13. YELLOW ORANGE LEAF VIRUS DISEASE IN THAILAND

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Yellow Orange Leaf Virus disease (YOLV) is widely distributed in Thailand and occurs throughout the growing season. The results of surveys begun in 1966 and continued to the present to determine the extent of distribution of the disease are shown in Table 1. Losses were higher in the Central Plain than in the other parts of Thailand every year. The vector, *Nephotettix virescens* has always played an important role in the virus transmission in the paddy field. Efforts to study the nature and control of this disease began in 1964 in the former Rice Department and were continued to the present following the merger of the Agriculture and Rice Departments. This paper discusses the most recent findings from our research in Thailand.

Table 1. Rice area affected with YOLV disease, 1968–1975

Year	Area affected (ha)
1968	133,734
1969	253,882
1970	209,022
1971	163,863
1972	95,008
1973	74,746
1974	152,040
1975	146,005

Source: Extension Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

Host range

Attempts were made to inoculate YOLV on 21 different species of *Grammineae* and two species of *Cyperaceae*. None were successful except on wild rice, *Oryza rufipogon* which exhibited symptoms nearly the same as those on cultivated rice. Furthermore, the virus was successfully back inoculated from the wild rice plants to *Oryza sativa* (Wathanakul, 1967, Hino *et al.* 1974). *Echinochloa colonum, E. crus-galli, Leersia hexandra, Leptochloa chinensis,* and *L. panicea* showed dibious symptoms, but the virus could not be back-inoculated.

Oryza rufipogon, widely distributed in Thailand and commonly found alongside canals and ponds close to paddy fields (Akihama *et al.* 1970). Even in the dry season, *O.*

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rufipogon is able to survive in those irrigation cannals where water never completely disappears. This seems to serve as a reservoir of inoculum for overseasoning of YOLV. In the main rice cropping season, with the continued expansion of irrigation facilities, it is becoming of even more importance as a major infection source for YOLV.

Seasonal changes in viruliferous vector population

In the Central Plain of Thailand, the active vector of YOLV, *N. virescens* generally diminishes in the fields in the dry season and increases in paddy fields as the rainy season progresses. Viruliferous vector populations in the field were surveyed several years, and reported to be low at the beginning of the rainy season but became higher later. In the first half of the rainy season from June to August, average air temperature was 28–29°C, the vector population was high and percentage of viruliferous vector gradually increased. In the second half of the rainy season from September to November air temperature ranged from 26–29°C, the vector population remained high and percentage of viruliferous vectors was also high. In some locations it was high as 50 or more per sample. In December which is the cool season, average air temperature dropped to 20–24°C, and at the same time the percentage of viruliferous vectors suddenly decreased. In January and February, air temperature again increased to 26–30°C, and the population of vectors increased. In the dry season from March to May, average air temperature reached as high as 28–32°C, but the vector population and percentage of viruliferous insects was low.

Vicissitude of the disease

Since YOLV disease was discovered in 1964 at Bangkhen, Bangkok, the affected rice area progressively increased in the years, 1965, 1966 and 1967. The incidence continued to be severe in 1968, 1969, 1970 and 1971 and reached a peak in 1969. In 1972 and 1973 the disease again occurred severely but not as extensively as in the earlier years.

Adjust noted, YOLV disease incidence fluctuates according to year. In years of high incidence, the disease spreads rapidly in the first half of the rainy season. On the other hand, in years of low incidence, the disease increases gradually and peaks into the last part of the rainy season. High in temperatures and wide rainfall intervals in February, March and April probably exert a strong influence on the outbreak of vectors at the beginning of the rainy season and also on the amount of YOLV overseasoning on host plants.

The incidence of YOLV also varied among the locations and changed with the stage of plant growth, being highest during reproductive growth. For example, the highest incidence occurred in the Nakorn-Pratom region during flowering. In area not far from Nakorn-Pratom such as Minburi incidence was markedly lower at the same stage of growth and year.

Forecasting vector density and virus occurrence

There have been several attempts in various locations to determine a significant correlation between meteorological factors and vector density. Long term fluctuations of vector density in each locality over 10 years suggest that no single or even a combination of several meteorological factors are directly responsible for the vacillation in virus occurrence; one approach might be to study the effects of changes in rice cultivation and growing systems. For YOLV, the percentage of infective vectors in the natural population is often of primary importance in predicting virus occurrence. Lately, predictions are being modified by surveys of vector densities of the overseasoning population and continuous checks for detection of the first generation until late in the monsoon season if necessary.

Breeding for YOLV resistance

Sigadis was reported as a resistant variety to Yellow Orange Leaf Virus (YOLV) in 1964 (Wathanakul and Weerapat 1967). It was used as a resistant parent in the Thai hybridization program in 1965. The progenies with acceptable plant type from the crosses Puang Nahk 16/Sigadis made in 1965 and Gow Ruan 88/Sigadis//C4-63 made in 1967, were screened for resistant plants or lines to YOLV by artificial inoculation in the glasshouse and natural infection in experimental fields, respectively. The YOLV resistant lines with good grain quality were then evaluated for grain yield in many rice experiment stations. Consequently, the line BKN 6517-9-2-2 from Puang Nahk 16/Sigadis was released as RD5 in 1973 and the line SPR 6726-134-2-226 from Gow Ruang 88/Sigadis//C4-63 was released as RD7 in 1975. Both RD5 and RD7 were resistant to YOLV and bacterial blight. The crosses made for YOLV resistance during 1975 and 1976 are summarized in Table 2.

Table 2. Recent crosses made for selection of YOLV resistance

Cross No.[1]	Combination	Heading of progenies
BKN BR 1003	KDML 105/RD1	Bulk
BKN BR 1008	RD3/BJ 1//BKN 6809-74-4	Pedigree
BKN BR 1009	DZ 192/BKN 6517-11-1-1//BKN 6809-74-4	Pedigree
BKN BR 1010	DZ 192/BKN 6517-11-2-1//Leuang Tawng	Pedigree
BKN BR 1012	F_1(DZ 192/BKN 6517-11-2-1)//RD 3/BJ 1	Pedigree
BKN BR 1014	RD3/BJ 1//RD1 EK 1263	Pedigree
BKN BR 1017	BKN 6517-63-4-3/IR648-3-1-2-3	Pedigree
BKN BR 1024	RD1/BKN 6517-63-4-3	Bulk
BKN BR 1030	BKN 6625-109-1/BKN 6809-74-40	Pedigree
BKN BR 1031	BKN 6517-63-4-3/BKN 6809-74-40	Pedigree
BKN BR 1032	BKN 6517-63-4-3/CR 52-3	Pedigree
BKN BR 1049	BKN 6625-109-1/BKN 6809-74-4//BKN 6517-63-4-3	Bulk
BKN BR 1054	LMN NSR 6517-27	Bulk
BKN BR 1055	KNN 11/NSR 6517-27	Bulk
BKN BR 1059	CNT 200-1/KDML 105	Pedigree
BKN BR 1061	IR22/PN16/Pankhari 203	Bulk
BKN BR 1066	LMN/NSR 6517-27//C4-63	Bulk
BKN BR 1071	GP/BKN 6809-74-40//BKN 6517-11-2-1/BKN 6806-46-62	Bulk
BKN BR 1073	Pankhari 203/RD1	Bulk
BKN BR 1074	RD1/Pankhari 203	Bulk
BKN BR 1075	IR8/Pankhari 203	Bulk
BKN BR 1076	T(N)1/Pankhari 203	Bulk
BKN BR 1077	Pankhari 203/T(N)1	Bulk
BKN BR 1078	BR 1030/Pankhari 203	Bulk
BKN BR 1079	BR 1017/RD1	Bulk
BKN BR 1080	BR 1017/T(N)1	Bulk
BKN BR 1084	30310/RD1	Pedigree
BKN BR 1086	E-Nawm/RD5	Pedigree

Cross No.	Combination	Heading of progenies
BKN BR 1087	Hawm/RD5	Pedigree
BKN BR 1088	30435/RD1	Pedigree
BKN BR 1089	Hawm/30502	Pedigree
BKN BR 1090	Jao Ngah 2/29954	Bulk
BKN BR 1091	30359/RD1	Pedigree
BKN BR 1092	30502/RD1	Pedigree
BKN BR 1093	Niaw Hawm 2/30359	Pedigree
BKN BR 1094	30055/BKN 6805-2-17	Pedigree
BKN BR 1095	30055/RD1	Pedigree
BKN BR 1098	Niaw Hawm 2/30055	Pedigree
BKN BR 1101	Jao Ngah 2/30055	Pedigree
BKN BR 1103	BKN 6625-109-1/Iraton//IR26	Bulk
BKN BR 1104	IR 1529-680-3/Khao'Rai	Pedigree
BKN BR 1105	IR 1529-680-3/BKN 6809-74-40	Pedigree
BKN BR 1106	IR 1545-284-3-1/BKN 6809-74-40	Pedigree
BKN BR 1107	IR 1529-680-3/Khao Ban Don	Pedigree
BKN BR 1109	BJ 1 Dwarf/IR 1529-680-3	Pedigree
BKN BR 1117	Sahm Deuan 3/IR 3265 P 195-6-3	Pedigree
BKN BR 1122	46725/RD5	Pedigree
BKN BR 1124	46725/NPY 132	Pedigree
BKN BR 1127	46725/RD1	Pedigree
BKN BR 1160	IR 1917-3-10-3/IR 24	Pedigree
BKN BR 1163	IR 2008-P43-11-3/IR24	Pedigree
BKN BR 1167	IR 2034-238-1-2-3/IR30	Pedigree
BKN BR 1168	IR 2034-238-1-2-3/IR26	Pedigree
BKN BR 1169	IR 2034-238-1-2-3/IR28	Pedigree
BKN BR 1171	IR 2035-290-2-1-1/IR24	Pedigree
BKN BR 1172	IR 2058-78-1-3-3-3/IR 7529	Pedigree
BKN BR 1173	IR 2058-78-1-3-3-3/IR 7444	Pedigree
BKN BR 1174	IR 2058-78-1-3-3-3/IR 2793-138-2	Pedigree
BKN BR 1175	IR 2058-78-1-3-3-3/IR 1544-181-1-1	Pedigree
BKN BR 1176	IR 2058-78-1-3-3-3/IR 1416-131 S	Pedigree
BKN BR 1178	IR 2071-251-1-1-3/IR 5533	Pedigree
BKN BR 1181	IR 2071-135-3-3/IR 24	Pedigree
BKN BR 1183	IR 2071-135-3-3/IR 30	Pedigree

[1] BKN=Bangkhen Rice Experiment Station
BR =Breeding for resistant to disease and insects

The rice plants in the fields of the Central Plain of Thailand were severely infected by YOLV in the wet season during 1966 to 1968. Many lines from the cross Leuang Tawng/IR8 when subjected to natural infection exhibited a high degree of YOLV resistance. From these, a resistant line was released as RD1 in 1969. However, recently workers have observed numerous plants of RD1 showing severe infection by YOLV. Studies conducted by Sutabutra *et al.* (1976) using the electron microscope show a different morphological structure to the virus particle than the those commonly found infected with YOLV. This suggests that the YOLV reaction RD1 has changed due to a new virus (Sutabutra, *et al.* 1976).

Chemical control of vectors

The application of insecticides, such as carbaryl and MIPC form of dust, emulsion or granules during the main transmission periods has been reported to be effective in controlling YOLV vectors. The effectiveness of these chemicals varies, however, according to the condition of the paddy field density of the vector and dispersal of vectors. To be effective, application covering a large area is recommended to control the YOLV vectors since they have a certain degree of mobility and not all of the "hot spots" can be easily identified by survey. The question of economics must also be brought into any such venture since price of paddy and production potential can become major considerations in any large scale operation.

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Discussion

W. P. Ting, Malaysia: In your opinion, do you feel that RD1 is still resistant to YOLV?

Answer: Yes, we still recommend it to farmers as resistant variety to YOLV.

I. N. Oka, Indonesia: What about the problem of grassy stunt virus of rice in your country?

Answer: The incidence of grassy stunt was observed in 1974, and occurrence of the disease is much severer on short-culmed varieties, such as RD1 and RD3.

N. Yamada, Japan: You reported that RD1, a resistant variety to YOLV, has became susceptible to YOLV probably due to the change in virus itself. You may have many varieties which are resistant, moderately resistant and susceptible to YOLV. What happened to the varietal spectrum in resistance?

Answer: Many susceptible commercial varieties seemed to be resistant in earlier years.