The Strategy
of
The Integrated Control of The Rice Gall Midge, *Orseolia Oryzae* (Wood-Mason) (Diptera, Cecidomyiidae) in Indonesia

under
The Joint Programme of The Food Crop Protection,
ATA 162, between Indonesia and Japan Governments

31 May 1984

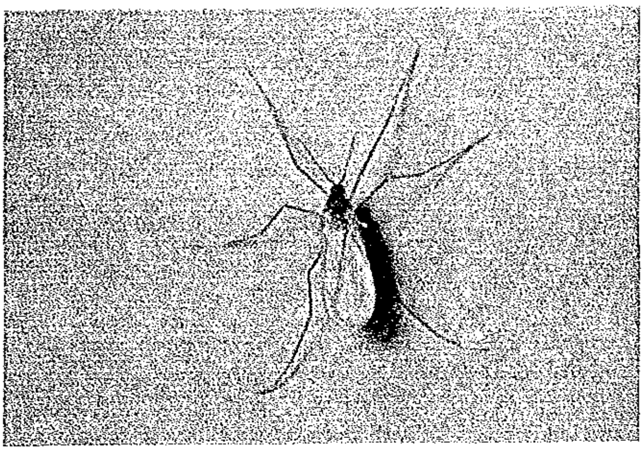
Japan International Cooperation Agency

The Strategy
of
The Integrated Control of The Rice Gall Midge, *Orseolia Oryzae* (Wood-Mason) (Diptera, Cecidomyiidae) in Indonesia

under
The Joint Programme of The Food Crop Protection,
ATA 162, between Indonesia and Japan Governments

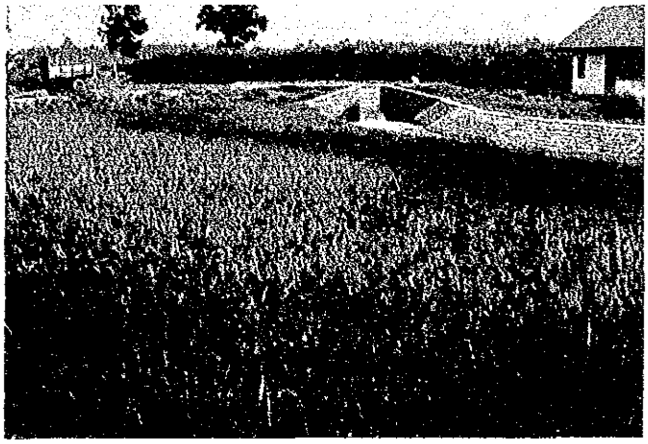
31 May 1984

Japan International Cooperation Agency



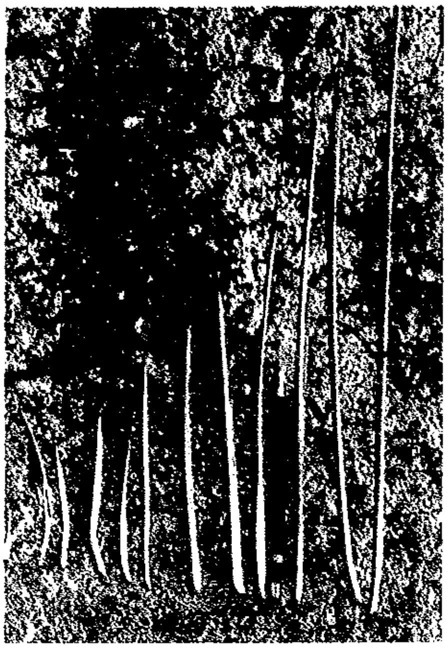
An adult female of the rice gall midge

Severely damaged rice fields in Cirebon district, West Java



A young gall (onion tube) occurred from 14 days old plant in Cirebon district

Severely damaged rice hill from which a lot of galls occurred



Galls formed in a rice hill, length of galls are variable

Galls of the alang alang gall midge from the wild grass, the alang alang. The alternate host of the parasites of rice gall midge

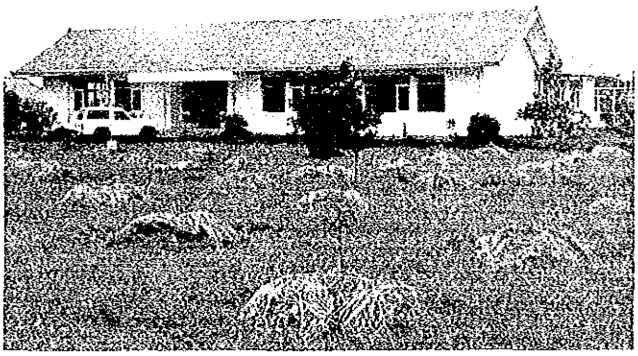
The experimental paddy fields of the rice gall midge set up in Cirebon, West Java

The field workers for checking the incidence of the rice gall midge in Cirebon, West Java

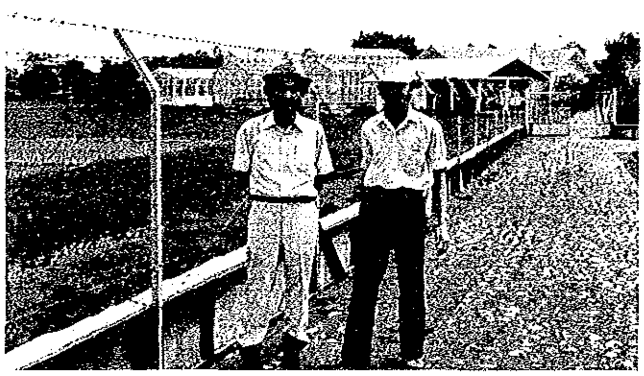
Dissection of rice tillers at the BPP Bayalangu in Cirebon to investigate on the developmental stages and parasites of the rice gall midge, and growing stages of rice plants

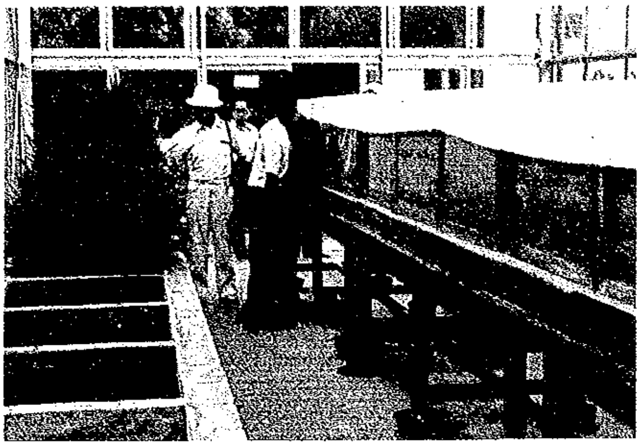
The meteorological site installed near the experimental field at Cirebon

The Jatisari Field Laboratory in Karawang district, West Java



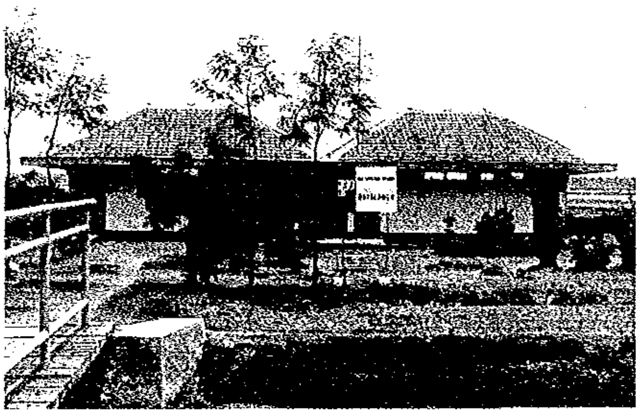
The newly constructed screen houses (back) and the experimental fields made by the model infrastructure project





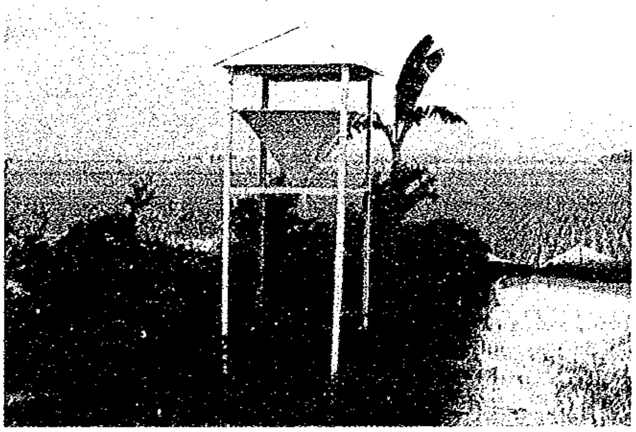
Mass rearing cages of the rice gall midge in the new screen house at the Jatisari Field Laboratory

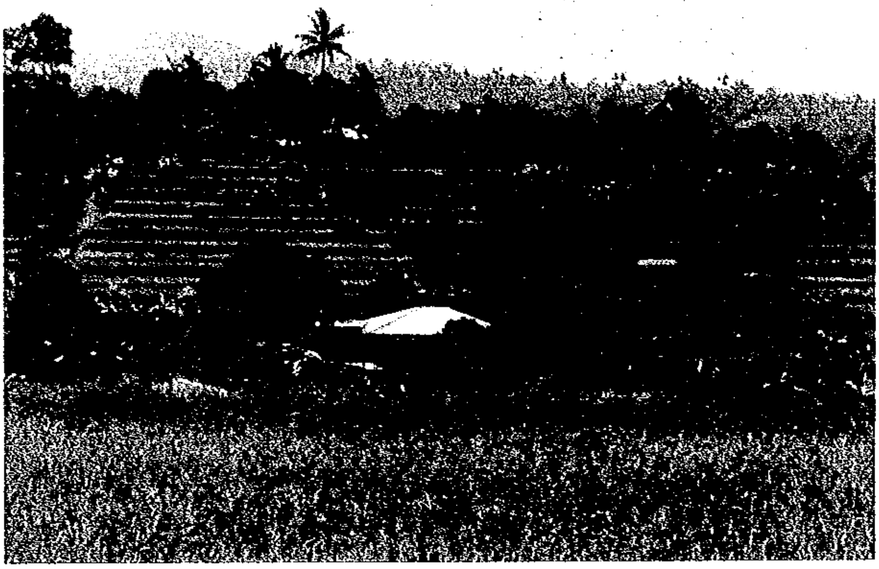
Training of special observers for the rice gall midge and the brown planthopper



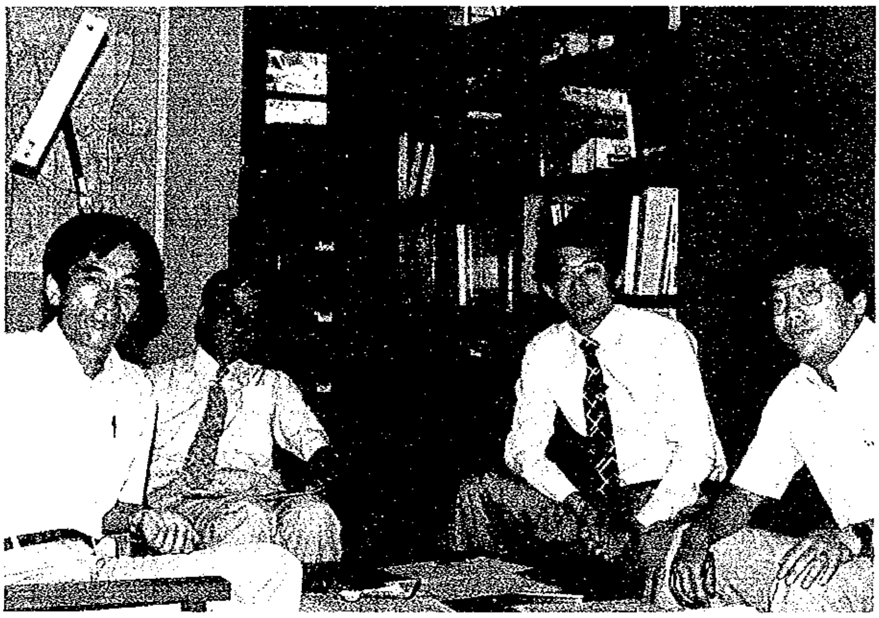
The rural extension service (BPP) at Bayalangu in Cirebon district, West Java

A light trap installed at the BPP Bayalangu for collecting the rice gall midge





Terraces of paddy fields between Pencak and Bogor, West Java



The Japanese team of the Plant Protection Project, ATA 162, at the Directorate of Food Crop Protection at Pasar Minggu, Jakarta. From right to left, Dr. S. Kawabe (Expert), Mr. S. Matsuo (Coordinator), Dr. S. Nasu (A team leader) and Dr. T. Hidaka (Expert)

CONTENTS

INTRODUCTION

The Food Crop Protection Project, ATA 162, has been initiated under the joint programme of cooperation between Indonesia and Japan Governments since 1980. The project is aimed to minimize yield loss caused by the rice pests and diseases as mentioned in the Master Plane in the Record of Discussion. In the Project, early detection of the outbreak of the pests and diseases and control technology has been requested to establish pest management in paddy fields. Although many kinds of rice pests occur, the following key pests, i.e. the rice gall midge, the brown planthopper, the green rice leafhopper, and the stem borrers, were selected to have priority as an object of the studies.

One of authors, Dr. Terunobu Hidaka, the National Institute of Agro-Environmental Sciences (formerly the Tropical Agriculture Research Center) at Tsukuba, Japan, was despached to Indonesia on 26 January 1981 and joined the Project until 31 May 1984, as an expert of the rice gall midge which is one of the important rice pests in Tropical Asia. During staying in Indonesia, the rice gall midge study group was organized since October 1981. The study group consists of 2 counterparts, 5 assistant counterparts, and 5 spot-workers and worked extensively to clarify the forecasting and control technology of the insect based on the results obtained from the factor analysis of the insect occurrence, field surveillance, injurious level, and field screening of insecticides and resistant varieties as reported herein.

In Indonesia, studies on the rice gall midge have been carried out from the view points of the bionomics, biology of the Hymenopterous parasites and the integrated control etc. These data obtained are very useful and practical for control of the rice gall midge, however, studies of fluctuation mechanism of the insect occurrence affected by the environment factors have not been conducted yet in Tropical Asia.

The factor analysis for the insect occurrence is the most important for establishing forecasting method to be enable to control the rice gall midge.

The basic studies on ecology in relation to control are needed to operate technology adapted for the field environment in Indonesia. It is still far a way to reach the purpose of the studies. A long termed field experiment for the rice gall gall midge occurrence is strongly recommended.

In present paper, the results obtained from the field experiments of the rice gall midge were reported with emphasis on the strategy of the integrated control of the rice gall midge.

Terunobu Hidaka[1)]

Harsono Lanya[2)]

Erma Budiyanto[2)]

Sarisito Wahono Gaib Subroto[2)]

Nyoman Widiarta[2)]

Sugandhi Zainudin[2)]

1) National Institute of Agro-Environmental Sciences, Yatabe, Tsukuba, Ibaraki 305 Japan

2) Directorate of Food Crop Protection, Pasar Minggu, Jakarta, Indonesia

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to Ir. Wardoyo, Junior Minister of Agriculture, Ir. Suhaedi Wiraatmadja, Director General of Food Crop Agriculture, Dr. Ida Nyoman Oka, former Director, Directorate of Food Crop Protection, and Dr. Ir. Sadji Partoatmodjo, Director, Directorate of Food Crop Protection, and staffs concerned with ATA 162 in the Directorate of Food Crop Protection for their kind cooperation and deep understanding for ATA 162 activities.

Thanks are also extended to the following gentlemen for their warm cooperation for conducting with the field experiments of the insect; Mr. Nono Sukarna, chief and staffs of the Observatory Laboratory of Jatisari; Mr. Sanusi, chief of Food Crop Protection Section, Cirebon Agricultural Extension Services; Mr. Umen, chief of Rural Extension Center at Bayalangu, Cirebon; Mr. Ateng Sukardi, chief of Food Crop Protection Section, Subang Agricultural Extension Services; Mr. Eddy Sawija a spot-worker for the rice gall midge (observer at present), the observatory Laboratory at Jatisari; Mr. Bambang Heryadi and Mr. Suyono, the spot-workers for the rice gall midge study at Cirebon Agricultural Extension Services; Mr. Eddy Sumardi and Mr. Chantra, the spot workers for the rice gall midge study at Subang Agricultural Extension Services .

One of the authors, Dr. Terunobu HIDAKA, deeply appreciate to Dr. Socho Nasu, a leader, Dr. Susumu Kawabe, former expert of the brown planthopper and Kyushu National Agricultural Experiment Station, Dr. K. Sogawa, an expert of brown planthopper, and Mr. Saburo Matsuo, a coordinator, the Food Crop Protection Project, ATA-162, for their guidance and encouragement given him during the cource of the study.

Thanks are also due to Dr. K. Iwata, Director of Environmental Biology Department and Dr. K. Kiritani, Head of Pest Management Section, National

Institute for Agro. Environmental Sciences, Dr. K. Umeya, Director of Pests and Diseases Control Department, National Agricultural Research Center, Dr. S. Nakagawa, Director and Dr. S. Konno, Deputy Director of Tropical Agriculture Research Center, Tsukuba, Japan, for their great assistance and support to the Project, ATA-162.

The authors express their hearty thanks to Mr. H. Yamamura, Representative and Mr. Y. Sasaki, Coordinator for Agriculture Technical Cooperation, Jakarta Office, and Mr. . Tauchi, Director of Agricultural Development Cooperation Department, Japan International Cooperation Agency (JICA), Tokyo, Japan.

We wish thanks to Mr. Memed Haryana, a clerk of the Food Crop Protection Project, ATA 162 and the field workers at Kertasura and BPP Bayalangu in Circbon regency for their help in course of the study.

I. ANNUAL PROGRAMMES OF THE RICE GALL MIDGE STUDY GROUP

T. Hidaka and H. Lanya

As given in Table 1, the investigations for improving forecasting and control methods of the rice gall midge have been carried out from 1981/82 to 1983/84.

In the Central office of the Directorate of Food Crop Protection, the annual work plans have been discussed with Indonesian staffs and the Japanese expert team once a year to determine the subjects of the study on the rice gall midge.

In the committee meeting of the Food Crop Protection Projects, ATA 162, the subjects of the studies on forecasting and control methods of the insect were accepted as follows.

In the Central office, the expert paid a great attension for the monitoring data obtained by the observers, the data have been kept at the Forecasting Section in the Directorate of Food Crop Protection. Then, at first, " Analysis of the monitoring data " was selected not only for finding out the characters of occurring and damage pattern of the rice gall midge but also understanding activity of the observers.

In the second, the expert strongly desired to grasp real incidence of the rice gall midge in West Java. Therefore, an observation of the insect incidence in low and high land of paddy fields in West Java had been conducted with the assistant counterparts from April 1981. The subject was entitled as " Field study of the monitoring incidence of the rice gall midge ".

In order to analyze occurring mechanism of the rice gall midge in paddy fields, the field experimants were needed. Then, locality of the field experiments were selected in Cirebon where is known as one of the endemic areas of the rice gall midge in Indonesia.

Dr. Ir. Sadji Partoatmodjo, a Director of the Directorate of Food Crop Protection, had also conducted the field experiments of the insect for his PhD thesis in Cirebon. Cirebon is considered to be a good place to do the field experiments of the insect through the supervise of Mr. K. Sanusi, Chief of Food Crop Protection Section, Agricultural Extension Services of Cirebon.

The main subject of ecological study of the rice gall midge in the field condition was " Factor analysis of gall midge occurrence between seriously damaged areas and low infestation areas ". This is to find out the key factors affecting the incidence of the rice gall midge. The factors are involved with physical (meteorology) and biological (painting time, natural enemies etc.) agents.

In order to minimize insecticide application, an economic injurious level is important to determine for control of the rice gall midge. Timing of insecticide application based on the economic injurious level was also carried out.

For controlling insect, the field screening of insecticides to find out an effective one was conducted in relation to the economic injurious level, as well as the field screening of resistant varieties which were introducted from Thailand and India to compare with Indonesian resistant variety, GH 27, to the insect.

After implementation of the model infrastructure and construction of the screen houses at the Jatisari Field Laboratory in 1983, a field experiment on occurrence and damage of the rice gall midge was carried out to analyze mechanism of low infestation in this area. A mass rearing of the rice gall midge was also conducted in the newly made screen house to be clear biological and ecological view points including laboratory tests of varieties and insecticides.

Table 1 Annual work plans of the rice gall midge study group under the Food Crop Protection Project ATA-162 from '81/82 - '83/84

Subjects	1981	1982	1983	1984
I. Central Office at Pasar Minggu.				
(1) Program for improving forecasting method of the national level.				
1). Analysis of the monitoring data	——	——	——	——
2). Field study of gall midge incidence	——	——	——	
II. Jatisari Field Laboratory.				
(1) Ecological studies for improving surveillance technology.				
1). Factor analysis of gall midge occurrence between serious damaged areas and low infestation areas.		——	——	——
2). Injuries level for control of gall midge.		——	——	
3). Field screening of resistant varieties.			——	——
4). Field screening of insecticides for control of gall midge			——	——
5). Timing of insecticide application in different damaged level				——
6). Occurrence and damaged caused by the rice gall midge at the different planting dates				——
7). Mass rearing				——
III. Research Institute for Food Crop of Bogor.				
(1) Physiological and Ecological studies for forecasting.				
1). Mechanism of gall formation	X X X			

II. ORGANIZATION AND ACTIVITY OF THE RICE GALL MIDGE STUDY GROUP

T. Hidaka, H. Lanya and N. Widiarta

The rice gall midge study group has been started in 1981 as shown in Fig. 1. Since an expert of the rice gall midge, Dr. Terunobu HIDAKA, arrived on 26 January 1981, Dr. Sadji Partoatmodjo became a counterpart of the expert and kindly arranged an assistant counterpart, Ir. Harsono Lanya, of the Pest Control Section. In 1981, main activity of the rice gall midge study was carried out to do the field survey on occurrence and damage of the rice gall midge in low and high lands in West Java as given in Table 2.

The field survey by the expert and the assistant counterpart was started from March in 1981 once a month before Ir. Erma Budiyanto and Ir. Subroto Wahono Gaib Sarsito who joined the rice gall midge study group as new assistant counterparts since 1982.

In September 1981, a total of five spot workers who graduated from the Agricultural High school joined to carry out the field survey with emphasis on the rice gall midge. Therefore, a special training of the rice gall midge for these spot workers had been conducted, at first, at the Jatisari Field Laboratory where Ir. Edi Sunarjo of Research Institute of Food Crop in Bogor and Ir. Harsono Lanya had the lectures and binocular microscopic observation of the rice gall midge.The field study was also carried out at the Pusakanegara Experimental Farm which belongs to the Research Institute of Food Crop in Sukamandi. These spot workers have been joined at one in the Jatisari Field Laboratory, two in the Agricultural Extension Services of Cirebon and the others in the Agricultural Extension Services of Subang as given in Fig. 1.

The spot workers have initiated to carry out the field survey from December 1981. In Subang and Cirebon regencies, number of checking sites of teh rice gall midge incidence were in 20 villages of 4

Fig. 1

Staffs of the Rice gall Midge Study groups under the Food Crop Protection Project, ATA - 162 1981 - 1984

Directorate of Food Crop Protection (DFCP)

[Counterpart]

Dr. Ir. Sadji Partoatmodjo 1) —— [Expert] Dr. Terunobu Hidaka

[Field worker]

A). Kertasura, Kapetakan, Cirebon

Mr. Jayadi	[1981 - 1984]
Mr. Mulya	[1981 - 1984]
Mr. Salir	[1981 - 1984]
Mr. Sanaji 2)	[1981 - 1982]
Mr. Sutiyono	[1981 / 1982]
Miss. Sri	[1982 / 1983]
Mr. Amsor	[1983 / 1984]
Mr. Naim	[1983 / 1984]

B). EPP. Bayalangu, Gegesik, Cirebon.

Mr. Dadang	[1981 - 1982]
Mr. Lili 2)	[1981 - 1982]
Mr. Endin 2)	[1981 - 1982]
Mr. Suptiman	[1982 - 1984]
Mr. Sudirman	[1982 - 1984]
Mr. Taufic	[1982 - 1984]

[Assistant Counterpart]

Ir. Harsono Lanya	[1981]	Control Section, DFCP
Ir. Erma Budiyanto	[1982 - 1983]	
Ir. Subroto Wahono Gaib Sarsito	[1982 - 1983]	Forecasting Section,
Ir. Nyoman Widiarta	[1983 - 1984]	
Ir. Sugandhi Zainudin	[1984]	Control Section

[Spot-worker]

Mr. Edy Suwardi Wijaya	[1981 - 1984]	Jatisari Field Laboratory
Mr. Bambang Haryadi	[1981 - 1984]	Cirebon Agricultural Extention Service
Mr. Suyono	[1981 - 1984]	
Mr. Edi Suryadi	[1981 - 1984]	Subang Agricultural Extention Service
Mr. Cantra	[1981 - 1984]	

[Driver]

Mr. Dohri Syarif	[1981 - 1983]
Mr. Agus Djunaedi	[1983 - 1984]

1) At present, Director of DFCP

2) Became the extention workers (PPL)

Table 2 Locality conducted the field survey of the rice gall midge by the spot-workers

Spot - worker	Duration (year)	Regency,	Subdistrict,	Village
Mr. Bambang Heryadi Mr. S u y o n o	1982-1983	Cirebon.	a). Kapetakan	1. Kapetakan, 2. Kartasura, 3. Surananggala Kidul, 4. Dukuh 5. Suranenggala Lor
			b). Plumbon	1. Keduanan, 2. Kedung Sana, 3. Plumbon, 4. Kebarepan 5. Karang Asem
			c). Astanajapura	1. Kanci, 2. Pangeaan, 3. Rawa Urip, 4. Bendungan 5. Astaurajapura
			d). W e r u	1. Gamel, 2. Trusmi, 3. Cangkring, 4. Setu, 5. Tegal Wangi
Mr. Edi Sumardi W. Mr. Chantra	1982-1983	Subang	a). Pabuaran	1. Pabuaran, 2. Pringkasap, 3. Rancabango, 4. Sihuman, 5. Tanjungrassa.
			b). Pagaden	1. Gembor, 2. Genung Gembung, 3. Sumpar, 4. Sunur Ginting 5. Tanjung
			c). Pamanukan	1. Pamanukan, 2. Pamanukan Seberang, 3. Rancahilir, 4. Sukarja, 5. Sukasari
			d). Purwadadi	1. Panjungkiran, 2. Pasir pamgru, 3. Purwadadi Barat, 4. Purwadadi Timur, 5. Wanakerta
			e). Subang	1. Belendung, 2. Cidahu, 3. Karang Anyar, 4. Soklat, 5. Sukamelang
Mr. Edi Sawija D.P.	1982-1983	Karawang		1. Jatisari Field Lab., 2. Jatisari, 3. Jatisari Bakam Sewi, 4. Jatiragas 5. Bolonggandu, 6. Bolonggandu|Krejan, 7. Pangulah, 8. Pangulah|Utasa 9. Pangulah Baru

subdistricts in each regency. However, in Karawang regency, 6 checking sites were selected in Jatisari subdistrict. Therefore, the field survey of the rice gall midge by these spot workers has been conducted in a total of 46 sites of paddy fields in 3 regencies. The spot workers have checking in these sites once a week, number of sampling hills were 48 in total (16 hills with 3 replicates) for counting number of galls, and then the other 10 hills were pulled out for dissecting tillers in each checking time for investigating the developmental stages and parasites of the rice gall midge. All of the data obtained in paddy fields were filled out in the form of the field survey as shown in Table 3 and sent to the Directorate of Food Crop Protection at Pasar Minggu through the Jatisari Field Laboratory.

On the other hand, the field experiments of the rice gall midge has been carried out at Kertasura and BPP Bayalangu in Cirebon from the wet season 1981/1982. The field workers, graduated from the Agricultural High School, for checking the rice gall midge as indicated by the expert were employed through the Food Crop Protection Section in Agricultural Extension Services of Cirebon. Number of the field workers were 8 in total for each year, 5 out of 8 the field workers in Kertasura and 3 in BPP Bayalangu. Among the field workers, 4 out of 8 field workers had succeeded to be the Agricultural Extension Worker (PPL) in 1982 and then 4 others field workers were newly employed just before the wet season in 1982/1983. All of them were well trained by the assistant counterparts for understanding the rice gall midge.

The assistant counterparts graduated from the Agricultural University of Bogor (IPB), Ir. Harsono Lanya in 1981, Ir. Erma Budiyanto and Ir. Subroto Wahono Gaib Sarsito in 1982 and 1983, Ir. Nyoman Widiarta in 1983 and 1984, and Ir. Sugandhi Zaenuddin in 1984 have joined to the rice gall midge study group and showed not only an important role for implementing activity of the study but also useful for themselves to increase correct and practical knowledge of rice entomology and to master methodology through rice gall midge study. Ir. Gaib, S.W.S. participated the individual training course of rice insect pests at Kyushu National Agricultural Experiment Station and Fukuoka Agricultural Experiment Station in Japan from November 1982 to May 1983, as wel as Ir. Erma Budiyanto at the Agriculture Research Center from November 1983 to February 1984.

The forecasting Laboratory in the Research Institute for Food Crop of Bogor is also recognized to be one of the joint works of the Food Crop Protection Project ATA 162. Therefore, Ir. Edi Sunarjo of the Entomology and Phytopathology Division was nominated as a counterpart of the expert, Dr. T. HIDAKA, because he is only a researcher to study the rice gall midge in Indonesia. However, Ir. Edi Sunarjo has been studying in the PhD course of the Agricultural University of Bogor (IPB). Really he had no time to joint activity of the rice gall midge study group although the expert planned to the subject concerning the gall formation of the insect. Then, the expert gave up to work in the Research Institute for Food Crop of Bogor and considered not to disturb his work in PhD programmes. No other counterpart in the Research Institute for Food Crop of Bogor was available for the rice gall midge study group.

III. INFESTED AREAS OF PADDY FIELDS CAUSED BY RICE GALL MIDGE

T. Hidaka and E. Budiyanto

According to the monitoring data obtained since 1976, two items such as a) the infested areas (ha.) and b) the percentage of intensification damaged tillers are shown in Tables 4-6.

The infested areas means that paddy fields are neccessary for control of the rice gall midge and the intensification damaged tillers are calculated by the following formula, Total infested area (ha.) X damaged tillers (%) / Total infested areas (ha.) X 100.

These data are shown in regency (Kabupaten) and Province levels, however, no data is given in subdistrict (Kecamatan) and village (Desa) levels which are more important than Province and regency levels to analyze the forecasting data year by year or month by month urgently giving the information of the damage by the rice gall midge to the farmers.

From the results obtained in the Provincial level, the rice gall midge is understood to occur in main Islands of Indonesia except Maluku and Irian Jaya. The infested areas of paddy fields are distinctly decreased from 112,568 ha in 1976 to 24,113 ha in 1982. However, the intensification damage ranges from 16.5 % in 1976 to 9.8 % in 1982.

Severely attacked areas by the insect are seen in Java Island where West and Central Java are to be epidemic areas of the insect. Bali, Lombok and Sumbawa Islands belonging to West Nusatenggara are also known as occuring area of the rice gall midge.

In Sumatera Island, although the insect damage has been reported from 8 Provinces, however 4 Provinces i.e. North Sumatera, Bengkulu, South Sumatera and Lampung are also occuring areas of the insect. Percentage of the intensification damage is between 2.3 and 11.7.

The other Provinces in Sumatera is observed that the rice gall midge has occurred in some years.

In Kalimantan, the insect infestation was observed to be in East and Central Kalimantan in 1982, however, the insect was also recorded to occur in West and South Kalimantan in some years from 1976 to 1981. Infestation degree was between 4.9 and 71.7 %.

In Sulawesi, all of Sulawesi Provinces have reported that the rice gall midge was recognized to occur. However, the insect is not found in paddy fields every years. In 1981, the insect damaged occurred only in North Sulawesi.

As given in Tables 7-14, incidence of the rice gall midge in West Java was observed to reduce from 45,742 ha in 1976 to 11,800 in 1981. This reason is considered to be effectiveness of the BIMAS and INMAS national programmes for control of rice insect pests as given in Tables 15-17. In West Java, the infested areas were the highest in Indramayu followed by Cirebon, Ciamis, Subang and Sukabumi in 1978 and 1979. However, the infested area was observed to become the highest in Cirebon followed by Cianjur and Subang in 1980, as well as Purwakarta, Cirebon and Indramayu in 1981, and Cirebon, Majalengka, Subang and Ciamis in 1982. These areas were infested by the insect more than 1000 ha every years. At present, the intensification damage more than10 % is observed in 13 regencies out of 20 regencies, the infested areas more than 1,000 ha are 5 out of 20 regencies. A total of 14,016 ha of paddy fields were still needed to control of the rice gall midge in 1982.

In Central Java, the following regencies such as Grobogan, Banyumas, Banjarnegara, Sragen and Brebes have been endemic areas of the rice gall midge, infested paddy fields ranged from 1000 ha to

3,200 ha in 1978, however, several regencies i.e. Cilacap, Kendal, Brebes and Grobogan were also attacked by the insect. The infested paddy fields in these areas were from 1,500 ha to 700 ha in 1982. Then, more than 7,000 ha of paddy fields are needed for control of the insect.

In East Java, the regencies which were infested by the insect more than 1,000 ha in 1978 were seen in Mojokerto, Ngawi and Sumenep, however, the infested areas were prominently reduced since 1979. At present, the infestation is seen at 15 regencies out of 30 regencies with remarkablly less infested areas from 1 to 4.3 ha.

In Yogyakarta, two regencies i.e. Bantul and Kulon Progo are considered to be occurring areas of the insect and the infestation reached 253 ha in Bantul and 427 ha in Kulon Progo in 1978, however, the infested areas of Kulon Progo had increased 992 ha. The insect is observed to occur even in the other regencies in 1982.

As shown in Figure 2, the infested areas of paddy fields which are neccessary for control of the insect has been distinctly decreased not only Java Islands but also the other Islands from 1976 to 1982. This reduction of infested areas is considered to be resulted with effectiveness of the monitoring system of rice pests, insecticide control and cultural practice. As given in Tables 18-20, pesticides were distributed to each regency for control of rice pests and diseases under the BIMAS and INMAS National programme which showed remarkable progress to control pests and increase rice production. However, it can be said that the rice gall midge is still dangerous and important pests of rice plants in Indonesia, therefore, control programmes of the rice gall midge must be strengthening under national policy of Rice Production Projects in the fourth Pelita.

It is also pointed out that field survey of the occuring areas has to carefully check and correct indentification of gall and damage *symptom* of the rice gall midge is more important to make right report by the observers.

IV. MONTHLY FLUCTUATION OF THE INFESTED AREAS CAUSED BY THE RICE GALL MIDGE IN JAVA ISLAND

T. Hidaka and S.W.G. Subroto

According to the data obtained by the observers belonging to the Rural Extention Services in West Java in 1981-1983, as given in Tables 21-32. It can be said that the infested areas caused by the insect was much higher in the wet season (December - March) than in the dry season (May - October). The rice gall midge is understood to be a rice pest giving mainly serious damage in the wet season.

In West Java, a peak of damaged area was seen in February in 1981 and 1982. The rice gall midge occurred in all of regencies during the wet season. However, the data in Bandung and Bekasi regencies in the Wet season 1981 and 1982 were not given. Of course, the insect always occurs in these two regencies as well.

In the dry season, rice cultivation is consecutively done in high land areas of paddy fields such as Bogor, Sukabumi, Cianjur, Bandung and Garut etc. In these areas, the infestation by the insect is also occurring throughout the year. However, infested areas in the dry season were less than the wet season and the intensification damage was also lower in the dry season than in the wet season.

In lowland paddy fields in the dry season, incidence of the rice gall midge is observed to be low and is suggested to be unneccessary for control to the insect.

In Central Java, incidence by the insect was seen as same as in West Java in the wet and dry seasons as shown in Fig. 3. In some of regencies i.e. Banjarnegara, Purbalingga, Pati and Sragen etc. damage by the insect continuously occurred throughout the year i.e. 1981 and 1982. This means rice cultivation has been consecutively done every years.

However, incidence by the insect occurred in 1414 ha in Cilacap and 660 ha in Banyumas in July 1981. This was an exceptional phenomenon so far as the data obtained, the intensification damage reached 1 % only in July and August. This is suggested that the rice gall midge has a possibility to occur in wide range even in the dry season with high incidence. In Banyumas, infested areas and damaged tillers were 660 ha and 11.0 % in July 1981. If the rice gall midge is given appropriate environment in the dry season, outbreak of the insect will occur and then be careful for the monitoring even in the dry season.

In East Java, infested areas were prominently less than in West and Central Java in 1981 and 1982. The incidence of the rice gall midge was seen in 16 regencies in 1981 and 14 regencies in 1982 out of 30 regencies in the wet season. On the contrary, damaged areas of paddy fields were 4 regencies and 3 regencies in 1981 and 1982 in the dry season.

In Yogyakarta, incidence of the insect could not see in the dry season in 1981 and 1982. The incidence mainly occurred in the wet season. In another word, the rice gall midge is understood to be a key pest of rice plants, however, the infested areas of paddy fields can be seen throughout the year, so that the monitoring for the insect must be carefully done.

According to the intensification damage caused by the insect, the percentage of damage in general was lower than 10 %, however, the damage is found to be higher than 10 % in some areas of Java

Islands. This is suggested that the occuring areas of the rice gall midge still remain in Java Islands. The control measures must be carried out in these occuring areas especially in the wet season as given in Figure 3.

V. RICE PEST PROBLEM IN INDONESIA

T. Hidaka, N. Widiarta and S. Zainudin

According to the data obtained in the Central Office of the Food Crop Protection Project (ATA 162) at Pasar Minggu as shown in Table 33, the key pests attacking rice plants are listed as follow i.e. the stem borers (mainly the yellow stem borer), rodents, the rice leaf roller, the rice bug, the brown planthopper, the army worms and the rice gall midge. The list of the key pests are ranked by the damaged areas which are indicating neccessary for control measures of these pests.

On the other hand, a total of 11 kinds of rice diseases occurs in paddy fields, among them Rhizoctonia oryzae, tungro transmitted by the green rice leafhoppers and Pyricularia sp. are most important group, and then Xanthomonus sp. and Helminthosporium sp., followed by Acrocylindrium sp. and Cercospora sp. are also infesting rice plants. The grassy stunt, the yellow dwarf and the ragged stunt occurs in some areas in Indonesia.

In general, judging from the total areas infested by the insects and diseases, rice insect pests are considered to be more important than the diseases. The damaged areas of paddy fields reached more than 800.000 ha by rice pests including insects and vertebrate animals, however, the infested areas by rice diseases were about 34,000 ha. It is noticed that rice diseases are expanding the infested areas year by year, for example, infested areas by rice diseases reached about 7 times in 1982 comparing with 1977, and species of rice diseases have been increased, this may concerned the change of rice varieties and others in Indonesia.

In rice insect pests, the brown planthopper was the most destructive pest before 1980 due to the infested areas, at present the stem borers and rodents are occurring in wide areas. The rice gall midge is still one of the key pests of rice plants in Indonesia as well as the army worm, the rice bug and the rice leaf roller.

The infested areas caused by the brown planthopper and the rice gall midge have been reduced from 1977 to 1982. However, of the other key pests, the damaged areas have not been changed between 1977 and 1982. The army worm has remarkably increased the damaged areas. Outbreaks of the rice case worm was seen in 1981. The black rice bug also occurred every years.

It is interesting to note that wild pig, monkey, and elephant are also important pests giving damage in some areas in Indonesia.

In Indonesia, recent outbreak of rice pests has been seen as given in Table 34. Tungro disease seriousely occurred on a variety, IR 36, in Bali Is., Central Java and Maluku Is. The brown planthopper also infested IR 42 in North Sumatera and became a big problem to the farmers since 1982/1983. *Helminthosporium* sp. and the green rice leafhoppers were seen to seriousely damage on IR 42 in Bali Is. and Central Sulawesi respectively. The rice gall midge attacked a variety, Cisadane, in Cirebon, Majalengka and Cianjur in West Java. Cisadane is a moderate resistant variety to the brown planthopper, however a highly susceptible variety of the rice gall midge.

It can be said that the monitoring for rice pests must be strengthened to prevent the outbreaks of the pests in cooperation with the observers and farmers.

VI. FIELD SURVEILLANCE ON OCCURRENCE AND DAMAGE CAUSED BY THE RICE GALL MIDGE

T. Hidaka, H. Lanya and N. Widiarta

The surveillance of the incidence of the rice gall midge is aimed to grasp a real situation of the damaged pattern and degree in paddy fields and to find out effectiveness of natural control in low and highland areas in West Java.

Materials and Method.

The present surveillance of the incidence of the rice gall midge was carried out by the expert, Dr. T. Hidaka, and the assistant counterparts, Ir. H. Lanya, Ir. E. Budiyanto, Ir. S.W.G. Sarsito, Ir. N. Widiarta since 1981/1982 as given in Table 35.

The field surveillance covered in low and high land areas in West Java and approximatedly more than 600,000 ha of paddy fields. A total of 15 checking points in 10 regencies were selected. In each checking point, a total of 48 hills were sampled at random, and then, number of galls and tillers were counted. All galls collected were carefully dissected to investigate on natural enemies and the developmental stages of the rice gall midge. The checking sites of paddy fields were same in each checking time throughout the year. The investigation was also carried out at the rate of once a month. The following items i.e. transplanting date, rice variety, fertilizer and insecticide applications etc., were also recorded by the hearing from the farmers.

The field surveillance concerning the rice gall midge was also carried out in East and Central Java by Ir. S.W.G. Sarsito, and Ir. Erma Budiyanto in the wet season, 1981/82, as well as in Bali Island, Lombok and Sumbawa Islands of West Nusa Tenggara by Ir. N. Widiarta in July 1983. During the surveillance, adults of the rice gall midge were also collected by light trap in those localities to compare with the morphological characteristics of the insect in Indonesia.

Results

a) West Java.

The results obtained by the surveillance are shown in Tables 36-37. In the wet season, the incidence of the rice gall midge was significantely higher in lowland areas of paddy fields than in high land areas. The highest damaged tillers reached 98.41 % and 90.85 % in Garawangi of Majalengka regency in 1982 and 1983, seriousely damaged areas were found to be in Subang, Majalengka, Cirebon and Sumedang regencies in 1982.

On the other hand, the damaged tillers were comparatively low in high land areas of paddy fields i.e. Bandung, A part of Sumedang, Cianjur, Sukabumi and Bogor. In high land area, the consecutive transplanting of rice plants has been carried out by the farmers throughout the year. Therefore, activity of natural enemies (parasites mainly Platygaster oryzae and Neanastathus oryzae, and predators Ablysius imbricatus) was found to be higher in high land than in low land paddy fields. In high land, different stages of rice plants are usually growing all the year round. This means that the population of the rice gall midge including natural enemies is conserved from generation to generation. Natural balance between the host insect and natural enemies is considered to be kept in good condition.
A predator Amblysius imbricatus attacking egg of the insect.

As given in Figure 4 , in 20 out of 27 checking points showed the relationship of " high incidence and low parasitism in low land " and " low incidence and high parasitism in high land ". However, Relationship between the host insect and parasites was not recognized in 7 out of 27 checking points in West Java because the host insect population was too low and the damaged tillers were also less than 5%.

During the dry season, the incidence of the rice gall midge was found to be low in general. The highest damaged tillers was seen in Sumedang at 37.19 % and Majalengka at 33.76 %. More than 95 % of the checking points were found to be less than 10 % of damaged tillers. Parasitism was rather high even in the dry season, for instance, parasitism more than 30 % was in 6 out of 15 checking points. High land areas showed high percentage of the parasitism. The relationship between damaged tillers and parasitism by gall was not clear in the dry season as given in Figure 5.

However, it is understood that the population of natural enemies can be maintained nevertheless the damaged tillers is low in the dry season. In lowland paddy fields, these parasites were transfered from the wet season crop of rice to the dry season crop. After harvesting of the dry season crop of rice, these parasites are considered to disappear due to no the host insect under dried conditions in paddy fields.

b) Central and East Java.

As given in Table 38, a total of 9 checking sites of paddy fields were selected. 48 hills were sampled and galls collected were dissected for checking the parasitism.

In Central Java, the damaged tillers were relatively low from 0.45 to 13.04 %, however, the parasitism was very high from 50 to 66.66 %. In East Java, the damaged tillers ranged from 22.41 to 66.24 %. However, the parasitism was lower 4.48 to 8.98 % than that of Central Java. Relatively highly damaged areas were Mojokerto and Jombang in East Java, the highest damage was seen in Pesantren of Jombang. Effectiveness of the parasites for control of the rice gall midge was clearly recognized.

c) West Nusa Tenggara.

In Lombok Island, a total of 13 sites of paddy fields were investigated to check the damaged tillers. The rice hills were rooted up and each tiller was carefully dissected to check number of larvae and pupae. All galls collected were also dissected to observe the parasites. Present Investigation was carried out from June 28 to 29 1983.

The results obtained are given in Tables 39-40. The incidence of the rice gall midge was very low by galls and galls + larvae. Damaged tillers ranged from nil to 4.63 %. No damaged tillers were seen in 5 out of 13 checking sites. Parasitism by the hymenopterous parasites was relatively high in paddy fields.

In Sumbawa Island, two localities were observed in June 30. The damaged tillers were 0.59 % and no the parasites were found. No gall midge was collected at Lunpe in Sumbawa Besar.

In Bali Island, a total of 9 checking sites were investigated from July 5 to 7. The damaged tillers by galls showed 1.48 to 5.98 % and by galls + larvae 3.06 to 25.10 %. Generally parasitism was higher 25.92 % to 79.16 %. It is suggested that the parasites population is well conserved in natural condition under the consecutive cultivation of rice throughout the year in Bali Island. The hymenopterous parasites can control well the rice gall midge in Bali Island.

d) In 1981, serious infestation caused by the rice gall midge was seen at Tambakan village in Subang regency where is located in hill site as far as 30 km south of the town of Subang. Rice varieties planted were Pogol and Bungawan. Percentage of damaged tillers by gall reached 71.53 % at the checking time on 12 March 1981. The damaged areas were 0.3 ha in total. The parasitism reached 85 % at the heading stage of rice plants. The parasites were Platygaster oryzae and Neanastathus oryzae .

The serious infestation was also observed in paddy fields located at 9 km north of Subang city. The rice plant examined was at 55 days old after transplanting, rice variety was IR 36 which was transplanted in January. A variety, IR 36, was found to be highly susceptible to the rice gall midge.

High incidence was also observed at Marikangen village of Plumbon in Cirebon. The damaged tillers by galls of variety Cisadane reached 49.26 %. In Cirebon, outbreak of the rice gall midge occured in several localities such as Tukumuda village of Weru Subdistrict where damaged tillers by galls in a variety Cisadane were observed to be more than 90 %. The incidence areas of paddy fields were about 0.5 ha, one or two healthy panicles per hill were formed. The damaged tillers withered and became brown colour. As the results of the dissection of tillers which pulled out at random from paddy fields, the damaged tillers reached 77.57 % and the parasitism was 40.9 % respectively.

Serious infestation by the rice gall midge was also observed to be in Sunyaragi village in Cirebon and Kanci village of Astanajapura in Cirebon, the former showed 99.9 % of damaged tillers in a variety, Pelita I/1 and the latter was 91.68 % in IR 36, as well as 50.64 % in C 4-63.

e) Purwakarta regency.

The field surveillance was carried out by the expert (Dr. T. Hidaka) and the assistant counterparts (Ir. Erma Budiyanto, Ir. Nyoman Widiarta) at Sirnagalih and Citamiang villages of Plered Subdistrict in Purwakarta in February and March 1983.

Paddy fields where the rice gall midge incidence investigated were the rainfed areas surrounded by the mountains.

As given in Table 41, rice plants were at 30 days after transplanting in the Surinagalih village, a variety planted was Cisadane. The damaged tillers by galls and the dissection (larvae + pupae + galls) were 9.27 and 35.16 % respectively. However, the damage was higher than the economic injurious level at this time considered that the control measures are needed. The parasitism was still lower than 13%. However, age of rice plants were at 71 days after transplanting at the 2nd investigation at the Surinagalih village. The damaged tillers by galls and by the dissection were 15.69 and 44.63 % respectively. However, the parastism reached clearly in 62.68 in galls and 59.12 % by the tiller dissection. This is suggested that the parasite, Platygaster oryzae, is very important for control of the rice gall midge.

In Citamiang village, although damaged tillers by galls were less than 8 %, the parasitism in galls ranged 56 and 76 %. The parasite is understood to have important role for depressing population of the rice gall midge.

f) Cianjur regency.

The field surveillance was also carried out in Cianjur regency by Ir. Erma Budiyanto between 15 and 21 February 1983. The checking sites were selected at a total of 15 villages in 5 Subdistrics. The varieties planted by the farmers were mainly Cisadane followed by GH 147, Pelita and local ones. Percentage of damage tillers were calculated by a) number of galls and b) number of the developmental stages of the rice gall midge in tillers which were dissected after hills pulled out. The growing stage of the plants during the checking time was 25 to 70 days after transplanting.

As the results obtained from the surveillance as given in Table 42, more than 40 % damaged tillers by the dissection were found in

Cirateun, Pasirmalang, Sindangjaya, Cikuk and Karangwangi in the Rural Extension Services (BPP), as well as Samolo, Mahan Mandarjaya in BPP Karang Tengah, Pasir Batu in BPP Cibeber, and Cijangang in BPP Cikalang. Ten out of 30 checking sites were seriousely damaged, however, the other 20 sites were less infestation. High infestation was seen at 50 days old plants after transplanting in BPP Ciranjang and BPP Karang Tengah. The damaged tillers by galls were correlated with the damaged tillers by the dissection. The maximum damage by gall reached 49.21 %. More than 20 % of the damage by galls are considered to become dangerous incidence.

According to the surveillance, at least ten checking sites were needed to control urgently by insecticide at the time of Surveillance. On the other hand, it is interesting to note that the parasitism by the hymenopterous parasites were considerablly higher in BPP Karang Tengah than the other localities. In highland area of paddy fields, the parasites are active to parasitize the host insect and can depress the population of the rice gall midge in the field conditions. The maximum parasitism reached 71.79 at Bajong in BPP Karang Tengah, however, low parasitism was seen at BPP Cikalang and Cianjur Kota.

Relationship between damaged tillers by gall and by dissection was closely correlated as given in Figure 6. This means that percentage of damaged tillers by the dissection will be estimated from the damage by galls. On the contrary, the parasitism and damaged tillers by galls and by dissection have no close relationship.

VII. INCIDENCE OF THE RICE GALL MIDGE INVESTIGATED BY THE SPOT WORKERS

T. Hitaka, S.W.G. Subroto, E. Budiyanto and S. Zainudin

A total of 5 spot workers has joined to the rice gall midge study group ATA 162 since September 1981. These spot workers were trained at the Jatisari Field Laboratory, the Pusakanegara farm of the Sukamandi Research Institute for Food Crop in Subang regency, and Pekalongan regency in September 1981. After hard training, one of the spot workers for the rice gall midge was in the Jatisai Field Laboratory, as well as two of them in the Cirebon Agricultural Extension Services and the two others in the Subang Agricultural Extension Services. Cirebon and Subang regencies are known as one of the occuring areas of the rice gall midge, so that the insect occurrence and damage in paddy fields are very important to analyze the occuring pattern and the mechanism of damage in both regencies. The Jatisari Field Laboratory also occupies an important position to manage the field experiments of the key pests. Then, a spot worker has joined to the laboratory.

Mr. Eddy Suwardi of the Jatisari Field Laboratory in Karawang regency made surveillance of the rice gall midge in a total of 11 checking sites from 1981 to 1982. Mr. Eddy Suryadi and Mr. Chantra in the Subang Agricultural Extension Services have also investigated on the insect damage in a total of 20 checking sites in 4 Subdistricts. Mr. Bambang Haryadi and Mr. Suyono in the Cirebon Agricultural Extension Service have checked in 20 sites in 4 Subdistricts. The checking times were 4 days per week from Monday to Thursday. The data obtained were arranged in Friday and then the data were regularily sent to the Central Office at Pasar Minggu, Jakarta. The copies of the data were also given to the Food Crop Protection Section of the Agricultural Extension Services of the Cirebon and Subang regencies.

In a checking site of the rice gall midge, a total of 48 hills were sampled at randoom With 3 replicates and then number of galls and healthly tillers per hill were counted. 10 hills of rice plants were pulled out and dissected all tillers to check larvae, pupae, parasites and galls. Eggs deposited on leaves were also counted.

a) KARAWANG regency

In the regency of Karawang, the field investigation was conducted at the Jatisari Subdistrict where nine checking sites were selected as given in Tables 43-50. The damaged tillers by galls were found to be 16% at the maximum and, in general, lower than 10 % in the wet and dry seasons. The damaged tillers by the dissection were also as same tendency as damage by galls. There are no difference of damage between the wet and dry seasons, as well as damage by galls and by the dissection. The parasitism by the hymenopterous parasites in galls were recognized to be about 30 % in the average. However, effectiveness of the parasites for control of the rice gall midge was not clear.

In Jatiragus and Bolonggandu, the parasitism was higher in the wet season than the dry season although there is no difference between the damaged tillers in both localities. On the other hand, the parasitism in the wet season was comparatively same as in the dry season in Jatisari and Jatisari Field Laboratory. Rice variety during the investigation in Karawang regency was IR 36 which was a dominant variety to prevent the brown planthopper incidence.

b) CIREBON regency

In Astanajapura Subdistrict, the damaged tillers by galls were prominently higher in the wet season 1981/82 than in the wet season 1982/1983. The maximum percentage of damaged tillers by galls reached to 80%, a variety IR 36 was seriousely infested. In the dry season, incidence of the insect was less than 10% by the dissection. In the wet season 1982/83, the percentage of damaged tillers by galls was less than 14 %. This was quite different phenomenon due to serious drought in December 1982. Transplanting in 1982/83 was delayed about one month comparing with the preceeding year.

Then, the population of the rice gall midge became very low in the wet season in 1982/83. This phenomena were also observed in the other four villages in Astanajapura. The parasitism was also low in all seasons in all checking sites.

In Kapetakan, Plumbon and Weru Subdistricts, the rice gall midge has gave serious damage to the rice variety, IR 36 or Cisadane, in the wet season 1981/82. However, damage was very low in the wet season in 1982/83 due to serious drought at the end of 1982. Of cource, incidence of the rice gall midge was low in the dry season every years. The parasitic activities were not so high, the parasites could not collect in some checking sites as given in Table 51-86.

According to the investigation in Cirebon, serious incidence was found to occur in rice plants transplanted in January. Effect of the drought on the insect occurrence was observed that damaged tillers were comparatively lower in 1982/83 than in 1981/82.

c) SUBANG regency

In general, so far as the checking sites are concerned, the damaged tillers and the parasitism were found to be very low throughout the year. There were no difference of the damaged tillers between the wet and dry seasons. The parasitism could not increase due to low population of the insect as given in Tables 87-142.

VIII. AN ALTERNATE HOST OF THE HYMENOPTEROUS PARASITES ATTACKING THE RICE GALL MIDGE

T. Hidaka, N. Widiarta and E. Budiyanto

During the off season of rice, it was long questioned where the hymenopterous parasites could exist, because no rice plants are growing in paddy fields and besides, the rice gall midge could not be found.

In high land areas, rice plants are also not cultivated in some period of the months. Present observation was carried out at Cijalingan and Sukalarang villages in Sukabumi, West Java to clarify relationship of the hymenopterous parasites between rice plants and the Alang alang gall midges. The galls occurred from the Alang alang were sampled along the dykes of paddy fields, for example four dykes (total 60 meter) in Sukalarang and five dykes (100 meter) in Cijalingan. All galls collected were carefully dissected to check the parasites. Species of these parasites were indentified under the binocular microscope. The observation for the sampling was conducted once a month.

As the results obtained from the field investigation from 1983, the Alang alang gall midge, Orseoliella sp., was found to occur on the host plant, Imperata cylindrica, which is abundantly growing around paddy fields in Sukabumi regency. As given in Tables 143-146, three kinds of the hymenopterous parasites i.e. Platygaster oryzae, Neanastathus oryzae and Obtusiclava oryzae were found it both villages.

Number of galls occurred were much more in Cijalingan than in Sukalarang. More than 100 galls at the checking time were collected at Cijalingan in 22 January, 25 March, 16 May and 14 June 1983. On the other hand, number of galls collected at Sukalarang at the checking time were less than 40 galls except 86 galls in 20 July 1983.

In Sukalarang, number of the parasites were not abundant, the parasitism wass less than 31 %. In Cijalingan, it was very difficult to identify a peak of generation of the Alang alang gall midge, as well as number of generation per year. The parasitism was less than 20 %. Among the parasites, Platygaster oryzae was more abundant than the other parasites. It can be said that activity of these parasites can be maintained in the Alang-alang gall midge throughout the year.

From the morphological viewpoints of these parasites so far as collected, body length of the parasites raised from the Alang-alang gall midge was slightly larger than that of the parasites of the rice gall midge. However, as the results obtained from the microscopic study, morphological characters of these parasites raised from rice plants and Alang-alang were observed not to be different. At present, Ir. Eddy Sunaryo, an entomologist of the Research Institute for Food Crop in Bogor has been carrying out the biological investigations on Platygaster oryzae raised from both plants.

At the same time, the incidence of the rice gall midge was also investigated at Sukalarang and Cijalingan in Sukabumi regency. The results obtained were given in Tables 143 and 145. In Sukalarang, percentage of damaged tillers by galls was less than 4.5 in all seasons and then Platygaster oryzae were a dominant species, however the parasite was found at 3 times from 20 July 1982 to 25 January 1984. The parasitism ranged 10 to 22 %. In Cijalingan, percentage of damaged tillers was lower than 7.78 during checking times. A parasite, Platygaster oryzae, was more numerous than the other parasites. The parasitism was more higher in Cijalingan than in Sukalarang and fluctuated from none to 100 %.

IX. ALTERNATE HOST PLANTS OF THE RICE GALL MIDGE

T. Hidaka, S.W.G. Subroto and S. Zainudin

The alternate host plants of the insect has been report from Thailand and India such as wild rice and Leersia hexandra etc. which are important as source of the insect occurrence.

Present study was carried out to find out the alternate host plants during the off season of rice in West Java in Indonesia. The surveillance of the alternate host plants was conducted in low and high land areas of paddy fields throughout the year.

Wild rice, the most important host plants in tropical country of Asia, could not be found in West Java. However, Leersia hexandra, one of the alternate host plants, are growing in huge areas of paddy fields or of the dykes. L. hexandra is found in low and high land areas in the cultivated land. Therefore, the sampling for checking galls and dissection of tillers for finding larvae and eggs was carried out in many localities in West Java.

As the results obtained from the surveillance, only two galls of the rice gall midge were found in Sukamandi Research Institute for Food Crop in Karawang and Kertasura in Cirebon. Two pupae of the rice gall midge were collected from the galls. However, any larvae were not found although a lot of tillers were dissected in many localities.

In fact, the rice gall midge is considered to feed on L. hexandra in remarkablly low probability as an alternate host plant. During the fallow period between September and November in lowland areas in West Java, the insect can not survive in paddy fields. The rice gall midge is considered to have a short distant flight from the consecutive planting areas to the synchronized planting areas. Then, the insect starts to infest rice plants.

X. STUDY ON ECONOMIC INJURIOUS LEVEL FOR CONTROL OF THE RICE GALL MIDGE

T. Hidaka and N. Widiarta

Clarification of the economic injurious level is very important to minimize insecticide application and avoid influence to natural enemies.

Materials and methods.

Present study was carried out at Kertasura village in Cirebon regency in the wet season 1981/82 and 1982/83. A rice variety, Cisadane, was transplanted on 5 January 1981/82 and 10 February 1982/83. Number of seedlings at the time of planting were 3 per hill with the planting space 25 x 25 cm. A plot size was 50 m^2.

Twenty five per plot were sampled at random, the sampling hills were marked by the bamboo sticks for checking the same hills. Number of galls and healthly tillers were counted every 14 days and galls were pulled out to check natural enemies. Rice yield was also weighed for each plot and number of healthy panicles was counted.

An insecticide, Ekalux 5 % in the granular form, was applied every 10 days after transplanting at the rate of 1.0 kg of the active ingredient per hectare. The experiment was conducted in 4 replications. The application time of the insecticide was 1, 2, 3, 4, and 5 to make different damaged tillers levels.

Results

The following relationship was clarified in the wet season 1981/82 and 1982/83. For example, coefficient relation between damaged tillers by galls and number of panicles per hill was - 0.799 and - 0.968, as well as damaged tillers by galls -0.846 and -0.757 and rice yield and number of panicles per hill 0.981 and 0.677 respectively, as shown in Figures 7-9. A high correlation between time of insecticide application and damaged tillers by galls was recognized as given in Figure 10 and Tables 147-148.

From these relationship, minimum insecticide application is concluded to be 2 times after transplanting which means in the vegetative growth period. Population of the rice gall midge continue to increase until panicle primordium is formed.

Paddy rice yielded about 3.0 tones per hectare. However, rice yield was rather lower in the experimental fields than the other paddy fields. Rice yield increased in proportion to number of application times of the insecticide.

The injurious level was examined to determine from the data based on the relationships mentioned above.

a) Damaged tillers by gall

It is obvious that high rice yield was obtained when infestation by the insect was low. Percentage of damaged tillers by gall within one month after transplanting was highly correlated to rice yield. Then, it can be said that the maximum rice yield was possible to obtain when the insect infestation was lower than 5 % of damaged tillers. However, good rice yield could get when 10 % damaged tillers. This means that if one or two galls per hill occurred within one month after transplanting, control measures must be taken. The injurious level is suggested to be 5 % of damaged tillers by gall. In another word, the incidence must be lower than 5 % of damaged tillers by gall in order to keep good rice yield.

b) Damaged tillers by the developmental stages

Percentage of damaged tillers is expressed by number of the developmental stages (i.e. larvae, prepupae, pupae, adults, and parasites etc.) which are obtained by dissection of the growing points of rice tillers. Number of the developmental stages are included galls which consist of pupae, adults and parasites.

As shown in Figure 11, rice plants transplanted in January (the late planting) are seriously damaged by the rice gall midge at Kertasura and BPP Bayalangu in Cirebon regency. Damaged tillers by the developmental stages sharply increased, for instance, 4.08 %, 10.40, 36.80, 41.74 and 55.91 at 5, 10, 15, 20, 25 and 30 days after transplanting respectively. In this case , damaged tillers by galls was less than 4.11 % before 25 days after transplanting, however 17.24 % at 30 days after transplanting.

Damaged tillers by the developmental stages reached more than 10 % at 10 days after transplanting. In general, damaged tillers sharply increased between 10 and 30 days after transplanting. The period within 30 days after transplanting is indicated to be most important for operating control measures. Therefore, judging from relationship between damage and rice yield, 10 % of the damaged tillers by the developmental stages are critical point to prevent serious damage caused by the rice gall midge.

c) Relationship between damaged tillers by galls and developmental stages.

As a point to indicate the injurious level to the farmers and even to the observers for monitoring rice pests and diseases, observation of gall occurring on rice hills is certainly easier than the developmental stages by dissecting tillers of rice. Dissection method is rather difficult to do by the farmers and observers. However, percentage of damaged tillers by the developmental stages is significantly higher than damage by galls at the time of observation. Exact data of damaged tillers can be obtained by the dissection of tillers.

Therefore, the monitoring the rice gall midge has to start for checking number of galls per hill at 14 days after transplanting. This is the first checking for damage , as well as 2nd at 28 days after transplanting.

According to the data obtained in the late planting of the rice plants in Cirebon in 1981/82, the folllowing formulae are found such as

$$Y = 2.307\ x + 24.328, \quad r = 0.488$$

(Y, damaged tillers by the developmental stages and X, damaged tillers by galls) and

$$Y = 2.262\ x + 19.821, \quad r = 0.628$$

(Y, damaged tillers by the developmental stages and X, damaged tillers by accumulated galls).

Therefore, percentage of damaged tillers by developmental stages can estimate from damaged tillers by the accumulated galls. This mean that damaged tillers by counting number of galls are really practical in the monitoring by the observers.

d) Capability of insecticide application by the farmers

In the farmer's fields, rice yiel per hectare averaged 5 tones of paddy rice in Cirebon regency. Cost of the paddy rice is 100 Rp per kg. The total income of the farmer from the paddy rice is estimated about 500.000 Rp per hectare in one time cropping of rice. If the farmer can transplant two times per year, the income increases double.

On the other hand, the farmer has to expend for many items necessary management for obtaining rice yield. For example, these items are land preparation, tax of paddy fields, irrigation cost, rice seeds, fertilizer, weeding, insecticide, and harvesting with threshing and packing to the gunny bug as given in Table 149. The total expenses amounted 312.500 Rp. Therefore, the benefit reached 187.500 Rp which is seen in the averaged farmers in Cirebon. In case, the rental fee of paddy fields is also added.

Insecticide cost is about 1.500 Rp per litre in the emulicified concentrate form and 400 Rp per kg in the granular from in the market price. In general, insecticide spray by a person takes 3 days for a hectare. For control of the rice gall midge, at least two times of insecticide application are needed in the endemic areas as mentioned before. When the insecticide " Ekalux " is used, the application cost of the insecticide will reach about 24000 Rp. per hectare.

If the farmer is not rental of paddy fields, two time of application are possible. However, if rental, the insecticide application can not be done more than two times per rice cropping. If the farmer has less than 1.0 ha of paddy fields, insecticide application is also difficult to do by the farmers.

XI. FIELD SCREENING OF GRANULAR INSECTICIDES FOR CONTROL OF THE RICE GALL MIDGE

T. Hidaka, E. Budiyanto and S. Zainudin

Present study was conducted to find out effective insecticides for control of the rice gall midge.

Materials and method

A total of 6 kinds of the granular insecticides as given in Table 132 were examined at Kertasura village in Cirebon regency in the wet season 1982/83. The insecticides were applied at the rate of 1.0 kg (A.I.) per hectare. The timing of these insecticides application was at 12 and 24 days after transplanting which are appropriate period for control of the rice gall midge.

A variety examined was Cisadane which is susceptible to the rice gall midge. Transplanting was done on 5 February 1983. Number of seedlings was 3 per hill at the time of transplanting. A plot size was 50 m^2.

The damaged tillers by galls were checked 14 days intervals and 25 hills per plot were sampled at random. Number of tillers and galls were counted. The sampling hills were marked by the bamboo stick and the same sampling hills were observed throughout the checking time. The field experiment was carried out under 4 replications.

Results

As given in Table 150, a peak of incidence of the rice gall midge reached at 70 days after transplanting. The peak of the incidence came later than the usual year due to effect of the long drought at the end of December 1982. It is also understood that the incidence was very low until 56 days after transplanting, usually the peak occurs just before the panicle primordium formation stage which cames 50 and 60 days after transplanting.

As given in Table 151, the transformed damaged tillers by galls treated by Ekalux 5 % were 6.13 %, followed by Furadan 3 % 14.95 % and Diazinon M 24.15 % respectively. The Padacin 5 % was as same damage as in non treated plot. Padan 10 % and Diazinon 5 % were not effective for control of the insect. In addition, number of galls per hills was 1.64 in Ekalux, 3.92 in Furadan and 6.22 in Diazinon M, as well as more than 11 galls in the other insecticides examined. Number of panicles per hill was 17.74 in Ekalux, 16.68 in Furadan and 15.49 in Diazinon M. Rice yield per 50 m^2 was 14 kg in Ekalux, 14.10 kg in Furadan and 12.73 in Diazinon M, however 9 kg in non treated plot.

It is considered that the insecticde which is effective for control of the rice gall midge is Ekalux and Furadan so far as examined. At present, the both insecticides have been used widely in Indonesia. However, Padan and Padacin were not effective at all, because these are effective for control of the rice stem borers.

The systemic insecticide must be used for control of the insect because the larvae are always feeding in the growing points of rice plants.

XII. FIELD SCREENING OF RESISTANT VARIETIES TO THE RICE GALL MIDGE

T. Hidaka and N. Widiarta

In order to recommend the resistant varieties to prevent the rice gall midge attack in the late planting areas which the insect gives serious damage to rice plants in the wet season.

Materials and method

The field screening was carried out at Kertasura in Cirebon, West Java in the wet season 1982/83 and 1983/84. In this report, the results obtained in 1982/83 were summarized. The data in 1983/84 were not involved because of the fields experiments were implementing at the report making.

The resistant varieties tested were a total of 9 varieties, 6 out of 9 varieties were RD 4, RD 9, RD 11, RD 21, RD 23 and MN-62 M from Thailand, Phaelgune and Surekh from India, and GH 27 from Indonesia. The susceptible varieties as standard were Cisadane and IR 36. These varieties were transplanted on February 1983. A plot size was 50 m^2. The experiment was conducted with 4 replicates. Twenty five hills were sampled for checking number of galls and healthly tillers.
Sampling hills were marked by the bamboo sticks (1 m long). The same hills were traced to check during the field experiment. Galls found at the time of checking were pulled out to prevent the double counting of the same gall.

Results

As given in Table 152, Thailand varieties such as RD 4, RD 11 and MN-62 M, Indian ones such as Phaelgune and Surekh, and Indonesian GH 27 were found to be resistant to the rice gall midge. Among these varieties, MN-62 M and GH 27 showed none of gall occurrence until 56 and 42 days after transplanting. The incidence in the other varieties examined was more than 10 % damaged tillers at 70 days after transplanting. These varieties are considered to be susceptible ones to the insect. Although some varieties i.e. RD 9, RD 21 and RD 23 are moderate resistance in Thailand, however, these became susceptible in Indonesia. There are different reaction of resistance to the insect between Indonesia and Thailand. The biotypes are supposed to occur between both country.

It can be said that the following varieties i.e. RD 4, RD 11, Phaelgune, Surekh and GH 27 are suggested to recommend in the late planting areas in the wet season in Indonesia.

In Indonesia, the brown planthopper has been a major rice pest, therefore these varieties mentioned above have to screen resistance to the brown planthopper in the seedling stage. The screening test to the brown planthopper has been requested to the brown planthopper Study Group of ATA 162 at the Research Institute for Food Crop, Bogor, in 1984. The results obtained seedling test were given the Table 154. The resistant varieties to the biotype 1 were RD 4, RD 9, RD 21 and RD 23 from Thailand. The other varieties i.e. RD 11, RPW 6-17 and RP 9-4 were moderate resistance. The resistant varieties to the biotype 2 were RPW 6-17, RP 9-4, and RD 23, as well as the biotype 3 RD 4, RD 21, and RD 23. RD 23 showed resistant to moderate resistant to the biotypes 1, 2, and 3.

In addition, during the field screening experiment, the white backed planthopper, Sogatella frucifera, seriously attacked the varieties as given in Table 134. This is a problem from the view point of resistant variety utilization that two resistant varieties from India and four from Thailand to the rice gall midge are susceptible to the white backed planthopper.

The results obtained from the field screening of the resistant varieties from Thailand and India in the wet season 1983/84 are given in Table 153. RPW-GIT and GH2T were recognized to be highly resistant varieties to the insect.

XIII. FACTOR ANALYSIS FOR THE RICE GALL MIDGE OCCURRENCE

T. Hidaka, E. Budiyanto and N. Widiarta

Present study aims to clarify mechanism of the rice gall midge occurrence between seriously damaged areas and low infestation areas for implement forecasting technology and effective control measures.

Materials and method

Two localities of the endemic and non endemic areas of the rice gall midge were selected in Cirebon regency in West Java. The endemic area was at Kertasura village of Kapetakan subdistrict, as well as non endemic at the Rural Extension Services (BPP) of Bayalangu village in Gegesik subdistrict.

In the wet season, transplanting was done in December and January since 1981/82. On the other hand, in the dry season, rice plants were transplanted in May. However, at first, transplanting was done in May and June in the dry season 1982, the rodents attacked severely rice plants planted in June. Therefore, transplanting was in May only in the dry season.

Rice variety examined were Cisadane which is a susceptible to the rice gall midge. Number of seedlings at the time of planting was 3 per hill. Twenty days old seedlings after sowing were transplanted. A plot size was 100 m^2 (50 x 20 m) per planting time. Planting space was 25 x 25 cm. Amount of fertilizer apllied was 200 kg/ha of Urea and 100 kg/ha of TSP. Application time of the fertilizer was as follows. The first application was one day before transplanting at the rate of Urea 67 kg + TSP 100 kg, in the second at 3 weeks after transplanting in 67 kg of Urea, and the third at 6 weeks after transplanting 67 kg of Urea.

The checking was done at every five days after transplanting, number of sampling hills were 50 hills X 3 replications (150 hills in total) for gall occurrence and the other 20 hills were uprooted at randoom and all of tillers were dissected to check the developmental stages and its natural enemies. In the sampling hills, number of galls and healthy tillers were counted and all galls visible from outside were pulled out and counted the developmental stages and its natural enemies. The same hill was sampled during the checking time. The sampling hills were marked with the bamboo stickes as one meter long. Number of eggs laid on leaf blade and leafsheath were counted.

The meteorological station was installed in the experimental fields to gain climatic data to investigate on the influence of the climatic factor on the insect occurrence. The climatic data collected were as follows, i.e. precipitation, air temperature, relative humidity, sunshine duration, solar energy, wind velocity and direction, and water temperature in paddy fields. The micro temperature and humidity were also investigated using by the synchrometer at the height of 10, 20, 30, 40, and 60 cm at 7:00, 13:00 and 18:00 hours in every 5 days throughout the planting season.

Results

a) Correlation among gall, developmental stages, and rice plants

as given in Tables 155-157, three kinds of the correlation coefficient, $r > 0.900$, $r > 0.800$, and $r > 0.700$ were classified in the developmental stages of the rice gall midge - gall - parasites - damaged tillers - growing stages of rice plants especially panicle primordium formation stage.

The highest coefficient of correlation was seen in the relationship between gall and adult which was common in the early and late planting in Cirebon. It can be said that number of adult in paddy fields can estimate from the number of galls sampled at paddy fields, as well as damaged tiller by gall and damaged tiller by larvae + pupae + adults in the early planting. The six other relations out of 8 were specified by the planting time and localities. However, these important relationship among the relations can be practical to estimate fluctuation and damaged tillers through sampling of galls in paddy fields.

In $r > 0.800$, as given in Table 156, pupae and gall are common in the early and late planting in Cirebon, as well as a total number of larvae and pupae, tillers and galls, panicle and adults. The following relations i.e. larvae (1) and larvae (2), tillers and adults, tillers and panicle primordia, larvae (1) and panicle primordia, larvae (2) and panicle primordia, larvae (1 + 2) and panicle primordia, galls panicle primordia were also seen in common between planting types. 18 other relations out of 29 were specified by planting time and locations.

In $r > 0.700$, as shown in Table 157, 4 relations out of 23 showed in the early and late plantings, the others were rather independent phenomena.

In fact, number of galls visible from the outside are easily counted during the fiel survey. Therefore, if the galls and other relations are clarified to be relatively high, population density and damaged tillers at the time of the field survey can be estimated without dissection of tillers to check number of the developmental stages.

Number of eggs laid on leafblades of rice plants, as given in Figs. 12-17. So far as present experiment is concerned, number of eggs and adults, eggs and galls, eggs and larvae, eggs and parasites, eggs and damaged tillers were recognized to be higly related.

It is also important to estimate population and damaged tillers from the early planting to the late planting, as well as the wet season crop of rice to the dry season crop of rice. If there are highly significant relations among the developmental stages, tillers, galls and parasites between the early and late planting, forecasting of damaged tillers in the late planting and dry season crop of rice is considered to be possible. At present, the relations between the early and late planting are investigating in progress. Rice gall midge damage is more serious in the late planting in the wet season rice than in the dry season rice. Then estimation of damaged tillers in the wet season rice have to be done from the data obtained in the dry season crop of rice.

b) Occurrence of the rice gall midge and parasites after transplanting, larvae were found from 20 days after transplanting, as well as pupae from 30 days, adults and galls 35 days respectively. However, the parasites (mainly Neanasthatus oryzae) started to appear from 55 days after transplanting, as given Tables 158-184.

In general, the developmental stages were appeared at 10 days earlier in the late planting than in the early planting. The insect disappeared at the harvesting time. A peak of population was seen at 60 days after transplanting which coincided with the initiation stage of panicle primordium formation in a variety Cisadane. A total of 3 generations of larvae were observed from transplanting to harvesting as shown in Fig. 18.

In Jatisari Field Laboratory, from the results obtained from light trap studies since 1980, 3 peaks of adult occurrence were observed for each year. A peak of adult emergence came at middle of February in 1982. There were some differences of the peak occurrence by the years as given in Fig. 19 and Table 185-186. Light trap study has been carried out in Kertasura and BPP Bayalangu as shown in Table 187-188. The parasite appeared from 35 days after transplanting in the late planting which was 25 days earlier than in the early planting.

c) Population increase was observed to be more rapidly in the late planting than in the early planting. This is suggested that the insect population occurred in the early planting fields removed to the late planting and damage by the insect sharply increased because the insect could propagate only in the tillering stage of rice plants.

For example, number of eggs sharply increased more in the late planting at both Kertasura and BPP Bayalangu villages than in the early planting as given in Figs. 20-23. Number of larvae, pupae, adults and galls were also prominently increased in the late planting in both villages.

d) Annual change of damaged tillers caused by the insect pest was given in Figs. 24-27 as based on the data obtained from the fields experiments from 1981 to 1984. It is very clear that occurrence pattern of the insect was observed to be highly damaged tillers in the wet season and low infested in the dry season. This is considered that the late planting of rice plants was severely attacked due to population pressure of the insect raised from the early planting, high humidity with continous rainfall for high percentage of eggs hatchiability, and low percentage of parasitism by Neanastatus oryzae. Annual change of number of developmental stages are given in Tables 189 and 190.

e) Fluctuation of number of leafblades, tillers and panicle primordia per hill in the different planting dates are given in Figs. 28-31. In the variety, Cisadane, examined, panicle primordia formation has started from 55 to 65 days after transplanting. In the late planting, a peak of number of tillers and leafblade was seen at 60 days after transplanting. However, tillers in the early planting has gradually increased and there was no peak of tillering. Number of leaf-blades were not coincided with tillers in both localities.

f) Climatic condition is shown in Figs. 32-35 and Tables 191-224, in Cirebon, air temperature showed 28°C in the average throughout the year with maximum 34°C and the minimum 22°C. The relative humidity was 81 % in the average during the wet season and 62 % in the dry season. The relative humidity fluctuated in relation to the precipitation which amounted about 1800 mm for the year. Rainfall started in the middle of November and continued until June. Peak of rainfall month was seen in January (307.8 mm) in 1982 and 519 mm in 1983 and February (349 mm) in 1984 at Kertasura, as well as March (478 mm) in 1982, January (348 mm) in 1983, and February (398 mm) in 1984. The insect occurrence is closely related to the precipitation which is one of the most important factors for population build. Therefore, the long termed data between precipitation and insect occurrence are needed.

In the wet season 1982/83, rainfall was delayed for 30 days in West Java so that transplating was also shifted for 1.5 monts. In general, the gall midge infestation was lower in 1982/83 than the other years and started to occur lately on the ineffective tillers which can not form panicles. This is suggested that infestation caused by the insect became higher if rainfall starts from November as normal. However, if precipitation was extremely low in November and December, gall midge infestation became low. Precipitation in November and December is important factor to build the insect population of the wet season.

The micro air temperature and humidity, as given in Tables 225-242 and Figures 36-42, were also studied to find out effect on mortality and survival rate of the rice gall midge. However, the micro temperature and humidity in the early planting fluctuated as same as in late planting.

On the other hand, the infestation by the insect was prominently lower in the dry season than in the wet season. This is considered that adults and egg hatchiability became higher due to dry condition in relation to no rainfall, long sunshine duration, higher solar energy, and high evaporation rate in the day time. In Indonesia, outbreak of the insect has not been observed in the dry season crop of rice.

Long term study on relationship between insect occurrence and climatic factors is needed in order to be possible to make forecasting method of the insect. The data collected in 3 years only were not enough to discuss with the relationship.

XIV. STRATEGY OF THE INTEGRATED CONTROL OF THE RICE GALL MIDGE

T. Hidaka and N. Widiarta

From the viewpoints obtained by the comprehensive studies on the rice gall midge, the strategy to control the insect was designed as given in Figure 43. At first, early detection of the insect damage and occurrence by the field monitoring with the pest observers was practically the most important to determine control measures. In the monitoring, adequate timing for checking the insect occurrence was at 14 and 28 days after transplanting to know whether or not the insect damage reached the injurious level which meant two categories i.e. 5 % damaged tillers by the galls and 10 % damaged tillers by the larvae.

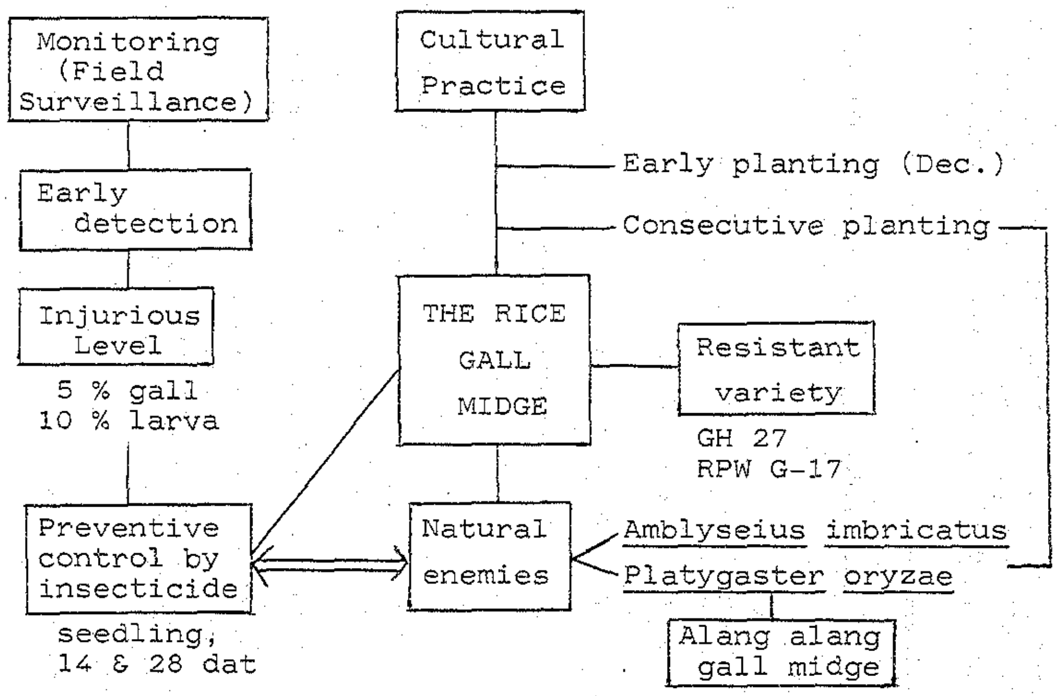
As the results obtained from the monitoring, the following items were also clarified the endemic areas, seasonal occurring pattern, and important season for control the insect.

As the practical control of the insect, early planting in December was found to be effective for evade serious damage, especially in low land areas such as in Cirebon. This is a recommendable technique in Indonesia. On the other hand, natural enemies i.e. an predator *Amblyseius imbricatus* and a hymenopterous parasite, *Platygaster oryzae*, were also clarified to be very important to suppress the insect population in the concecutive planting areas as seen in high land areas i.e. Bandung, Cianjur and Sukabumi. It can be said that the concecutive planting is more effective to conserve population of the natural enemies than the synchronized planting which has been practical in the lowland fields under the irrigation system. In the high land areas, these natural enemies were found to have an alternate host i.e. the alang alang gall midge, during the fallow season.

Resistant varieties such as GH 27 from Indonesia and RPW G-17 of a Indian variety, showed to be promissing to control the insect as the results obtained from the field experiments. This is suggested that the breeding programme to establish the resistant varieties against the rice gall midge must be carried out as early as possible. Two varieties mentioned above are considered to be used as parent for the breeding. The resistant varieties are recommended in the seriously occurring areas of the rice gall midge such as in Cirebon in West Java.

In the insecticide application, it was certified that 14 and 28 days after transplanting were adequate time to apply the insecticides because preventive control of the insect was more effective and activity of natural enemies i.e. the hymenopterous parasites, were very low within 30 days after transplanting so that insecticide application in that time was ineffective to these natural enemies.

The control measures of the rice gall midge have to do not only insecticide but also cultural practice with effectiveness of natural enemies in tropical Asia.



(Fig. 43) The strategy of the integrated control of the rice gall midge in Indonesia

X V. PUBLICATION and PRESENTING PAPERS

During activity of the rice gall midge study group from 1981 to 1984, the following papers were issued by the group.

1. The rice gall midge and its control, 23 pp, (October 1983) (Indonesian). This is a guide book for the observers and the extension workers for understanding ecology and control technology.
2. *Studies on field surveillance of the rice gall midge in West Java.* 10 pp. (25 January 1983). 2nd Congress of Entomology Society in Indonesia. (Indonesian with an English summary)
3. Report on the rice gall midge in the wet season 1981/82. 29 pp. (12 July 1982)
4. A summary report on the rice gall midge study group (ATA 162) in 1982/1983. 23 pp. (31 August 1983).
5. The following papers were issued in the Annual Report of Research Activity of the Tropical Agriculture Research Center on February 1984.
   a) Occurrence and damaged caused by the rice gall midge in West Java, Indonesia. 2 pp. (Japanese)
   b) Analysis of the monitoring data of the rice gall midge in Indonesia since 1976. 2 pp. (Japanese)
   c) Factor analysis of the rice gall midge occurrence. 2 pp. (Japanese)
   d) *Economic injurious level for control of the rice gall midge.* 2 pp. (Japanese)
   e) Field screening of resistant varieties to the rice gall midge. 2 pp. (Japanese)
6. In the Joint Committe Meeting being held in 1982, 1983, and 1984, the results obtained by the study group were briefly presented by

the expert and the assistant counterparts.

7. A special lecture entitled " ecological and control studies of the rice gall midge in the Tropics " was presented by Dr. T. Hidaka for obtaining the awards in the 28th Meeting of Applied Entomological Society in Japan.

8. Seminar on the rice gall midge was held at the meeting room of the Directorate of Food Crop Protection, Pasar Minggu, on May 1984.

XVI. SUMMARY

The results obtained from the rice gall midge studies in the period 1981 - 1984 are summarized as follows.

1. The rice gall midge study group, consisting of an expert, 2 counterparts, 5 assistant counterparts, 5 spot-workers (observers for monitoring the rice gall midge), and 14 field workers in Cirebon regency, has been started since 1981 and the joint programme under ATA 162 was successfully carried out.

2. A total of 8 subjects of the rice gall midge studies were carried out. The title of the subjects were as follows, a) analysis of the monitoring data of the insect, b) field surveillance of occurrence and damage caused by the rice gall midge, c) economic injurious level for control of the rice gall midge, d) timing of insecticide application in relation to the injurious level, e) field screening of insecticides for control of the insect, f) field screening of resistant varieties for control of the insect. These experiments were conducted in Cirebon regency, however, b) field surveillance was observed in low and high lands of paddy fields in West Java.

In the Jatisari Field Laboratory, g) the field experiments on effect of the planting dates on the insect damage and h) mass rearing in Laboratory were also carried out.

3. Analysis of the monitoring data of the rice gall midge in Indonesia, the monitoring data has been obtained for 8 years since 1976. The rice gall midge occurs mainly in Java Island, especially serious incidence was seen in West Java. The incidence of the rice gall midge has been remarkably decreased from 1976 to 1983 due to well managed control programme under BIMAS and INMAS. The rice gall midge is still one of the destructive insect pests in the wet season, however, less incidence in the dry season.

4. Field surveillance on occurrence and damage caused by the rice rice gall midge.

Field surveillance was carried out by the expert, the assistant counterparts, and the spot workers in low and high land paddy fields in West Java since April 1981. The rice gall midge seriousely occurred in lowland paddy fields such as Cirebon, Majalengka, and part of Subang regencies in the wet season. Percentage of damaged tillers by the galls reached 85 % in 1981/82. In the dry season, the infestion was less than 5 % by gall damage and the rice gall midge is indicated not to be important economically in the dry season.

In highland areas i.e. Sumedang, Bandung, Cianjur, Sukabumi and Bogor, infestation of the rice gall midge was low throughout the year. The insect was found to be well controlled by the parasites, i.e. Platygaster oryzae, Neanastathus oryzae, Obtusiclava oryzae and the predators, i.e. Amblyseius imbricatus, and Ophionia indica etc. Parasitism reached about 45 % of galls in all seasons.

The consecutive planting is more effective for conserving the natural enemies than the synchronized planting (two times planting as seen in low land paddy fields). Positive relationship between damaged tillers and population of predator, Amblyseios imbricatus, was recognized. The predator is understood to be the most important to control number of eggs of the rice gall midge.

A long and serious drought occurred at the end of 1982, then, transplanting was delayed about 1.5 months. The drought remarkablly affected occurrence of the rice gall midge which showed less damage than that of usual years in West Java. Mortality rate of the rice gall midge became high by the long drought.

During off season of rice (September - November), the rice gall midge could not survive in the low land paddy fields. Population of the rice gall midge was maintained in the consecutive planting areas which are considered to be occurring source of the rice gall midge to low land paddy fields by the short distance migration in the wet season.

In West Java, wild rice as one of the alternative host plants was not found. Leersia hexandra is growing in huge areas near paddy fields and was not enough host plant for the occurrence of the rice gall midge, Two galls of the rice gall midge in Sukamandi and Cirebon were found on Leersia hexandra.

In the consecutive planting areas (high land), the parasites of the rice gall midge have an alternate host insect, Orseolia sp., which is attacking the Alang Alang wild grasses, Imperata cylindrica.

5. Economic injurious level for control of the rice gall midge.

The following relationships were closely related such as damaged tillers by galls vs number of panicles $r = -0.799$, damaged tillers by larvae + galls vs rice yield $r = -0.896$, number of panicles vs rice yield r = 0.981.

The injurious level necessary for insecticide application is a) 5 % of damaged tillers by galls, b) 10 % by damaged tillers by larvae and galls at 14 days or 28 days after transplanting. In the endemic areas of the rice gall midge, insecticide must be applied in the seedlings at 10 days before transplanting. At least, two time applications of granular insecticide i.e. Ekalux 5 % or Furadan 3 % are needed at the rate of 0.5 kg of the active ingredient per hectare at 14 and 28 days after transplanting.

Careful monitoring of the injurious level by the observers and the farmers in the late planting areas must be practiced and preventive control technology is possible to establish.

6. Field screening of insecticides for control of the rice gall midge.

The effective insecticides for control of the rice gall midge must be systemic for directly killing larvae feeding on the growing points. The following insecticides i.e. Ekalux 5 % and Furadan 3 % have been used in Indonesia. Diazinon M 5 % was less effective than Ekalux and Furadan. Number of galls occurred per hill were 1.64 in Ekalux, 3.92 in Furadan, and 6.22 in Diazinon M. Number of panicles per hill were 17.74 in Ekalux, 16.68 in Furadan, and 15.49 in Diazinon M respectively. Systemic insecticides with low toxicity must be applied into paddy fields.

7. Field screening of resistant varieties to the rice gall midge.

Among the varieties tested in 1982/83, RD 11, RD 4, Phaelhune, Surekh, and GH 27 were ranked to resistance to the insect, however, these except GH 27 were seriousely attacked by the white back plant-hoppers. In 1983/84, RPW 6-17 and GH 27 were highly resistance, the others were susceptible varieties. The Indian variety RPW 6-17 can be recommended to transplant in the occurring areas or the late planting areas of the insect. RPW 6-17 showed moderate resistance to the biotype 1 and 2 of the brown planthopper. Thailand varieties examined were susceptible and then different biotypes are considered between Thailand and Indonesia.

8. Factor analysis of occurrence and damage caused by the rice gall midge.

The analysis was studied from the view points of a) damage difference between the wet and dry seasons and b) between low and high infestation areas in the wet season in Cirebon, West Java.

The transplanting time was one of the important factors to control of the rice gall midge. Transplanting in January was resulted with higher damage of the rice gall midge than planted in December. Rice plants transplanted in December was clarified to avoid serious damage of the insect. At present, 95 % of total paddy fields in Cirebon regency were practiced to transplant in December.

Survival rate of the rice gall midge increased under high humidity with rain in the wet season, however, the rice gall midge population prominently decreased with high mortality rate under dried condition with comparatively long sunshine duration in the dry season.

In Cirebon, the parasites, Platygaster oryzae, Neanastathus oryzae, and Obtusiclava oryzae, and predators, Amblyseius imbricatus, and Ophionia indica, were not active. These natural enemies were not found for 30 days after transplanting. The parasitism was at least 15 % and the parasite, mainly Neanastathus oryzae, were not effective for control of the rice gall midge during the vegetative growth stage of rice plants in low land areas of paddy fields and started to appear from 40 days after transplanting.

A peak of occurrence of the rice gall midge appeared at February or March, the rice gall midge had 3 generations during the planting seasons. The second generation reached a peak of the insect population by light trap and larval sampling in the experimental fields.

Population of the rice gall midge in the early planting (December) started to increase slightly, however, the rice gall midge in the late planting (January) remarkablly propagated during the vegetative growth period.

The factors affecting population decrease were the early planting, generative growth stage of rice plants, low humidity with long sunshine duration, parasites and predators attack after booting stage of rice plants. The factors affecting population increase were the late planting, vegetative growth stage, high humidity (75 %) with rain, low activity of parasites and predators during the vegetative growth stage of rice plants.

Positive relationship between number of adults and galls was recognized and then the number of adults of the next generation can be possible to estimate. High correlation ($r > 0.900$) in the developmental stages including growing stage of rice plants was as follow, % damage by gall - damage by larva + pupae + galls, number of eggs - number of <u>Neanastathus oryzae</u>, tillers - galls, panicle primordia - pupae, and the third larvae + prepupae - pupae. The correlation $r > 0.800$ was also recognized of 29 items among developmental stages of the rice gall midge, as well as items in the correlation $r > 0.700$.

10. During activities of the rice gall midge study group, a guide book for the observers and the extension workers, a paper presented in the Entomology Meeting in Indonesia, and 6 papers in Annual Report of the Tropical Agriculture Research Center in Japan have been issued.

XVII. RECOMMENDATION

1. One of the field experiments, " the factors analysis of the rice gall midge occurrence " has been successfully carried out from 1981/82 to 1983/84 in Cirebon in order to clarify mechanism of population dynamics of the insect. The experiment is suggested to be important for establishing PRACTICAL forecasting method in Indonesia. However, the experiment of the factor analysis is needed at least more than 5 years to accumulate enough data of the biological and physical factors. Therefore, all data of these factors are computerized to make important relationship between the insect and factors for complete the forecasting technology.

2. Monitoring to detect galls of the rice gall midge by the farmers in their own paddy fields is needed within 14 days after transplanting. If galls are found, it is suggested to be the timing of the insecticide application. In this case, larval infestation is more than 10 percent of damaged tillers. At first, training of the progressive farmers for detect galls in some model areas in West Java must be done as soon as possible.

   In order to help observers activity, these progressive farmers are expected to be useful for monitoring of rice insect pests in moderate sized areas of paddy fields. More exact data of damage by rice insect pests will be obtained to be enable for practical forecasting method.

3. It is recommended to distribute resistant cultivar to the rice gall midge in highly infested areas and in the late planting areas, i.e. Cirebon, Majalengka, and Subang in West Java.

   The breeding programme of resistant cultivar to the rice gall midge has aggresively to start in Indonesia and field screening of resistant cultivars which were established in foreign countries must be carried out in Indonesia. If a highly resistant cultivar is found, it can be used in the breeding programmes.

From present situation, an Indian variety, RPW 6-17, is recommended to transplant in a large scale paddy fields in the late planting areas in Cirebon in the wet season 1984/85.

4. In the endemic areas of the rice gall midge in West Java, insecticide application to the seedling nursery in the late planting is needed at 10 days before transplanting.

Two kinds of insecticides, Furadan and Ekalux, have been used by the farmers, however, these are high toxicant insecticides.

Then, the systemic insecticide with low toxicity is essential to control of the rice gall midge, without any side effect to natural enemies. The field screening of insecticide has to carry out in Cirebon where is the best place for the purpose.

5. In the tropical country, conservation of natural enemies is the most important to implement biological control of the rice gall midge. The biological control studies of the insect have to continued to find out effective natural enemies and their utilization. One of the predators, Amblyseius imbricatus, is considered to be very useful to control eggs of the rice gall midge, therefore the bionomics and effectiveness must be clarified.

6. Correct identification of the species of rice insect pests and natural enemies is also very important in the field studies such as monitoring and field experiments.

A monograph for the identification of the insects occurring in paddy fields should be made and practical training for the identification of the rice insect species has to carry out for those who work in the monitoring and control programmes in paddy fields.

7. In the monitoring data of the rice gall midge obtained by the observers in Sumatera, Kalimantan and Sulawesi Islands, occurrence of the insect must be reviewed whether or not the insect is distributed.

8. The monitoring data are needed not only in provincial and regency levels but also in subdistrict and village levels with damaged tillers for analyzing occurring pattern of the rice gall midge to implement the forecasting method. The file system of the data sent from the Food Crop Protection Center to the Central office at Pasar Minggu must be established after transfer to the data sheet. The data filing room at Pasar Minggu must be constructed in connection with the Computer.

9. A total of 13 field workers (graduated from Agricultural High School) have joined to the field experiments of the rice gall midge in Kertasura and BPP Bayalangu in Cirebon since 1981/82. However, 4 out of 13 field workers have succeeded to be extension worker (PPL) since 1981/82. Although training for them was done by the assistant counterparts. There are still some problems of activity of the field workers so that effective supervise for them must be done with tight control through the staffs of the Cirebon Agricultural Extension Services, Rural Extension Services (BPP), and the assistant counterparts of ATA 162. The latter should stay at Cirebon at least 14 days per month for supervising the field study.

10. In Cirebon, many kinds of rice insect pests occurs and give serious damage to rice plants every years. In another word, fauna

of rice insect pests are more rich than any other places in West Java. There is a sufficient place to do intergrated study and extension programme not only of rice insect pests but also upland crop pests. Therefore, a Center for the integrated study and extension including training should be established. This Center will cover about 200,000 ha including paddy fields and upland crop fields such as corn, soybeans, mungbeans, sugercane, onion, sweet potatos, water melon and vegetables etc. Cirebon is considered to be good living condition for staff of the Center.

11. In Indonesia, there are difficulties to directly utilize the technology transfered from the foreign countries. It is considered that Indonesia is required a big strategy to make her own technology fitted to the environmental conditions. Therefore, in the Food Crop Protection, basic study in the paddy fields in relation to forecasting and control methods is much more needed in the agro-economic areas in the long term basis for finding Indonesian technology.

12. More advanced seminar consisting of small member in each Subdirectorate should be carried out to discuss not only for indigenous studies but also research results obtained in foreign countries.

References and Journals for food crop protection has to aggressively collect for information to the staffs of the Directorate of Food Crop Protection.

The Information Section (Center) for food crop protection would be ideal to set up in the Directorate of Food Crop Protection, Pasar Minggu.

XVIII. REFERENCES

Amu Singh, S. (1982) Time of transplanting and gall midge incidence in Manipur, The International Rice News Letter (IRRN). 7(3): 13.

Arifin, K. and G. V. Vreden (1977) Mass rearing of the rice gall midge, Orseolia oryzae (Wood-Mason). Contr. Centr. Res. Inst. Agric. Bogor. (32) 1-15.

Arifin, K. (1979) Mass rearing of the rice gall midge in the green house in Indonesia. IRRN. 4(3):8-9.

Bhaskara Rao, C. (1981) Rice gall midge incidence in the dry season. IRRN. 6(6):17.

Bodhade, S. N., Garde, V. R. and M. N. Borle (1981) Some observations on the relation of the development of maggot of paddy gall fly and the development of silver shoot of paddy. Indian Journal of Entomology. 43(2): 239-240.

Chand, P. (1981) Rice gall midge in the summer crop at Ranchi. IRRN. 6(6): 19.

Chatterji, S. M., Prasad, K. and B. C. Misra (1979) Identification of gall-midge (Orseolia oryzae Wood-Mason) resistant rice germplasms and their utilisation in breeding. Journal of Entomological Research. 1(1): 111-113.

Central Bureau of Statistics (1978) Area and intensity of pests and diseases in rice in Indonesia. 1977. Central Bureau of Statistics Jakarta (Indonesia). V. 1977: 1-85.

Chiu, S. F. Gall midge life cycle and plant injury in south China. IRRN. 5(4): 22.

Das, P. K. (1979) Effect of pesticidal application on the rice gall midge parasite, Platygaster oryzae. Oryza. 15(1): 102-104.

Ehara, S. and F. Oomen-kalsbeck (1983) Stigmaeid mites associated with tea plants in Indonesia (Prostigmata: Stigmaeidae). Int. J. Acarol. 9(1): 19-26.

Garg, A. K. and G. R. Sethi (1980) Succession of insect pests in Kharif paddy. Indian Journal of Entomology. 41(3): 482-487. 487.

Halteren, P. van. (1979) The insect pest complex and related problems of lowland rice cultivation in south Sulawesi, Indonesia. Mededelingen Landbouwhogeschool. 79(1): 1-111.

Harris, K. M., R. J. Gagne (1982) Taxonomy of Asian and African rice gall midges. IRRN. 7(2): 8.

Heinrichs, E. A. and P. K. Patak (1981) Resistance to the rice gall midge, Orseolia oryzae in rice. Insect Science and its Application 1(2): 123-132.

Hidaka, T., Vungsilabutr, P. and S. Kadkao (1974) Studies on ecology and control of the rice gall midge in Thailand. Technical Bulletin, Tropical Agriculture Research Center. (6): 1-118.

Hidaka, T. (1974) Recent studies on the rice gall midge, Orseolia oryzae (Wood-Mason), (Cecidomyidae, Diptera). Review of Plant Protection Research (Japan) 7: 99-143.

Hidaka, T., Vungsilabutr, P., and S. Rajamani (1977) Geographical differentiation of the rice gall midge, Orseoria oryzae (Wood-Mason)(Diptera: Cecidomyiidae). Applied Ent. Zool. 12(1): 4-8.

Hidaka, T., Ya-klai, V. and N. Chantraprapha (1978) Serious incidence of the rice gall midge in the central plain of Thailand. Applied Ent. Zool. 13(4): 260-263.

Hidaka, T., Ya-klai, V. and S. Kadkao (1979) Different origins of the rice gall midge occurrence in Thailand. JARQ. 13(1): 78-79.

Hidaka, T., Partoatomodjo, S. and E. Sunarjo (1980) Studies on the incidence of the rice gall midge in Indonesia. Japanese Journal of Tropical Agriculture. 24(3): 132-136.

Hidaka, T., Ya-klai, V. and S. Kadkao (1983) Occurrence of the rice gall midge, Orseolia oryzae (Wood-Mason) in wild rice in Thailand. JARQ 17(3):211-214.

Hidaka, T., Ya-klai, V., Kadkao, S. and V. Yaoapakorn (1984) Incidence of the rice gall midge, Orseolia oryzae (Wood-Mason), at different localities in northern Thailand. JARQ 1891): 69-71.

Hummelen, P. J. and E. Soenarjo (1977) Population studies of the rice gall midge, Orseolia oryzae (Wood-Mason), in Java. Contr. Centr. Res. Inst. Agric. Bogor. (25): 1-17.

Hummelen, P. J. and Soenarjo, E. (1977) Light trap studies on the rice gall midge, Orseolia oryzae (Wood-Mason) and some other insects. Contr. Centr. Res. Inst. Agric. Bogor, (29): 1-16.

Hummelen, P. J. and E. Soenarjo (1977) Notes on the biology of Platygaster oryzae, Obtusiclava oryzae, and Neanastatus oryzae, parasites of the rice gall midge, Orseolia oryzae. Contr. Centr. Res. Inst. Agric. Bogor. (31): 1-18.

Jena, B. C., Patnaik, N. C., and N. Panda (1983) Incidence of rice gall midge at Bhubaneswar, Orissa, India. IRRN. 8(3): 12.

Joshi, R. C., and M. S. Venugopal (1983) Light trap catches of rice gall midge. IRRN. 8(4): 19-20.

Karuppuchamy, P., Uthamasamy, S. and G. Chakkaravarthy (1982) Influence of planting time on gall midge incidence at Aduthurai. IRRN. 7(4): 11.

Kittur, S. U. and R. K. Agrawal (1983) Gall midge damage at rice panicle stage. IRRN. 8(5): 19.

Litsinger, J. A. (1979) Major insect pests of rainfed wetland rice in tropical Asia. IRRN. 4(2): 14-15.

Mishra, U. S. (1979) Insect pest problems of rice in Chhattisgarh. Pesticides. 11(12): 24-26.

Misra, U. S., Shukla, B. C., Kosta, V. K. and A. K. Dubey (1981) Effectiveness of seedling root dip for control of gall midge. IRRN 6(2): 15-16.

Natarajan, K., Mathur, K. and S. Rajamani (1981) Muesithia laevis - a non-host for rice gall midge. Current Science, 50(6): 290-291.

Oka, I. N. (1979) Integrated control programme on some important rice pests in Indonesia. FAO. 1979: 16-30.

Pathak, P. K. and G. B. Pant (1981) Problem of biotype development in major insect pests of rice plant. Int. Conf. on Tropical Crop Protection, July 8-10, 1981, France.

Patnaik, N. C. and J. M. Sathpathy (1983) Parasitization of gall midge maggots in exposed and suppressed galls. IRRN. 8(5): 16-17.

Peraiah, A. and J. K. Roy (1979) Studies on biochemical nature of gall midge resistance in rice. Oryza (16(2): 149-150.

Potinent, K. and R. K. Agarwal. (1984) Parasitization of gall midge by Neanastathus grallarius (Masi). IRRN. 9(1): 27.

Prem Chand and R. C. Achatya (1982) Correlations between silvershoots and panicle and tiller numbers. IRRN. 7(4): 8-9.

Rai, P. S. and B. Vidyachandra (1979) Incidence of rice gall midge (Orseolia oryzae (Wood-Mason) in relation to date of planting. Current Research. 8(4): 65-66.

Rawat, S. N. and M. C. Diwakar (1982) Survey of natural enemies of paddy insect pests in Chhatisgarh (Madhya Pradesh), India. IRRN. 7(1): 13-14.

Sadji Partoatmodjo (1980) Current programme of rice pest and diseases control in Indonesia. TARC Symposium. 1-12.

Sadji Partoatmodjo (1980) Problems of implementation of insect pest management for rural communities in Indonesia. TARC Symposium. 1-13.

Sastrodihardjo, S. (1972) Observations on rice stem borers and gall midge in West Java. Mushi. 45: 39-46.

Shrivastava, S. K. (1981) Potential of rice stubble for gall midge multiplication. IRRN. 6(4): 11.

Shrivastava, S. K., Patidar, G. L., Shukla, B. C., Pophaly, D. J., Kaushik, U. K., Deshmukh, P. D. and G. A. Gangrade (1982) Populations of gall midge, white backed planthopper, and thrips on Pragati paddy. IRRN. 7(4): 16.

Soenardi (1965) Results of some field experiments on the chemical control of the major rice insects in Indonesia. Plant Protection Service. 1965: 11-26.

Soenarjo, E. and P. J. Hummelen (1976) Population studies of the rice gall midge, Pachydiplosis oryzae, in Indonesia. Rice Entomology Newsletter. (4): 32-33.

Soenarjo, E., and P. J. Hummelen (1976) Observations on the occurrence of the rice gall midge, Pachydiplosis oryzae, and its parasites in Java, Indonesia. Rice Entomology Newsletter (4): 32.

Soenarjo, E. and P. J. Hummelen (1976) Observations on the occurrence of the rice gall midge Orseolia oryzae (Wood-Mason) and its parasites in Java during wet seasons 1975 and 1976. Contr. Centr. Res. Inst. Agric. Bogor (20):11.

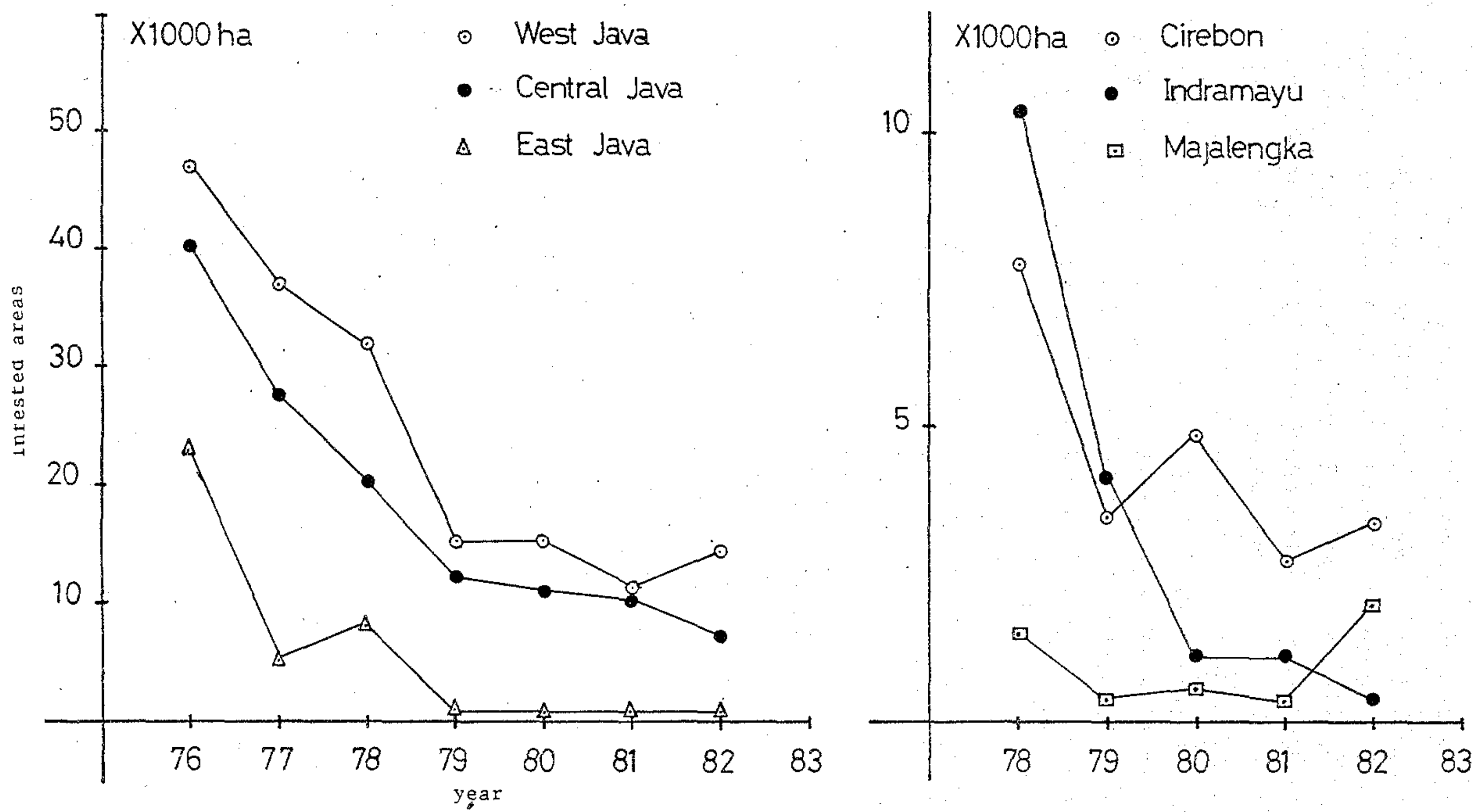
Vanich Ya-klai, Saner Buranapawang and Terunobu Hidaka (1978) Occurrence of the rice gall midge in the central olain and southern peninsula of Thailand. IRRN. 3(5): 21.

Vidvachandra, B., Roy, J. K. and Bhaskar Das (1981) Chemical differences in rice varieties susceptible or resistant to gall midge and stem borer. IRRN. 6(2): 7-8.

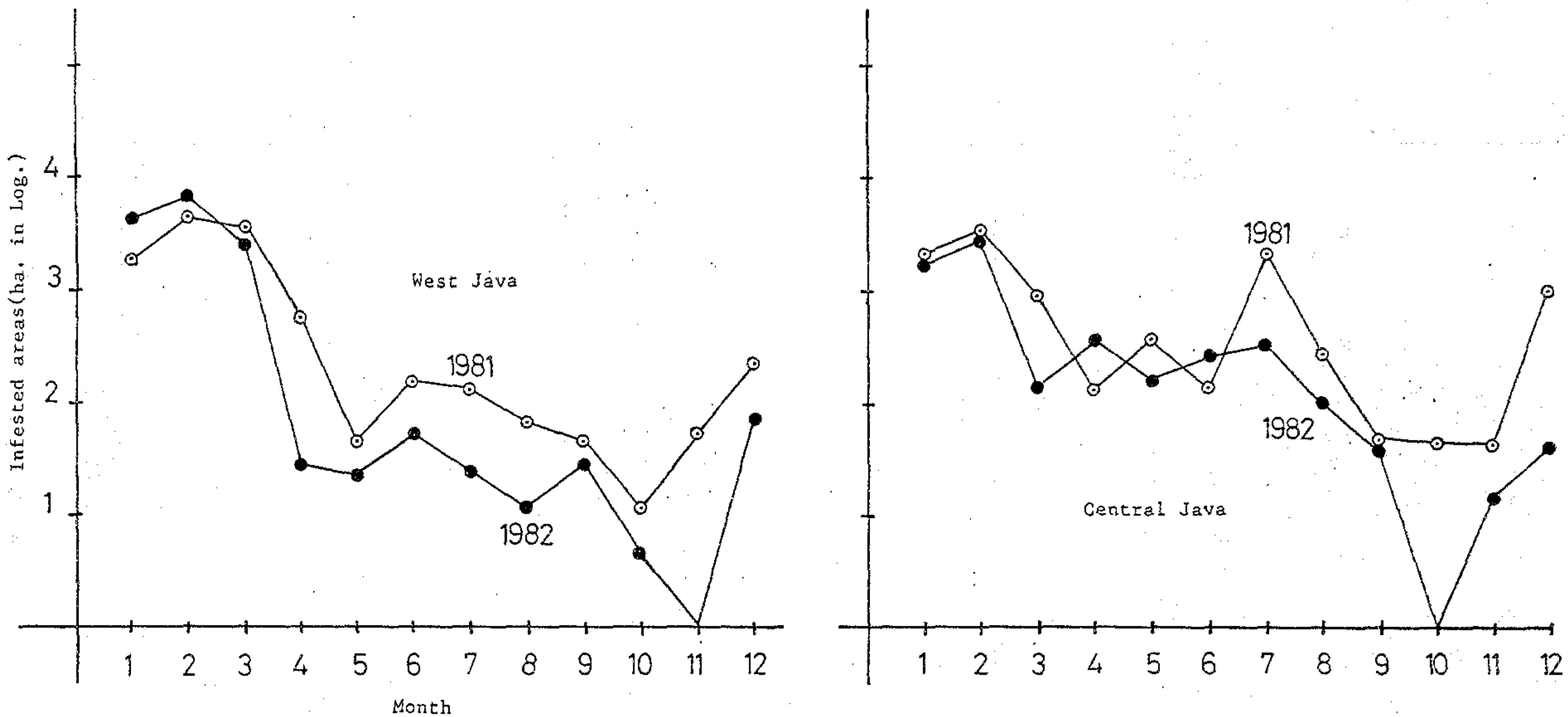
Weerawooth Katanyukul, Sawang Kadkao and Nipha Chansriso-mmai (1982) Rice yield losses to gall midge in north Thailand. IRRN. 7(6):14-15.

Weerwooth Katanyukul, Sawang Kadkao and Chintana Tayathum (1983) Resistance of RD 4 and RD 7 mutants to rice gall midge. IRRN. 8(1): 7-8.

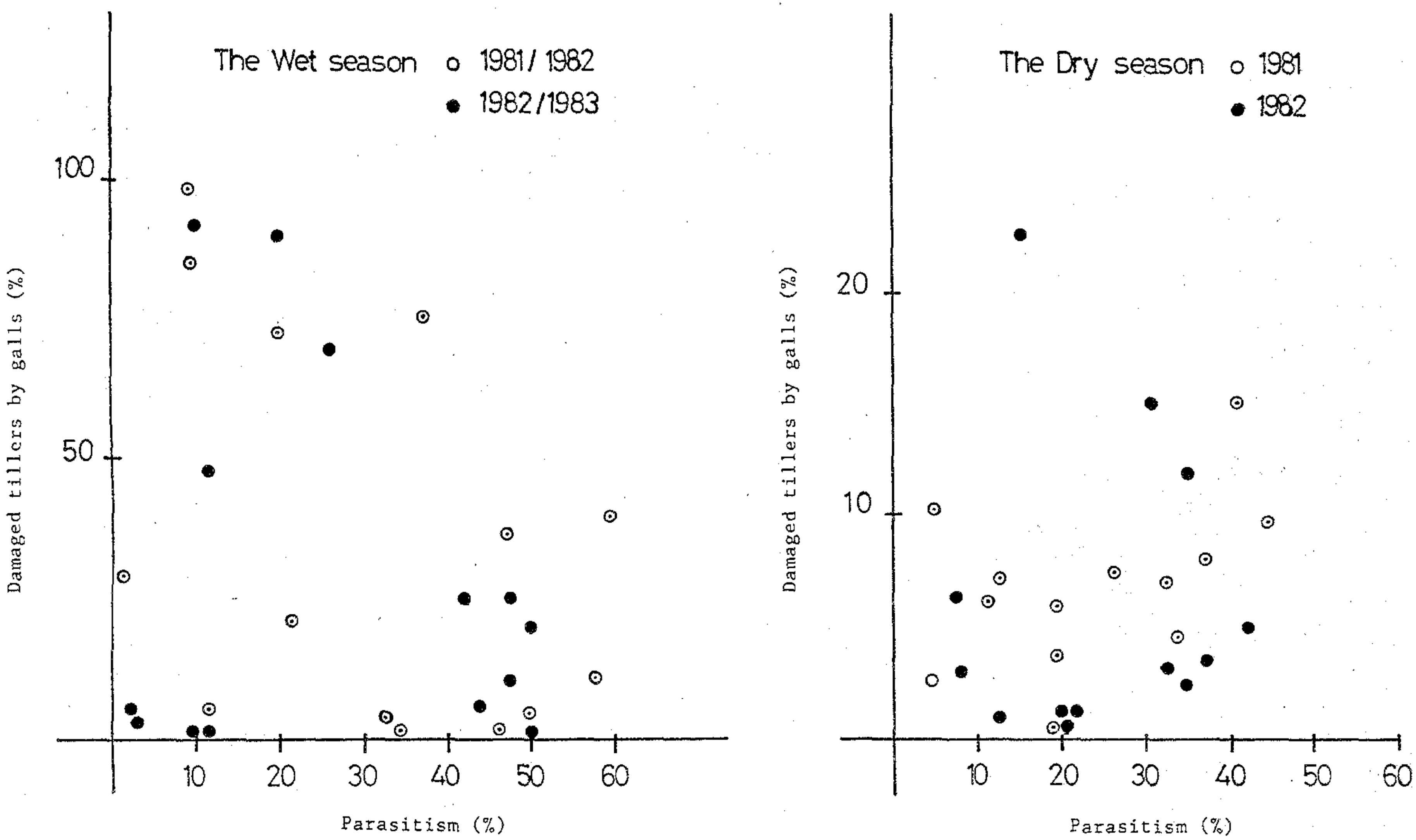
Yaui Chu (1980) Chemical and cultural control of the seed-ling fly, Etherigona exigua Stein (Diptera, Muscidae), on corn in east Java, Indonesia. Plant Prot. Bull. (Taiwan). 22: 327-335.



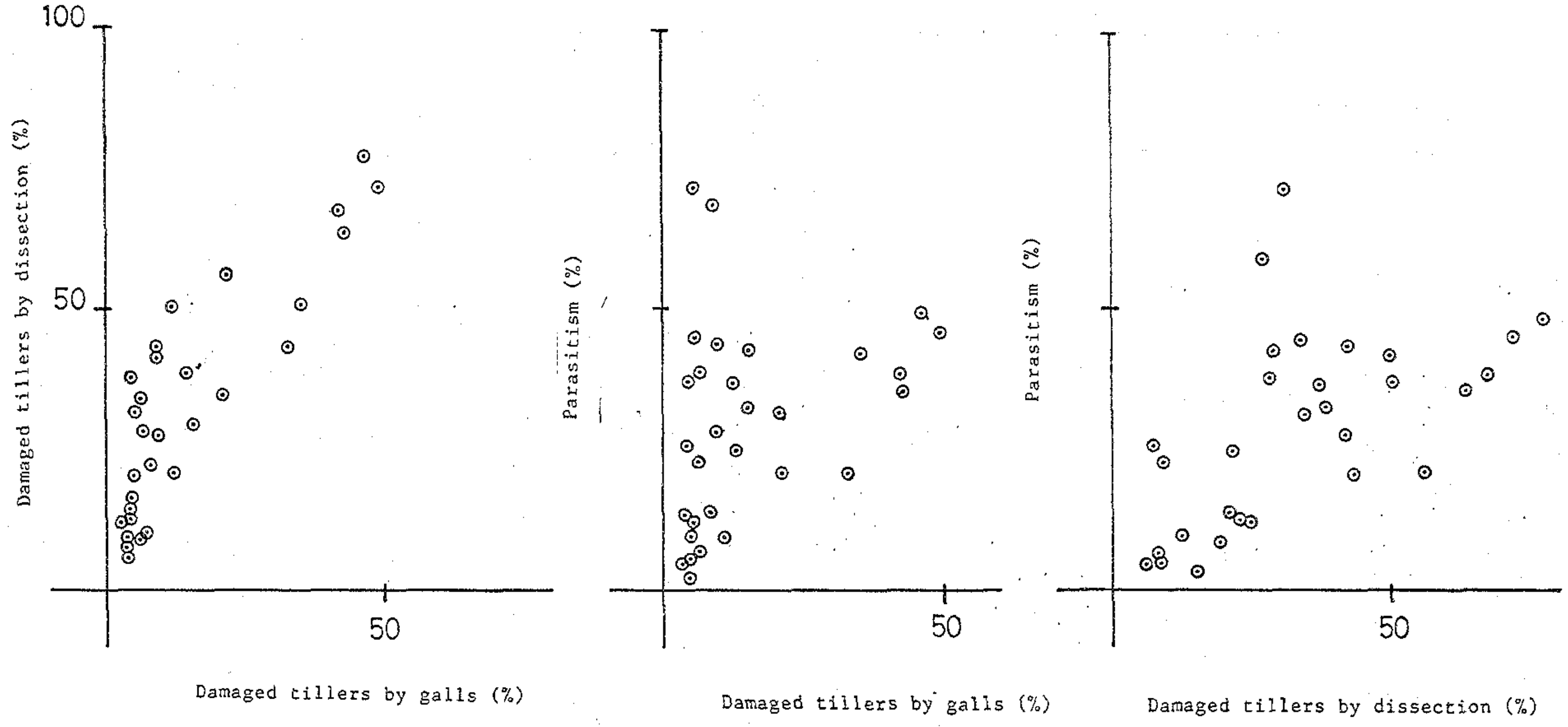
(Fig. 2) Change of infested areas of paddy fields caused by the rice gall midge in Java Island in Indonesia



(Fig. 3) Monthly change of infested areas of paddy fields by the rice gall midge in West and Central Java, Indonesia



(Fig. 4 & 5) Relationship between damaged tillers by galls and parasitism by hymenopterous parasites in low and high land in the wet (4) and dry seasons (5) in West Java 1981 - 1983



(Fig. 6) Relationship between damaged tillers by galls and by dissection of tillers, parasitism and damaged tillers by gall, Parasitism and damaged tillers by dissection of tillers in Purwakarta, in the wet season 1982/83

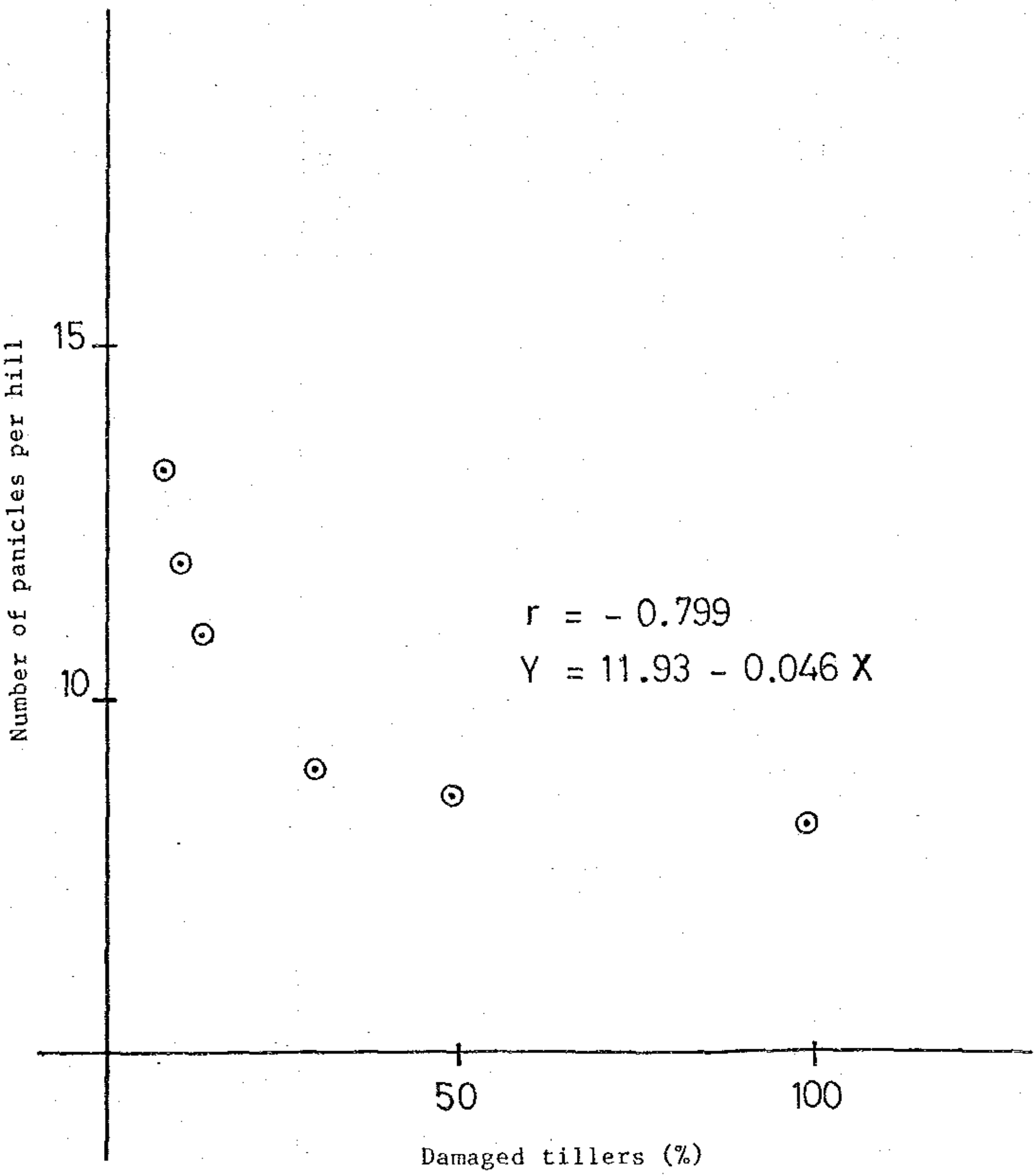


Fig. 7 Relationship between damaged tillers and number of panicles at Kertasura in Cirebon. The Wet season 1981/1982

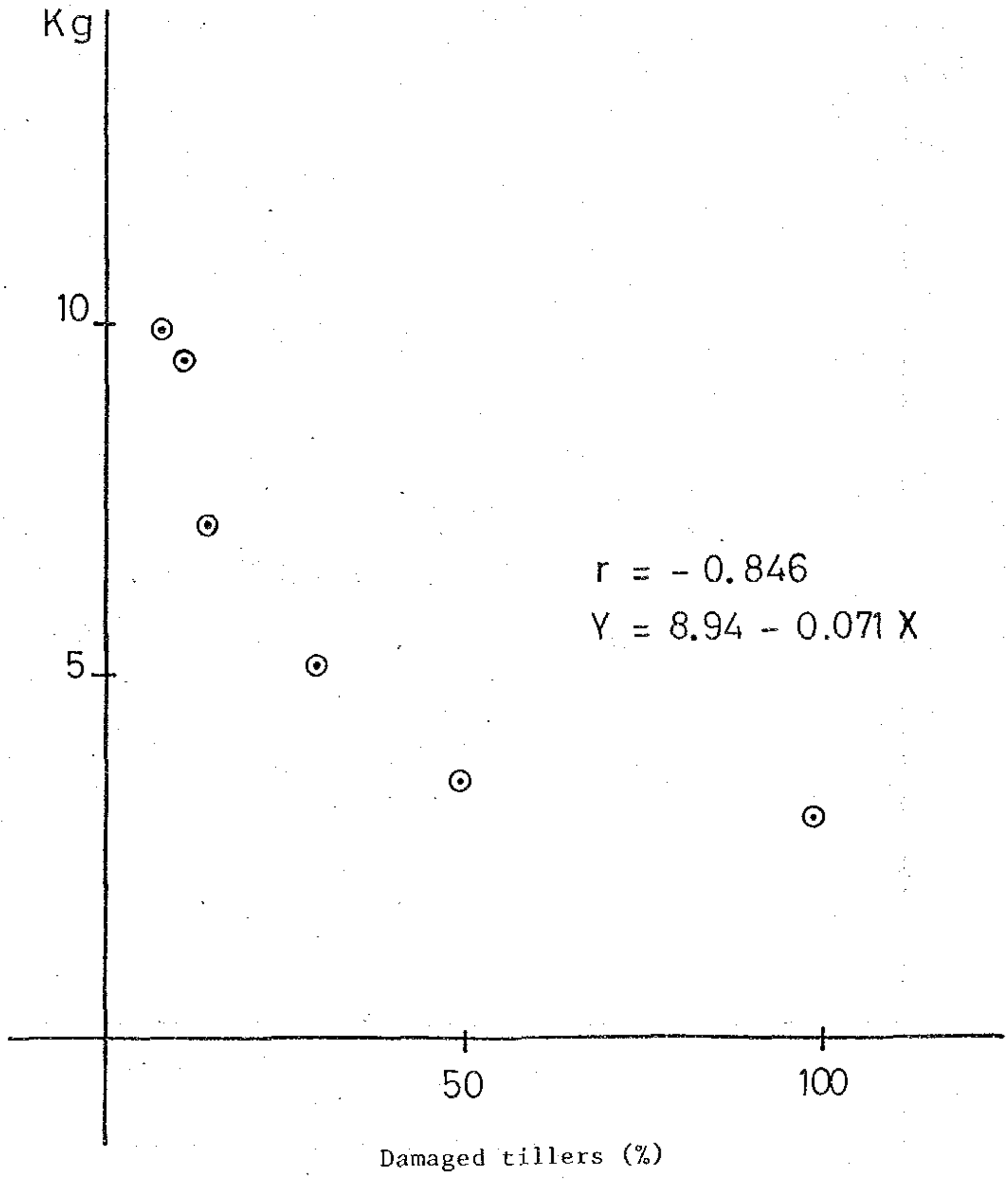


Fig. 8 Relationship between damaged tillers and rice yield at Kertasura in Cirebon. The Wet season 1981/'82

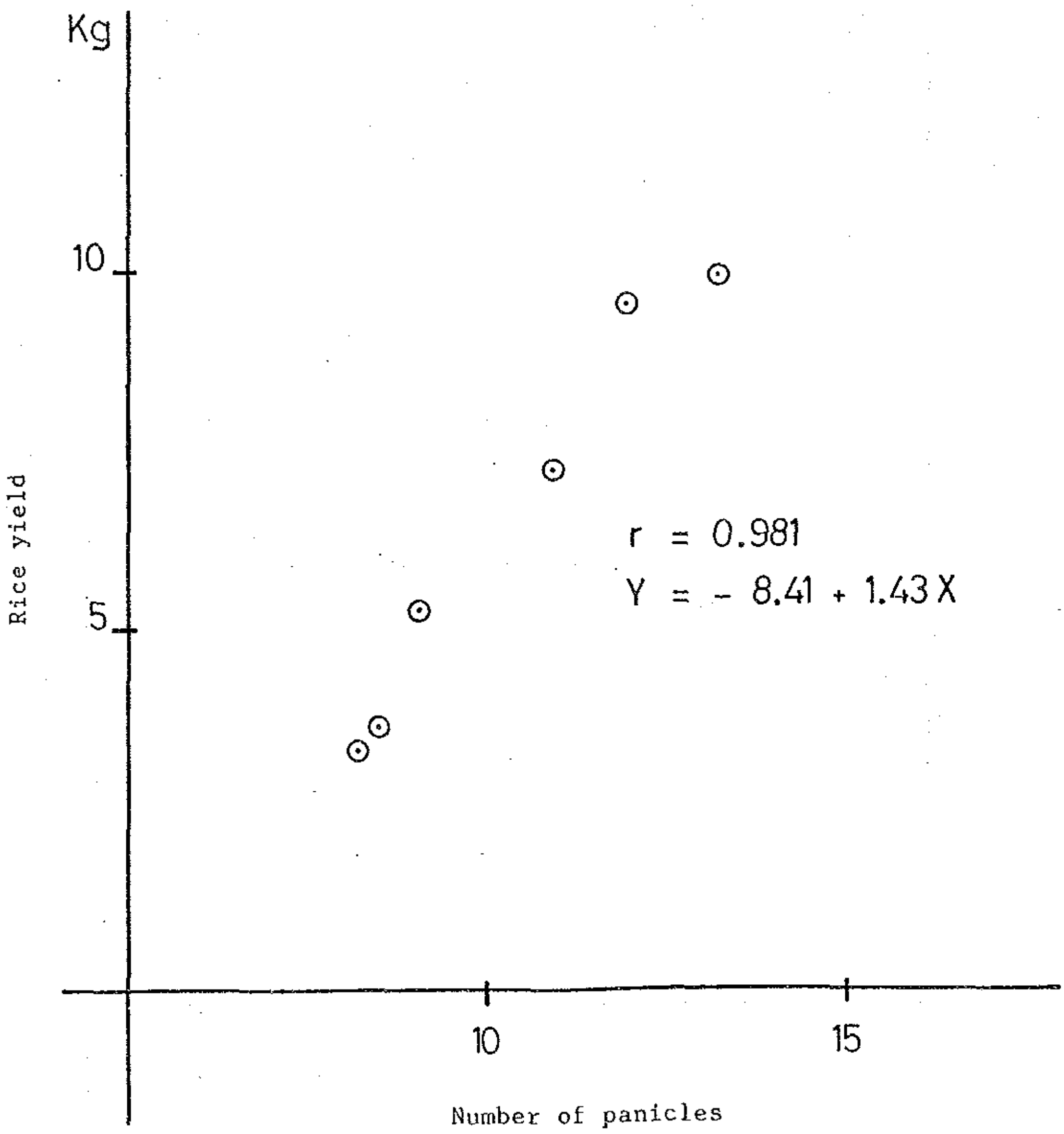
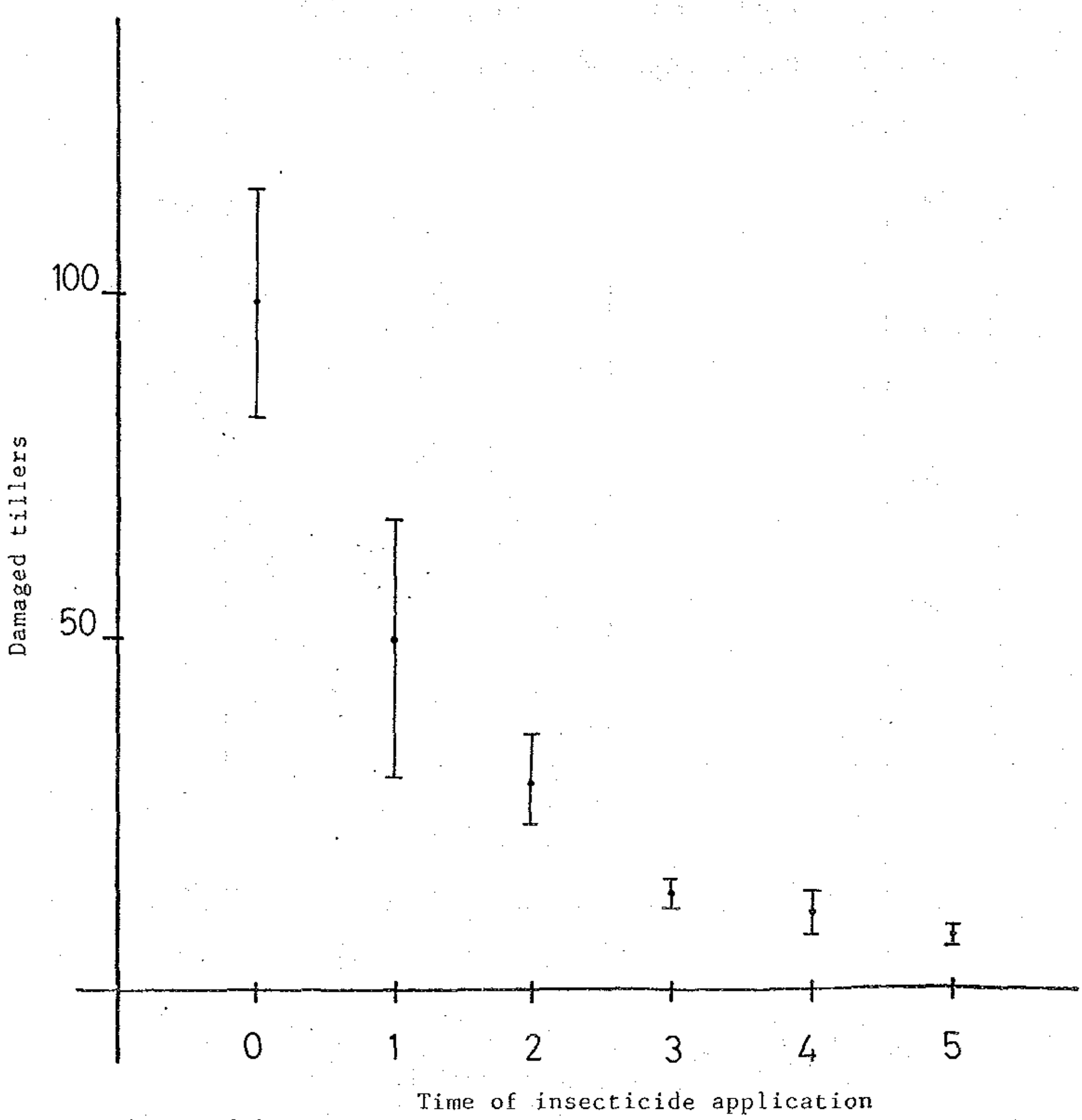
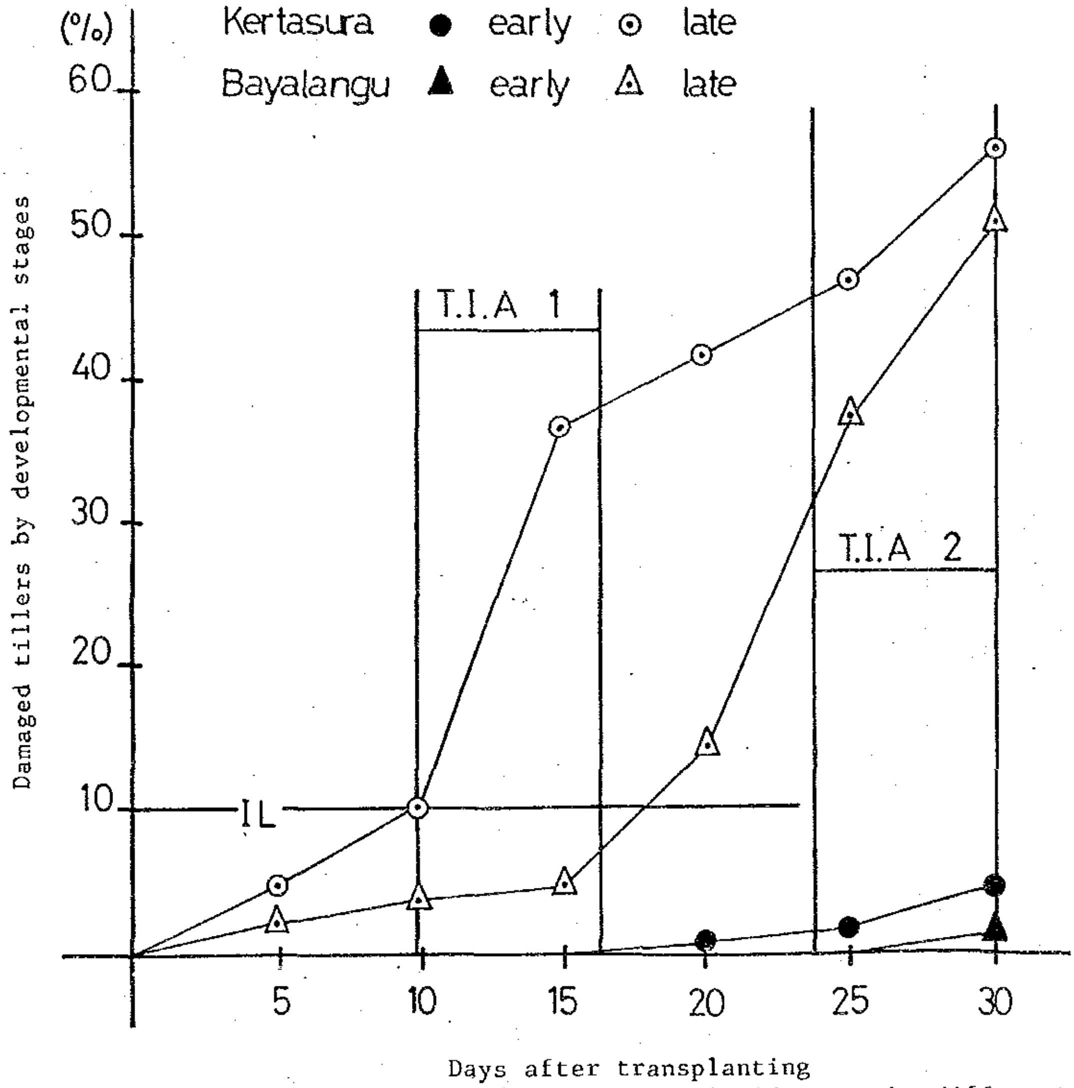


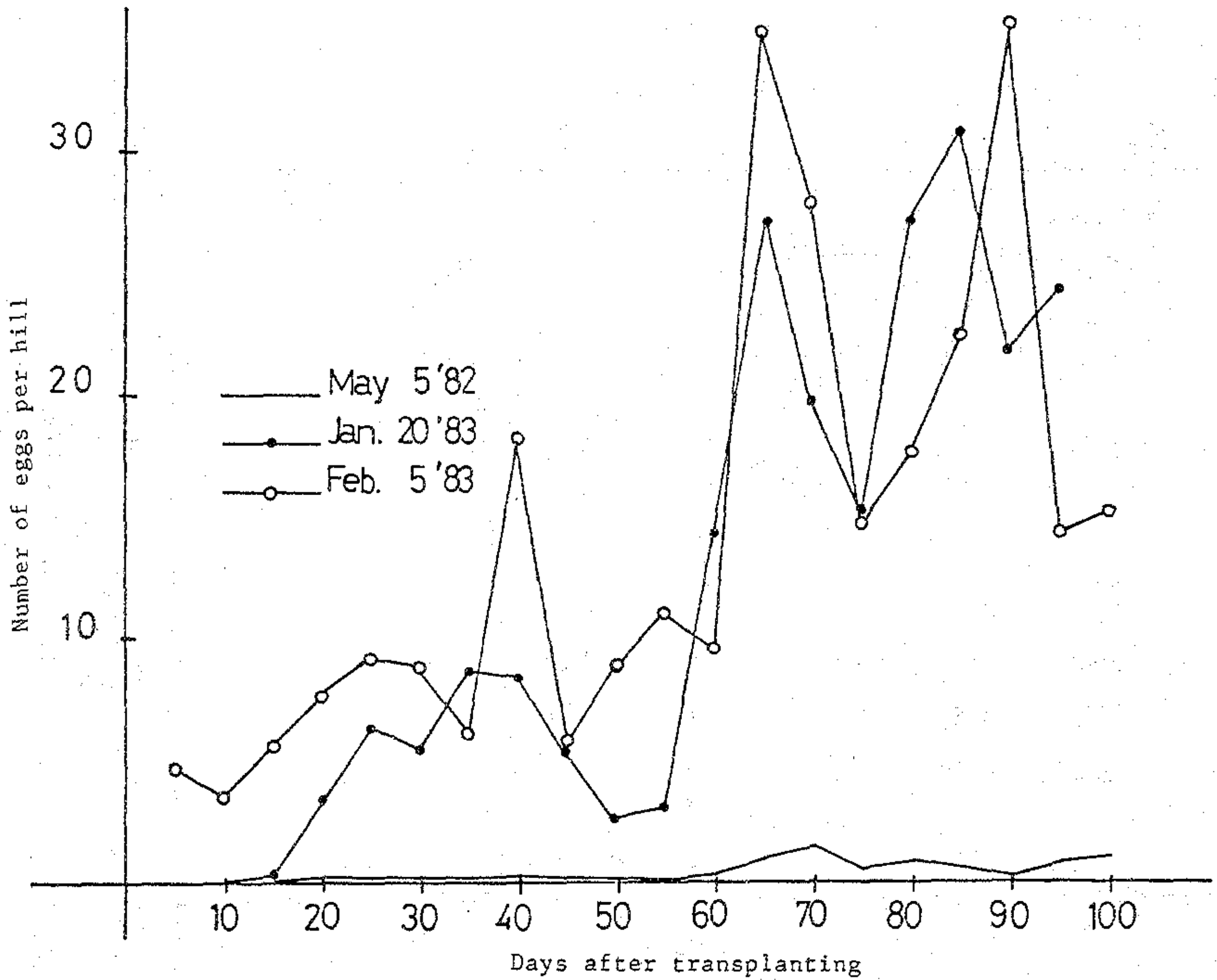
Fig. 9 Relationship between number of panicles and rice yield at Kertasura in Cirebon, the Wet season 1981/'82



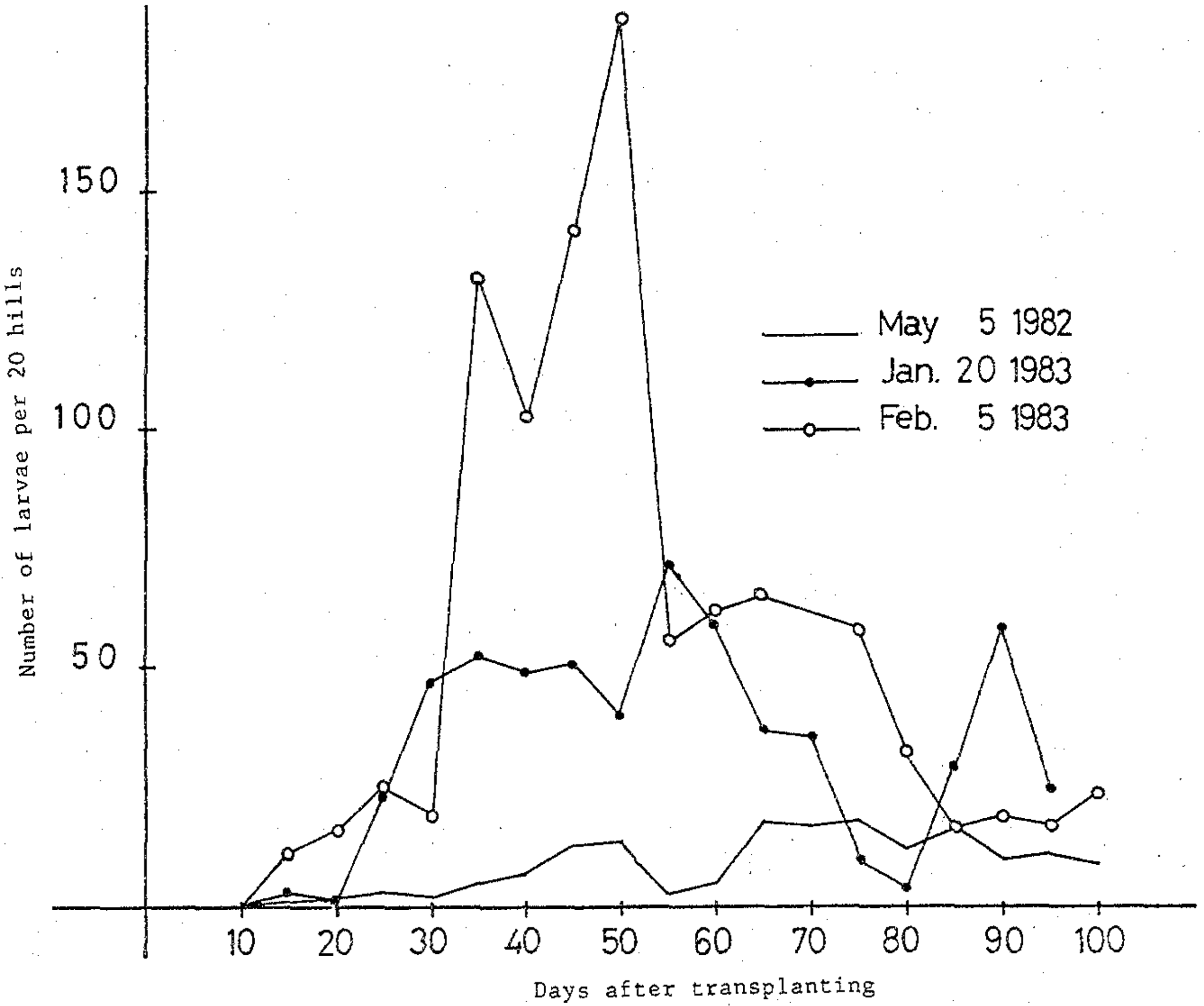
(Fig. 10) Relationship between damaged tillers and application time of insecticide in Cirebon, West Java. The wet season, 1981/1982.



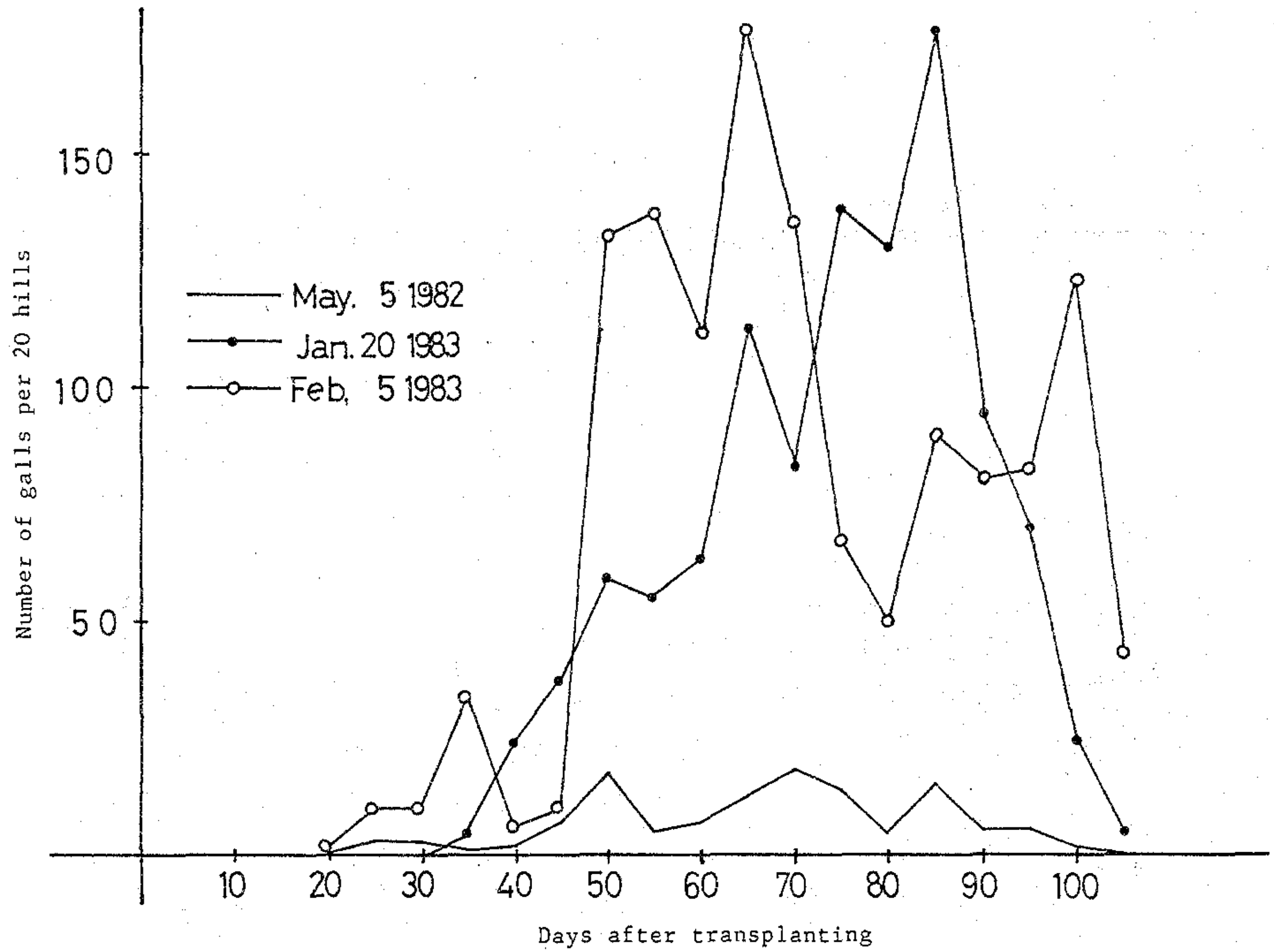
(Fig. 11) Damage increase of the rice gall midge in the different planting dates, Injurious level (IL), and timing of insecticide application (TIA) in Cirebon, west Java. The wet season 1981/1982. Early and late at Kertasura represent transplanting date on December 1981 and January 1982, as well as early and late at Bayalangu on December 1981 and January 1982.



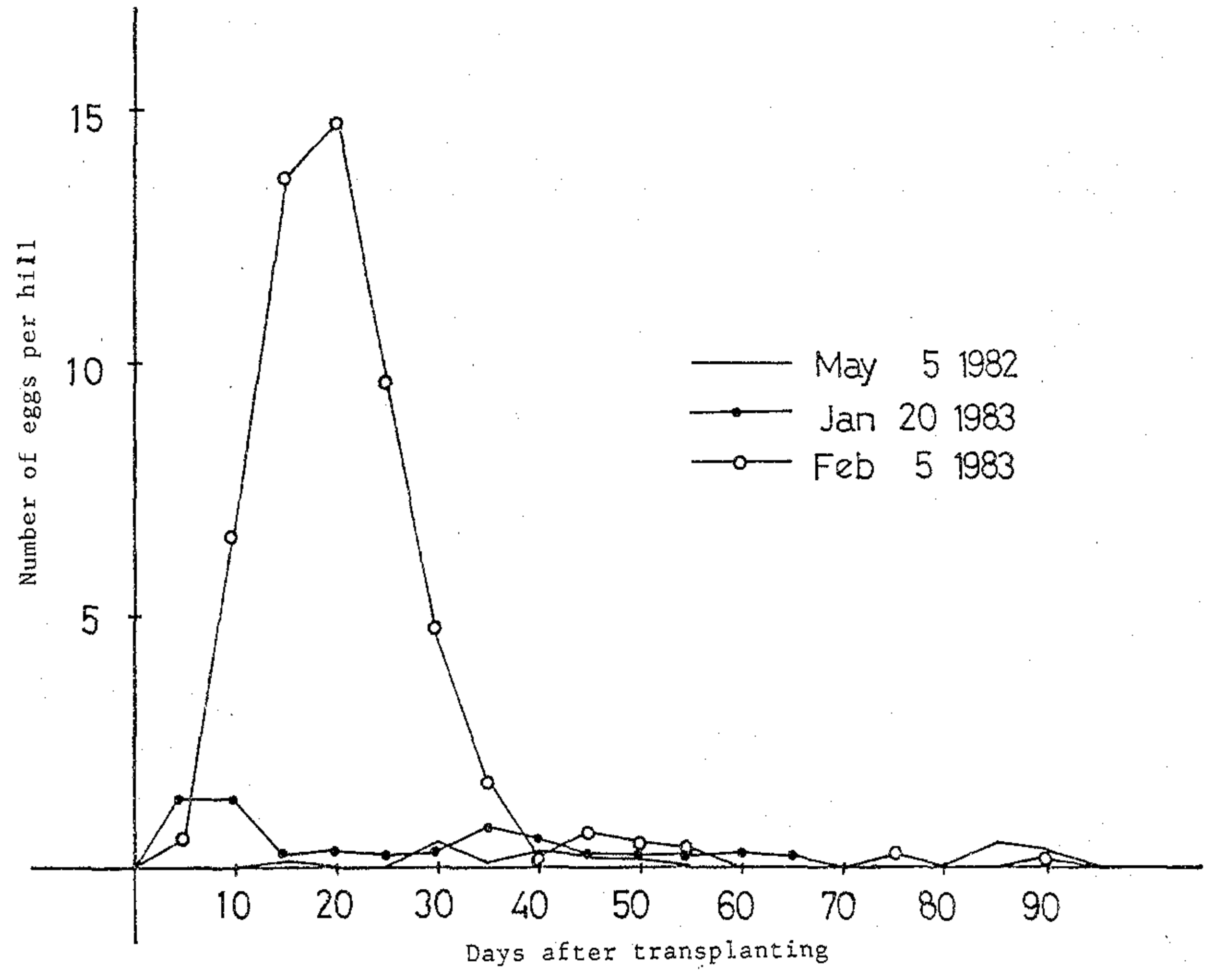
(Fig. 12) Fluctuation of number of eggs at the different planting dates at Kertasura in Cirebon, West Java.



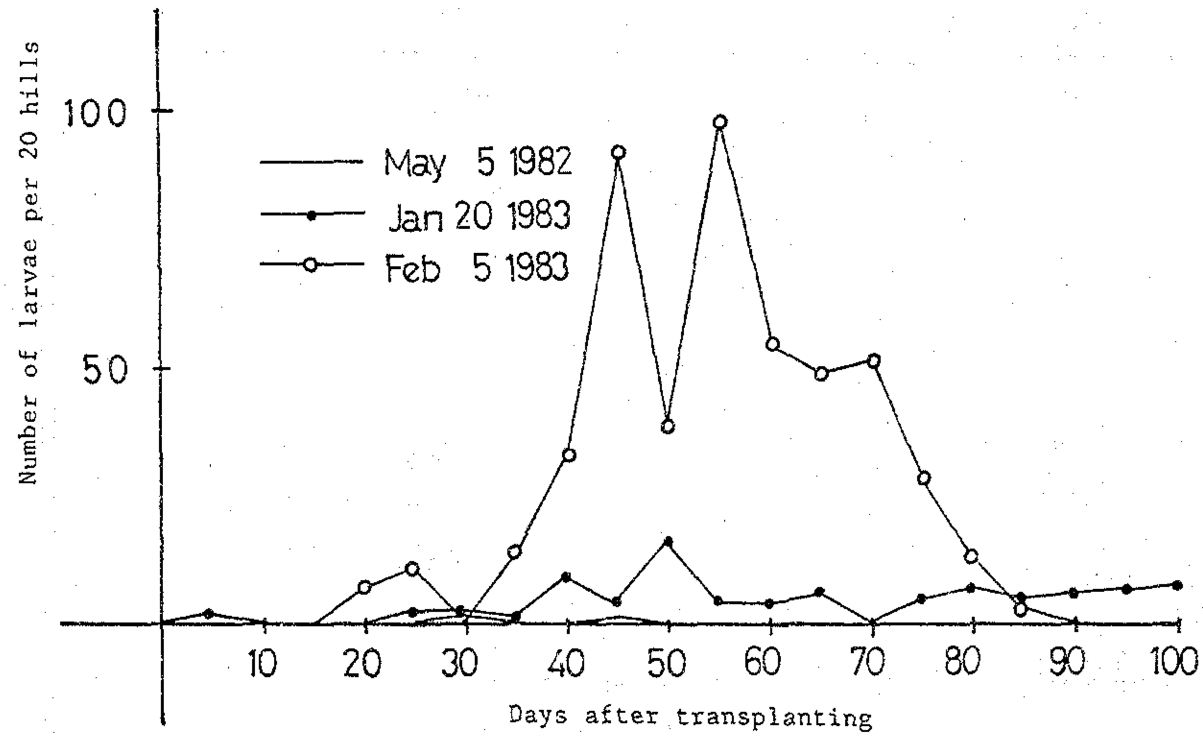
(Fig. 13) Fluctuation of number of larvae in the different planting dates at Kertasura in Cirebon, West Java.



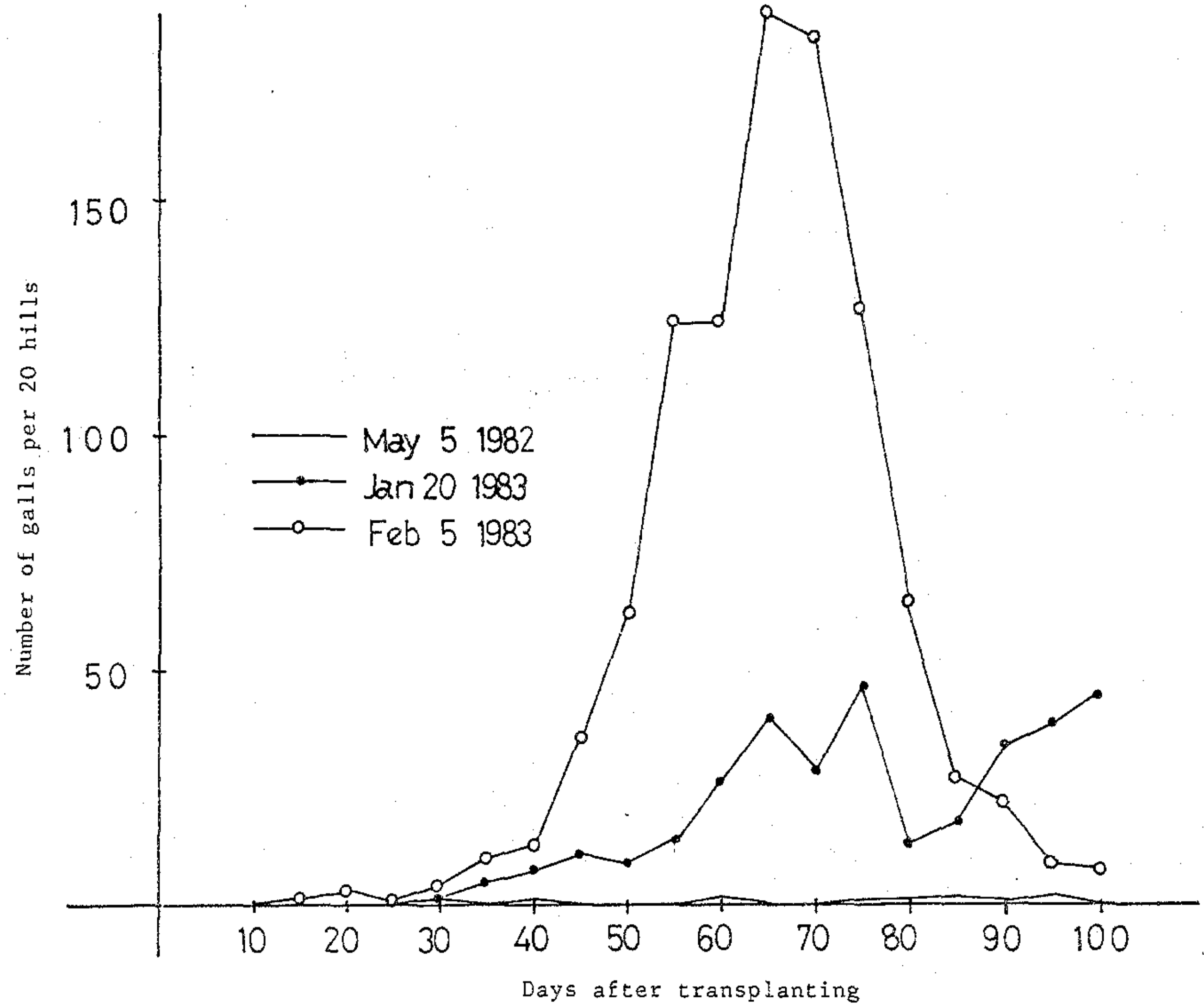
(Fig. 14) Fluctuation of number of galls in the different planting dates at Kertasura in Cirebon, West Java.



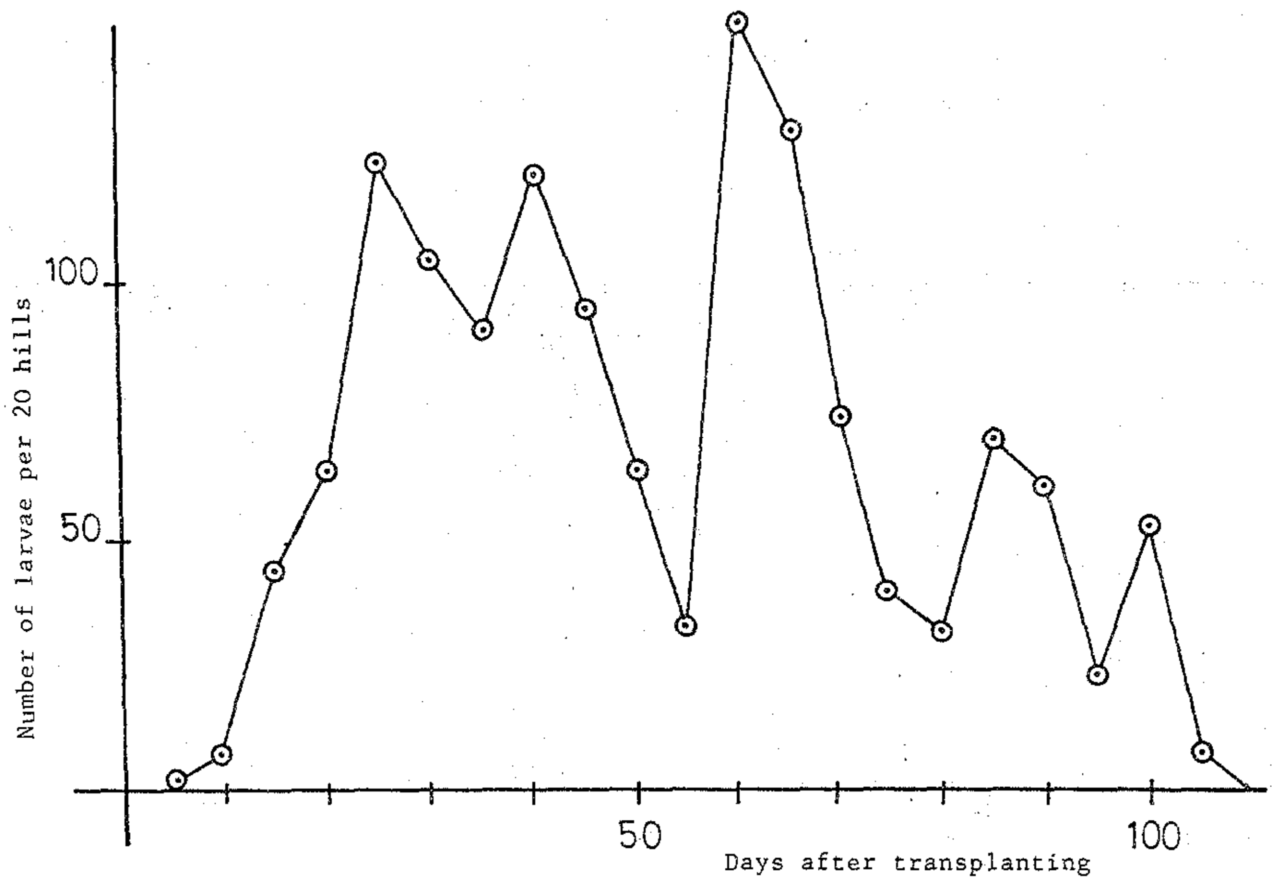
(Fig. 15) Fluctuation of number of eggs at the different planting dates at the BPP Bayalangu in Cirebon, West Java.



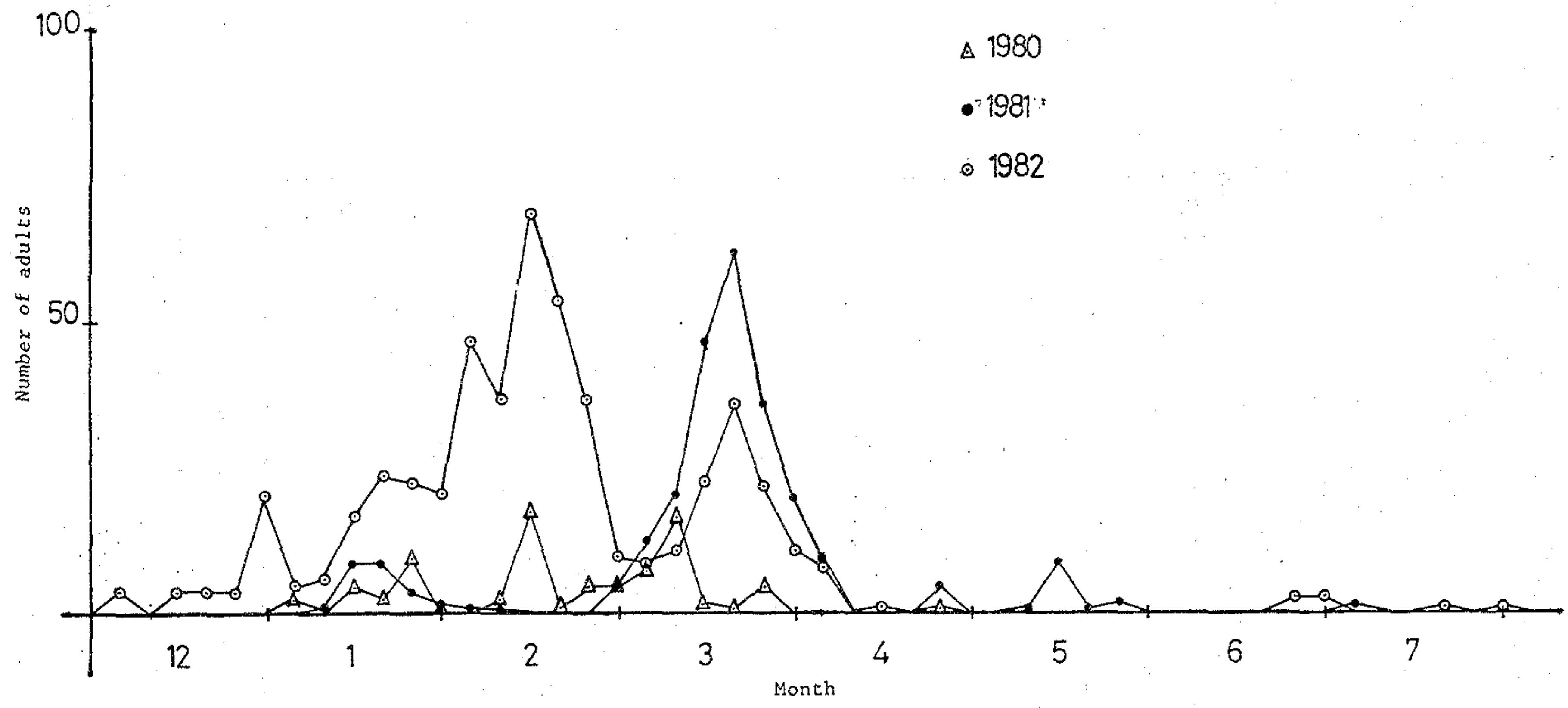
(Fig. 16) Larval occurrence in the different planting dates in the BPP Bayalangu in Cirebon, West Java



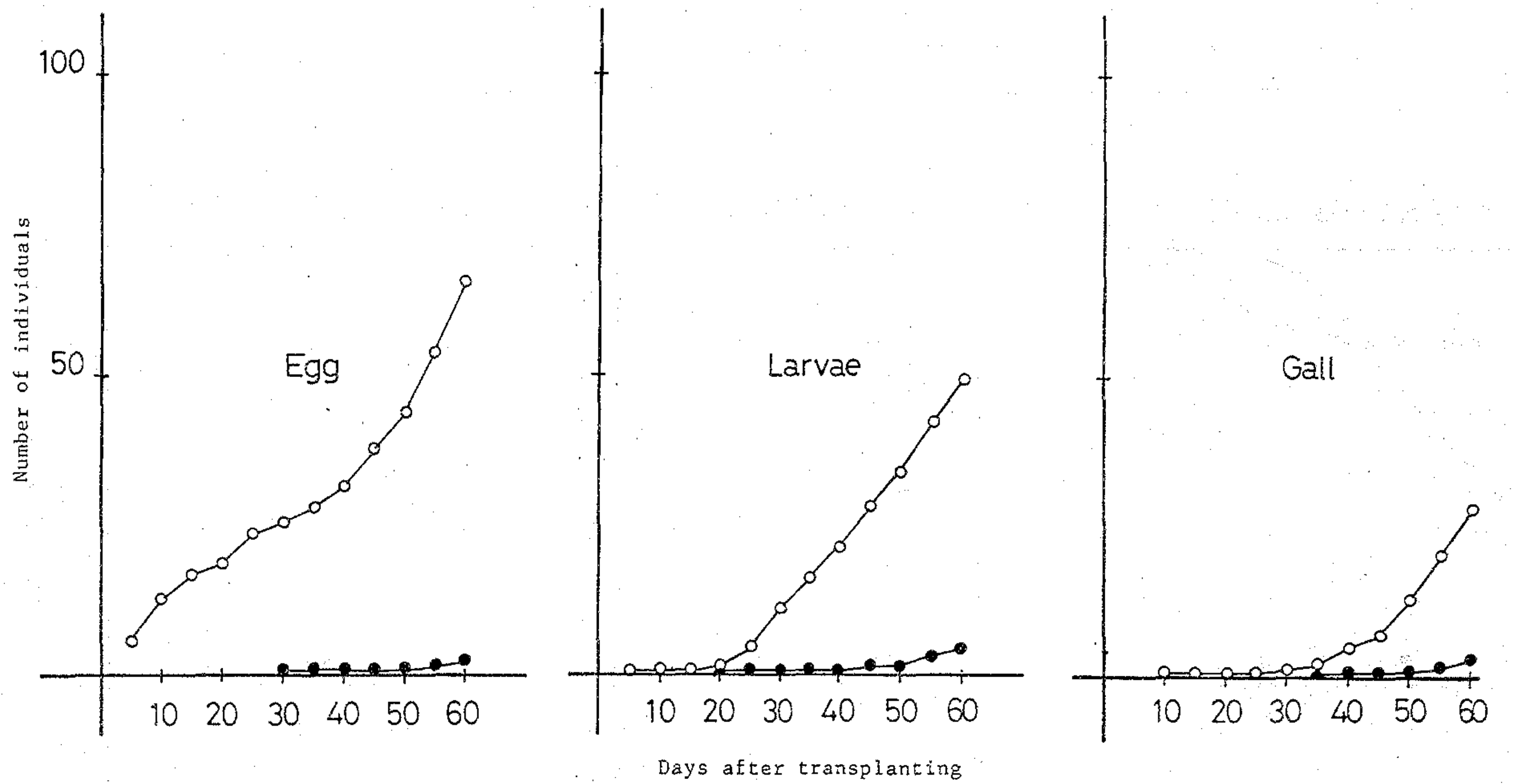
(Fig. 17) Fluctuation of number of galls in the different planting dates at the BPP *Bayalangu in Cirebon*, West Java.



(Fig. 18) Larval generations of the rice gall midge in the late planting at Kertasura in Cirebon, West Java, the wet season 1981/82

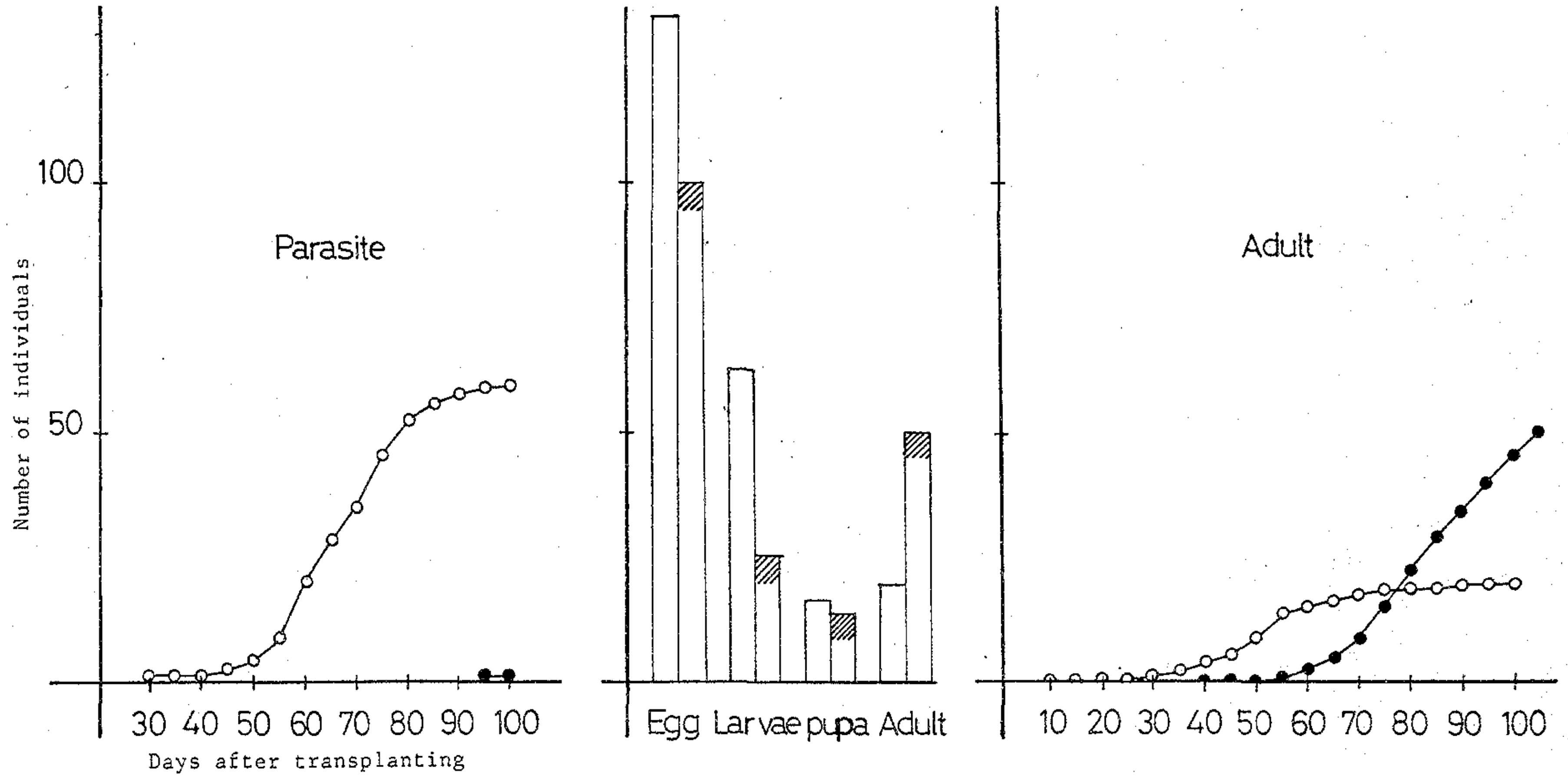


(Fig. 19) Seasonal fluctuation of the rice gall midge collected by light trap in the Jatisari Field Laboratory in Karawang, West Java, from 1980 to 1982. Kerosen lamp before February 1981 afterward electric bulb.

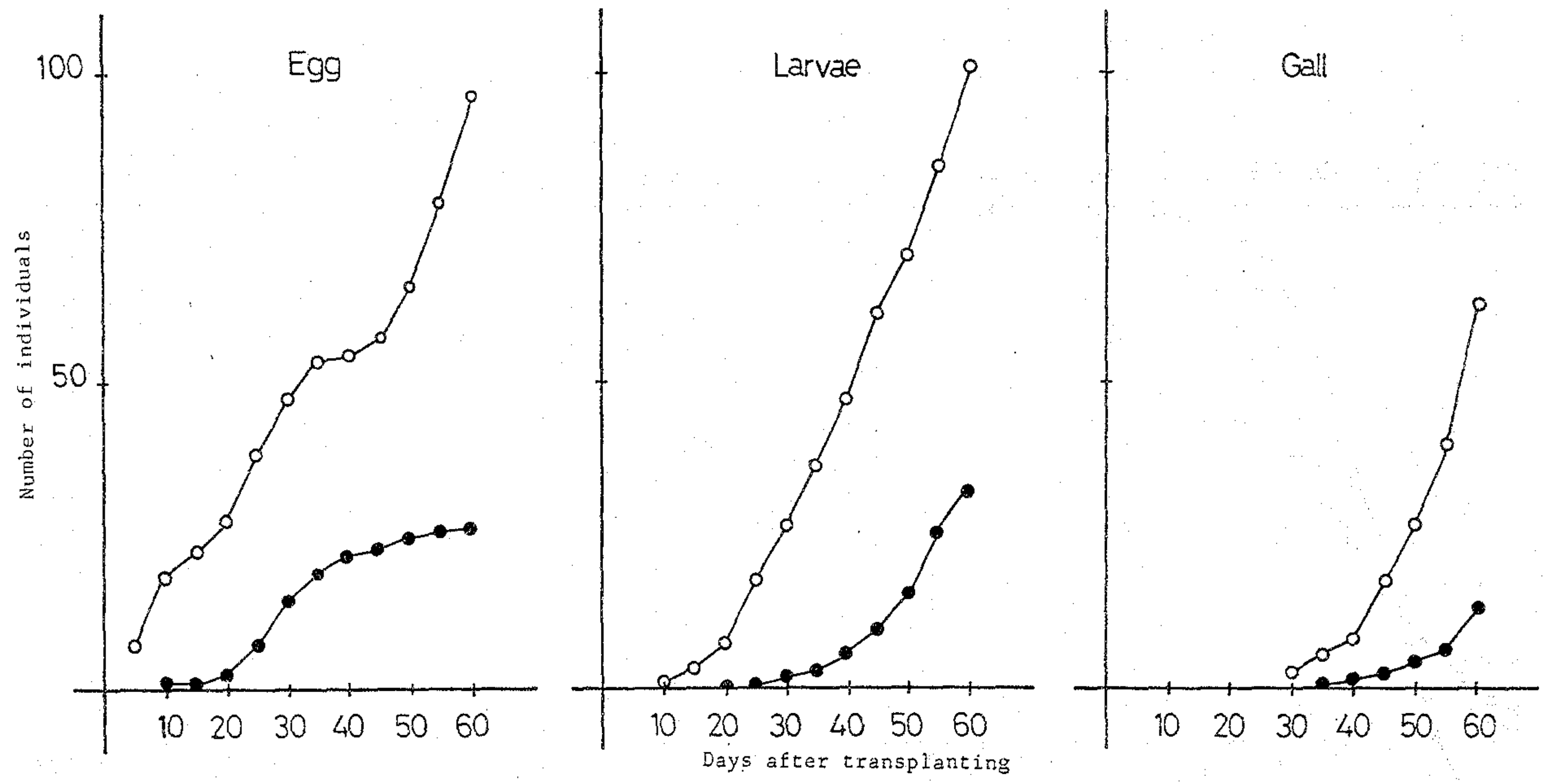


(Fig. 20) Difference of population increase of the developmental stages of the rice gall midge in the different planting dates at the BPP Bayalangu in Cirebon, West Java, in the wet season 1981/82.

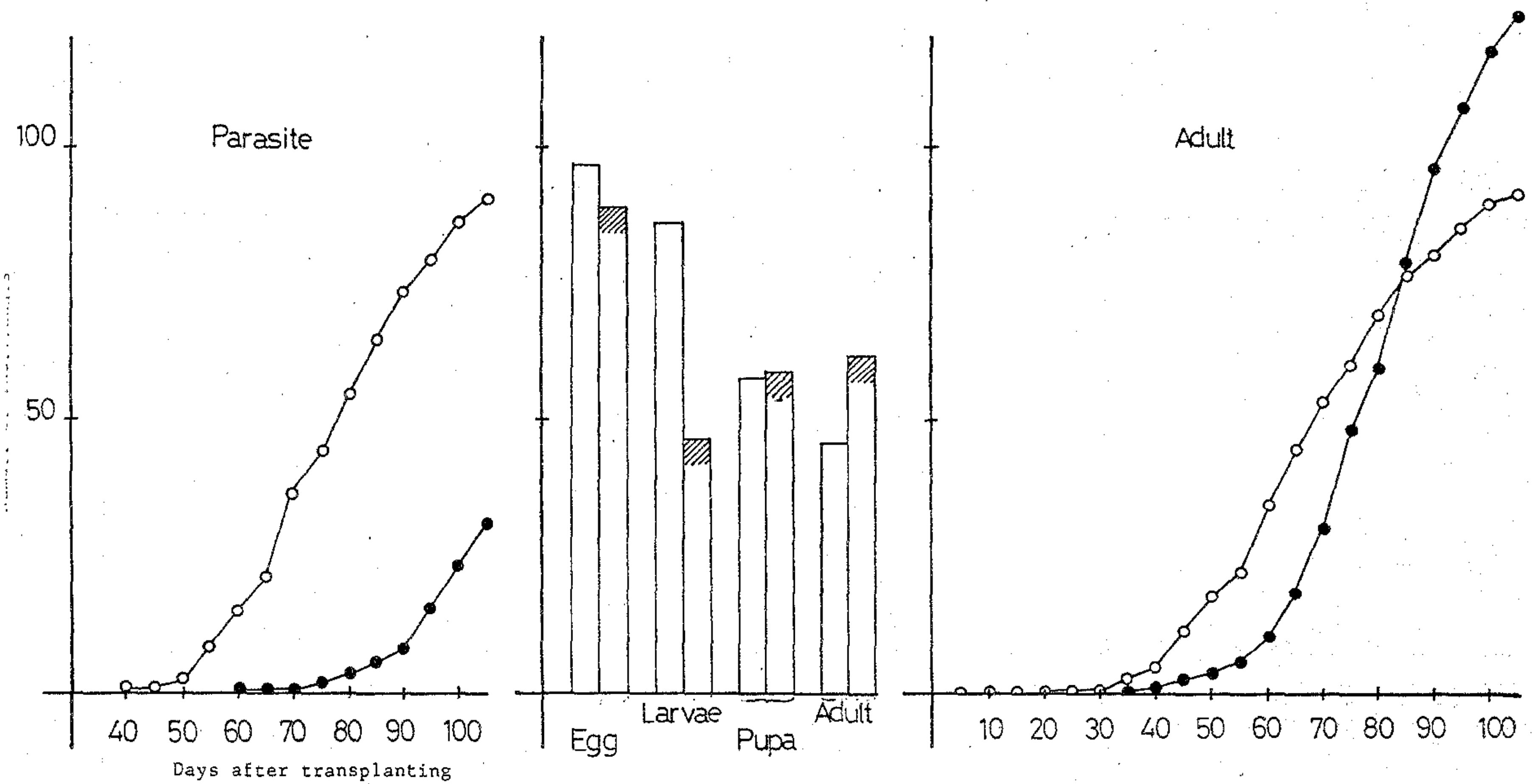
○ Transplanted in January, ● in December



(Fig. 21) Difference of population increase of the developmental stages of the rice gall midge in the different planting dates at the BPP Bayalangu in Cirebon, West Java, in the wet season 1981/82. ● ▭ } Transplanted in January, ○ ▨ } in December

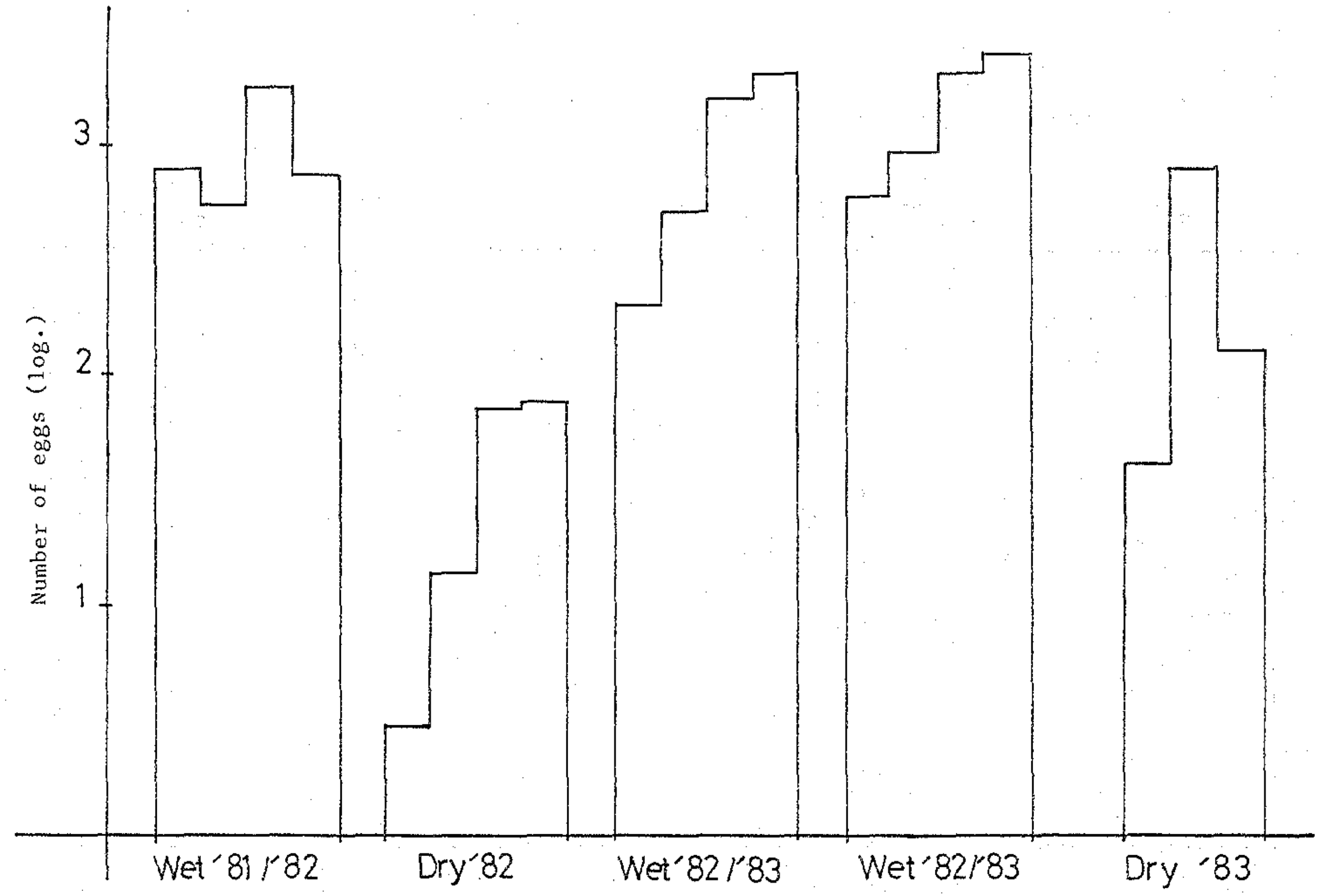


(Fig. 22) Difference of population increase of the developmental stages of the rice gall midges in the vegetative growth period in the different planting dates at Kertasura in Cirebon, West Java, in the wet season 1981/82. ○ Transplanted in January, ● in December

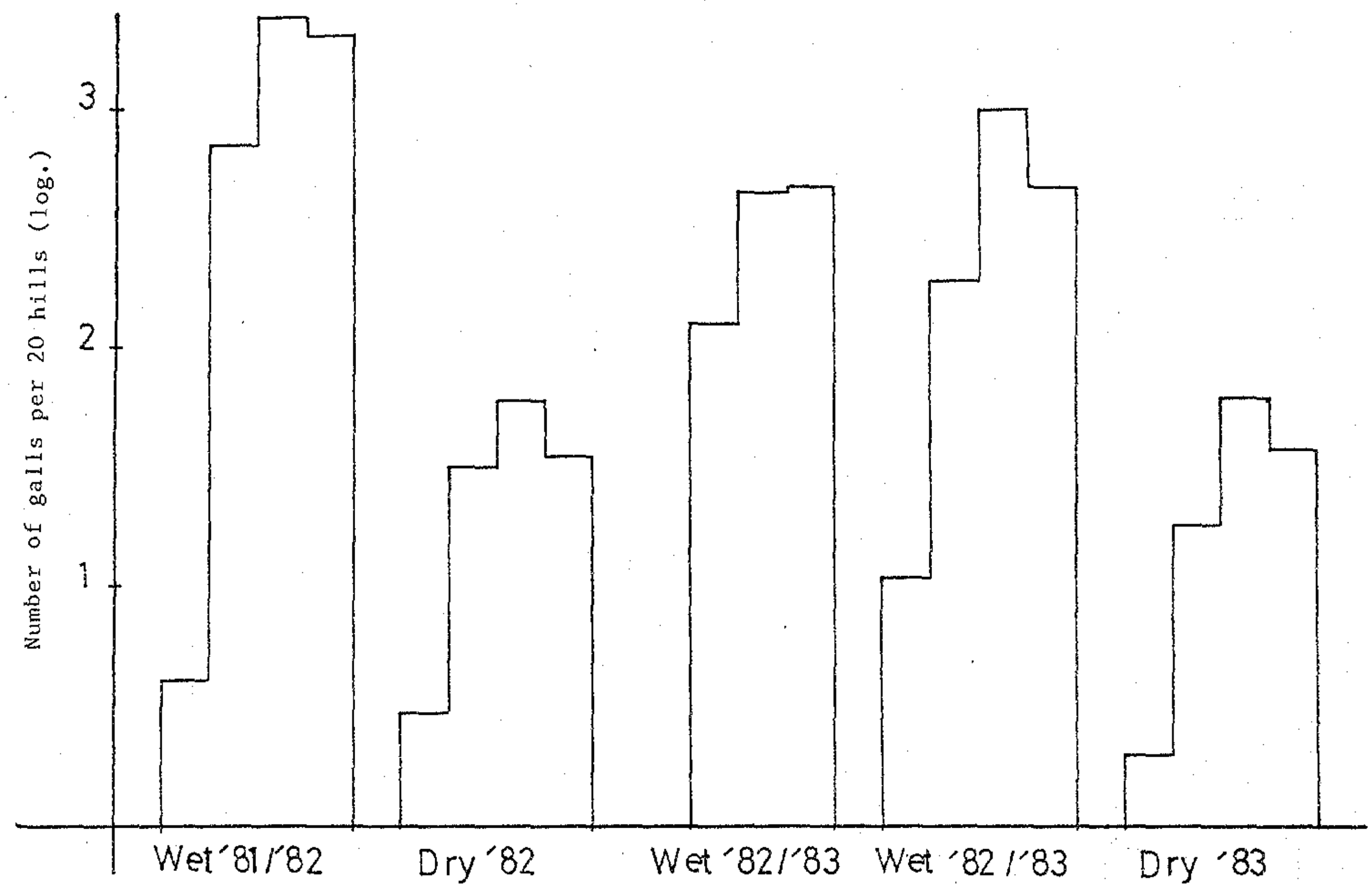


(Fig. 23) Difference of population increase of the developmental stages in the different planting dates at Kertasura in Cirebon, West Java, in the wet season 1981/82

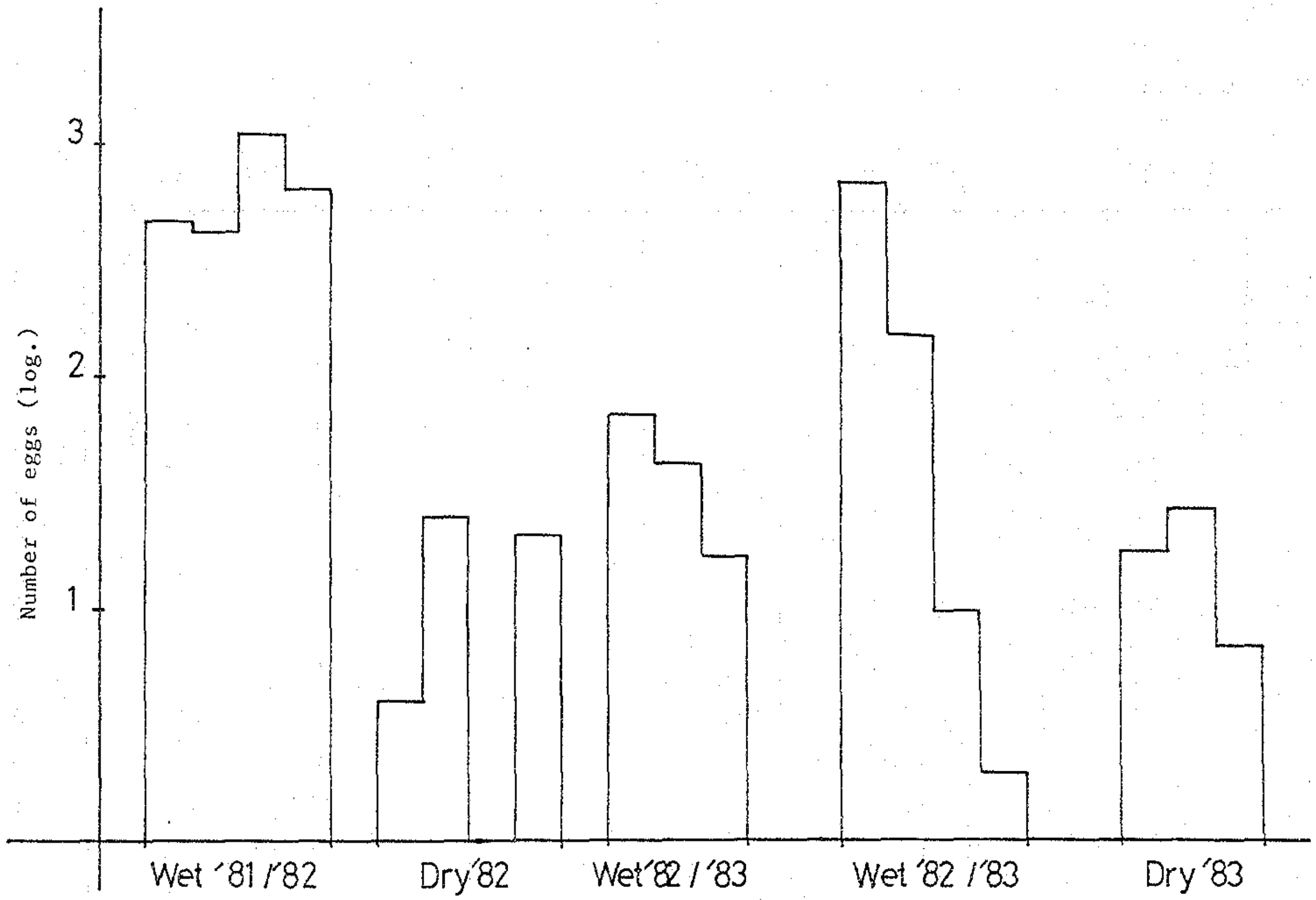
○ ▭ } Transplanted in January, ● ▨ } in December



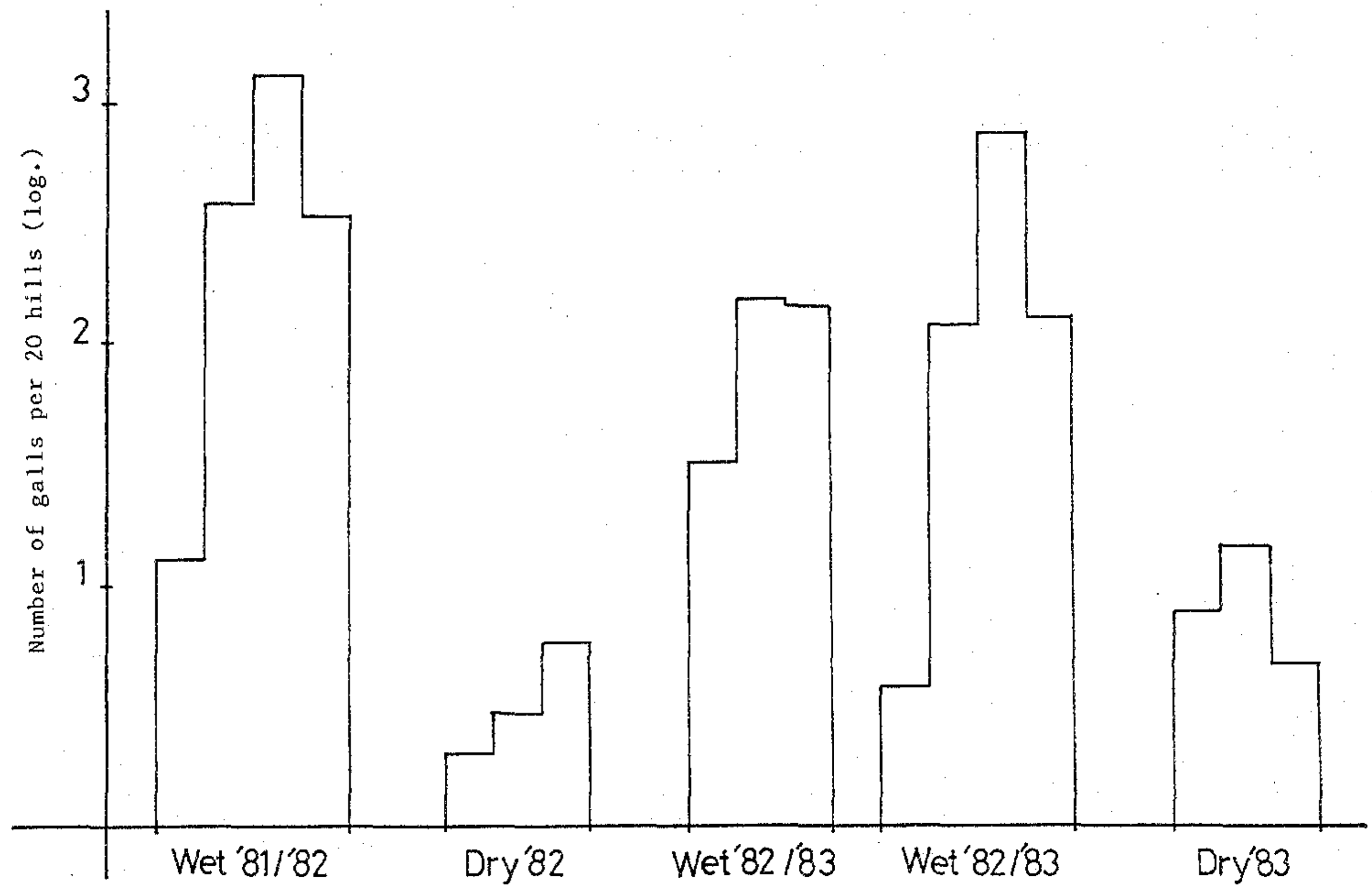
(Fig. 24) Difference of number of eggs of the rice gall midge between the wet and dry seasons at Kertasura in Cirebon, West Java, from 1981 to 1983



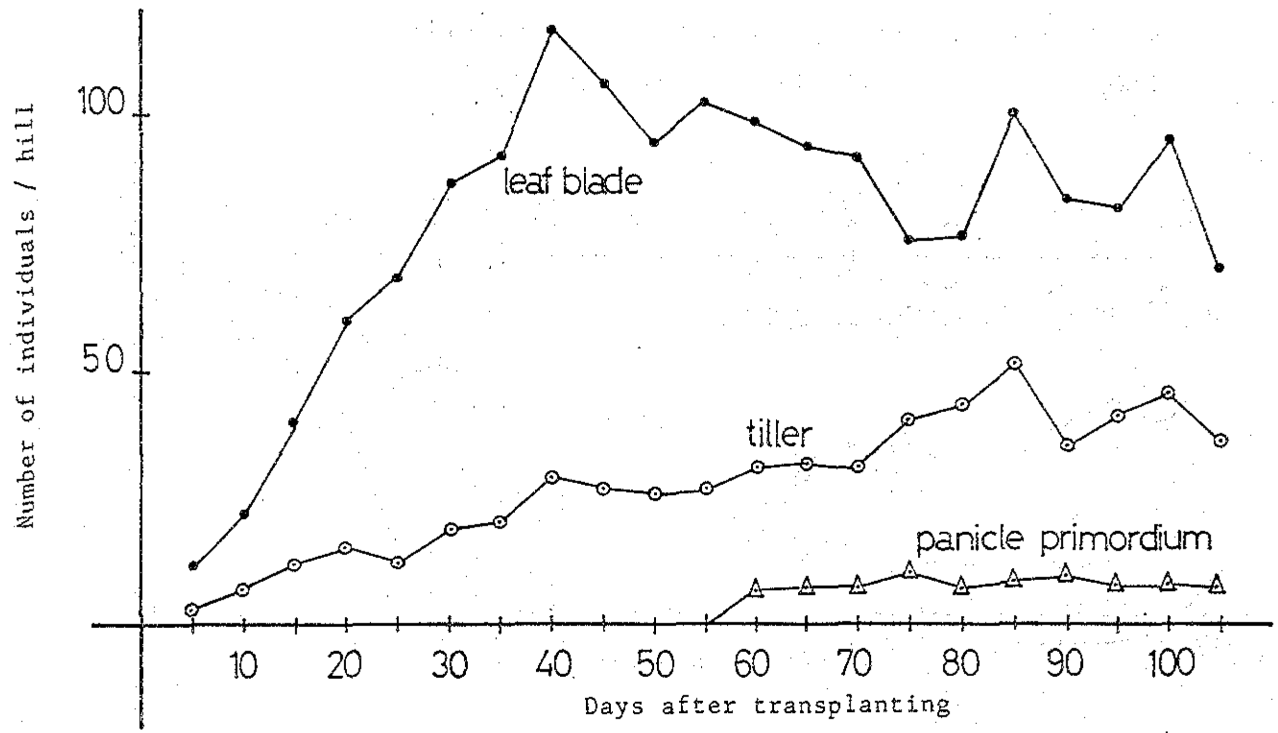
(Fig. 25) Differnce of gall occurrence of the rice gall midge between the wet and dry seasons at Kertasura in Cirebon, West Java



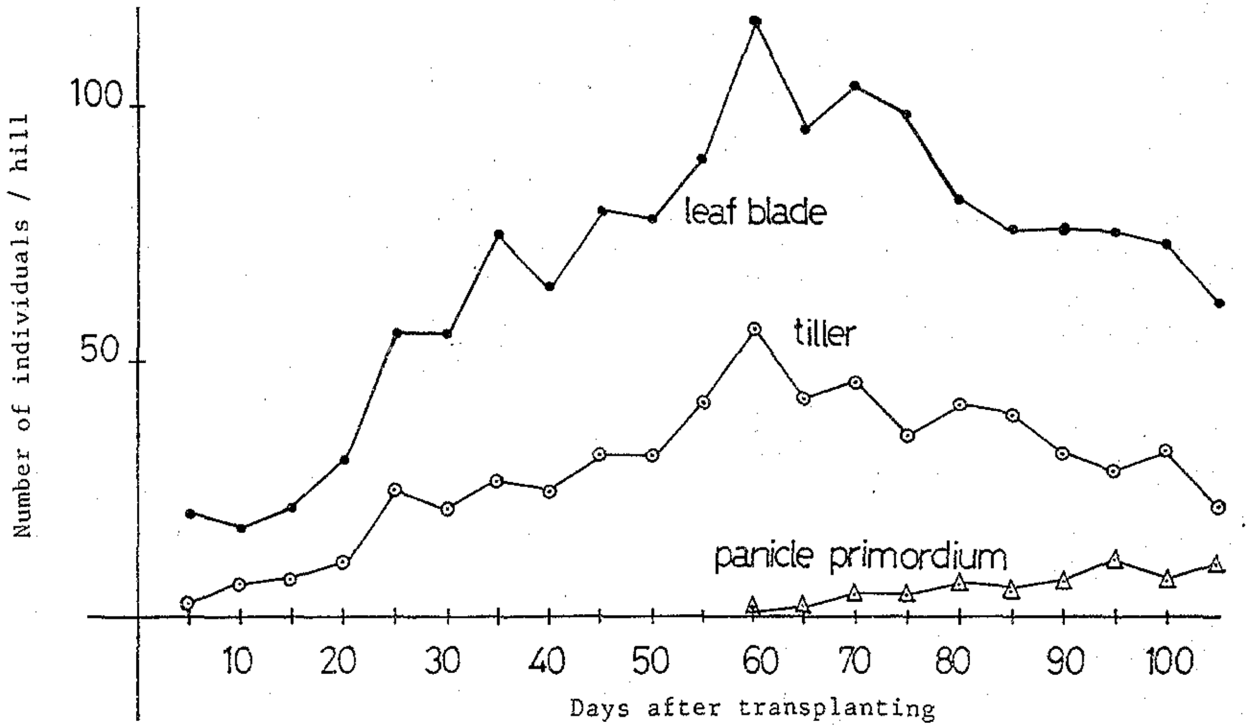
(Fig. 26) Difference of number of eggs of the rice gall midge between the wet and dry seasons at the BPP Bayalangu in Cirebon, West Java, from 1981 to 1983



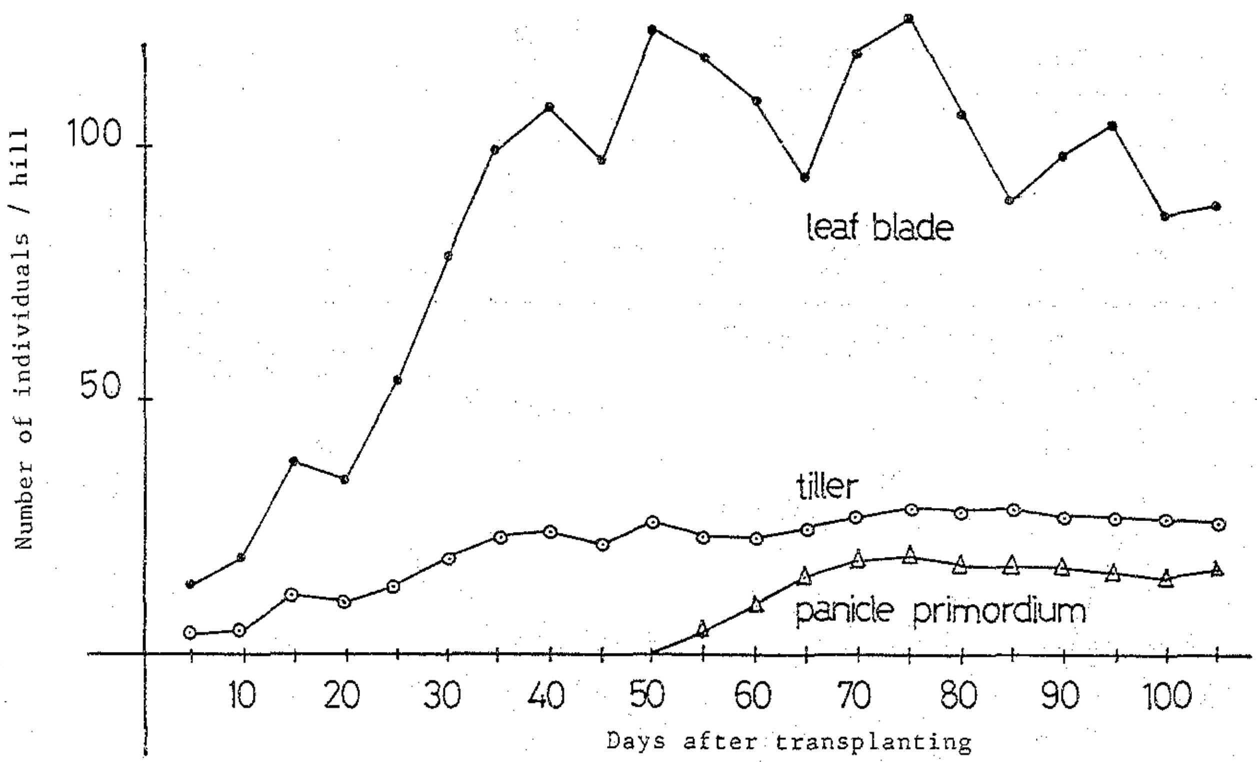
(Fig. 27) Difference of gall occurrence of the rice gall midge between the wet and dry seasons at the BPP Bayalangu in Cirebon, West Java, from 1981 to 1983



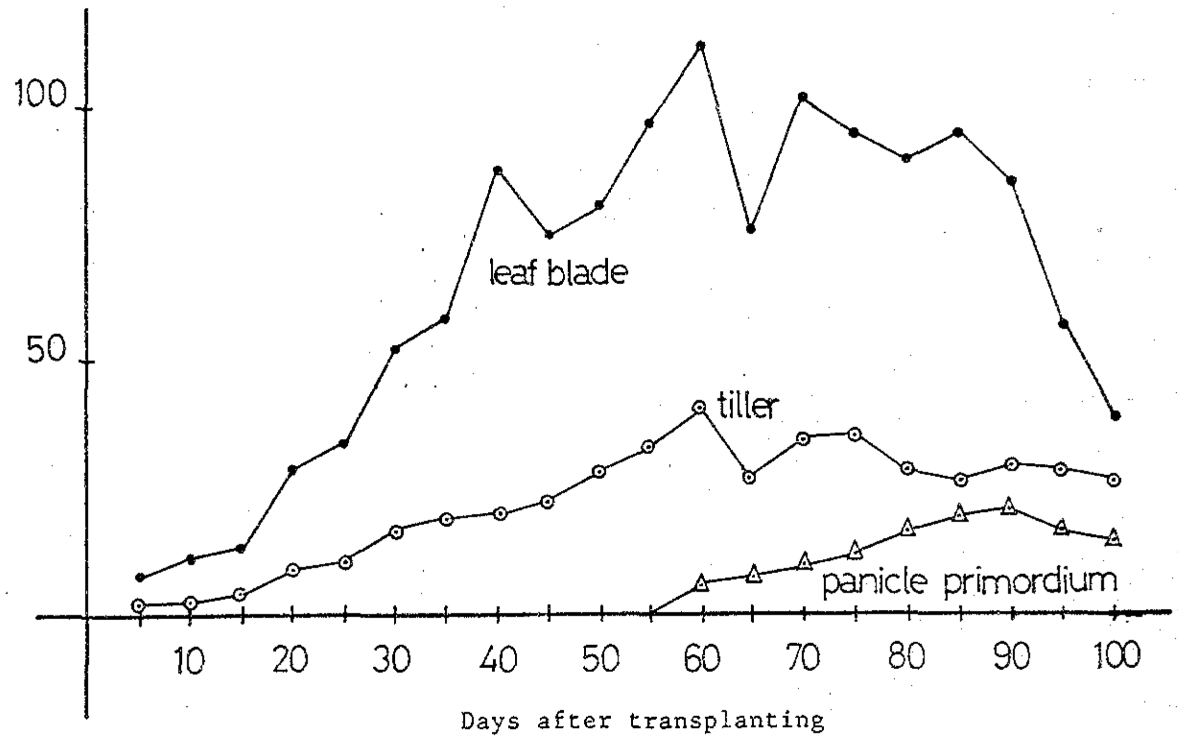
(Fig. 28) Fluctuation of number of leafblade, tillers and panicle primordia per hill at early planting in Kertasura in Cirebon, West Java, in the wet season 1981/82.



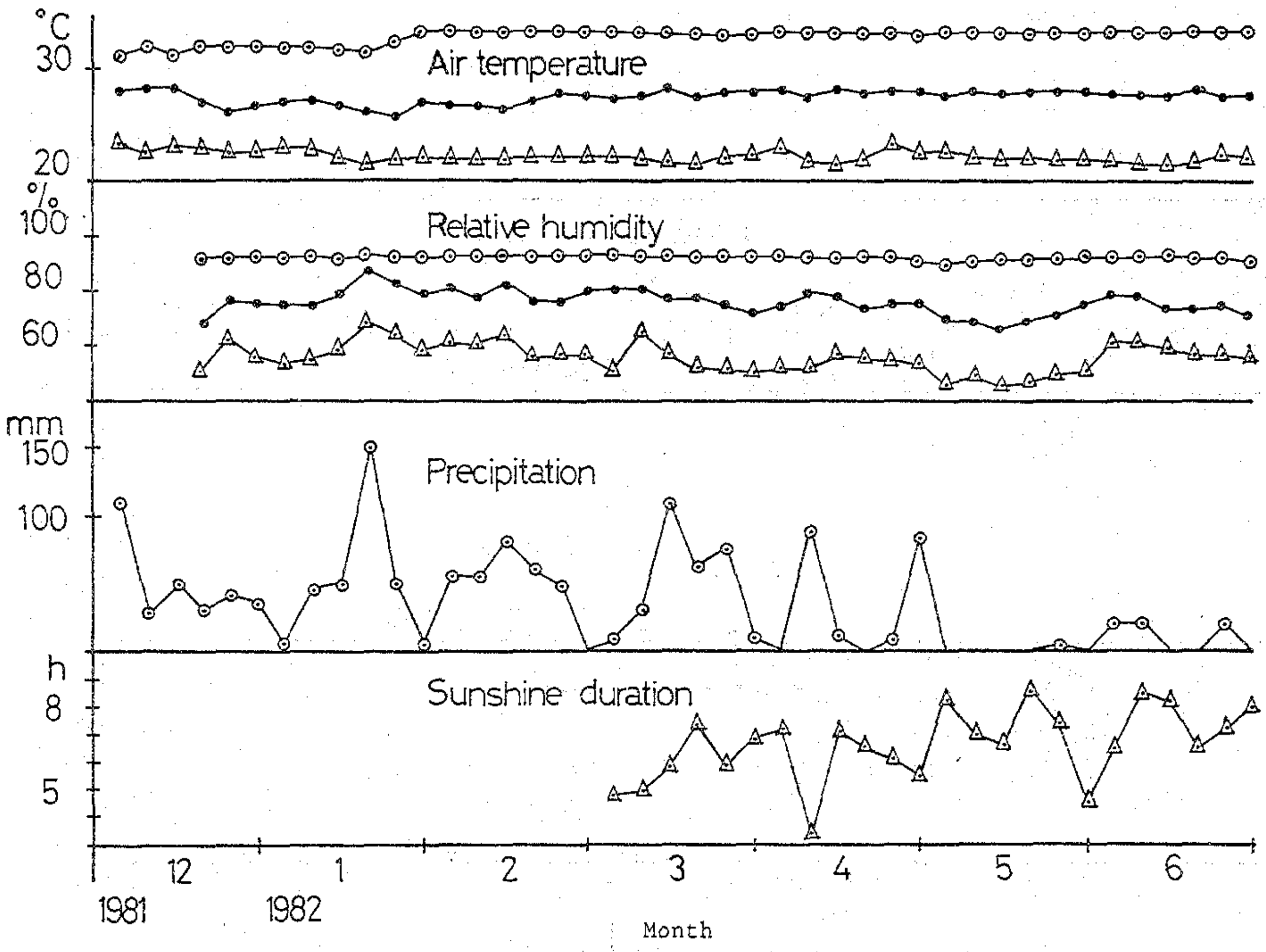
(Fig. 29) Fluctuation of number of leafblade, tillers and panicle primordia per hill at late planting in Kertasura in Cirebon, West Java, in the wet season 1981/82.



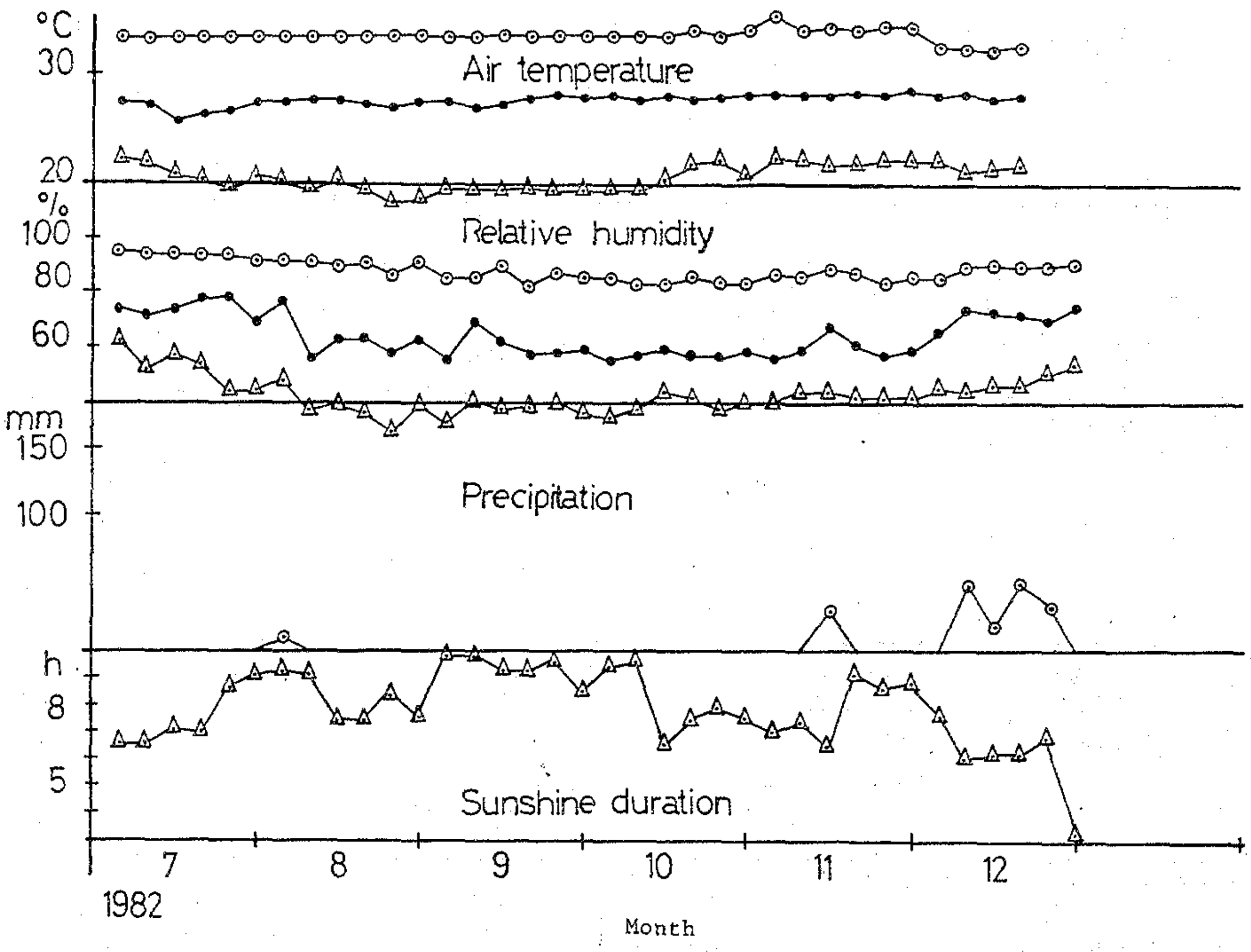
(Fig. 30) Fluctuation of number of leafblades, tillers and panicle primordia per hill at early planting at the BPP Bayalangu in Cirebon, West Java, in the wet season 1981/82.



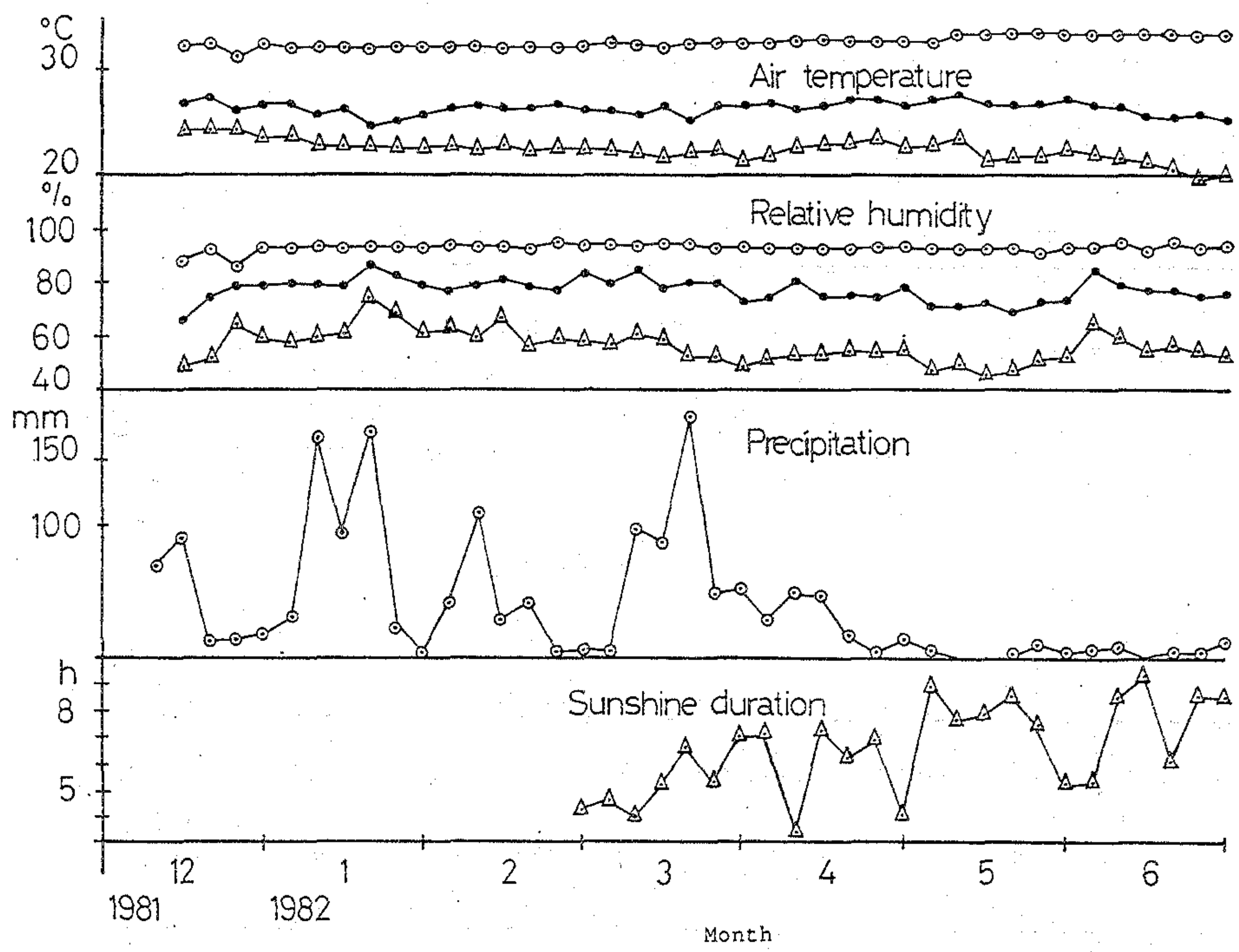
(Fig. 31) Fluctuation of number of leafblades, tillers and panicle primordia per hill at late planting in Bayalangu in Cirebon, the Wet season 1981/'82.



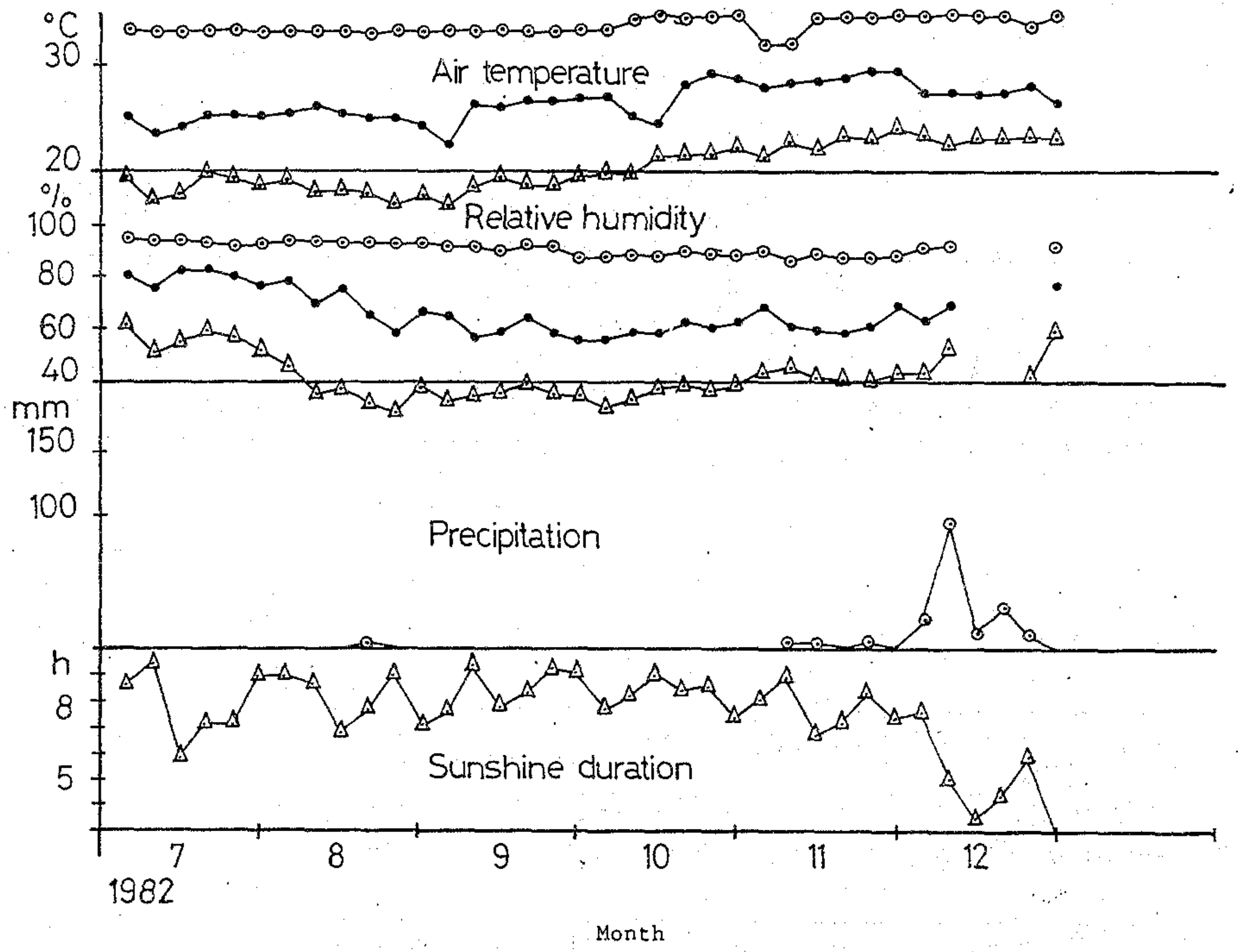
(Fig. 32) Seasonal fluctuation of air temperature, relative humidity and precipitation at Kertasura in Cirebon, West Java



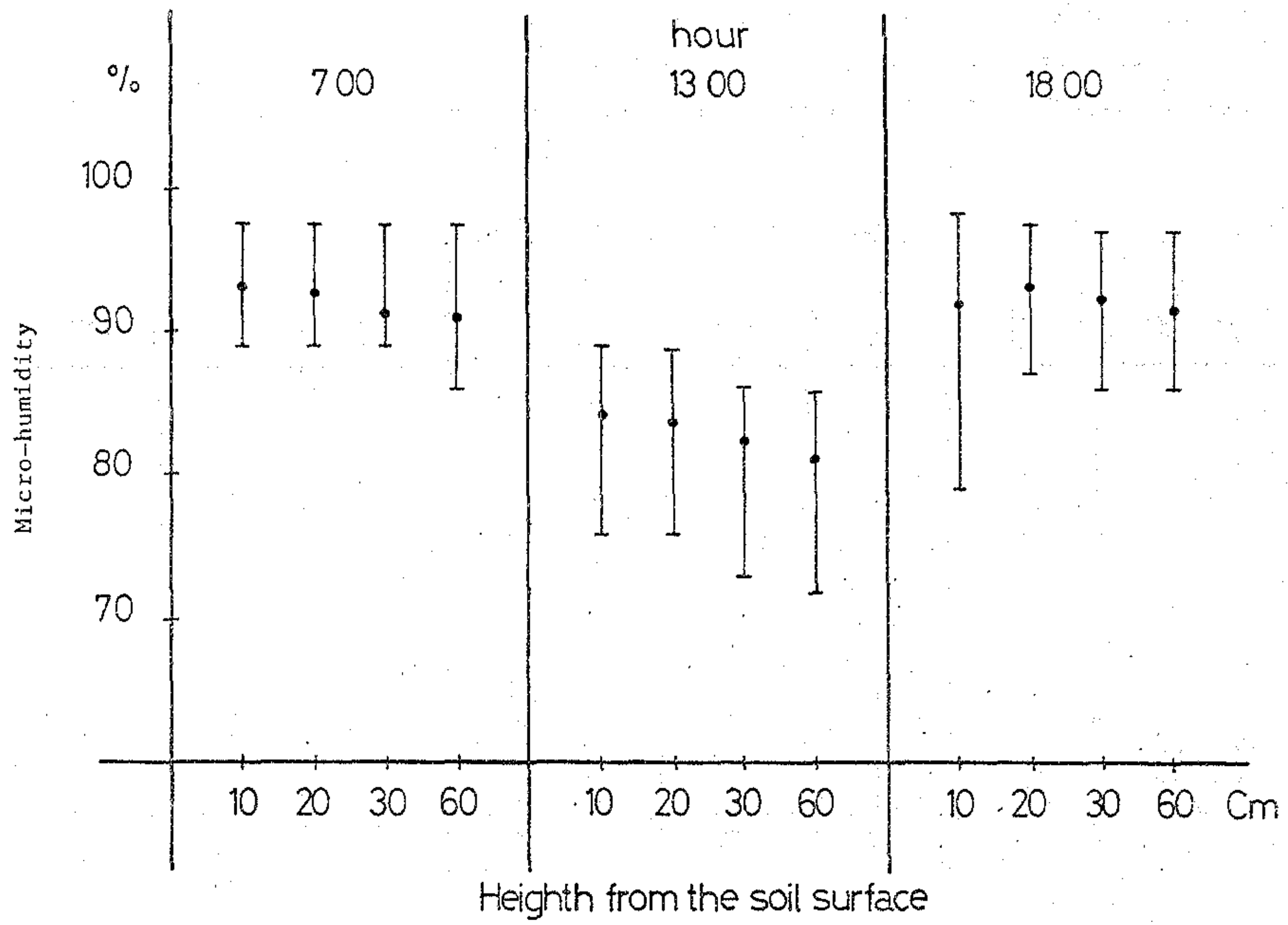
(Fig. 33) Seasonal fluctuation of air temperature, relative humidity and precipitation at Kertasura in Cirebon, West Java



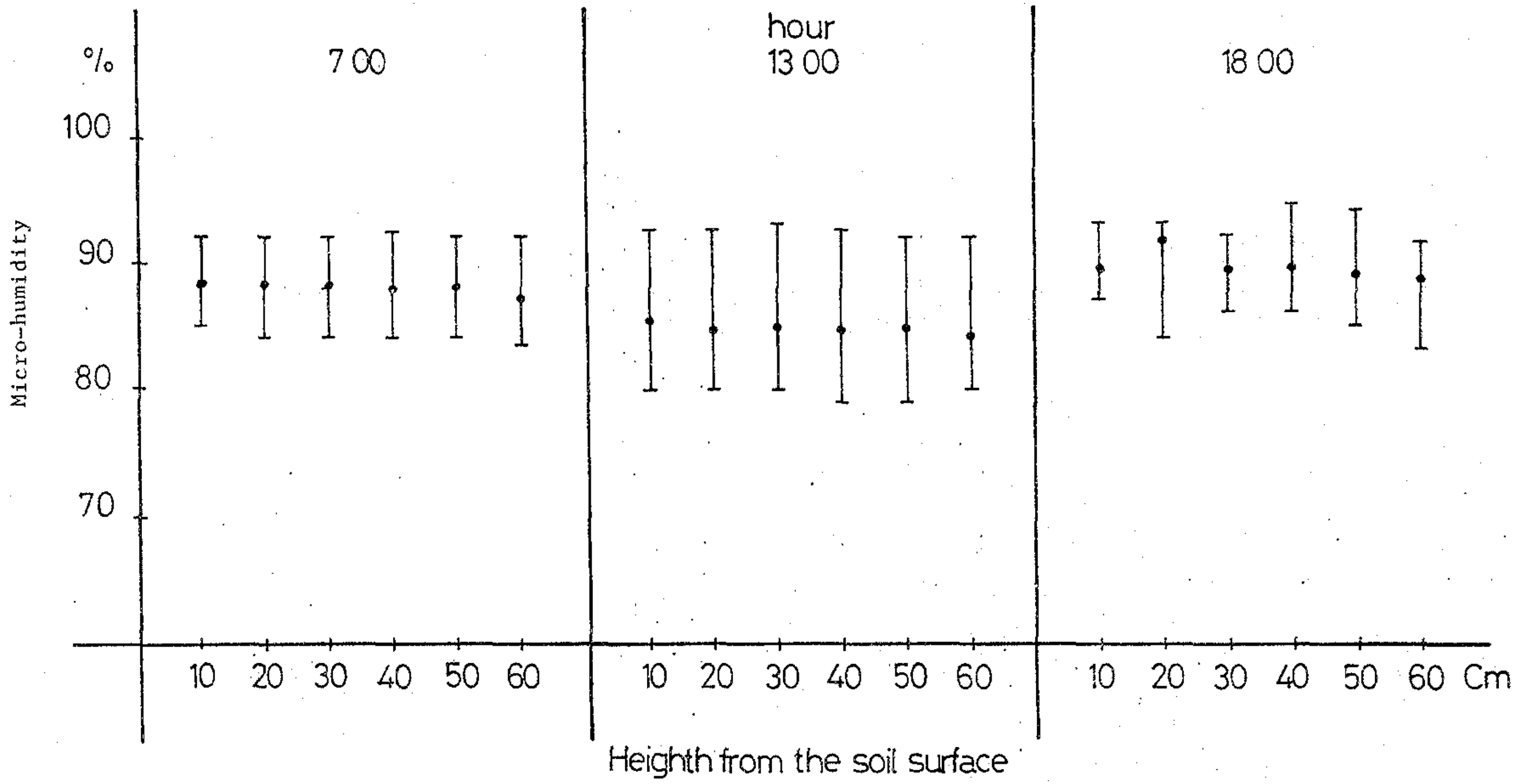
(Fig. 34) Seasonal fluctuation of air temperature, relative humidity, and precipitation at the BPP Bayalangu in Cirebon, West Java



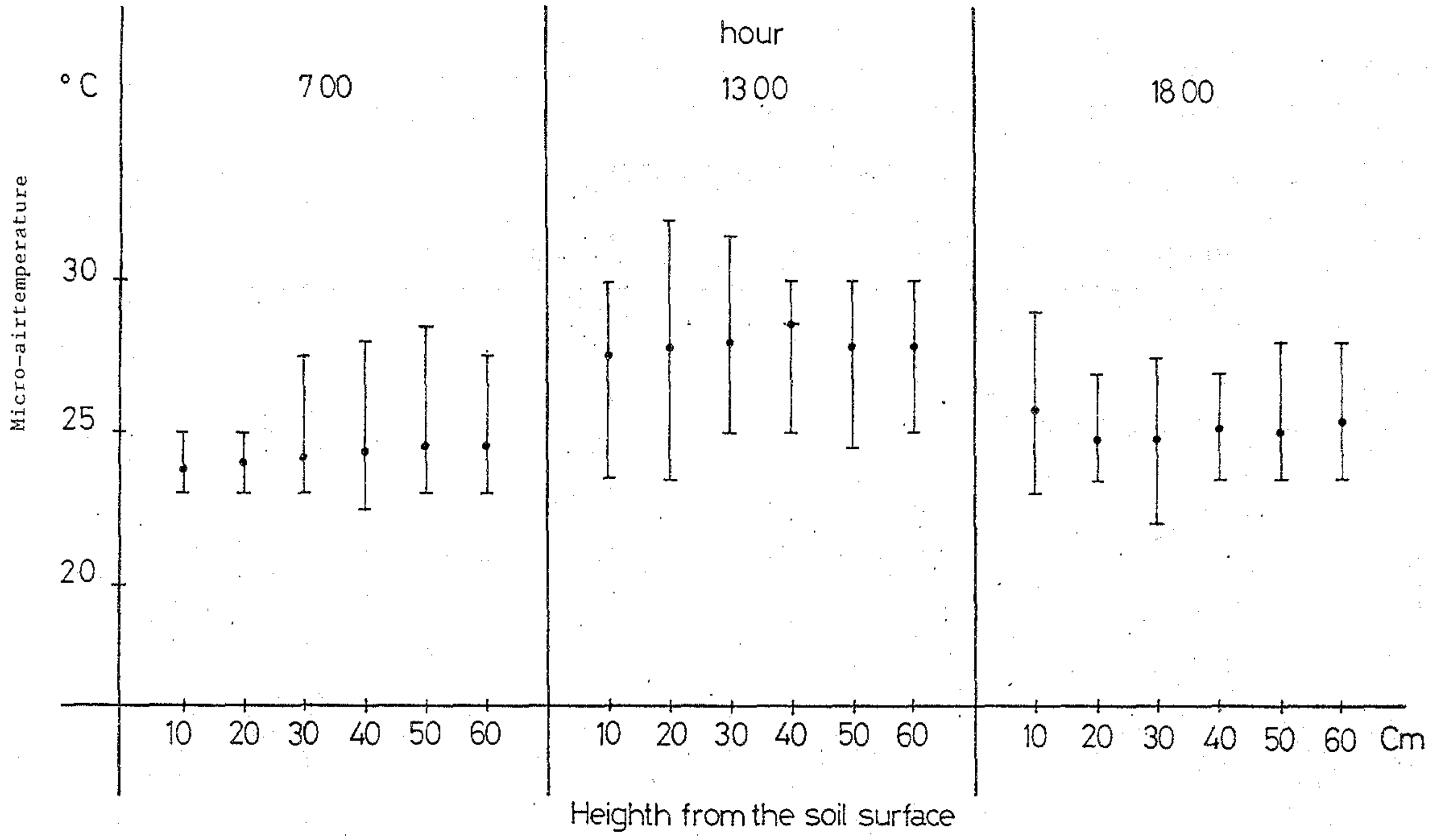
(Fig. 35) Seasonal fluctuation of air temperature, relative humidity and precipitation at the BPP Bayalangu in Cirebon, West Java



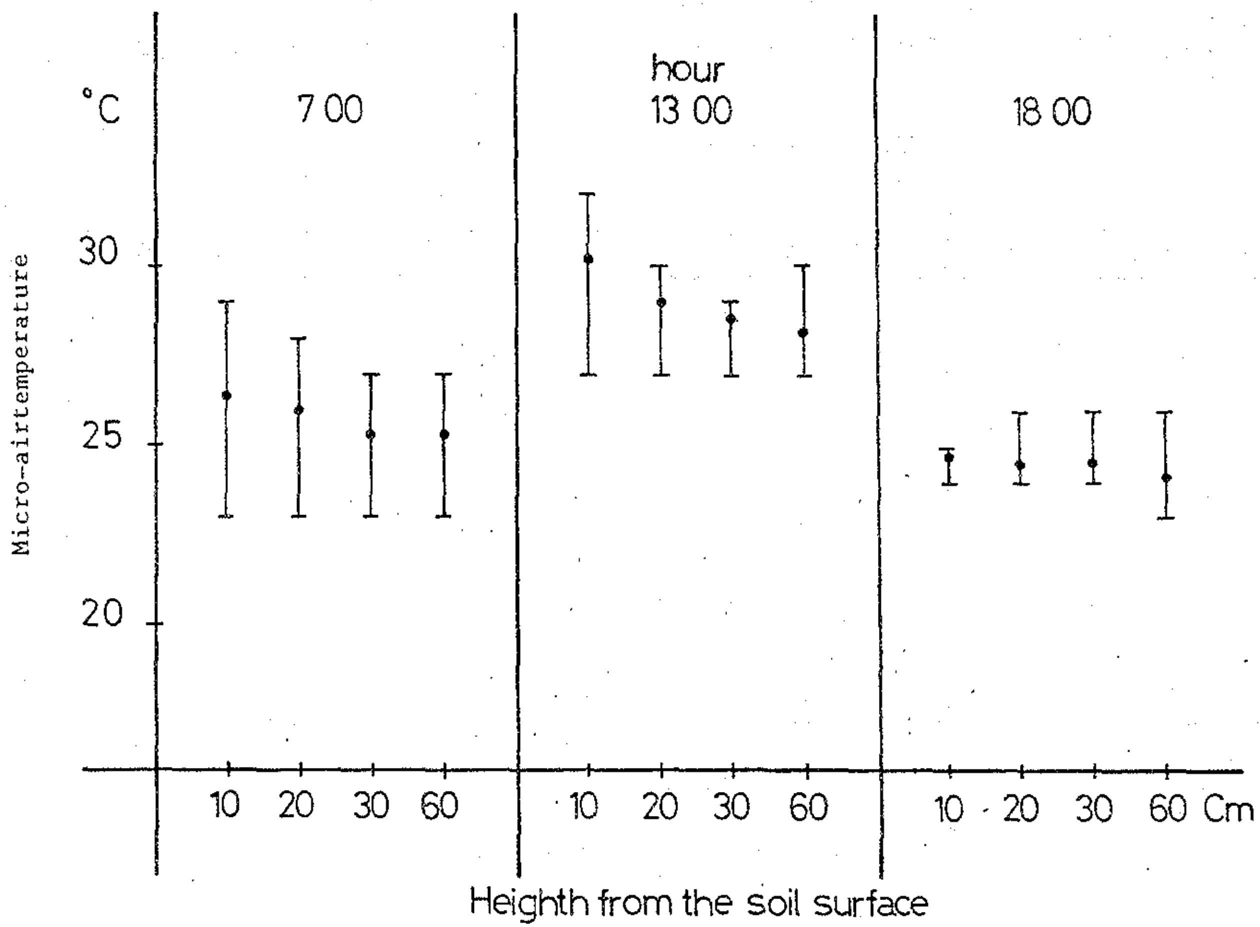
(Fig. 36) Micro-humidity in individual spacing of rice hills at Kertasura in Cirebon, West Java. Transplanted on December 25 1981, the average between January 1 and 21 1982.



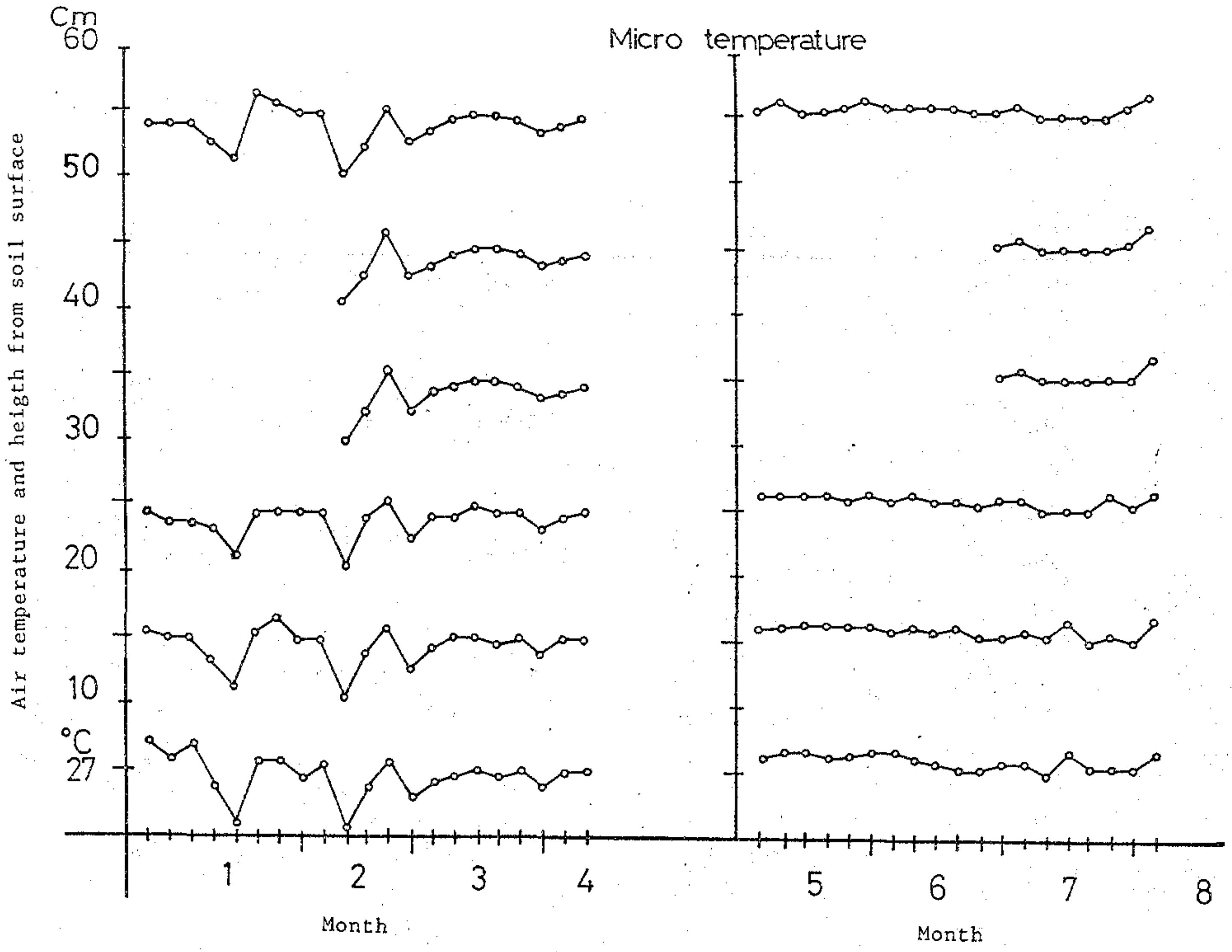
(Fig. 37) Micro-humidity in individual spacing of rice hills at the BPP Bayalangu in Cirebon, West Java. Transplanted on December 5 1981, the average between December 26 and January 20 1982.



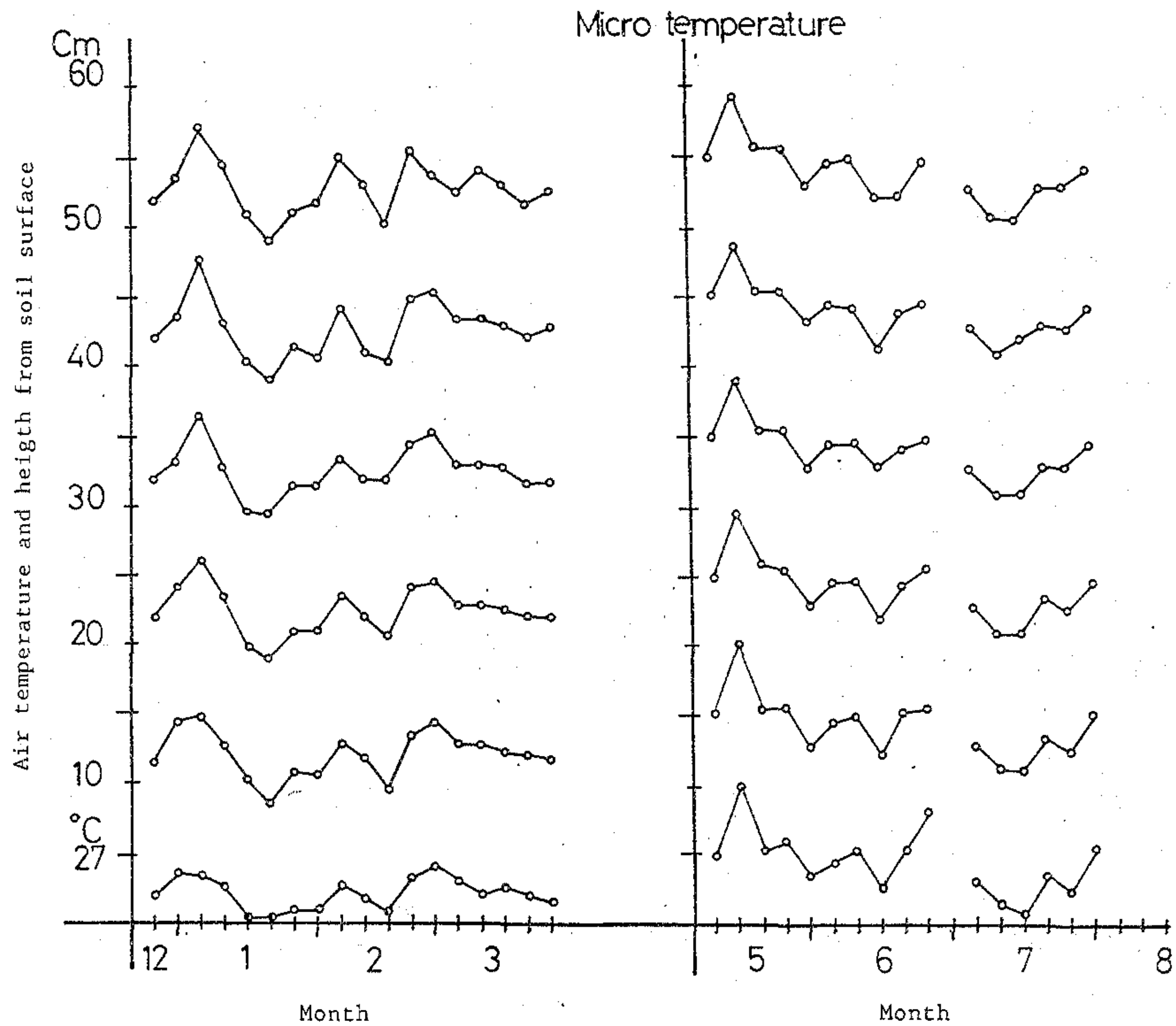
(Fig. 38) Micro-air temperature in individual spacing of rice hills at the BPP Bayalangu in Cirebon, West Java. Transplanted on December 5 1981, the average between December 26 1981 and January 20 1982



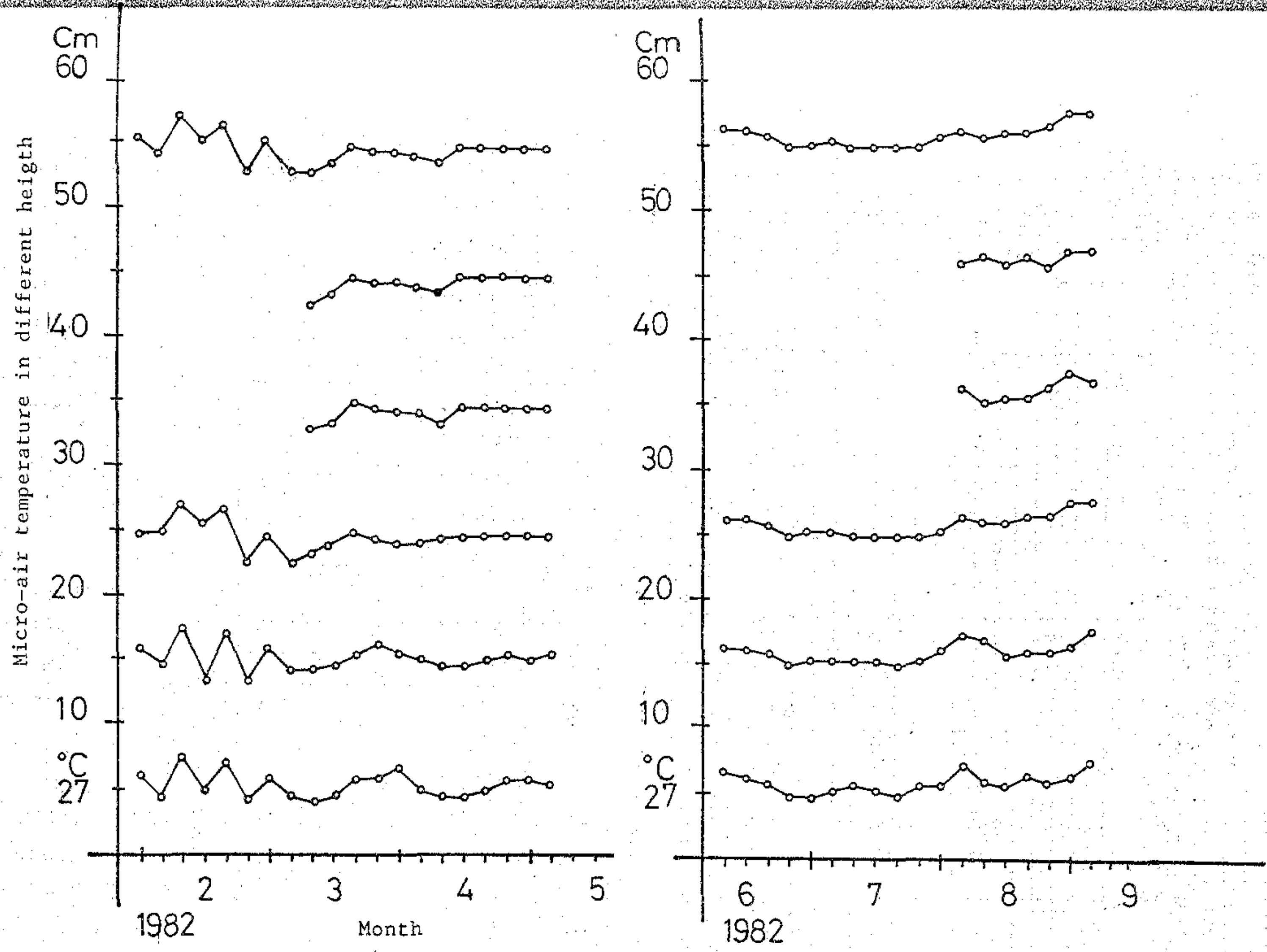
(Fig. 39) Micro-air temperature in individual spacing of rice hills at Kertasura in Cirebon, West Java. Transplanted on December 25 1981, the average between January 1 and 21 1982



(Fig. 40) Micro-air temperature at different heigth in individual spacing of rice hills at Kertasura in Cirebon, West Java, in the wet season 1981/82 and the dry season 1982



(Fig. 41) Micro-air temperature at different heigth in individual spacing of rice hills at BPP Bayalangu in Cirebon, West Java, in the wet season 1981/82 and the dry season 1982



(Fig. 42) Micro-air temperature in individual spacing of rice hills in different heigth from the soil surface at Kertasura in Cirebon, West Java, in the wet and dry seasons in 1982.