2. RECENT PROGRESS IN RICE INSECT RESEARCH IN INDONESIA

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Introduction

At the moment six insect pests appear of major importance on the island of Java. They are the white rice borer *Tryporyza innotata* Wlk, the yellow rice borer *Tryporyza incertulas* Wlk, the striped rice borer *Chilo suppressalis* Wlk, the rice gall midge *Pachydiplosis oryzae* W-M, the brown plant hopper *Nilaparvata lugens* Stal and the white-back hopper *Sogatella furcifera* Horv. Other so called minor pests may occasionally be of major importance, causing severe reductions in yield in certain areas; the army worm might be mentioned in this respect.

Research trials to study the biology, ecology and chemical control of the major pests were carried out in Java and in South Sulawesi. In South Sulawesi however, the rice gall midge so far has not been recorded.

This paper reviews the studies made during the period 1968–1970.

Ecological Studies on the Rice Stem Borers

For accurate assessments of stem borer incidences in the field and to study whether

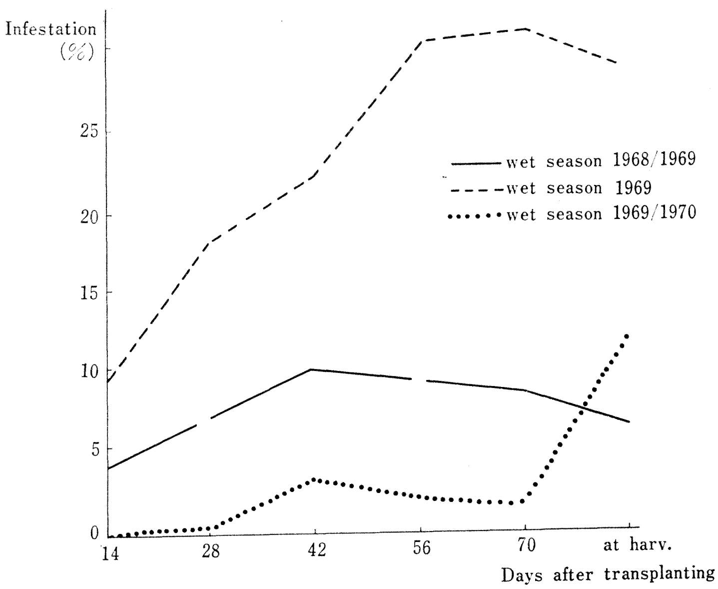

Fig. 1. Relation between age of rice plants and degree of stem borer infestation. (Cria experimental garden "Pusakanegara")

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there is a relationship between field populations, light trap catches, damage, yield and climatological conditions, a planting date trial was set up. This trial consisted of 5 dates of plantings, each one week apart. From results obtained during 3 successive wet and dry seasons, it was found that the highest level of borer infection nearly always occurred later than 5 weeks after transplanting. This is shown in Fig. 1 (2, 3 and 4).

According to Van Der Goot (14), the white rice borer (*Tryporyza innotata*) was principally found along the north coast of Java and was more common there than the yellow rice borer (*Tryporyza incertulas*). However, based on insect catches which were obtained from a kerosene light trap, operating every night from 6 p.m. until 6 a.m. during the year 1969, the largest number of moths trapped belonged to *Tryporyza incertulas*. This was found at Pusakanegara which is also situated on the north coast of Java. *Tryporyza innotata* was found in much smaller numbers (Fig. 2). During the year 1970, it was found that the white rice borer was caught in higher numbers than the yellow rice borer (Fig. 3).

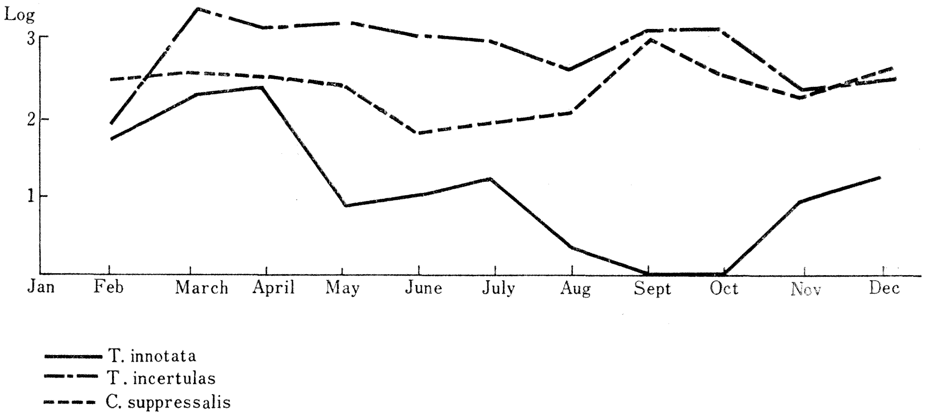

Fig. 2. Number of moths caught per month in kerosene light trap. (Cria Experimental Garden "Pusakanegara", 1969)

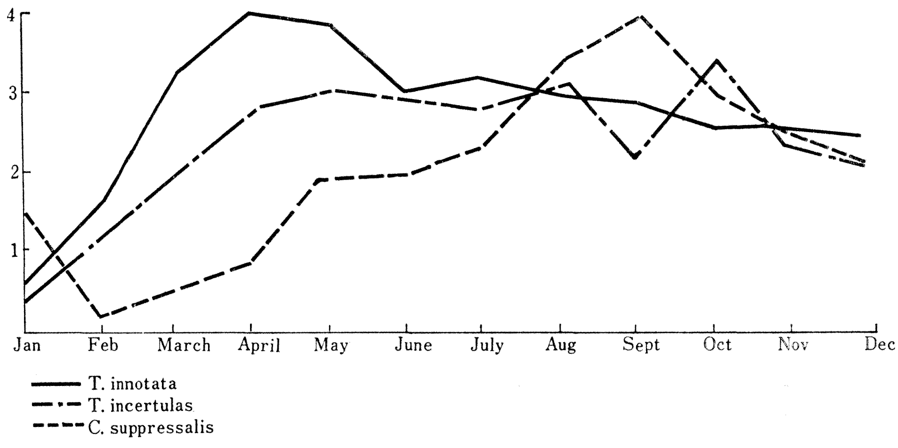

Fig. 3. Number of moths caght per month in kerosene light trap. (Cria Experimental Garden "Pusakanegara", 1870)

The light trap catches indicated also high population of *Chilo suppressalis* in the north coast area as shown in Fig. 2 and 3. This had not been recorded by previous authors (13 and 14). Although the light trap catches do not indicate quantitatively the occurrence of the various borer species (mainly due to photo-taxic differences between the species); it does show the qualitative occurrences. In addition to the data obtained from the light trap, supporting quantitative information will be procured from plant dissection as to determine the species of borer found in the rice.

By counting hourly catches it was found that the highest number of moths of *Tryporyza innotata* trapped by the light were found before midnight (Fig. 4). Similar findings were recorded for *Tryporyza incertulas* (1 and 5).

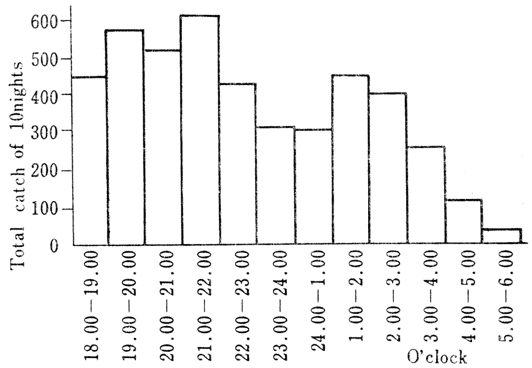

Fig. 4. Number of *Tryporyza innotata* caught per hour in kerosene light trap, during 2 non successive periods. (March 25–29, 1971 and April 26–30, 1971)

Biological and Ecological Studies on the Rice Gall Midge

By comparing specimens collected in Java, with the description of the gall midge by Mani from India (7) and with specimens from Thailand, it may be concluded that the gall midge occurring in Javan is *Pachydiplosis oryzae* (Wood-Mason) Mani.

Studies on the life cycle of the gall midge in Java using the Bengawan rice variety as host plant indicate that the development from egg to adult requires 24 to 40 days (from 80 observations). In other gall midge countries (11) similar periods for the life cycle have been recorded. It was found that the variation in the period of development from egg to adult depends according to our observations, on the place of entrance of the larvae into the plant. Those larvae entering from the main growing point of the rice plant passed the period shorter than those entering at the axilary bud.

From 120 observations, it was shown that the average life cycle of the gall midge reared on 50 days old rice plant was 25.7 days, while on 15 to 20 days old rice plant the average life cycle was 29.5 days.

The female can produce 41–168 eggs (from 30 observations). It was found (from 30 observations) that thirteen per cent of the fertilized eggs did not hatch.

In a laboratory rearing experiment, out of 303 pupae, 246 females and 57 males were obtained, the sex ratio being 4 : 1. Determination of the sex ratio of the gall midges collected from the field during one month showed a corresponding ratio with those reared in the laboratory. Data collected over a period of 2 years from petromax light traps showed an even higher sex ratio, namely 90% of the adults were female.

From results obtained during 3 consecutive seasons in the above mentioned planting date trial, it was found that early transplanted rice suffered less damage from the gall midge damage started to increase at 45 days after transplanting, reaching a peak at about 85 days after transplanting (Fig. 5). The larvae of gall midge can develop only in the growing primordia and cannot survive on a crop beyond the vegetative stage of the rice plant. Beyond the vegetative stage, they live on unproductive tillers. So, in the case of a gall midge infestation attention should be paid to the stage of 31 to 50 days after transplanting, if chemical control measures will be taken (12). This will be especially true for the high tillering improved varieties.

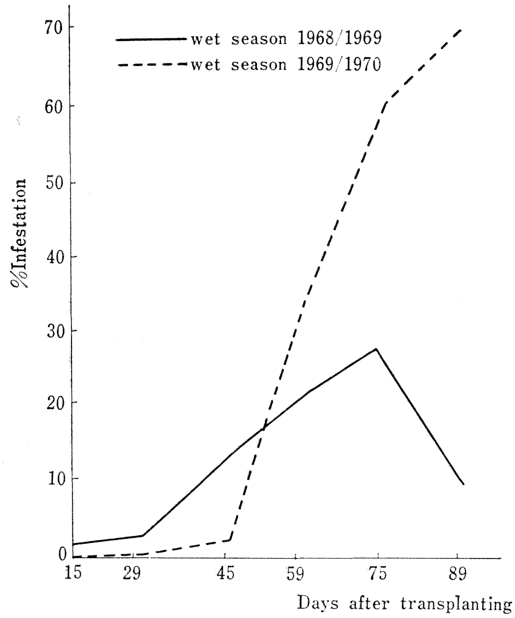

Fig. 5. Relation between age of rice plants and degree of gall midge infestation. (Cria Experimental Garden "Pusakanegara")

Screening for Varietal Resistance

Screening on the resistance of rice varieties to the major insect pests has recently started. So far only field experiments were carried out. In 2 successive seasons 70 varieties were screened, including foreign lines, local and improved local varieties.

During the wet season 1969/1970, low borer and high gall midge damage occurred. It was found that IR 127-80-1-10 at 65 days after transplanting had the lowest gall midge infestation, namely 19.2%, compared to IR 579-160-2 (IR 22) which had the highest infestation, namely 80.9%. The other varieties (IR 5, IR 8 and the improved local varieties) got an infection ranging from 58% to 78% (Table 1).

PTB 18 was found to be fairly resistant to the attack of the rice gall midge in India (11), however, it was found to be susceptible in our experiment (Table 1).

During the dry season of 1970, a heavy borer infestation and no gall midge out-break occurred.* All varieties showed a high infestation of dead hearts, at 60 days after

* Based on the light trap catches, the infestation of *Tryporyza incertulas, Tryporyza innotata* and *Chilo suppressalis* were 37.8, 32.4 and 29.8% respectively.

Table 1. Gall midge and stemborer infestations of some of 33 rice varieties tested in Java, Wet season 1969/1970.

Variety	40 days after transplanting		65 days after transplanting		White heads (%)
	Silver shoots (%)	Dead hearts (%)	Silver shoots (%)	Dead hearts (%)	
IR 127-80-1-10	2.5	0.6	19.0	7.5	5.4
IR 532-E-576 (IR 20)	18.8	1.2	58.0	3.9	3.9
IR 8	19.1	0.6	59.9	2.6	1.1
PTB 18	12.9	1.6	60.6	3.7	×
C4-63	14.7	2.9	66.8	3.7	2.6
IR 5	24.2	2.3	78.0	2.9	5.6
IR 579-160-2 (IR 22)	32.2	0.8	80.9	1.9	2.1
Syntha	13.9	2.4	58.5	5.4	3.7
Bengawan	12.4	5.9	61.2	3.1	×
Sigadis	14.6	2.3	62.2	4.0	9.6

* Average of 4 replications.
× Rat damage.

transplanting, varying between 18% and 50%. The white head infestation also varied considerably, from 2.7% to 36.7% respectively for Warrangal 1236 and Panhhari 203. The varieties which had a high dead heart infestation, but a low white head infestation were Binolayangun (4.4%), Paddy Warrangal Culture (2.7%), IR 532-E-295 (33%) IR 532-E-420 (2.8%), IR 12-178-2-3 (4.2%), IR 589-54-2 (2.8%). According to Pathak

Table 2. Stemborer infestations of some of 51 rice varieties tested in Java, Dry season 1970.*

Variety	60 days after transplanting	At harvest
	Dead hearts (%)	White heads (%)
Paddy Warrangal Culture 1263	25.6	2.7
IR 532-E-420	34.4	2.8
IR 589-54-2	33.2	2.8
IR 532-E-295	39.9	3.3
IR 2-178-2-3	36.5	4.2
Binolayangun	47.8	4.4
IR 532-E-576 (IR 20)	31.1	6.9
DV 139	20.4	13.3
Milfor 6 (2)	47.2	13.6
Chianan 2	30.1	16.3
TKM 6	23.2	23.3
Suyai 20	17.5	23.4
Taitung 16	18.8	29.2

* Average of 4 replcations

et al. (1971), TKM 6, Taitung 16, Chianan 2, Suyai 20 and DV 139 to be highly resistance to striped rice borer; while Milfor 6(2), Rexoro, Bluebonnet, and Sapan Kwai were susceptible varieties. In our test during the dry season 1970, TKM 6, Chianan 2 and DV 139 had more or less the same level of white heads infestations as Milfor 6(2). Taitung 16 and Suyai 20 got an higher of white heads infestations compared with Milfor 6(2) (Table 2).

Taitung 16 and Chianan 2 have been recorded as being highly resistant during the vegetative stage but susceptible after flowering (10). In our experiment Taitung 16 proved its susceptibility after flowering, whereas findings with Chianan 2 did not confirm this (Table 2).

No detailed information is available yet for the other rice pests.

Survey on Rice Pests in Java

Starting in March 1970 a rice pest survey has been carried out. The survey was projected along the main road through rice growing areas of Java. About every 25 km along the fixed route, 4 samples each of one square meter were taken. The samples were taken 100 meters apart in a square. The purpose of this survey was to make an inventory of all rice pests on the island of Java.

So far the survey indicates some new information which will be presented below.

The rice gall midge was found everywhere including the north coast area. Levels between 20 and 60% were observed all that region. Until 2 years previously, such outbreaks were unknown in that area.

The distribution of the rice stem borer and the rice gall midge and their levels of infestations during the dry season June–October 1970 are presented in Fig. 6.

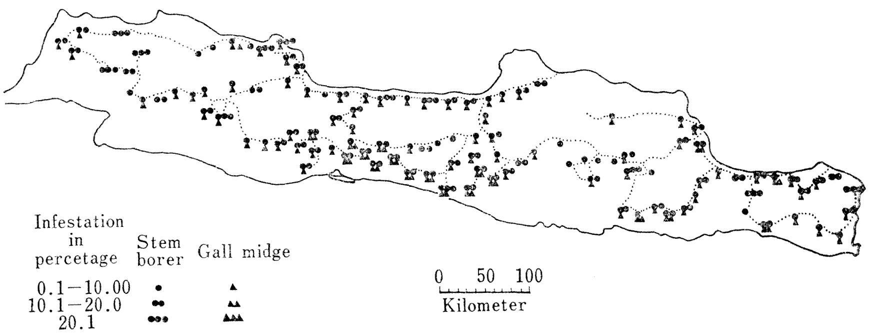

Fig. 6. Degree of rice stem borer and gall midge infestation in Java, determined from a survey, carried out during the dry season, June–October 1970. Each location was visited once.

In the survey mentioned above, leaf and planthoppers were collected by use of a D-Vac Suction Machine. The following species were found on the rice plants: *Nephotettix impicticeps Ish, Nephotettiix apicalis Mots, Recilia dorsalis Mots, Thaia oryzivora Ghauri, Tettigela spectra Dist, Erythroneura sp., Macrosteles sp.* (Farm Jassidae), *Sogatella furcifera Horv, Nilaparvata lugens Stal, Detocephalus (?) sp.* (Fam. Delphacidae) and *Nisia sp.* (Menoplidae). In the paper dealing with the distribution of rice leaf hoppers, Nasu (8) mentioned only the occurrence of *Nilaparvata lugens* in Java.

The most abundant species found in West Java during the wet season 1969/1970 was *Thaia* followed in succession by *Sogatella, Recilia, Nephotettix* and *Nilaparvata*.

Thaia and *Recilia* seemed to prefer seedlings to older rice plants.

On transplanted rice, *Thaia, Nephotettix, Sogatella, Nilaparvata* and *Recilia* were somewhat higher in numbers on rice plants of more than 61 days old (Table 3).

Table 3. Numbers of adult leaf and planthoppers on different ages of the rice plant.*

Stages of rice plant	Average numbers per square meter of				
	Thaia	*Nephotettix*	*Recilia*	*Nilaparvata*	*Sogatella*
Seedbed	82.0	3.9	11.4	2.6	5.6
Less than 30 days	6.5	0.9	1.0	0.6	3.2
Between 31-60 days	9.0	1.5	1.5	1.2	4.0
More than 61 days	10.2	2.7	2.7	1.5	4.7
Average	26.9	2.4	4.1	1.5	4.4

* Average of 13 samples for seedbeds and 302 samples for transplanted rice plants, located throughout West-Java.

In higher altitudes, ranging from 400 m to 757 m above sea level, it was found that the population of *Thaia* increased (Fig. 7), while this was not true for the other species.

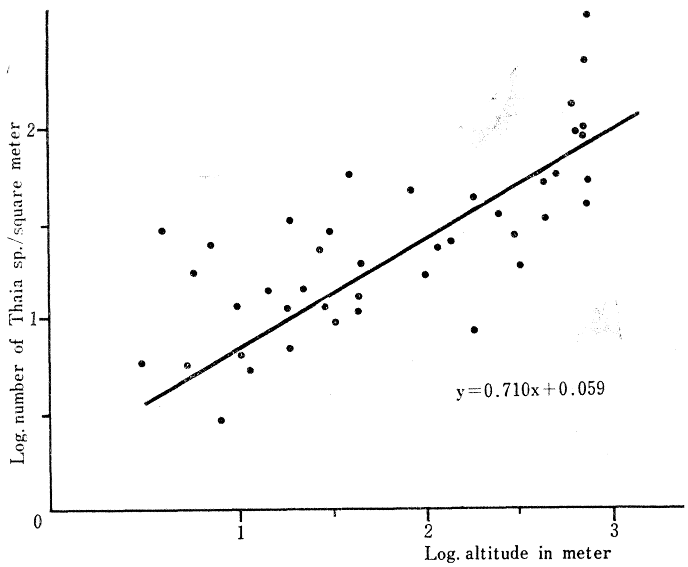

Fig. 7. Correlation between number of *Thaia sp.* and altitude. Each point in the graph indicates the average of 2 observations. Data collected from a survey, carried out during the wet season, March-April 1970.

Insecticidal Studies

Testing procedure

For testing insecticides against the major pests of rice, the following procedure is followed. Each year during the wet season a total of about 18 new insecticides are being tested under field conditions in a screening test. Based on the levels of infestations, but mainly on the yield responses several best products are selected for further testing in the two successive seasons both in Java and in South Sulawesi in a so called levelling test. In this levelling test various levels of dosage of each product are compared with a standard insecticide.

This type of trial is carried out at a few locations; but whenever the best level of dosage has been determined these insecticides are being tested in a higher number of locations in so called advanced screening trials.

Screening of insecticides

The objective of this screening is to test new insecticides against the major rice pests under field conditions. The insecticides are offered by the various private companies. The standard insecticide previously was diazinon G but it was recently replaced by „Sandoz 6626" 5 G. All insecticides were applied mostly 6 times, at a two weeks interval, starting 2 weeks after transplanting.

The results so far, based on the level of the rice stem borer infestations and on the yield responses, are as follows: The most effective E.C. formulation are surecide, endrin, endosulfan azinphos-methyl, dursban and phosvel. To a less effective group of the E.C. formulations, but still usable, belong diazinon, phosphamidon, chlorfenvinfos, bayrusil. The most effective group of granular compounds include „Sandoz 6626" 5 G, solvigam, diazinon, BHC, sevidol, salithion, endosulfar, endrin, dursban and chlorfenvinfos (3, 4 and 9).

In the field trials, the gall midge infestation was also taken into account. Besides these field trials, a laboratory experiment was also carried out to study the effectiveness of insecticides against the rice gall midge. In order to obtain gall midge infestation, rice plants of the variety IR 5 were grown in pots and were infected with freshly hatched larvae. Insecticides were applied 7 days after infection. Ten days later, mortality was observed by dissecting the plants.

Based on these field and pot studies it was found that the control of the rice gall midge was much more difficult than the control of stem borers. Up till now only one insecticide i.e. „Sandoz 6626" 5 G or „Barusil" 5 G (which have similar active ingredient) has given excellent control. Products which give moderate control are: salithion, solvigam and parathion (3 and 9).

Levelling of promising insecticides

The objective of this levelling is to determine the best level of dosage of promising insecticides. Three levels of dosages of each insecticides were compared for their effectiveness against the major pests. All inscticides were applied 6 times at a 2 week interval, starting 2 weeks after transplanting. When using three dosage rates ranging from 1 to 3 kg active ingredient per ha application no differences in yield were observed. These differences were not clear probably due to the 6 times of applications which was too often. However, the experiments indicated that the percentage of borer damage was decreasing with increasing dosage of insecticide (3, 4, 6 and 9). Nowadays 4 levels of dosage of each promising insecticide is used, and only 4 times per season each insecticide is applied.

Timing of insecticide applications

A number of trials has been carried out to determine the most suitable time of the insecticide applications. Due to the lack of information on the ecology and biology of the pests and due to the non-existence of a forecasting service which warns the farmers when to expect outbreaks of a certain pest, it was tried to determine the best time of the insecticide application independently from outbreaks, but merely based on the age of rice plant.

It was found that the best time for controlling stem borer was either 5-7-9-11 weeks after transplanting or 7-9-11 weeks after transplanting for IR 5, in West Java and also this was true in South Sulawesi. These applications, even in cases where early infections occurred, will give significant yield increases. Especially the high tillering varieties, such as IR 5, will easily recover from damage suffered from early infestations (3, 4, 6 and 9).

Volume of spray liquid

A trial was carried out to determine the amount of spray liquid to be applied per ha when using a simple knapsack sprayer. The long established recommendation has been a spray volume varying from 600–1000 liter per ha. Usually the farmers are not willing to apply such large quantities, because they need too long a time per ha to apply. Our trials are not yet completed, however, it was found so far that if the amount of insecticide in the spray liquid was kept constant, 400 liter per ha gave the same yield responses and control borers as in the case if 600 or 1000 liters were applied (4).

The use of much smaller quantities of spray liquid, the so called ultra low volume application, is in study under Indonesian condition now. Dust formulations have been tried out in the past without too much of success. The new formulations, however, should be studied also in the near future.

Discussion

Y. Ito, Japan: Is remarkably high sex ratio of the rice gall-midge reported by Dr. Soehardjan common in Ceylon?

Answer (Fernando): Yes, this is so in Ceylon.

D. B. Reddy, FAO: Has there been any study made on the sex ratio during emergence?

Answer (Tanongchit): No study has been made on this. In Thailand the sex ratio is 1:1 in the laboratory and field studies are in progress. In Ceylon, the sex ratio is high under the field condition.

H. A. Custodio, The Philippines: How long is the effective flight range of the gall midge adult? This information has relevance to the possibility of the pest getting into the Philippines where the insect is nct yet found.

D. B. Reddy, FAO (Comment): No information is available on the flight range of the rice gall midge. The chances of the rice gall midge crossing international boundaries by migration are very few. However there are other means of the rice gall midge being introduced accidentally: the chances of spread through carriage by wind currents, particularly in bordering areas cannot be over-ruled. The rice gall midge at preset is not found in some of the important rice growing areas in Asia, such as, Japan, Korea and the Philippines.

The rice gall midge was reported and still is the main rice season pest. In recent years it has been reported to be serious in summer season also, particularly from Indonesia and India. This change in the seasonal habit is of great economic significance.

Answer: No study has been made by the speaker. However, Session Chairman, Dr. Fernando said that since adults fly a short distance and are susceptible to adverse conditions, there is no possibility of the pest coming to the Philippines. Dr. Reddy also mentioned that this may not be possible. However, in study of other insects, the flight range of fruit flies, is about 50 kilometers. So, study should be made on the flight range of the gall midge for plant quarantine purposes.

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