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HETEROSIS AND INBREEDING DEPRESSION IN LENTIL

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ABSTRACT

The existence and magnitude of heterosis was affected by the day length. Heterosis for seed yield and its components, such as, harvest index, pods/plant and pod clusters/plant, was more rewarding in cross-combinations involving Precoz as one of the parents. The relationship between heterosis in F_1 and inbreeding depression in F_2 was variable for different crosses and traits. L-9-12 x Precoz and L-830 x Precoz crosses should be exploited to produce biparental progenies to get superior segregants.

Key words: Lentil, *microsperma*, *macrosperma*, heterosis, inbreeding depression.

Lentil (*Lens culinaris* Med.) is a crop of great economic importance. However, its yield levels are low. Exploitation of hybrid vigour is considered to be one of the outstanding achievements of plant breeding. Lentil is a highly self-pollinated crop and the scope for exploitation by hybrid vigour will depend upon the direction and magnitude of heterosis, feasibility and type of gene action involved. Also, the study of heterosis and inbreeding depression will have a direct bearing on the breeding methodology to be employed for genetical improvement. Very little attempts have been made to obtain information about the magnitude of heterosis involving *microsperma* genotypes [1]. However, there is no information on heterosis and inbreeding depression involving *microsperma* and *macrosperma* subspecies. The present study, therefore, aims to obtain information on heterosis and inbreeding depression in *microsperma* x *macrosperma* crosses.

MATERIALS AND METHODS

Four *microsperma* genotypes (Pant L-639, Pant L-406, L-830 and L-9- 12) were crossed with each of the two *macrosperma* testers, viz., Precoz and HPL-4, in a line x tester mating design during winter 1985-86. *Microsperma* genotypes are medium flowering and cultivated as commercial varieties, while macrosperma genotypes are new introductions. Precoz is one of the earliest flowering genotypes, whereas HPL-4 is a very late genotype. A few seeds of each F_1 along with the parents were grown during off season (summer 1986) under long days at Kukumseri in Lahaul valley of Himachal Pradesh for recording observations and advancing the generation. The experiment was laid in randomized block design with three replications. The entries were grown in single rows of 1 m length with interplant spacing of 5 cm. During winter 1986-87, the trial comprising 6 parents, $8F_1$s and $8F_2$s was laid out in randomised block design with three replications under short days at Palampur. Parents and F_1s were grown in single rows of 1 m length, while the F_2s were grown in three rows in 1 m length with the spacing of 5 and 50 cm within and between rows, respectively. The observations were recorded for various traits on five randomly selected plants in parents and F_1 and 20 plants in F_2 replication. The magnitude of heterosis over better parent (BP) and inbreeding depression from F_1 to F_2 were calculated using the standard procedures.

RESULTS AND DISCUSSION

The expression and magnitude of heterosis was affected by day length (Table 1). The effect was more pronounced for some traits, while it was less for others. There was no heterosis for plant height under long days, while it was substantial under short days in all the crosses. In case of flower clusters/plant, primary and secondary branches, the magnitude of heterosis was higher under short days than long days. Days to flowering revealed heterosis both under short and long days for all the crosses, indicating undirectional dominance of lateness over earliness, a desirable trait in lentil.

As for days to maturity, the crosses L-406 x HPL-4, L-639 x HPL-4, L-9-12 x HPL-4, and L-830 x HPL-4, involving HPL-4, a late *macrosperma* parent, did not reveal any heterosis under both day lengths (Table 1). However, it was observed in the crosses Pant L-406 x Precoz, Pant L-639 x Precoz, L-9-12 x Precoz, and L-830 x Precoz, involving Precoz as one of the parents under short days. The absence of heterosis in the crosses involving Precoz under long days is due to delayed maturity in the otherwise medium flowering F_1 hybrids due to decrease in temperature towards maturity September onwards. 100-seed weight revealed either no or negative heterosis under both the day lengths in most of the crosses, particularly in those involving HPL-4 as one of the parents. In these crosses, the seed size in F_1 was smaller than in HPL-4. These results only confirm that large seed size of *macrosperma* was incompletely dominant over small seed size of *microsperma* lentil.

Seed yield, the most economic trait revealed heterosis under both the day lengths in the crosses Pant L-406 x Precoz, Pant L-639 x Precoz, L-9-12 x Precoz, and L-830 x Precoz. Of these, Pant L-639 x Precoz exhibited the highest heterosis under long and short days, (60.0 and 56.0%, respectively), followed by L-830 xPrecoz (44.4 and 44.0%). The crosses involving HPL-4 as one of the parents did not reveal any heterosis for seed yield/plant under both day lengths. The absence of heterosis in F_1 was due to the fact that lateness being dominant over earliness, the F_1 plants gave less seed yield due to poor seed and pod setting under high temperature during the period of flowering and maturity. In case of harvest index,

Table 1. Better parent heterosis for seed yield and other quantitative characters under long (L) and short days (S) in lentil

Cross	Day length	Plant height	Primary branches	Secondary branches	Flowers per plant	Flower clusters per plant	Days to flowering	Days to maturity	Pods per plant	Pods clusters per plant	100-seed weight	Seed yield per plant	Harvest index
Pant L-406 x HPL-4	Long	–6.5	17.4*	28.4*	4.9	9.74	44.4*	6.9	25.0	20.0*	–30.2*	23.3	17.9
	Short	36.2*	23.1*	37.9*	35.3*	–4.6	39.5*	6.3	23.1	23.6*	–34.2*	32.2*	21.5
Pant L-639 x HPL-4	Long	0.6	8.7	26.8*	18.4*	19.0*	39.5*	6.3	23.1	23.6*	–34.2*	32.2*	21.5
	Short	29.9*	17.2*	40.7*	45.1*	26.2*	25.0*	9.7	19.9	22.4*	16.3*	7.1	23.7*
L-9-12 x HPL-4	Long	–22.9	1.0	4.5	22.5*	18.5	55.6*	7.1	26.7	29.3*	–23.4*	22.7	17.5*
	Short	40.7*	41.2*	74.6*	2.5	5.1	17.9*	9.7	6.1	8.4	–8.2	18.0	13.1*
L-830 x HPL-4	Long	1.1	21.8*	12.2	16.9	–9.3	27.5*	3.8	35.1*	25.0*	–25.5*	27.8	14.2
	Short	25.5*	46.7*	17.4*	1.7	79.0*	3.8	–1.6	1.6	51.2*	–14.3*	28.2	19.7
Pant L-406 x Precoz	Long	0.5	16.7*	56.8*	20.7*	8.3	41.7*	3.5	31.2*	36.4*	22.2*	27.7	19.5
	Short	4.2	48.3*	10.1	2.9	10.9	27.9*	25.5*	1.1	61.2*	–2.3	40.0*	32.9*
Pant L-639 x Precoz	Long	–23.8*	25.0*	45.4*	1.3	16.6	43.6*	0.4	52.8*	31.5*	–24.4*	60.0*	22.6*
	Short	16.9	76.9*	17.2*	2.1	36.7*	43.8*	23.7*	8.7	18.7*	–14.0	56.0*	23.0*
L-9-12 x Precoz	Long	–1.8	11.5	6.6	25.4*	14.3	52.8*	13.5	32.6*	26.1*	–15.5*	18.2	36.1*
	Short	21.2*	22.0*	15.1	14.6	47.8*	69.9*	35.7*	32.8*	52.9*	–2.3	80.0*	64.5*
Pant L-830 x Precoz	Long	6.1	8.3	48.6*	13.9	25.3*	35.9*	12.5	45.7*	33.3*	–20.0*	44.4*	23.3*
	Short	21.7*	27.6*	33.9*	3.6	4.6	46.9*	32.4*	16.1	52.6*	–0.8	44.0*	39.8*

*P = 0.05.

practically no heterosis was observed in the crosses involving cv. HPL-4. Nevertheless, substantial heterosis was observed in the crosses involving Precoz as one of the parents under both the day lengths. It was the highest (36.1 and 64.5% under long and short days, respectively), in the cross L-9–12 x Precoz, followed by L-830 x Precoz and Pant L-639 xPrecoz. The crosses involving Precoz as one of the parents, particularly Pant L-639 x Precoz and L-830 x Precoz were more rewarding and should be exploited.

The inbreeding depression in F_2 under short days was variable for different crosses and traits (Table 2). In case of plant height, days to flowering, and harvest index, there was heterosis in F_1 but no inbreeding depression in F_2 generation. These observations indicate the importance of additive genes in the control of these traits. Primary and secondary branches, pods/plant, pod clusters/plant, and seed yield/plant revealed a relationship between heterotic response and inbreeding depression (crosses showing high heterosis also showed high inbreeding depression), show the importance of nonadditive genes for these traits in lentil. Similar observations were also recorded in gram [2, 3].

Table 2. Inbreeding depression for seed yield and other quantitative characters under short days in F_2 generation of lentil

Cross	Plant height	Primary branches per plant	Secondary branches per plant	Flowers per plant	Flower clusters per plant	Days to flowering	Days to maturity	Pods per plant	Pods cluster per plant	100-seed weight	Seed yield per plant	Harvest index
Pant L-406 x HPL-4	15.1	35.9*	20.0*	13.7	31.3*	1.9	3.5	–22.3*	20.3*	–9.7	18.9*	17.7*
Pant L-639 x HPL-4	9.1	29.4*	21.0*	22.7*	28.3*	6.0	4.3	–23.1*	19.6*	22.6	13.9	15.0
L-9-12 x HPL-4	27.3*	50.0*	59.1*	37.3*	27.0*	1.0	7.8	4.6	2.1	–2.2*	21.6*	8.9
L-830 x HPL-4	13.4	36.5*	20.0*	22.7*	11.8	0.6	8.0	–24.2*	22.7*	7.0	22.2*	12.2
Pant L-406 x Precoz	–6.3	43.8*	32.2*	28.9*	10.2	16.3	–1.0	6.8	9.5	2.4	21.0*	8.0
Pant L-639 x Precoz	9.2	38.0*	21.3*	26.9*	31.1*	3.0	–6.1	2.4	22.2*	4.5	17.9*	10.3
L-9-12 x Precoz	17.1	44.6*	26.2*	9.9	46.6*	21.0*	7.5	–20.2*	27.3*	11.2	37.7*	10.8
L-830 x Precoz	13.4	36.5*	20.0*	22.7*	11.8	0.6	8.0	–24.2*	22.7*	7.0	22.2*	12.2

*P = 0.05.

In case of pods/plant, all the crosses except L-9-12 x HPL-4, Pant L-406 x Precoz, and Pant L- 639 x Precoz exhibited negative inbreeding depression. These cross-combinations produced more pods/plant in F_2 than in F_1. It could be due to epistatic gene action [4]. Such crosses should be used to produce biparental progenies to get superior segregants, which may be handled through pedigree method of breeding.

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