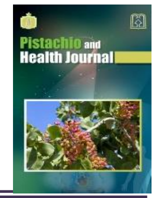

The impact of zeolite in the planting medium and seed priming on some vegetative parameters of pistachio (Pistachio Vera L.) under drought stress conditions

Fahime Hosseini (MSc) [1*] , Maryam afrousheh, (PhD) [2]

[1] *Researcher of kia Nahal Mehregan group, Pistachio Technology Incubator, Pistachio Research Center, Rafsanjan, Iran.*

[2] *PhD Pistachio Research Center, Horticultural Sciences Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Rafsanjan, Iran*

Information

Article Type:
Original Article

Article History:

Received: 15.02.2022
Accepted: 15.03.2022

Doi: 10.22123/PHJ.2022.329825.1122

Keywords:
Priming
Zeolite
Drought Stress
Polyethylene Glycol

Corresponding Author:
Hosseini, Fahime

Email: hosseini.1987@yahoo.com

Tel: +98-9212739424

Abstract

Introduction: With global warming and the reduction of groundwater, research on the effective use of available water for an important product such as pistachio in Rafsanjan, which is the hub of pistachio production, is essential.

Materials and Methods: To investigate the effect of priming and zeolite on some vegetative parameters of Pistachio Vera L. seeds under drought stress conditions, an experiment was conducted in a completely randomized factorial design with four treatments and four drought levels in three replications in greenhouse conditions The treatments included zeolite at three concentrations (0, 10, and 20%) and priming at four levels including control (no priming), polyethylene glycol (PEG) (250 mg/l), zinc (Zn) (300 mg/l) + polyethylene glycol (250 mg/l), and polyethylene glycol (500 mg/l). The parameters investigated in this study were stem diameter, fresh and dry weight of leaves, stems, and roots, and the number of healthy and damaged leaves.

Results: showed that under the influence of applied treatments, the parameters in questions showed statistically significant differences compared to the control treatment. The data indicated the highest seedling height (17.4) and fresh and dry leaf weights were observed in the priming with PEG250 + Zn300 concentration, showing significant differences (17.4%, 100%, and 100%) compared to control. Zeolite also had a significant effect on reducing the number of damaged leaves. Moreover, the interaction effects of the applied treatments were not significant for any of the traits. Following these data, it can be concluded that PEG250 + Zn300 treatment and application of 10% zeolite significantly reduced drought stress ($p<0.05$).

Conclusion: In general, it is concluded that the combination of priming and zeolite or super-gravity factors can be effective in reducing the effect of drought stress or increasing the irrigation period of seedlings, but this requires more and more extensive research.

►Please cite this article as follows:
Hosseini, F, afrousheh M. The impact of zeolite in the planting medium and seed priming on some vegetative parameters of pistachio (Pistachio Vera L.) under drought stress conditions. Pistachio and Health Journal. 2022; 5 (1): 30-38 .

1. Introduction

Pistachio is one of the most important export products of Iran. This plant belongs to the Anacardiaceae family and the genus Pistacia and is propagated by seeds. Harmful effects of biotic and abiotic stresses, including high and low temperatures, soil crust, water accumulation due to poor soil texture or water deficiency, salinity, pathogenic diseases, and insects can reduce the speed of germination and seedling emergence or completely prevent these processes. To this end, priming or seed pretreatment with different materials is used as a practical method for producing high-quality seedlings. A review of the literature indicated that priming (seed pretreatment) under stress conditions has been effective in increasing the percentage and uniformity of seed germination and improving seedling growth and seed vigor index [1, 2]. The literature also shows that priming has a positive effect on improving vegetative growth under stress conditions and can cope with drought stress. Ramezani et al. [3] suggested that the best priming solution for tomato seeds was pretreatment with 10% polyethylene glycol (PEG).

Given that Iran is located in an arid and semi-arid area with low precipitation, water shortage is one of the main agricultural challenges across the country [4]. Lack of water resources for irrigation and less water efficiency in traditional agricultural systems are among factors restricting agricultural activities in Iran and other parts of the world. Methods to increase water use efficiency for optimal production in irrigated farms are the main topics in studies addressing the interaction between plants and the environment [5]. Some chemicals and minerals have been used in recent years to increase water retention in agriculture. Moreover, some studies have addressed the application of hydrophilic polymers to increase water use efficiency [6]. Zeolites are also among the other porous compounds that contain minerals composed of aluminum silicate and are naturally produced in geological processes [7] .A review of the literature indicated that zeolite helps to increase plant resistance to drought stress. Zeolites have a high water absorption, which depends on the type of zeolite and the type of cations in its channels [7]. Mahmoud and Tadayon [8] reported that application of 10 tons of zeolite per hectare, along with supplying 60 and especially 80% water requirement, reduces land stress damage to cannabis plants. This being so, the present study aims to investigate the effects of zeolite in the planting medium and seed priming on some vegetative parameters of pistachio under drought stress conditions.

2. Materials and Methods

This study examined the effect of zeolite applied to the planting medium and different seed priming treatments on some vegetative parameters of pistachio under drought stress. This research project was conducted in a completely randomized factorial design in the greenhouse of the Pistachio Research Institute located in Rafsanjan. The treatments included zeolite at three concentrations (0, 10, and 20%) and priming at four levels including control (no priming), polyethylene glycol (PEG) (250 mg/l), zinc (Zn) (300 mg/l) + polyethylene glycol (250 mg/l), and polyethylene glycol (500 mg/l). Drought stress was applied at three levels (normal irrigation {once every three days}, a 9-day irrigation cycle, and a 12-day irrigation cycle). The studied traits were stem diameter and height, fresh and dry weight of leaves, stems, and roots, and the number of healthy and damaged leaves.

Badami Zarand pistachio seeds were placed in solutions with the mentioned concentrations of polyethylene glycol for 24 hours without the need for refrigeration. They were then planted in pots containing a mixture of different zeolite and soil percentages to a depth of 2 cm. Since the study aimed to simulate the experimental conditions and seedling production process similar to garden conditions, the pots were placed in a greenhouse-like space that was only covered with a 50% canopy, and the environmental conditions were set to be completely normal. The seedlings were irrigated every other day (normal irrigation) and then with the establishment of seedlings, twice a week. EC irrigation water was 3 dS/m. When the seedlings were six months old, drought stress was applied for 9 and 12 days for two months. After the application of the treatments, the seedlings were taken out of the pots and transferred to the laboratory to measure the studied traits. Stem diameter was measured with a caliper, seedling height with ruler, fresh and dry weight of leaves, stems, and roots were measured separately with a digital scale with an accuracy of 0.001. The number of healthy and damaged leaves was also counted. The obtained data were analyzed by SPSS software and their mean comparisons were performed using Duncan's new multiple range test (MRT) at the significance level of 0.05 ($p<0.05$).

3. Results

Table 1 shows the results of the analysis of variance for the studied parameters:

Table 1: Analysis of variance for the germination indices

Source of changes	df	Stem diameter (cm)	Height (cm)	Leaf wet weight (gr)	Leaf dry weight (gr)	Stem wet weight (gr)	Stem dry weight (gr)	Root wet weight (gr)	Root dry weight (gr)	Number of healthy leaves	Number of damaged leaves
Drought stress	2	0.3 ^{NS}	669.675*	0.316 ^{NS}	0.193 ^{NS}	217741.7 ^{NS}	1.590 ^{NS}	1.732 ^{NS}	0.564 ^{NS}	98.12 ^{NS}	31.454 ^{NS}
Priming	3	0.217 ^{NS}	711.474*	5.976**	0.872**	219755.7 ^{NS}	3.792*	5.999 ^{NS}	3.87 ^{NS}	623.81**	26.701 ^{NS}
Zeolite	2	1.831**	376.58 ^{NS}	1.086 ^{NS}	0.363 ^{NS}	220795.5 ^{NS}	3.932*	8.384 ^{NS}	5.133 ^{NS}	122.34 ^{NS}	86.009**
Drought× priming	6	0.11 ^{NS}	108.38 ^{NS}	0.287 ^{NS}	0.069 ^{NS}	218639.9 ^{NS}	0.634 ^{NS}	2.690 ^{NS}	0.979 ^{NS}	96.97 ^{NS}	24.886 ^{NS}
Drought × zeolite	4	0.145 ^{NS}	425.06 ^{NS}	1.119 ^{NS}	0.177 ^{NS}	218061.95 ^{NS}	2.823 ^{NS}	4.683 ^{NS}	1.937 ^{NS}	179.24*	20.718 ^{NS}
Priming × zeolite	6	0.183 ^{NS}	145.16 ^{NS}	0.544 ^{NS}	0.056 ^{NS}	218606.7 ^{NS}	0.508 ^{NS}	0.564 ^{NS}	0.372 ^{NS}	84.343 ^{NS}	13.182 ^{NS}
Drought ×priming × zeolite	12	0.185 ^{NS}	119.91 ^{NS}	0.804 ^{NS}	0.079 ^{NS}	219490.11 ^{NS}	0.857 ^{NS}	2.185 ^{NS}	1.011 ^{NS}	40.431 ^{NS}	20.798 ^{NS}
Error	72	0.302	191.92	1.060	0.140	219333.67	1.373	3.890	1.887	58.620	13.343

ns: Not significant; * Significant at $p<0.05$; ** Significant at $p<0.01$

Stem diameter

The results of the analysis of variance showed that in zeolite treatment, stem diameter was significantly greater in the control sample ($p<0.01$) (Table 1). The largest stem diameter was measured in the control sampling (no priming and no zeolite) under normal irrigation conditions (Fig. 1):

Fig. 1. The impact of zeolite content on the seedling diameter

Seedling height in drought stress

The results of the analysis of variance showed that the seedling height was significantly different in the priming and drought treatments ($p<0.05$) (Table 1). The data also showed that seedling height under 9-day and 12-day drought stress significantly increased compared to the control treatment. As shown in Fig. 2, the seedling height increased by 17.4%.

Seedling height in the priming treatments

The results also showed that PEG250 + Zn300 and PEG500 priming treatments had a significant effect on increasing seedling height ($p<0.05$) but there was no significant difference between the control and PEG250 treatments (Fig. 3).

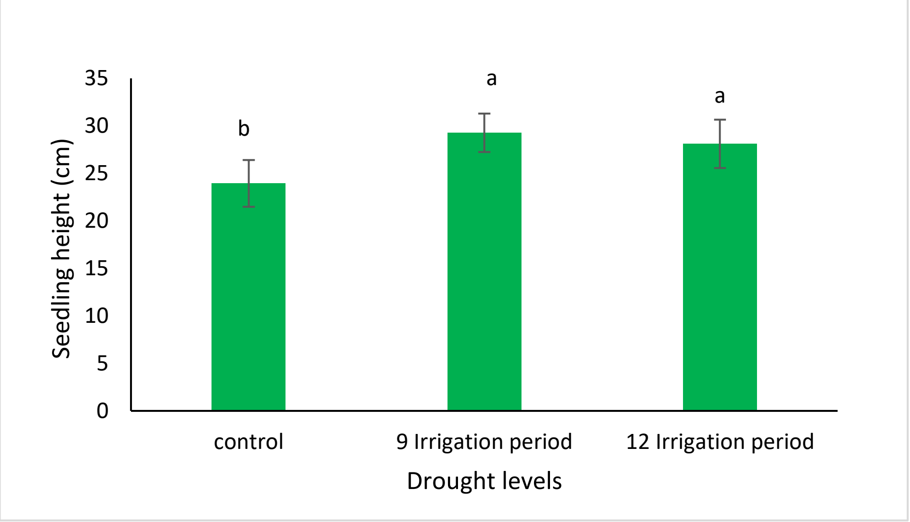

Fig. 2. The impact of drought levels on seedling height

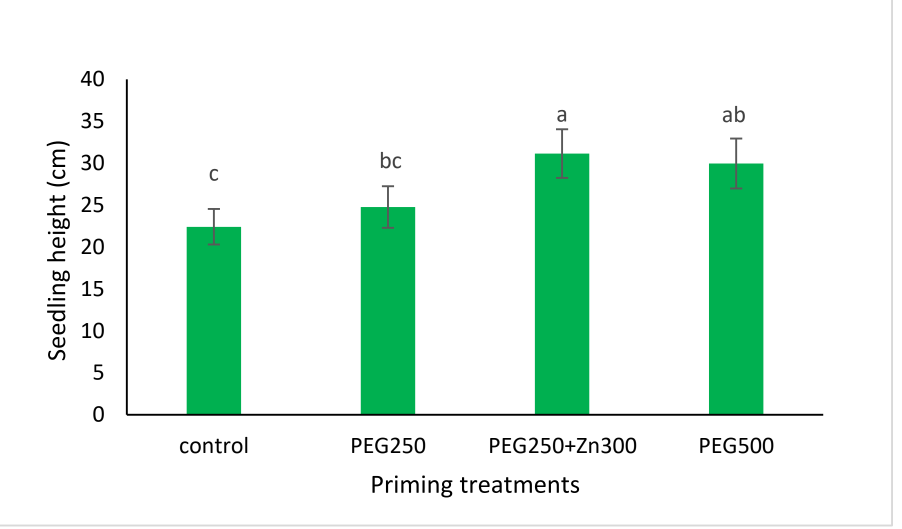

Fig. 3. The impact of priming treatments on seedling height

The leaf wet and dry weight

The results of the analysis of variance (Table 1) indicate that fresh leaf weight was significantly affected by the applied treatments ($p<0.01$). As can be seen, fresh leaf weight increased significantly at all three priming levels compared to the control treatment (Fig. 4). Moreover, the highest leaf fresh weight was found in the PEG250 + Zn300 priming treatment, which increased this trait by 100% compared to the control treatment. However, there was no significant difference between the priming treatments (Fig. 5). The data also revealed the highest leaf dry weight was obtained in the PEG250 + Zn300 priming treatment but showed no significant difference from the PEG500 treatment. However, the leaf dry weight increased by 100% showing a significant difference compared to the control treatment (Fig. 5):

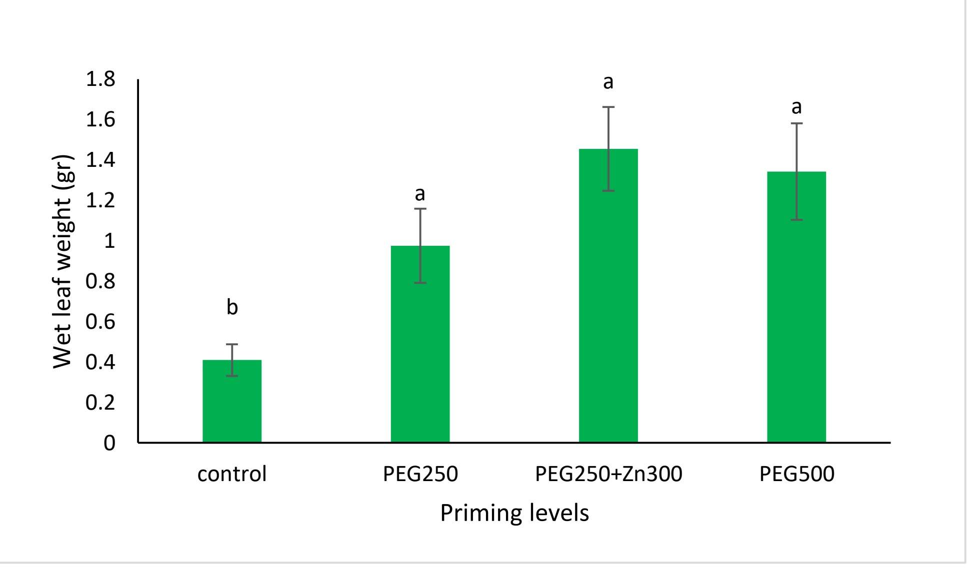

Fig. 4. The impact of priming levels on fresh leaf weight

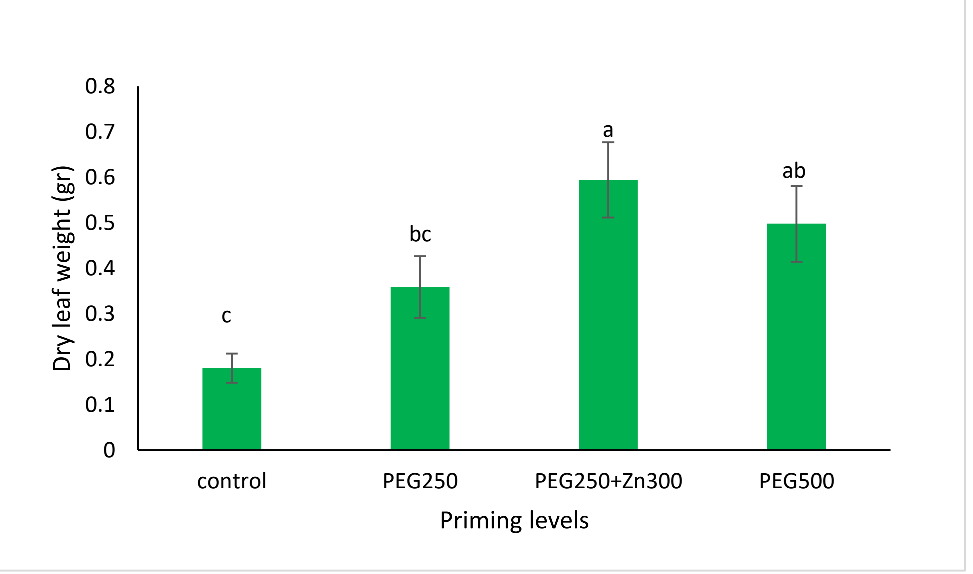

Fig. 5. The impact of priming levels on leaf dry weight

The stem dry weight

The results showed that under normal irrigation conditions, stem dry weight showed significant differences between different treatments (Table 1). Accordingly, the stem's highest dry weight was observed in the PEG250 + Zn300 priming treatment but showed no significant differences with the PEG250 and PEG500 treatments. However, the stem's highest dry weight increased significantly by 72.26% compared to the control treatment (Fig. 6). The data also revealed that the application of zeolite had no significant impact on the stem dry weight

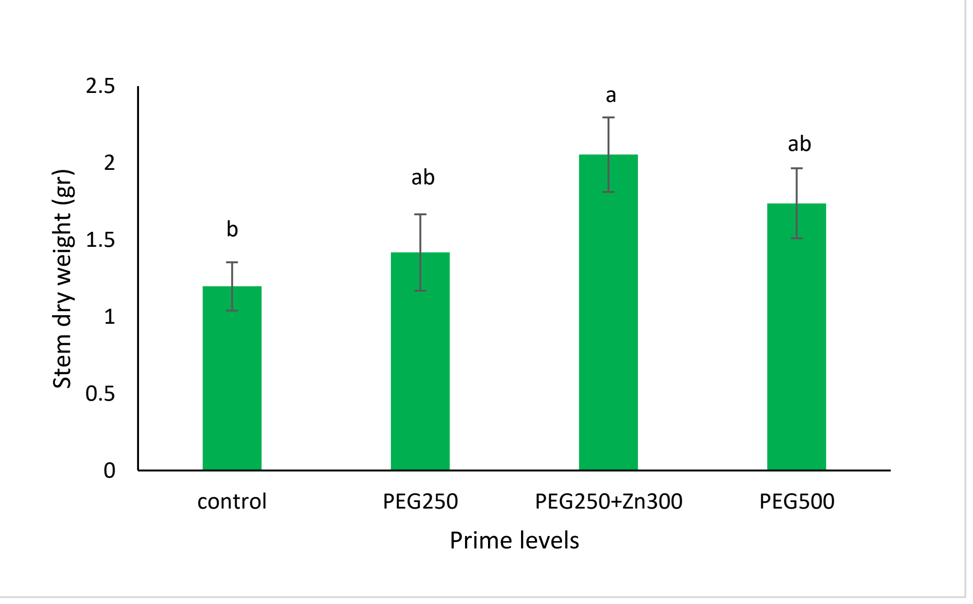

Fig. 6. The impact of priming levels on stem dry weight

Number of healthy leaves

As shown in Table 1, the number of healthy leaves per seedling showed significant differences between the treatments ($p<0.01$). The highest number of healthy leaves was seen in the PEG250 + Zn300 priming treatment. The number of healthy leaves increased by 181.8%, showing a significant difference compared to the control treatment and this caused healthier leaves to be kept on seedlings (Fig. 7). Besides, the application of 10% zeolite in the 9-day irrigation period led to a significantly greater number of leaves to be kept on the seedlings ($p<0.05$). However, in the 12-day irrigation period with 20% zeolite, the highest number of healthy leaves was seen on seedlings but showed no significant differences from the control treatment (Fig. 8). Madani et al. [9] reported that consumption of different amounts of zeolite had a significant effect on shoot and leaf dry weight, yield and leaf area index.

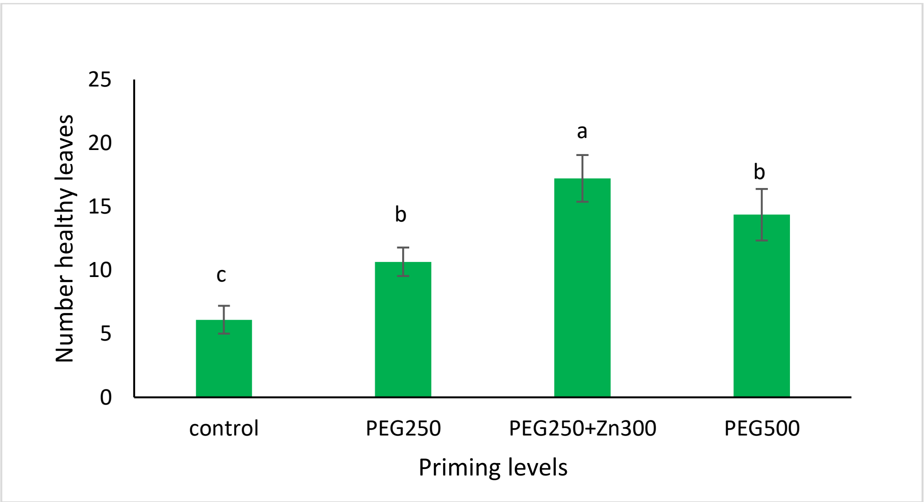

Fig. 7. The effect of priming levels on the number of healthy leaves

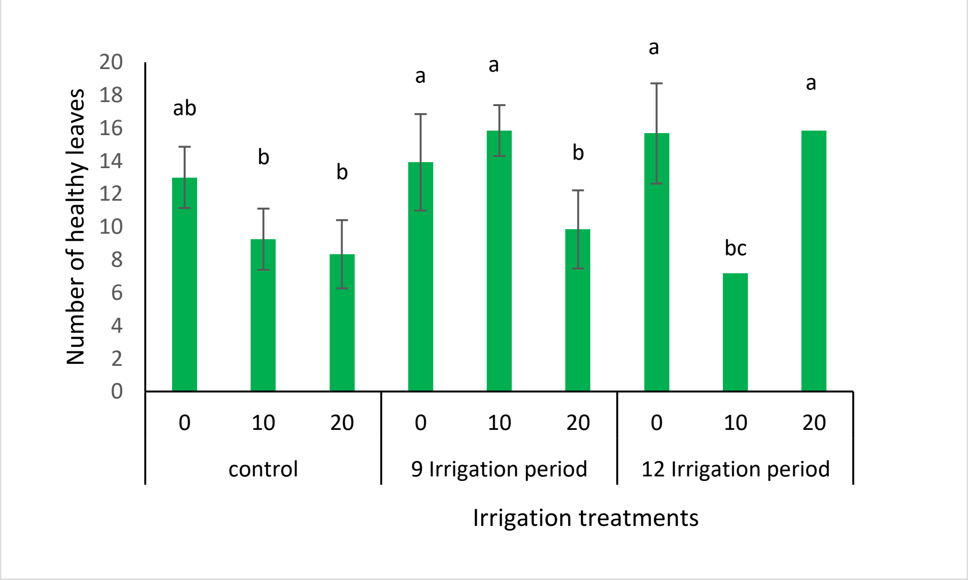

Fig. 8. The effect of drought stress and zeolite treatments on the number of healthy leaves

Number of damaged leaves

The results of the analysis of variance showed that the number of healthy leaves was significantly different across the treatments ($p<0.01$) (Table 1). The data also confirmed the highest number of damaged and fallen leaves in the non-application of zeolite, showing a significant difference from other treatments. In other words, the non-application of zeolite resulted in damages to 63.32% of the leaves (Fig. 9). This is because the water storage in the soil under stress and its transfer to the plant will be reduced, and finally, when the plant is under stress, one of the ways to deal with dehydration is leaf fall.. As Tadayon and Karimzadeh Sureshjani [8] reported that the use of one kilogram of zeolite per square meter is recommended to achieve better performance. This indicates that under drought stress and non-application of zeolite, the radicle length and root-to-stem ratio decrease, reducing the ability of the plant to withstand drought stress.

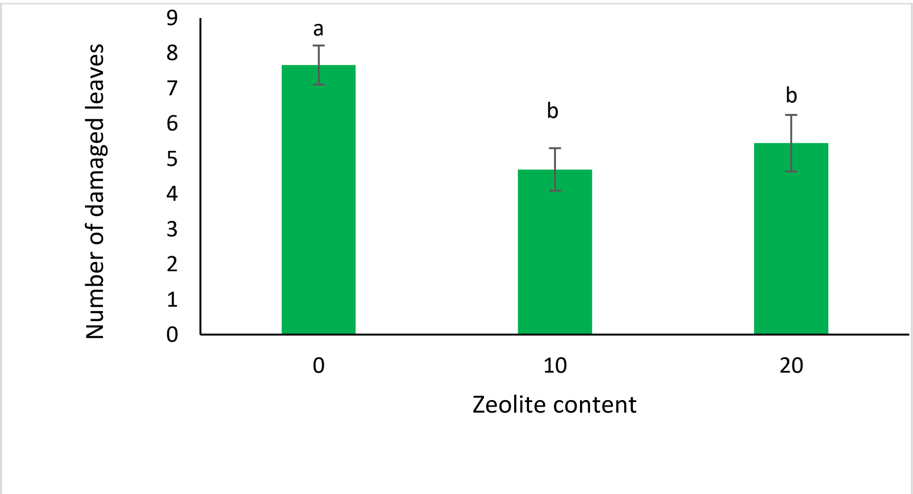

Fig. 9. The effect of drought stress and zeolite treatments on the number of damaged leaves

4. Discussion

The data in this study showed that the application of priming with PEG250 + Zn300 significantly increased the ability of seedlings under drought stress. The application of zeolite reduced the number of damaged leaves under drought stress conditions.. Considering that Zeolites have a high water absorption, which depends on the type of zeolite and the type of cations in its channels [7, 10]. Mahmoud and Tadayon [10] stated that application of 10 tons of zeolite per hectare, along with supplying 60 and especially 80% water requirement, reduces land stress damage to cannabis plants. However, zeolite has not yet been used to test its positive or negative effects on pistachio planting bed. Therefore, this requires more and more extensive research and application of different percentages of zeolite and different concentrations of priming materials.

5. Conclusion

In general, it is concluded from this experiment that the application of priming and zeolite can somewhat increase water use efficiency for seedlings that are placed under stress conditions. But as mentioned above, this requires more research, especially in the case of pistachio, which is rafsanjan's main product, and groundwater aquifers are drying up in this city.

Acknowledgments

The authors would like to express their gratitude to the officials in Pistachio Research Institute and the Technological Units Growth Center, especially to Dr. Nadi (Head of the Growth Center) and Dr. Tajabadipour for their cooperation in this research project.

Conflict of Interest

The authors declare no conflict of interest.

Funding: This study is financially supported by Pistachio Research Center.

References

1- Chen CC, Sung JM. Priming bitter gourd seeds with selenium solution enhanced germinability and antioxidative responses under sub-optimal temperature. Physiologia Plantarum. **2010**; 111: *9-16*.

2- Sepaskhah AR, Barzegar M. Yield, water, and the nitrogen-use response of rice to zeolite and nitrogen fertilization in a semi-arid environment. Agriculture Water Management. **2010**; 98:*38-44*.

3- Ramezani M, Rezaei Sukht Abandani R. The effect of osmotic pretreatment on seed germination components of tomato cultivars (*Lycopersicum esculentum* Mill.). Journal of Agricultural Knowledge and Sustainable Production. **2011**; 21(4).

4- Tavakoli AR. Deficit irrigation and supplemental irrigation management for rainfed and irrigated wheat at Selseleh region. J. of Water Research in Agriculture. **2013**; 27(4): *589-600*. (In Persian).

5- Moghimi A, Fathi P, Toushih V, Ardalan MM. The effect of perlite on irrigation water use efficiency and some growth components in Zarrin wheat cultivar. Journal of Water and Irrigation Management. **2011**; 1(2): *42-31*.

6- Mortezavi SM, Tavakoli A, Mohammadi, MH, Afsahi K. Effect of superabsorbent on physiological traits and yield of wheat Azar2 cultivar under dry farming conditions. Agronomy Journal (Pajouhesh & Sazandegi). **2015**; 104: *118-125*. [In Persian].

7- Baghodrat Gh, Ahmadi K, Valizadeh B. The effect of sulfur, Wollastonite, biotite, zeolite,graphite, perlite, and feldspar on oviposition and egg hatching of common pistachio psylla (*Agonoscena pistaciae* Burckhardt & Lauterer (Hem.: Psyllidae) in orchard conditions. Pistachio and Health Journal. **2021**; 4 (2): 56-74.

8- Tadayon MR, Karimzadeh Sureshjani H. The effect of zeolite on growth and physiological indices of. *miliaceum Panicum* L Under the management of a lack of irrigation. Environmental Stresses in Crop Sciences. **2019**; 12(2): *415-427*.

9- Madani H, Moghimi A, Sajedi NA. The effect of different amounts of zeolite and irrigation period on yield and yield of some potato traits. Journal of New Agricultural Findings. **2010**; 4(3): *281-289*.

10- Bahador M, Tadayon MR. Effect of deficit irrigation and zeolite levels on phenology, oil yield and water use efficiency of hemp. Iranian Journal of Field Crop Science. **2018;** 49(3)*: 25-38*.