A REPORT OF THE TECHNICAL ADVISARY TEAM ON FORECASTING AND CONTROL OF RICE DISEASES AND INSECT PESTS FOR THE INDO-JAPANESE AGRICULTURAL EXTENSION CENTRE

November 1970

Overseas Technical Cooperation Agency

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INTRODUCTION

As the second step of Japan's technical cooperation to India, the Indo-Japanese Agricultural Extension Centres were established in 1968 after reorganizing their predecessors, the Japanese Model Farms, which had so far been engaged mostly in demostration activities. Since their establishment, the Extension Centres have been vigorously pushing forward their work aiming at the extension of improved agricultural techniques among farmers in the neighbouring areas for their production increase.

Extension work carried out by respective Centres with emphasis placed on mechanized tilling and threshing using Japanese farm machinery and equipment, introduction of new varieties, increase of planting density, and higher and rationalized doses of fertilizer application, is steadily yielding the expected results through the streneous efforts exerted by the experts specialized in different fields who are stationed at the Centres.

With the exception of the mechanization efforts, however, the introduction of new varieties and other promotional measures, if viewed from another angle, are conductive to the planting of susceptible varieties, dense planting, overgrowth, overdosage of nitrogen fertilizers and other factors which lead to the occurrence of rice diseases and insect pests. It is no exaggeration to say that this constitutes the major cause of diseases and pests suffered each year by the Extension Centres.

Therefore, when the Overseas Technical Cooperation Agency requested me, at the end of July 1970, through Mr. Iwata, the former Head of Department of Plant Pathology and Entomology, National Institute of Agricultural Sciences, to conduct a study tour in India with Dr. Socho Nasu and Dr. Minoru Yoshino of the said institute and Mr. Shohei Matsumoto of the Tropical Agriculture Research Center for the control of rice diseases and insect pests in and around the Indo-Japanese Agricultural Extension Centres, I readily came to the understanding that the tour was necessitated by the damages resulting from the past agricultural extension measures.

The study tour conducted last year by Dr. Satoshi Wakimoto of the said institute, which was intended chiefly to cope with the severe occurrence of virus diseases in Bihar State, covered all the Extension Centers during the harvesting season.

Accordingly, instructions were given to the team prior to its departure from Japan to make the study tour a little earlier than in the last year, i.e., during the mid-growth period of paddy, so as to be able to formulate control measures on the basis of forecasting of diseases and insect pests. However, since the preparations for the study tour coincided with the busiest experimental and testing activities for summer crops in Japan, the team's departure on August 19 was not preceded by satisfactory prior arrangements and preparations. The team conducted the study tour towards the end of the wet season. In the latter half

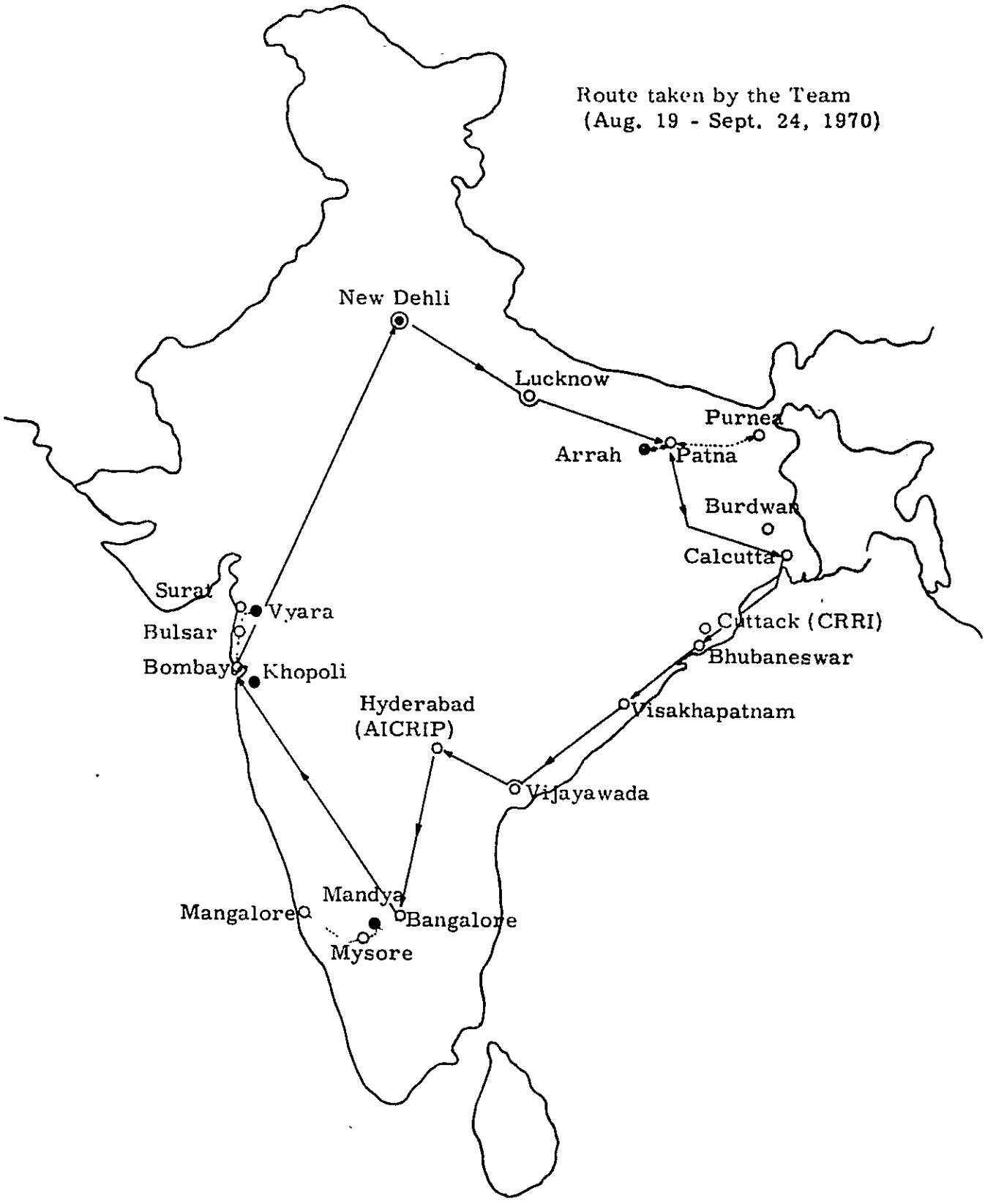
of the tour, the team members suffered fatigue due partly to the severe climate. It is my sincere hope that the team's activities, though handicapped by its deficient prior preparations and the fatigue of its members, have served to meet the expectation of experts and officers stationed at each Extension Centre.

This report has been prepared on the basis of the study tour, and incorporates the description by respective team members supplementing their field activitieis in plant pathology, entomology and plant phisiology, and further deals with the problems pointed out from the viewpoint of their respective specialized fields. It will give me a great pleasure if this report proves useful for the experts and officers of Extension Centres in promoting their extension activities.

Availing myself of this opportunity, I wish to express my heartfelt gratitude to the International Coorperation Division of the Ministry of Agriculture and Forestry, the Research Council of Agriculture, Forestry and Fisheries and the National Institute of Agricultural Sciences for their kind support and arrangements, and to the Directors and experts of Extension Centres, competent officials of the Central and State Governments of India, staffs of the Japanese missions in India and of the New Delhi Office of the Overseas Technical Cooperation Agency for their valuable assistance and cooperation.

S. Yoshimura

November 1970


Route taken by the Team
(Aug. 19 - Sept. 24, 1970)
New Dehli
Lucknow
Purnea
Arrah
Patna
Burdwan
Calcutta
Surat
Vyara
Bulsar
Bombay
Khopoli
Cuttack (CRRI)
Bhubaneswar
Visakhapatnam
Hyderabad
(AICRIP)
Vijayawada
Mandya
Mangalore
Bangalore
Mysore

I. BACKGROUND OF STUDY TOUR

The Indo-Japanese Agricultural Extension Centres, now established at four places in India, have been subjected to severe occurrences of various rice diseases and insect pests virtually each year since the days of their predecessors, the Model Farms. In 1969, in particular, the wet season crops at Shahabad Extension Centre in Bihar State suffered a heavy damage due to virus disease and *Xanthomonas oryzae*. This led to a meeting of Directors of Extension Centres at which the necessity for effective control of rice diseases and insect pests was discussed and adopted as one of their top urgent measures.

In concert with this, the Japanese Ambassador in India sent a formal request to his home ministry for dispatching a team of experts for the control of rice diseases and insect pests. The request was supported by a number of factors such as the non-existence of pertinent experts at any of the Extension Centres, high evaluation given not only by Japanese experts and their Indian counterparts but also by many Indian agricultural experts and research workers to the outcome and control guidance provided by Dr. Satoshi Wakimoto of the National Institute of Agricultural Sciences who had been sent to India in 1969 to cope with the diseases developed at Shahabad Extension Centre, intensified cultivation at all Extension Centres of high-yielding varieties which are less resistant against diseases and insect pests than the conventional varieties, and high probability that other Extension Centres, than Shahabad Centre will also be afflicted with rice diseases and insect pests.

In compliance with the said request, a study team comprising the following experts was dispatched in 1970 during the growing stage of paddy when the forecasting was feasible. The team studied the occurrence and future trends of various rice diseases and insect pests, and also provided their control and diagnosis guidance with every effort made to meet the expectation of the Central Government of India.

II. FORMATION OF TEAM AND PERIOD OF STUDY TOUR

Leader Dr. Shoji Yoshimura, Plant Pathologist.
Chief, Disease Laboratory I, Environmental Research Division,
Central Agricultural Experiment Station.

Member Dr. Socho Nasu, Entomoligist,
Chief, Insect Occurrence Forecasting Laboratory, Division of Entomology,
Department of Plant Pathology and Entomology, National Institute of Agricultural Sciences.

Member Dr. Minoru Yoshino, Plant Physiologist,
Chief, Laboratory of Plant Nutrition II, Division of Plant Nutrition, Department of Soil and Fertilizers, National Institute of Agricultural Sciences.

" Mr. Shohei Matsumoto, Plant Pathologist (Liaison),
Tropical Agriculture Research Center.

Period of Study Tour: 35 days from August 19 to September 24, 1970.

III. MAP SHOWING ROUTE OF STUDY TOUR

(Reference of the growing)

IV. ITINERARY OF TEAM

Date and Day	Description
Aug. 19, Wed.	Departure from Tokyo and arrival at Bangkok. Joined by Japanese experts in Bangkok (1).
20, Thu.	Visit to Technical Div., Rice Dept., Ministry of Agriculture (Thai) (2). Departure from Bangkok and arrival at New Delhi.
21, Fri.	Visit to the Japanese Embassy (3). Interview and discussion with the officials concerned of the Central Government of India (4).
22, Sat.	Visit to Indian Agricultural Research Institute (5).
23, Sun.	Holiday
24, Mon.	Departure from New Delhi and arrival at Patna. Visits to Agricultural Research Station and Plant Protection Office of Bihar State (6). Arrangements for study itinerary (7).
25, Tue.	Lecture meeting of Shahabad Extension Centre (8). Inspection of Dhangain Dist. Farm, at Bikramganj (9).
26, Wed.	Inspection of Purnea East Block (10). Press interview at Purnea East Block (11).
27, Thu.	Inspection of Jabey and Bhawanipur, Purnea District (12).
28, Fri.	Lecture meeting at Bihar State Agricultural Research Station (13).

	Interview and discussion with the officials and experts of Bihar State (14). Discussion with Dr. Birat and Japanese experts (15).
Aug. 29, Sat.	Departure from Patna and arrival at Calcutta.
30, Sun.	Holiday (Courtesy call on the Japanese Consulate-General) (16).
31, Mon.	Cancellation of the planned activities at the advice of the Japanese Consulate-General (poor public peace in Calcutta).
Sept. 1, Tue.	Departure from Calcutta and arrival at Bhubaneswar. Visit to Central Rice Research Institute (17).
2, Wed.	Visit to Central Rice Research Institute.
3, Thu.	Departure postponed till September 4 by the suspended flight service due to bad weather. Discussion with the staffs of Central Rice Research Institute and Bhubaneswar University (18).
4, Fri.	Departure from Bhubaneswar and arrival at Hyderabad.
5, Sat.	Visit to All India Coordinated Rice Improvement Project (19). Joined at Hyderabad Airport by Dr. B. Ganguly dispatched by the Central Government of India. Departure from Hyderabad and arrival at Bangalore. Arrangements for study itinerary (20).
6, Sun.	Interview and discussion with the experts of Mandya Extension Centre and officials of Mysore State Government (21). Inspection of paddy fields of Mandya Extension Centre.
7, Mon.	Inspection of Coorg District (22). Departure of the Leader from Coorg for Mangalore.
8, Tue.	Inspection of Mangalore District and discussion with the agricultural experts of the same district (23). Lecture meeting at Mandya Extension Centre (24).
9, Wed.	Interview and discussion with the officials of Mysore State Government and experts of Bangalore University of Agricultural Sciences (25). Departure from Bangalore and arrival at Bombay.
10, Thu.	Coutesy call on the Japanese Consulate-General in Bombay (26). Discussions with the officials of Maharashtra State Government and experts of Khopoli Extension Centre (27). Arrangements for study itinerary (28).

Sept.11, Fri. Visit to Lonavla Rice Research Station (29).
Visit to Agricultural Research Station, Karjat (30).
Inspection of Jambrivri Village.

12, Sat. Visits to Karjat Agriucltural Research Station and Jambrivri Village.

13, Sun. Findings of study tour reported at Khopoli Extension Centre (31).
Departure from Khopoli and arrival at Bombay.

14, Mon. Preparation of the interim report (32).

15, Tue. Departure from Bombay and arrival at Bulsar.
Inspection and discussion at Vyara Extension Centre (33).

16, Wed. Inspection of Mheuwa, Navsari Talka (34).

17, Thu. Inspection of Chikhli, Bulsar Talka (35).

18, Fri. Inspection of Bardoli Talka (36).
Departure from Bulsar and arrival at Bombay.

19, Sat. Preparation of the report.
Departure from Bombay and arrival at New Delhi.

20, Sun. Preparation of the report for submission to the Central Government of India (37).

21, Mon. Discussion with the officials of the Central Government of India (38).
Luncheon (39).
Lecture meeting at the Indian Agricultural Research Institute (40).
Consultation with Ambassador Uyama (41).

22, Tue. Duscussion with the experts of the Indian Agricultural Research Institute (42).
Courtesy call on the Japanese Embassy.

23, Wed. Departure from New Delhi.

24, Thu. Arrival at Tokyo.

V. DETAILED DESCRIPTION OF STUDY ITINERARY

(1) Discussion about rice diseases and insect pests with the following Japanese experts.

FAO experts: Dr. Jisuke Takahashi, Dr. Hidetoshi Matsuo, Mr. Kenichi Hayashi.
CP experts: Mr. Hiroshi Fujii, Dr. Mitsuo Yoshimeki, Dr. Akio Osada.
Inst. for PL. Virus Dis.: Dr. Yasuo Saito.
Experts of Tropical Agr. Research Center: Dr. Toshihiko Hino, Mr. Hitoshi Inoue, Mr. Satoru Motomura, Mr. Tatsuhiko Matsuguchi, Mr. Mitsuaki Watanabe.

National Inst. of Agr. Sciences: Dr. Shuichi Ishizawa.

(2) Discussion with Japanese and the following foreign experts stationed at Technical Div., Rice Dept. Ministry of Agriculture about studies currently made on orange leaf virus, yellow orange leaf virus and *Xanthomonas oryzae.*

Drs. Pracob Kanjanasoon, Piya Giatgong, Luansark Wathanakul, Tanogehit Wongsiri.

(3) Courtesy call on Ambassador Uyama, Minister Kambara, Counsellor Fujimoto, Secretary Kosaka of the Japanese Embassy and Mr. Inagaki, Chief of OTCA New Delhi Office; and arrangement with them for the itinerary of study tour.

(4) Visit to the Department of Agriculture accompanied by Secretary Kosaka and Mr. Inagaki. Information provided by the following experts on the severe occurrence of leaf yellowing in 1969 and on the periodical inspection scheme currently implemented for the occurrence of leaf hoppers and leaf yellowing, with the request for the team's cooperation in the study on leaf yellowing.

Dr. K.D. Paharia (Plant Protection Advisor, Dept. of Agr.)
Dr. N.C. Joshi (Ass't Systemic Mycologist, Dept. of Agr.)
Dr. B. Ganguly (Plant Protection Specialist, Dept. of Agr.)
Dr. H.P. Srivastava (Joint Commissioner, Dept. of Agr.)
Dr. D.N. Srivastava (Ass't Director General, Indian Council of Agricultural Research)
Dr. Y.P. Rao (Plant Bacteriologist, Indian Agricultural Research Inst.)
Dr. R.A. Mishra (Virus Pathologist, I.A.R.I.)
Mr. S.I.H. Naqvi (Deputy Director-Coordination, Directorate of Extension)

(5) Inspection of Indian Agricultural Research Institute at the guidance of Dr. V.V. Chenulu (Prof., I.A.R.I.), Dr. Y.P. Rao, Dr. R.A. Mishra and Dr. D.N. Srivastava. Research activities of the institute explained to the team.

(6) Visit to Bihar State Plant Protection Office in company with Director C. Miyasaka of Shahabad Extension Centre and other experts of the Centre including Mr. N. Chida, Mr. K. Ogasawara and Mr. M. Masuda. Information given by the following Indian experts on the occurrence of rice diseases and inspect pests in Bihar State, with detailed and emphatic explanation on the leaf yellowing incidence of 1969.

Dr. R.B.S. Birat (Plant Protection Officer, Bihar State)
Mr. V.A. Kulkarni (Rice Specialist, Bihar State)
Mr. S.B. Triar (Ass't Entomologist-Rice, Bihar State)
Mr. Kishore Kumar (Jr. Plant Protection Officer, Patna)
Mr. U.S. Sharma (Plant Protection Inspector, Patna)

(7) Consultation with Dr. Birat and Director Miyasaka for arrangement of the team's study itinerary in Bihar State.

(8) Lecture given at Shahabad Extension Centre to its plant protection specialists and extension staffs on the techniques for diagnosing and identifying major rice diseases and insect pests.

(9) Inspection of Dhangain Dist. Farm, at Bikramganj, with the following experts.

Mr. J.N. Verma (Project Executive Officer, Bikramganj)
Mr. D.P. Singh (Jr. Ass't Agronomist, Dhangain Dist. Farm)
Mr. R.N. Singh (Ass't Res. Officer)
Mr. A.K. Duer (Agricultural Inspector)
Mr. J.P. Sharma (J.R.A., Bot. Sub. St., Dhangain, Bikramganj)

(10) Inspection of Purnea and discussion with the following experts who provided information on the occurrence of leaf yellowing in the current season in Purnea District.

Mr. Jamuna Pandy (Project Executive Officer, Purnea East Block)
Mr. Bhup Narain (Ass't Res. Officer-Oil seeds, Dist. Farm)
Mr. Ayudhya Jha (Block Agr. Officer, Purnea East Block)
Mr. J.P. Sahu (Jr. Plant Protection Officer, Purnea)
Mr. A.N. Sharma (Secretary to Koshi Area, Development Commissioner, Purnea)
Mr. Kishore Kumar

(11) Press interview with Mr. A.D. Dey (press correspondent, Purnea) at Purnea Guest House with the attendance of Project Executive Officer of Purnea, other experts, and Dr. Birat.

(12) Inspection of Jabey and Bhawanipur Villages with Mr. S.D. Mishra (Project Executive Officer).

(13) Lecture delivered to the experts mentioned in item (10) and the staffs of Agricultural Research Station and Plant Protection Office on the techniques of diagnosing and identifying diseases and insect pests.

(14) Discussion with the following officials and experts on the occurrence and counter measure of rice diseases and insect pests in Bihar State, followed by the presentation of the team's interim report.

Mr. S.K. Chakraberti (Agr. Production Commissioner, Bihar State)
Mr. R. Nath (Secretary, Agr. Production Commissioner, Bihar State)
Mr. R.S. Roy (Deputy Director of Agriculture, Bihar State)
Dr. R.N. Ram (Deputy Director of Headquarters, Min. of Agr., Bihar State)

During its study tour in Bihar State, the team was accompanied by Dr. Birat, Director Miyasaka and other Japanese experts.

(15) Discussion with Dr. Birat, Japanese experts and Mr. Shiro Kiuchi, member of JOCV.

(16) Coutesy call on Consul-General Kobayashi, Vice-Consul Yamaguchi and Secretary Ito at the Japanese Consulate-General in Calcutta. Planned departure for Burdwan urged to be postponed by the consulate staff on account of the poor public peace in Calcutta and vicinities. Talk with Mr. Yonamine, Mr. Fujimaki and Mr. Okami (members of JOCV) at the Consulate-General.

(17) Visit to Central Rice Research Institute and discussion with the following experts about studies recently made for control of rice diseases and insect pests, particularly *Xanthomonas oryzae* and Leaf Yellowing.

Dr. S.Y. Padmanabhan (Director)
Dr. N.K. Chakrabarti (Mycologist)
Mr. S. Devadath (Jr. Plant Pathologist)
Mr. K.V.S.R.K. Row (Jr. Plant Pathologist)
Mr. S.S. Jain (Research Officer)
Mr. J.P. Kulasrestha (Entomologist)
Dr. K.S. Murty (Plant Physiologist)
Dr. S.C. Mathur (Genetist)
Dr. M.J.B.K. Rao (Botanist)
Dr. A.P. Misra (Proof., Jirhut College of Agriculture, Bihar)

(18) Discussion with the experts mentioned in item (17) about leaf yellowing due to the suspension of flight service to Visakhapatnam.

(19) Discussion at All India Coordinated Rice Improvement Project (Hyderabad) with the following experts on the general conditions of rice diseases and insect pests in India. Opinions exchanged between the team and the Indian experts on the relationship between physiological diseases and leaf yellowing as well as on countermeasures against Tungro and *Xanthomonas oryzae.*

Dr. S.V.S. Shastry (Project Coordinator)
Dr. W.H. Freeman (Joint Coordinator)
Dr. H.E. Kauffman (Bacteriologist)
Dr. V.T. John (Virologist)
Dr. H. Sakai (Plant Physiologist)

(20) Arrangement at Bangalore with Director Dr. I. Suetsugu, Mr. M. Nozaki, Mr. A. Yoshino and Mr. K. Kanemitsu of Mandya Extension Centre for the study and guidance itinerary in Mysore State.

(21) Team joined by Dr. B. Ganguly dispatched by the Central Government of India for study tour in Mysore State. Discussion with the following officials of Mysore State and Japanese Experts at Mandya Extension Centre about Disease and Insect Pests of Rice.

Mr. K.R. Bhagwad (Agronomist, Dept. of Agr., Mysore State)
Mr. H.N. Kamath (Deputy Director of Agr., Mandya)
Mr. H.B. Ananda (Agronomist-cum-Farm Management Specialist)
Mr. M.R. Naidu (Agr. Engineer)
Mr. C.C. Gowda (Farm Manager)

Members of Regional Research Station, Bangalore University of Agricultural Sciences.

(22) Inspection of paddy fields in Coorg District with the following Indian experts and Mr. M.N. Chittiappa, a cultivator of an extensive paddy field in Thithimathi, South Coorg.

Mr. H.C. Najaiah (Joint Director of Agr., Mysore Div.)
Mr. P.U. Belliappa (Deputy Director of Agr., Mysore Dist.)
Mr. N. Balakrishna (Deputy Director of Agr., Coorg Dist.)
Mr. R.A. Hoskote (Ass't Plant Protection Officer, Mercara, Coorg Dist.)

Departure of the team's Leader and Director Suetsugu to Mangalore.

(23) Inspection of rice diseases and insect pests in Kullur Village with the following Indian experts.

Mr. K.G. Biddappa (Deputy Director of Agr., Mangalore Dist.)
Mr. N. Gangappa (Ass't Plant Protection Officer, Manglore Dist.)
Mr. U. Sooryanarana Maiya (Technical Ass't, Mangalore Dist.)

Visit to Kankanady Agricultural Research Station and inspection of its paddy fields, followed by the discussion with the following experts of the station on *Fusarium nivale* found prevalent upon inspection.

Mr. B. Tagannath
Mr. P. Bhadrayya (Research Officer, Agr. Res. Station, Kankanady, Mangalore)

The team also met Mr. K. Shamprakash (Ass't Agr. Officer, Coondapur, South Kanara Dist.) who brought speciments of paddy affected by *Xanthomonas oryzae*, *Selerotium oryzae-sativa* and panicle browning from Coondapur.

The 'team's Leader was accompanied by Director Suetsugu and Mr. Bhagwad during its study in Mangalore.

(24) Lectures given by the team members (Nasu, Yoshino and Matsumoto) to the trainees at Mandya Extension Centre on the method of diagnosing, forecasting and controlling insect pests and parastic and physiological diseases.

(25) Final report on the team's study and guidance tour given to the following officials and experts at Bangalore University of Agricultural Sciences.

Officials of Mysore State:

Mr. C.H. Levanna (Deputy Director of Agriculture, Bangalore)
Dr. S.R. Chandra Sekhariah (Crop Botanist, Dept. of Agr., Mysore State)
Dr. Y. Chandra Shekhar (Plant Protection Officer, Dept. of Agr., Mysore)
Mr. Kanthiah (Plant Pathology-Extension, Dept. of Agr., Mysore)
Experts of Bangalore University:
Dr. G. Rangaswamy (Dean)
Dr. H.C. Govindu (Prof. and Head of the Div. of Plant Pathology)
Dr. R.K. Hegde (Assoc. Prof., Div. of Plant Pathology)
Dr. T.R. Everett (Project Specialist, Plant Protection, Ford Foundation)

A question raised during the explanation by the Deputy Director of Agriculture, Mysore State, as to the effectiveness of spraying using a helicopter under present situation.

(26) Courtesy call on Consul-General Hitomi, Consul Nozaki, Vice-Consul Takahashi at the Japanese Consulate-General in Bombay.

(27) Discussion with the following officials of Maharashtra State and Japanese experts at Khopoli Extension Centre about rice diseases and insect pests. Information provided by the said officials and experts about factors impeding the control of diseases and insect pets in Maharashtra State. The team explained to the said officials and experts about the techniques of diagnosis, identification, control and forecast of diseases and insects using slide films, graphs and tables, and also introduced the plant protection system established in Japan.

Officials of Maharashtra State:

Mr. B.G. Bhalerao (Extension Agronomist)
Mr. Khokale (Divisional Soil Cons. Officer, Kolaba Alibag.)
Mr. V.M. Khaire (Rice Entromologist, Agr. Res. Station, Karjat)
Mr. V.R. Garde (Entomologist, Agr. Res. Station, Karjat)
Dr. D.G. Bhapkar (Rice Specialist, Dept. of Agr., Maharashtra)
Mr. S.M. Dahat (Superintending Agr. Officer, Konkan Div., Bombay)

Mr. Chachoria (Chief Plant Protection Officer, Poona)
Mr. Khatdare (Deputy Director of Agr., Kolaba)
Mr. Gupte (Deputy Director of Agr., Bombay)
Mr. V.B. Banoor (Deputy Director of Agr., Irrigation)
Mr. Purandare (Agr. Development Officer, Kolaba)
Mr. M.V. Thombre (Plant Pathologist, Rice Res. Station, Lonavla)
Mr. D.P. Talekar (Jr. Agronomist, Farm Manager, Agr. Ext. Centre, Khopoli)
Mr. Dawakar (Ass't Plant Pathologist)
Mr. Handekar (Agr. Officer)
Mr. M.H. Jadhav (Foreman Supervisor)
Mr. M.T. Nasare (Agr. Supervisor)
Mr. A.S. Kopikar (Plant Protection Officer, Dept. of Agr., Poona)

Experts of Khopoli Extension Centre:

Director S. Sato
Mr. K. Umeno
Mr. T. Harada
Mr. T. Kato

(28) Information on the agriculture in Maharashtra State and activities of Khopoli Extension Centre given to the team members, Indian and Japanese experts including Mr. D. P. Talekar, as well as to the following Japanese experts accompanying the team.

Mr. K. Miyamoto (Land Bureau, Ministry of Agriculture and Forestry)
Mr. H. Ando (Agricultural Land Development Machinery Public Coorporation)
Mr. S. Takahashi (Member of JOCV)
Mr. M. Yamamoto (Member of JOCV)

Arrangement made for study itinerary.

(29) Information given by Mr. M.V. Thombre about the activities in Lonavla Rice Res. Station. Discussion held with him about the transmission route of *Pyricularia oryzae* and *Xanthomonas oryzae* as well as their control by spraying pesticides.

(30) Information given by Dr. D.G. Bhapkar, rice specialist, about the activities of Karjat Agricultural Experiment Station. Inspection of *Xanthomonas oryzae*, physiological diseases and symptoms resembling virus diseases in Jambrivri Village. Guidance for identification of virus diseases using young rice seedlings and rice grains soon after germination given by the team, with the request that tests be conducted on collected specimens for identification of their syptom resembling virus disease.

(31) Findings of the team's study tour and the identifying and diagnosing techniques explained to the Japanese experts and Mr. D.P. Talekar, Farm Manager, of Khopoli Extension Centre.

(32) Preparation of the interim report for submission to the Central Government of India.

The team was accompanied by Director S. Sato and Mr. K. Umeno of Khopoli Extension Centre throughout its study tour in Maharashtra State which covered Khopoli, Karjat, Jambrivri, Bombay, etc.

(33) Inspection of Vyara Extension Centre and its paddy fields, and arrangement for study itinerary with the following Indian and Japanese experts.

Indian Experts:

Dr. B.K. Mehta (Plant Pathologist, Gujarat State, & Prof., College of Agr., Jamnagar)
Mr. N.K. Vanjaria (Ass't Plant Breeder, Agr. Res. Station, Vyara)
Mr. T.B. Patel (Administrative Officer, Vyara Ext. Centre)
Mr. F.N. Patel (Dist. Agr. Officer, Surat)
Mr. M.H. Patel (Seed Development Officer, Surat)
Mr. R.N. Patel (Plant Protection Officer, Surat)

Japanese experts:

Director Kiyoshi Morita
Mr. Morio Chiba

(34) Inspection of diseases and insect pests and their control guidance at the demonstration plot in Mhauwa, Navsari Talka, with the following Indian and Japanese experts.

Mr. B.T. Vashi (Plant Protection Officer, Navsari)
Mr. C.V. Patel (Agr. Ext. Coordination Officer, Navsari)
Dr. B.K. Mehta
Director K. Morita
Mr. M. Chiba

(35) Inspection of diseases and insect pests and their control guidance in each demonstration plot in Chikhli, Bulsar Talka, in cooperation with the following Indian and Japanese experts.

Mr. S.V. Chandorikar (Dist. Development Officer, Bulsar)
Mr. Majmudar (Dist. Agr. Officer, Bulsar)
Mr. K.M. Patel (Seed Development Officer, Bulsar)
Mr. S.V. Naik (Plant Protection Officer, Bulsar)

Dr. B.K. Mehta
Director K. Morita
Mr. M. Chiba

(36) Inspection of demonstration plot in Bardoli District. in cooperation with the experts mentioned in item (33).

(37) Preparation of the interim report with Secretary Kosaka and Mr. Inagaki for submission to the Central Government of India.

(38) Submission of the interim report with Secretary Kosaka and Mr. Inagaki at the Department of Agriculture, and discussion with the following officals of the Central Government.

Dr. S.N. Banerjee (Plant Protection Advisor, Dept. of Agr.)
Dr. N.C. Joshi
Dr. B. Ganguly
Dr. D.N. Srivastava
Dr. Y.P. Rao
Dr. R.A. Mishra
Mr. S.I.H. Naqvi

(39) Luncheon at Ashoka Hotel under joint auspices with the Japanese Embassy, with the presence of Indian and Japanese guests mentioned in item (38).

Speech delivered by Minister Kambara of the Japanese Embassy.

(40) Lecture delivered and opinions expressed to the staffs of Indian Agricultural Research Institute including the following experts on *Xanthomonas oryzae* and virus diseases with special reference to leaf yellowing.

Dr. D.N. Srivastava.
Dr. Y.P. Rao
Dr. F.A. Mishra
Dr. H.E. Kauffman

(41) Report to Ambassador Uyama on the outcome of study tour, with the team's opinions conveyed to him for the control of rice diseases and insect pests in future.

(42) Exchange of opinions with the following experts on insect pests.

Dr. S. Pradhan (Entomologist in charge of Entomological Div., I.A.R.I.)

Dr. S.K. Bhatia
Dr. J.C. Pant

VI. GENERAL DESCRIPTION OF OCCURRENCE OF RICE DISEASES AND INSECT PESTS

Occurrence of rice diseases and insect pests at and around the four Indo-Japanese Agricultural Extension Centres is as shown in Table 1 below. The table only represents the severity of diseases and insect pests observed by the team at specific places and times of inspection. It therefore does not show the occurrence throughout the current Kharif season, nor does it indicate the degree of all incidences in the entire area covered by the study tour.

The growth of paddy observed by the team was generally in the phase of young ear formation to just after heading, through it varied to some extent by places and varieties.

Table 1. Relative Severity and Abundance of Major Rice Diseases, Insect Pests and Physiological Diseases.

Name of Diseases and Insect Pests	Bihar 24-29/Aug. 1	Mysore 5-9/Sept. 2	Maharashtra 10-14/Sept. 3	Gujarat 15-18/Sept. 4
Parasitic Diseases				
Bacterial Diseases	Kresek phase			
Bacterial Leaf Blight *(X. oryzae)*	++ (Vikramganj, Shahabad)	+	++++ (Jambrivri, Karjat)	+ (Bardoli, Surat)
Bacterial Leaf Streak *(X. translucens var oryzae)*	+			
Fungal Diseases				
Blast *(Pyricularia oryzae)*	+	+++ (Coorg)		
False Blast *(Alternaria oryzae, Epicoccum neglectum, Cladosporium herbarum etc.)*		+		+
Rhynchosporium Blight (Leaf Scald) *(Fusarium nivale)*		+++ (Mangalore & Coorg)	+	+
Helminthosporium Leaf Spot *(Cochliobolus miyabeanus)*	+	+	+	+
Cercospora Leaf Spot *(Sphaerulina oryzina)*		±	±	+
Leaf Smut *(Entyloma oryzae)*			+	
Sooty Mold *(Neocapnodium tanakae. etc.)*			+	
Sheath Blight *(Pellicularia sasakii)*	+	+	+	+
Sheath Rot *(Acrocylindrium oryzae)*		Summer paddy ++ (Mandya)	+	+
Sheath Net Blotch *(Cylindrocladium scoparium)*			±	
Stem Rot *(Helminthosporium sigmoideum)*		+	+	+
Brown Sclerotium Disease *(Sclerotium oryzae-sativae)*	±	±	±	+
False Smut *(Ustilaginoidea virens)*		+	+	+
Panicle Browning* (including Glume Blight)	+	++	++	++

Name of Diseases and Insect Pests	Bihar 24-29/Aug. 1	Mysore 5-9/Sept. 2	Maharashtra 10-14/Sept. 3	Gujarat 15-18/Sept. 4
Parasitic Diseases				
Virus Disease				
Leaf Yellowing			+?	
Mycoplasma Disease				
Yellow Dwarf		+ (Ratoon)		
Nematode				
White Tip *(Aphelenchoides besseyi)*		+		+
Insect Pests				
Gall Fly *(Pachydiplosis oryzae)*	+	+		
Stem Borers				
(Tryporyza incertulas)	+	+	+	+
(Chilo partellus)			+	
Small Caseworm *(Nymphula vitaris)*				+
Paddy Skipper *(Parnara guttata)*				+
Leaf Roller *(Cnaphalocrosis medinalis)*		+	+	+
Leaf Hoppers				
(Nephotettix apicalis)	+	+	+	+
(N. impicticeps)	+	+	+	+
(Inazuma dorsalis)	±	±	+	
(Tetigella spectra)	+	+	+	
Plant Hoppers				
(Sogatella furcifera)			+++	+
(Nilaparvata lugens)			+	
Thrips *(Chloethrips oryzae)*	+	+		
Blue Leaf Beetle *(Leptispa pygmoea)*				++

Name of Diseases and Insect Pests	Bihar 24-29/Aug. 1	Mysore 5-9/Sept. 2	Maharashtra 10-14/Sept. 3	Gujarat 15-18/Sept. 4
Physiological Diseases				
Nitrogen-Deficiency	+++	++	++	++
Phosphorus-Deficiency	++ (Purnea)		+	
Iron-Deficiency	++	++	++	++
Zinc-Deficiency	++ (Patna & Vikramganj)	+++ (Mandya)		+ (Upland rice)
Magnesium-Deficiency			++ (Jambrivri)	
Salt-Injury (Na^+ toxicity)		+++ (Mandya)		
H_2S-Toxicity		+ (Mandya)		

Remarks: ± ; Slight, + ; Scarce, ++ ; Moderate, +++ ; Severe, ++++ ; Very Severe

* ; More than 20 species are recorded as causal organisms.

(Outline of Occurence)

As is clear in Table 1 above, occurrence of rice diseases and insect pests in the current Kharif season was generally very slight and the growth of rice was observed quite satisfactory in all the four Extension Centres and their neighbouring areas.

However, the team noted the occurrence of *Xanthomonas oryzae*, *Sogatella furcifera* and magnesium deficiency in Jambrivri Village, Kolaba District, Maharashtra State, *Pyricularia oryzae* and *Fusarium nivale* in Coorg and Mangalore Districts of Mysore State, phosphorus deficiency in Purnea District of Bihar State, and phosphorus deficiency and salt injury in Mandya District of Mysore State. These diseases were noted to be inflicting heavy damages in some localities. In all areas it visited, the team frequently noticed that "Panicle browing" was discovered to have caused considerable damages at many places, and especially the newly introduced variety, "Padma", was subjected to its severe occurrence. In addition, it came into the team's notice on many occasions that paddy suffered from nitrogen deficiency.

Above is the briefing of rice diseases and insect pests observed by the team at different places inspected during its study tour.

With respect to leaf yellowing to which the team was requested to direct its particular attention by the Central Government of India, only one paddy field was found in Meharashtra State which presented a dubious symptom. However, since the test conducted on specimens collected from the said field did not suggest the development of a virus disease, no leaf yellowing was detected during the present study tour.

Leaf yellowing is treated as a disease identical to Tungro (a kind of virus disease) in some reports. In actuality, however, leaf yellowing in India appears to refer to damages invited by other causes than Tungro such as the deficiency of zinc, phosphorus, magnesium or hopper burning by *Nephotettix impicticeps*, *N. apicalis* and *Sogatella furcifera*. Sometimes, it even seems to represent the damage by nitrogen deficiency, damages by *Xanthomonas oryzae* and *Fusarium Nivale*.

The team is therefore of the opinion that what must be done above all is to classify the symptoms of leaf yellowing and clarify their causes.

VII. TECHNICAL ADVICE FOR CONTROL OF MAJOR PARASITIC AND PHYSIOLOGICAL DISEASES AND INSECT PESTS IN INDIA

1. Parasitic Diseases

In the past years, incidence of *Cochlioboulus miyabenus*, *Sphaerulina oryzina* and *Pyricularia oryzae* was severe on local varieties, and importance was attached to these diseases as they were regarded quite injurous. However, with the implementation of the Intensified Agricultural Development Project (IADP, 1960 – 1968) which was accompanied by the introduction of improved high-yielding varieties and higher doses of fertilizer application, notable changes have taken place in the pattern of occurrence of diseases. To be more precise, *Cochliobolus miyabeanus* and *Sphaerulina oryzina* which used to occur rather on poorly manured paddy gave place to *Xanthomonas oryzae*, *Pyricularia oryzae*, virus diseases, *Pellicularia sasakii*, and Panicle Browning which are liable to occur on well fertilized and satisfactorily grown paddy. In particular, *Xanthomonas oryzae* started to afflict many districts in India with its severe occurrence since around 1963. Damages by this disease seem to have been augmented by the later introduction of Taichung native 1, a high-yielding variety having high susceptibility, short statured, leafly and high fertilizer tolerability and by the activities for encouraging the cultivation of IR-8 which was introduced in 1965 under All India Coordinated Rice Improvement Project (AICRIP). In recent years, promotive measures are taken for cultivation of "Padma" which was improved by Central Rice Research Institute at Cuttack. This new variety, however, is susceptible to *Xanthomonas oryzae* and *Fusarisum nivale* and shows an extremely poor resistance against "Panicle Browning" including *Phoma glumarum*. Further, its resistance against Tungro which recorded a heavy occurrence last year is even smaller than another new variety, Jaya. Since varieties cultivated in India are thus susceptible to diseases, any attempt to expand the acreage of paddy fields must be preceded by suitable plant protection measures.

In the following paragraphs, measures for controlling those specific diseases which were identified and considered detrimental to the future rice production are given.

(1) *Xanthomonas oryzae*

It is rarely the case that the technical reports issued by the Extension Centres do not deal with the problem of *Xanthomonas oryzae*. Damages caused by this disease, whether severe or slight, never fail to be reported each year. During the current Kharif season, the team observed a paddy field severely afflicted with the occurence of this disease near Karjat in Kobala District of Maharashtra State. In the nearby Khopoli Extension Centre and its vicinities, however, the occurrence was extremely slight. Insofar as the team inspected, the occurrence was similarly slight at Extension Centres at Shahabad and Vyara and neighbouring areas, though these areas are known to be subjected to heavy occurrence each year. In an attempt to clear up the cause of the slight occurrence, the team studied the

meteorological report submitted by the Bihar State Government, but found that the information it contained was just too deficient. The team therefore employed the weather maps of Khopoli Extension Centre for comparison of meteorological data recorded this year with those of normal years. An inference drawn from the comparative study led to the conclusion that the slight occurrence mentioned above was caused most likely by the low temperature and deficient sunshine in August when the disease starts to occur and by the small rainfall observed around the end of June (latter nursery stage which is the effective infection period), and in the latter half of July (tillering stage) when the propagation of causal organisms on paddy is believed to take place. (The team hopes that further studies will be made by the competent organizations in India as to the justifiability of the said conclusion. It is also hoped that the meteorological data of Shahabad and Vyara Extension Stations, which must naturally be divergent from those of Khopoli, will be analyzed in India for reference in future since the team is not in possession of the necessary data).

It deserves attention that the occurrence of *Xanthomonas oryzae* is noticeable on certain kinds of planted varieties. In India, high susceptibility to this disease is noted with the most important recommended varieties as evidenced by the past occurrence on BR-34, followed by Taichung native 1, IR-8 and then Padma. IR-20 and IR-22 to be introduced under AICRIP and Bala, Vijaya, Ratna and other new varieties recommended by CRRI for their excellent quality, grain shape and taste are unexceptionally susceptible to this disease. Occurrence of this disease will therefore sustain its severity for sometime to come.

The newly developed TF-130 (Celdion-S, product of Takeda Pharmaceutical Co.), which appears to have a remarkable effectiveness against this disease, is being tested not only in Japan but also by all the Extension Centres, IARI, CRRI and AICRIP to clarify its field applicability. During the study trip, however, the team noticed that none of the Centres succeeded in conducting the test with satisfactory results due to the aforementioned slight occurrence. It is hoped that the test will be conducted again in the next season.

It is to be added that the development of a new chemical such as TF-130 or the evidence of its superlative effectiveness does not promise its extensive application. The prevailing situation of farming villages in India is suggestive of the impracticability of spraying in the paddy field season. The team felt that unless subsidies are granted by the State Government, spraying of TF-130, no matter how it is effective, would be limited to the protection of rice seeds or nursery beds (for prevention of Kresek phase).

Considering from all angles, measures for control of *Xanthomonas oryzae* in India should be based primarily on the breeding of resistant virieties. In this connection, it is highly recommendable that due regard be given to the breeding of resistant varieties in the operation and management of extension and demonstration farms and in the characteristic test of different varieties at Extension Centres at Shahabad, Khopoli and Vyara where this disease is liable to develop frequently. It is very discouraging that with the exception of

Jaya which is reported to have some resistance against the disease by Khopoli Extension Centre, there are very few recommendable resistant varieties. Breeding of resistant varieties, though carried out laboriously by CRRI, AICRIP and IRRI of the Philippines, has not yet yielded fruitful results. This is ascribable to the fact that the isolates of causal organisms of *Xanthomonas oryzae* in India are more virulent than any other same isolates in the world and in consequence renders it difficult to search for proper resistant genes. It is to be hoped, however, that the efforts exerted at present will result in the creation of many highly resistant varieties in the near future.

Measures to be taken under present conditions would be, as have already been recommended over the past years, to disinfect rice seeds with mercuric compound and to apply 1/500 streptocycline solution or 1/1000 TF-130 (Celdion-S) solution three to four times at an interval of 10 days after seeding on the nursery arranged at a place easy for drainage. The surface of the nursery bed must be exposed to assure the maximum effect of the spraying operation. It is believed that due to the severe physical conditions in India, protective operation in the paddy field is not only impracticable but would give little effect for the heavy labour required. Under the circumstances, there is no choice but to concentrate on the prevention of Kresek phase arising from the transmission in the nursery at first, and save the top dressing and keep the irrigation water preferably until the muturing period.

Problems and measures not pointed out in the above description are given below in the form of questions and answers.

(Q-1) What is the transmission route of causal organism in the single crop area? How and from where is the causal organism of *Xanthomonas oryzae* transmitted to the paddy cultivated in the wet season which visits the single crop area after the dry season during which wild paddy withers away and the soil dries as hard as concrete? .(Khopoli)

(A-1) Survival of causal organism of *Xanthomonas oryzae* assumes the form of static existence or xeromorphism. Organism in xeromorphism is known to survive for a long period and is highly resistant against aridity. In the rhizosphere of wild paddy and *Leersia oryzoides*, the organism survives in the propagative or static existence. Recent studies have revealed that the static existence in the root of grasses other than host plants lasts for a considerably long period. Consideration of these facts leads to the conclusion that the causal organism on a dried paddy leaf survives in xeromorphism until the following wet season when wild paddy and weeds germinate and extend their roots, then it comes into the rhizosphere of such wild paddy or grasses to enter into symbiosis with them, and later affects the paddy after it is sown.

(Q-2) How effective is the hot water disinfection of rice seeds? (Khopoli)

(A-2) The causal organism of *Xanthomonas oryzae* dies when it is subjected to hot water with a temperature of 52°C for 10 minutes. Since the transmission of the disease is largely attributable to the paddy infected in the preceding season, infection of rice seeds does not actually constitute the major route of transmission. Disinfection of seeds may be considered, however, as having a partial effect in reducing the severity of infection. It may be added that hot water disinfection serves to kill the organisms attached to the seeds or intruding in their inner or and outer glume, whereas the application of organic mercuric compound is more effective since it is blieved to display the additional function of rejecting organisms for a number of days after seeding because of its absorption.

(Q-3) We have never know Kresek phase before. How does it develop? And what are the measures for preventing it? (Shahabad)

(A-3) Kresek phase occurs on young paddy two to three weeks after transplanting. The uppermost developing leaves of infected paddy are rolled suddenly with dehydrating symptom, followed by the wilting of tillers. The symptom shows a strong resemblance to the inferior growth due to dead heart stem caused by stem borer or rotten root, and also develops at about the same time. It often happens, therefore, that one disease is taken for the other. On the edge of rolled leaf, oozing out of mucilagineous bacteria can be sometimes observed, and this serves as the key to diagonosing. This disease occurs when the causal organisms which infected the paddy in the nursery propagate after transplanting and foul the vessels of young tillers. It can be artificially developed in about three weeks after transplanting if the tip of seedling is cut and inoculated by spraying or the seedling is inoculated by submersion (submersion of seedling in the bacterial suspension for 24 to 48 hours). For control of this disease, there are no other measures than to raise the seeling in upland nursery or to spray the bacteriocide a number of times during the nursery period.

(Q-4) Is there any simple way of preparing the bacteria-containing solution for inoculation? (Khopoli)

(A-4) Bacterial suspension sufficient for spray inoculation of pin pinch inoculation can be obtained by manual rubbing and squeezing in water of newly infected leaves collected from the diseased field and cut into a size of about 5 mm or of portions of such leaves presenting the legion of the disease which are similarly cut into a size of 5 mm. It is recommendable to filter the solution through two sheets of gauze if it is to be used for spraying inoculation.

(Q-5) Our test on Taichung native 1 and IR-8 which had been susceptible to *Xanthomonas oryzae* over the past years produced the results suggesting that these two varieties are "slightly resistant this year." How can this be explained? (Khopoli)

(A-5) Since the infection ratio of plant, leaf and stem shows a same trend, it is not plausible that the difference in maturing period contributed to the resistance. With TK-25 and EK-70 presenting the same susceptibility in the current Kharif season as in the past, the "unusual resistance" indicated by the two varieties calls for further studies and discussions. If the inversion of resistance had taken place, it would mean that the isolates of causal organisms having a different pathogenicity (not virulence) contributed to the infection of the two varieties. Such an incidence, however, has never been reported by past studies and researches. The slight occurrence observed in the current season can be assumed to have been caused by the difference in resistance by leaf order of each tiller and the low temperature in August, but the clarification of its cause must await the study of future transition of resistance (It may be added that a inoculation test conducted in Thailand produced a resistance of IR-8 but proved that Taichung native 1 was very susceptible).

(Q-6) What is the proper way of carrying out the simple diagnosing by dipping method? (Surat)

(A-6) Oozing probability of causal organism is limited if a single leaf is cut and tested for diagnosing. Therefore, 10 to 15 leaves collected and bundled together are to be cut with a razor blade, with the cut surface dipped into a testing tube filled with water. This will assure oozing out of a substantial quantity of causal organism, making the diagnosis to be conducted with a fair accuracy and reliable results.

(Q-7) What could be suggested to the State Government about its intention to actually conduct the forecasting of occurrence of *Xanthomonas oryzae* by Bacterio-phage method? (Khopoli)

(A-7) The intended practice of forecasting work is not recommendable for sometime to come for a number of reasons (deficiency of facilities and equipment and lack of plant protection specialists).

(Q-8) Are there any grasses in India which are the host plants of causal organisms of *Xanthomonas oryzae*? (Shahabad)

(A-8) No definite answer can be given, but the suspected host plant is a grass belonging to Leersia Gen. Which resembles *Leersia oryzoides* and grows spontaneously in the ditches of paddy fields. During the study trip, the team observed this grass in different localities, but failed to detect diseased leaves. The team is of the

opinion that wild paddy is more problematic as the source of transmission since it was found to be infected rather frequently.

(2) *Pyricularia oryzae*

Severe occurrence of leaf blast was observed during the study trip at a part of field attached to Mondya Extension Centre of Mysore State and at a number of places in Coorg District of the same state. Rain-fed cultivation is practised in these districts because of their elevation of about 1,000 m. Paddy is cultivated with the advent of the wet season in June and harvested around the end of October when the temperature declines. Meteorological conditions in the wet season such as temperature and sunshine and the high elevation of these districts give rise to the development of *Pyricularia oryzae*. There are many coffee plantations in these districts. Fertilizers flowing out from them into terraced paddy fields on the slopes, coupled by the morning mist which is slow to clear off, create environmental conditions highly favourable for the occurrence of this disease. Spraying of protective chemicals is carried out actively by many farmers in these districts who are cultivating in a relatively large scale, but is not yielding successful results because the spraying is not always conducted at the suitable time and also because the spraying in the nursery stage is neglected. Damages by this disease seem to be aggravated by the lack of sellection of resistant varieties.

The mountainous areas of Western Ghat of the States of Maharashtra, Mysore and Kerala which face Arabian Sea and embrace many paddy fields are subjected to high humidity and temperature, and are consequently believed to have frequent outbreaks of Pyricularia oryzae. The team felt it both necessary and recommendable to conduct tests for determining suitable spraying time, studying distribution of pethogenic races, and breeding of resistant varieties for future plant protection in these areas.

(3) *Fusarium nivale* (formerly *Rhynchosporium oryzae*)

Noticeable outbreak of this disease was observed on high-yielding varieities such as Padma, Manila, Hamsa and IR-8 in Coorg, Mangalore and South Kanara Districts of Mysore State. In case of heavy occurrence of this disease its symptom appears not only on the leaf blade but on the leaf sheath, and accelerates the wilting of lower leaves to the extreme disturbance of ripening. In an extreme case, this disease is taken for *Xanthomonas oryzae* because the whole rice plant withers away into white colour. The causal organism of this disease has so far been given the name of *Rhynchosporium oryzae* Hashioka et Yokogi. However, with the recent development made in Japan in the study of pathogen, the causal organism of this disease has been judged to be identical to *Fusarium nivale* by Dr. Tominaga of the National Institute of Agricultural Sciences. While the perfect stage of *Fusarium nivale* has long been established to be *Calonectoria nivale*, Dr. Tominaga suggests the adoption of *Micronectriella* Gen. rather than *Phragmosperma* Gen. or

Calonectoria Gen. As such, the name commonly given to this disease, "Rhynchosporium Blight or Leaf Scald of Rice", which represents the symptom it develops but originated from the past assumption that it is caused by *Rhynchosporium*, may be changed in future. (The name was actually changed to *Fusarium nivale* on November 21, 1970)

In Japan, *Fusarium nivale* is one of minor diseases, and there are no data for its actual protection, etc. It is accordingly hoped that studies be conducted in India to devise suitable countermeasures.

(4) Panicle Browning or Panicle Blight

The captioned term is employed to indicate collectively the infection of panicle by *Pyricularia oryzae* and *Cochliobulus miyabeanus* as well as the parasitic or saprophytic diseases of panicle caused by *Phoma glumarum*, *Sphaerulina oryzae*, *Fusarium nivale* and other causal organisms shown in Table 2.

Panicle browing therefore includes incidences which should be distinguished as *Pyricularia oryzae*. In Japan, causal organism of this disease is reported to vary by the place of occurrence and evironmental conditions.

During the study trip, the team observed the panicle of unreaped summer crop presented the symptom of this disease on certain occasions. The team's attention was also attracted by the browning of ghume in Padma. This was noted to be the same as the incidence of discloured rice reported in Advice Report No. 1 of Mandya Extension Centre. Dr. Ohata of Shikoku Agricultural Experiment Station states in his report that he succeeded in isolating *Fusarium nivale* (called *Rhynchosprium oryzae* in the report), *Nigrospora* sp. and *Phoma glumarum* from the discoloured glume. It was suspected that the occurrence of browning incidence might have resulted from the characteristics of Padma because it was observed at quite a number of places including Coorg, South Kanara and Mangalore Districts of Mysore State, Kolaba District of Maharashtra State, Vyara, Surat and Bulsar Districts of Gujarat State, etc. However, learning that the same incidence recorded frequent oubreaks on IR-8 last year, the team was unable to reach any definite conclusion. It is to be pointed out that among the four types of browning incidence covered by the said Advice Report, the Dark Brown Type is ascribable to *Acrocylindrium oryzae*. Control of this disease must await future studies and research work since no countermeasures are as yet established.

Table 2 Causal organisms isolated from various part of rice panicle. (1969, Tominaga)

Causal organisms	Spiklet	Axis, branch, base of panicle (including uppermost internode)
Alternalis sp.	+++	++++++++++
A oryzae	++	++
Ascochyta sp.	+	+
Aspergillus sp.	++	+
Brachysporium sp.=*Curvularia* sp.	++	+
B oryzae=Curvularia lunata	++	++
Cercospora oryzae	++	+++
Cephalosporium sp.	+	
Choanephora cucurbitarum	+	
Cladosporium sp.	+	++++
C. cladosporioides	+	+
C. harbarum	+	
Curvularia sp.		++
C. lunata	+	+
Epicoccum sp.		+++
E hyalopes=Nigrospora sphaerica	++	+
E neglectum	+	
Helicoma echinesporium	+	
Helminthosporium sp.	+	+
H. oryzae	++++	++++++++++
H. sigmoideum		+++
Hendersonia sp.	+	
Hormodendrum sp.=*Cladosporium* sp.		++++
Fusarium sp.	++++	++++++++
F. graminearum	++	+
F. moniliforme	+++	
F nivale (Rhyncho. Blight Fungus)	+	+
Leptosphaeria sp.	+	
Macrosporium sp.=*Alternalia* sp.	+	
Nigrospora sp.	+	++
N. oryzae	+	+
Penicillium sp.	+	++
Pestalotia sp.		+
P. oryzae	+	
Phoma sp.	++	+
P grumarum	+	
Phylosticta sp.=*Phoma* sp.	++	
Pyrenochaeta sp.	++	
Pyricularia oryzae	++	++
Rhizopus sp.		+
Rhynchosporium oryzae=Fusarium nivale	++	++

Causal organisms	Spiklet	Axis, branch, base of panicle (including uppermost internode)
Sphaerulina sp.	+	
Trichosporium sp.	+	
Bacteria	+	+++

Remark: Number of plus are shown the frequency of isolations.

(5) *Ustilaginoidea virens*

Ustilaginoidea virens, also called the "bumper crop disease," is commonly believed to register relatively frequent occurrences in abundant years. In actuality, however, it develops if it keeps on raining from immediately before heading to immediately after it. Dr. Ono and his colleague state, in a report dealing with the studies conducted by them in 1959, that the development of one diseased grain in one panicle increases the sterility ratio of that panicle by 3.5 to 5%. This is suggestive of the need of measures against *Ustilaginoidea virens* in those areas of Maharashtra and Mysore State which face Arabian Sea and where the rainfall is abundant.

For control of this disease, spraying of copper agents before heading is effective. Spraying after heading is known to give no effect at all. What counts most for its control is to forecast the degree of its occurrence before the booting stage, but forecasting techniques applicable for actual control operation are not yet established.

(6) Other Diseases

The team observed the occurrence of other diseases than mentioned in the preceding paragraphs such as *Pellicularia sasakii*, *Helminthosporium sigmoideum*, *Cylindrocladium scoparium* and *Sclerotium oryzae-sativa*, but the damages invited by them were not very serious. It may be added that a symptom which appeared to be *Pyrenochaeta* sp. was observed during the study trip.

(7) Problems relating to Plant Protection and Forecasting Techniques

Extension Centres in India shifted the course of their activities from the demonstration of Japanese paddy cultivation techniques conducted by their predecessors, the Model Farms, to the extension of such Japanese techniques in the surrounding areas for their actual application by Indian farmers. Since 1968, each of the four Extension Centres has been pushing forward its own extension activities for the development of Indian agriculture.

It appears that the extension activities conducted by all the Extension Centres are chiefly intended for the following.

1) Mechanization of tilling, harvesting and threshing work using Japanese farm machinery and equipment;

2) Introduction of new varieties;

3) Increase of planting density; and

4) Attainment of higher and rationalized doses of fertilizer application.

With the exception of the mechanization efforts, these extension activities, if implemented without due regard to plant protection, are all conductive to heavy occurrence of diseases.

As discussed earlier, selection of new varieties now recommended in India is based on "quality and high yield," and virtually all the recommended new varieties are susceptible to major diseases such as *Xanthomonas oryzae, Pyricularia oryzae* and virus diseases. The planned increase in the number of seedlings per hill and planting density or the higher doses of fertilizer application could invite the excessive supply of nitrogen and overgrowth which would lead to the occurrence of diseases. This is the fact to be borne in mind as a remote cause of diseases which developed each year at all the Extension Centres and impeded their extension efforts.

It goes without saying that the dosage of fertilizer application and planting density now adopted cannot be reduced to a lower level. It follows, therefore, that the plant protection must find its future course of progress in the breeding and use of resistant varieties, early detection of disease incidences, and spraying of chemicals to be conducted effectively for labour saving and radical control of diseases at the suitable time indicated by the forecasting activities. Spraying of chemicals for plant protection produces undesirable side effects which pose themselves as a serious problem in Japan. It is therefore recommended that sufficient care be taken in conducting spraying operation in India with due regard given to the future prospect.

Briefing of technical problems relating to major diseases is as tabulated below.

Table 3 Technical Problems relating to Rice Diseases in India

Name of Disease	Strains of Causal Organism, etc.	Breeding of Resistant Varieties	Protection by Spraying of Chemicals	Forecasting Techniques
Xanthomonas oryzae	Further studies required.	None.	TF-130 under test.	Not established yet.
Pyricularia oryzae	Ditto	No studies made on field resistance.	A good number of effective protective chemicals available.	Ditto
Virus Diseases	Further studies required for identification of viruses	None	Chemicals effective on available vectors.	Ditto

Fig. 1 Seasonal prevalence of the appearance of rice yellow stem borer moth on Kharif paddy in Khopoli District, Maharashtra (1968-'70).

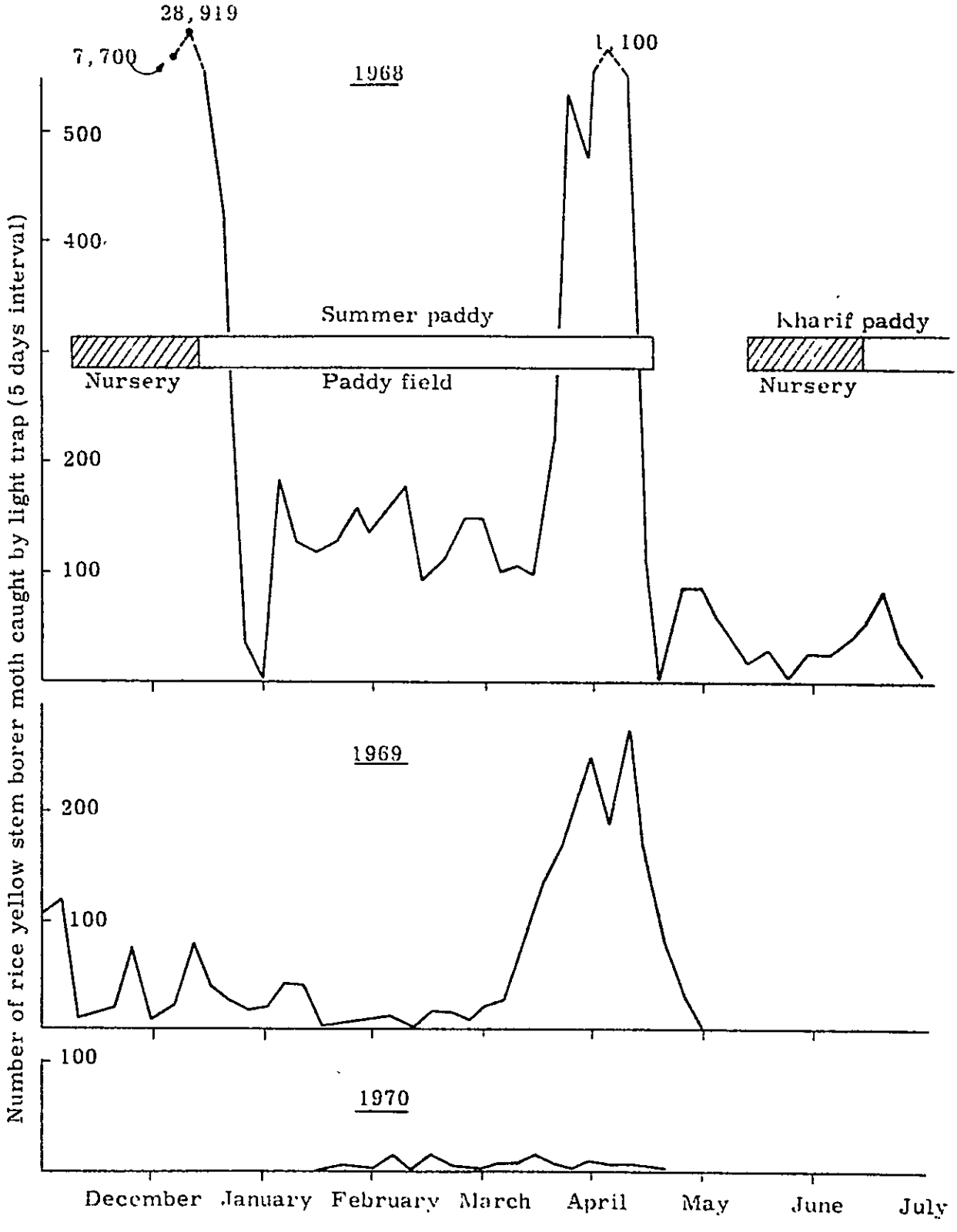
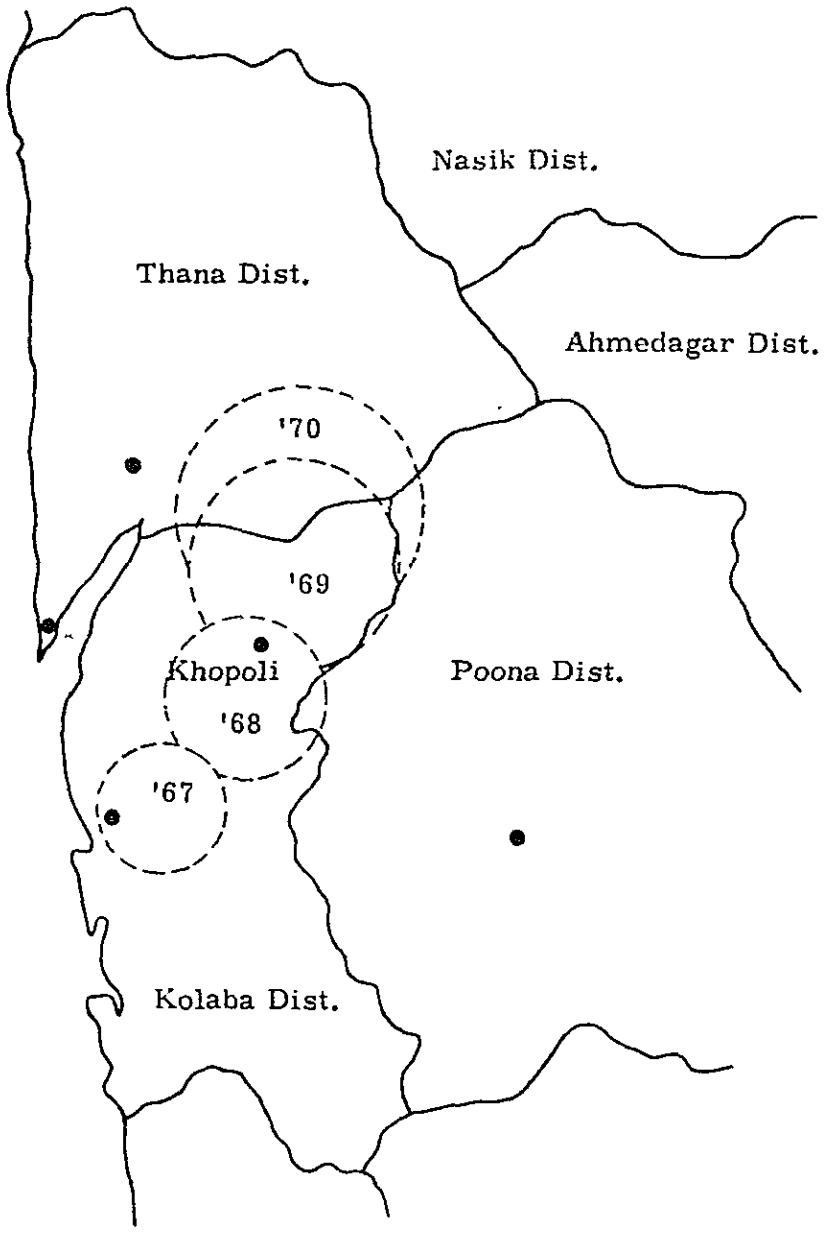


Fig. 2 Yearly migration of occurred area damaged by rice yellow stem borer on kharif paddy in Kolaba Dist., Maharashtra (presumed map).



------ : Area of severely occured

As shown in Table 3 above, there are many problems of plant protection which are unsolved or untouched in India. Each of the Extension Centres will be required to conduct, concurrently with their extension activities, various tests in their paddy fields on those specific problems whose solution is urgently needed in their respective areas. Outcome of such tests will certainly serve for the improvement of their extension activities and betterment of the general situation.

However, since the experts now stationed at respective Extension Centres can neither spare time for nor are experienced in plant protection, arrangements must be made immediately for the service of plant protection specialists at the Centres who would engage in plant protection in coorperation with other experts.

2. Insect Pests

(1) *Tryporyza incertulas*

Tryporyza incertulas occurs often on paddy in India, and its occurrence has been reported frequently in the past by many Indian research institutues. Insofar the Indo-Japanese Agricultural Extension Centres are concerned, occurrence of this pest has been suffered, since the days of Model Farms, by Bapatla Farm in Andhra Pradesh State and Khopli Farm, Maharashtra State. At Bapatla Farm, seasonal prevalence of occurrence of this pest was studied for a period of three years since 1966 using light trap, with a partial study also conducted on its ecology with respect to Kharif paddy and Rabi paddy, setting the first step towards its control. However, studies made by Bapatla Farm, given in detail in the Report on Seventh Study Tour for Forecasting and Control Guidance, were unfortunately brought to an end without succeeding in establishing effective control measures. Khopoli Farm, on the other hand, embarked upon the control of this pest which developed in 1968 in Kolaba District and Thana District of Maharashtra State in cooperation with the State Government at Poona and Karjat Agricultural Research Station. In the same year, Khopoli Farm initiated the study of seasonal prevalence of occurrence with the installation of light trap. These activities of Khopoli Farm have been carried on to date by the present Khopoli Extension Centre. It merits attention that the continuous observation using light trap conducted by Khopoli Extension Centre in its vicinities during the period of successive occurrence of this pest provided the basic data for forecasting its occurrence and attracted the attention of the State Government.

As is clear in Fig. 1, occurrence of this pest rose to its peak in 1968 and showed a sudden decline in 1970. Fig. 2 illustrates this seasonal prevalence in Khopoli District and surrounding areas. As shown in Fig. 2, the severe occurrence observed in Khopoli District in 1968 did not develop abruptly and spontaneously, but the signs for its development was observed in other areas in 1967 or 1966. This finding placed the State Government under the pressing need for forecasting such heavy occurrence and area of occurrence, and also induced the Extension Centre to study the problem of forecasting. Problems relating to the forecasting of occurrence are already described in detail in the Report on Seventh Study Tour for Forecasting and Control Guidance.

Yearly migration of occurrence area in Maharashtra State, which is not very reliable since the major source of information were local inhabitants, is as given below.

During the August-September period of 1967, *Tryporyza incertulas* recorded a heavy occurrence covering 3,000 acres in Kolaba and Mahngaon Districts, with the percentage of damaged stem reaching as high as 70 to 80%. Total acreage subjected to the occurrence of this pest was as wide as 130 thousand acres in 1967 and the rice crop in this extensive area was reduced to half the normal harvest.

In January 1968, heavy occurrence of moth was observed in Khopoli and Karjat and surrounding areas, with the maximum number of moths killed by light traps on one night recording as many as 12,842. As a result, egg mass laid in nursery beds numbered as many as 100 per 1 m^2. In Mahngaon District which suffered a heavy occurrence in the preceding year, however, only slight occurrence was observed on the summer paddy and monsoon paddy, indicating that the centre of severest occurrence had shifted in a year's period.

The occurrence on the monsoon paddy in 1969 was not very heavy judging from the number of moths killed at the Centre. However, the study of paddy crops in villages where the Centre provided guidances for extension of improved paddy cultivation techniques discloses noticeable damages caused by this pest. (See the table below)

Kharif Paddy of 1969 (June – October)

Name of Village and Degree of Occurrence		Improved Cultivation Method	Conventional Cultivation Method
Shedouli-Chinchouli Village (Slight)	Yield in paldy:	2,420 k.	972 k.
	Gross income:	942 Rs.	419 Rs.
Jumbrivri Village (Heavy)	Yield in paddy:	1,152 k.	432 k.
	Gross income:	60 Rs.	37 Rs.

Note: Yield and gross income represent values per acre.

As is clear in the above table, the yield and gross income in Jumbrivri Village which suffered a heavy occurrence of this pest were about half and one-tenth respectively of those of Shedouli-Chinchouli Village where the damage was negligible. Thus, heavy occurrence was observed in limited small areas in 1969, but as a whole, the occurrence was rather slight.

In 1970, the occurrence area expanded from Kolaba District to Thana District. The occurrence in 1970 was characterized by its expansion over the entire paddy field area of the State and the absence of concentrated occurrence in specific areas.

In a wide country like India where a single district of a state is as extensive as a prefecture in Japan, it entails many difficulties to have accurate knowledges on the seasonal prevalence of this pest or yearly migration of its occurrence area even in the single Maharashtra State. However, tracing of occurrence in Kolaba and Thana Districts over the past three years clearly indicates the migration of areas of heavy occurrence. This yearly migration is a phenomenon noticed with *Chilo suppressalis* in Japan.

The team understands that the Maharashtra State Government has the intention to augment its activities for forecasting the extent of occurrence and occurrence area by carrying out the study by light trap at more selected places. It is to be noted, however, that the forecasting of this pest calls for many other activities besides the study by light trap. Of numerous studies to be made for forecasting, the following two studies are urged to be undertaken by Khopoli Extension Centre since they allow for immediate implementation.

(i) Study on the appearance of *Tryporyza incertulas* in the paddy fields of Khopoli District (Kharif Paddy and Summer Paddy).

(ii) Extensive study tour covering the paddy field area of Maharashtra State.

If Study (i) mentioned above leads to the clarification of the seasonal prevalence of this pest in paddy fields and to the establishment of a guide post in conducting studies for forecasting, and if the Extensive Study Tour (ii) is carried out on the basis of such seasonal prevalence and guide post, studies for forecasting can almost fulfill the intended purpose.

However, the extensive study tour covering all the paddy field area is not practicable unless supported by the organization back-up and maneuverability of the State Government. If such study tour is to be set aside for the moment as a project to be undertaken at a future date, Khopoli Extension Centre would then be required to direct its efforts to the study on the seasonal prevalence in Khopoli and Kolaba Districts. This study should not be intended merely for forecasting, but should include other studies such as the survey of the population of larvae of *Tryporyza incertulas* in the paddy field.

Points to be observed in actually conducting the abovementioned studies are explained below in the form of questions and answers. Questions given below were raised by the experts of the State Government before and after the meeting held at the Khopoli Centre between the State officials and the team. The team felt that these questions had a close bearing upon the control of this pest in the State since they were all raised by the experts actually engaged in control activities. The team is of the opinion that problems entailed in these questions will have to be studied by the Khopoli Extension Centre in future.

Q: Of a total of 300 thousand acress of paddy field cultivated in Kolaba District, 290 thousand acres are for Monsoon Paddy and the remaining 10 thousand acres alone are the double crop area of Summer Paddy and Monsoon Paddy. What is the source of massive yellow stem borers that attack the nursey bed of Summer Paddy despite of such distribution of paddy fields?

A: *Tryporyza incertulas* recorded a heavy occurrence in Kolaba District after the unexpected rainfall observed in mid-December of 1968. The source of yellow stem borer moth must therefore be the paddy field were Monsoon Paddy has been harvested. However, there are no data at all which could indicate where and how this pest survices the dry season in tropical zone. At the Model Farm at Bapatla of Andhra Pradesh State, which was almost under the same conditions as the paddy fields in Kolaba District, Studies were made with particular efforts exerted to discover these unknown factors, but not a single pest was discovered in 1,000 rice stubbles collected from the paddy field before transplanting of Kharif Paddy. But this study was conducted in summer when the temperature is extremely high and the air is dry. Flying of moth to the Summer Paddy referred to in the question takes places during the November – December period when the climate is quite agreeable. It is possible, as reported in Indian literatures, that larvae or pupae stay alive in the rice stubble during this agreeable season. At any rate, since the ecology of this pest during the November – December period or during the period from November to May of the following year (in case of single crop area) is not fully clarified, studies for forecasting must be aimed at discovering this unknown ecological conditions before anything else.

Q: For how many generations does a moth stay in a paddy field since it first arrives? Which generation incurs the heaviest damage? and what is the degree of such damage?

A: It is already confirmed that a moth stays for four to five generations in the paddy field in India, but the ecology of each generation is not clarified yet. Severest damage is incurred by the generation which intrudes into the neck of spike and causes white head. The yield decrease ratio (Y) can be obtained by the following equation.

Y = % of white head (w) x 1.5
where, w = number of white heads (x) x 0.025

Results of the above calculation do not necessarily conform to the actual situation in respective Extension Centres. Detailed eclogical study of each generation in the paddy field and on-the-spot examination of damages incurred are the first step to be taken in giving a definite answer to the question.

Q: In areas covered by the recent study, damages caused by larvae of *Chilo partellus* and not *Tryporyza incertulas* proved to be the heaviest. Why is it, then, that *Tryporyza incertulas* alone is killed by trap lights?

A: Local inhabitants claim that *Chilo partellus* is not allured by the light trap in any season of the year. But experts specialized in Pyralid moths (*pyralidae* Gen.) are dubious about the credibility of such claim. Since it appears to be an undeniable fact that both *Tryporyza incertulas* and *Chilo partellus* occur in a same paddy field, ecology of each must be made clear for the sake of forecasting. It is known that three to four different kinds of stem borers can be found in the paddy fields in India, and that their existence is found in varying ratios by States. However, details of their seasonal prevalence are still indistinct.

Q: How wide is the area that can be covered by a single light trap employed for forecasting the occurrence? With how many killed borers should the control be initiated? And what is the method to be adopted for control?

A: Area coverable by a single light trap is not so wide, and ranges from 25 to 50 ha. Number of moth that can be allured and killed by it also varies by the place of its installation. Accordingly, light trap are used for forecasting the general trend of occurrence. In employing light trap, utmost attention must be given to the interrelationship between the pouplation of each generation and the number of moth killed in each field since the comparative study of these two factors is the first step to be taken towards establishing India's own techniques of light trap utilization. It is hoped that results of such comparative study be obtained at an early date to provide a definite answer as to when the control activities are to be commenced and what control method is be adopted.

Q: Do average Japanese farmers perform preventive spraying of chemicals each year or do they spray on the basis of occurrence forecast information?

A: Japanese farmers spray chemicals on the basis of long-term and short-term forecasting. Control of insect pests in Japan is recently characterized by the spraying of chemicals which is conducted in an extensive area using helicopters before planting according to the long-term prediction of occurrence. The extensive spraying activities prove effective for control of virus diseases. However, forecasting

of occurrence over a long term involves many unsolved technicals problems, and efforts are made each year for their early solution.

Measures for Control of *Tryporyza incertulas*

Besides problems entailed in the forecasting of occurrence, there are many problems involved in the actual control of yellow stem borers.

The following measures are currently recommended for control of this pest.

(i) Removal of stubbles and affected straw
(ii) Removal of egg mass
(iii) Removal of dead heart stem
(iv) Spraying of chemicals

Removal of stubbles and affected straw must be practised without fail in areas afflicted with severe occurrence. Adoption of other control measures, however, must be determined after examing the actual conditions in the area of occurrence. Egg mass can be removed rather easily in the nursey bed, and can also be removed by cutting the leaf tips. Removal of dead heart stem is also effective in the initial stage when the damage is limited to deal heart. If the occurrence of moth coincides with the early paddy field stage, effective control measure is the removal of egg mass to be conducted combinedly with the spraying of 0.03% Folidol, 0.02% Endrinemalsion, 0.03% Dimecron and 0.2% Dipterex in two to three weeks after transplanting. Besides these chemicals, powdered BHC and Smithion emulsion are also effective.

The chemicals mentioned above can be classified into two groups, the one intended for killing moths flying to paddy fields and reducing their oviposition, and the other which is for preventing the intrusion of hatched larvae. They are to be applied during different spraying periods, and their effect also varies by the generation of moth and the growth phase of paddy. Powdered BHC is effective for killing moths, if applied during the peak occurrence period and the subsequent one week period, but is not suited for application after the boot stage when the paddy is affected by its spray injury. Smithion, on the other hand, serves to prevent the intrusion of larvae and displays the same effectiveness as Endrin emulsion.

Plant protection resorting to powdered and emulsion agents is subject to the problem of washing away of chemicals by rainfall. As to how long the sprayed chemicals should be free from rainfall to display their effect, no detailed studies have been made in the past. It is believed, however, that their effect will not decline largely by the rainfall in two hours after spraying.

Pest control by chemicals involves many problems including the supply of spraying apparatus.

Literatures distributed in various areas of India for control of insect damages indicate the names of chemicals to be employed and the amount to be sprayed per acre. One of the future tasks of Extension Centres will be to provide guidances for appropriate control measures, with efforts directed to establishing the method and time of effective application on the basis of aforementioned studies for forecasting.

(2) *Cnaphalocrosia medicnalis* and *Spodopter mauritia*

Occurrence of *Cnaphalocrosia medinalis* as leaf roller was observed in various areas covered by the study trip. Damages incurred by it were noted to have reached the extent that called for control measures, and in certain areas, early implementation of control measures was considered necessary because of the probable aggravation of damages by the passing of another generation of this pest in the current season. This pest passes four generations in the paddy field, and eats the mesophyll inside of rolled leaf, withering the leaves into white colour. Since it binds leaves in a rough way, faeces are not found accumulated on the leaf bottom. Eggs are laid sporadically on the leaf. It is known that its occurrence tends to be heavy in years with much rainfall.

Control measure currently recommended is the spraying of powdered BHC during the peak occurrence of moths. Since BHC application after the heading stage is liable to lead to the injury of paddy, eradication of moths should preferably be conducted prior to the boot stage according to the occurrence forecast.

Spodoptera mauritia inflicts heavy damages on Aman Paddy as cutting caterpillar. Though its occurrence was not detected during the study tour, it is believed to incur damages each year at some place or other. Young larvae of this pest eat the leaves into white speckle while older ones incur heavy damages by eating the entire leaf and cutting off the spike after the heading stage. Older larvae shift to the spike after the heading stage, intrude into the glume to eat the stamen, and eventually affects the entire spike. Though this pest is known to be active at night, it is known that it damages the grown paddy or in the daytime on cloudy days.

Cause of its heavy occurrence is not known yet. As in the case of *Cnaphalocrosis medinalis*, its ecology during the dry season is still indistinct and this is impeding the forecasting of its severe occurrence. In the future, studies must be made to clarify how this pest survives the dry season and propagates on Aman Paddy.

Since chemicals have a limited effect on older larvae, eradication of larvae must be conducted while they are young. For this purpose, it is essential to study the ecology of this pest on Aman Paddy and eradicate the larvae in their young stage prior to the development of damages.

(3) Leaf Hopper and Virus and Mycoplasma Diseases

It is known that there are four kinds of leaf hoppers in India, i.e., *Naphotettix impicticeps*, *N. apicalis*, *N. parvus* and *N. malavanus* Of these four kinds of leaf hoppers, *N. impicticeps* and *N. apicalis* occurr in the paddy field and transmit yellow dwarf. Tungro virus is transmitted only by one of them, *N. impicticeps*.

(a) Tungro and Leaf Hopper

It is believed almost certain that a substantial portion of the leaf yellowing which recorded a servere occurrence in the paddy field area of the four northeastern stages (Utter Pradesh, Bihar, West Bengal and Orissa) in 1969 was caused by the virus disease transmitted by leaf hopper. Though there are divergent views on this question in India, none of them is substantiated by defenite facts. Insofar as the team learned during the study trip, the only corroborative report dealing with this question was that of Dr. V.T. John (AICRIP) who conducted transmission tests uing specimens collected from the damaged areas in substantiating his view that the leaf yellowing had been caused by Tungro virus transmitted by *N. impicticeps*.

However, paddy specimens which were claimed to have been damaged by leaf yellowing and presented to the team for examination during the study trip in Bihar, Mysore, Maharashtra and Gujarat States all showed no symptom for which Tungro virus transmitted by *N. impicticeps* could be considered responsible. Greater part of specimens shown to the team presented symptoms which could be judged physiological diseases.

In the following description, stress will be placed on the disease developed in Purnea District of Bihar State and in Kolaba District of Maharashtra State which the Indian experts suspected to be attributable to Tungro virus.

Leaf Yellowing in Purnea District of Bihar State: Leaf yellowing in the paddy field in Jabey Bhawanipur of Purnea District was observed on thin paddies about two weeks after transplanting. The entire rice plant was found to have turned into yellow colour, indicating a symptom of nitrogen deficiency or phosphorus deficiency at a glance. Since the symptom could not be attributed to the mere deficiency of fertilizer application, population of *N. impicticeps* in the said paddy field was studied. The study showed a very low density, with two larvae in the second instar and five larvae in the third instar found in all the 16 rice plants examined. This low density coincides with the results of studies conducted in Bihar State by the Indian team around the same time which revealed the existence of less than one leaf hopper per plant. In Purnea East Block, however, occurrence of leaf hopper was substantially high within a limited number of plots, with *N. apicalis* noted to have an extremely high population.

Leaf Yellowing in Kolaba District of Maharashtra State: In Jambrivri Village of Kolaba District, severe occurrence of *Sogatella furcifera* and consequent damages were observed together with considerably heavy occurrence of leaf hoppers in the paddy fields of IR-8. Leaf hoppers observed in the said paddy fields were predominantly *N. aplicalis* with *N.impicticeps* constituting about 10%. Since some of the rice plants observed were suspected to be infected with Tungro virus, the team recommended Karjat Rice Research Station to conduct a transmission test. In the recommended transmission test, dubious rice plants are to be exposed to *N. impicticeps* for one day for acquisition feeding, then rice grains soon after germination are to be exposed to the said *N. impicticeps* for one day for inoculation feeding, after which the inoculated rice grains are to be transplanted in a separate container to detect the development of symptom peculiar to Tungro virus disease. This test provides fairly accurate results by the use of simple apparatus. If the collected specimens are diseased by Tungo virus, midlib of new leaves presents yellowish green colour and leaves get slightly twisted in 10 to 15 days after inoculation.

Identification of Tungro virus disease can also be done by the transmission test using young seedlings, but the test using rice grains is more advantageous in that it is much simpler and convenient for isolated raising.

As to the results of the reocmmended test, the team was later informed that Karjat Rice Research Station failed to detect symptoms of Tungro virus disease, which confirmed that Tungro virus was not responsible for the leaf yellowing in Jambrivri Village. The said test is planned to be repeated at Karjat Station to give a confirmed information on the question.

The team discussed repetitively with the experts of the Central and Local Governments of India, IARI and CRRI about leaf yellowing and Tungro virus as its suspected cause, identification of Tungro virus and other problems. It was felt, however, that discussions on these problems would have to be preceded by the classification of symptoms generally called leaf yellowing and accumulation of identification records of each symptom based on the aforementioned transmission test using rice grains.

Severe Occurrence of Leaf Yellowing in 1969 and Seasonal

Prevalence of *N. impicticeps* It can not be concluded that the leaf yellowing developed on Padma and IR-8 in 1969 at Shahabad Extension Centre is ascribable to Tungro virus. Judging from all circumstances and evidences, however, it appears undeniable that Tungro virus was the major cause.

The team's attempt to review the relationship between the serious occurrence of Tungro virus disease at Shahabad Extension Centre and the seasonal prevalence of leaf hoppers 1969 encountered the lack of data on the appearance of leaf hoppers in Shahabad. To make up for the

deficiency of information, the seasonal prevalence of the appearance of leaf hoppers on paddy in Dacca from 1961 to 1962 (Fig.s3) was employed assuming that it represents the general trend of appearance in Bengal Area. Fig. 4 which shows the presumed pattern of occurrence of Tungro and the seasonal prevalence of appearance of leaf hoppers was prepared on the basis of the said data (Fig. 3) and the seasonal prevalence of Tungro virus disease in Shahabad.

Fig. 3 Seasonal prevalence of the appearance of rice leaf hoppers (*Nephotettix impicticeps, N. apicalis,* and *Sogatella furcifera*) on paddy in Dacca, West Pakistan (Pakistan-Japan Agr. Training Center, 1961).

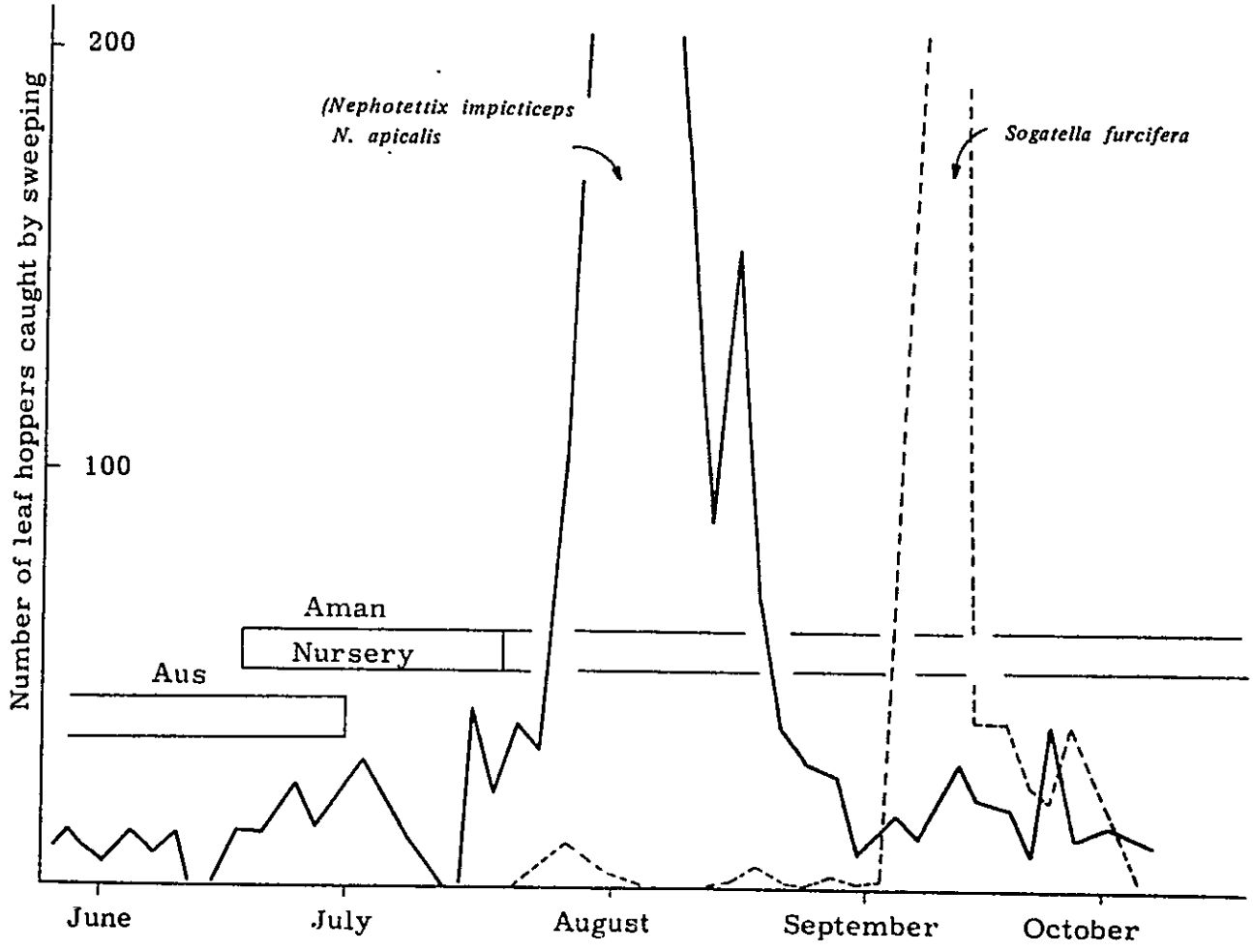
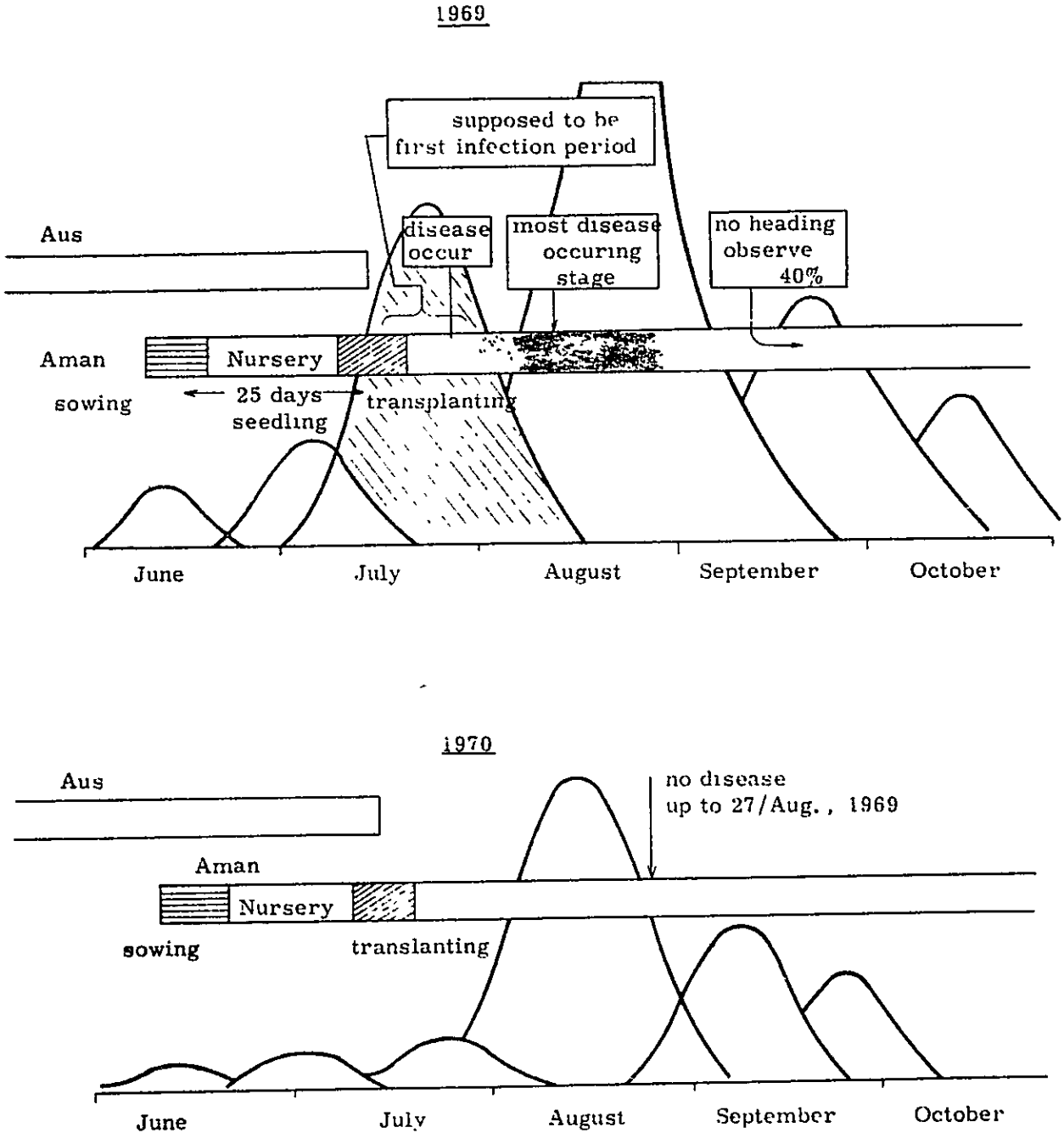


Fig. 4 Presumed pattern of the occurrence of Tungro and seasonal prevalence of appearance of rice leaf hopper (*N. impicticeps*) on Kharif paddy in Arrah Dist., Bihar.



According to Mr. Ogasawara of Shahabad Extension Centre, Padma was sown on June 10 and T-141 on June 20 in 1969. Padma was transplanted on July 6 and rooted on July 10 and 11. This variety showed abnormality around July 27, and presented a clear symptom of disease around Aguust 10. Abnormality was noted on all rice plants of which 30 to 40% failed to proceed to heading. Mr. Ogasawara stated that he remembered, though not clearly, that many adult hoppers were found during the nursery stage, but decreased after transplanting. He added that the appearance of leaf hoppers in 1969 at his Extension Centre was heavier than in 1970. As for T-141 which was transplanted 10 days after Padma, damages incurred seem to have been slight.

From the abovementioned information, inference can be drawn that the first infection period was the 20-day period from mid-July when transplanting was completed to the end of July. This period coincides with the period covering the later nursery stage and early paddy field stage of Aman Paddy. It may be said that during this period of 1969, heavy occurrence of *N. impicticeps* took place or some factors developed which accelerated the migration of leaf hoppers. The general impression of many people that the appearance of leaf hoppers in 1969 was earlier than in 1970 indicates that the generation of July made an abnormally severe outbreak as shown in Fig. 4 or the generation which usually shows heavy appearance in August appeared earlier than in normal years. The viruscarrying generation of *N. impicticeps* appears to be the population which develops around the rooting stage of Aman Paddy, and the generations of June and August are not likely to be directly contributing to the transmission of Tungro virus.

In an effort to detect meteorological elements conductive to the heavy occurrence such as the one witnessed in 1969, the team made a comparative study of atmospheric temperature, rainfall and other data recorded at Shahabad Extension Centre in 1969 and 1970, but failed to discover any appreciable abnormalities. The atmospheric temperature most suited for the growth of *N. impicticeps* is 27 to 30°C. When the temperature drops below 27°C, its growth is impeded, and at temperatures lower than 20°C, it requires a growth period more than twice as long as is normally needed. Further, if the temperature rises above 30°C, its growth is deterred and the number of eggs is lays decreases. The atmospheric temperature in Shahabad ranges from 26.6°C (min.) to 33.1°C (max.) in July, averaging 29.1°C. The temperature during the July – August period is most suited for the growth of *N. impicticeps*. July is the harvesting season of Aus Paddy. If the occurrence of leaf hoppers on Aus Paddy and the propagation of *N. impicticeps* on weeds are made clear, it will serve to detect the source of development of *N. impicticeps* which appears in July when Aman Paddy is rooted. For the forecasting of the occurrence of Tungro virus disease, studies for locating the source of development of *N. impicticeps* would have to intended primarily for ascertaining the plants on which this pest grows into adult and clarifying its propagation on such plants.

In addition to the aforementioned questions to be solved with respect to the development of Tungro virus disease and leaf hoppers, establishment of forecasting system

and control measures demands that solution be brought to many other questions including the source of Tungro virus acquisition by *N.impicticeps* and the secondary and tertiary transmission in the paddy field. One of such unsolved questions relates to the fact that a *N. impicticeps* retains its viruliferous capacity only for three to six days after acquiring it. After the elapse of this period, the pest does not carry the virus. A high rate of infection with Tungro virus in a certain paddy field must therefore be occasioned by the development of a population of *N. impicticeps* containing a rather high ratio of vris carrying individuals. This leads to the high probability that the plants on which the larvae of this pest grow in early July are infected with Tungro virus. At the present stage, it is unknown whether the larvae grow on Aus Paddy or grasses.

Studies for forecasting and control of Tungro virus disease must be made with efforts directed primarily to the clarification of the aforementioned questions. Needless to say, control of Tungro virus disease has no effect at all once the disease develops. Forecasting techniques are indispensable for control of vectors at the time of infection which precedes the appearance of its sympton. And effective control cannot be expected unless the countermeasure using helicopters and other means is implemented to cover an extensive area simultaneously. Such forecasting and control techniques are being applied to yellow dwarf, stripe disease and rice plant dwarf in Japan, with the results already obtained as expected. These techniques may as well be applied, with success, to the control of Tungro virus disease in India.

(b) Yellow Dwarf

Yellow dwarf carried by leaf hoppers occurs in the southern states of India, but it does not incur heavy damages. As detailed in the Report of Seventh Study Tour for Forecasting and Control Guidance, some paddy fields belonging to Chengamanad Model Farm in Kerala State suffered the occurrence of this disease on about 30% of all rice plants. Prevalence of yellow dwarf in Kerala State appears to be suppressed by the death of leaf hoppers during the one month interval between two cropping seasons. During the study tour, the team noted the occurrence of this disease only in the year-round cultivation farm included in the University Farm adjacent to Mandya Extension Centre. In the said farm, about 30% of rice plants (stubbles) were noted to be diseased. It is probable that the year-round cultivation is the cause of successive infection of paddy with this disease. However, this is a highly exceptional case and may be safely said to take place under no circumstances in the paddy fields of common farmers. It should be added that since the infected paddy was a conventional variety, severe outbreak could occur in future if conditions allow for its transmission.

(4) Problems Entailed in Control and Forecasting of Insect Damages

In the control of major insect pests in India, *Tryporyza incertulas* and leaf hoppers that carry Tungro virus, the basic problem to be solved is the breeding of resistant

varieties and establishment of an effective spraying method.

Untiring efforts have been made to data towards breeding high-yielding varieties resistant against stem borer and virus. In Japan, a new variety having resistance against rice stripe virus disease was bred but its extension is delayed because it cannot withstand other virus diseases.

The most desirable measure to be taken in India for the control of insect pests is the breeding and extension of resistant varieties. However, this is by no means an easy work as already evidenced by the difficulties experienced in Japan. Pest control in India for the coming few years would therefore have to centre on the development of control techniques resorting to chemicals, with endeavours also made for breeding resistant varieties.

In India, spraying of chemicals using helicopters and light planes is already in practice. The team noted an unexpectedly strong desire to control pests with chemicals. It deserves serious attention, as pointed out by many experts, that extension activities intended for accelerated cultivation of new high-yielding varieties in paddy fields where local varieties have hitherto be grown by the conventional cultivation techniques will invite the development of those pests that have so far incurred no serious damages, and will also exert adverse effect on their natural enemeies that have propagated with them. It would require a considerably long period of time before an equilibrium is established between such new pests and their natural enemies. For the development of control techniques, therefore, it cannot be fully justified to take a hasty measure of eradicating both pests and their natural enemies with chemicals.

As things stand now, implementation of pest control measures in India is destined to be initiated with many conflicting factors and dangers involved. In the future control activities, therefore, selection of suitable chemicals must be carried out, and efforts should be made to bring remedy to the current control activities in which the testing of chemicals occupies the major portion. Development of effective chemicals naturally bears much importance, but it should be noted that studies on effective application techniques of such chemicals are far more significant. Use of chemicals should be preceded by the detailed study on the change in the pattern of pest development caused by the introduction of new cultivation techniques for one thing, and by the establishment of techniques for forecasting such development for another.

Spread of insect pests and virus diseases sometimes takes place quite suddenly and unexpectedly. Forecasting techniques serve for early prediction of such an unexpected heavy development on the basis of accumulated data and information, making it possible to attain the maximum control effect by applying chemicals at right times. Needless to say, application of chemicals based on the forecast information should be so conducted that natural enemies of the pest to be controlled will be subjected to the miniumum effect of chemicals.

3. Physiological Disease

This section deals with the physiological diseases developed within a specific season under specific soil conditions. Compared with the insect pests described in the preceding section, damages incurred by physiological diseases show less yearly changes, and their occurrence areas are more or less fixed. Pattern of occurrence shown in the following table may therefore be construed as fairly representing the general conditions of physiological diseases in India.

Physiological diseases and the degree of their development observed during the study trip are as shown below.

Table 4 Major Physiological Diseases and Degree of Their Development

Name of Disease	Bihar	Mysore	Maharashtra	Gujarat
Nitrogen Deficiency	+++	++	++	++
Iron Deficiency	++	++	++	++
Phosphorus Deficiency	++ (Purnea)		+ (Jambrivri)	
Zinc Deficiency	++ (Vikramganj)	+++ (Mandya)		+
Magnesium Deficiency			++ (Jambrivri)	
Salt Injury		+++ (Mandya)		
H_2S Injury		+++ (Mandya)		

Physiological diseases shown in Table 4 above were diagnosed on the basis of the symptoms they presented and conditions of their development without resorting to analytical work. It is to be added that the table shows the development conditions only at limited number of places and not in all the four states. The team noted that each disease indicated a complication attributable to the deficiency of plural elements or combination of such deficiency and parasitic disease or pest rather than to the deficiency of a single element. An example of such complication is the intercurrent physiological disease caused by the deficiency of both nitrogen and iron.

The salt injury observed in the paddy field of Mandya Extension Centre presented the so-called Bronzing symptom complicated by the extreme deficiency of zinc and iron, with some rice plants noted to have been withered away. The main cause of this salt injury is believed to be to $N\dot{a}$ toxicity.

The zinc deficiency in Gujarat State was observed only with upland rice.

In indicating physiological disease, it is preferable to avoid using common names such as Khaira disease (zinc deficiency observed in Utta Pradish State) or Bronzing (iron or magnesium toxicity caused by soil deoxidation or H_2S toxicity), and employ correct scientific names such as those used in Table 4.

(1) Technical Problems and Countermeasures for Control of Physiological Diseases

a. Technical Problems

Nitrogen deficiency was noted to be prevalent over an extensive area. The heavy occurrence of nitrogen deficiency in India can be traced to the difficulty in obtaining fertilizers due to the existing socio-economic conditions, poor doses of nitrogen fertilizer application resulting from the fear for damages by parasitic diseases and insect pests, heavy loss of applied nitrogen fertilizer incidental to the tropical meteorological conditions, and the consequent low rate of nitrogen utilization.

Method of nitrogen fertilizer application is the most important research theme for paddy cultivation in Japan. Countermeasure against nitrogen deficiency is likewise a research theme of paramount importance for paddy cultivation in India.

Development of physiological diseases of paddy in India can be ascribed, without exaggeration, to the extensive distribution of alkaline soil in the country. The team's study on pH values of soil at different places revealed a value of 6.5 – 7.0 at Shahabad Extension Centre in Bihar State, around 7.5 at Mandya Extension Centre in Mysore State (where a high alkalinity with pH value ranging from 9.0 to 9.5 was observed at certain places), and 7.0 – 8.0 in the paddy field under AICRIP at Hyderabad (where the soil is either granitic or composed of granitic chalka).

Thus, alkaline or highly alkaline soil is generally found extensively in all areas, giving rise to the frequent development of deficiency of such elements as iron and zinc. Since these physiological diseases arise from the alkalinity of soil, a measure for radical settlement of alkalinity problem must be worked out.

The team did not find any noticeable difference between varieties in the development pattern and degree of deficiency of various elements. However, since this difference bears closely on paddy cultivation, studies on this subject must be continued in future.

b. Measures to be Taken in Future

The following major countermeasures are recommended in prevention of physiological diseases.

(1) Water Management for Irrigation and Drainage:

Implementation of irrigation and drainage contributes to economic and effective use of water, and also has such effects as prevention of soil deoxidation, acceleration of soil oxidation, improvement of fertilization effect, and prevention of deficiency of inorganic elements such as iron and zinc.

(2) Input of Materials for Soil Improvement:

Application of organic materials such as compost, raw straw and green manure and input of a large amount of soil improving materials such as fused phosphatic fertilizer and superphosphate of lime is recommended. Provision of additional soil is also effective.

(3) Application of Acid Fertilizers:

This is quite instrumental in preventing diseases arising at present from the soil alkalinity.

(4) Application of Deficient Nutrients:

To cope with the deficiency of different elements, mixing of soil with respective elements or their application on soil surface is recommended. (See the following paragraph)

Construction of a dam is desirable to assure satisfactory irrigation and drainage. However, as a provisional measure to meet the immediate needs, boring of wells and construction of closed and open ditches is conceivable. It is to be added that the input of soil improving materials and application of chemicals for nutrient deficiency must be planned in conformity to the agricultural mechanization scheme.

c. Description of Physiological Diseases and Their Countermeasures

(1) Nitrogen Deficiency:

Countermeasure against nitrogen deficiency, which is found over an extensive area in India, bears closely on the overall paddy cultivation techniques, and

should accordingly be implemented after the actual state of its prevalence has been brought to light by detailed studies.

(2) Iron Deficiency:

This is considered ascribable to poor-absorption of iron due to soil alkalinity. It develops in the initial growth stage of paddy, but usually shows recovery in about one month after transplanting. This recovery from deficiency is believed to be attained as pH value declines and paddy gains higher resistivity with the elaspse of time after submerging. At the outset of iron deficiency, Chlorosis develops between veins, and as the symptom progresses, veins are discoloured into yellow, with the entire leaf presenting the symptom of Chlorosis. It develops on both upper and lower leaves. Iron deficiency presents a symptom resembling that of nitrogen deficiency, but differs in that it normally develops at the initial growth stage of paddy and is recovered later, shows decelerated growth of root, and presents almost no tissue of iron oxide. Its wholesale solution can be brought about by expediting soil oxidation through water management, but as expeditious measures, there are such means as infusion of sulfuric acid into rhizosphere, application of acid fertilizers and foliar spray of soluble ferric salts (ferric sulfide, iron oxide, ferrous sulphate and ferrous ammonium sulfate are all effective. Ferric sulfide, in particular, displays the most outstanding effect, and its recommended dosage is 125 to 250 lb. per acre).

(3) Phosphorus Deficiency:

Phosphorus deficiency causes a relatively small number of tillers, extremely short stalk height, dark green leaf colour, and development of brownstigmata resembling those of *Cochliobolus miyabeanus* from the tip of lower leaves and the resultant withering of leaves from their tip. It also impedes the heading, and develops extremely small and weak spikes and irregular booting. Sufficient application of fertilizers with phosphorus fertilizer as the base is recommended for its prevention.

(4) Zinc Deficiency:

Zinc deficiency shows particularly severe development in areas where drainage is deficient and soil has a conspicuous accumulation of salts. Its symptom shows itself during the period from early tillering stage to the young-ear formation stage. It usually develops many stripes of brown or dark brown colour on lower leaves, which gradually proceeds to the withering of the whole leaf blade into brown, with the midrib often retaining green or greenish yellow colour. Affected paddy generally has a short stalk height and small leaf width, and its growth is extremely retarded and yield also drops. In general, a paddy whose zinc content ranges from 10 to 15 ppm is highly liable to be affected by zinc deficiency. The following measures are recommended for its prevention. (Courtesy of Mr. Yoshida, IRRI)

i) Application of zinc sulfate on nursery bed (100 kg/ha).

ii) Immersion treatment of nursery plant in 1% zinc oxide solution before transplanting.

iii) Application to soil or foliar spray of zinc sulfate at a rate of 100 kg/ha at time of development of symptom.

iv) Zinc may be applied in the form of zinc sulfate, zinc sulfide, or zinc chloride.

In addition to above, the following may also be advised as effective preventive measures. (Courtesy of Mr. Shiratori, Chiba Agricultural Experimental Station)

i) Application of $ZnSO_4$-Zn on nursery bed at a rate of $5g/m^2$.

ii) Washing of root of rice seedlings with 1% ZnO solution immediately before transplanting.

iii) Raising and transplanting of rice seedling by means of paper pot ($ZnSO_4$ content of soil: 250 ppm).

(5) Magnesium Deficiency:

Magnesium deficiency discolours midleib and develops stripe stigma, which is ensued by the withering of leaves from tip, then by the withering of all lower leaves. It develops in sandy and degraded paddy fields with poor water capacity, and was observed during the study tour. The magnesium deficiency observed at Jambrivri, Kolaba District, Maharashtra, may be assumed to have developed as an intercurrent disease complicated by the damage by *Sogatella furcifera* or virus disease. Whether it was developed by the deficiency of absorbable magnesium content in soil or was a symptom resembling magnesium deficiency that had occurred consequent on the infection of virus is not known. It may be added that the virus transmission test conducted by Karjat Agricultural Research Station on specimens collected from the said place of development produced a negative result.

For prevention of magnesium deficiency, application of magnesium sulfate in the paddy field or its foliar spray at time of its manefestation is recommendable.

(6) Salt Injury:

Salt injury of paddy varies in its degree depending on the salt water content of soil. Paddy shows weak resistivity at its early stage. Salt injury develops when salt water content of soil reaches 0.08% in terms of NaCl. Resistivity against salt injury varies by variety, and it is commonly said that Johna 345, Pokkali, IR-8 have a relatively high resitivity. For prevention of salt injury, removal of salts by dashing water over the soil and dressing of upland soil (rich in ferric iron) or sandy soil is effective.

(7) H_2S Toxicity:

Root of paddy affected by salt injury was noted to be rotten in black colour due to hydrogen sulfide or methane gas, with healthy and whitish young roots observed slightly on the surface ground. As in the case of salt injury, it can be effectively prevented by dashing water on the soil and supplying additional soil.

VIII. TECHNICAL AND SYSTEMATIZED APPROACH TO THE CONTROL OF PARASITIC AND PHYSIOLOGICAL DISEASES AND INSECT PESTS MADE BY INDO-JAPANESE AGRICULTURAL EXTENSION CENTERS

Extension Centres at all four places have suffered substantial damages by rice diseases and insect pests since the days of Model Farms. To cite a few examples, Sambalpur Farm in Orissa State was afflicated with the occurrence of *Xanthomonas oryzae* and *Pachydiplosis oryzae* in the year of its establishment (1962), the latter occuring heavily in the neighbouring 360 thousand acre area, Shahabad Farm in Bihar State experienced a heavy occurrence of *Xanthomonas oryzae* and damages incurred by Leef bugs (*Miridae* Gen.), immediately after its establishment in 1963, and Nadia Farm in West Bangal State suffered the occurrence of *Xanthomonas oryzae* and Owlet moths (*Noctuidae* Gen.). Japanese rice cultivation experts dispatched to these farms had much hardship in coping with such unexpected outbreak of diseases and pests. Similar occurrence was experienced by the four farms established several years later. Bapatla Farm in Andhra Pradesh State suffered the outbreak of *Tryporyza incertulas* and *Santhomonas oryzae* each year, Khopoli Farm in Maharashtra State experienced a serious occurrence of *Xanthomonas oryzae*, Owlet moths (*Noctuidae* Gen.) and *Tryporyza incertulas*, and Chengamanad Farm in Kerala State was affected by the occurrence of *Pachydiplosis oryzae*. Thus, for a certain period after their establishment, all of the Model Farms was embrassed by the occurrence of rice diseases and insect pests peculiar to tropical zone, though the damages incurred varied in degree.

In 1961, Shahabad Extension Centre experienced a serious occurrence of leaf hoppers, which served as a direct impetus to the dispatch of the team.

Plant protection practised during the days of Model Farms was chiefly intended for the protection of paddy cultivated in respective farms, and full-scale control activities were carried out by making maximum use of chemicals, equipment and materials for complete eradication of diseases and pests. Hence the plant protection techniques employed in those days were not suited for extension among farmers in India. With the later reorganization of Model Earms into Agricultural Extension Centres which accompanied the expansion of paddy field area to be covered by technical guidance activities of Japanese experts, it became evident that the spraying of chemicals so far practised for protection of paddy in

Model Farms was no longer practicable. The newly organized Extension Centres were therefore required to establish an effective plant protection system under which they can be fully and constantly informed of the seasonal prevalence of major pests and diseases for early forecasting of their occurrence in respective guidance areas.

It merits attention that the introduction of high-yielding varieties and guidance activities for new cultivation techniques inevitably called for plant protection techniques. Extension Centres were accordingly demanded to depart from the conventional method of eradicating diseases and pests with chemicals after their occurrence and to provide guidance on forecasting techniques which would allow the implementation of appropriate preventive measures before the occurrence.

For successful plant protection activities based on forecast information, collection of necessary data should be started immediately because the forecasting of diseases and pests demands the availability of data collected and accumulated over at least five years.

In 1970, the Central Government of India set about a large scale study tour on rice diseases and insect pests in the northern four states with the cooperation of the members of Ford Foundation and AICRIP. The study tour, initiated in prevention of heavy occurrences such as the serious virus disease incidence experienced in 1969, is planned to be conducted for the coming several years to accumulate data on the facts about the occurrence of diseases and pests in the northern paddy field area. Needless to say, the tour is intended to collect and analyze all the necessary data for the forecasting of respective diseases and pests and establishment of compatible plant protection measures.

In Japan, activities for forecasting the occurrence of rice diseases and insect pests were occasioned by the heavy occurrence of leaf and plant hoppers in 1941. Outcome of numerous research activities and experience of experts gained since that time have combined systematically with the plant disinfection administration over the past 30 years to produce the comprehensive and systematized techniques. The forecasting principles that provide the basis for the improvement of plant protection techniques have been revised according to the accumulated findings of researches and studies including special investigations for forecasting techniques at an interval of about five years.

Efforts made by the Extension Centres towards introduction of the Japanese forecasting techniques are to be highly evaluated as quite opportune particularly in view of the approach made by the Central Government of India to the problem of plant protection.

However, if the Extension Centres tackle the problem of forecasting techniques as things stand now, their activities will be naturally confined because the experts stationed at respective Centres are already engaged in different specialized fields divergent from the forecasting for plant protection for one thing, and the planned introduction of forecasting

techniques, if undertaken by the currently stationed staffs alone, are certain to prove too heavy a burden for another. This problem can be solved only by the dispatch of plant protection specialists to India. The team considers it most realistic and practicable to send technical staffs experienced in the forecasting activities conducted at present by different prefectures in Japan and let them stay at the Extension Centres for three to six months for data collection. (The team believes that the dispatch of Japanese plant protection specialists for the said duration is quite feasible even under the existing system).

Assuming that the agreement between the Government of India and Japan regarding the Extension Centres will be extended for their continued activities, rice diseases and insect pests to be studied at respective places are given below together with study items to be undertaken in future.

(Shahabad)	Tungro virus disease and leaf hoppers that carry it, and *Xanthomonas oryzae.*
(Mandya)	*Pyricularia oryzae, Fusarium nivale* and Panicle Browning.
(Khopoli)	*Tryporyza incertulas* and *Xanthomonas oryzae.*
(Vyala)	*Xanthomonas oryzae, Cnaphalocrosis medinalis,* and Owlet moths (*Noctuidae* Gen.)

Study on Insect Pests: Year-round study on the number of killed pests using light trap and study on the number of generation should be undertaken. Further, growth of weeds belonging to Gramineae in paddy field area should be conducted for leaf hoppers together with the study on the rate of virus-carrying adult hoppers of each generation. With respect to *Tryporyza incertulas, Cnaphalocrosis medinalis* and Owlet moths, detection of places where they survive during the dry season is to be carried out.

Study on Parasitic Diseases: Study on the seasonal prevalence (initial occurrence period, peak occurrence period and disappearance period of diseases on paddies cultivated in each season), study on pathogenic races using a lot of isolates, and daily survey of dispersed conidia by sporetrapping *Pyricularia oryzae,* and periodical servey of the number of phayes in irrigation water of *Xanthomonas oryzae* should be conducted.

In addition to above, testing of varieties resistant against the abovementioned diseases and pests, testing of effect of chemicals, year-round meteorological survey by every half decade, and establishment of demonstration farms protected perfectly against *Xanthomonas oryzae*, virus diseases and *Tryporyza incertulas* may be cited as part of the overall plant protection scheme.

The abovementioned studies will prove quite effective if aided by high-level research workers who, stationed for a long period in New Delhi, would analyze the data obtained and provide respective Extension Centres with suitable guidance and advice with respect to the method of implenting their studies and research activities.

It is certain that the outcome of various studies and tests thus obtained will largely contribute to the plant protection measures to be taken by the State Government exercising jurisdition over the area in which the Extension Centre is located. The Team is therefore convinced that the experts and specialists assigned to the task of plant protection in India will find their work most meaningful and execute their duties to the satisfaction of all parties concerned.

Note: For plant protection measures against respective rice diseases and insect pests, refer to "Plant Protection against Diseases and Insect Pests (in colour) - published by Ienohikari Publishing Co." which was distributed to each Extension Centre in 1970.

IX. REQUESTS AND RECOMMENDATIONS

1. Visits of Advisory Team to Foreign Research Institutes en route to India

With respect to the desired visits to IRRI in Manila and Techinical Div., Rice Dept., in Thailand, the team was allowed only a one-day visit to the latter on its way back to Japan. These two research institutes, where many Japanese research workers are stationed, are the nucleus of studies on agriculture in tropical zone. If an agricultural advisory team is allowed to visit these institutes to get directly acquainted with the outcome and progress of their latest research activities and to have discussions with their research staffs before arrival in the country to which the team is dispatched, it will certainly facilitate the planned guidance and study activities of the team and at once enable it to meet the purpose of its deputation.

It is therefore desired that Japanese teams dispatched overseas in future for technical guidance activities will be given the opportunity of visiting the said two institutes en route to the country of destination.

2. Study Tour in Wet Season

In case a team is obliged to carry out a wet season study tour for reasons beyond control, its itinerary should be so prepared that a sufficient surplus time is allowed for the team. During the present study trip, the team was much pressed for time as it often encountered service suspensions of transport media invited by heavy rain or bad weather. The itinerary of a wet season study tour should be prepared to have about 20% surplus time.

3. Preparation of Colour Slide Films or Guide Books in Colour for Diagnosing Rice Diseases and Insect Pests at Extension Centres

It is believed that the preparation and distribution of colour slides and guide books in colour to respective Extension Centres will prove quite instrumental in facilitating their activities for guidance and extension of plant protection techniques. The team is ready to cooperate in the preparation of such films and guide books.

X. INTERIM REPORT SUBMITTED TO THE CENTRAL GOVERNMENT OF INDIA

A REPORT ON RICE DISEASES AND INSECT PESTS CONTROL FOR INDO-JAPANESE AGRICULTURAL EXTENSION CENTRE

(1970)

Conducted by JAPANESE PLANT PROTECTION ADVISORY TEAM

Members of the Team:

Dr. S. Yoshimura, Plant Pathologist
Dr. S. Nasu, Entomologist
Dr. M. Yoshino, Plant Physiologist
Mr. S. Matsumoto, Plant Pathologist

Report:

We have visited the Indo-Japanese Agricultural Extension Centres at four places, Arrah in Bihar State, Mandya in Mysore State, Khopoli in Maharashtra State and Vyala in Gujarat State, for about one month, from 24th August to September 19th, 1970, on our study tour for finding Rice Diseases and Insect Pests and advise on control measures. We would like to express our heart-felt appreciation to the concerned both of the Central and the State Governments for their kind assistance and cooperation extended towards us. We may be allowed to take this opportunity to point out some of the aspects on our findings in respect of Rice Diseases and Insect Pests. We shall be much pleased if this report could be of some use to the Department of the Government of India.

The Indo-Japanese Agricultural Extension Centres have sometimes experienced severe damage on paddy caused by Diseases and Insect Pests as that of last year particularly in Bihar. Unfortunately, Plant Pathologist and Entomologist are not stationed at the Centres. As such, countermeasures against Diseases and Insects seemed to be lacking.

Since the present activities of the Centres are at their initial stages and concentrated on the introduction of new varieties and methods of cultivation, so thereafter, we should pay much more attention to Diseases and Insect Pests Control including Minor Elementary Deficiency.

Following are our report of observation,

I. Disease and Insect Occurrence at Indo-Japanese Agricultural Extension Centres and Their Neighbourhood.

Rice disease, Insect and Physiological Disease occurrence at Agricultural Extension Centres and their neighbouring areas are as shown below;

Table 1. Relative Severity and Abundance of Major Rice Diseases, Insect Pests and Physiological Diseases.

Name of Diseases and Insect Pests	Bihar 24-29/Aug. 1	Mysore 5-9/Sept. 2	Maharashtra 10-14/Sept. 3	Gujarat 15-18/Sept. 4
Parasitic Diseases				
Bacterial Diseases	Kresek phase			
Bacterial Leaf Blight (*X. oryzae*)	++ (Vikramganj, Shahabad)	+	++++ (Jambrivri, Karjat)	+ (Bardoli, Surat)
Bacterial Leaf Streak (*X. translucens* var. *oryzae*)	+			
Fungal Diseases				
Blast (*Pyricularia oryzae*)	+	+++ (Coorg)		
False Blast (*Alternaria oryzae*, *Epicoccum neglectum* *Cladosporium herbarum* etc.)		+		+
Rhynchosporium Blight (Leaf Scald) (*Fusarium nivale*)		+++ (Mangalore, Coorg)	+	+
Helminthosporium Leaf Spot (*Cochliobolus miyabeanus*)	+	+	+	+
Cercospora Leaf Spot (*Sphaerulina oryzina*)		±	±	+
Leaf Smut (*Entyloma oryzae*)			+	
Sooty Mold (*Neocapnodium tanakae*, etc.)			+	
Sheath Blight (*Pellicularia sasakii*)	+	+ Summer paddy	+	+
Sheath Rot (*Acrocylindrium oryzae*)	+	++ (Mandya)	+	+
Sheath Net Blotch (*Cylindrocladium scoparium*)			+	
Stem Rot (*Helminthosporium sigmoideum*)		+	+	+
Brown Sclerotium Dis. (*Sclerotium oryzae-sativae*)	±	±	±	+
False Smut (*Ustilaginoidea virens*)		+	+	+
Panicle Browning* (including Glume Blight)	+	++	++	++

Name of Diseases and Insect Pests	Bihar 24-29/Aug. 1	Mysore 5-9/Sept. 2	Maharashtra 10-14/Sept. 3	Gujarat 15-18/Sept. 4
Virus Disease				
Leaf Yellowing			+?	
Mycoplasma Disease				
Yellow Dwarf		+ (Ratoon)		
Nematode				
White Tip *(Aphelenchoides besseyi)*		+		+
Insect Pests				
Gall Fly *(Pachydiplosis oryzae)*	+	+		
Stem Borers *(Tryporyza incertulas)*	+	+	+	+
(Chilo partellus)			+	
Small Caseworm *(Nymphula vitaris)*				
Paddy Skipper *(Parnara guttata)*				+
Leaf Roller *(Cnaphalocrosis medinalis)*		+	+	+
Leaf Hoppers				
(Nephotettix apicalis)	+	+	+	+
(N. impicticeps)	+	+	+	+
(Inazuma dorsalis)	+	+	+	
(Tetigella spectra)	+	+	+	
Plant Hoppers				
(Sogatella furcifera)			+++	+
(Nilaparvata lugens)			+	
Thrips *(Chloethrips oryzae)*	+	+		
Blue Leaf Beetle *(Leptispa pygmoea)*				++
Physilogical Diseases				
Nitrogen-Deficiency	+++	++	++	++
Phosphorus-Deficiency	++ (Purnea)		+	
Iron-Deficiency	++	+++	++	++
Zinc-Deficiency	++ (Patna, Vikramganj)	+++ (Mandya)		+ (Upland Rice)
Magnesium-Deficiency			++ (Jambrivri)	
Salt-Injuly (Na+ toxicity)		+++ (Mandya)		
H_2S-Toxicity		+ (Mandya)		

Remarks: ± ; Slight, + ; Scarce, ++ ; Moderate, +++ ; Severe,
++++ ; Very Severe
* ; More than 20 species are recorded as causal organism.

As shown in Table 1, there are severe occurrence of Rice Diseases and Insect-Pests mainly on new varieties introduced recently although they may be said rather scarce this Kharif season, except Blast in Coorg District, Mysore, and Bacterial Leaf Blight in Karjat, Maharashtra. Most notable among them are Bacterial Leaf Blight, Rhynchosporium Blight, Panicle Browning and Plant-Hoppers (*Sogatella furcifera*). The occurrence of Bacterial Leaf Blight could be seen in the area under the development Programme, except in the Southern hilly region of Mysore State. However, we could not find the incidence of Leaf Yellowing in any places observed where this happened last year. We felt that Cultivators are confused in identifying the yellowing of paddy which might be caused by various factors including virus and nutrient deficiencies. However, yellowing of paddy which was observed this time may be seemed to have been caused by nutrient deficiencies such as Nitrogen, Iron, Zinc, Phosphate and Magnesium. The severe incidence of Leaf Yellowing on High Yielding Varieties had been reported in Kharif season in 1969, and therefore, it is necessary to pay considerable attention as to how identify and protect it, and also the same thing, can be said to Rhynchosporium Blight and Panicle Browning.

Regarding the Insect Pests, as shown in the Table above, the occurrence of *Sogatella furcifera* has been observed on highly yielding varieties such as IR-8 in Kolaba District (Jambrivri Village), Maharashtra, and also its insect damage there. At the same time, occurrence of *Nephotettix apicalis* and *N. impicticeps* have been noticed in the field where *Sogatella furcifera* was observed, and the growth of the paddy was stunted and Leaf Yellowing-like symptom has been noticed. In this connection, we have advised to the staff of Rice Research Station, Karjat, to conduct transmission test by *N. impicticeps* on rice plant. By the report conducted at that Station, regarding the transmission test which we have received recently, the recovery of Tungro symptom was not successful. Therefore, it seemed like that it may be caused by some other damage due to *Sogatella furcifera* or Magnesium Deficiency which was observed there. In general, the incidence of other insect pests to which plant protection is required are not much noticed. But, the occurrence of Leaf Roller and Blue Leaf Beetle

(especially on local vaieties in Surat, Gujarat State) is severely observed during our tour.

Regarding Physiological Diseases, the deficiencies of Iron and Zinc are seen widely on alkaline soil. At the same time, Nitrogen Deficiency is widely observed in many places because of high temperature and rainfall in Torrid Zone. During our tour, it is noticed that the intensity and locality of the physiological diseases varied to a wider extent with the latitude soil conditions varieties and cultivation practices. Symptoms caused by physiological deficiencies, we recognized are complexed deficiencies of plural elements such as nitrogen plus iron etc., rather than a typical symptom caused by a single element.

II. Countermeasures against Main Incidences.

1. Bacterial Leaf Blight

Countermeasures against Bacterial Leaf Blight are to breed and cultivate resistant varieties, treat mercuric disinfectant seed, use upland nursery, if possible, save top dressing, keep irrigation water up to maturing period, apply newly developed bacteriocides which are proposed by Dr. Wakimoto last year. The first thing to be considered in India is the cultivation of resistant varieties. It is unfortunate that we do not have the good varieties to be used practically which are highly resistant to the disease. Therefore, for this purpose, the improvement of resistant varieties is urgently needed. Furthermore, we should make out a definite measure in an attempt to realize a control method using economical chemicals from the standpoint of virulence of causal bacterial strain probably to obtain a wide attention in near future, and countermeasures against Kresek phase should be considered urgently. In 1969, attractive bacteriocides named TF-128 and TF-130 were newly developed in Japan. These chemicals are now undergoing experiment not only at IARI (New Delhi), CRRI (Cuttack) and AICRIP (Hyderabad), but also at the Indo-Japanese Agricultural Extension Centres. We really hope it would prove to be effective.

2. Rhynchosporium Blight and Panicle Browning

Both of these incidence are commonly observed on highly yielding varieties such as Padma in many demonstration fields. As Rhynchosporium disease is very minor in Japan and as such no countermeasure formula is available, it is recommendable that this subject be considered as a future problem in India. In Japan, by the recent research, the causal fungus of this disease was confirmed as *Fusarium nivale* by Tominaga(1970). The scientific name of *Fusarium nivale* at the Perfect Stage was called as *Calonectoria nivale* since old time, however, according to the various research. Tominaga proposed that the adoption of Genus *Micronectriella* as scientific name was more adaptable.

Panicle Browning is concerned with many fungi, for example, *Helminthosporium*, *Epicoccum*, *Phoma*, *Fusarium* etc., as shown Table 2. It is, therefore, recommendable that this disease may be eradicated by spraying the organo mercuric compound chemicals (i. e., Dithane) at the beginning stage of heading of rice. (Table 2 is attached to the next page)

3. Blast

Especially infestations to neck and ear of rice will be predicted in monsoon season with the expansion of improved high yielding varieties which are always accompanied by a lot of doses of fertilizer application. Therefore, we would like to advise to promote the following measures by its own originality.

1) Breeding of resistant variaties against infections to neck and ear of rice taking into consideration the experience and occurrence of pathogenic races.

2) Ecological study of source for those infections considering to contribute to the forecasting of the disease.

3) Foundamental studies on mechanisms of resistant reaction and disease establishment of those infections.

4. Yellow Incidence

Paddy Yellow Incidence is supposed to be another important problem of the high yielding varieties as in case of last year. There are many case of Yellowing Incidences including Leaf Yellowing (Tungro), and various

deficiencies such as Nitrogen, Iron, Potassium, Zinc and Magnesium deficiencies. However, we could not identify the cause of yellowing by so-called Tungro within our one month's field inspection. So far as virus is concerned, establishment of the identification and transmission tests is urgently needed among yellowing incidences as described later.

On the contrary, Nitrogen, Iron, Zinc deficiencies were widely observed during our tour and typical Potassium, Phosphate and Magnesium deficiencies also observed at certain places. Deficiency of minor elements such as Zinc, Iron, Magnesium is never seen in Japan as it has acidic soil. It is no doubt that the above mentioned minor element deficiency are in existence in India because of alkaline soil. Research of physiological diseases on paddy such as progress and distribution of alkaline soil, biochemistrical works of various deficiencies of paddy under the conditions of alkaline soil are highly recommended.

Table 2. Related Causal Organisms of Rice Panicle Browning. (Tominaga, 1969)

Cusal Organisms	Spiklet	Other Parts*
Alternalia sp.	+++ ***	++++++++++ ***
A. oryzae	++	++
Ascochyta sp.	+	+
Aspergillus sp.	++	+
Brachysporium sp.= *Curvularia* sp.	++	+
B. oryzae=Curvularia lunata	++	++
Cercospora oryzae	++	+++
Cephalosporium sp.	+	
Choanephora cucurbitarum	+	
Cladosporium sp.	+	++++
C. cladosporioides	+	+
C. harbarum	+	
Curvularia sp.		++
C. lunata	+	+
Epicoccum sp.		+++
E. hyalopes=Nigrospora sphaerica	++	+
E. neglectum	+	
Helicoma echinesporium	+	
Helminthosporium sp.	+	+
H. oryzae	++++	++++++++++
H. sigmoideum		+++
Hendersonia sp.	+	
Hormodendrum sp.=*Cladosporium sp.*		++++
Fusarium sp.	++++	++++++++
F. graminearum	++	+
F. moniliforme	+++	
F. nivale **	+	+
Leptosphaeria sp.	+	
Macrosporium sp.=*Alternalia* sp.	+	
Nigrospora sp.	+	++
N. oryzae	+	+
Penicillium sp.		++
Pestalotia sp.		+
P. oryzae	+	
Phoma sp.	++	+
P. grumarum	+	
Phylosticta sp.=Phoma sp.	++	
Pyrenochaeta sp.	++	
Pyricularia oryzae	++	++
Rhizopus sp.		+
Rhynchosporium oryzae=Fusarium nivale	++	++
Sphaerulina sp.	+	
Trichosporium sp.	+	

Cusal Organisms	Spiklet	Other Parts*
Bacteria	+	+++

Remarks: *Axis, Panicle branch, Base of Panicle (including uppermost internode),
**Rhynchosporium Blight Fungus,
***Number of plus are shown the frequency of isolations.

III. Suggestion

(A) Technical Advice of the Rice Diseases and Insect Pests Control.

1. Simple diagnosing method of the Bacterial Leaf Blight.

Introduction of the simple and quick method of diagnosis against Bacterial Leaf Blight in the field is as follows, especially first one being very simple anductual method using only one test tube. Procedures are,

1) Collect the dubious leaves in the paddy field, and cut off the discoloured part by scissors. Then put this leave into a test tube filled up with clean water. When infested by Bacterial Leaf Blight it can be observed bacterial oozing down by naked eyes. The safety and clearness of this method are obtainable by bundling several leaves (Yoshimura, 1963).

2) Out of the irrigation water is taken and mixed with 2 ml of *X. oryzae* bacterial suspension in a test tube. About 5 ml of melting potato-semi-synthetic medium (adjusted at about 50 degree centigrade) is added to the mixture and poured into a petri dish. Plaques may be counted after 15 hrs. at 26 degree centigrade. Thus the number of phage per 1 ml of irrigation water can be obtained. When detected more than 1,000/ml plaques in the irrigation water, the above water is to be affected by Bacterial Leaf Blight in high possibility in near future.

2. Identification of Tungro Virus Disease.

The Tungro virus is not mechanically transmissible but is carried by Green Rice Leaf Hopper, *Nephotettix impicticeps* in a non-persistent way. There are three methods to identify Tungro virus disease virologically,

1) Bioassay by the vector.

N. impicticeps

2) Confirmation of virion by electronmicroscopy.

3) Detection of viral proteins by serological methods. Among them, most easiest method is Bioassay by the vector *N. impicticeps*. Accordingly, the transmission test using rice seedlings (Nasu, 1957 and 1963) is recommended. Detail is as follows,

Transmission test using rice seedlings: This is a general method in which a rice grain soon after germination is put together into a test tube with a rice leafhoppers after acquisition feeding from diseased rice plant

to be tested, and then the test tube rice seedling to detect whether the leafhopper is viruliferous or not. Rice seedling is put into a test tube (1.5 x 10 cm) with a drop of water and kept at room temperature. Soon after germination, the seedling is exposed to a leafhopper, *N. impicticeps* for a certain period, and transplanted into a flat with soil to be examined for disease symptoms on third to fourth leaves. At higher temperature above 25 degree centigrade, symptom develop in several days after inoculation feeding.

(B) Rice Diseases and Insect Pests Researches and its Control Guidance at Indo-Japanese Agricultural Extension Centres

We are proposed the following items to the Government of Japan.

1. At least one Plant Protection Specialist and one Soil Nutrition Chemist shall stay (-2 years taking turn) in suitable institutions in India and carry out disease and insect and physiological disease researches and its control consultation necessary for respective Indo-Japanese Agricultural Extension Centres. And also, they shall proceed necessary experiment on the spot.

2. We have suggested that the experienced Local Forecasting Officer who is engaged in the Rice Diseases and Insect Pests Forecasting Works in Japan is to be sent urgently to respective Centres. Those Officers will mainly work on the survey of the Disease and Insect Forecasting and Technical Guidance of Plant Protection concerned at the area of each Centres and its vicinity. And, they will cooperate for the execution of the experiment on the spot and promote the research of the above mentioned Plant Protection Specialist and Plant Physiologist.

3. Above Experts and Officers staying in India shall always keep a close contact with the Indian Government and Institutions in order to have effective research activities and to exchange technical information.

4. Several spots selected among the Extension Areas shall be designated as Perfect Disease and Insect Control Demonstration Plots. (Approximately two or three spots with Bacterial Leaf Blight as an objective at this moment).

5. Accumulation of survey of the severity of various incidences, occurrence area and environmental datas related to those of diseases and insect

pests are quite necessary at the present moment. In order to obtain this purpose, the Plant Diseases and Insect Pests Forecasting Works should be urgently organized for avoiding the serious outbreak of Diseases and Pests.

6. It is highly recommendable to supply to the Indo-Japanese Agricultural Extension Centres, State Plant Protection Officers and other officers concerned, the colour slides and hand-books illustrating in colour of the symptoms of various diseases, major insect pests and physiological diseases eases of rice.

Lastly, we supposed that the staff of the Indo-Japanese Agricultural Extension Centres are lack of experience in Disease and Insect Pests Diagonosing Technique including physiological incidence. Whenever new varieties or a new cultivation method are introduced to some area, the occurrence of disease and insect charge seriously, and the unknown disease and insect occur on such cases. For example, Leaf Yellowing which occured on new developing varieties last year is a typical example of this case, as we mentioned. So, we suppose that the practical training of Experts of Centres are needed in a Plant Pathological, Entomological and Plant Nutritional Diagnosing technique to make a accurate diagnosis at any time himself, as a important future problem. Because, accurate diagnosis is a first step of plant protection.