Efficient Screening of Rice Varieties for Resistance to Rice Green Leafhopper by Estimating the Insect Population with Sticky Boards

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Introduction

The rice green leafhopper (GLH), *Nephotettix cincticeps* Uhler is one of the most important insect pests of rice because of its ability of transmitting some viruses, i.e., rice dwarf virus and rice waika virus in the warm region of Japan. Breeding programs of rice for GLH resistance are in progress and many fundamental studies have been done in Japan. Some screening methods for resistance, estimating antibiosis or nonpreference, were studied and developed by Kishino & Ando (1978),[8] Sekizawa & Ogawa (1980),[13] Ōya & Sato (1980)[11] and Ando & Kishino (1981).[1] IRRI (1970)[4] developed a bulk seedling test for resistance to GLH, *Nephotettix virescens* Distant. These testing methods are useful for the study and screening of resistance, but they need to keep stock cultures of insects. It is not easy for rice breeders to keep stock cultures of insects, and therefore a new screening method without the use of artificially cultured insects has been looked for.

Nagata & Masuda (1978)[10] developed a simple sampling method using the sticky boards for field evaluation of effectiveness of insecticides to the brown planthopper. The present author studied the applicability of that method for the screening of rice varieties for GLH resistance.

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Materials and methods

1) Sampling of GLH using the sticky board method

Rectangular boards (18×25 cm) made of plastic plate were prepared. One side of the board was coated lightly and uniformly with adhesive, Supertangle 4 (Fuji Yakuhin Co. Ltd., Japan).

A sticky board thus produced was placed horizontally at about 5 cm height from the surface of water adjacent to a pair of rice hills in a paddy field, and then the 2 rice hills were beaten 2 times by hand (Fig. 1) to drop down GLH adults and nymphs onto the sticky board from the rice hills. This operation was repeated 10 times with other pairs of rice hills to collect the insect from 20 hills in each varietal plot. The number of the insects collected was counted in a

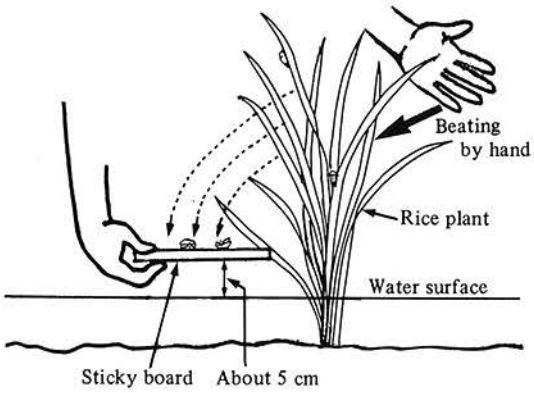

Fig. 1. Collecting GLH on the sticky board from rice plants growing in paddy field

laboratory. The adhesive and the insects caught on the boards were removed after the insect number counting, and the adhesive was applied again for the next use. Field trials of GLH counting were carried out 7 times from June 26 to August 27 in 1980, and 5 times from July 28 to August 25 in 1981. In 1980, 12 plots of the border variety, susceptible Reiho, used for GLH multiplication were also tested to check the change and uniformity of GLH population density in the field.

2) Varieties and cultivation in the field

Field experiments were carried out under the natural condition of paddy field at Kyushu Nat. Agr. Exp. Sta., Chikugo, Fukuoka, in 1980 and 1981.

In 1980, 16 varieties consiting of 8 indica varieties that were the gene sources of GLH resistance, 6 resistant breeding lines, and 2 susceptible japonica varieties as checks were planted in the experimental paddy field by the randomized block design in 3 replications. Each varietal plot contained 50 plants, and the susceptible variety Reiho was planted as the border plots according to the layout shown in Fig. 2.

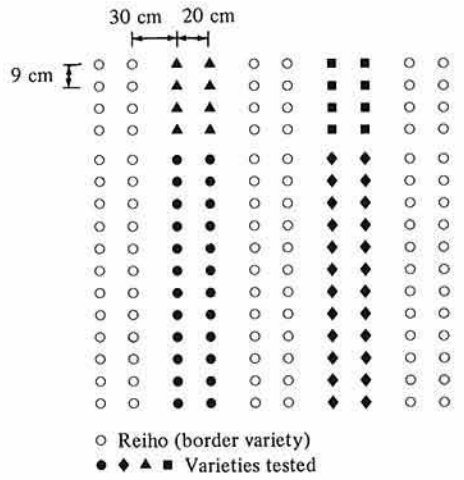

Fig. 2. Field layout of test plots

Seedlings of 29 days of age grown in a greenhouse were transplanted on June 4, about 3 weeks earlier than the usual cultivation. No insecticide was applied. The level of fertilizer application was low, because the test materials included some tall varieties. The planting density was 2 times higher than that of the usual cultivation.

In 1981, 11 varieties composed of 8 varieties commonly used in 2 years and 3 varieties newly added were tested in the field experiment. Mature seedlings grown in a nursery bed were transplanted on July 2, about 1 week later than the usual cultivation and 4 weeks later than the trial in 1980. Other cultivation practices were the same as in 1980.

Results

Changes in the number of GLH adults and nymphs collected in the border plots of susceptible Reiho (means of 12 plots) in 1980 are shown in Fig. 3.

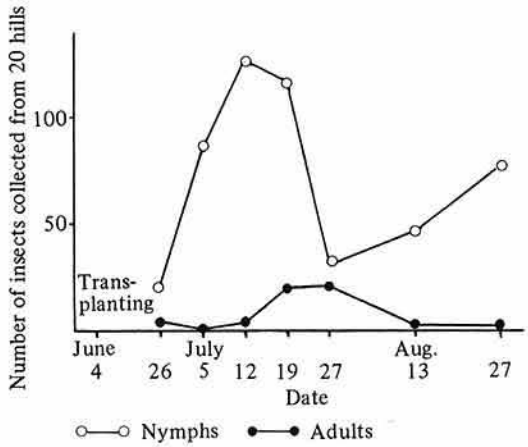

Fig. 3. Seasonal change in the number of GLH nymphs and adults collected from Reiho (means of 12 plots)

The first trespassing adults belonged to the first generation of GLH. Then the first nymphal peak was observed in the middle of July, and the next peak was presumed to appear in the middle of August though data are lacking. The adult peak was observed in late July, but the number of adults at the peak was much smaller than that of nymphs at the nymphal peak. The coefficients of variation of the number of nymphs and adults among 12 plots were lowest at each peak, and hence the distribution of GLH seemed to be most uniform at the peaks.

There were remarkable differences in the nymphal number on the sticky board among the varieties (Fig. 4). Large numbers of GLH were counted on Reiho and Nipponbare, both susceptible varieties. On the other hand, small numbers were found on

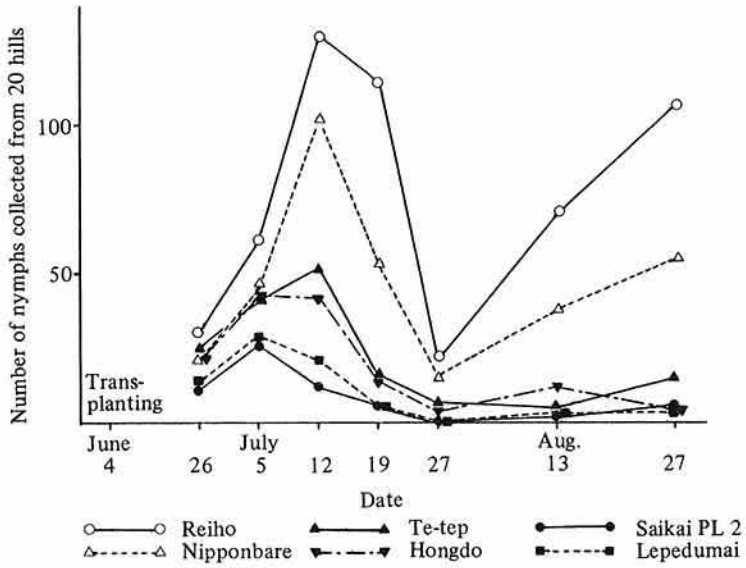

Fig. 4. Seasonal change in the number of GLH nymphs collected from some varieties (means of 3 plots)

Lepedumai and Saikai PL 2 (now the lines were registered as Rice Norin-PL 5) both of which were highly resistant in another test on antibiosis to GLH (Iwasaki & Imbe, not published). Moderate numbers were counted on Te-tep and Hongdo, both moderately resistant in that antibiosis test. This tendency

Table 1. The number of GLH nymphs collected on the sticky board from rice varieties at the time of nymphal peaks (means of 3 plots) and rating of varietal resistance based on the nymphal number

Variety	1980		1981	Resistance to GLH**
	July 12	August 27*	August 11	
Lepedumai	22	4	—	R
Saikai PL2	12	6	11	R
Rantaj emas 2	20	9	—	R
Pe-bi-hun	20	8	—	R
C203-1	16	3	—	R
Aichi 42	20	24	53	R-M
Te-tep	52	15	—	M
Hongdo	42	5	—	M
Tadukan	40	16	—	M
IR 24	52	10	37	M
Kanto PL 6	28	22	80	M
Saikai 164	55	36	109	M
Kyukei 750204	51	23	—	M
Kanto PL 3	86	32	77	M-S
Milyang 23	—	—	31	M
Suweon 258	—	—	56	M
Nipponbare	102	55	230	S
Asominori	—	—	215	S
Reiho	130	107	247	S

* About 10 days later than the time of second peak of nymphs.
** R: Resistant, M: Moderately resistant, S: Susceptible.

of nymphal number was also recognized with adult number, but the difference among the varieties was not so clear as that in the nymphal number because the adult number was small. Therefore the following analysis of the varietal difference was carried out with the nymphal number.

There was no statistically significant difference among the varieties on June 26. But on July 5 the number of nymphs caught from Lepedumai and Saikai PL 2 was significantly smaller than that caught from Reiho. Then on July 12 all 4 resistant varieties mentioned above were significantly different from Reiho. In addition, significant difference was also observed among the 4 varieties, that is, the number from Lepedumai and Saikai PL 2 was smaller than that from Te-tep and Hongdo. On July 19 the same result as on July 5 was obtained. In August, the same tendency as observed in July was also recognized, but it was far less clear.

Concerning other varieties, Aichi 42, Rantaj-emas 2, Pe-bi-hun, and C203-1 that is the gene source of GLH resistance of Saikai PL 2 showed the same result as Lepedumai or Saikai PL 2 (Table 1). On the other hand, Tadukan, IR 24, Kanto PL 6 and 2 breeding lines, Saikai 164 and Kyukei 750204 developed from the cross using C203-1, showed the same result as Te-tep or Hongdo (Table 1). Saikai 164 and Kyukei 750204 were presumed to possess a part of resistance genes of C203-1. The difference between Kanto PL 3 and Nipponbare was not significant on July 12.

In 1981, the same result was obtained except for Kanto PL 3 and Aichi 42 (Table 1). These 2 varieties were classified as moderately resistant in the test of 1981. Two additional varieties, Milyang 23 and Suweon 258, both developed in Korea, were classified as moderately resistant.

Discussion

Inoue (1966)[3] reported firstly that there were varietal differences in population density of GLH in field experiment. Ishii et al. (1969)[5] also reported that the small number of GLH was found on varieties resistant to rice dwarf virus disease. In the present study, too, remarkable differences in the number of GLH were found among varieties. Kawabe (1979,[6] 1985[7]) showed that the resistance to GLH was attributable to the factor inhibiting the GLH's ingestion of phloem sap, and that the factor was responsible for three phases of the resistance, i.e., "antibiosis", "nonpreference" and "tolerance" classified by Painter (1941).[12] Therefore, the decrease in GLH number on resistant varieties in the field would be explained by the factor shown by Kawabe.

Since an objective of insect resistance is to suppress population density of insect, it is more important to estimate the relative density on resistant varieties in the field. Nagata & Masuda (1978)[10] found out that the sticky board method was reliable in estimating relative population density. They pointed out that the method requires much less labor than the conventional technique, and, in addition, the sticky boards are inexpensive, easy to prepare and handle, and insect specimens remain in good condition for at least a week.

The result of the present study clearly indicates that the number of GLH on resistant varieties was significantly lower than that on susceptible varieties. It is concluded that the population estimation by means of the sticky boards can be used as a simple and easy screening method to evaluate GLH resistance of rice varieties.

There are some technical problems to be considered in the use of this method. One is fluctuations of resistance occurring in relation to the growing stage of rice plants, and another is different efficiency of catching insects among varieties varying widely in plant height. Kishino & Ando (1979)[9] reported that intensity of antibiosis fluctuated with the growing stage of the rice plants in the period from seedling to maturity. In the present study, some difference in the nymphal number was recognized between the result obtained in July and that obtained in August, or between the result in 1980 and that in 1981. Since some varieties came to the heading stage in August, their resistance might have fluctuated somewhat. When the plant height of varieties differs widely each other, the efficiency of collecting GLH may be different between tall varieties and short ones.

It is desirable, therefore, to conduct the screening for the resistance in an early half of the vegetative growth stage of rice plants, because varietal differences in the growth stage and plant height are still small.

The sticky board method can be employed suffi-

ciently in line selection fields. When the intensity of resistance of gene sources are as high as that of Saikai PL 2, replication in field trials is not needed. In case we want to know only whether each variety is resistant or susceptible, i.e. whether it has a resistance gene (or genes) or not, a smooth black board without using the adhesive can better be used instead of the sticky board, because the number of GLH collected from highly resistant varieties or lines is distinctly smaller than that from the susceptible check.

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