

EFFECT OF DIFFERENT CONCENTRATIONS OF VERMICOMPOST (BIOHUMUS) ON THE ROOT COLLAR DIAMETER AND HEIGHT GROWTH IN THE SEEDLINGS OF ANATOLIAN BLACK PINE

Atila Atik^{1*}

¹Department of Landscape Architecture, Inonu University, Malatya, Turkey

ABSTRACT

In the present study, effect of vermicompost, a product of Biohumus[®], on the root collar diameter and height growth of 1+0 aged seedlings of Anatolian black pine growing in Bartın-Turkey was investigated. Seedlings were treated with three different concentrations of vermicompost solution from seed dibbling. Statistical comparison of morphologic data for treatments was performed using ANOVA test while the treatments were categorised using Duncan test. Compared to control, mean root collar diameter growth was found to be about 25% higher in seedlings in V1 treatment type (Vermicompost of 1:1000) and nearly 26% more in V2 and V3 treatment type while height growth was 13% more in V1 treatment and 20% in V2 and V3 treatment. Findings of the study were thought that Vermicompost can be used to obtain quality black pine seedlings in nurseries by developing root collar and plant height.

Keywords: Vermicompost, Seedling height, Root collar diameter, ANOVA, Black pine, Turkey.

Contribution/ Originality

This study is important in terms detect the effect on forest tree seedling production of vermicompost fertilizer.

1. INTRODUCTION

According to data of General Directorate of Forestry, 21.5 million ha of forested land covers 28% of Turkey's entire territory, of which 11.2 million ha (52%) consists of productive forest areas. The other forest land, 10.3 million ha (48%), is forest land with either no yield, consisting of degraded coppice. Coniferous forests cover approximately 61.3% (13.2 million ha) of Turkey's total forest area [1].

Pinus nigra Arnold. subsp. *pallasiana* Lamb. (Holmboe) also as known Anatolian black pine is one of the commonest and economically important native primary tree species in Turkey [2] and has the third largest expansion area (4.2 million ha) after oak (*Quercus* sp.) and red pine (*Pinus brutia* Ten.) among forest tree species [3]. Black pine may grow naturally in seven geographical regions of Turkey except Eastern Anatolia Region [4].

Anatolian black pine constitutes pure or mixed forests in the mountainous parts of Turkey's coastal regions, even goes into steppe. It constitutes forest stands which are pure or mixed with beech (mainly *Fagus orientalis* Lipsky.), oak (*Quercus* sp.), red pine (*Pinus brutia* Ten.), cedar (*Cedrus libani* A. Rich.), Scots pine (*Pinus sylvestris* L. ssp. *hamata*) and various juniper (*Juniperus* sp.) species on the inward slopes of North Anatolian mountains, on the northern slopes of the Western and southern Anatolia. Black pine surrounds Marmara, Aegean, the coastal areas of Middle and Western Black Sea and Mediterranean Regions and goes into Central Anatolian steppe zone. Its naturally propagation in the vertical direction is between 700 and 2100 m. [4-9].

Black pine is the only species to be planted in each of seven geographic regions of Turkey [4]. In order to meet the need for seedlings, over 100 million black pine seedlings were grown in 2012 in the forest nurseries in Turkey. It is in the first row for seedling propagation in the rate of approximately 22% afforestation carried out in Turkey [1].

Commonly, afforestation value of seedlings and adaptation ability can be measured by considering the quality of their seedlings [10]. But, one of the most important problems of forest nurseries in Turkey is the low productivity power of their soils. Poor management for a long time and deficiency of organic and artificial fertilizer caused reduced productivity of the forest nurseries by decreasing the quality of produced seedlings [11].

As in other forms agricultural production, the use of chemical fertilisers in nurseries can cause environmental pollution. Therefore, there is a need for biologically based natural substances to increase the fertility of nurseries and seedling quality [12, 13].

An important component of sustainable organic agriculture is vermicompost fertilisers, which have been used in many countries. Vermicompost is quite rich in terms of plant nutrients. It is a microbiologically active organic material formed from the interactions between earthworms and microorganisms during the decomposition of organic material [14].

In the present study, effect of vermicompost on seedling height and root collar diameter, which are significant morphological parameters in determining seedling quality, in 1+0 aged Anatolian black pine seedlings growing in Bartın-Kozcağız Temporary Nursery was investigated.

2. MATERIALS AND METHODS

2.1. Study Area

Anatolian black pine seedlings growing in the temporary nursery in Kozcağız and originating Kumluca. Kozcağız Temporary Forest Nursery is on Kozcağız town centre (41° 28' 33" N and 32° 20' 41"E) in Western Black Sea Region of Turkey. The nursery is 20 km far from the Bartın city centre. The elevation of the region is 75 m and its general aspect is in West course.

According to the data obtained from Bartın Meteorology Station which is at 33 m altitude, mean annual, minimum and maximum temperatures are 12.6°C, 0.3°C and 18.8°C, respectively annual rainfall is 1035 mm [15]. Length of vegetation period in the area is totally seven months from April (11.1°C) to October (13.6°C). Total rainfall in vegetation period is 527 mm. According

to the Thorntwaite method, the area has a B₂B₁'rb₄' climate, which means that it is similar to an oceanic climate and is mesothermal with few or no water shortages.

The nursery was established on a plain, and the soil is a medium heavy texture, such as sandy clay, with a pale brown dark colour. The nursery's total sand level is 70.6%, while the clay level is 12.5% and the dust level is 16.9%. The soil pH is 8.0, and it is semi-alkali. The lime rate in the soil is 4.18%; therefore, it is not rich in lime. The organic substance rate of the soil is 5.05%

2.2. Seed Sowing and Preparation Process

Facial sterilisation was applied to seeds before sowing by soaking them in a solution containing 40% sodium hypochlorite for 30 minutes and rinsing in distilled water to remove remaining sodium hypochlorite.

Seeds were then incubated in three different aqueous solutions of vermicompost for 18 h in the dark at 22°C, which are 5 ml in 5 l of water, 1:1000; 10 ml in 5 l of water, 1:500; 50 ml in 5 l of water, 1:100) in. Seeds in control group were incubated in distilled water for the same period of time and planted in seedbed.

Seeds were sown at a 6 cm distance and in the depth of 1 cm on parallel lines 15 cm far from each other in seedbed in the middle of March. Seeds were then covered with a layer of material composed of sawdust and silt and pressed using a cylinder.

Study was designed according to randomized block experiment design with three repetitions for each of four treatments thus constituting 12 blocks. The number of seeds to sow was determined considering the desired number of seedlings to be obtained. It was planned to measure the changes in root collar diameter and height of 1+0 aged seedlings over 100 seedlings in order to determine the size of effect caused by treatments on the development of two parameters at the end of vegetation season. After the completion of germination in all seed beds, VC solution prepared in the concentrations given above was applied to the seedlings in the middle of months from April to October. During the same period control blocks were irrigated with distilled water equal to the volume of solution.

2.3. Data Collection and Analyses

Height and root collar diameter of randomly selected from each treatment type 100 black pine seedlings at the age of 1+0 were measured at the end of the vegetation season in nursery.

Descriptive statistics were applied for the values of obtained height and root collar diameter data and Kolmogorov-Smirnov test were used to determine whether a set of observations is from a homogenous distribution. Then Analysis of Variance (ANOVA) test was applied for the evaluation of height and root collar diameter data of black pine seedlings at various different aqueous solution of VC.

In the case of significant difference as the result of variance analysis, related categorisation was performed considering Duncan test. Data were transferred to computer and analysed statistically using MS Office and Stat Plus 2009 Professional software package.

3. FINDINGS

According to treatment type the results of one sample Kolmogorov-Smirnov test and measurement root collar diameter and height growth of black pine at 1+0 age seedlings were given in Table 3. Root collar diameter and height growth of seedlings in all treatment types constituted using three different VC concentrations are higher than controls. When treatment types are compared with each other, the highest height and root collar diameter growth was seen in V3 followed by V2 and V1 (Table 1, Figs. 1 and 2).

According to the results of one sample Kolmogorov-Smirnov test, values of root collar and seedling height are convenient to normal distribution (Table 1).

Table-1. The results of one sample Kolmogorov-Smirnov test and measurement of root collar diameter and height growth of seedlings.

Compared Feature	Treatment type ^a	N	μ	X_{min}	X_{max}	σ	One-Sample Kolmogorov-Smirnov Test	
							Z	Asymp. Sig.
Root collar diameter (mm)	Control	100	3.25	2.77	3.92	0.3	0.734	0.501 ^b
	V1		4.31	3.13	4.91	0.3	0.795	0.497 ^b
	V2		4.37	3.14	5.05	0.4	0.802	0.754 ^b
	V3		4.39	3.14	5.15	0.3	0.702	0.715 ^b
Height (cm)	Control	100	8.8	7.3	9.1	0.5	1.111	0.301 ^b
	V1		10.1	7.5	11.6	0.7	0.879	0.299 ^b
	V2		11.1	7.9	13.4	0.9	1.012	0.201 ^b
	V3		11.4	8.5	13.4	0.8	0.823	0.802 ^b

^a: Control-Treatment with distilled water; V1-5 ml in 5 l of water, that is, 1:1000; V2-10 ml in 5 l of water, that is, 1:500; V3-50 ml in 5 l of water, that is, 1:100.

^b: Asymp. Sig.>0.05, test distribution is normal.

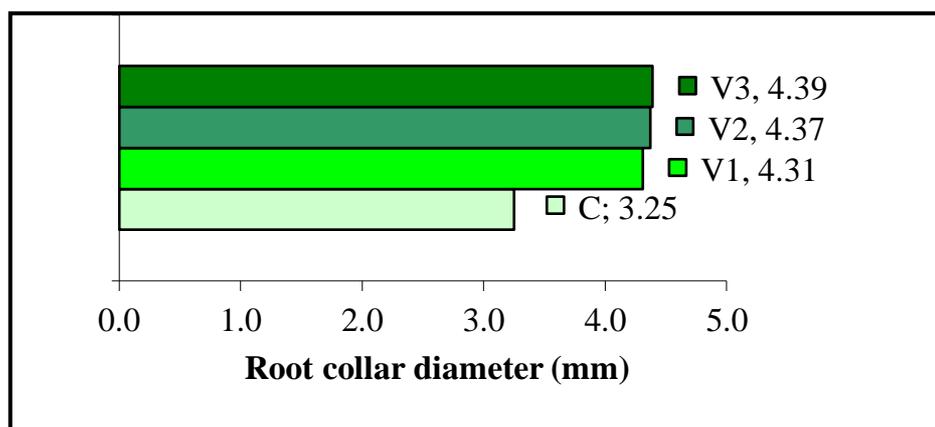


Figure-1. Effect of different concentrations of VC on seedling root collar growth.

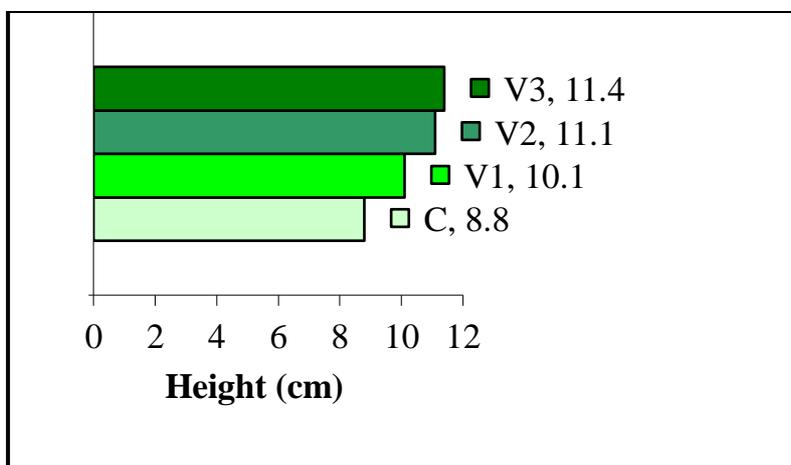


Figure-2. Effect of different concentrations of VC on seedling height growth.

Values of root collar diameter and seedling height were subjected to logarithmic transformation in order to achieve variance homogeneity between treatment groups (\log_{10}). Results of one direction variance analysis (ANOVA), related to the effect of the treatments on diameter and height growth of seedlings, and are presented in Table 2. It can be seen from Table 2 that the difference in root collar and height between treatment types is statistically significant ($p < 0.05$). Results of Duncan test showing the distribution of differences are given in Table 3.

Table-2. The results of ANOVA for root collar diameter and height.

Compared Feature		Sum Squares	df	Mean Square	P
RCD	Between Groups	0.971	3	0.331	0.000
	Within Groups	0.330	396	0.001	
	Total	1.301	399		
H	Between Groups	0.964	3	0.327	0.000
	Within Groups	0.432	396	0.001	
	Total	1.396	399		

*: $P < 0.05$, 5% significant to confidence level.

Black pine seedlings were classified into three groups according to the results of Duncan test considering treatment types for root collar diameter and height growth. Seedlings in control for

Table-3. Results of Duncan test for root collar diameter and height.

Treatment	N	Root Collar Diameter (mm)			Height (cm)		
		1	2	3	1	2	3
Control	100	3.25			8.8		
V1			4.31			10.1	
V2				4.37			11.1
V3				4.39			11.4

both parameters constituted Group 1, those in V1 treatment type were Group 2 while seedlings in V2 and V3 treatment types were Group 3 (Tables 3).

4. DISCUSSION

Mean number of black pine seedlings produced yearly in Turkey is nearly 110 million [1]. Success in afforestation depends greatly on several factors on which practitioners can have limited or no effects such as climatic, edaphic and physiological. However, seedling quality is a factor which can be affected by authorities of the subject. High quality seedlings have to be used in plantation works which are both expensive and time consuming [10, 16].

Parameters considered in the determination of seedling quality are some morphological features such as root collar diameter, height, robust index, stratum, seedling dry weight, root percentage and physiological features such as plant water capacity, root regeneration potential. However, morphological parameters are used more in the studies related to seedling quality categorisation both in Turkey and the world since it is practical and has high applicability [10, 16-19]. Standards of TSI (Turkish Standards Institution) based on morphological parameters are used for the classification of seedlings produced in forest nurseries in Turkey.

An increase in height, root collar diameter and weight of the seedlings with decreasing numbers of seedlings grown in per unit area were found by Güner, *et al.* [20] in black pine (*Pinus nigra* Arnold ssp. *pallasiana* Lamb. (Holmboe)). Schultz and Thompson [21] reported that decreasing the planting density of seedlings caused an increase in the height and root collar diameter in northern red oak (*Quercus rubra* L.) and black walnut (*Juglans nigra* L.). Wichman and Coggeshall [22] found that even though planting density affected the root collar diameter, it did not affect root the collar diameter in white oak (*Quercus alba* L.).

It was determined from the findings of the present study that VC (Biohumus) has positive effect on the development of root collar diameter and height of 1+0 aged black pine seedlings growing in Kozcağız Temporary Forest Nursery.

5. CONCLUSIONS

Black pine is one of the most important tree species in the country since it is planted extensively in each of seven geographical regions of Turkey for the economic value of its wood.

In the present study, effect of Vermicompost in three different concentrations on root collar diameter and height growth of 1+0 aged seedlings of black pine. It was determined that Vermicompost (Biohumus) contributed positively to seedling root collar diameter and height, which are significant parameters for seedling quality categorisation. Increase in these parameters was seen in the same rate in V2 and V3 treatments using the concentrations of 1:500 and 1:100 respectively. From the results of the study it was found that optimum benefit may be obtained by using 1:500 concentration of VC under the conditions of Bartın-Turkey

It was suggested that effect of VC on the development of seedlings from different species and at various ages in nurseries with different edaphic, climatic, physiographic and biologic conditions using different production techniques for different aims.

REFERENCES

- [1] GDF, *Republic of Turkey ministry of forestry and water affairs general directorate of forestry*. Ankara: Forestry of Turkish. Available: <http://www.ogm.gov.tr> [Accessed 14.01.2013], 2013.
- [2] İ. Atalay and R. Efe, "Ecological attributes and distribution of Anatolian black pine [Pinus Nigra Arnold. Subsp. Pallasiana Lamb. (Holmboe)] in Turkey," *J. Environ. Biol.*, vol. 33, pp. 509-519, 2012.
- [3] GDF, *Republic of Turkey ministry of forestry and water affairs general directorate of forestry. The presence of forest in Turkey*. Ankara: Printing Office, 2011.
- [4] N. Öner and F. Eren, "The comparisons between root collar diameter and height growth of pine (Pinus Nigra Arnold.) and scots pine (Pinus Sylvestris L.) seedlings in bolu forest nursery," *Journal of Applied Biological Sciences*, vol. 2, pp. 7-12, 2008.
- [5] İ. Çevik, "The researches on storage in cold warehouse of black pine seedlings," *Journal of Aegean Forestry Research Institute*, vol. 4, pp. 7-8, 1996.
- [6] I. Atalay, *Ecoregions of Turkey*. İzmir. TR: Ministry of Forestry Publication No. 163, 2002.
- [7] T. Mataracı, *Trees*. İstanbul, TR: TEMA Publications No. 39, 2002.
- [8] F. Yalçırık and A. Efe, *Dendrology*. İstanbul, TR: İstanbul University Faculty of Forestry, 2000.
- [9] R. Anşın and Z. C. Özkan, *Plants with seed (Spermatophyta) woody taxons*. Trabzon, TR: Karadeniz Technical University Faculty of Forestry Publication No. 19, 1997.
- [10] Y. Şimşek, "Problems of quality seedling usage in afforestation," *Journal of Forestry Research Institute*, vol. 65, pp. 5-29, 1987.
- [11] H. Yılmaz, "Fertilization of nurseries and fixation question of some plant nutrient in nursery lands," *Journal of Poplar and Fast Growing Forest Trees Research Institute*, vol. 1988, pp. 1-7, 1988.
- [12] A. Atik, "Effects of planting density and treatment with vermicompost on the morphological characteristics of oriental beech (Fagus Orientalis Lipsky.)," *Compost Science & Utilization*, vol. 21, pp. 87-98, 2013a.
- [13] A. Atik, "Effect of different concentrations of effective microorganisms (Baikal EM1) on the root collar diameter and height growth in the seedlings of Anatolian black pine [Pinus Nigra Arnold. Subsp. Pallasiana Lamb. (Holmboe)]," *Journal of Food, Agriculture & Environment (JFAE)*, vol. 11, pp. 1300-04, 2013b.
- [14] J. Domínguez, *State of the art and new perspectives on vermicomposting research. In: Earthworm ecology*, edited by Edwards C.A, 2nd ed.: CRC Press LLC, 2004.
- [15] Anon, "Turkish state meteorological service, Ankara." Available: <http://www.meteor.gov.tr> [Accessed 14.01.2013], 2013.
- [16] B. Avanoğlu, S. Ayan, N. Demircioğlu, and A. Sivacioğlu, "Evaluation of two years old seedlings of the Anatolian black pine (Pinus Nigra Arnold. Subsp. Pallasiana (Lamb.) Holmboe.) raised in

- Kastamonu-Taskopru forest nursery as to TSI quality classification," *Journal of Engineering and Natural Sciences*, vol. 5, pp. 73-83, 2005.
- [17] S. Ürgenç, C. Ü. Alptekin, and H. Dirik, *Produce and quality problems in our forest nursery*. Ankara, TR: I.Seedling Symposium in Turkey, 1991.
- [18] Ö. Görücü and S. Çağlar, "Root renovating (Regeneration) on deciduous seedlings after replaced," *Journal of Poplar and Fast Growing Exotic Forest Trees Research Institute*, vol. 210, pp. 1-14, 1996.
- [19] H. Dirik, "Relations between some important seedling characteristic and success of planting in Calabrian pine (*Pinus Brutia* Ten.)," Ph. D. Thesis, İstanbul University Institute of Science, Department of Silviculture, İstanbul. TR, 1991.
- [20] Ş. T. Güner, A. Çömez, R. Karataş, and M. Genç, "The effect to some morphological and physiological seedling characteristics of planting density on anatolian black pine (*Pinus Nigra* Arnold. Subsp. *Pallasiana* (Lamb.) Holmboe)," *Journal of Soil and Ecology Research Institute*, vol. 325, pp. 1-55, 2008.
- [21] R. C. Schultz and J. R. Thompson, "Effect of density control and undercutting on root morphology of 1+0 bareroot hardwood seedlings: Five-year field performance of root-graded stock in the central USA," *New Forests*, vol. 13, pp. 301-314, 1997.
- [22] J. R. Wichman and M. V. Coggeshall, "Effects of seedbed density and fertilization on root-pruned 2-0 white oak nursery stock," *Tree Planters' Notes*, vol. 35, pp. 22-24, 1984.

Views and opinions expressed in this article are the views and opinions of the author(s), Journal of Forests shall not be responsible or answerable for any loss, damage or liability etc. caused in relation to/arising out of the use of the content.