RESEARCH PAPER International Journal of Agricultural Sciences, June, 2010, Vol. 6 Issue 2 : 537-540

Heterosis and inbreeding depression in cowpea

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ABSTRACT

Heterosis and inbreeding depression were studied in 28 F1s and 28F2s of eight parental diallel for green pod yield and its component characters in cowpea. The cross IC 201085 x CO 4 recorded the maximum heterosis over better parent for green pod yield (34.90%), followed by EC 4865 x SL 3, EC 4865 x IC 201085 and EC 4865 x Pusa Dofasli. These crosses also exhibited positive and significant inbreeding depression. The heterosis for green pod yield in these crosses was only attributed due to heterosis in dry matter in pod, pods/cluster and pods/plant. Non–additive gene action was mainly operative in the expression of these characters. Hence, the scheme of inter-matting in F2 and resulting generation may be advantageous for rapid fixation of dominant genes and to break undesirable linkages for facility of selection to improve the green pod yield in cowpea.

Key words : Heterosis, Inbreeding depression, Cowpea

INTRODUCTION

Heterosis is being utilized successfully now a days in cross pollinated crops. However, in the commercial exploitation of heterosis in self pollinated crops like cowpea [*Vigna unguiculata* L.Walp)] is locked up due to difficulties in large scale emasculation and lack of availability of male sterile lines with suitable fertility restoring system. The alternative left to the the breeder is to isolate the superior segregants from the crosses showing high heterotic response. Hence, an attempt was made in this study to know the nature and magnitude of heterosis and inbreeding depression in eight parental diallel crosses to select out the economic crosses for search fo transgressie segregants of cowpea.

MATERIALS AND METHODS

A diallel cross excluding reciprocals was made among eight genetically diverse parents namely, EC 4865, IC 201085, Pusa Dofasli, V 39, CO 4, GC 27, SL 3 and DL 1. The parents were selected from the germplasm collected from NBPGR, different research centres of the country and indigenous collection made from various parts of the State of Madhya Pradesh. The parents, and their all possible 28 F1s and 28 F2s were evaluated in randomized complete block design with three replications during rainy season of 1998. The experiment was sown on June 27, 1998. All the genotypes were sown in a single row plot of 5m length. The distance between and within row was maintained at 45 and 30cm, respectively. Fertilizer was applied @ 100 kg DAP/ha. Observations were recorded on ten randomly selected and tagged plants on each genotypes in each replications for plant height, days to 50% flowering, pods/cluster, pod length (cm), pods/ plant, seeds/pod, dry matter in pod (%), protein content (%) and green pod yield/plant. The protein content was determined by estimating organic nitrogen using conventional micro-kjedahl's techniques as described in AOAC (1965) and by multiplying in nitrogen percentage with factor 6.25. Heterosis and inbreeding depression were estimated according to formula given by Hayes *et al.* (1955).

RESULTS AND DISCUSSION

The results obtained from the present investigation are presented in Table 1 and 2.

Highly significant differences among the genotypes observed for all the characters, which indicated that considerable/genetic variability was generated in the present materials for all the characters. The partitioning of mean sum of squares due to genotypes into its components namely parents, F_1 and F_2 also showed significant differences for all the characters except days to 50% flowering. In all the populations, the mean sum of squares due to parents Vs F_1 were also significant for plant height, pods/cluster, pods/plant, dry matter in pod and green pod yield /plant.

The magnitude of overall heterosis ranged from -47.84 to 16.34% for plant height, -20.79 to 7.59% for days to 50% flowering, -20.25 to 34.01% for pods/cluster, -24.37 to 9.15% for pod length, -53.37 to 39.91% for pods/ plant, -34.05 to 15.25 % for seeds/pod, -58.84 to 46.38% for dry matter in pod, -59.87 to 35.50% for protein content and -59.91 to 34.90% for green pod yield/plant (Table 1). Similarly, inbreeding depression ranged from -75.11 to 20.66% for plant height, 1.31 to 14.29% for days to 50%

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Table 1: Heterosis for yield and its component characters in F1 generation of Cowpea

Crosses	Plant height		Days to 50% flowering		Pods/cluster		Pod length		Pods/Plant		Seeds/pod		Dry matter in pod		Protein content		Green Pod yield / plant	
	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP
EC 4865 x IC 201085	-6.24	20.95*	-12.36	-4.59	28.70**	52.63**	3.25	4.31	10.39	54.79**	-1.17	4.68	38.04**	48.33**	9.95	18.45*	27.98**	0.83**
EC 4865 x P. Dofasli	7.66	27.14*	-1.34	0.00	5.31	27.80**	-22.68	-11.58	6.91	59.43**	-13.62	3.07	19.06**	27.86**	14.44**	25.60**	20.20**	6.60**
EC 4865 x V39	13.12	22.19	-1.40	-5.26	0.39	5.71	-16.11	-6.34	39.91**	54.95**	-7.16	0.99	3.73	47.20**	21.62**	21.79**	8.61	4.13**
EC 4865 x CO4	14.94	25.69	-7.38	-6.44	34.01**	60.62**	9.15	9.16	15.47	46.55**	15.25	16.67	9.89	19.48*	-8.57	7.26	10.90	18.75*
EC 4865 x GC 27	11.92	48.08*	0.67	3.09	4.43	13.55	-17.49	-1.08	10.64	47.69**	-8.96	8.00	0.16	44.83**	5.13	23.49**	0.23	2.71**
EC 4865 xSL3	-9.22	5.48	-0.57	8.26	-8.05	-4.89	-13.01	-4.34	10.70	40.84**	-7.12	-1.34	29.55**	66.07**	12.87**	35.55**	29.43**	6.42**
EC 4865 xDL1	7.49	23.80	-5.26	1.25	1.72	3.28	-10.56	-5.56	28.73**	65.55	-13.83	-12.10	8.17	36.34**	-4.01	20.44**	10.07	4.81**
IC201085 x P.Dofasali	-47.84**	-41.84**	-107	-1.55	7.12	10.20	-15.80	-2.86	-23.33**	-14.82*	-27.78*	-9.77	-12.26	0.70	3.33	5.44	-14.29*	5.73
IC201085 x V 39	-15.36	2.82	-7.30	5.10	13.17	27.36**	-24.37	-14.80	-10.70	17.63	-25.86*	-15.02	-29.79**	3.83	-15.74*	-9.11	-31.12**	3.22
IC201085 x CO4	-20.00*	-3.85	-14.04	-5.56	22.91**	24.53**	4.45	5.51	14.40	31.47**	-6.76	-2.48	46.38**	69.22**	-25.90**	-18.70**	34.90**	7.82**
IC201085 x GC 27	-23.52**	19.35	-20.79*	-11.88	-11.24	1.18	-22.38	-6.18	8.30	16.73*	-3405**	-18.08	-30.07**	-39.95**	-4.63	24.28*	-41.03**	-11.37
IC201085 x SL3	-12.48	-0.73	-5.62	-5.62	-15.83	-2.98	-21.97	-13.41	-36.63**	-27.38**	-22.14	-12.72	-58.84**	-44.47**	-11.94*	-2.48	-59.91**	-0.87**
IC201085 x DL1	-17.44*	-5.49	-5.62	-3.72	0.74	20.90*	-4.69	1.60	-25.86**	-16.12*	-8.81	-1.60	-24.59**	-1.15	-36.11**	-24.55**	-25.94**	-2.40
Pusa Dofasli x V39	5.04	15.78	1.38	4.63	4.75	21.75**	-5.80	-3.20	-26.71**	2.99	-9.53	0.16	-18.11	11.06	-5.55	3.78	-7.01	20.87
Pusa Dofasli x CO4	-19.76	-12.62	-5.48	-5.15	16.34*	18.16**	4.02	18.96	-15.04*	6.72	5.67	27.43*	14.57	16.11	-21.33**	-15.28*	12.26	19.70
Pusa Dofasli x GC27	-23.39*	13.10	7.59	8.71	-17.32*	-3.43	1.80	7.60	-19.43**	-4.35	7.08	7.83	-32.33**	-6.30	17.70**	49.29**	-22.14	1.61
Pusa Dofasli x SL3	-13.71	-12.02	2.81	13.31	-3.63	17.77	-3.85	0.44	-53.37**	-41.58**	-566	6.84	-48.59**	-37.67**	-7.09	1.01	-39.59**	-9.09*
Pusa Dofasli x DL1	-16.13	-13.60	-14.04	-6.69	-20.25**	-2.06	-16.80	-9.44	-26.18**	-8.55	-14.74	0.09	-37.33**	-26.61**	-32.58**	-21.71*	-28.10*	-1.54**
V39x CO4	16.34	14.77	-7.53	-4.26	0.86	15.70*	3.66	15.74	6.93	24.73**	5.52	16.18	20.42*	61.96**	-13.33*	1.78	16.90	8.86**
V39 x GC27	-8.42	27.59	-2.82	-0.72	-0.19	0.39	-4.53	3.53	02.36	26.50**	-1.45	8.43	-14.73	-11.92	35.50**	58.98**	-11.46	-10.94
V39 x SL3	3.56	12.15	-5.62	7.01	-1.16	0.69	0.75	2.46	-36.76**	-26.02*	-0.16	2.41	10.15	27.29	8.76	28.87**	20.48	8.72**
V39 x DL1	-1.28	5.86	-12.28	-2.28	-16.09	-10.35	-10.35	-4.88	-22.95*	-8.76	-11.58	-5.56	10.61	32.41*	-30.98**	-3.31*	11.36	35.25*
CO4 x GC 27	11.81	57.02**	-7.53	-6.25	11.38	28.41**	-14.45	2.58	8.20	16.02	-0.28	19.53	-21.49*	7.82	-9.52	21.02	-23.98*	3.70
CO4x SL3	2.94	10.09	-19.10	-11.10	5.91	23.43**	4.48	14.91	20.99	21.40*	5.77	13.76	20.66*	44.74**	1.12	2.16	14.66	9.83**
CO4x DL1	-4.93	0.68	-8.77	-1.58	18.16*	43.30**	-1.57	3.94	14.38	16.47	-0.95	2.35	8.54	25.70*	-59.87**	-56.44**	6.01	22.60
GC27X SL3	-2.10	43.03**	-2.25	8.75	-20.00	-18.97*	-17.87	-9.55	4.79	12.02	-16.22	-5.70	-35.53*	-23.43	-36.57**	-14.57	-31.45	20.69
GC27X DL1	-12.42	27.22	0.00	9.27	-16.67	-11.46	-17.00	-4.99	10.66	16.64*	-18.36	-4.72	-12.38	2.37	-1.28	39.29**	-22.15	-5.01
SL3 X DL 1	-22.73*	-21.40	-.39	-2.01	-6.84	-2.22	-1.65	2.68	-7.55	-6.18	-6.00	-2.02	9.51	17.64	-14.93**	-8.54	10.16	17.34
H	-6.50	11.16	-6.05	-0.56	1.38	12.79	-8.26	-0.17	-2.86	15.19	-7.96	1.69	-5.59	14.98	-7.48	7.21	-4.75	18.39
SE(H)±	±19.27	±16.69	±6.39	±5.60	±0.19	±0.16	±2.25	±2.02	±3.83	±3.29	±2.13	±1.86	±3.68	±3.05	±0.28	±0.33	±30.44	±25.35

h= Average heterosis, BP= Better parent, MP=Mid parent, * and ** significant of values at P=0.05 and 0.01, respectively flowering, 0.71 to 33.04% for pods/cluster, -1.66 to 10.83% for pod length, -1.33 to 35.09% for pods/plant, -5.35 to 15.22% for seeds/pod, -25.51 to 35.19% for dry matter in pod and -16.01 to 36.08% for green pod yield/plant (Table 2).

Six crosses namely, IC 201085 x Pusa Dofasli, IC 201085 x CO 4, IC 201085 x GC 27, IC 201085 x DL 1, Pusa Dofasli x GC 27 and SL3 x DL 1 showed significant negative heterosis for plant height. The cross IC 201085 x Pusa Dofasli exhibited the highest negative coupled with maximum negative and significant inbreeding depression. It indicated that heterosis in this cross have been governed by interallelic interaction. Hence, transgressive segregants for dwarf plant type can be isolated in later generations of this cross. The extent of heterosis for days to 50% was in both directions, but none of the crosses exhibited positive heterosis for this character. Five crosses namely EC 4865 x IC 201085, EC 4865 x CO 4, IC 201085 x CO 4, Pus Dofasli x CO4 and CO 4 x DL1 exhibited significant positive heterosis with positive and significant inbreeding depression for pods/cluster. It indicated that heterosis in this cross might have been governed by dominant genes rather than interallelic interaction as was reported earlier (Patil and Shete, 1986; Supaporn, 1992). None of the crosses exhibited significant heterosis for pod length. The range of heterosis for this character was in range also reported by Bhaskaraiah *et al*. (1980) and Khattak *et al*. (2000).

Two crosses namely, EC 4865 x V39 and EC 4865 x DL 1 showed significant positive heterosis for pods/ plant, while ten crosses exhibited negative and significant heterosis. Positive and significant inbreeding depression

Table 2: Inbreeding depression for yield and its component characters in F_2 generation of cowpea

Crosses	Plant height	Days to 50% flowering	Pods/ cluster	Pod length	Pods/ plant	Seeds/ pod	Dry matter in pod	Green pod yield / plant
EC 4865 x IC 201085	12.34	2.56	14.83	-1.03	25.02**	7.93	35.19**	36.08**
EC 4865 x P. Dofasli	16.14	14.29	0.53	5.17	13.00*	15.22	18.76*	19.69**
EC 4865 x V39	17.49	8.15	7.53	5.11	14.57	6.10	22.53**	22.95**
EC 4865 x CO4	1.89	10.87	19.89**	8.43	-1.33	6.68	1.03	-1.62
EC 4865 x GC 27	12.16	10.00	16.82	2.38	20.70*	12.69	2.71	10.22**
EC 4865 xSL3	12.90	14.12	6.35	5.45	35.09**	-1.50	15.81*	15.69*
EC 4865 xDL1	14.88	7.14	21.82	6.18	15.95	6.01	24.59**	23.90**
IC201085 x P.Dofasali	-75.11**	6.29	10.17	2.24	12.66	-5.35	14.44	16.01
IC201085 x V 39	18.22	4.85	29.41**	-1.66	7.42	1.60	2.18	9.33
IC201085 x CO4	14.60	1.31	15.83*	-0.35	8.37	9.62	1.32	12.69**
IC201085 x GC 27	5.72	5.67	9.17	2.32	16.66*	5.94	-18.82	21.76
IC201085 x SL3	16.36	10.71	21.79*	2.87	9.57	3.95	6.59	9.37
IC201085 x DL1	2.77	10.12	33.04*	2.78	15.40	5.42	6.33	10.88
Pusa Dofasli x V39	5.28	2.72	13.33	10.83	-0.23	5.39	4.47	6.83
Pusa Dofasli x CO4	1.55	11.59	15.37*	8.23	10.77	12.86	10.99	15.83
Pusa Dofasli x GC27	6.12	5.13	12.16	6.38	20.30*	4.24	18.11	16.15
Pusa Dofasli x SL3	2.39	3.83	10.87	7.16	27.40	3.76	-3.04	4.51
Pusa Dofasli x DL1	3.58	4.08	21.19*	8.60	9.05	4.94	8.87	7.98
V39x CO4	9.21	9.63	0.71	6.17	-1.33	14.69	25.35**	23.53
V39 x GC27	2.51	5.80	5.44	3.24	9.47	2.79	3.30	9.84
V39 x SL3	3.87	10.12	11.18	3.67	3.99	2.46	-3.91	5.93
V39 x DL1	2.17	2.67	15.70	2.18	17.00	9.05	-4.87	0.94
CO4 x GC 27	20.66	8.89	24.58**	6.57	22.47*	11.53	-25.51*	-16.01
CO4x SL3	14.28	11.11	14.29	10.57	21.17*	-1.36	30.99**	31.06**
CO4x DL1	4.96	4.49	8.54	9.26	27.55	14.10	29.34**	28.18**
GC27X SL3	12.41	2.87	31.37	2.38	3.20	1.56	11.11	12.48
GC27X DL1	4.28	1.75	6.59	5.34	3.01	4.33	8.33	8.75
SL3 X DL 1	10.81	2.92	8.86	2.31	10.64	2.98	8.58	12.76
I	6.23	6.93	14.55	4.74	13.48	5.99	9.10	13.42
S.E. (ID)±	17.88	5.96	0.21	2.39	4.21	2.00	3.45	29.30

I=Average inbreeding depression. ID= inbreeding depression. * and ** indicate significant of values at P=0.05 and 0.01, respectively was observed in eight crosses. The crosses namely EC 4865 x V 39 and EC 4865 x DL 1 showed positive heterosis coupled with positive inbreeding depression, hence, these are expected to through transgressive segregants in advanced generations. Maximum positive heterosis for dry matter in pod was records in IC 201085 x CO 4 followed by EC 4865 x IC 201085 and EC 4865 x SL 3. Eight crosses exhibited positive and significant inbreeding depression. The crossed EC 4865 x IC 201085 and EC 4865 x Pusa Dofasli exhibited high heterosis with high positive inbreeding depression. These results support the findings of Jain (1982). Five crosses exhibited positive and significant heterosis, while 11 crosses showed negative and significant heterosis for protein content as also reported by Mak and Yap (1977) and Lodhi *et al*. (1990).

Green pod yield/plant is a complex character governed by polygenes, Four crosses namely EC 4865 x IC 201085, EC 4865 x Pusa Dofasli, EC 4865 x SL 3 and IC 201085 x CO 4 showed positive and significant heterosis for green pod yield/plant. Eight crosses exhibited negative and significant heterosis for this character. All the crosses exerted positive and significant inbreeding depression. The highest inbreeding depression was observed in cross EC 4865 x IC 201085 followed by CO 4 x SL 3 and CO 4 x DL 1 (Singh and Jain, 1972; Jain 1982; Patil *et al*., 1992 and Damarany (1994), for green pod yield/plant. Similarly, high heterosis with high inbreeding depression have also been reported by Bhor *et al.* (1997). A close relationship between heterotic response and inbreeding depression suggests the presence of non-additive gene action for green pod yield in cowpea. The study also reflects that the heterosis for green pod yield was attributed due to heterosis in dry matter in pod, pods/cluster and pods/plant. Probably the genetic diversity in the present study and non-additive gene action play and important role in the manifestation of heterosis. Hence, it may not be fixable in later generation. An other important aspects for the exploitation of heterosis are production of hybrids in cowpea. However, looking into floral biology and availability of male sterile lines with suitable fertility restoring system, production of hybrids has not been successful in commercial scale so far. Hence, the alternative left to the breeder is to isolate superior segregants from the crosses showing high heterotic response. The scheme of inter-mating in F_2 and resulting generations may be advantageous for rapid fixation of dominant gene and break undesirable linkages for facility of selection to improve the green pod yield in cowpea.

REFERENCES

A.O.A.C. (1965). Official methods of analysis. Association of official agricultural chemists, Washington, D.C.

Bhaskaraiah, K.V., Shivshankar, G. and Virupalashappa, K. (1980). Hybrid vigour in cowpea. *Indian J. Genet.* **40**:334-337.

Bhor, T.J., Kute, N.S., Dumbre, A.D. and Sarode, N.D. (1997). Heterosis and inbreeding depression in cowpea. *Indian J.Agri. Res.* **31**:122-126.

Damarany, A.M. (1994). Estimates of heterosis and drought tolerance of cowpea under gradient irrigation system III. Flowering and some vegetative characters. *Asian. J. agric. Sci.* **25**:47-56.

Hayes, H.K., Immer, F.R. and Smith, D.C. (1955). *Methods of Plant Breeding*. Mc. Graw Hill Book Co. Inc., Newyork.

Jain, S. (1982). Studies of heterosis and combining ability for forage and seed yield characters in cowpea. *Thesis Abstract*, **8**: 182-183.

Khattak, G.S.S., Haq, M.A., Ashraf, M. and Tahir, G.R. (2000). Heterosis for some morphological traits in mungbean (*Vigna radiata* L.). *Kasetsart J. Nat. Sci*.. **34**(4):439-442.

Lodhi, G.P., Boora, K.S. and Balchand (1990). Heterosis for fodder yield and quality charactrers in cowpea (*Vigna unguiculata* L. Walp) *Crop Res*. (Hissar), **3** : 66-73.

Mak, C. and Yap, T.C. (1977). Heterosis and combining ability of seed protein yield and yield components in long bean. *Crop Sci.* **17**:339-341.

Patil, R.B. and Shete, M.M. (1986). Combining ability analysis in cowpea. *J. Maharashtra Agri. Uni.,* **44**: 293-295.

Patil, A.J., Wanjari, K.B., Patil, A.N., Raut, B.R. and Ghawghawe, P.B. (1992). Studies on heterosis in mungbean. *J. Soil Crops*, **2**:1-4.

Singh, K.B. and Jain, R.P. (1972). Heterosis and combining ability in cowpea, *Indian J. Genet.*, **32**:62-66.

Supaporn, R. (1992). Genetic variations in growth habits and pod charactrers of crosses between yard long bean and cowpea. *Pl. Breed. Abst.*, **62**:770.

Received : February, 2010; Accepted : April, 2010