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Relationship between Laboratory-Developed Biotypes of Green Leafhopper and Resistant Varieties of Rice in Malaysia

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Introduction

Green leafhopper (GLH: *Nephotettix virescens* Distant) is one of the most important pests of rice (*Oryza sativa* L.) since it transmits the tungro disease which is a serious virus disease in tropical area. Kobayashi et al. (1983)[5] reported that GLH resistant varieties can be tungro resistant varieties. The causes of virus resistance are primarily antibiosis and non-preference, and there is a close relationship between the vector resistance and the incidence of virus infection (Heinrichs and Rapusas 1983.[2] Therefore, the authors attempted to take up GLH resistance as one of the way in breeding for tungro resistance, and in fact, a GLH resistant cultivar IR 42 has been planted as a tungro resistant variety in Malaysia. However, there is a problem of outbreaks of resistance-breaking biotypes after releasing resistant cultivars (Kobayashi et al. 1983).[5] The problem is recognized but we do not have any certain breeding strategy to solve that problem so far in Malaysia.

In this paper, the relationship between biotypes of GLH and resistant varieties of rice in Malaysia will be analyzed and a breeding strategy for GLH resistance will be discussed.

Materials and methods

1) Establishment of resistance-breaking biotypes

Two highly resistant varieties, Pankhari 203 and IR 42, and one moderately resistant variety IR 28 were used to find the possibility of establishing biotypes which are able to develop and reproduce on resistant varieties. GLH were collected from the rice field of MARDI at Bumbong Lima in Malaysia and multiplied on a susceptible cultivar Kadaria in cages (31×25×28 cm). Second or third instar nymphs were used to infest seedlings inside the respective cages. A total of 2,000, 1,000, and 100 GLH nymphs were placed on the seedlings of Pankhari 203, IR 42, and IR 28, respectively. Number of newly developed adult GLH on the respective host variety was recorded in successive generations.

2) Relationship between 5 biotypes and 5 resistant varieties

Five resistance-breaking biotypes of GLH were selected by the way of raising them more than 5 generations on 5 resistant varieties, i.e. Pankhari 203, ASD 7, Ptb 8, TAPL 796, and IR 42, which seemed to have different GLH resistant gene each other and all of them were introduced from IRRI. The resistance-breaking biotype selected on Pankhari 203 was

named Pankhari 203 colony, for instance, according to the method by IRRI (1981).[3]

The resistance level of the varieties to each biotype was evaluated by the following antibiosis test. Seedlings of 19 days of age with 3.0–3.5 leaves including the first leaf without leaf blade were tested in 5 replications. In each replication, 1 seedling and 5 second or third instar nymphs were put in a test tube (18×1.8 cm), the top of which was covered by net, and the GLH mortality was recorded 4 days after infesting. The resistant levels were classified as susceptible (S: 0–30%), moderate (M: 31–70%) and resistant (R: 71–100%) according to the GLH mortality.

3) *Resistance to GLH in some rice varieties from Malaysia and IRRI*

A total of 26 Malaysian varieties or lines and of 25 IRRI lines were tested against non-selected GLH and a biotype IR 42 colony selected on IR 42 (Table 3). Seedlings of 15–25 days of age were used in 2 or 4 replications. The resistance level was evaluated by the antibiosis test described above.

Results

1) *Establishment of resistance-breaking biotypes*

In the first and second generation, the GLH populations on Pankhari 203 and IR 42 decreased rapidly but they increased after that (Table 1). In IR 28, a moderately resistant variety, GLH could increase after the second generation.

2) *Relationship between 5 biotypes and 5 resistant varieties*

Each of Pankhari 203, Ptb 8 and IR 42 was resistant to all colonies developed on other varieties, but not resistant to the colony developed on it (own colony). However ASD 7 was moderately resistant to IR 42 colony and resistant to other colonies except its own colony. The mortality of IR 42 colony on ASD 7 was 40%. TAPL 796 was susceptible to Pankhari 203 colony and its own colony but resistant to the other 3 colonies (Table 2).

Table 1. Change of GLH population on resistant varieties

Varieties	Initial GLH number (2nd or 3rd instar nymphs)	Adult GLH number			
		Generation			
		G_1	G_2	G_3	G_4
Pankhari 203	2000	64	24	>200	>1000
IR 42	1000	36	80	>500	—
IR 28	100	30	>200	—	—

G_1 is the first generation on resistant varieties.

Table 2. Relationship between resistant varieties and resistance-breaking biotypes

Varieties	GLH biotypes					
	Non-selected	Pankhari 203 colony	ASD 7 colony	Ptb 8 colony	TAPL 796 colony	IR 42 colony
Pankhari 203	R	S	R	R	R	R
ASD 7	R	R	S	R	R	M
Ptb 8	R	R	R	S	R	R
TAPL 796	R	S	R	R	S	R
IR 42	R	R	R	R	R	S

S=0–30%, M=31–70% and R=71–100% in GLH mortality.

Table 3. Resistance to mon-selected GLH and IR 42 colony of GLH in some varieties from Malaysia and IRRI

Varieties from Malaysia	Resistance (S–R)		Varieties from IRRI	Resistance (S–R)	
	Non-selected	IR 42 colony		Non-selected	IR 42 colony
1 Mahsuri	M	S	27 IR 5	S	
2 Mat Candu	M	M	28 IR 8	S	
3 Setanjung	S		29 IR 20	S	
4 Sekencang	S		30 IR 22	S	
5 Kadaria	S		31 IR 24	S	
6 MR 68	S		32 IR 26	S	
7 MR 69	M	S	33 IR 28	M	S
8 MR 70	M	S	34 IR 29	M	S
9 MR 71	S		35 IR 30	S	
10 MR 72	S		36 IR 32	R	S
11 MR 73	S		37 IR 34	M	S
12 MR 74	S		38 IR 36	R	S
13 MR 75	S		39 IR 38	S	
14 MR 76	S		40 IR 40	R	S
15 MR 77	M	S	41 IR 42	R	S
16 MR 78	S		42 IR 43	S	
17 MR 79	S		43 IR 44	R	S
18 MR 80	S		44 IR 45	S	
19 MR 81	R	S	45 IR 46	S	
20 MR 82	R	S	46 IR 48	R	S
21 MR 83	S		47 IR 50	M	S
22 MR 84	S		48 IR 52	R	S
23 MR 85	R	S	49 IR 54	R	S
24 MR 86	R	S	50 IR 56	R	S
25 MR 87	S		51 CR 94–13	R	S
26 MR 88	S				

S=0–30%, M=31–70% and R=71–100% in GLH mortality.

3) Resistance to GLH in some varieties from Malaysia and IRRI

Most of the Malaysian varieties and breeding lines were susceptible to non-selected GLH (Table 3). However, Mahsuri, Mat Candu, MR 69, MR 70 (Mahsuri/Pongsu Seribu), and MR 77 were moderately resistant. In addition, MR 81 (IR 24*2/IR 36), MR 82 (IR 42/Setanjung), MR 85 and MR 86 (IR 42*2/Mahsuri) were resistant to non-selected GLH but susceptible to IR 42 colony.

More than half of the IRRI lines were resistant or moderately resistant to non-selected GLH. However all of these lines were susceptible to IR 42 colony.

Discussion

1) Selection of new biotypes

IRRI (1982)[4] reported that it is possible to select the GLH biotypes which are able to develop and reproduce on resistant varieties by the same method as used in the present study. Kobayashi et al. (1983)[5] also reported that a GLH biotype which is able to reproduce on a resistant variety IR 42 was selected in Malaysia. It seems not peculiar that 5 resistance-breaking biotypes were selected and that the GLH collected in the field in Malaysia had wide genetic variability in resistance-breaking character.

2) Relationship between biotypes and resistant varieties

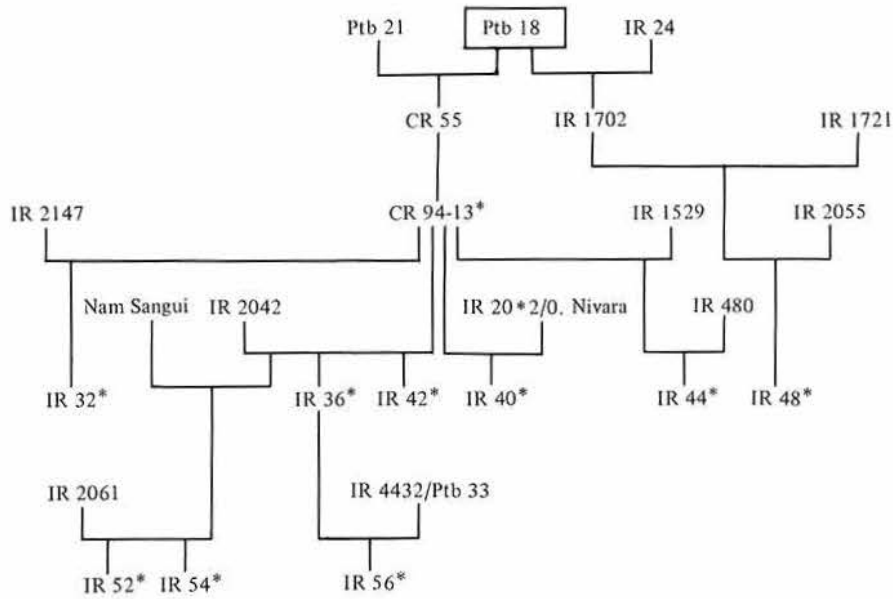

Fig. 1. Inheritance of GLH resistance gene of Ptb 18 in IRRI lines
* Resistant lines confirmed in this study.

Rezaul Karim and Pathak (1982)[6] reported that some resistant varieties showed different reaction to 2 GLH collected in Bangladesh and the Philippines. Sama (1984)[7] reported that there were 3 biotypes in South Sulawesi of Indonesia and each biotype could not attack the other 2 resistant groups of varieties. In addition, Habibuddin et al. (1985)[1] also revealed the relationship between Malaysian GLH and Philippine GLH showing that IR 42 was more resistant than IR 28 to Malaysian GLH and the reverse was true to Philippine GLH. These reports seem to suggest that the varietal resistance of rice to GLH is specific or vertical and there is a gene-for-gene relationship between rice varieties and GLH biotypes. The results obtained in the present study by using 5 biotypes and 5 resistant varieties represent a further demonstration of the gene-for-gene relationship.

3) *Identification of resistant genes by using biotypes*

All of the GLH resistant lines including CR 94–13 and Malaysian breeding lines were susceptible to the biotype IR 42 colony. This means that they may have the same resistant gene as IR 42. According to Rezaul Karim and Pathak (1982),[6] it seems that the resistant gene of IR 42 is derived from Ptb 18 because IR 36 which is the sister line of IR 42 has the same resistant gene as Ptb 18 has. Since all of the resistant lines have the same ancester Ptb 18, we can consider the resistant gene is derived from Ptb 18 (Fig. 1).

Rezaul Karim and Pathak (1982)[6] also reported that the resistant genes of Pankhari 203, ASD 7, Ptb 8 and TAPL 796 are G1h1, G1h2, G1h4 and G1h6 respectively and the resistant gene of IR 36 which is considered to have the same gene as IR 42 used here is G1h6 same as TAPL 796. However, in our present study, it was found that IR 42 and TAPL 796 differed in their reaction to the biotypes i.e. IR 42 colony and TAPL 796 colony. In addition, Kobayashi et al. (1983)[5] reported that IR 42 has two resistant genes. The present authors are going to take up a further analysis on this problem in the next study.

4) *Breeding strategy to overcome outbreaks of new GLH biotypes*

In Malaysia it is not difficult to predict the outbreak of new GLH biotype capable of

reproducing on a resistant variety IR 42 because IR 42 has been planted for more than 2 years, covering about 40% of the rice-planted area in Muda region, the largest rice farming region in Malaysia. However, in the case of Malaysia where the RTV disease does not occur every year but only once or twice in 10 years, it is possible to consider that we can overcome the disease if we can prepare a variety which is resistant to new GLH biotype and can sustain the resistance for more than 2 years. We found that Pankhari 203, Ptb 8 and TAPL 796 are resistant to IR 42 colony. In addition, we can consider that these varieties can sustain their resistance for more than 2 years, because breaking down of insect resistance of varieties usually occurs more than 2 years later. Therefore, we can conclude that it is possible practically to use their resistant genes after the breaking down of IR 42 even though the problem of outbreaks of new biotypes will continue for long in the future.

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Summary

When green leafhopper (GLH: *N. virescens* Distant) was fed on resistant varieties of rice (*O. sativa* L.), its population decreased remarkably in the first 2 generations, but after that it increased steadily. Namely, GLH biotypes which are able to develop and reproduce on each resistant variety were established. Thus, 5 GLH biotypes were selected on 5 resistant varieties, Pankhari 203, ASD 7, Ptb 8, TAPL 796 and IR 42 respectively, and the relationship between GLH biotypes and rice varieties was analyzed. There was specific or vertical resistance of rice varieties to GLH biotypes: Each of Pankhari 203, Ptb 8 and IR 42 was resistant to all biotypes developed on other varieties but susceptible to the biotype developed on it. Most of resistant cultivars or lines from West Malaysia and IRRI were considered to have a same resistant gene as that of IR 42 derived from Ptb 18, because they were all susceptible to the GLH biotype developed on IR 42. On the basis of the results of this study, the authors recommend that Pankhari 203, Ptb 8 and TAPL 796 are the genetic source of GLH resistance to be used after the breakdown of IR 42 which has already been planted for several years in Malaysia.

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