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Combining ability and gene action studies in brinjal (*Solanum melongena* L.)

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Abstract

Combining ability effects were estimated for fruit yield and its component characters in a line x tester analysis model comprising 24 crosses developed by using eight lines and three testers. On the basis of *gca* and *sca* variances, most of the characters under study indicated predominance of non additive gene action. The parents HABR-5, HABR-6, BL-3, Swarna Pratibha and HAB-899 were good general combiners for fruit yield, and fruit weight. The F_1 hybrid HABL-11 x HAB-381 was the combinations for fruit yield.

Keywords: Combining ability, Gene action, GCA, SCA, Predictability ratio

Introduction

Brinjal (*Solanum melongena* L.) is one of the important vegetable crops of the family Solanaceae being grown in India. Eggplant is widely consumed with distinct preferences for their size, shape and colour in different ethnic groups and geographical regions of the India and world. This crop possesses rich genetic diversity for various qualitative and quantitative traits and has a great potential for improvement as per preference of consumers. Yield being a complex character is influenced by a number of component characters and they are polygenically inherited. Hence it requires a better understanding of their gene action to formulate a sound breeding strategy. Line x tester analysis is one such approach to know the nature and magnitude of gene action and also identifies good general combiners and specific crosses for different economic traits. Thus combining ability analysis gives the estimates of combining ability effects and aids in selecting desirable parents and crosses for further exploitation. Hence the present study has been undertaken in a line x tester design using eight lines and three testers to study gene action and combining ability of yield and its component traits.

Materials and Methods

Advanced breeding lines and released variety of brinjal from ICAR RCER Research Centre, Ranchi were used as parents in the crossing programme. Crosses were done in line x tester fashion using eight lines *viz*., HABR-5, HABR-6, BL-22, HABL-11, HABL-3, BL-5, Swarna Pratibha and three testers *viz*., HAB-898, HAB-899 and HAB-381. . The trials were conducted during main season of 2008-09 and 2000-10 at Experimental Farm of ICAR RCER Research Centre, Ranchi (23.35^0 N and 85.33^0 E at 629m altitude). Total annual rainfall was 1430mm with 1100 mm during June to September and the average maximum and minimum temperatures 37^{0}C and 40^{0}C respectively. Eleven parents along with 24 F_1s were evaluated in a randomized block design. The net plot size was 2.25m x 2.4m with 60 x 45 cm inter and intra spacing respectively. All the recommended agronomic practices were followed to raise the normal crop. Data was recorded on ten randomly selected plants in each treatment over each replication for seven characters *viz*., fruit yield (q/ha), fruit weight (g), fruit length (cm), fruit breadth(cm), days to 50% flowering, number of branches/plant and plant height (cm). Combining ability analysis was done according to Kempthorne (1957) using SPAR 2.0. Relative importance of gca and sca was established by calculating predictability ratio 2ó^{2}g/ 2ó^{2}g + ó^{2}s (Baker 1978). Average degree of dominance was estimated by using the formula VD / VA.

Results and Discussion

Analysis of variance indicated highly significant variance for all traits among parents and hybrids. The parents *vs* hybrids component was significant for most of the traits indicating superior performance of hybrids over parents (Table 1). The analysis of variance for combining ability, VA, VD, average degree of dominance, predictability

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ratio, contribution of lines , testers and lines x testers are given in Table 2. The variance due to lines and testers (indicative of gca variance) were significant and higher in magnitude for fruit yield, fruit weight, fruit length, fruit breadth and plant height. This indicates that these characters are predominantly governed by additive gene action. Variance due to lines x testers which was related to dominance variance was significant for fruit yield, fruit weight, fruit length, fruit breadth and days to 50% flowering. Hence, both additive and dominance gene action were important for fruit yield, fruit weight, fruit length and fruit breadth. Similar results were reported by Aswani and Khandelwal (2005), Suneetha et al. (2008) and Sao and Mehta (2010). Predominance of non additive gene action for yield and yield components was reported by Rai et al. (2005), Nalini et al. (2011) and Ramesh Kumar and Arumugam (2016). Choudhary (2001) established presence of both additive and non additive gene actions for inheritance of various characters. Predictability ratio was observed to be <0.5 for all the characters studied indicating the predominant role of non additive component of variance for improvement of these characters. Reddy and Patel (2014) and Prasad et al. (2010) revealed similar findings. Higher values of average degree of dominance for all these characters confirmed the results of above findings.

The estimates of general combing ability effects indicated that HABR-5 was best general combiner for fruit weight and fruit breadth, HABR-6 for fruit weight and fruit length, BL-22 for plant height, HABL-11 for days to

Table 1: Analysis of variance with parents and crosses

Source of variation	d.f	Fruit yield (q/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Days to 50% flowering	No. of branches/ plant	Plant height (cm)
Replications	1	214275.39*	6299.84**	7.09*	0.68	20.20	0.017	196.90
Treatments	34	77732.12**	4121.35**	36.41**	2.77**	31.21*	0.641	174.46**
Parents	10	23199.32	3583.38**	15.88**	0.33*	14.90	0.869	33.97
Crosses	23	91787.79**	4504.46**	43.74**	3.80**	37.58*	0.568	243.12**
P. *vs.* C	1	299779.55**	689.76	73.30**	3.56**	47.71**	0.048	0.32
Error	34	29649.61	476.47	1.43	0.18	16.94	0.516	83.78

*P = 0.05, **P = 0.01

Table 2: ANOVA for Line x Tester analysis

Source of variation	d.f	Fruit yield (q/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Days to 50% flowering	No. of branches/ plant	Plant height (cm)
Lines	7	156262.49*	7484.87**	60.46**	7.35**	47.54	0.445	649.67**
Testers	2	10944.31	1753.81	123.97**	2.65	29.28	0.543	35.15
Lines x Testers	14	71099.51**	3407.20**	23.91**	2.19**	33.79*	0.633	69.55
Error	34	29649.61	476.47	1.43	0.18	16.94	0.516	83.78
Genetic component								
V_A		1428.92	75.78	1.38	0.12	0.26	-0.004	11.98
V_D		22868.61	1762.06	32.06	1.78	9.6	0.018	66.86
V_D/V_A		16.00	23.25	23.23	14.83	36.92	-4.5	5.58
V_{gca}		714.46	37.89	0.69	0.06	0.13	-0.002	5.99
V_{sca}		22868.61	1762.06	32.06	1.78	9.6	0.018	66.86
Predictability ratio		0.06	0.04	0.04	0.06	0.026	-0.29	0.15
Contribution of lines (%)		51.81	50.57	43.07	58.82	38.50	23.84	81.33
Contribution of s (%)		1.04	3.39	24.65	6.07	6.77	8.31	1.26
Contribution of lines x testers (%)		47.15	46.04	33.28	35.11	54.72	67.85	17.41

*P = 0.05, **P = 0.01

Table 3: GCA effects of 11 parents for seven characters in brinjal

Source of variation	Fruit yield (q/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Days to 50% flowering	No. of branches/ plant	Plant height (cm)
GCA effects Lines							
HABR-5	-185.81*	56.68**	-4.38**	2.20**	0.25	0.16	-2.53
HABR-6	-162.22*	33.80**	5.25**	-0.03	2.35	-0.30	-0.08
BL-22	-156.02*	10.18	-1.94**	0.25	-0.08	0.008	-20.14**
HABL-11	-50.94	-45.49**	-1.61**	-0.99**	-5.85**	-0.26	-5.28
HABL-2	140.33	-3.78	0.07	0.28	-0.65	-0.13	-0.16
BL-3	205.70**	8.92	-1.28**	0.39*	-0.71	0.41	9.30
BL-5	31.37	-18.07	-0.10	-0.69**	0.95	0.33	14.59**
Swarna Pratibha	177.60*	-42.24**	3.98**	-1.40**	3.72*	-0.22	4.30

*P = 0.05, **P = 0.01

Table 4: SCA effects in 8x3 (Line x Tester) crosses of brinjal

Source of variation	Fruit yield (q/ha)	Fruit weight (g)	Fruit length (cm)	Fruit breadth (cm)	Days to 50% flowering	No. of branches/ plant	Plant height (cm)
HABR-5 x HAB-898	-40.06	-9.24	-1.53	-0.05	-3.87	0.15	-9.49
HABR-5 x HAB-899	124.21	-4.79	-1.47	0.93**	4.03	0.54	0.58
HABR-5 x HAB-381	-84.15	14.03	3.00**	-0.88**	-0.17	-0.69	8.91
HABR-6 x HAB-898	164.66	-47.12**	6.50**	-1.79**	-2.17	-0.27	3.18
HABR-6 x HAB-899	-99.48	68.59**	-3.25**	1.60**	4.23	-0.62	0.62
HABR-6 x HAB-381	-65.18	-21.47	-3.25**	0.19	-2.07	0.89	-3.80
BL-22 x HAB-898	-111.05	5.51	-4.33**	0.97**	2.87	-0.03	-3.71
BL-22 x HAB-899	233.51	58.09**	4.78**	0.16	-3.73	0.20	2.06
BL-22 x HAB-381	-122.47	-63.60**	-0.46	-1.13**	0.87	-0.16	1.64
HABL-11 x HAB-898	-216.13	-9.20	-0.99	-0.29	1.13	-0.31	4.64
HABL-11 x HAB-899	-142.08	-38.00*	-0.08	-0.78**	0.33	-0.04	-4.17
HABL-11 x HAB-381	358.21**	47.20**	1.06	1.07**	-1.47	0.35	-0.47
HABL-2 x HAB-898	105.89	22.84	0.62	-0.10	-4.47	0.19	8.89
HABL-2 x HAB-899	-135.02	-19.45	0.73	-0.70*	-1.87	0.59	-1.92
HABL-2 x HAB-381	29.13	-3.39	-1.35	0.80*	6.33	-0.77	-6.97
BL-3 x HAB-898	141.77	32.27*	0.54	0.52	7.20*	-0.23	1.55
BL-3 x HAB-899	108.73	-25.53	0.32	-0.62**	-4.80	-0.08	0.50
BL-3 x HAB-381	-250.49*	-6.74	-0.86	0.10	-2.40	0.31	-2.05
BL-5 x HAB-898	-94.64	19.88	-2.14*	0.81*	0.43	-0.14	-7.36
BL-5 x HAB-899	-20.50	-24.66	-2.44**	-0.03	1.43	0.13	4.71
BL-5 x HAB-381	115.14	4.78	4.59**	-0.78*	-1.87	0.18	2.69
S.Pratibha x HAB-898	49.56	-14.95	1.32	-0.07	-1.13	0.64	2.30
S.Pratibha x HAB-899	-69.37	-14.25	1.40	-0.56	0.37	-0.71	-2.38
S.Pratibha x HAB-381	19.82	29.20	-2.72**	0.63*	0.77	0.06	0.08
S.E	121.76	15.43	0.85	0.30	2.91	0.51	6.47

*P = 0.05, **P = 0.01

50% flowering, BL-3 for fruit yield, fruit breadth, Swarna Pratibha for fruit length and fruit yield, HAB-898 for fruit length, HAB-899 for fruit weight and fruit length and HAB-381 for fruit breadth. None of the parents displayed desirable general combining ability effects for all traits indicating scope for improving their general combining ability. In general, contribution of lines was higher for all traits except for days to 50% flowering and number of branches/plant where percentage contribution of lines x testers was highest.

Highly significant specific combining ability effects (Table 4) were observed for the crosses HABR-5 x HAB-899 for fruit breadth, HABR-5 x HAB-381, HABR-6 x HAB-898 for fruit length, HABR-6 x HAB-899 for fruit weight and fruit breadth, BL-22 x HAB-898 for fruit breadth, BL-22 x HAB-899 for fruit weight and fruit length, HABL-11 x HAB-381 for fruit yield, fruit weight and fruit breadth, HABL-2 x HAB-381 for fruit breadth, BL-3 x HAB-898 for fruit weight, BL-5 x HAB-898 and Swarna Pratibha x HAB-381 for fruit breadth. These hybrids with higher specific combining ability effects are useful to derive high performing hybrids. Fifteen crosses had significant specific combining ability effects in addition to high *per se* performance for fruit yield, fruit weight, fruit length and fruit breadth (Table 5). These crosses involved parents with high x high, high x low and low x low general combining ability effects indicating presence of additive, dominance and epistatic gene actions for controlling these characters. Similar results were obtained by Nalini et al. (2011), Deshmukh et al. (2015) and Prasad et al. (2015). High x low general combining ability combinations are suitable for heterosis breeding. High x high general combining ability combinations can be considered for developing superior variants through pedigree method.

Table 5: GCA Status and *per se* performance of crosses with significant SCA effects

Character	Crosses	GCA effects	Mean
Fruit yield (q/ha)	HABL-11 x HAB-381	L x L	47.71
Fruit weight (g)	HABR-6 x HAB-899	H x H	165.25
	BL-22 x HAB-899	L x H	125.88
	HABL-11 x HAB-381	L x L	82.13
	BL-3 x HAB-898	L x L	103.13
Fruit length (cm)	HABR-5 x HAB-381	L x L	16.90
	HABR-6 x HAB-898	H x H	10.63
	BL-22 x HAB-899	L x H	14.93
Fruit breadth (cm)	HABR-5 x HAB-899	H x L	4.91
	HABR-6 x HAB-899	L x L	5.65
	BL-22 x HAB-898	L x L	6.04
	HABL-11 x HAB-381	L x H	3.18
	HABL-2 x HAB-381	L x H	4.25
	BL-5 x HAB-898	L x L	5.06
	Swarna Pratibha x HAB-381	L x H	3.80

Lkkjka'k

बैंगन में फल उपज तथा इसके सम्बन्धित कारकों के लिए संयोजन क्षमता के प्रभावों का आंकलन लाइन x टेस्टर प्रजनन विधि द्वारा किया गया जिसमें 8 लाइनों एवं 3 टेस्टरों के प्रयोग से 24 संकरों

को विकसित कर मूल्यांकन किया गया। अध्ययन के अन्तर्गत अधिकांश विशेषतायें, सामानय संयोजन क्षमता तथा विशिष्ट संयोजन क्षमता विविधता के आधार पर, असंयोजी जीन क्रिया हेतु प्रभावी पाया गया। पितृ एच.ए.बी.आर.–5, एच.ए.बी.आर.–6, बी.एल.–3, स्वर्ण प्रतिभा एवं एच.ए.बी.–899 को फल उपज एवं फल वजन का सामान्य संयोजन क्षमता उत्तम पाया गया। प्रथम पीढ़ी के संकर एच.ए.बी.एल.–11 x एच.ए.बी.–381 तथा एच.ए.बी.आर.–6 x एच.ए.बी.–899 को फल उपज एवं इसके सम्बन्धित घटकों के लिए सर्वश्रेष्ठ विशिष्ट संयोजी पाया गया।

References

Aswani RC and Khandelwal RC (2005) Combining ability studies in brinjal (*Solanum melongena* L.). Indian J Hort 62 (1): 37-40.

Baker RJ (1978) Issues in diallel analysis. Crop Sci 18: 533-535

Chaudhary DR (2001) Components of genetic variation in yield traits of brinjal (*Solanum melongena* L.). Him J Agric Res 25 (1/2): 43-47.

Deshmukh SB, Dod VN, Gudadhe PS and Shinde SM (2015) Combining ability analysis in brinjal (*Solanum melongena* L.). Ecol Env Cons 21(1): 199-203.

Kempthorne O (1957) An Introduction to Genetic Studies. First edn, John Wiley and Sons, New York, pp 458-471

Nalini AD, Patil SA and Salimath PM (2011) Heterosis and combining ability analysis for productivity traits in brinjal (*Solanum melongena* L.). Karnataka J Agic Sci 24(5): 622-625.

Prasad V, Dwivedi V K, Deshpande AA and Singh B K (2010) Gene action of economic traits in brinjal (*Solanum melongena* L.). Vegetable Science 37 (1): 97-99.

Prasad V, Dwivedi VK, Deshpande AA and Singh BK (2015) Genetic combining ability for yield and other economic traits in brinjal (*Solanum melongena* L.). Vegetable Science 42(2): 25-29.

Rai N, Yadav DS, Patel KK and Yadav RK (2005) Genetics of earliness in brinjal (*Solanum melongena* L.). Veg Sci 32(1): 44-46.

Ramesh Kumar S and Arumugam T (2016) Gene action in eggplant landraces and hybrids for yield and quality traits. Int J Farm Sci 61(1): 79-89.

Reddy EEP and Patel AI (2014) Studies on gene action and combining ability for yield and other quantitative traits in brinjal (*Solanum melongena* L.). Trends Biosci 7(5): 381-383.

Sao A and Mehta N (2010) Heterosis in relation to combining ability for yield and quality attributes in brinjal (*Solanum melongena* L.). Elect J Plant Breed 1(4): 783-788.

Suneetha Y, Kathira KB, Patel JS and Srinivas T (2008) Studies on Heterosis and combining ability in late summer brinjal (*Solanum melongena* L.). Indian J Agric Res 42 (3): 171-176.