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Studies on Heterosis and Combining Ability of Bacterial Leaf Blight Donors in Rice (Oryza sativa L.)

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ABSTRACT

A line x tester analysis involving four bacterial leaf blight donors and three high yielding varieties was taken up to elucide information on heterosis and combining ability of bacterial leaf blight donors for yield and yield component character during kharif 2009. The results revealed IET 8585 to be good combiner for grain yield per plant and hence, its importance in rice breeding programmes aimed at the development of high yielding and bacterial leaf blight resistant varieties. Further, the hybrid MTU 2077/IET 8585 exhibited high per se, heterosis and desirable sca effects for grain yield per plant and was identified as the most potential combination for isolation of homozygous lines generations for the development of high yielding and bacterial leaf blight resistant varieties.

Key words : Bacterial leaf blight donors, Combining ability, Heterosis, Rice, Yield, Yield components.

Bacterial leaf blight caused by *xanthomonas campestris pv. Oryzae* is one of the major diseases of tropical rice causing an yield loss even upto 60 per cent in severe cases. (Srivastava. 1967). No chemical control is available and hence, cultivation of resistant cultivars is the only effective way for management of the disease. Breeding and development of resistant varieties for the disease is therefore an important objective in rice breeding programs. In this direction, several resistant donors have been identified by rice research workers.

Information on heterosis and combining ability of these donors for yield and yield components would help in the formation of effective breeding programs aimed at the development of bacterial leaf blight resistant varieties. The present investigation was undertaken in this direction to elucidate information on heterosis and combining ability of few bacterial leaf blight donors with regards to yield and yield component characters.

MATERIAL AND METHODS

The investigation was undertaken at Andhra Pradesh Rice Research Institute, Maruteru, West Godavari District. Andhra Pradesh and the experimental material comprised of four bacterial leaf blight donors namely, BJ-1, DV-85, IET 8585 and Hashikalmi along with three high yielding varieties with BLB susceptibility namely MTU 1008, MTU 2067 and MTU 2077. These entries were crossed during seasonal year in a 4x3, line x tester fashion and the resultant 12 hybrids were evaluated along with their parents in a randomized block design with four replications for yield and yield component triats during seasonal year.

Thirty day old seedlings of each genotype were transplanted in two rows each of 4.5m length by adopting a space of 15 cm between rows and 15 cm between plants within the rows. All recommended practices were followed to raise a healthy crop. Observations were recorded for six characters namely days to 50% flowering, plant height, ear bearing tillers/m^2, panicle length, filled grains per panicle, harvest index and grain yield per plant were recorded on five randomly selected plants for each entry in each replication. However, observations on days to 50% flowering and harvest index were recorded on plot basis, while the observations on ear bearing tillers were recorded from randomly selected one square metre area of each entry in each replication.

The data obtained was subjected to standard statistical procedures. Heterosis over mid-parent, better parent and best parent/check namely, MTU 2067 was obtained for each hybrid, for each character, as per the procedures outlined by Liang *et al.,* (1972) and their significance was tested using the t-test suggested by Snedcor and Cochran (1967). The estimates of combining ability variances and effects were obtained using the line x tester analysis suggested by Kempthorne (1957).

Table 1. Analysis of variance (ANOVA) for yield and yield component characters in rice.

Source	d.f.	Days to 50% flowering	Plant Height	Ear bearing tillers /m²	Panicle length	Filled grains per panicle	Harvest index	Grain yield per plant
Replications	3	2.08	6.47	1344.36	5.35	66.15	36.92	4.39
Treatments	18	242.71**	1070.18**	35206.23**	27.95**	2918.71**	133.86**	86.60**
Error	54	1.76	15.21	835.18	1.46	133.38	21.22	10.01

**significant at 1% level.

Table 2. Mean performance of lines, testers and hybrids for yield and yield component characters.

Treatments	Days to 50% flowering	Plant Height (cm)	Ear bearing tillers/m²	Panicle length (cm)	Filled grains per panicle	Harvest index(%)	Grain yield per plant (g)
Lines							
BJ1	96.75	122.75	400.75	20.25	117.75	43.65	15.61
DV 85	94.75	129.75	383.75	20.75	69.00	38.51	15.10
IET 8585	92.75	85.25	229.50	17.78	126.00	47.87	15.11
Hashikalmi	98.00	86.75	325.50	19.60	59.75	46.93	15.04
Mean	**95.56**	**106.13**	**334.88**	**19.60**	**93.13**	**44.24**	**15.22**
Testers							
MTU 1008	112.00	107.00	344.25	26.03	119.00	40.42	15.30
MTU 2067	111.75	94.75	365.00	22.50	121.00	47.09	17.78
MTU 2077	114.00	99.75	378.00	24.43	133.50	32.82	17.42
Mean	**112.58**	**100.50**	**362.41**	**24.32**	**124.50**	**40.11**	**16.83**
Cross							
MTU 1008/BJ1	94.50	126.75	515.25	27.55	85.25	42.67	17.97
MTU 1008/DV85	97.50	126.50	517.50	23.50	71.50	41.56	18.13
MTU 1008/IET 8585	109.50	105.00	313.50	23.50	125.50	34.60	15.27
MTU 1008/Hashikalmi	106.25	89.50	399.50	26.28	128.25	38.65	13.00
MTU 2067/BJ1	91.75	129.50	540.75	25.05	65.75	39.91	16.74
MTU 2067/ DV85	94.25	128.50	544.50	25.38	94.00	45.57	22.64
MTU 2067/ IET 8585	110.75	119.00	355.75	23.23	117.50	42.32	19.73
MTU 2067/ Hashikalmi	106.00	106.65	507.25	25.05	143.50	47.36	22.65
MTU 2077/ BJ1	95.50	137.25	512.50	27.35	105.00	32.41	14.78
MTU 2077/ DV85	97.50	128.50	543.25	23.80	69.25	34.51	14.27
MTU 2077/ IET 8585	109.75	113.75	475.75	25.60	134.50	53.66	33.23
MTU 2077/ Hashikalmi	108.25	106.50	478.50	24.78	103.25	46.36	21.79
Mean	**101.79**	**118.12**	**475.33**	**25.09**	**103.60**	**41.63**	**19.18**
CD (0.05)	2.42	7.10	52.63	2.20	21.03	8.39	5.76
SEm	0.66	1.95	14.45	0.60	5.77	1.58	2.30

Table 3. Hybrid vigour over mid-parent (MP), better parent (BP) and check (SH) for 0yield and yield components of bacterial leaf blight donors in rice.

Parent/Hybrid	Days to 50% flowering			Plant height			Ear bearing tillers/m^2			Panicle length		
	MP	HB	SH	MP	HB	SH	MP	HB	SH	MP	HB	SH
MTU 1008/BJ1	-9.46**	-2.33**	-15.44**	10.34**	18.46**	33.77**	38.32**	28.57**	40.40**	19.07**	5.86	22.44**
MTU 1008/DV 85	-5.68**	2.90**	-12.75**	6.86*	18.22**	33.51**	42.17**	34.85**	41.01**	1.23	-9.03**	5.22
MTU 1008/IET 8585	6.96**	18.06**	-2.01*	9.23*	23.17**	10.82**	9.28	-8.93	-14.58*	9.13	-8.17*	6.22
MTU 1008/Hashikalmi	1.19	8.42**	-4.92**	-7.61*	3.17	-5.54	19.30*	16.05**	8.86	15.18**	0.96	16.78**
MTU 2067/BJ1	-11.99**	-5.17**	-17.90**	19.08**	36.68**	36.68**	40.87**	34.93**	47.34**	17.19**	11.33**	11.33**
MTU 2067/DV 85	-8.72**	-0.53	-15.66**	14.03**	35.09**	35.09**	45.05**	41.89**	48.37**	17.34**	12.78**	12.78**
MTU 2067/IET 8585	8.31**	19.41**	-0.89	32.22**	39.59**	25.59**	19.28*	55.01**	-3.07	15.33**	30.66**	3.22
MTU 2067/Hashikalmi	1.31	8.42**	-4.92**	17.08**	22.48**	12.14**	46.50**	38.22**	38.22**	19.00**	11.33**	11.33**
MTU 2077/BJ1	-9.37**	-1.29	-14.54**	23.37**	37.59**	44.85**	31.62**	27.89**	39.65**	22.44**	11.98**	21.56**
MTU 2077/DV 85	-6.59**	2.90**	-12.75**	11.98**	28.82**	35.62**	42.63**	41.56**	48.02**	5.37	-2.56	5.78
MTU 2077/IET 8585	6.17**	18.33**	-1.79*	22.97**	33.43**	20.05**	56.63**	25.86**	29.63**	21.33**	4.81	13.78**
MTU 2077/Hashikalmi	2.12	10.46**	-3.13**	14.21**	22.77**	12.40**	36.03**	26.59**	30.38**	12.55*	1.43	10.11**

Parent/Hybrid	Filled grains per panicle			Harvest Index			Grain yield per plant		
	MP	HB	SH	MP	HB	SH	MP	HB	SH
MTU 1008/BJ1	-27.98**	-28.36**	-29.55**	1.52	-2.25	-9.38	16.29	15.12	1.10
MTU 1008/DV 85	-23.94*	-39.92**	-40.91**	5.31	2.83	-11.75	19.32	18.54	2.00
MTU 1008/IET 8585	2.45	-0.40	3.72	-21.63*	-27.74**	-26.54**	0.44	-0.16	-14.09
MTU 1008/Hashikalmi	43.50**	7.77	5.99	-11.49	-17.63*	-17.92*	-14.28	-15.00	-26.86*
MTU 2067/BJ1	-44.92**	-45.66**	-45.66**	-12.05	-15.25*	-15.25*	0.25	-5.85	-5.85
MTU 2067/DV 85	-1.05	-22.31**	-22.31**	6.46	-3.24	-3.24	37.75*	27.37*	27.37*
MTU 2067/IET 8585	-4.86	-2.39	-2.89	-10.87	-10.13	-10.13	19.99	30.58*	11.00
MTU 2067/Hashikalmi	58.78**	18.60**	18.60**	0.74	0.56	0.56	38.04*	27.40*	27.40*
MTU 2077/BJ1	-16.42*	-21.35**	-13.22	-15.24	-25.76**	-25.76**	-10.49	-15.13	-16.85
MTU 2077/DV 85	-31.60**	-48.13**	-42.77**	-3.24	-10.39	-10.39	-12.21	-18.06	-19.72
MTU 2077/IET 8585	3.66	0.75	11.16	33.04**	12.12	12.12	104.34**	90.81**	86.95**
MTU 2077/Hashikalmi	6.86	-22.66	-14.67*	16.28	- 1.20	-1.20	34.27*	25.09	22.56

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed significant differences among the genotypes for all the characters studied, indicating the existence of variability in the experimental material for yield and yield component characters studied. A perusal of the mean performance of lines, testers and hybrids for the different triats studied (Table 2) revealed the hybrids to be tall with greater number of ear bearing tillers per m^2; greater panicle length and grain yield per plant, compared to the lines and testers. Among the lines, BJ-1 had recorded maximum grain yield per plant. However, IET 8585 has recorded maximum harvest index and filled grains per panicle, while among the testers, MTU 2067 has recorded maximum grain yield per plant and harvest index. Among the hybrids, MTU 2077/IET 8585 has recorded highest grain yield per plant and harvest index.

A perusal of the results on hybrid vigour over mid parent, better parent and best parent /check for the different traits studied (Table 3) revealed maximum expression of hybrid vigour for grain yield per plant, followed by ear bearing tillers per m^2. Hybrid vigour to an extent of 104.34 per cent over mid parent, 90.81 per cent over better parent and 86.95 per cent over the best parent/check was notice for grain yield per plant in the hybrid, MTU 2077/IET 8585. Similar levels of high heterosis for grain yield were also reported earlier in rice (Krishnaveni and Shobharani, 2003). Further, four hybrids had recorded significant heterosis over mid-parent, better parent and the best parent/check for grain yield per plant. Among these MTU 2067/DV-85, MTU 2067/ Hashikalmi and MTU 2077/IET 8585 had recorded hybrid vigour more than 25 per cent uniformly over mid, better and best parent/check and hence these hybrids are identified as potential combinations. The hybrid, MTU 2077/IET /8585 had also recorded significant levels of hybrid vigour over mid-parent and the best parent/check for harvest index.

The analysis of variance for combining ability (Table 4) revealed significant mean squares for lines, testers and lines vs. testers components of variation, with regards to days to 50 per cent flowering and plant height, indicating the importance of both additive and non additive gene actions for these triats. Further, the lines vs. testers component was noticed to be highly significant for ear bearing tillers per m^2, panicle length, filled grains per panicle, harvest index and grain yield per plant, indicating the importance of non – additive gene action for these triats. A perusal of the results on gca-sca variance ratio also indicating the pre ponderance of non-additive gene action for these traits. Similar results were reported earlier (Swamy *et al., 2003).* However, pre ponderant additive gene action was noticed for days to 50 per cent flowering and plant height, similar results were also reported earlier. (Rao *et al., 2001)*

A perusal of results on general combining ability effects (Table 5) revealed IET 8585 to be good general combiner for grain yield per plant and filled grains per panicle, indicating its utility in rice breeding programs aimed at the development of high yielding and bacterial leaf blight resistant varieties. Hashikalmi was also observed to be good combiner for filled grains per panicle. Further,BJ-1 and DV-85 were observed to be good combiners for days to 50 per cent flowering, plant height and ear bearing tillers per m^2. Among the testers, MTU 2077 was observed to be a good combiner for grain yield, plant height and ear bearing tillers per m^2, while MTU 2067 was

Table 4. Line x tester analysis of variance for yield and yield component characters.

Source	d.f.	Days to 50% flowering	Plant Height	Ear bearing tillers /m^2	Panicle length	Filled grains per panicle	Harvest index	Grain yield per plant
Lines	3	738.19**	2374.81**	59137.06**	15.49	7714.29*	87.59	82.41
Testers	2	16.19**	449.77*	19107.91	2.55	30.65	78.16	115.88
Lines vs. Testers	6	6.69**	84.33**	7861.2**	5.77**	1400.09**	206.43**	142.81**
Error	54	1.76	15.21	835.18	1.46	133.38	21.22	10.02
GCA		16.42	57.75	1469.89	0.29	150.03	0.05	1.42
SCA		1.23	17.28	1756.51	1.08	316.67	46.30	33.19
GCA/SCA		13.35	3.34	0.84	0.27	0.47	0.001	1.04

* Indicate significance

Table 5. General combining Ability effects of Lines and Testers for yield and yield components.

Source	Days to 50% flowering	Plant Height	Ear bearing tillers /m²	Panicle length	Filled grains per panicle	Harvest index	Grain yield per plant
Lines							
BJ1	-7.89**	13.13**	47.5**	1.51**	-18.27**	-3.30*	-2.69**
DV 85	-5.39**	9.63**	59.75**	-0.85*	-25.35**	-1.09	-0.84
IET 8585	8.18**	-5.45**	-93.67**	-0.89*	22.23**	1.89	3.56**
Hashikalmi	5.10**	-17.69**	-13.58	0.23	21.39**	2.49	-0.04
SE (gi)	0.38	1.13	8.34	0.35	3.33	1.33	0.91
Testers							
MTU 1008	0.13	-6.10**	-35.89**	0.21	-0.97	-2.26	-3.09**
MTU 2067	-1.063**	2.65**	11.73	-0.46	1.58	2.15	1.26
MTU 2077	0.938**	3.45**	27.17**	0.25	-0.60	0.11	1.83*
SE 9gi)	0.33	0.98	7.22	0.30	2.89	1.15	0.79

* Indicate significance

Table 6. Specific Combining Ability effects of Lines and Testers for yield components and yield in rice.

Source	Days to 50% flowering	Plant Height	Ear bearing tillers /m²	Panicle length	Filled grains per panicle	Harvest index	Grain yield per plant
MTU 1008/BJ1	0.71	-10.52**	-46.48**	1.12	-1.06	2.08	-1.615
MTU 1008/DV 85	1.21	-7.23**	-56.48**	-0.39	-7.73	-1.25	-3.31*
MTU 1008/IET 8585	-0.38	-13.69**	-107.06**	-0.13	-1.31	-11.19**	-10.56**
MTU 1008/Hashikalmi	-0.54	-17.35**	-101.15**	1.12	2.27	-7.73**	-9.23**
MTU 2067/BJ1	-3.23**	0.98	29.65*	-2.06**	-18.00**	3.73	1.49
MTU 2067/DV 85	-3.23**	2.98	21.15	0.63	17.33**	7.17**	5.55**
MTU 2067/IET 8585	-0.31	9.06**	-14.19	-1.48*	-6.75	0.94	-1.76
MTU 2067/Hashikalmi	-1.73*	8.15**	57.23**	-0.78	20.08**	5.39*	4.76**
MTU 2077/BJ1	2.52**	9.54**	16.83	0.95	19.06**	-5.81*	0.12
MTU 2077/DV 85	2.02**	4.29**	35.33*	-0.24	-9.60	-5.93*	-2.24
MTU 2077/IET 8585	0.69	4.63*	121.25**	1.60*	8.06	10.25**	12.32**
MTU 2077/Hashikalmi	2.27**	9.21**	43.92	-0.35	-22.35**	2.35	4.47**
SE (ij)	0.66	1.95	14.35	0.61	5.77	2.30	1.58

observed to be good combiner for days to 50 per cent flowering and plant height.

The studies on specific combining ability effects (Table 6) revealed significant and desirable *sca* effects for several hybrids with regards to the yield and yield component triats studied. Four hybrids namely, MTU 2067/DV 85, MTU 2067/ Hashikalmi, MTU 2077/IET 8585 and MTU 2077/ Hashikalmi has recorded significant and desirable *sca* effects for grain yield per plant. Among these, MTU 2067/DV 85 and MTU 2067/Hashikalmi had recorded significant and desirable levels of hybrid vigour and *per se* performance for grain yield per plant. However, these hybrids involve both parents with low general combining ability indicating the role of dominant x dominant gene interactions. In contrast, the hybrid, MTU 2077/IET 8585 involving both parents with good combining ability had recorded maximum heterosis over mid, better and the best parent /check for grain yield per plant, in addition to maximum *per se* performance. Similar association of high gca effects in the parents with maximum *sca* effects and heterosis for yield in the resulting hybrids was also reported earlier (Wilfredmanuel and Rangaswamy, 1995). The presence of both good combiner parents in the hybrid, MTU 2077/IET 8585 indicating the role of additive x additive type of gene action and hence, a scope for fixation of the heterotic effects through the isolation of homozygous lines in advance generations. The hybrid is therefore identified as the most potential combination for development of high yielding and bacterial leaf blight resistant varieties.

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