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S AND INSECTS OF RICE PLANTS AND THEIR CONTROL IN INDONESIA

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PREFACE

"To know one's enemy is considered to be one of the basic principles of tactics together with "to know oneself".

This saying has some bearing on persons engaged in agriculture. Especially when they deal with diseases and insects of crops, these are their enemies which should be prevented and eradicated as quickly as possible to minimize damages. To control these diseases and insects quickly as well as effectively, we should be able to discrimine between their kinds and varieties, their symptoms and their ecological characteristics.

This manual explains the ecology and the control methods for the main deseases and insects of rice plants in Indonesia, proper use pesticides and insect occurrence forecasting methods used to determine kinds and occurrence phases.

In South-east Asia, basic research materials on diseases and insects have not always been available in sufficient amounts.

The author hopes that the contents of this booklet will be of interest among all the persons engaged in the control agriculture in Indonesia and will also be of use in efficient insect and disease control to save labour and costs, through the establishment of effective research and investigation activities in this field in the future.

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CONTENTS

1. Ecology and control of main insects

It is said that there are about 100 insects which injure crops in tropical regions. Among these, however, the total number of actually injurious insects are fifteen, with the others observed only on a small scale.

The variations in insect occurrence and injury are closely related to the cultivation of the host plant and climatic conditions.

For instance, the occurrence and growth of the white rice borer and gall midge are influenced by precipitation and they are apt to be prevalent in the wet season. Close planting and heavily fertilized cultivation are also apt to cause severe injury by insects. With the future introduction of new variety accompanied – with progress in rice cultivation techniques and multi-cultivation by the provision of large scale irrigation facilities, changes in insect occurrence phases and an increase of quantities are forecast. Therefore, it is necessary that the ecology of insects be clarified and a protection system to meet these predicted changes in cultivation methods be established.

1-1 Rice borers

1-1-1 White rice borer

The white rice borer is prevalent in South-east Asian countries.

The adult moth is whitish and the egg mass is covered with short light-brown hair.

The larva is grayish in the early stage, but after 3 inters it changes to cream-color. The pupa is whitish-yellow in color. The larva hatches 6–8 days after oviposition and bores into the rice stem. The period of the larva stage is 25–30 days and after that, the larva changes to the pupa. The larva which bores into the rice stem toward the end of the wet season does not change to the pupa, but remains for about five months as a diapause larva. In the next wet season this larva emerges as a moth 6–8 weeks after the start of the wet season, and the moth oviposites eggs on the leaf of the rice plant. The term of the pupa stage is 7–9 days. The life history of this insect is closely related to precipitation and as

mentioned before it stays in soil as a diapause larva in the dry season.

In regions where rice is also cultivated in the dry season, this diapause larva dies when submerged in water. Therefore the occurrence of moth in the following wet season is suppressed. On the other hand, in regions where rice is cultivated only in the wet season, this insect becomes severe again in the next season. In Java, for example, this insect occurs widely ever year on the north coast where rice is cultivated only in the wet season.

Since there are few natural enemies of this insect, wide-ranging outbreaks sometimes occur and rice plants are severely injured.

It is necessary to use insecticides such as organophosphorous insecticide to control this insect.

1-1-2 Yellow rice borer ワタノメイガ

The yellow rice borer ranges over a wide area of Eastern and Middle Eastern countries in Asia. The color of the moth is light yellowish brown. The egg mass is oviposited on the leaf and covered with short hairs of the mother moth. This insect has a generation period of 30 days and does not diapause even in the dry season unlike the white rice borer.

In Indonesia, this insect is distributed mainly in the plateaus and irrigation facilities. The yellow rice borer is parasitized by its natural enemy, the egg parasitical fly, which considerably suppresses injuries. Control by chemicals is the same as in the case of the white rice borer.

To control it without using chemicals, the following cultivation procedures should be used. The stems after harvest should be plowed into the submerged soil and within a certain area, the transplanting time in one plot should be different from that in other plots to avoid overlapping of cultivation periods so that the host plant does not exist in the area at least for a time.

1-2 Gall midge イネシマキフデムシ

The gall midge is distributed in South-east Asian countries. The adult fly is light brownish and the shape like that of a mosquito.

It has the habit of gathering around the light and its life is short. Oviposition is observed at night on leaves and sheathes of rice plants.

The egg is cylindrical in shape; originally it is white and later changes to yellowish. The egg hatches 2–3 days after oviposition. The larva is whitish yellow, without legs and inactive. The period of the larva stage is up to 20 days, and it is in this larva stage that gall midge causes injury to rice plants. The pupa is found in the silver shoot. The color of the pupa is yellow and it moves actively. The term of the pupa is 4–7 days.

The stage when the gall midge gives injuries rice plants is the early stage of growth. The larva attacks the tissue near the growth point.

The cells near the growth point attacked by gall midge begin to divide abnormally because of stimulation caused by this attack and finally a silver shoot like an onion leaf is formed. This silver shoot is considered to be formed by adhesion and expansion of about three sheet origins.

The gall midge occurs mainly in the wet season, and its growth is active when there is more than 200 mm of precipitation per month.

In Indonesia, paddies transplanted from January to March are apt to be injured by this insect. The natural enemies of gall midge parasitize at a fairly high rate in paddy fields.

To date two kinds of have been found in the Cihea region, of these, Platygasteridae is more important as a natural enemy due to its high parasitism.

Since control of the gall midge by insecticides is very difficult, it is more important to adjust the cultivation period so as to minimize the injuries. The time when the gall midge causes actual injury to the rice plant is before the ear-premordia stage of growth. Even though the gall midge attacks rice plants after the ear-primordia stage, it has little influence on the yield of rice, because such attacks are limitted to non-effective tillers.

To avoid injury by the gall midge, therefore, the transplanting

time should be arranged so that the ear-primordia stage is over by the time the gall midge begins to appear widely.

For this reason, the seasonal prevalence of the gall midge should be understood as mentioned in a later chaper.

Gramineae weeds are also parasitized by the gall midge, and since these weeds might become a source of the midge, weeds in paddy fields and farm roads should be cut.

If rice plants are attacked by the gall midge, growth of the plants should be promoted and tillering should be accelerated to lessen the injury rate.

In respect to insecticides, the gall midge injures the rice plant in its early stage of growth, and control in the nursery stage should be given priority. Spraying of insecticides should be performed at intervals of five days about one week after sowing to kill the larva before it bores into the rice plant.

The natural enemies of gall midges generally exist in regions where gall midges occur annually.

Because of these parasites, large outbreaks of gall midges are being suppressed. After transplanting in such regions, there is the problem of an increase of gall midge injury by the application of insecticides which might kill the natural enemies.

Table 1 shows the results of insecticide experiments conducted at the Cihea State Farm in the 1972/1973 wet season. According to these results, Diazinon E.C. showed higher incident of silver shoots and a lower yield compared with the check plot. The importance of the natural enemy and the influence of the insecticide on the natural enemy is evident.

Table 1. Experiments on control of gall midge at the Cihea State Farm in the 1972/1973 wet season

Treatment	Silver shoot (%)	grain yield ton/ha
Diazinon E.C. (60 %)	58.2	3.14
Diazinon G (10 %)	29.7	4.67
BHC G (6 %)	33.7	4.60
Check	40.5	3.93

Remarks: Dosages and time of application

1. Diazinon E.C.

800, 1000 and 1200 ℓ/ha in 1000-fold dilution were sprayed 15,35 and 68 days respectively after transplanting.

2. Diazinon G. and B.H.C. G.

30 and 35 kg/ha were applied 35 and 68 days respectively after transplanting.

1-3 Other insects

1-3-1 Rice bug

The Corbett rice bug and shield bug are common.

The former is green in colourand is fifteen mm long.

Both the nymph and adult suck the contents of the grain in the milk ripe stage. The eggs are laid on the leaf. The hatched nymph sucks the leaf juice for one or two days and then shifts to ear of the rice. After that, the nymph turns into an adult in three weeks. In the case of severe injury by the corbett rice bug, the rice ear head becomes white and the grain yield decreases remarkably. Even though injury is slight, the quality of the rice deteriorates. The shield bug is a small, black bug, which oviposits ordinarily on the lower portion of the rice sheath where both nymph and adult damage the rice plant.

The growth rate of rice plants injured by this insect is reduced. These insects are easily controlled by the application of organophosphorous insecticides.

1-3-2 Leaf hopper and plant hopper

The leaf hopper and plant hopper suck the juice of the leaf and sheath of the rice plant, and cause reduction in the number of tillers number and in growth rate. These insects are more injurious as a vector of virus desease. In Indonesia, these insects have not been very in jurious, but in the future the emergence of these insects can be predicted in accordance with changes and progress in rice cultivation techniques.

The brown plant hopper especially reproduces very rapidly and

destroys the rice plant in the milk ripe stage.

For control of these insects, daily observation of the field is necessary in order to eliminate them in the early stages.

1-3-3 Rice stem maggot and rice leaf roller

These insects do not much influense on the yield, but they should be controlled in case of heavy outbreaks. Organophosphorous insecticide is effective in killing these insects.

2. Ecology and control of main diseases

Diseases occur mainly at high temperatures and high humidity which are suitable for the growth of pathogenic fungi and bacteria. In the temperate zone, the seasonal prevalence of diseases corresponding to changes in temperature and to the growth stage of the rice plant has been investigated. In tropical zones, there are many kinds of disease and even though they have not become noticeable, many diseases have become latent problems.

The presently used traditional rice cultivation techniques have been established through victory in long struggles with these diseases. The main factor in this victory is the introduction of breed resistance. If a new variety of rice plant which has no resistance to deseases is introduced, there is the fear that this new variety will be completely destroyed. For an example, the introduction of IR-8 in East Pakistan failed completely because of the prevalence of virus diseases in 1966–1967. In addition, the occurrence of diseases is closely related to the physical condition of rice plant, i.e. when physical condition is abnormal, diseases are liable to occur and under unhealthy conditions due to over-fertilization with nitrogen, almost all diseases including rice blast might occur. When the absorption of nutrients is suppressed owing to bad soil condition, Helminthosporium leaf spot is apt to occur.

To control these deseases effectively, integrated countermeasures should be taken including consideration of climatic conditions, the use of resistant breeds, improvement of cultivation methods, improvement of soil and the use of pesticides.

2-1 Bacterial leaf blight

Bacterial leaf blight ranges over all Asian countries and is one of the most noticeable diseases, particularly in tropical zones. This desease caused by the bacteria of Xanthomonas oryzae (Ueyda et Ishiyama) Dowson, attacks the leaf, sheath and ear head of the rice plant.

The pathogenic bacteria enter the tissue through the water pore or a wound opening in the leaf, and make a yellowish white lesion on the fringe of the leaf. When the young seedling in the seedbed or field are flooded frequently, the rice plant is attacked by this disease at an early stage, and in some cases, it suffers from "kresek". The "kresek" sympton seems like the damage of rice borers; 2–3 weeks after transplanting, young leaves roll up and hang down, and the plant withers due to dehydration.

The main sources of infection are diseased stumps and straws, and the bacteria are transmitted to the rice plant by irrigation water. Generally this disease occurs more often in the wet season than in the dry season and in regions where the period between two cultivation seasons is short or the preceeding cultivation period overlaps the following one. To control this disease, consideration of cultivation techniques as mentioned below is necessary.

a) Locate the seedbed where it will not easily be flooded or prepare an upland nursery.
b) Cultivate a resistant variety of rice (for example, Pelita I/1 and I/2 is more resistant than PB-5)
c) Do not apply N-fertilizer non-uniformly.
d) Delay drainage before harvesting in fields usually attacked by the disease.

For chemical control, spray chemicals such as shirahagen-c, Sankel and Fenazin, when the young seedlings are flooded and early symptoms of the disease are recognized. When using a liquid solution, a spreading agent has to be added. /

2-2 Sheath blight

Sheath blight is caused by the fungi Pellicularia sasakii (Shirai) S. Ito. First, an oval le-sion, white in the center and brown in the surrounding parts, is formed on the lower sheath near the water surface. Thereafter, lesions are formed on the upper sheath and leaves with the advance of the disease.

In case of severe attacks, the lesions are also formed on the flag leaf and ear head which causes the lower leaves to die, and occasionally the rice stem collapses. Naturally, the yield is reduced in such cases. This disease is seen even in the nursery stage. The main sources of infection are sclerotium which falls into the paddy field from the diseased straw and weeds.

High temperature and high humidity are favorable to the growth of these pathogenic fungi and this disease is liable to occur in case of thick growth with well fertilized cultivation and closely spaced planting.

Usually this disease begins in the tillering stage and develops in the upper parts after the booting stage.

Control methods are as follows.

a) Do not apply N-fertilizer non-uniformly and only in certain areas.
b) Do not leave the straw infected by disease in the field. If possible, burn it.
c) Cut weeds in farm roads to destroy the source of the disease.
d) When using chemicals, spray chemicals such as Validamycin and Neo-asozin in the booting stage of rice growth.

If the third sheath and leaf counting from the top leaf are attacked, spray chemicals immediately. When applying liquid solutions, add a spreading agent and spray only on the diseased parts.

2-3 Stem rot

This disease is caused by two kinds of pothogenic fungi, Helimthosporium sigmiudeum carvara, and Helminthosporium Carvara var. irregulare Cralley et Tuiis.

The former occurs mainly in ill-drained paddy fields and the latter in semi-ill-drained paddy fields or drained paddy fields. This disease begins in the tillering stage and forms a black lesion on the sheath near the water surface. Then the pathogenic fungi invade the sheath and finally surround the stem in the heading stage. The upper part of the rice plant then dies, and sometimes, the rice plant collapses.

Innumerable black sclerotia are found in the stem and sheath of diseased rice plants. The sclerotium of Helminthosporium sigmoideum is 0.25 mm in diameter and black in color. The shape is globular, and its surface is smooth. That of Helminthosporium Carvara var. irregulare is 0.15 mm in diameter and black in color. The shape is not always fixed and its surface is not smooth.

The main sources of infection are sclerotia in the diseased stumps and straw at the time of puddling and weeding. These sclerotia float to the water surface and adhere to the rice plant.

Stem rot is liable to occur especially in K-deficient fields and in ill-drained fields where rooting ability is suppressed.

The control methods are as follows:

a) Do not apply N-fertilizer non-uniformly, and apply sufficient K-fertilizer.
b) Do not apply diseased straw in the paddy field; apply it only after using it for compost.
c) Keep the water level low in the most active tillering stage, to increase root vitality.
d) Delay the drainage after the booting stage so that the stem does not become dry.
e) Among the chemical fungicides, Hinozan and Kitazin-P are effective.

2-4 Helminthosporium leaf spot

Helminthosporium leaf spot is caused by the fungi of Ophiobius miyabeanus (S. Ito et Kuribayashi) Drechsler.

In this disease, lesions which are first black and then change to brown or gray are formed on the leaf.

The size of the lesion is usually up to 5 mm in diameter but it becomes as large as 1 cm in the case of K-deficiency. The occurrence of this disease is closely related to the nutritional condition of the rice plant. In case of K and Mg-deficiencies, N-deficiency after the middle stage of growth, and also when the nutritional absorption of the root is suppressed due to root rot, this disease is apt to occur. In many cases this disease does not have a fatal affect on rice plant, but in fields where this disease usually occurs, the growth of the rice plant is in sufficient and the yield in such regions is generally low.

Although this disease is caused by a pathogenic fungi, countermeasures for physical diseases, such as improvement of the soil, drainage and fertilization should be taken to prevent this disease.

3. Characteristics and directions for use of pesticides

There are many kinds of insects and diseases which injure rice plants. Their ecological characters such as living areas and feeding habits are different and their sensibility to pesticides is also different in many cases.

Application of pesticides is one means to control of these insects and disease. To date many kinds of pesticides have been developed, but the appliable insects and diseases for these pesticides are generally limitted. For instance, a certain insecticide is effective in controlling several kinds of insects, but is not effective for others.

Since each pesticide has its own characteristics in respect to control capacity and usage, we must know tlieir characteristics prior to actual use so as to control insects and diseases economically as well as effectively.

Recently in Indonesia many kinds of pesticides have been examined and many promising pesticides have been found under the supervision of the Central Research Institute for Agriculture (LP3). It is hoped that these exporiments and research will continue and pesticides suitable for Indonesian agriculture will be developed.

3-1 Formulation of pesticides

Pesticides are formulated in the form of emulsifiable concentrates, dusts, wettable powders or granules, according to use in the field. In order to control diseases and insects effectively with pesticides, a properly formulated pesticide should be chosen considering the types and ecological characteristics of the diseases and insects.

3-1-1 Emulsifiable concentrate

This is formed dissolving the active ingredient in an organic solvent and adding an emulsifying agent. At the time of use, this mixture is added to a fixed quantity of water and is sprayed as an emulsion by sprayer.

The dilution rate should be decided according to the directions for use indicated on the label of container, since each pesticide has a different dilution rate.

The sprayed amount is related to the growth of the rice plant. Generally, a spray of 700–1200 ℓ/ha is necessary and the larger the rice plant, the more spray is needed. As a rough standard for the amount sprayed, the rice plant must be sprayed until it is thoroughly wet. In actual spraying, the location of diseases and insects should be sprayed sufficiently. For example, rice borers live in the sheath and leaf rollers and rice bugs on the upper portions of the rice plant.

Emulsifiable concentrate is cheaper than granules and other forms, but its disadvantages are that it takes considerable time and labor in applying and its period of effectiveness is short.

If it rains just after spraying of it is possible that the chemicals on the rice plants might be washed away. In Indonesia, therefore, spraying should be finished in the early morning.

3-1-2 Wettable powder

This powder is formed by the following process. To the active ingredient a carrier such as clay or a surface activating agents is added, and this mixture is pulverized.

The method used for emulsifiable concentrates is applicable to

wettable powders.

The chemicals for control of diseases are, in many cases, in the form of wettable powders and emulsifiable concentrates because these formulations can have spreading agents added which help the chemicals to adhere uniformly to the rice plant and penetrate into the rice plant.

3-1-3 Dust

Dust is formed by adding the active ingredient to a carrier such as talc or clay, and the mixture is crushed to a fine powder.

This dust is spread by a duster.

If a pipe-duster is used, spreading over a wide range can be performed at one time. It is desirable that dust be spread in the early morning when dew is still present to increase dust adherance to the rice plant and increase the efficiency.

3-1-4 Granules

Granules are formed as follows.

The active ingredient, the carrier such as clay, and a small amount of surface activating agent are mixed and crushed. Then this mixture is added to a solvent such as water, granulated and then dried. Another mehtod of making granules is to coat rough sand or other granules with an active ingredient.

The method of applying granules is as follows.

Spread the granules uniformly by hand over the field under flooded conditions. Close the water outlet and keep water level at 3–5 cm for at least 3–5 days after application. Do not stir the soil for weeding, etc. after application so that the active ingredient will not be adsorbed into the soil and the solubility of the active ingredient in the water will not be reduced.

3-2 Problems of resistance to chemicals

After a certain insecticide has been used continuously to control insects, and these insects survive this chemical treatment, they are known "insects resistant to chemicals".

The mechanism of resistance development is complicated.

Briefly, weak individuals are selected by the chemicals, while the other strong ones which can detoxicate and reject the chemicals survive. Over many generations, genes having these strong characteristic accumulate through crossbreeding among individuals and resistant insects emerge.

These resistant insects are also apt to show resistance to newly used chemicals.

This phenomenon is called "Cross resistance".

For controlling resistant insects, the dosage should be increased or new insecticides which have different modes of action should be developed.

At present Japan faces this problem, and it will become important in Indonesia in the future.

It is impossible to check completely the aquisition of resistance. Since insufficient control promotes the development of resistance, ordinary control activity should be completely to minimize the number of insecticide applications.

3-3 Precautions in pesticide application

Pesticides are chemicals used for the control of insects or diseases, but in many cases, they are rather poisonous to humans. When handling pesticides, therefore, basic knowledge concerning the toxin is required. When choosing pesticides, chemicals with low texicity humans should be used, and since pesticides flowing out of paddy fields might kill fish in ponds and rivers, chemicals with low toxicity to fish should be used.

Workers who feel ill should not engage in such work and sprayers should be inspected beforehand.

Workers performing spraying should stand in the windward direction in order not to be sprayed by the chemical solution.

After finishing the work, exposed parts of the body such as the face, hands, legs and neck should be washed immediately.

4. Occurrence forecasting for insects

Insecticides promote favorable growth of plants by killing injurious insects. It is, therefore, useless and even harmful to use insecticides when there are no insects.

Effective control of insects by insecticide is possible only by the timely control conducted after observations of insect occurrence.

For timely control of insects, it is essential to be able to predict what kind of insects, how many there will be and when they will appear.

Occurrence forecasting is based on past data of seasonal prevalence of insects.

4-1 Methods of occurrence forecasting

Equipment for forecasting is shown in Fig. 1. It should be enclosed with a wire net fence to prevent it from being stolen. In places where electricity is not available, a light trap using a kerosene lamp as a light source (used in the Bimas Project in 1969) will be sufficient.

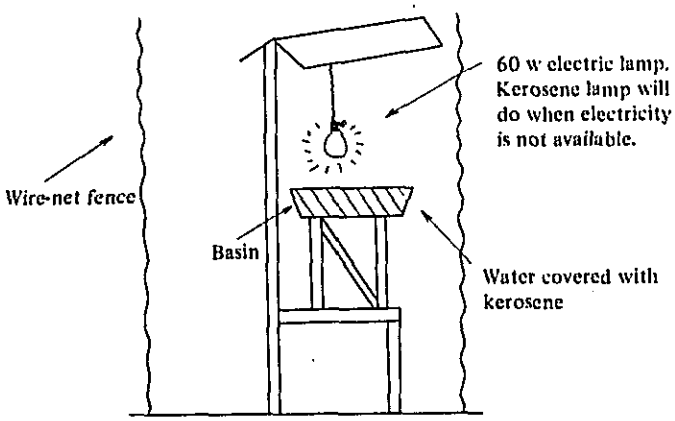

Fig. 1 Equipment for forecasting insects

In general adult insects are most active from 6 to 11 p.m. and it is sufficient to light the lamp only during these hours.

Adult insects which gather around the light the lamp touch the surface of the water covered with kerosene and are caught.

Every morning, the insects caught by the light trap are classified by types, the numbers are totalled and the totals for each type for three days are recorded on a graph.

An example is shown in Fig. 2. In Indonesia, the white rice borer, yellow rice borer and gall midge are particularly important as harmful insects, and these three species should be counted as a minimum.

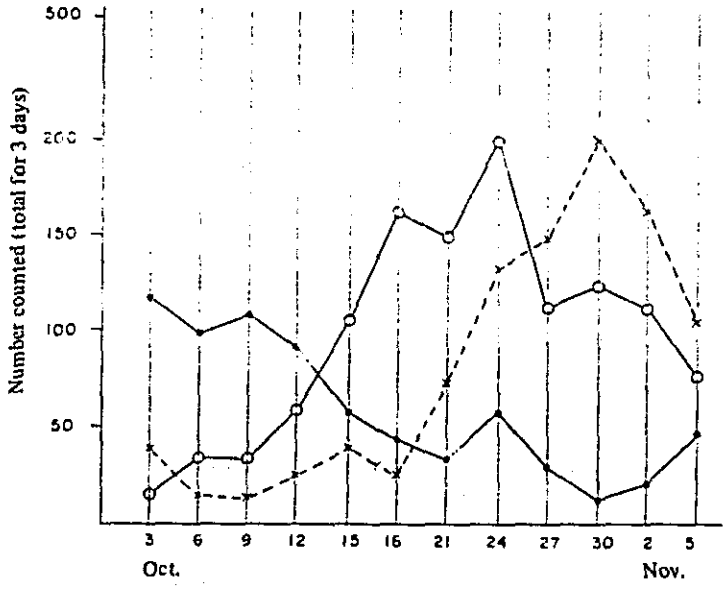

Fig. 2 An example for an occurrence graph

The light trap should be located as far as possible from houses and should not be influenced by other lights. The problems are lightning and counting of the moths which are caught.

4-2 *Consideration and application of the results*

From the results obtained, annual trends can be observed in the long-run, and the periods when special care must be taken concerning the insects can be forecast. Knowing this, it is possible to change the cultivation period to avoid damage.

In the short run, daily observations will permit application of insecticides when the insects tend to increase noticibly. Insecticides developed to the present are not effective as preventive agents and are only effective in killing insects. For this reason, the necessity of timely control is emphasized. The best time for application of insecticides to control rice borers is usually within a week after the peak of occurrence.

For reference, results and examples of successful prevention of damage at the Cihea State Form are noted here.

The seasonal prevalence of insects examined in the Cihea State Form from November in 1972 to October in 1973 is shown in Fig. 3.

In the wet season of 1972/1973, the occurrence of gall midge showed a tendency to increase in late January with peaks in February and March.

The time when the gall midge injures the rice plant is before the ear-primordia stage of growth. Therefore, the damage by the gall midge in fields where transplanting is finished in early December when the ear-primordia stage had already passed in February was slight. However, the damage in fields where transplanting was carried out after January was great because of the delay in transplanting time.

In the next dry season in 1973, the occurrence of gall midge showed peaks in July and August.

Although the gall midge does not usually appear much in the dry season, there was a severe outbreak in the dry season of 1973.

The reason for this was probably that the natural conditions were suited to the growth of gall midges due to frequent rainfall. In this dry season, early transplanting was advised considering the experience in the previous wet season.

Therefore, in spite of the severe outbreak of gall midges, injury could be effectively avoided.

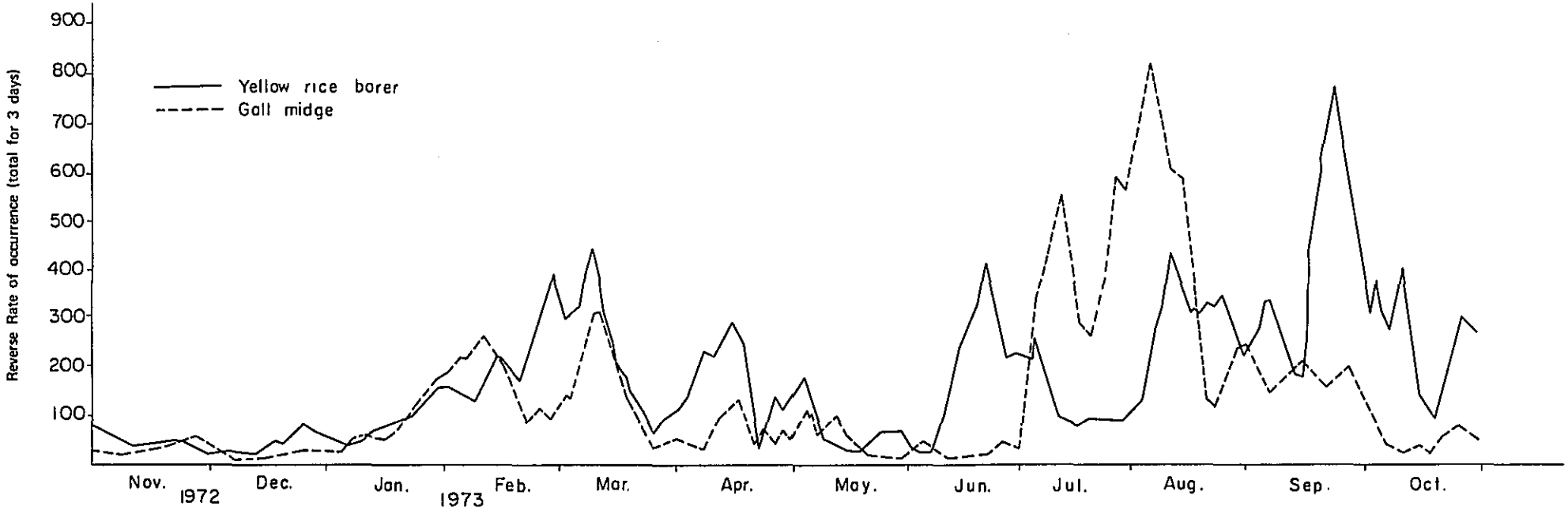

Fig. 3 Results of occurrence forecasting on the Cihea State Farm