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Research Article

Line x Tester analysis for yield components and *cercospora* leaf spot resistance in brinjal (*Solanum melongena* L.)

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Abstract
A line x tester analysis was made to assess the nature and extent of heterosis and combining ability using 36 eggplant hybrids along with their respective parents 15 parents (12 lines and 3 testers). Lines KS-5623 and KS-7840 and tester KS-7512 were found good general combiners for fruit yield per plant. The hybrid, T2 x KS-8821 was found best on specific combining ability .The hybrid, KS-8507 x KS-7512 shows high magnitude of heterobeltiosis (111.84 %).There was high heterosis response in most of the hybrids which supports the role of non-additive gene effects**.** The heterobeltiosis for Cercospora leaf spot field resistance significantly high in the hybrid, KS-7570 x KS-8822(-66.41 %). Indirect selection for traits such as, fruits per plant, fruit length, fruit diameter, branches per plant and disease resistance could be done in order to achieve higher yield through heterosis breeding in brinjal.

Key words: Brinjal, heterobeltiosis, combining ability, yield, cercospora leaf spot, resistance.

Introduction

Brinjal (*Solanum melongena* L.) is an important vegetable of tropical and subtropical regions of the world and has originated in India. In India, its cultivation is scattered across the country particularly in Uttar Pradesh, Andhra Pradesh, Maharashtra, Rajasthan and Gujarat. Egg plant fruits have high nutritive value and high market demand. The present production, however, is not proportionate to the country's demand. Therefore, the crop deserves a deep deliberation for improvement. Being a centre of origin, eggplant has a huge genetic divergence in India which offers much scope for improvement through heterosis breeding. The effort could enhance its quality and productivity without sacrificing the consumer's choice. The required goals of increasing productivity in the quickest possible time can be achieved only through heterosis breeding which is feasible in this crop (Kakikazi, 1931). The estimation of heterosis for yield and its component characters would therefore is useful to judge the best hybrid combination for exploitation of superior hybrids. Growth and productivity of eggplant crop is largely hampered by the incidence of diseases like Cercospora leaf spot in general. Therefore, it is necessary to have the security of crop through inbuilt resistance. Only few reports are available pertaining to the extent of hybrid vigour in eggplant on yield, and disease resistance. Hence, the present study was taken up with the following objectives 1) to study the combining ability effects of parents and hybrids for differenttraits and 2) to estimate the magnitude of heterobeltiosis in the hybrids.

Material and methods

The experiment was conducted during *kharif* season 2011-12 and 2012-13 at Vegetable Research Station, Chandra Shekhar Azad university of Agriculture and Technology, Kalyanpur, Kanpur(U.P.) India. The biological materials used in the study comprised of 12 local genotypes of Kalyanpur as lines, *viz.*,KS-7570, KS-8204-2, KS-7305, KS-6103, KS-7509-1, KS-7846, KS-8507, KS-5623,T2, KS-7846, KS-8507, KS-7840 and three local genotypes of Kalyanpur as testers viz.,KS-8821, KS-7512, KS-8822 Crosses were made in line x tester fashion during *kharif* season 2011-2012 and the resulting 36 F_1-hybrids including parents were evaluated in Randomized Block Design with two replications during *kharif season* 2012-13. Standard cultural practices were followed to raise the normal crop. Observations were recorded in five randomly selected plants in each replication. The data recorded for 11 biometrical traits *viz*., days to 50% flowering, days to maturity, plant height, branches per plant, fruit length, fruit diameter, fruit weight, number of fruits per plant and fruit yield per plant, harvest index, Cercospora leaf spot incidence. The combining ability were estimated by the formula as suggested by Kempthorne (1957). The

magnitude of the heterobeltiosis was estimated as per the standard procedure.

Results and discussion

Analysis of variance (Table 1) for 11 characters revealed that variance due to lines and testers were not significant for all the traits. However, the variance due to interaction between lines x testers was significant for days to 50% flowering, number of branches per plant, fruit length, fruit diameter and CLS incident revealed the importance of non-additive component of genetic variance in the inheritance of these traits.

Among the eleven attributes studied highly significant negative heterosis over better parent (Table 2) for days to 50% flowering and days to maturity in KS-6103 x KS-8821 (-23.08% and -21.21%, respectively) and for *Cercospora* leaf spot incidence in KS-7570 x KS-8822 (-66.87%) was observed while highly significant and positive heterosis over better parent was observed in order of magnitude by number branches per plant in KS-7509-1 x KS-7512 (52.23%),f ruit length in KS-5623 x KS-7512 (70.51%), fruit diameter in KS-6103 x KS-8821 (63.27%), fruit weight in KS-7570 x KS-8821 (19.25%), number of fruits per plant in KS-5623 x KS-7512 (67.0%),yield per plant inKS-8507 x KS-7512, (111.84%) and harvest index(KS-8507 x KS-7512 17.53%). Singh *et al.* (2003), Prathibha*et al* . (2004) and Dhameliya *et al.* (2009) also reported highly significant heterosis for fruit yield and its contributing traits in brinjal. The maximum heterosis for fruit yield per plant over better parent was exhibited by cross KS-8507 x KS-7512 (111.84%) followed by KS-5623 x KS-7512 (110.13%) and KS-8204-2 x KS-8822, 87.14%. Similar trend was also reported by Kumar *et al.* (2012) and Singh *et al.* (2003).

The estimates of general combining ability effects for 12 lines and 3 testers for 11 characters (Table 3) indicated that best combiners were KS-8204-2 and KS-7509-1 for days to 50% flowering , KS-7305 and KS-7840 for branches per plant , KS-6103 for days to maturity, KS-5623 and KS-7840 for fruit length , KS-6103 and KS-7846 for fruit diameter, for fruit weight, KS-5623 and KS-7840 for yield per plant, and KS-7840 and KS-7305 for *Cercospora*leaf spot resistance. For many of the characters studied, the parents KS-5623 and KS-7840 were found as good general combiners. Therefore, these parents may be exploited to develop productive new recombinations for optimum yield and desirable quality parameter. High GCA effects also cited by Ramesh *et al.* (1996) and Varshney *et al.* (1999).

The specific combining ability effects for hybrids pertaining to different characters are given in Table 4. SCA which represents the predominance of non-additive gene action is a major component that may be utilized in heterosis breeding. The crosses exhibiting best sca effects for number of day to 50 % flowering was T2 x KS-7512, KS-7509-1 x KS-7512 was for number of branches per plant, was T2 x KS-7512 for total yield per plant followed by KS-8204-2 x KS-8822 and KS-7846 x KS-8822 was for fruit length followed by KS-8504 x KS-8822.

The high heterobeltiosis and specific combing ability responses observed in most of the hybrids further supported the predominant role of non-additive component in the characters studied. High general combining ability of the parents therefore seems to be reliable criterion for the prediction of specific combining ability. The top three hybrids selected separately on the basis of high heterosis over better parent for various yield and quality characters are presented in Table 2. On the basis of above findings it can be concluded that characters like days to 50 % flowering , days to maturity, plant height improved through selection while yield and contributing traits fruits per plant, fruit length, fruit weight, fruit diameter, number of branchesper plant, harvest index and field resistance for Cercospora leaf spot may be improved through heterosis breeding. The superior crosses selected on the basis of significant heterosis over better parent can be further exploited for commercial cultivation after multi location testing.

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Table 1. ANOVA for combining ability for yield traits

Source	Lines	Testeers	Lines x Testers	Error	Variance		
					GCA	SCA	GCA/ SCA
Degrees of freedom	11	2	22	35			
Days to 50% flowering	4.2	1.13	3.69*	1.64	0.068	1.132**	0.06
plant height	98.2	16.32	56.15	153.1	0.074	-26.75	-0.001
Branches per plant	1.64	0.03	1.65*	0.51	-0.054	0.606**	-0.089
Days to maturity	6.76	0.54	6.12	3.37	-0.165	1.287	-0.128
Fruit length (cm)	6.94	8.75	6.51**	0.94	0.092	2.664**	0.034
Fruit diameter(cm)	2.01	0.68	1.25**	0.33	0.006	0.458**	0.013
fruit weight (cm)	171.63	116.74	116.26	84.64	1.861*	21.51	0.086
fruits per plant	4.58	0.14	4.17	9.38	-0.121	-1.645	0.735
Yield per plant (kg.)	0.32	0.05	0.2	0.14	-0.001	0.046*	0.021
Harvest index (%)	0	0	0	0	0.000	0.0001	0
CLS incident	39.37	9.57	18.04**	1.23	0.428*	8.371**	0.051

CLS- Cercospora Leaf Spot *Significant at 5%level and **Significant at 1% level

Table 2. Top three desirable crosses with their per se performance and heterosis on better parent for 11 characters

Character	Heterosis Range	Desirable crosses	F1 mean value	Heterosis on better parent
Days to 50% flowering	-23.08 to -5.77	KS-6103 x KS-8821	45.00	-23.08**
		KS-6103 x KS-8822	46.50	-20.51**
		KS-7305 x KS-8822	47.00	-18.26**
Plant height	-0.42 to 26.28	KS-6103 x KS-8822	104.53	26.01*
		KS-6103 x KS-8821	104.75	26.28*
		KS-8504 x KS-8821	105.50	24.85
Branches per plant	1.38 to 52.23	KS-7509-1 x KS-7512	11.95	52.23**
		KS-7305 x KS-8822	12.30	38.98**
		KS-7305 x KS-8821	11.85	33.90**
Days to maturity	-21.21 to -5.65	KS-6103 x KS-8821	52.00	-21.21**
		KS-7509-1 x KS-7512	53.50	-16.41**
		KS-8507 x KS-8821	53.50	-13.71**
Fruit length	- 1.94 to 70.57	KS-5623 x KS-7512	16.63	70.51**
		KS-5623 x KS-8821	16.63	64.20**
		KS-7840x KS-8821	16.63	64.20**
Fruit diameter	- 8.0 to 63.27	KS-6103 x KS-8821	10.00	63.27**
		KS-8204-2 x KS-8821	08.95	46.12**
		KS-7846 x KS-8821	08.88	44.90**
Fruit weight	-6.15 to 19.25	KS-7570 x KS-8821	158.00	19.25**
		KS-8204-2 x KS-8822	159.50	18.13**
		KS-7570 x KS-8822	157.20	16.42*
Number of fruits per plant	15.39 to 67.0	KS-5623 x KS-7512	25.05	67.00**
		KS-8204-2 x KS-8822	26.55	57.33**
		KS-7570 x KS-8822	26.10	56.99**
yield per plant	14.02 to 122.48	KS-8507 x KS-7512	04.20	111.84**
		KS-5623 x KS-7512	04.15	110.13**
		KS-8204-2 x KS-8822	04.22	87.14**
Harvest index	- 2.91 to 17.53	KS-8507 x KS-7512	00.91	17.53**
		KS-6103 x KS-7512	00.87	12.99*
		KS-7846 x KS-7512	00.87	12.34*
CLS incidence	-66.87 to -10.03	KS-7570 x KS-8821	08.47	-65.04**
		KS-7570 x KS-8822	08.03	-66.87**
		KS-8204-2 x KS-8822	09.97	-65.46**

Table 3. Estimates of general combining ability (gca) effects for yield traits

Source	Days to 50% flowering	Plant height (cm)	Branches per plant	Days to maturity	Fruit length (cm)	Fruit diameter(cm)	Fruit weight (cm)	Fruits per plant	Yield per plant (kg.)	Harvest index (%)	CLS incident
KS-7570	-0.08	-2.77	-0.07	-0.50	-0.65	-0.07	-1.62	0.22	0.00	-0.01	-4.55**
KS-8204-2	-1.92**	-2.29	-0.71*	-0.17	0.85	0.12	5.42	-0.26	0.08	0.01	-2.66**
T2	1.08*	-8.99*	0.05	1.00	0.87	0.18	-1.85	-0.36	-0.10	-0.04*	1.43**
KS-7305	0.75	3.81	1.23**	0.83	0.40	-0.65**	-0.33	-1.18	-0.20	-0.01	2.46**
KS-6103	-0.58	7.55	0.25	-2.00*	-0.05	1.02**	-3.88	-1.12	-0.26	0.00	1.51**
KS-7509-1	-1.08*	-0.14	0.26	-0.67	-1.96**	-1.21	-8.80*	-0.63	-0.31*	-0.01	2.35**
KS-5605-1	0.08	2.69	-0.30	1.33	0.25	-0.28	6.31	-0.30	0.10	0.01	0.76
KS-8504	0.25	1.69	-0.50	0.67	0.01	-0.15	-6.70	-0.36	-0.22	0.00	-1.46**
KS-5623	0.08	-0.85	0.22	0.83	1.33**	-0.23	7.27*	1.12	0.35*	0.01	-1.91**
KS-7846	0.58	-1.46	0.15	0.83	-1.91**	0.56*	-2.12	0.18	-0.02	-0.01	1.64**
KS-8507	0.42	-0.49	0.07	-1.17	-0.25	0.31	-0.36	1.40	0.20	0.03	-2.90**
KS-7840	0.42	1.23	-0.65*	-1.00	1.12*	0.39	6.66	1.27	0.37*	0.01	3.33**
KS-8821	-0.13	0.84	0.03	0.04	0.25	0.04	-2.22	0.07	-0.04	0.01	-0.65**
KS-7512	0.25	-0.80	-0.04	0.13	0.44	-0.19	2.19	0.01	0.05	0.00	0.61*
KS-8822	-0.13	-0.04	0.01	-0.17	-0.69**	0.14	0.04	-0.08	-0.02	-0.01	0.05
SE (Lines)	0.49	4.28	0.27	0.77	0.44	0.27	3.49	1.11	0.13	0.02	0.47
SE (Testers)	0.24	2.14	0.14	0.38	0.22	0.12	1.75	0.56	0.07	0.01	0.23

Table 4. Estimates of specific combining ability (sca) effects for yield traits

Source	Days to 50% flowering	plant height	Branches per plant	Days to maturity	Fruit length (cm)	Fruit diameter (cm)	fruit weight (cm)	fruits per plant	Yield per plant (kg.)	Harvest index (%)	CLS incident
KS-7570 x KS-8821	-1.54	-2.46	-0.31	0.13	0.98	0.12	9.16	-1.84	-0.05	0.03	-0.62
KS-7570 x KS-7512	1.58	-3.31	0.76	1.04	-1.03	-0.02	-15.25*	-0.16	-0.41	-0.02	2.39
KS-7570 x KS-8822	-0.04	5.77	-0.44	-1.17	0.05	-0.10	6.10	2.01	0.47	-0.01	-1.77
KS-8204-2 x KS-8821	-0.21	-0.09	0.23	-1.21	0.28	0.88*	-3.11	-0.78	-0.20	0.01	3.00
KS-8204-2 x KS-7512	-0.08	3.00	-0.55	-0.29	0.17	-0.09	1.75	-2.16	-0.31	-0.01	-1.28
KS-8204-2 x KS-8822	0.29	-2.91	0.32	1.50	-0.45	-0.79	1.35	2.94	0.51*	0.00	-1.72
T2 x KS-8821	1.79*	0.66	-1.38**	1.13	0.46	0.87*	10.27	1.69	0.52*	0.00	1.66
T2 x KS-7512	-2.08*	-0.30	0.54	-1.96	1.02	-0.40	-7.27	0.74	-0.04	-0.01	0.20
T2 x KS-8822	0.29	-0.36	0.84	0.83	-1.48	-0.47	-3.00	-2.44	-0.48	0.00	-1.85
KS-7305 x KS-8821	1.63	-3.99	0.24	1.79	1.06	-0.29	-4.75	0.44	-0.04	-0.05	5.25
KS-7305 x KS-7512	-0.75	-0.97	-0.94	-0.79	-1.38	-0.31	1.14	-0.26	-0.02	0.01	-1.28
KS-7305 x KS-8822	-0.88	4.97	0.71	-1.00	0.32	0.61	3.61	-0.19	0.06	0.03	-3.97
KS-6103 x KS-8821	-1.54	3.96	0.27	-2.38	-1.50	1.04*	-6.18	0.60	-0.07	0.00	-6.38
KS-6103 x KS-7512	1.58	-8.59	-0.71	2.54	0.31	0.77	7.01	-0.47	0.11	0.03	2.60
KS-6103 x KS-8822	-0.04	4.62	0.44	-0.17	1.19	-1.81**	-0.84	-0.13	-0.04	-0.02	3.78
KS-7509-1 x KS-8821	-0.54	-4.54	-0.60	2.79*	-0.83	-0.24	-6.13	0.34	-0.11	0.04	1.31
KS-7509-1 x KS-7512	-0.92	6.80	1.37**	-2.29	1.23	-0.18	-0.60	-0.08	-0.02	-0.04	1.07
KS-7509-1 x KS-8822	1.46	-2.26	-0.78	-0.50	-0.39	0.42	6.73	-0.26	0.13	-0.01	-2.39
KS-5605-1 x KS-8821	-1.21	-4.58	0.92	0.29	0.08	-0.29	-1.49	0.56	0.08	-0.01	-2.78
KS-5605-1 x KS-7512	0.92	3.92	-0.03	-0.29	1.90*	-0.44	7.67	-0.99	0.01	0.02	0.86
KS-5605-1 x KS-8822	0.29	0.66	-0.89	0.00	-1.98*	0.73	-6.18	0.43	-0.09	-0.01	1.92
KS-8504 x KS-8821	1.63	10.57	0.86	-2.04	-1.18	-0.79	1.52	-0.38	-0.02	0.04	0.60
KS-8504 x KS-7512	-0.75	-8.53	-0.69	0.88	-1.25	0.44	-3.67	0.29	-0.05	-0.02	-0.37
KS-8504 x KS-8822	-0.88	-2.04	-0.17	1.17	2.43**	0.36	2.15	0.09	0.07	-0.02	-0.23
KS-5623 x KS-8821	-1.21	-2.49	-0.70	-0.21	1.12	-0.96*	7.79	0.41	0.23	0.02	-2.34
KS-5623 x KS-7512	-0.58	2.29	0.32	-1.29	0.94	0.27	3.15	-0.04	0.10	-0.01	1.58
KS-5623 x KS-8822	1.79*	0.20	0.39	1.50	-2.06*	0.69	-10.95	-0.37	-0.33	-0.01	0.75
KS-7846 x KS-8821	0.29	-1.03	0.74	1.29	-1.51	0.37	-5.47	-1.32	-0.34	-0.02	-0.25
KS-7846 x KS-7512	-0.08	1.00	-0.42	0.71	-1.07	0.23	1.65	1.88	0.33	0.02	-0.04
KS-7846 x KS-8822	-0.21	0.03	-0.32	-2.00	2.58**	-0.60	3.82	-0.55	0.01	0.00	0.30
KS-8507 x KS-8821	0.96	-1.04	-1.33**	-1.71	-0.29	-0.88*	-7.23	-0.92	-0.32	-0.04	-0.66
KS-8507 x KS-7512	0.08	3.30	0.77	2.21	2.27**	-0.02	8.54	0.64	0.31	0.03	-2.26
KS-8507 x KS-8822	-1.04	-2.26	0.56	-0.50	-1.98*	0.90*	-1.31	0.28	0.01	0.01	2.92
KS-7840 x KS-8821	-0.04	5.04	1.07*	0.13	1.33	0.16	5.63	1.21	0.33	-0.03	1.21
KS-7840 x KS-7512	1.08	1.39	-0.41	-0.46	-3.10**	-0.23	-4.13	0.61	0.00	0.00	-3.47
KS-7840 x KS-8822	-1.04	-6.43	-0.66	0.33	1.77*	0.07	-1.50	-1.82	-0.33	0.03	2.26

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