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THE RESISTANCE OF SOME RICE VARIETIES TO GREEN LEAFHOPPER AND PENYAKIT MERAH VIRUS

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Keywords: Nephotettix spp., Penyakit Merah Virus, Rice varieties, Resistance.

RINGKASAN

Ketahanan varieti-varieti padi IR dan MR yang berpotensi telah diuji terhadap kultur lelompat hijau, *Nephotettix virescens* dan PMV dari Bumbong Lima, Seberang Perai. Wujud korelasi yang erat (r = −0.7629**) di antara ketahanan terhadap pembawa dengan kerentanan terhadap jangkitan PMV di makmal. Darjah kevariabilan di antara varieti yang diuji adalah lebih ketara di antara varieti-varieti IR berbanding dengan MR. Walaupun perbezaan ketahanan tidak begitu ketara bagi varieti-varieti MR di dalam ujian makmal, perbezaan kerentanan terhadap PMV telah wujud di sawah dengan MR 77 dan MR 78 paling kurang dijangkiti. Terdapat perbezaan biotip di antara kultur *N. virescens* Bumbong Lima, Seberang Perai dengan kultur IRRI. Varieti padi IR42 lebih tahan kepada lelompat hijau dibandingkan dengan IR28 di Malaysia, tetapi sebaliknya berlaku di IRRI, Filipina.

INTRODUCTION

Penyakit Merah Virus (PMV), transmitted predominantly by the green leafhopper (GLH), *Nephotettix virescens* Dist. (Homoptera: Cicadellidae) is a serious threat to rice production in Peninsular Malaysia. Its presence is not new though in the past confined predominantly to Krian area in Perak (LIM, 1969). Since the late seventies it has spread to the major rice producing areas in Pulau Pinang, Kedah and Perlis (SUPAAD, OTHMAN and CHANG, 1982). It has been estimated that in Muda area alone it infected 5 884 hectares and 5 839 hectares in 1981 and 1982 respectively (CAWANGAN PEMELIHARAAN TANAMAN, 1983).

Various methods of controlling the disease in Malaysia including the use of resistant varieties were formulated (SUPAAD *et al.*, 1982). Resistant varieties are widely used to control PMV or tungro in Indonesia, Vietnam and Philippines (HEINRICHS, SAXENA and CHELLIAH, 1979), but the use of PMV resistant varieties in Peninsular Malaysia is relatively new. Preliminary results have shown that there are varieties in Malaysia which are less preferred by GLH and less susceptible to PMV infection (HEONG, 1977; KOBAYASHI, 1982; VAN VREDEN, MOHAMAD and AHMAD, 1982).

An attempt was made to evaluate the reaction of advanced International Rice Research Institute (IRRI) varieties to PMV and GLH in this country in comparison to advanced MARDI Rice (MR) varieties developed by the Rice Division of MARDI. Some of these varieties may be used as sources of resistance in the local breeding programme.

MATERIAL AND METHOD

Green Leafhopper and Viruliferous GLH

Green leafhopper, *Nephotettix virescens*, used in the experiments was laboratory-bred on rice variety Taichung Native One (TN1) for several years. For each experiment, adult females were caged on healthy TN1 plants for a 24-hour oviposition access period, before removal. The host plants with oviposited eggs were kept insect-free,until the nymphs emerged. The plants were watered and replaced when necessary until the emerging nymphs were ready to be used for survival tests at the 2nd–3rd instar stages, or developed into adults to be used for susceptibility to PMV

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infection tests as required. Viruliferous GLH was prepared by introducing 3-day-old adult GLH onto the virus source plants for two days of acquisition feeding access period.

PMV Source Plants and Rice Varieties

Rice variety TN1 was used as PMV source plants. Thirty-day-old TN1 plants in a medium size pot of 20 cm in diameter were inoculated with PMV at the rate of ten viruliferous GLH per hill. The inoculated plants were kept for symptoms development and used as the virus source plants one month after inoculation.

All IR varieties used in these experiments originated from IRRI, Los Banos, Philippines. On the other hand, advance MR varieties were from the Rice Research Centre of MARDI at Bumbong Lima, Seberang Perai.

Survival Test

Pregerminated seeds of each test variety were sown in a medium size pot of 20.0 cm in diameter with homogenous but fertilizer-free soil and watered when necessary. Test plants were kept insect- and disease-free in the greenhouse until they were suitable for the test at 30 ± 5 days after sowing (DAS). Three seedlings of each variety were uprooted, washed with water and inserted into a test tube of 2.3 cm x 20.0 cm containing ± 4 cm of water. The test was carried out in three replicates and the test tubes were arranged in Completely Randomized Design (CRD). Twenty-five 2nd–3rd instar nymphs of GLH as prepared were introduced into each test tube whose mouth was covered with a piece of cloth. The nymphs were allowed to feed on the seedlings for three days. Mortality of the nymphs in each tube was recorded on the third day after introduction (DAI) or when all the nymphs on the check variety IR42 died, whichever came first.

Susceptibility to PMV Infection

Rubber cups of 12.5 cm in diameter were sown with 25 pregerminated seeds each. The cups were arranged in CRD with three replications. Rice varieties TN1 and IR42 were used as the susceptible and resistant checks respectively. Inoculation for one-day access period was done on the ten-day-old seedlings at the rate of one viruliferous GLH per seedling. A mylar cage of 10.0 cm diameter x 25.0 cm high was used to contain the insect on each cup. After the one-day access period, all the GLH were killed with *Bassa 50EC* (0.1% *a.i.*). The seedlings were kept insect-free for 14 days when the number of infected seedlings was recorded based on the symptoms of stunting, incomplete emergence of younger leaves and discolouration as described by CHIN, SUPAAD, KOBAYASHI and SHAMSUDDIN (1983).

Field Evaluation of Advance MR Varieties to Natural PMV Infection

The experiment was conducted in Randomized Complete Block Design (RCBD) with three blocks of 15 test varieties. Each plot size was 5 x 5 square metres. Single 30-day-old seedling was transplanted per point at 25.0 cm spacing between seedlings. Symptoms of natural infestation of PMV such as stunting and discolouration of the leaves were noted at the maximum tillering stage. An assessment on the number of infected hills was done based on the iodine test (LING, 1972) by using the second and third top leaf tips.

Method of Classification and Analysis

Analysis on the transformed Arc-Sine values of the original percentages was done and tabulated using Duncan Multiple Range Test (DMRT). A further classification into groups of resistant (R), susceptible (S) and moderate (M) was done based on method developed by KOBAYASHI (1982), *i.e.* by the

formulae of:

R = Score of resistant check + ¼ (score of susceptible − score of resistant checks).

S = Score of susceptible check − ¼ (score of susceptible − score of resistant checks).

M = Score in between R and S.

RESULTS

Survival Test

Result on IR varieties is presented in *Table 1* in the form of mortality value. Rice variety with highest mortality value is the most resistant and *vice versa*. Rice varieties IR8, IR20, IR22, IR24, IR45, IR46 and the susceptible check variety, TN1, were found to be susceptible by KOBAYASHI's (1982) classification, while Mat Candu, Seribu Gantang, IR26, IR28, IR34, IR36 and IR50 were moderate. The resistant group included IR38, IR44, IR52, IR54 and IR42, the resistant check.

None of the tested MR varieties are resistant *(Table 2)*. Most of them are susceptible except Seribu Gantang, MR 74 and MR 69 which are moderate.

Susceptibility to PMV Infection

Rice variety with highest PMV infection is the most susceptible and *vice versa*. Under forced inoculation tests, almost all of MR varieties were found susceptible, comparable to TN1, except MR 77 which was moderate *(Table 2)*. Greater variability existed amongst IR varieties *(Table 1)*. IR36, IR38, IR42 and IR44 are resistant, while IR8, IR20, IR24, IR28, IR50, IR52 and IR54 are moderate. Rice varieties Seribu Gantang, IR22, IR26, IR34, IR45, IR46 and TN1 are susceptible.

Field Evaluation of Advance MR Varieties to Natural PMV Infection

Natural infestation of PMV on selected advanced MR varieties was recorded and tabulated in *Table 2*. Based on KOBAYASHI's (1982) classification, IR42, MR 78 and MR 77 are resistant followed by moderate group in the following order MR 67 > MR 70 > MR 74 > MR 75 > MR 69 > MR 73 > MR 68 > MR 71; while Setanjung, MR 72, Kadaria and MR 76 are in susceptible group.

Table 1. Reaction of IR varieties to GLH, *Nephotettix virescens* and PMV infection

Variety	GLH mortality	PMV infection
Seribu Gantang	43.0(M) cde	75.5(S) ijk
Mat Candu	44.6(M) cd	67.8(M) hij
TN1	17.5(S) fg	85.8(S) k
IR 8	6.8(S) g	65.8(M) ghij
20	16.1(S) fg	61.9(M) fghi
22	16.1(S) fg	73.5(S) ijk
24	24.0(S) efg	66.5(M) ghij
26	35.2(M) def	77.6(S) ijk
28	53.2(M) bcd	44.6(M) bcde
34	52.1(M) bcd	80.5(S) jk
36	47.4(M) cd	36.3(R) abcd
38	79.2(R) a	28.1(R) ab
42	84.1(R) a	24.1(R) a
44	89.4(R) a	33.2(R) abc
45	14.1(S) fg	74.4(S) ijk
46	15.3(S) fg	73.9(S) ijk
50	57.6(M) bc	50.9(M) defg
52	79.0(R) a	45.4(M) cdef
54	70.5(R) ab	56.3(M) efgh

Analysis was done on the Arc-Sine transformed values of the original percentage. All means within a column followed by similar letter are not significantly different at $P<0.05$ by DMRT. The M, R and S represent moderate, resistant and susceptible respectively based on method of classification developed by KOBAYASHI (1982).

DISCUSSION

The four factors contributing to an epidemic of PMV were established (LIM, TING and HEONG, 1974). They are the availability of susceptible varieties or susceptible stage of the crop to the virus; the abundance of the vector population, their transmissive ability and vector composition;

Table 2. Reaction of MR varieties to GLH, *Nephotettix virescens* and PMV infection

Variety	GLH mortality	PMV infection	Natural PMV infection in field
IR42	74.5 (R) a	28.3 (R) a	6.2 (R) a
TN1	0.0 (S) e	64.3 (S) d	–
MR 64	9.3 (S) cd	64.3 (S) d	–
65	9.3 (S) cd	63.1 (S) d	–
66	15.6 (S) cd	62.4 (S) d	–
67	10.6 (S) cd	72.5 (S) d	24.6 (M) abc
68	6.8 (S) d	67.0 (S) d	40.2 (M) bcde
69	30.2 (M) bc	64.1 (S) d	36.2 (M) bcde
70	17.0 (S) cd	69.2 (S) d	25.0 (M) abc
71	13.5 (S) cd	68.3 (S) d	44.3 (M) bcde
72	9.8 (S) cd	64.7 (S) d	54.8 (S) de
73	8.9 (S) cd	60.9 (S) d	39.3 (M) bcde
74	22.9 (M) cd	62.8 (S) d	29.6 (M) abcd
75	0.0 (S) e	62.4 (S) d	33.5 (M) abcd
76	10.6 (S) cd	69.4 (S) d	62.8 (S) e
77	13.5 (S) cd	48.1 (M) bc	19.0 (R) ab
78	10.9 (S) cd	59.4 (S) cd	6.6 (R) a
Seribu Gantang	49.4 (M) b		–
Setanjung	–		49.3 (S) cde
Kadaria	–		57.9 (S) de

Analysis was done on the Arc-Sine transformed value of the original percentage. All means within a column followed by similar letter are not significantly different at $P<0.05$ by DMRT. The M, R and S represent moderate, resistant and susceptible respectively based on method of classification developed by KOBAYASHI (1982).

the availability of virus source and the varietal susceptibility to the vector. The resistance of a plant to PMV infection could be divided into four categories (LING, 1972), *i.e.* (a) resistance to the vector only, (b) resistance to the virus only, (c) resistance to both and (d) susceptible to both the vector and the virus.

Most of the recent IR varieties carry gene or genes resistant to GLH (KHUSH, 1977). Presently seven genes resistant to GLH have been identified (REZAUL KARIM and PATHAK, 1982). From the tests for survival and susceptibility to PMV amongst the IR varieties *(Table 1)*, a wide variation in the degree of resistance was observed and there was a very close correlation ($r = -0.7629^{**}$) between the mortality of GLH nymphs and the susceptibility to PMV infection under forced inoculation test *(Figure 1)*.

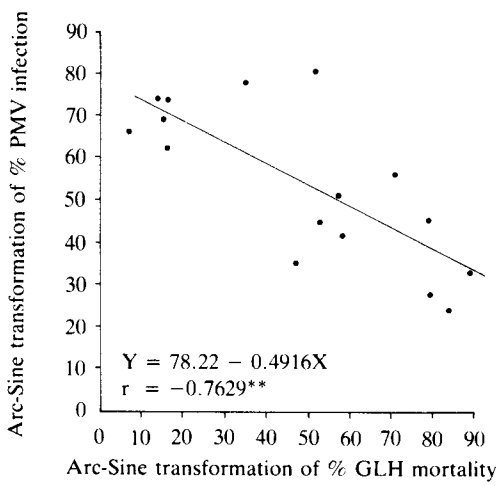

Figure 1. Relationship between mortality of GLH and incidence of PMV infection under forced inoculation test amongst IR varieties.

Amongst the IR varieties tested by both methods, IR42 (with Ptb 18 as source of resistance) was significantly more resistant than IR28 (with Gam Pai as source of resistance). Rice variety IR8 is as susceptible to Malaysian GLH culture as TN1, and the resistance to PMV infection is just slightly higher than that of TN1, and distinctly different from that of IR42 and IR28. On the other hand at IRRI, Philippines, IR28 is significantly more resistant than IR42. Variety IR8 is in the same resistance class as IR42 but different from IR28 (RAPUSAS and HEINRICHS, 1981; HEINRICHS, MEDRANO, SUNIO, RAPUSAS, ROMENA, VEGA, VIAJANTE, CENTINA and DOMINGO, 1982). The results suggested a difference in the GLH biotypes between the two countries. In fact, the phenomenon is not new since differences in biotype between IRRI's and India (CHELLIAH, HANIFFA, HEINRICHS and KHUSH, 1981) or Bangladesh (REZAUL KARIM and PATHAK, 1982) have been shown earlier. The Malaysian biotype could either be naturally different from that of Philippines or new biotype had developed from the wild biotype that can attack IR8 gene (Glh 3). Although IR8 is no longer grown in Malaysia, most of the varieties grown originate from crosses involving IR8 (OTHMAN, ALIAS and HADZHIM, 1983).

Variety IR42, which is highly resistant to Malaysian GLH and PMV, is also a high yielder (BAHAGIAN PENYELIDIKAN PADI, 1982; 1983). The only drawback of this variety is its high susceptibility to stem rot disease caused by *Sclerotium oryzae* (CHIN, *pers comm.*, 1983) and its low percentage of head rice recovery and relatively inferior eating quality (BAHAGIAN PENYELIDIKAN PADI, 1982). However, the good characters of this variety are being incorporated into other local potential varieties.

The variability of MR varieties to both the vector or PMV is not as wide as in the case of IR varieties. A significant correlation could not be established between the mortality of GLH nymphs or the susceptibility to PMV infection under forced inoculation test to the infection of PMV under natural infestation. This could be attributed to the lack of active breeding programme for PMV or GLH resistance in Malaysia for the past years (ANON., 1979). However, when the MR varieties were tested under natural infestation of PMV in the farmers' fields, varietal differences were observed. Varieties MR 77 and MR 78 are highly resistant and most of the advanced MR lines are moderately resistant except MR 76, MR 72 and Kadaria which are susceptible to the natural infestation. However, the degree of field resistance will vary according to the intensity of potential inoculum in the area.

In the case of Seribu Gantang, it is moderately resistant to GLH under survival tests (*Tables 1* and *2*), but susceptible to PMV infestation. This clearly showed that resistance of a variety to the vector is not always related to the virus resistance. The vector resistance alone may be of great value by maintaining the vector population at low level (PATHAK, 1970) or reducing PMV infection (RAPUSAS and HEINRICHS, 1981). However, continuous planting of these types of varieties under bigger acreage may result in the development of new biotypes. With the development of new biotype, vector population will be increased. Under dense population plus the availability of the virus source, PMV resistance will be unstable and decreased (TIONGCO, CABUNAGAN and HIBINO, 1983). Thus, this type of resistance also has a disadvantage (HEINRICHS, 1979) and of course the ideal mean of PMV control will be the use of varieties which have both the vector and virus resistance.

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ABSTRACT

The resistance of some IRRI (IR) and advance Malaysian Rice (MR) varieties against *Nephotettix virescens* and PMV was investigated using GLH culture from Bumbong Lima, Seberang Perai. There is a strong correlation ($r = -0.7629^{**}$) between vector resistance and susceptibility to PMV infection under forced inoculation tests. The degree of variability is more pronounced in IR compared with MR varieties tested. Even though the differences in resistance were not noticed amongst MR varieties under laboratory tests, variation could be detected under natural field infestation where MR 77 and MR 78 were found to be less infected. There was a difference in biotype between IRRI and Malaysian cultures of GLH. Rice variety IR42 was more resistant to Malaysian GLH compared with IR28, the reverse was true against the IRRI culture.

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