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Biotypical Property in the Populations of the Brown Planthopper, *Nilaparvata lugens* Stål (Homoptera: Delphacidae), Collected in China and Japan[1]

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The brown planthopper (abbr. BPH) *Nilaparvata lugens* Stål is one of the major insect pests of rice in southern part of Asia. A large number of BPH-resistant rice varieties have been bred and planted to control this pest in Southeast Asia. However, virulent BPH biotypes capable of defeating the resistant varieties of rice appeared within a few years after the distribution (Khush, 1979). It is, therefore, important to determine what kind of biotypes occur in the area before new rice varieties are introduced or what kind of biotypes are likely to develop after the introduction of the resistant varieties. Moreover, it would be useful to know the biotypical properties of the BPH populations for estimating the source areas of BPH migrants (Sogawa, 1993).

In this report, we aim to identify the biotypical properties of several BPH populations collected in China and Japan under the collaborative research program, "Studies on migration mechanism of insect pests of rice in monsoonal East Asia," conducted between 1990 and 1994 by TARC, Japan and CNRRI, China.

MATERIALS AND METHODS

Four BPH populations collected from rice fields in China and one Japanese population collected in Kyushu, in 1993, were used for the test (Table 1). After the collection each population was kept in a rearing cage with seedlings or young plants of a susceptible rice variety ("Kinuhikari" or "TN1"). Female macropterous adults from the offspring generation, as shown in Table 1, were tested.

We determined the biotypical property of BPH populations by comparing the amount of honeydew excreted by adult females on five standard differential varieties; "Mudgo" (harboring the resistance gene *Bph 1*), "ASD7" (*bph 2*), "Rathu Heenati" (*Bph 3*), "Babawee" (*bph 4*) and "TN1" (lacking resistance genes).

Potted rice plants, 40 to 50 days after sowing, were used for the experiments. We adopted the parafilm sachet method (Sogawa, 1992) to measure the amount of honeydew excreted by an insect. Four sachets were attached to the basal part of the stem of each plant. A gravid female, about one week old, was confined in a sachet on a rice plant and was allowed to feed on the plant for two days under fluorescent lamps (500 lx) at 25°C. Twenty-three to 48 females were tested for each variety. Then, the weight of the dew collected in the sachet was measured by a balance immediately after the feeding period. After weighing, the sample of the dew was tested with a bromocresol green (BCG)-treated filter paper. Since BCG filter paper is a pH indicator, true honeydew turns the filter paper dark blue. There were a few cases in which the "dew" may have been plant sap from the leaf sheath rather than honeydew. Such occurrences were not included in the analysis.

RESULTS AND DISCUSSION

Since no difference was found in the amount of honeydew among the four sachet positions for a given variety, data were analyzed without considering the position.

The amount of honeydew excreted varied among the populations even on the susceptible variety "TN1." Therefore, we compared the honeydew

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Table 1. BPH populations used for the biotype experiment

Population	Collection site	Collection date	Tested generation (collected gen. =0)
HAINAN	Hainan Is., Hainan, China (19.5° N, 110.5° E)	March 1993	4
NANNING	Nanning, Guangxi, China (22.8° N, 108.1° E)	April 1993	3
FUYANG 1	Fuyang, Zhejiang, China (30.0° N, 120.0° E)	7 July 1993	2
FUYANG 2	Fuyang, Zhejiang, China (30.0° N, 120.0° E)	16 July 1993	1
KUMAMOTO	Nishigoshi, Kumamoto, Japan (32.9° N, 130.7° E)	7 July 1993	2

Table 2. Number of BPH macropterous females which excreted 10 mg or more of honeydew for 2 days[a]

Population	Differential rice variety <resistance gene>				
	Mudgo <*Bph 1*>	ASD7 <*bph 2*>	Rathu Heenati <*Bph 3*>	Babawee <*bph 4*>	TN1 <none>
HAINAN	5/24(20.8)	1/24(4.2)	0/24(0)	0/24(0)	17/24(70.8)
NANNING	4/28(16.7)	0/24(0)	0/24(0)	0/24(0)	18/24(75.0)
FUYANG 1	8/43(18.6)	1/46(2.2)	0/44(0)	0/47(0)	41/47(87.2)
FUYANG 2	2/20(10.0)	0/20(0)	0/19(0)	0/18(0)	10/20(50.0)
KUMAMOTO	2/24(8.3)	0/24(0)	0/24(0)	0/24(0)	22/24(91.7)

[a] Figures indicate No. of individuals that excreted 10 mg or more/No. tested (%).

excretion among the populations in two ways. First, the females which excreted 10 mg or more of honeydew during the feeding period were tentatively classified as individuals which were able to feed on the variety. The percentage of such females was compared among the populations. Secondly, we standardized the data: half replicates (one-half of the tested insects) with larger amounts of excretions from each variety in each population were used for analysis, and the average amount of honeydew on "TN1" in each population was defined as 100, and the excretion rate of each insect on each variety was calculated. The means of the rate (excretion index) in a population was used in a comparison of the feeding activity among the varieties and BPH populations.

The percentage of females which excreted 10 mg or more of honeydew on each variety is shown in Table 2. On "TN1," more than 70% of the females in each population excreted 10 mg or more, except for the FUYANG 2 population (50.0%). There were no females which excreted 10 mg or more honeydew on "Rathu Heenati" and "Babawee" in all the populations, and only one female on "ASD7" in FUYANG 1 and HAINAN populations. These results indicate that the tested populations contained no, or very few, individuals capable of feeding on these resistant varieties. All the populations contained insects (8.3–20.8%) which were able to feed on "Mudgo," but no significant difference was found among the populations ($\chi^2=2.26$, $d.f.=4$, $p>0.05$).

Excretion index for each population is presented in Fig. 1. The excretion indexes on "Mudgo" attained the highest values among the four resistant varieties in all the tested populations, but the indexes were still small, ranging from 5.2 to 21.4, and showing much less honeydew excretion on "Mudgo" as compared with the "TN1." These findings indicate that tested Chinese and Japanese populations contained some individuals which were able to feed on "Mudgo," although the extent of the virulence is limited.

Biotypes of BPH populations and their shift have

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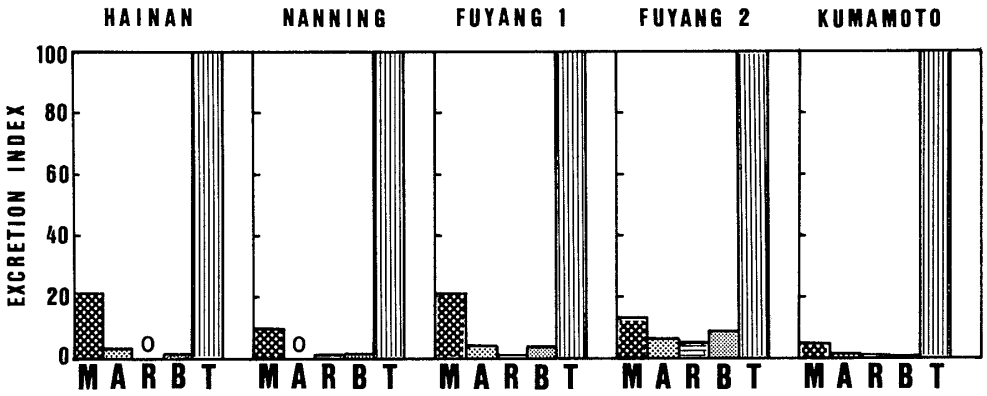

Fig. 1. Excretion index (when the mean of the excretion on "TN1"=100; see text for details) of BPH populations on five differential rice varieties. M: "Mudgo," A: "ASD7," R: "Rathu Heenati," B: "Babawee," T: "TN1."

been reported in some areas of the Southeast and East Asia. For example, Malaysian BPH populations collected in 1989–1990 consisted of a mixture of biotypes: a considerable proportion of insects were able to feed on "ASD7" and "Mudgo" (Ito, 1994). Wada et al. (1994), examining the biotypical nature of the populations collected in Malaysia, Thailand, Vietnam and Japan in 1992 by the same method, concluded that these populations could be divided into two groups based on the virulence to "ASD7"; tropical populations (Malaysia, Thailand and South Vietnam) were able to feed on "ASD7," but the North Vietnamese and Japanese populations were much less capable of feeding on this variety. Tao et al. (1992) reported that the virulence of Chinese BPH populations collected in Zhejiang province had changed from biotype 1, which is not able to attack any resistant varieties, to biotype 2, which is capable of attacking *Bph 1* gene, since 1989, as determined by the nymphal survival rates on resistant varieties.

A gradual but significant change from biotype 1 to biotype 2 was observed in the immigrant BPH populations in Kyushu, Japan during the period from 1987 to 1991, based upon the results of the honeydew excretion tests (Sogawa, 1992).

The present study supports the results of Tao et al. (1992) and Sogawa (1992), although the extent of the virulence to the variety with *Bph 1* is different. The testing method (survival vs. honeydew excretion) or the differential variety used ("Saikai-184" and "IR26" vs. "Mudgo") might affect the virulence level. Ito and Kisimoto (1981) observed that "Mudgo" exhibited a higher resistance level than did the practical cultivars or breeding lines harboring *Bph 1*.

In conclusion, no significant difference was found in the biotypical properties among the Chinese and Japanese BPH populations collected in 1993; some insects in each population were able to feed on "Mudgo," although the virulence level was still low. These populations apparently differentiated from those in the tropical Southeast Asia in their inability to feed on ASD7 with *bph 2*.

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