POPULATION GROWTH PATTERN OF THE BROWN PLANTHOPPER IN THAILAND

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ABSTRACT

The population growth of the brown planthopper in paddy fields and the infestation with rice ragged stunt disease were studied during a three-year period since 1979 in the Central Plain, Thailand. The population trends of the insect were also observed in Northwest Java, Indonesia during the 1982/83 wet season.

The immigrants of the brown planthopper produced two generations in a discrete way until harvest of rice. The females showed brachypterous wing forms with a ratio of more than 90% in the first generation. This pattern was commonly observed both in Thailand and Indonesia.

The immigrants during the early weeks after transplanting of rice played a significant role in the infestation with the disease. These early immigrants did not establish their field populations on rice. The infection occurred within a 40-day period after transplanting. Secondary transmission in the later period did not cause any disease symptoms until harvest. The infection during the nursery period was important only under severe epidemic conditions.

Population growth in rice fields

Seven rice virus diseases are distributed in Thailand and the brown planthopper is the vector of two of them (Morinaka, 1981). The population growth pattern of the vector insect is important in relation to the infestation with the diseases. In the tropics, though generation overlap of the brown planthopper seems to be greater than in temperate regions (Otake, 1978), there are distinct generations in a given rice field (Mochida, 1977; Dyck *et al.*, 1979).

The population trends of the brown planthopper were studied in the Central Plain of Thailand during a three-year period from 1979 (Tsurumachi and Khusakul, unpublished) and in Northwest Java in the 1982/83 wet season (Tsurumachi and Kamal, unpublished).

Macropterous females appeared twice 18 and 45 days after transplanting in a rice field of Bangkhen Rice Experimental Station (Fig. 1). The increase in the field population occurred following the migrations of the brown planthoppers which were detected by a tow net near the fields. Nymphs were abundant on the 60th day after transplanting and gave rise to the adults of the 1st generation on the 70th day. The females of this generation were found to be mainly brachypterous in many observations. When the brown planthopper was reared in a mesh cage in rice fields and the rearing was completed until the booting stage of rice, more than 90% of the females were brachypterous.

The time of appearance of each generation in Thailand is summarized in Fig. 2. Immigrants appeared from 15 to 45 days after transplanting. This population increase estimated by visual counts on rice followed the capture of the migrants by tow nets. Sometimes immigrants did not build up their population in rice fields in the early stage of rice growth. Before these immigrants were observed by visual counts, water pan traps often monitored macropterous forms from the first week after transplanting. Two generations appeared successively at 25 to 30 day intervals until rice harvesting. The brachypterous forms predominated in the females of the 1st generation, and even in the later generations, the number of brachypterous forms was comparatively high. After the heading stage of rice, the population usually seemed to decrease.

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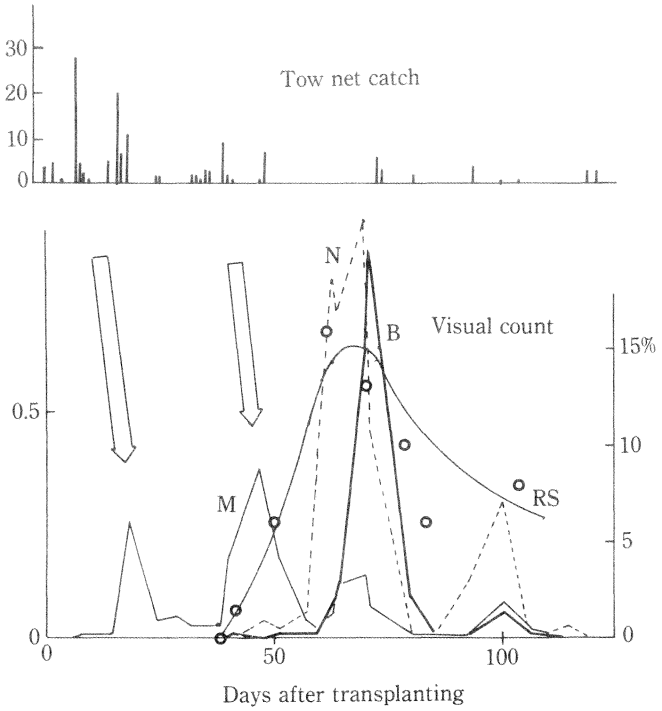

Fig. 1 Population trend of brown planthopper on RD 7, transplanted on April 23, 1979 in Bangkhen, Thailand. M, B, N: Macropterous, brachypterous females and nymphs per 1 rice hill. RS: Incidence of rice ragged stunt, percentages on a hill basis. Above: Daily catches of brown planthoppers by a tow net near the fields.

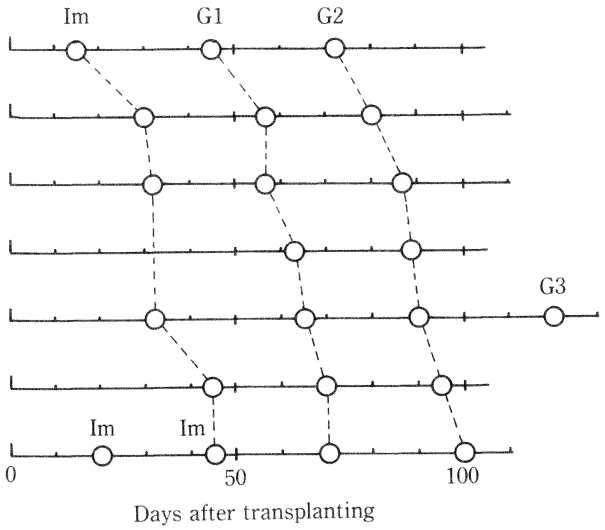

Fig. 2 Appearance time of brown planthopper (adult) in rice cultivation. Im: immigrant, G1, G2, G3: 1st, 2nd and 3rd generations.

Population fluctuations of the migratory brown planthopper

1 Thailand

Seasonal fluctuations in the dispersal of the vector insects and the ranges of the dispersal flight are factors that may determine the epidemics of rice virus diseases.

During the survey period in Thailand, populations of the migratory brown planthopper were studied by tow nets at some locations in the Central Plain and in Northern Thailand. Fig. 3 shows the fluctuations observed in 1980 and 1981 at Bangkhen, Nakhon Pathom, Chainat, and Chachoengsao, 50–150 km west, north and east respectively from Bangkhen. The number of migrant brown planthoppers was smaller at Bangkhen in the outskirts of Bangkok. The other 3 places are located in the major rice cultivation areas. In these areas, sometimes spells of mass flights which exceeded one hundred daily catches by a tow net were observed during a long period. In Chachoengsao and Nakhon Pathom, hopperburns were observed sporadically. Most of the farmers were growing susceptible rice varieties. Though the outbreak of the brown planthopper did not seem to be very serious, the epidemic of rice ragged stunt began in 1980.

Similarity in the seasonal fluctuations of the migrant brown planthoppers was not appreciable between these 4 locations, and presumably the prevailing rice cultivation practices affected the results of tow net monitoring in each location. The rather rapid dissemination of rice ragged stunt in the Central Plain in 1980 suggests that the range of dispersal of the brown planthoppers was comparatively wide. Monthly catches of plant and leafhoppers in a three-year period at Bangkhen did not suggest any definite seasonal pattern (Fig. 4).

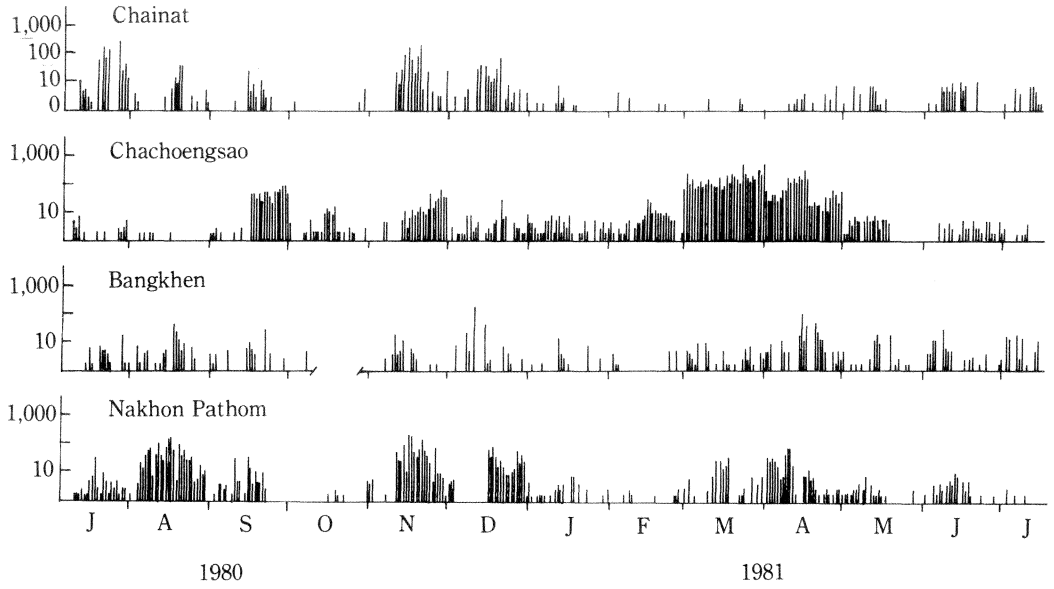

Fig. 3 Daily catches of brown planthopper by tow nets at 4 locations in the Central Plain, Thailand. Chainat, Chachoengsao and Nakhon Pathom are located 60 to 150 km north, east and west from Bangkhen.

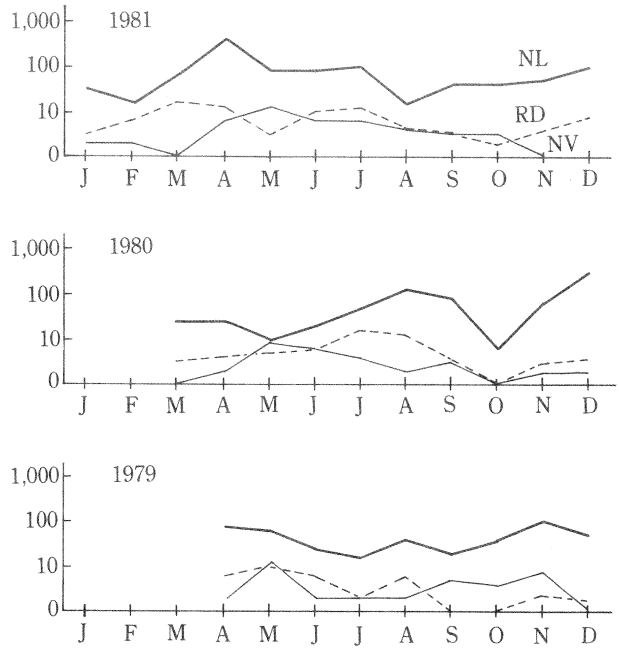

Fig. 4 Monthly catches of plant- and leafhoppers by a tow net at Bangkhen, Thailand. Thick line (NL): brown planthopper, broken line (RD): zig-zag leafhopper, *Recilia dorsalis*, thin line (NL): green leafhopper, *Nephotettix virescens*.

2 Indonesia

The population fluctuations were studied in the 1982/83 wet season in Northwest Java, Indonesia (Fig. 5). Jatisari is in the lowlands, where rice cultivation is synchronized over very large areas. Warungenung is situated in the highlands, where the rice cultivation area is much smaller and the cropping pattern is staggered.

In November, no rice cultivation was observed in the lowlands where there seemed to be no source of migrant brown planthoppers. Lowland rice might have been infested with immigrant brown planthoppers from the surrounding highland rice cultivation areas, although the number of insects was very small. Catches of brown planthoppers by a tow net at Jatisari were unfrequent until late January. The number of migrant populations increased when rice in many fields in the area reached maturity. Daily catches by a tow net did not exceed 10 insects throughout the wet season. The incidence of rice virus diseases was very low in the areas. Rice ragged stunt was observed only once during the survey period.

A susceptible rice variety transplanted at Jatisari in November and December, early in the wet season, was destroyed by hopperburn. The initial population of brown planthoppers in the field was so low that it could not be detected by regular visual counts. The reproductive rate of the brown planthopper is presumably much higher in Java than in Thailand. In Java, it was easy to detect several nymphal populations of brown planthopper in the rice nurseries or on resistant rice varieties whereas it was very difficult to identify nymphs in nurseries in Thailand.

Unexpectedly, susceptible rice varieties transplanted later in the wet season at Jatisari did not sustain any damage by brown planthoppers both in experimental fields and farmers' fields, though the initial populations in these fields were much more abundant than in the early rice crop. The rate of increase of the field populations which were inoculated at various times (Table 1)

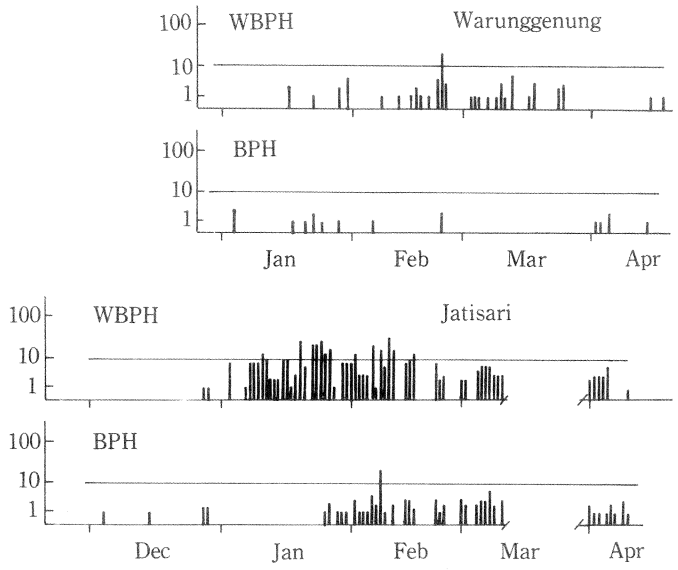

Fig. 5 Daily catches of planthoppers by tow nets in wet season, 1982/83 in northwest Java. WBPH: white backed planthopper, BPH: brown planthopper. Above: Hilly area (Warunggenung), Below: Lowland (Jatisari).

Table 1 Peak densities of brachypterous females in inoculated populations on Pelita (Java) and on RD 7 (Bangkhen, Thailand)

	Released populations	Populations which reproduced	
Date (DAT)	+ Built up/hill	Next generation	Last generation
Java, 1982			
Jan 4 (38)	2.6	13.3	hopperburn
Jan 5 (13)	7.4	31.8	hopperburn
Jan 19 (27)	5.0	3.2	2.5
Jan 19 (53)	15.8	64.8-hopperburn	
Jan 21 (55)	3	3.1	less than 1
Feb 4 (43)	3.5	9.1	less than 1
Feb 4 (43)	9.5	11.3	〃
Feb 4 (43)	23.7	15.8	〃
Bangkhen, 1979, 1970			
Sep 18 (15)	2.9	0	-
Nov 14 (15)	3.1	0.4	-
Nov 28 (30)	2.0	0.6	-
Nov 13 (45)	3.8	1.0	-
Nov 3 (60)	4.6	0.2	-

was much lower later in the wet season in Java. In the tropics, staggered rice cropping has been regarded as one of the possible factors which may cause outbreaks of brown planthoppers. The situation observed in Java was opposite. The proportion of acreage with resistant rice varieties exceeded 95% of the area. It is probable that staggered rice cropping may be safer if the migrant populations of brown planthoppers are controlled below a certain threshold level by the presence of a wide acreage of resistant rice varieties. Later in the wet season in Java, both the populations of brown planthopper and predacious mirids were increased.

Estimation of time of infection of rice ragged stunt in rice fields

In order to analyse the relations between the infestation of rice ragged stunt and the population trend of the vector insect, the incubation period of the disease in rice plant was determined under field conditions (Fig. 6). Distinct symptoms of rice ragged stunt appeared 40 days after the infection in the cages in which brown planthoppers were released on the day of transplanting and 30 days after. The symptoms were not distinct and the incubation period was longer when the vectors were released on the 40th day after transplanting. The inoculation on the 50th day after transplanting did not result in any disease symptoms.

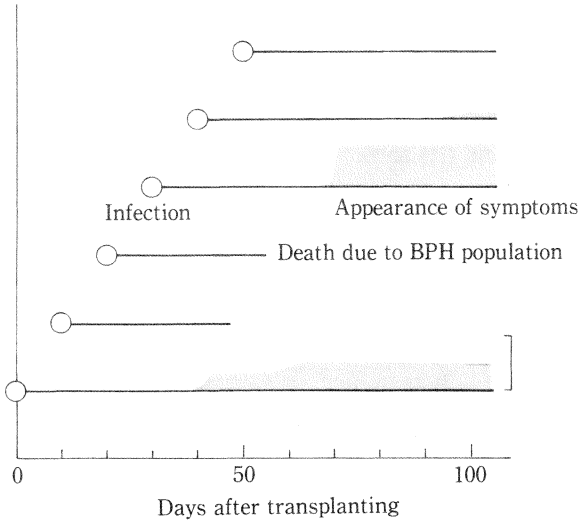

Fig. 6 Incubation period of rice ragged stunt in rice field. Six rice hills covered with mesh cages were inoculated with rice ragged stunt each time during 0 to 50 days after transplanting.

It has already been determined that the incubation period in plant lasts two weeks (Hibino, 1977). The 40-day incubation period was determined on the basis of the same criteria as those used in the visual counts to study the progression of the disease in the field.

In the course of the study, few diseased rice seedlings appeared 1 to 2 weeks after transplanting and the infection may have occurred in the nurseries. The incidence of the disease increased from around 40 days after transplanting and it reached a peak around 80 days after transplanting at the booting or heading stage of rice. Thereafter the number of diseased rice hills decreased probably due to the fact that the symptoms were overlooked under the dense canopy (Fig. 7).

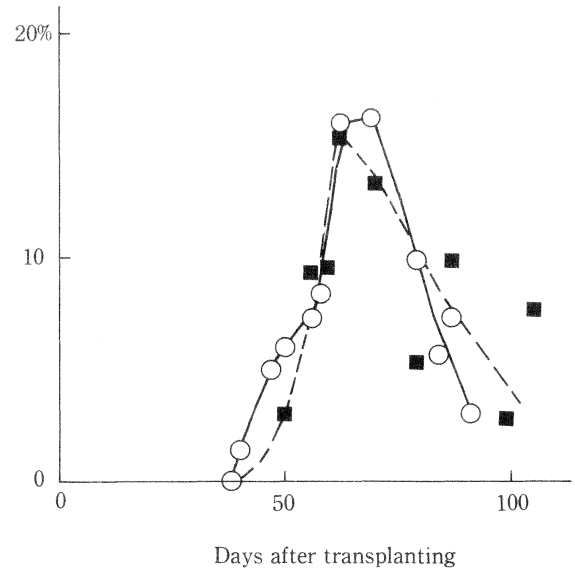

Fig. 7 Sequential changes of rice ragged stunt disease incidence in rice field at Bangkhen. RD 7 was transplanted on April 23, 1979.

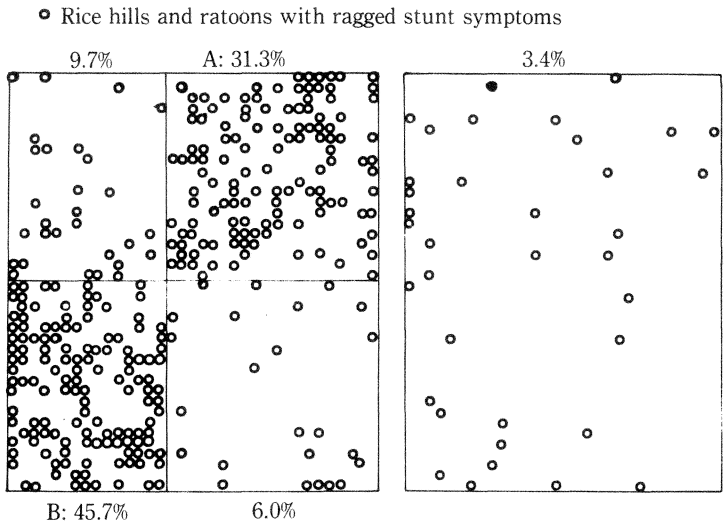

Fig. 8 High incidence of rice ragged stunt on ratoons. Rice hills in A and B plots were mowed at the booting and flowering growth stages. Diseased hills were counted at the ripening stage.

The increase in the number of diseased hills during the 40- to 80-day period suggests that the infection occurred during the first 40-day period of rice cultivation including the very early rice growth stage immediately after transplanting. Water pan traps collected some migrant populations during the early period including the day of transplanting. The natural infection appeared to occur chiefly before the immigration of the planthoppers was detected by visual counts.

During the study period, some farmers discontinued rice cultivation 2 weeks after transplanting due to the heavy infection in nurseries. Except for these few instances, during the 3-year study period, the disease appeared to progress during 40 to 70 or 80 days after transplanting.

To study the process of natural infection in the later period of rice growth, some of the plots in an experimental rice field were mowed at the booting and flowering stages of rice to promote ratoon development (Fig. 8). Rice hills showing symptoms of the disease were counted on the 106th day. Higher ratio of rice hills with symptoms was observed on ratoons. Infections in treated plots and untreated plots could be considered to have occurred before the 65th day from transplanting, if the incubation period lasted 40 days. A significantly high rate of infection without distinct disease symptoms seemed to have occurred in the late tillering stage or in the booting stage. Significance of these diseased hills without symptoms for rice yield and for the acquisition of pathogens by the emigrating vectors has not been studied.

Fluctuations in the disease incidence

A severe epidemic of rice ragged stunt was observed in vast areas of the Central Plain in the rainy season of 1980. The disease incidence at Bangkhen and the number of viruliferous migrants of brown planthopper as determined by light trap catches and inoculation tests also showed a sharp rise (Fig. 9, Fig. 10). Rapid spread of the disease over wide areas may be due to the dispersal flight of the vector. In the Central Plain, rice cultivation was intensively practiced throughout the year due to the development of irrigation systems. No particular pattern in the seasonal fluctuations of disease incidence and vector populations was recognized.

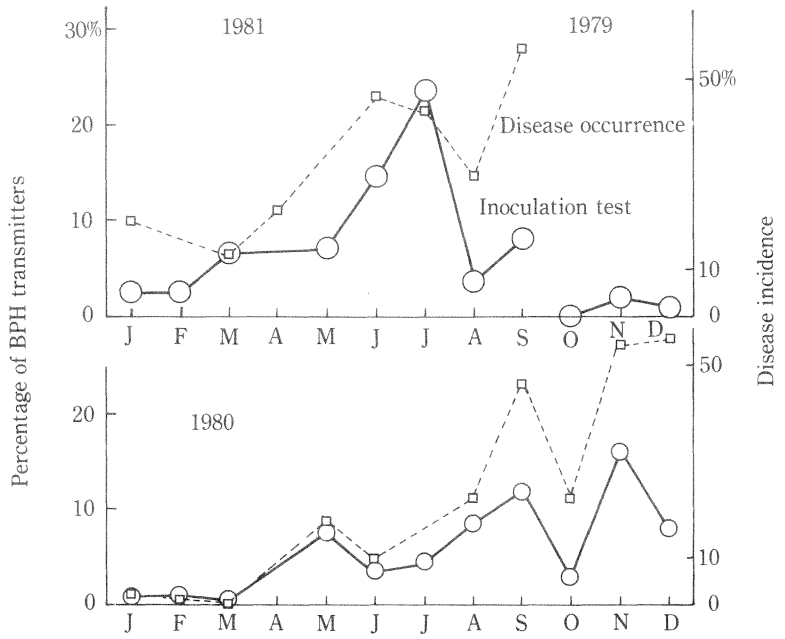

Fig. 9 Relationship between the ratio of viruliferous brown planthoppers collected by a light trap and the incidence of rice ragged stunt in rice fields transplanted in each month at Bangkhen, Thailand. Thick line: Percentage of viruliferous brown planthoppers; broken line: Disease incidence.

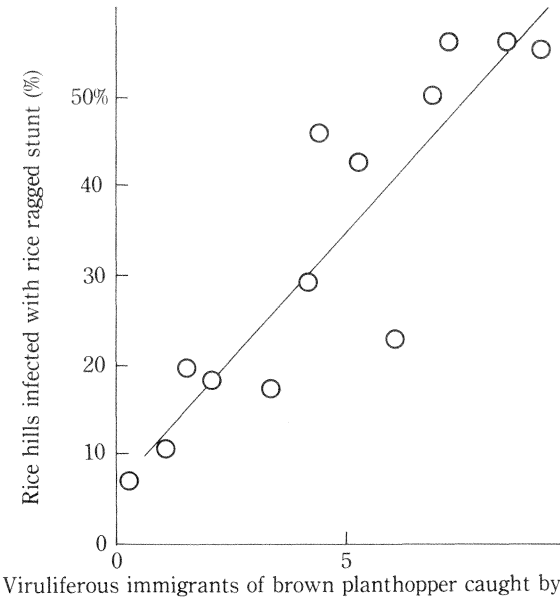

Fig. 10 Relationship between the incidence of rice ragged stunt and the immigration of brown planthopper. Infected rice hills were counted 60 to 70 days after transplanting. The number of viruliferous immigrants was determined by water pan traps and inoculation tests of brown planthoppers collected by light trap.

References

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Discussion

Mochida, O. (IRRI): It appears from your report that even if there is a large population of hoppers they may not be caught in the trap if the wind velocity is low. Therefore your comparison of the data on net trap catches between Thailand and Indonesia where the wind conditions are different may not be valid.

Answer: The same difference between the two countries was observed in visual counts of initial populations in rice fields, supporting the view that the populations of migrants in Java are much lower than in Thailand. Although I did not check the wind velocity and other meteorological factors, I believe that the difference observed must be ascribed to the difference in planting types, namely synchronous transplanting over large areas in Indonesia and continuous cropping in the Central Plain of Thailand.

Tantera, D.M. (Indonesia): You reported significant differences in the data between Java and Thailand which you attribute to differences in planting type pattern. For simulation or for monitoring the peak of insect population, what is preferable the staggering planting type system or the synchronous planting type system?

Answer: To protect rice from direct infestation of brown planthoppers, continuous cropping of resistant varieties over a wide acreage is preferable. For the prevention of virus diseases synchronous planting is better.

Tantera, D.M. (Indonesia): In Indonesia, we recommend the synchronous type of planting.

Mochida, O. (IRRI): What is the best way to monitor hoppers so as to prevent the occurrence of virus diseases?

Answer: For research purposes, the use of water pan traps is recommended for the brown planthopper and sticky traps for the green leafhopper to detect early immigrants.

Kishimoto, R. (Japan): The present work clearly indicates that the population process of the brown planthopper of the temperate zone type may occur in the tropics under certain conditions including the cultivation of susceptible varieties. In the tropics it had long been assumed that BPH immigrate into paddy fields from generation to generation and that the damage is related to the density of immigrants in each generation. In the temperate zone the population build-up starts with a few immigrants of the long-wing form, followed by one to two generations of short-winged females and finally clear and round hopperburns occur in the part of the field where the short-winged females are located. The rate of increase is usually high and consequently the economic injury level should be set at a lower level compared with that in the tropics.

Mochida, O. (IRRI): With regard to the origin of the immigrants you seem to refer to a situation

where rice is cropped continuously. However in most of the areas of the tropics there is only one crop of rice each year, as in Japan.

Anjaneyulu, A. (India): The brown planthopper is very important both from the standpoint of a pest and of a vector which transmits at least two or three virus diseases. The green leafhopper causes less direct damage to the plant but is an important vector of virus diseases. I believe that further studies on vector ecology, including vector control and resistance should be promoted.