PROGRESS REPORT
OF
JAPAN-INDONESIA JOINT FOOD CROP RESEARCH PROGRAM

(MARCH 1971 - JUNE 1973)

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO, JAPAN
JUNE, 1973

CONTENTS

1. Conclusion of the Agreement

A Japanese survey mission organized by the Overseas Technical Cooperation Agency (OTCA) of Japan, headed by Mr. S. Hoshide, visited Bogor on October 1969 and discussed with Mr. Sadikin Sumintawikarta, Director General of Agriculture, and Dr. B. H. Go, Director of the Central Research Institute for Agriculture, the agricultural research cooperation between Japan and Indonesia.

From February to March 1970, the second survey mission organized by OTCA, headed by Dr. Y. Iwata, visited Bogor and had a full discussion with Mr. Sadikin Sumintawikarta and Dr. B. H. Go and on the 25th of March 1971, Dr. Y. Iwata and Mr. Sadikin Sumintawikarta signed a "Record of Discussions" concerning "Japan-Indonesia Joint Food Crop Research Program".

Thereafter, the Government of Japan and the Government of the Republic of Indonesia carried on negotiations and reached an agreement which was signed by Mr. S. Edamura, counsellor of the Japanese Embassy in Jakarta, and Mr. Sadikin Sumintawikarta, Director General of Agriculture, on the 23rd of October 1970. (Appendix 1)

The Program consists of the following :

(1) Research work through interdisciplinary approach on three themes.

 (a) Study on ecology and control of major diseases of food crops.

 (b) Study on forecast of occurrence of major diseases and vectors of virus diseases of food crops.

 (c) Plant physiological study on physiological disorders and major diseases of food crops.

(2) Exchange of information, samples, materials and research reports.

(3) Exchange of researchers and other personnel.

(4) Development of research capabilities of the Indonesian personnel and other activities to be agreed upon between the two Governments.

Japanese researchers and consultants who will take part in research cooperation at the Central Research Institute for Agriculture (CRIA) in Bogor are: (a) Team leader, (b) Researcher on plant pathology, (c) Researcher on plant physiology, (d) Researcher on forecast of vectors of virus diseases (virologist), and (e) Consultants on short term assignment. The duration of the program will be 5 years from the date of conclusion of the Agreement.

2. Japanese experts and Indonesian counterparts

Dr. Y. Iwata (Team leader, plant pathologist), Dr. T. Nishizawa (plant pathologist), and Mr. F. Yazawa (plant physiologist) arrived at Bogor in March 1971, and Mr. H. Satomi (plant virologist) arrived in May 1971. Thereafter, they carried on cooperative research works with Indonesian counterparts in the Subdivision of Plant Pathology and the Subdivision of Plant Nutrition of CRIA.

Mr. H. Mikoshiba from the Tropical Agriculture Research Centre arrived at Bogor in October 1971, as a shortterm consultant of the Program. Mr. T. Yamamoto (plant pathologist) and Mr. M. Higuchi (plant physiologist) also from the Tropical Agriculture Research Centre, arrived at Bogor in April 1972, as shortterm consultants of the Program.

Dr. T. Nishizawa and Mr. F. Yazawa returned to Japan in March 1973, upon expiration of their terms of office, and Mr. H. Satomi returned to Japan in May 1973. As their successors, Dr. T. Kajiwara (plant pathologist), Dr. M. Iwaki (plant virologist) and Mr. M. Miyake (plant physiologist) arrived at Bogor on March, April and May, respectively. Mr. M. Higuchi and Mr. H. Mikoshiba returned to Japan in May and June 1973, respectively, upon expiration of their terms of office.

On the Indonesian side, from the beginning of the Program Mr. Dahro, former Director of CRIA, Mr. I. N. Oka, Head of the Division of Pests and Diseases, and Mrs. Paransih Isbagijo, Head of the Division of Plant Physiology, have cooperated with the Japanese team for the development of the Program.

At present, Mr. Suharsono, Director of CRIA, Mr. Dandi Sukarna, Acting Head of the Division of Pests and Diseases; Mrs. Paransih Isbagijo; Dr. Rusli Hakim in the Division of Agronomy; Dr. I.D.M. Tantera, Head of the Subdivision of Plant Pathology; and Mr. M. Ismunadji, Head of the Subdivision of Plant Nutrition, are cooperating in the implementation of the Program covering research administration and research activities.

Mr. Mukelar A, Mr. Machmud, Mr. Roechan, Mr. Sudjadi, Mrs. Nunung H.A. and Mrs. Hartini R.F. in the Subdivision of Plant Pathology are conducting research works in the field of plant pathology or plant virology in cooperation with Japanese experts. In the Subdivision of Plant Nutrition, Mr. I. Zulkarnaini, Miss Sismiyati, Miss Ratna Hasan, Mr. M. Fathurochim, Mr. Lukman N.H., Miss S. Insijah and Mr. Hidajat are carrying on research cooperation in the field of plant nutrition or chemical analysis.

3. Budget and major equipments.

Budget for equipments and consumables, and also for the training of counterparts in Japan from 1970/1971 to 1972/1973 are as follows.

	1970/71	1971/72	1972/73	Total
1. Equipments & consumables	$92,200 (¥33,192)	$100,481 (¥30,948)	$104,490 (¥32,183)	$297,171 (¥96,323)
2. Training of counterparts		$3,600 (¥1,108)	$13,973 (¥4,303)	$17,573 (¥5,411)

Note: 1. Equipments include greenhouses, Jeeps and Trucks.
2. The amount in parentheses: in thousand yen.
US$ = ¥360 : 1970/71
US$ = ¥308 : 1971/72, 1972/73

In 1973/74 about ¥25,000,000 and ¥4,300,000 are allocated for equipments and consumables, and for the training of counterparts in Japan, respectively. The Central office of OTCA in Tokyo is taking necessary measures based on the list of equipments requested by the Program in which a greenhouse of 202.5 m^2 for plant physiological research and a small one (40.5 m^2) for rearing the insect vectors of virus disease are included.

Major equipments and machineries provided by OTCA from 1970/71 to 1972/73 are as follows.

1970/1971

A. Plant pathology and virology

Thermostatic hot air sterilizer	2	Bacterial filter	1
Shaker	1	Slide duplicator	1
Wide range incubator	3	Sliding microtome	1
Autoclave	3	Rotary microtome	1
Arnold sterilizer	1	Diesel generator	1
Magnetic stirrer	1	Insect light trap	2
Homogenizer	1	Insect specimen cabinet	2
Portable high-speed centrifuge	1	Spore trap	1
Centrifuge	1	Copier	1
Glass electrode pH meter	1	Electronic computer	1
Vacuum pump	1	Hand computer	2
Freezer	2	Typewriter	2
Deep freezer	1	Transformer	10
Refrigerator	3	Slide auto regulator	8
Camera	2	Compressor	1
Microscope	4	Air conditioner	4
Stereoscopic microscope	2	Jeep	1
Microphotographic unit	1	Direct reading balance	1
Enlarger	1	Thermostatic water bath	3
Photographic stand	1	Seed bed warmer set	2
Kalver film printer	1		

B. Plant physiology

Constant temperature oven	1	Carbohydrate determination apparatus	1
Electric incubator	1	Soil & plant testing kit	1
Willey's cutter mill	1	Micro diffusion analysis unit	1
Ball mill	1	Soil humus determining apparatus	1
Shaker	1	Refrigerator	2
Homogenizer	1	Deep freezer	1
Rotary vacuum evaporator	1	Spectrophotometer	1
Direct analytical balance	1	Flame photometer	1
pH meter	2	Transformer	6
Portable Eh meter	1	Diesel generator	1
Portable conductivity meter	1	Demineralizer	1
Thinlayer chromatography apparatus	1	Electric water bath	1
Nitrogen semimicro determination apparatus	2	Electronic computor	1

Handling computor	1
Typewriter	1
Muffle furnace	1
Auto still for distilled water	1
Fan for draft chamber	1
Jeep	1
Air cleaner for microelement laboratory	1
Leaf area meter	1
Grain fertility tester	1
D.O. meter	1
Camera	1

1971/72

A. Plant pathology and virology

Green house	4
Jeep	1
Soil sterilizer	1

B. Plant physiology

Low constant temperature water bath	1
Draft chamber	1
Universal projector	1
Microscope	1
Photosystem for microscope	1
Water test set	1
Microtome	1
Fat collecting set	1
Top pan direct reading balance	1
Balance	3
Dilute system	1
Automatic voltage regulater	1
Auto evaporation meter	1
Robitch sunbeam meter	1
Self-registering ground thermometer	2
Grain moisture meter	1
Lux meter	2
Dust collector	1
Auto balance type temperature recorder	1
Auto solar radiation recorder	1
Constant temperature oven	1
Cation exchangeable capacity measuring apparatus	3
Atomic absorption photometer	1
Double beam grating spectro-photometer	1
Paddy husker	1
Tohmi	1
Grain separator	1
Rice clearing machine	1
Rice plant capacity checker	1
SK type drawing set	1

1972/73

A. Plant Pathology and virology

Constant temperature oven	3	Portable photometer	1
Constant low temperature incubator	5	Air conditioner	2
Deep freezer	1	Microscope for universal research	1
Water bath	1	Microscope	4
Paraffin oven	1	Electro-magnetic atomizer	2
Auto still for distilled water	1	Slide regulator	10
Pipet washer	1	Automatic voltage regulator	6
Pipet dryer	1	Clean bench	1
Hanger dryer for glassware	2	Labo-cart	4
Homogenizer	1	Water test set	1
Handy aspirator	2	Standard thermometer	1
Turn table	1	Storage cabinet for chemicals	4
High-speed centrifuge	1	Drying shelf	5
Universal mills	1	Power tiller	1
Electric microtome knife sharpener	1	Light truck	1
Electronic temperature poly-recorder	1	Electronic ricopy	1
Lux meter	1	Steel black board	1
Portable pH meter	1	Electronic calculator	3

B. Plant physiology

Hot wind circulating thermostatic drying oven	1	Autoclave	1
Willey's cutter mill	2	Laboratory bench	3
Grain moisture meter	1	Laboratory bench unit	4
Paddy shattering habit tester	1	Glassware drying shelf	6
Van Slyke amino-N determining apparatus	1	Grain volume weight measuring apparatus	2
Thermocouple thermometer	1	Grain hardness tester	1
Thermostatic water bath	1	Gas burner for glass work	1
Acme type thermostatic drying oven	2	Photographing stage with camera stand & lighting set	1
Rotary shaker	1	Thermostatic water bath for pot experiment	1
Centrifuge, table model	1	Soil suspension pipetter for mechanical analysis	1
Warburg thermostatic water bath & manometers	1	Soil humus determining apparatus	2
Air compressor	1	Small size arista breaker	1

Soybean sieve	1	Light truck	1
Rapid battery charger	1	Universal drawing instruments	1
Slide automatic transformer	10	Pocket electronic calculator	2

Besides the equipments and machineries described above, the tools, glassware, chemicals, and books and scientific journals required for research works were also provided from OTCA.

4. Research activities and results.

As mentioned above, the Japanese experts arrived at Bogor in March 1971 and received the equipments and consumables based on the budget for 1970/71 in June 1971. However, at that time basic laboratory conditions such as capacity of electricity, water supplies, gas, etc. were not satisfactory to operate the equipments and machineries for laboratory works. Furthermore, the number of counterparts was not enough, particularly in the Subdivision of Plant Nutrition.

The experts have made much efforts to improve the laboratory conditions and to obtain the researchers and research assistants to carry out the research cooperation. At the same time, the experts carried out the experiments in the laboratory and greenhouse under the existing conditions insofar as possible, and also conducted field surveys as well as field tests according to the research schedule.

The construction of four green houses for the researches in plant pathology and virology was completed in April 1972, and other equipments and consumables for the budget of 1971/72 arrived on May 1972. Laboratory equipments and consumables for the budget of 1972/1973 were received at CRIA in January and March 1973.

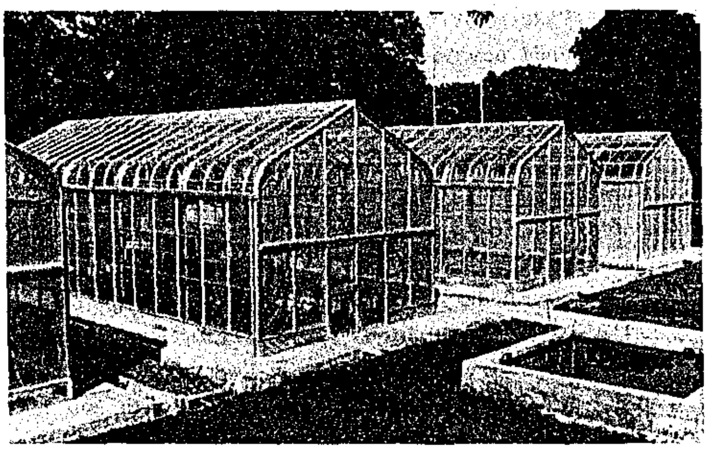

Fig. 1 Four green houses for plant pathological and virological research, constructed in April 1972

Although the arrangement of basic conditions for laboratory work should be continued, conditions for research work are being improved steadily, and the Program is getting on the right track in cooperation with Indonesian research administrators and research workers concerned.

Concerning the researchers and research assistants in cooperation, they have increased in number and their research capabilities are being developed. Some of them received training in Japan in their respective research fields.

Researches in the Program have been carried out on the following items.

A. Plant pathological and virological research.

a. Survey on the occurence of food crop diseases.

b. Study on bacterial leaf blight of rice.

b-1. Study on varietal resistance of rice to bacterial leaf blight.

b-2. Study on variation in virulence of *Xanthomonas oryzae.*

b-3. Study on bacteriophage of *Xanthomonas oryzae.*

b-4. Study on chemicals for controlling bacterial leaf blight.

c. Study on sheath blight and stem rot of rice.

c-1. Study on varietal resistance of rice to sheath blight.

c-2. Study on chemicals for controlling sheath blight and stem rot of rice.

d. Study on the virus diseases of rice and their vectors.

d-1. Identification of virus disease of rice.

d-2. Seasonal prevalence of leafhoppers and planthoppers in the rice field.

d-3. Varietal difference to the occurence of rice virus diseases and their vectors among some rice varieties.

e. Study on downy mildew of corn.

e-1. Field observation on natural infection of *Sclerospora maydis.*

e-2. Field study on conidial dissemination under natural conditions.

e-3. Field observation on downy mildew infection of corn in Java.

e-4. Occurrence of downy mildew on Gelagah (*Saccharum spontaneum L*).

B. Plant physiological research.

a. Survey on the occurrence and distribution of physiological disorders of lowland rice.

b. Study on yield and nitrogen nutrient of lowland rice on physiologically disordered fields.

c. Physiological disease of rice in Cihea.

d. The effects of fertilization on growth, nitrogen nutrition and the occurrence of Helminthosporium leaf spot in lowland rice.

e. The effects of straw incorporation on growth and nutrient status of lowland rice.

f. Study on root activity of rice varieties.

g. Study on the toxic action of biuret in urea on the growth of rice seedlings.

h. Study on fertilizer response of soybean plant.

Results of research obtained so far are summarized in the following.

A. Plant pathological and virological research.

a. Survey on the occurrence of food crop diseases.

To study the present situation of the occurence of food crop diseases in Indonesia, surveys were conducted in several localities in Java, Bali, South Selawesi, Lampung and South Kalimantan.

The diseases of food crops observed during these surveys are as follows :

Rice: yellow dwarf, grassy stunt, tungro, bacterial leaf blight (*Xanthomonas oryzae*), bacterial leaf streak (*Xanthomonas translucens* f. sp. *oryzicola*), blast (*Pyricularia oryzae*), sheath blight (*Rhizoctonia solani*), stem-rot (*Leptosphaeria salvinii* and *Helminthosporium sigmoideum* var. *irregulare*), Helminthosporium leaf spot (*Cochliobolus miyabeanus*), Cercospora leaf spot (*Sphaerulina oryzina*), false smut (*Ustilaginoidea virens*), sheath net-blotch (*Cylindrocladium scoparium*), Fusarium leaf spot (*Fusarium nivale*), panicle blight (many kinds of pathogen).

Corn: downy mildew (*Sclerospora maydis*), rust (*Puccinia sorghi*), leaf spot (*Cochliobolus heterostrophus*), sheath blight (*Rhizoctonia solani*), leaf blight (*Trichometasphaeria turcina*).

Wheat and barley: scab (*Gibberella zeae*), brown rust (*Puccinia triticina*).

Sweet potato: witches' broom, leaf spot (*Phyllosticta batatas*), scab (*Elsinoe batatas*).

Pulses: Peanuts – witches' broom, mosaic, bacterial wilt (*Pseudomonas solanacearum*), rust (*Puccinia arachidis*), southern blight (*Corticium rolfsii*), leaf spot (*Mycosphaerella berkeleyii*). Soybeans – mosaic, bacterial pustule (*Xanthomonas phaseoli* var. *sojensis*), rust (*Phakopsora pachyrhizi*), stem rot (*Corticium rolfsii*), Septoria brown spot (*Septoria glycines*). Kacang hijau (*Phaseolus radiatus L.*) – mosaic, witches' broom, southern blight (*Corticium rolfsii*), powdery mildew (*Sphaerotheca fuliginea*), damping off (*Rhizoctonia* sp., *Pythium sp.).*

Among the diseases described above, grassy stunt, tungro, bacterial leaf blight and sheath blight of rice; downy mildew of corn; witches' broom of sweet potato; witches' broom, bacterial wilt and rust of peanuts; rust and Sclerotial blight of soybeans; and mosaic, witches' broom, Sclerotial blight and damping off of kacang hijau (*Phaseolus radiatus* L.) were observed to be severe in occurrence.

b. Study on bacterial leaf blight of rice.

Bacterial leaf blight of rice is widely distributed in many parts of Southeast Asia and is one of the most serious diseases in Indonesia. So far, differences in resistance to bacterial leaf blight among rice varieties has been observed, and the use of resistant varieties would be the main coutermeasure for controlling the disease, because there are no effective and economical control methods under present farming conditions in Indonesia. Therefore, a study on varietal resistance of rice to bacterial leaf blight has been carried out.

b-1. Study on varietal resistance of rice to bacterial leaf blight.

b-1-1. Investigation on varietal resistance of rice under natural infection in rice fields.

i) Wet season, 1971/72.

Thirty five rice varieties, including 3 Japanese varieties and 231 lines from IRRI, were tested for their resistance to bacterial leaf blight under natural infection at Muare Expt. Substation of CRIA, Bogor. Single rice seedling was planted per hill with 15 X 15 cm spacing. Three rows of PB5, susceptible variety, were planted as a spreader between every 5 rows of rice varieties, each row being of a different variety. A row consisted of 10 hills and the experiment was repeated twice. Assessment of disease occurrence was made on the lesion degree of flag leaf and the 2nd leaf of 2 to 5 stems per hill at booting to yellow ripe stage (April 19 to May 3, 1972), and the disease degree was calculated by the following formula.

$$\text{Disease degree} = \frac{\text{Sum of lesion degree of flag leaf and the 2nd leaf}}{\text{Number of stems X 2 X 4}} \text{ X } 100$$

Lesion degree 0:	lesion area/leaf area	less than	1/8
1:	lesion area/leaf area	about	1/4
2:	lesion area/leaf area	about	1/2
3:	lesion area/leaf area	about	3/4
4:	lesion area/leaf area	more than	7/8

Infections were observed on all varieties and lines tested. Among the varieties Pelita 1/1, Pelita 1/2, Pulu Bolong, Banda, Pute Abeng, Nemal, Manglai and Padi Bengala were relatively low in disease degree, while Jikkoku (Japanese variety), Kamand Pance and Rogol Cepak were rather high. Among the lines from IRRI, HP236, HP239, 91787, 91846, 91850, 91865, 91867, BKN6806-18 and BKN6806-56 were low in disease degree.

ii) Dry season, 1972.

In order to obtain data of varietal resistance against wilting phase (kresek) caused by leaf blight bacteria under natural infection, investigations were carried out on 653 Indonesian local varieties which were planted on the experimental farm of Division of Agronomy of CRIA at Muara Expt. Substation.

Single rice seedling was planted per hill with 25 X 25 cm spacing, and investigation was conducted on the percentage of diseased hills for 45 to 75 hills according to rice varieties.

From the results of investigation, variety Panjang Tiga Bulan, Panjang Piawi, Pulut Hitam, Ampeh Kumpai, Manglar, Padi Solo, Cere Sugi, and Cempo Siyum were shown to be severe in kresek occurrence. Since the distribution of disease occurrence was not uniform in rice fields, it would not be proper to judge that rice varieties not infected were resistant, but the varieties such as those described above infected severely by bacterial leaf blight can be considered as being susceptible to kresek.

b-1-2. Study on varietal resistance of rice seedlings by various inoculation methods.

Various inoculation methods on rice seedling were tried to find an efficient and simple method to investigate the varietal resistance of rice to bacterial leaf blight.

i) Spraying method,

1971

From August to September 1971, 13 rice varieties, including improved and introduced varieties in Indonesia and also Japanese varieties, were tested preliminarily for varietal resistance by inoculating them with bacterial suspension to the seedlings. Causal bacteria (LP3, P1-71) used in the experiment was isolated from diseased leaf of variety PB5 collected at Muara Expt. Substation in April 1971.

Rice seedlings at 3.1 leaf stage grown in the enameled ironware (vat), 25 X 20 X 4.5 cm in size, were sprayed with suspension (10^9/ml) of causal bacteria by glass sprayer at the rate of 100 ml/m^2 and the vats were placed in boxes (50 X 35 X 50 cm) covered with plastic film for 20 hrs to keep air humidity high.

Assessment of infection was carried out about 15 days after inoculation on the 3rd and 4th leaf seedlings at 5.1 to 6.0 leaf stage and the percentage of diseased seedlings was calculated.

The experiment was repeated twice. In the first experiment, the percentage of diseased seedlings was low in Syntha, Pelita 1/1, Pelita 1/2, C4-63 IR 20, IR 22 and Nagomasari (Japanese variety). In the second, Pelita 1/1 was relatively low in percentage of diseased seedlings although other varieties showed rather high percentages.

Following these experiments described above, the difference in disease development of several rice varieties was also investigated. Rice seedlings of 9 varieties were grown on the soil in enameled ironware (vat) in greenhouses and inoculated by spraying with bacterial suspension (10^9/ml) of *X. oryzae* (LP3, P1-71) by small glass sprayer at 1.5 to 3.5 leaf stage of seedling. After inoculation the vats were placed in plastic boxes for a night to keep air humidity high. Fifteen seedlings were used for each variety and the experiment was repeated twice.

Nine days after inoculation, symptoms appeared such as water-soaked streaks at leaf margin of rice varieties, except for varieties C4-63 and IR20. On C4-63 and IR20 it appeared on the 10th and 11th day after inoculation, respectively. Investigation on percentage of diseased seedlings was carried out every day after the symptoms appeared until 15 days after inoculation.

As shown in Fig. 2., the percentage of diseased seedlings 15 days after inoculation is high on variety Padi Jambu and PB5, being 100 and 93%, respectively, while it is relatively low in IR 20, C4-63 and Syntha. It is interesting that the percentage of diseased seedlings increased very rapidly day by day on Padi Jambu, PB5 and Bengawan, particularly on Padi Jambu, but slowly on IR 20, C4-63, Syntha, Pelita 1/1 and Dewi Ratih, although the percentage of diseased seedlings of these varieties reached 63 - 76%

15 days after inoculation.

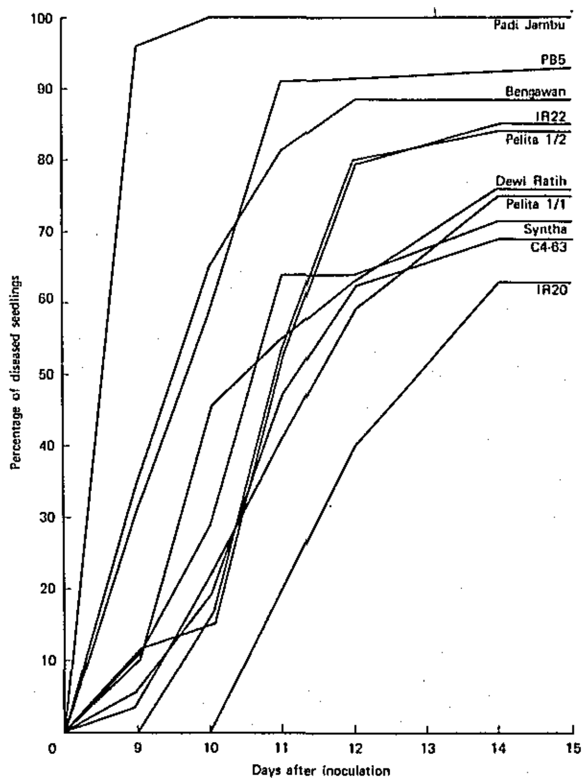

Fig. 2 Difference in disease development of several rice varieties

1972 - 1973

During the period from July 1972 to January 1973, about 270 rice varieties, including local, introduced and improved varieties in Indonesia and also Japanese varieties, were tested for their resistance to bacterial leaf blight. Seeds of 10 to 11 varieties (20 seeds for each variety) were sown in a enameled iron vat and inoculation was conducted on the seedlings at 1.8 to 2.8 leaf stage by the same method as that of the experiment in 1971.

Assessment of infection was made on the 2nd and the 3rd leaf of seedlings at 3.1 to 5.8 leaf stage 15 days after inoculation, and the percentage of diseased seedlings was calculated. Results of the experiment showed that all varieties were infected with bacterial leaf blight, but varieties such as Banda, Padi Mohong, Pelita 1/1, Bali Banda, Dewi Ratih, Pulu Bolong, C4-63 and Syntha were relatively low in percentage of diseased seedlings.

In December 1972, a similar experiment was conducted using several rice varieties which showed low percentage of diseased seedlings. As a result, PB5 and Jikkoku used as check variety showed about 100 percent of diseased seedlings, while the percentage of diseased seedlings of Padi Mohong, Bali Banda, Banda, Pelita 1/1, Pulu Bolong and Dewi Ratih was relatively low, ranging from 11.6 to 52.4%.

ii). Submerging method

The experiment was conducted from June to July 1972 using 34 rice varieties including local, improved and introduced varieties in Indonesia.

Concrete blocks were placed side by side to form the bottom and side walls of the nursery, and vinyl sheet was used as a cover to prevent the leakage of water. Then the soil was filled and rice seeds were sown. Size of the nursery was 0.8 X 3.6 m.

When the second leaf of rice seedlings was being unfolded, water was poured into the nursery to immerse the seedlings up to the top. Under this condition, the suspension of bacteria cultured on PSA slant media for 48 hrs was added to the nursery water to inoculate the rice seedlings. Inoculation was conducted in the evening and the nursery was drained next morning. About 20 days after inoculation, the percentage of diseased seedlings was calculated. The experiment was repeated twice.

As a result, the reaction of each rice variety to bacterial leaf blight proved to be different in these two experiments. Accordingly, it was difficult to assess the resistance of each rice variety from the results.

iii). Needle prick method

Preliminary experiments on the varietal resistance by needle prick method were conducted in greenhouses from April to May 1971.

Seven rice varieties, introduced or improved, were seeded in the pots, and 28, 36 and 57 days after sowing, the uppermost and the next leaf of the seedlings were inoculated by single needle prick method with suspension (10^9/ml) of bacteria (LP3, PI–71) cultured on PSA.

Assessment of disease occurrence was made on length of lesion 7–12 days after inoculation. As a result, lesion was shortest on IR20, and IR22, followed by Syntha, Dewi Ratih, C4–63, Bengawan and PB5 in that order.

In the dry season of 1972, a similar experiment was conducted in greenhouses, using 278 rice varieties which included local, introduced and improved varieties. Forty rice varieties were assorted in each experiment, and PB5 and Padi Jambu were used as check varieties. Rice seeds were sown in a plastic container 11 X 11 X 8 cm in size, filled with soil, and 4 weeks after sowing, the uppermost unfolded leaf and the next leaf were inoculated with bacterial suspension by single needle prick inoculation method between the midrib and leaf margin. Measurement of length of lesion was made 10 days after inoculation.

The results showed that lesion length was relatively short on the varieties such as Pelita 1/1, Pelita 1/2, IR20, IR22, Syntha, Dewi Ratih, Jelita, Merci and Remaja.

iv). Dipping method for kresek infection.

Twenty-two-day old rice seedlings growth in a nursery of upland conditions at Muara Expt. Substation were picked out and their roots were dipped overnight in bacterial suspention (10^6/ml) of *X. oryzae* (LP3, P1-71). After this treatment rice seedlings were transplanted, a seedling per hill at a spacing of 15 X 15 cm. The number of rice varieties tested was 279, including local, introduced and improved varieties. The experiment was carried out from July to August 1972, and repeated twice. Assessment was made twice on the percentage of diseased hills.

As a result, rice varieties such as Ketan Hitam, Hawara Butu, Rojolele, Jambon, Ketek Randah, Katiek Birah, Kuning Saruaso and Katik Randah showed a relatively high percentage of diseased hills (13-25%).

Eighteen rice varieties which showed high or low kresek infection in the field experiment described above were tested for their resistance to kresek, by inoculating them with the bacteria at the root of water-cultured seedlings from September to October 1972.

Rice varieties were water-cultured in Kasugai's solution in plastic baskets. Twenty-one days after sowing, the roots of rice seedlings coming out from the bottom of the baskets were dipped in suspension (10^7/ml) of bacteria (LP3, P1-71) for a day. Thereafter rice seedlings were cultured again in Kasugai's solution, and the number of seedlings showing kresek sympton was investigated 25 days after inoculation.

The results showed that the degree of kresek infection of some rice varieties in this experiment did not coincide with that in the field experiment. In this experiment Hawara Batu, Jambon and Ketek Randah were low in kresek infection, while Randah Sasak showed a rather high kresek infection although no infection was observed on this variety in the field experiment.

b-1-3. Study on varietal resistance of rice plant by needle-prick inoculation method.

i) Experiments in greenhouse.

Preliminary experiments were conducted on varietal resistance of rice plants in greenhouses from July to August and from August to November, 1971.

Rice plants grown in Wagner's pots in greenhouses were inoculated on the central part of the flag leaf by four needle-prick inoculation method of the National Kyushu Agric. Expt. Stat., Japan, when they were at the booting to heading stage.

Thirteen rice varieties including improved and introduced varieties in Indonesia and also Japanese varieties were inoculated. *X. oryzae* (LP3, P1-71) was cultured on PSA at 25°C for 72 hrs and bacterial suspension (10^9/ml) was used for inoculation. Twenty-one to 31 days after inoculation, the lesion area ($\sqrt{mm^2}$) was measured by the scale of the National Kyushu Agric. Expt. Stat., Japan.

As a result, IR20, IR22, and Nagomasari were shown to be small in lesion area compared with other varieties.

A similar experiment was carried out on varietal resistance of rice plant in greenhouses using 261 varieties which included local, improved and introduced varieties in Indonesia from October 1972 to February 1973.

The results of the experiment showed that rice varieties such as Malaman, Banda, Urang^{2}an, Lapang, G. Beton, Glinduran Putih, Matraman, Poloman, Sunting Danau, IR22, Jelita, Hoing, Beak Ganggas, Nagomasari, Pelita 1/1, Nemal, Randah Sasak, Longong, etc., were small in lesion area. Following these varieties, Pelita 1/2, Padi Mohong, Cere Rawit, Barlean, H.S.4, H.S.5, etc., also showed a small lesion area, while varieties such as Larang, G. Raci, Lengser, Andeng, Angkong (Lebak) were shown to be large in lesion area.

ii) Experiments in the field.

Varietal resistance of rice to bacterial leaf blight was tested by needle-prick inoculation on 268 rice varieties including local, introduced and improved varieties in Indonesia at the Muara Expt. Substation from September to December, 1972.

Rice seedlings were planted, a single seedling per hill with 15 X 15 cm plant spacing. Each plot had 100 hills and the experiment was duplicated. Bacterial suspension (10^9/ml) of *X. oryzae* was inoculated on the central part of the flag leaf by the four needle-prick method. Dates of inoculation differed depending on the difference of maturity of rice varieties. Four weeks after inoculation, disease lesion was investigated and the disease degree was calculated for each variety by the following formula of the National Kyushu Agric. Expt. Stat., Japan.

$$\text{Disease degree} = \frac{aX1 + bX2 + cX3 + dX4 + eX5 + fX6}{N \ X \ 6} \ X \ 100$$

N: Total number of leaves investigated.

o, a, b, c, d, e and f: Grade of lesion enlargement, ranging between o (no lesion) and f (lesion covers entire leaf area).

Results of the experiment showed that IR20, IR22, IR24, H.S.3, H.S.5, Nagomasari, Longang, Cere Rawit, Jabang, Barlean, Sri Makmur, Randah Sasak, Malaman and Padi Jalan were low in disease degree, while Rojolele, Mentik Kutulan, Sirai and Padi Putih were high.

From the results of the experiment obtained so far, it is proved that no rice varieties or lines are highly resistant to bacterial leaf blight, but varieties such as Pelita 1/1, Pelita 1/2, IR20, IR22, Syntha, C4-63, Dewi Ratih and Nagomasari have shown resistant reaction to some degree.

So far, an isolate of *X. oryzae* (LP3, P1-71) was used for inoculation experiments. It is desirable in the future that *X. oryzae* is collected from various rice varieties and from many localities in Indonesia, and that several strains of *X. oryzae*, if any, are used for the study on varietal resistance of rice to bacterial leaf blight.

b-2. Study on variation in virulence of *Xanthomonas oryzae.*

Up to the present, studies on variabion in virulence of *Xanthomonas oryzae* and *classification based on virulence have been made by many researchers.*

The clarification of the virulence of *X. oryzae* in Indonesia is important in relation to the breeding of a rice variety resistant to bacterial leaf blight.

In this experiment, a strain of *X. oryzae* isolated from the diseased leaf of rice variety PB5 at Muara Expt. Substation on April 3, 1971, was compared with Japanese strains in their virulence to some rice varieties. Two Japanese strains N and Q, preserved in the National Institute of Agricultural Sciences and the National Kyushu Agric. Expt. Stat., respectively, were used in this experiment. Strain N has the virulence to a narrower range of rice varieties compared with strain Q.

Seeds of rice varieties used in this experiment were brought from the National Instutute of Agric. Sciences, National Kyushu Agric. Expt. Stat. and the National Hokuriku Agric. Expt. Stat. in Japan, except for PB5, Pelita I/1 and Padi Jambu.

Causal bacteria were cultured on PSA media for 48 hours at 25°C.

Bacterial suspension was inoculated on rice variety PB5 or Jikkoku, and then bacteria reisolated from the lesion of these rice varieties were used for inoculation.

Inoculation was conducted on the central portion of the flag leaf of rice plants grown in pots in the greenhouse by the four needle-prick inoculation method.

Experiments were carried out from October to November 1972. Investigation of disease occurrence was done on the lesion area ($\sqrt{mm^2}$) and disease degree. Results of the investigation on the lesion area of 45 rice varieties caused by 3 strains are shown in Table 1.

Table 1. Virulence of a strain of *X. oryzae* from Muara compared with two Japanese strains

Rice variety	Lesion area ($\sqrt{mm^2}$)		
	Japanese strain N	Japanese strain Q	Muara strain
Nagomasari	1.9 (R)	3.1 (R)	6.8 (R)
Kunigami 1	1.5 (R)	8.4 (R)	3.2 (R)
Nakashin 120	2.0 (R)	7.0 (R)	4.6 (R)
Fujiminori	8.3 (R)	6.8 (R)	4.4 (R)
Chinsura Boro II	3.3 (R)	3.7 (R)	5.8 (R)
Pelita 1/1	1.8 (R)	7.2 (R)	8.9 (R)
IR8	1.8 (R)	5.2 (R)	8.7 (R)
Koentoelan	5.2 (R)	4.1 (R)	25.1 (S)
Chugoku 45	2.0 (R)	3.2 (R)	34.6 (SS)
Waseaikoku 3	3.0 (R)	2.6 (R)	31.3 (SS)
TKM-6	2.0 (R)	24.3 (S)	6.6 (R)
Ohu 244	2.3 (R)	25.3 (S)	11.4 (S)
Ohita Mii 120	6.3 (R)	27.9 (S)	11.5 (S)
Kinpa	2.2 (R)	21.8 (S)	24.7 (S)
PB5	2.0 (R)	16.7 (S)	30.1 (SS)
Zenith G. 713	2.0 (R)	10.6 (S)	35.8 (SS)
Manryo	6.1 (R)	26.2 (S)	38.5 (SS)
Shiranui	2.0 (R)	29.4 (S)	37.1 (SS)
Zensho 26	2.0 (R)	28.7 (S)	36.2 (SS)
Jamica	4.8 (R)	14.5 (S)	89.3 (SS)
Precoce Alloris	2.0 (R)	34.7 (SS)	14.0 (S)
Chusei Kogyoku	3.1 (R)	37.5 (SS)	28.9 (S)
Sachikaze	5.8 (R)	34.9 (SS)	25.9 (S)
Louisiana Awnless	1.2 (R)	42.5 (SS)	26.4 (S)
Rantaj-emas	2.0 (R)	41.4 (SS)	21.1 (S)
Nikisakae	7.4 (R)	40.7 (SS)	23.0 (S)
Norin 27	2.0 (R)	56.5 (SS)	33.7 (SS)
Tadukan	4.2 (R)	73.1 (SS)	29.7 (SS)
Te-tep	2.0 (R)	62.1 (SS)	45.1 (SS)
Hoyoku	2.0 (R)	34.4 (SS)	32.4 (SS)
Nishikaze	2.0 (R)	48.2 (SS)	40.5 (SS)
Kokumasari	2.0 (R)	46.9 (SS)	30.0 (SS)
Koganemaru	2.0 (R)	43.4 (SS)	30.6 (SS)
Asakaze	2.0 (R)	53.4 (SS)	38.8 (SS)
Shinzeki 1	2.0 (R)	55.4 (SS)	42.5 (SS)
Benisengoku	9.9 (S)	26.8 (S)	25.3 (S)
Ortiglia	12.0 (S)	21.9 (S)	16.5 (S)
Jikkoku	19.2 (S)	30.9 (SS)	26.8 (S)
Kogyoku	10.8 (S)	51.9 (SS)	30.2 (SS)
Kinmaze	13.2 (S)	29.6 (SS)	36.5 (SS)
Akashinriki	9.7 (S)	38.9 (SS)	32.1 (SS)
Padi Jambu	26.7 (S)	44.4 (SS)	36.6 (SS)
Taichung Native 1	16.0 (SS)	51.2 (SS)	42.2 (SS)
Asahi 1	31.5 (SS)	49.0 (SS)	40.0 (SS)
Kagui	49.4 (SS)	72.1 (SS)	57.2 (SS)

Among the rice varieties 10 and 35 varieties have shown S-SS reaction to strains N and Q, respectively, while 38 varieties have shown S-SS reaction to Muara strain. Only 7 rice varieties showed R reaction to Muara strain.

From the results of this experiment, Muara strain seems to have a virulence to a wider range of rice varieties compared with Japanese strains N and Q. Further studies are needed to make clear the virulence and distribution of the strains of *X. oryzae* in Indonesia using many isolates from various localities.

b-3 Study on bacteriophage of *Xanthomonas oryzae.*

A bacteriophage (or a phage) is a virus that is propagated by living bacteria. The phage of bacterial leaf blight bacteria, *Xanthomonas oryzae,* was isolated for the first time in 1953 in Japan, and thereafter some kinds of phages with different characteristics were isolated not only in Japan but also South East Asia.

The study on the ecology of leaf blight bacteria has made rapid progress by the utilization of bacteriophage, and recently the forecast of occurrence of bacterial leaf blight has been practiced by the use of phage in Japan.

i) Study on phage population in water in rice fields.

Population of bacteriophage in canal (irrigation) water and surface water in the nursery and rice fields at Muara Expt. Substation was investigated from April 1971 to March 1973, using the following procedure.

a. Canal water and surface water were taken at fixed places in the rice fields and poured into sterilized plastic vessels, 20-30 ml in volume. The vessels were placed in an ice box and brought to the laboratory.

b. Suspension (10^9/ml) of *Xanthomonas oryzae* isolated from the diseased leaf of rice at Muara Expt. Substation was poured into sterilized test tubes, 2 ml per tube.

c. One or 0.1 ml of canal water or surface water mentioned above was poured into a test tube which contained bacterial suspension.

d. Dissolved PSA media was poured into the test tube to mix with bacterial suspension and then poured into sterilized petri dish to make plate culture.

e. Petri dish was kept at 20°C for 24 hrs, and the number of plaque appearing on the media was calculated.

Dry season, 1971.

On April 20, bacteriophage was detected for the first time in the surface water on the rice field at Muara Expt. Substation. It was also detected in the surface water on the rice field in October when rice variety PB5 was growing at heading stage and in the surface water on other fields before transplanting. Phages could be detected also in canal (irrigation) water.

Wet season, 1971/72 and dry season, 1972.

a) Canal (irrigation) water or surface water at 7 spots at the nursery at Muara were taken on Dec. 29, 1971, and Jan. 3 and 4, 1972, and the number of phage was investigated. First appearance of symptoms of bacterial leaf blight was observed on Jan. 13-17, 1972, when rice plants were at 4.5-4.6 leaf stage, and the percentage of diseased seedlings reached about 46% on Jan. 20-22, 1972.

As shown in Table 2, phage of leaf blight bacteria was found in high population in canal water and surface water in the nursery.

Table 2. Number of phage/ml in canal water and surface water in the nursery.

Date \ Spot No.	1	2	3	4	5	6	7
Dec. 29, 1971	20	5	10	2	10	17	–
Jan. 3, 1972	–	–	–	740	600	474	710
Jan. 4, 1972	–	–	380	N	N	N	N

Note : Spot Nos. 1, 4 and 7 : canal (irrigation) water.
Spot Nos. 2, 3, 5 and 6 : surface water.

b) A rice field at Muara Expt. Substation was selected to investigate the bacteriophage in surface water and canal water of the rice field. In this rice field, rice variety IR24 was cultivated and bacterial leaf blight occurred heavily in the dry season 1971.

In the wet season 1971/72, local varieties and PB5 were transplanted on Jan. 7 and 8, 1972. Investigation of phage in surface water and canal water of the rice field was carried out on Feb. 10 and March 24, 1972.

In the dry season 1972, a similar investigation was conducted on July 22, and August 22 on the same rice field as in the wet season 1971/72, where PB5 and local varieties were planted. Canal water and surface water were taken at 7 and 26 spots, respectively.

The data obtained at some spots on the field are shown in Table 3.

Table 3. Number of phage/ml in canal water and surface water in the rice field.

	Spot no.	Wet season, 1971/72		Dry season, 1972	
		Feb. 10, 1972	March 24, 1972	July 22, 1972	Aug. 22, 1972
Canal (irrigation) water	1	40	51	10	47
	2	–	–	21	61
	3	–	–	15	55
	4	–	–	9	106
Surface water	5	2490	264	–	–
	6	2200	N	340	1270
	7	1760	0	271	1064
	8	100	0	–	760
	9	–	–	11	1448
	10	–	–	355	2960
	11	–	–	441	1360
	12	–	–	8	0

Wet season, 1972/73

Investigation was carried out on phage population in the canal (irrigation) water and surface water in the nursery and the same rice field as that in the dry season 1972 at Muara Expt. Substation. Results of the investigation in the nursery are shown in Table 4.

Table 4. Number of phage/ml in the water in the nursery.

	Phage/ml
Canal water	443
Surface water	866

Note: Investigation, Jan. 13, 1973.
Transplanting; Jan. 16, 1973.

In the rice field, canal water and surface water were taken at 6 and 14 spots, respectively. The data obtained at some spots are shown in Table 5.

Table 5. Number of phage/ml in the canal water and surface water in the rice field.

	Spot no.	Jan. 13, 1973 1)	Feb. 15, 1973 2)	March 15, 1973 3)
Canal water	1	317	3	1848
	2	–	41	2552
	3	295	191	716
	4	–	163	1512
Surface water	5	–	540	2812
	6	–	663	2120
	7	–	240	1296
	8	–	230	1680
	9	–	714	3716
	10	–	186	1010
	11	–	97	579
	12	–	213	515

Note: 1) Before transplanting
2) Plant height (PB5); 21.3 cm, No. of tillers/hill; 3.3.
3) Plant height; 58.9 cm, No. of tillers/hill; 13.2.
Occurrence of BLB was observed.

Results of the experiment conducted from 1971 to 1973 have shown that bacteriophage could be detected in the surface water in the nursery as well as rice field and also in canal water. Population of phage seems to change according to the environmental conditions. Further studies are desirable to make clear the periodical change of phage population and its relation to the occurrence of bacterial leaf blight.

ii) Study on the susceptibility of causal bacteria to bacteriophage.

Xanthomonas oryzae in Japan are divided into 5 groups, i.e., A, B, C, D and E, according to their susceptibility to four kinds of phages which have different hosts of their own as shown in Table 6.

Bacterial strains A and B, and bacteriophages OP_1, OP_1h, OP_1h_2 and OP_2 used in this experiment were sent from Japan. *X.oryzae* isolated from the diseased leaf of PB5 and bacteriophage isolated from the water in the rice field at Muara Expt. Substation were investigated for their reactions to bacteriophages OP_1, OP_1h, OP_1h_2 and OP_2 and bacterial strains A and B, respectively.

Results of the experiment are shown in Table 6.

Table 6. Relation between bacterial strains and phages.

Bacterial strain \ Phage	Muara phage	OP_1	OP_1h	OP_1h_2	OP_2
Muara isolate	+	–	–	+	–
A	–	+	–	+	+
B	+	–	+	+	+
C		–	–	–	–
D		–	–	+	+
E		–	–	–	+

In Japan, A is distributed most widely, followed by B, while strains belonging to C, D and E are very few. Results of research which have been carried out so far indicate that most of *X. oryzae* strain in Asian countries such as India, Thailand and the Philippines belong to C, D and E, according to their susceptibility to phage.

As shown in Table 6, *X. oryzae* and bacteriophage isolated from the rice field at Muara Expt. Substation are different from those in Japan.

b-4. Study on the chemicals for controlling bacterial leaf blight.

At the present time, the chemicals for controlling rice diseases are not used practically by the farmers in Indonesia. However, the chemicals can be used effectively, for instance, on the experimental farm for agronomical or physiological research to avoid the disturbance of experiment caused by diseases. They may also be used practically on such farms as seed production farms.

Several kinds of chemicals for the control of bacterial leaf blight have been developed and their effectiveness has already been confirmed in Japan. But the effectiveness of these chemicals in Indonesia, which differs from Japan in environmental conditions, must be tested. From this point of view, several chemicals were investigated for their effectiveness for controlling bacterial leaf blight.

Experiments were conducted in the greenhouse in the Subdivision of Plant Pathology and on the rice field at Muara Expt. Substation.

Chemicals tested are as follows:

Chemicals	Active ingredients
TF130 (w.p.)	2-amino-1, 3, 4-thiadiazole 10%
Shirahagen-C (w.p.)	1-chloramphenicol 10%
Phenazin (w.p.)	Phenazin-5-oxide 10%
Sankel (w.p.)	Dimethyl dithiocarbamate Ni 65%
Celdion (w.p.)	Fentiazon 50%
Sankel (d.) 6	Dimethyl dithiocarbamate Ni 6%
Sankel (d.) 8	do 8%
NK 15558 (g.)	New compound 5%

Sticker was added at the rate of one-two thousandths volume of bacteriocides (w.p.) at the time of application.

i) Experiment on chemical application to rice seedlings inoculated with *X. oryzae*.

a) Experiment on chemical application to rice seedlings grown in the vat in greenhouse (wet season, 1971/72).

Experiments were repeated twice. Germinated rice seeds (rice variety, PB5) were sown in the soil filled in enamelled iron vat (20 X 25 X 3 cm). Bacterial suspension (10^9/ml) was sprayed on rice seedlings at 2.0-2.1 or 1.1-1.3 leaf stage by small glass sprayer. Chemicals were applied twice 2 to 5 days after inoculation, at the rate of 1500 lit/ha for wettable powder, 40 kg/ha for dust and 50 kg/ha for granule. Results of the experiment are shown in Table 7.

Table 7. Results of experiment on control chemicals for bacterial leaf blight of rice seedlings.

Chemicals		Dosage dil. (ppm)	Expt. I			Expt. II			Phytotoxicity
			Dis. seedl. (%)			Dis. seedl. (%)			
			1) 1	1) 2	mean	1) 1	1) 2	mean	
w.p.	TF 130	1/1000(100)	0	0	0	0	0	0	–
	Shirahagen	C1/1000(100)	0.9	0	0.5	0	0	0	–
	Phenazin	1/2000(50)	10.3	3.7	7.0	6.7	3.7	5.2	–
	Sankel	1/400(1625)	31.6	8.7	20.2	1.3	2.5	1.9	–
	Celdion	1/500(1000)	73.8	47.7	60.8	26.4	40.8	33.6	–
	Check	– –	85.4	60.4	72.9	63.1	65.7	64.4	
d.	Sankel 6		69.3	42.4	55.9	66.7	62.5	64.6	–
	Sankel 8		44.4	57.3	50.9	66.9	50.0	58.5	–
	Check		57.8	55.0	56.4	74.1	76.3	75.2	–
g.	NK 15558		1.2	0.5	0.9	0.8	0	0.4	–
	Check		69.5	59.3	64.4	63.2	54.0	58.6	

Note: 1) replication.

b) Experiment on chemical application to rice seedlings in nursery (wet season, 1971/72).

The experiment was conducted at the Muara Expt. Substation. The nuasery was flooded by irrigation water for 24 hrs when rice seedlings (rice variety PB5) were at 1.5-1.8 leaf stage. Thereafter, it was flooded again with irrigation water and inoculated by suspending *x. oryzae* at a concentration of about 10^{5-6}/ml of the water, when the seedlings were at 2.3 leaf stage. The length of inoculation by flooding was 12-22 hours and water temperature was 25.5-27.0°C.

Chemicals were applied 4 and 8 days after inoculation when the rice seedlings were at 3.3-3.5 and 4.3-4.5 leaf stage, respectively, and the rate of application of chemicals for each time was 1,500 lit/ha for wettable powder, 40 kg/ha for dust and 50 kg/ha for granule.

After disease symptoms appeared, 300 plants per plot were picked out, and the percentage of diseased seedlings was calculated by investigating the disease occurrence on the 3rd leaf. Results are shown in Table 8.

Talbe 8. Results of experiment on control chemicals for bacterial leaf blight of rice seedlings in the nursery.

Chemicals		Dosage dil. (ppm)	Diseased seedlings (%)			Phytotoxicity
			1) 1	1) 2	mean	
w.p.	TF 130	1/1000 (100)	5.0	4.2	4.6	–
	Shirahagen C	1/1000 (100)	10.0	5.2	7.6	–
	Phenazin	1/2000 (50)	35.0	16.9	25.9	–
	Sankel	1/400 (1625)	15.4	20.5	17.9	–
	Celdion	1/500(1000)	20.2	27.8	24.0	–
	Check	–	45.1	46.3	45.7	–
d.	Sankel 6		15.8	7.4	11.6	–
	Sankel 8		26.2	12.4	19.3	–
	Check		19.7	18.5	19.1	
g.	NK 15558		15.4	8.0	11.7	–
	Check		30.3	19.1	24.7	

Note : 1) replication.

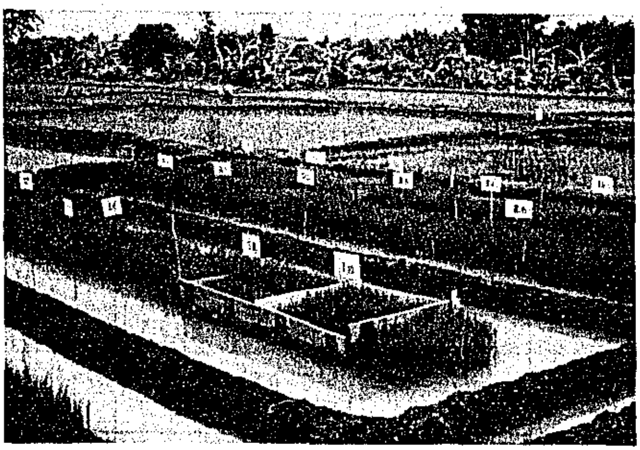

Fig. 3 Screening test of chemicals for controlling bacterial leaf blight of rice at Muara Expt. Substation of CRIA

ii) Experiments on chemical application to rice plant under natural infection in rice field (wet season, 1971/72).

Effectiveness of chemicals for controlling bacterial leaf blight was tested under natural infection the the rice field at Muara Expt. Substation.

Rice seedlings (variety PB5) were transplanted on Jan. 8, 1972, 3 seedlings per hill with 20 x 20 cm plant spacing. One test plot was 12 m^2 for spraying, 25 m^2 for dusting and 20 m^2 for granule application. Three plots were used for each chemical.

Dust and granule were applied on March 9, 1972, and wettable powder was sprayed on March 10, 1972. All chemicals were applied again on March 20, 1972. The rate of application of wettable powder was 1500 lit/ha and those of dust and granule were 40 kg/ha and 50 kg/ha, respectively.

Percentage of diseased hills was calculated on March 13, 1972. Investigation on lesion degree was made on April 27, 1972 (yellow ripe stage) for the plots of dust and granule application and on April 28, 1972 for the plot of wettable powder application.

Fifty hills were picked out for each plot and the lesion degree of flag leaf and the 2nd leaf were investigated on 5 stems for each hill. Then the disease degree was calculated. Results obtained are shown in Table 9.

Table 9. Results of experiment on control chemicals for bacterial leaf blight of rice in rice fields.

Chemicals		Dosage dil. (ppm)	Disease degree (%)				Phytotoxicity
			1[1)]	2[1)]	3[1)]	Mean	
w.p.	TF 130	1/1000 (100)	7.8	6.4	16.2	10.1	–
	Shirahagen C	1/1000 (100)	7.2	13.8	17.7	12.9	–
	Phenazin	1/1000 (100)	11.0	10.3	10.7	10.6	–
	Sankel	1/400 (1625)	22.1	6.1	8.4	12.2	–
	Celdion	1/500 (1000)	8.4	19.8	14.1	14.1	–
	Check		11.7	21.4	11.7	14.9	
d.	Sankel 6		5.0	15.4	15.1	11.8	–
	Sankel 8		6.9	15.8	12.5	11.7	–
	Check		8.2	19.2	15.5	14.3	
g.	NK 15558		13.9	5.4	13.6	11.0	–
	Check		15.6	7.8	11.7	11.7	

Note : 1) replication.

As described above, in the vat test in the greenhouse, wettable powder, dust and also granule application was effective for the control of bacterial leaf blight although the effect was not distinct in dust application, probably due to the use of defective dusting apparatus.

In the nursery test, in spite of heavy rain every day, both wettable powder and granule were shown to be effective for the control of bacterial leaf blight.

In the rice field, the chemicals did not show such great effectiveness for the control of bacterial leaf blight although there was a tendency for the disease degree of bacterial leaf blight to be lower in chemical applied plots than check plots.

No phytotoxicity was observed in rice plants by chemical application.

c. Study on sheath blight and stem rot of rice.

Sheath blight is one of the important and common diseases of rice in Indonesia. Meteorological conditions such as higher temperature and higher humidity in most parts of Indonesia are favorable for the development of sheath blight. Up to the present, the damage to rice caused by sheath blight may be underestimated. There is a possibility of further development of sheath blight, with increasing application of nitrogen fertilizer in rice culture, and distribution of rice varieties shorter in plant height and higher in tillering, because these are favorable factors for infection by sheath blight.

For the control of sheath blight, the cultivation of resistant varieties is most efficient and economical. Thus the experiments on varietal resistance of rice were carried out. Some tests on the chemicals for controlling sheath blight were also conducted.

c-1. Study on varietal resistance of rice to sheath blight.

In the wet season 1971/72, a preliminary experiment was carried out in the greenhouse. In this experiment, 30 varieties including local and improved rice varieties in Indonesia were tested for varietal resistance.

Three seedlings of each variety were planted in a pot and at the heading stage rice plants were inoculated by inserting the pathogen (mycelia) with culture media inside the leaf sheath of rice. Then, rice plants were covered with vinyl sheet up to the uppermost leaf sheath to keep the air humidity high.

The pathogen used for inoculation is an isolate from the lesion of the diseased rice variety PB5 collected at Serang on March 1970, and had been cultured on PDA.

When the occurrence of disease was observed on the leaf sheath of the flag leaf, all stems were cut and the disease degree of each stem was investigated, and then the degree of damage was calculated by the following formula.

$$\text{Degree of damage} = \frac{3n_1 + 2n_2 + 1n_3 + 0n_4}{3N} \times 100$$

N : $n_1 + n_2 + n_3 + n_4$ (Total number of stems investigated).

n_1 : No. of stems with lesions on leaf sheath or leaf blade of flag leaf, the 2nd, the 3rd and the 4th leaf.

n_2 : No. of stems with lesions on leaf sheath or leaf blade of the 2nd, the 3rd and the 4th leaf.

n_3 : No. of stems with lesions on leaf sheath or leaf blade of the 3rd and the 4th leaf.

n_4 : No. of healthy stems with no lesions on leaf sheath or leaf blade.

The results of the experiment indicated that the degree of damage ranged from 33.3% to 94.4%, depending on rice varieties. In this experiment, however, the number of rice varieties was limited and the number of stems tested was small.

In the wet season 1971/72, field tests were also conducted at the Muara Expt. Substation. Number of varieties and lines of rice tested were 266 in all, including 4 Japanese varieties, 31 Indonesian varieties and 231 lines from IRRI. They were planted in the field, a seedling per hill with 15 X 15 cm spacing, ten hills per a plot and two plots for each variety.

The isolate of pathogen used for inoculation in this field test was same as that in the greenhouse test. Wheat bran and dried husk were mixed in equal amount, and a 1% solution of peptone was added to this mixed material. An Elrenmyer flask of 500 ml was filled with this material and used for the propagation of pathogen at a temperature of 25-30°C.

After the pathogen had grown in the flask, it was mixed with dried husk at a rate of volume 1 to 3 and then dispersed in the rice field at a rate of 200-300 lit. per hectare 46 days after transplanting.

Disease occurrence was investigated on all hills of rice varieties and lines from May 5 to 8, 1972, 72 to 75 days after inoculation, and the percentage of diseased hills and diseased stems was calculated. Furthermore, the degree of disease occurrence on each stem was assessed and the degree of damage was calculated on the hills in which the lesions were observed on leaf sheath or leaf blade higher than the 4th leaf counted from the uppermost leaf.

Results of the experiment have shown that all of the varieties and lines tested were infected by sheath blight, although considerable difference in degree of damage was observed. However, growth period and plant height are considerably different depending on rice varieties and lines, so that development of fungus towards the upper parts of the rice plant from the lesion which occurred by the inoculation was different. In other words, the development of fungus on the upper part of rice plant is more rapid on shorter varieties or lines of rice than on taller ones.

As is generally known, damage to rice by sheath blight becomes bigger when the upper part of the rice plant was infected, and the microclimatological condition in the rice hills has a great influence on the development of fungus on the upper part of rice plants.

In this experiment the number of plants for each variety or line was small. The experiment has to be repeated, using a larger number of plants for each variety or line and cultivating rice varieties or lines similar in growth period and plant height side by side in the rice field.

c-2. Study on the chemicals for controlling sheath blight and stem rot of rice.

i) Sheath blight.

The results of preliminary pot tests showed that some chemicals were effective for controlling sheath blight of rice. In the wet season 1971/72 and the dry season of 1972, these chemicals were tested on rice plants in pots in greenhouses at the Subdivision of Plant Pathology and in the rice field at Muara Expt. Substation.

In both pot tests and field tests, rice variety PB5 was planted and inoculated with pathogen. In the pot test, inoculation was conducted by inserting the pathogen (mycelia) with PDA culture media inside the leaf sheath of rice. In the field test, the method for culture of pathogen and inoculation were the same as those in the field test on varietal resistance.

Name of chemicals and their active ingredient are as follows:

Name of chemicals	Active ingredients
Validacin (liq.)	Validamycin A 3%
Validacin (d.)	Validamycin A 0.3%
Polyoxin Z (e.c.) 22	Polyoxin Zn complex salt D 2.2%
Polyoxin Z (d.) 2.5	Polyoxin Zn complex salt D 0.25%
Polyoxin Z (f.g.)	Polyoxin Zn complex salt D 0.25%
Neoasozin (liq.)	Methyl arsonate Fe 6.5%
Neoasozin (d.)	Methyl arsonate Fe 0.4%
Neoasozin (f.g.)	Methyl arsonate Fe 0.4%
Kitazin P (g.)	O, O-diisopropyl-S-benzyl thiophosphate 17%
IKF-214 (w.p.)	New organic compound 50%

Liquid chemicals were sprayed at the rate of 1500 lit. per ha and sticker was added at the rate of one-two thousandths volume of liquid chemicals at the time of application. For the evaluation of effectiveness of chemicals, the degree of damage was investigated and the protective value was calculated according to the following formula.

$$\text{Protective value} = \frac{\text{Degree of damage in check plot - degree of damage in treated plot}}{\text{Degree of damage in check plot}} \times 100$$

Results of the field test in the wet season 1971/72 and the dry season 1972 are summarized in Table 10.

Table 10. Effect of chemicals to sheath blight of rice.

Chemicals		Dosage (Active ingredient)	Wet season, 1971/72		Dry season, 1972	
			Degree of damage (%)	Protective value (%)	Degree of damage (%)	Portective value (%)
liq.	Validacin	1/600 (50ppm)	57.77	36.03	–	–
	Validacin	1/1000 (30ppm)	49.06	39.12	18.94	70.43
e.c.	Polyoxin Z22	1/800 (25ppm)	55.14	22.75	–	–
	Polyoxin Z22	1/1000 (22ppm)	–	–	18.33	73.80
w.p.	IKF-214	1/500 (1000ppm)	–	–	26.48	61.82
liq.	Neoasozin	1/2000 (32ppm)	60.52	29.54	12.08	84.24
	Check	–	70.65	0	36.59	0
d.	Validacin	40 kg/ha	40.11	66.32	25.38	31.87
	Polyoxin 2.5	40 kg/ha	–	–	28.75	39.83
	Neoasozin	40 kg/ha	47.53	47.26	16.64	79.05
	Check	–	69.84	0	38.51	0
f.g.	Neoasozin	40 kg/ha	–	–	15.49	75.72
	Polyoxin Z	40 kg/ha	–	–	18.53	56.91
	Check	–	–	–	29.37	0
g.	Kitazin P	60 kg/ha	–	–	24.19	38.13
	Check	–	–	–	39.85	0

Note:	West season, 1971/72	Dry season, 1972
Date of transplanting;	Jan. 8, 1972	July 11, 1972
Date of inoculation;	Feb. 22, 1972	Sept. 18 & 19, 1972
Date of chemical application;	March 9 & April 3, 1972	Sept. 28 or 29 & Oct. 11, 1972
Assesment of disease;	April 29, 1972 (dust) May 1, 1972 (liquid)	Oct. 30, 31 & Nov. 1, 1972

From the results of the experiment, it was proved that Validacin (liq. and d.), Neoasozin (liq., d. and f.g.), Polyoxin Z (e.c., d. and f.g.), IKF-214 (w.p.) and Kitazin P(g.) were effective for controlling sheath blight of rice. The practical application of these effective chemicals should be examined from the economical point of view in the future.

ii) Stem rot.

In the field observation at Muara and Cihea 1971/72, stem rot caused by *Leptosphaeria salvinii* was found to be serious. It occurred in both the wet and dry season. In the dry season of 1972, effectiveness of Kitazin P (g.) for controlling stem rot was tested in the field at Muara Expt. Substation under natural infection.

At harvesting time, the disease degree was investigated for all stems of rice according to the following standard and degree of damage was calculated by the formula.

Standard for damage assessment of stem rot.

Order of damage	Degree of disease occurrence	Coefficient of damage
0	No lesion.	0
1	Small lesions of leaf sheath, and no penetration into stem.	1
2	Large lesions of leaf sheath, and mycelia and sclerotia on stem surface, without penetration into stem.	10
3	Small black spots or small number of black streaks on stem.	50
4	Many black streaks on stem or general browning of stem surface without fragility of stem. No mycelia or sclerotia in the cavity of stem.	100
5	Presence of mycelia and sclerotia in the cavity of stem and fragility of stem tissue	200

$$\text{Degree of damage} = \frac{\text{S (No. of diseased stem according to order of damage X coefficient of damage)}}{\text{N (Total no. of stems investigated)}}$$

Table 11. Control effect of Kitazin P granule on stem rot of rice.

Chemical	Diseased stem %	Degree of damage %
Kitazin P granule	31.6	11.4
Check	90.3	76.4

Note : Rice variety; PB5
Date of transplanting; July 11, 1972
Chemical application; Date - Sept. 28 and Oct. 9, 1972
Dosage - 60 kg/ha

As shown in Table 11, Kitazin P granule is very effective for controlling stem rot.

d. Study on the virus diseases of rice and their vectors

A rice disease called "mentek" had been known and studied in Indonesia since almost a hundred years ago, but the decisive cause had not yet been established.

Recently a virus was suspected to cause "mentek" (S.H. OU, 1965). Then Rivera et al. (1968) verified the presence of tungro virus in the diseased rice plants from West Java and South Sumatra, and suggested that tungro may probably be involved in the epidemiology of "mentek". They also reported that yellow dwarf and grassy stunt have been observed in West Java and South Sumatra, but they did not confirm this experimentally.

Early in 1969 a serious outbreak of "penyakit habang" occurred in South Kalimantan. At about the same time an outbreak of "mentek" disease occurred in South Sumatra and Lampung provinces. Both diseases have similar characteristic symptoms which are identical with tungro-like disease occurring in West Java. The disease continued to occur in large rice areas in South Kalimantan in 1970 and 1971, but in 1972 it began to diminish.

In Central and South Sulawesi a similar disease incidence was noticed in 1972. This is called "cella pance" by farmers in South Sulawesi. The disease spread quickly and within a few months large areas of rice fields were affected. At present the disease epidemic is still going on and has posed a threat to the present and future rice crop of these regions.

In 1972 the occurrence of grassy stunt disease was reported in Central Java. This disease has also been observed in West Java, East Java, South Kalimantan and South Sulawesi. Recently there was a report from North Sumatra indicating that this disease has also occured in that region.

Yellow dwarf has been noticed occurring in various regions of Indonesia.

In this study experiments on the identification of virus diseases, seasonal prevalence of insect vectors in rice field and varietal difference of rice to the occurrence of virus diseases were carried out.

d-1 Identification of virus disease of rice.

Identification of rice virus disease in Indonesia was tried, since this is quite important as an initial step to the development of research on virus disease. Diseased samples were collected from various localities and identified through the transmission experiment. As a result the presence of yellow dwarf and grassy stunt in Indonesia was confirmed so far. A new disease probably due to a mycoplasma or a virus was also found in the rice field at the Muara Expt. Substation.

i) Yellow dwarf

The experiment was conducted at room temperature since August 1971. *Nephotettix nigropictus* was used as vector. A diseased rice plant (variety IR 22) brought from Panggentungan in South Sulawesi by Dr. Nishizawa was used as the source of the disease. Acquisition feeding was done in two ways; 1) 5 groups of about 10 first instar nymphs were given 2 days' access feeding on a diseased leaf in a test tube respectively; 2) 30 fourth or fifth instar nymphs were fed in groups on the potted diseased plant for 2 days. After the feeding period, the insects were transferred singly to individual seedlings of variety PB 8 in 1-leaf stage of growth in test tubes. The seedlings were renewed at intervals of one or two days, and from the 16th day after acquisition feeding they were transplanted in enameled hypo baths.

The results of serial inoculation by individual insects are indicated in Figure 4.

Days after the first day of acquisition feeding

No.		16–17	18–19	20–21	22–23	24	25–26	27–28	29–30	32	32–33	34–35	36–37	38	39–40	41–42	43–44	45	46–47	48–49	50–51	52	53–54
1	f	o	o	x	●	●	x	●	●	x	●	x	x	x	x	x							
2	f	o	x	x	●	●	●	●	x	x	●												
3	f	x	o	●	x	●	●	●	x														
4	f	x	o	●	●	●	x	●	x														
5	f	o	o	●	o	●	●	●	●														
7	f	x	o	o	●	●	x	●	●	x	x	x	x	x	x	x	●	●	●				
8	m	x	o	●	x	●	x	●	●	x	●	x	●	●	●	●	●	●	●	●	●	●	●
10	f	o	o																				
14	m	●	●	●	x	●	●	●	x	●	●	x	x	●	●	●	●	●	●	●	●	●	
15	f	●	●	●	●	●	x	●	●	●	●	●	●	x	x								
16	m	x	●	o																			
18	f	x	o	●	●	●	x	●	●	x	●	●	●	o	●	x	●	x	●	o			
19	f	o	o	x	●	●	x	●	●	x	x	●											
20	f	o	o	x	●	x	●	x	x	x	●	●	●	x									
21	f	o	o	o	●	x	●	●	●	o	●	x											
22	m	o	●	●	●	x	●	●	x	o	●	x	●										
23	m	o	o	o	x	x	●	x															
26	f	x	●	●	●	x	●	x	x	●	x	x	●	●	x	●							
27	f	o	o	●	●	●	x	●	●	x	●	x	x	●	x	x							
28	f	o	x	o																			
29	f	o	o	x	●	x	x	●	●	●	x	x	●										
30	m	x	o	o	●	o	●	x	o	x	x	x	x	●	●	x	o						
31	m	o	●	●	x	●	x	x	x	x	o	●	x	●	●	x	x						
34	m	x	x	o	●	x	●	●															
36	f	o	x	o	●	●	x	x	●	o	●	x	●	x	x	x	●	o	●				
37	f	o	o	o	o	●	●	●	●	●	●	x	●	x	x	x							
38	f	o	●	●	x	●	x	x	o	●	x	●	●	x	x	x	●	x	●	x	x	●	
40	m	o	o	x	x	●	●	●	x	x	o												
42	m	o	o	●	●	●	●	x	●	x	●	●	x	o									
43	m	o	o	o	o	o	o	o															
47	f	o	o	x	o	o	●	●	x	x	x	x	●	●	●	●	●	x	●	o			
49	f	o	o	●	●	●	x	o															
51	f	o	●	x	●	o																	
52	f	o	x	o	o	o	x	●															
54	f	o	o	o	●	●	●	x	x	o	x	x											
55	f	o	x	●	●	x	●	●	x	x	x	x	●	x	x	●							
57	f	●	●	●	●	x																	
59	f	o	o	●	●	●	●	x															
61	m	o	o	o	●	●	x																
62	m	o	o	o	●	o	●	●	o	x	x	x	x										
63	m	●	●	x	●	x	●	x	x	●	x	x	●	x	●	●	●						

● : infected, o : noninfected, x : dead or undeveloped (test plant)
f : female, m : male

Figure 4. Serial transmission of yellow dwarf disease by individual *Nephotettix nigropictus* following acquisition feeding.

Thirty-nine of 41 leafhoppers transmitted the disease; that is, the percentage of infective leafhoppers was 95.1%. As for the incubation period in insects, 50% of the insects became infective within about 20 days and 90% within about 23 days after the first day of acquisition feeding, respectively. Four insects transmitted the disease within 17 days after the first day of acquisition feeding. This may be the shortest record of the incubation period in insects. As the development of disease symptoms was not regularly observed, it is difficult to determine the exact number of days of incubation period in plants. But from several observations it is safe to say that 50% of the infected test plant developed symptoms within about 33 days and 90% within about 43 days after inoculation feeding.

All of the above mentioned results, that is, the high percentage of active transmitters, the long incubation period in insects as well as plants, and the long retention period, are characteristics of yellow dwarf.

Subsequently, diseased plants from Muara, Pacet (West Java) and Barambai (South Kalimantan) were also confirmed to be yellow dwarf by the experimental transmission. At Cimande (West Java), Barabai (South Kalimantan), Lanrang and Sidrap (South Sulawesi) some diseased plants were observed.

Another experiment was conducted to compare the ability of transmission between *Nephotettix nigropictus* and *N. virescens*. The results are summarized in Table 12.

Table 12. Comparison of the percentage of infective insects and the incubation period of yellow dwarf in insect between two species of *Nephotettix*.

	N. nigropictus	*N. virescens*
Percentage of infective insects	67.1% (55/82)	28.4% (21/74)
Incubation period in insect (mean)	22.7 days	22.0 days

Percentage of infective leafhoppers was much higher in *N. nigropictus* than in *N. virescens*, but the incubation period of the disease agent in insect was nearly same between both species.

ii) Grassy stunt.

The transmission experiment was begun November 3, 1971. Two diseased rice plants were used as the source of the disease. One of them was a local variety brought by Mr. Leeuwangh from Tegal and the other was variety Pelita 1/1 from Muara. Twenty leaves of each diseased plant were cut off and put singly into test tubes. Five larvae from one female planthopper were introduced into each test tube and were given 2 days' access feeding on a diseased leaf. After the feeding period the insects were transferred singly to individual seedlings in the test tubes. The seedlings were renewed every other day, and from 10th day after acquisition feeding they were transplanted in enameled hypo baths. Development of disease symptoms was observed several times after 37 days of inoculation feeding.

The symptoms noticed were stunting, erect growth habit, leaf discoloration and many rusty spots on older leaves.

The results showed that 20 of 65 individual planthoppers of 30.8% transmitted the disease. Individual insects which died within 13 days after the first day of acquisition feeding were excluded from the calculation. Cumulative percentages of transmission with increasing number of days after acquisition feeding are shown in Figure 5.

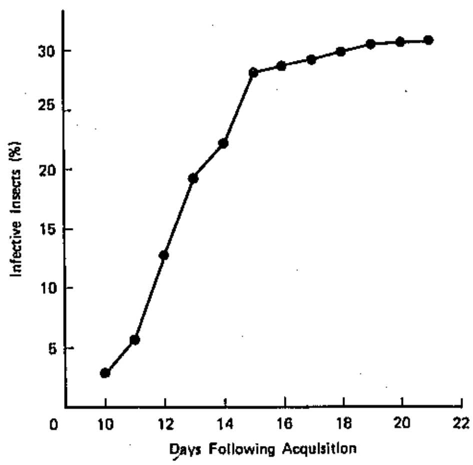

Fig. 5 Cumulative percentage of the first transmission of grassy stunt by individual *N. lugens* following acquisition feeding

It is assumed from this figure that 50% of the insects transmitted the disease by the 13th day and 90% did so by the 15th day after the first day of acquisition feeding. Viruliferous insects apparently were able to retain the disease agent for at least 20 days, the longest period used in serial transfers.

These experimental results show, that the percentage of infective planthoppers, incubation and retention period of the disease agent in insect generally coincide with those of Rivera et al. (1966) in the Philippines. Diseased plants have been found throughout Java, South Kalimantan, South Sulawesi and North Sumatra.

Later, Dr. Tantera and others also made an intensive study on grassy stunt. These results were presented at the Regional Symposium at Jogjakarta and printed as Contribution No. 2 of CRIA under joint authorship.

iii) A new mycoplasma/virus disease.

A disease was found in a rice field of variety C4-63 at the Muara Expt. Substation in November to December 1971. It was only one field but there were many diseased plants in it. Diseased symptoms are as follows;

Leaf-color is almost normal, but length of leaf blade is short. There are white mottlings which appear as bands intersecting leaf surface. Area of mottlings is larger on young leaves but becomes smaller as the leaves grow. Growth of newly formed tillers is abnormally upright and flowering is completely absent.

In December 1972 another 3 plants of variety Pelita I/I presenting similar symptoms were observed in the field at Muara. Experimental transmission by *Nephotettix virescens*, *N. nigropictus* and *Nilaparvata lugens* was tried, but none of them could transmit the disease.

d-2. Seasonal prevalence of leafhoppers and planthoppers in the rice field.

Studies on seasonal prevalence of leafhoppers and planthoppers were carried out at the Muara and Pusakanegara Experiment Substations. In the dry season 1971 and in the wet season 1971/72, an experimental rice field (plot Nos. 36 and 37, 9.32 are in area) at Muara was used, and in the dry season 1972 and in the wet season 1972/73, an experimental rice field at Muara (plot Nos. 19, 20 and 21, 14.62 are in area) and that at Pusakanegara (7.5 are in area) were used for the survey. Variety Pelita I/I was planted in all of these fields.

Five methods to estimate population density of insects were tried, i.e. direct counting, sweeping, suction catcher, yellow-pan water trap and light trap. In direct counting leafhoppers and planthoppers on each hill of rice plants were counted within 40 days after transplanting and classified into species, adult or larva, sex and wing form. In the sampling by suction catcher at nursery beds, a cylindrical net-frame inclosing 0.1 m^2 was used in combination with a suction catcher to collect all the insects inside the frame. As for yellow-pan water trap, 2 traps were set at Muara in the wet season 1971/72, and then 3 and 2 traps were set at Muara and Pusakanegara, respectively, in the dry season 1972 and in the wet season 1972/73. In addition, 2 light traps equipped with a 30 w luminescence lamp and a fan were set at Muara and Cianjur.

Results of the experiment obtained in the wet season 1971/72, the dry season 1972 and the wet season 1972/73 are described in the following:

i) Population density of leafhoppers and planthoppers at rice field at Muara in the wet season 1971/72.

Four hundred hills of rice plants transplanted on January 9 were sampled systematically on January 22, 1972, from those in the plot No. 36 (6.96 are in area), and the number of leafhoppers and planthoppers on them was counted by eyesight. Then on February 24, 1972, 20 samples of 10 net-sweeps were taken from the same field. Results are shown in Table 13.

The population density of leafhoppers and planthoppers was very low 15 days after transplanting and did not show marked increase even 48 days after transplanting. The population density of *Sogatella furcifera* was higher than other species.

Table 13. Population density of leafhoppers and planthoppers at the rice field at Muara in the wet season 1971/72.

Leaf- and planthoppers species	Total no. on 400 hills (Jan. 22, 1972)	Total no. by 200 net-sweeps (Feb. 24, 1972)
Nephotettix nigropictus	5	8+ (4)
Nephotettix virescens	2	3
Recilia dorsalis	0	4
Nilaparvata lugens	2	4
Sogatella furcifera	17	22+ (3)

Note: Number in parenthesises is of larvae.

In this season insect-catches by yellow-pan water trap were examined at intervals of 1-2 days. During the first week after transplanting there was no catch of both traps except one *Nephotettix nigropictus*. From 10th or 11th day *Sogatella furcifera* and *N. nigropictus* began to immigrate into the rice field. Later the number of *Sogatella* fluctuated from 0 to 5 (sometimes over 5) per trap per day till the middle of April (about 3 months after transplanting). Thereafter there was no catch till harvest.

Nephotettix nigropictus showed a similar population trend as *Sogatella*, but the number of catch per trap per day was 0-2. *Nephotettix virescens* appeared later than *N. nigropictus* from the beginning of March (about 50 days after transplanting). Since the beginning of April *Nilaparvata lugens* were found in traps until harvest. Most of them were brachypterous females.

ii) Population density of leafhoppers and planthoppers at nursery beds in the dry season 1972.

A survey on the population density of leafhoppers and planthoppers at nursery beds was made by suction catcher. 10 or 20 samples each from 0.1 m^2 in nursery beds of the different dates of sowing were taken at Muara and Pusakanegara. The number of each species per 1 m^2 is shown in Table 14.

Table 14. Number of leafhoppers and planthoppers per 1 m^2 of nursery beds in the dry season 1972.

Locality	Muara		Pusakanegara	
Date of sowing	June 14	June 20	June 1	June 15
Date of survey	July 1	July 1	June 20	July 4
No. of samples	20	20	10	20
Nephotettix nigropictus	0.5	0.5	1	1.5+(0.5)
Recilia dorsalis	1.5	4	4	2
Nilaparvata lugens	1.5	0.5	2	4.5
Sogatella furcifera	0.5	0	1	0
Thaia ghaurii	4	2.5	7	0

Note: Number in parenthesises is of larvae.

In this period, *Recilia dorsalis* and *Thaia ghaurii* were found to be somewhat abundant at both localities, and *Nilapravata lugens* was somewhat abundant at Pusakanegara but a little at Muara. A little amount of *Nephotettix nigropictus* was caught but *N. virescens* was not.

iii) Population density of leafhoppers and planthoppers at nursery beds in the wet season 1972/73.

Survey method was same as the above. The number of each species per 1 m^2 of nursery beds is shown in Table 15. The population density of leafhoppers and planthoppers during this period was rather lower than that in the dry season 1972.

Table 15. Number of leafhoppers and planthoppers per 1 m^2 of nursery beds in the wet season 1972/73.

Locality	Muara			Pusakanegara	
Date of sowing	Jan. 20	Feb. 8	Feb. 17	Jan. 3	Jan. 17
Date of survey	Feb. 6	Feb. 26	Mar. 6	Jan. 24	Feb. 7
No. of samples	10	10	10	40	20
Nephotettix nigropictus	1		1		
Recilia dorsalis	1	1	2	0.75	
Nilaparvata lugens		1	2		
Sagatella furcifera					3.5
Thaia ghaurii			5		

iv). Population density of leafhoppers and planthoppers at the rice field at Pusakanegara in the wet season 1972/73.

A rice field, 7.5 are in area, was separated into two plots. Transplanting of rice seedlings was done on January 24 in one of them and February 8 in the other. Number of leafhoppers and planthoppers on 100 hills in each plot was counted by eyesight on March 11, and then that on 40 hills was counted on April 3. Results are shown in Table 16.

Table 16. Population density of leafhoppers and planthoppers at the rice field at Pusakanegara in the wet season 1972/73.

	Nilaparvata lugens					*Sogatella furcifera*			
	B♀	B♂	M♀	M♂	L	B♀	M♀	M♂	L
March 11									
Plot A	2.4	0.8	1.6		0.8			0.4	9.6
Plot B	1.2						3.6		10
April 3									
Plot A	19		22		47		1		6
Plot B	11	1	11	1	13	1		3	8

Note: The density is presented as number per 40 hills of rice plants.
B = brachypterous, M = macropterous, L = larva
Date of transplanting: January 24 (Plot A),
February 8 (Plot B)
Mean number of stalks per hill on March 11 : 19.6 (Plot A), 18.2 (Plot B)

Only two species of planthoppers, *Nilaparvata lugens* and *Sogatella furcifera,* were found in this field. But the population density of these species was much higher than that at Muara in the wet season 1971/72. *Nilaparvata lugens* increased its number by more than ten times in these 23 days, but the population density of *Sogatella furcifera* showed no change. The density of *Nilaparvata lugens* was much higher in Plot A than in Plot B, but that of *Sogatella furcifera* was a little higher in Plot B than in Plot A. It is interesting to note that the number of *Nilaparvata lugens* was nearly the same between the two wing forms on April 3.

Most of the light trap catches have not yet been examined. The examination of light trap catches is not easy work and requires well-trained specialists.

d-3. Varietal difference to the occurrence of rice virus diseases and their vectors among some rice varieties.

Rice field (22.83 are in total area) at the Muara Expt. Substation was used for this study. Varieties tested in each season were as follows (3 replicates).

Wet season 1971/72: PB 8, PB 5, Dewi Ratih, Syntha, Taichung Native 1, C4-63, Pelita 1/1.

Dry season 1972 : PB 8, PB 5, IR 22, Bengawan, Taichung Native 1, C4-63, Pelita 1/1.

Wet season 1972/73: PB 8, PB 5, IR 22, IR 24, Taichung Native 1, C4-63, Pelita 1/1.

Some of the data obtained on the occurrence of virus diseases are shown in Table 17.

Table 17. Varietal difference to the occurrence of rice virus diseases.

Variety	Wet season 1971/72				Dry season 1972		
	No. hills observed	Grassy stunt	Tungro	Yellow dwarf	No. hills observed	Grassy stunt	Tungro
PB 5	1552	3	0	0	1479	5	0
PB 8	1601	3	1	0	1811	3	0
C4-63	1670	1	1	0	1398	2	0
Pelita 1/1	1638	1	0	0	1435	3	1
Taichung Native	1543	9	2	1	1602	8	1
Syntha	1714	0	0	0	–	–	–
Dewi Ratih	1553	0	0	1	–	–	–
Bengawan	–	–	–	–	1454	1	0
IR 22	–	–	–	–	1070	4	0

Here also the occurrence of virus diseases was so small that a clearcut conclusion could not be drawn. But generally speaking, Taichung Native 1 as a control variety is most susceptible to grassy stunt, improved varieties are resistant, and among the introduced varieties C4-63 is moderately resistant. This may be explicable from the fact that the occurrence of *Nilaparvata* was also lesser in C4-63.

As for the differences in the occurrence of leafhoppers and planthoppers among 7 varieties, data in the wet season 1972/73 are shown in Table 18. Population density of these insects at the Muara experimental field was a little higher in this season. It is noteworthy that the density of *N. virescens* was much higher in IR 22 than other varieties. IR 24 seems to be promising as a tolerant variety to leafhoppers.

Table 18. Varietal difference to the occurrence of leafhoppers and planthoppers in the wet season 1972/73.

Field No.	Variety	No. hills observed	*Nephotettix virescens*	*Nephotettix nigropictus*	*Nilaparvata lugens*	*Sogatella furcifera*
4b	IR 22	65	6+(2)	1	3	6
9	T N 1	81	4+(4)	1	9	10+(1)
	IR 24	77	0	0	3	7
	C4-63	82	0	2	2	7
	Pel. 1/1	85	2+(1)	0	3	12
	PB 8	77	0	1+(1)	2	15
	PB 5	75	0	0+(1)	1	5+(1)
10b	IR 22	74	23	0	7	10
	PB 5	59	5	2	14	13
11b	C4-63	77	4	1	6	3
	Pel. 1/1	81	1	2	12+(2)	1

Note: Number in parenthesises is of larvae.

e. Study on downy mildew of corn.

Corn is an important food crop next to rice in Indonesia and 80 - 90% of corn production has been used for human consumption. However, average yield of corn is still low, ranging 9 to 10 quintals per hectare.

Downy mildew of corn caused by *Sclerospora maydis* is one of the important factors which have conditioned the low yield of corn, and the existing improved corn varieties of high yield and good quality in Indonesia are not resistant to downy mildew. Together with the breeding of corn varieties resistant to downy mildew and the improvement of cultural practices, studies on the epidemiology of the disease are necessary for its control.

e-1. Field observation on natural infection of *Sclerospora maydis*.

An experiment on the effects of corn planting date to the downy mildew infestation was conducted at Cikeumeuh Substation, Bogor, from January 15, 1972, January 15, 1973.

In this experiment, Bogor Composite-2 (BC-2), a susceptible variety, and Pemadi (BS-2), a moderately susceptible variety, were planted at a half-month intervals. In each planting the plot size was 4.5 X 4.0 m^2 for each variety and the experiment was replicated 3 times. All plots were fertilized at the rate of 120 kg N, 60 kg P_2O_5 and 30 kg K_2O per hectare.

Observations on the rate of infection were conducted 2, 4 and 8 weeks after sowing. At each planting time, 3 records of percentage of infection were collected

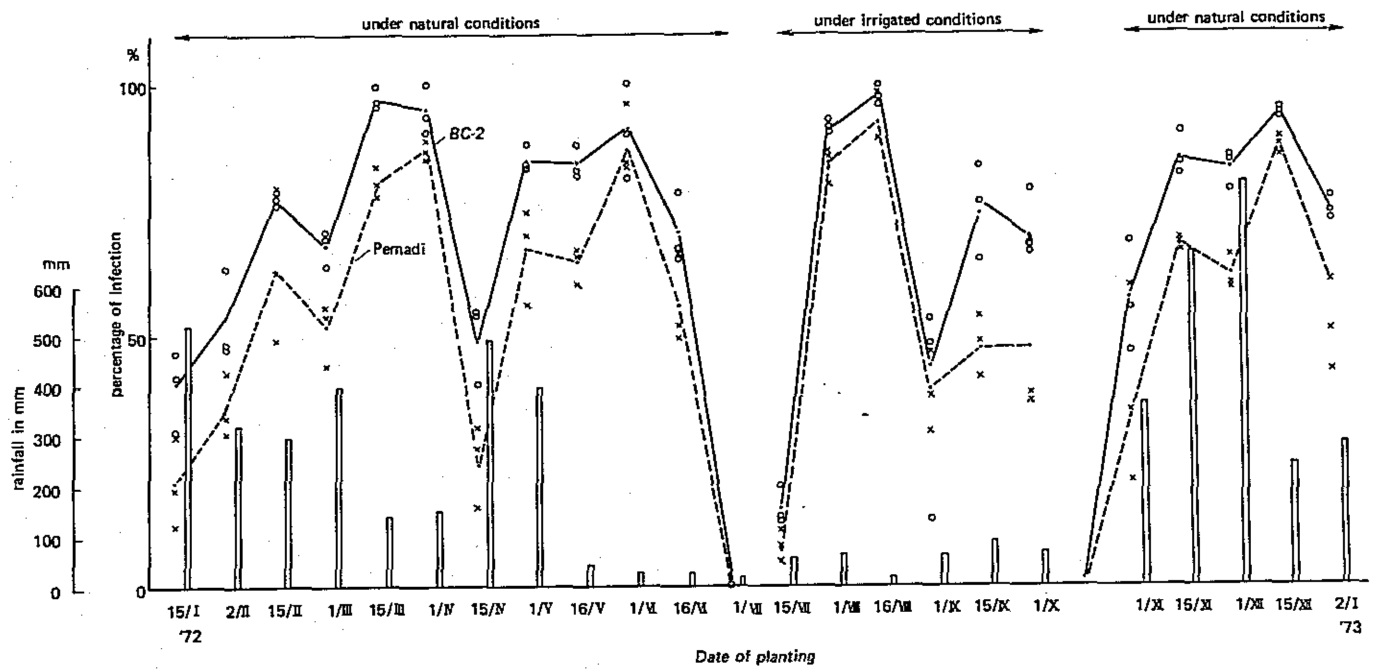

Fig. 6 Seasonal change of infection and monthly rainfall

Note; Rainfall were calculated from date of planting to 30 days after planting.

for each variety. The fluctuation trend was drawn based on the average of the 3 records. Rainfall data were recorded from Muara and Cikeumeuh Substation, Bogor. As additional data, extent of damage to plant height, stem thickness and leaf size, and decrease in number of ears of infected plants were also recorded.

Results of the experiment are shown in Fig. 6. BC-2 always indicates a high rate of infection compared with Pemadi. The total amount of rainfall does not seem to have much influence on the rate of infection on corn plants, particularly when the susceptible varieties are continuously grown. This is due to the fact that downy mildew fungus depends on the presence of dew in newly emerging leaves of young plants for new infection to occur. Even in the dry season when there was a limited amount of rain, the presence of a few drops of water on the leaf in the early morning hours was enough for infection.

In BC-2 variety, the reduction of leaf length and leaf width due to infection ranges from 0 to 25.3 % and from 47.4 to 56.5 %, respectively, depending on the leaf position. Plant height and stem thickness of infected plants are from 50 to 85 % and from 44 to 72 %, respectively, compared with healthy plants. Only less than 10 % of the infected plants produce ears.

e-2. Field study on conidial dissemination under natural condition.

A test to observe the conidial dissemination under natural condition was carried out in the wet season of 1972/73 at Pacet Substation at Cibadak (1200 m above sea level).

Infected plants (BC-2) were brought from Bogor and planted in the field 2 weeks before test plants of the same variety were seeded around it. The infected plants acted as the source of inoculum for the newly planted crop.

The number of diseased plants in the new crop was recorded daily, and newly infected plants were removed as soon as they were detected, so that they will not serve as a new source of inoculum. The distance from the source of infection to the newly infected plants was measured in each case.

Similar observations were conducted in field plots at Cikeumeuh Substation in Bogor. In this field during the beginning of the wet season of 1972/73, 15 rows of corn plants of variety Harapan were planted one month later than rows of already infected plants which act as source of inoculum. The newly planted crops were spaced at 0.5 m intervals with the distance from the source of inoculum ranging from 3 to 16 m. Observations were made daily regarding the number and distance of newly infected plants from the source of inoculum. Here again newly infected plants were removed as soon as symptoms appeared.

When the source of infection was in the centre of the field at the Cibadak Substation, the number of infected plants in relation to its distance from the source of inoculum are as shown in Fig. 7.

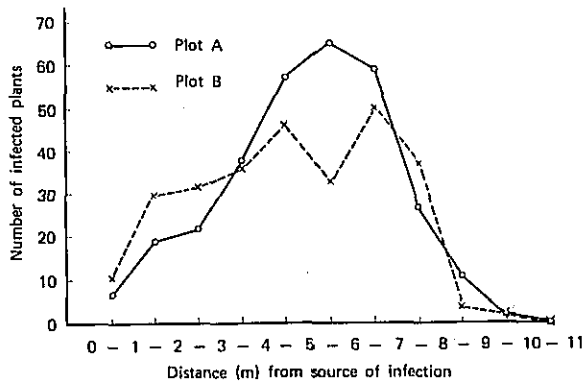

Fig. 7 Distribution of the infected plants at Chibadak Substation of CRIA

Note; i) Variety BC-2.
ii) Planted on 20th Sep. 1972.
iii) Observed from 2nd Oct. 1972 to 11th Nov. 1973

Most of the infected plants are at a distance of about 4.5 to 6.5 m from the source of inoculum. Infection occurs rarely at a distance of 10 - 11 m.

Data collected from the test at Cikeumeuh Substation indicated a similar trend. Percentage of infection decreases as the distance from source of inoculum increases. The rate of decrease in percentage of infection is sharp at a distance from 0 to 8 m. Farther away the rate of decrease levels up to less than 10 % infection at 16 m from source of inoculum (Fig. 8).

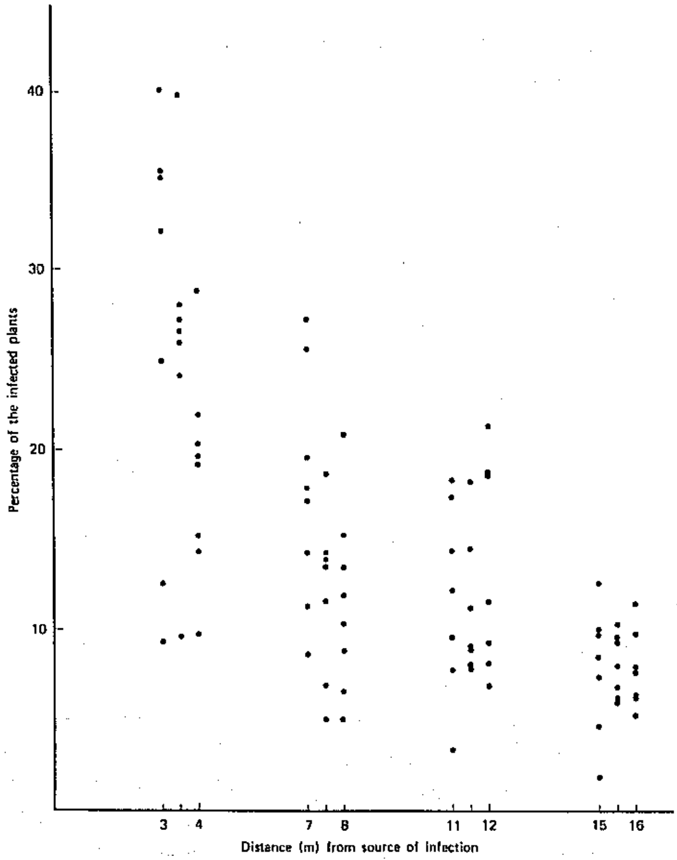

Fig. 8 Distribution of the infected plants at Cikeumeuh Substation of CRIA

From the results of these observations, it is revealed that conidia of *Sclerospora maydis* under natural conditions do not travel very far from its source. Previously it was believed that conidia could infect corn plants as far as 2 km from its source.

e-3. Field observation on downy mildew infection of corn in Java.

a) Sukabumi area (West Java)

Field observations were carried out at 7 places in Sukabumi area in September 1971 when corn plants were 2 months old. In each observation, rate of infection and also the surrounding cropping pattern were recorded.

In these observations, the local varieties had less infection than improved ones, especially when both were planted in the same location. Also most corn plants were planted in a multiple cropping pattern which helps to reduce the rate of infection.

At high elevations, such as at Bojonglopang (500 m above sea level), the improved variety had 5 % infection. Apparently, corn had just begun to be introduced into this area or the disease occurred for the first time.

b) Central and East Java.

During the period between October 1972 and January 1973, observations were carried out on the incidence of downy mildew disease on corn crop grown in Central and East Java. The purpose of the observation was to study the spread of the fungus from time to time. Seven places representing areas where corn plants were usually grown were selected and visited at regular time intervals to record the degree of infection.

In the observations from December 1972 to January 1973, high infection was found at 5 places, which are Kalasan, Sedatu, Karang kunci, Bedali and Banyuwangi.

Results of observation at these 5 places showed the same trend, that is, the late planted crops have a higher percentage of infection (80 - 90 %) compared with the early ones (10 - 20 %). It seems that the disease spreads from the older diseased plants to the younger ones by means of conidial dissemination by wind. In this case the older diseased plants play a role as an infection source, although these plots have only a few percentage of infection.

The infection rate seems to be lower for the plots located farther from the older source plants, and it appears that the spread of disease will be within 50 meters distance from the source of infection.

e-4. Occurrence of downy mildew on Gelagah (*Saccharum spontaneum).*

Along the hill of Bojonglopang district (West Java) where Gelagah (*Saccharum spontaneum*) grew abundantly, some of the plants were found to be infected with downy mildew fungus.

The infected leaves split up and resemble those of downy mildew of millet (Siragabyo), caused by *Sclerospora graminicola.* Some of these plants were brought to the Central Research Institute for Agriculture, Bogor, for observation under microscope. Abundant oospores could be found in the infected leaf tissue, but the presence of conidia could not be confirmed, possibly due to the dry condition of the leaf material. Size of oospore was 72 X 82 μ on the average. Further study is needed for identification of the fungus and its pathogenicity.

B. Plant physiological research.

a. Survey on the occurrence and distribution of physiological disorders of lowland rice.

Survey on the occurrence and distribution of physiological disorders of rice in Indonesia has been conducted at various localities in Java, Sumatra, South Kalimantan and South Sulawesi from August 1971 to December 1972.

Samples of physiologically disordered rice plants were collected from various places and analysed chemically for nine components, i.e. N, P, K, Ca, Mg, Na, Zn, Fe and Mn.

According to the results of chemical analysis, most of rice plants showing symptoms of physiological disorders are deficient in nitrogen, phosphorus and potash, and in some rice plants, a high content of iron or manganese which is considered to be the cause of disorder was detected.

So called "Mentek" symptom was observed at Cihea, Serang, Klaten, Bantul, Demak and Kepandjan of Java, and also at Sidikkalang in North Sumatra and Padang in West Sumatra.

Symptoms on leaves of "Habang" observed at Barambai in Kalimantan are not same according to rice varieties, and symptoms on PB5 are similar to "Mentek".

Rice plants grown on undrained fields show a disturbance in growth caused by soil reduction, and also abnormal distribution and unusual development of roots. Iron toxicity may be one of the causes of these disorders.

On rice fields of grumusol in Ngale, the growth of rice plants at the early stage is unhealthy, showing chlorosis of the leaves. On soil of this type which shows high pH, roots of rice plants at early growth stage are white in colour and chlorosis of leaves may be caused by a deficiency of Fe.

On the field of rotation system such as lowland rice-rosella or lowland rice-sugar cane in Central Java, marked physiological disorders of rice have been observed. These disorders may be caused by heavy dressing of ammonium sulfate and by soil reduction due to much residue of organic matters of preceding crops.

On the paddy fields south of Mt. Merapi in Central Java having the soil profile of "Akiochi" type, severe occurrence of Helminthosporium leaf spot has been observed. Additional application of fertilizer at later stage of rice growth would be one of the countermeasures on these fields.

b. Study on yield and nitrogen nutrition of lowland rice on physiologically disordered fields.

The productivity of rice fields in Indonesia showed great variations, ranging from low to rather high productivity as indicated by the harvested straw and grain yield.

It is a well known fact that among the nutrient elements which often limits the grain yield of rice, nitrogen is the most important. In many cases application of nitrogen alone increases grain yield of rice significantly.

The aim of the experiment is to have some idea of nitrogen uptake and nitrogen efficiency of fertilizer used on lowland rice located in different soil types in Java island, which is of importance for the improvement of rice production.

Plant samples for chemical analysis and yield were obtained from experiments conducted by the Agronomy Division in the dry season 1971 to study the response of different levels of nitrogen application on grain yield of different rice varieties located in different experimental fields with an elevation from 5 to 270 m above sea level, i.e., Genteng (alluvial, 145 m), Mojosari (regosol, 10 m), Ngale (grumusol 50 m), Pusakanegara (alluvial 5 m) and Muara (latosol 270 m).

There were five increasing rates of N application, namely, O, 45, 90, 135 and 180 kg N per hectare. Nitrogen was given in the form of urea and applied three times, 1/3 as basic dressing, 1/3 at active tillering stage and the other 1/3 at flower primordia stage. Each treatment was supplied with 60 Kg P_2O_5 and 60 Kg K_2O per hectare as triple superphosphate and potassium sulphate, respectively.

A split plot design with three replications was used. Three rice varieties PB5, Pelita 1/1 and Pelita 1/2, which are high yielding, responsive to fertilizer application, early maturing and short in statue, were used to obtain the experimental data.

Two representative hills from each plot at harvest were sampled for chemical analysis. The samples obtained were divided into grain and straw, dried in a drying oven at 70°C, powdered using C & N Junior mill, and used for N determination following the Kjeldahl method. The evaluation of nitrogen in the rice plant derived from the fertilizer applied was determined by the conventional method from the difference in plant nutrient yield between the nitrogen treated and untreated plot.

The results of the experiment showed that nitrogen application increases grain yield significantly in all locations, and that at the highest nitrogen application at a rate of 180 Kg N per hectare, there is still a significant increase in grain yield in Mojosari, Pusakanegara and Ngale, while in Genteng there is only a slight increase. In Muara the highest grain yield is obtained at 135 Kg N per hectare and higher nitrogen application causes a decrease in yield. The highest yield was obtained in Mojosari, followed by Pusakanegara, Ngale, Genteng and Muara (Fig. 9).

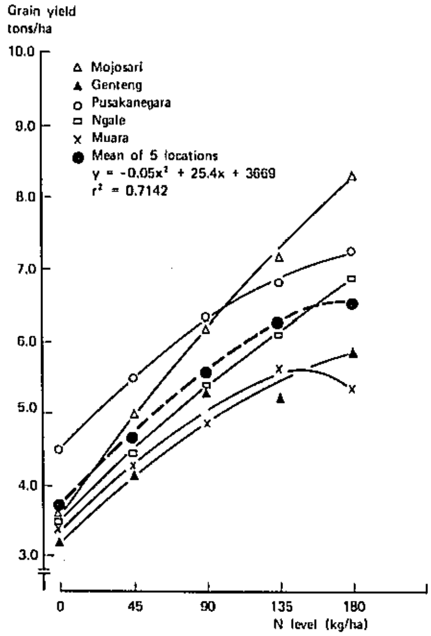

Fig. 9 Relation between rice grain yield and increasing rates of nitrogen application at 5 different locations.

The values of N content at harvest time in the straw vary between 0.34 to 0.63% and in the grain between 0.82 to 1.24%. The percentage of N in straw as well as in grain increases with increasing rates of N supply and as more N is translocated to the grain than to the straw. Application of 45 Kg N per hectare causes practically no increase in N content in comparison with untreated plot, and the effects of higher doses are more apparent in increasing N content in straw as well as in grain.

There is a positive correlation between N content in grain and yield, and for high grain production the N content in grain has to be higher than 1.0%. Lower values seem to be related with low yield. There is almost no relation between grain yield and N content in straw. It can be concluded in so far as this experiment is concerned that N content in grain is more correlative than N content in straw at harvest time with crop yield.

The total N uptake of the rice plant at harvest increases proportionally with increasing N supply. The total N absorption varies between 46 to 148 Kg N per hectare, and 46 to 65 Kg N originates from the natural supply of the soil. Pusakanegara has the highest indigenous and total N uptake. The other four locations have about the same value of indigenous N, around 50 kg N per hectare. Muara has the lowest total N uptake (Fig. 10).

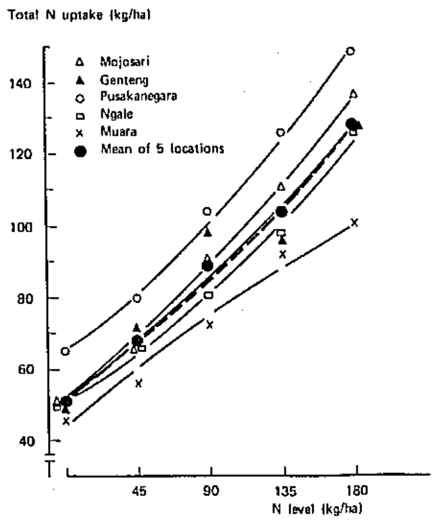

Fig. 10 Relation between total N uptake of rice plant at harvest and increasing rates of N application at 5 different locations.

The percentage of indigenous N from the total uptake decreases with increasing N supply. The mean values for 5 locations for increasing rates of N application, i.e. 45, 90, 135 and 180 kg N per hectare are, respectively, 75, 58, 49 and 40%. These decreasing values are due to increasing uptake of N derived from the fertilizer applied.

There is a positive correlation between total uptake of N and grain yield. The grain yield increases significantly with increasing N absorbtion. Low N uptake is related with low yield. For high crop production, 5 tons or more grain yield per hectare, the total N absorption must be higher than 80 kg N per hectare. The highest total N uptake takes place in Mojosari and the lowest in Genteng, while in other locations it lies in between (Fig. 11).

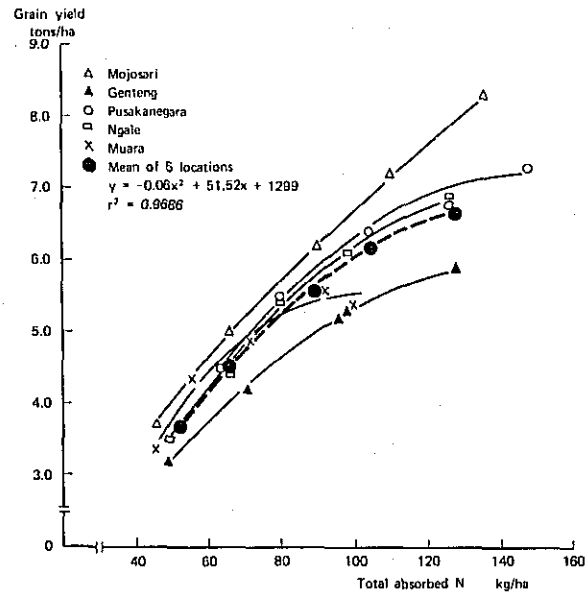

Fig. 11 Relation between total uptake of nitrogen and grain yield of rice at 5 different locations.

There is a clear relation between accumulation of N in grain and in straw. From the total N absorbed about 70% is translocated to the grains. It means that the great portion of nitrogen absorbed from the soil is accumulated in the grains and only a small portion is allocated to the other plant parts at harvest time.

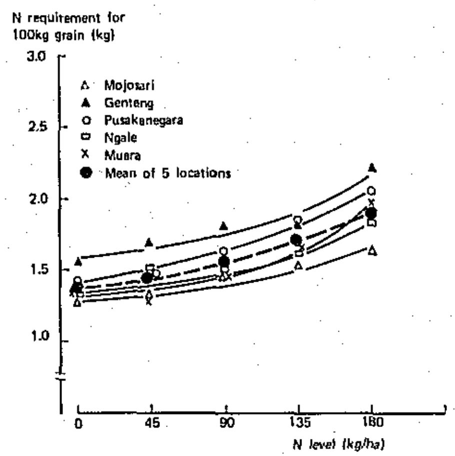

Fig. 12 Relation between N requirement for 100 kg grain production and increasing rates of nitrogen application at 5 different locations.

The N requirement to produce 100 kg grain is shown in Fig. 12. The curves indicate that the values increase with increasing N supply, and vary between 1.27 to 2.20 kg.

Yield return per kilogram fertilizer N used can be calculated by yield increase due to fertilizer N applied divided by the amount of fertilizer applied. The values are, respectively, 22, 21, 19 and 17 kg grain per kilogram fertilizer N applied for 45, 90, 135 and 180 kg N application. This means that the yield return decreases by increasing N supply.

Taking into consideration the utilization of added fertilizer by rice plant, the mean utilization ratio is for Muara 29%, Ngale 38%, Pusakanegara 42%, Genteng 45% and Mojosari 48% (Fig. 13).

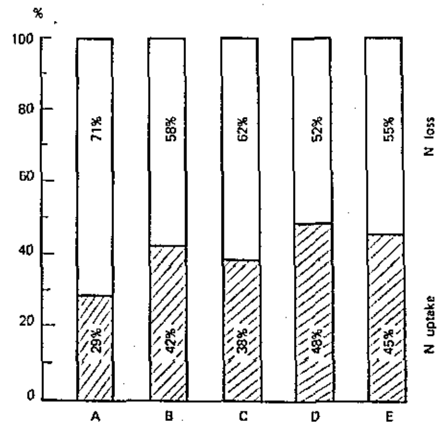

Fig. 13 Nitrogen utilization ratio of applied fetilizer N in the rice plant at Muara (A), Pusakanegara (B), Ngale (C), Mojosari (D) and Genteng (E).

In other experiments conducted in problem field at Cihea, West Java, nitrogen utilization ratio is very low, being 9 to 23%.

c. Physiological disease of rice in Chiea

In Cihea, West Java, a physiological disease of rice, which was known by local farmers for many years, was observed in 1970. However the cause of the disease has not been precisely identified. Normally, the farmers in this area did not apply potassium fertilizers in rice fields, and the disease was also observed in rice areas fertilized with nitrogen or phosphate fertilizers.

The disease appears when the rice plant is about one month old and the symptoms proceed from the older leaves. Initially the normal green color of the lower leaves changes into orange to brown starting from the tips and spreading downwards to the leaf base often accompanied by many small brown spots starting from the leaf tips. At later stage the orange to brown discoloration of the lower leaves becomes more pronounced, and at the severe stage the entire leaf blade is brown colored and subsequent growth is retarded. Subsequently, the affected leaves dry up and die. Small purplish brown spots are also observed on the veins of the leaf blades and leaf sheaths, especially on lower leaves. Affected plants give low grain yield. The disease occurred in the wet as well as in the dry season.

The soil of the problem field was grumusol with local alluvial, containing heavy clay, pH 6.2, and was strong reductive. The field was technically irrigated.

In the dry season 1971, PB5 rice shoot samples were taken at successive stages of growth from the problem field and healthy field in Cihea to gain some idea of the nutritional status of the plant. The plant material was separated into leaf blade, leaf sheath and culm, and panicle, then dried in a drying oven at 70°C, powdered and analyzed for macro and micronutrients.

Nitrogen was determined by the Kjehldahl method, and after wet digestion with nitric acid, sulphuric acid and perchloric acid, phosphorus was determined by the ammonium vanadomolybdate method, potassium and sodium by flamephotometry, magnesium, manganese, iron and zinc by atomic absorption spectrophotometry, following the method of the National Institute of Agricultural Sciences, Tokyo, Japan.

Fig. 14 Laboratory of the Subdivision of Plant Nutrition at Sindanbang.

The results of chemical analysis of the plant samples taken from the problem field and healthy field are presented in Table 19 and Fig. 15.

Table 19. Element content of leaf blades, leaf sheaths, culms and panicles of the rice plant at successive stages of growth in Cihea problem field West Java.

Sample No.	Age	dry matter g	Plant parts	N %	P %	K %	Na %	Ca %	Mg %	SiO_2 %	Fe ppm	Mn ppm	Zn ppm
1.	Active tillering	7.08	l	3.51	0.20	1.14	0.01	0.31	0.23	11.2	345	968	72
		7.18	s	1.82	0.25	1.29	0.04	0.07	0.16	8.9	1150	968	77
2.	Preprimordia stage	9.43	l	1.78	0.18	1.23	0.01	0.46	0.26	14.8	245	1248	64
		14.23	s	1.32	0.21	0.93	0.04	0.08	0.15	9.0	488	980	72
3.	Heading	16.86	l	1.67	0.17	0.85	0.01	0.40	0.22	15.3	285	1142	46
		27.35	s	1.05	0.19	0.65	0.04	0.09	0.13	9.6	572	900	58
4.	Full heading	13.15	l	1.55	0.14	0.63	0.01	0.26	0.27	19.6	220	1418	50
		27.62	s	0.86	0.14	0.48	0.03	0.19	0.12	11.5	480	970	66
		6.97	p	1.15	0.18	0.73	0.01	0.08	0.16	8.0	250	365	59
5.	Harvest	12.70	l	0.74	0.06	0.23	0.01	0.37	0.19	15.6	232	1700	43
		27.81	s	0.70	0.08	0.51	0.03	0.45	0.14	14.0	310	1235	60
		27.83	p	1.52	0.17	0.30	0.01	0.12	0.10	9.8	132	110	58

Note: Average of 4 samples.
l : leaf blade, S : leaf sheath and culm, p : panicle.
Fertilization ; 120 kg N as urea and 90 kg P_2O_5 as triple superphosphate per ha.
Rice variety ; PB5.

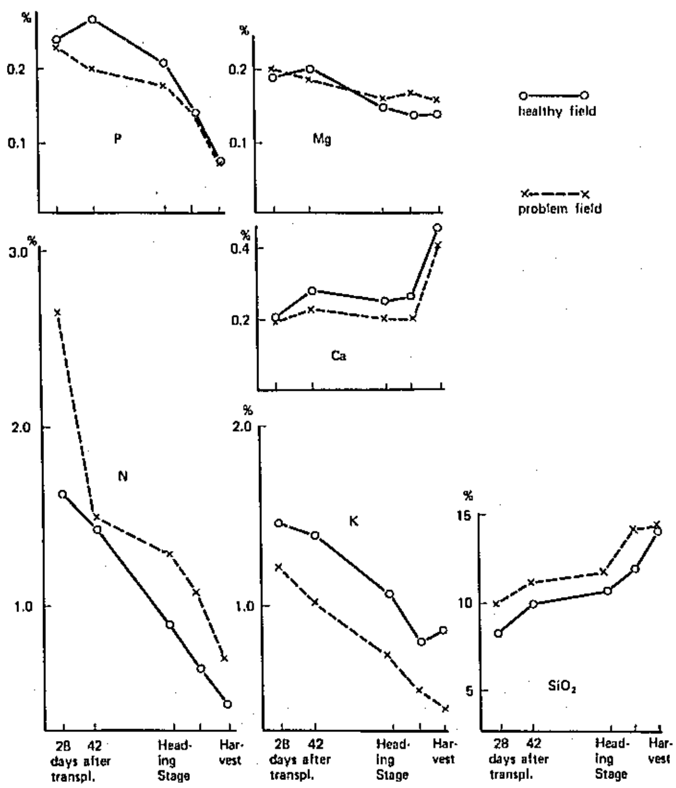

Fig. 15-1 Change in element content of rice straw at sucessive stages of growth in problem and healthy field

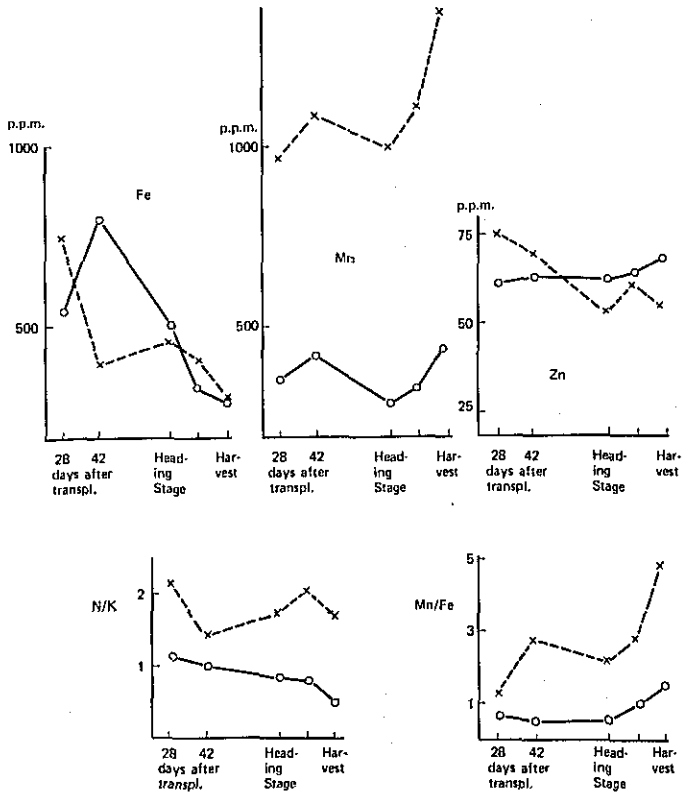

Fig. 15-2 Change in element content of rice straw at successive stages of growth in problem and healthy field

The chemical data indicate that the plant is low in potassium content. On the other hand, iron and manganese are high. Low level of potassium probably inducing iron toxicity and the high manganese content very likely contributed also in the abnormal appearence of the rice plant, seen in the brown discoloration of the lower leaves and purplish brown spots on the veins of the leaf blades and leaf sheaths. Incident sampling of severely affected plants showed a manganese content of 2400 ppm in the leaf blades.

From the results of chemical analysis of the preliminary sampling of the rice plant it was considered that low potassium content was the main cause of the disorder. To confirm this assumption in the wet season 1971/72, an experiment was conducted in the problem field to study the effects of potassium application on the nutrient composition, yield and disorderly appearence of the rice plant. Three treatments were involved in this experiment; 90 kg N as urea and 60 kg $P_2 0_5$ as triple superphosphate were given per hectare in all treatments. The second and third treatment received 60 kg $K_2 0$ as potassium chloride and 60 kg $K_2 0$ as potassium sulphate, respectively, besides 90 kg N as urea and 60 kg $P_2 0_5$ as triplesuperphosphate per hectare.

Urea was given three times, one-third as basal dressing, one-third 15 days after transplanting, and one-third at the primordia stage. Phosphorus and potassium fertilizers were applied as basal dressing. Twenty-one-day-old PB_5 rice seedlings were used, planted three seedlings per hill with 25 X 25 cm plant spacing. It was a randomsized block design with 3 replications. The second and third rice rows of the 3 X 5 m experimental plots were used as sampling materials for chemical analysis and yield component determination. The effects of potassium on yield component and yield of rice is presented in Table 20.

Table 20. The effects of potassium on yield component and yield of rice in Chihea problem field in the wet season 1971/72.

Treatment	No. of panicles/ hill	No. of spikelets/ panicle	% of ripened grains	Weight of 1000 kernels	Grain yield kg/ha
A	23.5	92	54.3	20.1	2958
B	21.7	108	75.9	26.2	5594
C	19.4	112	70.7	26.4	5932
LSD 0.05	n.s.	n.s.	12.0	2.44	726
0.01	–	–	19.8	3.99	1204
C.V.	10.7	7.38	7.88	4.38	6.63

Note :

	N		P		K
	N	:	P	:	K
A.	90	:	60	:	0
B.	90	:	60	:	60 (K as KCL)
C.	90	:	60	:	60 (K as K_2SO_4)

The data indicate that potassium application has a beneficial effect on increasing grain yield of rice in the Cihea problem field and this is mainly due to the increase of percentage of filled grains and the weight of 1000 kernels. The data show that potassium treated plots resulted in a substantial increase in grain yield, about twice the non-potassium treated plots. Although there is no significant difference in the number of spikelets per panicle between the non-potassium and potassium treated plots, the low percentage of ripened grains of the spikelets in the nonpotassium treated plots causes a strong decrease in grain yield. This means that potassium has a significant effect in improving grain ripeness in rice plants. The increase in weight, 1000 kernels with about 30% in plots supplied with potassium, proved the effectiveness of potassium in increasing grain yield of rice in the Cihea problem field. The rice plants treated with potassium fertilizers showed better growth appearence in comparison with the non-potassium treated plots.

Chemical analysis of the samples from the field experiment at harvesting time is shown in Table 21.

Table 21. The effects of potassium application on the nutrient composition of the rice plant in the Cihea problem field.

Treatment	N %	P %	K %	Ca %	Mg %
A	0.76	0.39	0.35	0.33	0.14
B	0.61	0.44	1.00	0.34	0.12
C	0.62	0.46	1.00	0.35	0.12

Note: N : P : K
A. 90 : 60 : 0
B. 90 : 60 : 60 (K as KCL)
C. 90 : 60 : 60 (K as K_2SO_4)

Again the chemical analysis proved the significant role of potassium application on the improvement of the nutrient status of the rice plant reflected in the better grain yield. Potassium chloride as well as potassium sulphate were both effective in increasing the potassium level of the rice plant. The potassium content of the non-potassium treated plants remained lower than the normal limit.

The results indicated that the physiological disease of rice in Cihea was mainly due to potassium deficiency and in some cases due to high manganese content of the plant tissue, and a complex of symptoms due to low potassium and high manganese was observed.

d. The effects of fertilization on growth, nitrogen nutrition and the occurrence of Helminthosporium leaf spot in lowland rice.

Helminthosporium leaf spot is one of the major disease of rice in Indonesia. The infestation of the disease reduces rice yield to some extent depending on the severity of the disease. Usually the disease occurs in unfavourable soil conditions, such as degraded soils, and in sandy land with shallow top soils.

Imbalance in the supply of nutrients during growth, especially nitrogen and potassium shortage or nitrogen and potassium imbalance, induces the occurrence of Helminthosporium leaf spot. Acidic soils and shortage of iron, manganese and silica also promote the severity of the disease.

The experiment was conducted in the wet season 1972 to study the effects of fertilization on growth, nitrogen nutrition and the occurrence of Helminthosporium leaf spot. A farmer's field in Moguwoharjo about 15 km from Jokjakarta was chosen as an experimental site at an elevation of 200 m above sea level. It was composed of regosol, sandy clay loam containing small gravels and yellowish brown in colour with a shallow topsoil 10 - 13 cm deep. Between the topsoil and subsequent layer there was a clear wavy boundary about 16 cm thick, reddish brown in colour with mottles of iron. The third layer was 5-10 cm thick, very hard with many mottles of manganese, and no penetration of rice roots were observed in this hard pan. The fourth layer was light grey and relatively weak.

There were 5 treatments, replicated four times and arranged in a randomized block design. The 20 plots were 3 X 5 m in dimension each. Twenty-one-day-old PB5 rice seedlings were used, planted three seedlings per hill with 25 X 25 cm plant spacing. The seedlings were transplanted on January 17, 1972.

Urea, triple superphosphate and potassium chloride were used as source of netrogen, phosphorus and potassium, respectively. Slag with colloidal silicon containing 35% soluble silica and 40% alkali, and slow acting compound ball fertilizer (5-5-5) were involved in this experiment. The ball fertilizer contained peat material about 3 cm in diameter and weighed about 16 grams each.

Fertilizer treatments

Treatment	N	P_2O_5	K_2O	Form of fertilizer applied
A	0	60	0	TSP
B	90	60	0	urea, TSP
C	90	60	60	urea, TSP, potassium chloride
D	90	60	60	urea, TSP, potassium chloride plus slag 2 tons per hectare
E	90	60	60	urea (30 kg N), ball fertilizer (60 kg N, 60 kg P_2O_5, 60 kg K_2O)

Triple superphosphate, potassium chloride and slag were applied as basic dressing. Urea was applied, one-third as basic dressing, one-third 2 weeks after transplanting, and the other one-third was applied at flower primordia stage. For treatment E, 30 kg nitrogen as urea was applied as basic dressing and 3 weeks after transplanting the ball fertilizers were incorporated 10 cm deep in the soil, placed between rice hills.

Plant height and tiller number were recorded. Samples were taken at harvest for determination of yield components of the rice plant. At flower primordia stage, heading time and harvest samples were taken, separated into grain and straw, dried in a drying oven at 70°C, powdered and used for chemical analysis. The determination of nitrogen and SiO_2 followed the methods of Yoshida et al. The severity of disease infestation was regularly recorded using 10 hills per plot.

The results of the experiment indicated that the difference in plant height and tiller number was apparent between nitrogen and non-nitrogen treated plots. In the case of same amount and condition of nitrogen applied, ball fertilizer resulted in relatively poor growth at the early stage of development, but at the later stage the plant showed the best growth, as seen in its best appearence with the highest number of productive tillers. The valid tiller ratio, although not significant, was the highest compared with the other treatments. These facts indicate the effectiveness of slow-acting fertilizer for better crop growth due to slow continuing supply of nutrients. Potassium and silicon application had no effect on growth.

The effect of different nutrients on yield component and yield of the rice plant is presented in Table 22. Plot without nitrogen application yielded only 2.88 tons grain for hectare, while nitrogen treated plots yielded more than 4 tons per hectare. Ball fertilizer application gave the highest yield, 4.80 tons per hectare, and showed a highly significant difference with other treatments. The high yield was mainly due to more panicle per square meter and number of filled grains per hill.

Table 22. The effects of fertilization on yield component and yield of PB5 rice variety.

Treatment	Yield kg/ha	Yield index	Panicle number /m^2	Number of filled grains/hill	Percentage of filled grains	Percentage of productive tillers	Weight of 1000 kernels (g)
A	2.88	100	176	804	75.3	68	25.6
B	4.13	143	211	1070	72.1	59	26.6
C	4.16	144	228	1128	72.0	66	26.6
D	4.13	143	228	1091	73.5	65	26.7
E	4.80	167	249	1204	72.8	73	25.9
LSD 0.05	0.218	–	33.1	180	n.s	n.s	n.s
LSD 0.01	0.306	–	46.4	252	–	–	–
C.V %	3.51	–	0.89	11.0	6.36	14.0	2.84

Potassium and slag had no effect on yield. To obtain grain yield up to 4-5 tons per hectare, the natural supply of potassium derived from the soil seemed to be sufficient as confirmed by the same grain yield between potassium and non-potassium treated plots. The highest number of panicle per square meter in this experiment was 249, the equivalent of 15.6 panicles per hill. For higher yield this amount of tillers is considered to be too low. Better management of fertilizer application and culture practices probably could increase the number of panicles per hill, which means more yield. The percentage of productive tillers was not affected by treatments, although there was a slight increase with ball fertilizer treated plants.

Nitrogen content at heading stage and harvesting time in straw and grain for all treatments is presented in Table 23.

Table 23. The effects of fertilization on nitrogen and SiO_2 content of PB5 rice variety and nitrogen utilization ratio of fertilizer applied.

Treatment	Nitrogen					SiO_2		N
	Primordia	Heading stage		Harvest		Harvest		Utilization
	stage	Straw	Grain	Straw	Grain	Straw	Grain	ratio
	%	%	%	%	%	%	%	%
A	1.07	0.69	0.94	0.53	1.14	16.5	6.8	–
B	1.34	0.78	1.05	0.54	1.17	15.1	6.4	30
C	1.28	0.74	1.00	0.53	1.17	15.9	5.9	36
D	1.37	0.69	0.99	0.58	1.22	16.3	6.1	38
E	1.37	0.81	1.06	0.55	1.22	15.0	7.3	43

The nitrogen contents at primordia and heading stage are considered to be too low, indicating a shortage of nitrogen supply from the growing medium resulting in low tiller and low grain yield. In this condition due to lack of supply of nitrogen the rice was not able to produce more tillers, since the available nitrogen was consumed by the growing rice plant and diluted by growth to less than one percent in the straw at heading stage. This numerical value is considered to be too low to obtain a high yield. Although the nitrogen concentration of straw and grain at harvest is assumed to be within the normal limit, it was because of low dry matter production due to restricted amount of nitrogen available, and other nutrients then seemed to be limited.

In this experiment the total amount of natural supply of nitrogen derived from the soil was 58 kg nitrogen per hectare. The nitrogen utilization ratio of fertilizer application at a rate of 90 kg N and 60 kg P_2O_5 per hectare according to the experiment was about 30% and considered to be low. Application of potassium slightly increased nitrogen utilization ratio to 36%. Slow acting compound fertilizer in the form of ball fertilizer gave the best results in nitrogen recovery and the nitrogen utilization ratio of fertilizers used was 43%, about 50% more than application of straight fertilizers, at a rate of 90 kg N and 60 kg P_2O_5 per hectare in the form of urea and triplesuperphosphate, respectively. The total amount of nitrogen absorbed by the rice plant was the lowest for non-nitrogen plot and the highest for ball fertilizer plot. For treatments A, B, C, D and E the values were, respectively, 58, 85, 90, 92 and 97 kg per hectare at harvest. The translocation ratio of nitrogen to the grains for total nitrogen absorbed showed no big variations around 70%, and the magnitude for treatments A, B, C, D and E were, respectively, 71, 70, 69, 68 and 70%.

Helminthosporium was observed from the early stage of growth. One month after transplanting there was a tendency of increase in the severity of the disease. The non-nitrogen treated plants were the worst affected at all stages of growth. Ball fertilizer plot was the least affected, due to the favorable characteristics of slow acting fertilizers, which had beneficial effects for better rice growth and resistance against the disease.

Silicon application in the form of slag has no effect on the occurrence of the disease, due to sufficient natural supply of silicon originating from the soil and irrigation water. The concentration of SiO_2 in straw and grain at harvest was normal in all treatments. In the case of straw, it exceeded 10%, a value which is considered as the minimum for rice growth. This means that the natural supply of silicon originating from the soil and irrigation water was sufficient.

Fig. 16 Research works in the green house of the Subdivision of Plant Nutrition at Sindanbarang

e. The effects of straw incorporation on growth and nutrient status of lowland rice.

1. The effect of low amount of straw application on 13 rice varieties.

After the rice is harvested a large amount of rice straw remains in the field. It is a common practice in Indonesia for some farmers to incorporate straw during soil preparation for the next rice cultivation. When rice straw is plowed into the rice field, a process of decomposition takes place after application and has an important effect on the growth of the rice plant. During the active process of decomposition it is considered to be harmful to the growing rice plant due to the release of toxic gasses and fixation of nutrients from the surrounding medium caused by the decomposing rice straw, although this would be released again at a later stage. Among the nutrients fixed, especially nitrogen is the most important to be considered. The growing rice plant can suffer from nitrogen shortage by a high amount of straw application. Another disadvantage of straw incorporation is increasing reductive condition of the soil due to high carbohydrate present in the rice straw. The application of rice straw in this experiment was limited to a small amount of 3 tons per hectare.

To gain some idea whether straw application has an injurious effect on rice growth, records were made on the shoot dry weight of the rice plant at three weeks after transplanting and primordia stage. The results are presented Table 24.

Table 24. The effects of rice straw incorporation on shoot dry weight of 13 rice varieties at three weeks after transplanting and flower primordia stage.

Rece variety	Treatment	Shoot dry weight gr/hill	
		3 weeks after transpl.	Primordia stage
PB 5	–	31.7	42.2
	+	26.7	44.9
Pelita 1/1	–	27.7	39.0
	+	28.7	44.0
Pelita 1/2	–	25.3	40.2
	+	28.6	40.7
IR–20	–	27.2	44.8
	+	30.2	44.5
Syntha	–	32.0	56.5
	+	35.9	56.1
Bengawan	–	28.8	60.0
	+	33.5	56.0
Dara	–	30.8	45.8
	+	33.1	52.4
Remaja	–	28.4	53.1
	+	21.2	59.1
Sentral	–	39.6	62.7
	+	34.7	65.8
Genjah raci	–	31.7	40.3
	+	27.6	41.2
Sukanandi	–	26.4	39.3
	+	25.9	48.5
Manglar	–	20.1	32.4
	+	19.4	33.1
Hawara batu	–	29.3	45.0
	+	27.3	40.1

Note : - without straw + plus straw

They show that most varieties can withstand straw incorporation, as confirmed in some increase in shoot dry weight, while some varieties seem to be adversely affected to some extent as reflected in a decrease in shoot dry weight three weeks after transplanting. However it recovers again at flower primordia stage and only Bengawan and Hawara Batu varieties did not improve up to primordia stage. Fortunately, this unbeneficial decrease in shoot dry weight is not reflected in a decrease in grain yield as shown in Table 25.

Table 25. The effects of rice straw incorporation on grain yield of 13 rice varieties.

Rice variety	Treatment	Yield kg/ha	Yield Index
IR 5	–	5968	100
	+	6384	107
Pelita I/1	–	4768	100
	+	5680	119
Pelita I/2	–	5152	100
	+	5648	110
IR 20	–	5808	100
	+	6384	110
Syntha	–	5872	100
	+	6000	102
Bengawan	–	3648	100
	+	4592	126
Dara	–	2848	100
	+	4336	152
Remaja	–	4320	100
	+	4800	111
Sentral	–	3440	100
	+	4192	122
Genjah raci	–	2416	100
	+	2928	121
Sukanandi	–	3328	100
	+	3680	111
Manglar	–	2016	100
	+	2792	138
Hawara batu	–	2736	100
	+	3024	111

Note : – without straw
+ plus straw

No unfavourable effects of straw incorporation on yield component and plant height at harvest are observed, as shown in Table 26.

Table 26. The effects of rice straw incorporation on yield component, grain straw ratio and plant height at harvest of 13 rice varieties.

Rice variety	Treat-ment	No. panicle/ hill	No. grain/ panicle	% filled grains	Wt 1000 grains gr	Grain straw ratio	Plant height cm
IR 5	–	19.3	113	67.6	25.5	0.95	112
	+	18.2	112	75.5	25.9	1.02	110
Pelita I/1	–	16.7	100	64.8	27.9	0.93	118
	+	17.6	106	66.4	28.2	0.93	118
Pelita I/2	–	16.6	112	64.0	27.4	0.86	117
	+	15.5	114	71.3	28.3	0.98	117
IR 20	–	20.8	127	68.5	20.4	1.20	103
	+	21.5	122	74.5	20.4	1.15	104
Syntha	–	13.9	135	68.4	28.7	0.57	154
	+	13.3	149	65.8	28.7	0.60	155
Bengawan	–	17.5	79	62.5	28.8	0.44	157
	+	17.5	95	62.8	28.5	0.52	161
Dara	–	16.5	65	65.9	24.3	0.42	148
	+	14.9	102	70.4	24.7	0.59	158
Remaja	–	15.0	106	62.5	26.8	0.49	153
	+	13.6	120	61.8	28.7	0.59	156
Sentral	–	11.7	108	66.3	25.5	0.57	152
	+	12.8	122	63.8	26.0	0.54	165
Genjah raci	–	11.9	84	45.9	29.0	0.20	139
	+	14.5	102	45.2	29.3	0.33	144
Sukanandi	–	10.9	120	63.8	25.0	0.48	155
	+	11.8	139	60.1	23.3	0.49	157
Manglar	–	5.6	104	55.3	25.6	0.32	148
	+	7.4	134	66.3	26.3	0.34	162
Hawara batu	–	7.7	132	62.5	27.3	0.34	166
	+	6.9	142	68.6	27.3	0.39	166

Note : – without straw
+ plus straw

Generally speaking, application of straw into the soil has a slight beneficial effect on plant height and yield component of rice plant. There is also a tendency of increasing grain straw ratio value due to application of straw.

Concerning nutrient composition, in most cases there is an increase in nutrient content of the plant tissue at primordia stage. Especially the increase in potassium content is most pronounced as shown in Table 27.

Table 27. The effects of rice straw incorporation on nutrient composition of the shoot of 13 rice varieties at flower primordia stage.

Rice variety	Treatment	N %	P %	K %
IR 5	–	1.53	0.27	1.20
	+	1.52	0.29	1.49
Pelita I/1	–	1.55	0.24	1.04
	+	1.67	0.28	1.53
Pelita I/2	–	1.72	0.28	1.20
	+	1.72	0.30	1.45
IR 20	–	1.67	0.25	1.15
	+	1.63	0.26	1.13
Syntha	–	1.36	0.28	1.13
	+	1.32	0.30	1.62
Bengawan	–	1.21	0.25	0.78
	+	1.27	0.26	1.20
Dara	–	1.27	0.29	0.98
	+	1.34	0.25	1.17
Remaja	–	1.32	0.25	1.06
	+	1.45	0.24	1.16
Sentral	–	1.31	0.24	0.91
	+	1.42	0.29	1.18
Genjah raci	–	1.36	0.24	1.08
	+	1.47	0.26	1.08
Sukanandi	–	1.60	0.24	1.03
	+	1.59	0.24	1.20
Manglar	–	1.56	0.27	1.11
	+	1.57	0.28	1.63
Hawara batu	–	1.46	0.24	1.02
	+	1.56	0.24	1.17

Note : – without straw
+ plus straw

The total N, P and K uptake also increases due to straw application. Among the three nutrients the total K uptake is the most pronounced. This is understandable since potassium is the major constituent of rice straw and after decomposition 3 tons of rice straw co-incides with about 30 kg K or 36.4 kg K_2O.

The evidence obtained in this experiment proves that application of 3 tons of rice straw in rice cultivation is beneficial. The rice plant shows better growth and increases grain yield and uptake of nutrients. Especially K uptake is most pronounced. The fertilizing effect of potassium as the major constituent of rice straw is probably the most important factor affecting crop growth and yield. Very likely this is the explanation for the fact that in some cases the application of inorganic potassium fertilizers has no effect on growth and yield of rice, especially when rice straw is incorporated into the soil. According to above mentioned data, it is assumed that rice straw could be used as a substitute of potassium inorganic fertilizers in lowland rice cultivation. Up to the present, it was assumed that the ineffectiveness of inorganic potassium fertilizers is due to a sufficient natural supply of potassium from the irrigation water and soil, but the present findings indicate that the K fertilizing effect of rice straw also should be taken into consideration, especially in the cultivation of high yielding varieties.

f. Study on the root activity of rice varieties.

Root activity has an important role on nutrient absorption of growing rice plant. The activity of the root is related with the respiration rate, and the main function of root activity is supplying energy for nutrient absorption, which is takes place from the respiration of the root. Thus, root activity can be measured by its respiration rate. For this purpose, in the present experiment a simple method was used by measuring the oxidizing activity of the root using alpha-naphtylamine. The activity of the root is closely related with root age. This means that its activity has a correlation with the growth stage of the growing plant. Thus, the root activity was measured at different growth stages, using 12 rice varieties in Indonesia.

The experiment was conducted in a glasshouse in the Subdivision of Plant Physiology, Sindangbarang, using plastic cylindrical containers of 3.5 lit. capacity. Water culture was chosen for this experiment to avoid the risk of root damage and losses during harvest by using soil as the rooting medium. During the experimental period tapwater was used for watering. The experimental pots were supplied with complete nutrient solution, renewed once a week until one month after transplanting and then renewed twice a week. The pH of the nutrient solution was kept between 5.3 - 5.5 by adding sulphuric acid.

The seedlings were transplanted 21 days after sowing, one healthy seedling per pot. Each variety consisted of 6 pots and were placed in rows. Root activity measurement was done at seedling, primordia and heading stages (15 days after heading), using the alpha-naphtylamine method which is based on the oxidizing activity of the roots by measuring the oxidation of the alpha-naphthlamine by the roots.

Table 28. Root dry weight per pot, root activity per mg root dry weight and total root activity per pot of 12 rice varieties.

Variety	ppm α-NA/mg root dry weight			ppm α-NA/pot			Root dry weight per pot (gr)		
	Seedling stage	Primordia stage	15 days after heading	Seedling stage	Primordia stage	15 days after heading	Seedling stage	Primordia stage	15 days after heading
1. PB 5	2.14	2.07	1.16	1.08	11.0	5.78	0.16	5.32	4.97
2. C4-63	1.46	2.03	1.17	0.75	11.3	5.04	0.15	5.56	4.32
3. Syntha	1.63	1.92	1.13	1.02	12.4	7.13	0.20	6.44	6.34
4. Dewi Ratih	1.91	2.04	1.08	1.09	14.1	5.45	0.16	6.91	5.04
5. Bengawan	1.75	1.86	1.08	1.09	14.2	5.71	0.19	7.63	5.30
6. PB 8	1.86	1.87	1.22	0.87	11.5	5.52	0.14	6.16	4.52
7. Remadja	1.82	1.85	1.20	1.29	10.2	7.55	0.22	5.53	6.29
8. Sigadis	1.82	1.72	1.03	1.18	8.8	5.11	0.19	5.15	4.97
9. Pelita I/1	2.28	2.15	1.02	1.17	12.2	5.82	0.15	5.68	5.69
10. Pelita I/2	1.93	2.08	1.19	1.01	11.6	8.45	0.17	5.56	7.12
11. Gendjah Beton	1.87	1.82	1.21	1.08	11.0	8.51	0.19	6.03	7.03
12. Sukanandi	2.27	2.00	1.38	0.97	9.5	10.2	0.13	4.76	7.36

Results of the experiment are shown in Table 28. The root activity per unit root dry weight of the rice varieties are relatively high at the seedling and primordia stages and decreases at heading time. The value at the seedling stage varies between 1.46 - 2.28 ppm, primordia stage 1.72 - 2.15 ppm and heading time 1.02 - 1.38 ppm alpha-naphtylamine per mg root dry weight. This means that the root activity from seedling to heading time decreases about 60%. The low value of root activity at heading time is probably mainly due to detioration of a part of the root system, which was observable during the experimental period.

Among the varieties, PB5, Dewi Ratih, Pelita I/1, Pelita I/2 and Sukanandi are varieties with relatively high root activity of around 2 ppm alpha-naphtylamine per mg root dry weight.

The *total root activity depends not only on the activity per unit root dry weight*, but also on the total root dry weight per pot. The total root dry weight increases substantially from seedling to primordia stage, about 30 to 45 times, and then increases slightly until heading time.

For the varieties PB5, C4-63, Dewi Ratih, Bengawan, PB8 and Sigadis the total root dry weight per pot decreases from primordia to heading stage due to starvation of part of the root system.

The value of total root activity per pot at seedling stage varies between 0.75 - 1.29 ppm, primordia stage 8.8 - 14.2 ppm and heading stage 5.04 - 10.2 ppm alpha-naphtylamine per root dry weight per pot.

From the results obtained, it is clear that there are differences in dry weight and activity of the root system among the varieties. It is valuable to conduct more intensive experiments to study the root system and root activity of the rice plant, and it is of importance for breeding work and increasing rice production.

g. Study on the toxic action of biuret in urea on growth of rice seedling.

A certain injury of rice seedlings was observed in some localities in Indonesia and it was suspected to be caused by application of urea. Urea sometimes contains biuret ($NH_2CONHCONH_2$) which is produced during the manufacturing process of urea. Biuret might cause injury to the germination or early stage of growth of rice seedlings.

This experiment was conducted to investigate the effect of several urea fertilizers available in Indonesia on rice seedlings. Commercial urea fertilizers imported from different countries and produced in Indonesia have been used. As a result, no injury could be observed on rice seedlings by use of these fertilizers.

Some experiments have been conducted on the toxic effects of biuret on rice seedlings using chemical pure biuret. When biuret was applied to the soil, rice seedlings showed a symptom, which appeared at 15 ppm of biuret in the case of grumusol, while at 30 ppm in the case of alluvial. The symptoms of rice seedling by biuret is a retardation of root growth and discolouration of leaf blade and leaf sheath.

h. Study on the fertilizer response of soybean plant.

Soybeans are one of the main food crops in Indonesia, being an important source of protein for the Indonesian people. In Indonesia most farmers cultivate soybeans in paddy fields after harvesting rice at the end of wet season. However, the cultivation is done without irrigation, soil tillage, regular plant spacing, and weed and pest control. Usually fertilizers are not used in soybean cultivation. Thus, the average yield of soybeans in Indonesia is very low compared with that in other countries such as Japan, U.S.A., Canada, Italy, etc.

In order to clarify the influence of fertilizer application on the growth, yield and chemical components of soybean plant, the experiment was carried out during the dry season 1972.

The experiment was conducted at the Muara Expt. Substation of CRIA in Bogor in latosol area where rice was cultivated during the wet season of 1971/72. The soil, brown latosol, used in this experiment shows slightly acid (pH 5.0). Available phosphorus content is very low, nitrogen rather low, and ferric very high. Soybean variety used was TK-5, introduced variety. The seeds were dibbled, 2 to 5 cm deep, 2 seeds per hill, with 25 X 20 cm plant spacing. The fertilizers applied were urea, triple superphosphate (TSP) and potassium sulfate as source of nitrogen, phosphorus and potassium, respectively.

Treatment of each plot was as follows;

Plot	Fertilizer level kg/ha				
	N	P_2O_5	K_2O	CaO	Stable manure
A	0	30	30	–	–
B	20	60	30	–	–
C	20	60	60	–	–
D	20	0	60	–	–
E	20	60	0	–	–
F	40	60	60	–	–
G	20	60	60	4,000	–
H	20	60	60	–	10,000

Calcium and stable manure were applied 19 and 7 days before sowing, respectively, while urea, TSP and potassium sulfate were applied 2 days before sowing. This was repeated twice for each plot. The field was irrigated once a week during the course of the experiment. Height of plants and number of branches were regularly measured on 10 representative hills in each plot. Five hills in each plot were sampled for leaf area measurement every two weeks. Leaf area of the plants was determined by using Automatic Area Meter (Hayashi Denko Co., Japan).

Ten or 20 hills depending on the growth in each plot were taken for chemical analysis every two weeks. The samples obtained were dried in a drying oven and were ground, and chemical analysis for N, P, K, Ca, Mg, Mn and Fe was conducted by Yoshida's method (Laboratory manual for physiological studies of rice, 1971).

The results of the experiment are summarized as follows:

1) Height of plants of plot G and H was higher than that of other plots. However, a difference is hardly found on a number of branches among the plots at each stage.

The leaf area index (LAI) of all plots reached a maximum at 45 days after emergence (flowering stage) as shown in Table 29.

Table 29. Changes with time in LAI of soybean plant.

Plot	Days after emergence				
	19	32	45	61	73
A	0.48	1.09	1.89	1.22	0.46
B	0.46	1.39	1.93	1.39	0.30
C	0.46	1.54	2.19	1.32	0.35
D	0.45	1.49	2.41	1.09	0.62
E	0.43	1.81	2.47	1.66	0.34
F	0.40	1.55	1.99	1.84	0.32
G	0.46	1.88	2.96	1.82	0.52
H	0.44	1.24	2.18	1.16	0.47

LAI of the plant in Ca applied plot indicated 2.96 at 45 days after emergence, the highest value among the plots in spite of N level 20 kg, while LAI of plot A and B on the same day was low, being 1.89 and 1.93, respectively. LAI of all plots in this experiment, about 2 to 3 as a maximum at the stage of 45 days after emergence was too low, compared with the value 5 to 6 in Japan.

2) Highest yield was obtained in the plot of Ca application with N, P and K nutrients (plot G), being 1,100 kg per hectare which is approximately two times as compared with the yield in plot A. Next to plot G, yield of plot H and F was high in order (Table 30).

Yield of plot H in which both stable manure and chemical fertilizers were applied, increased noticeably more than that of plot C in which only chemical fertilizers were applied in the same amount as plot H.

In plot F in which N, P and K were heavily applied, the 1000 grain weight was highest, being 152 g.

Table 30. Yield components and yield of soybean plant.

Plot	No. of seeds per hill	1000 grain weight (gr.)	Yield Kg/Ha
A	21.4	128	548
B	26.4	141	744
C	29.9	126	753
D	27.0	135	729
E	26.4	129	681
F	33.4	152	1015
G	38.2	144	1100
H	35.8	148	1060

3) The uptake of N by soybean plants reached a maximum 61 days after emergence (pod filling stage). In plot F in which N was heavily applied with P and K, N was remarkable absorbed by soybean, as compared with plot A, B and E. Nitrogen uptake per hectare in plot F was highest among the treatments. If the amount of N uptake in plot A is indicated as zero, N utilization ratio of fertilizer used in plot G and F was 79 and 71%, respectively, while the ratio in other plots were shown to be lower (Table 31).

It is a matter of course that nitrogen fixed from air in all plots and nitrogen contained in stable manure in plot H were included in the nitrogen utilization ratio described above. Nitrogen application has a beneficial effect on the absorption of nutrients such as N, P, K, Mg and Ca, dry metter production and seed yield of soybean plant.

Table 31. Nurtient accumulation in the soybean plant at successive stages of growth. (mg/hill)

Plot	Days after emergence	N	P	K	Ca	Mg
A	32	36	1	19	44	20
	45	80	11	49	77	35
	61	481	51	218	203	78
	*73	171	14	46		
B	32	38	1	19	48	21
	45	101	11	56	100	44
	61	475	44	204	200	82
	*73	220	19	59		
C	32	39	1	18	55	23
	45	110	13	72	103	46
	61	550	51	216	207	84
	*73	216	18	66		
D	32	38	1	17	44	18
	45	81	9	50	97	40
	61	537	52	208	224	90
	*73	188	16	66		
E	32	34	1	19	37	16
	45	75	8	46	83	38
	61	410	37	175	161	61
	*73	198	16	63		
F	32	37	1	16	45	20
	45	94	10	49	106	52
	61	622	52	245	226	93
	*73	307	27	91		
G	32	43	2	19	56	23
	45	121	13	67	141	58
	61	560	43	241	249	97
	*73	327	25	90		
H	32	36	1	20	58	24
	45	118	14	79	130	52
	61	512	49	255	247	93
	*73	307	27	96		

Note: * seed only

4) Application of phosphorus, even at the rate of 60 kg P_2O_5 per hectare, hardly showed response to the growth, P uptake and yield of soybean plant. The amount of P uptake was very low in all plots as compared with that of N uptake.

Phosphorus utilization ratio of fertilizer by soybean plant was only several per cent. However, number of root nodules seemed to be increased by P application (table 32).

Table 32. Changes with time in number of root nodules.

Plot	Days after emergence (per hill)				
	19	32	45	61	73
A	53	57	66	39	32
B	42	44	62	58	45
C	25	38	54	40	46
D	25	38	54	36	27
E	36	54	70	44	32
F	41	56	42	28	33
G	31	53	71	52	59
H	35	80	64	37	45

Note : Mean of 5 hills

5) The effects of K application were marked on the growth, nutrient absorption, dry matter production and yield of soybean plant. The maximum uptake of K was shown in pot H at pod filling stage, being 51.1 kg per hectare, while in non-potassium applied plot, K uptake as well as N and P uptake was very low at each stage of growth. If the amount of K uptake in plot E is indicated as zero, K utilization ratio of fertilizer used in other plots was from 34.7 to 13.3%.

The yield of soybean increased obviously by K application. The yield in plot C and B in which K was applied at the rate of 60 kg and 30 kg per hectare, respectively, was higher than that in non-potassium applied plot E, at the same amount of application of N and P.

6) The uptake of Ca reached a maximum at 61 days after emergence (pod filling stage). The amount of Ca uptake in plot G and H was higher than that in other plots. When calcium was applied to the field at the rate of 4,000 kg CaO per hectare, soil pH increased up to 7.0 at harvest time. The number of root nodules was highest in Ca applied plot at 45 days after emergence (flowering stage).

7) The uptake of Mg reached a maximum at 61 days after emergence, and the largest amount of Mg absorption was obtained in plot G at that stage.

8) Manganese and iron content of soybean in this experiment was shown to be 185 and 205 ppm as a maximum, respectively. Iron uptake by soybean plants reached a maximum at 61 days after emergence. At flowering stage of soybean plants, the content of Fe as well as Mn in soybean plants was lowest in plot G among all plots. Manganese absorption by the plants seemed to be inhibited by Ca application at that stage. The Fe/Mn ratio of soybean at flowering stage indicated 1.7 in Ca applied plot G, the highest value among the plots (Table 33)

Table 33. Nutrient content of the soybean plant at successive stage of growth.

Days after emergence	Plot	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)
19	A	3.02	0.09	1.57				
	B	3.23	0.08	1.59				
	C	3.46	0.11	1.60				
	D	3.40	0.09	1.54				
	E	3.12	0.12	1.80				
	F	3.56	0.11	1.50				
	G	3.68	0.15	1.66				
	H	3.10	0.12	1.76				
32	A	2.56	0.34	1.55	1.39	0.63	113	113
	B	3.03	0.34	1.68	1.43	0.62	125	105
	C	2.77	0.34	1.82	1.39	0.59	103	132
	D	2.63	0.29	1.63	1.41	0.59	123	112
	E	2.69	0.30	1.65	1.34	0.56	128	119
	F	2.74	0.27	1.43	1.32	0.58	115	138
	G	2.96	0.31	1.63	1.38	0.59	125	106
	H	2.75	0.31	1.83	1.34	0.55	107	149
45	A	2.78	0.32	1.79	1.38	0.65	135	127
	B	2.98	0.32	1.84	1.32	0.58	110	112
	C	2.52	0.27	1.73	1.29	0.57	123	177
	D	2.52	0.29	1.68	1.37	0.57	110	109
	E	2.96	0.28	1.94	1.33	0.61	128	118
	F	2.78	0.28	2.01	1.38	0.68	118	173
	G	3.23	0.28	1.76	1.31	0.54	108	65
	H	3.04	0.35	2.12	1.26	0.50	110	185
61	A	3.28	0.34	1.48	1.38	0.53	155	83
	B	3.19	0.29	1.38	1.34	0.55	135	73
	C	3.35	0.31	1.32	1.26	0.51	123	128
	D	3.36	0.33	1.30	1.40	0.56	205	115
	E	3.25	0.30	1.39	1.28	0.48	168	106
	F	3.47	0.29	1.37	1.26	0.52	185	119
	G	2.95	0.23	1.28	1.31	0.51	165	82
	H	2.75	0.26	1.37	1.33	0.50	173	104
73*	A	6.21	0.52	1.67				
	B	5.95	0.51	1.60				
	C	5.71	0.48	1.75				
	D	5.17	0.45	1.81				
	E	5.84	0.48	1.86				
	F	6.04	0.53	1.80				
	G	5.95	0.46	1.64				
	H	5.82	0.51	1.83				

Note : * seed only

Soybean plants had been considered as one of the crops which are difficult in fertilizer application, since the seed yields do not increase readily by the improvement of fertilizer application. However, the results of the experiment obtained so far give some suggestions for the increase of seed yield of soybeans.

i) Liming to the acid soil is most beneficial to produce the highest seed yield because the N utilization ratio of fertilizer used and the number of root nodules have shown a tendency to increase. Liming should be accompanied by N, P and K application.

ii) The optimum rate of N fertilization to increase LAI up to 5 to 6 as a maximum seems to be 40 kg/ha with liming.

iii) Soybean plants did not show a clear response to P fertilization in this experiment, although the Muara soil was considered to be low in content of available phosphorus. It is suggested that the amount of P application, 60 kg P_2O_5 per hectare, is still insufficient to obtain a maximum yield, and a grester amount of application is required at Muara latosol.

iv) The study of P fertilization method is important to increase the utilization ratio of fertilizer used and pod filling rate.

v) The potassium application at the rate of 60 kg K_2O per hectare seems to be optimum rate.

Up to now some of the research results was presented at staff meeting of CRIA or printed as Contribution of CRIA as in the following :

1). "Nitrogen Requirement of Lowland Rice on Major Java Soils" by M. Ismunadji, I. Zulkarnaini and F. Yazawa (presented at staff meeting of CRIA, May 29-30, 1972).

2). "Preliminary Experiment on the Study of Root Activity of 12 Rice Varieties" by R. Hasan, M. Nasir, M. Ismunadji and F. Yazawa (ditto).

3). "Yellow Dwarf Disease of Rice in Indonesia" by H. Satomi (presented at the South East Asia Resional Symposium on Plant Diseases in the Tropics, Jogjakarta, Sept. 11-15, 1972).

4). "Grassy Stunt Diseases of Rice in Indonesia" by D.M. Tantera, H. Satomi and Roechan (Contribution No. 2 of CRIA, Jan. 1973).

5). "Physiological Disease of Rice in Cihea" by M. Ismunadji, L.M. Hakim, I. Zulkarnaini and F. Yazawa (Contribution No. 4 of CRIA, March 1973).

6). "The Effect of Fertilization on Growth, Nitrogen Nutrition and the Occurrence of Helminthosporium Leaf Spot in Lowland Rice" by M. Ismunadji, Sismiyati, Sutantyo and F. Yazawa (Contribution No. 5 of CRIA, April, 1973).

Other experimental results obtained are being arranged for presentation.

5. Training of Indonesian counterparts in Japan.

Based on Article V of the Agreement between both countries, Indonesian researchers engaged in the Program have been invited for the training and observation tour in Japan. Up to now, the following persons received training in respective fields.

1. Mr. Lukman Nol Hakim (plant physiology) 6 months, 1971/71, at the National Institute of Agricultural Sciences (NIAS).
2. Mr. M. Ismunadji (plant physiology) 3 months, 1972, at NIAS.
3. Mr. Machmud (plant pathology) 6 months, 1972/73, at NIAS.
4. Mr. Iskandar Zulkarnaini (plant physiology) 6 months, 1973, at NIAS and Central Agricultural Experiment Station.

In addition to the above-mentioned, Mrs. Paransih Isbagijo of the Plant Physiology Division had a one-month observation tour in Japan in 1972.

In 1973/74, 2 researchers in the Plant Physiology Division and also 2 researchers in the Plant Pathology Division are expected to be trained for 6 months at the national institutes in Japan.

The training in Japan is considered advisable for the counterparts to gain more knowledge and experience in research, to study the modern research technique and also to have an opportunity to come into contact with experienced scientists in Japan, and it would surely be profitable to promote the development of the Program in the future.

6. Visit of Advisory Survey Team to Bogor.

An Advisory Survey Team for the Program organized by OTCA, headed by Dr. H. Asuyama, visited Indonesia for 17 days from January 31 to February 16, 1973, and studied the existing situation and problems in the program and held discussions with the Director of CRIA, staff concerned in the Divisions of Plant Pathology and Plant Physiology and Japanese experts.

Discussions have been conducted in a frank manner with mutual understanding on many problems which are confronted with difficulties at the present time. At the Team's departure, Dr. Asuyama presented "Brief Report of a Survey on the Progress in Indonesia-Japan Joint Food Crop Research Program" to the Director General of Agriculture and the Director of CRIA. (Appendix 2)

7. Acknowledgements

We would like to express our sincere gratitude to Mr. Soegandhi Soeryo Amidharmo, the Director General of Agriculture; Mr. Sadikin Sumintawikarta, the former Director General of Agriculture; Mr. Suharsono, the Director of the Central Research Institute for Agriculture; and Mr. Dahro, the former Director of the Central Research Institue for Agriculture, for their continuing encouragement and advice.

We also would like to thank Mr. I.N. Oka, the Head of the Division of Pests and Diseases; Mr. Paransih Isbagijo, the Head of the Division of Plant Physiology; Mr. Dandi Sukarna, the Acting Head of the Division of Pests and Diseases; Dr. Rusli Hakim in the Division of Agronomy; Mr. M. Ismunadji, the Head of Subdivision of Plant Nutrition, Dr. I.D.M. Tantera, the Head of the Subdivision of Plant Pathology, and staffs concerned in the Institute for their kind and helpful cooperation.

Appendix I

AGREEMENT BETWEEN THE GOVERNMENT OF JAPAN AND THE GOVERNMENT OF THE REPUBLIC OF INDONESIA CONCERNING THE IMPLEMENTATION OF JAPAN-INDONESIA JOINT FOOD CROP RESEARCH PROGRAM

The Government of Japan and the Government of the Republic of Indonesia, earnestly desiring to cooperate with each other to promote the improvement of agricultural productivity in Indonesia, have agreed as follows:

Article I

(1) The two Governments will jointly carry out a program on plant protection in the field of plant pathology, virus vector and physiological diseases which will be called as Japan-Indonesia Joint Food Crop Research Program (hereinafter referred to as "the Program"), at the Central Research Institute for Agriculture in Bogor, Indonesia.

(2) The Program will consist of the following:

(a) Research work through interdisciplinary approach on the themes as listed in Annex I;
(b) Exchange of information, samples, materials and research reports; in Annex I;
(c) Exchange of researchers and other personnel; and
(d) Development of research capabilities of the Indonesian personnel and other activities to be agreed upon between the two Governments.

Article II

In accordance with laws and regulations in force in Japan, the Government of Japan will take necessary measures to provide, at its own expense the services of the Japanese researchers and consultants (hereinafter referred to as "the Experts") as listed in Annex II.

Article III

The Experts and their families will be granted in the Republic of Indonesia the privileges, exemptions and benefits as listed in Annex III and will be granted privileges, exemptions and benefits no less favourable than those granted in the Republic of Indonesia to the experts of third countries or of international organizations such as the United Nations serving under similar circumstances.

Article IV

(1) In accordance with laws and regulations in force in Japan, the Government of Japan will take necessary measures to provide at its own expense machinery, equipment, vehicles, instruments, tools, spare parts and other materials as listed in Annex IV.

(2) The articles referred to above will become the property of the Government of the Republic of Indonesia upon being delivered c.i.f. at the port of Djakarta to the Indonesian authorities concerned.

(3) The Government of the Republic of Indonesia will utilize these articles exclusively for the purpose of implementing the Program.

Article V

In accordance with laws and regulations in force in Japan, the Government of Japan will take necessary measures to receive Indonesian researchers and research administrators engaged in the Program for training and study tours in Japan as well as for symposia or other similar meetings to be held in Japan, through the normal procedures of the Government of Japan required therefor.

Article VI

The Government of the Republic of Indonesia undertakes to bear claims, if any arise, against the Experts resulting from, occurring in the course of, or otherwise connected with the discharge of their official functions covered under this Agreement, except for those claims arising from the wilful misconduct or gross negligence of the Experts.

Article VII

The Government of the Republic of Indonesia will take necessary measures to provide at its own expense:

(a) Indonesian researchers and other personnel as listed in Annex V;
(b) Land and buildings as listed in Annex VI as well as incidental facilities;
(c) Supply of replacement of machinery, equipment, vehicles, instruments, tools and other materials necessary for the implementation of the Program other than those provided by the Government of Japan.

Article VIII

The Government of the Republic of Indonesia will take necessary measures to meet:

(a) Customs duties, internal taxes and other similar charges, if any, imposed in the Republic of Indonesia in respect of the articles referred to in Article IV;

(b) Expenses necessary for the transportation within the Republic of Indonesia of the articles referred to in Article IV as well as for the installation, operation and maintenance thereof;

(c) Running expenses necessary for the implementation of the Program.

Article IX

The Program will be implemented through mutual consultation between the Japanese Team Leader and the Director of the Central Research Institute for Agriculture.

Article X

For the successful implementation of the Program, close relationship will be maintained between the Central Research Institute for Agriculture and Japanese agricultural research institutions.

Article XI

This Agreement will come into force on the date of signature and remain in force for a period of five years.

However, either Government may at any time give notice to the other Government of its intention to terminate the Agreement, in which case the Agreement will terminate six months after such notice has been given.

Done in duplicate in English at Djakarta on this day of 23 of October, 1970.

For the Government of Japan:	For the Government of the Republic of Indonesia:

Annex I

I. Study on ecology and control of major diseases of food crops.

II. Study on forecast of occurrence of major diseases and vectors of virus diseases of food crops.

III. Plant physiological study on physiological disorders and major diseases of food crops.

Note: Further details of the above theme will be determined by the Director of the Central Research Institute for Agriculture and the Japanese Team Leader.

Annex II

Team Leader
Researcher on Plant Pathology
Researcher on Plant Physiology
Researcher on Forecast of Vectors of Virus Diseases (Virologist)
Consultants on short term assignment

Annex III

(1) Exemption from income tax and charges of any kind imposed on or in connection with the living allowances remitted from abroad.

(2) Exemption from import and export duties and any other charges in respect of personal and household effects, including one motor vehicle, one refrigerator, one air-conditioner per family, other minor electric appliances and optical instruments which may be brought into Indonesia from abroad.

(3) Free local medical services and facilities to the Experts and their families.

Annex IV

(1) Equipment, instruments, tools, spare parts and other materials for laboratory work.

(2) Machinery, equipment, instruments, tools, spare parts and other materials for field work.

(3) Vehicles.

(4) Audio-visual aids and printing equipment.

(5) Other necessary minor equipment for testing work.

(6) Books and other necessary printed matters.

Annex V

(1) Researchers (counterparts to the Experts)

(2) Laboratory assistants

(3) Field workers

(4) Clerical and service personnel including typist, clerk, driver, etc.

Note: The Director of the Central Research Institute for Agriculture will be the leader of the Indonesia counterpart researchers and personnel.

Annex VI

I. Buildings at Bogor:

Offices, laboratories, glass houses and facilities for storing equipment for the studies of diseases, vectors and physiology.

II. Farm land:

(1)	At Muara	2 ha
(2)	At Pusakanegara	1 ha
(3)	At Kuningan	1 ha

Note: Besides the buildings and lands mentioned above, as necessity arises, some buildings, land and incidental facilities may be used.

Appendix 2

BRIEF REPORT OF A SURVEY ON THE PROGRESS IN INDONESIA-JAPAN JOINT FOOD CROP RESEARCH PROGRAM

February 16, 1973
Advisory Survey Team for Indonesia-Japan
Joint Food Crop Research Program, Japan

Advisory Survey Team for Indonesia-Japan Joint Food Crop Research Program, Japan, organized by Overseas Technical Cooperation Agency headed by Dr. H. Asuyama, has visited Indonesia for 17 days from January 31 to February 16, 1973. Members of the team, five in all, studied the present situation and problems in the joint research, and discussed with Director of Central Research Institute for Agriculture, Ir. Dahro, staffs concerned in the Divisions of Plant Diseases and of Plant Physiology, and Japanese experts as well as Team Leader, Dr. Y. Iwata. A survey of experimental stations and fields located in West, Central and East Java has also been made. The outline of the finding will be described briefly as follows.

1. BACKGROUND

Indonesia's present Five-Year Development Plan has placed agriculture, particularly increasing food production, on the top of its scale of priorities. Indonesia-Japan Joint Food Crop Research Program was established in 1970, with the aim of contributing to the improvement of agricultural productivity in Indonesia through technical cooperation, under the agreement between Indonesia and Japan. The Program is intended to strengthen the Central Research Institute for Agriculture, covering the field of plant pathology, virus vector and physiological diseases. The research theme described in the agreement involves three items, viz. 1) Study on ecology and control of major diseases of food crops; 2) Study on forecast of occurrence of major diseases and vectors of virus diseases of food crops; 3) Plant physiological study on physiological disorders and major diseases. In early 1971, Dr. Y. Iwata, Team Leader, and three experts came to Bogor and started to perform the Program in cooperation with the counterparts of Indonesian side. Since then, equipment and facilities for joint research have been gradually improved, and the field tests for various projects have become feasible in selected localities. Exchange of researchers engaged in the Program and technical training have been realized step by step.

2. Researchers and Personnel

Japanese research team consists of four experts, including Team Leader, Y. Iwata, Plant Pathologist, T. Nishizawa, Plant Physiologist, F. Yazawa, and Plant Virologist, H. Satomi, and for the time being it is supplemented by three short term consultants, viz. H. Mikoshiba, T. Yamamoto, in the field of plant pathology, and M. Higuchi in the field of plant physiology. Accordingly seven Japanese experts, as a whole, are working at present on this Joint Research Program. In Indonesian side, the counterpart researchers and laboratory assistants have increased in number markedly, attaining presently more than a dozen. To ensure a successful implementation of the Program, it would be most desirable and necessary to keep adequate number of competent researchers and assistants.

Exchange of researchers engaged in the Program and improvement of research capabilities are also important activities covered by the Program. Until now following persons received training at National Institute of Agricultural Sciences in Tokyo in respective fields.

1.	Lukman Nol Hakin	(plant physiology)	6 months, 1972
2.	M. Ismunadji	(plant physiology)	3 months, 1972
3.	Machmud	(plant pathology)	6 months, 1972
4.	Iskandar Zulkarnaini	(plant physiology)	6 months, 1973

In addition to above mentioned, Mrs. Paransih Isbagijo in Plant Physiology Division had one month observation tour in Japan. Furthermore, four persons are expected to visit Japan for training in 1973. It would be advisable for the researchers of experience to have opportunity to research in a specialized institute in Japan, and for young assistants and workers to receive training of particular technique and method in Bogor by short term consultants to be sent from Japan for this purpose.

4. Research activities

The details of the theme were determined by the Director of CRIA and the Japanese Team Leader, after an extensive survey on plant diseases and physiological disorders and subsequent discussion. The theme is itemized as follows.

Plant Pathological and Virological Research

(1) Survey on the distribution of food crop diseases
(2) Studies on bacterial leaf blight of rice
(3) Studies on sheath blight of rice
(4) Studies on rice blast
(5) Studies on bacterial leaf streak of rice
(6) Studies on virus diseases of rice

(7) Studies on the major diseases of corn
(8) Studies on the major diseases of legumes

Plant Physiological Research

(1) Survey on the physiological diseases of food crop
(2) Studies on the relation between yield and nitrogen requirement of rice on physiological disordered fields
(3) Studies on growth and root activity of rice grown on different type of soils
(4) Studies on resistance of rice varieties to high nitrogen application and to soil reduction
(5) Studies on countermeasures on fields of "Akiochi" and "Mentek"
(6) Studies on physiological disorders of soybean

But the first task to be done by the Research Team from Japan on arrival was to set the equipment and instruments in the laboratory and to improve the facilities. Team members made every effort to make the equipment available and to construct greenhouse in the first year. The efforts were repaid by acceleration of laboratory works. Field tests became more reliable and more scientific than mere observation under natural condition as done before, by introducing reasonable methods, for example, by use of inoculation with causal agent of known pathogenicity or adoption of chemical analysis. In the second year, some note-worthy results were obtained. For example, the presence of yellow dwarf and grassy stunt diseases of rice in Indonesia was verified throught transmission tests by insect vectors: so-called "Mentek" disease in Cihea was shown to be effectively prevented by application of adequate fertilizer. The running research theme is considered to hold good for coming several years. With better facilities and with trained assistants, more sophisticated research hereafter will yield fruitful results, giving rise to fundamental to practical agriculture in Indonesia.

4. Equipment and Facilities

For the implementation of the Program, a lot of equipment, instruments, tools, machinery, vehicles and their spare parts were provided by Japan every year since 1971. It amounted $92,000, $100,500 and $104,500 in 1971, 1972 and 1973, respectively. These equipment and machinery have already been installed in the laboratories and most of them are actually used for performance of the joint research. As a result, the laboratories of plant pathology and of plant physiology seem to have been fairly well equipped. The problems to be taken into consideration hereafter will be pointed out as follows.

(1) Goods which were transported from Jakarta port to Bogor were usually unloaded only by human power from mortor trucks at the Instutute. During such handling, equipment, instruments and glass wares have been found liable to breakage. In the case of such accident, it will take about one year to import substitutes. To solve this trouble, it is suggested that reducing in weight of a package of goods on one hand and careful handling on unloading from trucks on the other hand would be helpful.

(2) Full and efficient use of the equipment and machinery for research work is unthinkable in the absence of an adequate supply of electric power, water and gas. At the present moment, it seems insufficient. It would be desirable to increase supply of electric power and to improve facilities of supplying water and gas.

(3) It is foreseen that the equipment and machinery will be added as research progresses. The existing buildings need more space for housing the equipment and machinery. This lack of space is important to be taken into consideration.

(4) The equipment and instruments for research involve various structures and functions and proper handling for operation and maintenance varies from instrument to instrument. It would be profitable for the laboratory assistants and service personnel to have an instruction by a short term specialist sent from Japan for guidance of operation, maintenance and repair.

Conclusion

All of the members of the Survey Team are happy to learn that cooperation between the research teams of both countries has been successful in laying rails toward the development of agricultural science in Indonesia and joint research is beginning to bear fruits. In order to give more satisfactory results in future, it is hoped that the authorities concerned of Indonesia would kindly take the problems above-mentioned into consideration.

Finally, we appreciate all the favours and kindness shown to us by the institutions and persons concerned in Indonesia.