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Effect of Organic Soil Amendments on Growth and Efficiency of Redbud (*Cercis griffithii*) Seedlings in Nurseries

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ABSTRACT Redbud (*Cercis griffithii*) is an Iranian native species that plays a crucial role in protecting soil and water in Zagros forests areas. Although many reforestation projects of this species in this area were unsuccessful, the restoration of redbud must continue using new applied studies to help conserve this precious resource. This can be achieved through increasing the quality and quantity of seedling production in nurseries. This study thus aimed to evaluate the effects of various organic amendments on growth and efficiency of redbud seedlings in a nursery. Four treatments viz. 1) control (standard nursery mix) (C) 2) control: cattle manure (5:1) (CCM), 3) control: leaf composts (5:1) (CLC) and 4) control: cattle manure - leaf composts (5:1:1) (CCML) were applied for the present study. After one year, all growth indices were significantly increased by organic soil treatments compared to the standard nursery mix. The growth characteristics such as height, root dry weight, length of the longest root, stem length to diameter ratio and relative height growth of redbud seedlings were associated with an organic soil treatment. These positive results on growth indices were explained by the reduction in EC and pH of planting bed induced by the organic soil amendments.

Key words: *Biomass, Compost, Growth and Quality, Manure, Planting bed*

1 1INTRODUCTION

With an area of more than 5 million ha, Zagros forests correspond to about 41% of the Iranian forested territory. These forests, that extend from the northwest (South of Piranshahr, west of Iran) to the southwest of the country, are composed of trees with slow growth rate whereas natural regeneration is very limited due to human activities (Heydari *et al.*, 2013). Accordingly, the percent cover of these forests is presently less than 26% in 90% of the Zagros forest area while only 7% is considered as high forests. This decline in productivity of Zagros forests was mainly associated with socioeconomic factors and the lack of comprehensive management of natural resources (Mahdavi and Fallah Shamsi, 2012). The main problems affecting Zagros forests are

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livestock overgrazing and overexploitation which are amplified by soil loss and dry climate. Therefore, to stop forest degradation, plantation and reforestation seem necessary, especially in the mountainous areas of Iran (Mossadegh, 2010).

However, a successful plantation is generally achieved with the use of healthy seedlings. The production of such seedlings depends on genetic factors and seedling growth conditions. One of the important objectives in forest nurseries is to increase the qualitative and quantitative production of seedlings per area unit. Enhancing the efficiency of plant production is the most basic factor to achieve these goals. Early seedling characteristics in nurseries are often used to forecast the plantation success. The growth and quality of produced seedlings in forest plantations are the interactions between environmental factors (e.g. humidity, temperature, light, food and planting method) and plant inner and physiological factors (e.g. storage of carbohydrates, various hormones and resistance to frost) (Lavendar, 1984). One of the most important factors affecting seedling production and quality is the physical and chemical properties of plantation bed (Teng and Timmer, 1996). Chemical fertilizers are effective in increasing nutrient availability, soil texture and seedling growth (Shan *et al.*, 2001 and Will *et al.*, 2002). However, due to environmental constraints (Malakouti and Homaei, 2004), organic amendments are increasingly used (Katalin *et al.*, 2005). Soil organic amendments can improve seed germination, root growth and seedling productivity by optimizing soil physical conditions (Oliet *et al.*, 2004) such as soil temperature and moisture (Hassanzadeh Gourttappeh, 2000).

In this regard, Noorshad and Qurani (1990) reported that erlite mix, tea waste, composted animal manure , loam soil, forest leaf compost (1:1:1:2:1) for *Pinus taeda* and *P. elliottii* and combination of tea waste, composted manure and leaf compost (1:1:2) for *Pinus pinea*, were the best treatments for diameter and height growth.

Ahmadloo *et al*. (2009) studied the influence of soil combination on the growth and efficiency of silver cypress seedlings and cypress in the nursery in Kludeh, Amol, Iran and concluded that organic matter increases the growth characteristics and biomass of seedlings of both species. Durgapal *et al*. (2002) and Kumar singh *et al*. (2008) in their studies stated that soil organic matter affect the germination of *Cedrus deodara* and *Pinus wallichiana* and *Rhododendron* seeds, respectively. According to Guerrero *et al*. (2002) pine bark and mixed municipal sewage were favorable treatment for *P.pinea* and *Cupressus arizonica* growth. Jacob *et al*. (2005) in a study about replanted seedlings of *Juglans nigra*, *Fraxinus americana* and *Liriodendron tulipifera* found that over the past two years, injecting of liquid fertilizer of 60 g around roots, increased the mean height to 52 % and 17 % and diameter to 33 % and 21% in the first and second year, respectively. A similar result was observed in the study of Oskarsson *et al*. (2006) so that, the use of liquid fertilizer for birch (*Betula alba*) and American poplar (*Populus deltoids*) for two years could provide 7 and 5 times increase in annual height than control treatment, respectively.

This study intends to improve germination and seedling efficiency by addition of various combinations of organic matter in the planting bed soil and examine their effects on growth and efficiency of redbud, which has a widespread use in reforestation projects in west of Iran. Redbud is a beautiful and precious species, which is distributed in

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different parts of Iran. This tree species represents the Mediterranean climate (Sabeti, 1976). Redbud is a native species that play a crucial role in soil and water conservation in Zagros forests and many rare plant and animal species are living in its habitat which are considered as reserve sites. Today, due to the failure of many plantation projects of this species in the area, conservation, development and awareness of its function toward environmental factors would be a step in reclamation of these forests. Therefore, considering the suitable seedling production is necessary as the first step of reclamation. According to the results of the mentioned studies that organic fertilizers can improve germination and seedling efficiency by changing the nutritional conditions. In the present study the effect of using different organic fertilizer treatments on growth and efficiency of redbud seedlings (*Cercis griffithii*) has been investigated in nursery conditions.

2 MATERIALS AND METHODS

2.1 Study area

This research was conducted in a nursery located in Ivan, Iran. Ivan City is located west of the Zagros Mountains, between 31˚ 58′ to 34˚ 15′ north latitude and 45˚ 24′ to 48˚ 10′ east longitude (Figure 1).

2.2 Experimental design

Seeds of redbud trees were collected in Ilam during the late winter of 2012 (Table 1). Four different soil combinations were prepared according to Table 2. Analysis of variances was done by factorial test in a completely randomized design. Therefore, for each treatment 30 pots in four replications (120 pots per treatment) were being considered. Three seeds were planted in each pot. It should be noted that both the seeds and the prepared pots had similar weights. The physical and chemical characteristic of soil in each treatment was measured at the beginning of the study (Table 3).

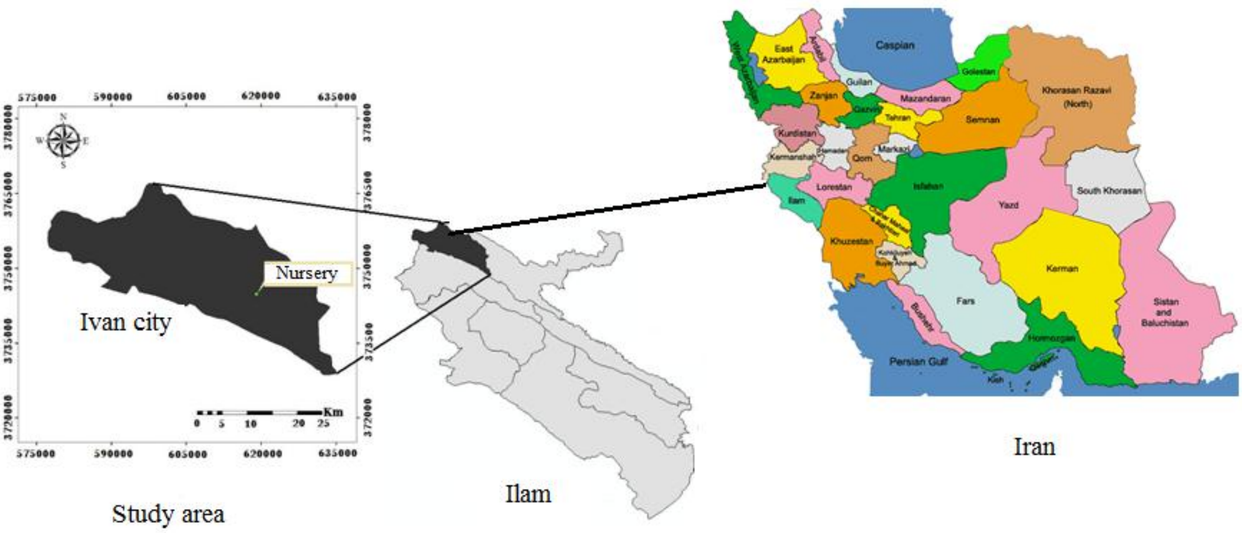

Figure 1 Location of the study nursery in Ilam Province, Iran

Seeds were disinfected with Carboxin-Tiram fungicide (1:1000) before they were put in each pot. After germination, only the best seedling (based on morphological characteristics such as height, collar diameter) was kept in each pot. Daily watering was used during growing period in summer and plants were watered according to the need and field capacity in the other seasons. Weed removal was performed twice a month in each pot whereas height (±0.1 cm) and diameter (±0.1 mm) of each seedling were measured four times (September, November, December and February). Height and diameter relative growth rate of height growth was calculated (Table 4) (Ostos *et al*., 2008; Ahmadloo *et al*., 2009).

To determine the root and shoot dry weights of seedlings, five seedlings were randomly selected from each treatment 12 months after planting and placed in an oven at 70 °C during 24 hours before weighting (Iqbal *et al*., 2007). The seedling quality index (QI) and vigor index of seedlings were calculated according to the following equations (Ahmadloo *et al*., 2009):

$$QI=\frac{T}{RW/SW+D/H} \quad (1)$$

where QI: Seedling quality index, T: Total dry weight, RW: Root dry weight, SW: Shoot dry weight and D/H: Diameter/ Height.

$$VI=(H\times RL)\times G \quad (2)$$

where VI: Vigor index of seedling, H: height of the aerial part, RL: Root length and G: Germination percentage.

Table 1 Seed stock characteristics

Seed provenance	Vigor (%)	Purity (%)	Humidity (%)
Ilam	85	100	5.4

Table 2 Composition of the four soil treatments

Treatments	Loamy Soil	Sand	Straw	Solid Rotten Cattle Manure	Leaf Compost	Germination Percentage
Control (C)	3	1	1	-	-	58.33
Cattle Manure (CCM)	3	1	1	1	-	78.61
Leaf Composts (CLC)	3	1	1	-	1	84.1
Combination (CCML)	3	1	1	1	1	95

Table 3 Chemical characteristics of soil treatments

Soil Treatments	C%	OM%	N%	C/N	Absorbable Phosphorus	Absorbable Potassium	Exchangeable Calcium	Exchangeable Magnesium	Ec	pH
Control	1.81	2.80	0.40	41.05	8.04	30.34	21.28	16.03	0.23	7.8
Cattle Manure	2.66	5.64	0.21	22.07	10.25	75.99	25.16	24.05	0.37	7.6
Leaf Compost	2.21	3.31	0.90	27.10	20.37	55.10	31.20	19.07	0.30	7.6
Combination	3.91	6.84	0.34	11.41	68.38	89.23	40.22	43.12	0.31	7.5

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2.3 Statistical analyses

Statistical analyses were performed using SPSS19. First, we verified the data normality with the Shapiro-Wilk test whereas the homogeneity of variance was evaluated with the Levene test. One-way analysis of variance (ANOVA) in a completely randomized design was used to determine the effect of treatments for each measured variables. When the ANOVA indicated a significant difference among treatment means, the LSD test (Least Significant Difference) was used for mean comparisons. In addition, the Spearman correlation test was used to determine the correlation between the measured traits and soil treatments.

3 RESULTS

3.1 Relationships between growth indices and soil organic amendments

Redbud seedling height, diameter, root dry weight, shoot length to diameter ratio, vigor, relative height growth and relative diameter growth were positively correlated with organic soil amendments (Table 4). The results indicated that the lowest correlation was between stem dry weight and treatment of soil organic matters.

3.2 Growth traits

The results of the ANOVA indicated that all growth indices were significantly affected by at least one organic amendment at the 1% level (Table 5). The fourth treatment (CCML) seems the most efficient since several of the measured traits were associated with the highest values among treatments. On the other hand, the control treatment was associated with the lowest values of all traits. The comparison between the average growth traits suggested that traits of height, root dry weight, length of the longest root, stem length to diameter and relative height growth had the highest values in the combined soil treatment. The third treatment (CLC) was associated with the highest values of seedling diameter, height to diameter, shoot dry weight, total dry weight, quality and vigor.

Table 4 Spearman correlation between growth indices of redbud seedlings and soil organic amendment treatments

Growth indices	Soil organic amendment treatments
Height (cm)	0.705**
Diameter (mm)	0.639*
Height To Diameter	0.456NS
Root Dry Weight (g)	0.598*
Shoot Dry Weight (g)	0.340NS
Total Dry Weight (g)	0.480NS
Length Of Root (cm)	0.474NS
Root To Shoot Length	0.493NS
Stem Length To Diameter	0.540*
Seedling Quality	0.498NS
Seedling Vigor	0.540*
Relative Height Growth	0.859**
Relative Diameter Growth	0.899**

** Significant correlation at 1% level, * significant correlation at 5% level, NS indicates no significant correlation

Table 5 Results of ANOVAs to detect differences among soil treatments for each growth indices

Growth indices	Sum of square	df	Mean square	F	p
Height (cm)	5846.063	3	1948.88	126.046	0.000**
Diameter (mm)	166.31	3	55.43	85.77	0.001**
Height To Diameter	381.55	3	127.18	43.30	0.000**
Root Dry Weight (g)	180.66	3	60.22	71.09	0.000**
Shoot Dry Weight (g)	307.03	3	102.34	86.39	0.000**
Total Dry Weight (g)	528.77	3	176.25	54.80	0.002**
Length Of Root (cm)	3137.91	3	1057.97	30.44	0.000**
Root To Shoot Length	110.48	3	36.82	34.07	0.000**
Stem Length To Diameter	547.01	3	183.33	49.44	0.000**
Plant Quality	3986.14	3	1328.71	89.90	0.000**
Seedling Vigor	4463129.05	3	148770.68	407.56	0.000**
Relative Height Growth	0.000	3	0.000	9.94	0.000**
Relative Diameter Growth	0.000	3	0.000	20.82	0.001**

** Significant correlation at 1% level

Table 6 Mean values (±SE) of each considered trait measured on redbud seedlings submitted to four soils organic amendment treatments

Growth Indices	Treatments			
	C	CCM	CLC	CCML
Height (cm)	6.08[a]±0.16	7.90[ab]±0.17	9.16[b]±0.17	10.8[b]±0.20
Diameter (mm)	1.51[a]±0.03	1.66[a]±0.02	1.93[b]±0.03	1.84[a]±0.20
Height to diameter	3.20[a]±0.07	4.26[b]±0.08	4.31[b]±0/07	4.00[b]±0.08
Root dry weight (g)	1.68[c]±0.04	2.11[b]±0.04	2.09[b]±0.03	2.54[a]±0.03
Shoot dry weight (g)	1.95[c]±0.05	2.77[b]±0.04	2.83[a]±0.05	2.07[c]±0.04
Total dry weight (g)	3.63[b]±0.09	4.89[a]±0.07	4.93[a]±0.07	4.62[a]±0.07
Length of root (cm)	13.70[b]±0.32	16.40[a]±0.24	16.68[a]±0.24	16.68[a]±0.24
Root to shoot length	2.03[b]±0.06	2.17[a]±0.05	1.84[c]±0.03	1.53[abc]±0.03
Stem length to diameter	3.20[ab]±0.07	4.26[b]±0.08	4.31[b]±0.07	4.61[a]±0.11
Plant Quality	5.31[b]±0.19	7.45[a]±0.17	7.82[a]±0.20	4.37[ab]±0.11
Seedling vigor	54.12[ab]±1.54	110.85[b]±2.50	141.63[a]±2.83	136.71[a]±3.70
Relative height growth	0.0031[a]±0.0001	0.0020[b]±0.0000	0.0030[a]±0.0001	0.0034[a]±0.0001
Relative diameter growth	0.0039[b]±0.0002	0.0051[a]±0.0002	0.0043[b]±0.0002	0.0040[b]±0.0001

Different letters in columns indicate significant mean by the LSD test at 5% level

From 180 to 240 days of growth, the relative height growth rate increased over time whereas the relative diameter growth rate decreased (Figures 2 and 3). At each measuring time, the highest relative height growth rate was allocated to the treatments 2 and 4 and the lowest rate was observed in the control treatment (Figure 2). Relative diameter growth rate had the highest values in treatments 1 and 4 (Figure 3).

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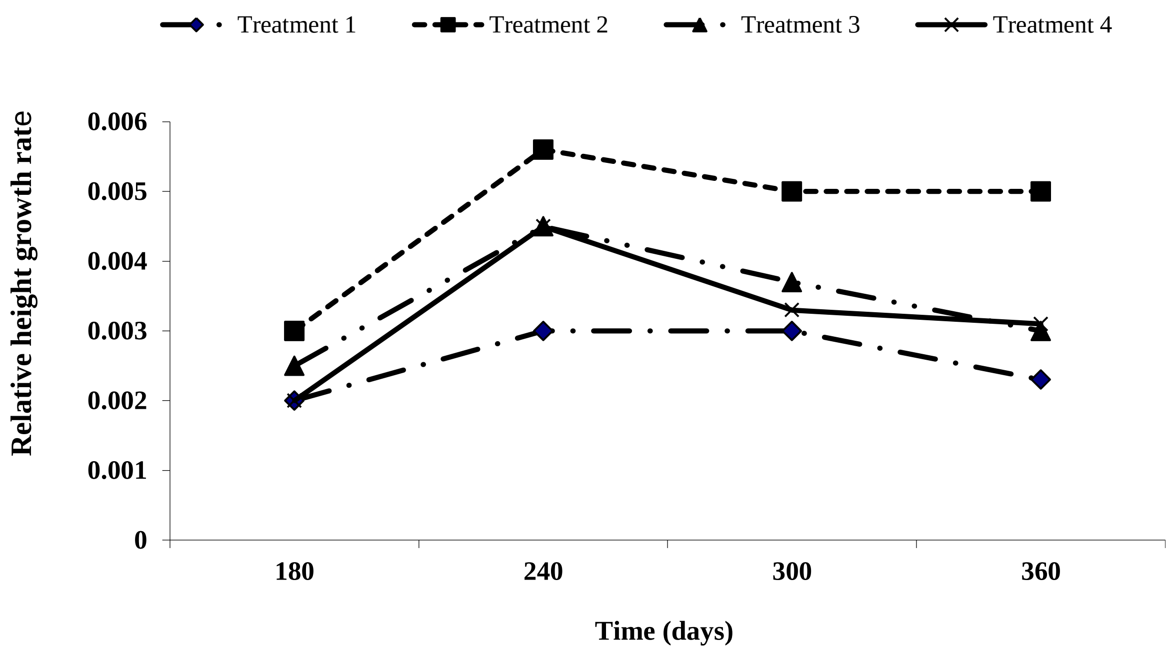

Figure 2 Relative height growth rates of redbud seedlings as a function of time for four soil organic amendment treatments

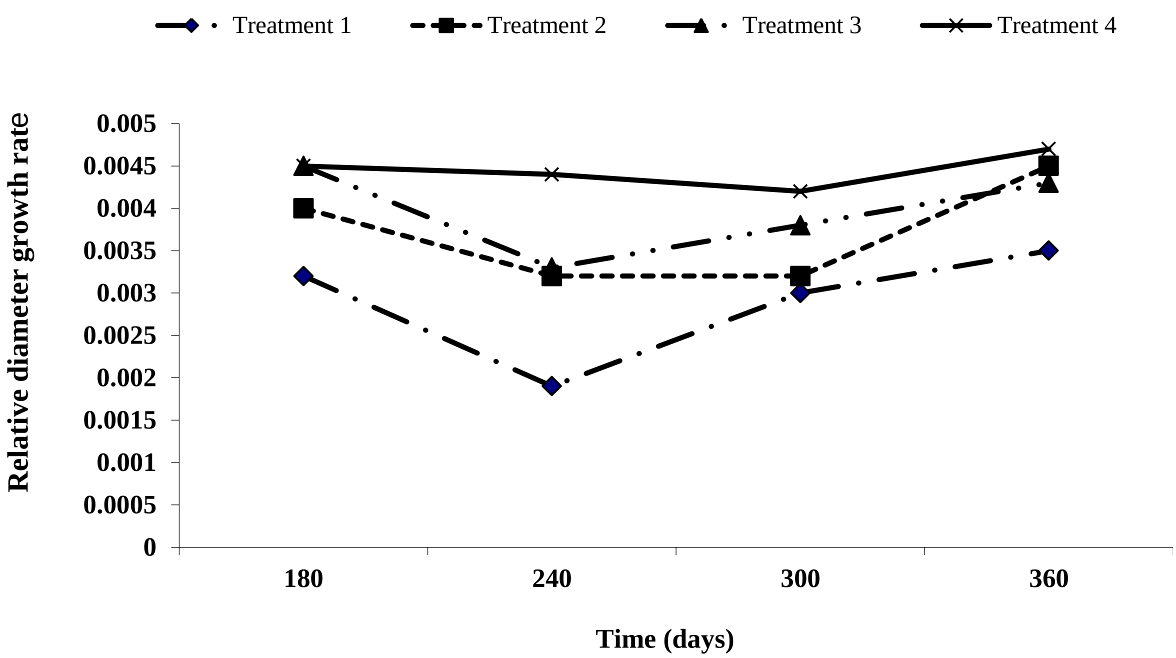

Figure 3 Relative diameter growth rates of redbud **s**eedlings as a function of time for four soil organic amendment treatments

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4 DISCUSSION

The destruction of forests especially by human activity in many habitats, including the Zagros ecosystem forest is rising (Ren *et al*., 2007). These regions need to have restored. In this regard *Cercis griffithii* requires special attention because its sites is limited and subject to serious degradation (Jaferyan, 2013). For successful establishment of seedlings in reforestation projects, seedlings with high quality should be provided (Ahmadloo *et al*., 2009). One of the most important strategies to increase the efficiency of plant production (quantity and quality) in forest nurseries is the optimal management of planting bed combination (improvement of soil physical and chemical properties). To improve the quality of nursery soil, fertilizers such as green manure, cattle manure, chemical and biological fertilizers are used. Our results indicated that soil organic amendments significantly influenced growth indices of redbud seedlings. This seems to be due to improvements in soil physical and chemical characteristics, particularly moisture conditions and nutrient availability (Shibu *et al*, 2006). The addition of organic matter to the soil would have stimulated plant nutrient uptake and increased plant metabolism and growth (Tichy and Phuong, 1975). Similar results have been already observed by Román *et al*. (2003) for Pistacia lentiscus, Pinus halepensis and Picea sitchensis, Tsakaldimi (2006) for Pinus halepensis seedlings and Ostos *et al*. (2008) for *Pistacia lentiscus*. The soil organic amendment that was generally associated with the highest values of growth indices was the fourth treatment, i.e. the combination of cattle manure and leaf compost. It thus seems that the combination of cattle manure and leaf compost provides favorable conditions for plant growth likely due to abundant nutrients, proper ventilation, faster release of nutrients and proper moisture conditions (Jones *et al*, 1999). In general, high correlations between growth parameters and soil treatments could be due to increased soil nutrient. In the present study, the increase in soil nutrients such as phosphorus, potassium, calcium and magnesium due to the increase in enzyme activity and protein synthesis might be effective on plants growth and efficiency that is consistent with Khasa *et al* (2005). In fact, the increase in nutrients would cause more carbon absorption and the stem elongation would increase by stimulating the plant through accessing more light because of higher photosynthetic rates (Jocobs *et al*, 2005; Landsberg *et al.*, 1997). The significant effect of soil organic amendments on root length in the present study might be because of adequate nutrients around the root, which provides the need to develop more roots for nutrients absorption (Agren and Franklin, 2003). In the case of the influence of soil organic matter and other nutritional elements on the growth of other tree species due to their effect on the concentration of sugars, proteins, organic acids and mineral elements in plant tissues researches of (Samuelson *et al.*, 2000; Salifu *et al.*, 2001; Blevins *et al.*, 2006) can be mentioned.

The traits of diameter, height to diameter, shoot dry weight, total dry weight, seedling quality and vigor had the highest values for the third treatment (CLC). The results of this study demonstrated the increase in growth indices of redbud seedlings in the treatment of organic material. With regard to the treatment of organic material had higher nutritional elements such as phosphorus, potassium, calcium and magnesium compared to control treatment (Ahmadloo *et al*., 2009). Therefore, the increase in growth indices could be attributed to this issue. Auina *et al* (2007) for Pinus sylvestris and Nilson and Jorgensen (2003) for Fagus sylvatica found similar results. The high correlation between biomass and soil treatments corroborated the same issue. Kaakenin et al (2004) reported a significant correlation ($P<0.05$) between soil organic matter treatment and plant biomass for

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Picea abies, as increase in nutrient reserves in plant tissues had led to increased biomass (Berger and Glatzel, 2001 and Nordberg *et al.*, 2003). This finding, however, contradicts the result of Imo and Timmer (2003) which reported that the biomass of *Prosopis chilensis* seedlings was independent of productivity in situations with different amounts of nitrogen because different species react differently to environmental factors.

Organic fertilizers accelerate the germination and seedling growth through increased temperature and soil moisture (Hassanzadeh Gourttappeh, 2000) and increase metabolic activity of hydrolytic enzymes in the seed embryo, since hydrolytic enzymes play an important role in stimulating the food supply and hydrolyzing carbohydrates, protein and fat (Farooq *et al.*, 2006).

From 180 to 240 days of growth, the relative height growth rate increased over time whereas the relative diameter growth rate decreased.

One reason for the change in growth pattern over time could be that older seedlings, which are kept in pots longer and later transported to the plantation area. Therefore, their root, would be deformed in a small space (Mossadegh, 2010).

5 CONCLUSION

Overall, regarding to meet the goals of this research it can be stated that the use of organic matter especially in a treatment with the greatest amount of organic matter in the nursery soil would improve the growth indices and biomass of redbud seedlings. In reforestation projects this seedlings will probably a better chance against stress due to site destruction.

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7 REFERENCE

Agren, G.I. and Franklin, O. Root: shoot ratios, optimization and nitrogen productivity. Ann. Bot., 2003; 92: 795-800.

Ahmadloo, F., Tabari, M., Rahmani, A., Yousefzadeh, H. and Kooch, Y. Effect of organic matter compositions on growth and production performance of Pinus brutiaTen. and P. halepensisMill. seedlings, Iran. J. Forest., 2009; 1(4): 287-299. (In Persian)

Auina, A., Rudawska, M., Leski, T., Skridalia, A., Riepas, E. and Iwanski, M. Growth and mycorrhizal community structure of Pinus sylvestrisseedlings following the addition of forest litter. J. Appl. Environ. Microbiol., 2007; 15(73): 4867-4873.

Berger, T.W. and Glatzel, G. Response of Quercus petraeaseedlings to nitrogen fertilization. Forest Ecol. Manag., 2001; 149: 1-14.

Blevins, L.L., Prescott, C.E. and Annette, V.N. The roles of nitrogen and phosphorus in increasing productivity of western hemlock and western redcedar plantations on northern Vancouver Island. Forest Ecol. Manag., 2006; 234: 116-122.

Durgapal, A., Pandey, A. and Palni, L.M.S. The use of rhizosphere soil for improved establishment of conifers at nursery stage for application in plantation programmers. J. Sustain. Forest., 2002; 15(3): 57-73.

Farooq, M., Barsa S.M.A. and Wahid A. Priming of field-sown rice seed enhances germination. seedling establishment, allometry and yield. Plant Growth Regul., 2006; 49: 285-294.

Guerrero, F., Gasco, J.M. and Hern_andez-Apaolaza, L. Use of pine bark and

[DOR: 20.1001.1.23222700.2015.3.1.1.5]

sewage sludge compost as components of substrates for Pinus pinea and Cupressus arizonicaproduction. J. Plant Nutr., 2002; 25(1): 129-141.

Hassanzadeh Gourttappeh, A. Study on the effects of organic, inorganic and integrated fertilizers on the quantitative and qualitative traits of different sunflower (Helianthus annuusL.) cultivars in west Azerbaijan, Iran. Ph.D. Dissertation. Tarbiat Modares University, Iran. 2000; 195 P. (In Persian)

Heydari, M., Pourbabaei, H., Esmaelzade, O., Pothier, D. and Salehi, A. Germination characteristics and diversity of soil seed banks and above-ground vegetation in disturbed and undisturbed oak forests, Forest Sci. Practice, 2013; 15 (4): 286-301.

Imo, M. and Timmer, V.R. Growth, nutrient allocation and water relations of mesquite (Prosopis chilensis) seedlings at differing fertilization schedules. Forest Ecol. Manag., 2003; 55: 279-294.

Iqbal, G.M.A., Huda, S.M.S. Sujauddin, M. and Hossain, M.K. Effects of sludge on germination and initial growth performance of *Leucaena leucocephala* seedlings in the nursery. J. For. Res., 2007; 18(3): 226-230.

Jaferyan, E. Physiographic factors influence the spatial distribution of Love tree, Iran, Kordestan University, Iran, 2013; 55 P.

Jocobs, D.F., Salifu, K.F. and Seifert, J.R. Growth and nutritional response of hardwood seedlings to controlled-release fertilization at outplanting. Forest Ecol. Manag., 2005; 214: 28-39.

Jones, H.E., Madeira, M., Herraez, L., Dighton, J., FabiaÃo, A., GonzaÂlez-Rio, F., Fernandez, M., Marcos, C., Gomez, M., TomeÂ, H., Feith, M.C. MagalhaÃes and Howson, G. The effect of organic-matter management on the productivity of Eucalyptus globulus stands in Spain and Portugal: tree groeth and harvest residue decomposition in relation to site and treatment. Forest Ecol. Manag., 1999; 122: 28-39.

Kaakenin, S., Joikkonen, A., Livonen, S. and Vapaavuori, E. Growth, allocation and tissue chemistry of Picea abies seedlings affected by nutrient supply during the second growing season. Tree Physiol., 2004; 24: 707-719.

Katalin, B., Tama´s, K. and Katalin, D. Effect of Organic Matter Recycling in Long-term Fertilization Trials and Model Pot Experiments, Soil Science and Plant Analysis Journal, 36 (1-3): 191-202. Forest Ecol. Manag., 2005.122:73-86.

Khasa, D.P., Fung, M. and Logan, B. Early growthresponse of container- grown selected woody boreal seedlings in amended composite tailings and tailings sand. Bioresour. Technol., 2005; 96: 857-864.

Kumar Singh, K., Kumar, S. and Pandey, A. Soil Treatments for Improving Seed Germination of Rare and Endangered Sikkim Himalayan Rhododendrons. World J. Agr. Sci., 2008; 4 (3): 288-296.

Landsberg, J.J. and Gower, S.T. Applicationsof physiological ecology to forest management. In: Mooney, H.A., (ED.), Academic Press, USA. 1997.

Lavendar, D.P. Plant physiology and nursery environment. Interactions affecting seedling growth. In: Duryea, M.L. and Landis, T.D., (eds). Forest Nursery Manual, Production of bare root seedling. Forest Research Laboratory, Oregon

State University, Martines Nijhoff/Dr. W. Junk Publishers: 1984; 133-139.

Mahdavi, A. and Fallah Shamsi, S.R. Mapping Forest Cover Change, Using Aerial Photography and IRS-LISSIII Imagery (Case Study: Ilam Township), J. Wood Forest Sci. Technol., 2012; 19(1): 77-92. (In Persian)

Malakouti, M.J. and Homaei, M. Soil fertility of Arid and Semi-arid Regions (Difficulties and Solutions), Tarbiat Modares University Press, Iran, 2004; 482 P.

Mossadegh, A. Afforestation and Forest Nursery, Iran, Tehran, 4th edition, University of Tehran Press. 2010; 516 P.

Navarro, R.M., Retamosa, M.J., Lopez, J., Campo, A.D., Ceaceros, C. and Salmoral, L. Nursery practices and field performance for the endangered Mediterranean species Abies pinsapoBoiss. J. Ecol. Eng., 2006; 27: 93-99.

Nilson, C.N. and F.V. Jorgensen. Phenology and diameter increment in seedling of European beech (Fagus sylvaticaL.) as affected by different soil water contents: variation between and within provenances. Forest Ecol. Manag., 2003; 174: 233-249.

Noorshad, M. and Qurani, M. Research project to select the best soil mix for container seedling production, Publications Office of the Afforestation and parks. Mazandaran. 1990; 153 P.

Nordberg, F., Nilsson, U. and Orlander, G. Effect of different soil treatments on growth and net nitrogen uptake of early planted Picea abies (I.) Karst. Seedlings. Forest Ecol. Manag., 2003; 180: 571-582.

Oliet, J.A., Planelles, R., Segura, M.L., Artero, F. and Jacobs, D.F. Mineral nutrition and growth of containerized Pinus halepensis seedlings under controlled-release fertilizer. Scientia Hort. 2004; 103: 113-129.

Oskarsson, H., Sigurgeirsson, A. and Raulund-Rasmussen, K. Survival, growth, and nutrition of tree seedlings fertilized at planting on Andisol soils in Iceland: Six-year results. Forest Ecol. Manag., 2006; 229: 88-97.

Ostos J.C., Lopez-Garrido, R., Murillo, J.M. and Lopez, R. Substitution of peat for municipal soild waste- and sewage sludge-based composts in nursery growing media: Effect on growth and nutrition of the native shrub Pistacia lentiscus L. Bioresour. Technol., 2008; 99: 1793-1800.

Ren, H., Shen, W., Lu, H., Wen, X. and Jian, S. Degraded ecosystems in China: status, causes, and restoration efforts. Landscape and Ecol. Eng., 2007; 3: 1-13.

Román, R., Fortún, C., De Sá ME. García López and Almendros, G. Successful soil remediation and reforestation of a calcic regosol amended with composted urban waste, J. Arid Land Resour. Manag., 2003; 17: 297-311.

Sabeti, H. Forests, Trees and Shrubs of Iran. Ministry of Agriculture and Natural Resources of Iran, Tehran. 1976.

Salifu, K.F. and Timmer, V.R. Nutrient retranslocation response of Picea marianaseedlings to nitrogen supply. Soil Sci. Soc. Am. J., 2001; 65:905-913.

Samuelson, L.J. Effects of nitrogen on leaf physiology and growth of different families of loblolly and slash pine. New Forests, 2000; 19: 95-107.

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Shan J., Morris, L.A. and Hendrick, R.L. The effects of management on soil and plant carbon sequestration in slash pine plantations. J. Appl. Ecol., 2001; 38: 932-941.

Shibu, M.E., Leffelaar, P.A., Van Keulen, H. and Aggarwal, P.K. Quantitative description of soil organic matter dynamics-A review of approaches with reference to rice-based cropping systems, Geoderma, 2006; 137: 1-18.

Teng, Y. and Timmer, V.R. Modeling nitrogen and phosphorus interactions in intensively managed nursery soil-plant systems. Can. J. Soil Sci., 1996; 76: 523-530.

Tichy, V. and Phuong, H.K. On the character of biological effect of humic acids. Humus Planta. 1975; 6: 379-382.

Tsakaldimi, M. Kenaf (Hibiscus cannabinusL.) core and rice hulls as components of container media for growing (Pinus halepensis M.) seedlings Bioresour. Technol., 2006; 97: 1631-1639.

Will, R.E., Munger, G.T., Zhang, Y. and Borders, B.E. Effects of annual fertilization and complete competition control on current annual increment, foliar development, and growth efficiency of different Aged (Pinus taeda) stands. Can. J. Forest Res., 2002; 32: 1728-1740.

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اثر ترکیبات آلی خاک بر رشد و راندمان نهال‌های ارغوان (*Cercis griffithii*) در شرایط نهالستانی

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چکیده ارغوان یکی از گونه‌های بومی ایران است که نقش مهمی در حفاظت آب و خاک در جنگل‌های زاگرس ایفا می‌کند. اگر چه بسیاری از پروژه‌های جنگل‌کاری با این گونه ناموفق بوده ولی احیای آن باید با کمک مطالعات کاربردی جدید برای کمک به حفظ این منبع با ارزش ادامه پیدا کند. این هدف می‌تواند با افزایش کمیت و کیفیت تولید نهال در نهالستان‌ها قابل حصول باشد. بنابراین هدف این مطالعه بررسی اثرات ترکیبات آلی مختلف بر رشد و راندمان نهال‌های ارغوان در نهالستان بود. چهار تیمار شامل ۱- شاهد (ترکیب رایج نهالستان) ۲- شاهد: کود دامی (۱:۵) ۳- شاهد: خاک‌برگ (۱:۵) و ۴- شاهد: کود دامی: خاک‌برگ (۱:۱:۵) در نظر گرفته شد. نتایج پس از یکسال نشان داد که تمام شاخص‌های رشد با تیمارهای آلی خاک در مقایسه با ترکیب رایج نهالستان افزایش یافته بود. خصوصیات رشد ارغوان از قبیل ارتفاع، وزن خشک ریشه، طول بلندترین ریشه، طول ساقه به قطر و رشد نسبی ارتفاعی با تیمارهای آلی خاک ارتباط داشتند. این نتایج مثبت در شاخص‌های رشد با کاهش شوری و اسیدیته در بستر کاشت به‌وسیله ترکیبات آلی خاک مرتبط است. نتایج پس از یکسال نشان داد که تمام شاخص‌های رشد ارتباط معنی‌داری با تیمارهای مختلف خاک دارند، به‌طوری که صفات مختلف رشد گونه ارغوان در تیمار ترکیبی از جمله ارتفاع، وزن خشک ریشه، طول بلندترین ریشه، طول ساقه به قطر و رشد نسبی ارتفاعی دارای بیش‌ترین میانگین شدند. در حالی‌که در تیمار شاهد، این صفات کم‌ترین مقدار را نشان دادند. هم‌چنین نتایج تحقیق نشان می‌دهد که با کاهش EC و pH بستر کاشت در تیمارهای آلی میزان شاخص‌های رشد نهال‌های ارغوان افزایش یافته است.

کلمات کلیدی: بستر کاشت، رشد و کیفیت، زی‌توده، کمپوست، کود دامی

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