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PATTERN OF VARIATION OF HARVEST INDEX IN CHICKPEA CROSSES

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ABSTRACT

Variation in harvest index was studied in F_1 and F_2 generations of eight chickpea crosses. The gene action controlling the expression of harvest index was primarily additive type. Means and degrees of dominance of F_1 and F_2 populations indicated partial dominance of high harvest index. Magnitude of heterosis over midparent was low. Estimates of heritability and genetic advance were low to moderate.

Key words: Chickpea, harvest index, selection pressure.

Determination of the response to photoperiod, temperature etc. which are important components of the physiological genetics of yield is not only time taking but not practical on a large number of plants in segregating populations. High harvest index indicates increased physiological capacity of plants to mobilize photosynthate to organs of economic importance. Thus harvest index, forms an useful and easy measure of yield potential. Studies by different workers involving new cultivars of different crop plants like wheat, oat, etc. indicate that improvement in grain yield of new cultivars has been due almost entirely to an increased harvest index.

Although genetic control of harvest index is an important aspect of differential partitioning of photosynthate, no information is available on the pattern of variation of harvest index in the segregating population of chickpea (*Cicer arietinum*) following a cross. The present paper reports the results of such a study.

MATERIALS AND METHODS

The parents involved in chickpea crosses were JG 1265, JG 1258, K 850, RSG 44, BDN 9-3 and Phule G 12. JG 1258 and JG 1265 having moderate harvest index, were used as testers and crossed with two high harvest index parents (BDN 9-3 and Phule G 12) to produce two

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sets of crosses each with four hybrids. All the six parents used in the study were pure lines and were evaluated for two consecutive years prior to their use in crossing programme.

The F_1 and F_2 populations of each of eight crosses along with their parents were grown in a randomized block design with three replications at the Institute's Farm in 1987-88. Sowing was done in 3 m rows spaced 50 cm apart with intrarow spacing of 10 cm. In each replication, the experimental rows allotted to each of P_1, P_2, F_1 and F_2 populations were 6, 6, 2 and 14, respectively.

The data on harvest index were recorded at maturity on 30 and 100 random individual plants from each of the parental and F_2 populations, respectively while in F_1 35–45 plants per cross were selected.

The pooled data over three replications were used to compute means and variances of each population. The theoretical means corresponding to additive and nonadditive gene actions were computed by the method of Burton [1]. Degrees of dominance, h1 and h2 for harvest index in F_1 and F_2 populations, respectively were calculated following the method of [2]. Heritabilities in broad sense and genetic coefficients of variation were computed by the method of [1]. Genetic advance expected by selecting top 5% of the plants was estimated according to [3].

RESULTS AND DISCUSSION

The harvest index values for all the parental lines ranged from 28.5 to 45.6%. The high and low harvest index parents differed from the testers by about 9 and 6%, respectively. None of the crosses showed evidence of positive and negative transgressive segregation but two, JG 1258 x K 850 and JG 1258 x RSG 44 where a little more than one percent of segregates transgressed the high harvest index parents.

The observed mean values of crosses ranged from 32.4 to 44.9 and 32.4 to 41.4% in F_1 and F_2 generations, respectively (Table 1). In each cross, F_1 mean values were higher than the midparent and F_2 mean values. F_1 mean values closer to high harvest index parent in each cross indicating the role of partial dominance of genes controlling harvest index which was confirmed by the F_2 means of each cross which were intermediate between midparent and parent with high harvest index.

Theoretical means corresponding to additive and non-additive gene actions are presented in Table 1. The observed mean and the calculated arithmetic mean of the F_1 crosses JG 1258 x BDN 9-3, JG 1258 x Phule G 12, JG 1265 x K 850, JG 1265 x RSG 44, and JG 1265 x Phule G 12 were similar in magnitude which indicate additive gene action. Significant differences between observed F_1 mean and the calculated arithmetic mean of the crosses JG 1258 x K 850, JG 1258 x RSG 44 and JG 1265 x BDN 9-3 suggest nonadditive gene action. Similarity of the observed F_2 means of each cross with both the calculated arithmetic and geometric means made it difficult to determine the type of gene action in F_2 generation.

Table 1. Means, variances, degrees of dominance, heterosis and inbreeding depression for harvest index in eight chickpea crosses

Cross	F_1 generation					F_2 generation					
	observed mean	C.A.M.	variance	degrees of dominance	heterosis (%)	observed mean	C.A.M.	C.G.M.	variance	degrees of dominance	inbreeding depression (%)
JG 1258 x K 850	44.9	40.9*	1.39	0.85*	9.96	41.4	42.9	42.7	14.29	0.20*	8.6
JG 1258 x RSG 44	42.7	36.6*	1.28	0.88*	7.87	39.7	41.1	41.0	11.48	0.02	7.7
JG 1258 x BDN 9-3	34.2	33.8	1.43	0.16*	1.15	33.9	34.0	33.9	6.54	0.13*	7.2
JG 1258 x Phule G 12	33.2	32.3	1.61	0.23*	2.75	32.6	32.7	32.6	5.03	0.16*	1.8
JG 1265 x K 850	40.7	39.9	1.67	0.13*	1.92	40.0	40.3	40.1	10.92	0.03	1.7
JG 1265 x RSG 44	39.2	38.7	1.96	0.12*	1.47	38.8	39.0	38.8	12.71	0.03	1.3
JG 1265 x BDN 9-3	35.1	32.9*	2.04	1.59*	6.75	33.5	34.0	33.9	7.15	0.92*	4.7
JG 1265 x Phule G 12	32.4	31.4	1.34	0.36*	3.34	32.4	31.9	31.8	7.06	0.69*	0.2

C.A.M.—calculated arithmetic mean; C.G.M.—calculated geometric mean; *significant at 5% level.

A perusal of degree of dominance values for harvest index (Table 1) revealed significant partial dominance in each cross in F_1 generation. The F_1 values ranged from 0.12 to 1.59. In F_2, all but three crosses exhibited significant values for degree of dominance and ranged from 0.02 to 0.92. The values of degree of dominance were greater in F_1 than in F_2 for all the crosses except in JG 1265 x Phule G 12 which showed opposite trend. The h2 values could be lower than h1 values due to confounding effects of epistatic gene action. In the present study this happened for seven out of eight crosses.

Values of variances presented in Table 1 revealed little difference among the F_1 values of various crosses which ranged from 1.28 to 2.04. The F_2 variances ranged from 6.54 to 14.29 and were about 3 to 12 times larger than the corresponding F_1 values. High magnitude of variation was observed for those crosses which involve high harvest index parent and vice versa. It was pertinent to note that the two testers behaved in a similar manner in releasing variability for harvest index since the variances of the two sets of crosses were comparable in magnitude.

There was complete absence of better parent heterosis for harvest index. Also, none of the crosses exhibited significant heterosis and inbreeding depression in F_1 and F_2 generation (Table 1). The midparent heterosis and inbreeding depression ranged from 1.15–9.96 and 0.1–8.63, respectively. Low values of heterosis for harvest index was earlier reported by [4].

In general, the magnitude of heterosis in F_1 was proportional to the degree of inbreeding depression in F_2.

Heritability in broad sense, genetic coefficients of variability and expected genetic advance for harvest index are given in Table 2. Heritability value ranged from 29.6 to 76.3% and the average heritability estimate was 49.6%, which was considered to be a moderate value. The estimates of genetic advance indicate that about 17.6% improvement in harvest index should result from selection of segregates in cross JG 1265 x BDN 9-3. This was amply verified by examining the values in the cross JG 1258 x BDN 9-3 which showed low estimates for all the parameters. An average of 10.7% genetic advance in harvest index could be expected from the crosses.

Table 2. Estimates of heritability, genetic coefficients of variability (GCV) and genetic advance for harvest index in eight chickpea crosses

Cross	Heritability (%)	GCV (%)	Genetic advance (% of mean)
JG 1258 x K 850	41.5	10.1	10.1
JG 1258 x RSG 44	38.5	8.5	8.4
JG 1258 x BDN 9-3	29.6	7.4	6.8
JG 1258 x Phule G 12	33.7	7.9	7.6
JG 1265 x K 850	7c.3	14.9	13.0
JG 1265 x RSG 44	70.8	11.7	10.9
JG 1265 x BDN 9-3	69.1	18.5	17.6
JG 1265 x Phule G 12	37.2	11.5	11.4
Mean	49.6	11.3	10.7

Wallace et al. [5] have emphasized the importance of easily obtained information on harvest index as it would provide understanding of physiological basis of yield differences among different genotypes. However, there are not much evidences to show that selection has been done on the basis of variation in harvest index together with high estimates of heritability and genetic advance suggest the possibility of improving harvest index vis-a-vis grain yield. Results obtained from the present study indicate the possibility of yield improvement in chickpea by exerting selection pressure for harvest index in early segregating generations.

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