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Research Article

Seedling emergence, periodic growth, and survival of some multipurpose agroforestry tree species of Garhwal Himalaya

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Abstract

This study evaluated the seedling emergence behavior, growth performance, leaf area, and biomass allocation of seven multipurpose tree species *(Celtis australis, Grewia optiva, Bauhinia retusa, Bauhinia variegata, Ficus auriculata, Quercus semecarpifolia, Quercus floribunda)*. The (emergence) germination experiments were conducted under the polyhouse condition in poly bags. Significant differences ($p < 0.05$) were found among different tree species for nursery germination percent. The seedling emergence and Seedling Vigour Index (SVI) significantly varied among all the seven multipurpose tree species. Seed germination was maximum (80%) recorded in *G. optiva* and minimum (21%) was recorded in *Q. semecarpifolia* irrespective of tree species. Significant ($p < 0.05$) variation was also observed for Mean Germination Time (MGT) and Germination Index (GI) among tree species. Significant variations were found in the performances of seedling growth for leaf area in periodic intervals and it is also noted that a significant difference was found in the performance of seedling growth for survival percentage at periodic intervals.

Introduction

Talking people-forest in the present context, the former comprehensively depend on the latter for their subsistence. Cattle rearing, agriculture to fuel, and timber requirements of the residents, particularly those living in upper reaches are fulfilled by the forests growing in their vicinity. However, due to the substantial increase in human and bovine populations coupled with decreasing forests in the recent past, the very existence of the rural folk is being threatened. Similarly, the green fodder requirement has been estimated to be 10.34 kg/ cattle/day, irrespective of livestock reared (Sachan, 2004). Therefore, agroforestry needs to be strengthened to meet the ever-increasing demand for fuel and fodder.

Multipurpose tree species have been incorporated in agroforestry for their uses more than service or production function in an agroforestry system. These are fast-growing and grow successfully in a wide range of environments [1]. The demands of the fast-growing multipurpose trees in plantation programs are immense all over the world [2]. In Central Himalaya, rural people cultivate different species of trees and shrubs in or around their traditional agricultural fields, home gardens, and fallow land [3]. For the conducting the present investigation seven multipurpose *i.e. B. Semla, B. variegata, C. australis, F. auriculata, G. optiva, Q. semecarpifolia, Q. floribunda* were selected on the basis of their multiple uses and importance. They provide fuel, fodder, food, and small timber/ wood products appreciated by local people in Garhwal Himalaya. These are also important for reforestation and afforestation programs in the reclamation of wastelands in the Himalayan region. Most of the fodder and fuel wood tree species of the Garhwal Himalayas are under stress because of unplanned or unscientific lopping [4]. On the basis of their different uses and suitability for the plantation progamme, the present investigation was carried out for the evolution of emergency survival and growth of these multipurpose tree species.

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Methodology

The present study was conducted in the College of Forestry, Ranichauri, Tehri Garhwal located at an altitude of about 2100 meters mean above sea level, lying between 30° 15' N latitude and 78° 30' E longitudes under mid hills of Uttarakhand, India. The Seeds of *Bauhinia semla and Bauhinia variegate* were collected from Ripe pods collected off the trees. Seeds of *Ficus auriculata*, the ripe fruits are collected, rubbed, and washed to obtain the seed whereas, *Celtis australis*, *Grewia optiva*, *Quercus floribunda*, and *Quercus semecarpifolia*, were collected after they fell to the ground. Seeds of all the species were collected from their natural habitat. The (emergence) germination experiments were conducted under the polyhouse condition in poly bags. Poly bags were filled with the mixture of soil, sand, and Farm Yard Manure in a 2:1:1 ratio. Randomised Block Design (RBD) was used to avoid the biases. Poly bags were arranged in RBD (Twenty poly bags in five replicates) total of a hundred poly bags were used for sowing seeds for each species separately. Four seeds of each species were sown in each poly bag for estimation of seedling emergence. The total period was 28 days to record the emergence of seedlings [5]. A single seedling was maintained per polybag after germination. Adequate watering and care were taken regularly. Fifty representative seedlings from each species were selected (Ten polybags, five replicates each). Shoot length, collar diameter, number of branches, and number of leaves, were recorded after 3, 6, 9, and 12 months growth periods with the help of a meter scale. After the completion of 12 months of growth, shoot dry weight, root length, root dry weight, and root shoot ratio were estimated as per the stranded procedure. The following formula is used for the calculation and measurements. Germination percent was calculated by the formula:

$$\text{Germination (\%)} = \frac{\text{Total number of germinated seeds}}{\text{Total number of sown seeds}} \times 100$$

Mean germination time was calculated based on the following equation of Ellis and Roberts [6].

$$MGT = \frac{\sum^{Dn}}{\sum^{n}}$$

The Germination Index was calculated by the following formula given by Kendrick and Frankland [7]:

$$\text{GI} = \frac{\text{Total germination percent}}{\text{Time}\left(\text{ hours}\right)\text{taken for 50\% germination}} \times 100$$

Survival of seedlings (%):

Surviving plants in each bed were counted at the time of recording seedling traits (height, collar diameter, etc.) four months after sowing in the nursery and the survival percent was worked out as follows:

$$\text{Survival(\%)} = \frac{\text{Total germination percent}}{\text{number of seeds germinated in the that seed source}} \times 100$$

Seedling Vigour Index (SVI):

The seedling vigour index was calculated by the given formula [8]. The seedling vigour index was used for determining the germination percentage and seedling length for each tree species:

SVI = Germination (%) × seedling length (cm)

Statistical analysis

The data were subjected to statistical analysis as Described by Panes and Sukhatme (1978). The Standard Error of difference (SE) was calculated as follows: $SE = SD / \sqrt{n}$

Where, SD = Standard Deviation

n = Sample size

Results and discussion

The results of seed germination percent of studied multipurpose tree species under nursery conditions are represented in Table 1. Significant differences ($p < 0.05$) were found among different tree species for nursery germination percent. On average, seed germination ranged from 21 to 80 percent among different tree species. The highest seed germination was recorded in *G. optiva* (80%) lowest was recorded in *Q. semecarpifolia* (21%) *B. retusa*, *B. variegata*, and *C. australis* < 50% germination. In *F. auriculata*, *Q. semecarpifolia* and *Q. floribunda* recorded >50 per cent germination (Table 1). The lowest (emergence) germination in *Q. semecarpifolia* and *Q. floribunda* may be due to the collection of immature seeds. The poor emergence of *F.auriculata* might be due to problems in the estimation of seed viability (very small seed) at the time of seed sowing and having a seed coat.

Significant ($p < 0.05$) differences were found among different tree species for mean germination time. The maximum mean germination time of 15.37 days has been recorded for *Q. semecarpifolia* and a minimum of 13.25 days was recorded in *G. optiva*. The highest MGT in *Q. semecarpifolia* and *F. auriculata* indicated late and slow germination whereas the lowest MGT was recorded in *G. optiva* species indicating

Table 1: Germination percent, mean germination time, germination index, and seedling vigour index of seven multipurpose tree species in nursery condition.

Species name	Germination%	MGT	GI	SVI
Bauhinia semla	72 ± 3.65^{a}	13.48 ± 0.31^{c}	0.16 ± 0.01^{b}	3296.25 ± 23.48^{ab}
Bauhinia variegate	75 ± 2.83^{a}	14.29 ± 0.50^{bc}	0.19 ± 0.03^{a}	2793.60 ± 21.96^{b}
Celtis australis	66 ± 0.45^{ab}	13.84 ± 0.52^{c}	0.14 ± 0.05^{bc}	2744.94 ± 17.26^{bc}
Ficus auriculata	48 ± 2.24^{b}	14.59 ± 0.93^{b}	0.07 ± 0.01^{d}	1413.12 ± 13.12^{c}
Grewia optiva	80 ± 2.35^{a}	13.25 ± 0.54^{d}	0.18 ± 0.02^{ab}	3840.80 ± 22.62^{a}
Quercus floribunda	27 ± 0.89^{c}	13.97 ± 1.00^{c}	0.06 ± 0.03^{d}	533.52 ± 5.12^{c}
Quercus semecarpifolia	21 ± 1.10^{c}	15.37 ± 1.20^{a}	0.12 ± 0.02^{c}	456.75 ± 0.53^{c}
LSD (least significance difference)	18.21	0.53	0.02	992.72

Mean values followed by the same letters are not significantly ($p < 0.05$) different.

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early and rapid germination as compared to other tree species. Mean germination time indirectly expresses the rapidity of germination as the lower the mean germination time faster the germination, which was evidenced by the average value of MGT. Thus, the seeds of species *Q. semecarpifolia* germination in 15.37 days whereas, the *Grewia optiva* process was faster, with uniform germination, and completed the germination in a minimum of 13.25 days (Table 1).

The data on the Germination Index (GI) of different multipurpose tree species revealed that the average mean GI values were significantly different among all seven tree species. On average the germination index values ranged from 0.06 to 0.19. The maximum average germination index value was recorded for *B. variegata* (0.19), whereas the minimum GI value was recorded in *Q. floribunda* (0.06) among different tree species. The corresponding higher values for the germination index represent comparatively higher germination percentages, *e.g. B. variegata* had 75% germination.

Table 1 depicts the seedling vigour index of seven multipurpose tree species. The average mean SVI values significantly differ among different tree species. The average SVI values ranged from 456.75 to 3840.80. The maximum average SVI value was recorded in *G. optiva* (3840.80), whereas the minimum seedling vigour index value was recorded in *Q. semecarpifolia* (456.75).

Table 2 predicts the periodic growth such as shoot length, collar diameter, survival percent, leaf area (cm^2) and number of leaves/ plant of the seedlings of seven multipurpose tree species revealed that the *Celtis australis* represents shoot lengths

Table 2: Periodic growth of shoot length, collar diameter, number of leaves/plant, leaf area, and survival percent of *seven multipurpose tree species* in the nursery.

		Shoot length (cm)	Collar diameter (mm)	Number of leaves/ plant	Leaf area (cm^2)	Survival %
Bauhinia semla						
Month	3	16.92 ± 1.84^{c}	2 ± 0.44^{c}	4.18 ± 0.30^{b}	169^{b}	26.39 ± 0.71
	6	21.62 ± 3.83^{bc}	5.27 ± 0.19^{c}	5.59 ± 0.23^{b}	335^{b}	23.61 ± 0.42
	9	24.13 ± 3.50^{b}	6.26 ± 0.63^{b}	7.16 ± 0.52^{b}	482^{a}	22.22 ± 0.42
	12	34.80 ± 3.85^{a}	7.04 ± 0.35^{a}	8.30 ± 0.48^{a}	556^{a}	19.44 ± 0.55
CV		12.76	16.29	5.07	169.18	7.98
Bauhinia variegata						
Month	3	25.67 ± 0.85^{b}	2.12 ± 0.49^{c}	7.64 ± 1.28^{d}	114^{c}	28.00 ± 0.55^{a}
	6	28.64 ± 3.38^{b}	4.35 ± 0.54^{b}	9.36 ± 1.45^{c}	$225b^{c}$	25.33 ± 0.45^{a}
	9	40.62 ± 4.86^{a}	5.87 ± 0.34^{ab}	7.53 ± 1.12^{b}	365^{a}	24.00 ± 0.55^{ab}
	12	43.95 ± 3.42^{a}	7.24 ± 0.23^{a}	10.32 ± 1.46^{a}	436^{a}	21.33 ± 0.42^{b}
CV		9.25	12.38	4.49	169.18	7.84
Celtis australis						
Month	3	9.21 ± 2.07^{d}	1.35 ± 1.35^{b}	3.83 ± 0.43^{c}	32.25^{b}	25.00 ± 1.58^{a}
	6	12.85 ± 3.77^{c}	2.31 ± 2.35^{b}	5.09 ± 2.88^{b}	59.25^{b}	22.92 ± 1.52^{b}
	9	19.10 ± 1.77^{b}	2.88 ± 2.88^{b}	6.54 ± 2.35^{b}	86.35^{b}	20.83 ± 1.30^{c}
	12	29.44 ± 2.77^{a}	3.75 ± 3.75^{a}	7.48 ± 2.25^{a}	170^{ab}	19.23 ± 1.52^{c}
CV		7.08	16.62	9.75	80.19	3.74
Ficus auriculata						
Month	3	22.67 ± 2.85^{c}	2.08 ± 0.37^{c}	4.16 ± 1.25^{b}	79^{c}	27.27 ± 0.55^{a}
	6	32.46 ± 5.83^{b}	3.28 ± 0.66^{b}	5.49 ± 1.18^{b}	108^{b}	$24.24 \pm 0.55a$
	9	35.75 ± 4.02^{a}	3.59 ± 0.85^{ab}	7.46 ± 2.15^{a}	158^{b}	22.73 ± 0.71^{ab}
	12	41.59 ± 5.49^{a}	4.30 ± 0.66^{a}	10.39 ± 4.16^{a}	246^{a}	22.35 ± 0.13^{b}
CV		9.60	20.72	19.63	86.09	9.68
Grewia optiva						
Month	3	29.05 ± 1.26^{d}	5.34 ± 0.68^{c}	4.66 ± 1.28^{c}	86^{b}	29.41 ± 0.45^{a}
	6	37.53 ± 1.45^{c}	6.50 ± 0.63^{b}	6.22 ± 1.45^{b}	179^{b}	29.06 ± 0.35^{a}
	9	38.90 ± 3.98^{b}	7.16 ± 0.31^{a}	4.52 ± 1.12^{ab}	285^{ab}	25.53 ± 0.45^{ab}
	12	48.01 ± 1.74^{a}	8.71 ± 0.66^{a}	6.13 ± 1.46^{a}	339^{a}	22.35 ± 0.55^{b}
CV		6.00	11.99	4.93	128.5	8.65
Quercus floribunda						
Month	3	3.72 ± 2.01^{b}	1.24 ± 0.21^{b}	2.10 ± 1.02^{b}	66.46^{c}	22.58 ± 0.45
	6	4.08 ± 2.49^{b}	1.52 ± 0.30^{b}	2.41 ± 0.72^{b}	86.52^{b}	18.45 ± 0.45
	9	4.91 ± 2.44^{a}	1.85 ± 0.31^{a}	3.06 ± 0.73^{a}	109^{a}	14.29 ± 0.55
	12	9.83 ± 3.47^{a}	$1.91 \pm 0.22a$	3.83 ± 0.59^{a}	129^{a}	10.71 ± 0.53
CV		37.40	12.96	17.83	31.76	19.17
Quercus semecarpifolia						
Month	3	5.56 ± 0.62^{c}	1.49 ± 0.26^{b}	3.65 ± 0.73^{b}	56.75^{b}	20.00 ± 0.71
	6	9.41 ± 0.51^{b}	1.86 ± 0.44^{ab}	4.40 ± 0.59^{ab}	83.24^{b}	16.00 ± 0.45
	9	11.13 ± 0.74^{a}	2.19 ± 0.24^{a}	2.19 ± 1.08^{a}	116^{b}	14.20 ± 0.55
	12	18.72 ± 0.88^{a}	2.00 ± 0.47^{a}	2.00 ± 1.43^{c}	183^{ab}	12.00 ± 0.29
CV		5.59	17.78	17.18	64.14	27.66

Mean values followed by the same letters are not significantly different. CV: Coefficient of Variation

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in the intervals of 3, 6, 9 and 12 months were 22.67 cm, 32.46 cm, 35.75 cm, 41.59 cm respectively. Significant differences ($p < 0.05$) were observed in the performance of seedling growth attributes at various stages of plant growth.

The root length of *C. australis* after one year of growth was recorded as 21.62 cm. Whereas total length of root and shoot length was accumulated as 63.21cm and the root/ shoot length ratio was 0.51cm under nursery growth. The collar diameter of *C. australis* in periodic intervals of 3, 6, 9, and 12 months was recorded as 2.08 mm, 3.28 mm, 3.59 mm, and 4.30 mm respectively. The values extended on leaf number per plant in the periodic intervals in the nursery were 4.16 cm, 5.49 cm, 7.46 cm, and 10.39 cm, respectively after 3, 6, 9, and 12 month's growth. A significant difference was observed in the performance of the number of leaves at periodic intervals. Wide variation was observed for leaf area in periodic intervals and the range of minimum and maximum values was extended from 79 cm^2 and 246 cm^2 after 3 and 12 month's growth. The data on survival percent in periodic intervals after 3, 6, 9, and 12 months in the nursery were 27.27%, 24.24%, 22.73%, and 22.35% respectively.

It has been observed that the periodic shoot length of the seedlings of Grewia *optiva* in the intervals of 3, 6, 9, and 12 months was 29.05 cm, 37.53 cm, 38.90 cm, and 48.01 cm respectively (Table 2). Significant ($p < 0.05$) differences were observed in the performance of seedling growth for shoot length, collar diameter, leaf area, and survival at various stages of plant growth in *G. optiva*. The root length of *G. optiva* was measured as 25.10 cm only after one year of growth and the total length (root and shoot) of 73.11cm was recorded and the root/ shoot length ratio was 0.52cm in the nursery growth (Table 2). The collar diameter of *G. optiva* in periodic intervals of 3, 6, 9, and 12 months was recorded as 5.34 mm, 6.50 mm, 7.16 mm, and 8.71 mm, respectively. The values of periodic data on the number of leaves per plant at periodic were extended from 4.66 cm, 6.22 cm, 4.52 cm, and 6.13 cm, respectively after 3, 6, 9, and 12 months of growth. The leaf areas of *G. optiva* seedlings at the age of 3, 6, 9, and 12 months were 86 cm^2, 179 cm^2, 285 cm^2, and 339 cm^2 respectively. The data on the survival percentage of *G. optiva* at periodic intervals was extended from 29.41%, 29.06%, 25.53%, and 22.35% respectively, after 3, 6, 9, and 12 months of growth (Table 2).

In *Bauhinia variegata*, the shoot length in periodic intervals of 3, 6, 9, and 12 months was 25.67 cm, 28.64 cm, 40.62 cm, and 43.95 cm respectively Table 2. Significant differences in the performance of seedling growth were observed for shoot length and all the studied parameters (Table 2). The root length of *B. variegata* was recorded as 22.06 cm after 12 months of growth. The total length of the root and shoot was 66.01cm and the root/ shoot length ratio was 0.50 cm after 12 months of growth (Table 2). Collar diameters of *B. variegata* were observed as 2.12 mm, 4.35 mm, 5.87 mm, and 7.24 mm after 3, 6, 9, and 12 months of growth respectively. The periodic data on leaf number per plant was 7.64 cm, 9.36 cm, 7.53 cm, and 10.32 cm respectively, after 3, 6, 9, and 12 month's growth. The leaf area of *B. variegata* was observed as 114 cm^2, 225 cm^2, 365 cm^2, and 436 cm^2 after 3, 6, 9, and 12 month's growth respectively. The data on survival percentage was extended from 28.00%, 25.33%, 24.00%, and 21.33% respectively, after 3, 6, 9, and 12 months of growth. Significant differences were recorded for survival percentages at different periodic intervals.

Table 2 depicts the data on shoot length, collar diameter, number of leaves, and leaf area of *Bauhinia semla* after different growth intervals. Significant ($p < 0.05$) differences in the performance of seedling growth were observed for shoot length at various stages of plant growth. The shoot length of *B. semla* in periodic intervals of 3, 6, 9, and 12 months was 16.92 cm, 21.62 cm, 24.13 cm, and 34.80 cm respectively. Table 2 represents the root length, total length, and root/ shoot length ratio of *B. semla*. A root length of 23.40 cm was recorded after one year's growth. While the total length was 62.02 cm and the root/ shoot length ratio was observed as 0.60 cm after 12 months of growth in nursery condition.

The collar diameter of *B. semla* was recorded as 2 mm, 2.27 mm, 3.26 mm, and 4.04 mm at periodic intervals of 3, 6, 9, and 12 months, respectively. The values extended for leaf number per plant in periodic intervals in the nursery were 4.18 cm, 5.59 cm, 7.16 cm, and 8.30 cm after 3, 6, 9, and 12 months of growth respectively. The leaf area of *B. semla* was recorded as 169 cm^2, 335 cm^2, 482 cm^2, and 556 cm^2 at periodic growth of 3, 6, 9, and 12 months of the seedlings, respectively in a nursery.

The periodic data on the survival percentage of *B. semla* was extended from 26.39%, 23.61%, 22.22%, and 19.44% respectively, after 3, 6, 9, and 12 months of growth. The results of shoot length, collar diameter, number of leaves, and leaf area of *Ficus auriculata* are given in Table 2. It has been observed that in *F. auriculata* shoot length in the periodic intervals of 3, 6, 9, and 12 months were 9.21 cm, 12.85 cm, 19.10 cm, and 29.44 cm respectively. The root length of *F. auriculata* was observed as 20.13 cm after one year's growth. The total length of the seedling was 49.57 cm and the root/ shoot length ratio was recorded as 0.68 cm at the age of one year in the nursery (Table 2).

The collar diameter of *F. auriculata* seedlings in the nursery was recorded as 1.35 mm, 2.31 mm, 2.88 mm, and 3.75 mm at periodic intervals of 3, 6, 9, and 12 months, respectively. Periodic data on leaf number per plant was observed as 3.83 cm, 5.09 cm, 6.54 cm, and 7.48 cm, after 3, 6, 9, and 12 month's growth respectively. The leaf area of *F. auriculata* was recorded as 32.25 cm^2, 59.25 cm^2, 86.35 cm^2, and 170 cm^2 at the ages of 3, 6, 9, and 12 months respectively (Table 2).

The survival percentage of the seedlings of *F. auriculata* was recorded as 25.00%, 22.92%, 20.83%, and 19.23%, respectively after 3, 6, 9, and 12 months. It has been recorded that shoot length in *Quercus semecarpifolia* was 5.56 cm, 9.41 cm, 12.84 cm, and 21.75 cm at periodic intervals of 3, 6, 9, and 12 months, respectively. Table 3 revealed that the root length of *Q. semecarpifolia* was 17.98 cm after 12 months of growth. The total length of the seedling was 39.73 cm and the root/ shoot length ratio was 0.82 cm after 12 months of growth in the nursery. Significant ($p < 0.05$) differences were recorded

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for collar diameter at various stages of plant growth. The collar diameter of *Q. semecarpifolia* seedlings in the nursery was recorded as 1.10 mm, 1.53 mm, and 2.71 mm at 3, 6, 9, and 12 months of periodic intervals, respectively (Table 3). The periodic data on leaf number per plant was 2.69 cm, 3.24 cm, 3.68 cm, and 4.36 cm, respectively after 3, 6, 9, and 12 month's growth. The leaf area of *Q. semecarpifolia* was found as 56.75 cm^2, 83.24 cm^2, 116 cm^2, and 183 cm^2 after 3, 6, 9, and 12 month's growth respectively. Survival percentage of 20.00%, 16.00%, 14.20%, and 12.00% in *Q. semecarpifolia* was recorded after 3, 6, 9, and 12 months of growth, respectively.

The results of 25 random seedlings' seedling growth performance of *Quercus floribunda* at different periodic intervals are given in Table 2. The shoot length of *Q. floribunda* was 5.46 cm, 8.03 cm, 12.12 cm, and 19.76 cm after 3, 6, 9, and 12 months of growth respectively (Table 2). The collar diameter of *Q. floribunda* seedlings was recorded as 1.16 mm, 1.44 mm, 2.10 mm, and 2.56 mm respectively after 3, 6, 9, and 12 months of growth. Significant differences in growth performance were recorded in collar diameter at various stages of plant growth (Table 2). The root length of *Q. floribunda* was observed as 15.84 cm at 12 months of growth. The total length of seedlings was 35.6 cm and the root/ shoot length ratio was 0.80 cm in the nursery (Table 3)

The data on leaf number per plant in periodic intervals under nursery was 2.10 cm, 2.41 cm, 3.06 cm, and 3.88 cm after 3, 6, 9, and 12 months of growth, respectively. Nursery growth of *Q. floribunda* seedlings further revealed that the leaf area at the age of 3, 6, 9, and 12 months growth was 66.46 cm^2, 86.52 cm^2, 109 cm^2, and 129 cm^2 respectively (Table 2). Survival percentage of *Q. floribunda* seedlings was recorded as 22.58, 18.45, 14.29, and 10.71 % respectively at 3, 6, 9, and 12 months of growth. Significant ($p < 0.05$) differences were recorded in growth performance for survival percentage at periodic intervals (Table 2).

Table 4 represents the data on the biomass production (dry weight basis) after 12 months of growth of *Celtis australis*. Twenty-five random seedlings were selected on periodic months 3, 6,9,12 for each replication. Shoot dry weight, leaves dry weight, root dry weights, and root and shoot dry weight were 2.18 g, 1.2 g, 2.08 g, and 0.95 g, respectively and the total dry weight was 5.46 g/plant after 12 months of growth.

Shoot dry weight and leaves dry weight of *Bauhinia variegata* were recorded as 2.36 g and 1.16 g, respectively after 12 months of growth. Root dry weight and root/shoot dry weight were recorded as 2.1 g and 0.88 g respectively and the total dry weight of seedling was 5.62 g after 12 months of growth (Table 4).

Table 4 depicts the data on the biomass production of 12 months of seedling growth of *B. semla*. Shoot dry weight and leaves dry weight were recorded as 1.59 and 1.06 g, while, the root dry weight and root/shoot dry weight ratio were recorded as 2.55 and 1.6 g, respectively. The total dry weight of *Bauhinia semla* seedlings after 12 months of growth was 5.2 g.

Table 3: Root length, shoot length, and root/shoot length ratio of one-year-old seven multiple tree species.

Species	Root length (cm)	Shoot length (cm)	Root/ shoot ratio (cm)
Bauhinia semla	23.4	62.02	0.60
Bauhinia variegate	22.06	66.01	0.50
Celtis australis	21.62	63.21	0.51
Ficus auriculata	20.13	49.57	0.68
Grewia optiva	25.1	73.11	0.52
Quercus floribunda	15.84	35.60	0.80
Quercus semecarpifolia	17.98	39.73	0.82

Table 4: Variations with respect to root-shoot and leave dry weight (g/ plant) of the studied species.

Name of Species	Shoot dry weight	Leaves dry weight	Root dry weight	Root/shoot dry weight	Total dry weight
Bauhinia semla	1.59	1.06	2.55	1.6	5.2
Bauhinia variegata	2.6	1.16	2.1	0.88	5.62
Celtis australis	2.18	1.2	2.08	0.95	5.46
Ficus auriculata	1.34	0.38	1.08	0.81	2.8
Grewia optiva	3.21	1.14	2.12	0.66	6.47
Q. floribunda	1.24	0.79	1.18	0.95	3.21
Q. semecarpifolia	1.15	0.24	1.04	0.91	2.43

In *Grewia optiva* shoot dry weight was 3.21 g, the leaves' dry weight was 1.14 g, the root's dry weight was 2.12 g, the root and shoot dry weight was 0.66 g, and the total dry weight of the shoot, the leaves and root was 6.47 g (Table 4). In *Ficus auriculata*, the shoot dry weight was estimated as 1.34 g, the leaves dry weight was 0.38 g, the root dry weight was 1.08 g, and root and shoot dry weight was 0.81 g, and the total dry weight of the shoot, leaves, and root was 2.8 g (Table 4). After 12 months of growth, the shoot, leaves, root, and root/shoot dry weight of *Quercus semecarpifolia* was recorded as 1.15 g, 0.24 g, 1.04 g, and 0.91 g, respectively. The total dry weight of seedlings after 12 months of growth was recorded as 2.43 g (Table 4). Table 4 represents the shoot dry weight of 1.24 g, leaves dry weight was 0.79 g, root dry weight of 1.18 g, and root/shoot dry weight of 0.95 g of *Quercus floribunda*. The total dry weight of the seedling was recorded as 3.21 g after 12 months of growth. Variations in seed germination and initial growth performance of eight multipurpose trees were recorded by Mahmud, et al. 2005 [2]. These findings conformed to the results of the present study. Variation in seed germination and growth performance of tree species selected for the present investigation due to the species-specific. These data are not compared because the growth and seed germination depend on the nature of seed physiology and their germination behavior as well as the initial growth characteristics of tree species. The study of Sarmin, et al. [9] reported that seedling growths of four Multipurpose Tree species (MPTs) (two leguminous and two non-leguminous) were varied in nursery conditions. Leguminous species showed better growth performance than the non-legume species. The results of an investigation conducted by Ale metal, 2012 reveal that the germination and growth performance of leguminous tree species varied under nursery conditions. Seed germination

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and growth were significantly influenced by the time of seed sowing. Because seed germination temperature depends on and the favorable temperature for seed germination varies from tree species to tree species. These findings conformed to the study of Yucedeg and Gultikin [10]. The results of their study showed that seed sowing in the early spring was more effective on germination percentages of all the species. Similar results were recorded in the present study. The seed emergence and seedling growth attributes were significantly varied due to the variation in seed size, time of collection and source of mother plants where the seed was collected, seed processing, and their storage methods if the time of seed collection was earlier than the time of seed sowing in the nursery. In the Garhwal Himalaya region, different researcher evaluated the variation in Provenance (seed source) in seed traits, their germination, and growth attributes at the nursery stage and found that all these traits and attributes significantly varied [11–14].

Conclusion

The present investigation was carried out for the evolution of emergency survival and growth of these multipurpose tree species. Significant variations were found in the performances of seedling growth for leaf area in periodic intervals and it is also noted that a significant difference was found in the performance of seedling growth for survival percentage at periodic intervals.

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