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Assessment of Variation in Planting Stock Quality of Open Pollinated Seeds of Teak Clones

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ABSTRACT

The investigation was carried out on 25 teak clones of Orissa, India, to find out the variation in growth and quality of planting stock raised from open pollinated seeds. The clonal trees are of 30-year old and at a spacing of 6m x 6m in the seed orchard at Silvicultural Research Station, Koshala, Angul, Oriss. The seeds were collected in month of January, 2014. After pre-sowing treatment, the seeds were sown in forest nursery in first week of April, 2014. The growth and quality parameters of seedlings were studied at 3-month interval from the date of sowing for nine months till the deciduous phase started. The collar diameter, height, shoot biomass, root biomass, total biomass and quality of seedlings varied significantly among clones. All the parameters progressively increased with age. At all ages ORANP-17 excelled in all parameters closely followed by ORANP-16. At 9 month age the range of variation among clones was: 0.53-0.95 cm collar diameter, 20.06-50.02 cm height, 6.26-22.19 g shoot biomass, 5.33-18.93 g root biomass, 11.88-41.12 g total biomass and 2.37-6.39 quality index. ORAN-2 produced lowest quality planting stock among the clones studied.

Keywords:

Clone, quality planting stock, Teak

INTRODUCTION

Teak (*Tectona grandis* Linn. f.) is considered as king of Indian timbers. It is the principal timber tree of Peninsular India, Myanmar, Indonesia and Thailand and one of the most important timbers of the world. The reputation of teak timber is due to its matchless combination of qualities like resistance to termite, fungus,weather, lightness with strength, attractiveness, workability and seasoning capacity without splitting, cracking, warping or materially altering shape. It is aptly said that "there is virtually no use to which timber can be put for which teak cannot be employed" (Kadambi 1993). Teak is paragon among Indian timbers because of its versatile use, easy workability and consistent resilience. It is considered second to none for ship construction, excellent for all types of constructions, both for luxurious interior fittings and expensive furniture. It is a suitable timber for shutters, railway coaches, lorry making, etc. (Luna 2005).

Teak is indigenous in peninsular of India, north-eastern drier part of Java and other islands

of Indian Archipelago (Brandis 1906). It is one of the most valuable and widely planted tree species in South Asia including India. About 94 per cent of global teak plantation lies in tropical Asia, with the major chunk (44 per cent) in India (Pandey and Brown 2000). This is the most widely planted species in India. Every year about 50000 hectares are planted with teak in India (Subramanian et al. 2000). However, the productivity of Teak in India is very low. It has been reported that the average productivity of teak in the state of Kerala is 2.85 m^3/ha/year over a 53-year rotation. The productivity is still low in drier areas of other states. This is very low in comparison with other teak growing countries. There are various factors responsible for it and one of the most important factors is the quality of planting stock. In most of teak plantations in India, the planting stocks used are non-descriptive and not of good quality. Here an attempt has been taken to know the quality of planting stock raised from open pollinated seeds of some teak clones.

MATERIALS AND METHODS

The experiment was carried out during 2014-2015 to know the quality of planting stock raised from open pollinated seeds of 25 teak clones in Orissa, India. The seeds were collected from a 30 year old clonal seed orchard of teak established at Silvicultural Research Station, Koshala, Angul, Orissa. The seed orchard is located at 21°01'17.8"N longitude and 84°55'19.6"E latitude at an altitude of 440 m amsl. The area falls under tropical wet and dry climate having average annual rainfall of 1421mm. The clonal seed orchardhave been raised at a spacing of 6m x 6m under Latin Square Design with 25 replications. The clones are: ORANP-8, ORANP-9, ORANP-10, ORANP-12, ORANP-13, ORANP-14, ORANP-15, ORANP-16, ORANP-17, ORANP-18, ORANP-21, ORPUB-15, ORPUB-17, ORPUB-19, ORPUB-22, ORPUB-23, ORPUB-24, ORPUB-26, ORPUB-30, ORANR-2, ORANR-3, ORANR-4, ORANR-6, ORAN-1 and ORAN-2.

The ripe seeds were collected in the month of January, 2014 from the trees of different clones and brought to Forest nursery of Orissa University of Agriculture and Technology, Bhubaneswar, Orissa for raising planting stock. The nursery trial site is located at 20°15'N longitude and 85°52'E latitude with an altitude of 25.9 m amsl. The area has warm and moist climate having average annual rainfall of 1494 mm. In the second week of March, 2014 the seeds were subjected to pre-sowing treatment of alternate soaking and drying for three weeks. The treated seeds were sown in first week of April, 2014 in the raised nursery beds in lines of 10cm apart and after germination 25 number of seedlings were maintained per square meter. The nursery trial was laid out in Complete Randomised Design with 25 replications. The watering and intercultural operations were carried out regularly. The growth and quality parameters of seedlings were recorded at 3-month interval from the date of sowing for nine months till the deciduous phase started. The quality index of planting stock was determined as per the formula given by Dickson et al. (1960) given below.

$$Q[- \frac{\text{Seedling dry weight(g)}}{\frac{\text{Height (cm)}}{\text{Diameter(mm)}} + \frac{\text{Shoot dry weight(g)}}{\text{Root dry weight(g)}}}$$

RESULTS AND DISCUSSION

The variation in planting stock quality of different teak clones studied in terms of diameter growth, height growth, biomass and quality indexis presented in Table 1-3. The collar diameter of seedlings at 3, 6 and 9 month age differed significantly among the clones (Table 1). In all three assessments, it was observed that ORANP-1717 exhibited the highest collar diameter growth which is significantly higher over others followed by ORANP-16. The lowest values were recorded under ORAN-2. Among different clones it varied from 0.22 to 0.54cm at three month, 0.41 to 0.82cm at six month and 0.53 to 0.95 cm at nine month age. In all clones, the collar diameter increased progressively towards higher age.

Table 1. Collar diameter and height growth of seedlings from open pollinated seeds of different teak clones.

Serial No.	Clone ID	Collar Diameter (cm)			Height growth (cm)		
		3-MAS	6-MAS	9-MAS	3-MAS	6-MAS	9-MAS
1	ORANP-8	0.31	0.51	0.68	15.02	21.68	26.48
2	ORANP-9	0.26	0.42	0.64	12.36	17.38	20.76
3	ORANP-10	0.34	0.56	0.74	18.96	26.82	32.12
4	ORANP-12	0.33	0.56	0.72	15.66	22.86	27.75
5	ORANP-13	0.30	0.51	0.64	15.66	22.84	27.72
6	ORANP-14	0.38	0.60	0.72	19.48	23.28	31.48
7	ORANP-15	0.36	0.58	0.70	15.44	21.88	26.24
8	ORANP-16	0.48	0.76	0.90	26.36	38.42	46.37
9	ORANP-17	0.54	0.82	0.95	28.66	41.44	50.02
10	ORANP-18	0.32	0.56	0.70	19.34	26.52	31.32
11	ORANP-21	0.30	0.50	0.68	15.04	21.72	26.22
12	ORPUB-15	0.26	0.44	0.56	12.66	17.76	21.24
13	ORPUB-17	0.34	0.58	0.72	19.48	26.56	31.44
14	ORPUB-19	0.24	0.42	0.56	12.22	17.12	20.24
15	ORPUB-22	0.32	0.54	0.82	19.48	26.48	31.24
16	ORPUB-23	0.40	0.66	0.80	20.36	27.38	32.18
17	ORPUB-24	0.31	0.52	0.70	19.32	24.88	32.24
18	ORPUB-26	0.31	0.52	0.71	19.28	26.94	32.12
19	ORPUB-30	0.30	0.50	0.65	12.84	18.08	21.66
20	ORANR-2	0.27	0.48	0.60	12.24	17.24	20.66
21	ORANR-3	0.46	0.73	0.86	24.28	35.06	42.34
22	ORANR-4	0.28	0.51	0.62	12.22	17.54	21.12
23	ORANR-6	0.42	0.68	0.83	22.82	30.44	35.56
24	ORAN-1	0.39	0.64	0.76	19.42	26.58	31.46
25	ORAN-2	0.22	0.41	0.53	12.16	16.84	20.06
	$SEm_{(+)}$	0.01	0.01	0.01	0.28	0.45	0.49
	$CD_{(0.05)}$	0.02	0.03	0.04	0.79	1.24	1.37

MAS -Month After Sowing

The height of seedlings varied significantly among the clones studied (Table 1). ORANP-17 put remarkably maximum height growth at 3, 6 and 9 month followed by ORANP-16 and ORANR-3. The minimum height growth was noticed under ORAN-2. The height ranged from 12.16 to 28.66cm, 16.84 to 41.44cm and 20.06 to 50.02cm at 3, 6 and 9 month of age respectively. At 9 month age, the seedling height of ORANO-10, ORANP-14, ORANP-21, ORPUB-17, ORPUB-22, ORPUB-23, ORPUB-24, ORPUB-26 and ORAN-1 was at par and also the performance of ORANP-12, ORANP-13, ORANP-15 and ORANP-21 was statistically alike.

The biomass of planting stock in terms of shoot dry weight, root dry weight and total dry weight differed significantly among various clones (Table 2). The shoot dry weight varied appreciably at 3, 6 and 9 month observation. It was highest under ORANP-17 followed by ORANP-16 and lowest under ORANP-9. The shoot biomass per seedling varied from 2.15 to 6.85 g at 3 month, 3.66 to 14.19 g at 6 month and 6.26 to 22.19 g at 9 month age.

The root dry weight also differed pronouncedly among various clones. ORANP-17 produced significantly higher quantity of roots than all others followed by ORANP-16 at all stages of evaluation. The minimum root growth was found under ORANP-8 at 3 month (0.35 g), then under ORAN-1 at 6 and 9 month age. The root dry weight ranged from 0.35 to 3.63 g at 3 month, 4.22 to 18.93 g at 6 month and 5.33 to 18.93 g at 9 month age.

Table 2. Shoot dry weight, root dry weight and total dry weight of seedlings from open pollinated seeds of different teak clones.

Serial No.	Clone ID	Shoot dry weight (g)			Root dry weight (g)			Total dry weight (g)		
		3-MAS	6-MAS	9-MAS	3-MAS	6-MAS	9-MAS	3-MAS	6-MAS	9-MAS
1	ORANP-8	2.15	5.75	8.59	0.35	5.41	7.53	3.98	11.16	16.12
2	ORANP-9	2.45	3.66	6.26	0.51	4.82	5.96	2.96	8.48	12.22
3	ORANP-10	4.71	7.07	10.59	0.43	7.35	10.03	5.14	14.42	20.62
4	ORANP-12	3.95	6.22	9.36	0.57	6.44	8.78	4.52	12.66	18.14
5	ORANP-13	3.31	6.24	10.48	1.51	7.32	8.96	4.82	13.56	19.44
6	ORANP-14	4.19	7.44	11.41	1.19	7.64	10.27	5.38	15.08	21.68
7	ORANP-15	3.57	6.41	9.86	0.95	6.25	8.30	4.52	12.66	18.16
8	ORANP-16	6.20	12.47	20.94	3.38	13.09	17.28	9.58	26.56	38.22
9	ORANP-17	6.85	14.19	22.19	3.63	14.59	18.93	10.48	28.78	41.12
10	ORANP-18	4.19	7.13	11.70	1.17	7.89	9.86	5.36	15.02	21.56
11	ORANP-21	3.01	5.96	9.05	1.37	6.32	8.61	4.38	12.28	17.66
12	ORPUB-15	2.41	4.72	7.75	1.11	5.14	6.43	3.52	9.86	14.18
13	ORPUB-17	4.23	7.53	11.20	1.21	7.71	10.62	5.44	15.24	21.82
14	ORPUB-19	2.45	4.04	6.69	0.51	4.28	5.25	2.96	8.32	11.94
15	ORPUB-22	4.21	7.47	11.39	1.21	7.65	10.29	5.42	15.12	21.68
16	ORPUB-23	4.67	7.99	12.69	1.25	8.59	11.03	5.92	16.58	23.72
17	ORPUB-24	3.99	7.05	11.51	1.15	7.37	9.17	5.14	14.42	20.68
18	ORPUB-26	3.98	6.43	10.69	1.14	7.85	9.75	5.12	14.28	20.44
19	ORPUB-30	2.61	4.18	6.79	0.51	4.64	5.89	3.12	8.82	12.68
20	ORANR-2	2.56	4.12	6.60	0.50	4.46	5.72	3.06	8.58	12.32
21	ORANR-3	6.04	10.29	15.34	1.40	10.43	14.30	7.44	20.72	29.64
22	ORANR-4	2.62	4.18	6.74	0.52	4.64	5.88	3.14	8.82	12.62
23	ORANR-6	5.84	9.53	15.75	1.10	9.79	11.89	6.94	19.32	27.64
24	ORAN-1	5.07	8.34	12.81	0.95	8.52	11.35	6.02	16.86	24.16
25	ORAN-2	2.46	4.02	6.55	0.50	4.22	5.33	2.96	8.24	11.88
	$SEm_{(+)}$	0.10	0.11	0.20	0.02	0.13	0.16	0.08	0.26	0.34
	$CD_{(0.05)}$	0.21	0.31	0.55	0.05	0.35	0.43	0.23	0.73	0.95

MAS - Month After Sowing

The total dry weight of seedling varied significantly for different clones at 3, 6 and 9 month age, ORANP-17 exhibited highest root growth followed by ORANP-16 for all the intervals, whereas, It was lowest in ORAN-2 for all three assessments. The ranges of total dry weight were 2.96-10.48g, 8.24-28.78g and 11.88-41.12g at 3, 6 and 9 month, respectively. At 9 month the values of ORANP-9, ORPUB-19, ORPUB-30, ORANR-2, ORANR-4 and ORAN-2 were at par with each other. The biomass of seedlings increased gradually in all clones with advancement of age.

The quality of planting stock differed significantly among various clones in different ages (Table 3). The quality was remarkably higher in ORANP-17 followed by ORANP-16 in all three ages and was significantly lower in case of ORAN-2. In all the clones the quality of planting stock progressively increased with increase of age. The range of quality index was: 0.28-1.46 at 3 month, 1.63-4.78 at 6 month and 2.37-6.39 at 9 month age.

At 9 month age, the order of seedling quality was: ORANP-17 > ORANP-16> ORANR-3> ORANR-6> ORPUB-23> ORAN-1> ORPUB-17> ORANP-14> ORPUB-22> ORANP-10> ORANP-18> ORANP-12>ORANP-15>ORPUB-26> ORPUB-21>ORANP-13=ORPUB-24> ORPUB-8> ORANP-9> ORPUB-15> ORPUB-26> ORANR-4> ORANR-2>ORPUB-19> ORAN-2.

The growth parameters such as collar diameter, height, root growth under different teak clones varied significantly. This may be attributed to variation in genetic makeup of clones and compatibility of a particular clone with other clones in cross pollination to produce seeds of high

Table 3. Quality index of seedlings from open pollinated seeds of different teak clones.

Serial No. of Clone	Clone ID	Quality Index		
		3-MAS	6-MAS	9-MAS
1	ORANP-8	0.36	2.10	3.20
2	ORANP-9	0.31	1.73	2.85
3	ORANP-10	0.31	2.55	3.82
4	ORANP-12	0.39	2.51	3.69
5	ORANP-13	0.65	2.54	3.53
6	ORANP-14	0.62	3.11	3.95
7	ORANP-15	0.56	2.64	3.68
8	ORANP-16	1.31	4.47	6.01
9	ORANP-17	1.46	4.78	6.39
10	ORANP-18	0.56	2.66	3.81
11	ORANP-21	0.61	2.32	3.60
12	ORPUB-15	0.50	1.99	2.84
13	ORPUB-17	0.59	2.74	4.02
14	ORPUB-19	0.30	1.66	2.44
15	ORPUB-22	0.59	2.57	3.89
16	ORPUB-23	0.67	3.26	4.59
17	ORPUB-24	0.53	2.51	3.53
18	ORPUB-26	0.53	2.38	3.64
19	ORPUB-30	0.33	1.95	2.83
20	ORANR-2	0.32	1.90	2.68
21	ORANR-3	0.78	3.58	4.94
22	ORANR-4	0.33	2.03	2.77
23	ORANR-6	0.65	3.55	4.93
24	ORAN-1	0.58	3.28	4.59
25	ORAN-2	0.28	1.63	2.37
	$SEm_{(+)}$	0.01	0.05	0.07
	$CD_{(0.05)}$	0.03	0.14	0.21

MAS- Month After Sowing

quality. Considerable amount of genetic variations in height, diameter, etc. of teak has been reported by Nagarajan et al. 1996, Kumar et al. 1997, Gogate et al. 1997 and Mahmud and Hossain, 2016. The genetic architecture of quantitative characters was studied in teak clones by Swain et al. (1996) and the results indicated the presence of considerable genetic variation in the material. In an experiment involving progeny trials of different age groups, Sharma et al. (1996) concluded that the estimates of genetic parameters obtained at the early age do not change much at later stage and family alone accounted for 30-50 % variation of the total height, diameter and basal area. High genetic variation in floral traits among eight teak clones in Karnataka, India has been reported by Vasudeva et al. (2004).

The clones studied reflected significant variation in shoot biomass and root biomass. This was the result of variation in diameter, height and root growth among the clones. Jayasankar et al. (1999a), Mathew (2001) and Mahmud and Hossain (2016) have also reported significant influence of provenance/ clone on the root growth and biomass in teak. The variation in collar diameter, height, shoot biomass and root biomass of seedlings among different clones ultimately resulted significant variation in quality of planting

stock in particular age. The results are in line with the findings of Mahmud and Hossain (2016). The quality of seedling increased progressively from 3 to 9 month age in all clones. This may be because of the fact that the plants are in juvenile stage during which the growth factors are very active.

ORANP-17 excelled in growth and quality of planting stock closely followed by ORANP-16 in all three assessments over their counterparts. This suggests that these two clones are significantly superior in genetic makeup over other clones tested. The plantation of these clones may result remarkably higher timber production in comparison to others. An overview of the results of progeny trials obtained from different age groups of teak has suggested the estimates of genetic parameters do not change drastically with age (Sharma et al. 1996, Kumar et al. 1997 and Gera et al. 2001). ORAN-2 performed lowest among the clones studied. This may be due its inferior genetic makeup in comparison to other clones.

CONCLUSION

The collar diameter, height, shoot biomass, root biomass, total biomass and quality of seedlings raised from open pollinated seeds of 25 number of teak clones varied significantly among the clones at 3, 6 and 9 month age. ORANP-17 excelled in all aspects closely followed by ORANP-16. It may be concluded that these two clones are genetically superior over others. ORAN-2 performed least with regard to growth and quality of planting stock. It may be recommended that seeds of ORANP-17 and ORANP-16 may be collected from the seed orchard for raising large scale production of high quality planting material of teak. The plants of these two clones may be used for vegetative propagation of quality planting material.

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