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IDENTIFICATION OF GENETICALLY SUPERIOR HYBRIDS IN CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

The direct utilization of heterosis in legumes is limited due to cleistogamous nature of their flower. However, information on genetic parameters such as heterosis, heritability and genetic advance may be used for the identification of superior hybrids. Such hybrids have high probability of developing better pure lines. In the present investigation F_1 hybrids between 14 chickpea varieties were studied for heterosis and heritability estimates in various traits. The results showed that there were significant differences between genotypes for all the characters studied. The high heterotic effects were recorded for secondary branches, biological yield, number of pods/plant, grain yield and plant height. The hybrid of C727 and CM72 exhibited maximum heterosis for branches per plant, biological yield and pods/plant. Another hybrid, "ICC13416 X C727" showed maximum heterotic effect for grain yield. Heritability estimates for different characters revealed that the hybrid "F87508C X F85–114C" had high heritability for plant height, biological yield, pods/plant, grain yield and 100 seed weight. Another hybrid (F87-508 X F85-114C) had high heritability for plant height and grain yield whereas F84-508C X ICC13301 showed high heritability for 100 seed weight. Simultaneous study of heterosis and heritability revealed that there was no systematic relationship between these two parameters. High heterotic effects coupled with high heritability were observed in ICC13728 X CAI18608 for number of secondary branches, biological yield, pods/plant and grain yield/plant. The heterotic effects exhibited by this hybrid appeared to be genetically based as dominant proportion of its variability was heritable. Therefore, this hybrid could be used effectively for the simultaneous improvement of more than one character through selection of single plants with combination of various traits.

Introduction

Chickpea is an ancient crop and it is the fifth most important food legume in the world. Primarily, chickpea is a subtropical crop, however it can be grown in wide range of climates. Pakistan is one of the most important chickpea growing countries, where it is planted over an area of 1.092 million hectares. About 11% of the total area devoted to this crop is irrigated that includes the area of chickpea in rice based system.

Chickpea is the most important legume crop of the rainfed agriculture in Pakistan. The major constraint to production of this crop under rain fed conditions is moisture stress. The other production constraints include chickpea blight, wilt and root rot diseases. These factors limit the efforts to improve yield and stability in production. The cheapest and most effective solution to these problems could be the development of varieties with resistance against these biotic and abiotic stresses.

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The genetic based variability is an essential pre-requisite for a breeding programme aimed at the improvement of any crop. Though a considerable variation has already been reported in chickpea, that variability has, some how, not met the specific requirement of breeders to resolve the specific problems. Germplasm enhancement and widening of variation for target traits in chickpea is, therefore, very important for effective improvement in its yield. Hybridization, among parents, selected for specific objectives may be an effective tool to increase variability for specific traits. The hybrids with high heterotic effects are more likely to produce segregants with better performance than those with low heterotic effects (Sagar & Chandra, 1977). The present study was therefore, designed to estimate the heterotic effects in chickpea and then to use these information for further exploitation of the hybrids for variety development.

Materials and Methods

A number of 13 F_1 hybrids and their parental genotypes were used in this study. The hybridization between pure lines was performed under field condition following emasculation of female flowers. The F_1 hybrids and parental genotypes were planted in Randomized Complete Block Design with three replications. Each genotype was planted in a single row plot. Rows were spaced 30cm apart and plant to plant distance was maintained at 10cm. Ten plants of each of the parents and F_1 hybrids were randomly selected from each replication to record data on plant height, days to flowering, days to maturity grain yield, primary branches and secondary branches. These data were statistically analysed to determine the significance of difference and to estimate the heterosis and heritability for various traits (Steel & Torrie, 1980).

Results and Discussion

The increase or decrease in the productivity and vigour of hybrids compared to those of its parents is generally attributed to heterotic effects expressed in F_1's and following generations. The hybrids with high heterotic effects may offer better chances for identification of desirable pure lines in the following advance generations as compared to hybrids with low heterosis. These kinds of hybrids may be utilized for pulses improvement (Sagar & Chandra, 1977; Joshi, 1972; Malik *et al.*, 1987). However, direct utilization of hybrids in legumes is yet limited due to their cleistogamous nature of flower and difficulties involved in artificial hybridization.

The results of present study revealed that there were significant differences between genotypes for all the characters. The heterotic effects expressed by various hybrids over mid and better parents in which 10 out of 13 hybrids showed positive heterosis over mid and better parents for plant height (Table 1). The maximum positive heterosis for this character was exhibited by ICC13728 X CA18608. The maximum negative heterosis for plant height was revealed by PK51814 X HI11287. Another cross involving PK51814 as one of the parent also showed high negative heterosis over both the parents. Singh *et al.*, (1973) reported positive heterosis for plant height in 8 chickpea crosses. Positive heterosis for plant height in other legumes likes mungbean and urdbean has also been reported (Shinde & Dechmukh, 1989; Ghafoor *et al.*,1990). The differences in the results of present and previous studies for heterosis in plant height may be attributed to different genotypes or different species studied in different environments. The significant negative

Table1. Expression of heterosis (%) F_1 generation over Mid parents and better parents.

Cross	Plant height		Primary Branches		Secondary Branches		Biological Yield/Plant	
	Heterosis of F_1 over		Heterosis of F_1 over		Hetersis of F_1 over		Heterosis of F_1 over	
	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
PK51814 X HI11287	-51.70	-54.77	15.89	-1.60	-	-	63.50	$4.10
PK51814 X HG202-6-1	-52.96	-53.47	19.10	17.52	106.95	75.44	67.47	50.55
F87-508C X F85-114C	7.42	4.50	-5.08	-15.15	28.54	50.42	57.49	56.89
HI11287 X P51814	16.78	9.34	-2.80	-17.46	18.38	0.35	53.45	44.60
ICC11514 X ILC482	15.82	12.19	17.53	8.96	90.00	75.94	31.31	22.02
ICC13728 X CA118608	35.33	31.33	81.08	63.02	212.45	161.44	165.07	116.22
C727 X CM72	7.13	5.20	130.58	147.47	286.73	232.51	276.87	250.91
C727 X ICC13416	10.41	10.00	-0.51	-6.50	228.02	204.00	136.58	119.85
ICC13416 X C727	11.28	11.67	-8.16	-13.67	155.84	137.10	173.94	156.89
ICC11514 X CM72	10.58	8.40	-4.66	-11.70	163.27	115.18	185.30	128.24
HG202-6-1 X PK51830	-18.00	-2.65	-35.85	-44.26	96.18	75.84	45.97	33.15
ICC13301 X F84-78C	9.40	1.91	16.96	-0.50	134.10	113.47	52.27	9.24
F85-114C X F87 – 508C	5.60	2.73	-11.86	-21.21	49.21	39.49	53.66	53.07

Table 1 (Cont'd.)

Cross	Pods/Plant (No.)		Grain Yield/Plant (gm)		100 seeds weight/ plant		Harvest index	
	Heterosis of F_1 over		Heterosis of F_1 over		Heterosis of F_1 over		Heterosis of F_1 over	
	M.P	B.P	M.P	B.P	M.P	B.P		B.P
PK51814 X HI11287	60.41	49.77	70.72	53.00	-6.54	-15.72	13.90	8.93
PK51814 X HG202-6-1	86.90	70.07	65.91	46.70	-13.85	-21.89	-3.63	-3.84
F87-508C X F85-114C	41.03	35.33	31.30	42.94	-16.89	-20.72	-0.33	-3.41
HI11287 X P51814	38.97	29.82	66.90	49.57	-6.54	-15.72	2.84	-1.65
ICC11514 X ILC482	8.94	6.40	28.27	25.37	-6.33	-21.93	-8.03	-10.33
ICC13728 X CA118608	188.57	143.59	158.90	98.82	7.98	7.00	-7.91	-21.48
C727 X CM72	238.29	193.65	159.81	81.33	-43.34	-46.00	-2.71	-26.38
C727 X ICC13416	172.44	169.52	155.93	108.30	-0.69	-10.16	-1.59	-16.47
ICC13416 X C727	141.34	138.52	196.81	143.13	-27.58	-34.48	-2.61	-17.33
ICC11514 X CM72	202.75	12.37	118.65	143.13	4.03	1.84	-6.05	-17.69
HG202-6-1 X PK51830	92.87	93.87	69.06	55.86	-26.12	-33.91	32.89	19.25
ICC13301 X F84-78C	102.86	94.91	-3.92	-35.61	-33.75	-45.76	4.31	-1.03
F85-114C X F87 – 508C	24.81	20.00	44.59	41.51	16.66	11.27	2.73	-5.73

M.P: Mid Parent, B.P: Better Parent

heterosis for plant height may be utilized for the development of short stature varieties. Negative heterosis over better parents was also obtained for primary branches in most of the hybrids used in this study. However, two hybrids ICC13728 X CAI18608 and C727 X CM72 showed quite a high positive heterosis and heterobeltiosis. Positive heterosis for primary branches has already been reported in chickpea. The percent increase in number of secondary branches over the better parent obtained due to heterotic effects (heterobeltiosis) ranged from 0.35 to 232. All the hybrids exhibited positive heterosis for biological yield, number of pods and grain yield per plant except one cross that showed negative heterosis for grain yield. The manifestation of negative heterosis was quite prominent in 100 grain weight. All the hybrids except three had reduced 100 seed weight. Similarly, all the hybrids with two exceptions showed negative heterosis over better parents for harvest index. The positive heterotic effects for harvest index were not much pronounced. Heterosis in legumes including chickpea has already been reported by many workers (Singh *et al.*, 1973., Shinde & Deshmukh, 1989., Zubair *et al.*, 1989).

Since the legumes are strictly self pollinated and artificial hybridization is quite difficult, the commercial exploitation of heterosis in this species has not yet been made. However, the information on heterosis in F_1s helps to identify the potential crosses for the development of varieties. Sagar & Chandra (1977) also suggested that the manifestation of heterosis in legumes may be utilized for the selection of potential crosses in legumes for their genetic improvement. This is because of the high probability of having efficient segregants from better combinations than that from poor hybrids. Therefore, the information on heterosis may be used to select and promote hybrids for selection of genotypes keeping in view the specific objectives. The simultaneous consideration of heterotic values manifested in different characters showed that majority of the hybrids had negative heterobeltiosis for primary branches, 100 seed weight and harvest index. However, the same hybrids had positive heterosis for total biological yield, number of pod, grain yield per plant and secondary branches. This explains why there was negative heterotic effects for harvest index. Among those hybrids which were subject to analysis, four showed promising heterotic effects for grain yield, secondary branches and biological yield as well as pods per plant. These hybrids were ICC13416 X C727, ICC11514 X CM72, C727 X ICC13416 and C727 X CM72. Therefore chances of having good segregants from these hybrids are higher. The same four hybrids may be advanced and utilized for single plant selection.

Heritability Studies

The heritability estimates indicated that these values for primary branches ranged from 41% to 83% (Table 2). Maximum heritability (83%) associated with high genetic advance was recorded in ICC13728 X CAI18608, hybrid which also showed considerable heterosis for this character. For primary branches there was negative relationship between hybrid vigour and heritability cum genetic advance. However, in the case of secondary branches, biological yield, pods per plant, grain yield per plant and 100 seed weight high heritability and high genetic advance with high heterosis was observed in ICC13728 X CAI18608. The low heritability and negative heterosis for harvest index in this hybrid indicated that the total increase in biological yield of hybrid over the parental values may be due to more increase in vegetative parts than reproductive parts.

Table 2. Mean (X), Heritability (h2) and Genetic Advance Studies in various crosses of chickpea (*Cicer arietinum* L.) in F_2 generation.

Cross	Plant Height			Primary Branches		
	Mean	Heritability %	Genetic Advance	Mean	Heritability %	Genetic Advance
F87-508C X F85-114C	53.205	0.85	12.17	4.923	0.61	2.17
HI11287 X PK51814	47.146	0.75	11.30	3.740	0.41	1.08
ICC11514 X ILC482	45.892	0.81	9.37	4.452	0.50	1.56
ICC13728 X CAI18608	57.333	0.82	14.40	5.167	0.45	1.66
ICC13728 X ICC13301	46.233	0.22	2.79	5.533	0.83	4.92

Table 2 (Cont'd.)

Cross	Secondary Branches			Biological Yield		
	Mean	Heritability %	Genetic Advance	Mean	Heritability %	Genetic Advance
F87-508C X F85-114C	31.333	0.15	3.75	46.033	0.42	16.22
HI11287 X PK51814	19.615	0.33	7.45	32.340	0.87	22.06
ICC11514 X ILC482	17.484	0.34	5.37	35.023	0.36	9.78
ICC13728 X CAI18608	35.833	0.70	17.82	57.592	0.78	45.54
ICC13728 X ICC13301	27.667	0.64	18.85	51.117	0.74	29.42

Table 2 (Cont'd.)

Cross	Pods per Plant			Grain Yield		
	Mean	Heritability %	Genetic Advance	Mean	Heritability %	Genetic Advance
F87-508C X F85-114C	83.872	0.21	13.04	21.572	0.79	15.89
HI11287 X PK51814	56.229	0.61	26.95	14.943	0.56	7.87
ICC11514 X ILC482	77.860	0.94	149.85	16.896	0.45	6.09
ICC13728 X CAI18608	92.167	0.84	91.98	22.325	0.82	22.77
ICC13728 X ICC13301	72.300	0.58	46.10	16.100	0.63	11.49

Table 2 (Cont'd.)

Cross	100 Seed Weight			Harvest Index %		
	Mean	Heritability %	Genetic Advance	Mean	Heritability %	Genetic Advance
F87-508C X F85-114C	29.736	0.87	16.68	46.256	0.37	7.07
HI11287 X PK51814	24.854	0.60	7.35	45.435	0.83	20.67
ICC11514 X ILC482	24.900	0.85	5.51	48.466	0.91	15.03
ICC13728 X CAI18608	27.492	0.67	11.91	37.267	0.31	6.55
ICC13728 X ICC13301	19.010	0.94	10.18	28.645	0.32	6.83

High means, high heterosis and high heritability estimates recorded for various traits in this cross highlights the value of this hybrid for selection of single plants with improved performance. Since heritability is the portion of variability that is heritable, simultaneous consideration of herterosis and heritability may provide clues for the utilization of various hybrids for specific traits improvement. Heritability for secondary branches, biological yield, pods per plant, grain yield and harvest index respectively ranged from 15-70%, 43-87%, 21-94%, 46-80% and 31-90% in various crosses. The harvest index and 100 seed weight, though did not exhibit high heritability and high heterosis in any cross, it was recorded for other characters in different crosses.

Studies conducted by Misra (1991), Sharma *et al.*, (1990), Arora, (1991) have already shown high heritability for plant height. Both low and high estimates of heritability for primary branches (Sharma & Rao, 1988; Arora, 1991; Malhotra & Singh, 1973) for secondary branches (Rajesh *et al.*, 1988, Sharma *et al.*, 1990; Arora, 1991; Malhotra & Singh, 1973) have already been reported that support the findings of the present study. Similarly moderate to high heritability estimates recorded in pods per plant and grain yield per plant get support from the findings of previous studies reported by Ramprasad *et al.*, (1987) Misra (1991), Rajesh *et al.*, (1988) and Arora (1991). Since high heritability estimates are the reflection of additive type of gene action, high heterosis combined with high heritability may provide an opportunity to accommodate additive and dominant types of genes into a single genotypes. Plant of such type may be selected from cross with high heritability and high heterotic effects.

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