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STUDIES ON GENETIC VARIABILITY AND COMPONENT ANALYSIS IN *MACROSPERMA* AND *MICROSPERMA* LENTILS

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ABSTRACT

Studies on genetic variability and component analysis was under taken in lentil collection comprising 42 *macrosperma* and 40 *microsperma* genotypes. The parallelism in the magnitude of PCV, GCV, heritability and genetic advance for all the traits in both types of lentils revealed considerable similarity in genetic variability possessed by these two varietal groups. The magnitude of heritability in conjunction with genetic advance in both types of lentils revealed additive genetic control for days to flowering, dominance or epistatic effects for days to maturity, and nonadditive gene action for the remaining characters. The path analysis indicated the importance of pods/plant or seeds/plant as the most important parameter contributing to seed yield/plant in *macrosperma* and *microsperma* lentils.

Key words: *Lens culinaris, macrosperma, microsperma,* genetic variability, component analysis.

There are two distinct groups within the cultivated lentils (*Lens culinaris* Medik.), the small-seeded (*microsperma*) and large-seeded (*macrosperma*). The former, comparatively more tolerant to environmental stresses and photoperiod are grown in Indian subcontinent, West Asia and East African countries, while the later, adapted to long days and more sensitive to environmental stress, are grown in the Mediterranean, European and West-Asian countries. However, these possess some desirable genes for economic traits such as large seed, upright and taller growth habit. So far attempts have only been made to improve the genetic potential of *microsperma* lentils. Efforts have not been made for the improvement of *macrosperma* lentils alone by combining genes scattered in the gene pool. Hence, there is an urgent need to undertake suitable breeding programme to seek genetic upgradation of *macrosperma* lentils. Besides, *microsperma–macrosperma* introgression, which seems to have tremendous possibilities, has yet to receive concentrated and constant efforts to realise the full potential of this approach.

Information is available on the study of genetic variability and component analysis in *microsperma* lentils [1–4]. However, such information in *macrosperma* lentils is limited [5]. Besides, there is no report where these informations were generated simultaneously in *macrosperma* and *microsperma* gene pools. Such an attempt has been made in the present study. The informations could be used for the genetic restructuring of the *microsperma* and *macrosperma* lentils.

MATERIALS AND METHODS

The experimental material comprised 40 and 42 diverse genotypes of *microsperma* and *macrosperma* lentils respectively, which were grown in randomized block design with three replications. Each entry was grown in a single 1.5 m long row, 45 cm apart with the interplant distance of 2-3 cm. Days to flowering and maturity, were recorded when about 50% plants had flowered and matured respectively. Observations were recorded on five random plants in each replication for ten quantitative traits (Table 1). Protein content (N% x 6.25) was estimated by the conventional micro-Kjeldahl method. The data were subjected to variance and cross-product analysis. The variance components, genotypic coefficient of variation (GCV), heritability in broad sense (H) and genetic advance (GA) were determined [6, 7]. Phenotypic and genotypic correlation coefficients were computed [8]. Direct and indirect path coefficients were calculated as described by Dewey and Lu [9].

RESULTS AND DISCUSSION

The analysis of variance indicated significant differences among genotypes in *macrosperma* and *microsperma* (except seeds/pod and protein) groups. The comparative mean performance of different characters between *macrosperma* and *microsperma* lentils indicated that *macrosperma* genotypes were late in flowering and maturity. These had higher first pod height, plant height and 100-seed weight than *microsperma* lentils (Table 1). By contrast, *microsperma* genotypes produced higher flower clusters/plant, pod clusters/plant, pods/cluster, pods/plant and seeds/plant. The performance of the remaining characters was comparable in both the varietal groups.

The range values were higher for first pod height, pods/cluster and harvest index in *macrosperma* lentils, while they were higher in *microsperma* lentils for the remaining traits. These results were supplemented with the values of PCV and GCV, which were generally higher for days to flowering, first pod height, pods/plant, seeds/plant, 100-seed weight and harvest index in *macrosperma* lentils, and for the remaining nine traits in *microsperma* lentils. The PCV was generally higher than GCV for all the traits in both the gene complexes, but in many cases the two values differed only slightly. In general, there was a parallelism in the magnitude of PCV and GCV for different traits in both the varietal groups.

Table 1. Range, mean, phenotypic and genotypic coefficient of variation, heritability and genetic advance in *macrosperma* (A) and *microsperma* (B) lentils

Parameter	Group	Days to flowering	Days to maturity	First pod height (cm)	Plant height (cm)	Primary branches per plant	Flower clusters per plant	Pod clusters per plant	Pods per cluster	Pods per plant	Seeds per pod	Seeds per plant	100-seed weight (g)	Harvest index (%)	Protein content (%)	Seed yield per plant (g)
Range	A	111.9 – 141.8	194.7 – 216.7	11.3 – 20.5	19.0 – 36.2	2.6 – 7.2	11.0 – 62.3	4.9 – 34.2	1.0 – 2.6	5.9 – 50.8	1.0 – 1.6	7.5 – 78.4	1.6 – 3.7	18.7 – 40.0	22.5 – 28.7	0.5 – 2.9
	B	60.0 – 150.9	132.6 – 184.6	7.2 – 16.1	13.5 – 32.5	1.5 – 7.6	15.2 – 87.3	6.0 – 48.4	1.8 – 2.8	7.3 – 64.4	1.0 – 1.9	10.5 – 95.6	2.8 – 5.1	23.3 – 42.6	22.7 – 30.0	0.4 – 3.5
Mean	A	127.0*	202.5*	15.1*	26.7*	3.8	31.0	17.4	2.0	24.5	1.2	35.3	3.8*	33.0	25.8	1.4
	B	118.2	181.8	12.0	19.8	4.2	43.8*	24.9*	2.3*	29.0*	1.5	45.2*	2.6	32.5	24.9	1.2
PCV	A	17.1	1.1	27.5	14.8	32.2	46.4	65.1	20.3	63.3	26.1	66.3	35.1	26.2	6.5	50.1
	B	6.2	2.9	20.8	19.9	43.8	53.6	77.0	24.4	60.9	41.1	63.0	30.2	24.4	14.2	54.7
GCV	A	16.8	1.0	16.6	9.2	17.8	24.4	29.1	8.2	33.8	13.7	43.3	17.2	24.3	6.0	27.3
	B	4.3	2.5	11.8	10.4	19.7	26.9	20.3	12.4	27.8	2.1	27.8	12.8	14.3	5.3	28.1
H	A	82.5	81.7	36.7	38.3	30.6	27.5	20.0	16.3	28.6	27.5	42.6	24.1	29.6	25.2	29.7
	B	78.0	76.1	32.5	27.1	20.1	21.8	17.8	26.0	19.8	23.0	29.4	18.0	31.7	20.0	26.4
GA	A	31.2	2.0	20.7	11.7	20.2	26.3	26.8	7.0	37.2	14.7	58.3	17.5	16.0	11.3	30.4
	B	29.2	4.5	13.9	14.9	18.1	13.9	21.0	13.2	24.9	12.0	25.2	11.0	16.6	9.1	30.0

*Significant from the other varietal group at P = 0.05.

The extent of variation for 15 traits in *macrosperma* and *microsperma* lentils indicated that selection for several of these characters may be effective. However, selection efficiency is related to the magnitude of heritability and genetic advance [7]. The fact that heritability estimates of seed yield and its components were usually lower (Table 1), suggested that environmental effects constituted the major portion of the total phenotypic variance in these characters. The highest heritability was recorded for days to flowering, followed by days to maturity in *macrosperma* and *microsperma* gene complexes. Heritability for the remaining characters was low.

In the present study, broad sense heritability was computed, which includes both additive and nonadditive gene effects. Therefore, heritability estimates should be considered in conjunction with genetic advance [6, 7]. Based on this consideration, high heritability for days to flowering was accompanied by high genetic advance in *macrosperma* and *microsperma* gene pools, indicating additive genetic control for the inheritance of this trait. Days to maturity had high heritability accompanied by low genetic advance in *macrosperma* and *microsperma* groups. This may be because the phenotypic and error variances were lower for this trait, resulting in high broad sense heritability estimates. The high heritability and low genetic advance for days to maturity indicated that dominance or epistatic effects were of considerable value for the inheritance of this trait. The remaining characters had low heritability and genetic advance indicative of nonadditive gene action, and consequently, low genetic gain is expected from selection in such a situation.

Seed yield/plant was associated with flower clusters/plant, pod clusters/plant, pods/plant and seeds/plant in *macrosperma* and *microsperma* varietal groups (Table 2). In addition first pod height and primary branches/plant were also positively associated with seed yield/plant in *microsperma* lentils. The characters associated with seed yield were almost the same in *macrosperma* and *microsperma* varietal groups. The characters associated with seed yield/plant such as flower clusters/plant, pod clusters/plant, pods/plant and seeds/plant were also positively associated with plant height. Therefore, selection for upright and taller plants is likely to result in higher number of flower clusters/plant, pod clusters/plant, pods/plant, seeds/plant, and ultimately seed yield/plant. These results are in agreement with the studies reported earlier in *microsperma* lentils [10, 11].

The study of path analysis of the traits exhibiting positive association with seed yield/plant revealed that direct phenotypic contribution of flower clusters/plant, pod clusters/plant, pods/plant, seeds/plant and harvest index towards seed yield/plant was positive and substantial in *macrosperma* lentils (Table 3). Among the traits studied, seeds/plant was the most important component of seed yield/plant. Beside its high direct effect, the indirect contribution of plant height, branches/plant, flower clusters/plant, pod clusters/plant, pods/plant and seeds/pod was substantial to seed yield. It was followed by pods/plant. In *microsperma* lentils, the highest direct positive phenotypic effect was

Table 2. Simple correlation coefficients for various characters in *macrosperma* (A) and *microsperma* (B) lentils

Character		Days to maturity	First pod height	Plant height	Primary branches per plant	Flower cluster per plant	Pod clusters per plant	Pods per cluster	Pods per plant	Seeds per pod	Seeds per plant	100-seed weight	Harvest index	Protein content	Seed yield per plant
Days to flowering	A	0.16	0.11	0.05	0.11	0.10	-0.07	0.08	-0.09	-0.13	-0.06	-0.14	-0.05	0.12	-0.15
	B	0.59*	-0.04	-0.06	0.16	0.15	0.25	0.10	0.05	-0.05	0.11	-0.11	-0.08	-0.06	0.02
Days to maturity	A		0.30	0.14	-0.01	-0.25	-0.05	0.09	0.08	0.20	0.10	-0.11	-0.10	-0.22	0.11
	B		0.03	-0.02	0.21	0.17	0.18	0.19	0.13	0.10	0.13	-0.11	-0.13	-0.02	-0.00
First pod height	A			0.31*	0.11	0.28	-0.02	0.09	0.07	0.09	0.08	0.06	-0.01	0.01	0.08
	B			0.44*	0.14	0.25	0.39*	0.24	0.35*	0.22	0.39*	-0.12	0.26	0.02	-0.43*
Plant height	A				0.10	0.44*	0.33	0.22	0.34*	0.07	0.35*	0.11	0.10	-0.02	0.36*
	B				0.29	0.41*	0.28	0.28	0.48*	0.02	0.48*	0.01	0.09	-0.11	0.41*
Primary branches per plant	A					0.35*	0.29	-0.09	0.36*	0.15	0.34*	-0.09	-0.18	0.01	0.18
	B					0.60*	0.34*	0.14	0.41*	0.08	0.43*	-0.23	-0.05	-0.22	0.42*
Flower cluster per plant	A						0.71*	0.21	0.80*	0.12	0.71*	-0.07	0.04	-0.07	0.65*
	B						0.53*	0.28	0.74*	0.09	0.73*	-0.32*	-0.04	-0.20	0.53*
Pod clusters per plant	A							0.16	0.86*	0.14	0.80*	0.14	0.21	0.03	0.71*
	B							0.19	0.64*	0.42*	0.68*	0.29	0.20	0.02	0.50*
Pods per clusters	A								0.18	0.24	0.29	-0.14	0.14	0.14	0.23
	B								0.42*	0.08	0.33*	-0.14	-0.03	-0.26	0.24
Pods per plant	A									0.28	0.90*	-0.19	0.17	0.04	0.76*
	B									0.13	0.93*	-0.33*	0.08	-0.20	0.69*
Seeds per pod	A										0.39*	-0.11	0.08	-0.03	0.29
	B										0.27	-0.20	0.15	0.23	0.09
Seeds per plant	A											-0.23	0.27	0.05	0.76*
	B											-0.31	0.17	-0.14	0.71*
100-seed wt.	A											-0.11	-0.11	-0.18	0.08
	B												-0.01	0.61*	-0.30
Harvest index	A													0.08	0.30
	B													0.06	0.21
Protein content	A														-0.04
	B														-0.17

*Significant at P = 0.05.

Table 3. Correlation coefficients along with direct (in bold) and indirect effects of important traits on seed yield in *macrosperma* (A) and *microsperma* (B) lentils

Character		First pod height	Plant height	Primary branches per plant	Flower cluster per plant	Pod clusters per plant	Pods per clusters	Pods per plant	Seeds per plant	Harvest index (%)	Correlation with seed yield per plant
First pod height	A	**-0.01**	0.01	-0.01	0.04	0.01	0.01	0.01	0.03	-0.01	0.08
	B	**0.23**	-0.03	0.03	-0.01	0.03	0.02	0.14	0.10	0.02	0.43*
Plant height	A	-0.01	**0.02**	-0.01	0.07	0.06	0.01	0.07	0.14	0.01	0.36*
	B	0.10	**-0.07**	0.05	-0.02	0.02	-0.03	0.20	0.18	0.01	0.41*
Primary branches per plant	A	-0.01	0.01	**-0.05**	-0.05	0.06	-0.01	0.07	0.16	-0.03	0.18
	B	0.03	-0.02	**0.19**	-0.02	0.83	-0.03	-0.01	0.16	-0.01	0.42*
Flower clusters per plant	A	-0.01	0.01	-0.02	**0.15**	0.14	0.01	0.16	0.22	0.01	0.65*
	B	0.06	-0.03	0.11	**-0.04**	0.05	-0.03	0.31	0.19	-0.01	0.53*
Pod clusters per plant	A	0.01	0.01	-0.01	0.11	**0.19**	0.01	0.17	0.24	0.03	0.71*
	B	0.09	-0.02	0.06	-0.02	**0.09**	-0.02	-0.26	0.18	-0.01	0.60*
Pods per cluster	A	-0.01	0.01	0.00	0.03	0.03	**0.04**	0.04	0.09	0.02	0.23
	B	0.05	-0.02	0.02	-0.01	0.02	**0.10**	0.17	0.08	-0.00	0.24
Pods per plant	A	-0.01	0.01	-0.02	0.12	0.16	0.01	**0.20**	0.27	0.02	0.76*
	B	0.08	-0.03	0.08	-0.03	0.06	-0.04	**0.41**	0.25	0.01	0.69*
Seeds per plant	A	-0.01	0.01	-0.02	0.11	0.15	0.01	0.18	**0.30**	0.04	0.76*
	B	0.09	-0.03	0.08	-0.03	0.60	-0.03	0.39	**0.27**	0.01	0.71*

*Significant at P = 0.05.

recorded for pods/plant. Besides, its direct effect, the indirect effects of as many as five traits through it were substantial. Seeds/plant was the next most important trait. Pods/plant and seeds/plant appeared to be the most important characters for selection in *macrosperma* and *microsperma* lentils.

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