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Research Article

EVALUATION OF ESSENTIAL ELEMENTS OF SWEET BASIL (*OCIMUM BASILICUM* L.) AT DIFFERENT GROWTH STAGES UNDER DEFICIT IRRIGATION

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ABSTRACT. Sweet basil (*Ocimum basilicum*) is an annual herb plant belonging to the Lamiaceae family that is used as a drug, spice and fresh vegetable. In order to study the effects of different levels of water stress on some element of the plant, O. basilicum was subjected to deficit irrigation using four treatments viz. control, irrigated with 70% of soil water capacity (SWC), Treatment 1, irrigated with 50% SWC, Treatment 2, irrigated with 30% SWC and Treatment 3, irrigated with 10 % SWC. Plants were divided into four growth stages, *Viz.,* vegetative (35 days after sowing, DAS), pre-flowering (49 DAS), flowering (63 DAS) and seed setting (77 DAS). Essential elements of leaves were investigated under these irrigation treatments at each growth stages. The results at the end of each growth stage indicated that there is no significant reduction in essential elements quantities compared to that of full irrigation control. The quantities remained high even in the lowest irrigation plants (T3, 10% SWC). The lowest irrigation plants accumulated, high nitrogen (N) Calcium (Ca) , magnesium (Mg), potassium (K) and phosphor (P), compared to control plants. Moreover, low irrigation helped Ocimum plants to accumulate less chloride than the full irrigated control. These results may be attributed to the ability of this plant to acclimate to water shortage.

Key words: *Ocimum basilicum* L., essential element, irrigation treatments, growth stages. vegetative, pre-flowering, flowering, seed setting**.**

INTRODUCTION

Basil, (*Ocimum basilicum* L.) plant is cultivated as medicinal and seasoning plant, has strict requirements to water and minerals. Water has become an increasingly precious natural resource as population growth throughout the region has strained supplies, especially in summer when people water lawns more frequently. With increasing municipal and industrial demands for water, its allocation for agriculture is decreasing steadily (Kirda and Kanber, 1999; Dry *et al*., 2001 and John Wiley and Sons, 2008). The major agricultural use of water is for irrigation, which, thus, is affected by decreased supply. Therefore, innovations are needed to increase the efficiency of use of the water that is available. There are several possible approaches (Stegman *et al*.,1990 and Fereres and Soriano, 2007). Irrigation technologies and irrigation scheduling may be adapted for more effective and rational uses of limited supplies of water. Drip and sprinkler irrigation methods are preferable to less efficient traditional surface methods. It is necessary to develop new irrigation scheduling approaches, not necessarily based on full crop water requirement, but ones designed to ensure the optimal use of allocated water. Deficit (or regulated deficit) irrigation is one way of maximizing water use efficiency (WUE) for higher yields per unit of irrigation water applied: the crop is exposed to a certain level of water stress either during a particular period or throughout the whole growing season (Romero *et al* ,2003 ; Yang *et al* ,2003, Khalid, 2006 and Geerts *et al,*2008).

This paper aims to evaluate the feasibility of deficit irrigation and whether significant savings in irrigation water are possible without significant decrease in essential elements penalties. This paper reviews the responses of *Ocimum basilicum* to deficit irrigation in terms of evaluation of essential elements on different growth stages.

MATERIALS AND METHODS

Basil seeds were collected from the garden of Faculty of Science, King Abdul-Aziz University, Jeddah, Kingdom of Saudi Arabia, after the parent plants have been identified as *Ocimum basilicum* L. The soil was obtained from the same soil of the parent plants and from different nurseries. Eight soils were tested for germination; the selected soil is the one that gave 80% germination. The soil was then added to forty pots (30 cm, each). Fifteen seeds of *O. basilicum* were sown in each pot. Seedlings were irrigated to field capacity for one week, after which the plants were thinned down to one per -pot. Seedlings were irrigated regularly to assist establishment. Four treatments (10 pots each) were applied, these were: well-watered control, irrigated with 70% of soil water capacity (SWC), treatment 1(T1), irrigated with 50 % SWC, treatment 2 (T2), irrigated with 30 % SWC and treatment 3 (T3) , irrigated with 10% SWC. Measurements were taken at the beginning of vegetative stage (35 days after sowing (DAS)), pre-flowering stage (49 days after sowing (DAS)), flowering stage (63 days after sowing (DAS)) and at the beginning of seed formation stage (77 DAS).

Measurements

1) Nutrients Estimation:

Measurements were done following the procedure of (Humphirs, 1956; Stewart, 1983) . Five leaves (upper most expanded leaves) were taken randomly from each treatment at 36, 49, 63 and 77 DAS. 0.2 g of the dry powder leaves were extracted in 1 ml sulphoric acid in tubes. The tubes were left in cabin (15-30 min) until the samples burned. The tubes were left and cooled then added 1 ml of homogenous mixture of sulphoric acid and perochloric acid (1:1) . the mixture was heated in the cabin (20-30 min) until turned into colorless liquid.
Add 100 ml of distilled water to diluted. Measured using Atomic absorption spectrometer Model, varian Spectr AA10/ perk In Elmer Spectr AA3100/Mettler DL55/HACH DR2010/WTW).

RESULTS

Figure 1 shows that all plants had high content of Nitrogen (N) during the first three stages, and a very low amount at the seed-setting stage. T3 showed the lowest values of nitrogen at all growth stages compared to others. However, there were no significant difference between the treatments and the control. The reduction of nitrogen during the last stage was due to the age of the plant more than to irrigation treatment.

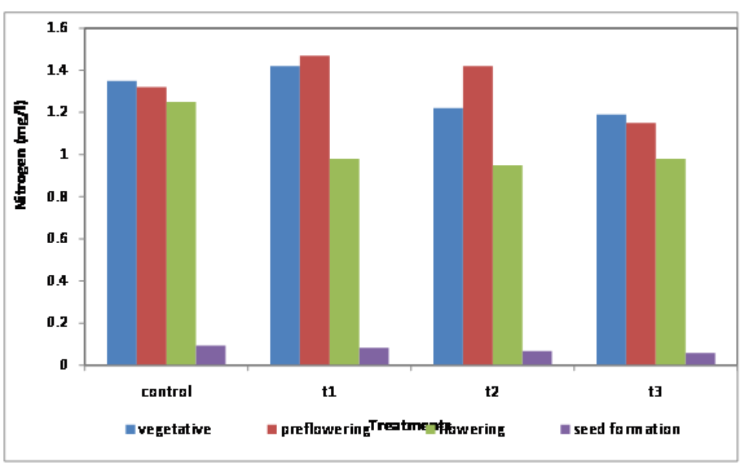


Figure (1) : Effect of Irrigation Treatments on Mean of Nitrogen (N) of Shoot (mg/l) at Different Growth Stages.

The results in Figure 2 revealed that the amount of Calcium (Ca) was high in deficit irrigated plants than the control ($p \leq 0.05$), except during flowering stage treatment where control plants recorded amount of 42.2 mg/l compared to 38.5, 33.4, and 33.6 mg/l of Calcium in T1, T2 and T3 .respectively

The amount of Magnesium (Mg) (Figure 3), showed an increase with the reduction of amount of irrigation (($p \leq 0.05$), except for T1 where there is no significant difference compared to control. The pattern of magnesium was T3 (10.1 mg/l), T2 (9.3 mg/l), and then control plants (7.2 mg/l).

Results in Figure 4 indicates the amount of Sodium (Na) accumulated in Basil plants under different irrigation regimes. The highest value of this element was recorded during flowering stages of all plants. The values were 1.8 mg/l, 1.9 mg/l, 1.5 mg/l and 1.9 mg/l in control, T1, T2 and T3 respectively. Nonetheless, water stress did not cause high accumulation of sodium. In contrast, stressed plants accumulated less sodium at later stages than the control.

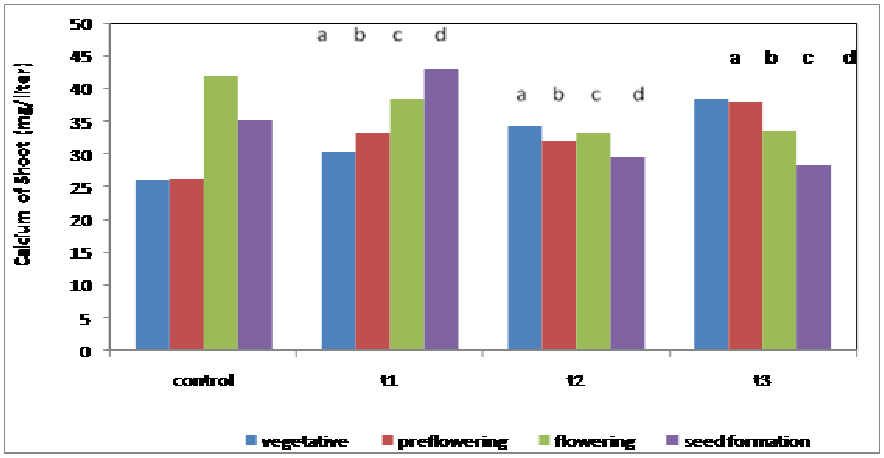


Figure (2): Effect of Irrigation Treatments on Mean of Calcium (Ca) of Shoot (mg/l) at Different Growth Stages. *.(a, b, c & d, statistically different compared to control at vegetative, pre-flowering, flowering and seed formation stages respectively,* **at** *p<0.05*

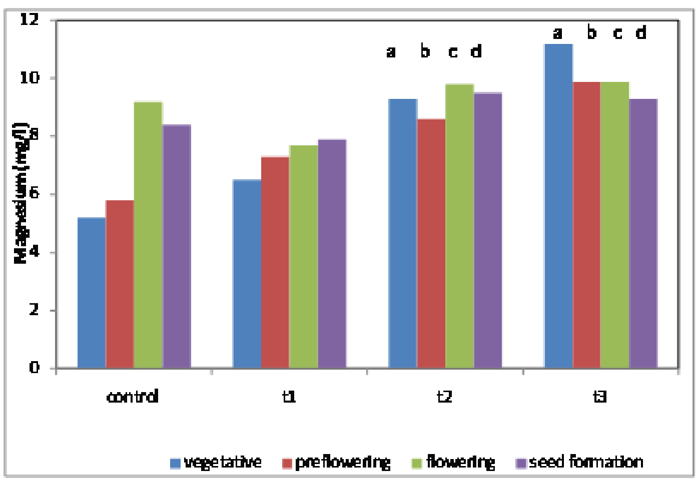


Figure (3) : Effect of Irrigation Treatments on Mean of Magnesium (Mg) of Shoot (mg/l) at Different Growth Stages. *.(a, b, c & d, statistically different compared to control at vegetative, pre-flowering, flowering and seed formation stages respectively,* **at** *p<0.05*

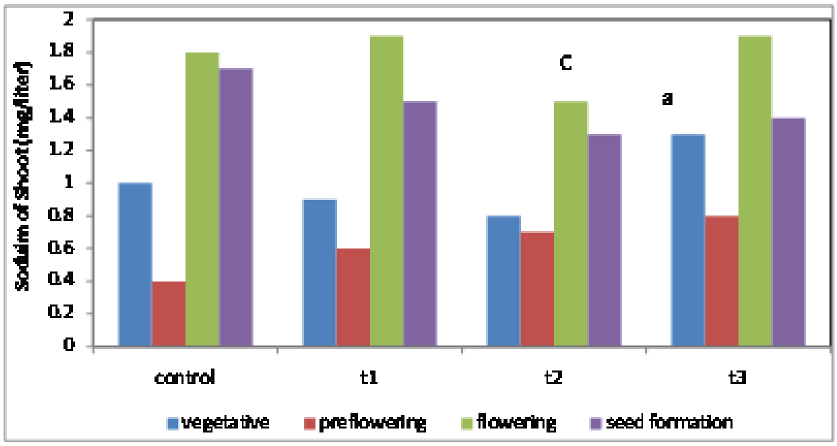


Figure (4) : Effect of Irrigation Treatments on Mean of Sodium (Na) of Shoot (mg/l) at Different Growth Stages. *.(a& c, statistically different compared to control at vegetative and flowering stages respectively,* **at** ***p<0.05.***

Results of Potassium (K) (Figure 5). Represented that, the highest Potassium values were recorded during vegetative stage for all plant, with stressed plants obtained high values compare to control especially in vegetative and pre-flowering stages ($p \leq 0.05$).

Concerning Ferrous (Fe) which is illustrated in Figure 6, T3 plants showed high values of Ferrous (Fe) during flowering and see-setting compared to control ($p \leq 0.05$). however all treatments attained high amount of Ferrous during the last two stages (flowering and seed-setting stages).

In regard to chlorine (Figure 7), it was observed that water stress has no pronounce effect on the accumulation of chlorine in *Ocimum basilicum* plants. T3 recorded the lowest amount of chlorine at all growth stages compared to control ($p \leq 0.05$).

Figure 8, demonstrated the amount of phosphorous (p) accumulated in plants. Water stress seemed to enhance Ocimum plants to accumulate high phosphorous content as was recorded in T3 compared to control ($p \leq 0.05$). control plants, however, recorded the highest amount of this element at the pre-flowering stage (10.0 mg/l).

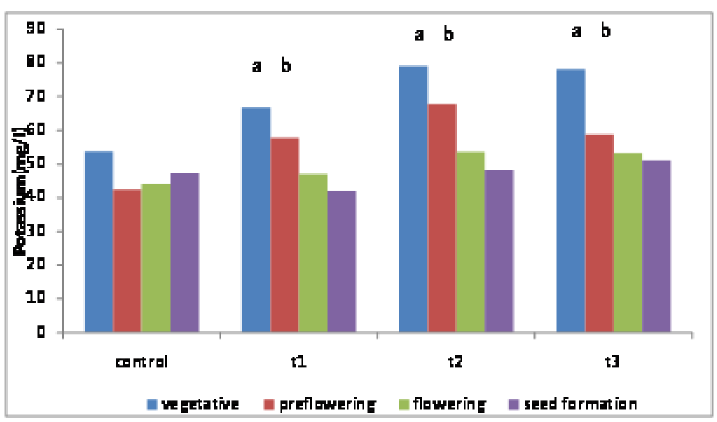


Figure (5) : Effect of Irrigation Treatments on Mean of Potassium (K) of Shoot (mg/l) at Different Growth Stages. *.(a& b, statistically different compared to control at vegetative and pre-flowering stages respectively,* **at** ***p<0.05.***

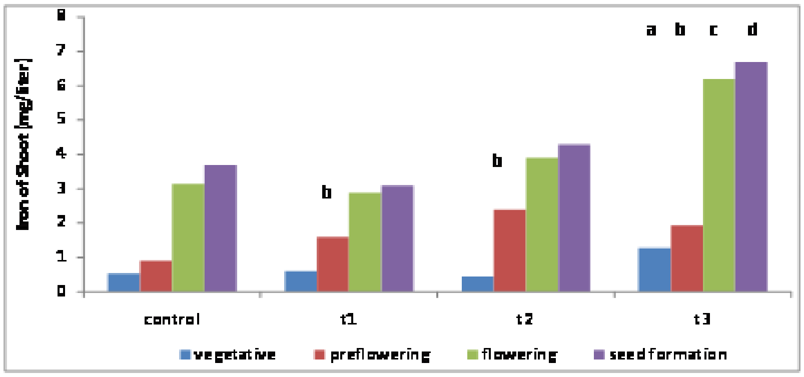


Figure (6) : Effect of Irrigation Treatments on Mean of Iron (Fe) of Shoot (mg/l) at Different Growth Stage. *.(a, b, c & d, statistically different compared to control at vegetative, pre-flowering, flowering and seed formation stages respectively,* **at** *p<0.05.*

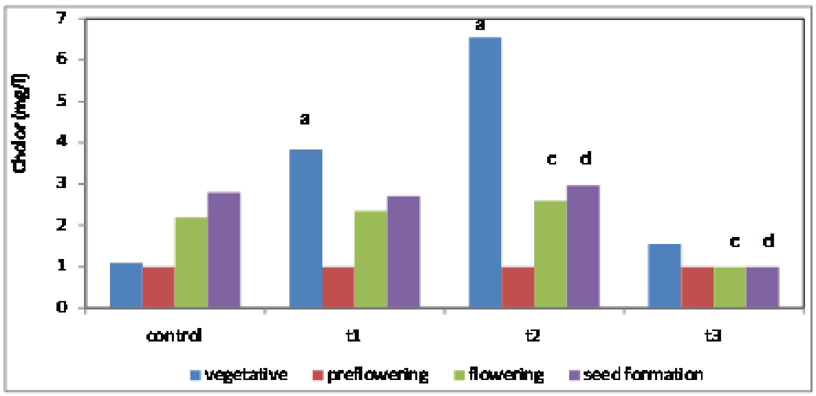
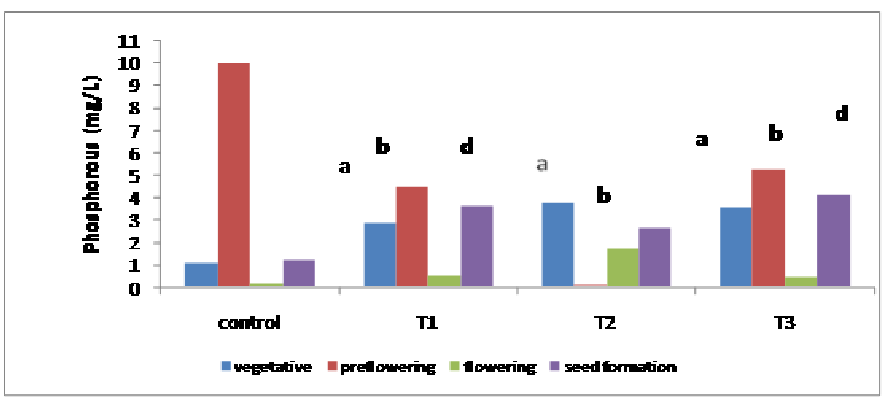


Figure (7) : Effect of Irrigation Treatments on Mean of chlorine (Cl) of Shoot (mg/l) at Different Growth Stages. *.(a, , c & d, statistically different compared to control at vegetative, flowering and seed formation stages respectively,* **at** *p<0.05*



Figure(8) : Effect of Irrigation Treatments on Mean of Phosphorous (P) of Shoot (mg/l) at Different Growth Stages. *.(a, , b & d, statistically different compared to control at vegetative, pre-flowering and seed setting stages respectively,* **at** *p<0.05.*

DISCUSSION

In the present study, *O. basilicum* plants seem to have high ability to accumulate sufficient level of essential elements at a very low quantity of irrigation water. Treatment 3 which was exposed to deficit irrigation of 10 % SWC, and at the same time it recorded reasonably high amount of essential element, the main goal that Ocimum is planted for (Walker, 1991 and Giani *et al*. 2007), since it is a medicinal plant (Tohti *et al*. 2006). Moreover, Singh et al., (2006) have reported that, reduced irrigation rates tend to enhance the plants to accumulate elements in their shoot. The high content of Calcium and Potassium in shoots considered as a good character for high productivity as was reported by Westage and Grant (1989) , Abdullatif (2000) and Khalid (2006).

There was no significant difference in the amount of Sodium) Na) between control and low amount of Chlorine in deficit irrigated plants. This phenomenon was mentioned by Larcher (1995), Al –Zahrani and Hajar (1998) to be one of the good character specially in Saudi Arabia plants.

On the other hand , the high levels of Magnesium (Mg) and Potassium (K) attained by low irrigation are thought to be beneficial to plants in icontrolling transpiration rate, through the effect on stomata as was mentioned by Flexas *et al.* (2002), Katazayna, (2010) and Sharafzadeh (2011).

CONCLUSION

During dry periods deficit irrigation would save water. The strategy used in the present study is to apply less water at different stages than normal irrigation. The amount of water used was 29% less from control in treatment 1, 57.2 % less in treatment 2 and 86 % less in treatment 3. Irrigation scheduling based on deficit irrigation requires careful evaluation to ensure enhanced efficiency of use of increasingly scarce supplies of irrigation water. Water stress had no adverse effect on essential elements of *O. basilicum* plants during all stages of the plant. normal irrigated plants (control) was not the best in term of the essential elements.

Further research is needed in this area to lead to the main goal of water conservation. Crops should be managed according to their sensitivity to water stress at various growth stages in making the irrigation decision.

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