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SEED SOURCE VARIATION IN GERMINATION BEHAVIOR OF *Vateria indica* Linn.

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ABSTRACT
The seed samples of *Vateria indica* were collected from three contrasting locations represented by three random trees for each location in Karnataka were studied to know the pattern and extent of variation in seed germination parameters. Significant variation was observed among seed sources for germination parameters like, germination per cent, time taken to initiate germination and germination value. But the results did not show any significant difference for speed of germination and time taken to complete germination. Similarly, tree-to-tree variations in each of the three seed sources studied were found to be significant for all the parameters except for speed of germination. These findings have significant relevance for identifying better seed source when there is need for large scale seed collection for mass production of quality seedlings for the restoration or aforestation programmes.

KEY WORDS: seed source, germination per cent, speed of germination, germination value, restoration.

INTRODUCTION

The forests form one of the major national assets; so much is dependent on their existence. and considered to be economic safety especially in developing countries by providing larger proportion of employment and livelihood security (FAO, 2010). These resources are under tremendous pressure due to careless, indiscriminate and massive clearance of forest for agriculture and other social benefits leading to deforestation. The reckless deforestation due to population growth along with the living standards would lead to many environmental issues (Nair *et al.,* 2010). Concerted efforts are being made continuously to reverse deforestation and reclaim the land degraded by deforestation. This will require large number of plants, which ultimately depend upon seed and its quality. Vegetative propagation has also become increasingly popular for the propagation with difficult seeds (Kantrali, 1993). Yet, seed propagation remains the principal mode of propagation in the temperate as well as in the tropical region. *Vateria indica* Linn. is an important evergreen tree in India. The tree is found in South-Western India from North Kanara in Karnataka to Tirunelveli in Tamil Nadu through entire Kerala. The genus belongs to the family Dipterocarpaceae and the red list status of this species has been assessed as "Critically endangered" species endemic to the Western Ghats, South India (Ashton, 1998). It is very popular due to its valuable uses as timber and medicinal importance. In order to sustain the species, organized efforts for tree improvement and plantation establishment are needed which requires high quality planting material. The occurrence of the species over a wide geographic range, encompassing a great diversity of edapho-climatic conditions expected to be reflected in the genetic constitution of its diverse seed sources which, intern influence germinability and plant production (Gera *et al.,* 1999; Indira and Chand Basha, 1999). Seed is one of the important inputs for forest nursery production and plantation establishment (Lauridesen and Oleson, 1990). Variation in germination of seed sources has been documented in number of tree species such as *Acacia catechu* (Kumar *et al.,* 2004), *A. nilotica* (Shekar *et al.,* 2002), *Albizia lebbeck* (Radhakrishnan and Vanangamudi, 2004), *Dalbergia sissoo* (Devagiri, 1997), *Grewia optiva* (Tyagi *et al.,* 1999) and *Pongamia pinnata* (Vasantha Reddy *et al.,* 2007). The present investigation was also envisaged to study the seed source variation among various germination parameters.

MATERIALS & METHODS

Seed collection

The experimental material was collected from three seed sources (viz., Begur and Sampaje sources at Kodagu and Janemane source at Uttara Kannada) of Karnataka and the geo-climatic details of these locations are presented in Table 1. Fruits were collected from three randomly selected trees in each of these seed sources. In order to give uniformity in sampling, after the collection, the fruit lots were processed by removing the dead and damaged fruits. The experimental samples were drawn from these lots.

Nursery trials

Standard raised nursery beds of the size 11×1.2×0.15 m were made in nursery at College of Forestry, Ponnampet. Each bed was divided into nine equal plots of 1.2 m^2, each one representing a treatment. The fruits were sown separately in a Compact Family Block Design with four replications, considering individual tree as sub-treatment while group of trees from a location as main treatment. In each treatment 50 fruits were sown in five rows with spacing of 20 cm between rows and 10 cm from fruit to fruit in a row. The number of seeds germinated was recorded every day, till the end of the experiment. The seeds were considered germinated when the sprouted plumule had emerged about 1 cm above the bed.

TABLE1: Geo-climatic details of the seed sources for *Vateria indica*

Seed source	District	Latitude (^oN)	Longitude (^oE)	Altitude (m amsl)	Mean Annual Rainfall (mm)
Begur	Kodagu	12.06	75.55	861.00	2400.00
Sampaje	Kodagu	12.27	75.39	378.68	4100.00
Janemane	Uttara Kannada	14.61	74.83	504.20	2503.20

Germination parameters

The various germination parameters worked out include germination per cent, speed of germination, time taken to initiate and complete germination, peak value of germination and germination value. The methodology and formulae used to calculate these are as under,

a) Per cent germination

All the seeds germinated normally till the end of the germination period were counted and cumulative germination was expressed as percentage of the total number of seeds sown.

$$\% \text{ Germimination} = \frac{\text{Number of seed germinated}}{\text{Total number of seed sown}} x\ 100$$

b) Number of days taken to initiate and to complete germination:

Number of days taken from sowing to initiation and completion of germination were recorded for each treatment.

c) Speed of germination:

An index of the speed of germination was calculated by adding the quotients of the daily counts divided by the number of days of germination.

$$\text{Speed of Germination (SG)} = \frac{G_1}{D_1} + \frac{G_2}{D_2} + \frac{G_3}{D_3} + \ldots\ldots\ldots + \frac{G_n}{D_n}$$

Where,

$G_1, G_2, G_3, \ldots\ldots G_n$ is number of seeds newly germinated on 1, 2, 3,…..n^{th}, day respectively.

D_1, D_2, D_3 …….D_n is count on 1, 2, 3…… n^{th} days, respectively.

d)Germination value (GV)

The concept of GV was calculated by Czabator method (Willan, 1985). An index combining speed and total germination. Total germination was expressed as (final) mean daily germination (MDG), calculated as the cumulative percentage of full seed germination at the end of the test divided by the number of days from sowing to the end of the test. Speed of germination is expressed as peak value, which is the maximum mean daily germination (cumulative percentage of full seed germination divided by number of days elapsed since sowing date) reached at any time during the period of test. GV was calculated as follows,

GV = PV × (Final) MDG

All the data collected and various germination parameters were worked out such as germination per cent, speed of germination, time taken to initiate and complete germination, peak value of germination and germination value were subjected to statistical analysis with following appropriate methods to estimate the mean values. The data thus, obtained related to all these parameters were arc-sine transformed and data of germination per cent were subjected to analysis of variance (ANOVA) (Jayaraman, 2001) to considered the significant difference between seed source.

RESULTS AND DISCUSSION

The geographical locations of various seed sources ranged from 12^o 06' N to 14^o 61' N for latitude, 74^o 83' E to 75^o 55' E for longitude, 378.68 m to 861 m above mean sea level for altitude and 2400 mm to 4100 mm for rainfall. The performance of seed germination parameters of various seed sources at nursery stage are presented in Table 2. The results indicate that the germination percentage was highest in Sampaje (84.44) followed by Begur (74.08) and it was as low (66.20) for Janemane location. Sampaje location was found to be statistically different from Janemane but on par with Begur location and there was no significant difference between Janemane and Begur source. As far as individual trees were considered, the germination per cent varied from 43.49 to 94.69 (Fig.1a). The results on speed of germination differ significantly among the source and also among the trees. The maximum speed was 3.21 in Sampaje while minimum was 2.05 in Janemane location (Fig.1b). Time taken to initiate germination was found to be maximum (7 days) for Janemane and was significantly different from other two locations, while fruits from Begur and Sampaje locations took less number of days (4.67 and 4.75). For individual trees, it was varied from 4.25 to 8.50 days. The effect of sources on time taken to complete germination was insignificant and the values varied from 28.50 days for Begur to 31.58 days for Janemane. Highest peak value of germination was recorded for trees from Sampaje (8.58) followed by those of Begur (6.92) and it was least for Janemane location (6.08) (Fig.1c). The data revealed that germination value was maximum (14.80) for Sampaje followed by Begur (12.00). The differences between these two sources were not statistically significant, while the tree from Janemane recorded lowest germination value of 8.45 and were significantly different from Sampaje. However, in each location only one tree was found to be significantly different in respect of germination value from other two trees (Fig.1d).

TABLE 2: Seed source effect on germination parameters in *Vateria indica*.

Seed source		Germination %		SG	*TTIG* (days)	TTCG (days)	PV	GV
Begur	Tree-1	(45.89)	51.59	1.95	4.25	30.00	4.00	4.26
	Tree-2	(58.81)	73.22	2.99	4.25	28.50	7.00	10.57
	Tree-3	(73.40)	91.87	3.42	5.50	27.00	9.75	21.18
	Mean	(59.37)	74.08	2.79	4.67	28.50	6.92	12.00
Sampaje	Tree-1	(54.81)	66.83	2.31	5.25	32.50	7.25	9.09
	Tree-2	(68.75)	86.90	3.03	4.75	36.50	8.00	10.81
	Tree-3	(76.65)	94.69	4.30	4.25	25.00	10.50	24.47
	Mean	(66.74)	84.44	3.21	4.75	31.33	8.58	14.80
Janemane	Tree-1	(41.24)	43.49	1.19	8.50	28.25	4.50	4.70
	Tree-2	(50.80)	60.09	1.79	7.50	34.00	5.75	6.50
	Tree-3	(71.26)	89.71	3.18	5.00	32.50	8.00	14.15
	Mean	(54.43)	66.20	2.05	7.00	31.58	6.08	8.45
CD for Location @ 5%		(10.83)		0.26	1.14	NS	2.13	4.76
CD for Trees @ 5%		(9.20)		0.26	1.09	4.06	2.76	7.38
CV%		10.30		5.44	13.51	8.98	25.83	42.30

* Values in parentheses are arc-sine transformations, SG: Speed of germination, TTIG: Time taken to initiate germination, TTCG: Time taken to complete germination, PV: Peak value of germination and GV: Germination value.

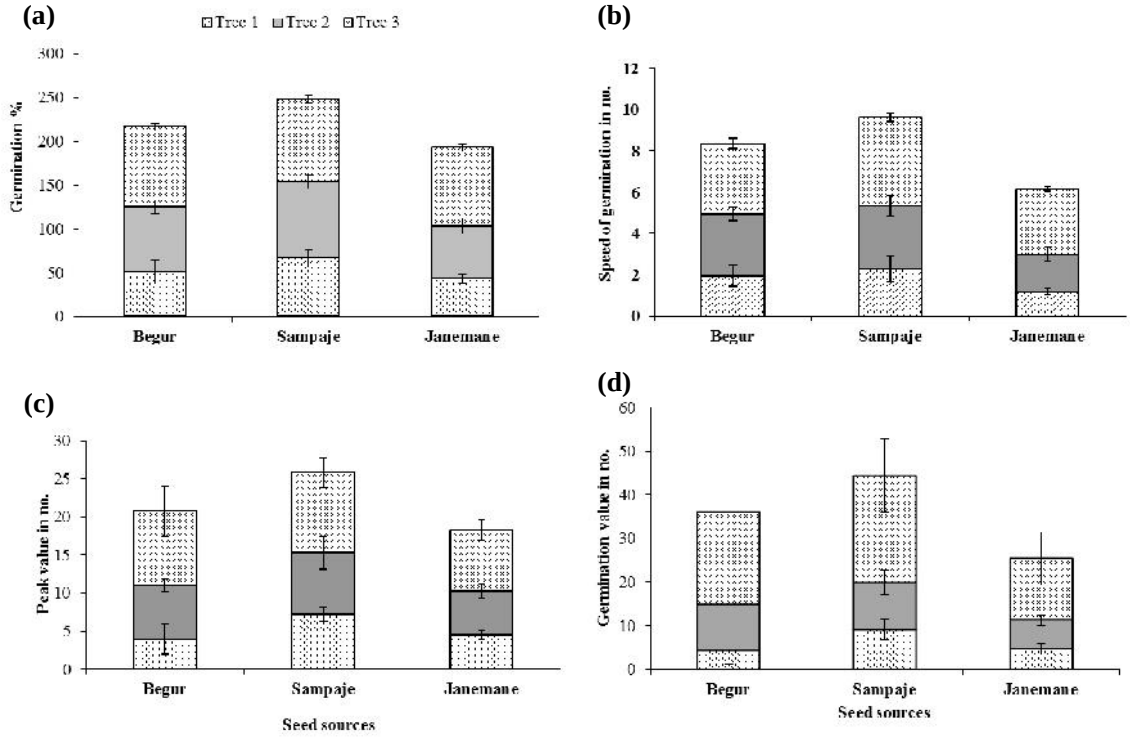

FIGURE 1. Inter and intra-population variation for germination parameters [(a). Germination %, (b). Speed of germination, (c). Peak value of germination (d). Germination value] in *Vateria indica*

With respect to relationship between geographical locations of the seed sources and variables studied, statistically significant differences were obtained for most of the germination parameters (Table 2). The results indicated that, the differences in the germination parameters could be due to wide variation in microclimate and local environmental conditions in the range of distribution of this species (Gera *et al.*, 1999; Devagiri, 1997). Due to particular set of local environmental conditions, the genetic constitution of the species for the particular traits must have changed resulting in geographically distinct clines (Kumar *et al.*, 2004). The occurrence of the species over a wide geographic range encompassing a great diversity of edapho-climatic conditions of its habitat is expected to be reflected in the genetic constitution of its diverse populations (Gera *et al.*, 1999). As a result, racial variation among the populations of diverse origin did show association with locality factors such as latitude, longitude. altitude, precipitation etc (Shekar *et al.*, 2002). It is clear from the present investigation that, in case of *Vateria indica* different seed sources as well as individual trees within each seed source influenced seed germination. The extent of variation was found to be higher among the trees within each seed

source than between the groups of trees growing in a locality. The significant variation could be due to average annual rainfall of the seed sources appears to have direct influence on seed germination, as the average annual rainfall of Janemane is much lower (2503 mm) as compared to that of Sampaje (4100 mm) (Table 1). Higher tree-to-tree variation observed for seed germination could be due to genetic dissimilarity among the trees as the recalcitrant seeds of the species might get dispersed within a narrow range due to lack of dormancy. Whatever might be the cause for seed source variation and tree-to-tree variation within a population for seed germination, its importance needs to be considered while taking up seed collection either for bulk planting or for research programme.

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