http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (2): 245-249, 2007
ISSN 1028-8880

Effect of Soil, Sowing Depth and Sowing Date on Growth and Survival of *Pistacia atlantica* Seedlings

Shayesteh Gholami, Seyed Mohsen Hosseini and Ehsan Sayad
Faculty of Natural Resources, Tarbiat Modarres University, Emam St. Noor,
46414 Noor, Mazandaran, Iran

Abstract: The effect of soil, sowing depth and sowing date on growth and survival of *Pistacia atlantica* seedlings was evaluated in nursery conditions. *Pistacia atlantica* is a deciduous tree species that belongs to the Anacardiaceae family. It is valuable in soil conservation and so suitable for plantation in dry lands. Regeneration of *Pistacia atlantica* in western part of Iran due to much destruction to its natural habitats has problems. Two levels of soil (Forest and nursery soil) and three levels of sowing date (9 and 29 January, 18 February) were used. In addition, seed were sown at three different depths (0, 4 and 8 cm) but no seedlings emerged when seeds were sown at 0 sowing depth. At the end of first growing season on September 2004 survival, height above the soil surface, collar diameter, shoot/root length ratio and shoot/root dry weight ratio were measured. Survival was significantly affected by sowing date and sowing depth but not by soil. Survival was greater at 4 cm than at 8 cm sowing depth and in 9 January and 29 January than in 18 February sowing dates. Collar diameter and height were significantly greater in nursery soil and 9 January and 29 January sowing date but were not different among sowing depths. Shoot/root ratio and shoot/root dry weight ratio were 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 showed any difference among sowing depth. In general soil type, sowing date and sowing depth are factors that can be influence on physical and morphological traits of seedlings.

Key words: Seedling, sowing depth, sowing date, survival, growth, nursery

INTRODUCTION

Pistacia atlantica Zohary is a deciduous tree species that belongs to the Anacardiaceae family. In the genus of *Pistacia* there are 11 species which some of them are used as ornamentals and some valued as fruit tree (Atli *et al*., 2000; Ozbek, 1978). The height of this tree reaches to 2 to 7 meters (Jazireai and Rastaghi, 2003). The seedlings of this species are slow growing (Atli *et al*., 2000; Jazireai and Rastaghi, 2003; Tabatabaii and Ghasriani, 1993). It is possible to plant one year old seedlings but as a result of their slow growth and low height they need to be protected from shading by neighboring herbs. For this reason, commonly 2 years old seedlings are used for planting in open field condition. Different species of *Pistacia*, especially *Pistacia atlantica*, as a result of their vigorous root growing ability can adopt with difficult environmental conditions (Jazireai and Rastaghi, 2003; Vargas *et al*., 1998), such as dry and hot summer, low moisture of soil, poor soil and cold winter (Tabatabaii and Ghasriani, 1993; Barzegar ghazi *et al*., 2001). *Pistacia atlantica* is a multipurpose tree that valued as fuel, fruit and therapy properties. It is valuable in soil conservation (Rahemi and Baninasab, 2001) and so suitable for plantation in dry lands (Jazirei, 2001). Barzegar *et al*. (2001) found this species have most survival and highest growth in comparison with other trees in semi-arid environment.

The regeneration of *Pistacia atlantica* in western part of Iran due to much destruction to its natural habitats has problems. In order to restoration of this important species, planting and direct seeding are used. Within this scope, producing vigorous seedlings in nursery and having information about suitable factors related to seed sowing are essential (Tabatabaii and Ghasriani, 1993). Sowing depth, sowing date and soil type are important factors in producing successful seedlings (Thompson, 1984).

Soil types because of their different properties could affect survival and growth. Soil fertility strongly affects foliage growth, for instance nitrogen concentration in soil tends to increase the allocation of carbon to foliage and

Corresponding Author: Dr. Seyed Mohsen Hosseini, Faculty of Natural Resources, Tarbiat Modarres University, Emam St. Noor, 46414 Noor, Mazandaran, Iran Tel: +98 911 121 3898 Fax: +98 122 6253499

stem that makes a species a better competitor for light (Vilela and Ravetta, 2001). Buried seeds are more likely to establish new plants than unburied seeds. Shallow burial, particularly improves the germination of seeds and the subsequent emergence and survival of seedlings. Seeds beneath a prospective layer of soil, sand or litter experience a much more moderate environment (e.g., temperature, moisture), because it prevents them from drying, freezing or ejecting due to frost heave (Seiwa *et al*., 2002). Seeds buried deeply, on the other hand usually establish very few seedlings, because pre emergence mortality results from a cessation of seedling growth before it reaches the soil surface or the seeds are unable to germinate due to lack of oxygen, light and/or temperature fluctuation (Van Assche and Vanlerberghe, 1989; Vleeshouwers, 1997). These traits suggest that there is an optimal range of burial depth to maximize the seedling emergence and subsequent seedling growth (Seiwa *et al*., 2002). Sowing date can greatly impact field performance. Finding the suitable sowing date for each species could help seedling become established during favorable growing conditions (McCreary, 1990). The study presented here is a nursery study to evaluate the effects of sowing date, sowing depth and soil on *Pistacia atlantica* survival and growth.

MATERIALS AND METHODS

Experimental design: The study was conducted in a nursery (35°16′ N, 47°1′ E, approximately 1450 m above sea level) located at Sanandaj in western part of Iran (Fig. 1). Mean annual temperature is 13.3°C. Average monthly temperatures range from 5.2°C in February to 21°C in August. Mean annual precipitation is 480 mm. According to ambrothermic curve, the dry season begin from last May to September.

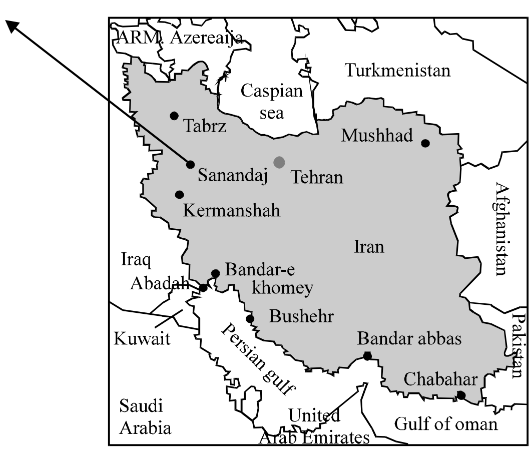

Fig.1: Map of Iran and location of study area

Table 1: The results of soil analysis with their standard error in the parenthesis soil type

Soil properties	Nursery soil	Forest soil	t-test [a]
pH	7.88 (0.023)	7.59 (0.018)	*
Organic matter (%)	2.45 (0.005)	2.47 (0.009)	ns
Total N (%)	0.31 (0.021)	0.24 (0.010)	**
$P_{available}$ (mg kg^{-1})	18.92 (2.14)	18.91 (1.98)	ns
$K_{available}$ (mg kg^{-1})	37.09 (2.97)	37.55 (3.00)	ns
$Ca_{available}$ (mg kg^{-1})	16.16 (0.95)	13.91 (0.63)	ns
$Mg_{available}$ (mg kg^{-1})	18.75 (1.62)	18.00 (1.51)	ns
Clay (%)	21.04 (0.75)	30.24 (0.49)	*
Silt (%)	26.00 (1.26)	34.00 (4.05)	ns
Sand (%)	45.94 (6.30)	35.76 (3.88)	ns

[a] t-test results: ns- not significant; *, $p<0.01$; **, $p<0.05$

Study area: The seeds were floated in water for 24 h to eliminate the empty ones. Then after putting the seeds in the hot water by using coarse gloves the hard shell of them were removed. The study design was a 2×3×3 factorial (with 5 seedling in 3 replicate arranged in a completely randomized design). The first factor was soil type (forest soil and nursery soil). Forest soil was collected from natural *Pistacia atlantica* stand in Marivan, Iran and nursery soil was made of clay, sand and organic matter (1: 1: 1 by volume) in the nursery. The soils were analyzed with the same methods and independent t-test was performed to compare them (Table 1).

Soil pH was determined using an Orion Ionalyzer Model 901 pH meter in a 1:2.5, soil: Water solution. Soil organic matter was determined using the Walkley-Black method. Total N was determined using the Kjeldhal method (Bremner, 1960). Available P was determined with spectrophotometer by using Olsen method (Homer and Pratt, 1961). Available K, Ca and Mg (by ammonium acetate extraction at pH 9) were determined with Atomic absorption Spectrophotometer (Bower *et al*., 1952). Soil texture was determined with Baikas densimetery method (Zarrinkafsh, 1993).

Common sowing depth and sowing date in nursery condition are 4 cm and last January. But there are not reliable knowledge about suitable sowing depth and sowing date. Therefore we choose the second factor as sowing date with three different dates (9 and 29 January, 18 February) and the third factor as sowing depth with three different depths (0, 4 and 8 cm). Two seeds were sown in poly bags (15 cm in diameter × 20 cm in height). All seedlings were irrigated between one and three times a week (during dry season that is about 4 months and begins from June).

Measurements: At the end of first growing season on September 2004 all the seedlings were measured of their height above the soil surface and collar diameter. For each replicate, seedlings survival percent was calculated. In order to measuring shoot/root length ratio, roots were cleaned with water then each seedling was separated into roots and shoots and the lengths of the shoots and roots were measured to nearest mm. The different parts of each seedling were then oven-dried at 80°C during 48 h for measuring shoot/root dry weight.

Statistical analysis: The effects of soil, sowing depth and sowing date on survival, height, collar diameter, shoot/root length ratio and shoot/root dry weight ratio were analyzed using three-way ANOVAs. Since no seedlings emerged from 0 sowing depth in all of the replicates, this treatment was not included in any analysis because it could not be validly analyzed with ANOVA. Duncan multiple comparison test was used to determine differences in sowing date and interactions of treatment.

RESULTS

No significant difference was found in survival between forest soil and nursery soil (p = 0.913). There was significant difference in survival among sowing date (p = 0.011). Seeds sown in 9 January and 29 January, whereas they did not have significant difference with each other, reached greater survival than those in 18 February. Seedling survival was significantly affected by sowing depth (p = 0.024). It was higher at 4 cm sowing depth. Survival was higher at 8 cm sowing depth in second and third sowing date in forest soil which resulted in a significant interaction among sowing depth, sowing date and soil type but the reason for this remain unknown (Fig. 2A).

Soil type had the large effect on collar diameter (p = 0.000). Seedlings in nursery soil showed the higher amount. Sowing date affected significantly the seedlings collar diameter (p = 0.001). Collar diameter was greater in 9 and 29 January than those in 18 February (Fig. 2B).

Collar diameter (Fig. 2B, p = 0.076), height (Fig. 2C, p = 0.136) and shoot/root ratio (Fig. 3A, p = 0.0212) was not significantly affected by sowing depth.

Seedlings height differed among soil type (p = 0.000). Seedlings in nursery soil were taller than those in forest soil. The height growth significantly differed among sowing dates (p = 0.036). It was higher in early seed sowing dates (Fig. 2C).

Shoot/root length ratio was lower for seedlings growing in forest soil than those in nursery soil (p = 0.000). No significant difference was found in this ratio among sowing date (p = 0.981) (Fig. 3A).

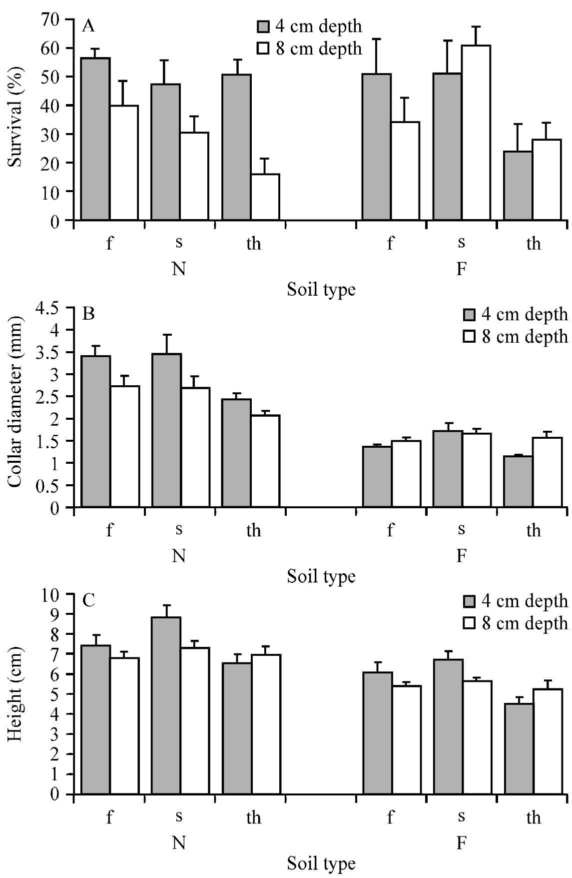

Fig. 2: (A) Mean (±SE) survival percent of seedlings, (B) mean (±SE) Collar diameter of seedlings, (C) Mean (±SE) Height of seedlings, f: 9 January sowing date, s: 29 January sowing date, th: 18 February sowing date, N: Nursery soil, F: Forest soil

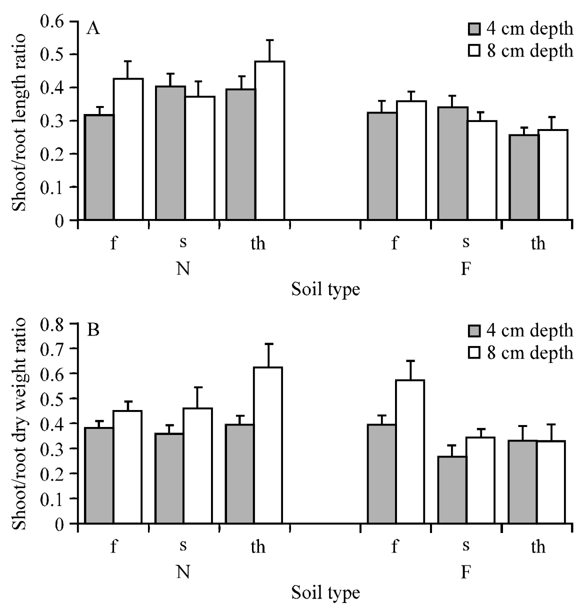

Fig. 3: (A) Mean (±SE) Shoot/Root ratio of seedlings, (B) mean (±SE) Shoot/Root Dry Weight ratio of seedlings, f: 9 January sowing date, s: 29 January sowing date, th: 18 February sowing date, N: Nursery soil, F: Forest soil

Shoot/root dry weight ratio was significantly affected by soil type (p = 0.012). Seedlings in forest soil showed the lower ratio. There was significant difference in seedlings shoot/root dry weight ratio between seed sowing depth (p = 0.001). It was greater at 8 cm than at 4 cm sowing depth. Sowing date had not significantly effect on this ratio (p = 0.052) (Fig. 3B).

There was interaction between the factors that change the main effects of the factors on collar diameter, height, Shoot/root dry weight ratio and Shoot/ root length ratio but the reason for this remain unknown.

DISCUSSION

There was no significant difference in survival between forest and nursery soil but it was significantly affected by sowing date. It was greater for seedlings from the early sowing dates. Probably due to greater soil moisture and favorable growing conditions in early sowing dates, which can help the seedlings to have greater survival (McCreary, 1990). Rainfall is gradually reduced from first sowing date. So seeds sown in early sowing date used favorable soil moisture and germinate earlier. Earlier germination provides earlier establishment and growth before beginning dry season. McCreary (1990) found the same result about the effect of sowing date on seedling survival of *Quercus douglasii* and *Quercus lobata*. Seedlings survival was lower at 8 cm sowing depth, mainly due to a greater fraction of seed reserves were exhausted by the time of the seedling emergence (Seiwa *et al*., 2002).

Seedlings height and collar diameter were greater in nursery soil. This could be a result of higher nitrogen concentration in nursery soil because soil fertility strongly affects growth (Vilela and Ravetta, 2001). Similarly, Vilela and Ravetta (2001) reported that the seedlings height of some *Prosopise* species in nursery soil was greater than those in forest soil. Seedlings height and collar diameter also differed among sowing dates. They were greater in 9 January and 29 January. Probably, early sowing date should help seedlings become established during favorable growing conditions, before dry season begins and soil moisture becomes limiting (McCreary, 1990). It seems that irrigation during dry season have the same influence on seedlings that grew in different sowing dates, so the seedlings that germinated and established earlier (seeds sown in early sowing date) grew better. These results are similar to the results by McCreary (1990) who indicated that seedlings height of *Quercus douglasii* and *Quercus lobata* was greater in early seed sowing dates. Also Sorenson (1978) reported greater height of *Pseudotsuga menziesii* seedlings in early seed sowing dates. There was no significant difference in height, collar diameter and Shoot/root length ratio between sowing depth. It seems to be a result of slowing growth of this species.

Soil type had significantly effect on Shoot/root length ratio. It was higher in nursery soil. It might be due to greater nitrogen percent in nursery soil because soil fertility tends to increase the allocation of carbon to foliage and stem. Greater allocation of carbon to foliage and stem growth makes a species a better competitor for light (Landsberg and Gower, 1997).

Seedlings in nursery soil had greater Shoot/root dry weight ratio than those in forest soil. It could be due to accumulation of greater carbon to stem, because nursery soil had greater fertility (Landsberg and Gower, 1997). Shoot/root dry weight ratio was higher at 8 cm sowing depth. The seedlings from deeper sowing depth showed greater dry weight allocation to stem, instead of the roots. Such plastic response in dry weight allocation suggests that the seedlings allocates lower carbon reserves to the roots and diverts the rest to the stem to facilitate emergence from a deep location (Seiwa *et al*., 2002). Seedlings from a deeper location have a longer first internode or subcoleoptile internode but shorter roots than those in a shallow depth (Maun and Rich 1981; Redmann and Qi, 1992).

Seedlings with large diameters often survive and grow better (Mexal *et al*., 2002). Light conditions would be improved by increasing the seedling height, since greater vertical growth into higher stratum is advantageous for seedlings to avoid being shaded by neighboring herbs (Givnish, 1982; Sewia, 2000). Thus this attribute serves as an indication of the potential of plants to grow in weedy places, as fast-growing shoots may face competition for light more favorably (Ngulube, 1989; Barnet, 1988). Nursery soil should be preferred to the soil from underneath the canopy of *Pistacia atlantica* trees, since diameter and height were higher in the former. While as a result of lower Shoot/root ratio and Shoot/root dry weight ratio in forest soil, it could be concluded that forest soil is better because longer and powerful roots enhances the capacity to compete for water and nutrients (Vilela and Ravetta, 2001).

The results of this study indicate that early sowing date was better because it leads to greater collar diameter, height and survival as compared to delayed sowing. Also 4 cm sowing depth showed better results such as greater survival and lower Shoot/root dry weight ratio than those at 8 cm sowing depth.

REFERENCES

Atli, H.S., S. Arpaci and H. Ayanoylu, 2000. Comparison of seedling characteristics of some Pistacia species. Pistachio research institute, Gaziantep, Turkey, pp: 4.

Barnet, J.P., 1988. Site preparation, containers and soil types affected field performance of loblolly and longleaf pine seedlings. In: Proceedings of the Fifth Biennial Southern Silvicultural Research Conference. USDA, Forest Service. New Orleans, pp: 155-158.

Barzegar G., A., Abdi A. Ghazi, A. Javanshir and M. Moghadam, 2001. Pistacia is a adaptable species in semi-arid region. Second National Proceeding of Pistacio (Shiraz), pp: 5-6.

Bower, C.A., R.F. Reitemeier and M. Fireman, 1952. Exchangeable cation analysis of saline and alkali soils. Soil Sci., 73: 251-261.

Bremner, J.M., 1960. Determination of nitrogen in soil by the Kjeldahl method. J. Agric. Sci., 55: 11-33.

Givnish, T.J., 1982. On the adaptive significance of leaf height in forest herbs. Am. Nat. No: 120, pp: 353-381.

Homer, C.D. and P.F. Pratt, 1961. Methods of Analysis for Soils, Plants and Waters. University of California, Agricultural Sciences Publications, Berkeley, pp: 309.

Jazirei, M.H., 2001. Aforestation in dryland. Tehran University Publication, pp: 447.

Jazireai, M.H. and M.E. Rastaghi, 2003. Silviculture of Zagros s Forests. 1st Edn., Tehran University Press, Tehran, Iran, ISBN: 964-03-4758-2, pp: 560 (In Persian).

Landsberg, J.J. and S.T. Gower, 1997. Applications of Physiological Ecology to Forest Management. Mooney H.A. (Ed.), San Diego: Academic Press, pp: 354.

Maun, M.A. and S. Rich, 1981. Morphology of caryopses, seedlings and seedling emergence of the grass *Calamovilfa longifolia* from various depths in sand. Oecologia. 49: 142-167.

McCreary, D.D., 1990. Acorn sowing date affects field performance of blue and valley Oaks. CA. Tree Planters' Notes, 41: 6-9.

Mexal, J.G., R.A. Cuevas Rangl, P. Nrgreros-Castillo and C. Paraguirre Lezama, 2002. Nursery production practices affect survival and growth of tropical hardwoods in Quintana Roo, Mexico. Forest Ecol. Manage., 168: 125-133.

Ngulube, M., 1989. Seed germination, Seedling Growth and biomass production of eight Central-American multipurpose trees under nursery conditions in Zomba, Malawi. Forest Ecol. Manage., 27: 21-27.

Ozbek, S., 1978. Special fruit growing. University of Cukurova, No. 128, Adana.

Redmann, R.E. and M.Q. Qi, 1992. Impact of seedling depth on emergence and seedling structure in eight perennial grasses. Can. J. Bot., 70: 133-139.

Rahemi, M. and B. Baninasab, 2001. Growth acceleration of *Pistacia atlantica* and *P. khinjuk* by jiberlic acid. Second National Proceeding of Pistacio (Shiraz), pp: 35-36.

Seiwa, K., 2000. Effects of seed size and emergence time on tree seedling establishment: Importance of developmental canstrains. Oecologia, 123: 208-215.

Seiwa, K., A. Watanabe. T. Saitoh, H. Kannu and S. Akasaka, 2002. Effects of burying depth and size On seedling establishment of Japanese Chesnut, *Castanea cranata*, Forest Ecol. Manage., 146: 149-156.

Sorenson, F.C., 1978. Date of sowing and nursery growth of provenance of *Pseudotsuga menziesii* given two fertilizer regimes. J. Applied Ecol., 15: 273-280.

Tabatabaii, M. and F. Ghasriani, 1993. Natural resources of Kurdistan. Jahade Daneshgahi Publication, pp: 767.

Thompson, B.E., 1984. Establishing a Vigorous Nursery Crop: Bed Preparation, Seed Sowing and Early Seed Growth. In: Forest Nursery Manual- Production of Bareroot Seedlings Duryea, M.L. and T.D. Landis, (Eds.), Forest Research Laboratory, Oregon State University. Martines Nijhoff/Dr.W. Junk Publishers, pp: 41-49.

Van Assche, J.A. and V.A. Vanlerberghe, 1989. The role of temperature on dormancy cycle of seeds of *Rumex obtusifolia* L. Funct. Ecol., 3: 107-115.

Vargas, F.J., M.A. Romero and J. Clave, 1998. Nursery behaviour of Pistachio rootstocks. Second international symposium on Pistachio and Almonds, ISHS, Davis (California. USA), Acta Hortic., 470: 231-236.

Vilela, A.E. and D.A. Ravetta, 2001. The effect of seed scarification and soil media on germination, growth, storage and survival of seedlings of five species of *Prosopis* L. (mimosaceae). Arid Environ.. 48: 171-184.

Vleeshouwers, L.M., 1997. Modelling the effect of temperature, soil penetration resistance, burial depth and seed weight on pre-emergence growth of weeds. Ann. Bot., 79: 553-563.

Zarrinkafsh, M., 1993. Applied soil science, soil survey and soil- plant- water analysis. Tehran University Publication, pp: 361.