HETEROTIC EXPRESSION FOR PROTEIN CONTENT IN DIRECT AND RECIPROCAL CROSSES OF DUAL PURPOSE PIGEONPEA

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ABSTRACT

A field experiment was undertaken with a view to know the extent of heterosis for protein content in dual purpose pigeonpea [Cajanus cajan (L.) Millsp.]. The hybrids were developed by adopting complete diallel mating design (including reciprocals) involving a set of 36 pigeonpea entries including six parents, 30 crosses and two parental lines viz., vegetable purpose released variety GT 1 and grain purpose released variety Vaishali as checks in randomized block design with three replications at Bharuch, Hansot and Navsari. Significant heterobeltiosis and standard heterosis over GT-1 and Vaishali for protein content suggested that there is a good scope of exploiting heterosis and also possibilities of isolating desirable segregants for protein content in dual type pigeonpea. AVPP-1 x SKNP-11-19 and SKNP-11-19 x ICPL- 87119 among direct crosses and ICPL- 87119 x AVPP-1 and ICPL- 87119 x SKNP-11-19 among reciprocals recorded significant heterotic values for protein content in dual type pigeonpea, which can be worked upon for the future breeding programme to improve quality parameters of dual type pigeonpea.

KEY WORDS: Diallel, Dual, pigeonpea protein content, reciprocal

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is a short-lived perennial member of family *Fabaceae* and it is invariably cultivated as an annual crop. Pigeonpea is an often cross pollinated crop (20 – 70 per cent cross pollination) (Saxena and Sharma, 1990) with 2n = 2x = 22 diploid chromosome number. It is widely grown on the Indian subcontinent. Pigeonpea offers many benefits to subsistence farmers as a food and cash crop and also ensures stable crop yields in times of drought. Recently multiple harvest potential of dual purpose pigeonpea (Vegetable as well as seed purpose) by rendering first two pickings for green pods and remaining left over for the harvesting of dry seeds can earn extra benefits and farmers are taking the cultivation more seriously than before. So, breeding for dual purpose pigeonpea is being considered as a life line of subsistence agriculture. This has brought the attention of pigeonpea breeders to develop high yielding dual purpose varieties with superior grain qualities. Protein content is important quality constituent of the dual purpose pigeonpea and it was rated as the best as far as its biological value concerned (Pal, 1939). Sharma *et al.* (1977), Manimekalai *et al.* (1979) and Singh *et al.* (1984) reported large variability for various chemical constituents and nutritive value of pigeonpea. It is to be noted that besides inherent genotypic differences, some degree of variation in protein content can also arise due to differences in environmental conditions where the crop was grown. Considering this the investigation was undertaken to identify heterotic crosses with superior dual type quality.

MATERIALS AND METHODS

The present investigation was carried out to elicit information on magnitude of heterobeltiosis and standard heterosis for quality parameters in dual purpose pigeonpea. The experimental material for the present investigation consisted of 36 entries including two vegetable purpose released varieties *viz*., GT-1 and AVPP-1; two grain purpose released varieties *viz*., Vaishali and ICPL-87119 as well as two dual type promising cultures viz., SKNP-11-19 and BP-06-33 used as parents and their resultant 30 crosses along with GT-1 and Vaishali (Included in parents) as checks. For obtaining hybrid seeds, the crosses were made at Pulses Research Station, NAU, Navsari during *rabi* 2013-14. All possible single crosses (including reciprocals) were made to complete the 6 x 6 full diallel set. The evaluation trials were conducted in Randomized Block Design with three replications at three locations *viz*., National Agricultural Research Project Farm, College of Agriculture, Bharuch; Cotton Wilt Research Sub-Station, Hansot (Dist- Bharuch) and Pulses Research Station, Navsari Agricultural University, Navsari during *kharif* 2014. Total protein content was estimated by Kjeldahl method using Gerhardt nitrogen digestion (turbotherm) and distillation (vapodest) apparatus from Bio-incorporation, India (Roopa and Premavalli, 2008). The mean values of the protein content was subjected to statistical analysis for each environment as well as pooled over environments by the usual statistical procedure (Panse and Sukhatme, 1985). Heterosis expressed as per cent increase or decrease in the mean value of F_1 hybrid over better parent (heterobeltiosis) and over standard check (standard heterosis) was calculated for protein content over environments following procedure given by Fonseca and Patterson (1968).

RESULTS AND DISCUSSION

Mean squares obtained from the individual environments (Table 1) indicated that, parents differed significantly for protein content. Hybrids differed significantly among themselves for the same. Comparison of mean squares due to parents vs. hybrids was found to be highly significant for protein content under all the three environments which suggested that parental group as a whole was quite different from their F_1s indicating the presence of heterosis for the same under investigation.

The analysis for pooled over environments (Table 2) revealed that mean squares due to environments were highly significant; which indicated variable environmental conditions. The considerable amount of variability was observed among all the entries as the mean squares due to genotypes were highly significant. Genotypes were found to interact non-significantly with the environments for protein content indicated similar response of parents as well as hybrids with different environments.

From the perusal of the *per se* performance of parents and hybrids (Table 3), it was noted that, the protein content of the parents ranged from 13.79 (ICPL-87119) to 22.54 per cent (BP-06-33) in pooled data. Among F_1s, the cross Vaishali x BP-06-33 registered highest mean value (22.61 %), while GT-1 x BP-06-33 recorded least average value (17.42 %) for protein content in pooled analysis. The reciprocal cross BP-06-33 x GT-1 pictured maximum (22.73 %) and cross ICPL-87119 x AVPP-1 showed least (17.40 %) protein content in pooled investigations. Average protein content of reciprocal crosses (19.26 %) was higher than direct crosses (18.96 %). In general, the lowest value of protein content was recorded at Hansot (18.86 %), while it was highest at Bharuch (19.15 %).

In the present study, the aim of heterosis analysis was to identify best combination of parents giving high degree of useful heterosis and characterization of parents for their prospects for protein content of dual purpose pigeonopea. For protein content among direct crosses, three and two crosses showed positive significant heterobeltiosis and standard heterosis over check Vaishali, respectively. The heterobeltiosis for direct crosses ranged from -22.70 (GT-1 x BP-06-33) to 39.00 per cent (AVPP-1 x SKNP-11-19), while standard heterosis ranged from -17.38 (GT-1 x BP-06-33) to 7.23 per cent (Vaishali x BP-06-33) in pooled analysis (Table 4). None of the direct cross had recorded significant standard heterosis over check GT-1 in desired direction in pooled investigations. The heterobeltiosis for reciprocal crosses ranged from -21.87 (BP-06-33 x SKNP-11-19) to 31.86 per cent (ICPL-87119 x SKNP-11-19), while the standard heterosis over GT-1 and vaishali in reciprocals varied from -21.98 (ICPL-87119 x AVPP-1) to 1.90 per cent (BP-06-33 x GT-1) and -17.47 (ICPL-87119 x AVPP-1) to 7.80 per cent (BP-06-33 x GT-1), respectively in pooled over environments (Table 4). In case of reciprocal crosses, three crosses for heterobeltiosis, one cross for standard heterosis over GT-1 and two crosses for standard heterosis over Vaishali depicted significant and positive values over environments. The results are akin to those reported by Patel and Tikka (2008) and Acharya *et al.* (2009).

Reciprocal differences were also observed and crosses viz., ICPL-87119 x AVPP-1 and ICPL-87119 x SKNP-11-19 performed good in terms of *per se* performance and heterotic expression for dual purpose pigeonpea indicating that small group of cytoplasmic genes are also playing key role and affecting the hybrid vigour. So, it is better to attempt even reciprocal crosses when direct crosses are not showing desired results.

CONCLUSION

From the results and discussion, it can be concluded that AVPP-1 x SKNP-11-19 and SKNP-11-19 x ICPL- 87119 among direct crosses and ICPL- 87119 x AVPP-1 and ICPL- 87119 x SKNP-11-19 among reciprocals recorded significant heterotic values for protein content in dual type pigeonpea, which can be worked upon for the future breeding programme to improve quality parameters of dual type pigeonpea.

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Table 1: Analysis of variance showing mean squares of individual environment for parents and hybrids (F_1's + reciprocals) in pigeonpea.

Source	D.F.	Protein Content (%)		
		Bharuch	Hansot	Bharuch
Treatments	35	15.50**	14.57**	15.50**
Parents	5	43.11**	45.47**	43.11**
Hybrids	29	11.09**	9.58**	11.09**
Parent v/s Hybrids	1	5.39**	4.50*	5.39**
F1's	14	9.83**	8.53**	9.83**
Reciprocals	14	13.09**	11.31**	13.09**
F1's v/s Reciprocals	1	0.58	0.12	0.58
Error	70	0.38	0.78	0.38

****Significant at 5% level and ** Significant at 1% level***

Table 2: Analysis of variance showing pooled mean squares (parents + hybrids) for protein content in pigeonpea.

Source	D.F.	Protein Content (%)
Environments (E)	2	0.74*
Genotypes (G)	35	14.38**
G x E	70	0.19
Error	210	0.18

****Significant at 5% level and ** Significant at 1% level***

Table 3: Per se performance (parents + hybrids) for protein content in pigeonpea.

Sr. No.	Parents/Crosses	Protein Content (%)			
		Bharuch	Hansot	Navsari	Pooled
	Parents				
1	GT-1	21.64	22.03	23.24	22.30
2	AVPP-1	15.56	15.83	14.48	15.29
3	SKNP-1119	16.61	15.96	15.51	16.03
4	Vaishali	21.23	20.74	21.28	21.08
5	ICPL-87119	13.82	13.24	14.30	13.79
6	BP-06-33	23.03	22.63	21.94	22.54
	Parental Mean	18.65	18.41	18.46	18.50
	F1's				
7	GT-1 x AVPP-1	20.29	19.92	19.73	19.98
8	GT-1 x SKNP-11-19	17.25	17.50	17.55	17.43
9	GT-1 x Vaishali	18.79	18.33	17.95	18.35
10	GT-1 x ICPL- 87119	18.05	17.67	17.71	17.81
11	GT-1 x BP-06-33	17.40	17.36	17.50	17.42
12	AVPP-1 x SKNP-11-19	22.59	22.38	21.86	22.28
13	AVPP-1 x Vaishali	19.59	19.48	18.77	19.28
14	AVPP-1 x ICPL- 87119	19.82	19.36	19.26	19.48
15	AVPP-1 x BP-06-33	17.56	17.35	17.64	17.52
16	SKNP-11-19 x Vaishali	18.49	17.91	17.98	18.13
17	SKNP-11-19 x ICPL- 87119	17.78	17.53	17.12	17.48
18	SKNP-11-19 x BP-06-33	20.18	19.68	19.50	19.79
19	Vaishali x ICPL- 87119	17.15	17.76	18.00	17.64
20	Vaishali x BP-06-33	22.89	22.47	22.47	22.61
21	ICPL- 87119 x BP-06-33	19.65	19.05	18.99	19.23
	F1's mean	19.17	18.92	18.80	18.96
	Reciprocals				
22	AVPP-1 x GT-1	20.82	20.15	20.45	20.47
23	SKNP-11-19 x GT-1	21.72	21.44	21.15	21.44
24	SKNP-11-19 x AVPP-1	17.52	17.07	17.83	17.47
25	Vaishali x GT-1	17.98	17.42	17.51	17.64
26	Vaishali x AVPP-1	20.11	19.75	19.65	19.84
27	Vaishali x SKNP-11-19	17.43	17.63	18.40	17.82
28	ICPL- 87119 x GT-1	17.58	17.50	19.79	18.29
29	ICPL- 87119 x AVPP-1	17.28	17.42	17.51	17.40
30	ICPL- 87119 x SKNP-11-19	21.42	20.98	21.00	21.14
31	ICPL- 87119 x Vaishali	17.42	17.28	18.51	17.74
32	BP-06-33 x GT-1	22.98	22.38	22.82	22.73
33	BP-06-33 x AVPP-1	17.74	17.42	17.91	17.69
34	BP-06-33 x SKNP-11-19	17.55	17.09	18.18	17.61
35	BP-06-33 x Vaishali	22.35	21.68	21.97	22.00
36	BP-06-33 x ICPL- 87119	19.99	19.62	19.40	19.67
	Reciprocals mean	19.33	18.99	19.47	19.26
	General Mean	19.15	18.86	19.02	19.01
	CD at 5%	1.00	1.44	1.14	0.71
	C.V. (%)	3.21	4.68	3.69	2.28

Table 4: Estimation of heterobeltiosis (BP) and standard heterosis (SC1 over GT-1 and SC2 over Vaishali) for protein content in different environments and pooled over environments in pigeonpea.

Sr. No.	Crosses	Bharuch			Hansot			Navsari			Pooled		
		BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2
F1's													
1	GT-1 x AVPP-1	-6.21**	-6.21**	-4.42	-9.61**	-9.61**	-3.97	-15.10**	-15.10**	-7.28**	-10.41**	-10.41**	-5.23**
2	GT-1 x SKNP-11-19	-20.26**	-20.26**	-18.73**	-20.59**	-20.59**	-15.63**	-24.48**	-24.48**	-17.52**	-21.83**	-21.83**	-17.31**
3	GT-1 x Vaishali	-13.16**	-13.16**	-11.50**	-16.82**	-16.82**	-11.63**	-22.78**	-22.78**	-15.67**	-17.71**	-17.71**	-12.95**
4	GT-1 x ICPL- 87119	-16.56**	-16.56**	-14.97**	-19.82**	-19.82**	-14.81**	-23.79**	-23.79**	-16.77**	-20.14**	-20.14**	-15.52**
5	GT-1 x BP-06-33	-24.45**	-19.58**	-18.04**	-23.29**	-21.21**	-16.29**	-24.71**	-24.71**	-17.77**	-22.70**	-21.90**	-17.38**
6	AVPP-1 x SKNP-11-19	36.04**	4.42	6.42**	40.21**	1.59	7.93*	40.92**	-5.93*	2.73	39.00**	-0.11	5.67**
7	AVPP-1 x Vaishali	-7.74**	-9.47**	-7.74**	-6.06	-11.57**	-6.06	-11.80**	-19.24**	-11.80**	-8.56**	-13.56**	-8.56**
8	AVPP-1 x ICPL- 87119	27.40**	-8.38**	-6.63**	22.30**	-12.15**	-6.67	33.08**	-17.12**	-9.48**	27.43**	-12.66**	-7.60**
9	AVPP-1 x BP-06-33	-23.74**	-18.83**	-17.27**	-23.32**	-21.24**	-16.33**	-19.60**	-24.09**	-17.10**	-22.25**	-21.45**	-16.90**
10	SKNP-11-19 x Vaishali	-12.89**	-14.53**	-12.89**	-13.64**	-18.71**	-13.64**	-15.50**	-22.63**	-15.50**	-14.02**	-18.72**	-14.02**
11	SKNP-11-19 x ICPL- 87119	7.08*	-17.81**	-16.24**	9.83*	-20.42**	-15.46**	10.35**	-26.34**	-19.55**	9.05**	-21.63**	-17.10**
12	SKNP-11-19 x BP-06-33	-12.38**	-6.73**	-4.95*	-13.04**	-10.68**	-5.11	-11.14**	-16.10**	-8.37**	-12.20**	-11.29**	-6.15**
13	Vaishali x ICPL- 87119	-19.22**	-20.74**	-19.22**	-14.36**	-19.39**	-14.36**	-15.42**	-22.55**	-15.42**	-16.35**	-20.93**	-16.35**
14	Vaishali x BP-06-33	-0.63	5.78*	7.80**	-0.71	1.98	8.35*	2.40	-3.32	5.58*	0.33	1.37	7.23**
15	ICPL- 87119 x BP-06-33	-14.70**	-9.20**	-7.46**	-15.82**	-13.54**	-8.14*	-13.48**	-18.31**	-10.78**	-14.68**	-13.79**	-8.80**
16	AVPP-1 x GT-1	-3.77	-3.77	-1.93	-8.55*	-8.55*	-2.84	-12.01**	-12.01**	-3.91	-8.21**	-8.21**	-2.90**

Table 4: Contd….

17	**SKNP-11-19 x GT-1**	0.39	0.39	2.30	-2.68	-2.68	3.40	-9.00**	-9.00**	-0.62	-3.88**	-3.88**	1.68
18	**SKNP-11-19 x AVPP-1**	5.47	-19.04**	-17.49**	6.93	-22.53**	-17.69**	14.95**	-23.27**	-16.20**	9.01**	-21.66**	-17.12**
19	**Vaishali x GT-1**	-16.88**	-16.88**	-15.30**	-20.95**	-20.95**	-16.02**	-24.66**	-24.66**	-17.72**	-20.93**	-20.93**	-16.35**
20	**Vaishali x AVPP-1**	-5.28*	-7.06**	-5.28*	-4.77	-10.36**	-4.77	-7.65**	-15.44**	-7.65**	-5.91**	-11.06**	-5.91**
21	**Vaishali x SKNP-11-19**	-17.90**	-19.44**	-17.90**	-14.99**	-19.98**	-14.99**	-13.54**	-20.83**	-13.54**	-15.48**	-20.10**	-15.48**
22	**ICPL- 87119 x GT-1**	-18.73**	-18.73**	-17.18**	-20.59**	-20.59**	-15.63**	-14.85**	-14.85**	-7.01*	-18.00**	-18.00**	-13.25**
23	**ICPL- 87119 x AVPP-1**	11.03**	-20.15**	-18.62**	10.06*	-20.94**	-16.00**	20.94**	-24.68**	-17.74**	13.83**	-21.98**	-17.47**
24	**ICPL- 87119 x SKNP-11-19**	28.99**	-0.99	0.91	31.44**	-4.77	1.18	35.36**	-9.65**	-1.32	31.86**	-5.24**	0.25
25	**ICPL- 87119 x Vaishali**	-17.95**	-19.49**	-17.95**	-16.68**	-21.57**	-16.68**	-13.01**	-20.35**	-13.01**	-15.87**	-20.47**	-15.87**
26	**BP-06-33 x GT-1**	-0.21	6.22**	8.26**	-1.09	1.59	7.93*	-1.83	-1.83	7.21**	0.85	1.90*	7.80**
27	**BP-06-33 x AVPP-1**	-22.96**	-17.99**	-16.43**	-23.01**	-20.92**	-15.99**	-18.40**	-22.96**	-15.86**	-21.50**	-20.68**	-16.09**
28	**BP-06-33 x SKNP-11-19**	-23.78**	-18.87**	-17.32**	-24.50**	-22.45**	-17.61**	-17.14**	-21.77**	-14.56**	-21.87**	-21.06**	-16.49**
29	**BP-06-33 x Vaishali**	-2.97	3.28	5.26*	-4.18	-1.59	4.55	0.10	-5.49*	3.22	-2.38**	-1.37	4.34**
30	**BP-06-33 x ICPL- 87119**	-13.20**	-7.61**	-5.84*	-13.29**	-10.94**	-5.38	-11.61**	-16.54**	-8.86**	-12.71**	-11.81**	-6.71**
	S.E.(d) ±	0.50	0.50	0.50	0.72	0.72	0.72	0.57	0.57	0.57	0.20	0.20	0.20
	CD at 0.05	1.00	1.00	1.00	1.44	1.44	1.44	1.14	1.14	1.14	0.40	0.40	0.40
	CD at 0.01	1.33	1.33	1.33	1.91	1.91	1.91	1.52	1.52	1.52	0.53	0.53	0.53

Significant at 5% level and **Significant at 1% level

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