



Response of Vermicompost on Seedling Growth and Quality Parameters of *Juniperus polycarpus* C. Koch under Nursery Condition

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Received: December 2022

Abstract: A trial was conducted to study the effect of different doses of vermicompost on the seedling growth and quality parameters of *Juniperus polycarpus* under nursery conditions. One year old seedlings of *J. polycarpus* raised in polybags filled with potting media composed of soil, sand, and farmyard manure (2:1:1) were externally given different doses of vermicompost having six treatments to study their effect on seedling growth and quality parameters. Significant differences were observed in shoot length, collar diameter, root length, number of roots, root and shoot biomass of *J. polycarpus* seedlings raised in different potting media. Maximum growth of various seedling parameters viz., shoot length (26.28 cm), root length (37.48 cm), collar diameter (4.61 mm) and number of roots (32.00) was recorded in treatment T₆ i.e. seedlings which were given 5 g vermicompost/seedling whereas minimum growth of various seedling parameters was recorded in treatment T₁ i.e., control where no external dose of vermicompost was applied. Maximum fresh shoot biomass (7.84 g seedling⁻¹), fresh root biomass (2.83 g seedling⁻¹), total fresh biomass (10.67 g seedling⁻¹), dry shoot biomass (4.73 g seedling⁻¹), dry root biomass (1.78 g seedling⁻¹) and total dry biomass (6.51 g seedling⁻¹) were also recorded in treatment T₆. The maximum value of various seedling quality parameters viz., root shoot ratio (0.37), volume index (558.50), Quality index (0.77), and least value of sturdy quotient (5.70) was also observed in seedlings that were given 5 g vermicompost/seedling. The study recommended the application of vermicompost @ 5 g seedling⁻¹ for the production of quality planting stock of *Juniperus polycarpus* in the nursery.

Key words: Quality planting stock, quality index, volume index, sturdiness quotient, root shoot ratio.

Juniperus polycarpus C. Koch is an important conifer found in inner arid ranges of the Himalaya from Nepal westwards to Uttarakhand, Himachal, Jammu & Kashmir, Ladakh, Pakistan and Afghanistan at altitude of 5,000-14,000 ft above MSL (Anonymous, 1959). It is locally known as "Shur", "Shukpa", "Shurgu" or "Shuru" in Himachal Pradesh and "Lashuk" in Ladakh. This conifer has immense ecological, socio-cultural, and religious significance in the Trans Himalayan region. The wood is used as fuel wood by the local communities during the harsh winter season and dried needles are used as incense in houses, temples and monasteries for performing various religious rites, especially in Kinnaur and Lahaul & Spiti districts of Himachal Pradesh and Union Territory of Ladakh. The leaves, twigs, and berries are also used to treat rheumatic pains (Aswal and Goel, 1989).

It is an excellent species for carrying out afforestation activities in dry temperate and

cold desert areas of the Trans Himalayan region. These areas due to their peculiar climatic and topographical features, exhibit xeric conditions due to low moisture availability and the occurrence of skeletal soil which is subject to high light intensity. The success of afforestation activities in cold desert areas is quite low due to the low survival of planted seedlings. The vegetation in these areas is predominantly represented by shrubs and herbaceous flora. Junipers being one of the prominent species of semi-arid and cold regions, possesses huge potential for rehabilitation of these areas. The seedlings of *J. polycarpus* are generally raised in the nursery from seeds after cold moist stratification treatment (Negi and Sharma, 2017) for the production of nursery stock for out planting in the field. The seedling quality parameters play a significant role in the production of healthy nursery stock required for out planting in the field. Nursery managers often use various types of organic growth promoters and soil amendments to enhance the growth of seedlings in the nursery. The use of

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good potting mixtures having sufficient organic manures not only ensures the production of healthy and quality nursery stock but also increases the survival percentage of seedlings in the nursery. Besides this, quality planting stock produced in the nursery, when out planted in the field, not only ensures better survival of seedlings but also promotes vigorous growth of seedlings in the field.

The effect of different doses of vermicompost on the growth performance of various forestry species has been carried out by many workers; however, there is no documented information available on the effect of different doses of vermicompost on the growth performance of *J. polycarpus*. In view of the above, the present study was conducted to evaluate the effect of different doses of vermicompost on seedling growth, quality parameters, and biomass production of *Juniperus polycarpus* seedlings so that the optimum dose for practical application of vermicompost to Juniper seedlings in the nursery could be standardized for production of quality planting stock in the nursery.

Materials and Methods

The experiment on the effect of different doses of vermicompost on seedling growth and quality parameters of *Juniperus polycarpus* was carried out at Model Nursery, Baragaon of Himalayan Forest Research Institute, Shimla (N 31°04'14.3" and E 77°10'15.7" at 1800 m above MSL). The area experiences light snowfall and freezing temperatures during winter months. The maximum temperature during summer months goes up to 32°C and the minimum temperature during winter months goes down to -2°C. One-year-old germinants of *J. polycarpus* were transplanted in polybags of size 9" x 5" filled with potting media comprising soil, sand, and farm yard manure (2:1:1) during March, 2019. A total of 40 seedlings per treatment (10 seedlings x 4 replication) were transplanted in polybags at Model Nursery, Baragaon. The texture of the nursery soil is clay loam. The experimental trial was laid out in randomized block design (RBD) with four replications and six treatments (T₁: Control; T₂: 1.0 g vermicompost polybag⁻¹; T₃: 2.0 g vermicompost polybag⁻¹; T₄: 3.0 g vermicompost polybag⁻¹; T₅: 4.0 g vermicompost polybag⁻¹ and T₆: 5.0 g vermicompost polybag⁻¹).

The polybags containing seedlings were given the first dose of vermicompost per polybag during May, 2019 and the second dose of vermicompost per polybag during May, 2020 as per treatment. The polybags containing seedlings were irrigated as and when required. The weeding and hoeing of potting media in polybags were also carried out periodically to keep the seedlings free from weeds. The seedlings were further maintained in the nursery for another two years for observing their growth behaviour. At the end of the experiment, three seedlings from all replications of each treatment were randomly extracted from polybags to study the growth and biomass. The root system containing potting media was thoroughly cleaned with water till all the particles of potting media were washed away from the root system. The various seedling growth parameters such as shoot length, root length, collar diameter, and the number of lateral roots were recorded. After that, the shoot and root were separated with a secateur and placed in the oven at 80°C for drying till constant weight was recorded. The fresh, as well as dry weight of the shoot, root, and total biomass of seedlings, were recorded by electronic balance. The seedling quality parameters viz., sturdiness quotient, volume index, quality index, and root shoot ratio were calculated as:

1. Sturdiness Quotient (Ritchie, 1984)

$$S.Q. = \frac{\text{Height (cm)}}{\text{Diameter (mm)}}$$

2. Volume Index (Hatchell, 1985)

$$V.I. = \text{Diameter (mm)}^2 \times \text{Height (cm)}$$

3. Quality Index (Dickson, *et al.*, 1960)

$$Q.I. = \frac{\text{Seedling dry weight (g)}}{\frac{\text{Height (cm)}}{\text{Diameter (mm)}} + \frac{\text{Top dry weight (g)}}{\text{Root dry weight (g)}}}$$

4. Root Shoot Ratio

$$\text{Root shoot ratio} = \frac{\text{Root dry weight (g)}}{\text{Shoot dry weight (g)}}$$

The data of various growth parameters, shoot, root, and total biomass of the seedlings were subjected to analysis of variance (ANOVA) to establish the significance of differences between the treatments. The critical difference (CD) was calculated for the variables studied using the

Table 1. Effect of vermicompost on growth parameters of *Juniperus polycarpus* seedlings in nursery condition

Treatment	Shoot length (cm)	Root length (cm)	Collar diameter (mm)	Number of rRoots
T ₁ : Control	22.64	24.40	3.74	26.50
T ₂ : 1 g Vermicompost	23.47	27.15	3.96	27.05
T ₃ : 2 g Vermicompost	23.98	29.35	3.99	28.37
T ₄ : 3 g Vermicompost	24.78	33.10	4.17	30.71
T ₅ : 4 g Vermicompost	25.75	35.20	4.41	31.31
T ₆ : 5 g Vermicompost	26.28	37.48	4.61	32.00
S. Em±	1.02	1.10	0.26	1.35
C.D.	2.17	2.34	0.55	2.87

Table 2. Effect of vermicompost on biomass production of *Juniperus polycarpus* seedlings in nursery condition

Treatment	Fresh shoot weight (g)	Fresh Root weight (g)	Total fresh biomass (g plant ⁻¹)	Dry shoot weight (g)	Dry root weight (g)	Total dry biomass (g plant ⁻¹)
T ₁	5.63	1.95	7.58	3.35	0.97	4.32
T ₂	5.85	2.25	8.10	3.50	1.15	4.65
T ₃	6.25	2.37	8.62	3.71	1.28	5.00
T ₄	6.76	2.47	9.23	3.90	1.43	5.34
T ₅	7.28	2.52	9.81	4.27	1.54	5.82
T ₆	7.84	2.83	10.67	4.73	1.78	6.51
S. Em±	0.58	0.31	0.81	0.32	0.18	0.44
C. D.	1.23	0.66	1.72	0.68	0.38	0.93

computer program "SPSS" - a statistical package for social sciences.

Results and Discussion

The effect of different doses of vermicompost on mean values of various growth parameters, shoot and root biomass, and seedling quality parameters of *Juniperus polycarpus* and their trends have been depicted in Table 1, Table 2 and Table 3 respectively. A perusal of data from the Tables reveals that the application of vermicompost at different doses per seedling significantly influenced the growth and quality parameters of *J. polycarpus* seedlings in the nursery.

The maximum shoot length (26.28 cm) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost/seedling followed by T₅ (25.75 cm), T₄ (24.78cm) and are statistically at par with each other but significantly better than treatments T₃ (23.98 cm), T₂ (23.47 cm) and T₁ (22.64 cm) in decreasing order. The minimum shoot length growth (22.64 cm) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. The maximum root length growth (37.48cm) was also recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹

followed by T₅ (35.20cm) and are at par with each other but significantly better than treatments T₄ (33.10cm), T₃ (29.35cm), T₂ (27.15 cm) and T₁ (24.40 cm) in decreasing order. The minimum root length growth (24.40 cm) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery.

The maximum collar diameter increment (4.61mm) was also recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by T₅ (4.41 mm), T₄ (4.17 mm) and are at par with each other but significantly better than treatments T₃ (3.99 mm), T₂ (3.96 mm) and T₁ (3.74 mm) in decreasing order.

Table 3. quality parameters of *Juniperus polycarpus* seedlings as affected by different doses of vermicompost under nursery condition

Treatment	Root shoot ratio	Sturdiness quotient	Volume index	Quality index
T ₁	0.28	6.05	316.67	0.45
T ₂	0.32	5.92	368.04	0.51
T ₃	0.34	6.01	381.76	0.56
T ₄	0.36	5.94	430.89	0.61
T ₅	0.36	5.83	500.78	0.67
T ₆	0.37	5.70	558.50	0.77

The minimum collar diameter (3.74 mm) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. The maximum number of roots (32.00) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost/seedling followed by treatments T₅ (31.31), T₄ (30.71) and are statistically at par with each other but significantly better than T₃ (28.37), T₂ (27.05) and T₁ (26.50) in decreasing order. The minimum root number was recorded in treatment T₁ (26.50) i.e., control where no vermicompost was applied to the seedlings in the nursery.

The maximum fresh shoot biomass (7.84 g seedling⁻¹) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost/seedling followed by treatments T₅ (7.28 g seedling⁻¹), T₄ (6.76 g seedling⁻¹) and are at par with each other but significantly better than treatments T₃ (6.25 g seedling⁻¹), T₂ (5.85 g seedling⁻¹) and T₁ (5.63 g seedling⁻¹). The minimum fresh shoot biomass (5.63 g seedling⁻¹) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. Similarly, maximum fresh root biomass (2.83 g seedling⁻¹) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost/seedling followed by treatments T₅ (2.52 g seedling⁻¹), T₄ (2.47 g seedling⁻¹), T₃ (2.37 g seedling⁻¹), T₂ (2.25 g seedling⁻¹) and are at par with each other but significantly better than T₁ (1.95 g seedling⁻¹). The minimum fresh root biomass (1.95 g seedling⁻¹) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery.

The maximum total fresh biomass (10.67 g seedling⁻¹) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ (9.81 g seedling⁻¹), T₄ (9.23 g seedling⁻¹) and are statistically par with each other but significantly better than T₃ (8.62 g seedling⁻¹), T₂ (8.10 g seedling⁻¹) and T₁ (7.58 g seedling⁻¹). The minimum total fresh biomass (7.58 g seedling⁻¹) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. The maximum dry shoot biomass (4.73 g seedling⁻¹) was also recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ (4.275 g seedling⁻¹) and are statistically par with each other but significantly better than treatments T₄ (3.90 g seedling⁻¹), T₃ (3.71 g seedling⁻¹), T₂ (3.50 g seedling⁻¹) and T₁ (3.35 g

seedling⁻¹). The minimum dry shoot biomass (3.35g seedling⁻¹) was recorded in treatment T₁ i.e., control, where no vermicompost was applied to the seedlings in the nursery.

Similarly, maximum dry root biomass (1.78 g seedling⁻¹) was also recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ (1.54 g seedling⁻¹), T₄ (1.43 g seedling⁻¹) and are at par with each other but significantly better than treatments T₃ (1.28 g seedling⁻¹), T₂ (1.15 g seedling⁻¹) and T₁ (0.97 g seedling⁻¹). The minimum dry root biomass (0.97 g seedling⁻¹) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. The maximum value of total dry biomass (6.51 g seedling⁻¹) was recorded in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ (5.82 g seedling⁻¹) and are statistically par with each other but significantly better than treatments T₄ (5.34 g seedling⁻¹), T₃ (5.00 g seedling⁻¹), T₂ (4.65 g seedling⁻¹) and T₁ (4.32 g seedling⁻¹) in a decreasing order respectively. The minimum total dry biomass (4.32 g seedling⁻¹) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery.

The seedling quality parameters calculated on the basis of various growth and biomass parameters as presented in Table 3 reveal that the maximum value of root shoot ratio (0.37) was observed in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ and T₄ (0.36), T₃ (0.34), T₂ (0.32), T₁ (0.28) respectively in decreasing order. The minimum value of root shoot ratio (0.28) was recorded in treatment T₁ i.e., control where no vermicompost was applied to the seedlings in the nursery. The least value of sturdiness quotient (5.70) was observed in treatment T₆ i.e., 5 g vermicompost polybeg⁻¹ followed by treatment T₅ (5.83), T₂ (5.92), T₄ (5.94), T₃ (6.01) and T₁ (6.05) respectively in increasing order.

The maximum value of volume index (558.50) was observed in treatment T₆ i.e., seedlings given 5 g vermicompost polybeg⁻¹ followed by treatments T₅ (500.08), T₄ (430.89), T₃ (381.76), T₂ (368.04) and T₁ (316.67) in decreasing order and the minimum value of volume index (316.67) was observed for the treatment T₁ i.e., control where no vermicompost was

applied to the seedlings in the nursery. The highest value of Dickson quality index (0.77) was recorded in treatment T_6 i.e., seedlings given 5 g vermicompost polybag⁻¹ followed by treatments T_5 (0.67), T_4 (0.61), T_3 (0.56), T_2 (0.51) and T_1 (0.45) respectively in decreasing order. The lowest value of the quality index (0.45) was recorded in treatment T_1 i.e., control where no vermicompost was applied to the seedlings in the nursery.

On the basis of the above results, the study reveals that *Juniperus polycarpus* seedlings which were given vermicompost @ 5 g seedling⁻¹ in the nursery resulted in better growth of various seedling growth parameters and biomass production in the nursery. The seedlings also exhibited the highest value of quality parameters viz., root shoot ratio, volume index, and quality index, and the least value of sturdiness quotient. Therefore, *J. polycarpus* seedlings should be given vermicompost @ 5 g seedling⁻¹ in polybags for better growth of seedlings as well as for raising quality nursery stock.

On the basis of values of various seedling growth parameters and biomass of the seedlings raised with the application of different doses of vermicompost, it clearly appears that the addition of vermicompost in potting mixtures considerably influences the growth of various seedling parameters and biomass production in the nursery as compared to potting mixture where no vermicompost was applied. The seedlings raised in potting mixture (control) without any addition of vermicompost exhibit poor performance in the nursery as compared to the seedlings where vermicompost was applied externally. This may be probably due to the lesser availability of essential macro and micronutrients in the nursery soil which is required for the proper growth of seedlings in the nursery. Therefore, the addition of vermicompost @ 5 g seedling⁻¹ in polybags is the appropriate dose for the enhancement of seedling growth and production of quality planting stock in the nursery. The study further revealed that seedlings that were given 5 g vermicompost seedling⁻¹ significantly influenced the growth of various seedling parameters, seedling biomass production, and quality parameters in the nursery as compared to control i.e. where no vermicompost was given to the seedlings in the nursery.

The seedlings which were given 5 g vermicompost seedling⁻¹ in the nursery resulted in the highest growth of various seedling growth parameters viz., shoot length, root length, collar diameter, number of roots, shoot biomass, root biomass, total biomass, and quality parameters viz., root shoot ratio, volume index, quality index and least value of sturdiness quotient under nursery condition. The sturdiness quotient value was also found least in seedlings that were given 5 g vermicompost seedling⁻¹ which shows the overall superiority of seedlings. Therefore, *J. polycarpus* seedlings should be given 5 g vermicompost/seedling in polybags for raising quality planting stock in the nursery.

The low sturdiness value helps in promoting vigorous growth in plantations (Chauhan and Sharma, 1997). Similarly, a higher value of volume index contributes significantly to better establishment, survival and subsequently promotes better growth of seedlings after planting in the field (Chauhan and Sharma, 1997). The Dickson quality index indicates the overall quality of the seedlings; therefore, it is evident from the above values of the quality index that Juniper seedlings that were given 5 g vermicompost/seedling perform well in the nursery. Similarly, a higher value of root shoot ratio helps in the vigorous growth of seedlings after planting in the field. The results are in accordance with the findings in *Acacia mearnsii* (Caldeira *et al.*, 2000), *Pinus pinaster* (Lazcano *et al.*, 2008), *Apuleia leiocarpa* (Caldeira *et al.*, 2005) and *Lycopersicum esculentum* (Fizabadi *et al.*, 2016) in which seedlings applied with different doses of vermicompost resulted in a significant increase in height and diameter growth, above ground dry matter, root dry matter and total dry matter production. This study is also in accordance with the outcomes of Grossnickle (2012) who mentioned that a desirable level of seedling quality attributes ensures high survival capability, increases the speed with which plants overcome stress, and ensures successful seedling establishment after out planting in the field. It is further stated that in the present study, maximum dose of vermicompost used was 5 g seedling⁻¹ which produced highest growth of various seedling growth parameters and plant biomass, however, vermicompost dose more than 5 g seedling⁻¹ may be equally effective for enhancing seedling

growth parameters and plant biomass of Juniper seedlings in the nursery.

Conclusions

The findings of the present investigation reveal that *Juniperus polycarpus* seedlings which were given vermicompost dose @ 5 g seedlings⁻¹ in polybags produced maximum shoot length, root length, collar diameter, number of roots, and plant biomass along with desired values of root shoot ratio, sturdiness quotient, volume index, and quality index. Hence, it is concluded that seedlings of *Juniperus polycarpus* should be given vermicompost @ 5 g seedlings⁻¹ in polybags for raising quality planting stock in the nursery after transplanting in the polybags.

Acknowledgment

The authors are thankful to the Director, Himalayan Forest Research Institute, Panthaghati, Shimla for providing the necessary facilities and the Indian Council of Forestry Research & Education, Dehradun (UK) for giving financial support. The assistance rendered by the field staff of Model Nursery, Baragaon, HFRI, Shimla during the execution of research work is highly appreciated and acknowledged.

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