HETEROSIS AND INBREEDING DEPRESSION STUDY IN COWPEA [*Vigna unguiculata* (L.) WALP.]

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ABSTRACT

An investigation to study the genetics of seed related attributes in cowpea [Vigna unguiculata (L.) Walp.]" was undertaken at the Centre of Excellence for Research on Pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. Three crosses (GC 2 x PGCP 5, GC 2 x PGCP 13 and GC 516 x PGCP 1) along with its parental seed, F_2, BC_1 and BC_2 made the complete set of six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) for genetic analysis. The experiment was laid out in a Compact Family Block Design with three replications during kharif 2011. A single replication comprised of one row of parents and F_1, two rows of the backcrosses generations, BC_1 and BC_2 and four rows of the F_2. The characters viz., days to flowering, days to maturity, number of pods per plant, number of seeds per pod, seed yield per plant, biological yield per plant, harvest index and 100-seed weight were subjected to estimate the heterosis and inbreeding depression. The analysis of variance revealed significant differences among generations in most of the characters studied in all the three crosses, except days to flowering in crosses I and II, indicating considerable variability in the experimental material. Out of three crosses evaluated, 2 crosses, GC 2 x PGCP 5 and GC 516 x PGCP 1 expressed significant and desirable heterosis for seed yield per plant and 100 seed weight. All three crosses (GC 2 x PGCP 5, GC 2 x PGCP 13 and GC 516 x PGCP 1) recorded significant and positive heterobeltiosis for 100 seed weight, also displayed high inbreeding depression for this trait, indicated the importance of non-additive gene action. Seed yield per plant also noted significant inbreeding depression in all three crosses.

Key Words: *Heterosis, Cowpea, [Vigna unguiculata (L.) Walp.]*

INTRODUCTION

Cowpea is an important multi utility crop introduced in Indian sub continent about 3500 years ago along with sorghum and millets. Among all the pulses, cowpea [*Vigna unguiculata* (L.) Walp.], locally known as *lobiya*, *chowla* (*chowli*), *southern pea* or *black eye pea*, is an annual legume that is adopted to warm condition and cultivated in the tropics and sub-tropics for dry grains, green edible pods for vegetable as well as fodder. Cowpea fits well in a variety of cropping system and is grown as cover crop, mixed crop, catch crop and green manure crop. It can be capable of restoring soil fertility and therefore, remain an integral part of subsistence and sustainable production system. Being a legume crop, cowpea fix substantial quantities of biological nitrogen by virtue of their symbiotic association with *Rhizobium* bacteria (Schultze and Kondorosi, 1998, Serraj, 2004) ranging from potential rates of 73 - 80 kg / ha (Yamada, 1974). Besides it would supply up to 230 - 275 quintals of palatable hay per hectare as fodder (Haq, 1981). Cowpea is chiefly important as a source of protein and varies from 20 - 25% that is double of the protein in most cereals (Stanton, 1966). Cowpea is comparatively a cheaper source of quality protein, phosphorus, iron and vitamins and an excellent substitute for meat, eggs and other protein rich foods. Dry cowpea seeds are an important source of affordable protein, vitamin B-complex and minerals in the predominantly carbohydrate based diet of people.

Presently, cowpea is an important pulse crop in India covering on an area of 7.7 million hectares (Yadav *et al.*, 2010). However, the exact productivity statistics are not available though the broad estimates put it around five to six quintals per hectare. The experimental yields of the improved genotypes have been reported around 15 quintals per hectare. In India, cowpea is grown in almost all the states but the major cowpea growing states are Gujarat, West Bengal, Tamil Nadu, Andhra Pradesh, Kerala and Orissa.

In a self-pollinating crop like cowpea, variability is often created through hybridization between carefully chosen parents. The scope of exploitation of hybrid vigour will depend on the direction and magnitude of heterosis, biological feasibilities and the type of gene action involved. The information of such estimates is essential to plan efficient breeding programme for the improvement of the crop. Although the hybrid vigour cannot be exploited commercially in highly self-pollinated crop like cowpea, the heterotic F_1's can be used to isolate a higher frequency of productive derivatives in their later generations. Being a self pollinated crop, genetic improvement in cowpea has been made through conventional techniques such as selection from local materials, pedigree method of breeding *etc*. However, a high degree of heterosis has been reported in the crop, though its commercial exploitation has not been possible due to absence of male sterility and efficient pollinating system. Keeping in view, the present experiments was planned to ascertain hybrid vigour and inbreeding depression in cowpea.

MATERIALS AND METHODS

The present investigation to study the genetics of seed related attributes in cowpea [*Vigna unguiculata* (L.) Walp.]" was undertaken at the Centre of Excellence for Research on Pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *kharif* 2011. Three crosses (GC 2 x PGCP 5, GC 2 x PGCP 13 and GC 516 x PGCP 1) made at the centre during *kharif* 2010 were grown along with its 5 parents (GC 2, GC 516, PGCP 5, PGCP 13 and PGCP 1) to make the F_2, BC_1 and BC_2 generations during summer 2011 by hand pollination. Therefore, the material for the present investigation consisting complete set of six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of for generation mean analysis. The experiment was laid out in a Compact Family Block Design with three replications. The three crosses formed the family block, whereas six generations of each cross represented individual plots within family. A single replication comprised of one row of parents and F_1, two rows of the backcrosses generations, BC_1 and BC_2 and four rows of the F_2. Inter and intra row spacing was kept 45 cm x 15 cm. Recommended agronomic practices and necessary plant protection measures were timely adopted for raising the successful crop. The observations recorded for the characters viz., days to flowering, days to maturity, number of pods per plant, number of seeds per pod, seed yield per plant, 100 seed weight, biological yield per plant and harvest index on five randomly selected plants for P_1, P_2 and F_1 in each replications. The mean values of P_1, P_2 and F_1 were subjected to estimate the relative heterosis and heterobeltiosis as per the formula suggested by Briggle (1963) and Fonseca and Patterson (1968). Inbreeding depression was computed for all the characters for that heterosis was estimated by using the following formulae:

Inbreeding depression (%) = $[(\overline{F}_1 - \overline{F}_2) / \overline{F}_1]$ x100

The significance of the heterosis and inbreeding depression was tested by comparing the calculated 't' value with the table 't' value at 5 per cent (1.960) and 1 per cent (2.576) levels of significance.

RESULTS AND DISCUSSION

The analysis of variance for individual character was carried out for each of the three crosses for seed yield per plant and its component traits *viz.*, days to flowering, days to maturity, number of pods per plant, number of seeds per pod, biological yield per plant, harvest index and 100-seed weight (Table 1). The mean sum of squares revealed significant differences among the generations for most of the characters studied in all the three crosses, except days to flowering in crosses I and II, indicating considerable variability in the experimental material.

The commercial exploitation of heterosis in crop plant is regarded as major breakthrough in the realm of plant breeding. It is a phenomenon of immense practical importance, as its utilization has led to considerable yield improvement in several crop plants. The main aim of heterosis in the present study was to search out the best combination of parents giving high degree of heterosis and its exploitation to get better transgressive segregants.

The degree of heterosis varied from cross to cross for all the eight characters. High heterosis in certain crosses and low in others revealed that nature of gene action varied with the genetic makeup of the individual parents. In the present investigation, the crosses exhibited conspicuous heterotic response over mid-parental values for different characters. However, the measure of relative heterosis is relatively less important than heterobeltiosis and, therefore, it is better to measure the heterosis in terms of superiority over the better parent rather than mid-parent.

With regard to the heterosis over mid-parent, two of three hybrids evaluated viz., GC 2 x PGCP 5 and GC 516 x PGCP 1 exhibited significant and desirable heterosis for seed yield per plant and 100 seed weight, with a value of 10.21 per cent and 21.69 per cent, respectively, and for100 seed weight with a value of 17.24 per cent and 30.10 per cent, respectively (Table 2). Cross, GC 516 x PGCP 1 (32.92 %) showed significant and desirable heterosis for biological yield per plant. Singh & Jain (1972), Kheradnam and Nicknejad (1975), Chikkadevaiah *et al.* (1980), Ningappa (1981), Selvaraj and Annappan (1983), Singh (1983), Zaveri *et al.* (1983), Patil and Shete (1987), Chaudhary (1993), Hazra *et al.* (1993), Sawant *et al.* (1994), Sangwan and Lodhi (1995), Bhor *et al.* (1997), Bhushana *et al.* (2000), Danam and Chaudhary (2000), Haibatpure *et al.* (2002), Rashwan (2002), Singh and Arora (2003), Swidan and Suzan (2005), Patel *et al.* (2009) and Rashwan (2010) have also reported significant and positive relative heterosis for seed yield per plant in cowpea.

In the present study, an attempt was made to estimate the heterobeltiosis and inbreeding depression for seed yield per plant and its attributes in cowpea. The manifestation of heterobeltiosis was presented in Table 2. The results revealed that significant and desirable heterobeltiosis was noticed for different characters studied. All the three crosses (GC 2 x PGCP 5, GC 2 x PGCP 13 and GC 516 x PGCP 1) recorded significant and positive heterobeltiosis for 100 seed weight, ranging from 60.00 per cent (GC 2 × PGCP 13) to 73.94 per cent (GC 2 × PGCP 5). Estimates of heterobeltiosis ranged from 56.79 per cent (GC 2 × PGCP 5) to -43.48 per cent (GC2 × PGCP13), -29.10 per cent (GC 2 × PGCP 13) to -9.04 per cent (GC 2 × PGCP 5), -38.93 per cent (GC 2 × PGCP 13) to 0.75 per cent (GC 516 × PGCP 1), -19.75 per cent (GC 2 × PGCP 13) to 2.25 per cent (GC 2 × PGCP 5), and -34.59 per cent (GC 2 × PGCP 5) to 17.79 per cent (GC 516 × PGCP 1) for number of pods per plant, number of seeds per pod, seed yield per plant, biological per plant and harvest index, respectively. In agreement to the findings of the present study, high heterobeltiosis for 100 seed weight has been reported by Singh and Jain (1972), Jain (1982), Singh (1983), Sangwan and Lodhi (1995) and Patel *et al.* (2009).

Data on inbreeding depression for seed yield per plant an its components presented in Table 2 indicated that crosses showing high heterobeltiosis effect for 100 seed weight also displayed high inbreeding depression for this trait, ranging from 6.52 per cent (GC 2 × PGCP 13) to 29.90 per cent (GC 516 × PGCP 1). Seed yield per plant also recorded significant inbreeding depression in all three crosses studied ranging from 5.99 per cent (GC 516 × PGCP 1) to 55.52 per cent (GC 2 × PGCP 5). In addition to that, cross I also evinced significant inbreeding depression for harvest index and number of seeds per pod. Bhor *et al.* (1997), Mehta (2000), Pal *et al.* (2003), Swidan and Suzan (2005), Rashwan (2010) and Yadav *et al.* (2010) also recorded significant and varying degree of inbreeding depression for seed yield and its different components. 100 seed weight that showed high heterobeltiosis with concomitant high inbreeding depression indicated the importance of non-additive gene action.

SUMMARY AND CONCLUSION

From the results it cane be concluded that experimental material had consider variability. Out of three crosses evaluated, 2 crosses, GC 2 x PGCP 5 and GC 516 x PGCP 1 expressed significant and desirable heterosis for seed yield per plant and 100 seed weight could be exploited for commercial cultivation. However, being a self pollinated crop, these crosses may be exploited for getting transgressive segregants in the subsequent generation for the yield improvement in cowpea. All three crosses (GC 2 x PGCP 5, GC 2 x PGCP 13 and GC 516 x PGCP 1) recorded significant and positive heterobeltiosis for 100 seed weight, also displayed high inbreeding depression for this trait, indicated the importance of non-additive gene action. Seed yield per plant also noted significant inbreeding depression in all three crosses.

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Table 1: Analysis of variance of generation means of three crosses for various characters in cowpea

Source	d.f	Cross		
		I	II	III
Days to flowering				
Replications	2	10.05	1.82	9.20
Generations	5	7.82	4.34	76.17**
Errors	10	4.32	1.54	7.51
Days to maturity				
Replications	2	8.17	5.62	1.30
Generations	5	13.97*	15.11*	61.08**
Error	10	2.83	3.02	0.93
Number of pods per plant				
Replication	2	2.18	0.98	6.70
Generation	5	153.64**	94.16**	88.36**
Error	10	2.42	1.87	8.84
Number of seeds per pod				
Replication	2	0.88	0.14	0.09
Generation	5	4.64**	11.48**	7.65**
Error	10	0.31	0.09	0.23
Seed yield per plant (g)				
Replications	2	0.21	0.26	0.16
Generations	5	24.94**	27.02**	7.50**
Errors	10	0.10	0.38	0.14
Biological yield per plant (g)				
Replications	2	14.48	2.96	19.66
Generations	5	43.41*	73.02**	491.43**
Error	10	12.49	3.96	13.96
Harvest index (%)				
Replication	2	1.14	6.49	4.72
Generation	5	277.46**	358.79**	260.60**
Error	10	2.24	4.98	5.99
100 seed weight (g)				
Replication	2	0.01	0.38	0.28
Generation	5	17.66**	25.99**	17.69**
Error	10	0.28	0.32	0.09

, ** Significant at 5 per cent and 1 per cent levels of significance, respectively

Table 2: Magnitude of heterosis (%) and inbreeding depression (%) for various characters in cowpea

Estimates	Crosses		
	Cross I (GC 2 x PGCP 5)	Cross II (GC 2 x PGCP 13)	Cross III (GC 516 x PGCP 1)
Days to flowering			
Relative heterosis	6.90	-0.85	34.74**
Heterobeltiosis	10.71*	0.86	36.61**
Inbreeding depression	4.03	-6.84*	19.09
Days to maturity			
Relative heterosis	5.69*	2.72	16.83**
Heterobeltiosis	3.72	2.16	19.90**
Inbreeding depression	8.21	-1.91	8.50**
Number of pods per plant			
Relative heterosis	-37.50**	-10.76	-44.48**
Heterobeltiosis	-56.79**	-43.48**	-55.97**
Inbreeding depression	17.71	-11.03*	-31.84
Number of seeds per pod			
Relative heterosis	4.89	-9.75**	7.49
Heterobeltiosis	-9.04*	-29.10**	-12.92**
Inbreeding depression	15.53**	-11.67**	-2.67**
Seed yield per plant (g)			
Relative heterosis	10.21**	-6.73	21.69**
Heterobeltiosis	-25.64**	-38.93**	0.75
Inbreeding depression	55.52**	37.12**	5.99**
Biological yield per plant (g)			
Relative heterosis	11.67	0.17	32.92*
Heterobeltiosis	2.25	-19.75*	-13.13
Inbreeding depression	15.39	2.91	9.23
Harvest index (%)			
Relative heterosis	-6.88	0.25	-24.60**
Heterobeltiosis	-34.59**	-24.05**	17.79
Inbreeding depression	44.88*	35.01	-2.61
100 seed weight (g)			
Relative heterosis	17.24**	-4.22	30.10**
Heterobeltiosis	73.94**	60.00**	82.19**
Inbreeding depression	9.79**	6.52**	29.90**

***** and ** indicates significant at 5 per cent and 1 per cent levels of significance, respectively.***

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