Annals of Tropical Research 29[2]:1-13(2007)

Reaction of hybrid rice and component lines to rice black bug [*Scotinophara coarctata* (Fabricius), Hemiptera: Pentatomidae]

Brian S. Sinangote[1], Reny G. Gerona[1], Ma. Dinah M. Reformina[1], Ma. Gina M. Babb[2] and Lucia M. Borines[1]

[1] Department of Pest Management, Visayas State University (formerly Leyte State Universirty), Visca, Baybay City, Leyte; [2] Philippine Rice Research Institute, Maligaya Science City of Muñoz, Nueva Ecija, Philippines

ABSTRACT

A limiting factor to hybrid rice production in the Philippines is the susceptibility of hybrid rice component lines to diseases and insect pests. Rice black bug (*Scotinophara coarctata* Fabr.) is among the insect pests and is the newest addition to the list of major pests of rice. This study aims to determine the reaction of hybrid rice component lines to rice black bug (RBB).

Eighty-four (84) hybrid rice componet lines were evaluated for their reacton to RBB. Two batches of unreplicated preliminary screening of the lines were done. Two sets of re-evaluation were also conducted. The standard evaluation system for rice (SE) was followed.

No lines showed resistance to RBB during the preliminary screening. Twenty-six (26) lines which showed a moderately susceptible reaction were re-evaluated in a replicated experiment. Among them, R2-6 and IR60819R showed resistance, PR4B showed an intermediate reaction and GUI99 showed a moderatley susceptible reaction. These promising lines were further valueated against RBB and results showed thatR2-6 was rated highly resistant (HR), IR60819R was resistant (R), PR4B was moderately resistant (MR) and GUI99 was moderately susceptible (MS). Most of the hybrid rice component lines are susceptible to RBB.

Keywords: Hybrid rice,component lines, reaction, rice black bug

Correspondence: L. M. Borines *Address*: Department of Pest Management, College of Agriculture, Visayas State University, Baybay City, Leyte, 6521-A, Philippines. *Tel. No*. (053) 335-----

INTRODUCTION

Hybrid rice is a new emerging technology across Asia and the tropics, including the Philippines that aim to help ensure food security and attain rice-self sufficiency. Recognizing the potential of hybrid rice to increase local rice production by at least 15% over the best inbred lines and the prospects the technology offers in terms of increasing profitability of rice farming, the Philippine government has launched a comprehensive Hybrid rice Program (HRP) in 1998 under the Department of Agriculture (DA) (De Leon *et al*., 2003).

The Philippine Rice Research Institute (PhilRice) which spearheads hybrid rice technology in the Philippines had developed several hybrids in collaboration with the International Rice Research Institute (IRRI) and is currently evaluating some other potential experimental hybrids. A common observation by hybrid rice researchers, breeders and producers is the susceptibility of most of the hybrid rice and component lines to local pests and diseases especiallytheones introduced from other countries, mainly China through collaboration with PhilRice. Such susceptibility served as a major constraint to large-scale adoption of hybrid rice technology inthe country.

Virmani (2001) stated that one major challenge to the large-scale adoption of hybrid rice technology in the tropics is the inadequate level of disease/insect resistance in the released hybrids. Thus,the current direction of researches on this aspect is on the improvement of the levels of resistance of hybrid rice to major pests.

The rice black bug (RBB), also known as Malayan Black Bug (*Scotinophara coarctata* Fabr. Pentatomidae, Hemiptera) is one of the most important insect pests of rice and was reported in several Asian countries including the Philippines (IRRI, 2001). RBB is the newest pest of rice in Leyte, although it has been in the Philippines for more than 2 decades now (NCPC, 2000; Po, 2004).

Both the adults and nymphs suck the plant sap through its mouthparts. It feeds on the rice plant from seedling to maturity. When RBB infestation is at the tillering stage,"dead hearts" occur but continued feeding results in leaves turning chlorate or reddish brown and in reduction in tiller number and stunting (Perez and Shepard, 1992). Attack during the booting stage results in panicles with empty grains similar to "white heads" caused by stemborers (Heinrich *et al*, 1985). Heavy infestation may lead to death of the plants and whole field appears "burned" similar to that of hopper-burned field. "Bug burn" is usually visible after the heading or maturing stage (Perez and Shepard, 1992).

RBB is considered as one of the pests that are difficult to manage in view of its distinct habit. The nymphs and adults aggregate at the base of the rice plants just above the water level during daytime and move to the upper part at night or on an overcast day (Ito *et al*., 1993). This habit makes this insect less vulnerable to the attack of natural enemies and other natural mortality factors, thus allowing them to increase their population tremendously.

The use of chemical sprays is one of the commonly recommended methods in controlling rice black bugs. Heinrich *et al*. (1985), for instance, recommended foliar spraying with Dimethoate EC and Malathion EC at 0.9 kg a.i./ha. This practice, however is not popular to farmers who cannot afford to buy expensive chemical pesticides. Besides, excessive use of chemicals pollutes the environment, kills non-target species and may lead to emergence of resistant pests (Perez *et al*., 1989). In view of these drawbacks, other control methods which are safe and effective such as the use of host plant resistance were looked into.

Hybrid rice breeding usually aims to develop varieties which are not only high yielding, have good grain quality, well adapted to different rice growing conditions but also with resistance to major pests. Therefore, evaluation of hybrid rice parental lines as well as newly developed hybrids for their reaction to major pests before they are further used in breeding works and before they are released to farmers is an integral part of any crop improvement program.

This study was conducted to determine the reaction of hybrid rice and component lines being used at PhilRice in hybrid rice breeding for their reaction to rice black bug and to identify resistant/promising entries to RBB resistance.

Mass rearing of the test insect

RBB adults were collected from the VSU rice fields, Visca, Baybay City Leyte. Collected insects were placed in plastic containers and given gabi (*Colocasia esculenta*) stalks as the mass rearing host (Fig. 1a). The insects were allowed to lay eggs and were allowed to hatch. Newly-hatched nymphs

Figure 1. a) Field-collected RBB nymphs mass-reared on gabi stalks, b) plastic containers containing the mass reared insects, and c) 3rd instar RBB nymphs that are about to be introduced to rice plants.

Figure 2. Galvanized iron trays with transplanted hybrid rice component line seedlings in rows used in RBB screening.

were transferred to 4 x 6 in. plastic containers provided with gabi stalks (Fig.1b). After every molt, the newly molted nymphs were transferred to the new containers provided with fresh gabi stalks until the third instar nymphal stage. The third instar nymphs were used in the succeeding experiments (Fig. 1c).

Evaluation of lines against RBB

Since there is no standard rating scale yet for RBB, evaluation of the lines against RBB was patterned after that of the standard rating scale for brown planthopper (BPH) as developed by INGER 1996. An initial unreplicated screening of the lines was first conducted before the replicated evaluation of the promising lines.

A. Unreplicated screening

Eighty four (84) entries including one resistant and one susceptible check were included in the initial unreplicated screening. Since no line with resistance to RBB as well as susceptible was ever reported, the resistant (IR62) and susceptible (TN1) checks for BPH screening used at IRRI were also used. Twenty seeds of each entry were pre-germinated in Petri dishes lined with moistened tissue paper. Seven days after germination, ten seedlings were transplanted in single rows in 24 x 26 in. seed boxes made up of galvanized iron sheet (Fig. 2). Each seed box was covered with mylar plastic box provided with a window covered with nylon sheer sleeves to facilitate insect introduction, prevent escape of introduced insects and provide ventilation to the plant and introduced insects. The seedlings were given the proper management practices like watering, fertilization and weeding as necessary during the entire duration of the experiment. The plants were allowed to establish for two weeks before RBB introduction. Twenty one (21) day-old seedlings were used in the evaluation.

Third instar RBB nymphs were introduced at the rate of five bugs per plant. The insects were picked-up with a camel's hair brush and introduced through the circular windows of the cage. Equal number. of insects was carefully distributed along each row to ensure even distribution among entries. The plants were observed daily for the appearance of damage by RBB.

RBB Damage rating

The reaction of all entries to RBB was based on the final damage ratings, i.e.8 days after introduction (DAI). The standard rating scale for BPH screening shown below (INGER 1996) was followed:

Rating Index	Description	Reaction
0.	No damage	Highly Resistant (HR)
1	Very slight damage	Resistant (R)
3	First and second leaves of most plants showed partial yellowing	Moderately Resistant (MR)
5	Pronounced yellowing and stunting or about 10-25% of the plants wilt	Intermediate
7	More than half of the plants wilt or dead and remaining plants severely stunted or dying	Moderately Susceptible (MS)
9	All plants dead	Susceptible (S)

B. Replicated evaluation and re-evaluation of the lines

The selected promising entries in the unreplicated screening were subjected to two steps of evaluation against RBB using the same procedure. Each stage of the evaluation was done in 3 trials to further verify their true reaction to RBB. The same procedure was followed as in the preliminary screening (same number of insects per seedling), however, the number of seedlings per row was increased to 20 and the set-up was replicated three times.

Experimental design and data analysis

Two stages of replicated re-evaluation of the lines were arranged in a completely randomized design (CRD) and the data gathered were subjected to ANOVA using the IRRISTAT software. Treatment means were compared using LSD.

RESULTS AND DISCUSSION

Reaction of hybrid rice and component lines to rice black bug (RBB) in the unreplicated screening

Rating scales and the reaction of the eighty four (84) entrylines together with TN1 (Susceptible Check) and IR62 (Resistant Check) are shown in Table 1. At 2 days after infestation (DAI) feeding damage of RBB was already evident in most entries at varying degrees except for R2-6 and GUI99. This suggests that these two lines were less preferred for feeding compared to the other entires. However as the time of insect infestation was prolonged (2-8 DAI), the damage due to feeding was more evident in all entries. Moreover, results indicate that even entries which may have some resistance to RBB, may succumb to insect attack if left unchecked at the early stage. Perez and Shepard (1992) cited that sucking of sap of rice by RBB results to yellowing of the leaves at the early stage of infestation. Prolonged RBB results to more severe symptoms like the browning of leaves, then weakening of the plant and finally death of plants. The same symptoms were observed in the test lines used as the time of observation progressed (Figure 2).

Based on overall plant reaction, a total of 26 entries were rated moderately susceptible (MS) at the end of the observation period (8 DAI) while the remaining entries were rated susceptible (S) including the resistant and susceptible checks used. Results further suggested that there was enough and uniform distribution of the test insects in the whole set-up as shown by the generally low level of resistance in all entries at 8 DAI.

Table 1. Rating Indices and reaction of hybrid rice and component lines to RBB from 2 to 8 days after infestation. (Unreplicated Trial).

ENTRIES	RATING INDEX							REACTION[2]
	Days After Infestation							
	2DAI	3DAI	4DAI	5DAI	6DAI	7DAI	8DAI	
1. AR329-3-36	3	7	7	7	7	9	9	S
2. BB-1	1	3	5	5	7	9	9	S
3. BB-2	1	1	3	3	5	5	7	MS
4. BB-3	5	7	7	7	7	9	9	S
5. BG90-2	1	1	5	5	7	7	7	MS
6. BOB	5	5	7	7	7	7	7	MS
7. CAN8502	7	7	7	9	9	9	9	S
8. CT-9505-12-10-9. 1MP	3	5	7	7	9	9	9	S
9. GINANTE B	1	3	5	7	9	9	9	S
10. GUI 99	0	1	3	3	5	5	7	MS
11. HJX52	5	5	7	7	7	9	9	S
12. IR16727-7B	1	1	3	3	3	5	7	MS
13. IR26016-B-B-B	1	3	5	5	5	7	7	MS
14. IR58025B	5	7	7	7	7	9	9	S
15. IR62161 R	1	3	7	9	9	9	9	S
16. IR628229B	1	3	3	5	7	9	9	S
17. IR68888B	1	3	3	5	5	7	7	MS
18. IR69626 B	1	1	3	7	7	9	9	S
19. IR70871 B	1	3	5	5	7	7	7	MS
20. IR72	1	5	7	7	7	7	7	MS
21. IR688886 B	1	3	5	5	7	7	7	MS
22. IR16549 B	1	3	5	5	7	9	9	S
23. IR69627 B	1	1	3	5	7	7	7	MS
24. IR34686 R	1	3	7	9	9	9	9	S
25. IR68897 B	3	5	5	7	7	7	7	MS
26. IR7201 B	7	7	9	9	9	9	9	S
27. IR60819 R	1	1	3	5	7	7	7	MS
28. IR68902 B	3	5	7	9	9	9	9	S
29. IR69625 B	1	3	5	7	9	9	9	S
30. IR16365-5B	3	5	7	7	9	9	9	S

Replicated evaluations

Twenty-six (26) entries in the unreplicated screening which showed a moderately susceptible (MS) reaction were subjected to two stages of re-evaluation in replicated experiments. Table 2 shows the mean rating and overall reaction of these lines inthe first stage of re-evaluation. Among the

Continuation Table 1...

31. IR59606-119-3R	1	3	5	7	7	7	7	MS
32. LIANB	1	3	5	7	9	9	9	S
33. LPO364	6	6	7	7	7	8	9	S
34. LPO353	5	6	6	7	7	8	9	S
35. LPO345	5	6	6	7	7	8	9	S
36. LPO330	6	6	7	7	8	8	9	S
37. LPO331	6	6	7	7	8	8	9	S
38. LPO364	6	6	7	7	7	8	9	S
39. LPO368	5	6	6	7	7	8	9	S
40. MAROS	3	5	5	7	7	7	7	MS
41. PJ3-5	1	5	5	5	7	7	7	MS
42. PJG6	5	7	7	7	7	9	9	S
43. PMS8B	1	5	7	7	9	9	9	S
44. PR1B	3	5	7	9	9	9	9	S
45. PR2B	5	7	7	9	9	9	9	S
46. PR3B	1	1	3	5	7	7	7	MS
47. PR4B	3	3	7	7	7	7	7	MS
48. PR5 B	1	1	5	7	9	9	9	S
49. PR6B	3	5	7	7	9	9	9	S
50. PR7B	5	7	7	7	9	9	9	S
51. PR8B	3	3	5	5	7	7	7	MS
52. PR9B	3	3	5	5	7	9	9	S
53. PR10	7	7	7	9	9	9	9	S
54. PR11B	3	5	7	7	7	7	7	MS
55. PR12B	3	5	7	7	9	9	9	S
56. PR13B	5	5	5	7	7	9	9	S
57. PR14B	3	5	7	9	9	9	9	S
58. PR15B	1	1	3	3	5	5	7	MS
59. PR16B	3	5	5	5	5	5	7	MS
60. PR17B	7	7	7	9	9	9	9	S

entries tested, R2-6 and IR60819R showed no visible feeding damage (0.0) at 2 to 3 days DAI although PR4B (0.33) also got a rating which did not differ significantly from the two entries at 2 DAI. Similarly, lower rating was observed in GUI99, however, this was significantly higher than those mentioned at 2 DAI. As the day of observation progressed, damage ratings became more pronounced. This was also the trend observed from 2 to 8 DAI in all entries. However, ratings from R2-6, IR60819R, PR4B and GUI99 were significantly

Continuation Table 1...

61. PR18 B	1	1	5	5	7	9	9	S
62. PR120-1-1B	3	3	7	7	9	9	9	S
63. PR249682-4-1-1-1	3	7	7	7	9	9	9	S
64.PR26243-68-1-10-1MP	3	5	7	7	9	9	9	S
65. PR28095-18	7	7	7	7	9	9	9	S
66. PR2955-2	1	5	7	7	9	9	9	S
67. PR31684 H	6	7	7	8	8	9	9	S
68. PR31712 H	5	6	7	7	7	8	9	S
69. PR31691 H	5	6	7	8	8	9	9	S
70. PR31191 H	5	7	7	8	8	8	9	S
71. PR31181 H	6	8	8	8	8	9	9	S
72. PR31733 H	6	7	8	8	8	8	9	S
73. IR78386 H	5	7	8	8	8	8	9	S
74. PRAGATHI B	1	1	3	5	5	7	7	MS
75. PSBRC34	1	3	5	7	7	7	7	MS
76. PSBRC52	7	7	7	9	9	9	9	S
77. PSBRC56	5	7	7	9	9	9	9	S
78. PSBRC80	1	5	7	7	9	9	9	S
79. R2-6	0	1	3	3	5	7	7	MS
80. RIZALINA 38	5	6	7	7	8	8	9	S
81. RIZALINA 28	5	6	7	8	8	9	9	S
82. 28B	3	5	7	7	9	9	9	S
83. IR628229	1	3	5	7	9	9	9	S
84. 913 B	1	1	3	5	7	7	7	MS
TN1 (susceptible check	7	7	7	8	8	9	9.00	S
IR62 resistant check	6	7	7	7	7	8	9.00	S

[1] Cummulative average resistance and overall reactions based on 10 plants per entry with three replications

[2] Based on the rating index at 8 DAI.

lower than those of the others which were consistent from 2 to 8 DAI. At 8 DAI, R2-6 and IR60819R were rated resistant (1.6 and 2.33, respectively), PR4B Intermediate (5.0) and GUI99 Moderately susceptible (7.0). The rest of the entries including the supposed to be resistant and susceptible checks (for BPH) were rated susceptible (9) to RBB.

The above results generally followed the same trend with that of the unreplicated screening. Although specifically, most of the entires showed a lower resistance reaction (S) compared with their reaction in the unreplicated test (MS). On the other hand, the reaction of R2-6 (R), PR4B (1) and IR60819R were better against the RBB than in the unreplicated screening.

Table 3 shows the average feeding damage ratings from 2 to 8 DAI and final reactions of the 6 selected promising entires together with the resistant and susceptible entries for BPH as checks in the second stage of re-evaluation. In R2-6, no feeding damage was observed at 2 to 4 DAI and with very slight damage up to 8 DAI. Similar results were observed in PR4B and IR60819R at 2-3 DAI but gradually increased with the observation period. However, the rating of IR60819R was significantly lower (2.78) than that of PR4B (3.22) at 8 DAI). On the other hand, among the four promising entries planted, GUI99 got the lowest level of resistance with the highest rating of 5.89. It should be noted that IR62 which was resistant to BPH got hte final rating of 6.78 which was almost comparable to that of TN1 (susceptible to BPH) with a rating of 7.22. The reactions of these checks were consistently low even during the unreplicated evaluation. The intermediate reaction of IR62 simply proves that reaction of a variety would vary among insect species.

It was observed that at 2-3 DAI, almost no RBB nymphs stayed on the seedlings of R2-6 and PR4B as well as IR60819R compared with the remaining entries especially TN1. Therefore, the low damage ratings in these entries were due to no or very minimal feeding. Consequently, results suggest that R2-6 was the least preferred line for feeding, thus it came out highly resistant (HR). This was followed by IR60819R (R), PR4B (MR)and GUI99 (I). Similarly, Pathak and Khan (1994) reported two cultivars resistant to RBB (IR10781-75-3-2-2 and IR13149-71-3-2). They attributed their finding to be possibly linked to the presence of resistance gene against RBB in these two cultivars. Such possibility could also be true to R2-6and IR60819R.

Generally, based on the overall reactions, the 4 entries seemed to perform better than in two earlier evaluations even with the resistant and susceptible checks IR62 and TN1 which were consistently rated susceptible (S) in the previous tests. These seemingly increasing levels of resistance of the four entries with stage of evaluation could be due to differences in some factors when the experiment was conducted. Panda and Khush (1995) cited several factors which could affectthe expression of resistance of a plant to a given pest. These factors could be related to the plant, to the insect or to the environment. In this study, it could be duemore to the differences in

Table 2. Average rating indices and reaction of 26 promising hybrid rice and component lines to Rice Black Bug, *Scotinophara coarctata* (Fabr.) taken at 2 to 8 days after infestation.[1]

ENTRIES	Days after Infestation (DAI)Average/Rating Index							REACTION[2]
	2	3	4	5	6	7	8	
IR6289	3.67	4.33	5.67	5.67	7.67	8.33	9.0	S
913 B	3.67	5.67	7.67	9.0	9.0	9.0	9.0	S
PR16 B	3.67	5.0	5.67	7.0	9.0	9.0	9.0	S
PR11 B	4.33	6.33	7.67	7.67	9.0	9.0	9.0	S
IR68886 B	4.33	6.33	7.0	7.67	8.33	9.0	9.0	S
PR4B	0.33	2.33	2.33	2.33	4.33	4.33	5.0	I
PR15 B	4.33	5.67	7.67	9.0	9.0	9.0	9.0	S
BoB	3.67	5.0	7.67	8.33	9.0	9.0	9.0	S
PJ3-5	3.67	4.33	7.0	7.67	8.33	9.0	9.0	S
IR70871 B	3.67	5.0	7.0	8.33	9.0	9.0	9.0	S
PR2624-69-10	4.33	5.67	8.33	9.0	9.0	9.0	9.0	S
PR3 B	4.33	5.67	6.33	7.67	8.33	9.0	9.0	S
IR68897 B	4.33	5.67	7.0	8.33	9.0	9.0	9.0	S
R2-6	0.0	0.0	0.33	0.33	1.0	1.67	1.67	R
IR16727-7B	4.33	5.67	7.67	8.33	9.0	9.0	9.0	S
IR72	2.37	4.33	4.33	6.33	7.67	9.0	9.0	S
MAROS	3.67	5.0	7.67	9.0	9.0	9.0	9.0	S
IR60819 R	0.0	0.0	0.33	1.0	1.67	2.33	2.33	R
PRAGATHI B	4.33	5.0	6.33	7.0	8.33	9.0	9.0	S
PSBRc 34	3.67	3.67	5.67	6.33	8.33	9.0	9.0	S
PR26016-B-B-B	3.67	4.33	6.33	7.0	9.0	9.0	9.0	S
IR59660610 B	3.67	4.33	4.33	7.0	7.67	9.0	9.0	S
BB-2	3.67	3.67	5.67	7.0	8.33	9.0	9.0	S
GUI 99	0.67	2.33	2.33	4.33	4.33	5.67	7.00	MS
IR69627 B	4.33	5.0	6.33	7.67	8.33	9.0	9.0	S
BG90-2	4.33	4.33	6.67	6.67	7.67	8.33	9.0	S
TN1 (susceptible check)	4.33	5.0	6.33	7.0	9.0	9.0	9.0	S
IR62 (resistant check)	3.67	5.0	7.0	7.67	9.0	9.0	9.0	S
LSD	0.470	0.339	0.376	0.320	0.391	0.274	0.297	
C.V. (%)	16.0	10.21	9.6	7.6	8.7	5.8	6.3	

[1] Cumulative average resistance and overall reactions based on 10 plants per entry with three replications

[2] Based on the rating index at 8 DAI.

environmental factors specifically temperature. The three stages of evaluation were conducted towards the drier months with the first evaluation (unreplicated) at an average temperature of 27.9°C and the final re-evaluation at an average temperature of 28.3°C. Such condition might have brought a warmer environement in the plastic cages used than in the earlier evaluations.

Table 3. Average rating indices and reactions of the selected promising rice entries to Rice Black Bug, *Scotinophara coarctata* (Fabr.) taken at 2 to 8 days after infestation. (Final Screening) [1]

ENTRIES	Days after Infestation (DAI)/Average Rating Index[2]							REACTION[2]
	2	3	4	5	6	7	8	
PR4 B	0.0	0.0	0.56	1.0	1.56	2.78	3.32	MR
R2-6	0.0	0.0	0.0	0.11	0.33	0.56	0.78	HR
IR60819 R	0.0	0.0	0.56	0.89	0.67	2.33	2.78	R
GUI 99	0.33	1.22	2.11	3.22	4.11	5.0	5.89	I
TN1(susceptible check)	1.11	1.89	2.78	3.89	4.78	5.0	7.22	MS
IR62 (resistant check)	0.44	1.44	2.78	3.44	5.0	5.11	6.68	I
LSD	0.172	0.285	0.348	0.370	0.274	0.268	0.454	
C.V. (%)	10.9	14.9	14.7	13.5	8.6	7.5	11.9	

[1] Cumulative average resistance ratings and final reactions based on 20 plants per entry with three replications, conducted in 3 trials.

[2] Based on the rating index at 8 DAI.

Consequently, the higher temperature might have adversely affected the RBB nymphs thus reducing their feeding activity.

Although modifying effects of temperature might have occurred, yet relative rankings of the four entries in comparison with the others were consistent in all evaluations. The same trend was observed from the first to the final screening wherein R2-6 and IR60819R were consistently better performers than the rest whcih were followed by PR4B and GUI99. Bernardo (1981) stated that resistance is often modified by variations in biotic and abiotic factors. However, as long as the relative ranking in comparison with the others stays more or less the same, than that is true reaction to the pest.

LITERATURE CITED

BERNARDO E.N. 1981. Plant resistance and insect pest control in the Philippines. *Phil. Entomol.* **4** (6):535-541.

DE LEON, J.C., REDONA, E.D. and GASPAR, M.G. 2003. The PhilRice Hybrid Rice R & D. Program. Pp. 22 In: *Hybrid Rice Seed Production Training Manual*. PhilRice Maligaya, Muñoz, Nueva Ecija. 174 pp.

HEINRICH, E.A., DOMINGO, I.T. and CASTILLO, E.H.. 1985. Levels of resistance and grain yield responses of rice cultivars when exposed to the black bugs (*Scotinophara coarctata* (F)] (Hemiptera: Pentatomidae). *J. Plant Tropics*, **4**:55-64.

HEINRICH, E.A., PATHAK, P.L. DYCK, V.Z., CHELLIAH, S., SAXENA, R.C. and LITSINGER, J. 1985. *Guide to the management of insect pest of lowland rice in tropical Asia*. IPC/SP/65.13 pp.

INGER. 1996. *International Network for Genetic Evaluation of Rice*. 4th ed. International Rice Research Institute. Los Banos, Laguna. 51 pp.

INTERNATIONAL RICE RESEARCH INSTITUTE (IRRI). 2001. *Rice IPM*. The University of Queensland. An Interactive Information and Identification system for IPM of Rice.

ITO, K.H. SUGIYAMA, H. SALLEH, N.M. and MIN, P. 2001. Effects of lunar phase on light trap catches of the Malayan black bug, *Scotinophara coarctata* (Heteroptera: Pentatomidae). *Bull. Entom. Res*. **83**:59-66.

NATIONAL CROP PROTECTION COUNCIL (NCPC) 2000. *Management of rice black bug*. NCPC, UPLB-CA. Philippines. 7 pp.

PANDA, N. and KHUSH, G.S. 1995. *Host Plant Resistance to Insects*. IRRI. CAB International, U.K. 431 PP.

PATHAK, M.D and KHAN, Z.R. 1994. *Insect pest of Rice*. IRRI. Los Baños, Philippines. 41 pp.

PEREZ, V. and B.M. SHEPARD. 1992. Mass production of Telenomus triptus (Nixon) an egg parasitoid of *Scotinophara coarctata* Fab. *Ann. Trop. Res*. **14**:42-47.

PEREZ, V., SHEPARD, B.M. and ARIDA, G.S. 1989. *Indegenous natural enemies of the Malayan Black Bug*. Rice tech. Bul.. Maligaya, Muñoz, Nueva Ecija. 12 pp.

PO, M.M. 2004. *Distribution, Spread and Biological Control of the Rice Black Bug Scotinophara coarctata (Fab) in Leyte*. M.S. Thesis. Leyte State University, Visca, Baybay, Leyte. 79 pp.

REDONA, E.D., MALABANAN, F.M., JAVIER, L.J., YABES, S.I., ORDONEZ, S.A., and OBEIN, S.R. 2001. Exploiting rice heterosis in the Philippines. Pp. 193-203 In: *Rice Research for Food Security and Poverty Alleviation*. EDS. PENG, S. and HARDY, B. Proceedings of the International Rice Research Conference, March 31-April 4, 2000, IRRI, Los Baños< Philippines. 692 p.

VIRMANI, S.S. 2001. Opportunities and challenges of developing and using hybrid rice technology in the tropics. pp. 151-166 In: *Rice Research for Food Security and Poverty Alleviation.* EDS. PENG, S. and HARDY, B. Proceedings of the International Rice Research Conference, March 31-April 4, 2000, IRRI, Los Baños< Philippines. 692 p.