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Effect of Drupe size and Earliness of Germination on Root growth potential of Teak (*Tectona grandis* linn.f.) Seedlings

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Abstract

The present study was conducted to find the influence of age of the seedling, drupe size and earliness of germination on the root growth potential of teak stumps. Teak drupes graded into diameter classes of 9-12, 12-15 and 15-18 mm, germinated and weekly germinants up to four weeks were planted in split plot design with drupe size as main plot and time of emergence as the sub plots. The drupe size and earliness of germination significantly influenced the seedling traits. Root growth potential of the stumps prepared from six and twelve month old seedlings were assessed. The analysis of variance of root growth attributes indicated that the interaction effects of drupe size, earliness of germination and age was significant in the case of biomass production of lateral roots (p=0.01). In stumps from six month and one year old seedlings, the highest root biomass observed in the stumps belonging to large size grade and first week of germinants. While selecting the seedlings for stump preparation, screening of seedlings based on the drupe size and earliness of germination as well as using one year old seedlings is essential or the successful establishment in the field.

Keywords: *Tectona grandis*, seed size, earliness of germination, root growth potential.

Introduction

Teak is a high value timber species originated from South East Asia and much prized for its technological characters as well as aesthetic beauty of wood; it is also well known for its durability. Obtaining superior quality planting stock is the crucial factor in initiating the large-scale teak plantation programmes. Stump planting is the centuries old technique in artificial regeneration of teak and root initiation potential of the stumps is the key factor for its early and easy establishment in the field. Root growth potential of the seedlings is an estimate of the ability of a seedling to put forth and elongate roots when exposed to congenial environment[1]. We studied the natural variability of teak (*Tectona grandis* Linn.f.) drupes belonging to different plantations in Nilambur Division, Kerala[2]. Drupe characteristics and drupe size were found to be positively correlated with the germination and seedling performance[3-5]. The effect of earliness of germination on seedling performance of teak is also established[6-7]. The present study was sought to find the influence of age of the seedlings, seed size and earliness of germination on the root growth potential of teak.

Material and Methods

The study was conducted at College of Forestry nursery (40 m msl altitude, 10°32'N latitude and 76°26'E longitude), Kerala Agricultural University, Kerala, during June 2002 and June 2003. The area experiences a warm and humid climate with distinct rainy season. The source of seed was the Cherupuzha (1971) plantation in Karulai range of Nilambur Forest Division, Kerala. The drupes were graded using the sieves of diameter 9 mm, 12 mm and 15 and designated as small, medium and large classes respectively. The drupes below 9 mm and above 18 mm diameter were discarded from the study[2]. Drupes were pre-treated by termites which aid to remove the mesocarp of the seeds and sown in the standard nursery beds[8]. The germinated drupes of different size grades were pricked out at weekly intervals and polypotted. After six and twelfth months after planting, 12 seedlings from each size grade and time of germination (first to fourth week) were randomly selected for root growth potential studies. The growth attributes of the seedlings selected for the study is presented in the table 1 and 2. Only seedlings with a single taproot were selected and the plants with forked taproots were discarded. The selected plants were pulled out with root system intact, shoot portion was detached with a sharp knife, leaving three cm portion of the shoot. From the root system, whole laterals were cut off without damage to the bark of the taproot and the taproot was cut at a distance of 20 to 22 cm from the collar. The stumps were planted in the poly-bags (gauge 300) of size 17 x 14 inches filled with finely sieved river sand and they were transferred to green house. After 28 days, stumps were taken out carefully with the newly produced root system by splitting open the bags and washed thoroughly in running water. The washed seedlings were spread out on a table and the following observations were recorded. The number and length of fresh sprouts and number of leaves produced per stump were recorded. The number and length of the longest lateral roots were recorded and the tertiary roots were counted. The dry weight of the lateral roots also was determined.

The data on seedling selected for the study were analyzed taking the repeated measurements as subplot factor in a split plot design. The data on root growth potential of the stumps were subjected to three factor Analysis of Variance in SPSS-16. The treatment means were compared with least significant difference (lsd). Pearson's bivariate correlation coefficient was determined between the root growth potential of the stumps and the seedling characters[9].

Results and Discussion

The tables 1 and 2 depicts the height, collar diameter, length of taproot, number of lateral roots and length of the longest lateral root of the seedlings selected for the root growth potential studies. The growth attributes of the teak seedlings at sixth and twelfth month were significantly influenced by the size grading and earliness of germination. At sixth month after planting, the seed size as well as earliness of germination significantly influenced the height, collar diameter, and taproot length only at one percent level. The height, root length, collar diameter, number of lateral root of and length of the longest lateral root of the seedlings ranged from 16.38 - 10.20 cm, 28.61-23.81cm, 5.25 -3.30 cm 31.67-22.58 and 12.58-7.13 cm respectively. At 12th month, analysis of variance revealed the significant influence of seed size on height, length of the taproot, collar diameter and number of lateral roots of the seedlings (p=0.01). Most of the seedling characters significantly increased with increase in seed size. The differences due to time of germination were not much observable and no definite trend was obtained. The height, root length, collar diameter, number of lateral roots and length of the longest lateral root of the seedlings ranged from 52.22 - 29.57 cm, 37.17-31.30 cm, 8.24 -6.01 cm 70.75-39.33 and 9.63 – 6.87 cm respectively.

Root growth potential attributes of the stumps prepared from six month and one year old seedlings as influenced by the drupe size and earliness of germination is given in the table 3. The analysis of variance revealed that the interaction effects of drupe size, earliness of germination and age of the seedling was significant only in the case of biomass of lateral roots (p=0.01). The figure 1 and 2 depict the root biomass of the stumps at sixth and twelfth month. In stumps from both six month and 12 month old seedlings, the highest root biomass observed in the stumps belonging to large size grade and first week of germination (3.10 and 77.29 mg respectively). No statistically significant difference was observed in number of sprouts and lateral roots and lateral root length due to any of these factors.

Table-1
The growth attributes of the six month old seedlings belonging to different size grade and time of germination

Seedling character	Time of germination (week)	Seed size		
		Large	Medium	Small
Height (cm)	First	16.38^{a}	14.10^{a}	10.78^{a}
	Second	14.30^{b}	14.20^{a}	11.79^{ab}
	Third	15.02^{ab}	10.20^{b}	10.33^{ab}
	fourth	13.65^{b}	14.78^{a}	12.88^{b}
Collar diameter (mm)	First	5.25^{a}	3.93^{ab}	3.36^{a}
	Second	4.46^{ab}	4.13^{b}	3.30^{a}
	Third	4.87^{bc}	3.83^{ab}	3.39^{a}
	fourth	4.28^{a}	3.54^{a}	3.73^{a}
Taproot length (cm)	First	28.61^{a}	27.13^{bc}	27.26^{b}
	Second	28.35^{a}	29.46^{c}	27.84^{b}
	Third	26.37^{ab}	26.13^{a}	23.81^{a}
	fourth	25.08^{b}	25.16^{ab}	25.93^{ab}
No. of lateral roots	First	30.58^{b}	29.08^{a}	29.25^{b}
	Second	31.67^{b}	28.25^{a}	25.17^{a}
	Third	27.33^{a}	25.42^{a}	22.58^{a}
	fourth	25.50^{a}	26.83^{a}	26.17^{a}
Length of the longest lateral root (mm)	First	9.14^{a}	9.21^{ab}	8.58^{b}
	Second	9.01^{a}	8.13^{a}	7.13^{a}
	Third	12.58^{b}	10.57^{b}	8.93^{b}
	fourth	9.2^{a}	9.58^{ab}	7.71^{ab}

Values with similar superscript within a column are homogenous

Table-2
The growth attributes of the 12 month old seedlings belonging to different size grade and time of germination

Seedling character	Time of germination (week)	Seed size grade (mm)		
		Large	Medium	Small
Height (cm)	First	46.64[a]	36.63[a]	33.95[ab]
	Second	49.93[a]	36.09[a]	38.93[b]
	Third	48.03[a]	35.80[a]	31.76[a]
	fourth	52.22[a]	35.57[a]	29.57[a]
Collar diameter (mm)	First	8.09[a]	7.41[a]	6.21[a]
	Second	8.24[a]	7.68[a]	6.01[a]
	Third	7.84[a]	7.04[a]	6.07[a]
	fourth	7.94[a]	6.92[a]	6.32[a]
Taproot length (cm)	First	36.63[a]	37.17[a]	31.30[a]
	Second	36.09[a]	35.45[a]	31.87[a]
	Third	35.80[a]	34.60[a]	32.53[a]
	fourth	35.57[a]	36.02[a]	34.31[a]
Number of lateral roots	First	55.83[a]	51.67[a]	43.58[a]
	Second	70.75[b]	49.92[a]	39.33[a]
	Third	58.75[ab]	50.58[a]	39.42[a]
	fourth	57.33[ab]	51.33[a]	41.17[a]
Length of the longest lateral root (mm)	First	8.75[a]	9.00[a]	7.59[a]
	Second	8.08[a]	9.63[a]	8.16[a]
	Third	9.45[a]	8.64[a]	7.63[a]
	fourth	9.00[a]	6.87[a]	9.01[a]

Values with similar superscript within a column are homogenous.

Table- 3
The root growth potential of the stumps as influenced by size grading, earliness of germination and age of the seedlings

Age (month)	Size grade	Time of germination (week)	No of sprouts	Length of sprouts(cm)	No of leaves	Lateral roots per stump	Tertiary roots per stump	Length of lateral root (cm)
6	Large	First	1.08	3.11	4.33	1.75	16.50	2.08
		Second	1.50	3.61	4.75	5.25	36.67	2.11
		Third	1.00	3.13	3.50	3.17	26.08	3.02
		fourth	1.08	2.12	3.83	1.42	14.00	7.68
	Medium	First	1.25	1.91	3.17	2.42	11.83	2.24
		Second	1.25	3.71	4.42	6.25	57.83	2.59
		Third	1.08	2.98	4.67	3.50	27.83	4.09
		fourth	1.00	3.31	3.83	2.75	16.58	2.46
	Small	First	1.00	2.74	3.67	1.83	13.50	1.93
		Second	1.25	2.86	4.17	5.08	30.17	1.95
		Third	1.08	3.09	4.17	3.33	22.17	3.21
		fourth	0.92	2.18	3.33	1.33	10.92	1.78
12	Large	1	1.08	4.22	5.00	1.92	34.67	3.24
		2	1.42	3.61	4.25	3.00	31.67	3.84
		3	1.17	3.13	3.83	2.75	28.00	3.02
		4	1.17	2.12	3.42	1.42	23.92	2.82
	Medium	1	1.50	1.91	3.33	2.50	23.08	2.24
		2	1.17	3.71	4.42	4.08	38.67	2.19
		3	1.08	2.98	4.67	3.00	22.08	4.09
		4	1.00	3.31	3.83	2.58	20.25	2.46
	Small	1	1.33	3.52	3.83	2.25	21.42	2.53
		2	1.33	3.13	4.50	4.50	22.58	2.18
		3	1.17	3.39	4.33	2.67	23.75	3.57
		4	1.08	2.33	4.33	3.58	15.50	1.95

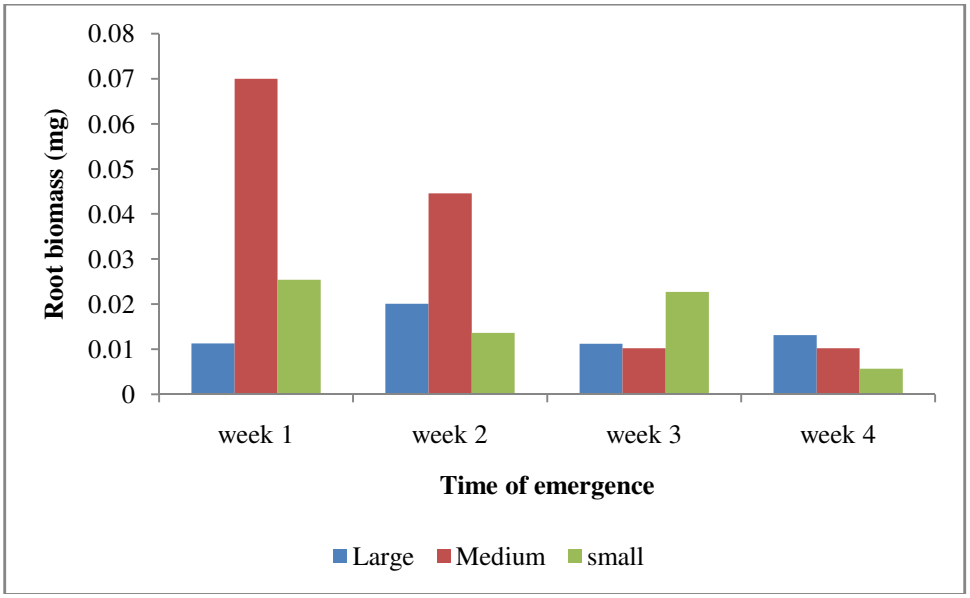

Figure-1
The root biomass of the sprouts at six month old seedlings as influenced by size grading and earliness of germination

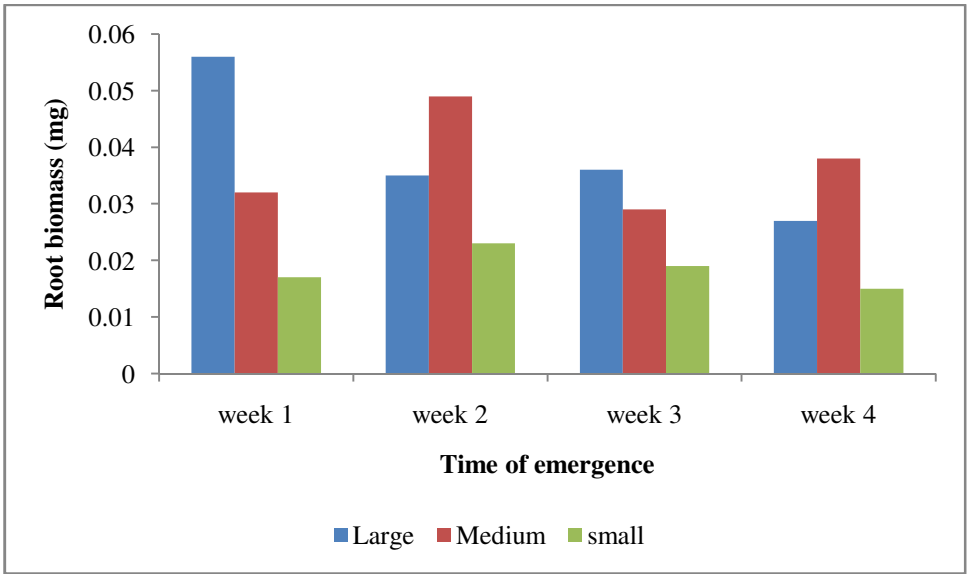

Figure-2
The root biomass of the sprouts at twelve month old seedlings as influenced by size grading and earliness of germination

The length of sprouts of the stumps varied mainly due to interaction effect of age of seedling and earliness of germination ($p=0.01$). The second week germinants followed by the first week has the highest average sprout length (3.39 and 2.59 cm, respectively at sixth month and 3.48 and 3.21 cm, respectively at twelfth month). Only the interaction effect of seed size and earliness of germination was significant in number of leaves produced per stumps. First week germinants (4.67) followed by second week (4.50) belonging to large size grade recorded a higher number of leaves. The number of tertiary roots per stumps was mainly influenced by interaction effects of age of the seedlings x earliness of germination and drupe size x earliness of germination. The second week germinants belonging to large size grade recorded a higher number of lateral roots (34.16) on sixth month old stumps. Similarly, the second week germinants belonging of 12 month old seedlings recorded a higher number of tertiary roots (41.55) in the one year old stumps. In context of seed size and time of germination, the second week germinants belonging to large size grade recorded a higher number of tertiary roots (34.16). Table 4 shows the values of correlation coefficient among the growth potential of the stumps and seedling characters. The seedling height, root length and collar diameter highly positively correlated with dry weight of the lateral roots (0.836, 0.789 and 0.854 respectively).

Table- 4
Correlation matrix obtained among the seedling attributes and root growth potential attributes

RGP characters / Seedling characters	No of sprouts	Length of sprouts(cm)	No of leaves	Lateral roots per stump	Tertiary roots per stump	length of lateral roots (cm)	Dry weight of lateral roots(mg)
Seedling height (cm)	.182	.042	-.048	-.098	.182	-.125	.836**
Root length (cm)	.087	.067	.004	-.115	.067	-.095	.789**
Collar diameter (mm)	.115	.113	-.013	-.116	.087	-.106	.854**
Number of lateral roots	.044	.024	.061	.090	.111	.039	-.143
Length of the longest lateral root (mm)	-.066	.081	.022	.127	.150	.051	-.005

Root growth potential (RGP) is the ability of a tree seedling to initiate and elongate roots when placed into an environment favorable for root growth[1]. The magnitude of RGP is often related with survival and even growth performance, of the seedling after out planting. Growth potential of the stumps is mostly used to test the seedling quality and which was started by Stone and his colleagues at Berkeley in 1950's[10-11]. Provenance evaluation for root growth potential teak stumps indicate that the attributes like number of lateral and tertiary roots, lateral root length its dry weight was highly variable[12]. The seedlings from Nilambur and Malayattur provenances were superior in this respect, while the Trichur produced the lowest mean values. In the present investigations with seeds of Nilambur provenance, total biomass of the lateral roots of the stumps varied significantly due to age of seedlings, drupe size and earliness of germination. Although the root dimensions and number did not vary significantly due to these factors, the total biomass of the roots was higher in one year old seedlings. The seedling characters also showed a high positive correlation with the biomass of the roots. The results obtained the present investigation was in conformity with the findings that to produce healthy stumps, grading of teak stumps based on diameter and removal of inferior grown seedlings in the nursery bed are essential for successful establishment in the field[13]. In contrary, there was no correlation between fruit size and seedling size or fruit size with stump size and the sprouting percentage of the stumps was not affected by the fruit size[14].

Conclusion

Traditionally, one year old seedlings are used to prepare the stumps in teak nurseries. Sometimes, deliberately or not, the inferior or immature teak seedlings are also included along with the healthy and mature seedlings during stump preparation. This may effect the quality of the stumps and thereby the establishment of them in the field. The present investigation indicates that the highest root growth potential is observed when one year old seedlings are used to prepare the stumps than the immature six month old seedlings. The size of seed and earliness of germination is found to influence the vigour of the seedlings in the initial stages of growth. The effect of seed size and earliness of germination is found to be carried over to the root growth potential of the stumps also. Hence, while selecting the seedlings for stump preparation, screening of seedlings based on the drupe size grades and earliness of germination as well as using the one year old seedlings has to be taken into consideration for the successful establishment in the field.

References

1. Ritchie G.A. Assessing seedling quality; In: Forest Nursery Manual: Production of bareroot seedlings (Eds. M.L. Duryea and T.D. Landis), Martinus Nijhoff/ Dr. W. Junk Publishers, for Forest Research Laboratory, Oregon State University, Corvallis, 243-259, (**1984)**

2. Jijeesh C.M. and Sudhakara K. Variations in number of seeds the physical characteristics of teak (*Tectona grandis* Linn.f.) fruits of Nilambur Forest Division, Kerala, *Seed Research*, **35**, 25-33 **(2007)**

3. Manonmani V. and Vanangamudi K. Effect of seed source and size on seed and stump quality of teak (*Tectona grandis* Linn.f.), *Seed Research*, **31**, 180-185 (**2003)**

4. Sudhakara K and Jijeesh C. M. Effect of germination conditions, grading and storage of teak (*Tectona grandis* Linn.f) drupes on the germination parameters, *Indian Forester***, 134**, 241-249 (**2008)**

5. Ahirwar J. R. 2012. Effect of seed size and weight on seed germination of Alangium lamarckii, *Research Journal of Recent Sciences*, **1(ISC-2011)**, 320-322 **(2012)**

6. Jijeesh C. M. and Sudhakara K. Effect of drupe size and earliness of germination on the chlorophyll content and chlorophyll stability index of teak (Tectona grandis Lin.f.), National seminar on physiological and molecular

approaches for the improvement of Agricultural, Horticultural and Forestry crops, November 28-30, Kerala Agricultural University, Thrissur, Kerala (**2006**).

7. Jijeesh C. M. and Sudhakara K. Effect of earliness in germination on seedling attributes of teak (*Tectona grandis* Linn. f.). 22nd Kerla Science Congress, Kerala State Council for Science & Technology, Govt of Kerala and Department of Science and Technology, Govt of India, 28-31, January 2010, KFRI, Peechi (**2010)**

8. Chacko K. C**.** Termite aided mesocarp removal of teak (*Tectona grandis* Linn.f.) fruits for germination and cost effective seed handling, *Indian Forester*, **124,** 134-140 (**1998)**

9. Snedecor G. W. and Cohran W. G. Statistical Methods*,* The Iowa State University Press, USA, p.593, **(1980)**

10. Stone E.C. and Jenkinson J. L. Influence of soil water on root growth capacity of Ponderosa pine transplants. *For. Sci.,* **16**, 230-239 (**1970)**

11. Stone, E.C. and Schubert, G.H. The physiological condition of Ponderosa pine (*Pinus ponderosa* Laws.) planting stock as it affects survival after cold storage. *J. For.,* **57**, 837-841**(1959)**

12. Jayasankar S., Babu L. C. and Sudhakara K. Evaluation of provenances for seedling attributes in teak (Tectona grandis Linn.F.). *Silvae Genetica* **48,** 3–4 **(1999)**

13. Sardar M. G. and subramanian K. Modern teak nursery management in Forest Development Corporation Maharashtra Ltd. *Teak*. Proceedings in international teak symposium. Dec 2-4. Thiruvananthapuram, Kerala **(1991)**

14. Suresh K. K., Jambulingam R. and Sekar, I. Effect of fruit size and sowing density on quality and recovery of stumps in *Tectona grandis* (Linn.F.), *Int. Tree Crop.* J., **9**, 195-202 **(1998)**