SEASONAL CHANGES OF INCIDENCE OF RICE VIRUSES AND THEIR INSECT VECTORS IN THAILAND

Tadashi MORINAKA[1], Masaichi TSURUMACHI[2], Methie PUTTA[3], Dara CHETTANACHIT[3], Tawat PATIRUPANUSARA[3], Amara PAREJAREARN[3], and Somkid DISTHAPORN[3]

Abstract

Seasonal changes of incidence of rice viruses (RRSV, RGSV, RGDV, and RTV) and their insect vectors (*Nilaparvata lugens, Nephotettix virescens, N. nigropictus,* and *Recilia dorsalis*) in the field of central Thailand were observed from July, 1979 to December, 1980. In case of RRSV which caused severe damage to the rainy season rice cultivation in some areas of the Central Plain in 1980, the increased incidence of RRSV was closely correlated with a higher percentage of viruliferous insect vectors. From the results obtained, it was deemed possible to forecast the incidence of RRSV on a short term basis by continuous observation of the population and testing the viruliferous percentage of the insect vector.

1. Introduction

There are two seasons in Thailand, that is, the rainy season (May to October) and the dry season (November to April). In the dry season, cool period (December to Janury) and hot period (March to April) are included. Leafhoppers and planthoppers, vectors of rice viruses, can grow in all the seasons in the tropics, if feeding plants are available, even though there are seasonal changes in the temperature, precipitation, and humidity. In the temperate zone, such as in Japan, the incidence of the insects is naturally regulated by the temperature in the different seasons, whereas temperature does not affect appreciably insect growth in the tropics. Therefore, the pattern of incidence of rice viruses and insect vectors in the tropics is different from that in the temperate zone.

The relationship between the incidence of rice viruses and bionomics of insect vectors in Southeast Asia has been reported in the case of rice yellow orange leaf or tungro by Hino *et al.* (1974), Inoue and Ruay-Aree (1977), and Ling and Tiongco (1980), in the case of rice transitory yellowing by Chen *et al.* (1980), and in rice ragged stunt by Morinaka *et al.* (1982). However, the results, for each rice virus do not enable to forecast the incidence of the disease.

The present report describes the seasonal changes of incidence of rice virus diseases and their insect vectors in Thailand.

2. Materials and methods

Field observations of rice virus diseases and insect vectors were carried out at Bangkhen Rice Experiment Station in Bangkok and at Chainat Rice Experiment

1) Tropical Agriculture Research Center, Yatabe, Tsukuba, Ibaraki 305, Japan.
2) Okinawa Branch, Tropical Agriculture Research Center, Maesato, Ishigaki, Okinawa 907-01, Japan.
3) Department of Agriculture, Bangkhen, Bangkok 10900, Thailand.

Station in the northern part of the Central Plain of Thailand. Rice variety Taichung Native 1 (TN1) was used in Bangkhen and RD7 and RD9 were used in Chainat. The varieties used were sown in the nursery beds every month and about 25 days after sowing the seedlings were transplanted in the field. The field tests were designed with 3 replications and 320 plants were grown at a spacing of 25 cm in each replication. Continuous rice cultivation was conducted during the period from June, 1979 to December, 1980. Before transplanting, the number of leafhoppers and planthoppers in the nursery beds were counted by insect net sweeps and the transmission ability of the rice viruses was examined. The rice virus diseases and insect vectors were as follows: rice ragged stunt virus (RRSV), rice gall dwarf virus (RGDV), rice grassy stunt virus (RGSV), rice tungro viruses (RTV, rice yellow orange leaf virus, RYOLV, in Thailand), *Nilaparvata lugens, Nephottetix virescens, Nephotettix nigropictus,* and *Recilia dorsalis.* Observations were made once a week in Bangkhen and once a month in Chainat.

N. lugens was collected by a light trap in the field of Bangkhen and its RRSV transmission ability was examined by individual inoculation using seedlings of TN1.

Results

1) Seasonal changes of incidence of rice virus disease

Observation results are shown in Figures 1 and 2. According to the results, RRSV

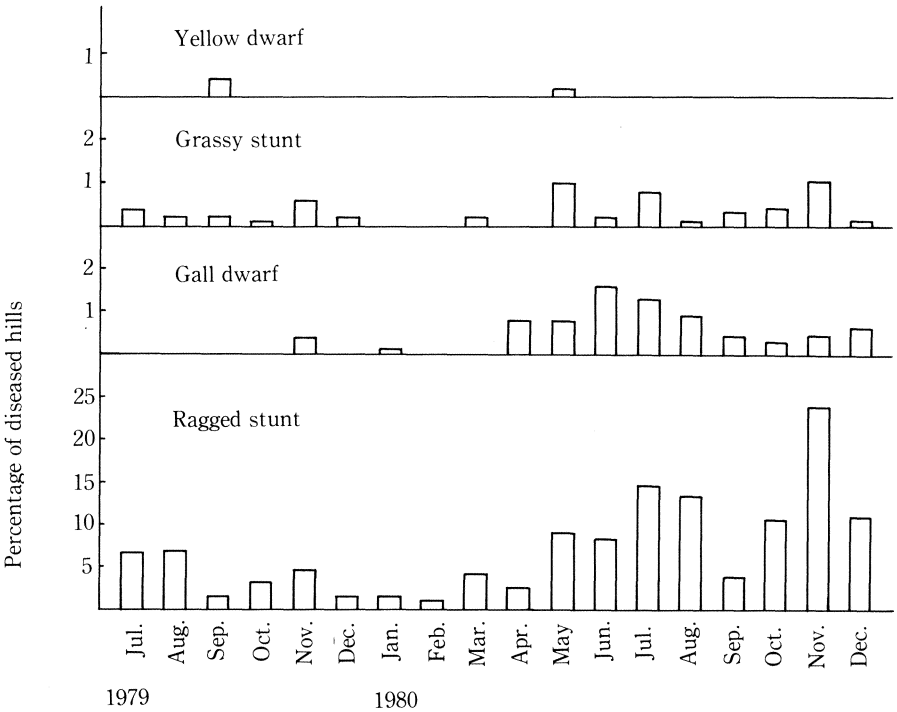

Fig. 1. Seasonal changes in the incidence of rice virus disease in the field of Bangkhen Rice Experiment Station

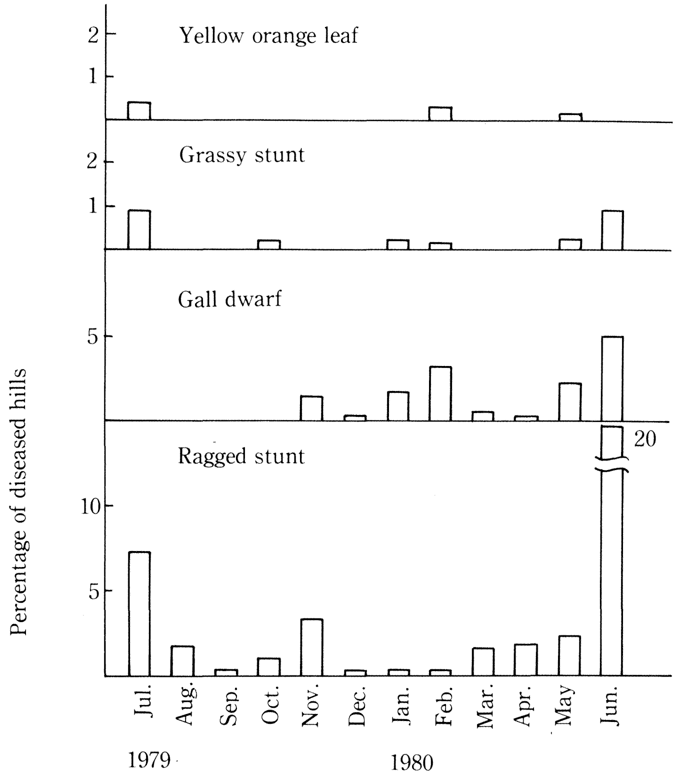

Fig. 2. Seasonal changes of incidence of rice virus diseases in the field of Chainat Rice Experiment Station

was observed almost all the year round both in Bangkhen and in Chainat. The increased incidence of RRSV was observed from the plot transplanted in May, 1980.

RGDV was observed in the plot transplanted in November, 1979, and thereafter the incidence has been detected every month. The percentage of the diseased hills was not very high, but it was higher than that of grassy stunt and tungro disease. Percentage of rice hills affected by grassy stunt was low for each variety tested, but the disease occurred almost throughout the year. Rice yellow dwarf disease occurred occasionally in Bangkhen and Chainat. Low incidence of rice tungro was detected in Chainat, but there was no incidence in Bangkhen. The observations in Chainat in the plot transplanted from July, 1980, were interrupted by flooding and all the rice plants died.

2) Seasonal changes of incidence of insect vectors of rice viruses

The number of leafhoppers and planthoppers collected from the nursery beds in Bangkhen and Chainat are shown in Figures 3 and 4, respectively, and the transmission ability of rice viruses by the insect vectors is shown in Tables 1 and 2.

According to Figure 3, the populations of *N. lugens* and *N. virescens* were higher than those of *N. nigropictus* and *R. dorsalis* in some periods in Bangkhen and the population fluctuated by season. Population of *N. nigropictus* was generally low and it increased at the end of the rainy season and decreased in the dry season. The population of *N. dorsalis* showed considerable fluctuations year by year. As shown in Figure 4, the population of each species greatly fluctuated in the Chainat field. Each species of insects showed a high population in almost the same season, and as a whole, the population of insects was high in Chainat as compared with that in Bangkhen.

In Table 1, large numbers of *N. lugens* and *N. virescens* were observed and RRSV infective *N. lugens* were detected throughout the year with relatively high viruliferous percentages, but no tungro infective individuals were detected in *N. virescens*. Infective individuals of RGDV were found both in *N. nigropictus* and in *R. dorsalis*, and the percentage of infective *R. dorsalis* was higher than that of *N. nigropictus* in Bangkhen.

As shown in Table 2, RRSV infective *N. lugens* and RGDV infective *N. nigropictus* and *R. dorsalis* were also detected in Chainat, and *R. dorsalis* showed a higher percentage in RGDV infectivity.

Table 1. Transmission ability of rice viruses by insect vectors collected in the field of Bangkhen Rice Experiment Station

Month of collection	*N. lugens* (RRSV)	*N. virescens* (RTV)	*N. nigropictus* (RGDV)	*R. dorsalis* (RGDV)
August, 1979	3/50 (6)	0/115	—	—
September	5/139 (4)	0/111	0/14	—
October	2/90 (2)	0/174	0/33	—
November	3/121 (2)	0/136	0/25	—
December	0/54	0/83	0/31	0/34
January, 1980	1/37 (3)	0/82	1/26 (4)	1/75 (1)
February	0/ 4	0/13	0/7	0/56
March	2/189 (1)	0/ 1	0/3	0/28
April	1/170 (1)	0/10	0/8	1/56 (2)
May	2/50 (4)	5/56	0/7	0/54
June	3/67 (4)	0/29	0/1	1/110 (1)
July	0/33	0/55	0/9	0/24
August	2/37 (5)	0/12	—	1/22 (5)
September	0/34	0/ 5	0/4	2/42 (5)
October	5/82 (6)	0/55	0/9	0/9
November	12/72 (16)	0/23	0/10	0/7
December	8/75 (10)	0/31	0/11	1/46 (2)
Total	49/1,304	0/991	1/198	7/563
	(3.7)	(0)	(0.5)	(1.2)

RRSV: rice ragged stunt virus
RTV: rice tungro viruses
RGDV: rice gall dwarf virus
Numbers: number of insects which transmitted/number of insects tested
Numbers in parenthesis: percentage of insects which transmitted

Table 2. Transmission ability of rice viruses by insect vectors collected in the field of Chainat Rice Experiment Station

Date of collection	*N. lugens* (RRSV)	*N. virescens* (RTV)	*N. nigropictus* (RGDV)	*R. dorsalis* (RGDV)
August 8, 1979	0/15	0/6	—	—
September 10	0/4	0/4	0/12	—
October 9	0/17	0/12	—	—
November 12	0/4	0/89	1/28	—
December 13	1/7	1/50	0/90	—
January 9, 1980	0/2	0/22	0/12	0/15
February 12	0/1	0/1	—	3/34
March 11	1/21	—	—	0/10
April 8	0/2	—	—	0/3
May 12	0/1	0/13	—	0/4
June 4	0/23	0/5	—	0/10
July 8	1/11	—	0/6	—
August 4	2/6	0/18	1/14	1/29
September	0/1	0/27	0/40	0/9
Total	5/115	0/247	2/202	4/114
%	4.3	0	1.0	3.5

RRSV: rice ragged stunt virus
RTV: rice tungro viruses
RGDV: rice gall dwarf virus
Numbers: number of insects which transmitted/number of insects tested

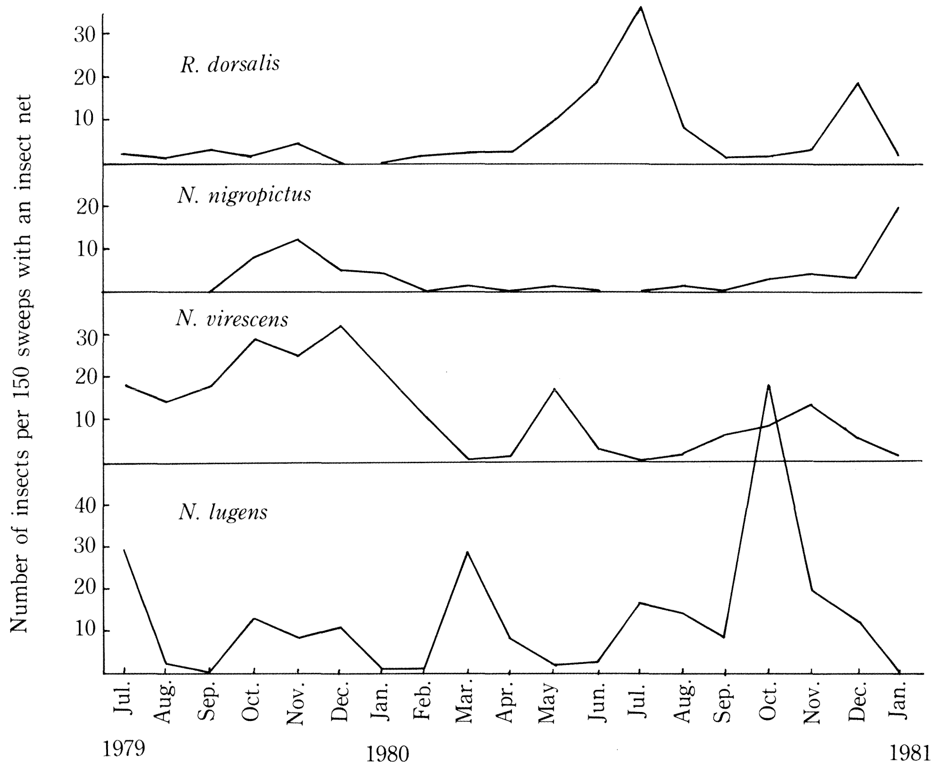

Fig. 3. Seasonal changes of insect vector population in the field of Bangkhen Rice Experiment Station

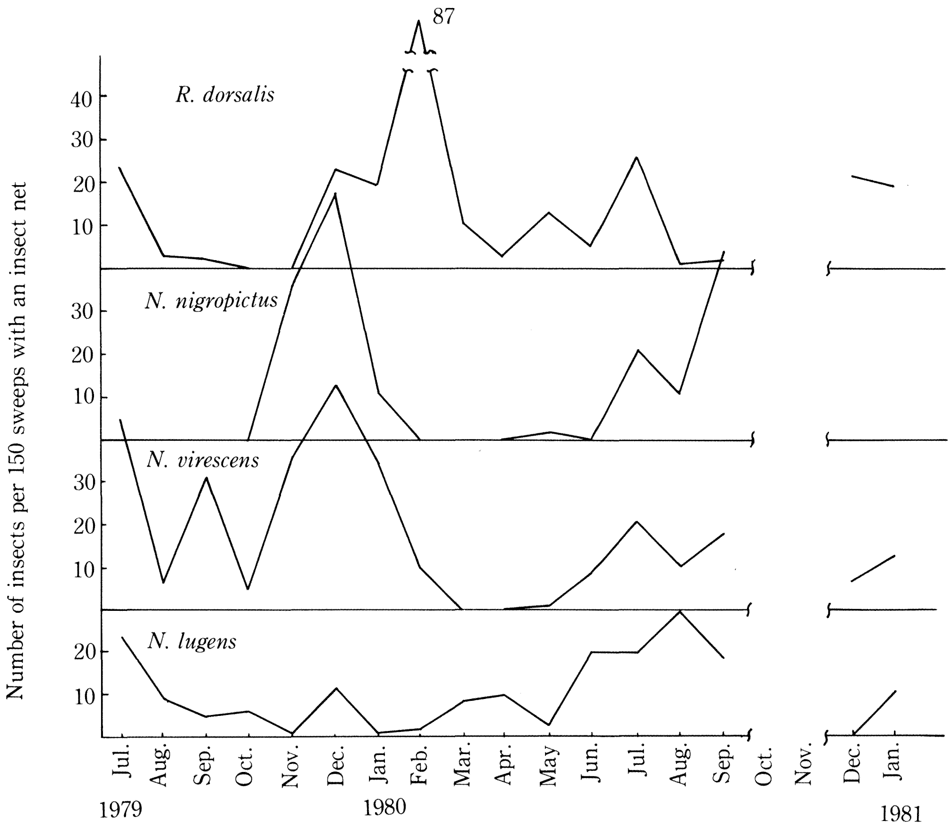

Fig. 4. Seasonal changes of insect vector population in the field of Chainat Rice Experiment Station

3) Seasonal changes of RRSV transmission ability in N. lugens collected by a light trap

Table 3 shows the results of transmission ability of RRSV by *N. lugens* collected with a light trap during the period from October, 1979 to December, 1980 in the field of Bangkhen. *N. lugens* was collected all the year round and especially large numbers flew into the light trap in November, 1979. The RRSV viruliferous insects were found throughout almost all the period tested and the percentage of viruliferous individuals increased after May, 1980.

Table 3. Rice ragged stunt virus transmission ability of *N. lugens* collected by a light trap in the field of Bangkhen Rice Experiment Station

Month of collection	Number of insects which transmitted/tested	Percentage of insects that transmitted
October, 1979	0/84	0
November	28/1,306	2.1
December	4/261	1.5
January, 1980	2/248	0.8
February	1/102	1.0
March	1/189	0.5
April	—	—
May	9/121	7.4
June	16/395	4.1
July	8/169	4.7
August	11/127	8.7
September	28/231	12.0
October	4/135	2.7
November.	29/208	13.9
December	30/392	7.7

4. Discussion

Based on the results of field tests conducted from June, 1979 to December, 1980, RRSV, RGDV, RGSV, and rice yellow dwarf disease (RYD) were observed in Bangkhen, and RRSV, RGDV, RGSV, RTV (RYOLV in Thailand) and RYD were observed in Chainat. Especially, RRSV incidence was observed throughout the year and the percentage of the diseased hills was high as compared with other rice virus diseases. Since the discovery of RRSV in Thailand in 1979, the acreage of the affected areas has increased and RRSV has become one of the most important diseases of rice in Thailand. The results from field tests support this assumption.

As for the population density of the insect vectors, the decreasing order of population levels in Bangkhen was as follows: *N. lugens, N. virescens, R. dorsalis,* and *N. nigropictus,* whereas in the Chainat field *N. virescens, R. dorsalis, N. lugens,* and *N.*

nigropictus. RTV was not detected in Bankhen and only a few plants with RTV were observed in Chainat during the period when the tests were conducted. There is a possibility that RTV may occur due to the large number of *N. virescens* individuals distributed in the field.

RGDV was a new virus disease found in Uthai Thani in August, 1979, and the disease was also observed in Bangkhen and Chainat. The vectors of RGDV were *R. dorsalis* and *N. nigropictus,* and *N. virescens. R. dorsalis* was present in the field of Bangkhen and Chainat all the year round, whereas *N. nigropictus* was not present in all the seasons. The percentage of RGDV transmitting individuals of *R. dorsalis* was higher than that of *N. nigropictus.* These data suggest that the major vector of RGDV might be *R. dorsalis.* It is known that the transmission ability of RGDV by *N. virescens* is very low. No RGDV viruliferous *N. virescens* were detected in this test, and the importance of *N. virescens* as a RGDV vector was not clarified.

Figure 5 shows the seasonal changes of percentage of RRSV hills in the field, the population of *N. lugens* in the nursery beds, and the percentages of RRSV transmitting *N. lugens.* From the figure, a correlation between these parameters is easily recognized. The percentage of viruliferous *N. lugens* collected with a light trap became remarkably higher after May, 1980. RRSV incidence in the field also increased in the plots transplanted after May, 1980. The increased incidence of RRSV was closely

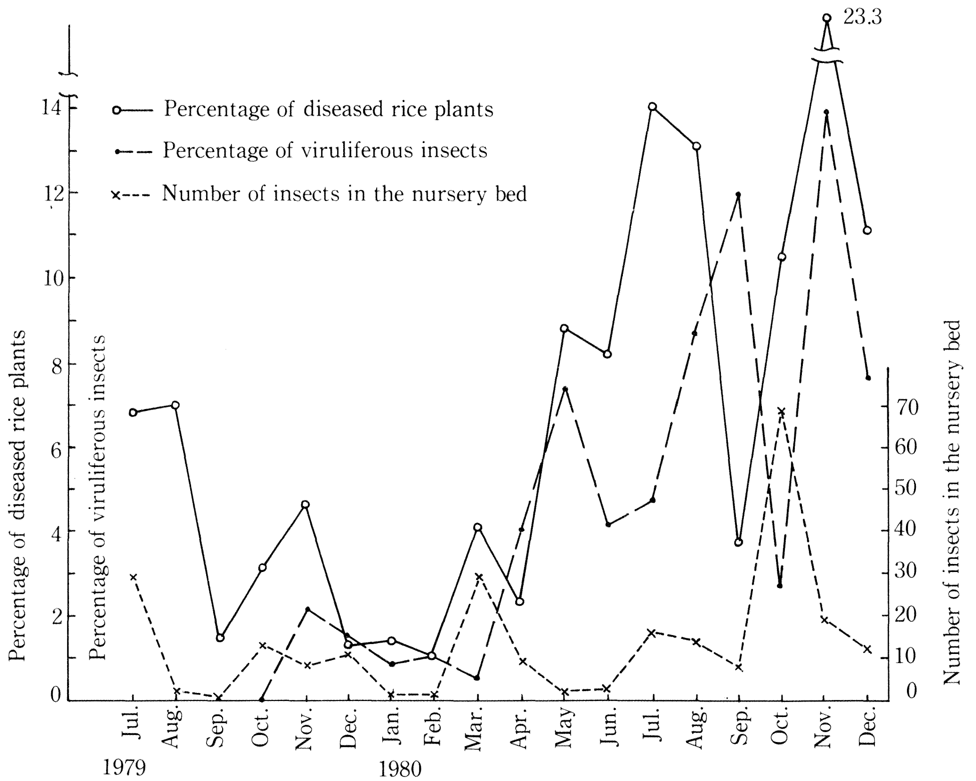

Fig. 5. Seasonal changes of incidence of rice ragged stunt virus and brown planthopper in the field of Bangkhen Rice Experiment Station

correlated with a higher percentage of viruliferous insect vectors. In this connection, a severe incidence of RRSV in some areas of the Central Plain of Thailand was observed in the rainy season rice cultivation in 1980. From the results obtained in this study, it is deemed possible to forecast the incidence of RRSV on a short-term basis by continuous observation of the population and testing of the viruliferous percentage of the insect vectors.

Literature cited

1. Ching-chung Chen, Wen-Hua Ko, E-Sa Wang, Su-Mei Yu, and Der-Gey Hu (1980). Epidemiological studies on the rice transitory yellowing with special reference to its transmission by the rice green leafhoppers. Bull. Taichung District Agricul. Improv. Sta. New Series No. 4: 1-61. (Chinese with English summary)
2. Hino, T., L. Wathanakol, N. Nabheerong, P. Surin, U. Chaimonkol, S. Disthaporn, M. Putta, D. Kerdchokchai, and A. Surin (1974). Studies on rice yellow orange leaf virus disease in Thailand. Technical Bulletin TARC No.7:1-67.
3. Inoue, H. and S. Ruay-Aree (1977). Binomics of green rice leafhopper and epidemics of yellow orange leaf virus disease in Thailand. Tropical Agr. Res. Ser. 10: 117-121.
4. Ling, K. C. and E. R. Tiongco (1980). Rice virus diseases in the Philippines. Developments in pest management in the Philippines: 27-72.
5. Morinaka, T., M. Tsurumachi, M. Putta, D. Chettanachit, T. Patirupanusara, A. Parejarearn, S. Disthaporn (1982). Relation between incidence of rice virus diseases and their insect vectors. Ann. Phytopath. Soc. Japan 48:389 (abstract, in Japanese)