9. RECENT STATUS OF THE RICE STEM BORER, *CHILO SUPPRESSALIS* WALKER, IN JAPAN

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Introduction

Since the organo-synthetic insecticides began to be used widely in Japan, many insect pests have changed their status in different ways. For example, the paddy borer, *Tryporyza incertulas* Walker, was a well-known menace to the rice plant until the 1950's, but it is a minor pest at the present. On the contrary, planthoppers and leafhoppers showed an increase from the 1950's to the 1960's.

The rice stem borer, *Chilo suppressalis* Walker, continued to occur severely in spite of heavy application of insecticides throughout these periods. However, it is often said that the occurrence of the rice stem borer is decreasing for the last several years in many places of our country.

In this paper, I would like to make sure this point, and reveal what is the cause of the decrease.

The Materials used for the analysis

For the purpose of the analysis, several statistics were taken up. These were the light trap records of the rice stem borer moth which were accumulated by the Prefectural Agricultural Experiment Stations, the statistics of the occurrence of insect pests and diseases, and the statistics of the application and production of agricultural chemicals. The last 2 statistics were published by Plant Protection Division, Agricultural Administartion Bureau, Ministry of Agriculture and Forestry.

Results and Discussion

1. Changes in the acreage where the rice stem borer occurred

Fig. 1 shows the last 20 years trends of the occurrence of the paddy borer, the rice stem borer, and the green rice leafhopper, *Nephotettix cincticeps* Uhler.

According to Fig. 1, the acreage where the paddy borer occurred showed a sharp decrease after 1952–'53, and this decrease just coincided with the period in which the organo-synthetic insecticides came into use widely against many insect pests. On the other hand, the occurrences of the rice stem borer and the green rice leafhopper tended to increase, although that of the rice stem borer was on the sideway trend after 1961.

The rice stem borer and the green rice leafhopper are so difficult to be controlled completely by an ordinary practice of insecticidal application that they do not decrease in number. It is said that the increases in both pests shown in the graph were supported greatly by an increase in quantity of nitrogen fertilizers applied to the rice plant. However, the occurrence of the rice stem borer during the last 5 years did not increase in parallel with the increase in quantity of nitrogen fertilizers applied.

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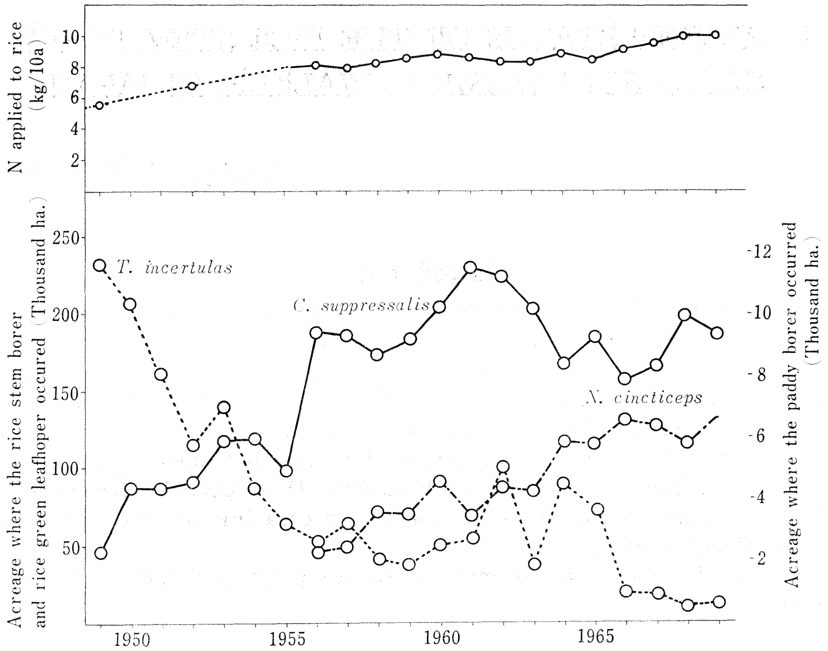

Fig. 1. Changes in the acreage where the paddy borer, the rice stem borer, and the rice green leafhopper occurred during the last 20 years.

2. Fluctuation in the number of the moths captured by a light trap

When we investigate the last 10 years fluctuation in the number of the rice stem borer moths captured by a light trap at different places, the characteristics of fluctuation will roughly be classified into 3 types; fluctuation in upward phase (Type 1), fluctuation on the same level (Type 2), and fluctuation in downward phase (Type 3). Fig. 2 shows the typical examples of these 3 types.

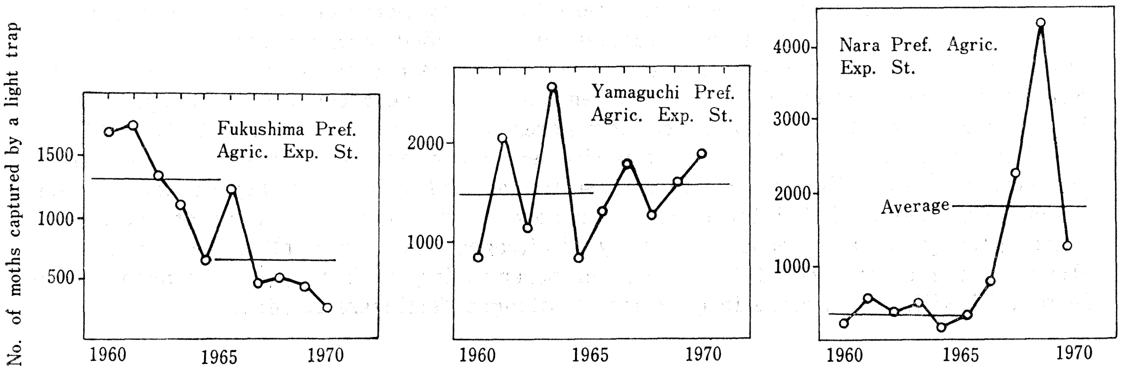

Fig. 2. Typical 3 types of fluctuation in the number of the moths captured by a light trap. The left indicates the fluctuation in downward phase, the second on the same level, and the right in upward phase, respectively.

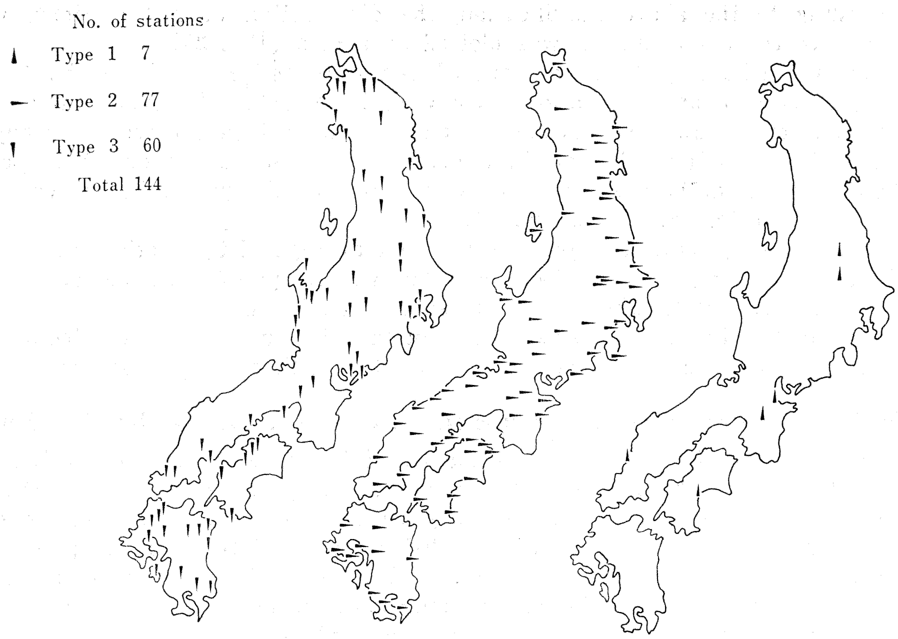

Fig. 3. The map showing the distribution of stations where type 3 (Left), type 2 (Middle), and type 1 (Right) of fluctuations in the number of the moths captured by a light trap were observed.

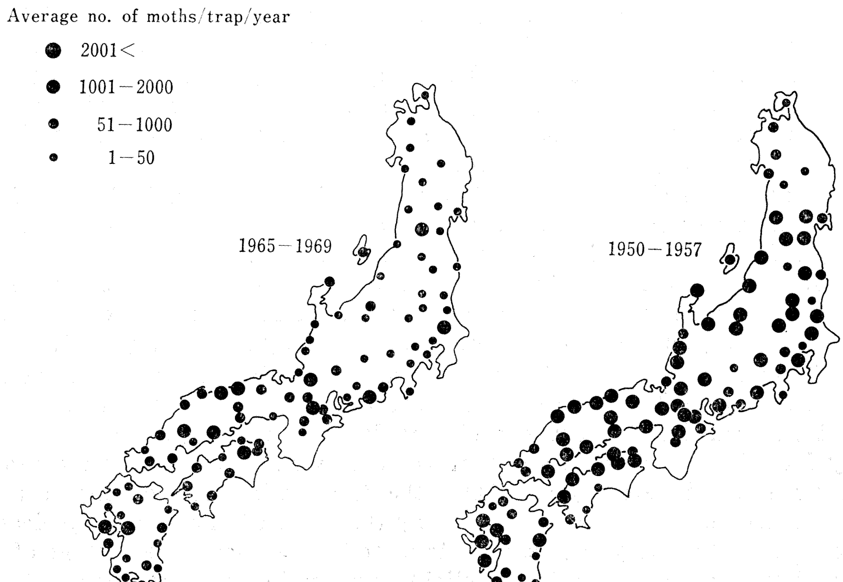

Fig. 4. A comparison of the 5 year averages of the moth number captured by a light trap in recent (left) and 21-14 years ago (right) at 95 stations scattering over this country.

According to the above classification, the distribution of 144 stations, where a light trap record was available, was plotted on a map (Fig. 3).

As shown in Fig. 3, 60 stations out of 144 were judged to have the fluctuation belonging to type 3, and 77 stations belonging to type 2. The type 1 was observed at only 7 stations. This result seems to indicate the fact that there are many places where the rice stem borer is now in a decreasing phase. However, this speculation is somewhat doubtful because the decreasing phase which appears in a wavy long-term fluctuation will be included in the type 1.

In order to make clear this point, the 5 year average of the moth number captured by a light trap for the recent period (1965–'69) was compared with that obtained about 15 years ago (1950–'57). The result was shown in Fig. 4.

According to Fig. 4, it is certain that the recent occurrence of the rice stem borer was clearly decreased in many places as compared with that of about 15 years ago.

3. The factors which cause the decrease in the occurrence of the rice stem borer

There are many factors which are suspected to cause a decrease in the number of the moths captured by a light trap. In our country, an expansion of urban areas was greatly progressed during the last 10 years at many places, so that the decrease in acreage of paddy field around the established point of the light trap occurred in many stations. In addiiton, light sources other than the light trap increased so much. These matters are considered to bring about a decrease in the number of the moths captured by the light trap standing at such places.

It has also been pointed out by many research workers that a change of cultural practice of the rice plant greatly affects the occurrence of the rice stem borer moth. For example, a mixed system of early and ordinary cultivations of the rice plant usually brings about an increase in the number of the rice stem borer moth (Miyashita, 1963), but a reverse result will be given when an ordinary cultivation system is altered to early cultivation system (Kiritani, *et al.* 1971). An introduction of some varieties of rice which are strong to the attack of the rice stem borer is said to give an important effect upon the occurrence of the insect. However, it is very difficult to trace the relationship between such changes of cultural practice of the rice plant and the occurrence of the rice stem borer at every place of the country. This is because of the lack of available data concerning with this problem.

In addition to the above mentioned factors, it is considered that there is another important factor which is also suspected to cause a decrease in the number of the moths captured by a light trap; that is the effect of insecticides.

When insecticides are used frequently in a large scale, the occurrence of some insect pests must be decreased in a certain degree. In the case of the rice stem borer, this is also expected, as has already been pointed out by Ishikura (1959).

The left-hand graph of Fig. 5 shows a reduction in larval density of the rice stem borer due to the application of insecticide observed at Kagawa Prefectural Agricultural Experiment Station. In this experiment, the densities of full grown larvae in the plot treated by insecticide and the check plot treated by no insecticides were examined at about the same date in every year. Thus, the decrease in larval density in the treated plots was considered to be mainly caused by the effect of insecticidal application. The insecticide was applied at young larval stage, so that the actual percentage of reduction in density of young larvae due to insecticidal application was not known. However, it was calculated that when we took up the density of fullgrown larvae which survived after the application of insecticides, the reduction of larval population due to insecticide was 800–100 per cent.

When these percentages of reduction calculated for the spring and summer brood

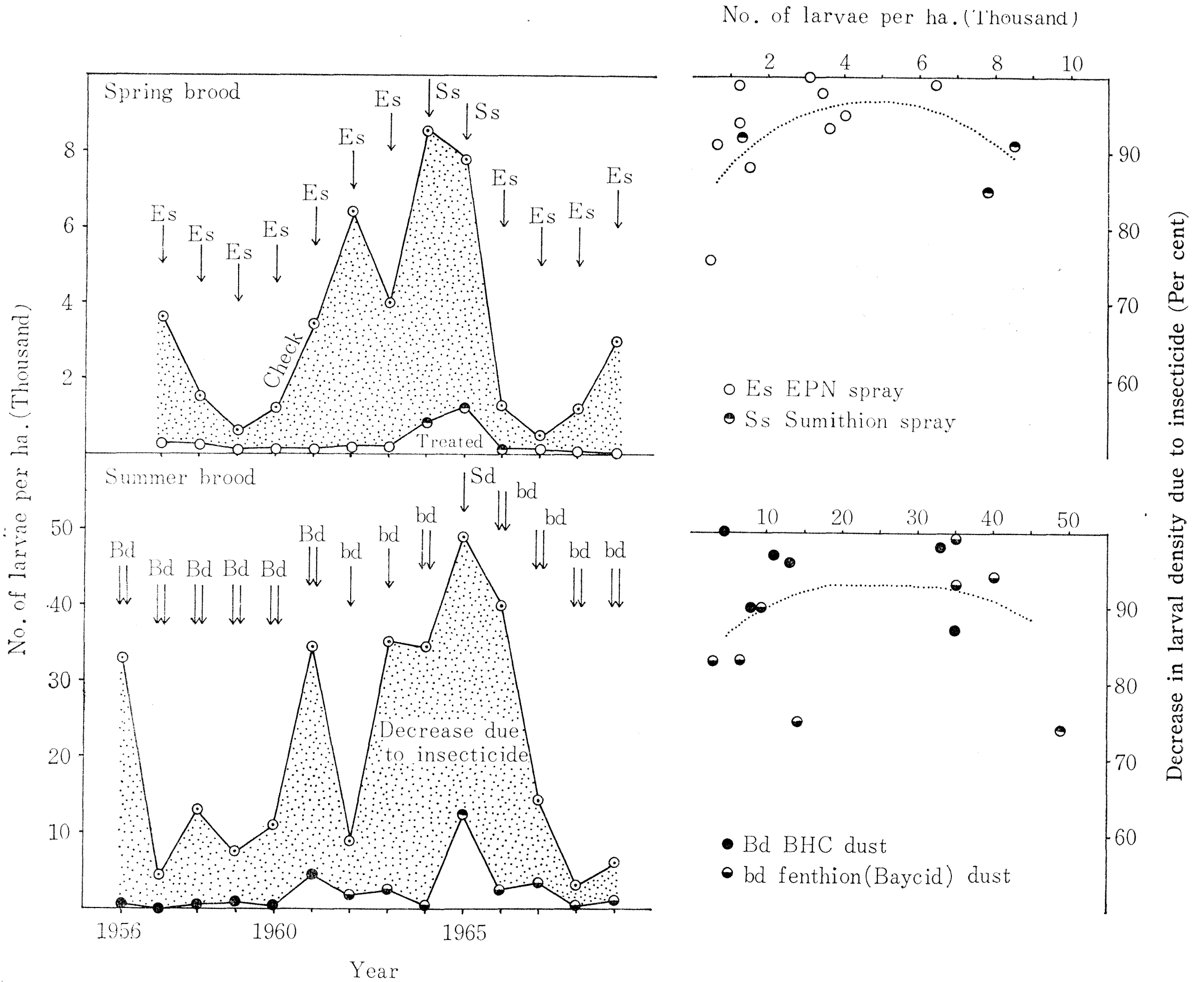

Fig. 5. A comparison of larval densities between the plot treated by insecticide and check plot (Left), and the relationship between the percentage reduction in larval density in the treated plot and the density in the check plot (Right).

of each year were plotted on the larval density observed in the check plot in respective broods, the relationship shown in the right-hand graph of Fig. 5 was given. According to this graph, the effectiveness of insecticidal application seems to be unstable when larval density is low. The effectiveness is relatively stable at the medium density, but it become unstable again as going to high density.

Considering from the result given in Fig. 5, it can be said that the application of insecticide to every brood in each year should bring about 80 per cent or more reduction in the density of moth population. However, this is quite different from an actual picture in the field. Fig. 6 shows such an example observed at a place near Fukuroi City, Shizuoka Prefecture. In this place, a large scale application of insecticide by power sprayers had begun from 1953 and continued up to 1960. As a result of this operation, the number of moths captured by the light trap standing at the place was reduced to

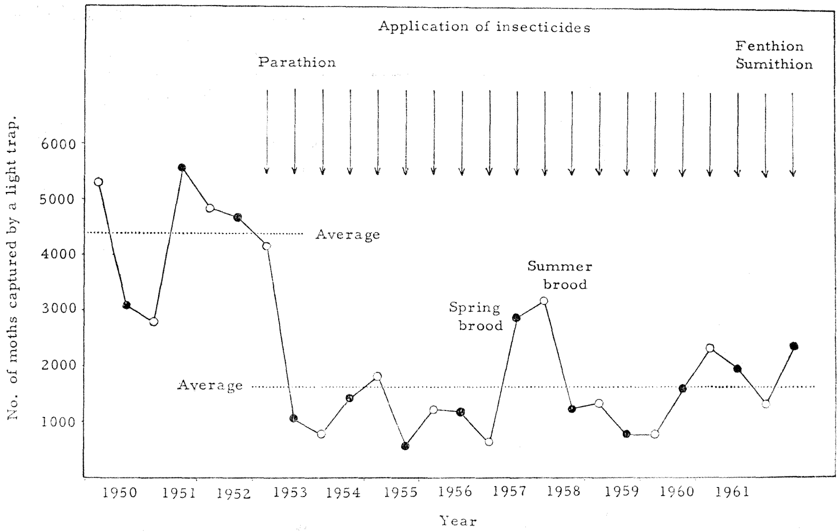

Fig. 6. The effect of large scale application of an insecticide (Parathion) upon the fluctuation in number of the moths captured by a light trap.

less than a half as compared with that of the period before the commencement of the operation. In other words, a reduction of moth population due to insecticide is about 60 per cent in the average.

Such a large scale application of insecticides had began to prevail in about 1955 in our country, and aerial application by a helicopter began in 1959 (see Fig. 7). However, the investigation of light trap records at different stations gives no sign to show the

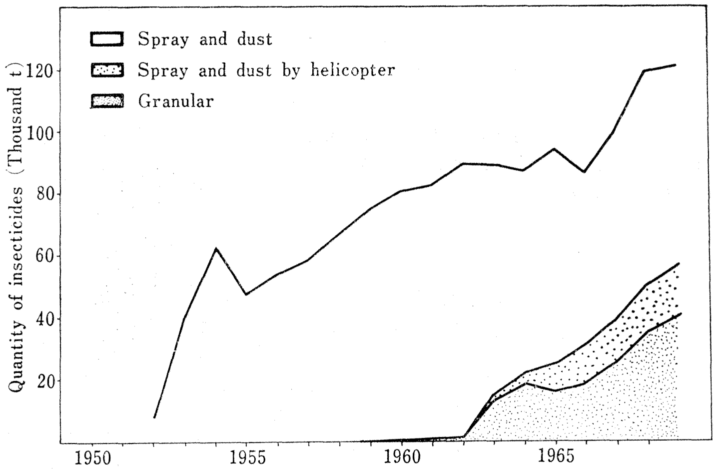

Fig. 7. A change in the estimated quantity of insecticides applied to the insect pests of the rice plant in Japan. The values in the graph were calculated in terms of powder type insecticides (30 kg per hectare×total acreage treated by insecticides). In the case of granular type insecticides, it was assumed that 80 per cent of annual production was used for the rice insect pests.

fact that a marked decrease in the number of the moths captured by a light trap at many stations occurred in connection with the popularization of these application methods.

A marked decrease in the number of the moths captured by a light trap at many stations was observed in the period after 1965. If we investigate the change in the application method of insecticides over that period, we will find that granular type insecticides have began to be used widely from 1963–4 (see Fig. 7).

It is not correct to assume that the recent decreasing trend of the rice stem borer was merely resulted from the application of granular type insecticides. However, it is natural to consider that a heavy use of insecticides, especially of granular type ones, strongly contribute to the recent decreasing trend of the rice stem borer, because the granulay type insecticides generally possess a long lasting residual effects as compared with the other types insecticides.

Summary

The recent status of the rice stem borer in Japan was investigated, mainly based on the light trap records accumulated by Prefectural Agricultural Experiment Stations and some statistics published by Plant Protection Division, Ministry of Agriculture and Forestry.

Analysis of the data presented many signs to show the fact that the occurrence of the rice stem borer during the last 5 years (1965–'69) was greatly decreased in many places as compared with that of about 15 years ago. It is assumed that a heavy use of insecticides, especially of the granular type ones, had a great contribution to the recent decreasing trend of the rice stem borer.

Discussion

J. S. Hyun, Republic of China: Your data are based on the total number of moths caught by light in a year; the total number of the first and second generation moths. What would you say on the number of the second generation moths? Are the insecticides effective to the second generation at the same degree as to the first generation?

Answer: Effectiveness of insecticides is generally high in the first generation because the plant is still small. The first generation larvae are not always killed completely even when insecticides were heavily applied, so that insecticidal spray to the second generation is needed.

F. B. Calora, the Philippines: Is it the observation in Japan that the decrease in moth population through the years corresponds to the decrease of the infestation on the crop during the growing seasons?

Answer: No.

Y. Ito, Japan (Comment, referring to the question by Dr. Hyun): In the period before the intensive use of organic insecticides, the number of moths caught by light trap and the intensity of injury to the rice crop by the rice stemborer seemed to be parallel. Since the wide use of insecticides had started, a mysterious fact was observed: while the injury by the rice stemborer decreased, especially in the south-western regions, the number of moths caught by light trap increased remarkably. However, the number of moths caught was considered to still represent the relative abundance of moths actually living in the field. Miyashita considered that the cause of this contradicted fact may be attributed to decreased larval and pupal mortality due to the destruction of a natural enemy fauna. For the most recent period, when the number of moths caught by light trap gradually decreased, detailed analysis of the record is not yet made.

K. G. Singh, Malaysia: As mentioned by you (Fig. 3), what are the reasons for the increase in the borer population in certain regions of your country?

Answer: In some places, the increase was due to the local outbreak, and in other places, it was caused by the introduction of early cultivation of the rice plant.

M. Sakai, Japan: What are the reasons for much occurrence of the borer around the year of 1960 (Fig. 1)? Your data in Fig. 6 shows the use of much amount of insecticides for many years up to this year.

Answer: I don't know exact reasons, but I think that the borer occurrence at the time was probably supported by good weather conditions.

H. Takahashi, Japan: In Fig. 5, there is a little increasing trend of population inspite of the very rapid increase of insecticidal use in Fig. 6. Do you think the insecticides can control the population ultimately in future?

Answer: It is a very difficult question to answer, but I think it will depend on the amount, kind, and frequency of application of insecticides used.

K. S. Kung, Republic of China: What is the relationship between the number of moths captured by means of light-trap and the actual number of moths in the paddy field?

Answer: This point was not determined yet, but we consider that the moth number captured by light trap is a reflection of actual density of adults living in the field.

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