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# Colonization of rice fields by *Nilaparvata lugens* (Stål) and its control using a trap crop

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ABSTRACT. Colonization of rice fields by the brown planthopper, *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae), was monitored using yellow pan oil–water traps. In approximately 3 months, 35 788 immigrant macropters (1·0 ♂ : 1·2 ♀) were caught in 512 traps installed over a 0·352 ha rice field. The trend of daily trap catches conformed closely to the number of macropters visually counted on rice hills. In sub-plots with a trap crop planted 20 days earlier than the main crop on a quarter of the total crop area, more macropters were recorded on trap-crop than on main-crop rows up to about 75 days after transplanting the main crop. In control sub-plots with one planting, more hoppers arrived on the middle than on the border rows. A blanket spray application of Perthane (0·75 kg a.i./ha) was made on the crop in control sub-plots, whereas only the trap crop was sprayed in trapped sub-plots. The combined yield in each treatment with trap crop was significantly higher than in the control treatment.

## Introduction

The brown planthopper, *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae), once only a minor pest, has in recent years attacked lowland rice in epidemic numbers in many countries in tropical Asia (Dyck and Thomas, 1979). Excessive feeding by a large hopper population, as during epidemics, results in complete drying or 'hopperburn' of rice fields over extensive areas. The insect also transmits grassy stunt and ragged stunt virus diseases (Ling, 1972; 1977), outbreaks of which have followed hopper attacks in India, Indonesia, and the Philippines. The resistance of the pest to several insecticides and resurgence with others makes effective chemical control more complicated than originally thought (Heinrichs, Saxena and Chelliah, 1979). Even the programme of introduction of pest-resistant varieties for cultivation suffered a setback in several countries because of the development of prolific biotypes of the pest which can survive on these resistant varieties (Mochida, 1978; Fernando, Senadhera, Elikawela, de Alwis and Kudagamage, 1979; Kalode and Krishna, 1979; Pathak and Khush, 1979; Stapley, May-Jackson and Golden, 1979; Pathak and Heinrichs, in press). The brown planthopper problem is becoming more serious as the insect is invading new rice-growing areas in Asia.

Information on the mode and time of colonization of rice fields by brown planthopper immigrants is essential for control of the pest. Such information will suggest the proper timing and frequency of individual or integrated control measures. Many devices, such as sticky boards, air-borne nets, light traps, yellow pan traps, suction machines, sweep nets, and the direct or visual counting of hoppers on rice plants, although labour-intensive, have been employed for monitoring planthopper immigration on experimental farms. Light traps have been used extensively for trapping different flying insects, but the information obtained is indicative only of the insect abundance in an area and not of the actual field colonization by insects (Kisimoto, 1977). The use of the more sophisticated trapping devices by an average farmer in the tropics is limited either because of the complexity of design and operation or the high cost of the equipment. For this reason, a simple trap was developed to monitor the brown planthopper in rice fields.

Bearing in mind the mode of colonization, the cultural concept of using a trap crop was tested as an alternative to conventional control of the pest with intensive insecticide applications. This approach has previously received little attention for want of an adequate knowledge of the pest behaviour which could be exploited to divert the colonizing hoppers to a trap crop. Essentially, a trap crop is a small, early planting of a crop that is more attractive to the pest insect than the crop to be protected (Rust, 1977; Graustein and Rust, 1978). The cultural control using a trap crop must also be more beneficial to justify it as a substitute for alternative control measures. These criteria were kept in mind while evaluating the feasibility of the trap crop in the control of the pest.

## Materials and methods

Brown planthopper colonization was monitored together with the trap-crop experiment on a 0·352 ha rice field at the experimental station of the International Rice Research Institute (IRRI), Philippines. This field was divided into four plots, each containing a control and three planting patterns of trap crop in sub-plots of 11 m × 20 m. A randomized complete block design was used. A susceptible rice selection, IR1917-3-17, was transplanted (25 cm × 25 cm) 20 days earlier (*trap crop*) than the main crop of the same selection. A quarter of the area of each treatment sub-plot was occupied by the trap crop. The first trap-crop pattern had two border rows and a central patch of trap crop (Figure 1a). The second pattern had two border rows and four longitudinal double rows in the middle of the trapped field (Figure 1b). The third pattern had six longitudinal double rows of trap crop (Figure 1c). Sub-plots with a single planting at the same time as the trap crop in the experimental plots served as control (Figure 1d). To prevent damage by rice whorl maggots and stem borers, carbofuran 3G (2,3-dihydro-2,2-dimethyl-benzofuran-7-yl methylcarbamate), (2 kg a.i./ha) and diazinon (*O*,*O*-diethyl *O*-2-isopropyl-6-methylpyrimidin-4-yl phosphorothioate) (2 kg a.i./ha) were applied to both control and trap crops at 5 and 45 days after transplanting (DAT), respectively. The brown planthopper nymphs and adults and their predators were visually counted and recorded daily on 32 rice hills each in the trap crop, main crop and the control up to crop maturity. Randomly selected rice hills in each sub-plot were hand-tapped and insects falling on the water surface below these hills were recorded with a manual counter.

A simple yellow pan oil–water trap (YPT) was developed to monitor the immigrant colonizing macropterous hoppers. The trap was made from a lightweight plastic can (17 cm in diameter, 21 cm high) of one-gallon capacity ($\approx$3·79 *l*) and filled with 1 *l* water and 2 ml paraffin oil. After transplanting the main crop, 32 traps

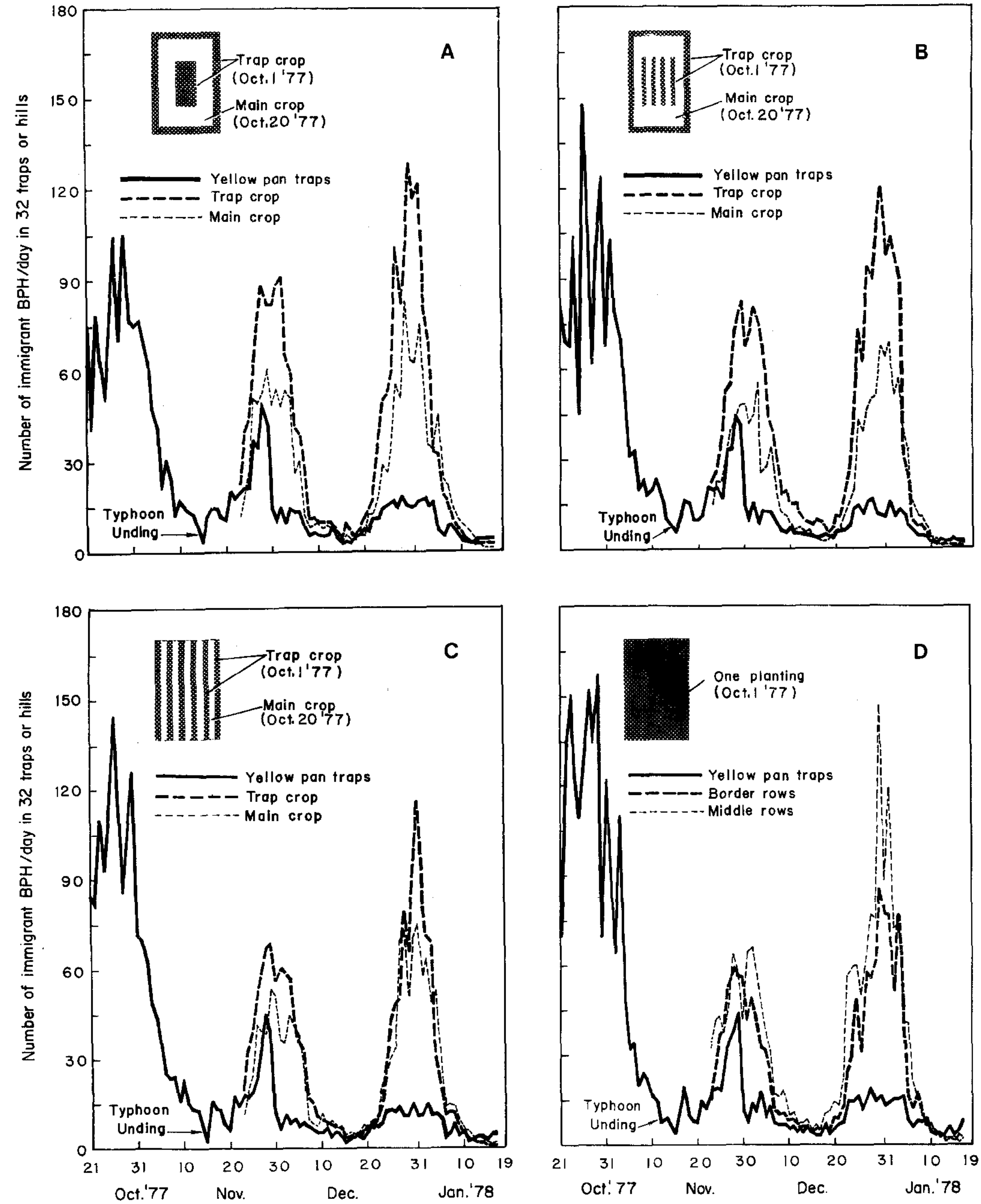


FIGURE 1. Trends in immigration of brown planthopper (BPH) macropters in field sub-plots with rows of trap crop planted 20 days earlier than the main crop. a: two border rows and a central patch of trap crop; b: two border rows and four longitudinal double rows of trap crop; c: six longitudinal double rows of trap crop; d: one planting (control). The hopper numbers were based on catches in traps and visual counts on plants. IRRI, October 1977 to January 1978.

were staked equidistantly at 2 m intervals around the border of each sub-plot and maintained at the level of the crop canopy. The yellow colour has been reported to attract the small brown planthopper, *Laodelphax striatellus* (Fallén) (Kisimoto, 1968) and the brown planthopper (Kisimoto, 1977). Thus, colonizing hoppers flying above rice fields are attracted by YPTs and trapped in their oily water surface. Every morning trapped hoppers were counted and removed, and compared with the number of hoppers visually counted on rice hills.

## Results and discussion

When the food resources available to the brown planthopper become limiting, as in a crop nearing maturity or in hopperburned rice fields, a preponderance of the long-winged macropters is produced; these macropters disperse and colonize new verdant rice fields (Saxena, Okech and Liquido, 1981). In certain circumstances, short-winged brachypters and even nymphs may hop about and be carried passively by wind or water across the levees (embankments) from a hopperburning field to an adjacent green rice field (personal observation). However, such movements are seldom used for colonizing new fields and are more likely to occur after infestation, for dispersal within a field.

The catches of brown planthopper macropters in YPTs were highest when the control and trap crops were 20–30 DAT, with a second high peak at 55–60 DAT, and a third peak at 80–100 DAT (Figure 1a–d). In about 3 months, 35 788 brown planthopper macropters were caught in 512 YPTs. A few other hopper species were also trapped: these comprised *Sogatella furcifera* (Horvath) (5687), *Nephotettix* sp. (4336), *Cicadella spectra* (Distant) (2100) and *Recilia dorsalis* (Distant) (1809). A total of 2146 individuals of *Cyrtorhinus lividipennis* (Reuter), a mirid predator of hoppers, was also trapped. These catches indicated that the brown planthopper was the most abundant pest species among the hoppers colonizing rice fields at the time when this study was conducted. In a 10-day YPT catch of 4296 brown planthopper macropters, males and females were recorded in a ratio of 1·0♂ : 1·2♀. Catches of macropterous hoppers in YPTs were high when a wind of 1 to 2 m/s (wind speed of 85–170 km/24 h recorded with a totalizing anemometer, W102—DC Skyvane 1) prevailed from the north-east and east of the experimental site (Figure 2). A survey made in the vicinity of the test plots on the IRRI farm recorded the successive incidence of hopperburn in five neighbouring fields each of 0·25 ha (Figure 3). Three fields, approximately 0·5 km north-east, were hopperburned from October 1977 to early January 1978, and two nearby fields on the eastern flank were hopperburned between November and December 1977. YPT catches of the brown planthopper macropters were negligible during a typhoon (total wind speed approximately 444 km/24 h) on 13 November 1977, indicating that the brown planthopper disperses and colonizes rice fields in relatively calm weather conditions (Ohkubo and Kisimoto, 1971; Ohkubo, 1973; MacQuillan, 1975; Saxena and Justo, unpublished).

In general, the trend of arrival of immigrants monitored visually on randomly selected rice hills in various sub-plots conformed closely to the YPT catches of the macropters, indicating the usefulness of the traps in monitoring the field colonization by this insect (Figure 1a–d). In sub-plots with a trap crop, more macropters were visually counted on the trap-crop rows than on the main-crop rows, irrespective of trap-crop patterns. This differential trend in hopper arrivals persisted

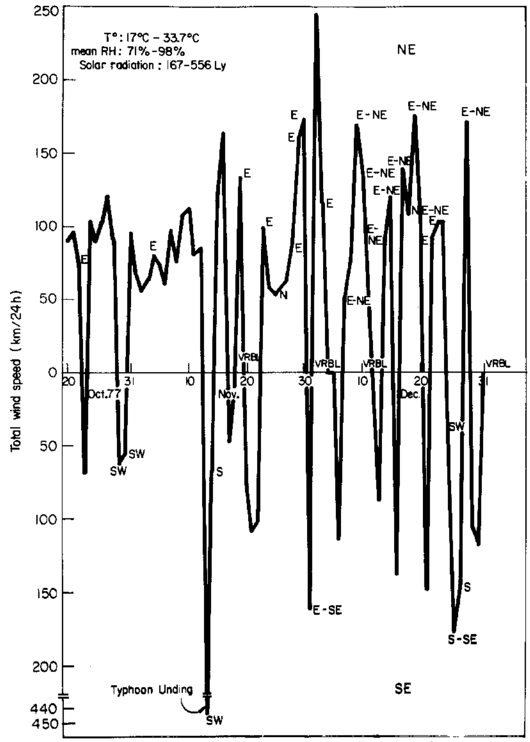


FIGURE 2. Wind speed and direction at IRRI farm area during October–December 1977. Ly=Langley; VRBL=variable. IRRI, 1977.

up to about 75 days after transplanting the main crop, after which hoppers arrived almost equally on both crops. However, in control sub-plots with one planting, more hoppers arrived on the middle than on the border rows. To avert the possibility of a high hopper population build-up and damage to the crop, Perthane (1,1-dichloro-2,2-bis(4-ethylphenyl)ethane) was sprayed at 0·75 kg a.i./ha only on control and trap crops at 95 DAT. Insecticidal treatment was not required on the main crop because the number of immigrant hoppers on rice hills, recorded visually, remained low at all stages of crop growth. By not treating the main crop with insecticide at any crop stage, the natural enemies of the pest were also conserved: spiders and other predators were encountered on almost all rice hills, providing a constant check on pest build-up. Infestation by other insect pests was negligible in all plots, irrespective of treatment.

Use of a trap crop resulted in economies of insecticide and labour because only 25% of the total crop area in the trapped fields was treated with insecticide. In the control plots, blanket insecticidal treatment was necessary to prevent the pest damage. Besides these benefits, the taller rows of trap crop were also seen to provide a certain degree of protection to the main crop against wind damage (withering of leaf tips) from the typhoon that occurred at the early stage of the growth of the main crop (Figure 4). The combined yield of the trap and main crops in each of the three trap-crop patterns was significantly higher than that in the control plot (Table 1).

These findings indicate that it is possible to divert the colonizing hoppers to a trap

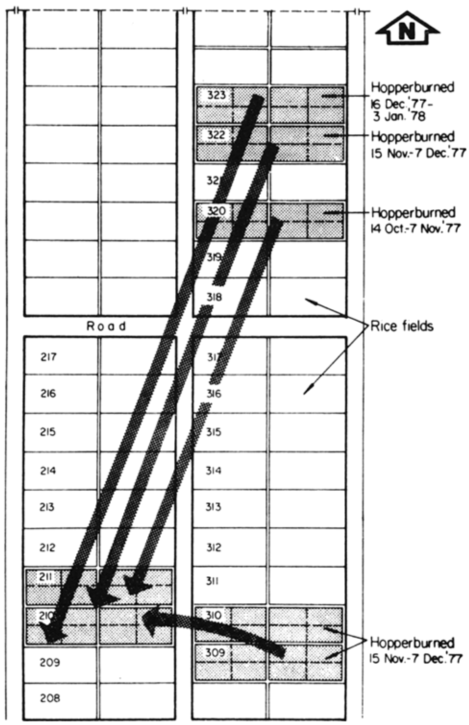


FIGURE 3. Outbreaks and movements of the brown planthopper in vicinity of the experimental site on IRRI farm. IRRI, October 1977 to January 1978.

FIGURE 4. Field sub-plots with rows of trap crop planted 20 days earlier than the main crop; taller rows of trap crop visibly exhibiting wind damage (withering of leaf tips), and unaffected rows of main crop after a typhoon. YPTs used in monitoring the immigrant brown planthopper macropters can be seen in the background. IRRI Farm, November 1977.

TABLE 1. Yield in rice fields with and without trap crop. IRRI Farm, October 1977 to January 1978.

| | Treatment* | Date of planting (1977) | Proportionate area/ha | Yield† (t/ha) | Combined yield** (t/ha) |
|---|---|---|---|---|---|
| 1 | Trap crop | Oct. 1 | 0·25 | 2·4 | 2·9 a |
| | Main crop | Oct. 20 | 0·75 | 3·0 | |
| 2 | Trap crop | Oct. 1 | 0·25 | 2·3 | 2·9 a |
| | Main crop | Oct. 20 | 0·75 | 3·1 | |
| 3 | Trap crop | Oct. 1 | 0·25 | 1·8 | 2·6 a |
| | Main crop | Oct. 20 | 0·75 | 2·9 | |
| 4 | One planting (control) | Oct. 1 | 1·00 | 1·9 | 1·9 b |

* Treatment 1 had two border rows and a central patch of trap crop; treatment 2 had two border rows and four longitudinal double rows of trap crop; treatment 3 had six longitudinal double rows of trap crop; treatment 4 (control) had no trap crop. Urea was applied in 3 split applications of 60, 30, 30 kg N/ha.

† Harvested rice grains were oven-dried to 14% moisture content before yield determination.

** Means followed by a common letter are not significantly different at 5% level; average of four replications.

crop where they can easily be destroyed with an appropriate insecticide. Besides a significant gain in yield and saving of insecticide, the restricted use of the insecticide helps to maintain a sanctuary for the natural enemies of the pest. However, the concept of a trap crop is meaningful only when rice fields are likely to be invaded with a high pest population.

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