APPRAISAL OF SPECIES AND PROVENANCES TRIAL OF TROPICAL PINES IN KARNATAKA

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Introduction

There is an ever increasing demand for the long fibred soft wood species (Subramanian, 1982). The indigenous bamboo resources are getting dwindled at an alarming rate because of gregarious flowering and subsequent sparse regeneration. Silviculturally concentrated bamboo plantations have not been much of a success on operational scale. Further, the cost of artificial regeneration of bamboo is very high and hence becomes unremunerative for pulp-wood industry. Efforts are being made to introduce various species of Tropical Pines throughout India to bridge the yawning gap between availability and demand for long fibred soft wood material for the paper industry.

The Tropical Pines were introduced way back in 1956 in India on regular and systematic basis (Chowdhary, 1982). These Pines are fast growing with better adaptability and higher productivity with long fibrous nature. These desirable traits have attracted the attention of the foresters in India to try these species for plantation development. There is a need to take-up the species/provenance trials of Tropical Pines in Karnataka for selection of desirable provenances for higher plantation productivity.

The Mysore Paper Mills Ltd., Bhadravathi, a Govt. of Karnataka undertaking in it's endeavour to find out suitable higher yielding Tropical Pine species and provenances to develop the Pine plantations on operational scale on the conceded degraded forests reserves and the other Govt. wastelands has tested various Tropical Pine species and provenances in technical collaboration with the Oxford Forestry Institute (OFI), United Kingdom (U.K.) under the financial assistance from the Overseas Development Administration (ODA), U.K. The performance of species and provenances tested is presented in this paper.

Materials and Methods

The trial was established at a location representing climatic and geographic conditions available for Pine plantation development by the MPM. Seed for trial was supplied by Danida Forest Seed Centre.

Details of Seed lot :

1. *P. caribaea* var. *hondurensis*, Prov. 13H, Queensland, Australia
2. *P. caribaea* var. *hondurensis*, Prov. 4H, Queensland, Australia
3. *P. pinaster* - unrecorded seed source
4. *P. kesiya* - CBC, Brazil

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5. *P. kesiya* - 9256, Brazil
6. *P. oocarpa* - Sebaco Bonette, Nicaragua.

Climatic and Site details of trial site in Karnataka : The trial site has a latitude of 13° 44' N, longitude 74° 55' E, altitude 610 m MSL, mean annual rainfall of 2400 mm with a mean annual temperature of 28°C and the number of rainy days are around 100 per year. Rainfall is received from South-West monsoon between June and October. The trial site has deep, red sandy loam soils with good drainage. Thick growth of Eupatorium (*Chromaelina oderatum*) intermixed with grassy blanks was found before the establishment of the trial. Further, the trial site was subjected to heavy grazing and repeated annual fire prior to trial establishment.

Seedlings raised from the seed lots were grown in nursery. Standard nursery technique was adopted to raise seedlings. Six months old seedlings were used to establish the trial and mycorrhiza was added to the seedlings in the nursery. Prior to rainy season, the trial site was cleared, burnt and line ripping all along the contours was done by using D-50 bulldozer. Seedlings prior to planting in the main field were dipped in 0.2% Aldrex solution as an anti-termite treatment. Mycorrhiza soil was added to polythene bags just before pricking-out and also one month after in the nursery. The trial was laid-out in a Randomised Complete Block Design (RCBD) with four replications.

Planting was done in the last week of June 1987 in the main field at an espacement of 3 m x 3 m. Inorganic fertilizer NPK (15 : 15 : 15) was given once to each plant at the rate of 25 g after planting during first year. Again NPK and Rock Phosphate at the rate of 25 g and 40 g respectively per plant were added during second year and third year. Weed competition in the trial site was kept to a minimum by frequent manual weeding only upto the end of third year. Digging of soil all along the trenches to a width of 1 metre on either side of the ripped line was done once in a year upto end of third year. This operation was carried out towards end of monsoon season (November-December) to benefit the plants from occasional rains and to prevent the loss of soil moisture during summer. Protection against biotic interference particularly against cattle browsing/damage is ensured by employing watchers continuously till harvest together with digging of cattle-proof trench all round the trial site before establishment of the trial. Further, "Brashing" operation was carried out during fifth year to a height of one metre from ground in all the treatments uniformly. This is to reduce the fire-hazard during fire season and to have access to plants for proper data recording.

Each treatment comprised 25 plants arranged in a square plot of 5 plants x 5 plants. All the nine centre plants (3 plants x 3 plants) in each treatment were measured for height growth and survival percentage twice during the year of establishment and there-after annually once in a year till harvest. Further, DBH is also recorded from third year till harvest. Analysis of variance (ANOVA) is carried out for plot-mean data and F-test is used to test the significance of differences between seed-lot means. However, only growth date recorded from fifth to ninth year are presented and discussed below.

Results

Height growth : Analysis of variance (ANOVA) indicated that there are significant differences between the species

and provenances tested in the trial in height growth at the end of 9th year. No-significent differences in the height growth however were observed between *Pinus kesiya* and *Pinus oocarpa*. *Pinus caribaea* var. *hondurensis* 13 H and 4 H provenances from Queensland, Australia have exhibited superior consistent height growth and exhibited an annual height increment of 1.69 m as against 1.42 m in *Pinus kesiya* CBC, 1.35 m in *Pinus kesiya* 9256 and 1.44 m in *Pinus oocarpa* at the end of 9th year.

Diameter growth : ANOVA (Table 2) indicated significant difference between species and provenances at various ages of plant growth. Highest diameter (21.52 cm) was recorded in *Pinus caribaea* var. *hondurensis*, 4 H QLD, followed by *Pinus caribaea* var. *hondurensis*, 13 H, QLD (21.08 cm), while *Pinus kesiya*, 9256, Brazil showed lowest diameter (14.62 cm). However, there are no significant differences between 4 H and 13 H provenances from QLD in *Pinus caribaea* var. *hondurensis* and so also between *Pinus oocarpa* and two seed sources of *Pinus kesiya* in respect of diameter growth at the end of 9th year.

A perusal of data indicated in Table 3 would reveal that *Pinus caribaea* var. *hondurensis* 13 H and 4 H provenances from Queensland, Australia have shown highest stand volume of 303.52 m^3 and 311.79 m^3 respectively when compared to other Pine species and provenances tested in the trial. *Pinus kesiya* CBC and 9256 from Brazil and *Pinus oocarpa* have exhibited satisfactory stand volume of 130.22 m^3, 99.31 m^3 and 111.36 m^3 per hectare respectively at the end of 9th year.

Pinus pinaster tested in the trial survived only upto the end of 2nd year. During 3rd year, most of the plants of *Pinus pinaster* dried up during summer and all the plants were completely wiped out towards the end of 3rd year.

Discussions and Conclusions

The results of the trial showed that the performance of Tropical Pines both in diameter and height growth varied considerably with species. *Pinus caribaea* var. *hondurensis* 13 H and 4 H provenances from Queensland have out-performed the other Pine species in diameter, height growth and stand volume. *Pinus caribaea* var. *hondurensis* 4 H and 13 H provenances from Queensland showed a mean annual increment of 34.18 m^3/ha as against 14.47 m^3 in *Pinus kesiya* CBC, 11.03 m^3/ha in *Pinus kesiya* 9256 Brazil and 12.37 m^3/ha in *Pinus oocarpa* at the end of 9th year. 4 H and 13 H provenances from QLD showed quick establishment in the main field and withstand wind damage. Besides, *Pinus caribaea* var. *hondurensis* maintained it's superior rate of growth from the beginning. *Pinus caribaea* var. *hondurensis* is showing best growth at low levels and is the only Pine likely to succeed. Further more, individual trees are already producing both female and male flowers, a good sign that the species is growing in the correct environment zone.

Pinus oocarpa though established well and putting on promising early growth, failed to maintain the same rate of growth as the tree ages. Further, it is also observed that *Pinus oocarpa* is less resistant to wind damage. However, other provenances in this species ought be tested as this species grows naturally in less fertile and hotter sites and therefore it may have some prospects on MPM lands. *Pinus kesiya*, CBC and 9256 from Brazil have also showed satisfactory rate of growth but it is not

Table 1

Mean plant height (m) of different Tropical Pine species and provenances tested at Kalammanagudi from 5th to 9th year

Tr. No.	Species/ Provenances	Mean height V	VI	VII	VIII	IX	Mean MAI (m) IX
1.	*P. caribaea* var. *hondurensis*, 13 H, QLD, Aus.	9.44	12.13	12.95	13.95	15.37	1.71
2.	*P. caribaea* var. *hondurensis*, 4 H, QLD, Aus.	9.15	11.72	12.69	13.48	15.15	1.68
3.	*P. pinaster*	-	-	-	-	-	-
4.	*P. kesiya*, CBC, Brazil	8.15	10.40	11.04	11.87	12.80	1.42
5.	*P. kesiya*, 9256, Brazil	7.60	9.67	10.88	11.30	12.15	1.35
6.	*P. oocarpa*, Sebaco Bonette, Nicaragua	8.44	10.51	11.24	11.88	12.97	1.44
L of Significance :		**	**	*	*	***	
S Ed- :		0.43	0.53	0.64	0.57	0.53	
C.D. :		1.33	1.61	1.41	1.24	1.62	

L of significance - Level of Significance
S ED - Standard Error of Difference of mean
C.D. - Critical Difference
DBH - Diameter at Breast-Height (1.3 m)
QLD - Queensland
Aus. - Australia
MAI - Mean Annual Increment
*, **, *** indicate significance at 5%, 1% and 0.1% levels, respectively.

comparable with that of *Pinus caribaea* var. *hondurensis*. This might be due to drying of lower branches both during rainy and summer seasons which reduces the active photosynthetic area considerably. Further, form of trees both in *Pinus kesiya* and *Pinus oocarpa* is not upto the mark. Besides, *Pinus pinaster* is a complete mismatch as it is a sub-tropical species and as such there are no prospects for this species under tropical condition.

Systematically laid out provenance trails in *Pinus caribaea* var. *hondurensis* and *P. tecunumanii* and inventory of Pine captive plantations raised on MPM lands have clearly confirmed the best adaptability and highest productivity of *Pinus caribaea* var. *hondurensis* at lower altitudes (200-700 m). While the performance of *Pinus oocarpa* is satisfactory, the performance of *Pinus kesiya* is not encouraging in operational scale plantations.

Table 2

Mean plant DBH (cm) of different Tropical Pine species and provenances tested at Kalammanagudi from 5th to 9th year

Tr. No.	Species/ provenances	Mean DBH					Mean MAI (cm)
		V	VI	VII	VIII	IX	IX
1.	*P. caribaea* var. *hondurensis*, 13 H, QLD, Aus.	13.65	16.87	18.80	20.51	21.08	2.23
2.	*P. caribaea* var. *hondurensis*, 4 H, QLD, Aus.	13.50	16.79	18.79	20.33	21.52	2.40
3.	*P. pinaster*	-	-	-	-	-	-
4.	*P. kesiya*, CBC, Brazil.	10.00	12.49	13.68	14.89	15.13	1.68
5.	*P. kesiya*, 9256, Brazil.	9.75	12.04	12.51	14.38	14.62	1.62
6.	*P. oocarpa*, Sebaco Bonette, Nicaragua	10.70	13.27	14.67	15.57	16.38	1.82
L of Significance :		**	**	***	***	***	
S Ed :		0.43	0.53	0.96	0.83	0.88	
C.D. :		1.33	1.61	2.93	2.54	2.69	

Table 3

Stand volume (m^3/ha) of different Tropical Pine species and provenances tested at Kalammanagudi from 5th to 9th year

Tr.No.	V	VI	VII	VIII	IX
1.	78.16	153.65	203.40	260.78	303.52
2.	74.11	146.83	199.11	247.59	311.79
3.	-	-	-	-	-
4.	36.22	72.10	91.82	116.95	130.22
5.	30.18	56.69	65.86	89.35	99.31
6.	40.35	72.40	89.21	95.96	111.36

Stand volume = D^2H x FF x No. stems FF = 0.4

Table 4

MAI (m^3/ha) of different Tropical Pine species and provenances tested at Kalammanagudi from 5th to 9th year

Tr.No.	V	VI	VII	VIII	IX
1.	15.63	25.50	29.06	32.60	33.72
2.	14.82	24.47	28.44	30.95	34.64
3.	-	-	-	-	-
4.	7.24	12.02	13.12	14.12	14.47
5.	6.03	8.45	9.41	10.17	11.03
6.	8.07	12.07	12.74	13.00	13.37

Table 5

Survival percentage of different Tropical Pine species and provenances tested at Kalammanagudi from 5th to 9th year

Tr.No.	V	VI	VII	VIII	IX
1.	100	100	100	100	100
2.	100	100	100	100	97
3.	-	-	-	-	-
4.	100	100	100	100	100
5.	94	91	87	86	86
6.	94	88	83	75	72

Trial of Tropical Pines have shown the possibility of their large scale cultivation especially *Pinus caribaea* var. *hondurensis*, Queensland provenances. Tropical Pines are not meant for moisture stress areas and for poor soils because of slow/improper development of mycorrhiza which comes in the way of establishing successful Pine plantations. Prior to large scale investment in industrial plantations with Tropical Pines, it is necessary to establish fully replicated series of trials covering various aspects at more than one site simultaneously by Research Wing. *Pinus caribaea* var. *hondurensis* is clearly best adapted and potentially more productive Pine species with best formed trees. There are many other species of Pines which may well be tried after studying their individual characteristics to suit the local conditions and they should be tested. It is also necessary to establish seed orchards in the areas where seed setting is noticed. Such a step would reduce the dependence of the country on foreign seed supplies and would give a good impetus to Tropical Pine plantation programme in the country to save our natural bamboo forests which are depleting at an alarming rate.

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SUMMARY

Due to inadequate and diminishing supply of bamboo, the only source of long fibred wood, Pines with long fibres are invaluable to meet the growing needs of the paper industry. Tropical Pines are fast growing with better adaptability and higher productivity. The performance of Tropical Pines varies with species, provenances, climatic and site conditions. *Pinus caribaea* var. *hondurensis*, 13 H and 4 H provenances from Queensland, Australia have been found to be best adapted and potentially most productive seed sources. *Pinus oocarpa* represented only by one provenance showed satisfactory rate of growth. *Pinus kesiya* also exhibited satisfactory growth but prevailing climatic conditions slow down/prevent it's further expansion. Prior to large scale investment in industrial plantations with Tropical Pines, it is necessary to lay-out site specific trials to find out their adaptability, suitability and productivity.

कर्णाटक की उष्णदेशीय चीड़ जातियों का मूल्याकंन तथा उनके स्थानज भेदों का परीक्षण

आर०के० टोर्वी, जी०एस० करियप्पा व बी०के० मोहम्मद अमानुल्ला

सारांश

लंबे रेशे वाले काष्ठ के एकमात्र स्रोत बाँसों का प्रदाय अपर्याप्त होने और घटते जाने से कागज उद्योग की वर्तमान ज़रूरतें पूरी करने के लिए लम्बे रेशे वाले चीड़ बहुमूल्य हो जाते हैं । उष्णदेशीय चीड़ शीघ्रवर्धी, अधिक अनुकूलता और अधिक उत्पादकता वाले हैं । उष्णदेशीय चीडों की क्रियाशीलता में उनकी जाति, उत्पत्ति स्थान तथा जलवायु और स्थल दशाओं के अनुसार अन्तर पाया जाता है । क्वींसलैण्ड, ऑस्ट्रेलिया से प्राप्त हुए *पाइनस कैरिबिया* विभेद *होण्डुरेंसिस* के 13 एच व 4 एच स्थानज भेद सर्वाधिक अनुकूल बने हुए और सबसे ज्यादा उत्पादक बीज देते पाए गए हैं । *पाइनस ऊकार्पा* की, इसका यहाँ एक ही स्थानज भेद उपलब्ध है, बढ़ने की दर संतोषप्रद रही है । *पाईनस केसिया* की वृद्धि दर भी संतोषजनक है परंतु जैसी जलवायु दशाएँ यहाँ हैं वे उसे धीमी कर देती हैं । उसका अधिक विस्तार नहीं होने देती । उष्णदेशीय चीड़ों के औद्योगिक वन लगाने में बड़े परिमाण पर धन लगाने से पूर्व यह आवश्यक है कि उनकी अनुकूलनीयता, उपयुक्तता और उत्पादकता मालूम करने के लिए उनकी स्थल विशिष्टता के परीक्षणों का अभिविन्यास किया जाए ।

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