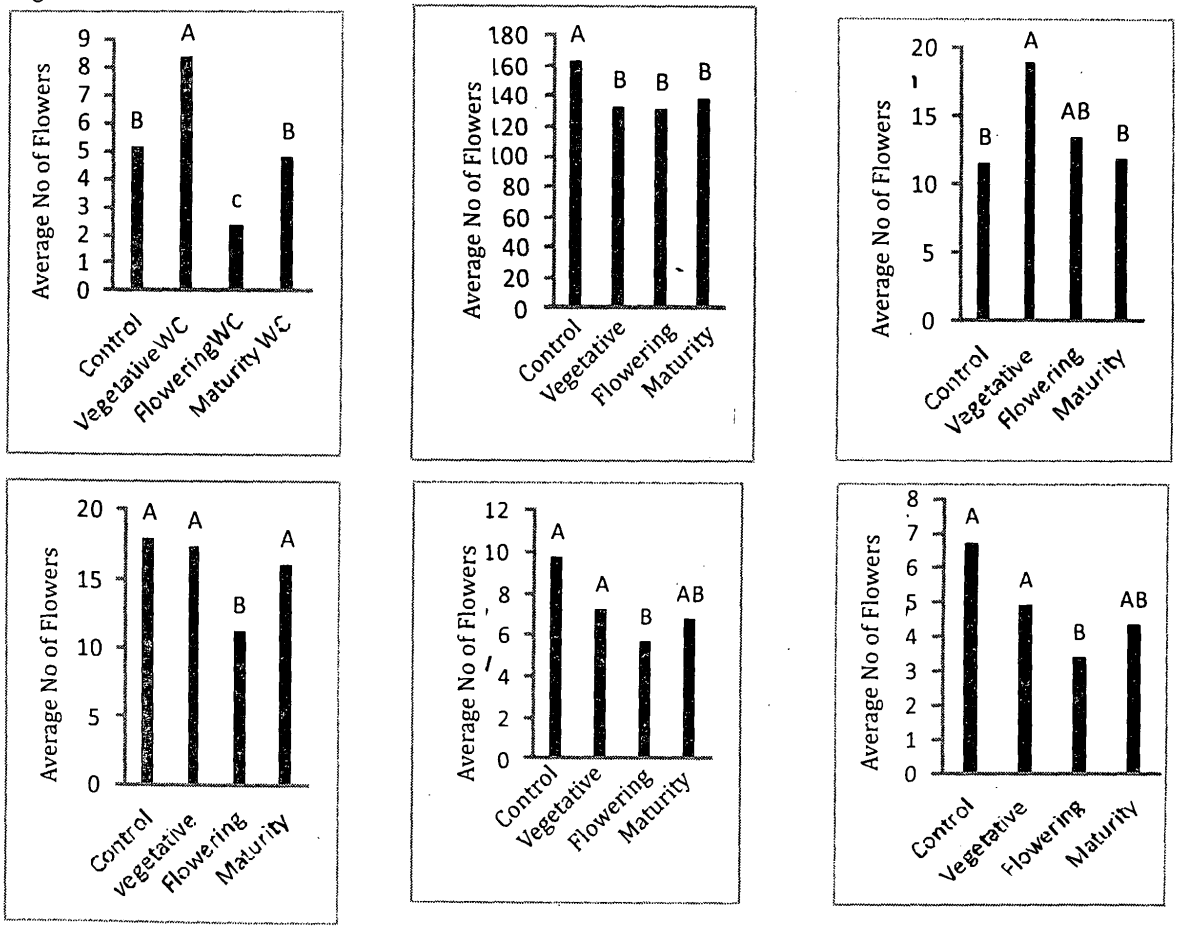

Figure 1: Effect of drought stress on different parameters at different growth stages with control. A, B, AB letters indicate the significant difference determine by Duncan's multiple range test.

significantly different from number of flowers at other growth stages. Water stress at flowering stage significantly reduced the number of flowers (2.4 flower/plant).

Head diameter is one of the essential traits which decrease under moisture stress and adversely effects on yield components like seeds number per head. There was a significant different between drought stress at flowering stage and other treatments on head diameter of flowers. Minimum average head diameter (11.2 cm) was recorded when water stress at flowering stage and maximum (17.9 cm) was in control treatment. The study conducted by Kalhori (2002) on the effects of irrigation cut-off indifferent growth stages of sunflower cultivars, found that drought stress severely affected head diameter at flowering stage, so that the lowest head diameter was observed at flowering stage when irrigation had been stopped. Maximum seed wet weight (9.79 g/plant) and maximum seed dry weight (6.75 g/plant) recorded in control treatment followed by minimum seed wet weight (5.702 g/plant) and seed dry weight (3.444 g/plant) recorded during the drought stress at flowering stage (Figure 1). Seed weights of these two treatments were significantly different, but other treatments were not significantly different. Drought stress at flowering stage was observed as a limiting factor for seed filling, resulting a significant reduction in unfilled seeds.

Conclusion

Water stress at vegetative stage induces the flowering ability, but not increases the final yield. Plant root length is increased when water stress at early vegetative stage comparatively drought tolerant than other stages of sunflower. Deficit water at any growth stage reduces plant shoot length significantly. Water stress at flowering stage severely affected to head diameter and seed yield. Irrigation at flowering stage was more effective on increasing the seed yield of sunflower than the vegetative and maturity stages.

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