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Effect of nitrogenous fertilizer on the seedling growth and quality parameters of *Juniperus polycarpos* C Koch under nursery conditions

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ABSTRACT

Investigations were carried out to study the effect of nitrogenous fertilizer ie urea on the seedling growth, biomass production and quality parameters of *Juniperus polycarpos* in nursery conditions. The seedlings were given eight different doses of urea including control to study their effect on seedling growth and quality parameters. Significant differences were observed in growth, biomass and quality parameters of seedlings applied with different doses of urea in the nursery. Maximum values for seedling parameters viz shoot length (55.97 cm), root length (40.50 cm), collar diameter (6.71 mm) and number of roots per plant (42.50) were recorded in seedlings that were given 3.5 g urea per seedling, along with other treatments, whereas, minimum values of various seedling parameters were recorded in seedlings where no external dose of urea was administered. Similarly, maximum fresh shoot biomass (29.50 g/seedling), fresh root biomass (7.12 g/seedling), total fresh biomass (36.62 g/seedling), dry shoot biomass (16.87 g/seedling), dry root biomass (4.27 g/seedling) and total dry biomass (21.15 g/seedling) were also recorded in seedlings that were given 3.5 g urea per seedling, whereas, minimum shoot, root and total biomass were recorded in seedlings where no external dose of urea was applied. The maximum values of seedling quality parameters viz root-shoot ratio (0.25), volume index (2,519.99) and quality index (1.72) were also observed in seedlings that were given 3.5 g urea per seedling. The study recommended the application of urea 3.5 g per seedling for promoting the growth of seedlings of *J polycarpos* and the production of quality planting stock in the nursery.

Keywords: Planting stock; biomass; quality index; volume index; root-shoot ratio

INTRODUCTION

The Trans-Himalayan region of the Indian sub-continent possesses unique diversity of floral and faunal wealth. These geographical regions, which fall in the rain shadow parts of Himalayan mountain ranges, possess peculiar climatic and topographical features and receive very less rainfall throughout the year. The precipitation occurs in the form of snow during the winter season.

They exhibit xeric conditions due to the presence of low moisture and the occurrence of sandy and skeletal soil which are subjected to high light intensity. The vegetation is primarily dominated by shrubs and herbaceous flora with very few tree species. Junipers are the only conifer that has an extensive distribution in the Trans-Himalayan region. Six species of junipers are found in the Himalayan region viz *Juniperus polycarpos*, *J excelsa*, *J recurva*, *J squamata*, *J indica* and *J communis*. Among them, *J polycarpos* C Koch, commonly called Himalayan Pencil Cedar, is dominant tree species found in the dry temperate and cold desert regions of the Himalaya extending from Nepal to Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Ladakh, Pakistan and Afghanistan at an altitude of 5,000-14,000 ft amsl (Anon 1959). It is the only indigenous conifer that has extensive distribution in the cold desert regions of Trans-Himalaya.

It has immense ecological, economic, socio cultural and religious significance in the Trans-Himalayan region. It is used as fuelwood and as incense in houses, temples and monasteries for performing various religious rites by the local tribal communities in

Himachal Pradesh and the union territory of Ladakh. The leaves, twigs and berries are also used to treat rheumatic pains (Aswal and Goel 1989).

It is a prominent conifer species for carrying out afforestation and restoration of degraded lands in dry temperate and cold desert areas of the Trans-Himalayan region. The species possesses huge potential in the rehabilitation of these fragile areas due to its xeric characteristics, strong root system and ability to survive in extremes of climatic conditions. In the past, there was no standardized technique available for raising seedlings of this important conifer in the nursery due to seed dormancy. ICFRE – Himalayan Forest Research Institute, Shimla, Himachal Pradesh has successfully developed technology for overcoming seed dormancy (Negi and Sharma 2017). It is a slow growing conifer species like other conifers of the Himalayan region and seedlings of this conifer are usually raised from seeds in the nurseries for the production of planting stock for field plantation. The seedlings normally take 5 years in the nursery before outplanting in the field. Nursery managers often use different types of organic and inorganic fertilizers, manures, compost, plant growth promoters and other soil amendments to enhance the growth of planting stock and to reduce the nursery period in the nursery.

It has been observed that the addition of organic and inorganic fertilizers, along with other supplements, not only promotes the growth of seedlings but also reduces considerably the nursery period of seedlings. These growth supplements further ensure the production of robust and quality planting stock. The quality planting stock produced in the nursery not only ensures better survival of seedlings but also promotes vigorous growth as well as the successful establishment of seedlings after outplanting in the field (Grossnickle 2012).

The effect of organic and inorganic fertilizers, vermicompost and growth boosters on the growth performance of various forestry species has been studied by many researchers (Patel and Suresh 2018, Fasalejo et al 2019, El-Boray 2021, Tiwari et al 2023, Mamadou et al 2022, Negi et al 2022), however, there is no documented information available on the effect of nitrogenous fertilizers on the growth performance of *J polycarpos* seedlings in the nursery. The nitrogenous fertilizers, especially urea is used for promoting the growth of plants in agriculture and forestry practices because it provides immense benefits to the plants during their growth and development.

The nitrogen content (46%) in urea promotes photosynthetic activity and favours green leafy growth. In view of the multifarious benefits of nitrogenous fertilizers in the overall development of seedlings in the nursery, the present study was conducted to evaluate the influence of different doses of nitrogenous fertilizer on seedling growth, quality parameters and biomass production of *J polycarpos* seedlings so that the optimum dose for practical application of nitrogenous fertilizer to juniper seedlings in the nursery could be standardized for production of quality planting stock.

MATERIAL and METHODS

Seed collection and sowing: The berries of *J polycarpos* were collected from the mature healthy trees from the juniper forest located near Asrang village of Kinnaur district, Himachal Pradesh, which is situated at 31° 36' 36" N latitude and 78° 25' 42" E longitude at an altitude of 3,200 m amsl. The berries were brought to the seed laboratory of Himalayan Forest Research Institute, Shimla, Himachal Pradesh. The seeds were extracted from the berries, cleaned and dried in the laboratory. The seeds were given cold moist stratification treatment in cow dung for 60 days and, thereafter, sown in germination beds in the nursery for raising of seedlings for laying of nursery trials (Negi and Sharma 2017).

Nursery trial: The experiment on the effect of different doses of nitrogenous fertilizer (urea) on seedling growth performance and quality parameters of *J polycarpos* was carried out at the model nursery, Baragaon of Himalayan Forest Research Institute, Shimla, Himachal Pradesh during 2017-2021.

The experimental site is situated at 31° 04' 14.3" N and 77° 10' 15.7" E at 1,800 m amsl. The one year old germinants of *J polycarpos* were transplanted in polybags of size 9" x 5" size filled with potting media comprising soil, sand and farmyard manure (1:1:1). A total of 40 seedlings per treatment (10 seedlings x 4 replications) were transplanted in polybags at model nursery, Baragaon. The experimental trial was conducted in the nursery with eight treatments and four replications in a randomized block design. The treatments used were: T_1 (Control), T_2 (0.5 g urea/

seedling), T_3 (1.0 g urea/seedling), T_4 (1.5 g urea/seedling), T_5 (2.0 g urea/seedling), T_6 (2.5 g urea/seedling), T_7 (3.0 g urea/seedling) and T_8 (3.5 g urea/seedling).

The seedlings planted in polybags were given the first dose of urea per seedling in May 2017 and the second dose of urea per seedling in May 2018 as per the treatments. The nitrogen content of urea was 46 per cent. 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 three 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 during March 2021 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 shoots and roots were separated with secateurs and placed in the oven at 80°C till constant weight was recorded. The fresh as well as dry weight of the shoots, roots and total biomass were recorded. The seedling quality parameters viz sturdiness quotient (Ritchie 1984), volume index (Hatchell 1985), quality index (Dickson et al 1960) and root-shoot ratio were calculated as per below:

$$\text{Sturdiness quotient} = \frac{\text{Height (cm)}}{\text{Diameter (mm)}}$$

$$\text{Volume index} = \text{Diameter (mm}^2\text{)} \times \text{Height (cm)}$$

$$\text{Quality index} = \frac{\text{Seedling dry weight (g)}}{\text{Height (cm)/Diameter (mm)} + \text{top dry weight (g)/Root dry weight (g)}}$$

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

The data on various growth parameters shoot, root and total biomass of the seedlings were subjected to analysis of variance (ANOVA) to establish the significance of differences among the treatments ($\leq$0.05). The significant difference was calculated for the variables studied using the computer programme SPSS.

RESULTS and DISCUSSION

The effect of different doses of nitrogenous fertilizer on various seedling parameters viz shoot and root biomass and quality parameters of *J polycarpos* and their trends have been depicted in Tables 1, 2 and 3 respectively. A perusal of data reveals that the application of nitrogenous fertilizer at different doses per seedling significantly influenced the growth, plant biomass and quality parameters of *J polycarpos* seedlings in the nursery.

The data given in Table 1 show that the shoot length of the seedlings applied with different doses of nitrogenous fertilizer varied significantly from 42.63 to 55.97 cm. The maximum shoot length was recorded in treatment T_8 (3.5 g urea/seedling) (55.97 cm) and T_7 (3.0 g urea/seedling) (53.70 cm), which were statistically at par but significantly better than treatments T_6 (2.5 g urea/seedling) (49.37 cm) and T_5 (2.0 g urea/seedling) (47.25 cm). Minimum shoot length (42.63 cm) was recorded in treatments T_1 (control), T_2 (0.5 g urea/seedling) (43.83 cm), T_3 (1.0 g urea/seedling) (44.88 cm) and T_4 (1.5 g urea/seedling) (45.52 cm), which were significantly at par.

The root length of the seedlings varied from 35.70 to 40.50 cm. The maximum root length was recorded in treatments T_8 (40.50 cm), T_7 (38.66 cm), T_6 (38.31 cm), T_5 (37.87 cm) and T_4 (37.25 cm), which were statistically at par. The minimum root length was recorded in T_1 (35.70 cm) which was at par with T_2 (36.50 cm), T_3 (36.62 cm), T_4, T_5 and T_6.

The collar diameter of the seedlings varied from 5.43 to 6.71 mm. The maximum collar diameter was recorded in treatments T_8 (6.71 mm), T_7 (6.62 mm), T_6 (6.55 mm), T_5 (6.40 mm) and T_4 (6.25 mm), which were statistically at par with each other but significantly superior to T_3 (6.10 mm) and T_2 (6.06 mm) and the minimum was recorded in treatment T_1 (5.43 mm).

The number of roots per seedling varied from 35.75 to 42.50. The maximum number of roots was recorded in treatments T_8 (42.50), T_7 (41.12), T_6 (40.37),

Table 1. Growth parameters of *Juniperus polycarpos* seedlings as affected by different doses of nitrogenous fertilizer (urea) under nursery condition

Treatment	Shoot length (cm)	Root length (cm)	Collar diameter (mm)	Number of roots
T_1	42.63	35.70	5.43	35.75
T_2	43.83	36.50	6.06	36.50
T_3	44.88	36.62	6.10	37.50
T_4	45.52	37.25	6.25	38.00
T_5	47.25	37.87	6.40	39.75
T_6	49.37	38.31	6.55	40.37
T_7	53.70	38.66	6.62	41.12
T_8	55.97	40.50	6.71	42.50
P ($\leq$0.05)	0.000	0.138	0.005	0.305
F-value	12.404	1.811	4.252	1.284
SEm±	1.92	1.58	0.28	2.95
$CD_{0.05}$	3.99	3.28	0.58	6.13

T_1: Control, T_2: 0.5 g urea/seedling, T_3: 1.0 g urea/seedling, T_4: 1.5 g urea/seedling, T_5: 2.0 g urea/seedling, T_6: 2.5 g urea/seedling, T_7: 3.0 g urea/seedling, T_8: 3.5 g urea/seedling

Table 2. Shoot and root biomass of *Juniperus polycarpos* seedlings as affected by different doses of nitrogenous fertilizer (urea) under nursery condition

Treatment	Fresh shoot weight (g)	Fresh root weight (g)	Total fresh weight (g)	Dry shoot weight (g)	Dry root weight (g)	Total dry weight (g)
T_1	15.75	3.12	18.87	8.12	1.62	9.75
T_2	20.37	4.12	23.75	10.72	2.25	12.97
T_3	21.87	4.50	26.37	11.00	2.65	13.65
T_4	23.75	4.60	28.35	12.40	2.72	15.12
T_5	24.25	4.75	29.00	12.87	2.91	15.78
T_6	27.00	5.27	32.27	14.75	3.37	18.12
T_7	28.00	5.92	33.92	15.14	3.61	18.75
T_8	29.50	7.12	36.62	16.87	4.27	21.15
P($\leq$0.05)	0.111	0.245	0.077	0.049	0.118	0.051
F-value	1.955	1.431	2.193	2.495	1.915	2.475
SEm±	4.53	1.42	5.46	2.51	0.84	3.26
$CD_{0.05}$	9.42	2.95	11.35	5.22	1.74	6.78

T_1: Control, T_2: 0.5 g urea/seedling, T_3: 1.0 g urea/seedling, T_4: 1.5 g urea/seedling, T_5: 2.0 g urea/seedling, T_6: 2.5 g urea/seedling, T_7: 3.0 g urea/seedling, T_8: 3.5 g urea/seedling

T_5 (39.75), T_4 (38.00), T_3 (37.50) and T_2 (36.50), which were statistically at par and the minimum in T_1 (35.75) which, on the other hand was at par with all other treatments except T_8.

The mean values of fresh and dry biomass production in *J polycarpos* seedlings as affected by different doses of nitrogenous fertilizer are given in Table 2. Data reveal that the fresh shoot biomass of the seedlings varied from 15.75 to 29.50 g per seedling. The maximum fresh shoot biomass was recorded in treatments T_8 (29.50 g/seedling), T_7 (28.00 g/seedling), T_6 (27.00 g/seedling), T_5 (24.25 g/seedling), T_4 (23.75 g/seedling), T_3 (21.87 g/seedling) and T_2 (20.37 g/seedling), which were statistically at par. The minimum fresh shoot biomass (15.75 g/seedling) was recorded in treatment T_1, which, on the other hand was statistically at par with T_2, T_3, T_4 and T_5.

Similarly, the fresh root biomass varied from 3.12 to 7.12 g per seedling. The maximum fresh root biomass was recorded in treatments T_8 (7.12 g/seedling), T_7 (5.92 g/seedling), T_6 (5.27 g/seedling), T_5 (4.75 g/seedling), T_4 (4.60 g/seedling) and T_3 (4.50 g/seedling), which were statistically at par with each other but significantly better than treatments T_2 (4.12

g/seedling). The minimum fresh root biomass was recorded in treatment T_1 (3.12 g/seedling) which was at par with all the treatments except T_8.

The total fresh biomass of the seedlings varied from 18.87 to 36.62 g per seedling. The maximum total fresh biomass was recorded in treatments T_8 (36.62 g/seedling), T_7 (33.92 g/seedling), T_6 (32.27 g/seedling), T_5 (29.00 g/seedling), T_4 (28.35 g/seedling) and T_3 (26.37 g/seedling), which were statistically at par but significantly better than treatments T_2 (23.75 g/seedling). The minimum total fresh biomass was recorded in treatment T_1 (18.87 g/seedling) which was at par with T_2, T_3, T_4 and T_5.

The dry shoot biomass of the seedlings varied significantly from 8.12 to 16.87 g per seedling. The maximum dry shoot biomass was also recorded in treatment T_8 (16.87 g/seedling), T_7 (15.14 g/seedling), T_6 (14.75 g/seedling), T_5 (12.87 g/seedling) and T_4 (12.40 g/seedling), which were statistically at par but significantly better than treatments T_3 (11.00 g/seedling) and T_2 (10.72 g/seedling). The minimum dry shoot biomass (8.12 g/seedling) was recorded in treatment T_1, which was at par with T_2, T_3, T_4 and T_5.

Similarly, the dry root biomass of the seedlings varied from 1.62 to 4.27 g per seedling. The maximum dry root biomass was also recorded in treatments T_8 (4.27 g/seedling), T_7 (3.61 g/seedling), T_6 (3.37 g/seedling), T_5 (2.91 g/seedling), T_4 (2.72 g/seedling) and T_3 (2.65 g/seedling), which were statistically at par but significantly better than treatments T_2 (2.25 g/seedling). The minimum dry root biomass (1.62 g/seedling) was recorded in treatment T_1 which was at par with T_2, T_3, T_4 and T_5. The total dry biomass of the seedlings varied from 9.75 to 21.15 g per seedling. The maximum total dry biomass was recorded in treatments T_8 (21.15 g/seedling), T_7 (18.75 g/seedling), T_6 (18.12 g/seedling), T_5 (15.78 g/seedling) and T_4 (15.12 g/seedling), which were statistically at par but significantly superior to T_3 (13.65 g/seedling) and T_2 (12.97 g/seedling). The minimum total dry biomass (9.75 g/seedling) was recorded in treatment T_1 which was at par with T_2, T_3, T_4 and T_5.

The seedling quality parameters calculated on the basis of various seedling growth and biomass parameters are presented in Table 3.

Perusal of data reveals that maximum root-shoot ratio (0.25) was observed in treatment T_8 followed by T_7 and T_3 (0.24), T_5 and T_6 (0.23), T_4 (0.22) and T_2 (0.21). The minimum root-shoot ratio (0.19) was recorded in treatment T_1.

The least value of sturdiness quotient (7.23) was observed in T_2 followed by T_4 (7.28), T_3 (7.35), T_5 (7.38), T_6 (7.53), T_1 (7.85), T_7 (8.11) and T_8 (8.34). The maximum volume index (2,519.99) was observed in T_8 followed by T_7 (2,353.37), T_6 (2,118.09), T_5 (1,935.36), T_4 (1,778.12), T_3 (1,669.98) and T_2 (1,605.59) and the minimum (1,256.94) was observed in T_1.

The highest value of Dickson quality index (1.72) was recorded in T_8 followed by T_7 and T_6 (1.52), T_5 (1.33), T_4 (1.27), T_3 (1.18) and T_2 (1.08). The lowest value of the quality index (0.75) was recorded in treatment T_1.

On the basis of above results, it is inferred that growth, biomass and quality of seedlings of *J polycarpos* in nursery were enhanced when given nitrogenous fertilizer as compared to control. The

Table 3. Seedling quality parameters of *Juniperus polycarpos* seedlings as affected by different doses of nitrogenous fertilizer (urea) under nursery condition

Treatment	Root-shoot ratio	Sturdiness quotient	Volume index	Quality index
T_1	0.19	7.85	1,256.94	0.75
T_2	0.21	7.23	1,609.59	1.08
T_3	0.24	7.35	1,669.98	1.18
T_4	0.22	7.28	1,778.12	1.27
T_5	0.23	7.38	1,935.36	1.33
T_6	0.23	7.53	2,118.09	1.52
T_7	0.24	8.11	2,353.37	1.52
T_8	0.25	8.34	2,519.99	1.72

T_1: Control, T_2: 0.5 g urea/seedling, T_3: 1.0 g urea/seedling, T_4: 1.5 g urea/seedling, T_5: 2.0 g urea/seedling, T_6: 2.5 g urea/seedling, T_7: 3.0 g urea/seedling, T_8: 3.5 g urea/seedling seedlings which were given 3.5 g urea per seedling in the nursery resulted in maximum shoot length, root length, collar diameter, number of roots, shoot biomass, root biomass, total biomass along with other tratments. This treatment also enhanced their quality parameters viz volume index and quality index. Therefore, *J polycarpos* seedlings should be given 3.5 g urea per seedling in polybags for raising of quality planting stock in the nursery. The higher value of the volume index contributes significantly to better establishment and 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 which were given 3.5 g urea per seedling performed well in the nursery. The findings is in conformity with the results in *Acacia catechu* (Brahmi et al 2010) where the application of chemical and biofertilizers considerably enhanced growth and quality parameters of *A catechu* in the nursery.

Similarly, Hoque et al (2004) reported that addition of nitrogen fertilizer significantly promoted collar diameter increment and total dry matter production of seedlings. Afa et al (2011) found that organic and inorganic fertilizers significantly increased the growth characteristics of *Khaya ivorensis* in the nursery. Dar et al (2015) reported that the application of varying levels of nitrogen fertigation considerably increased growth as well as the survival of *Cryptomeria japonica* seedlings in the nursery.

CONCLUSION

It was observed that *J polycarpos* seedlings that were given urea 3.5 g per seedling in polybags resulted into maximum shoot length, root length, collar diameter, number of roots, plant biomass, volume index and quality index along with lower concentration of urea. Hence, *J polycarpos* seedlings should be given nitrogenous fertilizer 3.5 g per seedling in polybags for raising quality planting stock in the nursery.

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