REPORT OF THE PLANT PROTECTION ADVISORY TEAM ON CONTROL OF RICE DISEASES AND INSECT PESTS FOR INDO-JAPANESE AGRICULTURAL EXTENSION CENTRES AND DANDAKARANYA AGRICULTURAL DEVELOPMENT PROJECT (1971)

MARCH 1972

OVERSEAS TECHNICAL COOPERATION AGENCY


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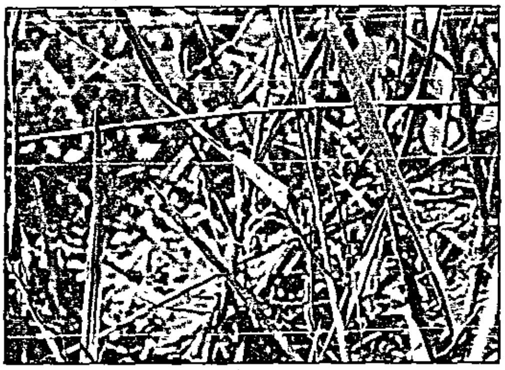
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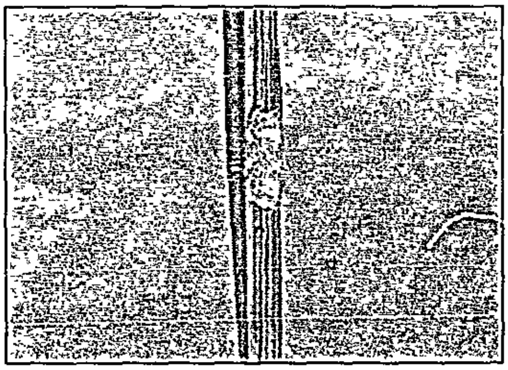
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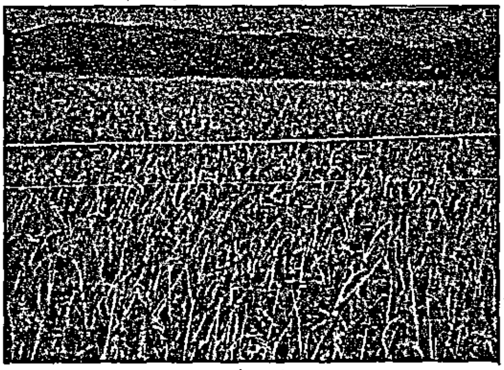
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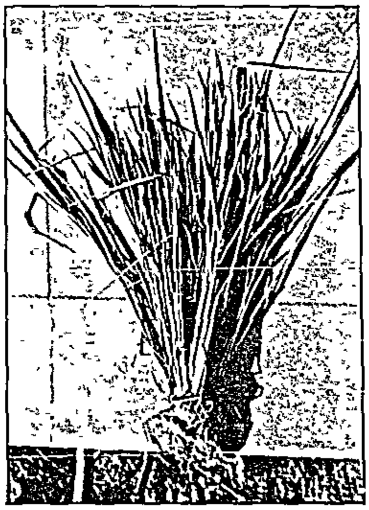
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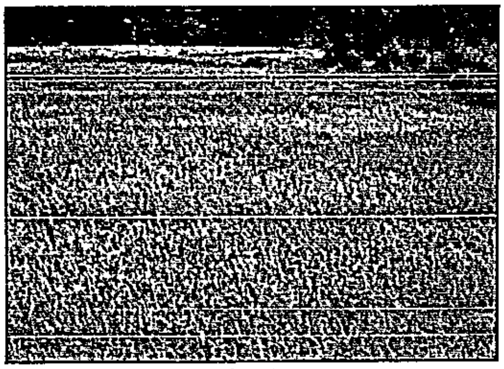

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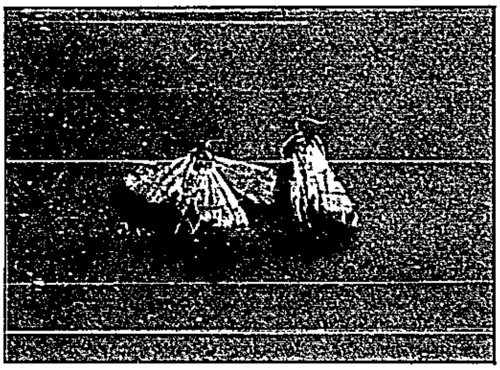

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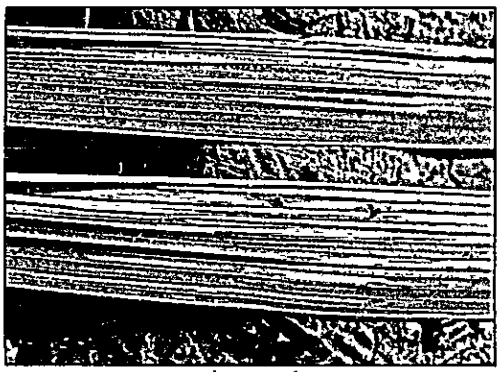

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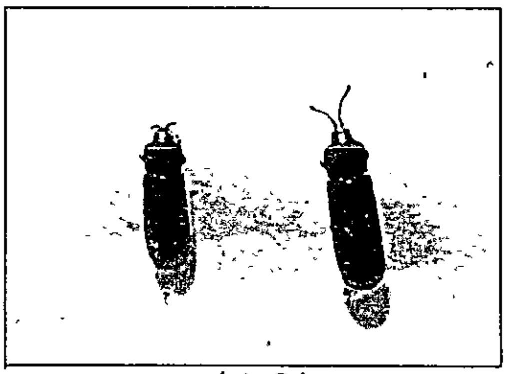

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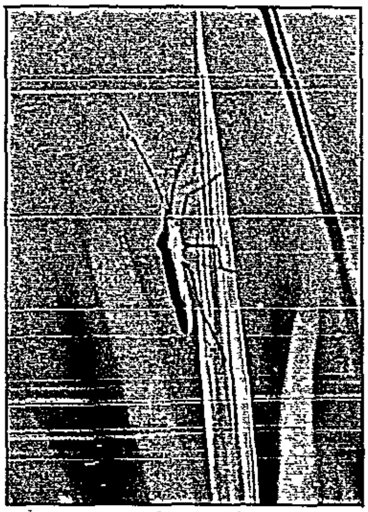
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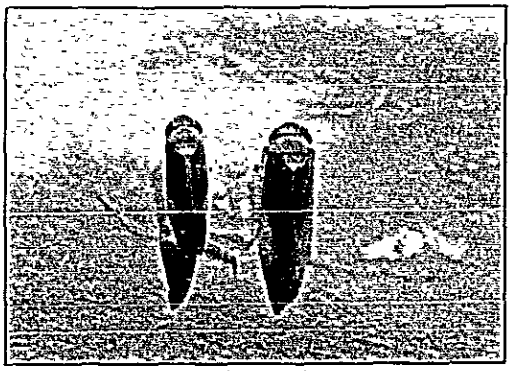
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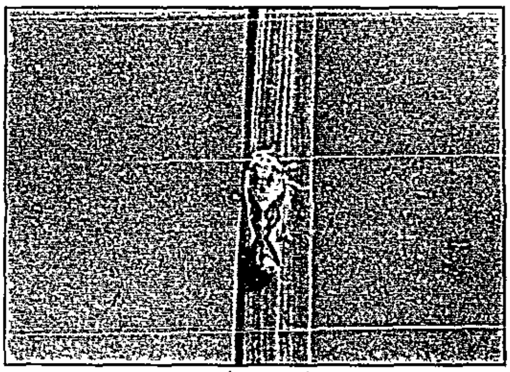
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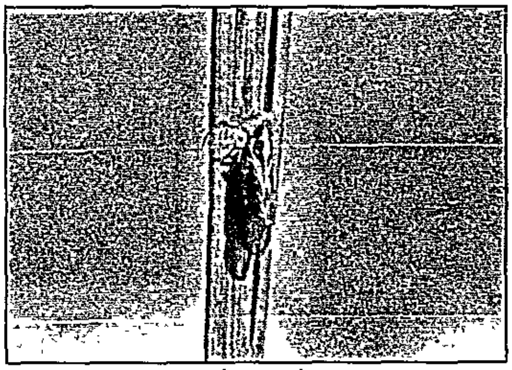
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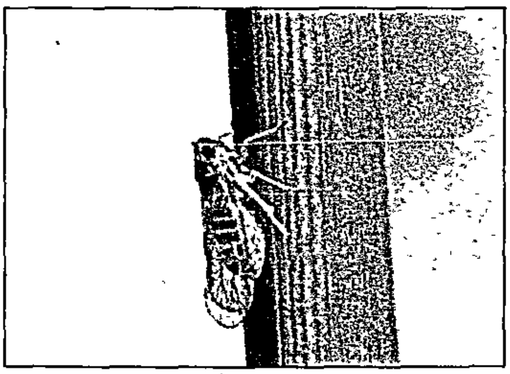
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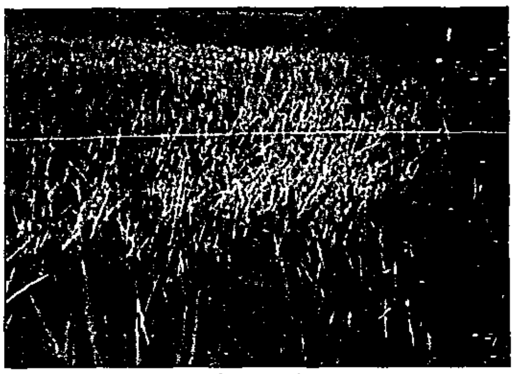
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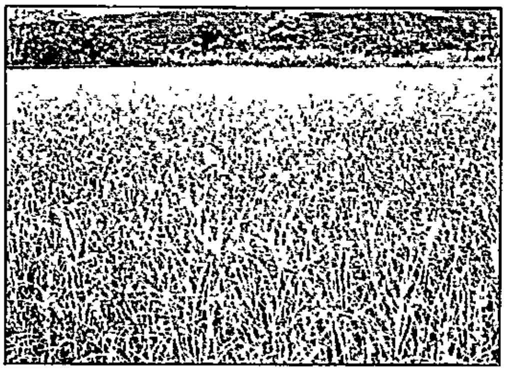

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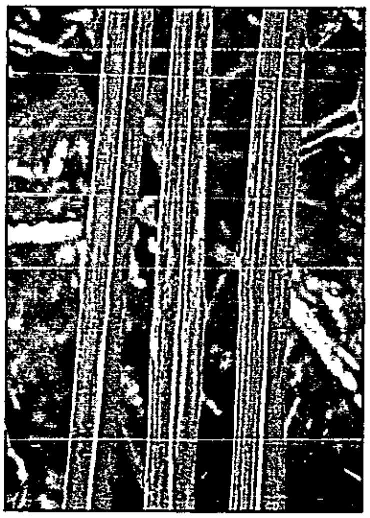

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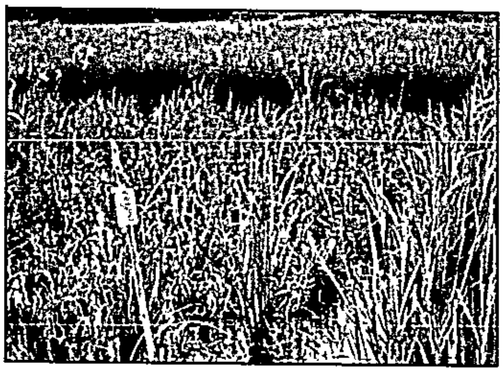

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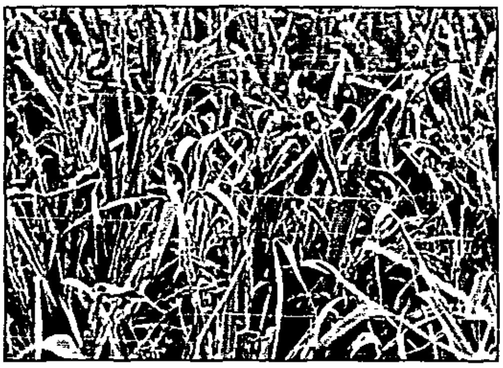

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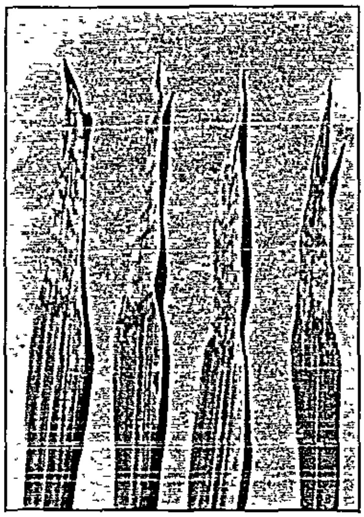

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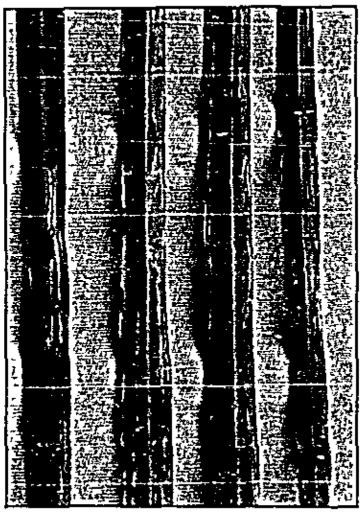

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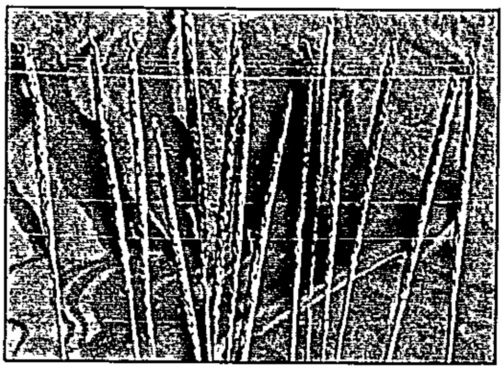
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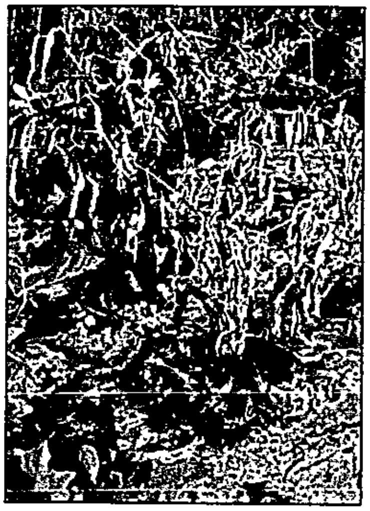
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INTRODUCTION

The Indo-Japanese Agricultural Extension Centres were established in 1968 at four places in India, viz., Arrah in Bihar State, Mandya in Mysore State, Khopoli in Maharashtra State and Vyara in Gujarat State, for the purpose of pushing foreward the technical cooperation between India and Japan. Several Japanese experts of agronomy, soil and fertilizer, agricultural machinery, and agricultural extension are stationed at each Centre and have been working in cooperation with the Indian counterparts for the extension of improved rice-growing techniques to the farmers in the neighbouring areas.

Their effort, in fact, is almost successful in getting yield increased and is drawing attention of the farmers and concerned authorities in each area. It should, however, be noted that their fields sometimes suffered from severe attack of bacterial leaf blight, leaf yellowing, panicle browning or other diseases and insect pests, which are now coming to serious obstacles to the extension of improved techniques.

It is well known fact that the hasty introduction of highly improved agricultural techniques may often bring about an unbalanced situation of environmental factors which lead to severe occurrence of some diseases or insect pests. It can be said that the Indo-Japanese Agricultural Extension Centres are just facing the problems of that kind, and the effective countermeasures are required to be urgently taken.

Since the Extension Centres have not Japanese experts of plant pathology or entomology, Japanese Government decided to dispatch an advisory team to India for several weeks every year to support the Centres by imparting technical advice on plant protection. In this way, Dr. S. Wakimoto visited India in 1969, and Dr. S. Yoshimura and his team also visited the country in 1970. Our team, therefore, is the third one for this purpose, though the Dandakaranya Agricultural Development Project was newly included in the team's itinerary.

The Dandakaranya Agricultural Development Project has started in 1958 under the direct control of the Central Government for the purpose of settling the refugees from East Pakistan. It is located in hilly districts of Central India covering a big area nearly equivalent to Kyushu Island of Japan. The area is devided into four zones, one of which is Paralkote where the Indo-Japanese Collaboration Scheme in agricultural field has started in 1970. There are now working some Japanese experts of agronomy, irrigation, land consolidation, and agricultural machinery, who are also facing the problems of diseases and insect pests not only of rice plant but also of many other crops such as maize, sugar-cane, mesta, lady's finger and various vegetable crops.

Thus our team visited India for imparting advice on plant protection to the Indo-Japanese Projects from September 8 through October 24, 1971. Incidence of diseases and insect pests were observed at and around the five places where the Indo-Japanese Projects are located. Authorities concerned of the states and the projects provided us with certain information on the control measures of pests and diseases being taken up by them.

The team also visited the Indian Agricultural Research Institute (IARI) in New Delhi, Central Rice Research Institute (CRRI) in Cuttack and All-India Coordinated Rice Improvement Project (AICRIP) in Hyderabad during its trip and had opportunities to discuss with the authorities concerned of the respective institutions about plant protection in rice culture. It should also be noted that the team dropped in at Bangkok, Thailand, on the way to India and visited the Rice Protection Research Centre in order to get acquainted with the diseases and insect pests peculiar to Tropical Asia.

It is our privilege that we could note down some comments in the report on what we have seen during our study tour. It is also our pleasure if this report is of some help to improve plant protection techniques in India.

We take this opportunity to renew our heartfelt thanks to the concerned authorities of the Central and State Governments, Projects and Institutes for their kind hospitality and thoughtful assistance extended to us during our trip in this great country.

Plant Protection Advisory Team,

A. Ezuka

(Dr. Akinori Ezuka)

J. Hirao

(Dr. Jutaro Hirao)

(Mr. Kenji Kikuchi)

December 1971.

I. TEAM MEMBERS AND PERIOD OF THE STUDY TOUR

Team members :

Dr. Akinori Ezuka (Plant Pathologist)
Chief, Laboratory of Plant Pathology, Environment Division,
Tokai-Kinki National Agricultural Experiment Station,
Ishinden-Ogoso, Tsu-shi, Mie-ken.

Dr. Jutaro Hirao (Entomologist)
Senior Researcher, Laboratory of Entomology, Environment Division, Chugoku National Agricultural Experiment Station,
Higashi-Fukatsu-cho, Fukuyama-shi, Hiroshima-ken.

Mr. Kenji Kikuchi (Coordinator of the Team)
Agricultural Cooperation Department, Overseas Technical Cooperation Agency (OTCA),
42, Hommura-cho, Ichigaya, Shinjuku-ku, Tokyo.

Period of the study tour : 49 days from September 6 to October 24, 1971.

II. ROUTE OF THE STUDY TOUR

As shown in Fig. 1, four Indo-Japanese Agricultural Extension Centres located at Arrah, Mandya, Khopoli and Vyara, Dandakaranya Agricultural Development Project at Pakhanjore, and three research institutes, IARI at New Delhi, CRRI at Cuttack and AICRIP at Hyderabad, were the main destinations of the team.

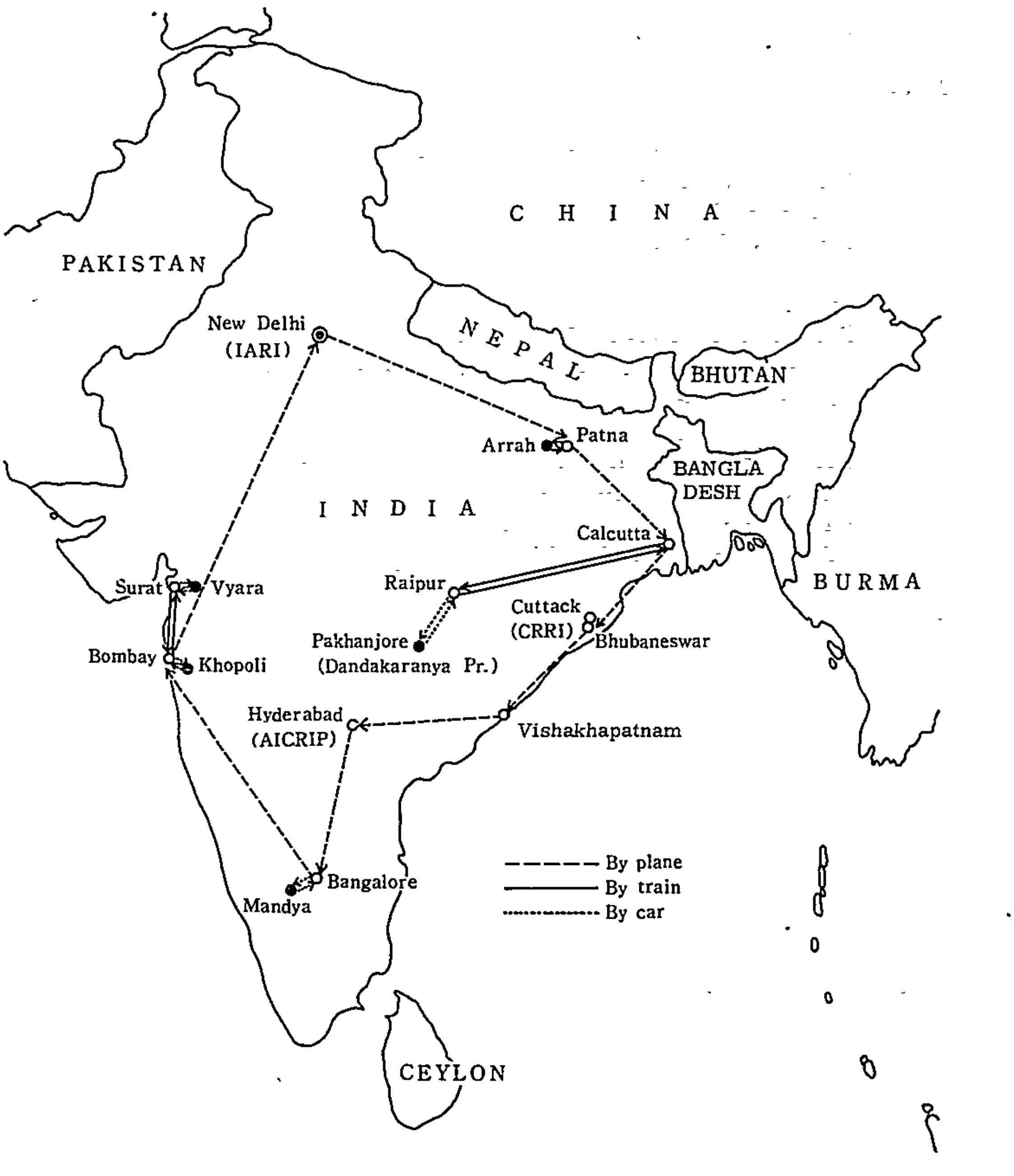


Fig. 1. The route taken by the team.

Scale : x 3/4

III. STUDY ITINERARY AND OUTLINE OF THE WORK

Sept. 6 (Mon.) : Departure from Tokyo and arrival at Bangkok in Thailand.

Sept. 7 (Tue.) : Called on Chief Mr. M. Miyamoto and Mr. K. Kumagishi of OTCA Bangkok Office.
Visited Rice Protection Research Centre, Rice Dept., Ministry of Agriculture, Bangkhen. Discussion and field observation on yellow orange leaf virus with the following Japanese experts stationed at the Research Centre.

- Dr. M. Yoshimeki (Entomologist, CP Expert)
- Dr. T. Hino (Plant Pathologist, Expert of Tropical Agr. Res. Centre)
- Mr. H. Inoue (Entomologist, Expert of Tropical Agr. Res. Centre)

Sept. 8 (Wed.) : Visited Rice Prot. Res. Centre again and exchanged views on rice diseases and insect pests in Thailand and Tropical Asia between the team and the Japanese experts.
Departure from Bangkok and arrival at New Delhi.

Sept. 9 (Thur.): Courtesy call to Minister T. Kambara, Counsellor Y. Fujimoto and Secretary K. Kosaka at the Japanese Embassy, and Chief Mr. S. Inagaki and Mr. K. Shimomura of OTCA New Delhi Office. Arranged itinerary of study tour in India.

Visited the Indian Council of Agricultural Research (ICAR), Central Government of India, accompanied by Secretary Kosaka. Explanation of the purpose of our study tour. Given information by the following officials on the general conditions of rice production in India and activities of Indo-Japanese Agricultural Extension Centres and Dandakaranya Agricultural Development Project.

- Dr. B.P. Pal (Director General)
- Dr. T.R. Mehta (Deputy Director-General)
- Mr. K. Prasad (Deputy Secretary, Dept. of Agr.)
- Mr. Koshi

Sept. 10 (Fri.) : Visited the Department of Agriculture, Central Government of India, accompanied by Secretary Kosaka. Information given to the team by the following officials on the current problems of plant protection in India.

Mr. A. J. S. Sodhi (Director of Administration & Extension Directorate)
Dr. S. N. Banerjee (Plant Protection Advisor)
Dr. D. N. Srivastava (Ass't Director General, ICAR)
Mr. G. S. Baweja (Joint Director-Extension)

Visited the Indian Agricultural Research Institute (IARI). Observation of the Institute and its experimental paddy field. Provided information on the the current studies on bacterial leaf blight and rice virus diseases by the following experts.

Dr. N. C. Pant (Prof. of Entomology)
Dr. V. V. Chenulu (Prof. of Plant Pathology)
Dr. S. K. Mohan (Plant Bacteriologist)
Dr. A. N. Basu (Virologist)

Sept. 11 (Sat.) : Holiday

Sept. 12 (Sun.) : Departure from New Delhi and arrival at Patna, Bihar State.

Visited the State Agricultural Research Farm (Mithapur Farm), Patna, accompanied by Mr. C. Miyasaka (Chief Advisor), Dr. L. M. Singh (Project Officer) and Mr. S. Akeda (Extension Expert) of Arrah Extension Centre. Gave information on plant protection in Bihar. Observation on rice diseases and insect pests in experimental field with the guidance of Dr. R. B. S. Birat (Plant Protection Officer), Mr. V. A. Kulkarni (Rice Specialist), and Mr. S. K. Choudhury (Farm Manager) of the Farm.

Held a meeting about plant protection in Bihar with Mr. Saran Singh (Agr. Production Commissioner) at the Circuit House, Patna.

Arrival at Arrah Extension Centre, Shahabad District.

Arranged study itinerary in Bihar.

Sept. 13 (Mon.): Observed the neighbourhood of the Centre, accompanied by Mr. S. Akeda of the Centre.

Sept. 14 (Tue.): Exchanged views on plant protection problems, especially bacterial leaf blight, with the following experts of the Centre and district plant officers at the Centre.

Indian experts and officers :

Mr. I. Prasad (Special Dy. Director of Agr. & Special Officer, Shahabad, Arrah)
Dr. L. M. Singh (Project Officer, Agr. Ext. Centre, Arrah)
Mr. D. Rao (Ass't Plant Prot. Officer, Muzaffarpur)
Mr. K. B. Chaturvedi (Do., Patna)
Mr. I. P. Agrawal (Dist. Information Officer, Arrah)
Mr. K. N. Dwevedi (Jr. Plant Prot. Officer, Arrah)
Mr. M. Kasmi (Do., Chapra)
Mr. R.K. Roy (Do., Kazaribagh)
Mr. W.N. Jones (Technical Ass't, Agr. Ext. Centre, Arrah)
Mr. S.K. Sinha (Do.)
Mr. S.P. Tiwari (Do.)
Mr. S.N. Prasad (Do.)
Mr. S.P. Singh (Farm Manager, Agr. Ext. Centre, Arrah)
Mr. N. Mahto (Agr. Inspector, Do.)
Mr. S.P. Srivastava (Plant Prot. Inspector, Patna)
Mr. M.P. Garaien (Do., Dhanbad)

Japanese experts :

Mr. C. Miyasaka (Chief Advisor)
Mr. S. Akeda (Agr. Extension)

Observed the field of the Centre.

Lectures at Shahabad Agricultural Extension Training Centre on "Varietal resistance to bacterial leaf blight" (by Dr. A. Ezuka) and "Rice virus diseases and their insect vectors" (by Dr. J. Hirao). About 150 attendants of trainees of Agricultural Extension Training Centre, plant protection officers or inspectors and farmers from different localities in Bihar.

Demonstration of insecticide spraying and dusting in fields of the Centre to the attendants.

Sept. 15 (Wed.): Visited Irrigation Research Station at Bikramganj.

Observation at Suara and Garahari Sub-Centres. Gave information to farmers on the techniques of diagnosing and identifying diseases and insect pests and their countermeasures.

Sept. 16 (Thur.) Visited Bihar State Government, Patna. Presentation of interim report and discussion about plant protection in Bihar with Dr. J.N. Mishra (Director of Agr.) and Mr. R.N. Sahay (Deputy Director of Agr.).

During the study tour in Bihar State, the team was accompanied by Mr. C. Miyasaka, Dr. L. M. Singh and other Indian and Japanese experts of the Centre.

Sept. 17 (Fri.) : Departure from Patna and arrival at Calcutta. Courtesy call to Consul-General Kobayashi, Vice-Consul Inoue and Secretary Ito at the Japanese Consulate-General in Calcutta. Discussion about general conditions of agriculture in India with them.

Departure from Calcutta to Dandakaranya Agricultural Development Project, Pakhanjore, Bastar Dist., Madhya Pradesh State.

Sept. 18 (Sat.) : Arrival at Dandakaranya Project via Raipur.

Sept. 19 (Sun.) : Arranged study itinerary in M.P. State. Information on activities of the Project was given by Chief Project Advisor Dr. S. Ohta, Mr. H. Duttamajumdar (Zonal and Tribal Administrator, Project Leader for Indo-Japanese Collaboration Scheme), Mr. J.S. Chaudhry (Zonal Agr. Officer) and other experts of the Project.

Observation at the "Mixed Farm," Pakhanjore.

Sept. 20 (Mon.): Observation of paddy fields at Bagunbechi and some crops other than rice plant at Periphery Village.

Sept. 21 (Tue.): Observation at tribal village and other places.

Discussion about plant protection problems and countermeasures at the Project with the following experts and officers.

Indian experts and officers :
Mr. H. Duttamajumdar
Mr. J.S. Chaudhry
Mr. C.R. Das (Jr. Agr. Extension Officer, South Paralkote)
Mr. I.W. Paul (Do.)
Mr. A.P. Bose (Do.)
Mr. R.C. Bhandari

Japanese experts and officers :
Dr. T. Ohta (Chief Advisor)
Mr. T. Shimada (Agronomy)
Mr. K. Fukuchi (Coordinator)
Mr. T. Namba (Member of JOCV, Raipur)
Mr. Y. Todaka (Do.)

During the study tour in M.P. State, the team was accompanied by the said experts and officers.

Sept. 22 (Wed.): Departure from Dandakaranya Project to Calcutta via Raipur. On the way to Raipur, inspection of gall midge outbreak in fields of JOCV Farm in Raipur Dist. with the guidance of JOCV members.

Sept. 23 (Thur.) Arrival at Calcutta and call at the Japanese Consulate-General.

Sept. 24 (Fri.) : Departure from Calcutta and arrival at Cuttack, Orissa State, via Bhubaneswar.

Visited the Central Rice Research Institute (CRRI). Observation in experimental fields and information provided on the current studies on rice diseases and insect pests at CRRI. Discussion about plant protection of rice plant with the following experts.

Dr. N.K. Chakrabarti (Mycologist)
Dr. S.C. Mathur (Plant Pathologist)
Mr. J.P. Kulshreshtha(Entomologist)
Dr. M.B. Kalode (Insect Physiologist)
Dr. S.S. Jain (Plant Pathologist)
Dr. S. Devadath (Jr. Bacteriologist)
Dr. K.V.S.R.K. Row (Jr. Plant Pathologist)
Dr. B.C. Misra (Jr. Entomologist)
Mr. P.S.P. Rao (Jr. Entomologist)
Mrs. A.P. Dath (Jr. Plant Pathologist)

Sept. 25 (Sat.) :	Observation of laboratories and glasshouses at CRRI.
Sept. 26 (Sun.) :	Departure from Cuttack and arrival at Vishakhapatnam, Andhra Pradesh State.
Sept. 27 (Mon.):	Departure from Vishakhapatnam and arrival at Hyderabad, Andhra Pradesh State.
Sept. 28 (Tue.):	Visited the All-India Coordinated Rice Improvement Project (AICRIP). Observation of experimental fields. Information on the organization and programme of rice breeding in India, and current studies on rice breeding, diseases and insect pests were provided by the following experts. Dr. S.V.S. Shastry (Project Coordinator) Dr. W.H. Freeman (Joint Coordinator) Dr. H.E. Kauffman (Plant Pathologist) Dr. V.T. John (Plant Virologist) Dr. D.D. Seshu (Plant Breeder) Dr. P.S. Rao (Plant Pathologist) Dr. K.S. Amin (Plant Pathologist)
Sept. 29 (Wed.):	Departure from Hyderabad and arrival at Mandya Extension Centre, Mysore State, via Bangalore. Arranged study itinerary in Mysore State.
Sept. 30 (Thur.)	Visited the Directorate of Agriculture, Mysore State Government, Bangalore, accompanied by Mr. M. Nozaki (Agronomy) and Mr. H.B. Ananda (Agronomist and Farm Management Specialist) of the Centre. Discussion about plant protection in Mysore with the following experts and officials. Mr. C.M. Revanna (Joint Director of Agr., Development and Intensive Cultivation Programme) Mr. S.S. Katagihallimath (Entomologist) Mr. N. Balakrishnan (Plant Pathologist) Mr. N.B. Nayak (Technical Ass't to Agr. Entomologist) Visited College of Agriculture, University of Agricultural Sciences, Bangalore. Observation of laboratories. Given information on current studies and held discussion about plant protection problems with the following experts. Dr. K. Ramakrishnan (Dean)

Dr. H.C. Govindu (Prof. of Plant Pathology,
Dr. G.P.C. Basavanna (Assoc. Prof. of Entomology)
Dr. T.S. Thontadarya (Ass't Prof. of Entomology)
Dr. V.S. Seshadri (Ass't Prof. of Plant Pathology)

Oct. 1 (Fri.) : Lectures at the Centre on "Testing methods of rice varieties for resistance to stripe virus disease" (by Dr. A. Ezuka) and "Major insect pests of rice plant and their control in South India" (by Dr. J. Hirao). About 60 trainees and 10 experts of the Centre attended.

Visited Regional Research Station (V.C. Farm), University of Agricultural Sciences, Mandya. Observation on rice diseases and insect pests in experimental fields with the following experts.

Dr. S. Usman (Chief Scientific Officer, Entomologist)
Mr. S.S. Gowda (Rice Pathologist)
Mr. B.C. Sekhava (Jr. Entomologist)
Mr. N. Shivanandappa (Jr. Pathologist, AICRIP)

Lectures at Reg. Res. Station on "Varietal resistance of rice plant to the rice stem maggot" (by Dr. J. Hirao) and "Varietal resistance to bacterial leaf blight in Japan" (by Dr. A. Ezuka) to about 30 experts of Reg. Res. Station and the Centre.

Oct. 2 (Sat.) : Field observation of Mercara and Ponnampet Reg. Res. Stations, University of Agricultural Sciences, Coorg. Dist., accompanied by Chief Advisor Dr. I. Suetsugu, Mr. K. Kanemitsu (AgriculturalMachinery),Mr. K.R. Bhagwat (Deputy Director of Agr., Agronomist) of the Centre and Mr. N. Shivanandappa of V.C. Farm.

Oct. 3 (Sun.) : Field observation of the Centre accompanied by Mr. M. Nozaki, Mr. A. Yoshino (Siol and Fertilizer) and two members of JOCV.

Oct. 4 (Mon.) : Left Mandya Extension Centre and visited the Directorate of Agriculture, Mysore State Government, Bangalore, accompanied by Mr. Nozaki.

Departure from Bangalore and arrival at Bombay.

Courtesy call to Consul M. Nozaki and Vice-Consul Takahashi at the Japanese Consulate-General in Bombay, accompanied by Chief Advisor S. Satoh of Khopoli Extension Centre.

Oct. 5 (Tue.) : Departure from Bombay and arrival at Khopoli Extension Centre, Maharashtra State.

Given information on the general conditions of rice cultivation, climatic conditions, diseases and insect pests in Maharashtra State, and activities of the Centre by Japanese experts of the Centre.

Arranged study itinerary in Maharashtra State.

Field observation of the Centre.

Oct. 6 (Wed.) : Visited Lonavla Rice Research Station, Mahatmaphule Agricultural University. Observation and discussion about biology and countermeasures of blast disease with Mr. T.F. D'Souza (Plant Pathologist, AICRIP) and Mr. D.G. Gaikwad (Plant Pathologist).

Visited Karjat Rice Research Station, Mahatmaphule Agricultural University. Provided information by Dr. D.G. Bhapkar (Director, Rice Specialist) on the current studies. Observation of experimental fields and neighbouring farmers' fields, and exchanged views on severe outbreaks of insect pests between the team and Mr. V.M. Khaire (Entomologist, Karjat Rice Res. Station).

Oct. 7 (Thur.) : Field observation in Kolaba District.

During the study tour in Maharashtra State, the team was accompanied by the following experts of the Centre.

Indian experts :
Mr. B.G. Bhalerao (Extension Agronomist)
Mr. D.P. Talekar (Jr. Agronomist)

Japanese experts :
Mr. S. Satoh (Chief Advisor, Soil & Fertilizer)
Mr. S. Umeno (Agronomy)

Mr. T. Kato (Extension)
Mr. N. Koike (Extension)
Mr. S. Wada, Mr. M. Yamamoto, and
Mr. S. Yamazaki (Members of JOCV, Kolaba Dist.)

Oct. 8 (Fri.) : Reported and discussed what was seen at the Centre with the said experts and the following experts or officials of Maharashtra State. Explained ways and means of forecast and control of diseases and insect pests, and also explained forecasting system in Japan. Provided information additionally on fungicides and insecticides used in Japan.

Dr. D.G. Bhapkar (Rice Specialist, Karjat)
Mr. S.M. Jagtap (Prof. of Chemistry, Agr. College, Dapoli)
Mr. S.G. Abhyankar (Prof. of Plant Pathology & I/C, Assoc. Dean, Agr. College, Dapoli)
Dr. B.P. Patil (Plant Pathologist, College of Agr., Poona)
Mr. T.F. D'Souza
Mr. V.M. Khaire
Mr. D.G. Gaikwad
Mr. G.S. Dawuhar (Ass't Plant Pathologist, Poona)
Mr. K.G. Nagarkar (Ass't Entomologist)
Mr. V.G. Mokal (Campaign Officer K.Z.P.)
Mr. K.B. Thade (Tech. Officer & Plant Breeder, Konkan Div., Bombay)

Departure from Khopoli Extension Centre and arrival at Bombay.

Oct. 9 (Sat.) : Preparation of the preliminary report to submit to the Central Government of India.

Oct. 10 (Sun.) : Holiday.

Oct. 11 (Mon.) : Departure from Bombay and arrival at Vyara Extension Centre, Gujarat State, via Surat.

Provided information on the activities of the Centre and general conditions of agriculture in Gujarat State by the Japanese experts. Arranged study itinerary.

Field observation of the Centre.

Oct. 12 (Tue.) : Observed Bardoli, Mota, Chikhli and Bamanvel Demonstration Farms. The team made identification of rice diseases and insect pests with samples brought by farmers. Explanation of rice diseases and insect pests and their countermeasures to farmers, showing colour slides.

Oct. 13 (Wed.) : Observed Mhauwa, Anawal, Bulsar and Dungari Demonstration Farms. The team again made identification of rice diseases and insect pests with samples. Explanation of rice diseases and insect pests and their countermeasures to faımers showing colour slides.

During the study tour in Gujarat State, the team was accompanied by the following experts.

Indian experts :

Dr. B.K. Mehta (Prof. of Plant Pathology, Gujarat State College of Agr., Junagadh)
Dr. R.M. Patel (Prof. of Entomology, Do.)
Dr. A.H. Shah (Prof. of Entomology, N.M. College of Agr., Navsari)
Dr. B.C. Dave (Ass't Prof. of Bacteriology & Plant Pathology, Do.)

Japanese experts of Vyara Extension Centre :

Mr. K. Morita (Chief Advisor, Agronomy)
Mr. M. Chiba (Soil & Fertilizer)
Mr. Y. Okano (Agricultural Machinery)

Oct. 14 (Thur.) Visited College of Agriculture, Navsari.

Observed its experimental fields.
Explanation of rice diseases and insect pests in India to the graduate and undergraduate students showing colour slides in the hall of the College.

Reported and discussed what was seen in Gujarat State, comparing with those of other States at the College with the said experts and the following Indian experts and officers. Gave information on fungicides and insecticides used in Japan.

Dr. H.U. Joshi (Prof. of Plant Pathology, N.M. College of Agr., Navsari)
Mr. K.B. Desai (Prof. of Botany, Do.)
Dr. U.M. Damor (Ass't Prof. of Agronomy, Do.)
Mr. N.V. Joshi (Rice Specialist, Nawagam Dist. Kaira)

Mr. A. D. Joshi (Plant Prot. Officer, Bangla)
Mr. S. V. Maile (Do., Bulsar)
Mr. N. K. Vanjaria (Ass't Plant Breeder, Vyara)
Mr. R. N. Patel (Crop Prot. Officer, Surat)

Oct. 15 (Fri.) : Departure from Vyara Extension Centre and arrival at Bombay via Surat.

Oct. 16 (Sat.) : Courtesy call to Director K. Tatsuke and Mr. J. Matsuda of OTCA, Tokyo, who were on tour to Khopoli Extension Centre.

Preparation of the preliminary report to submit to the Central Government of India.

Oct. 17 (Sun.) : Departure from Bombay and arrival at New Delhi.

Oct. 18 (Mon.) : Preparation of preliminary report.

Oct. 19 (Tue.) : Preparation of preliminary report together with Secretary Kosaka and Chief Inagaki at OTCA New Delhi Office.

Oct. 20 (Wed.) : Courtesy call to Ambassador Uyama at the Japanese Embassy.

Submission of the preliminary report.
Secretary Kosaka and Mr. K. Shimomura accompanied with the team to the Department of Agriculture,Central Government of India.

Views were exchanged between the team and the following Indian officials :

Dr. T. R. Mehta
Mr. K. Prasad
Mr. A. J. S. Sodhi
Dr. S. N. Banerjee

Oct. 21 (Thur.) Visited the Indian Agricultural Research Institute accompanied by Secretary Kosaka and handed the preliminary report. Discussion about it and general plant protection problems in India with the following experts.

Dr. S. P. Raychaudhuri (Head, Div. of Mycology & Plant Pathology)
Dr. S. Pradhn (Head, Div. of Entomology)
Dr. Y. P. Rao (Plant Pathologist)

Dr. S.K. Mohan (Bacteriologist)
Dr. M.D. Mishra (Virologist)
Dr. A.N. Basu (Virologist)

Oct. 22 (Fri.) : Holiday.

Oct. 23 (Sat.) : Visited the Japanese Embassy and OTCA New Delhi Office to thank for help given to our team during the study tour.

Oct. 24 (Sun.) : Departure from New Delhi and arrival at Tokyo.

IV. GENERAL DESCRIPTION OF INCIDENCE OF DISEASES AND INSECT PESTS

Being limited in time by the tight itinerary, it could not be helped that the fields seen by the team were naturally confined to rather limited areas. So far as we have observed, the incidence of rice diseases and insect pests this year seemed more severe than that reported by the team headed by Dr. S. Yoshimura last year.

As is given in Table 1, we saw severe incidence of bacterial leaf blight, blast, Rhynchosporium blight, panicle browning, yellow stem borer, leaf roller, armyworm, brown planthopper, gall midge, whorl maggot and blue leaf beetle in the fields of Indo-Japanese Projects and/or the neighbouring areas. Some brief description will be given below for respective Projects.

1. Arrah Centre, Shahabad Dist., Bihar State

As far as we have observed the area, the most important rice disease is bacterial leaf blight (BLB), which was found more or less at every place we visited. Both types of symptom, kresek phase and blight phase, were seen in the field, though the kresek phase in most cases had been overcome by the growth of new tillers at the time we visited there.

Some "high yielding varieties" and "improved varieties" such as IR-8, Jaya, CO-29, etc. were found to be attacked by BLB more severely than the ordinary local varieties, while Malinja seemed to be somewhat resistant as compared with IR-8 or Jaya. Among the local varieties Sathi, which was characterized by a peculiar habit of maturing without heading, was exceptionally susceptible to BLB.

It was very clear that the incidence of BLB was accelerated by increased dose of nitrogenous fertilizer. We could see a typical instance of such tendency in the experimental field of Irrigation Research Station at Bikramganj.

Bacterial leaf streak was also found to be widely spread in this area and sheath blight was partly observed in some plots, but their incidence was not so much as to affect the yield. Much effort should therefore be concentrated on the control measures against BLB.

Table 1. Relative severity and abundance of rice diseases and insect pests (1971).

Name of diseases or insect pests	Bihar 12 - 16/Sept.	Dandakaranya 18 - 22/Sept.	Mysore 29/Sept. -4/Oct.	Maharashtra 5 - 8/Oct.	Gujarat 11 - 16/Oct.
Bacterial diseases :					
Bacterial leaf blight (*Xanthomonas oryzae*)	++++ (With kresek)	+	+	+++++	+
Bacterial leaf streak (*X. translucens* var. *oryzae*)	++				
Fungous diseases :					
Blast (leaf, neck, panicle) (*Piricularia oryzae*)		++++	+++++ (Ponnampet)	+++ (Lonavla)	+
Rhynchosporium blight (Leaf scald) (*Fusarium nivale*)		++	+++ (Ponnampet)	+++ (Lonavla)	+
Panicle browning (*Fusarium*, *Helminthosporium*, etc.)		+	+	++++ (Lonavla)	++
Helminthosporium leaf spot (*Cochliobolus miyabeanus*)		+	++		+
Cercospora leaf spot (*Sphaerulina oryzina*)			++++ (Mercara)	+?	+?
Leaf smut (*Entyloma oryzae*)				++	+
Sooty mold (*Neocapnodium*, *Cladosporium*, etc.)		++		++	
Sheath blight (*Pellicularia sasakii*)	+	+		+++	++
Sheath net blotch (*Cylindrocladium scoparium*)				+	
Stem rot (*Helminthosporium sigmoideum*)					+
False smut (*Ustilaginoidea virens*)				+	+

(Table 1. Continued)

Name of diseases or insect pests	Bihar 12 - 16/Sept.	Dandakaranya 18 - 22/Sept.	Mysore 29/Sept. -4/Oct.	Maharashtra 5 - 8/Oct.	Gujarat 11 - 16/Oct.
Kernel smut (*Tilletia horrida*)					+++ (Bulsar)
Black chalk (Udbatta) (*Balansia oryzae-sativae* = *Ephelis oryzae*)			++	+	+
<u>Stem borers</u> :					
Yellow stem borer (*Tryporyza incertulas*)	++	+	++	+++++	++
Pink stem borer (*Sesamia inferens*)		+ (Upland rice)			
<u>Lepidopterous leaf feeders</u> :					
Leaf roller (*Cnaphalocrocis medinalis*)	+++	++++	++	+++++	+++++
Leaf folder (*Parnara guttata*)				+	
Armyworm (*Pseudaletia unipuncta*)				+++++	
Small case worm (*Nymphula vittalis*)		+++			
Satyrid butterfly (*Mycalesis* sp.)	+	+	+		
<u>Leafhoppers</u> :					
Green leafhoppers (*Nephotettix virescens* = *N. impicticeps*)	++	+++	+	++	++
(*Nephotettix nigropictus* = *N. apicalis*)	++	++	+	+++	+
Zig-zag leafhopper (*Inazuma dorsalis*)				+	++

(Table 1. Continued)

Name of diseases or insect pests	Bihar 12 - 16/Sept.	Dandakaranya 18 - 22/Sept.	Mysore 29/Sept. -4/Oct.	Maharashtra 5 - 8/Oct.	Gujarat 11 - 16/Oct.
Big white leafhopper (*Tettigella spectra*)	+	+	+	++	++
Planthoppers :					
Brown planthopper (*Nilaparvata lugens*)		+	++	+++++	+++
White-backed planthopper (*Sogatella furcifera*)	++	++	+	+++	+++
Bug :					
Gundhi bug (*Leptocorixa varicornis*)	+				
Flies :					
Gall midge (Gall fly) (*Pachydiplosis oryzae*)	+	+++++ (Raipur & Bastar)	+		
Whorl maggot (*Hydrellia* sp.)	+++	+++	++++ (Coorg)		+
Beetles :					
Blue leaf beetle (*Leptispa pygmoea*)					++++ (Bulsar)
Hispa (*Hispa armigera*)			+		

(Table 1. Continued)

Name of diseases or insect pests	Bihar 12 - 16/Sept.	Dandakaranya 18 - 22/Sept.	Mysore 29/Sept. -4/Oct.	Maharashtra 5 - 8/Oct.	Gujarat 11 - 16/Oct.
Thrips :					
Rice thrips (*Chloethrips oryzae*)	+		+		
Nematode :					
White tip (*Aphelenchoides besseyi*)		+	++ (Mandya)		
Land crabs :					
Land crabs (*Paratelthusa guerini*, etc.)				++	

Remarks :
+++++ : Very severe
++++ : Severe
+++ : Moderate
++ : Slight
+ : Scarce

We could not find after all the typical symptom of tungro, the virus disease reported by Dr. S. Wakimoto to be prevalent in Bihar State in 1969, though the vector insect, *Nephotettix virescens*, was seen commonly in this area. Throughout our trip in India, we could see only a few naturally infected tungro plants in the field of AICRIP, Hyderabad.

The incidence of insect pests in general was not found to be so severe as that of diseases. We could see only a little attack of yellow stem borer which is thought to be the most important pest in Bihar State. Only about 5 % of white heads were seen on early maturing variety, CO-29. This would probably be due to our early visit to the place because we could easily see many borer moths not only in paddy fields but also around outdoor lamps at night. The fact would suggest that white heads will increase later if no control practices were taken up.

Both leaf roller and whorl maggot were observed at every place we visited. The former was observed on the plant of advanced growth stage while the latter on that of tillering stage. Though gundhi bug was one of the important pests in this State, we could see its slight incidence on early maturing varieties. The other insect pests were of minor importance at the time of our observation.

The team had a chance to see a cooperative spraying for control of yellow stem borer at Suara Sub-Centre, Dehri Block. We were much interested in it and appreciated it, because cooperative works seemed to be rather rare in India.

In Suara Village, 266 acres of paddy fields are divided into five groups, each of which has one leader. The Centre is ready to depute one operator together with a power sprayer, which can be operated by the help of about ten persons. The labour is supplied by farmers in proportion to their own acreage of paddy field. Paramar (methyl parathion) is used and costs Rs. 4.50 per acre. Farmers buy insecticide at Plant Protection Centre of Block Office. All the work is under the supervision of Sub-Centre officer who is in close contact with the Centre. The Centre has a plan to extend such kind of cooperative works to other cultivating practices, based on the success in cooperative spraying of insecticide.

2. Dandakaranya Project, Bastar Dist., Madhya Pradesh State

The team, being the first plant protection team from Japan to visit the Project, found that blast was the most destructive disease in paddy culture in the area. Some high yielding varieties such as Bala, Padma and Ratna were severely attacked by leaf, neck and panicle blast in the demonstration farms and some local varieties as well in the farmers' fields. The more application of nitrogenous fertilizer apparently resulted in the more blast damage as in the case of BLB in Bihar State. Successful extension of improved rice-growing techniques among the settlers in this Project will hardly be expected, if they are not provided with any reliable control measures against blast disease.

Rhynchosporium blight (leaf scald) was also found frequently on the leaves of IR-8, ORS-11-5 and Bala. The causal fungus of this disease, *Fusarium nivale*, can also attack neck and panicle of rice plant and is known to be one of the most important causal fungi of so-called panicle browning in northern part of Japan. Some part of panicle symptoms seen here may be due to this fungus, though the team did not have enough time to identify it by microscopic observation. It is advisable to apply fungicides effective to both diseases of blast and Rhynchosporium blight in this area.

Sooty mold was found in some fields attacked by leafhoppers. The causal fungi of this disease are known to be saprophytic on excretions of leafhoppers and planthoppers without immediate injury to the host plant. BLB and sheath blight were little in the neighbourhood.

The team was informed of sporadic outbreak of gall midge in Raipur and Bastar Districts. More than one lakh acres were affected and considerable part of them was suffering from destructive damage. Stems were attacked up to 80 - 90 % on recommended high yielding varieties such as IR-8, Jaya and Taichung (Native)-1, and local varieties were also severely attacked. The incidence, however, was slight on those planted earlier or of early maturing varieties. The outbreak of gall midge in epidemic form was reported in some area last year though it has not reportedly stalked since 1934.
Such severe and wide incidence may be due to much rainfall prevailed from July to August, because high humidity is favourable condition to activities and reproduction of gall midge. Care must be taken of its subsequent spread over virgin areas.

Table 2. Diseases and insect pests of some crops other than rice plant in the area of Dandakaranya Project (1971).

Name of diseases and insect pests	Host plant	Severity*
Diseases :		
Bacterial wilt (*Pseudomonas solanacearum*)	Bringer (Eggplant)	++++
Do.	Chilli (Pepper)	++++
Leaf spot (*Cercospora hibisci*)	Lady's finger (Okra)	+++
? Southern blight (? *Corticium rolfsii*)	Bettel vine	+++
Leaf spot (Unidentified)	Do.	+
Wilt (Do.)	Radish	++++
Stem rot (Do.)	Sugar-cane	+++
Insect pests :		
28-spotted lady beetle (*Epilachna vigintioctopunctata*)	Bringer (Eggplant)	+
Striped flea beetle (*Phyllotreta strioleta*)	Radish	+
Pod borer (Unidentified)	Lady's finger (Okra)	+
Earworm (Do.)	Maize	+

* See Table 1.

The incidence of leaf roller was widely observed at every place. It was also severe in the previous generation in early August according to the Project's experts. Younger rice plants within 40 days after transplanting were spottedly attacked by small case worm and whorl maggot in the farmers' fields. Leafhoppers and planthoppers attacked rice plants, preferably of maturing stage and caused sooty mold as mentioned above.

The team also observed diseases and insect pests of some crops other than rice plant, which were summarized in Table 2. We found bacterial wilt (*Pseudomonas solanacearum*) of bringer and chilli, leaf spot (*Cercospora hibisci*) of lady's finger, and several unidentified diseases of bettel vine, radish and sugar-cane. The soil-borne diseases of vegetable crops seemed to be of special importance in this area. The insect pests observed were 28-spotted lady beetle on bringer, striped flea beetle on radish, one species of pod borer on lady's finger and one species of earworm on maize, each being very slight.

3. Mandya Centre, Mandya Dist., Mysore State

Severe incidence of blast, Rhynchosporium blight and Cercospora leaf spot was seen at Ponnampet or Mercara in Coorg District, where heavy rainfall and high humidity provided a favourable condition for disease development. Among them blast was most destructively attacking not only high yielding varieties but also local varieties. No varieties were found to be resistant to blast except some moderately resistant ones as MB-319, S-67, PS-1 and BKB, which were selected at Ponnampet Agricultural Experiment Farm, University of Agricultural Sciences.

Indian experts told us that spraying or dusting of fungicides is rather difficult in this area because of the frequent rainfall in rice growing season. It would be the most important subject to get resistant varieties and also to find effective granular fungicides for standing water application in order to control the blast damage under such climatic conditions.

Rhynchosporium blight and Cercospora leaf spot were also severe at Ponnampet or Mercara, and consequently would be important diseases in this area.

At Mandya we did not find severe diseases except some physiological diseases due to highly alkaline soils. These physiological diseases are omitted from Table 1 because the team is not specialized in this field. Blast was seen only on some susceptible varieties as Ratna in the Centre's field. BLB was found in the field of V. C. Farm, University of Agricultural Sciences, Mandya, but was very slight.

Black chalk, locally called "udbatta," was easily found on many varieties at Mandya and Ponnampet. The perfect stage of the causal fungus of this disease was recently reported by Dr. Y. Hashioka and its scientific name was changed to *Balansia oryzae-sativae* from *Ephelis oryzae*.

The incidence of insect pests was comparatively lower in Mysore than in the other States. Among 13 insect pests found in the area whorl maggot was the most destructive in the late transplanted fields at Mercara, Coorg District. Most of larvae had already grown up to the last instar. There were many varieties planted in the experimental fields at Mercara, but we could not find varietal differences in maggot infestation. Coorg District has an altitude of 1,000 m and frequent rainfall throughout rice growing season. The severe incidence of whorl maggot may be attributed to high humidity and cool temperature prevailing in the area.

The other insect pests observed were of minor importance except white tip nematode. Severe incidence of the nematode was seen on some of Japanese varieties in the Centre's field.

4. Khopoli Centre, Kolaba Dist., Maharashtra State

It was simply surprising that most of the varieties and strains in the Centre's field were attacked by BLB and some of them died up perfectly into white colour. It was again strange that such severe blight symptom had not been preceded, according to the experts at the Centre, by kresek phase. They informed us that the disease first appeared in leaf blight phase at the end of July or the beginning of August when the plants were at the maximum tillering stage, then rapidly became prevalent and finally resulted in such severe damage that yield from those highly susceptible varieties could hardly be expected.

The Centre is trying to avoid the top dressing of nitrogenous fertilizers in order to control the damage of BLB, but this is not effective enough to prevent the disease development under epidemic conditions.

Among twelve entries of a varietal test including major high yielding varieties, IR-22 and IR-20 appeared to be considerably resistant to BLB. A few other strains were also found to be resistant in the field for selection of breeding materials.

We found wild paddy grown in irrigation channel being infected by BLB at Loha. A species of *Isachne* growing around a paddy field at Loha was also found to be infected by a bacterial disease, though it was not determined just the same as BLB of rice plant.

The climatic conditions in the field of Agricultural Research Station at Lonavla were so favourable for diseases to develop just as in Coorg District in Mysore State that severe incidence of Rhynchosporium blight and panicle browning were seen on Karjat-184 and EK-70 and blast on EK-70. The panicle browning on Karjat-184 seemed to be caused by *Fusarium nivale*, the causal fungus of Rhynchosporium blight, but microscopic observation is required to precisely identify it since the similar symptom is sometimes due to blast fungus on some varieties.

Sheath blight was found on high yielding varieties to some extent in the Centre's field. This disease would possibly be one of the main factors affecting rice crop in future under the conditions of heavy dose of fertilizer and dense transplanting of high yielding varieties.

Leaf smut, sooty mold, sheath net blotch, false smut and black chalk were seen in some fields but they seemed to be of minor importance. Among them, however, false smut is sometimes severe according to Indian experts.

Severe incidence of insect pests threatened rice culture not only in the Centre's fields but also in farmers' fields. They were yellow stem borer, leaf roller, armyworm and brown planthopper. Affected acreage by these pests seemed immense, and yield losses were estimated at a half or less of normal crop in a large number of fields.

White heads caused by yellow stem borer on some tall local varieties with big stems were rather severe than high yielding varieties. More than 50 % of white heads were seen in many fields where such local variety as called Kolam was widely cultivated. Since the larvae dissected were still in younger stage, the damage on rice crop was supposed to increase further with larval dispersion to other healthy stems.

Leaf roller and armyworm were densely observed. Affected fields by leaf roller turned so white that we could easily find them from a distance. Both of the insect pests were often found together in the same fields. Late maturing varieties with vigorous growth were seriously affected by these pests. Leaf roller had already emerged into moth at the time of our visit, while armyworm still remained in old larval stage.

It is said that leaf roller has recently increased and spread its range of distribution while armyworm was sporadic this year. Distribution of rainfall in this area during the previous generation in August is supposed to be the cause of such severe incidence of these leaf feeding pests.

Hopper burn caused by brown planthopper was observed on early maturing varieties while medium and late maturing varieties remained green despite of higher insect population. Both nymphs and adults were seen together. White-backed planthopper was also seen in the same field, though the population was less than brown planthopper.

Population of green leafhoppers was comparatively higher in Kolaba District. Among green leafhoppers caught with a light trap at the Centre on October 7, *Nephotettix nigropictus* was found to be predominant over *N. virescens*, about 85 % of the total number of green leafhoppers. Leaf yellowing symptom is said to have been observed since 1969. In order to detect tungro virus from the leaf yellowing, Karjat Agricultural Research Station in Kolaba frequently tried transmission tests by using germinated rice grains, which were recommended by the last year's team. The results obtained however were all found negative.

Beside insect pests, land crab is important in Maharashtra State. We could see many burrows and destroyed rice plants around ridges in paddy field. According to Karjat Agricultural Research Station, three species, namely *Paratelthusa guerini* (Khekada in local name), *P. jacquimontii* (Chimburi), and *Gecarcinucus jacquimontii* (Muthya) are known as injurious land crabs. The first one is the most predominant species.

It was urgently necessary to apply insecticides against armyworm and planthoppers even at the time we visited there. Wet season had just cleared off at the time and the Centre was trying to apply insecticides against them. Abnormally heavy and continuous rainfall in September this year made it difficult to apply insecticide on suitable timing. There are many important problems of forecasting and control in connection with such extreme climatic conditions.

5. Vyara Centre, Surat Dist., Gujarat State

No remarkable incidence of rice diseases was observed except kernel smut which was found on Z-31 and some other varieties at a demonstration farm in Bulsar, though the number of diseases counted more than the other states we visited. Indian and Japanese experts told that the incidence of rice diseases this year was less than last year. This was only one exception throughout our study tour, though the reason was not clearly known.

Leaf roller and blue leaf beetle, among insect pests found in this area, were the most important, followed by planthoppers. The incidence of leaf roller was widely spread over the area, severely attacking vigorous rice plants. Leaf roller had then grown up to moth. Blue leaf beetle was seen only in Bulsar. Both larvae and adults of beetle attacked the leaves, so that the injury developed from lower leaves towards flag leaf of rice plant. The attacked plants therefore were stunted and withered away so as their heads could not emerge. Adult beetles remained, at the time, feeding on the upper leaves.

Brown planthopper did not seriously break out except the Centre's fields, where hopper burn was seen in places. White-backed planthopper and leafhoppers could also be seen. Yellow stem borer slightly sprang up this year against as its reported heavy outbreak last year.

It was not necessary to apply insecticides except on late maturing varieties since it was almost the time of harvest at the time of our observation. Some problems in controlling insects should also be met with.

V. COMMENTS ON THE CONTROL OF RICE DISEASES AND INSECT PESTS

1. Diseases

1) Bacterial Leaf Blight (*Xanthomonas oryzae*)

(1) Varietal Resistance

Under the severe occurrence of BLB as was seen in India, the most important and basic control measure is to breed highly resistant varieties and to extend them to the endemic areas. The breeding and screening of rice varieties and strains for BLB resistance are now going on at AICRIP, IARI, CRRI and other research stations in every state. We expect that those efforts will bring about good results in the near future.

In Japan, however, we have bitter experiences of so-called breakdown of highly resistant varieties belonging to "Kogyoku group," which were just bred for resistance to BLB. This phenomenon was later proved to be due to new physiologic races of the causal bacterium. Hundreds of bacterial isolates from various parts of Japan were classified into three groups with different reactions of pathogenicity, and hundreds of rice varieties including japonica, indica and intermediate type were classified into four groups with different reactions of BLB resistance (Table 3).

Recently the existence of physiologic specialization was also demonstrated in India, though the specific reactions were not so clear-cut as in Japan. Indian breeders would therefore be well advised to take into account the possibility of specific interaction between resistance of rice varieties and pathogenicity of bacterial strains, even though the details are not yet fully known in India.

It may be recommendable for the present to extend moderately resistant varieties such as IR-22 and IR-20 in Maharashtra State or Malinja in Bihar State.

(2) Cultivation Method

Adjustment of cultivation period and dose and application timing of fertilizer may be significant in reducing the

Table 3. Reaction of rice varieties to *Xanthomonus oryzae* strains from Japan.

Varietal group	Representative variety	Group of bacterial strains		
		I	II	III
Kinmaze group	Kinmaze, Jikkoku, Shimotsuki, Asahi, Norin 18, Norin 37, Benisengoku, Originario, IR-8	S	S	S
Kogyoku group	Kogyoku*, Zensho 17, Norin 27, Asakaze, Hoyoku, Pi No. 1, Nep-Vai, Daiyoshi, Sigadagabo	R	S	S
Rantaj-emas group	Rantaj-emas 2, Tadukan, Kele, Te-tep, Nigeria 5, Zenith, Chinsurah Boro II, IR-5	R	R	S
Wase Aikoku group	Wase Aikoku 3*, Nakashin 120, Chugoku 45, TKM-6, Lead Rice, X-43, Nagomasari, Koentoelan	R	R	R

Remarks
1) R : Resistant, S : Susceptible
2) * Kogyoku = Kidama, Wase Aikoku 3 = Aikoku-soto-sango-kei

damage caused by BLB. Heavy dose of top dressing of nitrogenous fertilizers should be avoided under the serious epidemic conditions.

Regarding the hot water treatment of seeds, an adequate explanation was given in the report of last year's team (p. 21). The possibility of seed transmission was demonstrated by some researchers in India, but the population of the pathogen in seeds was found to gradually decline after harvest to a very low level within three months. Further studies will be needed to make clear the significance of seed transmission under natural conditions.

The mode of perpetuation of the pathogen under field conditions is also being studied by some researchers in India. Infected straw, stubbles, volunteered rice plants and collateral hosts such as *Oryza perennis* according to them, play a role in survival of the pathogen from season to season. Among them the infected stubbles are regarded as the main source of primary infection in the next season in India especially considerable area in South where double cropping of rice plant is adopted. In single cropping area such as North and Central India, however, the fields are exposed to severe winter and then hot summer until the next rice growing season. The pathogen under such conditions, seems to be rather difficult to survive than in South India.

Removal of wild paddies growing in irrigation channels may be partially effective to check the incidence of BLB, if they are the source of primary infection.

The question of perpetuation of the pathogen is the most important aspect of epidemiology for forecasting and control methods of the disease. Further careful study will be required for demonstrating the complete life history of BLB in India.

(3) Chemical Control

Spraying of Streptocyclin, Dithane Z-78 or Copper oxychloride is now recommended to farmers for BLB control in every state, though they are not much effective under such conditions as we have seen. We have in Japan several widely used chemicals for BLB control such as Celdion, Phenazine, Sankel but even those chemicals are not always sufficiently effective to suppress grave outbreak of BLB.

In recent years some new chemicals tentatively called TF-128, TF-130, KU-100, KU-101, OHA, MUF-15 and NK- 558 have been developed in Japan and found to be highly effective to BLB. Among them TF-130 seems to be most promising for its striking effectiveness. Japanese Government, however, is very strict in these days in releasing new agricultural chemicals from the view point of environmental pollution, and TF-130 is now under examination of subacute and chronic mammalian toxicity. The result is not obtained yet because of some difficulties in quantitative analysis technique of small amount of TF-130.

Under the situation mentioned above, it may be advisable to keep up the present recommendation, paying special attention to new chemicals being developed.

(P.S. The efforts for developing TF-130 was finally abandoned in February 1972, because of its subacute mammalian toxicity and probable residual effects.)

2) Blast (*Piricularia oryzae*)

(1) Varietal Resistance

Just the same may be said about blast resistance as in the case of BLB resistance mentioned above. It is a well known fact that there are a number of physiologic races of blast fungus different from one another in their pathogenicity to rice varieties and also in their distribution areas. In India 16 races were distinguished among 19 isolates from various localities. A highly resistant variety in one area is not always resistant in another area. A new variety, therefore, should repeatedly be tested for blast resistance in the area where the variety will be recommended.

It is worthy of mentioning that, beside the qualitative resistance of high level, quantitative resistance should be noted, because the latter is in general considered as race-nonspecific, being called field resistance or horizontal resistance while the former called true resistance or vertical resistance. The race-nonspecific resistance, even though of low level, is significant for the control especially of such diseases as blast which is apt to produce new physiologic races of the causal fungus. We have suffered recently in Japan from severe breakdown of some leading varieties with blast resistance of high level, which was introduced from indica varieties through laborious breeding works. This was apparently due to the lack of attention to the quantitative resistance in the course of their breeding.

(2) Cultivation Method

Here again the same comments may be given as in BLB about the application of fertilizers. It is apparent that blast attack is also encouraged by the increase of nitrogenous fertilizers, so the heavy application of nitrogenous fertilizers should be avoided to control blast. Application of organic manures and silicon fertilizers is good for making rice plant tolerent to blast attack and reducing the damage to some extent.

Dense planting, being very favourable for the disease, should be avoided in the field as well as in the nursery bed.

Irrigation water should be kept up to maturing period as much as possible, because upland condition is more favourable for blast development than paddy condition.

Straws, hulls and other infected plant debris should be collected and burned. They can easily serve as the source of primary infection in the next season, if they are kept around the paddy field.

Salt water selection of seeds will be effective to prevent the seed transmission since healthy seeds are chosen through their heavier specific gravity than diseased seeds.

(3) Chemical Control

Among the fungicides available in India, Hinosan and Kasumin may be most strongly recommendable for blast control. Copper oxychloride and Dithane Z-78 are also used in some states but may be less effective than Hinosan or Kasumin.

We have many other brands of highly effective blast fungicides in Japan, i.e., Kitazin P, Inezin, Bla-S, Rabcide, etc., which are now widely used for blast control with satisfactory effextiveness. The granular fungicides such as Kitazin P may be worthy of testing since there are much difficulties in spraying or dusting in wet season in India.

Organomercury fungicides are useful for seed disinfection and, if possible, soaking may be better than coating, because the coated seeds may be uncoated by sowing time. The residual solution of mercury compound should not be discarded into the waters but on the ground, in order not to cause the water pollution.

3) Rhynchosporium Blight (*Fusarium nivale*) and Panicle Browning

The incidence of Rhynchosporium blight is sometimes so severe in India that it is confused with BLB of its later stage because of the dying up of whole plant into whitish colour. The severity seems somewhat depending upon the varieties of rice plant, so it is wanted to make a study of the varietial resistance to the disease.

It was recently reported in Japan that Hinosan and Bla-S. U were effective for control of Rhynchosporium blight and also of panicle browning caused by the same fungus, *Fusarium nivale* (= *Rhynchosporium oryzae*). The possibility of simultaneous control of the disease together with blast may be expected because Hinosan and Bla-S U are also effective for control of blast.

In Japan, panicle browning is known to be caused by many kinds of fungi, and *Helminthosporium oryzae* (= *Cochliobolus miyabeanus*), *Fusarium nivale*, and *Cercospora oryzae* (= *Sphaerulina oryzina*) are the most important among them. Hinosan and Bla-S U are also effective to *Helminthosporium oryzae* and Ohric, a newly developing fungicide in Japan, is proved to be more effective to *Helminthosporium oryzae* than Hinosan. The most effective fungicide so far tested for control of panicle browning is triazine, but it is not always suitable for paddy field because of its high toxicity to fish.

In regard to the panicle browning in India, general survey of the kind and frequency of causal organisms will be necessary for further consideration of control measures.

4) Sheath Blight (*Pellicularia sasakii*)

Though the incidence of sheath blight is not common in India at present, the recent trend toward intensive cultivation will lead to the increase of the disease in future.

It is recommendable for the control of this disease to avoid dense planting and heavy application of nitrogenous fertilizers. Vigorous growth of rice plants offers the favourable conditions to the mycelial development with high humidity of microclimatic condition among the plants and tillers.

In Japan organoarsenic fungicides such as Neoasozin are applied before heading and polyoxin PS, an antibiotic with less phytotoxicity and somewhat less effectiveness than Neoasozin, is applied after heading for the control of sheath blight. In recent days another two promising antibiotics named polyoxin Z and Validamycin, which are as highly effective as Neoasozin and with no phytotoxicity, are being developed.

5) Other Diseases

The diseases mentioned below may sometimes cause much damage on rice culture in India, while in Japan they are rather minor diseases or entirely absent, and we do not necessarily have sufficient knowledge about the control measures against them. The original studies in India are expected for further discussion.

(1) Cercospora Leaf Spot (*Sphaerulina oryzina*)

We have not effective fungicides in Japan for the control of this disease except triazine which is not suitable for application in paddy field as mentioned before.

The severity of the disease in Japan apparently varies from rice variety to variety, so it will be valuable to conduct a varietal test for resistance to the disease under Indian conditions.

(2) False Smut (*Ustilaginoidea virens*)

For the control of false smut, spraying of copper fungicides or Bla-S U just before heading is said to be very effective as written in the report of the last year's team (p. 27).

Though the transmission route of the causal fungus in Japan has not been experimentally proved yet, some researchers assume that the natural infection is due to ascospores produced on the overwintered sclerotia. Anatomical studies showed that the infection took place at a very young stage of flowers just before blooming. This is assumed as the reason why the spraying made only in the period from booting to early stage of heading is effective for preventing the false smut infection.

(3) Kernel Smut (*Tilletia horrida*)

The black powder produced in diseased seeds is the mass of chlamydospores of the causal fungus. The chlamydospores attached on the surface of healthy seeds come to the source of infection in the next season.

The seeds from infected field therefore, should not be taken in order to control the disease. If there be further possibilities of infection, it may be effective to make seed disinfection with organomercury fungicides as in the case of blast disease.

(4) Black Chalk = Udbatta (*Balansia oryzae-sativae = Ephelis oryzae*)

This disease is known to be distributed in India, South China and perhaps West Africa, but not yet found in Japan.

Some Indian researchers demonstrated that the hot water treatment of seeds was more effective than that of fungicidal disinfection. This fact suggests that the disease may be internally seed-borne. The hot water treatment recommended is as follows : Soak the seeds in normal water for 12 hours, and dip them in hot water at 52°C for 15 minutes (or at 54°C for 10 minutes), and dry them in shade and then sow.

(5) Bacterial Leaf Streak (*Xanthomonas translucens* var. *oryzae*)

Bacterial leaf streak is reported to occur only in Tropical Asia, viz., India, Thailand, Malaysia, the Philippines and China, and is not known to occur in Japan.

The chemicals effective for control of the disease are not known since the trial has not yet been made. The varietal difference in resistance to the disease is very clear and the screening tests for resistant varieties and strains are now under way at IARI and CRRI in India and IRRI in the Philippines.

There are two opposing opinions in India regarding the persistence of the causal bacterium from one season to another. One asserts that the seeds from infected field are the potential source of the disease and denies the survival on infected plant debris, while the other asserts that infected leaves or leaf debris harbour the pathogen during the off season and denies the possibility of seed transmission.

2. Insect Pests

1) Yellow Stem Borer (*Tryporyza incertulas*)

(1) Varietal Resistance

Since TKM-6 was selected as a highly resistant variety at CRRI, much efforts have been concentrated on breeding resistant varieties with better plant type and grain quality by crossing TKM-6 with high yielding varieties. As a result, some of CR lines were found to meet the purpose. Multilocation tests are now going on under the supervision of AICRIP. We expect good results in the near future.

(2) Cultivation Method

The borer incidence is generally lower in Kharif season than in Rabi or summer season in double cropping areas. In Kharif season late maturing varieties are liable to be more severely attacked at the heading stage than the early maturing ones. Rabi or summer season crops transplanted in February or thereafter suffer from severe incidence at both stages of tillering and heading.

Higher level of nitrogenous fertilizers tends to increase the borer incidence. Researchers at CRRI presented a positive correlation between the incidence and nitrogen : $Y = 4.18 + 0.1025\ X$, where Y is the percentage of white heads and X is the basal dose of nitrogen (kg AI/ha). Split application of nitrogen reduces the borer incidence when compared with the same amount of nitrogen applied in a single dose at transplanting.

After harvest of Kharif crops, it is noticed that larvae hibernate in stubbles below the soil surface until June or July when wet season begins. Ploughing after harvest results in destruction of hibernating larvae and is effective to suppress the incidence in the next season. Ploughing is also effective to enrich the soil fertility. This practices should cover a considerable area to get more effective results.

(3) Chemical Control

There are several generations which are considerably overlapping one after another. Seasonal prevalence of the insect depends much on the weather conditions and crop pattern in years, regions or localities. In case of internal feeders like stem borers it is difficult to determine the proper timing of insecticide application. A light trap is used for knowing the peak of moth appearance and degree of its incidence. One or two higher peaks of moth appearance are generally observed with a light trap in each crop season.

Insecticides should timely be applied following after the pattern of moth appearance and the proper timing of application is at the period of its peak. It should be applied at least two or three times : The first one is at vegetative stage to suppress dead hearts and the second or the third is from booting to heading stages depending on degree of moth incidence.

According to CRRI, diazinon at 2.5 kg AI/ha, lindane and carbaryl-lindane granules at 2.5 kg AI/ha promise good control when applied three times in standing water at 30 day intervals commencing from 10 days after transplanting. In case of moderate incidence, diazinon granule applied 25 and 70 days each after transplanting is also as effective as ordinary foliar applications of 0.04 % parathion or endrin five times at 15 day intervals.

Granular insecticides applied in standing water have longer residual effect than foliar sprays. A major lethal action of some granular insecticides was recently found to be due to gas effect rather than systemic action through root systems or leaf sheaths by capillary water. Diazinon granule has strong gas effect against stem borers, leafhoppers and planthoppers.

2) Gall Midge (*Pachydiplosis oryzae*)

(1) Varietal Resistance

Some of highly resistant varieties were selected at the institutes in India, but they are not recommendable for practical cultivation because of their tall plant height and low yield. Highly resistant varieties or lines (CR Nos.) have recently been bred by crossing them with high yielding varieties and are now being further tested in endemic areas of gall midge.

(2) Cultivation Method

The peak of infestation fluctuates from August to November depending on weather conditions in Kharif season. The insect population generally becomes intense 6 to 8 weeks after the beginning of wet season. Incidence of gall midge was considered to be serious in Kharif season, but it has increased in Rabi season since the introduction of high yielding varieties.

Gall midge is a host-stage dependent pest. The most susceptible stage of crop is within 50 days after transplanting. It is therefore possible to effectively avert the incidence simply if transplanting time is properly adjusted. During our study tour we observed differences of incidence caused by the difference of transplanting time in Raipur, Madhya Pradesh State. The severe incidence was observed in the fields transplanted later than the last week of July while early transplanting resulted in lower incidence. Cultivation of early maturing varieties was also seen effective. But whether this way of cultivation succeeds or not in reducing the incidence seemed to depend on weather conditions of the season. It can be said this time also that the more the application of nitrogenous fertilizer, the more the incidence.

(3) Chemical Control

Chemical control of gall midge would well be conducted basing on the time lag of transplanting and period of insect prevalence which is closely connected with susceptible stage of crops. Recent research at CRRI has proved efficacy of diazinon granule at 1.5 kg AI/ha applied in standing water, followed by Thimet at 1.5 kg AI/ha. Two times of application of these granules are required at 15-day intervals during the susceptible period of 10 to 40 days after transplanting. Cytrolane granule at 1.5 kg AI/ha was in addition found to be effective. These granular insecticides are as effective as ordinary foliar sprays of 0.04 % parathion or endrin four times at 10-day intervals commencing from 10 days after transplanting.

3) Leaf Roller (*Cnaphalocrocis medinalis*) and Armyworm (*Pseudaletia unipuncta*)

Younger larvae of these leaf feeders feed on green tissues of leaves. Old larvae of armyworm cut the immature heads. Nourishing plants are easy to be severely attacked. It is said that they coincide with some time when heavy rain and flood come on after dry weather.

The most effective measure for chemical control is to apply contact insecticides as foliar sprays in the younger larval stage. In order to find the suitable timing of application, intensive observation of the fields is most important. Judging from the growth stage of these pests at the time of our observation at Khopoli and Vyara, the proper time of insecticide to apply would be at the beginning of September. Effective insecticides are less in number except those with higher mammalian toxicity.

4) Green Leafhopper (*Nephotettix virescens*) as a Vector of Tungro Virus

Arrah Centre reportedly suffered from severe incidence of leaf yellowing including tungro in Kharif season in 1969. Needless to say, effective control of tungro cannot be expected without related knowledge between virus and vector insect. This may be summarized as follows :

Tungro is nonpersistent in its vector insect. Nearly 100 % of the insect individuals, both adults and nymphs, become active transmitters if they successfully feed on diseased plants. The minimum acquisition and inoculation feeding periods are 30 and 15 minutes respectively. The vector remains viruliferous for a maximum period of 5 days after acquisition, and about 50 % of leafhoppers lose their infective ability within 24 hours. The insects therefore need to repeatedly feed on diseased plants to remain viruliferous. Proximity of diseased plants is the main factor in spreading the virus.

Taking into account the transmission process of nonpersistent virus like tungro, roguing of infected plants in the early infection period is a reliable method to reduce the incidence and further spread of the virus. It is, however, difficult to distinguish new symptoms of tungro from those of other leaf yellowing without experienced observation. The last year's team showed relationship between seasonal prevalence of vector leafhoppers and virus infection period in Kharif season in Shahabad District,Bihar State(the report of last year's team p. 42).

As far as we know, practical control measures of leafhoppers have not been sought out under the field conditions in India, and we have no nonpersistent viruses in Japan. We would therefore like to inform control measures issued at IRRI in the Philippines.

Diazinon and Thimet granules at 2 and 3 kg AI/ha respectively are effective when applied three times in standing water 10, 35 and 50 days after transplanting, followed by carbaryl and Dimecron granules each at 3 kg AI/ha. Thimet and Dimecron, however, are not recommendable because of their high toxicity to mammals. Safer insecticides unfortunately are not available in most States in India, but these control measures may be worthy of testing under natural conditions in India if they are available. More effective control would be expected if control measures are taken to cover considerable areas simultaneously with cooperative works.

5) Planthoppers (*Nilaparvata lugens*, *Sogatella furcifera*)

Planthoppers increase their population towards crop maturity. They are very susceptible to most kinds of insecticides and can easily be controlled by both foliar and standing water applications. Carbaryl and malathion are the most common insecticides against planthoppers.

6) Whorl Maggot (*Hydrellia* sp.)

More than one hundred *Hydrellia* species are recorded in the world. Out of them, *H. griseola* and *H. sasakii* are common as the pests of paddy rice. The former is a leaf miner and the latter a stem maggot, and both of them being existent in Japan. Another maggot, *H. philippina*, was recently recorded in the Philippines as a new pest of paddy rice. *Hydrellia* species in India might presumably be the same as *H. philippina*.

As far as we know, little is known about biology and control measures of whorl maggot in India. The following information is from the studies in the Philippines.

Larvae mine the centre of leaf whorl which is still enclosed in the leaf sheaths. Damage can be seen as linear discolouration on the leaf blades. Severe incidence results in stunting, reduction in the number of tillers, delaying of plant maturity and yield reduction. Adults of the insect prefer the younger stage of plants within 40 days after transplanting. There are several overlapping generations. The peak of its population is generally in September in single cropping areas. We observed similar phenomenon in Mysore State.

Whorl maggot is quite difficult to control with foliar sprays since larvae inhabit in concealed position inside the stems. Granular insecticides such as carbaryl-lindane and Thimet at 1.5 to 2.0 kg AI/ha applied in standing water are effective. Two times of application are necessary at 15 and 35 days after transplanting. Dimethoate granule at 1.5 kg AI/ha applied one week after transplanting is effective against *H. sasakii* in Japan. These control measures should be re-examined under Indian conditions.

7) Other Pests

(1) Small Case Worm (*Nymphula vittalis*)

The insect attacks nursery and transplanted seedlings of 40 days. Larvae feed on epidermis of leaves and subsequently cut leaves and roll to form tubular case. Foliar application of insecticides promises good control when applied at the initial feeding stage of the insect before it forms tubular case.

(2) Blue Leaf Beetle (*Leptispa pygmoea*)

Both adults and larvae of blue leaf beetle attack the leaves. Foliar application at the younger larval stage promises good control. Denapon (carbaryl) is commonly used in Japan to control leaf beetle (*Oulema oryzae*)instead of prohibited BHC or lindane. Its efficacy should also be confirmed against blue leaf beetle in India.

(3) Rice Hispa (*Hispa armigera*)

Adults of rice hispa feed on epidermis of leaves and grubs mine inside the leaf tissues. Infestation of the insect generally decreases when trasnplanted before the end of July, while the incidence increases as transplanting is delayed in August. This pest is easily controlled by foliar sprays. Safer carbaryl would also be more effective than BHC and endrin.

(4) Gundhi Bugs (*Leptocorixa varicornis, L. acuta*)

Gundhi bugs first appear on graminaceous weeds around the field and then migrate to rice plants later than heading stage. *Echinochloa crus-galli, E. colonum*,etc. serve as alternate hosts.. Both adults and nymphs attack the developing ear heads. Clean cultivation reduces the incidence on paddy.

BHC dust is commonly used for controlling bugs in India, but it is not recommendable for yield reduces because of phytotoxicity when applied after the booting stage. Among insecticides available in India, Sumithion is recommendable. Care should be taken to spray on weeds also around the field. Simultaneous sprays covering large areas promise better control of the insect.

(5) White Tip Nematode (*Aphelenchoides besseyi*)

White tip is caused by seed-borne nematode and transmitted through the irrigation water in paddy. White tip symptom appears on the leaves after maximum tillering stage. Infested hulls should not be left in paddy after harvest and seeds from infested field should not be used.

Seed treatment with hot water is promising to kill nematode inside the seeds : Soak the seeds in hot water at 56 - 57°C for 10 - 15 minutes and dip them in cool water, and dry them in shade. Another treatment is as follows : Presoak the seeds in normal water for 16 - 20 hours, and then soak them in hot water at 50 - 52°C for 5 - 10 minutes, and dip them in cool water. For the chemical control, soak the seeds in 0.05 % Sumithion emulsion for 12 - 24 hours and wash them in tap water. When Sumithion is mixed with organomercuric fungicide, seed treatment can be done at a time for the control of both nematode and blast.

(6) Land Crabs (*Paratelthusa guerini, P. jacquimontii, Gecarcinucus jacquimontii*)

Crabs become active immediately after the beginning of wet season and cut rice plants till the end of October or November. Karjat Agricultural Research Station in Maharashtra State recommends the treatment of burrows with copper sulphate of 0.5 % solution.

VI. GENERAL SUGGESTIONS

As has already been pointed out by Indian experts, the problems of diseases and insect pests have come to the fore since high yielding varieties had introduced and subsequently extended. Major diseases and insect pests have increasingly become severe and spread over the new areas while minor diseases and pests have also become considerably important. It is said that these phenomena are mainly due to higher susceptibility of high yielding varieties along with application of higher dose of nitrogenous fertilizers. In addition, extension of double or triple cropping area along with the development of irrigation system and short duration varieties is responsible for the change of incidence pattern of diseases and pests.

We have seen much efforts are concentrated on breeding resistant varieties to major diseases and pests at every institution in India. Needless to say, cultivation of resistant varieties is the most effective and ultimate control measures without much cost and hazards of environmental pollution. We were interested in the breeding of resistant varieties and appreciated much the efforts.

The breeding work, however, requires much time and labour. It is especially laborious task to bring up commercial varieties with resistance to two or more diseases and insect pests. Chemical control, therefore, will be indispensable to yield much even in the cultivation of resistant high yielding varieties in the future.

Under Indian conditions it is rather not recommendable to apply chemicals so many times as in Japan, chemicals should be applied focusing on the most important stages of the most important diseases or insect pests instead. Forecasting work will be necessary to know the suitable timing of application.

The granular type chemicals may be useful in the area where heavy rainfall prevent the practice of foliar application of dusts or sprays.

Several subjects regarding these matters are discussed below from the general viewpoint. As to the chemicals recommendable for each disease or pest and their toxicity to mammals and fishes, the readers are refferred to Appendix I-IV attached to the end of this report.

1. Varietal Resistance

High yielding varieties have been introduced into India in order to attain rapid increase of rice yield and now they play a very important role in improving rice situation with improved cultivation techniques. But some of them are highly susceptible to BLB, blast or other diseases and insect pests, and have suffered frequently from severe attack of them.

The team had an impression that the breeding of high yielding varieties resistant to major diseases and insect pests is essentially important in order to secure the stabilized and satisfied rice yield in future. We have seen the breeding works to meet the purpose being conducted at every national and state institution in India, especially breeding for resistance to BLB, blast, yellow stem borer and gall midge. We hope those sustained efforts will result in producing a number of excellent resistant varieties.

It is also emphasized that there may be some specific interactions between disease resistance of rice varieties and pathogenicity of strains or races of causal organisms. Studies of this kind are of basic importance for the breeding programme of disease resistant varieties. IARI, CRRI and AICRIP have been carrying out those studies on the resistance to BLB, blast, tungro, bacterial leaf streak, sheath blight and stem rot, though much are to be solved in the future. It would be advisable to carry forward genetic studies of resistance besides the studies of the host-pathogen relations.

We should be careful as not to confuse vertical (or race-specific) resistance with horizontal (or race non-specific) resistance as well as vertical pathogenicity with horizontal pathogenicity in conducting those kind of studies. The problem of "breakdown" brought back the attention of breeders and plant pathologists to the practical utility of horizontal or field resistance, especially in the case of blast. The same thing of course can also be said to the other diseases.

2. Relation Between Fertilization on Crop Yield and Disease Incidence

The response ability to heavy fertilization is of course one of the advantageous traits of high yielding varieties. But we should take it into account that the incidence of some diseases such as BLB, blast and sheath blight is accelerated according to the amount of nitrogenous fertilizer applied.

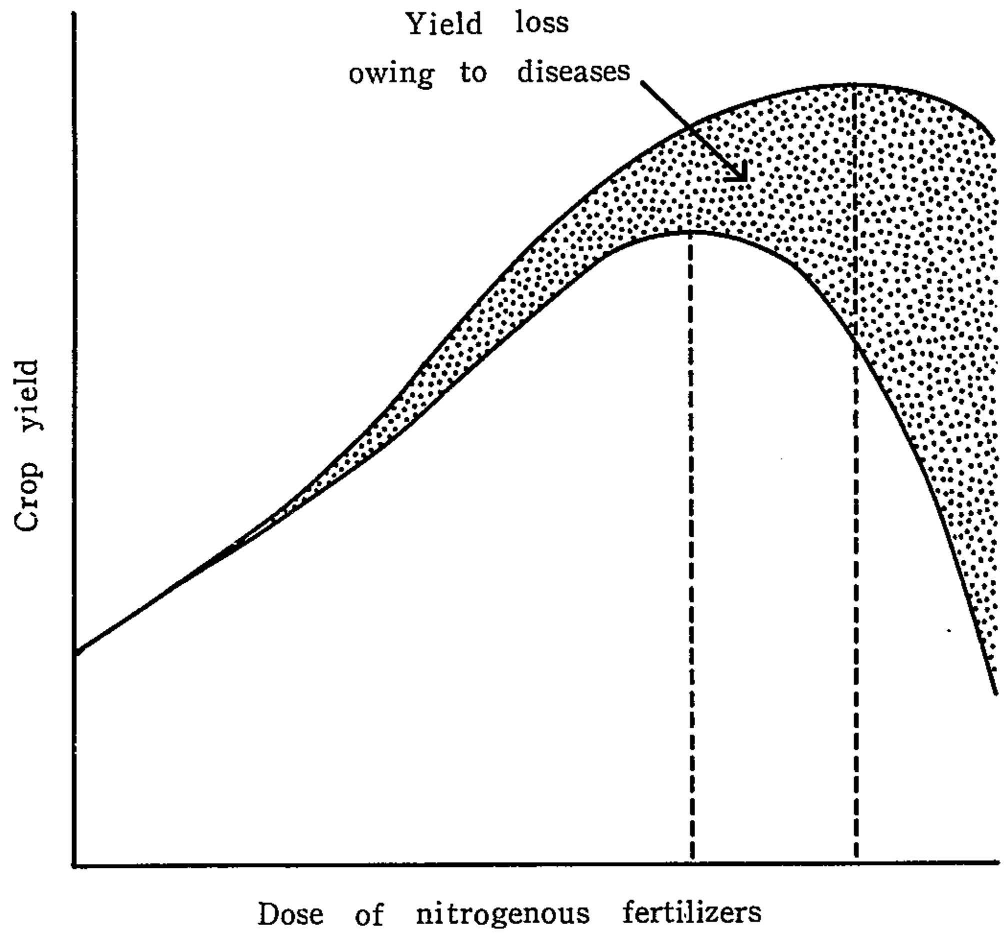


Fig. 2. Relation between fertilization on crop yield and disease incidence.

Scale : x 3/4

As shown in Fig. 2 the yield will be increased along as the dose of fertilizer increases up to a certain point, but acutually the yield will be decreased more or less by the disease attack which is accelerated in reverse proportion to heavy fertilization as a steeper slope than the yield increase. Consequently the optimum dose of fertilizer to get maximum yield under disease-infected conditions may be somewhat less than that under the disease-free conditions. The yield loss due to diseases, however, may be prevented to some extent by adopting control measures. The fertilization programme therefore should be made with due consideration to forecasted severity of diseases and the expectcd efficacy of control practices.

3. Importance of Forecasting Techniques

The team has met with many questions on forecasting techniques of rice diseases and insect pests from the officers concerned of the State Governments. Although we explained some techniques adopted in Japan, we felt the importance of forecasting techniques to be introduced to India. It can be said that control of diseases and insect pests can not be implemented without adequate knowledge on the forecasting techniques. Emphasis must be put on forecasting techniques as well as forecasting system in order to improve the efficiency of the present control measures.

The example given below, the light trap, is one of the simple and efficient forecasting techniques. It would be worthwhile to examine various other techniques of forecasting to achieve fruitful results.

Concerning yellow stem borer, seasonal variation in terms of moth number is clearly discernible with a light trap. At Khopoli Centre, for example, a light trap has been used since 1968 for forecasting yellow stem borer, and has supplied valuable data of them to its vicinities. This activity drew attention of the State Government. Information of the plant protection to deliver to farmers is surely one of the important extension works of the Centre. Taking into account the present situation in India, emphasis should be placed on preventive chemical control rather than protective one. Preventive application of chemicals would better be based on reliable forecasting techniques.

Yellow stem borer is the most important pest at Arrah Centre and tungro virus problem then arose in 1969. The team, therefore, suggested the importance of setting a light trap at the Centre to know the seasonal fluctuation in number of the borer and the vector leafhopper. This would be useful for timely control of these major pests. It is generally said that one light trap can effectively cover 80 hectares of paddy fields for *Chilo suppressalis* in Japan. Dry form light trap is recommended to set in the areas where heavy rain falls.

4. Some Problems of Forecasting System

We have heard that each State in India has its own forecasting system. It is feared that the forecasting system in Maharashtra State might be too complicated to secure the rapid communications.
The forecast information on outbreak, warning, etc. is reported to the Directorate of Agriculture through several different organizations and a number of officers and it returns back again through all of them, then delivered to farmers. It takes, therefore, much time to give the information to farmers. This may probably result in missing the suitable timing of chemical control.

Quick communication is of fundamental importance in forecasting work. Urgent informations are necessary to be dealt with at District level in order to give information to farmers or to control groups as quickly as possible. The similar system is actually operated in Japan. In a big country like India one District in a State may be as extensive as one Prefecture in Japan.

5. Application of Chemicals During Wet Season

Continuous and heavy rain often visits Arrah, Khopoli and Vyara Centres in Kharif season. There arises a difficulty of timely practice of plant protection works under such rainy conditions. The following advice from the general standpoint may be given on this problem.

Foliar application of contact insecticides should be employed at the pause of rain against leaf feeders and suctorial pests if footing condition is not bad. These pests unlike the stem inhabiting ones are always exposed to the air and are killed soon after the contact with insecticides. In case of stem inhabiting pests like stem borers, gall midge and whorl maggot, granular insecticides are effective even under the rainy conditions unless water is flooded over the fields. This is also true for the granular fungicide against blast.

6. Comparison of Granular and Foliar Application

Granular chamicals have increasingly developed especially in the field of insecticide. They have longer residual effect than sprays or dusts in foliar application.Granules make it possible to reduce the frequency of application. For example, diazinon granule at 1.25 kg AI/ha applied two times in standing water against yellow stem borer is as effective as seven times of continuous foliar application throughout the crop season in India. The granular fungicide, Kitazin P, retains fungicidal effect against blast for a long time within plants, and just one application is as effective as two or three times of foliar application in Japan. In addition, granular chemicals can be applied either with manual or power applicators, saving labour remarkably.
Simultaneous application with fertilizers or herbicides is also possible. On the other hand, granules are usually more costly than foliar sprays or dusts when applied for one time and at a unit area because the former requires more amount of active ingredient than the latter.

Whether granules are preferred to foliar chemicals or not depends on the factors such as weather conditions, available applicators, species of diseases or insect pests and so on. Granules are used to reduce the frequency of application and to control as well two or more pests at a time. Increase in yield is expected to make full compensation for the cost of applied chemicals when plant protection measures are taken.

Micro or fine granular chemicals have recently developed and have been testing against major pests and diseases in Japan. This type of chemical covers the effect of both foliar and granular application at a time without fear of air pollution due to the drift of dust.

APPENDIX I. RECOMMENDED CHEMICALS FOR PADDY RICE PROTECTION IN SOME STATES OF INDIA

The following tables were made from the materials provided to us by the Indo-Japanese Project or Directorate of Agriculture in each State.

I-1. Fungicides

Fungicide	Bihar	Madhya Pradesh	Mysore	Maharashtra	Gujarat	Disease
Mercury :						
Uspulun	0					Blast, BLB, etc. (seed treatment)
Agrosan GN		0				Blast, HLS (seed treatment)
Ceresan wettable		0				BLB (seed treatment)
? Mercury fungicide			0	0		Blast, HLS & other seed-borne diseases (seed treatment & spraying)
Copper :						
Copper oxychloride		0		0		Blast, HLS, BLB
Copper sulphate			0			Blast, HLS, BLB (seed treatment)
? Fytolan		0				Blast, HLS
Organosulphur (Dithiocarbamate):						

(I-1. Continued)

Fungicide	Bihar	Madhya Pradesh	Mysore	Maharashtra	Gujarat	Disease
Dithane Z-78 (Zineb)	0	0	0	0	0	Blast, HLS, BLB
Sankel	0					BLB
Organophosphorus :						
Hinosan			0			Blast, HLS
Antibiotics :						
Streptocyclin		0	0	0	0	BLB (seed treatment & spraying)
Agrimycin		0		0		BLB (seed treatment & spraying)
Cellomate	0					BLB
Kasumin			0			Blast

Remarks : BLB : Bacterial leaf blight

HLS : Helminthosporium leaf spot (Brown spot).

I-2. Insecticides

Insecticide	Bihar	Madhya Pradesh	Mysore	Maharashtra	Gujarat	Insect pest
Organic chlorine :						
DDT (D)	0	0				Termite
BHC (D, G)	0	0		0	0	Stem borer, Armyworm, Leaf beetle, Gundhi bug, Hispa
Lindane (G)		0		0	0	Stem borer
Endrin (EC, D)	0	0	0	0	0	Stem borer, Case worm, Caterpillar, Hispa
Aldrin (D)	0	0				Termite
Endosulfan(EC) (Thiodan)		0				Plant & leaf-hoppers
Organic phosphorus:						
Parathion (EC, D) (Paramar)	0	0	0		0	Stem borer, Armyworm, Case worm, Leaf roller
Malathion (EC)		0		0	0	Armyworm, Leaf roller, Plant & leafhoppers
Sumithion (EC)				0		Leaf roller
Thimet (G) (Phorate)			0	0		Gall midge

(I-2. Continued)

Insecticide	Bihar	Madhya Pradesh	Mysore	Maharashtra	Gujarat	Insect pest
Dimecron (EC) (Phosphamidon)		0	0		0	Leaf roller, Plant & leafhoppers
Dimethoate (EC)			0			
Diazinon (EC, G)		0	0			Plant & leafhoppers, Gall midge
Carbamate :						
Carbaryl (WP, D) (Sevin)				0	0	Leaf roller, Army-worm
Compound :						
Sevidol (D) (Sevin + lindane)				0		Stem borer, Plant & leafhoppers

Remarks :
- EC : Emulsifiable concentrate
- WP : Wettable powder
- D : Dust
- G : Granule

APPENDIX II. COMMONLY USED CHEMICALS FOR PADDY RICE PROTECTION IN JAPAN

The following tables were made on the basis of the standard of plant protection in some prefectures of Japan. The tables include main species of diseases or insect pests and the chemicals recommended and widely used for their control. These data are presented here for the reference of Indian experts to the situation of paddy protection in Japan.

II-1. Fungicides

Disease	Fungicide and formulation*
Virus diseases :	
Dwarf (Rice dwarf virus)	See green rice leafhopper (the vector insect) in the next table.
Stripe (Rice stripe virus)	See smaller brown planthopper (the vector insect) in the next table.
Black-streaked dwarf (Rice black-streaked dwarf virus)	Do.
Mycoplasma disease :	
Yellow dwarf (Yellow dwarf mycoplasma)	See green rice leafhopper (the vector insect) in the next table.
Bacterial disease :	
Bacterial leaf blight (*Xanthomonas oryzae*)	Celdion (WP), Phenazine (WP, D), Sankel (WP, D), Merkdelan (WP), Cellomate (WP), Shirahagen C (WP), Cellodelan (WP).

Fungous diseases :

Blast .... (*Piricularia oryzae*)	Hinosan (EC, D), Kitazin P (EC, D, G), Inezin (EC, D), Conen (EC, D), Kasumin (SC, WP, D, T), Bla-S (EC, WP, D), Rabcide (WP, D), Rabcon (D), Kasran (D), Kasu-Conen (D). Seed treatment : Ruberon (ST, SG, P), Riogen (ST, SP), Mer (ST, SP, P) Uspulun (ST, SP), Microgin (ST, SP, P), Sanzeron (ST), Toaron (SG).
Sheath blight .... (*Pellicularia sasakii*)	Neoasozin (SC, D), Mon (EC, D), Mongare (SC, WP, D), Mongaren (EC), Monkil (SC, WP), Shinmonkil (D), Monkit (SC, D), Monsan (WP, D), Arsin (EC), Arsen (D), Monzet (WP, D), Polyoxin PS (EC, D), Polyoxin Z (D).
Helminthosporium leaf spot .... (*Cochliobolus miyabeanus*)	Hinosan (EC, D), Kitazin P (EC, D, G), Inezin (EC, D), Conen (EC, D), Triazine (WP, D), Maneb Dithane M (WP), M Difar (WP), Sanipa (WP, D), Polyram S (WP), Bla-S U (D), Kasumate (D). Seed treatment : See blast
Panicle browning .... (*Helminthosporium*, *Cercospora*, *Fusarium*, etc.)	See Helminthosporium leaf spot.
Cercospora leaf spot .... (*Sphaerulina oryzina*)	Triazine (WP, D) Seed treatment : See blast.
Rhynchosporium blight..... (*Fusarium nivale*)	Hinosan (EC, D), Bla-S U (D). Seed treatment : See blast.
Stem rot .... (*Helminthosporium sigmoideum* & *H. sigmoideum* var. *irregulare*)	Hinosan (EC, D), Kitazin P (EC, D, G), Inezin (EC, D), Conen (EC)

Downy mildew .... (*Phytophthora macrospora*)	Nursery bed treatment : Copper fungicides (WP).
"Bakanae" disease .... (*Gibberella fujikuroi*)	Seed treatment : See blast
False smut .... (*Ustilaginoidea virens*)	Bla-S U (D), Copper fungicides (WP, D),
Seed and seedling rot...... (*Pythium, Achlya, Pythiomorpha, Dictyuchus*)	Nursery bed treatment : Carbamizol (SC), Captan (WP). Seed treatment : See blast
Damping off .... (*Fusarium, Rhizoctonia*)	Nursery bed treatment : Tachigaren (SC, D), Grand (EC), Captan (WP). Seed treatment : See blast.
Dorokana .... (*Diatomaceae*)	Nursery bed treatment : Lime sulphur

Remarks * Formulation :

EC	:	Emulsifiable concentrate
SC	:	Soluble concentrate
WP	:	Wettable powder
SP	:	Soluble powder
P	:	Powder for seed coating
D	:	Dust
G	:	Granule
SG	:	Soluble granule
ST	:	Soluble tablet

II-2. Insecticides

Insect pest	Insecticide [1] and formulation [2]
Stem borers :	
Rice stem borer .... (*Chilo suppressalis*)	Papthion (EC, D), Baycid (EC, D), Sumithion (EC, D), Diazinon (G), Padan (SP, D, G), Spanon (D, G).
Yellow rice borer .... (*Tryporyza incertulas*)	Papthion (EC, D), Baycid (EC, D), Sumithion (EC, D).
Leaf feeders :	
Rice-plant skipper .... (*Parnara guttata*)	Dipterex (EC, D), Padan (D).
Armyworm .... (*Leucania separata*)	Dipterex (EC, D)
Grass leaf roller .... (*Cnaphalocrocis medinalis*)	Dipterex (EC, D), Padan (D).
Rice green caterpillar .... (*Naranga aenescens*)	Papthion (EC, D), Sumithion (EC), Diazinon (EC, D), Padan (D).
Planthoppers :	
Smaller brown planthopper [3]..... (*Laodelphax striatellus*)	Di-Syston (G), Kilvar (EC), Diazinon (G), Suncide (WP)
White-backed planthopper ...... (*Sogatella furcifera*)	Malathion (EC, D), Di-Syston (G), Pestan (EC, D), Diazinon (G), Suncide (WP, D), Denapon (EC, WP, D), Mipcin (D, G), Meobal (WP, D), Tsumacide (D), Bassa (EC, D).
Brown planthopper .... (*Nilaparvate lugens*)	Di-Syston (G), Pestan (EC, D), Diazinon (G), Suncide (WP, D), Denapon (EC, WP, D), Mipcin (D, G), Mobal (WP, D), Tsumacide (D), Bassa (EC, D).

Leafhopper :	
Green rice leafhopper[4)] .... (*Nephotettix cincticeps*)	Malathion (EC, D), Di-Syston (G), Kilvar (EC), Pestan (EC, D), Baycid (EC, D), Diazinon (G), Suncide (WP, D), Denapon (EC, WP, D), Mipcin (EC, D, G), Meobal (WP, D), Tsumacide (D), Bassa (EC, D).
Bug :	
Black rice bug .... (*Scotinophara lurida*)	Baycid (EC, D), Sumithion (EC, D).
Beetle :	
Rice leaf beetle .... (*Oulema oryzae*)	Papthion (EC, D), Sumithion (D), Denapon (WP, D), Bassa (D), Padan (D)
Stem maggots (Flies):	
Rice stem maggot .... (*Chlorops oryzae*)	Dimethoate (G), Pestan (G).
Paddy stem maggot .... (*Hydrellia sasakii*)	Dimethoate (G)
Leaf miners (Flies):	
Rice leaf miner .... (*Agromyza oryzae*)	Dimethoate (G), Papthion (EC, D), Diazinon (G), Padan (SP).
Smaller rice leaf miner ...... (*Hydrellia griseola*)	Dimethoate (G), Pestan (EC, D), Diazinon (G), Papthion(EC, D), Sumithion(EC)
Nematode :	
Rice white-tip nematode...... (*Aphelenchoides besseyi*)	Baycid (EC), Sumithion (EC), Padan (SP), Sassen (EC) for seed treatment

Remarks

1) Other names : Dimethoate -- Rogor ; Di-Syston -- Disulfoton, Thio-demeton; Pestan -- Mecarbam; Papthion -- Cidial, Elsan; Dipterex -- Trichlorfon, Trichlorphon; Baycid -- Lebaycid, Fenthion ; Sumithion -- Fenitrothion; Suncide -- Arprocarb; Denapon -- Sevin, Carbaryl; Padan -- Cartap; Spanon -- Galecron.

2) Formulation : See the remarks of the preceding Table II-1.

3) Vector of stripe and black-streaked dwarf viruses.

4) Vector of dwarf virus and yellow dwarf mycoplasma.

APPENDIX III. REGULATIONS FOR APPLICATION OF AGRICULTURAL CHEMICALS IN JAPAN

Chemical control of pests and diseases is the most prompt and effective method of plant protection, but there is some anxiety of causing environmental pollution owing to the acute or chronic toxicity of the applied chemicals. The problems of environmental pollution caused by various industrial activities are now hotly debated in Japan by the people of all social standings, and the claim for its prevention has grown to a wide spread public opinion throughout the country. The situation does not allow the agricultural chemicals to remain free from the force of argument.

Consequently Japanese Government has adopted stringent regulations against the application of highly toxic agricultural chemicals as shown in Table III-1. Moreover, the Government has started to establish tolerances for residue amount and directions for safe application of all the agricultural chemicals used in Japan to all the main farm products. The work is now under way, and Table III-2 shows the tolerances for residue amount so far established and promulgated. The directions for safe application are settled so that the residues of the applied chemicals will not exceed the above mentioned tolerances for residue amount. Table III-3 shows the directions for safe application to rice plant as an example. The similar regulations are being established for all the combinations of chemicals and crop plants.

In India the regulations for application of agricultural chemicals are not yet established. It is of course depending upon the social, economic and natural conditions whether the regulations of that kind are required or not. We just present here the actual situation in Japan for the information of Indian authorities concerned in plant protection.

The team is indebted to Dr. K. Yoshida and Mr. H. Nakamura, who are the authorities of the Agricultural Chemicals Inspection Station, for their helpful suggestions made in the preparation of the manuscript.

III-1. Regulations for application of agricultural chemicals by laws, ordinances, or administrative instructions in Japan.

Name of chemicals	Regulations	Reason for the regulation
Organomercury fungicides:		
PMA (Riogen, Ceresan), PMF (Mer), EMP (Ruberon), MMC (Uspulun), etc.	Prohibited to spray and dust. Applicable for seed disinfection alone.	Chronic mammalian toxicity of the residues.
Organochlorine fungicides:		
PCBA (Blastin)	Prohibited to apply.	Phytotoxicity of the residues.
Inorganic insecticide :		
Lead arsenate	Fruit trees : Prohibited to apply 45 - 150 days (different with the species of fruit trees) before harvest. Vegetables : Prohibited to apply after flowering stage.	Chronic mammalian toxicity of the residues.
Insecticide from natural source:		
Rotenone (Derris)	Prefectural governer can specify the area where the chemical cannot be applied without the permission of him.	Fish toxicity.
Organochlorine insecticides :		
DDT	Prohibited to apply and sell	Chronic mammalian toxicity of the residues.

(III-1. Continued)

Name of chemicals	Regulations	Reason for the regulation
BHC	Prohibited to apply and sell	Chronic mammalian toxicity of the residues.
Aldrin	Prohibited to apply except to use for soil treatment of nursery bed for forest trees	Chronic mammalian toxicity of the residues in the soil.
Dieldrin	Prohibited to apply except to felled trees	Do.
Endrin	Prohibited to apply except to young citrus trees before fruiting age. Prefectural governer can specify the area where the chemical cannot be applied without the permission of him.	Chronic mammalian toxicity of the residues and fish toxicity
Telodrin	Prefectural governer can specify the area where the chemical cannot be applied without the permission of him.	Fish toxicity
Benzopien (Endo-sulfan, Thiodan, Malix)	Do.	Do.
<u>Organophosphorus insecticides</u> :		
Parathion-methyl (Folidol-methyl)	Prohibited to apply	Acute mammalian toxicity
Parathion-ethyl (Folidol-ethyl)	Do.	Do.
TEPP (Tepp, Nikkarin-T)	Do.	Do.

(III-1. Continued)

Name of chemicals	Regulations	Reason for the regulation
Demeton-S-methyl (Meta-Systox)	License system. Permission is needed to use.	Acute mammalian toxicity
Fluoroacetamide (Fussol, Yanock)	Do.	Do.
<u>Fumigant</u> :		
Aluminium phosphide (Phostoxin)	Do.	Do.
<u>Rodenticide</u> :		
Sodium fluoroacetate (Fratol)	Do.	Do.
<u>Herbicides</u> :		
PCP	Prefectural governer can specify the area where the chemical cannot be applied without the permission of him.	Fish toxicity
2, 4, 5-T	Prohibited to apply	Chronic mammalian toxicity (causing malformation).

Remarks Endrin, Telodrin, Thiodan, Meta-Systox, Dimecron and Thimet have never been used for paddy pests since they have introduced into Japan.

III-2. Tolerances for residue amount of agricultural chemicals in vegetable foods in Japan.

Foods	Chemicals (ppm)										
	DDT	BHC	Aldrin	+ Dieldrin	Parathion	EPN	Arsenic	Lead	Malathion	Diazinon	Carbaryl*
Unhusked rice	0.2	0.2	0	0	0	0.1	-	-	0.1	0.1	1.0
Summer orange (peal)	"	"	"	"	0.3	0.5	3.5	5.0	-	-	-
Summer orange (flesh)	"	"	"	"	"	0.1	1.0	1.0	-	-	-
Japanese pear	"	"	"	"	"	"	3.5	5.0	-	0.1	-
Grapevine	"	"	"	"	"	"	1.0	1.0	-	"	1.0
Peach	"	"	"	"	"	"	"	"	0.5	-	-
Apple	"	"	"	"	"	"	3.5	5.0	-	0.1	1.0
Strawberry	"	"	"	"	"	"	1.0	1.0	0.5	"	-
Cabbage	"	"	0.02	"	"	"	-	-	2.0	-	-
Cucumber	"	"	"	"	"	"	1.0	1.0	0.5	-	-
Japanese radish (leaves)	"	"	"	"	"	"	-	-	-	-	-
Japanese radish (root)	"	"	"	"	"	"	-	-	-	-	-
Tomato	"	"	"	"	"	"	1.0	1.0	0.5	0.1	-
Spinach	"	"	0	"	"	"	"	5.0	-	-	1.0
Potato	"	"	"	"	0	"	"	1.0	0.5	0.1	0.1

Tea (non-fermented)	"	"	"	"	0.3	"	-	-	-	"	1.0
Mandarin orange	"	"	"	"	"	"	-	-	0.5	-	"
Persimmon	"	"	"	"	"	"	-	-	"	0.1	"
Eggplant	"	"	0.02	"	"	"	-	-	"	"	-
Chinese cabbage	"	"	"	"	"	"	-	-	-	"	-
Pimiento	"	"	"	"	"	"	-	-	0.5	"	-
Lettuce	"	"	"	"	"	"	-	-	-	"	-
Squash	"	"	-	-	"	-	-	-	-	-	-
Burdock	"	"	-	-	"	-	-	-	-	-	-
Japanese turnip (leaves)	"	"	-	-	"	-	-	-	-	-	-
Japanese turnip (root)	"	"	-	-	"	-	-	-	-	-	-
Soybeans	"	"	-	-	"	-	-	-	-	-	-
Azuki beans	"	"	-	-	"	-	-	-	-	-	-

Remarks . - : The tolerance is not yet settled.

* : Other names : Denapon, Sevin.

III-3. Directions for safe application of agricultural chemicals to rice plant in Japan.

Chemicals	Regulations (for rice plant)
DDT	Prohibited
BHC	Do.
Aldrin & Dieldrin	Do.
Endrin	Do.
EPN	Prohibited to apply 30 (D) or 60 (EC, WP) days before the harvest. Application is restricted to 3 times or less at intervals of 7 days or more.
Arsenic	-
Lead	-
Malathion	Prohibited to apply 7 days before the harvest. Application is restricted to 6 times or less at intervals of 7 days or more.
Diazinon	Prohibited to apply 21 days before harvest. Application is restricted to 4 times or less at intervals of 7 days or more.
Carbaryl*	Prohibited to apply 14 (D, G) or 45 (EC, WP) days before the harvest. Application is restricted to 5 times or less at intervals of 7 days or more.

Remarks 1) Parathion is omitted from this table because it had been prohibited to manufacture in Japan by the time when the tolerances are established.

2) EC, WP, D, G : See the remarks of Table II-1.

3) * : See the remarks of Table III-2.

APPENDIX IV. TOXICITY OF MAJOR AGRICULTURAL CHEMICALS USED FOR PADDY RICE PROTECTION IN INDIA AND JAPAN

According to "Agricultural Chemicals Regulation Law" in Japan, no agricultural chemicals are allowed to sell without registration with the Minister of Agriculture and Forestry. All registered chemicals must put labels showing their toxicity to mammals and fishes and other necessary directions for effective and safe use.

1. Mammalian Toxicity

Agricultural chemicals are classified in Japan into four groups according to their mammalian toxicity. Detailed classification, however, is determined in each formulated product after due consideration of its contents of active ingredient and toxicity based on experimental data. The following classification is rough standard based on acute oral toxicity against mice (Median lethal dose (LD_{50}), mg/kg).

Special poisonous agent	less than 15
Poisonous agent	less than 30
Deleterious agent	less than 300
Ordinary agent	300 or more.

At present, no special poisonous agent is allowed to be used and will be registered any more. The use of poisonous and deleterious agents is regulated under the provision of the "Poisonous and Deleterious Substance Control Act".

2. Fish Toxicity

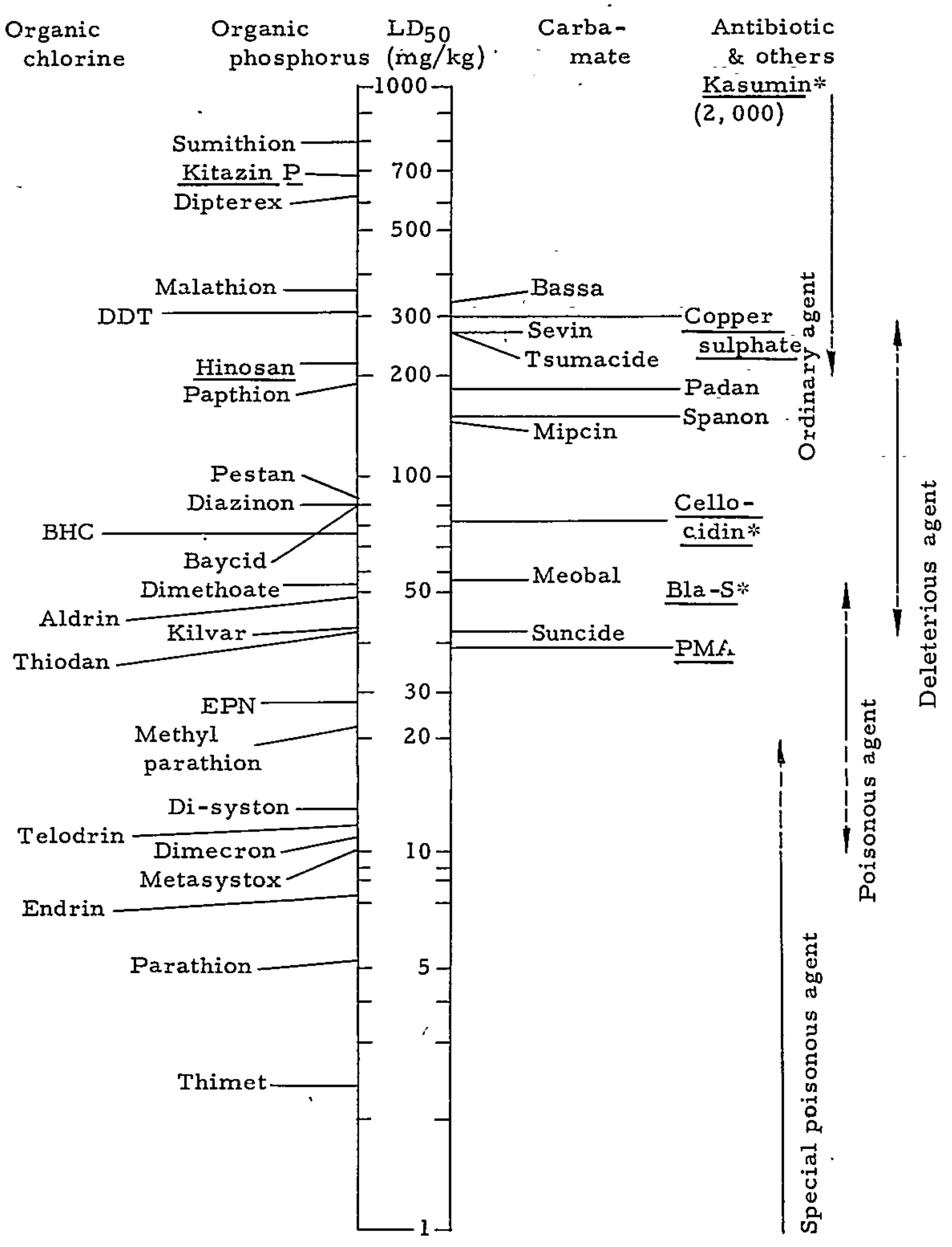
Agricultural chemicals are classified in Japan into three groups according to their fish toxicity. Each chemical is ranked in one of them in reference to contents of active ingredient and its toxicity to fishes, shells and other aquatic organisms, regardless of the type of formulated products. The following classification is rough standard based on median tolerance limit for exposure period of 48 hr(TLm-48) against carp, and precautions for safe use are also described.

Rank A : (Above 10 ppm). No danger of fish toxicity is expected when used according to instruction in the label.

B : (0.5 - 10 ppm). The same as A, but intensive care must be taken when used over an extensive area.

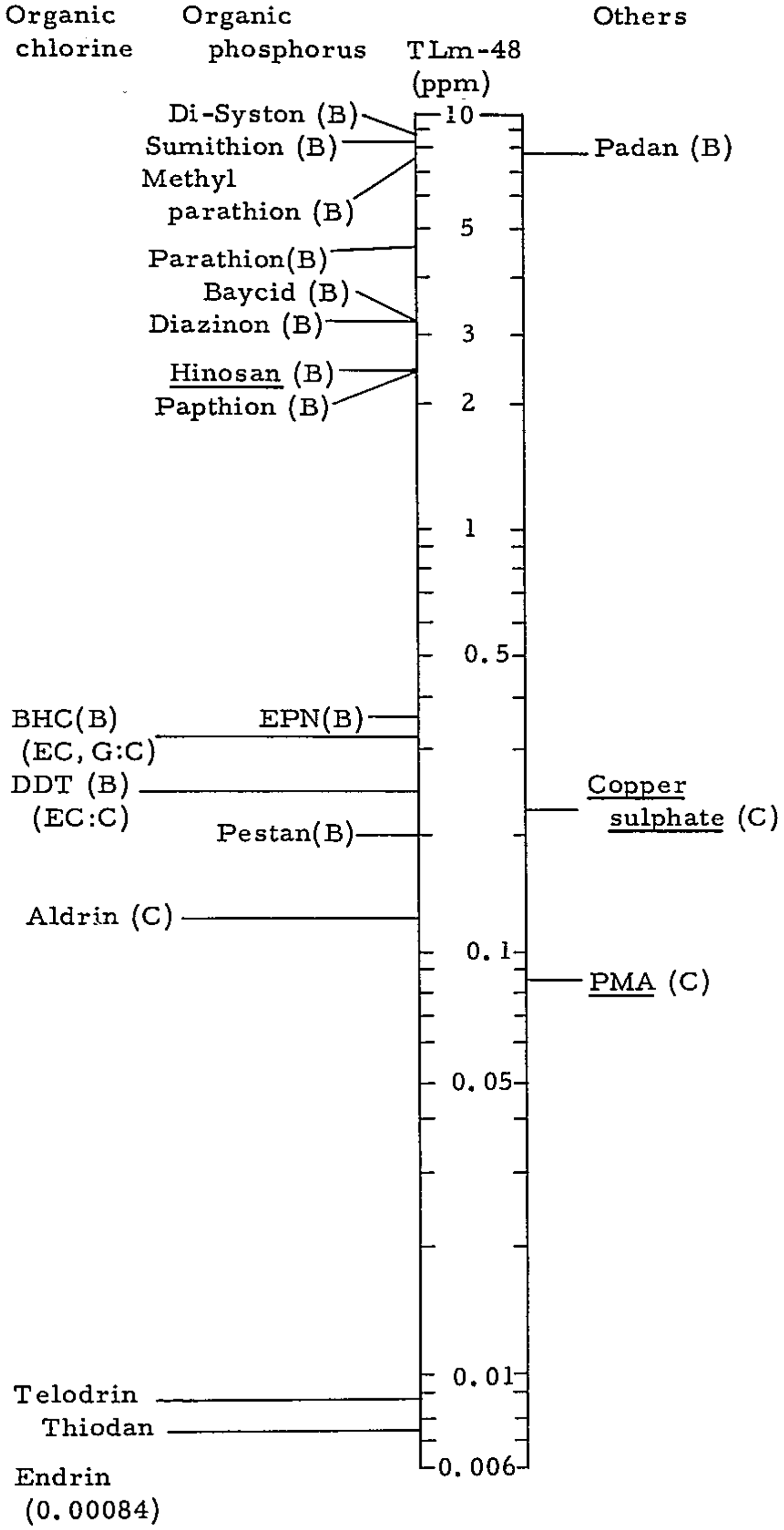
C : (Less than 0.5 ppm). Danger of fish toxicity is expected unless intensive care is taken so that chemicals will not contaminate lakes, rivers or other waters.

Besides there are some registered chemicals with extremely high toxicity such as endrin, Telodrin and Thiodan. The use of these chemicals is under strict control of the Act and ordinances. At present, these chemicals are not allowed to use for paddy, and no newly developed chemicals belonging to rank C will be registered any more for use in paddy.



Remarks : Underlined chemicals indicate fungicides, and an asterisk (*) indicates antibiotics.

IV-1. Mammalian toxicity of common chemicals used for paddy.



Remarks : The following chemicals show TLm-48 values above 10 ppm :
A : Kilvar, Metasystox, Spanon, Kasumin*, Bla-S*, Cellocidin*.

B : Dimethoate, Dipterex, Malathion, Kitazin P, Bassa, Suncide, Meobal, Sevin, Mipcin, Tsumacide.

IV-2. Fish toxicity of common chemicals (technical products) used for paddy.