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Full Length Research Paper

Growth parameters of *Pistacia atlantica* Desf under different soil conditions in Iran

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***Pistacia atlantica* Desf. is one of the most important wild species in Zagros forests which is of high economical and environmental value. Therefore the investigation on the vegetative parameters of this native species is necessary. The study was conducted in Shoorab nursery placed in Khoram Abad city, which was located in west of Iran. Experiment was carried out based on randomized plot (block) design including 4 soil treatments (pure forest soil, sandy soil, nursery soil and mixed forest soil) with 100 replications for each treatment. The height, vitality, and leaf number, collar diameter, survival, stem length, root length, stem: root length ratio and stem: root dry weight ratio of *P. atlantica* Desf seedlings were measured. The results showed significant effects of different soil treatments on different growth properties of seedlings except for effects on root length and stem: root length ratio. Grown seedlings on the forest soil had highest height, vitality, leaf number and survival, while the stem: root dry weight ratio for grown seedlings on this soil type was the least. The greatest collar diameter growth was observed on seedlings grown on the nursery soil. In conclusion the forest soil had better effects on vegetative parameters of *Pistacia atlantica* Desf seedlings.**

Key words: Soil treatments, *Pistacia atlantica* desf., seedlings, vegetative parameters, nursery.

INTRODUCTION

Geographically, the largest concentration of *Pistacia* species is in West Asia and in the mediterranean region (Zohary, 1995). Three *Pistacia* species occur naturally in Iran, including; *P/ atlantica* Desf., *Pistacia khinjuk* Stocks and *Pistacia very* Linnaeus. *P. atlantica* is one of the most widely distributed wild species. In addition it is divided into four ecogeographic subspecies: subs*P. Cabulica* (Stocks); subs*P. mutica* (Fischer and C.A. Meyer); subs*P.* Kurdica (Zohary); and subs*P. atlantica*. Seeds of *P. atlantica* can be used for seedling production and extraction of oil. Resin is also considered to be a valuable product of these trees (Mehrnejad, 2003; Ghalem and Mohamed, 2009).

P. atlantica is a semi-evergreen tree that grows to 60 ft tall. It is able to tolerate most soil conditions including alkaline and will survive with no irrigation. It is also able to withstand desert heat and winds (Onay, 2000; Karimi et al., 2009). These traits make it desirable for landscaping in harsh conditions but also enable it spread to adjacent natural areas. Once *P. atlantica* establishes in a natural area, it is able to grow and out-compete the surrounding native plants. It is not recommended for landscaping near natural areas (Farhoosh et al., 2008). *P. atlantica* is a deciduous tree species that belongs to the *Anacardiaceae* family. It is valuable for soil conservation and therefore suitable for plantation in dry lands. Regeneration of *P. atlantica* in western part of Iran is problematic due to much destruction of its natural habitats (Kafkas, 2002; Hosseini et al., 2007).

Pourreza et al. (2008) used the regression models for estimating the numbers of *P. atlantica* Desf in diameter classes <30 cm. The results of their study indicated that, there were 19 - 24 pistachio trees per hectare in 5 - 25 cm classes. In *Pistacia* flowering occurs before vegetative development, and males tend to flower before females (protandry). Females and males invest more energy in reproduction (that is, seed and fruits) and in

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flowering early before leaf production. So resources allocated to the development of vegetative growth, including photosynthetic tissues (leaf) in *P. atlantica* males, may be limited or unsteady (Inbar and Kark, 2007). This drought-tolerant tree, with an extensive root system, has been the subject of several studies aimed at selecting ecotypes best-adapted to present weather and soil conditions. In addition to its ecological use in reforestation programs and land preservation it has the advantage of being a good root stock and a good pollinator for the economic important *Pistacia vera* (Crossa-Raynaud, 1984; Isfendiyaroglu et al., 2001; Ozeker et al., 2006; Belhadj et al., 2007).

The objective of this study is to investigate the qualitative and quantitative characteristics of *P. atlantica* Desf seedlings in different soil treatments including pure forest soil, sandy soil, nursery soil and mixed forest soil.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Shoorab nursery in the southwest of Khoram Abad city, adjacent Khoram Abad-Andimeshk high way in Lorestan province. The experimental plot was at an altitude of 1180 m with approximately 3 ha field (33° 25′ 19″ N, 48° 10′ 25″ E). The average annual precipitation is 478 mm. The average temperature during the coldest and hottest month was 5.3 and 29°C, respectively. Relative humidity ranges from 32% in summer to 63% in winter. Average relative air humidity in our study area was 48% (Figure 1). According to Domarton approach, the climate is mid arid (I = 18.17). The soils are classified as Regosols and Lithosols. The soil depth is greater than 70 cm. The bedrock is typically conglomerate, limestone and young alluvial.

Sampling and measuring strategy

The Shoorab nursery is irrigated by pumping and spouting water from Khoram Abad stream. In this study, the required seeds were collected from Aligodarz region. The capability of *P. atlantica* Desf seeds to germinate was 44% and the weight of thousand seeds was 199.8 g. *P. atlantica* Desf seeds have thick and stable mesocarp. So in order to dormancy breakage, the seeds were imbibed in warm water for 24 - 48 h. Imbibing seeds in water cause fractures to appear on the seed surface. Then, the seeds epicarp which is usually thin, fleshy, light to dark green or red in color were removed from seeds surface. The seeds were disinfected by fungicide after extracting from warm water.

Experiment was carried out based on randomized plot (block) design with four replications, 100 in each treatment. The treatment includes four soil types, (1) pure forest soil composing 0 - 10 cm of surface soil; (2) sandy soil; (3) nursery soil composing sand, common soil and livestock muck in ratio 3:1:1, and (4) mixed forest soil composing sand, forest soil and litter in ratio 1:1:1. According to these treatments, 5 - 7 seeds were planted into the plastic vases.

After rainfall season, the irrigation was performed for two or three days per week for all vases. In addition, hand weeding was done three times during the growing season. In June, the qualitative and quantitative characteristics of seedlings including height, collar diameter, leaf numbers, stem length, root length, survival, vitality and ratios of stem length: root length, stem dry weight: root dry weight were measured. Also, 20% of seedlings in each replication were extracted from vases and their roots and stems were completely separated. In lab, the length of these organs were measured by ruler and then oven dried at 70°C for at least 48 h. Stem and root dry weight was obtained by digital weighing with an accuracy of ± 1.0 g.

Seedlings height was measured by ruler with an accuracy of ± 1.0 mm. Also, seedlings vitality was classified according to leaf color. Class 1 include seedlings with very low vitality (0 - 30% of leaves were completely green and without pale), class 2 include seedlings with medium vitality (30 - 70% of leaves were completely green and without pale), class 3 include seedlings with high vitality (70 - 100% of leaves were completely green and without pale). Collar diameter of *P. atlantica* Desf seedlings was measured by a vernier caliper with an accuracy of mm. Seedling numbers in each treatment were counted for determining survival percent.

Four samples from each soil treatment were randomly selected and then analyzed for determining soil chemical and physical properties. Soil texture was determined by the Bouyoucos hydrometer method (Bouyoucos, 1962). PH was measured using an Orion Ionalyzer Model 901 pH meter in a 1:2.5, soil: water solution. EC (electrical conductivity) was determined using an Orion Ional-yzer Model 901 EC meter in a 1:2.5, soil: water solution. Soil organic carbon was determined using the Walkley-Black technique (Walkley, 1947). The available P was determined with spectrophotometer by using Olsen method. The available K was determined by ammonium acetate extraction at pH 9.

Statistical analyses

All data were subjected to analysis of variance (ANOVA) using the Proc GLM procedure of SAS (SAS Institute Inc., 2000). The SNK test (Student Newman Kouls) at probability levels of 1 and 5% was carried out to compare the means.

RESULTS AND DISCUSSION

Pistachio is one of the most important horticultural crops in Iran. Selection of suitable genotypes, resistant to unfavorable environmental and soil conditions and diseases, are important for increasing yield and the acreage of this important crop (Karimi et al., 2009). The chemical and physical properties of different soil treatments are shown in Table 1. Also, Table 2 shows the significant differences among seedlings height under soil treatments. *P. atlantica* is valuable species in soil conservation and it is able to adopt with difficult environmental conditions such as dry and hot summer, low moisture of soil, poor soil and cold winter (Hosseini et al., 2007).

Two wild pistachio species and the cultivated pistachio were evaluated for resistance to the common pistachio psylla, a major pest of pistachio trees, in a laboratory trial. The results of this study showed the causes of resistance in tested materials. It was found that the cultivated pistachio, *P. vera* with high fruit quality, were more favorable to the common pistachio psylla than that of wild pistachio species with poor nut quality (Mehrnejad, 2003).

Salt stress is considered as one of the most important abiotic factors limiting plant growth and yield in many places of the world. It has been shown that vesicular arbuscular mycorrhizal (VAM) fungi can alleviate this

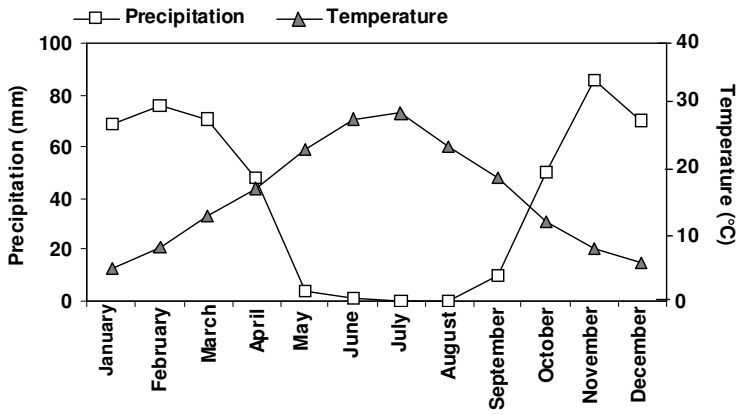

Figure 1. The ambrotermic diagram of study area.

Table 1. Comparison of the chemical and physical properties of soil treatments.

Treatment	Pure forest soil	Mixed forest soil	Nursery soil	Sandy soil
pH	7.57	7.59	7.53	7.55
EC (mS cm^{-1})	5.38	5.56	2.77	4.34
T.N.V. (%)	50.63	49.72	47.37	53.67
Organic C (%)	2.08	1.99	0.69	0.21
P (P.P.m)	4.30	17.37	43.25	3.05
K (P.P.m)	235.75	158.75	63.75	66.25
N (%)	0.22	0.30	0.285	0.14
Sand (%)	19.00	68.25	80.50	89.25
Silt (%)	55.00	19.50	15.50	6.75
Clay (%)	26.00	12.25	4.00	4.00

Table 2. Summary of analysis of variance (ANOVA) for height growth, collar diameter, leaf numbers, stem length, root length, survival, vitality, stem: root length ratio and stem: root dry weight ratio of *Pistacia atlantica* Desf seedlings in different soil treatments.

Variables	df	SS	MS	F
Height	3	2449.33	816.44	61.08**
Vitality	3	12.54	4.18	304.99**
Collar diameter	3	4.67	1.56	4.51**
Leaf numbers	3	230.47	76.82	77.14**
Survival	3	2044.34	681.45	130.13**
Root length	3	717.41	239.14	1.21ns
Stem length	3	35.43	11.81	4.41**
Stem: root length ratio	3	0.12	0.04	2.86ns
Stem: root dry weight ratio	3	0.48	0.16	8.95**

**, Significant at probability level of 1%; ns, not significant.

deficiency. The effects of VAM inoculation on growth and mineral nutrition of *P. vera* L. in salt stress condition were studied by Fallahyan et al. (2005). Plants were grown in a sterilized, low-P sandy soil with *Glomus etunicatum* inoculum (12 spore/g soil) in greenhouse. Results showed that RLC % (Root Length Colonized) was higher in control plants than treated plants with different salt concentration. Shoot and root dry weight and also leaf

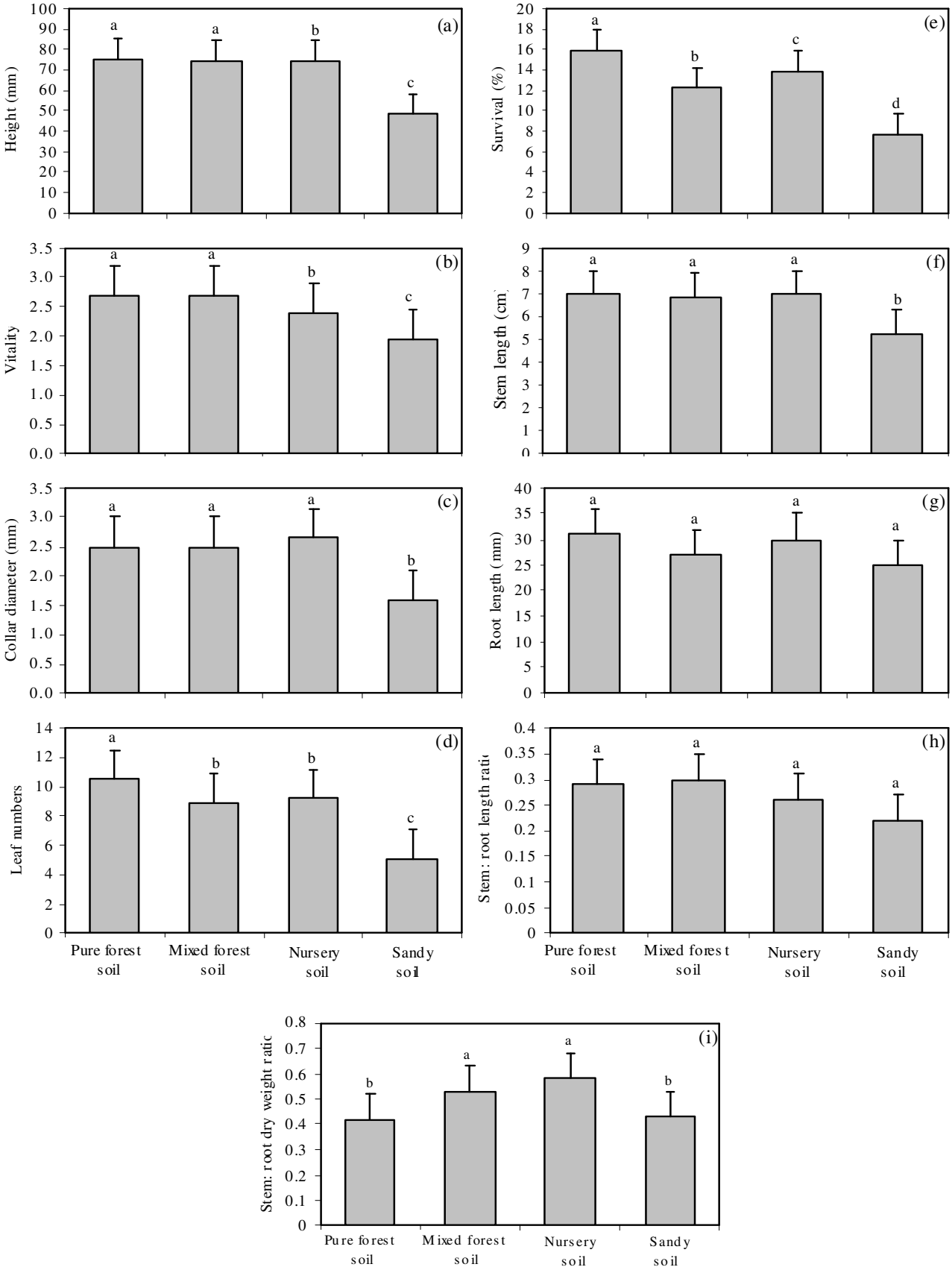

Figure 2. Comparison of the vegetative parameters of *Pistacia atlantica* D. seedlings in soil treatments.

area of mycorrhizal (M) plants were higher than non-mycorrhizal (NM) ones in both control and salt stressed plants. P, K, Cu and Zn content were higher in M than NM plants in control, low and medium salinity conditions but concentration of Na was lower in aerial parts of the M plants. Results showed a higher tolerance of inoculated pistachio to the salt stress and better growth.

The grown seedlings in pure forest soil and mixed forest soil had mean height growth of 75.39 and 74.23 mm, respectively. The lowest height growth for *P. atlantica* Desf seedlings (48.08 mm) was observed in sandy soil (Figure 2a). Seedlings with more vitality were in the pure forest soil and mixed forest soil (Figure 2b). The collar diameter of seedlings was the lowest in sandy soil treatment. In addition, no statistically significant difference was observed between the collar diameter of seedlings in the nursery soil, pure and mixed forest soil treatments (Figure 2c). Soil treatments had significant effect on leaves number of seedlings.

The maximum and minimum leaves number for *P. atlantica* Desf seedling was observed in pure forest soil (10.53) and sandy soil (5.04) treatments, respectively (Figure 2d). Onay et al. (2003) reported that the *in vivo* micrografting system provided good growth and development for new axillary shoots of pistachio (*P. vera* L. cv. "Siirt"). These plantlets were successfully transplanted and there were no problems in establishment of micrografted plants in soil. The recovery of microscions was slow, but the use of micrografts onto herbaceous rootstocks a useful technique.

There was significant difference between the seedlings survival in different soil treatments. Pure forest soil with mean survival rate of 15.82% had highest survival and sandy soil with mean survival rate of 7.68% had lowest survival (Figure 2e). The seedlings grown in sandy soil had significantly lower stem length (5.28 cm) compared to other soil treatments (Figure 2f). The root length of seedlings did not differ significantly between the nursery soil, sandy soil, pure and mixed forest soil treatments (Figure 2g). In addition, soil treatments have no significant effect on stem: root length ratio (Figure 2h). The stem: root dry weight ratio for grown seedlings on the nursery soil (0.58) and mixed forest soil (0.53) was more than the seedlings grown on the sandy soil (0.43) and pure forest soil (0.42) (Figure 2i).

Regeneration of *P. atlantica* has problems in western part of Iran due to much destruction to its natural habitats. The effect of soil, sowing depth and sowing date on growth and survival of *P. atlantica* seedlings was evaluated under nursery conditions in Iran. Survival of this species was significantly affected by sowing date and sowing depth but not by soil. Survival was greater at 4 cm by sowing dates which is on the 9th, 29th of January than at 8 cm sowing depth by 18th of February. Collar diameter and height were significantly greater in nursery soil on the 9th and 29th January sowing date but were not different among sowing depths. Shoot: root ratio and shoot: root dry weight ratio was significantly lower in forest soil but not affected by sowing date. Shoot: root dry weight ratio was lower in 4 cm sowing depth while shoot/root ratio did not show any difference among sowing depth. In general soil type, sowing date and sowing depth are factors that can be influenced on physical and morphological traits of seedlings (Gholami et al., 2007).

Conclusion

Results of this study showed that the soil treatments had significant effects on different growth properties of seedlings except for root length and stem: root length ratio. Grown seedlings on the forest soil had most height, vitality, leaf number and survival, while the stem: root dry weight ratio for grown seedlings on this soil type was least. The most collar diameter was observed for grown seedlings on the nursery soil. In conclusion forest soil had better effects on vegetative parameters of *P. atlantica* Desf seedlings.

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