# 9. DISEASES OF RICE IN WEST MALAYSIA AND THE BREEDING OF RESISTANT VARIETIES WITH PARTICULAR REFERENCE TO BLAST AND PENYAKIT MERAH

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## Introduction

West Malaysia (formerly Malaya) is one of the few tropical areas where agriculture has undergone remarkable development within a comparatively short period of about 60 years. From the subsistence type of crop production of essential foodcrops, agriculture has grown into a dominant sector of the country's economy. This development however was mainly brought as a result of the expansion of plantation crops with central management where technical development was of the highest degree.

Rice, the staple food of the major sector of the population, is derived essentially from smallholdings. In the past when the country was under colonial rule, the main interests had been towards the development of those commodities grown under plantation scale for export to sustain the industries in the parent country. Only scant attention was given to those smallholder's crops (including rice) which were not for export. However, with the attainment of Independence in 1957, greater emphasis was given to the improvements of the smallholder sector. Thit is clearly seen in the Government Policy on Agriculture which among other enunciations states:-

" to increase the quantity and to improve the quality of essential foods in order to achieve as near selfsusfficiency as is economically feasible and desirable."

The implementation of Government's policy in this direction has been the greater emphasis

**Table 1. Comparison of post war main season wet padi crop with 1941**

| Year | Area planted (Acres) | Production (1,000 tons) | Average Yield per acre (gantangs*) | % Increase over Production | | % Increase in Yield per acre | |
|---|---|---|---|---|---|---|---|
| | | | | 1941 | 1957 | 1941 | 1957 |
| 1940/41 | 742, 600 | 511 | 275 | - | - | - | - |
| 57/58 | 711, 600 | 638 | 362 | +24. 8 | - | +31. 6 | - |
| 58/59 | 721, 280 | 562 | 331 | +10. 0 | −11. 9 | +20. 4 | − 8. 6 |
| 59/60 | 729, 850 | 722 | 399 | +11. 3 | +13. 3 | +45. 1 | +10. 2 |
| 60/61 | 740, 730 | 786 | 427 | +53. 8 | +23. 2 | +55. 3 | +18. 0 |
| 61/62 | 734, 170 | 727 | 399 | +42. 3 | +13. 9 | +45. 1 | +10. 2 |
| 62/63 | 747, 600 | 780 | 420 | +52. 6 | +22. 2 | +52. 7 | +16. 0 |
| 63/64 | 744, 440 | 659 | 373 | +29. 0 | + 3. 3 | +35. 6 | + 3. 0 |
| 64/65 | 763, 160 | 795 | 417 | +55. 6 | +24. 6 | +51. 6 | +15. 1 |
| 65/66 | 763, 100 | 777 | 408 | +52. 1 | +21. 8 | +48. 4 | +12. 7 |

* gantang=1 imperial gallon or approximately 5.6 lbs.

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**Table 2. Acreage and production of off-season cropping**

| Season | Acreage planted (acres) | Production (tons) | Yield/acre (gantangs) | % Acreage increase over 1957 | % Production increase over 1957 | % Yield increase/acre over 1957 |
|---|---|---|---|---|---|---|
| 1957 | 6, 615 | 6, 000 | 369 | – | – | – |
| 1958 | 7, 260 | 7, 000 | 397 | 9. 8 | 11. 7 | 7. 6 |
| 1959 | 10, 570 | 11, 000 | 419 | 67. 2 | 85. 0 | 13. 6 |
| 1960 | 20 195 | 22, 000 | 443 | 232. 9 | 266. 7 | 20. 1 |
| 1961 | 35, 465 | 33, 000 | 378 | 436. 1 | 450. 0 | 2. 4 |
| 1962 | 46, 520 | 48, 000 | 414 | 603. 3 | 700. 0 | 12. 2 |
| 1963 | 49, 110 | 52, 000 | 438 | 642. 5 | 766. 7 | 18. 7 |
| 1964 | 58, 420 | 61, 000 | 429 | 783. 1 | 916. 7 | 16. 3 |
| 1965 | 89, 840 | 100, 000 | 447 | 1, 258. 1 | 1, 566. 7 | 21. 1 |

on research during the last ten years particularly with foodcrops, principally rice. The results of reseach on rice are reflected in the increased trend in production per unit area for both the main-season and the off-season crop as shown in Table 1 and Table 2.

It can be seen therefore that considerable progress has been made in the field of rice research in Malaysia, and for the purpose of this paper, the question of rice diseases and the breeding of resistant varieties, which forms an integral part of the rice improvement programme in West Malaysia (formerly Malaya) will be discussed.

## Rice Diseases in West Malaysia

Several diseases of paid are present in West Malaysia, some occurring year in most areas, while others are more sporadic and localised. The amount of damage caused by these diseases is difficult to assess. Some, such as leaf spots, cause no obvious decrease in yield although in the aggregate their weakening effect on the plant must result in considerable overall loss. Others, such as stem rot, are often difficult to recognize and damage done may not be realised or may be blamed on other agencies. Because the damage done by these diseases can easily be overlooked and is not easy to evaluate, comparatively little attention, until recently, has been paid to them.

As an aid in the recognition of the commoner diseases, Johnston in 1958 categorised them into four groups as follows:–

(1) Leaf Diseases such as Brown Spot (*Helminthosporium oryzae* Breda de Haan), Blast (*Piricularia oryzae* Cav.), Narrow Brown Leaf Spot (*Cercospora oryzae* Miyake), Leaf Smut (*Entyloma oryzae* H. and P. Syd.), and Sheath Blight (*Rhizoctonia solani* Kuhn.).

(2) Stem and Leaf Sheath Diseases, such as Sheath Blight (*Rhizoctonia solani* Kuhn.), Stem Rot (*Sclerotium oryzae* Catt.), and Blast (*Piricularia oryzae* Cav.).

(3) Grain Diseases, such as False Smut (*Ustilaginoides vireus* Tak.), Brown Spot (*Helminthosporium oryzae* Breda de Haan) and Blast (*Piricularia oryzae* Cav.).

(4) Disease causing General Stunting, such as Penyakit Merah.

In recent years, Bacterial Leaf Blight (*Xanthomonas kresek* Schure) has become a common disease. The fact that Johnston did not list this disease in 1958 was perhaps either that the disease was not present or that it was of rare occurrence in the past and has escaped the notice of research workers in Malaya; the latter case appears to be more probable as pointed out by Ou in 1964.

The above groups overlap to some extent. For example, blast although mainly a leaf

disease, is also found on the stem and grain. Nevertheless they form a useful practical basis for classification and identification. The diseases listed above are the commoner ones found in Malaya, but not all are considered necessarily of economic importance in so far as they affect the rice crop in general. Of the dozen or so rice diseases that are known in Malaya, Penyakit Merah and Blast diseases are now considered of major importance since they have become widespread and can cause considerable or even complete loss of the rice crop. On the other hand, diseases like Leaf Smut and Narrow Brown Leaf Spot, although relatively common and wide-spread, have not been considered to merit intensive investigation on them since they have not been found to cause any significant losses in yield. Others, like Brown Spot which are very common and may weaken the plants thus resulting in decreased yield are susally diseases connected with poor condition both in the nurseries and in the field. Cultural improvements are normally considered adequate as remedial measures. For these reasons, among others, such diseases are therefore considered to be of minor importance and have not been given the degree of emphasis in investigations and research as are accorded to the major ones like Blast and Penyakit Merah. Research on these two major diseases, therefore, have received considerable attention in West Malaysia in the rice improvement programme. In this paper it is proposed to review the work on these two diseases in greater detail.

## Rice Blast (*Piricularia oryzae* Cav.)

Blast was first observed in Malaya in 1945 among varieties brought into the country during the Second World War and was therefore thought to have been introduced from such varieties from Taiwan. Subsequently, however, the disease was found to be present in widely separated areas among local varieties all over the territory. It is now considered that the disease has been present all along but was not noticed because prior to the increased use of fertilizers, particularly nitorogen in rice cultivation severe damage was seldom recorded. Blast was therefore not considered a serious problem in the past.

As a result of the work of rice improvement after the war in which new varieties that are more responsive to fertilizer application became available to the farmers and also because of more intensified cultural practices, blast disease began to cause serious losses. The importance of blast disease was discussed in the 5th Working Party on Rice Breeding of the International Rice Commission of the F. A. O. in 1954 at Bangkok, Thailand, and again at the 6th Meeting in 1955 in Penang, Malaya. The outcome of such discussion was the adoption of a recommendation at the 6th Meeting in Penang which read as follows:-

"that member countries should wherever facilities exist, intensify their work on breeding new varieties resistant to blast diseases."

In pursuance of the above recommendation, and the need to finding suitable parental materials having the gene(s) for resistance to blast, the search for resistant varieties was given emphasis in the rice improvement programme in Malaya. Intially the search was directed towards the existing local varieties. As a first step the varieties that were currently recommended for cultivation were screened. As a result of such work, several resistant varieties were reported to the 8th Working Party Meeting on Rice Production and Protection of the International Rice Commission held at Peradeniya, Ceylon, in 1959. The results of the tests carried out were also summarised in a publication by Johnston in 1958. It is interesting to not that as a result of the International Rice Commission's cooperative testing for resistance to blast undertaken by a number of countries, no one variety among those tested has been found to be resistant to blast in all countries. Varieties which were regarded as resistant in their country of origin were often badly attacked by blast when introduced into other countries. This is due to different biotypes of the fungus or to the influnce of environment.

Following the set up of the International Rice Research Institute in 1961 the coordination of the international blast nurseries was passed to this Institute. At the 1963 Symposium of Rice Blast Diseases held at IRRI, a standard method of screening for blast resisistance was established and Malaysia has been using this method ever since both for the screening of materials under the International Uniform Blast Nurseries and as an integral part in the synthesis of new varieties in the rice improvement programme.

1. The Breeding of Blast Resistant Varieties in Malaya

It was pointed out earlier in this paper that blast in the past had not been considered a serious disease in Malaya. This did not mean that no attention was devoted to its investigation; rather because of the seriousness of the stem borer and Penyakit Merah problems the investigation on blast disease was given relatively less emphasis. Reports of outbreaks of the disease in Kelantan (1960 and 1961), in Perlis and Tanjong Karang (1963) and in Province Wellesley (1966) pointed to the fact that this disease posed a real potential threat to rice cultivation. In a survey carried out in the 1965/1966 season, the yield at the Bukit Merah Station and its vicinity was reported to be reduced by as much as 50%. Coupled with the information that in some countries where this disease was previously considered to be relatively unimportant had become serious, a strong rational rice breeding programme for resistance to this disease was emphasised.

Hitherto the breeding for resistance to blast disease in the rice improvement programme in West Malaysia was based on what could be termed negative selection of individuals. This approach presupposes that in a naturally affected area, individuals which are free from the infection of blast would be selected provided other desirable characters are also present. It takes no account of the fact that they may escape infection. In the absence of systematic screening such a system gives a measure of probability that tolerant or even resistant lines would emerge from the selection. Before systematic screening was introduced as part of the breeding programme all the improved varieties in West Malaysia was based on this method in so far as disease resistance was concerned.

The need to incorporate systematic screening for selection of resistant lines was emphasised after the release of Malinja and Mahsuri varieties in 1964 and 1965. These varieties at the time of release were comparatively free from blast in both experimental and field plantings. However serious attacks of neck-rot were soon reported when large scale cultivation of such varieties were carried out. It was evident that the these two varieties needed to be further improved to incorporate blast resistance into them. A programme of back-crossing was initiated using resistant parents from the blast nursery screening as a resistant gene source. In this programme 4–5 back-crossings have been found to be quite sufficient and the results so far have indicated that improved Malinja and Mahsuri would be available to the farmers for cultivation in the very immediate future. Likewise 1R8 have also been subjected to such a programme. Hand in hand with this back-crossing programme, the normal hydridization programm now uses a resistant variety as one of the parents. All progenies from the crossing programme are subjected to nursery blast screening and only resistant lines are planted for further selection.

2. Nursery Blast Screening

Nursery Blast Screening in West Malaysia was first started by Johnston following the recommendation of the International Rice Commission in 1965. The tests carried out at the time were mainly on varieties that were commonly recommended for cultivation. Later other varieties, particularly those recommended by the IRC as having been found to be resitsant in their home countries were also tested. The screening was carried out either in pots or in trays. In cases where natural infection was not obtained, infection was induced by means of sprays containing a suspension prepared from infected material. Gradually facilities were ex-

panded and proper dryland nurseries were established, and by 1964 the technque was standardised (with slight modifications) in accordance with the International Uniform Blast Nurseries adopted at the International Blast Symposium held at the International Rice Research Institute, Los Banos 1963. Blast screening are now in operation in 4 centres in West Malaysia. The technique used in West Malaysia is as follows:-

Each nursery bed is 4′×60′ long and is raised one foot from the ground level. Testing rows are 1.5 inches wide and 12 inches long. The distance between each row is 1.5 inches. Two border rows of a highly susceptible variety 1.5 inches wide and separated by a distance of 3 inches are planted in order to ensure a favourable micro-climate and to raise the inoculum potential. Susceptible varieties are planted after every 20 test rows. About 5 gm. of seed of a variety to be tested are sown for every 12 inch row. Each variety is being replicated at least 3 times in the test. Fertilizer application of the nursery bed is basal and consist of:-

Sulphate of Ammonia 145.2 kilograms per acre.
Christmas Island Rock Phosphate 108.9 kilograms per acre.
Muriate of Potash 108.9 kilograms per acre.

The nursery bed is watered 2-3 times daily. Recording of the results takes place 3-4 weeks from the date of sowing. The scoring is in accordance with the International Uniform Blast Nursery Programme.

| Symptom | Symbols used | Scale for Blast reaction |
|---|---|---|
| Highly resistant | HR | 1 |
| Resistant | R | 2 |
| Medium resistant | MR | 3 |
| Medium susceptible | MS | 4 |
| Susceptible | S | 5 |
| Very susceptible | VS | 6-7 |

The use of this method of screening enables very large numbers of varieties to be tested in a short time. Several thousand varieties, both local and introduced, have been tested and no less than 81 varieties have now been indentified which can provide a good source of material for breeding for resistance in West Malaysia.

3. Varietal Reaction

Our short experience of vaietal screening in West Malaysia points to the need for periodic re-testing of the varieties since different physiological races of *P. oryzae* are present in the county and their number would in all probability increase with time. In 1959 Japan reported no less than 15 physiologic races. This number, has since considerably increased.

In West Malaysia at least two races have been identified by foreign workers. There are no doubt many more which have not been identified. As difierent races may predominate in different regions, information regarding the resistance or susceptibility of a particular variety in all or certain localities is very useful for breeding purposes.

Varieties resistant now may become susceptible in time to come. This is clearly demonstrated in our tests with 1R8. This variety was found to be resistant when first introduced in 1965. In 1966 this variety was showing only moderate resistance. Now it is completely susceptible. The need for continued re-testing of varieties is therefore obvious, and that the breeding programme should ensure the continued flow of new resistant vareties to meet the variability of the pathogen. Disease resistance to be applied as a control programme is therefore a continuous process.

Although some antibiotics such as Bla-S and Blastin tested under Malaysia conditions have given good control in the nurseries, their extensive use under field conditions would not be economical.

## Penyakit Merah

Penyakit Merah is a phrase commonly and somewhat loosely used to describe the sick condition of the rice plants, the common symptom of which is the redness of the leaves. Hence the name "red disease". The sickness was first more closely defined by Johnston as:

> "Plants stunted, leaves discoloured dark red, purple orange or yellow, leaves dying prematurely. Badly affected plants die. Less severely affected plants may remain alive but are stunted and produce no grain. When attack is light, the plant may partially recover and produce some grain."

The first mention of Penyakit Merah in Malaya appeared to have been made by Coleman-Doscas in 1934. In 1938 the term Penyakit Merah was used to describe poorly developed paddy plants at the Bruas Paddy Test Station in Perak. In 1940 Thompson recorded that there was no evidence to show that a pathogen was associated with the disease. The next reference to this disease was made after the war in 1949 in a report on the failure of the padi variety Milek Kuning in the Raub District of Pahang. By 1950 the Plant Pathologist wrote that he "was unable to find any parasite connected with this trouble, which for the time being be regarded as physiological in origin", although various workers showed that Penyakit Merah affected plants made poor progress when transplanted and might develop rusty, reddish, yellowish or purplish colours in older leaves which finally withered. While flecking of the leaves was noted, it was attributed to a sucking insect, possibly *Evythroneura* spp.

In 1952 samples of plants which were 8–10 weeks older after transplanting and showing yellowish discoloration and stunting were collected. *Nephotettix bipunctatus* was found among the samples but the viral nature of the disease was never suspected. Consequently fertilizer treatments were carried out. The results obtained did not in anyway solve the problem as the disease was sporadic and did not reappear in the same field on successive years in which the tests were laid.

Researchers after having investigated the problem from the nutritional aspect came to the conclusion that such experiments did not provide any definite clue that Penyakit Merah was a nutritional disease. Spraying with trace elements, liming of the soil etc. did not show any obvious effect on Penyakit Merah.

In 1955 nematodes were implicated as the causative agents. However conclusive evidence regarding the cause of the disease by these eelworms could not be obtained.

Lockard in 1959 after having carried out detailed nutrient experiments in sand culture came to the conclusion that Penyakit Merah was a physiological disease.

The break-through in Penyakit Merah investigations came in 1964 when Ou *et al.* reported the recovery of a virus from Penyakit Merah plants collected from Malaysia by using virus free colony of *Nephotettix impicticeps* Ishihara. Following this preliminary study a cooprative effort in 1965 between Malaysian workers and an entomologist from IRRI working at Parit Buntar in Perak established that in the wild population of *N. impicticeps* caught from different localities in North Malaya, 35% of the population was capable of transmitting Penyakit Merah. Virus from infected plants from various localities was successfully transmitted to healthy plants which ultimately produced the symptoms of Penyakit Merah.

As a result of this work the true nature of Penyakit Merah was established and an accurate descripsion of the symptoms became possible to differentiate it from other maladies due to other causes but which also produce symptoms which may be confused Penyakit Merah. Penyakit Merah symptoms can be described as follows:–

> "In susceptible varieties, Penyakit Merah causes marked stunting and yellowing or mottling. Marked irregular areas of pale and dark green give young leaves a mildly mottled appearance. As the leaves mature, their tips and edges turn yellow or yellow orange. The

yellow orange colour persists for sometime, then the leaves die. At later stages, the symptoms are less pronounced or appear transitory, but the plants remain stunted. Tillering is limited and flowering is delayed in plants affected at an early age. Under field conditions, isolated plants here and there may show the symptoms or there could be wide-spread."

Studies carried out in Malaya and those at the International Rice Research Institute and elsewhere by Ou and his co-workers have thrown a lot of light on a number of diseases which were regarded as physiological in nature. As a result of such studies Ou was able to state:

"Until recently, Penyakit Merah had been classed with "mentek" disease in Indonesia and the "suffocation" disease in Taiwan as a physiological disease of rice. These is now sufficient evidence that many of the so-called physiological diseases which occur widely in South-east Asia are actublly virus diseases. The symptoms of Penyakit Merah are almost identical with those of mentek in Indonesia. They also resemble those of orange leaf disease and tungro in the philippines and "transitory yellowing" in Taiwan, all of which are caused by viruses. These symptoms vary slightly with variety, time of observation and environmental conditions."

It is possible that other diseases of unknown cause and considered as physiological in nature, such as "punsuk" in East Pakistan, "Mjit po", "Annyit-po" and "Yellowing" in Burma "Yellowing" in India, and "orange leaf type of leaf symptom" in North Borneo may also involve a virus or viruses.

1. Testing for Penyakit Merah Resistance

As it has been difficult to test varietal resistance to Penyakit Merah in the field, the cage method is being used to carry out transmission studies and screening of varieties for resistance. The species of leafhopper used in these studies is *N. impicticeps*. Transmission by *N. apicalis* has not been sucessful.

The method as used in the trasmission studies in Malaysia consists of small Mylar cages enclosing the 20 day old test seedlings, to which viruliferous leafhoppers (*N. impicticeps*) are introduced. For thd controls, virus free *N. impicticeps* are used. Normally tests are duplicated 2–5 times. It has been found that two insects per plant are sufficient for the test. The insects are left in the cages for 48 hours after which they are killed. The cages are then removed and the plants are allowed to grow normally. Susceptible varieties begin to show typical symptoms of mottling, yellow discolouration and stunting 7–10 days after inoculation.

By this means, resistant and tolerant varieties can be identified to provide good sources of resistance for breeding. The number of varieties that have been found to be resistant under Malayan conditions is much smaller than those found in the blast screening. Nevertheless there are resistant varieties. So far the varieties that have been found to fall into this category are Madu Tiga, $FB_{24}$ Tjeremas, Peta and Intan. It is interesting to note that some promising lines from a cross carried out at IRRI between Peta×Tangkai Rotan have been isolated in West Malaysia as possessing good resistance to Penyakit Merah.

2. Losses due to Penyakit Merah

Losses due to Penyakit Merah are difficult to estimate and vary from season to season since the occurrance of the virus in the field seems to be dependet on seasonal and biological factors that are linked with the vectors. It may amount to a total loss in individual fields and according to Lockard an average as much as 10% in some localities. Farmers in the Krian District, where Penyakit Merah is a serious problem during some seasons, believed that losses from this disease could be about 40%. Perhaps there is some justification in the farmer's observation as can be seen from the yeild records of the Krian District from 1960/61 to 1965/66.

**Summary of Yield Returns in the Krian District** (60,000 acres)

| Season | Acreage affected by Penyakit Merah (acres) | Average yield per acre from affected area (gantangs)* | Average yield/acre for the whole district (gantang) |
|---|---|---|---|
| 1960/61 | 315 | 430 | 496 |
| 1961/62 | 280 | 250 | 397 |
| 1962/63 | 2, 256 | 150 | 388 |
| 1963/64 | 1, 520 | 200 | 456 |
| 1964/65 | 8, 006 | 360 | 430 |
| 1965/66 | 1, 402 | 400 | 368 |

* 1 gantang=1 Imperial gallon or approx. 5.6 lbs.

A field cooperative experiment with the International Rice Research Institute carried out in Krian during the 1965/66 season also confirmed that appreciable losses can occur as a result of Penyakit Merah. The results of this expepiment could be summarised as foolows:-

| Treatment | Yield in metric tons per hectare (calculated) | % Loss in yield |
|---|---|---|
| A1 Healthy seedlings caged 2×2 m. | 4. 08 | - |
| A2 〃 | 5. 13 | - |
| B1 Inoculated seedlings caged 2×2 m. | 1. 28 | 68. 7 |
| B2 Inoculated seedlings not caged 2×2 m. | 0. 28 | 92. 2 |
| B3 〃 | 0. 92 | 77. 5 |
| B4 〃 | 0. 77 | 81. 0 |

It is obvious therefore that there is a great difference in yield between healthy and inoculated plants. In farmer's fields, losses could be as much as 68.7% or more, depending upon the period at which infection occurred, the density of the leafhopper population and other factors. In general there seem to be fairly general positive correlation between the density of population of *N. impicticeps* during the period from nursery to immediately after transplanting, and the loss of yield (compare Table 1 and Fig. 1).

3. Prevention and Control of Penyakit Merah

Since the primary cause of Penyakit Merah is due to a virus transmitted by the insect vector *N. impicticeps*, control meausures would therefore be directed towards:-

(1) The breeding of varieties resistant to the Penyakit Merah virus.

(2) The destruction of the insect vector.

The breeding of resistant varieties would necessitate a programme of varietal screening to identify materials resistant to the virus for use as parents in the breeding programme. The method of screening has already been described. As for the destruction of the pests, work on the evaluation of the efficacy of various insecticides has indicated that Sevin and Malathion are effective and rapid in their action. Sevin was slightly slower to act than Malathion which was not persistant. Sevin at concentration of 0.1% active ingredient has shown persistency up to at least 7 days after spraying.

## Conclusion

Because of the seriousness of blast and Penyakit Merah in rice cultivation in West Malaysia research work on these two diseases are given particular emphasis in the rice improvement programme. However there are indications that bacterial leaf blight is becoming serious.

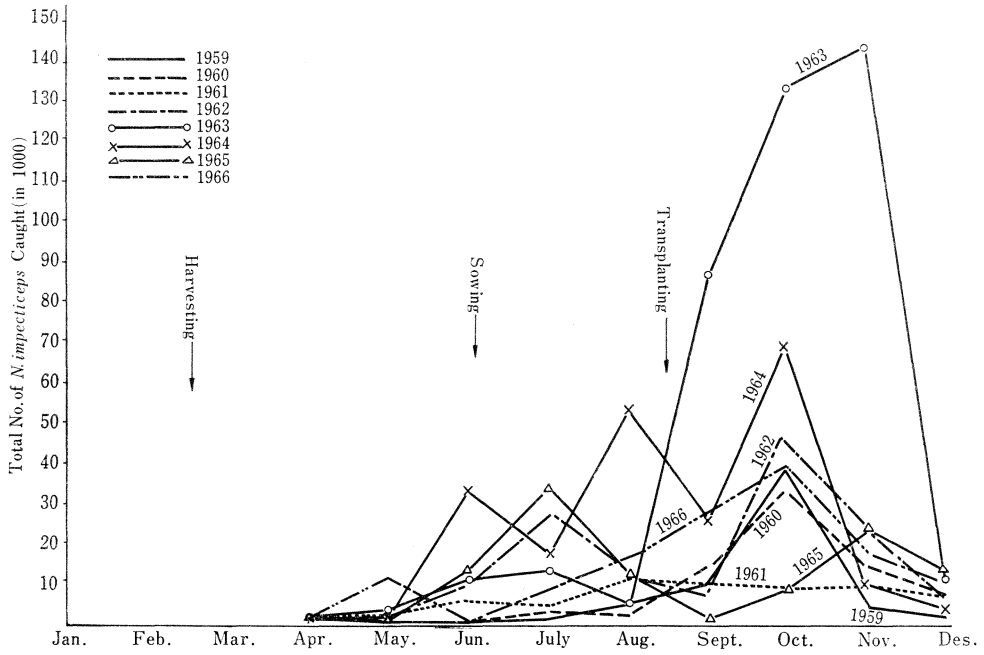


**Fig. 1. Titi Serong Padi Experimental Station annual light trap catches of *Nephotettix* 1959–1966**

Bacterial leaf blight until 1962 seldom occurred among the local varieties. With the increase use of fertilizer particularly in nitrogenous fertilizers and the testing of large number of hybrid populations, this disease has frequently occurred. This is particularly evident from materials emanating from the Rice Research Institute. Because of this the scope of varietal screening is being widened to include bacterial leaf blight besides that of blast and Penyakit Merah. It is the hope among rice breeders in Malaysia that future varieties will be resistant to a wide spectrum of diseases.

## Discussion

**B. H. Siwi,** Indonesia: You mentioned that Penyakit Merah in Malaysia has been identified to be the same as tungro in the Phillipines. Is Penyakit Merah associated with root rot? If so, I think symptoms of Penyakit Merah is very similar to mentek in Indonesia. Do you think mentek is also caused by virus?

**Answer**: The term "Penyakit Merah" has been used to describe the symptoms of the affected plant the leaves of which turn orange to red. Such symptoms could be caused by poor cultural conditions or by a virus, the latter of which has been identified as similar to tungro. In virus infected "Penyakit Merah" stunting of the plant and poor root development is usually noticed.

I do not know whether mentek is also caused by virus but accoding to a review of Dr. S. H. Ou of IRRI this is probably so.

**D. N. Srivastava,** India: How is the root system in tungro affected plant? Do the affected plants recover to normal condition?

**Answer**: Plants affected by Penyakit Merah virus normally are stunted and have poor root development. Mildly affected plants may recover to some extent but in severe cases they remain stunted and do not recover.

**H. I. Oka,** Japan: IR8 was resistant in the 1st year, moderately resistant in the 2nd year and susceptible in the 3rd year. Could you give us an outline of the data? Also, it was just released in 1965. You think that the racial change of the fungus is so fast?

**Answer**: IR8 was introduced in West Malaysia eary in 1965 and in the nursery screening it was found to be quite resistant. Late in 1966 it showed moderate susceptibility in the screening. When the screening was repeated in 1967 it has become comletely susceptible. We at present in Malaysia have no means of knowing the speed of the racial change of the fungus. Rather perhaps this could be due to a quick build up of the particular race of the fungus under our conditions.

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