

## Recent Status of Insecticide Resistance of Long-Distance Migrating Rice Planthoppers monitored in Japan, China and Malaysia

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**Abstract** Simultaneous monitoring on insecticide susceptibility of the long-range migrating rice planthoppers, brown planthopper (BPH), *Nilaparvata lugens* (Stål) and the white backed planthopper (WBPH), *Sogatella furcifera* (Horvath), was conducted in Japan, China (3 locations) and Malaysia by standardized topical application method on 10 insecticides in 2000. The LD<sub>50</sub> for the 2000 Japan BPH and WBPH coincided with those for the two China populations, but one of the China populations gave remarkably larger LD<sub>50</sub> for imidacloprid. The 2000 Malaysia population of WBPH gave LD<sub>50</sub> almost equal to those of the 2000 Japan WBPH.

**Key words** brown planthopper, white backed planthopper, insecticide resistance, migration

### Introduction

The long-distance migrating rice planthoppers, brown planthopper (BPH), *Nilaparvata lugens* (Stål) and the white backed planthopper (WBPH), *Sogatella furcifera* (Horvath), are believed to migrate to Japan from southern China or northern Vietnam (Sogawa, 1992) and also, exchange of the populations between tropical Asia and temperate Asia is highly plausible. Hence, we need to take all into consideration when we discuss about insecticide resistance in these migrating planthoppers, resistance levels in each area and migration of the hoppers throughout wide migration range covering tropical and Far East Asia.

We formerly summarized insecticide susceptibility of BPH and WBPH monitored in Asia so far until 1998 suggesting several points; 1) Gradual development

of resistance in these hoppers during these 30 years based on the 1967 monitoring data (Fukuda and Nagata, 1969), 2) Development of resistance in the tropical populations especially with the Malaysian and Vietnamese population of BPH and WBPH being more resistant than the temperate populations (Nagata, 1999). However, all these data were mostly produced by monitoring at different periods and sites and those comparisons are somewhat indirect.

Therefore, we organized a joint program with financial aid from Japanese Ministry of Education to monitor LD<sub>50</sub> by standardized topical application since 1999 with Nanjing Agricultural University, Nanjing, China and MARDI, Alor Setar, Malaysia extending 3 years. By this simultaneous parallel observation we tried to get a clear conclusion about relation between migration and resistance traits of these hoppers. In this program, we used standard insecticides and bioassay procedure standardized as far as possible and compared results each year.

### Materials and Methods

#### Insects

BPH and WBPH were collected at each sites and reared in the laboratory for the Japan populations at 25°C, 16 hour photoperiod on rice seedlings (Variety: Koshihikari) or in screen house for the other populations at the ambient temperature.

#### Bioassay

Female adults within 5 days after emergence were treated topically with a micro applicator (Burkard, UK) with acetone droplet of 0.08 µl each. Some of China populations was treated topically by a steel capillary

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device giving 0.05  $\mu$ l droplet of acetone on each adult (Tan, 1987). Technical grades of insecticides were obtained from Wako or pesticide companies. Mortality was taken 24 hours after treatment at 25 °C and LD<sub>50</sub> were calculated by Bliss's probit method. The insecticides tested were: malathion, fenitrothion, diazinon, methamidophos, carbaryl, BPMC (fenobucarb), MIPC (isoprocarb), fenvalerate, etofenprox, imidacloprid, DDT.

## Results

### Monitoring in 1999

Insects were collected from following sites; Anqing (Anhui Province), Dongtai (Jiangsu Province), Kagoshima (Kagoshima City, Japan), and China populations were treated topically by the steel capillary, Japan populations were treated with a Burkard applicator.

**China** The preliminary results obtained from the two China populations of BPH (Anqing and Dongtai) showed that some of the LD<sub>50</sub> for these populations were remarkably larger than those for the Japan population (Fig. 1). Also Dongtai WBPH gave ca. 11-times larger LD<sub>50</sub> for MIPC and fenvalerate as compared with the 1999 Japan population.

**Japan** The LD<sub>50</sub> values for the 1999 BPH collected from Kagoshima were compared with those obtained in 1997 by Endo (in press). Generally, no significant change was observed except slight decrease in LD<sub>50</sub>s for malathion, BPMC and MIPC, the differences were less than 3-times (Fig. 2).

The LD<sub>50</sub> values of the Japan 1999 WBPH were compared with those for the 1997 Japan population reported by Endo (in press) and proved to be generally more susceptible in general with significant difference for malathion (1/7), MIPC (1/6) and etofenprox (1/4),

difference being given in the parenthesis as the ratios (Fig. 5).

### Monitoring in 2000

**China** Three monitoring sites were established in China along the migration route of those planthoppers, Guilin (Guangxi autonomous region), Anqing (Anhui Province) and Dongtai (Jiangsu Province). The insects were reared in screenhouse outdoor and 5th-instar nymphs were transferred to the laboratory to obtain emerged adults. Collection periods were; Guilin BPH and WBPH in early July, Anqing WBPH in mid July, Anqing BPH in early Sept., Dongtai WBPH in mid July, Dongtai BPH in early September.

Only the Dongtai populations were treated by Burkard applicator, but BPH and WBPH from the other two sites were treated by the steel capillary device.

**Japan** Collection site was Kagoshima City. WBPH was collected 8-10 June and BPH was collected on 21 Sept. Insects were reared and multiplied in the laboratory and female adults within 5 days after emergence were treated topically by Burkard applicator.

**Malaysia** Insects were collected from Sg Lintang (Kedah State), collecting period was early June and insects were reared on rice seedlings (Variety: MR-84) in the screen house outdoor and treated by Burkard applicator.

### BPH

- 1) In Japan, no significant change in topical LD<sub>50</sub> was observed for most of the 10 insecticides tested between 1999 and 2000. The largest difference was for imidacloprid. LD<sub>50</sub> for the 2000 population was 10-times larger than the 1999 population (Fig. 2).
- 2) In China, remarkable difference in LD<sub>50</sub> for im-

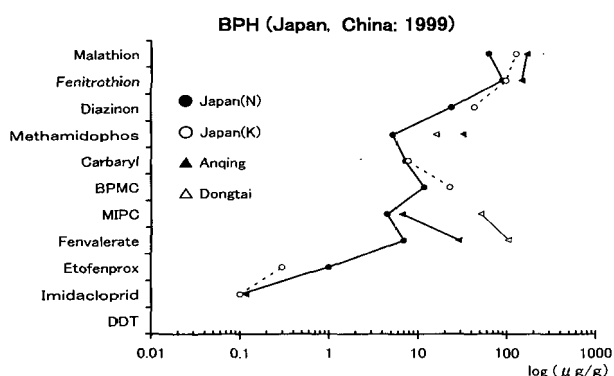


Fig. 1. LD<sub>50</sub> of BPH (Japan, China 2 sites: 1999).

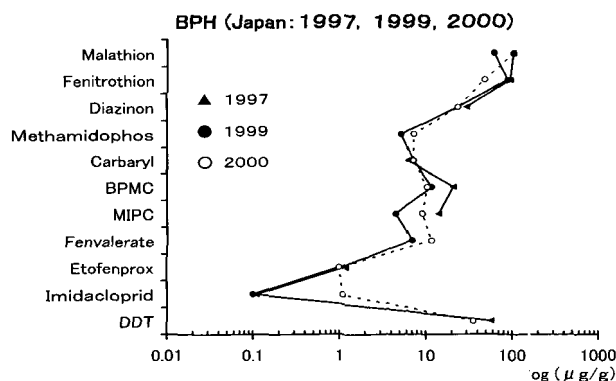


Fig. 2. LD<sub>50</sub> of BPH (Japan: 1997, 1999, 2000).

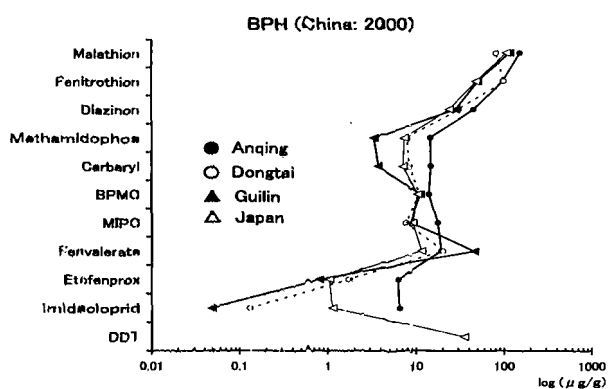


Fig. 3. LD<sub>50</sub> of BPH (China 3 sites, Japan: 2000).

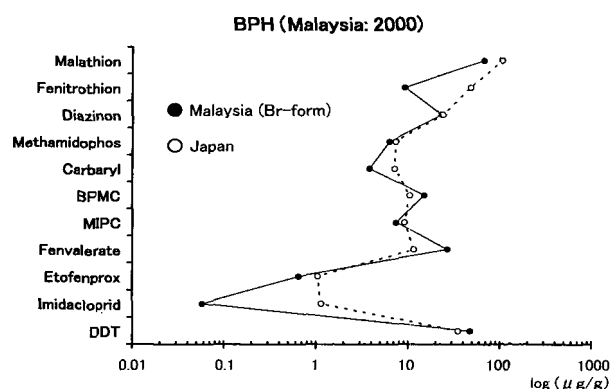


Fig. 4. LD<sub>50</sub> of BPH (Malaysia brachypterous form, Japan: 2000).

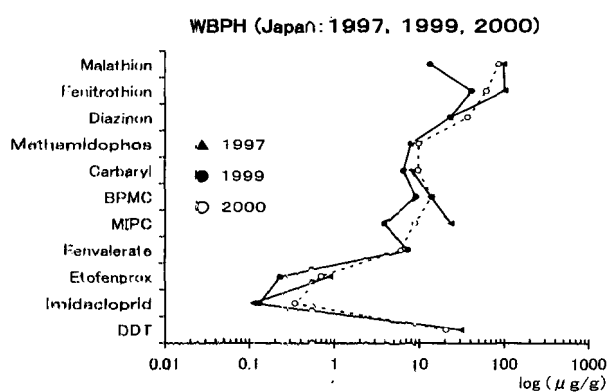


Fig. 5. LD<sub>50</sub> of WBPH (Japan: 1997, 1999, 2000).

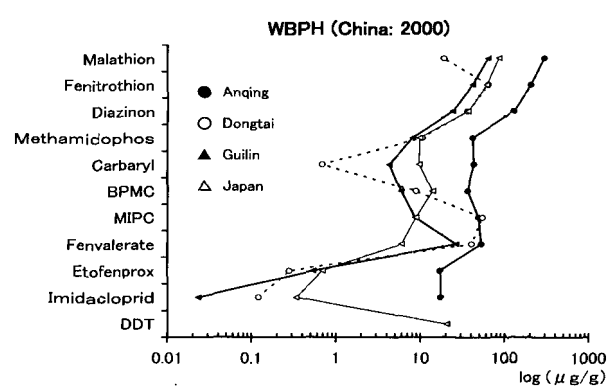


Fig. 6. LD<sub>50</sub> of WPH (China 3 sites, Japan: 2000).

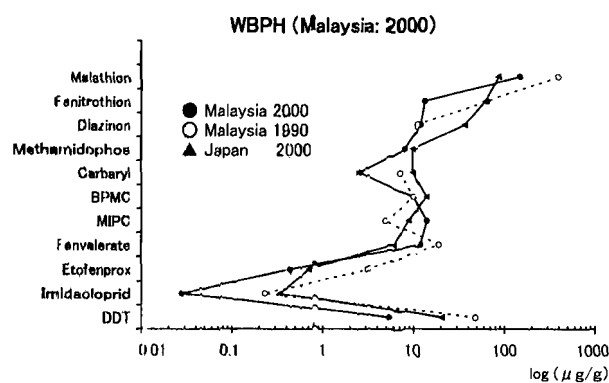


Fig. 7. LD<sub>50</sub> of WBPH (Malaysia: 1990, 2000; Japan: 2000) 1990 data by Iendo (in press).

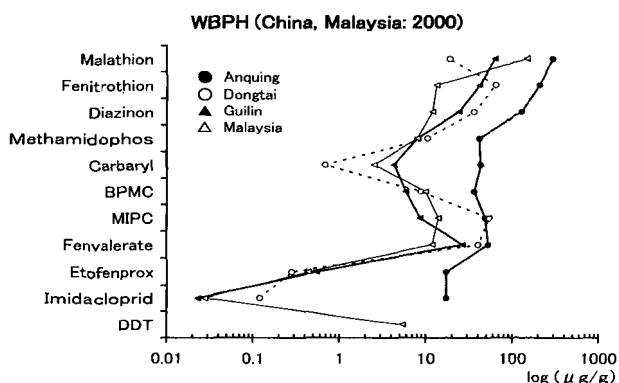


Fig. 8. LD<sub>50</sub> of WBPH (China 3 sites, Malaysia: 2000).

imidacloprid and etofenprox was observed among the 3 sites. 140-times difference was detected for imidacloprid between Anqing and Guilin (Fig. 3). Regrettably, the controversial Anqing population was not maintained in the laboratory. Reaffirmation is necessary if possible.

3) Japan population showed LD<sub>50</sub> almost similar to the China populations for all the insecticides tested except imidacloprid (Fig. 3).

4) For the Malaysian BPH, LD<sub>50</sub> were determined for the brachypterous females because it gave extremely high percentage of brachypterous adults when reared on rice seedlings. LD<sub>50</sub> of the Malaysian BPH were almost similar to the macropterous females of the Japan population except for imidacloprid (Fig. 4).

## WBPH

- 1) In comparison with the 1999 Japan population, significant increase in LD<sub>50</sub> was observed with the 2000 Japan population for malathion (6.4-times), etofenprox (3.0-times) and imidacloprid (2.6-times), but, no significant slight increasing tendency was observed for the rest (Fig. 5).
- 2) In China a large difference in LD<sub>50</sub> was observed among the 3 sites for imidacloprid, etofenprox and carbaryl. Difference for imidacloprid between Anqing and Guilin was so large as 700-times (Fig. 6).
- 3) Malaysian population gave LD<sub>50</sub> similar to Japan, Guilin and Dongtai populations, however, significant overall decrease in LD<sub>50</sub> was observed for all the insecticides tested as compared with the latest data obtained by Endo for the 1990 Malaysian populations (in press) suggesting recovery of resistance in these areas (Figs.7 and 8). 2001 monitoring is now being worked out on BPH and WBPH populations collected at Alor Setar, Kedah State, Malaysia.

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## Discussion

We aimed to achieve simultaneous parallel monitoring using standardized method to analyze relation between migration and resistance development in these plant hopper species.

As long as BPH and WBPH are migrating from China, LD<sub>50</sub> observed in Japan should be same with those observed in these origin areas. In fact there is no definite information that there exist different populations of these hoppers in terms of insecticide susceptibility in Japan and China. However, the 1999 preliminary tests in China showed Anqing and Dongtai BPH and Dongtai WBPH were remarkably more resistant than the Japanese populations of the same year.

Furthermore, the 2000 Anqing population of BPH and WBPH gave LD<sub>50</sub> remarkably larger than any other Chinese populations and Japan population, especially for imidacloprid and etofenprox.

We can assume this large gap was associated with the difference in testing equipment adopted in each sites. The steel capillary is a simple device developed in China and it works on the same principle with usual market-sold apparatus like Burkard, but it requires repeating refill of acetone solution on each treatment. It tends to give larger LD<sub>50</sub> by evaporation of solvent when unskilled technician delays treatment.

Imidacloprid is a new systemic insecticide developed in Japan and its use started in mid1990's (Iwaya *et al.*, 1998) becoming one of the most important BPH control agent as well as buprofezin. Difference in the susceptibility to this new insecticide is a matter of great concern if such big local difference in susceptibility really exists in those migrating insects. We need further reconfirmation if this is due to technical error or real local difference in insecticide susceptibility.

Though LD<sub>50</sub> of the Malaysian BPH was not comparable because macropterous females were not obtainable, Malaysian WBPH proved to be almost equal to those in temperate regions, Japan and China populations. It can be concluded there is no definite difference in insecticide susceptibility between the temperate populations and the tropical populations of those migrating planthoppers as speculated before (Nagata, 1982).

Apparently BPH and WBPH have developed insecticide resistance during these 30 years throughout whole Asian areas as summarized in previous report (Nagata, 1999). However, it is accompanied by yearly fluctuation.

Reduction in LD<sub>50</sub> of the Malaysian WBPH between 1992 and 2000 seems to be associated with decrease in the amount of insecticide used in these areas which actually took place. Also, in China, more areas are being planted to resistant varieties, which will cause reduction in LD<sub>50</sub> for all the conventional insecticides used in China.

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