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# SURVEILLANCE AND CHEMICAL CONTROL OF THE BROWN PLANTHOPPER【Research report】

## 褐飛蝨之管制與化學防治【研究報告】

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## Abstract

Early season rice plants (mid-April─early August) are cultivated on 8,000 ha and normal season ones (early June-October) on 30,000 ha in Kagoshima Prefecture located at the south-western tip of apan. General forecasting work for rice and vegetables is carried out by two researchers at the experiment station and 10 technical officers at three plant protection offices. Light taps, rborne net traps and sticky traps are used for catching brown planthopper immigrants from overseas during the rainy season (June-July). Besides, there are nine surveying points equipped with light trap over the prefecture. Monitoring observations at 100 fixed points are carried out twice a month during the cropping season. After the establishment of immigrants in rice fields, the temperature-sum rule is applied to predict the appearance of insect stages in the subsequent generations, and thus the timing of insecticide applications is determined in advance. The incidence of grassy stunt disease can be perdicted when immigrants come from the more southern part of China mainland, south to 25 N lat. In the standard control measures, insecticides are usually applied twice at 10-day intervals during late August to early Septmber for the suppression of hopperburn. Additional applications of insecticides are practised in the form of simulltaneous control when the outbreak of the leafroller occurs or the long-lasting heat prevails in late summer. Owing to planthopper resistance to insecticides, carbamate and phosphorus insecticides have been replaced by the mixtures of these insecticides.

## 摘要

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# Surveillance and Chemical Control of the Brown Planthopper

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## ABSTRACT

Early season rice plants (mid-April – early August) are cultivated on 8,000 ha and normal season ones (early June-October) on 30,000 ha in Kagoshima Prefecture located at the southwestern tip of ¨apan. General forecasting work for rice and vegetables is carried out by two researchers at t ie experiment station and 10 technical officers at three plant protection offices. Light traps, .rborne net traps and sticky traps are used for catching brown planthopper immigrants from overseas during the rainy season (June-July). Besides, there are nine surveying points equipped with a light trap over the prefecture. Monitoring observations at 100 fixed points are carried out twice a month during the cropping season.

After the establishment of immigrants in rice fields, the temperature-sum rule is applied to predict the appearance of insect stages in the subsequent generations, and thus the timing of insecticide applications is determined in advance. The incidence of grassy stunt disease can be predicted when immigrants come from the more southern part of China mainland, south to 25° N lat. In the standard control measures, insecticides are usually applied twice at 10-day intervals during late August to early September for the suppression of hopperburn. Additional applications of insecticides are practised in the form of simultaneous control when the outbreak of the leafroller occurs or the long-lasting heat prevails in late summer. Owing to planthopper resistance to insecticides, carbamate and phosphorus insecticides have been replaced by the mixtures of these insecticides.

## Introduction

Kagoshima Prefecture is located at the southwestern tip of Japan and has suffered from the outbreaks of insect pests of rice, especially long-distance migrants such as the planthoppers and the leafroller. Kagoshima, thus, has a long history to struggle for the outbreaks of these pests, especially the brown planthopper, *Nilaparvata lugens* Stål.

This paper outlines surveillance and chemical control of the brown planthopper only in Kagoshima Prefecture. As has well been known in recent years, the brown planthopper can not survive the winter season and is renewed every year in the temperate region of Asia by its immigrants from southwestern overseas (Kisimoto, 1971 and others).

## Outline of Kagoshima Prefecture

Kagoshima (9,163 km$^2$) extends from 32°18′N to 27°10′ lat., 586 km from south to north, including three major islands in the south: Tanegashima, Yakushima, and Amami-Oshima (Fig. 1). The annual mean temperature ranges from 15°C to 23°C. In Kagoshima mainland, major crops are rice on 38,000 ha, sweet potato on 20,000 ha, and fruit and tea on 15,000 ha, while sugarcane is widely cultivated on 15,000 ha in the subtropical southern islands.

There are two crop seasons for rice culture. Early season rice plants are cultivated on 8,000 ha in the southern coastal area and normal season ones on 30,000 ha in major area. The following is the cropping season arranged in order of the periods of transplanting, heading, and harvesting:

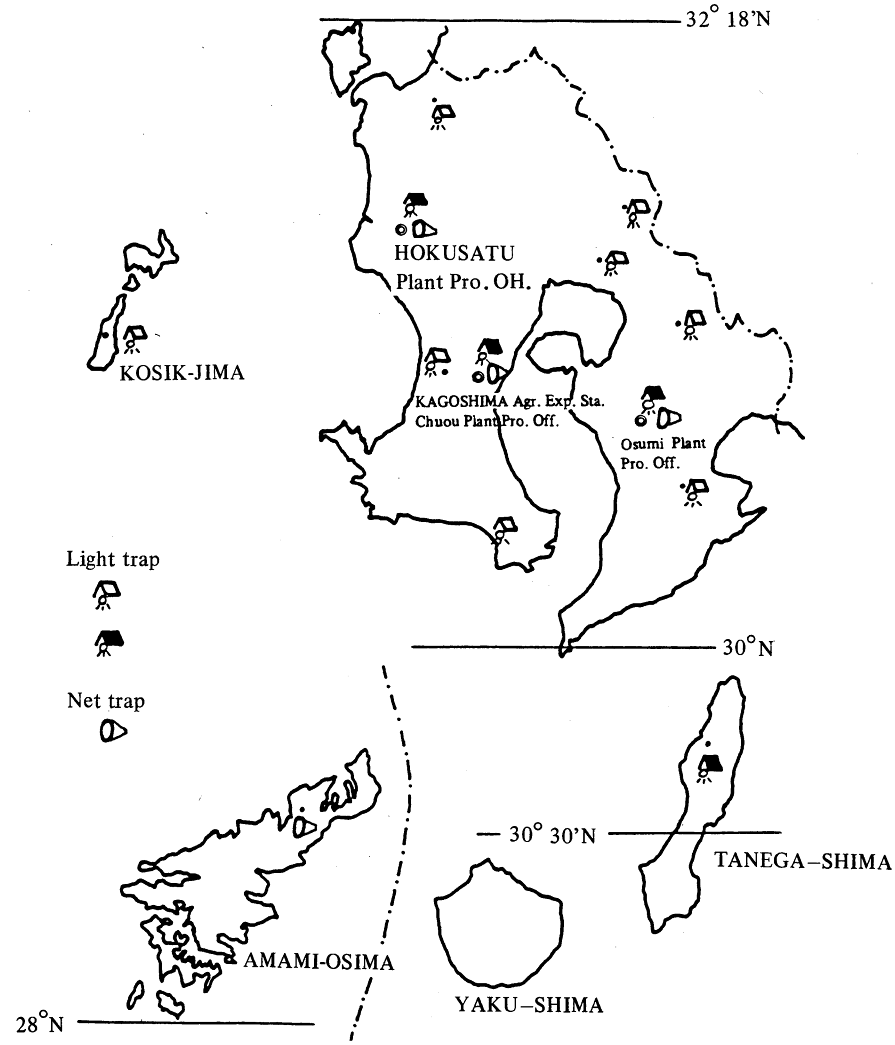



**Fig. 1.** Locations where traps are equipped for forecasting plautbopper migrants in **Kagoshima Pref.**

Early season culture: mid-to late April, late June to early July, and late July to early August.

Normal season culture: early to mid-June, late August to early September, and October.

Damage caused by the brown planthopper occurs usually in the normal season culture, but occasionally in the early season culture only when the immigrants population is extremely large in the former half of June.

## Surveillance Activity

Forecasting programs are carried out by "Details for the Enforcement of Disease and Insect Pest Outbreak for Ordinary Crops and Vegetables" established by the Government of Japan, and more detailed programs adaptable to Kagoshima Prefecture are also taken into practised. The number of staff members including forecasting for vegetable pests is two researchers at the agricultural experiment station and 10 technical officers in all at three district plant protection offices: Kagoshima, Sendai, and Osumi. In addition, there are nine representative surveying points over the prefecture (Fig. 1).

**General equipment for catching planthopper immigrants**

The following equipment is ordinary used for catching planthopper immigrants: a light trap (60W), an airborne net trap (lm in diameter) at a height of about 10 m above the ground, and a sticky trap (80 x 25cm) at the palnt height in the field. Additionally, there is an obervatory rice field where representative varieties are planted without pesticides. All the above-mentioned equipment are owned both at the experiment station and at the nine surveying points (Fig. 1).

### *Fixed point investigation*

Light trap records are taken every day throughout the cropping season from April to October at the experiment station and the plant protection offices, but only during the planthopper immigration period from June to July 20 at the surveying points or sometimes to the end of July when the rainy season lasts longer than usual. Airborne net traps are used during the immigration period at the experiment station and the plant protection offices. At the experiment station, different kinds of light sources are used in addition to the ordinary traps, presenting a lot of information about planthopper immigration. Field observations are also conducted nearly every day by visual counting, net sweeping, etc. during the immigration period.

### *Monitoring observation*

Squares of 1 $km^2$ are drawn on a map (1/5,000) and each fixed point per 1 $km^2$ is set when paddy fields account for more than one-second of 1 $km^2$. A total number of fixed points over the prefecture are 26 for the early season culture and 100 for the normal season culture. Monitoring observations over the district are extensively carried out by the technical officers at each fixed point and simultaneously at four or five points near each fixed point. Regular investigations are carried out twice a month (4th-6th and 19th-21st) about the status of major diseases and insect pests.

Beside the standard method, the following are carried out especially for the brown planthopper: visual counting and tapping rice hills on a sticky board during a month after transplanting. Twenty-five hills are sampled at random by those procedures; however, the number of sampled hills can be reduced with increasing insect population during the later season. When the population density further become high, the average number of insects per hill can be estimated by multiplying the maximum number of insects per hill by 0.4.

### *Reports*

The results of investigations and observations obtained by the technical officers are sent to the experiment station. A regular meeting is held once a month (early month) by the staff members concerned. Based on the current status of pests, forecasting and countermeasures are discussed. The information on pest forecasts consists of five reports: forecasting, caution, warning, situation of specific pests, monthly proceedings of forecasting activity, and an annual report. These information and reports are delivered to national and prefectural organizations concerned. Besides, the forecasting information at the district level is also delivered to the prefectural organizations such as agricultural extension offices and agricultural cooperatives. In Kagoshima, telephone services using tapes at the plant protection offices are available to farmers. Farmers can dial a fixed number and obtain current information on the status of pests and the suitable timing of pesticide applications at the district level. The tape is renewed every 10 days.

## Forecasting and Chemical Control

### *Forecasting outbreaks of brown planthopper*

One of the most important factors affecting the occurrence of damage is the levels of immigrant population. Therefore, the time of immigration and the population density of immigrants are recorded by traps and field surveys during the immigration period as mentioned before. As shown in Table 1, the total numbers of brown planthopper immigrants trapped are remarkably different in years, showing a maximum of several hundred-folds between 1981 and 1982. In addition, the levels of immigrant population differ among the periods in the same years, e.g. major immigration occurred in the latter half of July in 1982 when the rainy season lasted abnormally longer upto the end of July. In contrast, there were two major outbreaks of immigration in 1980: one occurred upto June 25 and another in the latter half of July. When the major immigration occurs earlier, more one generation can repeat until rice harvest, causing vigorous reproduction of the insects and resulting in the severe outbreaks of plant damage.

After the establishment of immigrants in rice fields, the temperature-sum rule is applied to predict the appearance of each insect stage in the fields (Fig. 2). The following threshold temperatures are used: 12°C for adults for

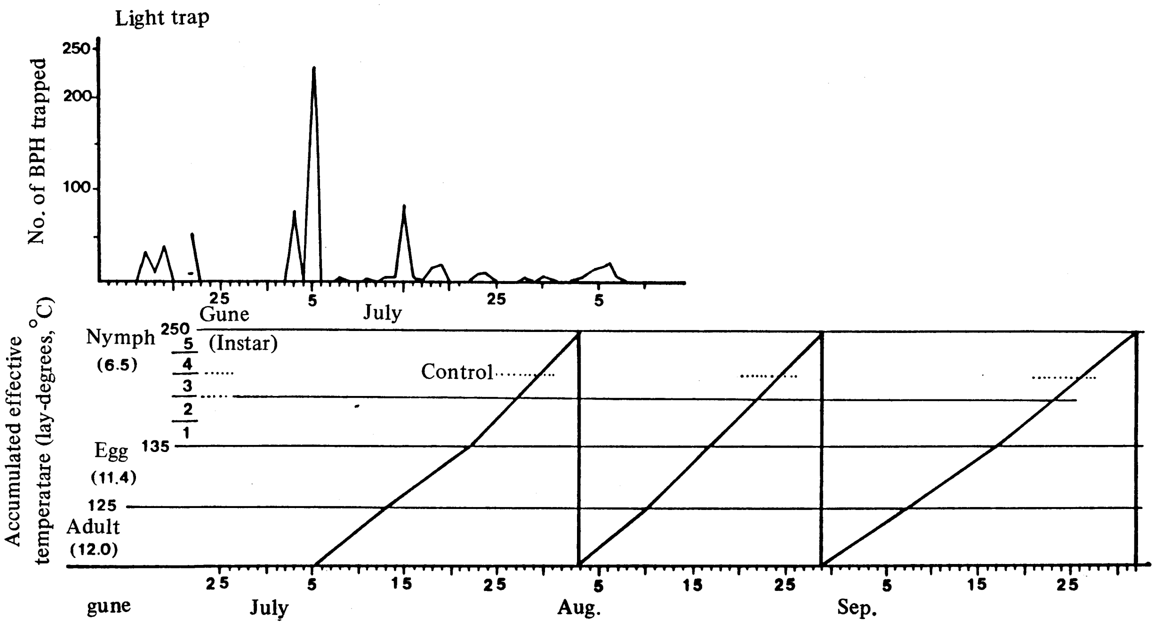



**Fig. 2.. Prediction of seasonal appearance of insect stages in the field by the temperature-sum rule (1983). Figures in parentheses show threshold temperature (°C) for each insect stage.**

oviposition, 11.4°C for eggs, and 6.5°C for nymphs. The sums of effective temperatures above the threshold are as follows: 125 days-degrees (°C) for oviposition, 135 day-degrees for the incubation period, and 250 day-degrees for the nymphal period (Fukamachi, 1979). In this case, the daily mean temperatures in normals are used; however, we should modify to some extent with real temperatures observed. Thus, the timing of insecticide application can be predicted in relation to insect stages.

In a few years there is no coorelation between the population levels of immigrants and the outbreaks of damage (Fig. 3). This fact suggests that many factors may affect the growth of insect population and the resultant occurrence of damage. One of the factors is temperature prevailing during late summer to autumn; the temperature factor is taken into consideration to predict the outbreaks of damage.

## *Forecasting grassy stunt disease*

The occurrence of grassy stunt disease was for the first time recognized in Kagoshima in 1978 (Iwasaki and Shinkai, 1979). Since then, the disease has occurred every year though its incidence fluctuated in years: the 1979 outbreak was the severest in the past six years. To predict the levels of the disease in the field, numerous

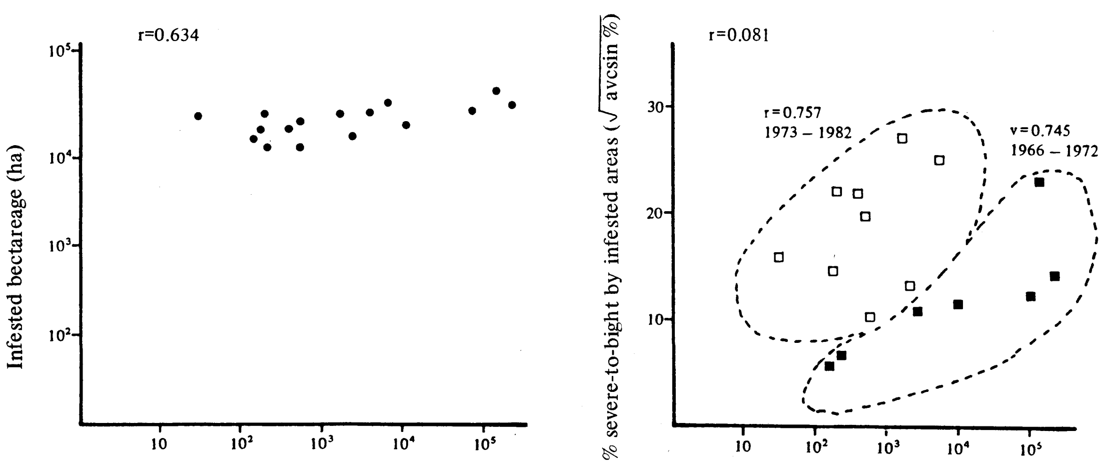



Fig. 3 Relationship between abundance of immigrants and infested bectareage.
**Abundance of immigrants**
No. of individuals captured by a light trap during the immigration period

numbers of immigrants were collected by traps and from the field, and they were tested on infectivity for several years. The results showed extremely low proportions of viruliferous immigrants, suggesting uselessness for forecasting the degrees of the disease incidence.

The periodic net-covering tests in the rice field were tried to observe what kinds of immigration waves were closely associated with the occurrence of the disease. The 1982 results showed that, among four waves of immigration observed in Kagoshima, the disease incidence was the highest in an immigration wave of July 6-8 (1st wave) as shown in Fig. 4 (Fukamachi and Izumi, 1983). The population of the first wave was not large compared with that of three others. The results also indicate no correlation between the incidence of the disease and the population density of immigrants. According to the weather maps that year, the first wave was supposed to come from the more southern part of China mainland, south to 25°N lat. (Fig. 5), while other waves were from the more northern part. From the same point of view, when referred to the 1979 and 1980 results, the above-mentioned conclusions were also confirmed.

It is usual that the earlier immigrants tend to come from the more southern part, and thus one should be careful of the outbreaks of the disease when immigration occurs earlier, probably earlier than July 10. This is believed to be one of the promising forecasting methods for disease outbreaks so far observed; however, current status of the disease epidemology in the different locations of China mainland has been unknown.

## *Chemical control*

The brown planthopper generally is difficult to control with insecticides in rice fields in

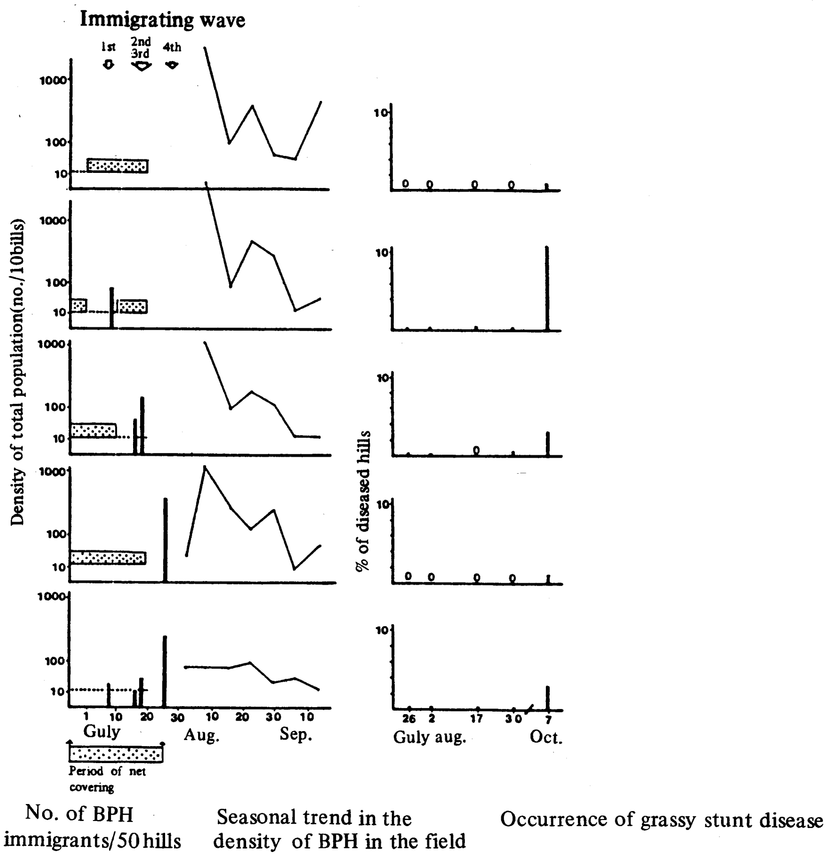



Fig. 4. Relationship between immigration waves of BPH and occurrence of grassy stunt disease (1982).
Immigrating wave 1st 2nd 3rd 4th **Density of total population (no./10hills)**

contrast to the white-backed planthopper sensitive to insecticides. Control of the brown planthopper, however, has completely been depended on the application of insecticides in Japan because no commerical rice varieties resistant to the planthopper have yet been bred. It is generally said that insecticides should be applied to the young nymphal stage which is much more sensitive to insecticides than any other stages.

Early season control measures against the nymphs produced from the immigrating adults are necessary in the normal season culture when any one of the following factors is observed.

1) More than 5,000 and 1,000 individuals per any of 5-day periods are captured by a light trap during late June to. July and during the latter half of July, respectively.
2) The source of immigration observed by a weather map is suggested to be the southern part of China mainland bellow 25°N lat. This fact suggests probable outbreaks of grassy stunt disease as mentioned before.

As to the early season culture, more than 1,000 individuals are captured by a light trap before June 20, insecticide application is necessary at 20 to 25 days after the major wave of immigration.

The control measures in the normal season culture are summarized in Fig. 6. The standard control measures in the years with the normal level of immigrants are practised as follows: insecticides are applied against the white-backed planthopper immigrants, and the effects of simultaneous control against the brown planthopper is promised by this insecticide application in the early cropping season. And then insecticides are usually applied twice at 10-day intervals during late August to early September for the suppression of hopperburn. When the outbreak of the leafroller occurs, simultaneous control with the leafroller is carried

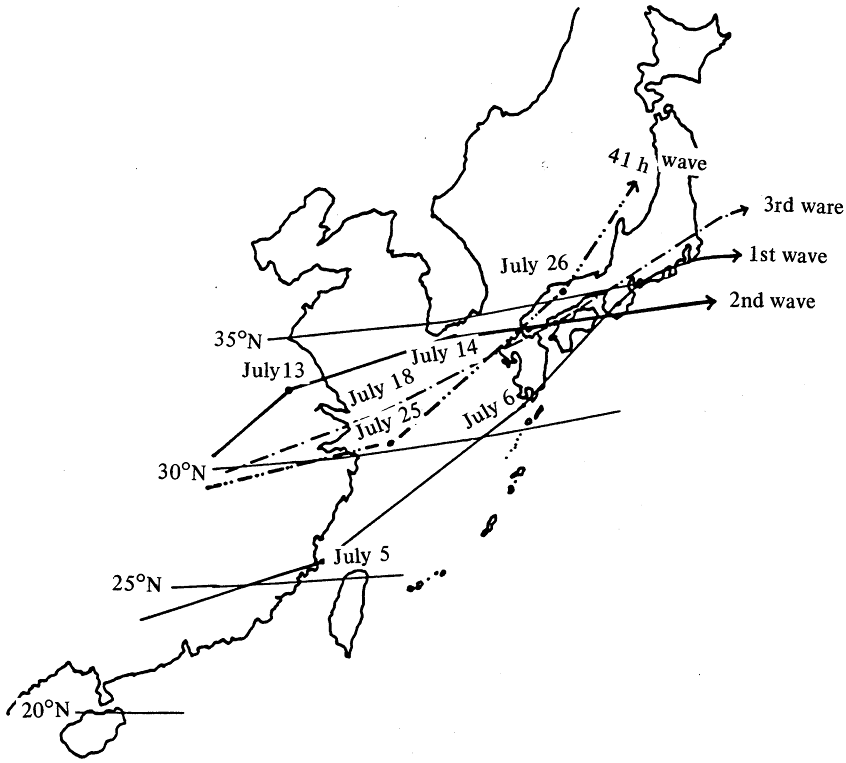



Fig. 5. Relationship between routes of depressions and occurrence of grassy stunt disease (1982).

out twice or occasionally three times during the period.

Control measures in the late season are practised when any one of the following factors is recorded:

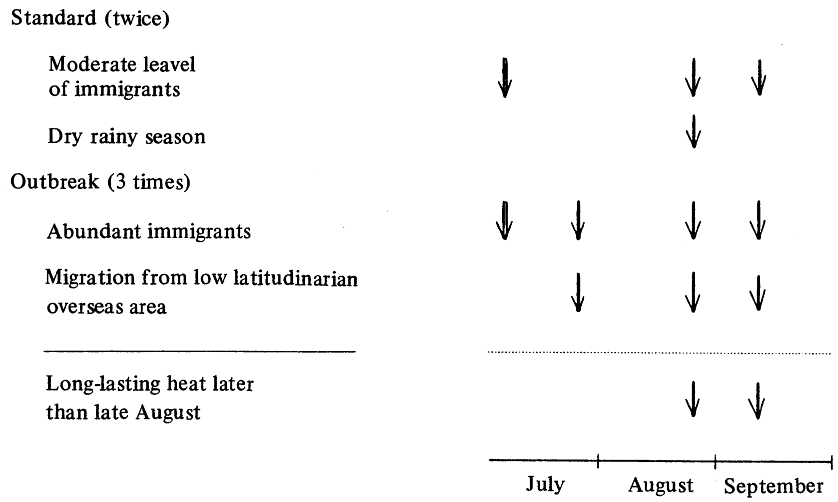
1) The long-lasting heat in late summer is predicted.
2) The report "caution" is issued, e.g. more than 5% highly-to-severely infested fields are observed.
3) The report "warning" is issued, e.g. more than 10% highly-to-severely infested fields are observed.

In relation to reports, Fig. 7 shows an example: 5.5% of fields were highly infested in the Osumi district when the surveys were conducted at a total of 54 points over the district (5,600 ha) in late August of 1983. Since the results suggested the occurrence of the outbreaks later than September (Kono, 1979), a report "caution" was issued. As a result, control measures were extensively carried out and resulted in the suppression of the outbreaks in late September.

## *Resistance to insecticide*

In recent years, there are trends in increasing the fields in number with high and severe infestations in contrast to the levels of immigrants population. Table 1 shows that insecticides are applied twice or three times only against the planthopper by using carbamates and carbamate-diazinon mixtures but five to seven times for the simultaneous control of pests with various pesticides throughout the cropping season.

One of the most important problems encountered in the control of the brown planthopper in recent years is resistance development of the insects to both carbamate and phosphorus insecticides, especially to the former (Nagata *et al.,* 1979; Fukamachi *et al.,* 1981; Kilin *et al.,* 1981; Ozaki and Kasai, 1982). The mixtures of these insecticides, however, were found effective, showing synergistic action. In 1977 carbamate and phosphorus insecticides used as single active ingredient preparations were replaced by the mixtures of both carbamate




Arrows show date of insecticide applications against white-backed (white) and brown (black) planthoppers.

Fig. 6. Control measures against rice planthoppers in the normal season culture of rice.

and phosphorus insecticides such as carbamate-malathion and carbamate-other insecticide-fungicide mixtures (Table 1). At present, these mixtures in the form of DL (driftless) dust have widely been used especially for the control of the brown planthopper because DL dust well reaches to the basal part of rice plant where the insects always inhabit. In addition, DL dust is considered to reduce environmental pollution as compared with dust.

As shown in Table 2, the efficacy of malathion-BPMC mixture against the brown planthopper fluctuated in years. It may be reasonable to say that the fluctuation might be responsible for the difference in the sources of imigrants probably originating from different locations in China mainland.

Table 1. Number of Insecticide Applications in the Izumi District, Kagoshima Pref.

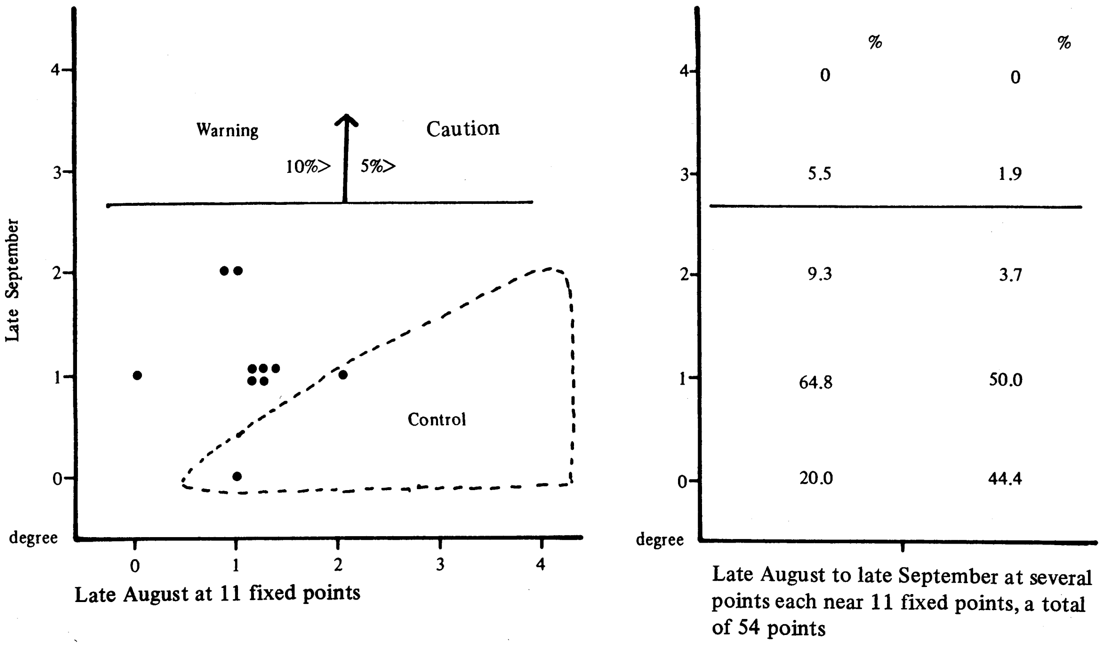
| Year | Carbamate | Carbamate + diazinon | Carbamate + fungicide* insecticide | Carbamate + malathion | Total |
|---|---|---|---|---|---|
| 1974 | 2.00 | 0.41 | 2,91 | 0 | 5.32 |
| 1975 | 2.42 | 0.65 | 4.49 | 0 | 7.56 |
| 1976 | 2.45 | 0.58 | 2.19 | 0 | 5.22 |
| 1977 | 3.22 | 0.23 | 3.92 | 0.29 | 7.66 |
| 1978 | 2.31 | 0.34 | 3.19 | 0.07 | 5.91 |
| 1979 | 1.41 | 0.44 | 2.88 | 1.06 | 5.79 |
| 1980 | 1.43 | 0.45 | 3.47 | 1.18 | 6.53 |
| 1981 | 1.55 | 0.43 | 3.35 | 1.35 | 6.68 |
| 1982 | 0.40 | 0.75 | 3.02 | 0.74 | 4.91 |

In December 1983, buprofezin, a different type of chemicals, was registered for the control of the brown planthopper. The chemical inhibits insect growth, disrupting post-embryonic development and molting, and is outstanding for its efficacy and long-lasting residual effects, showing an effective residual period of more than three weeks against the 3rd instar nymphs (Asai *et al.*, 1984). This fact promises the wide range of the timing of insecticide applications. Buprofezin has cross resistance to neither phosphorus nor carbamate insecticides (Asai *et al.*, 1984), and is expected to reduce the number of insectidide applications throughout the cropping season. In addition, field tests with buprofezin showed good control of grassy stunt disease (Hirao *et al.*, 1983).

Table 2. Efficacy of Mixture Insecticides (malathion + BPMC) in the Field

| Year | Corrected survival index [a] | | | | | | No. of insects/hill [c] |
|---|---|---|---|---|---|---|---|
| | 1st application | | | 2nd application | | | |
| | 1 [b] | 5 | 10 | 1 | 5 | 10 | |
| 1979 | 0.4 | ( Controlled ) | | | | | 0.3 |
| 1980 | 9.5 | 39.7 | 30.6 | 10.8 | 36.0 | 30.2 | 33 |
| 1981 | 15.9 | 12.2 | 55.6 | 4.9 | 0 | 7.2 | 0.3 |
| 1982 | 24.3 | 0.4 | 37.9 | 3.2 | 1.2 | 0.6 | 0.1 |
| 1983 | 59.2 | 1.8 | 2.5 | 41.1 | 214.9 | 139.4 | 28 |

a $\frac{T_a \times C_b}{T_b \times C_a} \times 100$ No. of insects before treatment ($T_b$) and after treatment ($T_a$) in treated plots, and $C_b$ and $C_a$ in check plots, respectively.
b Days after application.
c 10 days after 2nd application.




Degree: 0=non, 1=light, 2=moderate, 3=high, 4=severe.

Fig. 7. Relationship of the degree of insect occurrence between late August and late September survey (Osumi district, 1983).

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