The effect of water stress levels and selenium foliar application on some morphological characteristics of coriander

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Abstract

Drought is one of the most important factors of limiting plant growth around the world and is the most common environmental stress. Coriander (*Coriandrum sativum* L.) is a culinary and medicinal plant from the Umbelliferae family. In order to investigation of selenium foliar application on enhancing drought tolerance of coriander an experimental was carried out in a factorial experiment based on RCB design with three replication during 2012-2013. Drought stress was in four levels: 100% of field capacity (FC) as control, 80% FC, 60% FC and 40% FC and selenium was in shape of sealant sodium substance in four concentration: without using selenium as control, 20 mg/l, 25 mg/l and 30 mg/l. Measured traits were morphologic traits such as number of sub shrub, number of subshrubs with flower, plant height and root height. Results showed that simple effect of irrigation was significant in all of the traits ($p<0.01$). Simple effect of selenium had significant effect on all of the traits (in 1% level) too. Interaction effect of irrigation and selenium spraying had significant effect at 0.01 level of probability on all of the traits. The highest number of sub shrub obtained in control of both treatments that was 19.33 number and the lowest amount was 5.18 that obtained from 40% FC and 25 mg/l selenium. The highest amount of RWC obtained from control of both treatments (90.33 percentage) and the lowest amount was observed in 40% FC and 30 mg/l Se (42.66). The highest number of subshrubs with flower obtained in control condition of both treatments (24.33 number) and the lowest amount observed in 40% FC and 25 mg/l Se (4.12 number). The most plant height observed in control condition of both treatments that was (40.16 cm) and the lowest amount related to 40% FC and 25 mg/l Se (20.14 cm). The highest root height was observed in 40% FC and 25 mg/l Se (12.52 cm) and the minimum root height was observed in 100% FC and without using of Selenium (6.50 cm).

Keywords: drought, foliar application of selenium, coriander, agronomic traits

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Introduction

Although selenium (Se) is not an essential element for plants (Terry *et al*., 2000), several studies demonstrate that selenium supply may exert diverse beneficial effects, including growthpromoting activities (Turakainen *et al*., 2004; Djanaguiraman *et al*., 2005). Moreover, some plant species grown in Se-enriched media have shown enhanced resistance to certain abiotic stresses, e.g. drought (Kuznetsov *et al*., 2003; Germ *et al*., 2007; Yao *et al*., 2009), salinity (Kong *et al*., 2005; Djanaguiraman *et al*., 2005; Hawrylak-Nowak, 2009) and heavy metals (Srivastava *et al*., 2009; Cartes *et al*., 2010) stresses. Selenium exerts beneficial effects on growth and stress tolerance of plants by enhancing their antioxidative capacity (Kong *et al*., 2005; Rios *et al*., 2009). A stimulatory effect of foliar application of Se on growth has been reported for ryegrass (Hartikainen *et al*., 2000), lettuce (Xue *et al*., 2001), potato (Turakainen *et al*., 2004), soybean (Djanaguiraman *et al*., 2005) and green tea leaves (Hu *et al*., 2003). Selenium can also delay senescence and promote the growth of aging seedlings (Xue *et al*., 2001). Selenium supplemented water-deficit buckwheat exhibit significantly higher stomatal conductance (*g*s). A significantly higher actual photochemical efficiency of PSII was obtained in Sesupplemented water-deficit plants, which was possibly due to improvement of plant water management during treatment (Tadina *et al*., 2007). Selenium supply is favorable for growth of wheat seedlings during drought condition, however, the growth and physiological responses of seedlings were different, depending on the Se concentration (Yao *et al*., 2009). Simojoki (2003) reported that small Se addition that increased Se contents in lettuce shoots tend to enhance plant growth. It was shown that Se has the ability to regulate the water status of plants under drought conditions (Kuznetsov *et al*., 2003). Recent researches have demonstrated that Se is not only able to promote growth and development of plants, but also increases resistance and antioxidant capacity of plants subjected to various stress (Peng *et al*., 2002; Djanaguiraman *et al*., 2005). Stress factors such as drought trigger common reactions in plants and lead to cellular damages mediated by reactive oxygen species (ROS). According to Price and Hendry (1991) who studied the role of oxygen radicals in different grasses exposed to drought, water deficit stress causes an overall inhibition of protein synthesis, inactivation of several chloroplast enzymes, impairment of electron transport, increased membrane permeability, and increased activity of the H2O2 scavenger system. Antioxidative enzymes such as superoxide dismutase (SOD), ascorbate peroxidase (APX) and catalase (CAT) play an important role against drought stress (Apel and Hirt, 2004; Habibi and Hajiboland, 2011). However, there are few reports on the protective role of exogenous Se on drought stress in plant. Also, the plants treated with selenate induce higher increases in enzymes that detoxify H2O2, especially ascorbate peroxidase (APX) and glutathione peroxidase (GSH-Px), thereby improving stress resistance (Kong *et al*., 2005; Rios *et al*., 2009). The aim of present work was to study In order to investigation of selenium foliar application on enhancing drought tolerance.

The overall aim of this study was to investigate the effects of drought stress and foliar application of selenium and their interactions to increase drought tolerance in coriander.

Materials and methods

To evaluate the effect of foliar application of selenium on increasing drought tolerance in coriander, the experiment been conducted at the farm of Islamic Azad College of Agriculture shahre-ghods in 2012-2013. Coriander's seeds was prepared from the Institute of Seed and Plant Improvement at Agricultural Research Organization. Before testing

Undisturbed soil samples was prepared from a depth of 0-30 cm and sent to Laboratory of Soil Mechanics and finally soil properties were designated. According to soil test carried out on-site testing, soil texture was a loamy.

Project was conducted as a factorial experiment at the randomized complete block design with three replications. Since the stem elongation stage and two days before the drought stress, irrigation began with different treatments and foliar application. Factor A included drought stress treatment as 100% of field capacity (control) a_1, 80% of field capacity a_2, 60% of field capacity a_3 and 40% of field capacity a_4 and factor B included different levels of selenium in the form of sodium selenate (O_4 Se Na_2) with four concentrations (b_1=1), (b_2=20), (b_3=24) (b_4=30) mgl as foliar application. This experiment was conducted to evaluate the effect of foliar application of selenium on increasing drought tolerance in corianders. In this experiment, after the sampling of plants, some traits such as floral twigs, the number of subshrubs, plant height and root length manually and using a ruler was measured.

Drought stress began since stem elongation stage. Foliar application of Sodium selenite was conducted using a spraying device with the values of zero, 25, 20 and 30 mgl and on three occasions at 17, 24 and 31 July in 2012. Statistical analysis included analysis of variance and mean values was conducted using SPSS & SAS statistical software and mean values was carried out using Duncan test at 5% level.

Results and discussion

The number of subshrubs

According to the results of analysis of variance (Table 1), it was observed that the effect of irrigation on the number of subshrubs was significant in the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of irrigation treatments the highest number of subshrubs was obtained in 100% of field capacity with the average of (14/50) units while the lowest rate was obtained on 40% treatment of field capacity with the average of (4/50) units (Table 2). According to the results of analysis of variance (Table 1), it was observed that the effect of selenium on the number of subshrubs was significant in the 1% level. The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of selenium treatments, highest rate of the number of subshrubs was obtained the treatment of non-use of selenium with the average of (19/97) units and the lowest was obtained from 30 mgl treatment with the average of (11/33) units (Table 2). In fact, reduction in irrigation and increasing in levels of drought stress decreased the number of subshrubs significantly. The results of analysis of variance (Table 1) showed that the interaction between irrigation and selenium on the number of subshrubs was significant at the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that in 100% irrigation level of capacity field, concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (2/33) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (7/00) units (table 2). The concentration of 30 mgl compared to the treatment of non-foliar application decreased the number of subshrubs to the amount of (8/67) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of subshrubs to the amount of (4/67) units and the concentration of 20 mgl compared to 30 mgl significantly increased the number of subshrubs to the amount of (6/34) units and the concentration of 25 mgl compared to 30 mgl significantly increased the number of subshrubs to the amount of (1/67) units (table 2). In 80% irrigation level of field capacity, the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (1/16) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of subshrubs to the amount of (0/5) units and the concentration of 25 mgl compared to 30 mgl significantly decreased the number of subshrubs to the amount of (0/7) units (table 2). In 60% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (7/00) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (4/67) (table 2). The concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased the number of subshrubs to the amount of (2/33) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly decreased the number of subshrubs to the amount of (2/33) units and the concentration of 20 mgl compared to 30 mgl significantly decreased the number of subshrubs to the amount of (4/67) units (table 2). The concentration of 25 mgl compared to 30 mgl significantly decreased the number of subshrubs to the amount of (2/34) units (table 2). In 40% irrigation level of filed capacity, the concentration of 30 mgl compared to the treatment of non-foliar application significantly increased the number of subshrubs to the amount of (03/52) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of subshrubs to the amount of (0/92) units and the concentration of 25 mgl compared to 30 mgl significantly decreased the number of subshrubs to the amount of (04/84) units and the concentration of 20 mgl compared to 30 mgl significantly decreased the number of subshrubs to the amount of (03/92) units (table 2). Comparison of the interactions between irrigation and foliar application of selenium (Table 2) also shows that in control irrigation treatments (100% irrigation based on field capacity) the highest number of subshrubs was obtained from treatment of non-use of selenium with the average of (19/33) units and the lowest rate was obtained from 30 mgl with the average of (10/66) units (Table 2). In 80% irrigation treatments of field capacity, the highest number of subshrubs was obtained from treatment of non-use of selenium with the average of (15/66) units and the lowest rate was obtained from 25 mgl of selenium with the average of (14/50) units (Table 2). In 60% irrigation treatments of field capacity, the highest number of subshrubs was obtained from treatment of non-use of selenium with the average of (14/33) units and the lowest rate was obtained from 20 mgl of selenium with the average of (7/33) units (Table 2). In 40% irrigation treatments of field capacity, the highest number of subshrubs was obtained from 30 mgl of selenium with the average of (10/02) units and the lowest rate was obtained from treatment of non-use of selenium with the average of (6/5) units (Table 2). Based on the results drought stress decreased the number of subshrubs.

Drought stress reduced the number of branches in plant coriander, Mexican flowering plant and oregano. It seems that increasing foliar application of
Selenium in the drought stresses reduced the number of branches. Excessive branching under drought stress is an undesirable trait. Because it c causes soil's moisture been consumed vainly and limited branching in hemp plants under drought stress is an adaptation mechanism by which plant trying to retain water for more critical stages of development such as flowering stage. Thereby reducing the number and length of lateral branches in the severe water stress conditions may be a coping mechanism for Mexican flowering plant. In dry conditions, root growth is less affected than the subshrubs and to be allocated more photoassimilate to the roots. Therefore some plants in response to drought stress, they increase the rate of water absorption through maintaining relative root growth and increasing root to subshrub ratio and more water will be available (Table 2).

The number of floral twigs

According to the results of analysis of variance (Table 1), the effect of irrigation on the number of floral twigs was significant in the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of irrigation treatments the highest number of floral twigs was obtained in 100% of field capacity with the average of (19/66) units while the lowest rate was obtained on 40% treatment of field capacity with the average of (06/33) units (Table 2). According to the results of analysis of variance (Table 1), the effect of selenium on the number of floral twigs was significant in the 1% level. The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of selenium treatments, highest rate of the number of floral twigs was obtained the treatment of non-use of selenium with the average of (13/91) units and the lowest was obtained from 30 mgl treatment with the average of (8/66) units (Table 2). Reduction in irrigation and increasing in levels of drought stress decreased the number of floral twigs significantly. The results of analysis of variance (Table 1) showed that the interaction between irrigation and selenium on the number of floral twigs was significant at the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that in 100% irrigation level of capacity field, concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (5/66) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (6/00) units (table 2). The concentration of 30 mgl compared to the treatment of non-foliar application decreased the number of floral twigs to the amount of (7/00) units (table 2). The concentration of 20 mgl compared to 30 mgl significantly increased the number of floral twigs to the amount of (01/34) units and The concentration of 25 mgl compared to 30 mgl significantly increased the number of floral twigs to the amount of (1/00) units and the concentration of 25 mgl compared to 30 mgl significantly increased the number of floral twigs to the amount of (1/00) units (table 2). In 80% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (5/84) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (10/46) units and the concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (4/3) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of floral twigs to the amount of (04/62) units and the concentration of 20 mgl compared to 30 mgl significantly decreased the number of floral twigs to the amount of (01/54) units. The concentration of 25 mgl compared to 30 mgl significantly decreased the number of floral twigs to the amount of (06/16) units (table 2). In 60% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (01/59) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (3/58) and the concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (2/67) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of floral twigs to the amount of (2/26) units (table 2). The concentration of 25 mgl compared to 30 mgl significantly decreased the number of floral twigs to the amount of (1/18) units (table 2). In 40% irrigation level of filed capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (07/00) units and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased the number of floral twigs to the amount of (05/21) units and the concentration of 30 mgl compared to the treatment of non-foliar application significantly increased the number of floral twigs to the amount of (2/67) units (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased the number of floral twigs to the amount of (4/51) units and the concentration of 20 mgl compared to 30 mgl significantly decreased the number of floral twigs to the amount of (03/37) units and the concentration of 25 mgl compared to 30 mgl significantly decreased the number of floral twigs to the amount of (7/88) units (table 2). Comparison of the interactions between irrigation and foliar application of selenium (Table 2) also shows that in control irrigation treatments (100% irrigation based on field capacity) the highest number of floral twigs was obtained from treatment of non-use of selenium with the average of (24/33) units and the lowest rate was obtained from 30 mgl with the average of (17/33) units (Table 2). In 80% irrigation treatments of field capacity, the highest number of floral twigs was obtained from treatment of non-use of selenium with the average of (20/05) units and the lowest rate was obtained from 25 mgl of selenium with the average of (10/04) units (Table 2). In 60% irrigation treatments of field capacity, the highest number of floral twigs was obtained from treatment of non-use of selenium with the average of (10/00) units and the lowest rate was obtained from 25 mgl of selenium with the average of (6/15) units (Table 2). In 40% irrigation treatments of field capacity, the highest number of floral twigs was obtained from 30 mgl of selenium with the average of (12/00) units and the lowest rate was obtained from 25 mgl of selenium with the average of (4/12) units (Table 2). Based on the results drought stress decreased the number of floral twigs. In dry conditions, root growth is less affected than the subshrubs. And foliar application of selenium in drought stress by reducing the growth of vegetative causes to be allocated more photoassimilate to the roots.Therefore some plants in response to drought stress, they increase the rate of water absorption through maintaining relative root growth and increasing root to subshrub ratio and more water will be available (Table 2).

Plant height

According to the results of analysis of variance (Table 1), the effect of irrigation on stem length was significant in the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of irrigation treatments the highest plant height was obtained in 100% of field capacity with the average of (31/00) centimeters While the lowest rate was obtained on 40% treatment of field capacity with the average of (14/90) centimeters (Table 2). According to the results of analysis of variance (Table 1), the effect of selenium on plant height was significant in the 1% level. The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of selenium treatments, highest rate of plant height was obtained the treatment of non-use of selenium with the average of (29/60) centimeters and the lowest was obtained from 30 mgl treatment with the average of (22/51) centimeters (Table 2). Reduction in irrigation and increasing in levels of drought stress increased plant height significantly. The results of analysis of variance (Table 1) showed that the interaction between irrigation and selenium on essential oil percentage was significant at the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that in 100% irrigation level of capacity field, sthe concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (1/96) centimeters and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (10/36) centimeters (table 2). The concentration of 30 mgl compared to the treatment of non-foliar application decreased plant height to the amount of (17/33) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased plant height to the amount of (08/04) centimeters and The concentration of 20 mgl compared to 30 mgl significantly increased plant height to the amount of (15/37) centimeters and the concentration of 25 mgl compared to 30 mgl significantly increased plant height to the amount of (06/97) centimeters (table 2). In 80% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (8/67) centimeters and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (12/00) centimeters and the concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (09/00) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased plant height to the amount of (3/33) centimeters and the concentration of 25 mgl compared to 30 mgl significantly decreased plant height to the amount of (3/00) centimeters (table 2). In 60% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (8/4) centimeters and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (10/28) and the concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (3/51) centimeters (table 2). The concentration of 20 mgl compared to 30 mgl significantly decreased plant height to the amount of

(4/98) centimeters and the concentration of 20 mgl compared to 25 mgl significantly increased plant height to the amount of (1/88) centimeters and the concentration of 25 mgl compared to 30 mgl significantly decreased plant height to the amount of (3/89) centimeters (table 2). In 40% irrigation level, the concentration of 20 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (6/62) centimeters and the concentration of 25 mgl compared to the treatment of non-foliar application significantly decreased plant height to the amount of (9/67) centimeters and the concentration of 30 mgl compared to the treatment of non-foliar application significantly increased plant height to the amount of (2/17) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly increased plant height to the amount of (3/07) centimeters and the concentration of 20 mgl compared to 30 mgl significantly decreased plant height to the amount of (8/79) centimeters and the concentration of 25 mgl compared to 30 mgl significantly decreased plant height to the amount of (11/86) centimeters (table 2). Comparison of the interactions between irrigation and foliar application of selenium (Table 2) also shows that in control irrigation treatments (100% irrigation based on field capacity) the highest plant height was obtained from treatment of non-use of selenium with the average of (40/16) centimeters and the lowest rate was obtained from 30 mgl with the average of 22/83 centimeters (Table 2). In 80% irrigation treatments of field capacity, the highest plant height was obtained from treatment of non-use of selenium with the average of (40/00) centimeters and the lowest rate was obtained from 25 mgl of selenium with the average of (28/00) centimeters (Table 2). In 60% irrigation treatments of field capacity, the highest plant height was obtained from treatment of non-use of selenium with the average of (38/73) centimeters and the lowest rate was obtained from 25 mgl of selenium with the average of (28/45) centimeters (Table 2). In 40% irrigation treatments of field capacity, the highest plant height was obtained from 30 mgl of selenium with the average of (32/00) centimeters and the lowest rate was obtained from 25 mgl of selenium with the average of (20/14) centimeters (Table 2). Based on the results drought stress decreased plant height. Reduced plant height in this situation can be attributed to impairment of photosynthesis due to lack of moisture in the soil and reducing the transfer of assimilates to the developing parts of the plant. (Table 2).

Root length

According to the results of analysis of variance (Table 1) it was observed that the effect of irrigation on root length was significant in the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of irrigation treatments the highest root length was obtained in 40% of field capacity with the average of (6/40) centimeters While the lowest rate was obtained on 100% treatment of field capacity with the average of (5/77) centimeters (Table 2). According to the results of analysis of variance (Table 1) it was observed that the effect of selenium on root length was significant in the 1% level. The results of the comparison with Duncan test at 5% level (Table 2) showed that according to main effect of selenium treatments, highest rate of root length was obtained from 30 mgl foliar application of selenium with the average of (7/70) centimeters and the lowest was obtained in the treatment of non-use of selenium with the average of (4/75) centimeters (Table 2). Reduction in irrigation and increasing in levels of drought stress increased root length significantly. The results of analysis of variance (Table 1) showed that the interaction between irrigation and selenium on essential oil percentage was significant at the 1% level (Table 1). The results of the comparison with Duncan test at 5% level (Table 2) showed that in 100% irrigation level of capacity field, the concentration of 25 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (0/7) centimeters and the concentration of 30 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (01/28) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly decreased root length to the amount of (0/4) centimeters and the concentration of 20 mgl compared to 25 mgl significantly increased root length to the amount of (0/98) centimeters (table 2). In 80% irrigation level of field capacity, the concentration of 20 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (0/3) centimeters and the concentration of 25 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (1/08) centimeters and the concentration of 30 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (0/82) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly decreased root length to the amount of (1/83) centimeters and the concentration of 25 mgl compared to 30 mgl significantly increased root length to the amount of (1/12) centimeters (table 2). In 60% irrigation level of field capacity, the concentration of 25 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (1/14) centimeters andthe concentration of 20 mgl compared to 30 mgl significantly increased root length to the amount of (1/81) centimeters (table 2). The concentration of 25 mgl compared to 30 mgl significantly increased root length to the amount of (1/82) centimeters (table 2). in 40% irrigation level of capacity field, the concentration of 20 mgl compared to the treatment of non-foliar application significantly increased root length to the amount of (0/13) centimeters and the concentration of 30 mgl compared to the treatment of non-foliar application significantly decreased root length to the amount of (2/63) centimeters (table 2). The concentration of 20 mgl compared to 25 mgl significantly decreased root length to the amount of (2/01) centimeters and the concentration of 20 mgl compared to 30 mgl significantly increased root length to the amount of (2/05) centimeters and the concentration of 25 mgl compared to 30 mgl significantly increased root length to the amount of (4/51) centimeters (table 2). Comparison of the interactions between irrigation and foliar application of selenium (Table 2) also shows that in control irrigation treatments (100% irrigation based on field capacity) the highest root length was obtained from 30 mgl of selenium with the average of (7/78) centimeters and the lowest rate was obtained from treatment of non-use of selenium with the average of 6/50 centimeters (Table 2). In 80% irrigation treatments of field capacity, the highest root length was obtained from 25 mgl of selenium with the average of (8/92) centimeters and the lowest rate was obtained from 30 mgl of selenium with the average of (7/02) centimeters (Table 2). In 60% irrigation treatments of field capacity, the highest root length was obtained from 25 mgl of selenium with the average of (10/14) centimeters and the lowest rate was obtained from 30 mgl of selenium with the average of (8/32) centimeters (Table 2). In 40%

irrigation treatments of field capacity, the highest root length was obtained from 25 mgl of selenium with the average of (14/52) centimeters and the lowest rate was obtained from 30 mgl of selenium with the average of (10/01) centimeters (Table 2). Based on the results drought stress increased root length, and it seems that foliar application of selenium caused growth acceleration and reduce the growth of shoots and reduce the effects of drought stress. In dry conditions, root growth is less affected than the subshrubs. In these conditions the roots to be assigned more photoassimilate. Therefore some plants in response to drought stress, they increase the rate of water absorption through maintaining relative root growth and increasing root to subshrub ratio and more water will be available (Table 2). Drought stress increased root length. And at all levels of drought stress, the concentrations of 20 and 25 mg selenium increased root length (Table 2).

Overall Conclusions

The overall results of this study indicated that stress levels of 60 and 40% of field capacity increased root length and cause a significant reduction in the number of subshrubs, plant height and floral twigs in comparison to control. And all of the concentration of selenium increased root length and reduce the number of subshrubs, the number of floral twigs, plant height compared to the control. 25 mgl of selenium in twenty-five-percent stress of field capacity increased root length and reduce the floral twigs, plant height and number of subshrubs. 30 mgl of selenium in the forty-percent stress of field capacity increased floral twigs, plant height and the number of subshrubs and decreased root length. It appears that 25 mgl of selenium reduced floral twigs to the amount of 5/21 flowers and height to the amount of 9/69 centimeters and root lengthening to the rate of 1/88 centimeters increase performance in forty-percent stress in the field capacity. and 30 mgl of selenium increased floral twigs to the amount of 21/5 flowers and height to the amount of 2/17 centimeters and reduction in root length to the rate of 2/63 centimeters decreased the performance.

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Table 1. Analysis of variance number of subshrubs, floral twigs, plant height and root length in the drought stress and foliar application of selenium

Sources of variation	**Degrees of freedom**	**Mean square**			
		The number of subshrubs	Floral twigs	Plan height	Root length

Repeat	*۲	1.27 ns	0.27 ns	9.84 ns	0.29 *
Selenium	۳	207.41**	353.41**	166.69**	1.28**
irrigation	۳	56.80**	70.18**	201.51**	21.92**
Selenium*irrigation	۹	29.99**	49.33**	186.78**	11.20**
Error	۳۰	0.62	0.73	3.45	0.08
Coefficient of variation (CV%)		3.83	2.32	4.95	4.90

***, ** And ns = significant at the 5% and 1% and no significant, respectively**

Table 2. Comparison of simple effects and interactions between number of subshrubs, floral twigs, plant height and root length using the Duncan methods at the level of five percent

Treatment		The number of subshrubs	Floral twigs	Plant height (cm)	Root length (cm)
Irrigation					
100% FC		14/50a	19/66a	31/00a	5/77d
80% FC		7/83b	14/30b	28/00b	6/50c
60% FC		6/90c	9/40c	27/65c	7/80b
40% FC		4/50d	6/33d	14/90d	9/40a
Selenium					
Zero		19/97a	13/91a	29/60a	4/75d
20 mg		17/00b	10/16b	25/50b	5/02c
25 mg		14/58c	9/16d	24/30c	6/32b
30 mg		11/33d	8/66c	22/51d	7/70a
irrigation	Selenium				
100% FC	Zero	19/33a	24/33a	40/16a	6/50j
	20 mg	17/00b	18/67c	38/20bc	6/80j
	25 mg	12/33f	18/33b	29/80g	7/20hi
	30 mg	10/66d	17/33c	22/83j	7/78h
	Zero	15/66c	20/50b	40/00 a	7/84h
80% FC	20 mg	15cd	14/66f	31/33e	8/14g
	25 mg	14/50e	10/04h	28h	8/92f
	30 mg	15/20cd	16/20e	31ef	7/02i
	Zero	14/33e	10/00 h	38/73b	9/00 ef
60% FC	20 mg	7/33i	8/41jk	30/33f	9/44e
	25 mg	9/66h	6/15l	28/45h	10/14cd
	30 mg	12f	7/33k	35/22c	8/32fg
	Zero	6/5jk	9/33i	29/83g	12/64 c
40% FC	20 mg	6/10j	8/63j	23/21i	12/51 b
	25 mg	5/18k	4/12m	20/14k	14/52 a
	30 mg	10/02g	12/00g	32/00d	10/01 d

In each column, the means that have at least one letter in common are not significantly different