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VARIATIONS IN POD AND SEED TRAITS IN SIX DIFFERENT *DALBERGIA SISSOO* SEED SOURCES

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SINGH, N. & POKHRIYAL, T. C. 2001. Variations in pod and seed traits in six different *Dalbergia sissoo* seed sources. A study was conducted to elucidate the pattern of variation in pods, seed characteristics and germination behaviour among *Dalbergia sissoo* seed sources to develop selection criteria for future tree improvement programmes. Six seed sources were selected to represent widely divergent areas. All pod traits (except number of seeds per pod), seed characters, i.e. length, width, weight (except seed thickness) and germination parameters, i.e. germination percentage, germination value, germination period, etc., varied significantly among different seed sources. The variation observed among different seed sources may probably be influenced by different intensities of natural constraints acting upon these traits in the prevailing geographic/climatic conditions. Among the six different seed sources, Gonda (Tulsipur) showed the best performance followed by Kankai, Chiriyapur, Simblewala, Hissar and Sibsagar (the poorest). Seed weight and thickness showed highly positive and seed length negative correlation with germination percentage; hence these can be considered as important traits for the selection of superior seed source.

Key words: Seed source - trait - variations - germination behaviour - *Dalbergia sissoo*

SINGH, N. & POKHRIYAL, T. C. 2001. Perubahan sifat-sifat lenggai dan biji benih dalam enam sumber biji benih *Dalbergia sissoo*. Kajian dijalankan untuk menerangkan mengenai corak perubahan lenggai, ciri-ciri biji benih dan tingkah laku percambahan bagi sumber biji benih *Dalbergia sissoo* untuk membangunkan kriteria pemilihan dalam rancangan pembaikan pokok pada masa hadapan. Enam sumber biji benih dipilih untuk mewakili kawasan pencapahan yang luas. Semua sifat lenggai (kecuali bilangan biji benih dalam setiap lenggai), ciri-ciri biji benih, iaitu panjang, lebar, berat (kecuali ketebalan biji benih) dan parameter percambahan, iaitu peratus percambahan, nilai percambahan, tempoh percambahan, dan lain-lain berubah-ubah dengan bererti di dalam sumber-sumber biji benih yang berbeza. Perubahan yang dicerap dalam sumber-sumber biji benih yang berbeza mungkin dipengaruhi oleh keamatan yang berbeza dalam kekangan semula jadi yang berlaku kepada ciri-ciri ini dalam keadaan geografi/iklim yang biasa. Antara enam sumber biji benih yang berbeza, Gonda (Tulsipur) mempamerkan prestasi yang terbaik diikuti oleh Kankai, Chiriyapur, Simblewala, Hissar dan Sibsagar (yang paling teruk). Berat dan ketebalan biji benih mempamerkan korelasi yang sangat positif dan kepanjangan biji benih mempamerkan korelasi negatif dengan peratus percambahan; dengan ini ia dapat dianggap sebagai ciri-ciri yang penting dalam pemilihan sumber biji benih yang baik.

Introduction

Dalbergia sissoo Roxb. is a well-known multipurpose tree species, widely distributed in the tropics, especially in arid and semi-arid countries, for timber, fuel and fodder. The degrees of adaptation vary with the relative rates of environmental change or sometimes sudden changes in topography and soil, resulting in corresponding genetic variations in the species. It has been established that species with narrow range generally express less genetic variation compared to species with broad geographic range (Ingram 1984, Krause *et al.* 1984). This variation within a population of tree species has been exploited during the selection of superior provenance for a given site to evolve strategies for the conservation of genetic diversity within population of tree species. The significance of genetic variation studies and provenance testing in forest tree improvement is well known (Pryor 1963, Callaham 1964). Many provenance studies have confirmed the strong correlation between seed traits, particularly seed weight, and environmental conditions in which their parent trees normally grow. Apart from selecting and delineating provenance, improving seedling production and reducing nursery cost through selection of site matched quality seeds can be based on various seed parameters. However, little is known about these parameters in *D. sissoo* provenances. Therefore, in this study, an attempt was made to examine the morphological variations in pod and seed traits which could be used as an index for the evaluation of provenances or progeny trials in *D. sissoo.*

Materials and methods

Seeds were collected from six different seed sources representing different agroclimatic zones, viz. Chiriyapur (West Uttar Pradesh), Gonda (Tulsipur, East Uttar Pradesh), Hissar (Haryana), Kankai (Nepal), Sibsagar (Assam) and Simblewala (Jammu), and used immediately in the same year. The detailed information of seed sources is presented in Table 1. Thoroughly mixed bulk pods collected from different seed sources were sun dried. Four samples of 1000 undamaged, crisp pods from each seed lot were randomly collected for measurements of the morphological parameters, i.e. length, width, weight and number of seeds per pod. In manually extracted seeds, length, width, thickness and weight were recorded. Four replications, each containing 1000 seeds, were placed between two layers of paper towel which were rolled and placed vertically in germination cabinets at 25 ± 2 °C. The paper towels were kept moist throughout the period of experiment by spraying water as and when required (Vakshasya *et al.* 1992). The germination percentage and daily germination count were recorded for a period of 21 days. Each seed was considered to be germinated when the radical attained approximately 1cm length. Daily germination counts were recorded and germination value (GV) was calculated according to the equation of Czabator (1962). The speed of germination was expressed in terms of germination value. The observations on ten different characteristics were recorded and analysed using one way ANOVA and

simple correlations were also worked out among seed sources and other possible combinations with latitude, longitude and rainfall.

Table 1. Geographic locations of *Dalbergia sissoo* seed sources

S. No.	Seed source	State	Latitude (N °)	Longitude (E °)	Altitude (m above sea-level)	Rainfall (mm y^{-1})
1.	Chiriyapur	U.P.-West	29.5	76.4	454	1166.0
2.	Gonda (Tulsipur)	U.P.-East	27.1	81.9	110	1294.0
3.	Hissar	Haryana	28.9	76.6	178	567.0
4.	Kankai	Nepal	27.3	85.2	121	1125.0
5.	Sibsagar	Assam	27.0	94.6	97	2504.3
6.	Simblewala	Jammu	32.3	74.8	324	978.0

U.P. = Uttar Pradesh.

Results

The pods collected from Gonda exhibited maximum pod length (9.51 cm), closely followed by those from Sibsagar (9.48 cm), with the lowest (3.17 cm) from Simblewala. The differences among Gonda, Kankai and Sibsagar were statistically not significant. Chiriyapur, Hissar and Simblewala fell under the same bar (Table 2). However, overall average data on pod length showed significant (p= 0.05) differences with respect to different seed sources. Maximum pod width was recorded for Kankai (1.64 cm), followed by Gonda (1.44 cm), Chiriyapur (0.83 cm), Simblewala (0.70 cm), Hissar (0.58 cm) and Sibsagar (0.40 cm, the minimum). The pod widths for Kankai and Gonda sources were statistically higher than for the others (Table 2). Maximum 1000^{-1} pod weight was recorded in Gonda seed source (85.79 g) and the lowest in Sibsagar (35.03 g). Chiriyapur (56.61 g) and Kankai (53.31 g), the intermediate performers, did not differ statistically from each other. The differences among Sibsagar, Hissar and Simblewala seed sources were not significant. The pods collected from Kankai showed the highest number of seeds pod^{-1} (2.80), followed by those from Gonda (2.75), Simblewala (2.00), Chiriyapur (1.84), Hissar (1.35) and Sibsagar(1.00). No significant differences were recorded in the number of seeds pod^{-1} among various seed sources. Maximum 1000^{-1} seed weight (24.97 g) was noted in Gonda seed source, followed by Kankai (20.00 g), Chiriyapur (15.87 g), Hissar (15.00 g), Simblewala (10.00 g) and Sibsagar (9.90 g). No significant differences were observed between Chiriyapur and Hissar, and between Simblewala and Sibsagar at 5 per cent level of significance (Table 2).

Table 2. Pod and seed characteristics of *D. sissoo* : statistical analysis (the seed source is printed above each value)

Character	Bar diagram of mean values						C.D.	Level of significance
Pod length (cm)	Gonda	Sibsagar	Kankai	Chiriyapur	Hissar	Simblewala		
	9.51	9.48	7.34	5.63	4.32	3.17	4.53	*
Pod width (cm)	Kankai	Gonda	Chiriyapur	Simblewala	Hissar	Sibsagar		
	1.64	1.44	0.83	0.70	0.58	0.40	0.96	*
Pod weight (g 100^{-1})	Gonda	Chiriyapu	Kankai	Simblewala	Hissar	Sibsagar		
	85.79	56.61	53.31	43.70	38.43	35.03	8.77	***
No. of seeds pod^{-1}	Kankai	Gonda	Simblewala	Chiriyapur	Hissar	Simblewala		
	2.80	2.75	2.00	1.84	1.35	1.00	-	ns
Seed weight (g 1000^{-1})	Sibsagar	Simblewala	Hissar	Chiriyapur	Kankai	Gonda		
	9.90	10.00	15.00	15.87	20.00	24.97	4.53	***
Seed volume (cc)	Gonda	Kankai	Chiriyapur	Simblewala	Hissar	Subsagar		
	0.99	0.77	0.70	0.50	0.44	0.31	0.50	***
Seed length (mm)	Gonda	Kankai	Chiriyapur	Simblewala	Sibsagar	Hissar		
	5.93	6.33	6.41	7.68	8.92	8.96	1.49	***
Seed width (mm)	Sibsagar	Simblewala	Chiriyapur	Hissar	Gonda	Kankai		
	2.33	4.18	4.39	4.56	4.65	5.00	1.67	**
Seed thickness (mm)	Gonda	Kankai	Chiriyapur	Simblewala	Hissar	Sibsagar		
	2.22	1.77	1.10	1.02	0.99	0.94	-	ns
Germination %	Sibsagar	Hissar	Simblewala	Kankai	Chiriyapur	Gonda		
	59.23	64.81	70.42	89.39	92.37	95.56	11.57	***
Germination value	Gonda	Kankai	Chiriyapur	Simblewala	Hissar	Sibsagar		
	288.20	269.40	187.90	174.30	152.80	129.08	11.07	***
Germination period (days)	Sibsagar	Hissar	Chiriyapur	Simblewala	Gonda	Kankai		
	11.00	10.50	6.25	6.25	4.75	2.67	4.40	***

*p = 0.05, **. p = 0.01, ***p = 0.001, ns = not significant , (Bar): treatments under bar are homogenous.

Results obtained on the seed physical characteristics, viz., seed length, width and thickness are presented in Table 2. The lowest seed length was recorded in Gonda (5.93 mm) followed by Kankai (6.33 mm), Chiriyapur (6.41 mm) Simblewala (7.68 mm), Sibsagar (8.92 mm) and Hissar (8.96 mm). The highest seed width was noticed in Kankai (5.00 mm), followed by Gonda (4.65 mm), Hissar (4.56 mm), Chiriyapur (4.39 mm), Simblewala (4.18 mm) and Sibsagar (2.33 mm, the minimum). Seed thickness followed almost a reverse pattern of variation to that of seed length. The highest seed thickness (2.22 mm) was recorded in Gonda seed source, followed by Kankai (1.77 mm), Chiriyapur (1.10 mm), Simblewala (1.02 mm), Hissar (0.99 mm) and Sibsagar (0.94 mm). Differences in seed thickness of different seed sources were statistically not significant (Table 2).

The highest seed germination percentage was noticed in Gonda (95.6%), followed by Chiriyapur (92.4%), Kankai (89.4%), Simblewala (70.4%), Hissar (64.8%) and Sibsagar (59.2%). However, the differences among Sibsagar, Hissar and Simblewala, and among Kankai, Chiriyapur and Gonda were observed to be not significant (Table 2). A highly significant variation in germination value among the seeds collected from different sources was noticed. The seeds collected from Gonda showed the highest germination speed (germination value) and Sibsagar the lowest. However, non-significant differences were observed between Chiriyapur and Simblewala seed sources. The lowest germination period (2.67 days) was taken by Kankai, followed by Gonda (4.75 days), Simblewala and Chiriyapur (6.25 days each). All these seed sources were statistically under the same bar (Table 2). However, a significantly higher germination period was recorded in Sibsagar (11 days), closely followed by Hissar (10.5 days) as compared to other seed sources.

Pod length did not exhibit any significant correlation with other pod traits, viz. width, weight, number of seeds pod^{-1}, and seed traits, viz. seed weight, volume, thickness, width, length, survival (%), germination (%), energy period, germination energy and germination value (Table 3). However, pod width, pod weight and number of seeds pod^{-1} showed significant correlations with each other and other seed traits as well. Pod width showed significant ($p = 0.001$) positive correlations with number of seeds pod^{-1} and germination value and significant ($p = 0.01, 0.05$) negative correlations with seed length and energy period. Pod weight also showed a significant correlation with seed and pod traits except seed width and energy period (Table 3).

Seed traits showed significant correlations among themselves and also with germination parameters. With seed parameters, significant positive correlations among seed weight, thickness, germination (%), germination energy, germination value and negative correlations with seed length were noticed. However, correlation between seed width and energy period was observed to be not significant. Seed volume exhibited positive correlation with germination (%). Seed thickness showed significant positive correlations with germination percentage and germination value, and negative correlation with energy period. Significant negative and positive correlations between seed length and germination

Table 3. Correlation coefficients (r) among pod and seed traits of *D. sissoo*

Sl. No	Trait	01	02	03	04	05	06	07	08	09	10	11
01	Pod length	1										
02	Pod width	0.3261	1									
03	Pod weight 1000^{-1}	0.424	0.723*	1								
04	No. of seeds pod^{-1}	0.1554	0.961***	0.753*	1							
05	Seed weight	0.4395	0.852**	0.879**	0.782*	1						
06	Seed thickness	0.5453	0.902**	0.886**	0.864**	0.926***	1					
07	Seed width	-0.353	0.701*	0.503	0.749*	0.663*	0.525	1				
08	Seed length	-0.359	-0.81*	-0.82**	-0.83**	-0.72*	-0.76*	0.496	1			
09	Germination %	0.234	0.817*	0.852**	0.829*	0.899***	0.872***	0.6722	-0.955***	1		
10	Energy period	0.064	-0.90**	0.645**	-0.95**	-0.637	-0.72*	-0.702*	0.8778*	-0.845**	1	
11	Germination value	0.357	0.974***	0.854**	0.964***	0.907***	0.959***	0.689	-0.8510*	0.860**	0.8582*	1

Table 4. Simple correlation (r) between characters studied and geographical factors of *D. sissoo* seed sources

Character	Latitude	Longitude	Altitude	Rainfall
Pod length	-0.187	-0.393	0.259	-0.459
Pod width	-0.311	-0.158	-0.839	-0.389
Pod weight	-0.125	-0.265	-0.388	-0.612
No. of seeds pod^{-1}	-0.104	-0.264	-0.496	-0.488
Seed weight	-0.495	-0.070	-0.648	-0.263
Seed volume	-0.230	-0.160	-0.548	-0.538
Seed thickness	0.196	-0.278	-0.372	-0.506
Seed width	0.392	0.370	0.890**	0.102
Seed length	0.163	0.366	-0.369	0.719*

* Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
*** Significant at 0.1 per cent level of significance.

value and between seed length and energy period respectively were recorded. Germination (%) showed significant negative correlation with energy period and positive correlation with germination energy and germination value. A positive correlation between germination energy and germination value was noticed (Table 3).

Discussion

Environmental deviation effects on phenotypic characters are generally negligible under controlled conditions. Apart from genetic factors, germination is influenced by seed source (Allen 1961), pre-treatment (Kozlowski & Gentle 1959), seed maturity (Edwards 1980, Edwards & El-Kassaby 1988), and seed size (Wulff 1972, Hellum 1990). However, in this study pod characteristics did not exhibit any significant correlation with climatic factors and indicated a non-clinal variation, whereas seed sources representing moderate rainfall regions produced larger pods with more number of seeds than the humid and sub-humid regions (Tables 1, 2,4). Gonda seed source was able to gain the maximum pod and seed weight followed by Kankai and Chiriyapur. Almost similar observations with respect to pod and seed parameters have been reported earlier in *Prosopis cineraria* (Kacker *et al.* 1986), *Acacia mangium* (Salazar 1989) and *A. nilotica* (Sniezko & Stewart 1989).

A marked variation in seed parameters, viz. seed weight, length, width and thickness, among different seed sources was recorded. A strong correlation between seed weight and germination percentage in different seed sources, which gives a suitable base for the consideration of seed weight in delineating and understanding the geographic variation, may possibly be due to cumulative effects of both internal (maternal) and external (environmental) conditions prevailing during the process of seed development as earlier reported by Harper *et al.* (1970). It is apparent that seed sources from moderate rainfall areas, i.e. Gonda, Kankai and Chiriyapur, produced higher seed weight than heavy rainfall areas like Sibsagar in Assam. This could be possibly because the population from moderate rainfall area developed a better source-sink relationship resulting in the formation of better seed size to facilitate quick and uniform germination, hence faster root–shoot growth. Birot (1972) has reported a negative relationship between 1000 seed weight and latitude of origin. Palmblad (1968) reported seed size as one of the least flexible traits and considered in some cases seed size to identify seed lots of unknown provenances. The variation among seed source with respect to seed size and weight has already been reported earlier by many workers (Salazar 1989, Sniezko & Stewart 1989, Bagchi & Dobriyal 1990, Vakshasya *et al.* 1992, Hooda & Bahadur 1993, Krishan & Toky 1996, Sidhu 1997). In *Dalbergia sissoo* it was noticed that seed source with more pod weight, seed weight and seed size showed better germination performances. Earlier, Shiv Kumar and Banerjee (1985) have also reported significant correlation among seed weight, speed and uniformity of germination in *A. nilotica*. Baldwin (1942), Langdon (1958), Williums (1967), Taylor (1972) and Kandya (1978) reported seed size as an important character

to regulate germination and subsequent seedling growth in many species. Higher seed size and weight have been generally observed to produce faster germination and initial seedling growth. Czabator (1962), and Dunlap and Barnett (1983) reported that germination value, an index combining speed and completeness of germination, was influenced by seed size and weight. In the present study seed storage aspect was not considered because seeds have been found to remain viable for up to fifteen months at room temperature (Robbins 1988, Bangarwa 1993) and seed moisture has not shown any significant variation among different seed sources.

The results pertaining to pod, seed and germination behaviour exhibited a non-clinal pattern of variation. Among the six different seed sources, Gonda showed the best performance followed by Kankai, Chiriyapur, Simblewala, Hissar and Sibsagar, the poorest. The germination percentage and germination value showed strong positive correlations with pod weight, seed weight and thickness, and negative correlations with seed length; hence these traits can be taken into consideration while selecting superior seed material for better germination vigour. The occurrence of higher seed weight and germination percentage in moderately wet zones and lighter seeds with low germination percentage in wetter or drier zones is evident from the study.

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