EFFECT OF WILD ABORTIVE CYTOPLASM INDUCING MALE STERILITY ON RESISTANCE / TOLERANCE AGAINST BROWN PLANT HOPPER & WHITE BACKED PLANT HOPPER IN BASMATI RICE HYBRIDS.

F. A. Faiz, M. Ijaz, T. H. Awan, Z. Manzoor, M. Ahmad, N. M. Waraich and M. A. Zahid

Rice Research Institute, Kala Shah Kaku, Sheikhupura, Pakistan

ABSTRACT

One hundred sixteen F_1 crosses along with eight female (4 cms or A lines viz; IR 68280A, IR72788A, IR70372A & IR58025A and 4 maintainer or B lines viz; IR 68280B, IR72788B, IR70372B & IR58025B) parental lines were sown during wet season 1999 in the screen house of Entomology Division at IRRI. The difference in mean reaction of cms (IR68280A) and its maintainer (IR68280B) line against brown plant hopper was negative and highly significant while the difference in mean reaction of the other cms (IR72788A) and its maintainer (IR72788B) line was non-significant. In case of F_1 crosses of IR68280A & B, out of 16, 11 A x R crosses showed better mean score than their corresponding B x R crosses. Only two F_1 (A x R) crosses exhibited similar reaction to their corresponding B X R crosses and only three F_1 (A x R) crosses showed poor mean score than their corresponding B x R crosses. In case of IR 72788A & B, out of 12, four F_1 (A x R) crosses showed better mean score and five showed poor mean score than their corresponding B x R crosses while remaining three F_1 (A x R) crosses exhibited non significant difference in their mean score as compared to their respective B x R crosses indicating non association of wild abortive cytoplasm of cms line, IR68280A with the susceptibility to brown plant hopper. In case of white backed plant hopper, the two cms lines viz. IR70372A & IR58025A indicated non significant difference in their mean score as compare to their corresponding maintainer or B lines. The comparison of F_1 crosses of IR 70372A & B revealed that 9 out of 16 F_1 (A x R) crosses showed significantly better mean score and 3 A x R crosses showed poor mean score than their corresponding B x R crosses. In two cases, the difference in mean score of F_1 crosses (A x R & B x R) was non-significant and in two cases there was no difference at all. In case of other cms line, IR58025A & B, 9 out of 14 F_1 (A x R) crosses exhibited significantly better mean score than their respective B x R crosses. In four cases there was no difference in mean score of A x R & B x R F_1crosses. Only one B x R F_1 cross (IR58025B x IR67888-127- 3) showed significantly better mean score than its corresponding A x R F_1 cross (IR58025A x IR67888-127- 3). The inconsistent behaviour of the F_1 crosses of all cms (A) & maintainer (B) lines x restorers suggested nuclear gene ineteraction rather than the association of wild abortive cytolplasm to susceptibility to brown and white backed plant hopper.

Key words: Wild abortive cytoplasm, cms (A) line, maintainer (B) line, R line, male sterility and susceptibility

.

INTRODUCTION

Plant hoppers are important damaging pests of rice in Asia. The plant hoppers viz; brown plant hopper (bph) *Nilaparvata lugens*, white backed plant hopper (wbph) *Sogatella furcifera*, green leaf hopper, (glh) *Nephotettix virescens*, and zig zag leaf hopper (zlh) *Recilia dorsalis* feed on rice plant. They occur mostly at the base of the plants. By sucking cell sap and blockage of the vascular vessels by feeding sheaths the plants wilt and die. This wilting and drying of the plants is known as hopper burn and when hopper burn starts on a few plants, the plant hoppers move to next un infested plants because the dead plants have no cell sap. In this way the population of the insect become concentrated at the edge of the developing patch that slowly widens as more plants die at the centre. Plant hoppers first attack on early sown coarse / medium grain rice varieties and later when the coarse grain varieties are harvested they shift to the basmati varieties. Out breaks of these insects not only cause considerable yield losses but also impair the quality of the rice grain. Various sources of resistance for brown plant hopper and white backed plant hopper have been identified and several commercial varieties have been released.

In hybrid breeding programme, the Wild Abortive (WA) cytoplasmic male sterility (cms) system of cytoplasmic male sterile (A) lines was considered to be associated with susceptibility to insect pest and diseases. As the Hybrid Breeding programme was at initial stage in Pakistan, it was essential to determine the susceptibility of parental cms lines (mainly used for developing commercial rice hybrids) to plant hoppers. Some reports available in the literature indicate that several parental cms lines that possess WA cms system have resistance against certain insects and diseases (Kumar et.al. (1996). Therefore, the present study was undertaken to determine the association of WA cms system with susceptibility

against brown plant hopper and white back plant hopper in some basmati rice hybrids.

MATERIALS AND METHODS

One hundred sixteen F_1 crosses along with 8 female (4 cms or A lines viz; IR 68280A, IR72788A, IR70372A & IR58025A and 4 maintainer or B lines viz; IR 68280B, IR72788B, IR70372B & IR58025B) were sown during wet season 1999 in the screen house of Entomology Division at IRRI. Fifty-six F_1 crosses of IR 68280A & IR 68280B x Restorers and IR 72788A & IR 72788B x Restorers were used for brown plant hopper. Sixty F_1 crosses of IR70372A & IR70372B x Restorers and IR58025A & IR58025B x Restorers were used for white backed plant hopper.

Preparation of plant materials: Test seeds of 116 F_1 (A x R & B x R) crosses and 28 Parental (A, B & R) lines were heat-treated for 3 days in a convection oven to break the seed dormancy, Heat-treated seeds of all entries were directly sown in wooden trays 5-6 days after the removal of infested plants containing eggs of both insects from the oviposition cage, Resistant and susceptible check varieties, Babavea & TN -1 were used for bph and IR62 & TN-1 were used for wbph.

Inoculation of plant materials: At 6 days after sowing, the seedlings were infested with the 2nd and 3rd instar nymphs of bph and wbph respectively.

Scoring of test materials: Scoring of the test seedlings was done using 0 – 9 scale seven days after the infestation using Standard Evaluation System for Rice (IRRI, 1996).

Statistical Analysis: Data were statistically analysed using the simple Analysis of Variance (ANOVA) in Randomized Complete Block design. Differences in A & B lines and their F_1 (A x R & B x R) crosses were determined by comparing their mean values. Significance of the differences in mean values was computed by using t test,

$$t = \frac{diff}{\sqrt{EMSI\ \mathrm{rt}}}$$

where *diff* = difference of two means, r = number of replications and t = number of observations over the replications.

RESULTS & DISCUSSIONS

The difference in mean reaction of cms (A) line, IR68280A and its maintainer (B) line, IR68280B against brown plant hopper was negative and highly significant while the difference in mean reaction of the other cms line, IR72788A and its maintainer line, IR72788B was non-significant (Table 1). Similar findings were observed by Virmani (1994). The comparison of mean reaction of F_1 (A x R & B x R) crosses of IR68280A and IR68280B with restorers (R) lines indicated that 11 A x R crosses out of 16 exhibited significantly better mean score than their respective B x R crosses. Only three A x R crosses viz; IR68280A x IR67417-2-1, IR68280A x IR67417-2-1, IR68280A x IR67417-2-1 expressed poor mean score than their respective B x R crosses and two A x R crosses showed no difference in mean reaction when compared to their corresponding B x R crosses. However, on overall basis, the difference in mean reaction of A x R and B x R crosses of IR68280A & IR68280B was negative and highly significant (Table 2) which indicated that wild abortive (WA) cytoplasm of IR68280A was not associated with the susceptibility to brown plant hopper. These results are not in accordance with the findings of Mew *et al*., 1988 (in China) who reported that incidence of stem borer, white back plant hopper, leaf folder, BB and virus diseases were more frequent on hybrid rice than the inbred rices.

In case of IR72788A & its maintainer line IR72788B, the comparison of mean score of F_1 (A x R & B x R) crosses revealed that out of 12, 5 A x R crosses expressed poor mean score than their respective B x R crosses against brown plant hopper. Only four A x R crosses exhibited better mean score than their corresponding B x R crosses. In three instances, A x R crosses revealed no difference in mean score when compared to their respective B x R crosses. On overall basis, the difference in mean reaction of A x R & B x R crosses of IR72888A & IR72788B was non significant (Table 3) which indicated inconsistent behavior of the F_1 crosses. These results clearly revealed that the WA cytoplasm of the cms lines was not associated with susceptibility to brown plant hopper. This inconsistent behavior of the F_1 crosses suggested nucleo-cytoplasmic interaction rather than the negative effect of the WA cytoplasm. Similar findings were observed by Mew *et al*., (1981) in China and Virmani, (1994) at IRRI, Philippines.

Table 1. Comparison of mean differences of the A and B lines against brown plant hopper & white back plant hopper

Brown Plant Hopper		White Back Plant Hopper	
Variety	Mean Reaction	Variety	Mean Reaction
IR68280A	5.4	IR70372A	5.4
IR68280B	6.6	IR70372B	4.9
Difference	-1.2**	Difference	0.5ns
IR72788A	8.4	IR58025A	8.4
IR72788B	7.9	IR58025B	7.9
Difference	0.5ns	Difference	0.5ns

In case of wbph, data presented in table - 1 depicted that the difference in the mean score of both cms lines (IR70372A & IR58025A) and their corresponding maintainer lines (IR70372B & IR58025B) was non-significant (Table 1). All the F_1 crosses (A x R and B x R) of IR70372A x Restorers & IR70372B x Restorers depicted different behavior in mean reaction against this insect as described in table 4. On overall basis, the A x R crosses showed better mean reaction than their corresponding B x R crosses but the difference was non-significant. The data presented in table 4 further revealed that in nine cases out of 16, A x R crosses showed significantly better mean score than their corresponding B x R crosses and only in three B/R crosses viz; IR70372B x IR67422-226-3-5-2, IR70372B x IR68461-34-1-3 and IR70372B x IR68746-5-2 out of 16, showed better mean score than their respective A/R crosses. In two cases, the difference in mean score of A x R & B x R crosses was non significant and in two cases there was no difference in mean score of A x R & B x R crosses. Similar findings were observed by Sing (1995, 1966) and reported that some cytoplasm may interact more frequently with nuclear genes to produce reciprocal effects in maize. Scott and Futrell (1975) also found that nuclear gene resistance could overcome part but not all of the susceptibility associated with 'T' cytoplasm to the disease Bipolaris, race T. Similar findings were also observed by Fleming *et al*., (1960).

Table 2. Mean reaction of A x R & B x R crosses for resistance to brown plant hopper

IR68280A x R Lines (A x R)	A x R	S.No	IR68280B x R Lines (B x R)	B x R	A x R – B x R
IR68280A x			IR68280B x		
IR67415-170-2-2-2	6.0	1	IR67415-170-2-2-2	7.0	-1.0**
IR67417-2-1	6.0	2	IR67417-2-1	5.0	1.0**
IR67418-20-3-1-3	8.0	3	IR67418-20-3-1-3	8.0	0.0ns
IR67418-238-6-6-3-2	6.0	4	IR67418-238-6-6-3-2	8.0	-2.0**
IR67419-144-2-3-2-3	5.0	5	IR67419-144-2-3-2-3	7.0	-2.0**
IR67420-48-3-6-3	5.0	6	IR67420-48-3-6-3	6.0	-1.0**
IR67422-226-3-5-2	7.0	7	IR67422-226-3-5-2	9.0	-2.0**
IR67423-47-3-1-1	8.0	8	IR67423-47-3-1-1	4.0	4.0**
IR67423-208-2-1-2-2	8.0	9	IR67423-208-2-1-2-2	8.0	0.0ns
IR67888-127-3	5.0	10	IR67888-127-3	7.0	-2.0**
IR67900-10-3	4.0	11	IR67900-10-3	8.0	-4.0**
IR67904-79-2	6.0	12	IR67904-79-2	8.0	-2.0**
IR68459-13-1-2	7.0	13	IR68459-13-1-2	8.0	-1.0**
IR68461-34-1-3	6.0	14	IR68461-34-1-3	7.0	-1.0**
IR68737-61-1-3	6.0	15	IR68737-61-1-3	9.0	-3.0**
IR68746-5-2	9.0	16	IR68746-5-2	8.0	1.0**
Mean	6.4		Mean	7.2	-0.8**

* = Significant at 5 % ** = significant at 1 %, ns = not significant

R = Restorer lines, AxR = IR68280A x Restorers, BxR = IR68280B x Restorers,

Table 3.Mean reaction of A x R & B x R crosses for resistance to brown plant hopper

IR72788A x Restorers (R lines)	A x R	S.No	IR72788B x Restorers (R lines)	B x R	A x R – B x R
IR72788A x			IR72788B x		
IR67418-20-3-1-3	9.0	1	IR67418-20-3-1-3	9.0	0.0
IR67418-238-6-6-3-2	9.0	2	IR67418-238-6-6-3-2	7.0	2.0**
IR67419-144-2-3-2-3	8.0	3	IR67419-144-2-3-2-3	9.0	-1.0**
IR67420-48-3-6-3	9.0	4	IR67420-48-3-6-3	9.0	0.0
IR67421-255-3-6-2	7.0	5	IR67421-255-3-6-2	6.0	1.0**
IR67422-226-3-5-2	8.0	6	IR67422-226-3-5-2	8.0	0.0
IR67423-23-2-4	9.0	7	IR67423-23-2-4	8.0	1.0**
IR67423-208-2-1-2-2	6.0	8	IR67423-208-2-1-2-2	9.0	-3.0**
IR67888-127-3	7.0	9	IR67888-127-3	8.0	-1.0**
IR67924-17-2-2	6.0	10	IR67924-17-2-2	9.0	-3.0**
IR67924 -75-4-3-2	8.0	11	IR67924 -75-4-3-2	7.0	1.0**
IR68737-61-1-3	9.0	12	IR68737-61-1-3	6.0	3.0**
Mean	7.9		Mean	7.9	0.0ns

* = Significant at 5 % ** = significant at 1 %, ns = not significant

AxR = IR72788A x Restorers, BxR = IR72788B x Restorers

Table 4. Mean reaction of A x R & B x R crosses for resistance to white back plant hopper

IR72788A x Restorers (R lines)	A x R	S.No	IR72788B x Restorers (R lines)	B x R	A x R – B x R
IR72788A x			IR72788B x		
IR67415-170-2-2-2	5.0	1	IR67415-170-2-2-2	7.0	-2.0**
IR67417-2-1	5.0	2	IR67417-2-1	6.0	-1.0**
IR67418-20-3-1-3	5.0	3	IR67418-20-3-1-3	6.0	-1.0**
IR67418-238-6-6-3-2	5.0	4	IR67418-238-6-6-3-2	6.0	-1.0**
IR67419-144-2-3-2-3	5.0	5	IR67419-144-2-3-2-3	6.0	-1.0**
IR67420-48-3-6-3	8.0	6	IR67420-48-3-6-3	8.0	0.0
IR67422-226-3-5-2	6.0	7	IR67422-226-3-5-2	5.0	1.0**
IR67423-47-3-1-1	3.0	8	IR67423-47-3-1-1	4.0	-1.0**
IR67423-208-2-1-2-2	6.0	9	IR67423-208-2-1-2-2	7.0	-1.0**
IR67888-127-3	7.0	10	IR67888-127-3	7.0	0.0
IR67900-10-3	5.5	11	IR67900-10-3	6.0	-0.5ns
IR67904-79-2	3.0	12	IR67904-79-2	6.0	-3.0**
IR68459-13-1-2	4.5	13	IR68459-13-1-2	4.0	0.5ns
IR68461-34-1-3	6.5	14	IR68461-34-1-3	5.0	1.5**
IR68737-61-1-3	5.0	15	IR68737-61-1-3	6.0	-1.0**
IR68746-5-2	8.0	16	IR68746-5-2	7.0	1.0**
Mean	5.4		Mean	6.0	-0.6ns

*= significant at 5 % ** = significant at 1 % ns = not significant
AxR = IR70372A x Restorers, BxR = IR70372B x Restorers,

Table 5. Mean reaction of A x R & B x R crosses for resistance to white back plant hopper

S.No	IR58025A x Restorers (R lines)	A x R	S.No	IR58025B x Restorers (R lines)	B x R	A x R – B x R
	IR58025A x			IR58025B x		
1	IR67415-170-2-2-2	5.5	1	IR67415-170-2-2-2	8.0	-2.5**
2	IR67418-20-3-1-3	6.0	2	IR67418-20-3-1-3	6.0	0.0ns
3	IR67418-238-6-6-3-2	3.0	3	IR67418-238-6-6-3-2	5.0	-2.0**
4	IR67419-144-2-3-2-3	5.0	4	IR67419-144-2-3-2-3	7.0	-2.0**
5	IR67420-48-3-6-3	8.0	5	IR67420-48-3-6-3	8.0	0.0ns
6	IR67421-255-3-6-2	5.0	6	IR67421-255-3-6-2	5.0	0.0ns
7	IR67422-226-3-5-2	3.0	7	IR67422-226-3-5-2	6.0	-3.0**
8	IR67423-23-2-4	5.0	8	IR67423-23-2-4	6.5	-1.5**
9	IR67423-208-2-1-2-2	4.0	9	IR67423-208-2-1-2-2	6.5	-2.5**
10	IR67888-127-3	7.0	10	IR67888-127-3	6.0	1.0**
11	IR67924-17-2-2	6.0	11	IR67924-17-2-2	7.0	-1.0**
12	IR67924 -75-4-3-2	5.0	12	IR67924 -75-4-3-2	5.0	0.0ns
13	IR68737-61-1-3	5.0	13	IR68737-61-1-3	6.0	-1.0**
14	IR68746-5-2	6.0	14	IR68746-5-2	7.0	-1.0**
	Mean	5.3		Mean	6.4	-1.1**

* = significant at 5 % ** = significant at 1 %, ns = not significant
AxR = IR58025A x Restorers, BxR = IR58025B x Restorers,

In case of IR58025A & its maintainer IR 58025B, on over all bases, the difference in mean reaction of F_1 (A x R & B x R) crosses was highly significant (Table 5). The results in of table-5 further indicated that 9 A x R crosses out of 14, indicated highly significantly better mean score than their respective B x R crosses where as in four cases there was no difference in mean reaction of F_1 (A x R and B x R) crosses. Only one B/R cross (IR58025B x IR67888 -127-3) exhibited better mean score than its corresponding A x R cross. Similar results were found by Fleming *et al*., (1960) who observed significant cytoplasmic effects in double cross

maize hybrids for agronomic traits and resistance against bud worm damage. The above results revealed that all the A x R and B x R crosses showed inconsistent reaction against white back plant hopper indicating that the WA cytoplasm of the cms lines is not associated with susceptibility to both the major insects; brown plant hopper and white backed plant hopper. Mew *et al*., (1981) in China and Virmani, (1994a) at IRRI, found the similar results.

REFERENCES.

Fleming A.A., G.M. Kozelnick and EB. Browne. 1960. cytoplasmic effects on agronomic characters in double cross maize hybdrid. Agron J. 52: 112-115.

Kumar, R.V., P.V. Satyanarayana and M.S. Rao. 1996. New cytoplasmic sterile lines developed in Andra Perdesh. India.

Mew, T.W and G.S. Khush. 1981. Breeding for bacterial blight resistance in rice. Proc. 5th conf. Plant Path. Bac. Cali, Colombia.

Mew, T.W, F. M.. Wang, J.T. Wu, K.R. Lin and G.S. Khush. (1998). Disease and insect resistance in hybrid rice. In : hybrid rice. IRRI, Manila, Philippines, pp 189-200.

Scott, Gene E and M.C. Futrell. 1975. Reaction of diallel crosses of Maize in T And N Cytoplasm to Bipolaris maydis race T. crop Sci 15: 779-781.

Singh, M. 1965. Cytoplasmic effect in some agronomic characters in back cross maize hybrids. Indian J Genet 25: 198-207.

Singh, M. 1965. Cytoplasmic effect in agronomic characters in maize.Indian J Genet 26: 386-396.

Ulistrip, A.J. (1972).The impacts of southern corn leaf blight epidemics of 1970-1971. Ann. Rev. Phytopath. 10: 37-50.

Virmani, S. S. 1994. male sterility system for hybrid rice breeding. Theoretical and Applied Genetics Monograph No. 22. Springer-Verlag. P41-48.