ISSN (Online): 2349-1183; ISSN (Print): 2349-9265
TROPICAL PLANT RESEARCH
The Journal of the Society for Tropical Plant Research

6(2): 226–232, 2019
DOI: 10.22271/tpr.2019.v6.i2.032

Research article

Progeny variation in candidate plus trees of *Pterocarpus marsupium* Roxb. for seed germination and associated parameters

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[Accepted: 27 July 2019]

Abstract: Twenty-one progenies of *Pterocarpus marsupium* were evaluated for seed germination, seedling height, collar diameter, number of leaves, root length; shoot and root vigour indices. The genetic parameters for seed germination and other associated parameters showed a wide range of variations in progenies of different candidate plus trees (CPTs) at nursery stage except collar diameter. The CPTs, BHB-1 and BHB-2 invariably exhibited high germination and other parameters, whereas GK-1 recorded with the least performer with respect to germination, shoot and root vigour index. Analysis of variance indicated significant variation existed among the CPTs of different localities for all the traits under study. Considering genetic advance and heritability, the highest genetic gain obtained for germination, seedling height, shoot vigour index, root vigour index suggested these traits effective means for selection of CPTs. Highest 100 seed weight was recorded with CPT BHB-3 which was on par with other CPTs (BHB-1, BHB-2 and BHB-4) of the same locality. Initial growth at the age of 2 year old progeny trial confirms the superiority of these CPTs of Bilaspur along with by BL of Balod.

Keywords: Heritability - Progeny - *Pterocarpus marsupium*.

[Cite as: Mishra Y, Mohammad N & Mishra JP (2019) Progeny variation in candidate plus trees of *Pterocarpus marsupium* Roxb. for seed germination and associated parameters. *Tropical Plant Research* 6(2): 226–232]

INTRODUCTION

Pterocarpus marsupium Roxb. (Fabaceae), commonly known as Bijasal or Indian Kino, is one of the most valuable multipurpose forest tree. The tree possesses gum-kino, which is a powerful astringent and are used to cure various diseases. The tree is particularly known to have anti-diabetic properties in various forms (Manikam *et al*. 1997, Vats *et al*. 2002, Bajpai *et al*. 2016). The tree is commonly found throughout the Deccan Peninsula and extending to the states of Gujarat, Madhya Pradesh, Uttar Pradesh, Bihar, Orissa and certain parts of northern India (Krishnamurthi 1998). India is disreputably referred to as diabetic capital of the world (Kaveeshwar & Cornwall 2014) and due to extensive use of this species in preparation of diabetic medicine, it is rapidly depleting from its natural habitat. Chhattisgarh state forest department has also observed various illicit felling in its natural population and assigned the task of germplasm collection and to develop *ex situ* conservation strategy. During an extensive survey for selection and marking of candidate plus trees in Chhattisgarh, sparse population of the species was found in three agroclimatic zones of the state. However, twenty-one candidate plus trees (CPTs) were selected based on their superiority with respect to plant height, girth at breast height (GBH), clear bole, crown size and number of branches. However, the performance of progenies of CPTs needs to be evaluated at different stages from the seedling stage to at least one-third of the rotation of that crop for morphological characters like quality and quantity of timber yield.

Selection of CPTs and evaluation of their progenies are prerequisite for tree improvement programmes based on performance at seedling stage by providing same growing condition. Hence, such plus trees can be categorized as elite types based on their performance through progeny trials. The present communication describes the selection of CPTs from three agroclimatic zones in Chhattisgarh state and evaluating their performance at seedling stage followed by progeny trial establishment.

Received: 02 March 2019 Published online: 31 August 2019
https://doi.org/10.22271/tpr.2019.v6.i2.032

MATERIALS AND METHODS

Figure 1. Selection, germination and progeny trial of *Pterocarpus marsupium* Roxb.: **A–C**, Selection of CPTs in three agroclimatic zones of Chhattisgarh; **D**, Freshly collected seeds; **E**, Seeds ready for germination; **F–G**, Germination in root trainers; **H–I**, Transfer of seedlings in poly bags; **J–K**, Seedlings under growth measurement; **L**, Uprooted sample for root length measurement and biomass estimation; **M–N**, Establishment of progeny trial; **O–P**, Growth measurement after two years.

The CPTs of *Pterocarpus marsupium* from three agroclimatic zones of Chhattisgarh were selected during 2011-2012 (Fig. 1A–C). The places of selection are mentioned in table 1. The mature and dried pods of brown colour were collected from the selected trees during April-May 2012 (Fig. 1D). The tree wise pods were spread separately on the floor under the shade for one week. 100 Pod weight of each tree was determined in three replications (ISTA 2010). Then the seeds were cut from upper and lower ends (Fig. 1E). No prior seed treatment was given. Individual seed lot of different CPTs was sown in root trainers on 25 mm size filled with potting mixture consisting of soil, sand and farmyard manure (FYM) in the ratio 2:1:1 during April under non misting condition. This experiment was laid out in randomized block design with four replications having 100 seeds each. Watering and weeding were attended as and when required. Germination started from first week and continued up 60 days (Fig. 1F,G). Observation on daily germination count was recorded up to 60 days from the date of first emergence. After completion of emergence, all the seedlings were transferred (Fig. 1H) to polythene

bags of 25 cm × 25 cm size, (Fig. 1I). For estimation of growth of seedling, ten randomly selected seedlings (Fig. 1J) from each replication were harvested from the polybags and measured for their height (Fig. 1K), collar diameter and number of leaves after 6 months. To measure the root length, the samples were thoroughly washed with water so as to remove soil completely from root portion (Fig. 1L). Following the standard formula, shoot and root vigour indices were calculated. For quantification of dry root/shoot biomass, 10 random samples of each locality were oven dried at 60^{o}C for four days.

These parameters were calculated to test the vigour of different CPTs of *P. marsupium*. The data recorded on the germination and other associated parameters *i.e.* germination (%), seedling height (cm), collar diameter (cm), number of leaf, root length (cm), shoot vigour index and root vigour index were subjected to statistical analyses using statistical package by Windostat Version 9.2 from indostat services, Hyderabad licensed to Tropical Forest Research Institute Jabalpur. Estimates of descriptive statistics *viz.* mean, coefficient of variation, F ratio, F Probability, standard error, critical difference were calculated.

A progeny trial comprising 21 CPTs was established in July 2016 at Naya Raipur, Chhattisgarh with 25 numbers of plants in 3 replications each (Fig. 1M,N). The growth data scored after 2 years (Fig. 1O,P).

RESULTS AND DISCUSSION

Seed germination is one of the important characters which shows the speed of germination of any progeny or seed source. In the present study, significant variation for seed germination among progenies of 21 CPTs was recorded, which ranged from 20.81 (GK-1) to 79.81% (BHB-1). Five out of 21CPTs showed maximum seed germination (more than 70%, whereas five CPTs recorded poor seed germination of less than 40% (Table 1). This variation could be due to genotype differences as seeds from all the progenies were raised under similar environmental conditions. Sometimes seed dormancy may also influence seed germination in *P. marsupium*, which is controlled by various physical barrier (Kundu & Chaturbedi 2014), seed size and seed mass (Mishra *et al*. 2013). Patil *et al*. (2017) recorded variation in seed germination in *Pongamia pinnata* (L.) Pierre among different seed sources ranging from 12.50% to 84%. Similarly, progenies of candidate plus trees of *Pongamia pinnata* for seed germination and seedling vigour has been evaluated with the marked difference due to genotypic variation of individual progeny (Vasav *et al*. 2011). It shows that seed source and individual trees have the pronounced effect on seed germination.

Significant variation in the growth parameter of seedling of different among was recorded except collar diameter. After six months, seedling height greatly varied among progenies of CPTs, from 21.39 cm (TN-1) to 43.99 cm (BHB-1). Five CPTs showed the higher seedling height of more than 40 cm. Leaf number is one of the prospective characters of the plant that positively influences seedling growth. In the present study leaf number varied from 3.39 to 7.18 among progenies of CPTs. Such a range of variation has also been recorded among CPTs for other seedling parameters like and root length (11.40–19.39 cm) (Table 1). Besides, shoot and root vigour indices varied significantly among progenies. Minimum and maximum shoot vigour index were scored with a range of 589.7–3514.2 recorded for CPTs GK-1 and BHB-1. The root index also followed a similar trend (272.57–1496.1) among CPTs (Table 1). This variation is due to genetic and environmental factors which affect the seedling growth and substantiated with the findings of Geethanjali *et al*. (2003) in *Jatropha curcas* L. and George *et al*. (2003) in *Madhuca latifolia* (Roxb.) J.F.Macbr.

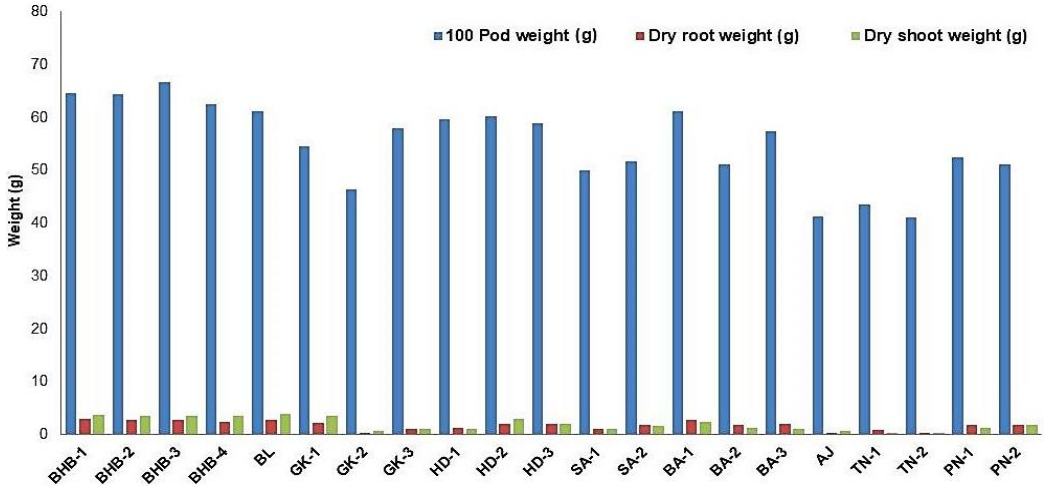

Figure 2. 100 Pod weight, dry root weight and dry shoot weight of different candidate plus trees of *Pterocarpus marsupium* Roxb.

Table 1. Descriptive Statistics of different localities for germination and other associated parameters in *Pterocarpus marsupium* Roxb.

S.N.	Localities (Range-CPT code)	Agroclimatic zones	Germination (%)	Seedling height (cm)	Collar diameter (cm)	No of leaf	Root length (cm)	Shoot vigour index	Root vigour index
1	Bharuadih (Bilaspur range-BHB-1)	Chhattisgarh plain	79.81	43.99	0.56	7.18	19.39	3514.23	1496.10
2	Bharuadih (Bilaspur range-BHB2)		77.35	41.62	0.55	6.13	17.64	3105.90	1363.70
3	Bharuadih (Bilaspur range-BHB-3)		70.90	39.22	0.45	5.70	16.45	2780.69	1167.46
4	Bharuadih (Bilaspur range-BHB-4)		75.47	40.91	0.32	4.94	14.80	3015.63	1118.53
5	Balod (Durg range-BL)		70.97	35.85	0.53	6.29	18.83	2538.26	1337.30
6	Gurda (Kharsia range-GK-1)		20.81	29.27	0.33	5.36	13.13	589.73	272.56
7	Gurda (Kharsia range-GK-2)		65.77	35.06	0.35	6.15	16.57	2422.93	1089.10
8	Gurda (Kharsia range-GK-3)		24.24	28.22	0.29	5.47	13.55	746.66	328.36
9	Hati (Dharamjaygarh range-HD-1)	North Hills of Chhattisgarh	55.62	28.40	0.26	4.50	12.94	1715.13	720.20
10	Hati (Dharamjaygarh range-HD-2)		61.27	34.98	0.39	5.64	14.38	2127.33	884.90
11	Hati (Dharamjaygarh range-HD-3)		57.54	26.65	0.23	3.61	11.66	1500.06	672.26
12	Sakola (Ambikapur range-SA-1)		30.69	23.68	0.28	5.21	14.74	733.93	453.33
13	Sakola (Ambikapur range-SA2)		42.00	26.20	0.28	4.50	13.27	1226.43	561.23
14	Baisgaon (Antagarh range-BA-1)	Bastar Plateau	64.05	42.28	0.44	6.58	17.29	2801.70	1111.26
15	Baisgaon (Antagarh range-BA-2)		50.70	23.18	0.24	3.69	11.47	1146.76	581.86
16	Baisgaon (Antagarh range-BA-3)		60.84	23.07	0.23	3.78	12.10	1382.93	736.40
17	Asna (Jagdalpur range-AJ)		43.35	22.16	0.22	3.39	12.21	983.80	537.23
18	Tadoki (Narayanpur range-TN 1)		39.83	21.39	0.21	3.54	11.40	830.30	453.26
19	Tadoki (Narayanpur range-TN 2)		37.35	23.85	0.24	3.8	12.33	895.53	461.00
20	Parvi (Narayanpur range-PN 1)		59.28	39.48	0.39	5.86	14.79	2360.03	873.53
21	Parvi (Narayanpur range-PN 2)		66.63	41.58	0.42	6.26	16.03	2770.47	1068.07
	Mean		54.97	31.95	0.34	5.128	14.534	1865.73	823.29
	CV		7.10	6.30	12.81	8.5845	7.4491	9.16	10.66
	F ratio		59.50	46.29	19.28	20.61	15.28	89.43	51.35
	F Probability		0.00	0.00	0.00	0.0000	0.0000	0.00	0.00
	SE		2.25	1.16	0.0258	0.2542	0.6251	98.73	50.67
	CD 5%		6.44	3.32	NS	0.7265	1.7867	282.22	144.85
	Range		20.81-79.81	21.39-43.99	0.21-0.56	3.39-7.18	11.40-19.39	589.7-3514.23	272.57-1496.1

Table 2. Estimates of genetic parameters for germination and other associated parameters in *Pterocarpus marsupium* Roxb.

S.N.	Character	Mean	ECV	GCV	PCV	Genetic advance		Genetic advance as % of mean		Heritability (Broad sense)	Expected mean next generation
						5%	1%	5%	1%		
1	Germination (%)	54.97	7.10	31.35	32.14	34.63	44.39	62.99	80.73	0.95	89.61
2	Seedling height (cm)	31.95	6.30	24.51	25.30	15.62	20.03	48.89	62.66	0.93	47.58
3	Collar diameter (cm)	0.34	12.81	31,63	34.13	0.21	0.27	60.40	77.41	0.85	0.55
4	No of leaf	5.12	8.58	21.95	23.56	2.16	2.77	42.11	53.96	0.86	7.28
5	Root length (cm)	14.53	7.44	16.25	17.88	4.42	5.67	30.44	39.01	0.82	18.96
6	Shoot vigour index	1865.73	9.16	49.76	50.60	1881.16	2410.82	100.82	129.21	0.96	3746.90
7	Root vigour index	823.29	10.66	43.68	44.96	719.73	922.37	87.42	112.03	0.94	1543.03

Biomass and 100 pod weight are the indictors of seedling vigour, which exhibit the genetic worth of selected CPTs (Sudrajat 2016). Dry biomass of root and shoot did not show significant difference among progenies of 21 CPTs (Fig. 2), which may be due to the control condition of these individuals grown in shadehouse condition that exposed to equal competition for light, nutrients and moisture for the seedlings. 100 Pod weight of trees selected from Bilaspur locality exhibited higher values probably because of young trees selected from this location, thus producing more vigorous seeds (Fig. 2).

In this experiment analysis of variance indicated significant variation among the CPTs of different localities. The highest phenotypic coefficient of variation (PCV) was exhibited by the shoot vigour index, root vigour index followed by collar diameter and germination percentage (Table 2). Genotypic coefficient variation (GCV) had similar trend as PCV. High heritability and high genetic advance was observed in the shoot vigour index, root vigour index and germination percentage. This combination of the high heritability and high genetic advance indicated the presence of a good amount of heritable additive component in both traits and provide a clear image of the trait in the selection process of *P.marsupium*. It is evident from table 2 that in general estimates, phenotypic coefficient of variation were higher compared to genotypic and environmental coefficients of variation (ECV). Broad sense heritability was higher for all the traits under investigation. If Genetic advance as percent of mean and heritability considered together as recommended by Johnson *et al.* (1955), response to selection or genetic gain would be higher for germination, seedling height, shoot vigour index, root vigour index as compared to collar diameter, number of leaf and root length.

The progeny trial established in Naya Raipur Chhattisgarh evaluated after 2 years showing BHB-1 as an outperforming CPT recorded with maximum average height (104.40 cm) and average girth (16.62). The responses of other CPTs from Bilaspur, *viz.* BHB-2, BHB-3 and BHB-4 overriding by BL selected from Balod (data not shown). Therefore, the performance of these CPTs in progeny trial needs to be evaluated for some more time for the precise screening of outperforming CPTs.

The results of the present study show that BHB-1, BHB-2, BHB-3 and BHB-4 selected from Bharuadih (Bilaspur) region performed better with respect to seed germination and other associated parameters, whereas CPTs like PN-2 from Parvi (Narayanpur), BL from Balod, and BA-1 from Baisgaon (Antagarh), performed better with respect to seedling growth characteristics compared to other progenies. Hence the progenies of these CPTs provide a great opportunity to the tree breeder to screen and capture natural variation for the success of afforestation programmes in Chhattisgarh, India.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the receipt of research grant received from Compensatory Afforestation Fund Management and Planning Authority (CAMPA), State Forest Department, Chhattisgarh, India for funding the research project on "Genetic improvement of *Pterocarpus marsupium* through germplasm selection in Chhattisgarh" (Sanction No. CAMPA/26/2011/1584, dated 23.12.2011) and for the work reported herein.

REFERENCES

Bajpai O, Pandey J & Chaudhary LB (2016) Ethnomedicinal uses of tree species by tharu tribes in the Himalayan terai region of India. *Research Journal of Medicinal Plant* 10(1): 19–41.

Geethanjali K, Balasubramanian A & Paramathma M (2003) Seed technological studies in *Jatropha curcus*, In: *National Workshop Jatropha Other Perennial Oil Seed Species*. 5–8th Aug. 2003, Bharathiya Agro-Industries Federation of India (BAIF), Pune, pp. 31–33.

George JV, Dasthagir MG, Parthiban KT & Jude SR (2003) Variability studies of seed and seedling attributes in mahua (*Madhuca latifolia*). *Indian Forester* 129: 509–516.

ISTA (2010) *International Rules for Seed Testing Edition*. The International Seed Testing Association, Bassersdorf, Switzerland, pp. 101–103.

Johnson HW, Robinson H & Comstock RE (1955) Estimates of genetic and environmental variability in soybean. *Agriculture Journal* 47: 314–318.

Kaveeshwar SA & Cornwall J (2014) The current state of diabetes mellitus in India. *Australian Medical Journal* 7: 45–48.

Krishnamurthi A (1998) *The Wealth of India: A Dictionary of Indian Raw Materials and Industrial Products*. Vol. VIII., National Institute of Science Communication and Information Resources, CSIR, New Delhi.

Kundu M & Chaturbedi N (2014) The role of fruit coat in germination of *Pterocarpus marsupium* seeds. *International Journal of Current Research* 6: 7935–7937.

Manikam M, Ramanathan M, Jahromi MA, Chansouria JP & Ray AB (1997) Antihyperglycemic activity of phenolics from *Pterocarpus marsupium*. *Journal of Natural Products* 60: 609–610.

Mishra Y, Rawat R, Rana P K, Sonkar MK & Mohammad N (2014) Effect of seed mass on emergence and seedling development in *Pterocarpus marsupium* Roxb. *Journal of Forest Research* 25: 415–418.

Patil HY, Mutanal SM, Mokashiands MV & Ghatanatti M (2017) Germination and vigor index of different sources of *Pongamia pinnata* (L.) Pierre. *International Journal for Crop Improvement* 8: 8–11.

Sudrajat DJ (2016) Genetic variation of fruit, seed, and seedling characteristics among 11 populations of white jabon in Indonesia. *Forest Science Technology* 12: 9–15.

Vasav VP, Narkhede SS, Rane AD, Gunaga RP, Rewale AP & Bhave SG (2011) Evaluation of progenies of candidate plus trees of *Pongamia pinnata* (L.) Pierre. for seed germination and seedling vigour. *Current Science* 100: 465–467.

Vats, V, Grover JK & Rathi SS (2002) Evaluation of anti-hyperglycemic and hypoglycemic effect of *Trigonella foenumgraecum* Linn, *Ocimum sanctum* Linn and *Pterocarpus marsupium* Linn in normal and alloxanized diabetic rats. *Journal of Ethnopharmacology* 79: 95–100.