6. BIONOMICS OF GREEN RICE LEAFHOPPER AND EPIDEMICS OF YELLOW ORANGE LEAF VIRUS DISEASE IN THAILAND

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Introdution

Rice virus diseases including mycoplasma-like diseases in Southeast Asia cause severe damages to rice production annually. The Tungro disease group, that is Tungro in the Philippines, Indonesia, Pakistan and India, yellow orange leaf virus disease in Thailand, penyakit merah in Malaysia and penyakit habang in Indonesia, is prevalent among rice virus diseases and is one of the most important problems of rice cultivation in the rainy season.

Tungro was first observed in the Philippines (IRRI) in 1963 and was indicated to be a non-persistent virus transmitted mainly by the green rice leafhopper, *Nephotettix virescens*, (Rivera et al, 1965), while a virus-like disease which had occurred about a hundred years ago is called "mentek" in Indonesia (Hadiwidjaja, 1956).

Severe occurrence of the disease prevailed widely in recent decade of years. This seems to be attributed to the increase in acreage of off-season rice cultivation and extensive cultivation of new high-yielding varieties together with the application of nitrogen fertilizer.

In Thailand, distinct prevalence of the disease occurred during the period from 1968 to 1970 after the first discovery of the disease at Bangkok in 1964 (Wathanakul, 1964). Afterwards, the disease subsided during 1971 to 1973, and again, it occurred severely in some provinces of central Thailand in 1974, where the disease-infected area was as much as in 1966 (Lamey et al, 1967).

The present research (Inoue et al, 1975) was conducted during the period from 1970 to 1974 in Thailand for the purpose of elucidating field epidemiology of the disease in relation to the incidence of vector leafhopper.

Occurrence of Yellow Orange Leaf Virus Disease and Transmission by Green Rice Leafhopper in Field

1. Occurrence of green rice leafhopper In central Thailand, rice is mainly cultivated in the rainy season from June to December or January. In paddy field throughout the country, the population of *N. virescens* was always more abundant than that of *N. nigropictus*. In the experimental result obtained at Bangkhen field, Bangkok, the number of *N. virescens* in the rainy season at the time of peak population exceeded that of *N. nigropictus* by 4 to 26 times. Thus, N. *virescens* plays an important role in the virus transmission.

There were 5 to 6 generations in the green rice leafhoper during the rice growing

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period in paddy field. Adult infestation into newly transplanted field was observed for a few days from 2 or 3 weeks after transplanting. Its population at the peak was 0.05 to 1.8 individuals per hill. The second generation nymphs began to appear about 3 weeks after transplanting and subsequently attained 2.8 to 19.0 individuals per hill at the time of peak incidence which fell on 4 to 5 weeks after transplanting.

Afterwards, the population of subsequent generations tended to be maintained at low level until harvesting time of rice. There was no significant difference in the number of newly borne nymphs on rice plants between 15 to 30 days old seedlings and the heading stage plants in pots. Population survey of the leafhoppers and the associated natural enemies in the experimental field suggested that the effect of spiders, which ordinarily increased almost one month after transplanting, at the time of peak population of the leafhopper seemed to be considerable.

There was a significant difference in the seasonal prevalence of *N. virescens* in the field as well as in its number caught by a light trap between the rainy and dry seasons every year. In the experimental field in the dry season of December 1974, the population of second generation nymphs at the time of peak incidence was only 0.8 individuals per hill in contrast to 8.6 in the rainy season field transplanted in July, though the population of the infested adults was 5.0 individuals per hill in the dry season and 0.4 in the rainy season field.

When the nursery beds were serially cultivated throughout the year, *N. virescens* population was very low during February to May, the latter half of the dry season (Hino, 1974). The humidity condition in the dry season would affect depressing the population effectively, giving poor egg hatchability and resulting in high mortality of nymphs at the younger stage, if they could successfully hatch. The temperature affected was secondary.

2. Time of yellow orange leaf virus infection to rice plants in relation to vector vicissitude Rice was transplanted at various time in Bangkhen field in June and July of 1971 and 1974 in order to clarify the time of virus infection. The results indicated that the virus infection during the seedbed period for 25 days was less than 1%. The major virus infection in fields ocurred after transplanting. The disease symptoms appeared mainly during the period of 2 to 5 weeks after transplanting in every field of different dates of transplanting though the percentage of diseased hill was either low or high at harvest, depending on the transplanting dates.

Hino (1974) also obtained similar result on the time of the virus infection in the paddy field; the percentage of the virus infection during the seed bed period was as little as 0.01% in July 1970 and 0.07% in September 1970. It was proven conclusively that the virus infection occurred in the early stage of rice; namely, until 3 weeks after transplanting when the incubation period of the disease in the seedling stage was taken into account.

From the experimental results on the relation between the vector outbreak and the time of the symptom appearance, the virus transmission was made mainly both by the infected adults and by younger nymphs of the second generation. Considering the spreading of the virus in paddy fields, the adults might be more active and conductive than the nymphs. In some cases, the vector population was very low, whereas the disease incidence was as much as more than 40%. Sticky trap records in the paddy field indicated a mode of active movement of the infected adults, capturing numerous numbers of the adults during a few days to 2 weeks after transplanting. Besides the vector activity, very short incubation period in insect might also relate to accelerating the disease epidemic.

Annual and Seasonal Population Fluctuation of Green Rice Leafhopper

Light trap records at the Bangkhen experimental field, Bangkok, in 1969 to 1974 was taken on the annual population fluctuation of *Nephotettix* spp., i.e., *N. virescens, N. nigropictus, N. malayanus* and *N. parvus*. The total number of catches on the average for one year was 10,075 of *N. virescens*, 1,375 of *N. nigropictus*, 482 of *N. malayanus* and 16 of *N. parvus*. According to Ishihara & Kawase (1968), interspecies percentage of the four species was 92.7% of *N. virescens*, 1.7% of *N. nigropictus*, 3.9% of *N. malayanus* and 1.7% of *N. parvus* in Malaya, Malaysia.

Thailand is located in the tropical monsoon climate region as characterized in sharp contrast to moisture conditions between the rainy and dry seasons. The outbreak of *N. virescens* occurred often from May or June, the beginning of rainy season, to December of the rice harvesting time. About 82% of leafhopers were caught during the rainy season.

N. nigropictus usually occurs in the rainy season. But its population on gramineous weeds was observed to be higher than on rice plants. *N. malayanus* was not abundant because of the restricted distribution of its preferred gramineous host plant, *Leersia hexandra*. More than 70% of individuals were collected during the late rainy season to early dry season. Regarding *N. parvus*, the number of specimens collected was fairly small probably due to the limited area of its major host plant, *Isachne globosa*, in central Thailand. In south and northeastern part of Thailand, a great number of *N. parvus* could be collected in the rainy season. For instance, the number of this species in light trap catches in the rainy season amounted to occasionally as many as that of N. *virescens* in south Thailand.

In light trap study, the yearly total number of *N. virescens* in 6 years was the greatest in 1969 and 1970, the smallest in 1971 and 1972, and ranked moderately in 1973 and 1974. The most important factor affecting quantitative occurrence of the leafhopper might be rainfall in the rainy season. Among 6-year records mentioned above, the smallest number of the leafhoppers was obtained in 1972 when drought weather prevailed continuously during May to August.

In respect to the relationship between the seasonal abundance of *N. virescens* and the disease incidence in the rainy season, the number in light trap catches in June and July related proportionally to the disease infected area and severity of disease in fields.

In addition, the number of leafhoppers caught in June and July related proportionally, at first, to the number in December and January in the last dry season, showing the significant correlation coefficient of $r=0.89$.

When rainfall was infrequent around November to January, the population of *N. virescens* on dry season rice might gradually decrease. Secondly, the beginning time of *N. virescens* outbreaks obtained in light trap reflected on the number caught in June and July. When the outbreak started earlier in the middle of May or before, as was seen in 1969, 1973 and 1974, *N. virescens* occurred often in June and July.

Alternative Host Plants of Green Rice Leafhopper

N. virescens could be grown on rice and wild rice, *Oryza spontanea*, throughout the year. Common 21 gramineous plants collected at Bangkhen field including officially identified 15 species and unidentified 6 species were tested on the adult mortality and fecundity in a laboratory, but all results were negative. In addition, no alternative host has yet been found in field surveys.

In the rainy season, however, when the population built up to be high in every field, the small number of adults could seldom be collected on *Leersia hexandra, Ischaenum rugosum* and some unidentified gramineous plants. This is considered to be a temporary habitat resulted from the dispersion of the adults in all directions from the main habitat because no nymph has been collected from any weed sites in season advanced.

N. nigropictus grew on *Echinochloa* spp., *Leersia hexandra*, wild rice and rice. In addition many adults and nymphs were callected on *Hymenachne pseudointerrupta* and *Isachne globosa*. Most of these host plants are observed in ditch or dike near a rice field. *N. malayanus* was comonly seen on *Leersia hexandra*, Gramineae, all the year round and was proved to reproduce on it. The adults have not survived on rice seedling for more than 3 days. *N. parvus* was ordinarily found on *Isachne globosa*, Gramineae, which grows in ditch or in rice field in the rainy season. The adult could survive on rice seedling for 5 to 12 days.

Aspects of Yellow Orange Leaf Virus Disease Epidemic in Thailand

1. Succession of the virus in dry season During the course of the survey in the dry season from 1970 to 1975, few diseased plants were found on dry season rice in March and April 1975 after the disease occurred severely in the previous rainy season. Moreover, the disease symptoms in dry season were vague and the symptoms did not last on rice plants for a longer period even on a susceptible variety.

According to the survey in the 1974 rainy season, the disease occurred in several provinces of central Thailand including Bangkok. The severely affected area was same or near the disease-infected one in 1966, two years after the discovery of the disease in Bangkhen field.

2. Occurrence of the disease on resistant RD 1 and RD3 RD 1 and RD 3 were resistant varieties bred by crossing IR 8 with Thai native Luang Tawng and have been delivered to farmers since 1969. In an experimental field in 1970, RD 1 showed high resistance against the disease, the percentage of diseased hills being only 0.32% in contrast to 84.1% susceptible T (N) 1.

Accordingly, some susceptible native varieties are gradually being replaced by these resistant varieties in central Thailand. About 15% of the area were presumedly covered by these varieties in 1974. However, in the 1974 rainy season the virus infection on these varieties was recognized in various provinces such as Bangkok, Thonburi, Nakonpatom, Chachiengsao, Klongruang and Petchburi. Among these provinces, the disease was observed to infect severely as nearly 100% in Chachiengsao province, 80 km easterly from Bangkok, where RD 1 covered nearly 90% of the total paddy field area. And the disease incidence at Klongruang Experiment Station field, about 15 km northerly from Bangkok, was 47%.

The above-mentioned phenomenon is considered to be attributed to the hereditary change of susceptibility of the variety against the virus and/or the vector insect; or the development of a new virus strain. In any case, this fact seems to indicate one of the causative factors in field epidemic of the yellow orange leaf virus disease.

Conclusion

Resistant varieties could offer the most effective and economical means of control in plant protection. Fortunately, resistant varieties against the Tungro disease have been reported from several countries. However, covering certain regions only by one resistant variety would be risky as a long-term control measure.

The adults invaded into the fields soon after rice transplanting play an important role in the virus transmission. As for chemical control, aplications of some granular insecticides like carbaryl and MIPC, two applications at the time of initial and peak occurrence of adults, promise good efficiency.

References

1. HADIWIDJAJA, T. (1956). Thesis Fac. Agr. Bogor, Indonesia, (Mimeographed).

2. HINO, T. *et al.* (1974). *Tech. Bull. TARC,* 7, 1–67.
3. INOUE, H. *et al.* (1975). Final report of the joint research work between Thailand and Japan, 1–104, (Mimeographed).
4. IRRI, (1963). *IRRI Annual Report,* 1963.
5. ISHIHARA, H. & KAWASE, E. (1968). *Appl. Ent. Zool.* 3(3), 119–123.
6. LAMEY, H. A. et al. (1966). *FAO Plant Prot. Bull.* 15(4), 67–69.
7. RIVERA *et al.* (1965). *Pl. Dis. Reptr.,* 49, 127–131.
8. WATHANAKUL, L. (1965). Report presented at fourth Nat. Conf. on Agric. & Biol. Kasetsart Univ., (Mimeographed in Thai).
9. YOSHIMEKI, M. (1971). Final report, Colombo Plan, (Mimeographed).

Disscussion

D. P. Shivanathan, Sri Lanka: What is the cost benefit ratio of two applications of granular insecticides? Is 2 applications of granular insecticides economically feasible?

Answer: Unfortunately the screened insecticides effective to control the YOLV disease vector were expensive due to the big amount of the chemical is necessary to apply.

K. Sogawa, Japan: Is it possible to forecast the outbreak of vector insect by means of analysis of meteorological factors in dry season?

Answer: There are some factors concerning to the occurrence of the leafhopper population as natural enemies, acreage of off-season rice cultivation, the area of the virus host plant in dry season etc.

D. A. Benigno, Philippines: Which gives a better picture of insect population, sticky trap or light trap?

Answer: Sticky trap did not show the trend of population of the leafhoppers in field depending on the changing mode of the leafhopper activity in field by generation to generation. Figure in light trap catching indicates the reliable population fluctuation of the leafhopper in a certain area.

W. P. Ting, Malaysia (Comment): 1. I would like to emphasize that unless total resistant varieties are available, the planting of varieties possessing partial resistance may result in much severer outbreaks in areas where the partially resistant variety is not planted. So I feel we should aim for insect resistance rather than resistance to the disease.

C. Kaneda, Japan (Comment): Regarding the effect of insect resistance upon the virus infection, we consider that host plant resistance is also of importance to reduce virus infection. In the screening for rice dwarf virus resistance of our breeding lines, the selections with green leafhopper resistance usually show low infection of the virus even they are not resistant to the virus, especially when the insect population is not very high.

I. N. Oka, Indonesia (Comment): Commenting on the suggestion of Dr. Ting's question, we experienced in Indonesia that IR 26 which is resistant to the BPH but susceptible to grassy stunt we still have much trouble to the disease.

Therefore, we should breed varieties which must have resistance to both the BPH and the grassy stunt virus.

The degree of resistance should not be too strong in order to minimize the selection pressure of the variety to the insect and the disease. This way we hope the resistance will last longer.