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Research Article

ESTIMATION OF HETEROSIS FOR YIELD AND ITS COMPONENTS IN PIGEONPEA [*Cajanus cajan* L. Millspaugh]

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Abstract- Twenty-eight pigeonpea hybrids resulting from 8 × 8 diallel mating design excluding reciprocal were evaluated in randomized block design with three replications for twelve different characters to study the magnitude of heterosis. The heterosis over mid parent, better parent and standard check were ranged from-38.05 to 33.02 per cent, -54.05 to 27.61 per cent and -48.50 to 13.75 per cent respectively, for seed yield per plant. Three cross combinations *viz.,* UPAS-120 × GT-103, BSMR-853 × Banas and BSMR-853 × GT-1 showed significant and desirable heterosis for seed yield per plant over mid parent and two hybrids *viz.,* BSMR-853 ×Banas and BSMR-853 × GT-1 showed significant and desirable heterosis for seed yield per plant over better parent. The best hybrids with significant positive heterosis over standard check were ICPL-87119 × GT-103 (13.75) and ICPL-87119 × AGT-2 (13.48). The best crosses selected on the basis of *perse* performance and heterosis for seed yield per plant were ICPL-87119 × GT-103 and ICPL-87119 × AGT-2 which could be utilized for their large-scale testing and general adaptability.

Keywords- Pigeonpea, Heterosis, Hybrids and Diallel analysis.

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Introduction

Pigeonpea [*Cajanus cajan* L. Millsp.], (2n= 2x= 22) is also known as Redgram, Tur or Arhar. It is the second most important pulse crop after chickpea in India and rank fifth in the world. It belongs to the family *Leguminaceae,* subfamily *papilionaceae* and cultivated food crop of the sub tribe *Cajaninae*. Pigeonpea is a short lived perennial shrub [1]. Pigeonpea differs from other legumes, as it exhibits large variation due to their large amount of (20–70%) natural crossing. Pigeonpea is considered as an often-cross-pollinated crop [2]. The seed of pigeonpea contain 20-21% protein [3] and used in 'dal' as an important constituent of the Indian meal. Globally pigeonpea is grown in about 6.23 million hectares with production of 4.68 million tones and productivity of 751 kg/ha [4]. Whereas, in India pigeonpea was cultivated under 3.90 million hectares, having 3.17 million tones production with 813 kg/ha productivity during year 2014-15 [5].

Heterosis expresses the superiority of F_1 hybrid over its mid parental value in terms of yield and other characters [6]. Heterobeltiosis is the estimate of the superiority of F_1 hybrid over its better parent out of two parents involved in the particular crosses. Standard Heterosis expresses the superiority of F_1 hybrid over its standard commercial check variety or hybrids [7]. Exploitation of hybrid vigour is well thought-out to be one of the outstanding achievements of plant breeding. The study of magnitude and direction of heterosis are very important to know the potential of hybrids.

Material and Methods

The experimental materials for the present investigation consist of eight genotypes *viz.,* UPAS-120, ICPL-87119, BSMR-853, AGT-2, GT-1, GT-101, Banas and GT-103 of diverse geographic region. The crosses were made in a diallel mating design during *kharif* 2014-15. A set of 36 entries, including eight parents, their 28 crosses and standard check used from the parent line (GT-103) was sown in a Randomized Block Design with three replications during *kharif* 2015-16.

Each entry was sown in a single row of 3.0 m length keeping inter row and intra row distance of 60cm and 20cm, respectively. The observations were recorded as visual assessment as well as on measurement of individual plants. The individual plant observations were recorded on five randomly selected plants. The data were subjected to analysis for various characters for mean performance of parents and their hybrids and heterosis.

Results and Discussion

The analysis of variance revealed that the mean squares due to genotypes were highly significant for all the characters which indicate the presence of variability among the genotype under study. Mean squares due to parents were found highly significant for all the characters except number of seeds per pod and harvest index. Mean squares due to hybrids differed significantly for all the characters. Further, mean squares due to parents *vs.* hybrids were also found significant for days to maturity, plant height, number of pod per plant, seed yield per plant and leaf area [Table-1].

The estimate of heterosis [Table-2] for the days to flowering in different crosses ranged from -11.68 to 10.06 per cent, -22.36 to 0.87 per cent and -9.93 to 27.57 per cent over mid parent, better parent and standard check, respectively. In present study, five hybrids *viz.,* UPAS-120 × BSMR-853, UPAS-120 × GT-1, UPAS-120 × GT-101, UPAS-120 × BANAS and UPAS-120 × GT-103 depicted significant and negative heterosis for all the three bases of heterosis estimation, which indicates the earliness of crosses. A particular cross which matured earlier was considered as better parent and accordingly heterotic effects were estimated and ranged from-11.31 to 8.20 per cent, -25.05 to 0.2 per cent and -15.64 to 12.78 per cent over mid parent, better parent and standard check, respectively. Out of

28 hybrids, 13 hybrids showed significant and negative heterosis the basis of estimation of heterosis. Similar results of high heterosis were also reported by [8, 9].

Table-1 *Analysis of variance for different characters in pigeonpea*

Source of variation	d. f.	Days to flowering	Days to maturity	Plant height (cm)	No. of branches per Plant	No. of pods per plant	Pod length (cm)	No.of seeds per pod	Seed yield per plant (g)	100- seed weight (g)	Harvest index (%)	Protein content (%)	Leaf area (cm^2)
Replications	2	8.03	7.56	39.30	0.24	382.30	0.06	0.01	65.29	0.02	11.75	0.18	26969.48
Genotypes	35	367.48**	686.14**	235.14**	7.67**	4813.76**	0.17**	0.10*	836.38**	1.06**	20.84**	1.32**	278947.52**
Parents	7	406**	580.35**	268.13**	9.61**	3921.89**	0.31**	0.11	699.84**	0.73**	4.39	1.90**	241875.77**
Hybrids	27	370.67**	737.68**	234.39**	7.45**	5222.71**	0.14*	0.11*	901.53**	1.16**	25.84**	1.19**	282368.58**
Parents Vs. Hybrids	1	11.87	34.98*	24.49*	0.07	15.24*	0.17	0.019	33.12**	0.53	0.95	0.69	446081.00**
Error	70	3.22	6.86	50.48	0.35	788.64	0.08	0.05	44.27	0.21	6.04	0.51	19325.99

*, ** significant at 5 per cent and 1 per cent levels of probability, respectively

Table-2 *Estimates of per cent heterosis over mid parent (MP), better parent (BP) and standard parent (SP) for different characters in pigeonpea*

Hybrids	Days to flowering			Days to maturity			Plant height (cm)			No. of branches per plant		
	Heterosis per cent over			Heterosis per cent over			Heterosis per cent over			Heterosis per cent over		
	MP	BP	SP	MP	BP	SP	MP	BP	SP	MP	BP	SP
UPAS-120 × ICPL-87119	-8.57**	-20.93**	0	-9.17**	-20.55**	-10.57**	-3.59	-10.37**	-3.71	-15.38**	-27.98**	-3.2
UPAS-120 × BSMR-853	-11.68**	-22.36**	-5.51**	-10.73**	-22.70**	-13.00**	0.07	-1.16	-6.45	-1.24	-3.25	-4.8
UPAS-120 × AGT-2	-10.70**	-22.19**	-3.31	-11.31**	-21.72**	-11.89**	-4.97	-12.41**	-4.12	-20.95**	-34.27**	-6.4
UPAS-120 × GT-1	-6.54**	-11.97**	-8.09**	-5.93**	-23.87**	-14.32**	-3.73	-9.87**	-4.65	-20.69**	-33.14**	-8
UPAS-120 × GT-101	-6.29**	-10.22**	-9.56**	-5.98**	-24.66**	-15.20**	-2.41	-8.83*	-3.09	-20.40**	-34.25**	-4.8
UPAS-120 × BANAS	-6.10**	-12.41**	-6.62**	-5.74**	-22.90**	-13.22**	-2.19	-7.07	-4.7	-7.39	-14.39**	-4.8
UPAS-120 × GT-103	-6.31**	-9.93**	-9.93**	-9.35**	-25.05**	-15.64**	1.99	-1.93	-1.93	3.7	0.8	0.8
ICPL-87119 × BSMR-853	0.74	-1.16	25.00**	0.1	-2.35	9.91**	5.18	-1.07	6.27	11.34*	-3.57	29.60**
ICPL-87119 × AGT-2	-3.81**	-4.65**	20.59**	-3.16**	-3.91**	8.15**	0.5	-0.44	8.99*	1.16	-1.69	40.00**
ICPL-87119 × GT-1	2.87*	-6.10**	18.75**	3.94**	-4.50**	7.49**	1.86	1.08	8.58*	5.29	4.07	43.20**
ICPL-87119 × GT-101	9.39**	-1.74	24.26**	6.12**	-3.33**	8.81**	-1.44	-1.96	5.32	-7.74*	-11.05**	28.80**
ICPL-87119 × BANAS	9.46**	0.87	27.57**	5.49**	-2.15	10.13**	-0.92	-3.17	4.02	-4.89	-13.10**	16.80**
ICPL-87119 × GT-103	10.06**	-1.45	24.63**	2.61*	-3.91**	8.15**	-0.01	-3.47	3.7	9.22*	-4.76	28.00**
BSMR-853 × AGT-2	-0.75	-1.78	22.06**	-1.29	-2.94*	9.25**	-8.69**	-14.87**	-6.81	-6.31	-20.79**	12.80*
BSMR-853 × GT-1	3.74**	-3.63 **	17.28**	3.66**	-5.68**	6.17**	-4.28	-9.32*	-4.06	0.34	-13.95**	18.40**
BSMR-853 × GT-101	3.47**	-5.44**	15.07**	3.69**	-6.46**	5.29**	-5.09	-10.29**	-4.64	0	-16.02**	21.60**
BSMR-853 × BANAS	4.35**	-2.11	19.12**	3.30**	-5.09**	6.83**	-2.79	-6.53	-4.15	3.82	-2.16	8.8
BSMR-853 × GT-103	7.79**	-1.81	19.49**	5.91**	-1.76	10.57**	-3.75	-6.33	-6.33	11.29*	10.4	10.4
AGT-2 × GT-1	1.93	-6.21**	16.54**	5.39**	-2.35	9.91**	-1.93	-3.57	5.56	-0.57	-2.25	39.20**
AGT-2 × GT-101	0.65	-8.88**	13.24**	8.20**	-0.59	11.89**	0.02	-1.43	7.90*	1.39	0.55	45.60**
AGT-2 × BANAS	-1.27	-8.28**	13.97**	7.11**	0.2	12.78**	-2.89	-5.96	2.95	7.26	-4.49	36.00**
AGT-2 × GT-103	-6.89**	-15.98**	4.41**	3.63**	-2.15	10.13 **	3.72	-0.77	8.63*	7.59	-8.43*	30.40**
GT-1 × GT-101	-4.66**	-6.34**	-2.21	-3.24*	-18.20**	-7.93**	3.79	3.54	10.06*	3.68	1.1	46.40**
GT-1 × BANAS	-1.39	-2.41	4.04*	-4.43**	-17.61**	-7.27**	2.96	1.38	7.25	10.61*	0	37.60**
GT-1 × GT -103	-5.40**	-7.39**	-3.31	-7.42**	-19.37**	-9.25**	5.38	2.5	8.43*	25.93**	8.72*	49.60**
GT-101 × BANAS	-0.71	-3.45*	2.94	-3.32 *	-17.42**	-7.05**	-0.63	-2.39	3.76	5.63	-6.63	35.20**
GT-101 × GT-103	-0.73	-1.09	-0.37	-5.90**	-18.79**	-8.59**	2.88	-0.17	6.12	13.07**	-4.42	38.40**
BANAS × GT-103	-0.36	-3.45*	2.94	-2.78*	-14.48**	-3.74**	-0.48	-1.71	0.79	1.52	-3.6	7.2
S. Em.±	1.27	1.46	1.46	1.85	2.14	2.14	5.02	5.80	5.80	0.41	0.48	0.48
Range	-11.68 to 10.06	-22.36 to 0.87	-9.93 to 27.57	-11.31 to 8.20	-25.05 to 0.2	-15.64 to 12.78	-8.64 to 5.38	-14.87 to 3.58	-6.81 to 10.06	-20.95 to 25.93	-34.27 to 10.4	-6.4 to 49.60

Table-2 *Conti…*

Hybrids	No. of pods per plant			Pod length (cm)			No.of seeds per pod			Seed yield per plant (g)		
	Heterosis per cent over			Heterosis per cent over			Heterosis per cent over			Heterosis per cent over		
	MP	BP	SP	MP	BP	SP	MP	BP	SP	MP	BP	SP
UPAS-120 × ICPL-87119	-18.25*	-32.40**	-32.58**	-3.91	-10.37*	-7.58	-9.40*	-14.52**	-13.11**	-29.54**	-46.40**	-44.28**
UPAS-120 × BSMR-853	-15.37	-27.36**	-33.90**	-0.38	-0.42	-11.06*	-0.9	-1.79	-9.84	-16.02*	-32.11**	-40.34**
UPAS-120 × AGT-2	-29.25**	-42.92**	-39.33**	-3.56	-8.4	-9.14*	-0.85	-6.45	-4.92	-38.05**	-54.05**	-48.50**
UPAS-120 × GT-1	-1.89	-17.01	-21.77**	2.74	1.81	-9.14*	0.9	0	-8.2	-5.86	-25.21**	-31.18**
UPAS-120 × GT-101	-15.92	-29.58**	-31.99**	0.74	-3.03	-6.46	-5.17	-9.84	-9.84	-23.38**	-40.23**	-42.18**
UPAS-120 × BANAS	-7.99	-20.68*	-28.57**	3.58	3.25	-7.27	-4.42	-6.9	-11.48*	-13.05	-28.49**	-39.91**
UPAS-120 × GT-103	22.27**	1	1	2.46	-3.05	-3.05	1.72	-3.28	-3.28	33.02**	2.56	2.56
ICPL-87119 × BSMR-853	2.12	-2.35	-2.62	1.16	-5.61	-2.67	5.08	0	1.64	5.96	-2.23	1.64
ICPL-87119 × AGT-2	5.91	2.64	9.1	1.26	-0.66	2.42	1.61	1.61	3.28	5.05	1.24	13.48*
ICPL-87119 × GT-1	10.95	7.91	7.62	5.96	-1.99	1.06	5.08	0	1.64	14.47*	7.89	12.16
ICPL-87119 × GT-101	2.72	1.1	0.82	-6.94	-9.95*	-7.15	-4.07	-4.84	-3.28	8.13	4.37	8.5
ICPL-87119 × BANAS	3.24	-1.76	-2.03	1.16	-5.36	-2.42	1.67	-1.61	0	5.63	-4.49	-0.71
ICPL-87119 × GT-103	6.67	6.52	6.52	-6.24	-7.66	-4.79	-5.69	-6.45	-4.92	11.55*	9.43	13.75*
BSMR-853 × AGT-2	-11.15	-17.55 *	-12.36	-0.56	-5.51	-6.28	0	-4.84	-3.28	-14.65**	-23.86**	-14.66*
BSMR-853 × GT-1	11.85	9.92	3.6	16.05**	14.96**	2.67	10.71*	10.71	1.64	20.21**	17.50*	8.13
BSMR-853 × GT-101	9.2	6.04	2.42	6.86	2.9	-0.75	4.27	0	0	13.22*	8.04	4.51
BSMR-853 × BANAS	17.77*	17.16	6.61	14.43**	14.12**	2.49	8.77	6.9	1.64	30.48**	27.61**	12.15
BSMR-853 × GT-103	-3.98	-8.3	-8.3	0.39	-4.97	-4.97	2.56	-1.64	-1.64	-5.96	-11.66	-11.66

AGT-2 × GT-1	-0.52	-6.16	-0.25	6.59	0.38	-0.44	8.47	3.23	4.92	-3.5	-12.13*	-1.51
AGT-2 × GT-101	4.05	-0.71	5.54	4.19	2.76	1.93	0.81	0	1.64	5.92	-1.33	10.59
AGT-2 × BANAS	0.98	-6.74	-0.87	-0.56	-5.26	-6.03	-1.67	-4.84	-3.28	1.52	-11.19	-0.45
AGT-2 × GT-103	-3.38	-6.24	-0.34	-1.34	-1.74	-1.74	-0.81	-1.61	0	-5.71	-10.79	-0.01
GT-1 × GT-101	6.93	5.64	2.03	7.09	2.19	-1.43	2.56	-1.64	-1.64	14.70*	11.9	8.25
GT-1 × BANAS	-2.45	-4.62	-10.1	3.89	2.63	-7.83	1.75	0	-4.92	-5.28	-9.39	-16.62**
GT-1 × GT -103	5.89	2.85	2.85	5.6	-0.93	-0.93	5.98	1.64	1.64	9.25	4.89	4.89
GT-101 × BANAS	6.94	3.33	-0.21	5.11	1.48	-2.11	2.52	0	0	15.45*	7.87	4.35
GT-101 × GT-103	-3.15	-4.81	-4.81	-9.02 *	-10.63*	-10.63*	-8.2	-8.2	-8.2	-3.52	-5.1	-5.1
BANAS × GT-103	-3.74	-8.53	-8.53	0.59	-4.54	-4.54	0.84	-1.64	-1.64	1.08	-6.99	-6.99
S. Em.±	19.85	22.92	22.92	0.20	0.23	0.23	0.16	0.19	0.19	4.70	5.43	5.43
Range	-29.25 to 22.27	-42.92 to 17.16	-39.33 to 7.62	-9.02 to 16.05	-10.63 to 14.96	-11.06 to 2.67	-9.40 to 10.71	-14.52 to 10.71	-13.11 to 4.92	-38.05 to 33.02	-54.05 to 27.61	-48.50 to 13.75

Table-2 *Conti…*

Hybrids	100- seed weight (g)			Harvest index (%)			Protein content (%)			Leaf area (cm²)		
	Heterosis per cent over			Heterosis per cent over			Heterosis per cent over			Heterosis per cent over		
	MP	BP	SP	MP	BP	SP	MP	BP	SP	MP	BP	SP
UPAS-120 × ICPL-87119	-6.93	-13.57**	-9.37*	14.93*	10.45	15.47*	-7.95**	-10.38**	-0.35	-16.10**	-24.89**	-16.67**
UPAS-120 × BSMR-853	-7.07*	-12.57**	-10.85**	-11.38	-15.68*	-9.99	-1.32	-1.9	3.33	-4.7	-9.74	-11.49*
UPAS-120 × AGT-2	-11.66**	-16.53**	-15.67**	8.99	6.98	7.07	1.03	-1.06	4.22	-8.47*	-17.83**	-9.4
UPAS-120 × GT-1	-4.07	-8.94*	-8.91*	0.63	-0.95	-1.43	-1.12	-1.95	5.04	-13.51**	-25.73**	-9.21
UPAS-120 × GT-101	-6.15	-13.29**	-8.07*	-2.09	-3.31	-6.8	-1.41	-1.57	4.01	-0.63	-11.94**	-0.02
UPAS-120 × BANAS	-7.17	-10.73**	-13.09**	1.08	1.02	-2.63	-0.5	-3.72	1.41	4.64	2.08	-5.88
UPAS-120 × GT-103	-1.94	-6.9	-6.9	6.3	4.38	4.38	5.62*	2.95	8.44**	7.2	0.61	0.61
ICPL-87119 × BSMR-853	-3.01	-4.34	0.3	-8.78	-9.73	-3.63	1.81	-1.44	9.59**	12.18**	5.67	17.23**
ICPL-87119 × AGT-2	2.21	0.35	5.22	7.03	4.75	9.51	0.25	-4.36	6.34*	9.11*	8.78*	20.69**
ICPL-87119 × GT-1	5.23	2.81	7.8	8.8	6.19	11.01	-6.97**	-8.67**	1.55	5.98	1.08	23.56**
ICPL-87119 × GT-101	-4.97	-5.49	0.2	2.76	-2.42	2.02	-10.46**	-12.68**	-2.91	-4.42	-5.51	7.28
ICPL-87119 × BANAS	0.5	-3.1	1.61	5.57	1.39	5.99	-3.71	-9.20**	0.96	14.83**	5.14	16.64**
ICPL-87119 × GT-103	-0.08	-2.39	2.34	-13.09*	-14.98*	-11.12	3.62	-1.6	9.41**	5.29	0.1	11.05*
BSMR-853 × AGT-2	-5.15	-5.58	-3.72	-12.27*	-15.01*	-9.27	-3.24	-4.69	-0.78	3.29	-2.43	7.59
BSMR-853 × GT-1	1.49	0.53	2.51	6.69	3.07	10.03	-2.64	-4.02	2.82	6.09	-4.4	16.86**
BSMR-853 × GT-101	-1.14	-3.03	2.81	9.74	3.19	10.16	-4.5	-5.21	0.16	15.66**	7.77	22.36**
BSMR-853 × BANAS	1.14	-1.15	0.8	1.66	-3.34	3.19	1.87	-0.87	3.19	34.96**	30.92**	28.39**
BSMR-853 × GT-103	-2.11	-3.05	-1.14	-20.55**	-23.06**	-17.86*	-2.59	-4.5	-0.59	10.32*	9.25	9.25
AGT-2 × GT-1	-6.26	-6.73	-5.76	10.05	9.74	9.83	-1.16	-4	2.84	0.65	-4.28	17.00**
AGT-2 × GT-101	-0.31	-2.65	3.21	-17.98**	-20.47**	-20.40**	1.27	-0.97	4.64	7.47*	5.92	20.26**
AGT-2 × BANAS	-0.37	-2.19	-1.17	-14.22*	-15.86*	-15.79*	0.3	-0.93	0.03	17.12**	7.52	18.57**
AGT-2 × GT-103	-1.75	-2.25	-1.24	0.51	0.47	0.55	5.67*	5.16	6.19	-0.31	-4.95	4.81
GT-1 × GT-101	4.66	1.71	7.83*	7.47	4.49	3.99	-2.56	-3.22	3.68	6.79	2.99	25.89**
GT-1 × BANAS	2.68	1.31	1.34	-1.82	-3.43	-3.89	-5.52*	-9.32**	-2.86	-1.72	-13.80**	5.37
GT-1 × GT -103	5.64	5.62	5.66	15.25*	14.97*	14.97*	2.92	-0.5	6.59*	13.57**	3.24	26.19**
GT-101 × BANAS	-0.02	-4.1	1.67	-4.42	-5.54	-9.07	-0.03	-3.41	2.06	19.02**	7.84	22.43**
GT-101 × GT-103	1.07	-1.8	4.12	-9.15	-11.87	-11.87	0.77	-1.93	3.63	12.93**	6.2	20.57**
BANAS × GT-103	-3.99	-5.26	-5.26	-13.79*	-15.40*	-15.40*	5.01	4.22	4.22	15.96**	11.44*	11.44*
S. Em.±	0.32	0.37	0.37	1.73	2.00	2.00	0.50	0.58	0.58	98.30	113.50	113.50
Range	-11.64 to 5.64	-16.53 to 5.63	-13.09 to 7.83	-20.55 to 15.24	-23.06 to 14.97	20.14 to 15.47	-10.46 to 5.67	-12.68 to 5.16	-2.91 to 9.59	-16.10 to 34.96	-25.73 to 30.92	-16.67 to 26.19

*, ** significant at 5 per cent and 1 per cent levels of probability, respectively

Heterosis was ranged from -8.69 to 5.38 per cent, -14.87 to 3.54 per cent and -6.81 to 10.06 per cent over mid parent, better parent and standard check, respectively for plant height. None of the hybrids exhibited significant and negative heterosis is for plant height. For number of branches per plant, the range of heterosis over mid parent, better parent and standard check were from-20.95 to 25.93 per cent, -34.27 to 10.4 per cent and -6.4 to 49.60 per cent respectively. The estimates of heterosis for this trait revealed that only one hybrid *viz.,* GT-1 x GT-103 showed significant positive heterosis over mid parent, better parent and standard check, respectively. Heterosis for number of pods per plant, ranged from-29.25 to 22.27 per cent, -42.92 to 17.16 per cent and -39.33 to 7.62 per cent over mid, better and standard parent respectively. The estimates of heterosis for this trait revealed that two crosses *viz.,* UPAS-120 × GT-103 and BSMR-853 × Banas showed significant positive heterosis over mid parent. Similar findings were also reported in pigeonpea by [10] for number of pods per plant.

For pod length, the range of heterosis over mid parent, better parent and standard check were from -9.02 to 16.05 per cent, -10.63 to 14.96 per cent and -11.06 to 2.67 per cent respectively. The estimates of heterosis for this trait revealed that two crosses *viz.*, BSMR-853 × GT- 1 (14.96) and BSMR-853 × Banas (14.12) showed significant positive heterosis over mid parent and better parent, respectively. Heterosis for number of seeds per pods, ranged from -9.40 to 10.71 per cent, -14.52 to 10.71 per cent and -13.11 to 4.92per cent over mid parent, better parent and standard check respectively. The hybrid BSMR-853 × GT-1 (10.71) showed highest significant and positive heterosis over mid parent. Similar findings were also reported by [11] and [10] for pod length and number of seeds per pod in pigeonpea.

For seed yield per plant, the range of heterosis over mid parent, better parent and standard check was from -38.05 to 33.02 per cent, -54.05 to 27.61 per cent and -48.50 to 13.75 per cent respectively. The two hybrids *viz.,* BSMR-853 × BANAS and BSMR-853 × GT-1 showed highly significant and positive heterosis over mid parent and better parent. The best hybrids with significant positive heterosis over standard check were ICPL-87119 × GT-103 and ICPL-87119 × AGT-2. Similar observations have been reported earlier by [10] in pigeonpea. Heterosis for 100 seed weight was ranged between -11.64 to 5.64 per cent, -16.53 to 5.63 per cent and-13.09 to 7.83 per cent over mid parent, better parent and standard check, respectively. None of the hybrids exhibited significant and positive heterosis for 100-seed weight. Similar finding was also reported by [8].

For harvest index, the range of heterosis over mid parent, better parent and standard check was from-20.55 to 15.24 per cent, -23.06 to 14.97 per cent and

20.14 to 15.47 per cent, respectively. Only one hybrid (GT-1 × GT -103) showed significant and positive heterosis on all the three basis of estimation for this trait. Heterosis for protein content ranged from -10.46 to 5.67 per cent, -12.68 to 5.16 per cent and -2.91 to 9.59 per cent over mid parent, better parent and standard check, respectively. In present study, none of the hybrid registered significant and positive heterosis for any kind of heterosis. The magnitude of heterosis for leaf area showed that only five crosses recorded significant and positive heterosis. The range of heterosis for these traits over mid parent, better parent and standard check was from -16.10 to 34.96 per cent, -25.73 to 30.92 and -16.67 to 26.19 per cent respectively. Similar findings were also reported by [9].

With respect to seed yield per plant, cross combinations ICPL-87119 × GT-103 (13.75) and ICPL-87119 × AGT-2 (13.48) manifested the best heterotic response when compared with standard check. These crosses also had desirable heterosis effects for other yield attributes *viz.,* number of pods per plant, number of seeds per pod and 100-seed weight. Similar results of high heterosis for seed yield were also reported by [8, 9].

As the result of the present study indicated that selection of desirable traits for developing high yielding varieties should be made by crossing UPAS-120 for early flowering and maturity; BSMR-853 for dwarfness; AGT-2, ICPL-87119 and GT-103 for seed yield per plant, BSMR-853 for harvest index and ICPL-87119, GT-1 and GT-101 for protein content. In case of hybrid breeding programme, high heterotic effects for economic yield and other associated characters, measures the feasibility of commercial cultivation of hybrids. Out of 28 hybrids two promising hybrids were identified which were superior to standard check ICPL-87119 × GT-103and ICPL-87119 × AGT-2in respect of seed yield per plant. Similarly, parent UPAS-120 for early flowering and maturity, BSMR-853 for dwarf plant stature and harvest index and ICPL-87119, GT-1 and GT-101 for protein content. Therefore, these crosses and parents could be exploited for heterosis breeding programme to boost up the seed yield and its component traits in pigeonpea.

Conclusion

Form this study we had to identified the best two crosses selected on the basis of *perse* performance and heterosis for seed yield per plant were ICPL-87119 × GT-103and ICPL-87119 × AGT-2 which could be utilized for their large-scale testing and general adaptability and may be utilize for commercial exploitation.

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