Common Leafhopper-Planthopper Populations and Incidence of Tungro Virus in Diazinon-Treated and Untreated Rice Plots

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ABSTRACT

Field experiments during 2 consecutive rice crops showed the relative abundance of common rice leafhopper and planthopper species as Nephotettix spp. > Sogatella furcifera (Horvath) > Nilaparvata lugens (Stål) > Inacumosa dorsalis (Motschulsky). The Nephotettix spp. and S. furcifera were more abundant during the early stages of plant growth, while I. dorsalis and N. lugens tended to be more numerous toward crop maturity.

Several species of leafhoppers and planthoppers cause serious damage to rice. The feeding of large infestations of these pests cause a complete drying of the crop, commonly termed “hopper-burn,” while an infestation by smaller numbers reduces tilling, plant height, and general crop vigor and induces unfilled grains (Bae and Pathak 1968'). The economic importance of these pests has exacerbated greatly in recent years when they have been recorded as vectors of virus diseases of rice plants.

The literature on bionomics, distribution, ecology of leafhopper and planthopper rice pests has been reviewed recently (Pathak 1968). In tropical Asia, the commonest leafhopper species are the rice green leafhoppers, Nephotettix impicticeps (Ishihara) and N. apicalis (Motschulsky), and the zigzag leafhopper, Inacumosa dorsalis (Motschulsky). The commonest planthoppers are the brown planthopper, Nilaparvata lugens (Stål), and the white back planthopper, Sogatella furcifera (Horvath). N. impicticeps, N. lugens, and I. dorsalis, respectively, are vectors of the tungro virus, grassy stunt, and orange leaf virus diseases of rice.

This paper describes population fluctuations of these species and virus incidence in insecticide-treated and untreated rice fields.

MATERIALS AND METHODS.—The experiments were conducted on 2 consecutive rice crops, the 1st planted in October and harvested in January and the 2nd planted in February and harvested in May. The test plots were planted with 25-day-old seedlings of the rice selection IR9-60 at 20 x 20 cm spacing using 2-3 plots were alternately infested diseased and healthy plants appeared to be main factors in the spread of this virus.

All diazinon-treated plots had significantly lower leafhopper and planthopper populations and low tungro virus infection in comparison with untreated plots. This virus disease is transmitted by Nephotettix impicticeps (Ishihara) and is nonpersistent in the vector. The proximity of virus-infected plants and the insect’s ability to alternately infest diseased and healthy plants appeared to be main factors in the spread of this virus.

The populations of all leafhopper and planthopper species were higher during the dry-season than the wet-season experiments. The average meteorological data during these 2 experiments ranged as follows:
Thus, lower rainfall and relative humidity and longer hours of sunshine were recorded during the dry-season than during the wet-season experiment, but in both seasons variations in temperatures were not pronounced. The conditions recorded during the dry season have usually been associated with the rapid buildup of leafhopper and planthopper populations. Hinkley (1963) reported that populations of S. furcifera on young plants and N. lugens on older rice plants increased considerably following brief dry periods. In Japan, Harukawa (1951) recorded an increased Nephotettix spp. population under field conditions during low rainfall, high temperature, and longer periods of sunshine. Suenaga (1963) recorded a positive correlation (0.93) between Nephotettix spp. population and amount of sunshine, but a negative correlation between this population and the average relative humidity (−0.67).

During the wet-season experiment when the 1st diazinon treatment was made 10 days after transplanting, a marked reduction in the leafhopper-planthopper population was recorded 10 days later in treated plots over the untreated controls. After another 10 days the populations in the treated plots, although showing some increase over the previous observations, were still lower than those in the untreated controls (Fig. 1). Since these observations indicated a reduction in insecticidal activity, another diazinon treatment was made at this stage. This treatment reduced the populations of all leafhopper and planthopper species. Thirty-five days after this application the treated plots contained an average of 3 Nephotettix spp., 3 N. lugens, 1 S. furcifera, and no I. dorsalis/100 sweeps in contrast to 24 Nephotettix spp., 9 N. lugens, 4 S. furcifera, and 2 I. dorsalis in the untreated plots (Fig. 1). Another diazinon application made following these observations kept the leafhopper and planthopper populations at low levels until harvest.

During the dry-season experiment, only 2 applications of diazinon were made (10 days and 30 days after transplanting). These treatments kept the

![Graph showing leafhopper and planthopper populations](image-url)

Fig. 1.—Common leafhopper and planthopper populations in control (C) and diazinon-treated (T), rice fields, IRRI, 1965–66.
leafhopper and planthopper populations consistently lower in the treated plots than in the untreated controls. While the populations of various species increased greatly in the untreated plots, they remained consistently low in treated plots until harvest at 60 days after the 2nd insecticidal application. However, the S. furcifera population, which was more abundant in this experiment than in the wet-season experiment, was comparatively less affected by diazinon treatments. Although *Nephotettix* spp. populations in treated plots were somewhat higher than those of other species, they were approximately 13 times lower than in the untreated control plots (Fig. 1) 60 days after the treatment. This long period of protection under field conditions is significant, since in greenhouse experiments the residual effectiveness of diazinon has been found to be only 20 days (Intern. Rice Res. Inst. 1966). This longevity might be explained partly by the fact that diazinon produced no apparent adverse effects on spiders which are field predators of leafhoppers and planthoppers. Frequently more spiders were observed in diazinon-treated plots than in plots treated with lindane or other insecticides. The application of diazinon granules to paddy water at the rate of 2 kg AI/ha significantly reduced the leafhopper-planthopper populations and prevented the spread of virus infection.

**Tungro Virus Incidence.**—As mentioned earlier, the experiments were conducted in each season in 2 separate fields (designated A and B) situated about 200 m apart. The virus incidence in these fields differed considerably and therefore the data from each are discussed separately. At 20 days after transplanting in the wet-season experiment, the virus incidence in treated and untreated control plots, respectively, was 2.5 and 2.7% in field A and 0.7 and 0.9% in field B. In subsequent observations the untreated plots of field A recorded a sharp increase in virus incidence, but no such increase was observed in field B (Table 1). Since the seedlings used in fields A and B were from the same seed bed, in all probability most of the infection occurred after transplanting. This assumption indicates that there were more vectors in field A than in field B. This difference could have been due to the facts that field A was situated in the vicinity of other experiments which were not treated with insecticides and consequently had higher virus incidence than the area surrounding field B which received regular insecticidal treatments.

Although the *Nephotettix* spp. population was higher in the dry-season than in the wet-season experiment, the initial virus infection, as well as its subsequent spread to other hills, was lower during the dry season. This phenomenon does not appear to be due to the effect of seasonal differences on virus incidence, since in other experiments high virus incidence has been recorded during almost all months of the year (Pathak et al. 1966; Intern. Rice Res. Inst. 1965, 1966). Apparently, the absence of virus-infected plants in the adjacent fields was the most important factor in low-virus incidence in the dry-season experiments since the tungro virus is nonpersistent in its vectors, which remain viruliferous for a maximum period of 5 days after becoming infective (Ling 1966). Therefore, to be vectors the leafhoppers must repeatedly feed on diseased plants. The shortest acquisition feeding period for the vector is 30 min, and the insect needs a minimum of 7 min as the inoculation period (Ling 1968). However, in these insects details of feeding behavior and migration from plant to plant are not known. Leafhoppers have been observed to feed from 1 min to more than 1 hr at 1 site.

All plots treated with diazinon had lower virus infection than the untreated controls. The magnitude of this difference was evident in field A where, during the wet season, untreated control plots had 94.3% virus infection in contrast to 7.9% infection in treated plots. This spread of virus in untreated control plots can be attributed to higher leafhopper populations in the control plots than in the treated plots (Fig. 2). Also, since the tungro virus is nonpersistent in its vector, it is important that the insects feed repeatedly on diseased plants to remain viruliferous. Thus, in treated plots the leafhoppers were exposed to diazinon toxicity twice; first while feeding on diseased plants to acquire the virus, and second while feeding on healthy plants to transmit it. In this process, some insects die off while feeding on diseased plants, while many others die on healthy plants. Although the vectors may infect a few plants, further spread of virus in treated plots is greatly reduced because of high insect mortality.

Apparently a certain level of virus incidence in a field is also important for any significant spread of the infection in the plots within the field. This conclusion is suggested by the fact that the virus infection in field B during the wet season and fields A and B during dry season was less than 0.9% and did not increase to a significant level in spite of a high vector population. The application of diazinon granules to paddy water at the rate of 2 kg AI/ha significantly reduced the leafhopper-planthopper populations and prevented the spread of virus infection.

![Table 1. Incidence of tungro virus in untreated control plots and those treated with diazinon at the rate of 2 kg AI/ha. IRRI 1965 and 1966.](image)

<table>
<thead>
<tr>
<th>Field</th>
<th>Treatment</th>
<th>Wet-season crop (1965)</th>
<th>Dry-season crop (1966)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>A</td>
<td>Control</td>
<td>2.7</td>
<td>4.7</td>
</tr>
<tr>
<td>A</td>
<td>Diazinon treated</td>
<td>2.5</td>
<td>3.2</td>
</tr>
<tr>
<td>B</td>
<td>Control</td>
<td>0.9</td>
<td>1.5</td>
</tr>
<tr>
<td>B</td>
<td>Diazinon treated</td>
<td>0.7</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* Each value represents an average of 2 replications of 11.4 X 21.4 = m plots. The fields A and B were about 200 m apart.
* See Fig. 1 for the timing of insecticidal treatments.
The reservoir of tungro virus may be reduced also by keeping fields adjacent to newly planted areas free from virus-infected plants and by systematic roguing of diseased plants in the rice fields.

REFERENCES CITED