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EARLY GENERATION EVALUATION FOR YIELD AND YIELD-RELATED TRAITS IN LENTIL

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ABSTRACT

Fifteen F_3 bulks along with one check were evaluated in a complete randomized block design with three replications. Harvest index coupled with pods/plant and primary branches were found to be reliable selection criteria in segregating generations for increasing yield. In the present study correlations alone were not good criterion of assessing the potentiality of crosses in early generations. However, promising crosses could be identify in early segregating generations only on the basis of combination of characters. Crosses involving Precoz sel. as one of the parents were promising. Study also reveals that the harvest index and pods/plant in conjunction with the secondary branches are helpful in selection for yield. It also appears that the random bulk procedure of generation advancement in F_2 was unable to identify the plants with increased yield in F_3 and yield *per se* could not be used as a reliable criterion for rejection/selection of the crosses in F_3.

Key words : *Lens culinaris*, lentil, early generation, correlation

A major problem facing plant breeders is to decide what crosses to make and once made, which ones to reject in early generations. Genetic potential of a cross can be determined in the F_2 and F_3 generations [1]. It is always desirable to isolate segregates suitable in all attributes early in the breeding program if they can be identified. In self-pollinated species, early generation testing was considered a method of identifying hybrid- bulk populations that would contain superior pure lines. Only few reports pertaining to the effectiveness of early generation selection and testing are available and there are conflicting views on the value of selection for yield in early generations [1-4]. Therefore, the present investigation was carried out to study the effectiveness of early generation testing in lentil.

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MATERIALS AND METHODS

Six diverse parents of lentils (Precoz sel., KL 86-2, Lens 4136, Pant Lentil 406, Pant Lentil 639 and HUL 12) were mated in a diallel fashion excluding reciprocals. The experimental material for the present study (15 F_3 bulks) was developed by bulking equal quantity of seeds from a large number of randomly selected F_2 plants in each of these 15 crosses. These F_3 bulks along with one check (Pant lentil 4) were planted in a randomized complete block design with three replications in 4 m long 4 row plots, spaced 23 cm apart; plant to plant distance was maintained at 5 cm. Data were recorded on 20 randomly selected plants in each replication for plant height (cm), primary branches/plant, secondary branches/plant, pods/plant, seeds/pod, grain yield/plant (g), biological yield/plant (g) and harvest index while data on 100- seed weight (g), seed yield/plot (g) and rust score were recorded on plot basis.

Analyses of variance were done utilizing mean data obtained for each character, genetic parameters were estimated following the method described by Johnson *et al.* [5]. Phenotypic and genotypic correlation for all character-pairs were also estimated following Robinson *et al.* [6].

RESULTS AND DISCUSSION

Presence of adequate variability was observed among the F_3 bulks for all the characters except plant height, primary branches/plant and biological yield/plant. Estimates of phenotypic and genotypic coefficients of variation (PCV, GCV), expected genetic advance (GA) and heritability (broad-sense) are given in Table 1. High heritability estimates were observed for 100-seed weight and plot yield. High heritability value for average seed weight was reported by Erskine *et al.* [7]. High heritability estimates indicate that either the traits under consideration are less influenced by the environment or less number of genes are involved. High expected genetic advance combined with high heritability was observed for plot yield only. A character with high heritability and high genetic advance may probably be controlled by additive gene action [8]. Characters without such combination appear generally because of non-additive gene action, including dominance and epistasis [9].

Improvement of a complex character like yield may be accomplished through component breeding in which method there should be strong association of yield with a number of characteristics and simpler inheritance of these yield components than that of yield itsef [10]. A positive correlation between pods/plant and secondary branches/plant was observed. Similar findings were also obtained by Goyal *et al.* [11]. Seed size (100-seed weight) had high heritability and showed negative correlation

Table 1. Mean squares, coefficient of variation, heritability and expected genetic advances for ten characters in fifteen F_3 bulks of lentil

Character	Mean squares	PCV (%)	GCV (%)	h^2_b	GA (%) of mean
Plant height (cm)	15.87	7.48	3.25	0.19	1.32
Primary branches/plant	0.04	4.95	2.70	0.12	0.04
Secondary branches/plant	0.66^{**}	12.63	8.41	0.44	0.54
Pods/plant	277.21^{**}	14.78	10.36	0.49	11.54
Seeds/pod	0.02^{**}	4.45	3.36	0.57	0.09
Biologicl yield/plant (g)	1.12	7.49	6.24	0.69	0.98
Grain yield/plant (g)	0.17^{**}	11.82	8.01	0.46	0.28
Harvest index (%)	5.76^{*}	10.59	6.12	0.33	1.98
100-seed weight (g)	0.48^{**}	19.56	17.98	0.85	0.74
Plot yield (g)	14347.91^{**}	10.49	8.51	0.66	106.55

*,** significant at 5% and 1% levels, respectively

Table 2. Phenotypic (upper half) and genotypic (lower half) correlation coefficients between different character-pairs

Character	Plant height	Primary branches /plant	Secondary branches /plant	Pods plant	Seeds /pod	Biological yield/ plant	grain yield/ plant	Harvest index	100-seed weight	plot yield
	1	2	3	4	5	6	7	8	9	10
1	-	0.08	0.04	–0.03	–0.02	–0.07	0.15	0.23	0.14	0.07
2	–0.10	-	0.07	0.30	0.13	–0.14	0.04	0.15	–0.09	0.08
3	0.36	–0.13	-	0.50*	0.23	–0.06	0.16	0.20	–0.35	0.20
4	–0.65	0.22	0.82	-	0.17	–0.07	0.29	0.38	–0.21	0.07
5	–0.07	0.22	0.31	0.24	-	–0.35	–0.18	0.05	–0.51*	0.33
6	0.41	–0.21	–0.14	0.04	–0.49	-	0.49	–0.17	0.60*	–0.48
7	0.27	–0.21	0.27	0.30	–0.53	0.63	-	0.76**	0.47	–0.23
8	0.02	0.47	0.51	0.39	–0.27	–0.17	0.65	-	0.10	0.11
9	0.43	–0.16	–0.56	–0.22	–0.80	0.75	0.75	0.22	-	0.55*
10	0.06	0.10	0.54	0.20	0.75	–0.68	–0.23	0.41	–0.75	-

*,** Significant at P = 0.05 & P = 0.01 respectively

with seeds/pods and positive association with biological yield/plant. The positive association of seed size with biological yield/plant indicate that genotypes having bolder seeds may ultimately need more biomass. The positive association between seed size and biological yield/plant indicate that the success could be achieved in combining the seed size with that of plant yield by attempting the crosses between bold seeded parent (e.g. Precoz selection in this study) and high yielding cultivars with higher biomass. Plot yield exhibited negative correlation with 100-seed weight which suggested that in the present material plants with bolder seed will have less number of seeds/pod and thereby less seed yield.

A list of crosses showing significant phenotypic correlation coefficient for different character pairs is furnished in Table 3. Grain yield/plant was positively correlated with secondary branches/plant in only one cross (Pant lentil 406 × Pant Lentil 639) and with primary branches/plant in crosses Lens 4136 × HUL 12 and Lens 4136 × Pant lentil 406. Similar findings have earlier been reported [13]. Contrary to finding of Muehlbauer [12] negative association of grain yield/plant with pods/plant was observed in crosses KL 86-2 × HUL 12 and KL 86-2 × Pant lentil 639. Grain yield per plant was positively associated with biological yield per plant in cross KL 86-2 × HUL 12 and it was negatively associated in cross Precoz sel. × KL 86-2. Such changes in character associations from cross to cross and generation to generation are possible because of the breakdown and formation of new linkage groups, reduction in dominance from F_2 to F_3 and also by method of sampling.

Three most promising crosses which were either significantly superior or had relative superiority vis-a-vis the check are marked in Table 4. The significant superiority of some of the crosses over the check was evident in biological yield/plant and 100-seed weight which also had high heritability estimates. Only one cross KL 86-2 × Pant lentil 639, had relative superiority for plot yield, however, nine of the crosses were found significantly superior to check. This was due to the fact that effect of random bulk and modified bulk methods become noticeable only after 4 to 5 generations. Five most promising crosses based on the meritorious scores indicate that the crosses between diverse parents, but within a limit, will have more residual heterosis and greater variability among the segregating progenies. Therefore, the crosses involving Precoz sel. as one of the parents may be carried forward and exploited with a view to isolate high yielding and bold-seeded segregates by following bulk pedigree method of breeding. From the present study it appears that random bulk procedure of generation advancement in F_2 was unable to give high yielding plants for yield in F_3 which is in corroboration with the findings in chickpea [14]. It may be concluded that harvest index and pods/plant in conjunction with the secondary branches are helpful in selection for yields and the superior or inferior

Table 3. List of crosses showing significant correlation coefficients in F_3 generation

Character-pair	Cross
Secondary branches/plant with pods/plant	Pant L 639 × HUL 12 (0.26*), Lens 4136 × HUL 12 (0.27*), Lens 4136 × Pant L 639 (0.31*), KL 86-2 × Pant L 639 (0.31*), KL 86-2 × Pant L 406 (0.45**), KL 86-2 × Lens 4136 (0.49**), Prevoz Sel. × Pant L 639 (0.56**), Precoz Sel × Lens 4136 (0.51**), Precoz Sel. × KL 86-2 (0.26*)
Secondary branches/plant with grain yield/plant	Pant L 406 × Pant L 639 (0.34**)
Pods/plant with biological yield/plant	Pant L 406 × Pant L 639 (–0.28*)
Primary branches/plant with plant height	Lens 4136 × HUL 12 (0.28*), Lens 4136 × Pant L 406 (0.34**), KL 86-2 × Pant L 406 (0.26*), Precoz Sel. × HUL 12 (–0.27*), Precoz Sel. × Pant L. 639* (0.35**), Precoz Sel. × Pant L 406 (0.31*), Precoz Sel. × Lens 4136 (0.42**)
Primary branches/plant with grain yield/plant	Lens 4136 × HUL 12 (0.31*), Lens 4136 × Pant L 406 (0.27*)
Plant height with pods/plant	Pant L 406 × HUL 12 (0.37**)
Plant height with seeds/pod	Lens 4136 × Pant L 406 (–0.26*)
Pods/plant with grain yield/plant	KL 86-2 × HUL 12 (–0.30*), KL 86-2 × Pant L 639 (–0.31*)
Biological yield/plant with grain yield/plant	KL 86-2 × HUL 12 (0.26*),Precoz Sel. × JL 86-2 (–0.26*)
Seeds/pod with biological yield/plant	Pant L 406 × Pant L 639 (–0.27*)
Pods/plant with seeds/pod	Precoz Sel. × HUL 12 (0.26*),Precoz Sel. × Pant L 639 (–0.27*)

*,** significant at 5% and 1% level, respectively, figures in parenthesis are respective correlation coefficients

crosses can not be identified on the basis of correlation studies alone. Grain yield itself did not appear to be a reliable criterion for assessing the potentiality of crosses in early segregating generations. However, promising crosses could be identified on the basis of a combination of characters.

Table 4. Three most promising crosses (bold) and means for each of the eleven traits alongwith meritorius score in F_3 bulks

Crosses	Plant height (cm)	Branches		Pods/ plant	Seeds/ pod	Biological yield/ plant(g)	Grain yield/ plant(g)	Harvest index (%)	100-seed weight (g)	Plot yield (g)	Rust score	Meri-torius score
		Pri-mary/ plant	Secon-dary/ plant									
Pant L 639 × HUL 12	45.12	2.12	4.78	86.80	1.87	8.75	2.23	26.13	1.83	753.3	5	0
Pant L 406 × HUL 12	42.10	2.31	4.58	76.95	1.88	8.25	1.98	24.00	1.67	753.3	3	1
Pant L 406 × Pant L 639	44.32	2.33	5.57	**98.78**	**1.93**	8.90	2.56	28.79	1.80	738.3	5	4
Lens 4136 × HUL 12	46.87	2.17	4.18	66.40	1.80	8.45	2.28	26.32	1.87	**800.0**	5	1
Lens 4136 × Pant L 639	44.08	2.22	4.46	71.60	**1.92**	8.92	2.56	27.62	2.17	761.6	5	1
Lens 4136 × Pant I 406	44.17	2.20	**4.95**	**90.28**	1.79	9.10	**2.75**	**30.16**	2.27	766.6	5	4
KL 86-2 × HUL 12	46.75	2.23	4.47	74.03	1.87	8.22	2.36	**29.39**	2.00	748.3	5	1
KL 86-2 × Pant L 639	46.40	2.17	4.88	76.00	1.92	9.07	2.41	26.65	1.90	**820.00**	5	2
KL 86-2 × Pant L 406	**49.43**	**2.33**	4.36	71.07	1.89	9.00	2.29	25.58	2.17	**866.6**	5	4
KL 86-2 × Lens 4136	**47.05**	2.02	**4.98**	83.23	1.78	9.75	2.67	27.25	**2.60**	750.0	5	4
Percoz Sel × HUL 12	40.80	2.18	4.51	85.77	1.91	9.66	2.31	26.02	1.87	595.0	5	0
Percoz Sel × Pant L 639	46.75	**2.35**	4.36	81.65	1.91	**9.87**	2.35	23.81	2.37	718.3	5	2
Percoz Sel × Pant L 406	44.00	**2.37**	4.15	**89.12**	1.83	8.98	**2.81**	**31.26**	**2.73**	713.3	5	5
Percoz Sel ×Lens 4136	44.00	2.32	4.17	72.17	1.66	10.40	2.66	25.88	**3.00**	735.0	5	2
Percoz Sel × KL 86-2	**49.00**	2.07	4.53	66.00	1.84	**9.75**	**2.76**	28.30	**2.60**	683.3	5	4
Pant Lentil 4 (check)	46.87	2.37	5.73	90.19	1.87	9.07	2.69	29.72	1.73	860.0	**1**	1
General mean	45.41	2.24	4.67	79.99	1.85	9.13	2.41	27.30	2.16	750.3	-	-
CD at 5%	5.09	2.28	0.73	14.08	0.09	0.63	0.36	2.51	2.28	86.93	-	-

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