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Variation in Seed Size of Acacia spp.

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Summary

In a study of Acacia species, the seed parameters of length, width and thickness of 23 genotypes were measured in millimeters. Analyses of the three traits showed significant species differences. The very low error variance component signified that the traits are highly heritable. The high %-contributions combined with the high species coefficient of variation indicated that seed size could be altered by selection and breeding.

The strong correlation between seed length and width indicated that improvement in one character would improve the other. The three seed parameters appear to be governed independently and the association between pairs of traits varied considerably.

Key words: *Acacia spp.*, seed size, species variation, %-contributions.

Introduction

The species of Acacia commonly known as Kikkars are one of a group of important forest tree species in the arid and semi-arid regions of Northern India. They are multipurpose species which are included in agroforestry programs for increasing benefit to rural farmers. In efforts to produce seedlings for the planting programs, it was observed that: 1) Acacia seeds continued germination even after 160 days (when the experiment was concluded) from the date of seed sowing and even then some seeds remained viable; (2) Only approximately 20% of the seeds of *A. nilotica* produced healthy transplantable seedlings after 20 to 25 days from sowing; (3) bigger (heavier) seeds yield better seedling vigour. SHIV KUMAR and BANERJEE (1986) reported that the provenances of *A. nilotica* with heavier seed weight yielded plants with the best height and diameter) and (4) seeds of smaller size take longer to germinate. The protracted germination time requires longer nursery care and inhibits raising uniform seedlings for large scale plantations. With a view to this the present investigation on the variation in seed parameters and on the opportunities for improving them were taken up. The study has a direct relevance to the field forestry management. The seed size if improved will reduce the seed requirement and curtail the expenditure on seed procurement. Improved seed will require lower seed-rate and lesser seed-bed area reducing seed-sowing cost. Finally uniform germination with better seedling vigour will ensure lesser nursery management time thereby lessening the maintenance cost.

Materials and Methods

Seeds of 23 species/varieties of *Acacia* were obtained from different sources (*Table 1*). Out of these, three species (*A. nilotica* var. *nilotica*, *A. raddiana* and *A. catechu*) were obtained from two sources each. From the individual bulk collections of each species/variety 40 seeds in 4 batches (10 seeds per batch) were measured for length, width and thickness to the nearest tenth millimetre. The significance of the mean differences for the three traits were obtained with the help of range tests and bar diagrams. Species and error variance, species coefficient of variation, error coefficient of variation, %-contributions and correlation coefficients were estimated using the method of KEMPTHORNE (1957).

Results and Discussion

Of the 23 species and varieties mean length of seed varied between 5.0 mm and 15.42 mm, mean width between 3.64 mm and 12.3 mm, and mean thickness between 1.5 mm and 4.49 mm. Highly significant differences

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Table 1. — Mean seed length, width and thickness from 23 sources of Acacia species and varieties.

Sl. No.	Species/Types	Source	Seed length (mm) Mean	± S.E.	Seed width (mm) Mean	± S.E.	Seed Thickness (mm) Mean	± S.E.
1.	*A. lenticularis*	Plant Introduction/ Botany Branch, F.R.I. & C, Dehra Dun. India.	14.75	0.23	12.11	0.10	2.52	0.03
2.	*A. benthamii*	"	10.21	0.23	7.77	0.14	3.38	0.03
3.	*A. modesta*	"	7.25	0.11	7.15	0.15	2.18	0.04
4.	*A. catechu*	"	7.72	0.16	6.18	0.11	1.61	0.01
5.	*A. confusa*	"	6.44	0.21	5.05	0.03	2.25	0.06
6.	*A. auriculiformis*	"	5.08	0.04	3.78	0.06	1.99	0.01
7.	*A. nilotica* var. *nilotica*	"	7.89	0.06	6.78	0.07	3.46	0.07
8.	*A. catechu*	Ranipur, Range Forest Office, Hardwar, India.	7.25	0.11	5.96	0.13	1.54	0.01
9.	*A. senegal*	Centre National de Semences Forestieres, Ouagadougou.	9.54	0.14	9.20	0.13	1.97	0.03
10.	*A. nilotica* var. *tomentosa*	"	8.34	0.17	6.80	0.11	4.25	0.06
11.	*A. albida*	"	8.22	0.08	5.20	0.04	2.99	0.09
12.	*A. dudgeoni*	"	9.32	0.17	9.32	0.24	2.02	0.07
13.	*A. nilotica* var. *andansonii*	"	8.37	0.08	6.70	0.07	4.39	0.04
14.	*A. polyacantha* var. *compylacantha*	"	8.63	0.03	7.57	0.15	2.36	0.01
15.	*A. macrostachya*	"	8.45	0.05	8.23	0.17	2.06	0.05
16.	*A. seyal*	"	7.27	0.14	4.59	0.07	2.08	0.03
17.	*A. raddiana*	"	6.39	0.07	4.47	0.10	3.09	0.03
18.	*A. gourmaensis*	"	8.17	0.09	7.68	0.19	2.42	0.04
19.	*A. senegal*	CAZRI Jodhpur, India	9.55	0.15	8.34	0.15	2.15	0.03
20.	*A. nilotica* var. *nilotica*	"	9.10	0.10	7.30	0.03	4.35	0.06
21.	*A. vereck*	"	8.51	0.10	8.67	0.17	1.81	0.07
22.	*A. raddiana*	"	7.37	0.03	5.25	0.07	2.71	0.02
23.	*A. tortilis*	"	7.12	0.05	5.35	0.08	3.02	0.05

in mean values for each character were observed among the species/varieties (*Table 2*). To compare the magnitude of variation due to species/varieties and the error for different characters, species and error coefficients of variation were calculated (*Table 3*). The variation due to error did not exceed 7% in the case of length and 5% in the cases of width and thickness, of the general mean of any character. The species coefficient of variation was maximum for thickness (32.1%), minimum for length (22.0%), and intermediate for width (27.7%). More than 90% of the variation in width and thickness and about 87% of the variation in length were due to differences in species/varieties. Environmental factor seems to play little part in changing any component of the seed size and all the characters under study seems to be highly heritable.

The correlation coefficient analyses among the three characters revealed that the relationships between seed length vs. seed thickness (0.1235, not significant) and seed length vs. seed width (0.8863, significant at 1% level), seed width vs. seed thickness (−0.0812, not significant) were of varying magnitudes which implies independant control. ROYCHOWDHURY (1961) showed that the genotypic association between length and breadth in rice grains is negative, and with an increase in length, breadth decreases. BAGCHI and SHARMA (1988) showed in *Santalum album* that the correlations among the three traits of length, breadth and weight were highly positively significant (at the 1% level) indicating that an increase in any one character will help increase the other two.

In the present investigation with *Acacia* species it was observed that only the correlation coefficient ("r") of length vs. width trait was highly significant, indicating that possible simultaneous improvement could be obtained while selecting for one or the other. Though the magnitude of r is low, the association between width vs. thickness is negative. Further, the significant species/varietal differences coupled with lower error variance signifies high heritability for the seperate characters. HANSON *et al.* (1956) showed that high heritability in conjunction with high genetic coefficient of variation (g.c.v.) is advantageous for practicing selection. In the present case high %-contributions with high s.c.v. was observed for all three traits. An effective selection may therefore increase seed length and width. This supposition is based on the results from the top 5% of the genotypes where length ranged from 9.103 mm to 14.750 mm ($\bar{x}$ = 8.280 mm) and width ranged

Table 2. — Significance of mean values and bar-diagrams.

Seed length		Seed width		Seed thickness	
Serial number as in table 1	Mean	Serial number as in table 1	Mean	Serial number as in table 1	Mean
1	14.75	1	12.11	13	4.39
2	10.21	12	9.31	20	4.35
9	9.54	9	9.20	10	4.25
19	9.55	21	8.67	7	3.46
12	9.32	19	8.34	2	3.38
20	9.10	15	8.23	17	3.09
14	8.63	2	7.77	23	3.02
21	8.51	18	7.68	11	2.99
15	8.45	14	7.57	22	2.71
13	8.37	20	7.30	1	2.52
10	8.34	3	7.15	18	2.42
11	8.22	10	6.80	14	2.36
18	8.17	7	6.78	5	2.25
7	7.89	13	6.71	3	2.18
4	7.72	4	6.18	19	2.15
22	7.37	8	5.96	16	2.08
16	7.27	23	5.35	15	2.06
3	7.25	22	5.25	12	2.02
8	7.25	11	5.20	6	1.99
23	7.12	5	5.05	9	1.97
5	6.44	16	4.59	21	1.81
17	6.39	17	4.47	4	1.61
6	5.09	6	3.78	8	1.54

Table 3. — Estimates of genetic variables as determined from measurement of length, width and thickness of seeds from 23 species/varieties of *Acacia*.

Parameters		Estimate for character		
		Length (mm)	Width (mm)	Thickness (mm)
General mean	$\bar{x}$	8.30	6.93	2.63
Species variance	(σ^2_L)	3.3337	3.6760	0.7138
Error variance	(σ^2_E)	0.4867	0.3417	0.0816
Species coefficient of variation (%)	$\frac{\sqrt{\sigma^2_L}}{\bar{x}} \times 100$	22.0	27.7	32.1
Error coefficient of variation (%)	$\frac{\sqrt{\sigma^2_E}}{\bar{x}} \times 100$	8.4	8.4	10.9
%-contributions	$\frac{(\sigma^2_L)}{\sigma^2_P} \times 100$	86.9	90.9	89.7

variance = $\sigma^2_P = \sigma^2_L + \sigma^2_E$

from 8.342 mm to 12.112 mm ($\bar{x}$ = 6.931 mm). The expected 'genetic' value ($\bar{x}$ plus expected 'genetic' advance) from the best 5% of the phenotypes for the respective characters would be expected to exceed the general mean.

It may be concluded that seed characters like length, width and thickness, observed as independent characters and character association patterns change between pairs of traits. Significant variation existed for each trait. Each character showed higher species coefficient of variation, higher %-contributions and lower error coefficient of variation. The strong positive correlation between length and width indicated that improvement in one character may improve the other.

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Optimizing Breeding Zones: Genetic Flexibility or Maximum Value?

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Summary

When the performance of genotypes vary across an environmental gradient in a non-linear manner the matching of genotypes and sites is a complex problem. To overcome this breeding zones are usually allocated so that sets of genotypes are used across different parts of the range to maximise production across all anticipated planting sites. Two different approaches to determining the number and constitution of these populations and the demarcation of their planting zone boundaries are contrasted. Both approaches use non-linear models to define the relationship between relative performance of a genotype and an environmental gradient. The approaches differ however, in the criterion used for choosing the populations. One approach will lead to a guaranteed minimum yield at each site whilst the other approach maximises the expected yield over the total range of planting sites.

Key words: Genotype x environment interaction, breeding zones, non-linear modelling.

For tree species that are planted over a wide range of sites, the relative performance of genotypes may vary depending on environmental factors that vary with site location. In such cases, breeding values must be measured over a range of sites instead of only in some "average" site. In fact, the definition of an "average" assumes that a frequency distribution of anticipated planting sites exists and planting on "average" sites assumes that the distribution mean can be estimated. Consequently, to maximize the breeding value of a set of genotypes, breeding populations, or provenances, their integrated performance over sites must be evaluated for a range of sites.

In the simplest case, site variations may cause no change in the relative performance of genotypes in all important traits and the same trees would be selected for breeding

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