Madras Agric. J., 87(7-9): 418 - 422 July - September 2000
https://doi.org/10.29321/MAJ.10.A00488

Combining ability in pigeonpea

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Abstract : Using combining ability studies line x tester analysis in pigeonpea revealed non-additive gene action for the expression of days to first flowering, days to 50 per cent flowering, number of branches per plant, plant height, number of pods per plant, days to maturity, number of seeds per pod and additive gene action for seed yield. Parents MS Prabhat DT and CORG 9060 were found to be good general combiners for days to MS Prabhat DT and CORG 9060 were found to be good general combiners for days to first flowering, days to 50 per cent flowering and days to maturity. For number of branches per plant, plant height, pods per plant and seed yield per plant, MS Co 5 and CORG 5 were the good combiners. The crosses MS Co 5 x ICPL 161 and MS Co 5 x CORG 5 were the best combinations for seed yield.
*(**Key words** : Pigeonpea, Combining ability)*

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important pulse crop in India. Knowledge on combining ability and type of gene action involved in inheritance of yield and its component traits are available in literature, understanding of genetic architecture of every material is essential for planning a sound breeding programme. Hence the present study was carried out with three lines and ten testers to gather the required information.

Materials and Methods

Thirteen pigeonpea genotypes were crossed in line x tester model using 3 females (MS Co 5, MS T 21 and MS Prabhat DT) and 10 males (ICPL 87 CORGE 9307, CORG 9302, ICPL 161, 88001, CORG 9060, ICPL 83024, ICPL 83027, CORG 5 and VBN-1). The resultant thirty hybrids were sown in a randomized block design with 4 replications with 45 x 30 cm spacing during *kharif* 1996. Each cross and parent were raised in single row of 3m long. Observations on 5 randomly selected plants in each type in each replication were recorded for days to first flowering, days to 50 per cent flowering, number of branches per plant, plant height, number of pods per plant, number of seeds per pod, days to maturity, 100 seed weight and seed yield per plant. Mean value of 5 plants were used for biometrical analysis. The estimates of combining ability and their variances were calculated as per the method suggested by Kempthorne (1957).

Results and Discussion

The results of analysis of variance for different characters are presented in Table 1. It revealed that the parents and hybrids differed significantly for all the nine characters. The parents significantly interacted with the hybrids for all the characters except plant height and number of seeds per pod. The lines differed significantly for plant height, 100-seed weight and yield per plant. The testers differed significantly for days to first flowering, days to 50 per cent flowering and days to maturity. The interactions between lines and testers were also highly significant for all characters.

The estimates of variances for general combining ability (GCA) and specific combining ability (SCA) have been presented in Table 1. The variance due to SCA was higher than the variance due to GCA for days to first flowering, days to 50 per cent flowering, number of branches per plant, plant height, number of pods per plant, number of seeds per pod, days to maturity and 100-seed weight, indicating the operation of non-additive gene action for the characters.

Patel *et al.* (1992) also reported non-additive gene action for number of branches per plant, number of pods per plant and number of seeds per pod. The variance due to GCA was higher than variance due to SCA for seed yield per plant indicating predominance of additive gene action for the character. This result corresponds with the findings of Sharma *et al.* (1973), Mehetre *et al.* (1988) and Ghodke *et al.* (1993), although presence of non-additivity was also reported by Sidhu and Sandhu (1981), Patel *et al.* (1987) and Satpute *et al.* (1992).

The parents showing higher mean performances (Table 2) generally proved to be the good general combiners for the specific characters. The GCA effects revealed that among the lines, MS Co 5 was a good general combiner for number of branches per plant, plant height, number of pods per

Table 1. Analysis of variance for various characters in pigeonpea.

Source	df	Days of first flowering	Days of 50% flowering	Number of branches	Plant height	Number of pods/plant	Number of seeds per plant	Days to maturity	100-seed weight	Seed yield per plant
Replications	3	0.12	2.26	1.37	144.93	96.06	0.087	61.95	57.32	14.95
Treatments	42	904.09**	916.62**	64.54**	6354.58**	22254.46**	1.30**	1687.67**	429.71**	1079.09**
Parents	12	168.10**	170.22**	5.49**	2629.25**	660.76**	0.4181**	663.97**	199.30**	41.96**
Hybrids	29	63.55**	66.75**	7.09**	1297.26**	1560.40**	0.3242**	194**	2.23**	121.63**
Parents x crosses	1	168.29**	178.59**	46.57**	18.18	16066.19**	0.1918	286.62**	114.02**	806.73**
Lines	2	48.93	35.65	8.89	5828.03**	2716.46	0.7026	116.38	8.19*	871.55**
Testers	9	111.11*	128.08*	8.90	1460.67	2187.63	0.1691	41.37**	2.30	87.49
Line x testers	18	41.39	39.55**	5.98**	712.14**	1118.34**	0.3596**	94.68**	1.67**	55.37**
Error	87	0.46	0.75	0.38	21.64	64.11	0.058	1.51	0.20	4.98
GCA		1.48	1.62	0.11	112.77	51.29	0.002	6.48	0.13	16.31
SCA		10.23	9.70	1.40	172.63	263.56	0.075	23.29	0.37	12.60

* Significant at 5 per cent level ** Significant at 1 per cent level

plant, number of seeds per pod, 100-seed weight and seed yield per plant, MS Prabhat DT for days to first flowering, days to 50 per cent flowering and days to maturity. Among the testers, CORG 5 was a good combiner for number of branches per plant, plant height, number of pods per plant and seed yield per plant, ICPL 88001 for number of seeds per pod, ICPL 83024 for 100-seed weight. CORG 9060 showed significant negative gca effects for days to first flowering, days to 50 per cent flowering and days to maturity, hence this line may be used in breeding programme aimed at short duration type.

The specific combining ability effects for all the crosses are presented in Table 3. MS T 21 x CORG 9060 exhibited high SCA effect for number of branches per plant MS T 21 x ICPL 8801 registered significant negative SCA effect for days to first flowering and days to maturity. MS Co 5 x ICPL 161 and MS Co 5 x CORG 5 recorded high sca effect for seed yield per plant. These hybrids also involve good general combiners and exhibited heterosis over better parent.

Hence the potentiality of these hybrids can be advantageously and commercially exploited for developing hybrids. Sexena *et al.*, (1980) suggested that pedigree breeding or bulk breeding methods can be used successfully in pigeonpea, directed towards pureline or multiline cultivars. This will also be a method to tap the additivity detected in the present study.

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Table 2. General combining effect of nine characters in pigeonpea

Parents	Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	No. of pods per plent	No. of seeds per pod	Days to maturity	100-seed weight (g)	Seed yield per plant (g)
1	2	3	4	5	6	7	8	9	10
LINES MS CO5	0.92**	0.82**	0.43**	11.85**	9.49**	0.13*	1.94**	0.45**	5.38**
	(79.25)	(80.75)	(8.00)	(120.52)	(100.48)	(4.10)	(120.75)	(7.85)	(20.70)
MS T 21	0.30**	0.22	0.08	0.44	-4.08*	0.00	-0.68*	0	-3.03**
	(66.00)	68.00)	(7.3)	(135.57)	(77.05)	(4.30)	(108.00)	(8.17)	(14.62)
MS	-1.22**	-1.03**	-1.51**	-12.28**	-5.40**	-0.14**	-1.26**	-0.45**	-2.34**
PrabhatDT	(59.50)	(60.75)	(5.90)	(95.50)	(64.38)	(3.90)	(100.75)	(7.72)	(17.62)
SE	0.10	0.14	0.09	0.74	1.27	0.04	0.19	0.07	0.35
TESTERS	-1.50**	-1.36**	-1.40**	-2.42**	-10.68**	0.10	-2.54**	-0.32	-0.57
ICPL 87	(61.25)	(62.25)	(6.00)	(131.50)	(74.18)	(4.25)	(1.06.75)	(9.23)	(18.05)
CORG	0.83**	0.73**	-0.37**	11.78**	1.63	-0.15	1.46**	-0.36*	-3.90**
9301	(61.50)	(63.25)	(6.05)	(87.18)	(64.43)	(4.15)	(108.75)	(7.28)	(14.17)
GORG	0.92**	0.39	-0.96**	-6.28**	-22.55**	-0.14	1.79**	-0.07	-1.77
9302	(67.00)	(68.00)	(8.00)	(135.75)	(64.30)	(3.90)	(113.50)	(6.95)	(12.62)
ICPL 161	-1.50**	-1.44**	-0.10	14.52**	5.18	-0.09	-3.71**	0.47*	3.85**
	(65.50)	67.75)	(6.70)	118.57)	(83.45)	(3.70)	(111.25)	(8.88)	(!8.03)
ICPL	-2.92**	-2.69**	-0.19	-16.84**	-6.27	0.20*	-5.71**	-0.06	-0.38
88001	(56.75)	(58.50)	(6.65)	(90.90)	(66.10)	(3.80)	(99.25)	(7.72)	(13.88)
CORG	-3.83**	-4.02**	1.20**	3.13	3.47	0.15	-6.12**	0.56**	-0.71
9060	(60.50)	(62.00)	(8.40)	(93.60)	(121.10)	(4.15)	(119.00)	(7.85)	(14.98)
ICPL	-0.50	-1.02**	0.50*	-9.71**	-1.05	0.01	-2.29**	0.66**	-1.52
83024	(66.75)	(69.00)	(6.75)	(86.97)	(63.50)	(4.20)	(125.75)	(8.15)	(11.60)
ICPL	6.42**	7.14**	0.71**	-4.15*	-2.75	0.00	11.71**	0.16	-1.07
83027	(76.25)	(78.25)	(6.25)	(!42.88)	(78.15)	(4.60)	(130.75)	(8.27)	(12.18)
CORG 5	3.33**	3.73**	0.09**	16.08**	30.36	0.00	7.96	0.42*	5.23**
	(60.50)	(63.00)	(9.70)	(153.07)	(146.88)	(4.90)	(80.25)	(9.02)	(21.12)
VBN -1	-1.25**	-1.44**	-0.49	-6.11**	2.66	-0.09	-2.54**	-0.34	0.82
	*(66.25)	(67.25)	(5.90)	(75.35)	(65.45)	(4.10)	(108.75)	(7.28)	(12.60)
SE	0.19	0.25	0.17	1.34	2.31	0.07	0.35	0.12	0.64

In parenthesis : Mean expression of parents

** Significant at 1% level

* Significant at 5% level

Table 3. Specific combining ability effect for nine characters in pigeonpea

Parents	Days to first flowering	Days to 50% flowering	No. of branches per plant	Plant height (cm)	No. of pods per plent	No. of seeds per pod	Days to maturity	100-seed weight (g)	Seed yield per plant (g)
1	2	3	4	5	6	7	8	9	10
MSCO5 X ICPL 87	1.33**	0.93	0.54	2.60	2.86	0.49**	-0.61	0.09	0.95
MSCO5 X CORG 9301	1.24**	1.10	0.32	-12.76**	-2.83	-0.21	-2.36**	0.38	-3.97*
MSCO X CORG 9302	-0.09	-0.18	-1.34**	4.05	-6.44	-0.23	1.06	-0.83**	-3.35*
MSCO5 X ICPL 161	-2.17**	-1.98**	0.64	-8.80**	13.66*	-0.23	-3.94	-1.02**	4.28**
MSCO5 X ICPL 88001	5.49**	5.27**	-0.52	6.70	6.00	-0.11	5.81**	0.73*	5.16**
MSCO5 X CORG 9060	-0.16	0.35	-0.01	4.64*	7.49	0.24	1.22	0.49	-5.01**
MSCO5 X ICPL 83024	-0.92	-0.90	-0.23	25.30**	-36.54**	0.17	-1.11	-0.01	-2.33
MSCO5 X ICPL 83027	-.34	-0.43	-0.17	-4.54	-2.19	0.29	4.64**	-0.06	-1.08
MSCO5 X CORG 5	-3.51**	-4.15**	0.56	-10.70**	6.30	0.04	-5.11**	0.13	3.68*
MSCO5 X VBN-1	-1.17**	-1.23*	0.21	-6.48**	11.70	-0.43**	0.39	0.11	1.66
MS T21 X ICPL 87	-3.55**	-3.47**	0.71	-12.26**	-8.24	-0.34*	-2.73**	0.05	-0.61
MS T21 X CORG 9301	2.62**	2.70**	0.29	-0.35	28.84**	-0.14	5.52**	0.31	4.69**
MS T21 X CORG 9302	-0.47	-0.72	1.55**	6.88**	0.47	0.25	-2.07*	0.68*	3.46*
MS T21 X ICPL 161	4.70**	4.12**	-0.09	16.66**	-5.65	0	4.68**	0.51	-0.86
MS T21 X ICPL 88001	-3.13**	-2.63**	-1.22**	-7.09**	-0.14	0.31	-3.32**	-0.29	-3.51*
MS T21 X CORG 9060	-2.97**	-2.55**	1.84**	-3.25	0.06	-0.04	-2.65**	-0.66*	0.90
MS T21 X ICPL 83024	-0.30	-0.30	1.56**	-27.37**	17.82**	0.05	0.52	0.44	2.96
MS T21 X ICPL 83027	-2.47**	-2.97**	-0.82	11.12**	-12.80*	-0.24	-9.48**	-0.43	-0.94
MS T21 X CORG 45	3.12**	3.20**	0.30	6.41**	-4.44	-0.19	8.77**	0.29	-5.44**
MS T21 X VBN-1	2.45**	2.62**	0.43	9.26**	-15.91	0.35*	0.77	-0.91**	-0.66
MS Prabhat DT X ICPL 87	2.22**	2.53**	0.17	9.66**	5.38	-0.15	3.34**	-0.13	-0.33
MS Prabhat DT X CORG 9301	-3.86**	-3.80**	-0.60	13.12**	-26.01**	0.35*	-3.16**	-0.69*	-0.73
MS Prabhat DT X CORG 9302	0.56	0.53	-0.21	-10.92**	5.97	-0.01	1.01	0.15	-0.11
MS Prabhat DT X ICPL 161	-2.53**	-2.13**	-0.55	-7.85**	-8.00	0.24	-0.74	0.51	-3.43**
MS Prabhat DT X ICPL 88001	-2.36**	-2.63**	1.74**	0.38	-5.86	-0.20	-2.49**	-0.44	-1.65
MS Prabhat DT X CORG 9060	2.81**	2.20**	-1.83**	-1.38**	-7.55	-0.20	1.43	0.17	4.11*
MS Prabhat DT X ICPL 83024	1.22**	1.20	-1.78**	2.08**	18.72**	-0.21	0.59	-0.43	-0.64
MS Prabhat DT X ICPL 83027	2.81**	2.53**	0.99*	-6.58**	-15.00**	-0.05	4.84**	0.49	2.01
MS Prabhat DT X CORG 5	0.39	0.95	-0.86*	4.28	-1.86	0.15	-3.66**	-0.42	1.77
MS Prabhat DT X VBN-1	-1.28**	-1.38**	-0.63	-2.77	4.21	0.09	-1.16	0.79*	-1.00
SE	0.34	0.43	0.31	2.33	4.00	0.12	0.61	0.22	1.12

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

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(Received : October 1998; Revised : January 2001).

Madras Agric. J., 87(7-9): 424 - 427 July - September 2000

Developmental period and survival of *Coccinella septempunctata var divaricata* predating on *Lipaphis erysimi* Kalt in mustard.

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Abstract : The average duration of first, second, third and fourth instar larvae of *C. septempunctata* var *divaricata* was observed to be 3.56 and 3.66, 2.60 and 2.38, 2.48 and 2.49 and 4.35 and 3.86 days during February and March, respectively. The survival rate of larvae varied between 86.25 and 99.50 per cent in different instars during February and March, respectively. The mean pupal period was 41.16 and 3.46 days with survival rate of 97.14 and 90.97 per cent during February and March, respectively. The average duration of adult longevity was higher in February than March. The survival rate of adult up to 15th day of emergence was higher in March. The adult mortality was recorded to be more after 20, 25, 30 and 35 days of emergence. *(**Key words** : Coccinella septempunctata* var *divaricata, Lipaphis erysimi* Kalt, Mustard*)*

Mustard is an important oilseed crop grown throughout India. As many as 38 species of insect pests have been reported by Bakhetia (1987) causing damage to the mustard and rapeseed crops at various growth stages, important among them being mustard aphid *(Lipaphis erysimi* Kalt.), mustard saw fly *(Athalia lugens proxima* Klug.), painted bug (*Bagrada hilaris* Burni.), Bihar hairy catter-pillar (*Spilosoma obliqua* walker), Cabbage butterfly (*Pieris brassicae* Linn.) and diamond back moth (*Plutella xylostella* Linn.). Out of these, the mustard aphid (*L. erysimi,* Kalt.) has been considered as the key pest of this cruciferous crop (Bakhetia, 1987). Biocontrol agents like predating coccinellids play an important role in the population regulation of mustard aphid (Singh and Malhotra, 1979, Sinha *et al.* 1982) *Coccinella septempunctata* var *divaricata* olive is an important predatory coccinellids preying upon *L. erysimi* in mustard.

With a view to know the effectiveness of aphids in mustard, it is imperative to know the duration and survival rate of coccinellids under the agro-ecosystem of North Bihar.

Materials and Methods

The experiment on the developmental period and survival rate of *C. septempunctata* var *divaricata* was conducted at P.G. Department of Entomology and Agricultural Zoology, Rajendra Agricultural University, Bihar, Pusa, during *rabi* 1996.

The pupae collected from field were reared in laboratory at room temperature for adult emergence. Freshly emerged as well as field collected adults were released in pairs in petridishes (15 cm) and provided with cardboard paper over its surface. The adults were provided with adequate number of live aphid