*Effect of Organic Phosphorous Insecticides Applied for Rice Stem Borer Control on the Leafhopper-Association in Paddy Fields**

Masatake SHIBUYA

(*Laboratory of Insect-pestology*)

I. Introduction

It is a matter of interest from the ecological point of view to ascertain that when an insecticide is applied on crops to control a certain insect pest, how it affects the population of other pests of the same crops. The present investigation was undertaken with a view to demonstrate the effect of the organic phosphorous insecticide applied at right time for control of the rice stem borer, *Chilo suppressalis* WALKER, on the succession of the leafhopper-association in paddy fields.

II. Method

Investigations were carried out on the Kagoshima Agricultural Experiment Station farm at Taniyama-chō in 1954 and 1955.** The experimental field had a total acrage of about 1/2 acre and was divided into subequal two plots, each consisting of two larger and one smaller sections. One plot was sprayed and the other was unsprayed for a check. In 1955 the smaller section in each plot was omitted from the investigation. Rice plants (Nōrin No. 18) were transplanted on July 2, in 1954 and on June 26, in 1955. In order to get the best results for the borer control, the insecticide was applied once during a period of the first brood of the borer and twice during the second brood. Insecticides used, dates of application, concentrations and rates are given in Table 1.

Table 1. The schedule of the application of the insecticide

Date of application		Insecticide applied	Concentration (%)	Rate (gal/acre)
	July 21	Parathion emulsion	0.05	80
1954	Aug. 25	〃	0.1	200
	Sept. 1	〃	〃	〃
	July 21	Diazinon emulsion	0 2	80
1955	Aug. 23	〃	〃	200
	Aug. 31	〃	〃	〃

* This work was performed by the grant-in-aid from the Ministry of Education.

** I wish to express my hearty thanks to Mr. S. Itoga, the chief of the division of plant protection, the Kagoshima Agricultural Experiment Station, for the kindness in allowing me to deal with the experimental field at will.

Population size of insects was determined by a sampling method: insects in each section were sampled by 20 sweeps with an insect net (36 cm in diameter) along the peripheral dikes of each section excepting the boundary between two plots.

Census was carried out 17 times from July 21 to October 18 in 1954: 14 times regularly at intervals of about a week and 3 times additionally, once the following day of every application of the insecticide, while in 1955 regular census was only done 8 times every ten days irrespective of dates of the application from July 15 to September 26.

From the census samples the specimens composing the leafhopper association, including the egg-parasite of the leafhoppers, *Anagrus* sp., were selected and enumerated. Of leafhoppers, adults of the green rice leafhopper (*Nephotettix bipunctatus cincticeps* UHLER), the white back planthopper (*Sogata furcifera* HORVÁTH) and the brown planthopper (*Nilaparvata lugens* STÅL) as well as nymphs of the green rice leafhopper were recorded separately, but the records for nymphs of the two kinds of planthoppers mentioned above were collectively treated as "nymphs of the planthoppers," for they, especially the first and the second instars, were difficult to be identified owing to their desiccation and shrinkage. In addition, the records for several other leafhoppers of less economic importance were lumped together as "miscellaneous jassoids" or "miscellaneous flugoroids" according to their position of classification. Thus the leafhopper association including the egg parasite was here classified into eight categories.

III. Results

1. *The effect of the insecticide on the population density of the leafhopper association*

The flactuations of the abundance of each category in the sprayed and the unsprayed plots are shown in Fig. 1. in logarithmic scale.

Though the rough comparison of the population density of each category of two plots at each census can be made by the direct examination of Fig. 1, the difference of the density of each category between two plots may be precisely evaluated by the deviation-from-mean of the probability of its distribution in either plot, which is the percentage of total individual number of the category collected at each census and obtained at the level of 90 % confidence. If the mean value (50 %) falls within the range of the probability, the deviation is regarded as zero, indicating that the densities of the two plots are not different from each other; if the lower limit of the range exceeds 50 %, the positive deviation is estimated by the difference between them, meaning that the population density of the plot is greater than that of the other; and if the upper limit does not reach 50 %, the negative deviation is calculated by the difference between them, the density of the plot proving to be less than that of the other. The deviations-from-mean of the probability of distribution of each category at class intevals of 10 % in the sprayed plot are given in Table 2.

According to Table 2 the influence of the insecticide on the population density of the main component categories of the association will be considered.

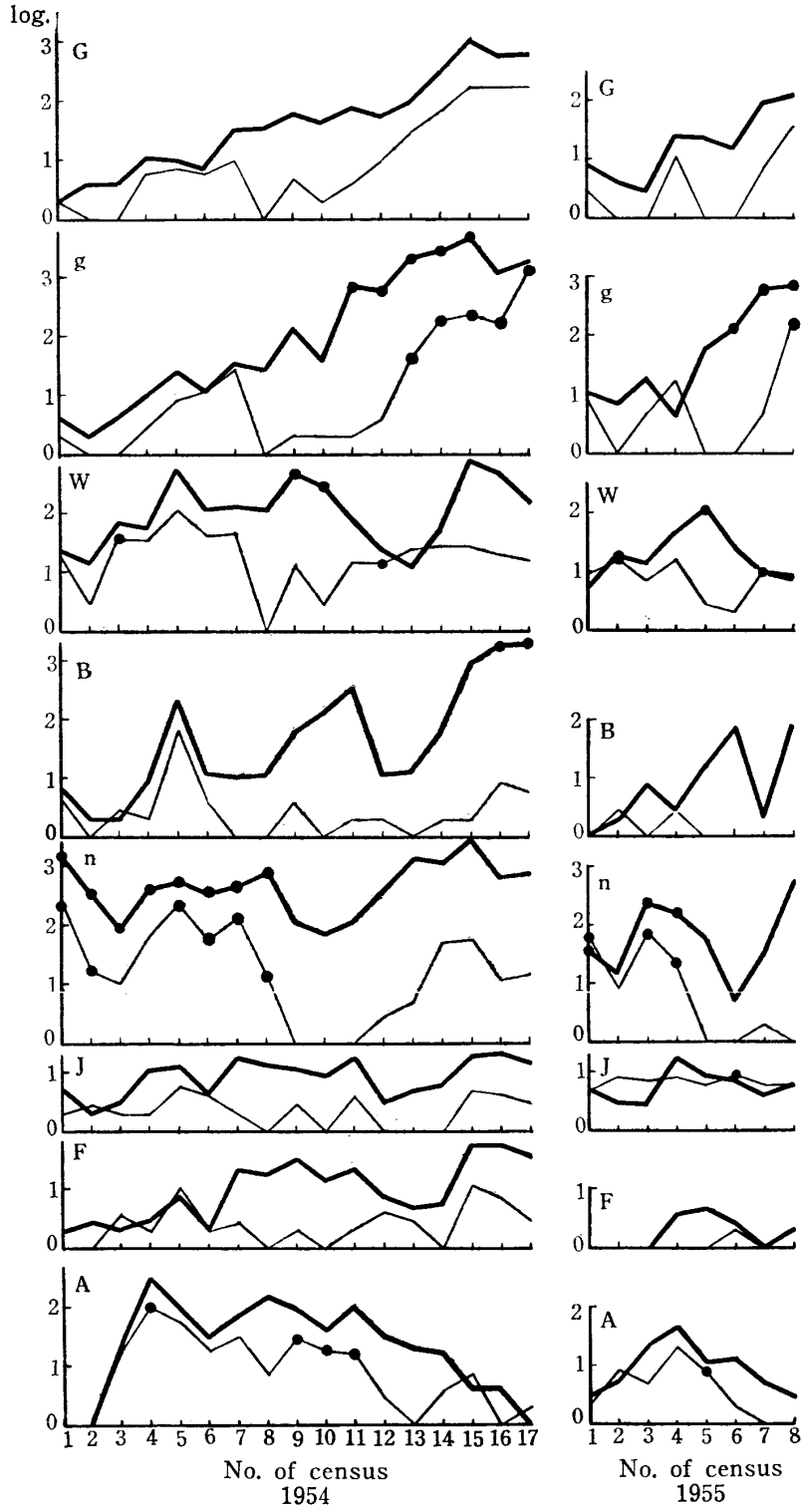


Fig. 1. Fluctuations of the specimens of each category collected by 60 sweeps in 1954 and 40 sweeps in 1955 (in logarithmic scale).

Thick line: the check plot, thin line: the sprayed plot; No. of census corresponds to the date in Table 2; Roman letters refer to the names of categories abbreviated in Table 2; a black circle points out a dominant category of each plot at each census.

Table 2. The deviations-from-mean of the probability of distribution of each cateogory at class intervals of 10% in the sprayed plot

No. of census	Date of census	G*	g	W	B	n	J	F	A
1	21/VII, '54	0	0	0	0	−4	0	0	/
2	22	0	0	−2	0	−5	0	0	/
3	28	0	0	−1	0	−4	0	0	0
4	4/VIII	0	−1	−1	−2	−4	−2	0	−3
5	11	0	−2	−4	−3	−2	−1	0	−1
6	19	0	0	−2	−1	−4	0	0	−1
7	25	−2	0	−2	−3	−3	−3	−3	−2
8	26	−5	−4	−5	−3	−5	−3	−4	−5
9	1/IX	−4	−5	−5	−4	−5	−1	−4	−2
10	2	−4	−4	−5	−5	−5	−2	−4	−1
11	9	−5	−5	−3	−5	−5	−2	−4	−4
12	15	−3	−5	0	−2	−5	0	0	−4
13	22	−2	−5	+1	−3	−5	−1	−3	−4
14	29	−3	−5	0	−4	−5	0	0	−2
15	6/X	−4	−4	−5	−5	−5	−2	−3	0
16	13	−3	−2	−5	−5	−5	−3	−4	0
17	18	−3	−1	−4	−5	−5	−2	−4	0
1	15/VII, '55	0	0	0	/	+1	0	/	0
2	25	0	−2	0	0	0	0	/	0
3	5/VIII	0	−2	0	−2	−3	0	/	−3
4	15	−1	+2	−2	0	−4	0	0	−1
5	25	−4	−5	−5	−4	−5	0	−1	0
6	5/IX	−4	−5	−4	−5	−1	0	0	−3
7	15	−4	−5	0	0	−4	0	/	−1
8	26	−2	−3	0	−5	−5	0	0	0

* G: adults of the green rice leafhopper, g: nymphs of the same, W: adults of the white back planthopper, B: adults of the brown planthopper, n: "nymphs of planthoppers," J: "miscellaneous jassoids," F: "miscellaneous flugoroids," and A: *Anagrus* sp.

In 1954 the remarkable reduction of the density of both "nymphs of the planthoppers" and adults of the white back planthopper which were predominant categories took place and lasted about one month after the first application of the insecticide. As a result of the second and the third applications the densities of both adults and nymphs of the green rice leafhopper, the white back planthopper and the brown planthopper were conspicuously reduced, though the density of nymphs of the green rice leafhopper was apt to increase in October and that of adults of the white back planthopper to increase temporarily in the latter half of September. It was noteworthy that the density of the brown planthopper in the sprayed plot did not increase to the last so much as to cause any appreciable

damage of rice plants, in contrast with the heavy infestation in the check plot resulting in the serious damage.

In 1955 much the same effect of the applications on the population density of each category as in the preceding year was observed until late September when the investigation was brought to an end.

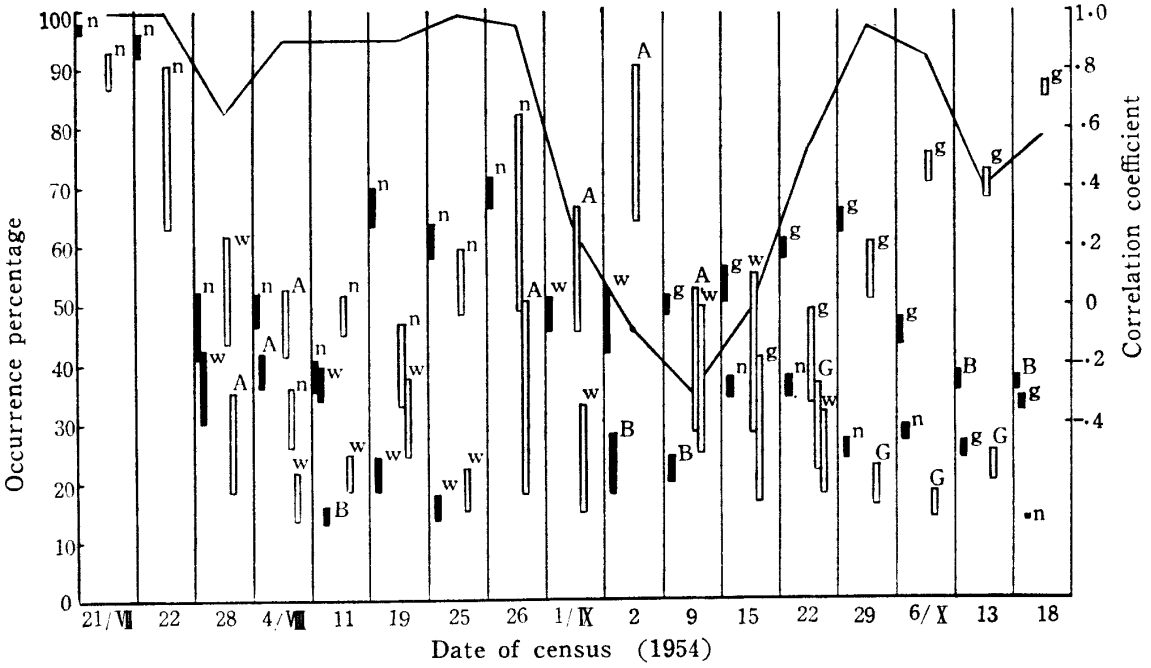


Fig. 2a. Ranges of occurrence percentage of dominant and subdominant categories of each plot at each census and correlation coefficients between the simultaneous associations of two plots in 1954. Blackbar : a check plot, white bar : a sprayed plot.

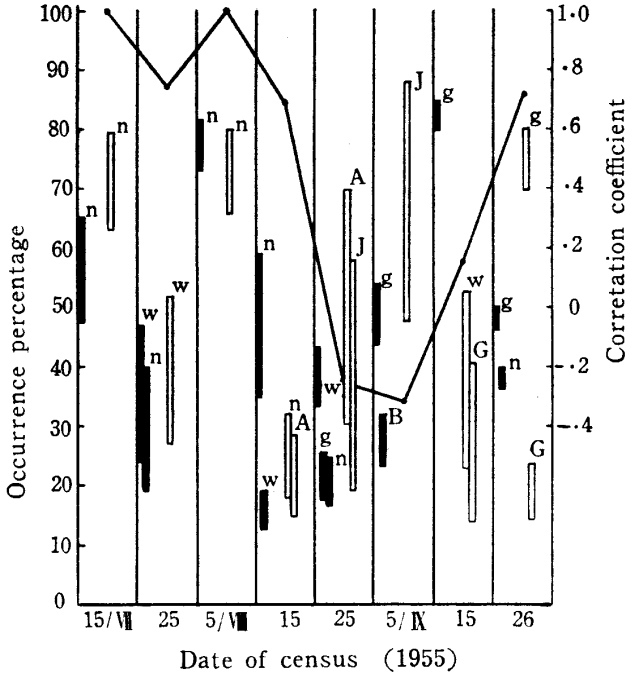


Fig. 2b. Ranges of occurrence percentage of dominant and subdominant categories of each plot at each census and correlation coefficients between the simultaneous associations of two plots in 1955.

2. *Effect of the insecticide on the relative constitution of the leafhopper-association*

The relative abundance of each component of the association was determined by the range of occurrence percentage at the level of 90 % confidence. The category having the lower limit of the range which was over 12.5 % (a mean value of occurrence of eight categories concerned) was considered as a dominant or subdominant one. In Figs. 2 a & b, are presented only the ranges of occurrence of such categories.

As known from these figures the dominant and the subdominant categories of the simultaneous associations of two plots were not necessarily the same, suggesting that the reduction of the population caused by the application of the insecticide was specifically variable.

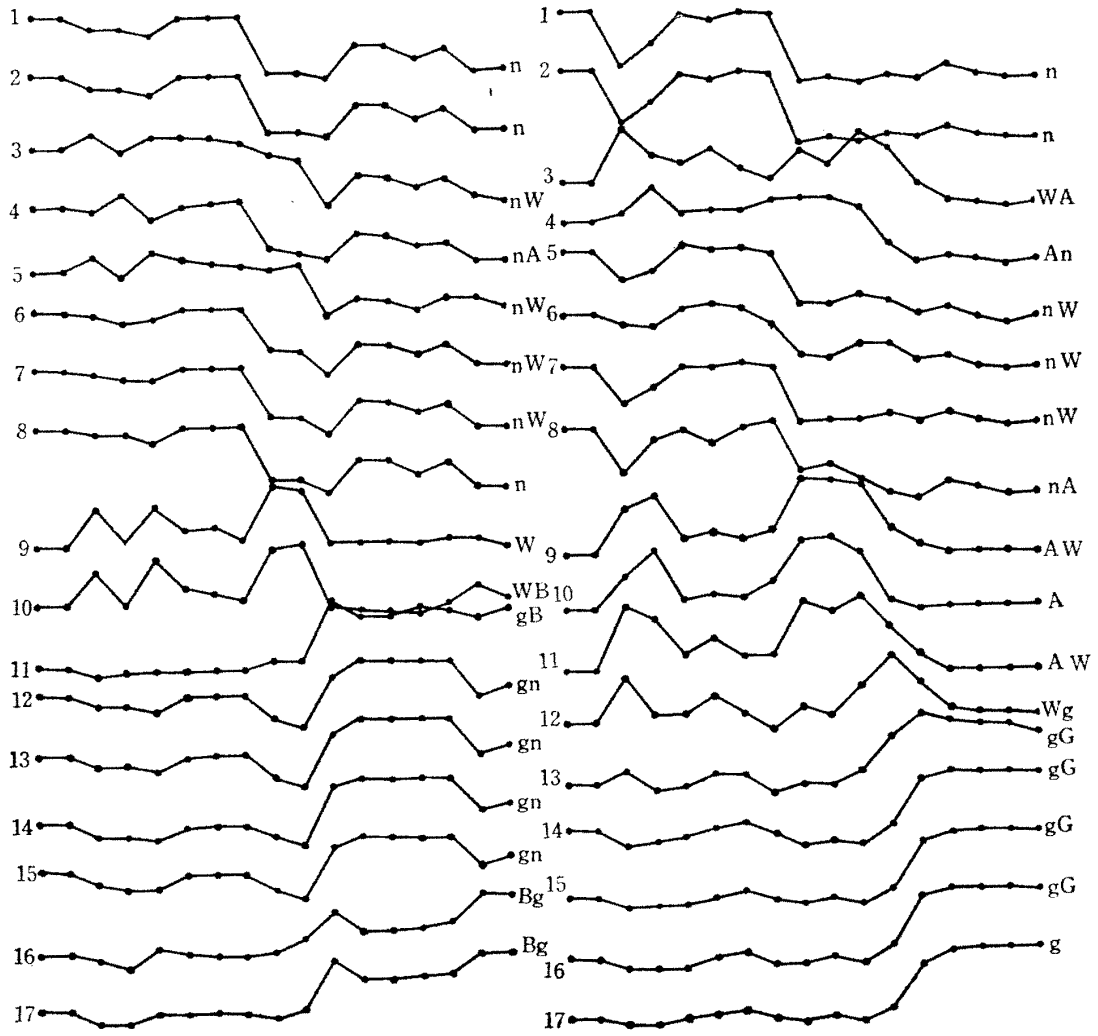


Fig. 3a. Series of correlation coefficients indicating the succession of the leafhopper association in two plots in 1954.

Arabic numerals: Nos. of census (refer to Table 2); Roman letters: abbreviations of dominant and subdominant categories (refer to Table 2).

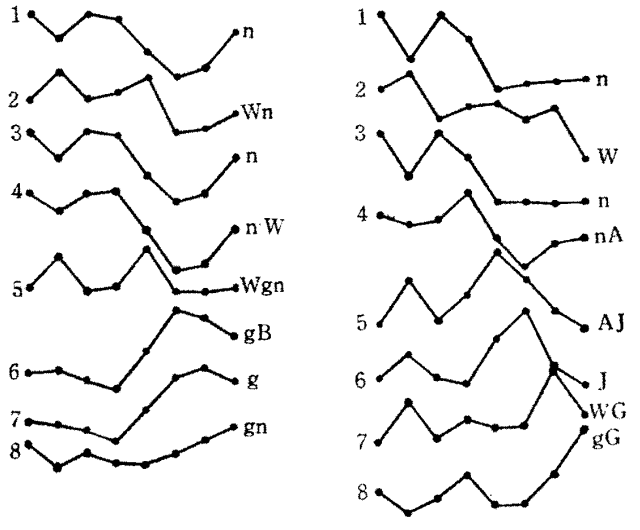
The sequence of the dominant category in the check plot was as follows: in 1954, "nymphs of planthoppers" (consisting mainly of the white back planthopper) → adults of the white back planthopper → nymphs of the green rice leafhopper → adults of the brown planthopper; and, in 1955, nymphs and adults of the white back planthopper → nymphs of the green rice leafhopper. Generally speaking, the white back planthopper was predominant in July and August, the green rice leafhopper in September, and the brown planthopper in October.

There was not much change of the dominant category of the association owing to the first application of the insecticide till the second application in both years, though *Anagrus* sp. was exceptionally predominant in early August, 1954. The second and third applications, however, had much influence upon the succeeding associations for about three weeks, *Anagrus* sp. or "miscellaneous jassoids" ranking the first notwithstanding their very low density. Thereafter nymphs of the green rice leafhopper became predominant like the check plot, but it was remarkable that it maintained its dormancy until the middle of October unlike the check plot.

In general, the similarity or difference of the relative constitution of any two associations may be judged from the value of a correlation coefficient obtained by the reciprocal treatments of the number of individuals of each component category. As the degree of freedom was 6 in the present case, if the value of the coefficient was below 0.707, the two associations were considered to be significantly different from each other at the 5% level.

The series of correlation coefficients obtained by the reciprocal treatments of associations in each plot are given in Figs. 3 a & b. From these figures, the seasonal changes of the association in each plot which have been already considered on the basis of the dominant category are more clearly understood, though the forms of the series having the same dominant category are not always exactly parallel according to the difference of the subdominant categories.

Next, the correlation coefficients obtained between simultaneous associations of each census are plotted in a curve in Figs. 2 a & b. From the curves which take a rather similar form in two years, it is noticed that a slight depression of the curve occurs after the first insecticide application, a conspicuous, prolonged one after the second and third applications, and a moderate one in the middle of October. Degrees of these depressions of the curve, needless to say, correspond to



Check plot Sprayed plot

Fig. 3b. Series of correlation coefficients indicating the succession of the leafhopper association in two plots in 1955.

degrees of the differences of the relative constitution between the two associations concerned.

IV. Conclusion

The application of organic phosphates, parathion and Diazinon, for the rice stem borer control had not only the initial but the prolonged effect on the reduction of the population density of the leafhoppers such as the green rice leafhopper, the white back planthopper and the brown planthopper. The similar result was presented by Itoga and Horikiri.[1] Here, reference needs to be made to the account by Yoshimeki[2] that in spite of a good initial kill at the time of treatment, BHC brings about the resurgence of the green rice leafhopper and the smaller brown planthopper as the time goes on. This inconsistency may be attributed to the different modes of action between the organic phosphates and the chlorinated hydrocarbons, but the detailed explanation of the phenomenon is beyond the present investigation. However it may be, it is desirable that available data in respect to various insecticides are accumulated, in order to draw a general conclusion of the influence of the insecticide on the leafhoppers in paddy fields.

Further studies are also required to explain the reason why the egg-parasite, *Anagrus* sp. tends to predominate over its host insects after the application of the insecticide in spite of a considerable reduction of its density as seen in Table 2.

Reference

1. Itoga, S. & Horikiri, M.: Kyushu Agr. Res., 16, 109 (1955)
2. Yoshimeki, M.: Sci. Rep. Res. Inst. Tohoku Univ. D-7 (1) 27–35 (1956)