Indian Journal of Ecology (2023) 50(4): 1024-1029
DOI: https://doi.org/10.55362/IJE/2023/4008

Manuscript Number: 4008
NAAS Rating: 5.79

Provenance Variation in Fruit and Seed Morphometric Characteristics of *Dysoxylum binectariferum* across Distribution in India

Suraj R. Hosur, A. Krishna, B.H. Shivakumar, M.R. Jagadish, R. Vasudeva and P. Mohanakumara[1]

College of Forestry Sirsi, University of Agricultural Sciences, Dharwad-581401, India
[1]KRC College of Horticulture, Arabhavi (University of Horticultural Sciences), Bagalkot-587 104, India
E-mail: srj1419@gmail.com

Abstract**:** *Dysoxylum binectariferum* is a rich source of rohitukine among known natural source, a billion-dollar anti-cancer drug. During January-March 2022, a pioneer study on provenance variation in fruit and seed morphometric traits in recalcitrant *D. binectariferum* species across its distribution in India was conducted. Seeds were collected from superior trees selected through eye ball screening from 7 provenances covering Assam, Arunanchal Pradesh, Karnataka and Maharashtra states. Seed morphometric characteristics were determined using digital caliper and electronic weighing balance and differences in performance of characteristic among provenances were compared using analysis of variance. Analysis of variance revealed significant variation in seed morphometric traits among 7 provenances. All fruit traits and seed traits of Jog provenance were found to be significantly superior over other provenances. Among trees, JT1 found to be best in fruit parameters and seed parameters over the other trees. The superior trees identified in the present study can further used for tree improvement work in order to get maximum genetic gain in timber and metabolite production.

Keywords**:** *Dysoxylum binectariferum*, Seed morphometric traits, Provenance variation, Superior tree

Dysoxylum binectariferum (Roxb.) Hook. (*Meliaceae)* is a medicinally important species grows medium to large-sized tree found in tropical and subtropical climates. The evergreen tree *D. binectariferum* is native to India, China, and other parts of Asia . *D. binectariferum* has gained international importance because of the presence of dysobinin and rohitukine. Dysobinin, a tetranortriterpenes isolated from the fruits, is a general central nervous system (CNS) depressant and also is reported to have mild anti-inflammatory activity (Singh et al 1976). Among all known botanical sources of rohitukine, *D. binectariferum* is reported to yield the highest amounts of rohitukine (Naik et al 1988). Further, the bark of the tree is also reported to be used for the treatment of leprosy and foul ulcers (Jain and DeFilipps 1991). Because of its economic value, *D. binectariferum* has been excessively harvested in many parts of the Western Ghats (Nath et al 2005). Despite its high value, only small-scale research on fruit and seed morphometric variation is conducted, and no literature on seed germination and propagation is available. Seed characters study is necessary for successful establishment and long-term secondary metabolite supply through selection of superior seed sources as well as superior mother trees.

Seed collected from same geographical region vary in their morphological characteristics, which intern reflects the genetic control of formation of seed (Abdelkheir et al 2003). *Dysoxylum binectariferum* has vast diversity between trees as well as among provenances. However, species distribution mainly affected by the extrinsic factors such as rodent's predation, seeds which are infected by the fungus on surface litter and adverse climatic conditions like lack of moisture for germination of fallen seeds just after the winter are the major causes that hinders seed germination (Gunaga et al 2015). Therefore, the identification of superior tree, source is necessary to get maximum benefits. With this background study was undertaken to know the intra-species variation in fruit and seed morphological traits of *D. binectariferum* and to identify the best seed source for better multiflication.

MATERIAL AND METHODS

Seed sources: Clues on the natural populations of *D. binectariferum* were obtained by consulting various published literatures Mohanakumara et al (2010), Gunaga et al (2015) and consulting various scientist who worked on this species as well as from forest department staffs. Extensive filed surveys were conducted to locate exact location of the populations. Natural populations of *D. binectariferum* are scanty and always small. Extensive and repeated visits were made to locate populations. Overall, seven populations from

four states were located *viz*., four populations (Jog, Kargal, Benagaov and Kathagal) from Karnataka, one population (Lonavala) from Maharashtra, one population (Manas) from Assam and another one population (Phasighat) from Arunanchal Pradesh (Fig. 1).

Seed collection: In each population, five superior trees (in girth class 50-150cm) were selected based on eye ball screening method (Hanumanth 2020). The trees were marked and their height, gbh and crown spread were recorded using altimeter and tape respectively. Since maturity of fruits vary in Western Ghat (2nd Fortnight of January) and North-East region (1st Fortnight of March). So matured 75 fruits from 5 superior trees from each source were collected during January from Western Ghat source and March from North-East source using tree pruner. Trees were coded with source and tree number ex. JT1 means First numbered tree from Jog source. Further fruit and seed parameters like length, width and weight were recorded using digital caliper and electronic weighing balance.

Statistical analysis: One way analysis of variation for tree growth parameters and two-way analysis of variation for fruit and seed morphometric traits was done using Operational Statistics (opstat) software.

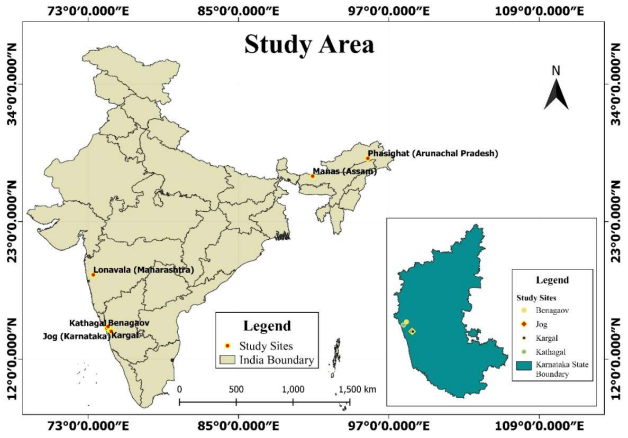

Fig. 1. Location of the study sites

RESULTS AND DISCUSSION

Variation in growth parameters of superior trees: Significant differences across population were observed for tree height, gbh and crown diameter of *D. binectariferum* is shown in Table 1. Highest gbh was observed for Jog (1.17m) and lowest for Kathagal and Lonavala (0.86m and 0.80m respectively), highest height was observed for Kargal (14.00m) and lowest for Manas and Phasighat (7.58m and 7.20m, respectively) and highest crown diameter was recorded for Benagaov and lowest for Phasighat. Overall tree girth is similar in Western Ghats and North-eastern regions. But height (7.20-7.58m) and crown diameter (2.80-3.10m) of North-Eastern region were significantly lower than Western Ghat regions height (11.00-14.00m) and crown diameter (4.50-5.50m). These variations might be contributed by the genetic makeup of the selected trees across different sites (Senthil Kumar et al 2010).

Effect of provenance and tree variation on fruit parameters: Significant variations were recorded for fruit traits across population as well as between trees. Among population, the fruit traits, namely fruit weight (71.58 g), fruit length (49.56 mm) and fruit diameter (54.45 mm) from Jog were found to be superior over the other followed by Manas and Phasighat, the second best sources, whereas least was observed in Lonavala population for all fruit parameters. Average fruit weight (75.90 g and 72.85g) respectively from Manas and Phasighat were on par with Jog population. Among superior trees, highest fruit weight (95.20g) and highest fruit length (56.68mm) recorded for JT1, highest fruit diameter (57.77mm) for JT4 and least was recorded for LT2 tree in all fruit parameters (Table 2). The variation existed among population as well as between trees for fruit traits is expected since the species naturally grows over wide range of climatic conditions. The results were conformity with the reports of Patil (2012) in *Zanthoxylum rhetsa*, Uma (2015) on *Buchanania lanzan*, Kallaje (2000) in *Garcinia indica*, Tomar and Rattan (2012) on *Hippophae salicifolia* and Jamaludeen et al (2015) in *Lagestromia speciosa*.

Table 1. Variation in growth parameters of selected trees of *D. binectariferum*

Mountain ranges	Sl. No.	Girth (m)	Height (m)	Crown diameter (m)
Western Ghat	Jog	1.17^{a}	11.20^{b}	4.70^{c}
	Kargal	1.07^{b}	14.00^{a}	4.90^{c}
	Benagaov	1.00^{b}	12.80^{ab}	5.50^{a}
	Kathagal	0.86^{c}	11.00^{b}	5.20^{b}
	Lonavala	0.80^{c}	11.30^{b}	4.50^{d}
North-East	Manas	1.06^{b}	7.58^{c}	3.10^{e}
	Phasighat	1.07^{b}	7.20^{c}	2.80^{f}
	SE(m)±	0.03	0.81	0.89
	CD (p=0.05)	0.09	2.37	0.30

Table 2. Effect of seed source and tree variation on fruit parameters of *Dysoxylum binectariferum*

Source	Trees	Fruit weight (g)		Fruit length (mm)		Fruit diameter (mm)	
Joga	JT1	95.20		56.68		57.10	
	JT2	51.44		39.82		51.45	
	JT3	51.57		48.24		54.39	
	JT4	86.66		55.62		57.77	
	JT5	73.04		47.43		51.52	
	Mn	71.58		49.56		54.45	
Kargal	KT1	51.92		45.78		46.19	
	K T2	52.38		42.01		56.62	
	K T3	45.38		39.22		45.75	
	K T4	57.47		41.94		55.22	
	K T5	53.07		40.02		49.51	
	Mn	52.05		41.79		50.66	
Kathagal	KtT1	56.81		45.28		48.15	
	Kt T2	38.86		40.89		49.70	
	Kt T3	61.53		42.43		54.05	
	Kt T4	61.52		47.06		49.60	
	Kt T5	50.96		40.29		48.18	
	Mn	53.94		43.19		49.94	
Benagav	T1	31.88		35.96		41.84	
	T2	37.68		38.85		49.42	
	T3	53.97		43.66		46.85	
	T4	38.98		37.35		44.14	
	T5	55.01		40.40		49.73	
	Mn	43.51		39.24		46.40	
Lonavala	LT1	44.89		39.52		42.23	
	LT2	6.94		27.58		21.84	
	LT3	43.37		38.90		42.18	
	LT4	46.07		39.52		43.51	
	LT5	18.49		32.11		30.38	
	Mn	31.95		35.03		36.03	
Manas	MT1	79.51		51.81		42.37	
	MT2	68.01		41.59		58.13	
	MT3	93.04		44.27		51.57	
	MT4	42.80		50.04		50.09	
	MT5	96.13		49.55		56.89	
	Mn	75.90		47.45		51.81	
Phasighat	PT1	43.02		52.27		48.17	
	PT2	92.37		46.62		49.09	
	PT3	75.28		53.56		53.73	
	PT4	64.45		39.82		42.36	
	PT5	89.14		47.29		56.84	
	Mn	72.85		47.91		50.04	
		SE(m)±	CD@5%	SE(m)±	CD@5%	SE(m)±	CD@5%
	Source	2.596	7.338	0.554	1.565	0.955	1.908
	Trees	2.194	6.202	0.468	1.323	0.807	1.613
	Source x Trees	5.805	16.409	1.238	3.499	2.135	4.267

Table 3. Effect of seed source and tree variation on seed parameters of *Dysoxylum binectariferum*

Source	Trees	Seed weight (gm)		Seed length (mm)		Seed diameter (mm)	
Joga	JT1	9.68		33.48		22.28	
	JT2	7.51		33.04		20.17	
	JT3	8.67		30.54		20.81	
	JT4	8.13		31.89		20.45	
	JT5	8.40		31.46		20.82	
	Mean	8.48		32.08		20.91	
Kargal	KaT1	6.96		28.22		19.47	
	Ka T2	7.07		26.77		19.70	
	Ka T3	6.18		23.99		18.87	
	Ka T4	7.59		27.31		20.34	
	Ka T5	6.51		27.35		19.60	
	Mean	6.86		26.73		19.60	
Kathagal	KtT1	7.19		28.64		20.10	
	Kt T2	7.24		26.64		20.63	
	Kt T3	6.49		24.38		26.57	
	Kt T4	6.62		25.40		19.64	
	Kt T5	4.70		24.08		17.03	
	Mean	6.45		25.83		20.79	
Benagav	BT1	3.69		23.24		15.91	
	BT2	7.20		26.77		19.45	
	BT3	3.88		25.84		16.25	
	BT4	3.91		25.03		15.78	
	BT5	8.11		27.54		20.21	
	Mean	5.36		25.68		17.52	
Lonavala	LT1	3.65		25.18		15.65	
	LT2	2.19		27.07		13.25	
	LT3	4.46		26.18		17.00	
	LT4	3.15		22.12		14.93	
	LT5	2.01		19.73		12.46	
	Mean	3.09		24.06		14.66	
Manas	MT1	8.15		25.49		20.64	
	MT2	9.03		31.79		21.54	
	MT3	7.67		28.92		19.95	
	MT4	9.17		29.15		20.42	
	MT5	6.39		31.68		21.88	
	Mean	8.08		29.41		20.89	
Phasighat	PT1	7.46		32.37		18.59	
	PT2	8.97		27.32		19.24	
	PT3	6.18		27.51		20.44	
	PT4	7.83		28.74		19.67	
	PT5	8.89		28.58		19.98	
	Mean	7.87		28.90		19.58	
		SE(m)±	CD@5%	SE(m)±	CD@5%	SE(m)±	CD@5%
	Source	0.196	0.555	0.418	1.182	0.372	1.051
	Trees	0.166	0.469	0.353	0.999	0.314	0.888
	Source x Trees	0.439	1.241	0.935	2.642	0.831	2.350

Effect of provenance and tree variation on seed parameters: Seed is a propagule which depict the growth and performance of a particular plant species. Seed polymorphism is a common feature for adaptation, which includes production of seeds of different size, weight, seed coat patterns etc. Selection for seed source with larger seeds may result in vigour and healthy seedlings. The significant differences in various seed morphological characteristics of *D. binectariferum* provenance is indicative of the possibility of selecting phenotypically superior plant within the species for further improvement work. But environmental factors also play a role in changing the component of the seed size as the species grow in wide range of ecological conditions and hence, populations can be expected to experience markedly selection pressure on seed characteristics.

Statistical parameters for various seed traits among seven provenances of *D. binectariferum* showed significant differences among the geographic source and trees of same source with regards to seed weight, seed length and seed diameter. Jog provenance was superior over other provenance in terms of seed weight (8.48g), seed length (32.08mm) and seed diameter (20.91mm) (Table 3). Jog seed diameter is on par with Manas (20.89mm) and Kathagal (20.79mm), similarly seed weight of Jog is on par with Manas (8.08g). There was significant variation among thirty-five superior trees from seven provenances for all seed traits, seed weight varied from 2.01g (LT5) to 9.68g (JT1), seed length varied from 19.73mm (LT5) to 33.48mm (JT1) and seed diameter varied from 12.46mm (LT5) to 26.57mm (KtT3) (Table 3).

Seed and fruit morphometric traits of this tree species are important because seed kernels and fruits contain considerable amount of rohitukine (Mohanakumara et al 2010). In the present study, among the various populations it was identified that, Jog source was best over others in terms of fruit weight (55.36%), fruit length (29.32%), fruit diameter (33.83%), seed weight (63.56%), seed length (27.24%) and seed diameter (42.63%) higher than Lonavala source. JT1 is superior tree over others in terms of fruit weight (92.71%), fruit length (51.34%), fruit diameter (61.75%) higher than LT2 and seed weight (79.23%), seed length (41.06%), seed diameter (44.07%) higher than LT5. Evidently, greater population variations and tree to tree variations were observed for fruit and seed morphometric traits which intern helps in the selection of superior source and superior types selection. Such large variations obviously indicate existing genetic diversity level in the species (Arjun 2017).

Similar kind of significant variation was found between *D. binectariferum* trees from Honnavar geographical sources were seed weight varied from 0.32-0.59g, seed length from 21.3-27.2mm and seed diameter 16.7-20.3mm among ten trees studied (Gunaga et al 2015). This variation may be due to wide range of ecological conditions quoted by Gunaga et al (2020) in *Saraca asoca.* Wide range of rainfall, temperature and soil type of seed sources with superior seed length and width possessed higher seed weight in *Zanthoxylum rhetsa* (Patil 2012) and also variations for reproductive traits are highly controlled by genetic factors (Zobel and Talbert 1984). Similar findings were observed by Basappa (2011) in *Emblica officinalis*, Manjunath (2003) in *D. malabaricum,* Abraham et al (2006) in *Cordia africana* and Hareesh et al (2008) in *Nathapodytes nimmoniana.*

Table 4. Correlation for fruit traits of *D. binectariferum*

Character	Fruit length	Fruit diameter	Fruit weight
Fruit length	-	0.77**	0.92**
Fruit diameter	0.76*	-	0.84**
Fruit weight	0.90*	0.84*	-

**: Genotypic correlations *: Phenotypic correlations

Table 5. Correlation for seed traits of *D. binectariferum*

Character	Seed length	Seed diameter	Seed weight
Seed length	-	0.64**	0.73**
Seed diameter	0.46*	-	0.89**
Seed weight	0.67*	0.71*	-

**: Genotypic correlations *: Phenotypic correlations

Correlation for fruit and seed traits: From the correlation matrix of different fruit traits (Table 4), it is evident that fruit length increases with fruit diameter (r = 0.77), fruit weight (r = 0.92). A positive correlation was observed between fruit diameter vs fruit weight (r = 0.84). Similarly seed length increases with seed diameter (r = 0.64), seed weight (r = 0.73). A positive correlation was observed between seed diameter and seed weight (r = 0.89) (Table 5). Correlation among traits is important to be studied since selection for one trait influences the other based on the nature and strength of correlations. Selection of provenances with larger seeds may result in sturdy and better seedlings (Arjun 2017). This kind of relation can be attributed to provision of larger amounts of soluble sugars required for germination and radicle protrusion and other energy expending developmental processes (Mamo et al 2006).

CONCLUSION

In the present study fruit parameters and seed parameters varied significantly among provenance, trees and their interaction. All fruit traits and seed traits of Jog provenance were found to be superior over other provenances. Among trees, JT1 found to be best in fruit

parameters and seed parameter over the other trees followed by JT4. Greater tree to tree and population variations existing in this species, that can be utilised to select superior types for tree improvement work in order get maximum genetic gain.

AUTHOR CONTRIBUTION

Suraj R Hosur, conceived and designed the experiment, performed the experiment, analysed and interpreted the data, wrote the paper. Shivakumar BH perormed the experiment. Krishna A, Jagadish MR, Vasudeva R and Mohanakumar, conceived and designed the experiments.

REFERENCES

Abdelkheir RM, Ibrahim AM and Khalil AAM 2003. Provenance variation in seed and germination characteristics of Acacia Karroo. *Sudan Silva* **9**(2): 14-28.

Abraham L, Mulualem T, Demel T, Kenneth L and Anders F 2006. Provenance variation in seed morphometric traits, germination and seedling growth of *Cordia africana* Lam. *New Forest* **32**: 71-86.

Arjun R 2017. *Seed source variation for fruit, seed, seedling and camptothecin, an anti-cancer drug, in Pyrenacantha volubilis.* M.Sc. thesis. University of Agricultural Sciences, Dharawad, Karnataka, India.

Basappa S 2011. *Seed source variation of Emblica officinalis garten for seed and seedling traits.* M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Gamble JS 1921. *Flora of the Presidency of Madras*. West, Newman and Adlard.

Gunaga RP, Manjunath AV, Gunaga SV and Vasudeva R 2015. Tree to tree variation in seed traits and germination in *Dysoxylum binectariferum* Hook.F. *Indian Forester* **141**(5): 578-580.

Gunaga RP, Mayur MM and Wanage SS 2020. Morphological variation in seed traits, germination and seedling growth in endangered medicinal tree species, *Saraca asoca* (Roxb.) de Wilde., from different seed sources of Konkan region, Maharashtra. *Journal of Pharmacognosy and Phytochemistry* **9**(4): 157-162.

Hanumantha M 2020. *Assembling, genetic evaluation and selection of superior types in Cinnomomum zeylanicum Blume*. Ph. D. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Hareesh TS, Gunaga RP, Vasudeva R, Shivanna KR, Uma Shanker R and Gladwin J 2008. Variation for seedling vigour among Half-sib families in *Nothapodytes nimmoniana* (Grah.) Mabber: an anti-tumor drug yielding plant. *Journal of Non-Timber Forest Products* **15**(3):161-165.

Jain SK and Defilipps RA 1991. *Medicinal Plants of India*, Reference Publications Inc., Michigan, USA vol. I.

Received 15 February, 2023; Accepted 20 July, 2023

Jamaludheen V, Gopikumar K and Sudhakar K 1995. Variability studies in *Lagestromia speciosa*. *Indian Forester* **121**: 137-142.

Kallaje SR 2000. *Improvement studies in Garcinia indica Choicy*. M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Mahajan V, Sharma N, Kumar S, Bhardwaj V, Ali A, Khajuria RK, Bedi YS, Vishwakarma RA and Gandhi SG 2015. Production of rohitukine in leaves and seeds of *Dysoxylum binectariferum*: an alternate renewable resource. *Pharma Biological* **53**(3): 446–450.

Mamo N, Mihreto M, Fekadu M, Tigabu M and Teketay D 2006. Variation in seed and germination characteristics among *Juniperus procera* populations in Ethiopia. *Forest Ecology and Management* **225**: 320-327.

Manjunath L 2003. *Reproductive biology and half sib family performance of Dysoxylum malabaricum Bedd: An important threatened timber species.* M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Mohanakumara P, Sreejayan N, Priti V, Ramesha BT, Ravikanth G, Ganeshaiah KN, Vasudeva R, Mohan J, Santhoshkumar TR and Mishra PD 2010. *Dysoxylum binectariferum* Hook. f (Meliaceae), a rich source of rohitukine. *Fitoterapia* **81**(2): 145-148.

Naik R, Ramacharan G, Kattige SL, Bhat SV, Alreja B, De Souza NJ and Rupp RH 1988. An anti-inflammatory immunomodulatory piperidinyl benzopyranone from *Dysoxylum binectariferum*: isolation, structure total synthesis. *Tetrahedron* **44**: 2081-2086.

Nath PC, Arunachalam A, Khan ML, Arunachalam K and Barbhuiya AR 2005. Vegetation analysis tree population structure of tropical wet evergreen forests in around Namdapha National Park, northeast India. *Biodiversity Conservation* **14**: 2109-2135.

Patil JB 2012. *Provenance variation studies on fruit, seed and seedling traits of Zanthoxylum rhetsa: A tree under high exploitation in Central Ghats.* M.Sc. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India).

Senthilkumar R, Krishnamoorthy B, Prasanth D, Venugopal MN, Ankegowda SJ and Biju CN 2010. Variability in Nutmeg (*Myristica fragans* Houtt.) under high rainfall and high altitude Kodagu region of Karnataka. *Indian Journal of Plant Genetic Resources* **23**(2): 191-194.

Singh S, Garg HS and Khanna NM 1976. Dysobinin, A New tetranortriterpene from *Dysoxylum binectariferum*. *Phytochemisitry* **15**: 2001- 2002.

Tomar A and Rattan V 2012. Source variation in fruit, seed and seedling traits of *Hippophae salicifolia. International Journal of Pharmacology and Life sciences* **3**(12): 2181-2185.

Uma R 2015. *Seed source performance and estimation of genetic parameters of fruit, seed and seedling growth and of Buchanania lanzan Spreng. In Uttara Kannada District,* M. Sc. Thesis. University of Agricultural Sciences, Dharwad, Karnataka (India).

Zobel B and Talbert J 1984. *Applied forest tree improvement.* John Wiley and Sons, 545p.