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ANALYSIS OF GENE EFFECTS FOR YIELD AND CERTAIN YIELD TRAITS IN CHICKPEA

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ABSTRACT

Character means of six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of six intervarietal crosses in chickpea were used to detect epistasis and gene effects for yield and seven yield components. All the eight characters appeared to be complex as genetic interaction manifested in all crosses for most of the characters. Both additive and nonadditive gene effects were recorded for days to flower, primary and secondary branches, No. of pods, and grain yield per plant.

Key words: *Cicer arietinum*, gene effects, generation mean.

Information on gene action for yield and its component traits in different population is imperative for planning effective breeding programme. Several biometrical procedures are available for obtaining information on the nature of genetic variation which form the basis of selection for the improvement of crop plants. Among the various designs used the generation mean analysis approach of [1] is simple which can provide preliminary notation on genetic components of mean. The present investigation has been carried out to obtain genetic information for yield and seven other related characters using generation mean analysis in six intervarietal crosses of chickpea.

MATERIALS AND METHODS

The material consisted of six intervarietal crosses of chickpea: BGM-417 x Ponaflair, E 100 Y (M) x E 100 Y, PDG-8416 x PRR-1, Ponaflair x PDG-8416, Hyb 16-3 x ICC-6671-WR, and L-550 (Pm) x P 436-2-WR. The first four crosses are desi x desi and the remaining two crosses are kabuli x desi. Six generations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of each cross were evaluated in compact family block design with two replications. Each parental, F_1, and backcross generation was represented by one row, and F_2 by six rows, 4 m long. The spacings between and within rows were 30 and 15 cm, respectively. Five random plants per row in a replication of each family were scored for eight quantitative traits (Table 1). The data were first subjected to the scaling tests of [1, 2] to detect epistasis and then the six-parameter model of [3, 4] was used to obtain estimates of m, (d), (h), (i), (j), and (l) parameters.

RESULTS AND DISCUSSION

The estimates of scaling test and gene effects for different traits (Table 1) revealed adequacy of additive–dominance model for days to flower only in the cross BGM-417 x Ponaflair. For the remaining characters digenic interactions were recorded.

From the analysis of the six-parameter model it can be inferred that both fixable and nonfixable gene effects are significant for most characters in all the six crosses. Both additive and dominance gene effects were recorded for days to flower in all the crosses except

Table 1. Estimates of scaling test and gene effects for eight characters in chickpea crosses

Cross	Scale				Genetic parameter					
	A	B	C	D	m	(d)	(h)	(i)	(j)	(l)
					Days to first flower					
BGM-417 x Ponaflair	1.00	– 4.10	6.40	4.75	76.00**	3.15	– 15.50**	—	—	—
E 100 Y (m) x E 100 Y	– 10.70**	– 13.81**	– 22.60**	0.96	73.90**	2.36**	– 3.21**	– 1.91	1.56**	26.42**
PDG-8416 x PRR-1	13.90**	– 12.57**	– 11.40*	– 6.37**	61.30**	9.04**	13.23**	12.73**	13.24**	– 14.06**
Ponaflair x PDG-8416	17.30**	7.26	4.70*	– 9.33**	63.90**	13.27**	11.81**	19.86**	5.02**	– 44.42**
Hyb 16-3 x ICC-6771-WR	– 1.00	– 15.21**	18.30**	17.26**	84.20**	11.26**	– 27.16**	– 34.51**	7.10**	50.72**
L-550 (Pm) x P 436-2-WR	– 3.90**	– 10.24**	12.80**	13.47**	79.10**	4.47**	– 18.34**	– 26.94**	3.17**	41.08**
					Plant height					
BGM-417 x Ponaflair	– 10.50**	15.56**	– 1.40	– 3.23	45.90**	– 16.23**	8.56*	6.46	– 13.03**	– 11.52
E 100 Y (m) x E 100 Y	– 6.70**	7.42**	– 45.20**	– 22.96**	49.70**	– 21.16**	28.12**	45.92**	– 7.06**	– 46.64**
PDG-8416 x PRR-1	1.00	– 10.78*	– 15.50**	– 2.86	61.50**	6.74**	2.17	5.72	5.89*	4.06
Ponaflair x PDG-8416	0.60	– 25.20**	– 127.60**	7.70*	59.20**	4.10	– 3.40	– 15.20**	12.90**	39.90**
Hyb 16-3 x ICC-6771-WR	9.70*	18.39**	23.20**	– 2.45	62.40**	2.36	– 6.11	4.89	– 4.34	– 32.98**
L-550 (Pm) x P 436-2-WR	– 13.60**	– 6.61	– 12.70**	3.76	59.20**	0.96	– 15.41*	– 7.51	– 3.50	– 28.79*
					Primary branches per plant					
BGM-417 x Ponaflair	– 2.90**	– 2.80**	14.20**	9.95**	8.50**	0.75**	– 21.80**	– 19.90**	– 0.05	25.60**
E 100 Y (m) x E 100 Y	1.10*	– 0.37	5.00**	2.14**	4.10**	0.74**	– 3.77**	– 4.27**	0.74**	3.54**
PDG-8416 x PRR-1	1.30**	– 1.07*	3.50**	1.64**	3.50**	0.64**	– 2.52**	– 3.27**	1.19**	3.04**
Ponaflair x PDG-8416	– 1.90**	0.53	2.50**	1.94**	3.70**	0.53**	– 3.62**	– 3.87**	– 1.22**	5.24**
Hyb 16-3 x ICC-6771-WR	0.30	1.43**	15.70**	6.99**	6.80**	0.78**	– 16.12**	– 13.97**	– 0.57*	12.24**
L-550 (Pm) x P 436-2-WR	3.80**	– 0.14	11.40**	3.87**	7.20**	1.07**	– 7.44**	– 7.74**	1.97**	4.08**

(Contd.)

Table 1 (contd.)

Cross	Scale				Genetic parameter					
	A	B	C	D	m	(d)	(h)	(i)	(j)	(l)
				Secondary branches per plant						
BGM-417 x Ponaflair	1.20	-10.24^{**}	57.20^{**}	33.12^{**}	31.10^{**}	5.12^{**}	-65.84^{**}	-66.26^{**}	5.72^{**}	75.28^{**}
E 100 Y (m) x E 100 Y	-3.70^{*}	-6.07^{**}	-11.10^{**}	-0.67	9.30^{**}	2.14^{**}	4.98^{**}	1.33	1.19	8.44^{**}
PDG-8416 x PRR-1	5.70^{**}	-10.81^{**}	-21.40^{**}	13.26^{**}	20.30^{**}	6.86^{**}	-17.61^{**}	-26.51^{**}	8.26^{**}	31.62^{**}
Ponaflair x PDG-8416	9.60^{**}	-7.04^{**}	-12.30^{**}	-6.43^{**}	11.40^{**}	12.17^{**}	15.11^{**}	12.86^{**}	8.32^{**}	-19.42^{**}
Hyb 16-3 x ICC-6771-WR	6.70^{**}	-0.73	51.20^{**}	22.62^{**}	22.50^{**}	5.62^{**}	-50.83^{**}	-45.23^{**}	3.72^{**}	39.26^{**}
L-550 (Pm) x P 436-2-WR	28.70^{**}	1.87	51.20^{**}	10.32^{**}	21.70^{**}	9.72^{**}	-22.03^{**}	-20.63^{**}	13.42^{**}	-9.94
				Pods per plants						
BGM-417 x Ponaflair	-161.70^{**}	-59.44^{**}	196.50^{**}	208.82^{**}	153.30^{**}	-7.98^{**}	-355.99^{**}	-417.64^{**}	-51.13^{**}	638.78^{**}
E 100 Y (m) x E 100 Y	25.00^{**}	-18.37^{**}	10.40	1.89	30.00^{**}	12.89^{**}	13.03^{*}	-3.77	21.69^{**}	-2.86
PDG-8416 x PRR-1	8.10^{**}	4.32^{**}	102.50^{**}	45.04^{**}	68.70^{**}	10.44^{**}	-59.23^{**}	-90.08^{**}	1.89^{*}	77.66^{**}
Ponaflair x PDG-8416	96.30^{**}	-33.00^{**}	97.40^{**}	17.05^{**}	64.70^{**}	61.05^{**}	-21.60^{**}	-34.10^{**}	64.45^{**}	-29.20^{**}
Hyb 16-3 x ICC-6771-WR	0.50	4.37^{*}	108.50^{**}	51.82^{**}	57.82^{**}	6.81^{**}	-102.38^{**}	-103.63^{**}	-1.94	98.76^{**}
L-550 (Pm) x P 436-2-WR	44.80^{**}	-45.77^{**}	103.20^{**}	52.09^{**}	68.60^{**}	29.69^{**}	-107.57^{**}	-104.17^{**}	45.29^{**}	105.14^{**}
				Seeds per pod						
BGM-417 x Ponaflair	-0.66^{**}	0.72^{**}	0.84	0.39	1.86^{**}	-0.41^{**}	-0.96	-0.78	-0.69^{**}	0.72
E 100 Y (m) x E 100 Y	0.22	-4.80^{**}	-8.48^{**}	-0.29^{**}	1.26^{**}	0.30^{**}	1.28^{**}	0.58^{**}	0.35^{**}	-0.32
PDG-8416 x PRR-1	-0.20	-0.01	-1.02^{**}	-0.41^{**}	1.44^{**}	-0.17^{*}	0.82^{**}	0.81^{**}	-0.95^{**}	-0.60
Ponaflair x PDG-8416	0.90^{**}	-0.42^{*}	0.42	-0.03	1.72^{**}	0.41^{**}	0.27	0.06	0.66^{**}	-0.54
Hyb 16-3 x ICC-6771-WR	-0.14	0.58^{**}	1.46^{**}	0.51^{*}	2.14^{**}	-0.03	-1.09^{*}	-1.02^{*}	-0.36^{**}	0.58
L-550 (Pm) x P 436-2-WR	-0.26	-0.38^{*}	0.44	0.54	1.74^{**}	0.14	-1.14	-1.08	0.06	1.72^{*}
				100-seed weight (g)						
BGM-417 x Ponaflair	1.36	3.88^{**}	-3.17^{**}	-4.21^{**}	12.90^{**}	0.40	6.74^{**}	8.41^{**}	-1.26	-13.65^{**}
E 100 Y (m) x E 100 Y	-9.91^{**}	2.34	-25.20^{**}	-8.82^{**}	22.89^{**}	-7.71^{**}	14.74^{**}	17.63^{**}	-6.13^{**}	-10.06
PDG-8416 x PRR-1	14.96^{**}	-15.15^{**}	-9.58^{**}	-4.69^{**}	22.74^{**}	6.48^{**}	11.93^{**}	9.38^{**}	15.05^{**}	-9.18^{*}
Ponaflair x PDG-8416	6.53^{**}	6.78^{**}	10.61^{**}	-1.32	17.44^{**}	-1.31^{*}	4.39^{*}	2.64	-0.13	-15.95^{**}
Hyb 16-3 x ICC-6771-WR	4.13^{**}	4.23^{**}	3.31^{*}	-2.53^{**}	22.66^{**}	-1.25^{**}	1.46	5.05^{**}	-0.05	-13.41^{**}
L-550 (Pm) x P 436-2-WR	-4.34^{**}	-4.00^{**}	9.50^{**}	8.92^{**}	23.96^{**}	-0.77	-14.23^{**}	-17.83^{**}	-0.17	26.17^{**}
				Yield per plant (g)						
BGM-417 x Ponaflair	-23.97^{**}	-12.48^{**}	50.44^{**}	43.44^{**}	34.59^{**}	0.99^{*}	-76.91^{**}	-86.88^{**}	-5.74^{**}	123.33^{**}
E 100 Y (m) x E 100 Y	9.73^{**}	-1.10	7.09	-0.78	11.44^{**}	4.12^{**}	4.96	1.55	5.41^{**}	-10.19^{*}
PDG-8416 x PRR-1	22.56^{**}	-32.47^{**}	13.84^{**}	11.87^{**}	28.03^{**}	16.74^{**}	-22.07^{**}	-23.74^{**}	27.51^{**}	33.65^{**}
Ponaflair x PDG-8416	23.50^{**}	-9.70^{**}	22.22^{**}	4.21^{**}	17.81^{**}	15.83^{**}	-5.46^{**}	-7.42^{**}	16.60^{**}	-5.78
Hyb 16-3 x ICC-6771-WR	3.88^{**}	1.80^{*}	47.18^{**}	20.75^{**}	24.94^{**}	3.45^{**}	-42.03^{**}	-41.50^{**}	1.04	35.83^{**}
L-550 (Pm) x P 436-2-WR	1.22	-20.74^{**}	24.99^{**}	22.26^{**}	24.35^{**}	6.53^{**}	-37.22^{**}	-44.51^{**}	10.98^{**}	64.03^{**}

*,**Significant at 5 and 1% levels, respectively.

BGM-417 x Ponaflair, for plant height in BGM-417 x Ponaflair and E 100 Y (M) x E 100 Y; for primary branches and secondary branches and pods/plant in all the crosses; for seeds/pod in E 100 Y (M) x E 100 Y and PDG-8416 x PRR-1; for 100-seed weight in E 100 Y (M) x E 100 Y, PDG-8416 x PRR-1 and Ponaflair x PDG-8416; and for yield/plant in all the crosses except, E 100 Y (M) x E 100 Y. The additive component was predominant in the cross PDG-8416 x PRR-1 for plant height; in BGM-417 x Ponaflair and Ponaflair x PDG-8416 for seeds/pod; in Hyb 16-3 x ICC-6671-WR for 100-seed weight; and in E 100 Y (M) x E 100 Y for yield/plant. The dominance component of gene effect was negligible for these characters. However, the dominance component was more predominant for days to first flower in the cross BGM-417 x Ponaflair; for plant height in L-550 (Pm) x P 436-2-WR, and for 100-seed weight in L-550 (Pm) x P 436-2-WR. In these crosses, the additive component was nonsignificant for these characters.

Digenic interactions were significant for most of the characters in all the six crosses, however, their magnitude varied depending on the character(s)/parent(s) choosen. In chickpea, varying magnitudes of additive and nonadditive gene effects have been reported earlier for different characters [5–7]. Additive and dominance gene effects have also been reported for different characters [5–9]. Epistasis was observed more frequently in the crosses where the parents had greater diversity [10], as also observed in this study. Simultaneous occurrence of significant estimates of dominance and epistasis in most cases suggests that both type of gene action could be due to the action of same gene(s).

To adopt a suitable breeding procedure under varying types of genetic control in such a material, the pedigree method of breeding involving multiple crosses may be used with greater advantage to exploit the additive genetic components for complex characters like seed yield and pods/plant. However, maximum gain could be attained by maintaining considerable heterozygosity through mating of selected plants in early segregating generations.

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