A Comparative Study of the Sowing Method of Seed in Pots and its Effect on the Vegetative Characteristics of Pistachio Seedlings

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Abstract

Introduction: Pistachio propagated in nurseries from seeds. The rootstock, as a root and a part of the stem, has a vital role in the uptake of water and nutrients, the growth and establishment of the graft. In nurseries, germinated seeds are planted on a large scale, and the placement of seeds is not considered due to the high workload. Therefore, this research aims to compare the sowing method of pistachio seeds in pots, how the roots are oriented, and its effects on the vegetative growth of seedlings.

Materials and Methods: The experiment was conducted in a completely randomized design with three treatments (including sowing directions, head up, head down, and ventral in pots) and 6 replications under greenhouse conditions. The seeds were selected from the common rootstock, Badami-e-Zarand. The statistical method was obtained based on the coefficient of variation and the maximum average of the data for each trait. The total index as an indicator was used to determine the priority and importance of treatments.

Results: The results of the index based on the mean and correlation coefficients showed that the highest index was related to sowing seeds in the downward direction, with the highest value in weight and total indexes of the vegetative traits.

Conclusion: According to the results, the best direction of the seed was head down and the root placed inside the soil, which was related to the production of a straight and healthy root without a bench in the collar and the better absorption of water and nutrient elements by seedlings.

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1. Introduction

Pistachio is one of the most important products in Iran and belongs to the Anacardiaceae family and Pistacia genus [1]. Vast areas are dedicated to its cultivation. According to agriculture statistics, the cultivated area is more than 498.7 thousand hectares, and 4% has been added in different provinces in recent years [2]. In more than 99% of the country's pistachio orchards, domesticated pistachio (*Pistacia vera* L.) is planted due to the type of root system, high compatibility with environmental stress (e.g., dryness, salinity, cold, and heat), and high production efficiency [3]. Due to its high nutrient components (including sterols, vitamins, minerals, fatty acids, and phenolic compounds) [4], pistachio is classified among the top 50 food products [5].

The pistachio tree is dioecious, with separate male and female trees. In Iran, almost rootstock pistachio trees are Badami-e-Zarand. A scion from commercial cultivars is grafted onto a one-year-old rootstock. The pistachio tree's root system is phreatophyte and vertical, penetrating the soil to a depth of more than two meters. Such a deep rooting system enables the tree to be well-absorbed water; therefore, pistachio trees can adapt to long periods of drought.

The seedlings are planted in orchards and used as rootstock. The rootstock, as a root and a part of the stem, plays an important role in the construction of the orchard. The rootstocks are propagated from germinated seeds in the nurseries. The quality of seedlings is greatly affected by the growth condition in the nursery [6]. It directly affects the germination, development, and functional rooting system [7]. The quality also affects the re-establishment in the field and the final productivity of the orchard [8].

Root health is one of the most important factors to consider in orchard construction. Pistachio trees have a very weak ability to produce secondary roots, and when the ends of the main roots are cut, the trees dry up and die. According to earlier studies, cutting the tip of the main root or root cap during the transfer of seedlings to the mainland could cause 30% to 40% losses [9]. The process of transferring seedlings from the nursery to the mainland is in the autumn season or at the end of winter. After transferring, it takes time to find the sub-roots that could uptake nutrients. Thus, the transfer of seedlings to the mainland should be done in the shortest time without damaging the roots [10]. Tekin et al. stated that the structure of the pistachio root was strong and deep but produced few branches [11].

One of the problems related to seedlings with an economic effect on the orchard construction is the bench root in large and old seedlings in pots. In such conditions, the seedlings with this problem are transferred to the orchard; they would not have normal growth and development. In pistachio seedlings, the curve in the root collar (bench root) is also observed, the reasons for which are not physiologically clear. Since it is located in the main root, the seedlings become weak during the first or second years because of disruption in the water and nutrient uptake. In this regard, the importance of the root due to suitable vegetative growth must be considered. In nurseries, seeds are planted on a large scale with laborers, and their placement is not considered due to the high workload. Therefore, there is a question of "how placing the germinated seeds in the soil could be

important in the nurseries." This research aims to investigate the growth of seedlings in three different orientations of sowing seeds in pots.

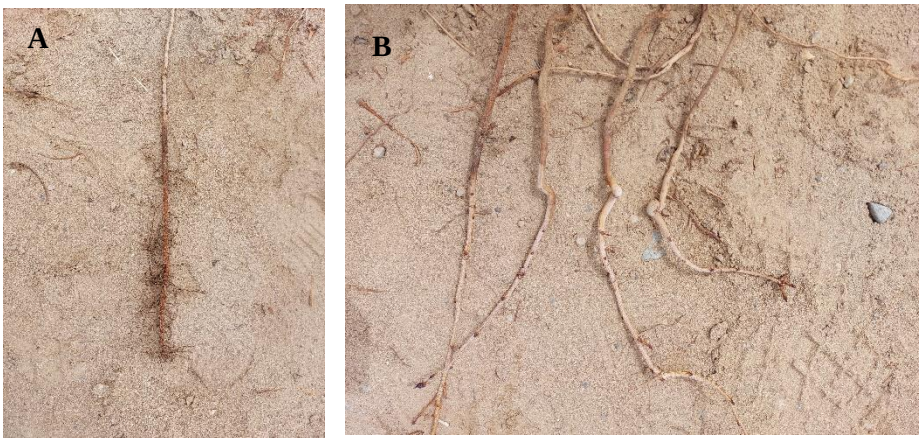

Fig. 1. Health root (A) and the curve in the root collar (bench root) (B) in pistachio seedlings

2. Materials and methods

This research was conducted under greenhouse conditions with an average temperature of 27±3°C, an average relative humidity of 55±5%, and 16 hours of light in summer. In this experiment, pistachio seeds were Badami-e-Zarand (common rootstock of pistachio orchards). First, the seeds were disinfected in a fumigate solution of 10% (containing 0.5% sodium hypochlorite) for 15 minutes; after washing them three times with distilled water, they were soaked in water for 24 hours. Then, they were transferred to plastic pots with a height of 30 cm. Perlite culture medium was used to investigate the growth of roots, and Hoagland solution ½ concentration was used for nutrition. Based on changes in volumetric moisture content in FC and PWP, the volume and frequency of irrigation were also determined [12]. This experiment was conducted in a completely randomized design with three treatments (including sowing seed in three directions of head up, head down, and ventral) and six repetitions.

After one month, the characteristics were evaluated as follows:

Stem height and length: these indicators were measured with the help of a ruler.

The number of leaves: leaf number was counted.

The fresh and dry weight of aerial and root parts: these indicators were measured using a sensitive scale (0.001).

The analysis of variance was done with SPSS statistical software. The statistical method obtained for comparing the type of seed orientation on the vegetative growth of seedlings was based on the coefficient of changes and weight and total indexes.

In probability theory and statistics, the coefficient of variation (CV), also known as relative standard deviation (RSD), is a standardized measure of the probability distribution. It is often expressed as a percentage and defined as the ratio of the standard deviation to the mean (or its absolute value). The coefficient of variation is a dimensionless number. For comparison of data sets with different units or widely different means, the

coefficient of variation can be used instead of the standard deviation.

The coefficient of variation (CV) is defined as the ratio of the standard deviation (σ) to the mean (μ).

$$Cv = \frac{\sigma}{\mu}$$

The following relationship was used to calculate the index:

$$Total\ Index = \omega 1\mu 1 + \omega 2\mu 2 + \cdots$$

$$\mu 1 = \frac{R1}{\mathcal{M}R1}$$

$$w1 = \frac{CvR1}{Cvmax}$$

In this formula, the desired variable value is R1, the highest value among the variables is M_{R2}, the coefficient of variation of each variable is $Cv_{R1,}$ and the highest coefficient of variation is Cv_{max}.

The importance of the treatments was determined by the total and weight indexes.

3. Results

The evaluation of vegetative traits in pistachio seedlings in different directions of seed placement is given in Table 1, based on standard deviation (σ), mean (μ), and the coefficient of variation. The coefficient of variation (CV) was used to compare vegetative traits with different units.

Table 1. The effect of different directions of seed placement on the vegetative traits of pistachio seedlings

Dry weight root (mg)	Dry weight aerial (mg)	Fresh weight root (mg)	Fresh weight aerial(mg)	Root length(cm)	Number of leaves	Stem length (cm)	Treatment
14.2667 ns	0.024333 ns	0.37 ns	0.08167 ns	17.4 ns	16 ns	14.26667 ns	Head up
15.833 ns	0.039 ns	0.46433 ns	0.112 ns	22.9 ns	15 ns	15.833 ns	Head down
14.5 ns	0.031667 ns	0.432 ns	0.09533 ns	18.5 ns	10.667 ns	14.5 ns	Ventral
32.48695	39.67562	23.72262	31.10669	26.08203	38.73603	18.63696	Cv

ns not significant, *significant at 5%, and **significant at 1% probability level

The effect of different directions of seed placement on the weight and total indexes of the vegetative traits in pistachio seedlings are presented in Table 2. The amount of these two indexes determined the importance and priority of each treatment and its effects on the vegetative traits. The results showed that sowing seeds in the downward direction had the highest values in the vegetative traits.

Table 2. The effect of different directions of seed placement on the weight and total indexes of the vegetative traits in pistachio seedlings

Dry weight root (mg)	Dry weight aerial (mg)	Fresh weight root (mg)	Fresh weight aerial(mg)	Root length(cm)	Number of leaves	Stem length (cm)	Treatment
0/818814	1	0/597914	0/784025	0/657382	0/976318	0/469733	$\omega 1$
0/623932	0/729167	0/840804	0/796841	0/759825	1	0/901053	$\mu 1$ Head up
1	1	1	1	1	0/9375	1	$\mu 2$ Head down
0/811966	0/85119	0/780526	0/930366	0/80786	0/666667	0/915789	$\mu 3$ Ventral
0/510884	0/729167	0/502729	0/624744	0/499495	0/976318	0/423254	$Total\ Index$ head up
0/818814	1	0/597914	0/784025	0/657382	0/915298	0/469733	$Total\ Index$ head down
0/664849	0/85119	0/466687	0/72943	0/531073	0/650879	0/430177	$Total\ Index$ ventral

The evaluation of the treatments based on the total index is provided in Table 3. The results indicated that the best treatment was the seed placement in the downward direction.

Table 3. The effect of different directions of seed placement on the total index of the vegetative traits.

Total Index	Treatment
4.266591	Head up
5.243166	**Head down**
4.324285	Ventral
13.83404	Total

The effect of different directions of seed placement (Badami-e-Zarand) on the vegetative characteristics of pistachio seedlings is shown in Figure 2. Based on the results, the seed placed in the downward direction was the best. This prevented the bench root to a large extent.

Fig. 2. The effect of seed placement (Badami-e-Zarand seeds) on the vegetative characteristics of pistachio seedlings and the bench root

According to the data analysis, they were evaluated in 2 main groups for the three treatments. The first main group included 2 sub-groups: seed placement in the pot in the upward direction and seed placement in the pot in the horizontal direction; the downward direction was in a separate group (Figure 3). Based on the results, the downward direction was the most effective treatment for the vegetative indicators of pistachio seedlings.

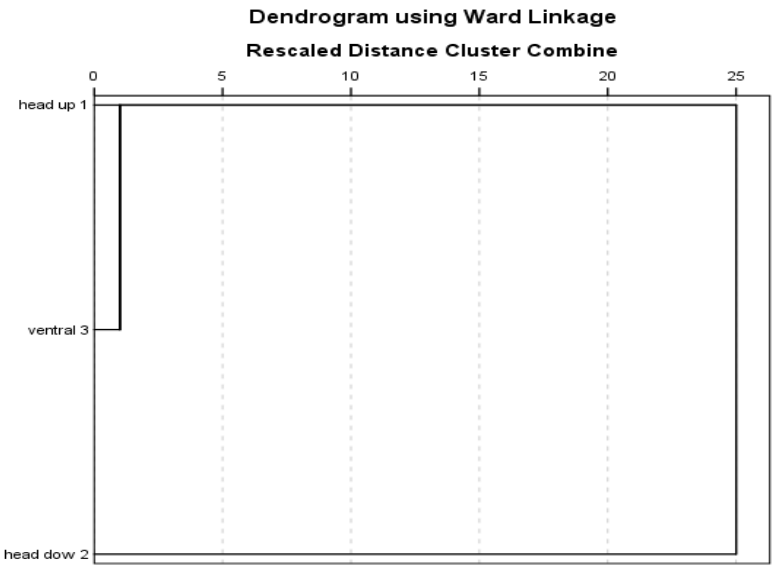

Fig. 3. Clustering of treatments based on vegetative traits of pistachio seedlings using Ward's method

4. Discussion

In general, the results showed that the direction of Badami-e-Zarand seeds did not have a statistically significant effect on the vegetative characteristics of the seedling, possibly because seed storage in seed embryos caused the same vegetative growth for one month. Also, it can be due to the supply of nutrients and optimal conditions for seedling growth in the greenhouse, with no significant difference between the treatments. Tekin et al. stated that seeds with sufficient stored materials in the embryos could produce vigor seedlings with a better establishment [11].

According to the relative comparison between the different directions of seed placement, the best direction of the seed was head down and the root placed inside the soil, which was related to the production of a straight and healthy root without a bench in the collar and the better absorption of water and nutrient elements by seedlings. This could also largely prevent the bench root. This was also confirmed by the results obtained from the clustering method of treatments. Moreover, root health is one of the important indicators of standard seedlings, mainly referring to healthy roots; the seedling should have sufficient roots and be healthy without bench roots and abnormal symptoms [13]. The appropriate establishment of seedlings in orchard conditions could help with the resistance of seedlings to environmental stress, as well as the absorption of water and nutrient elements and proper growth [3, 14, 10]. Commercial pistachio nursery production

requires the production of fast-growing rootstocks that allow early germination and grafting [15]. Root length is an important trait for resistance to drought stress in plants [14]. Therefore, it is important in the technical instructions for producing pistachio seedlings. This is the first research that presents the effect of the orientation status of seed placement on vegetative seedling growth.

5. Conclusion:

According to the results, the best direction of the seed was head down and the root placed inside the soil, which was related to the production of a straight and healthy root without a bench in the collar and the better absorption of water and nutrient elements by seedlings.

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Conflict of interest

None declared.

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