BENEFICIAL EFFECTS OF WHITE LEAF INFECTED PLANTS ON THE LEAFHOPPER, MATSUMuratettix hiroglyphicus MATSUMURA

Chen, Chu-Te; Lee, Ching-Shiou and Lee, Sin-Min
Taiwan Sugar Research Institute, Tainan, Taiwan, Republic of China

ABSTRACT
Effects of healthy and white leaf infected plants of sugarcane and Bermuda grass, Cynodon dactylon Pers., on the development of Matsumuratettix hiroglyphicus Matsumura, a vector of sugarcane white leaf disease, were studied.

The leafhoppers were able to survive and complete their life cycle on infected Bermuda grass, while those which were fed on the healthy grass died within a week. Leafhoppers which were fed for 5 weeks on white leaf infected sugarcane survived on healthy Bermuda grass significantly longer than those originally fed on healthy sugarcane plants and infected grass. These results indicate the beneficial effects of infected plants on the development of M. hiroglyphicus.

INTRODUCTION
Several species of graminaceous plants showing white leaf symptoms have been found in the field. They include Cynodon dactylon Pers, Brachiaria distachya (L) A. Camus, Dactylolentum aegytiacum Richt, Chloris bartata Sw, and Sporobolus fertilis (Steud) W. D. Clayton. Electron microscopical study revealed the presence of mycoplasma-like organisms in the sieve tube elements of the diseased leaves of the first 2 grasses, and there seemed to be no differences in the morphology of the mycoplasma-like organisms in the diseased grasses and sugarcane. Consequently a study on the relationship between the white leaf disease of grasses and of sugarcane has become one of the main projects of our research.

Yang and Pan reported that the host plants of Matsumuratettix hiroglyphicus Matsumura, the vector of sugarcane white leaf disease, were limited to sugarcane and wild cane, Saccharum spontaneum L., though 3 wild plants: C. dactylon, Cyperus rotundus L. and Euphorbia hirta L. also allowed temporary survival of the 4th and 5th instar nymphs. When the white leaf infected Bermuda grass C. dactylon and B. distachya were used as the sole food plant, the leafhopper could survive longer and develop better than on healthy plants.

The life history of M. hiroglyphicus on the healthy and diseased sugarcane and Bermuda grass was further investigated in order to determine the effects of diseased plants on the development of the vector.

MATERIALS AND METHODS
Healthy and diseased plants of sugarcane, variety F 160, and Bermuda grass planted in 15 x 20 cm pots were used as the test plants. Young plants of sugarcane were grown by planting one-bud cuttings collected from healthy and naturally infected stools. Bermuda grass collected from the field was directly
transplanted into pots. *M. hiroglyphicus* successively propagated on healthy young plants of F 160 since 1970 were used as the stock colony. The method of rearing was described in a previous report. Experiments were conducted in two ways. In one experiment, a group of 50 first instar nymphs was caged on test plants which were renewed every 4 days. From the 12th day, emergence of adults was recorded every day. Adults which emerged on the same day were paired, and each couple was kept on the host plant which was renewed every 7 days. River sand spread on the surface of pot was collected and sifted through a 48-mesh sieve every week, to count the eggs deposited by the females. Some of the eggs produced in the 3rd week were measured and used for a hatching experiment. Fifty eggs were placed in a petri dish with moist sand 3 mm deep in the bottom, and hatching was observed every day.

In another experiment, 3 groups of 500 first instar nymphs were reared on healthy and infected sugarcane as well as on Bermuda grass with white leaf symptoms. Five weeks later (the general incubation period of the agent of sugarcane white leaf in *M. hiroglyphicus*), about 120 adult insects were obtained from the different plant hosts. Thirty adults randomly collected from each group were transferred to healthy Bermuda grass and mortality among them was recorded each day.

All experiments were conducted in the laboratory at 25-28°C.

**RESULTS**

A total of 200 nymphs in 4 replicates died within 1 week when they were fed on healthy Bermuda grass. The leafhopper was able to develop on the diseased grass, though the growth of nymphs was still to some extent retarded when compared with that of nymphs on healthy or diseased sugarcane plants. As shown in Table 1, 71.5 to 78.5% adult emergence was obtained by feeding the nymphs on healthy and diseased sugarcane plants, while only 46.5% of the individuals fed on diseased Bermuda grass survived to the adult stage. The average length of the nymphal stage on the diseased grass was significantly longer than that on sugarcane plants. (Table 1).

**Table 1. Development of *Matsumuratettix hiroglyphicus* on healthy and diseased sugarcane and Bermuda grass.**

<table>
<thead>
<tr>
<th>Host plant</th>
<th>Nymphal stage (days)*</th>
<th>% Adult emergence*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
</tr>
<tr>
<td>Healthy cane</td>
<td>17.4 a</td>
<td>18.0 a</td>
</tr>
<tr>
<td>Diseased cane</td>
<td>17.2 a</td>
<td>18.4 a</td>
</tr>
<tr>
<td>Diseased grass</td>
<td>21.2 b</td>
<td>21.8 b</td>
</tr>
<tr>
<td>Healthy grass</td>
<td>All individuals died within one week.</td>
<td></td>
</tr>
</tbody>
</table>

* The differences between the means are statistically significant at 1% level except where figures are followed by the same letter.

 Couples of newly emerged adults were caged on the plants to determine the effects of 3 host plants on adult longevity and fecundity. Although 23 pairs of adults were used for each host plant, some of the adults escaped or were accidently killed during weekly transfers.
TABLE 2. Effects of host plants on longevity and fecundity of Matsumuratettix hiroglyphicus adults.

<table>
<thead>
<tr>
<th>Host plant</th>
<th>Longevity (days)*</th>
<th>Eggs/female †</th>
<th>Size of eggs (mm)</th>
<th>% eggs hatched</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>male</td>
<td>female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy cane</td>
<td>73.3 (16)</td>
<td>60.7 (14)</td>
<td>334.9 a</td>
<td>0.86 × 0.24</td>
</tr>
<tr>
<td>Diseased cane</td>
<td>69.3 (16)</td>
<td>32.9 (15)</td>
<td>335.4 a</td>
<td>0.87 × 0.25</td>
</tr>
<tr>
<td>Diseased grass</td>
<td>60.8 (15)</td>
<td>46.9 (14)</td>
<td>38.7 b</td>
<td>0.91 × 0.26</td>
</tr>
</tbody>
</table>

* Numbers in parenthesis are the number of adults tested.
† The difference between the means are statistically significant at 1% level except where figures are followed by the same letter.

The results shown in Table 2 indicate that longevity of the adults on the diseased Bermuda grass was comparable to that of adults fed on healthy or diseased cane, but rearing the adults on diseased grass resulted in a significant decrease in the number of eggs per female. Under these conditions the number of eggs laid by a female was 38.7, which was only about one-tenth of the number deposited by females fed on healthy or diseased cane. No significant differences in the size or viability of eggs were observed after feeding the adults on different host plants.

In another experiment, 183, 190 and 121 leafhoppers out of each 500 survived on healthy sugarcane, diseased sugarcane and Bermuda grass respectively, after feeding for 5 weeks. From this group, 30 adults were taken randomly and transferred to healthy grass.

TABLE 3. Survival of Matsumuratettix hiroglyphicus adults on healthy Bermuda grass after feeding on healthy sugarcane and diseased plants of sugarcane and Bermuda grass.

<table>
<thead>
<tr>
<th>Original host plant</th>
<th>Days of survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy cane</td>
<td>4.0</td>
</tr>
<tr>
<td>Diseased cane</td>
<td>5.0</td>
</tr>
<tr>
<td>Diseased grass</td>
<td>4.4</td>
</tr>
</tbody>
</table>

As shown in Table 3, adults which had been fed on diseased plants were able to survive on healthy Bermuda grass for a considerable period. The adults originally fed on healthy sugarcane survived on the healthy grass for 4.0 days, while those from diseased grass and diseased sugarcane survived for 4.4 to 5.0 days. These results seem to suggest a beneficial effect of diseased plants particularly of sugarcane on M. hiroglyphicus.

DISCUSSION

Yang and Pan recorded that adults of M. hiroglyphicus were frequently found on wild cane but that the females did not oviposit when they were reared from the first nymphal stage on wild cane. In our investigation, M. hiroglyphicus not only survived but produced eggs on Bermuda grass with white leaf symptoms. Our investigations confirmed previous observations that feeding the leafhoppers on healthy or diseased sugarcane did not result in any significant differences in length of nymphal stage, longevity of adults or fecundity.

M. hiroglyphicus has not been collected from healthy or diseased Bermuda grass in the field but the results of this investigation showed that the insect was
able to complete its life cycle when diseased grass was the only host plant. The presence of the disease in the Bermuda grass is apparently beneficial to the leafhopper.

On the other hand, adults which had been fed for 5 weeks on diseased sugarcane were able to survive on healthy Bermuda grass for longer than those from healthy cane or diseased grass. Plant pathogens, especially plant viruses and agents of yellows diseases, tend to show harmful or beneficial effects on their insect vectors. Maramorosch reported that the corn leafhopper, *Dalbulus maidis* could survive for a long period on China aster infected with aster yellows, although no progeny was produced. It is reasonable to suppose that the white leaf agent could alter the composition of Bermuda grass so that it becomes more palatable to the leafhopper.

The mechanism which may be responsible for this fascinating phenomenon can not yet be fully explained. The authors have made a preliminary analysis of elements contained in the healthy and infected leaves of sugarcane, and found that the N, P and K in diseased plants were increased by 20 to 50%. Further studies on this aspect may explain the mechanism by which the presence of white leaf disease in sugarcane and Bermuda grass is beneficial to the development of *M. hiroglyphicus*.

REFERENCES

EFECTOS BENÉFICOS DE PLANTAS INFECTADAS CON HOJA BLANCA SOBRE LOS SALTAHOJAS, MATSUMURATETTIX HIROGLYPHICUS MATSUMURA

Chen, Chu-Te; Lee, Ching-Shiou and Lee, Sin-min

RESUMEN

En este estudio se determinaron los efectos de plantas de caña y pasto Bermuda, Cynodon dactylon, sobre el desarrollo de Matsumuratettix hiroglyphicus Matsumura, un vector de la enfermedad "hoja blanca" de la caña de azúcar.

Los saltahojas fueron capaces de sobrevivir y completar su ciclo biológico sobre pasto Bermuda infectado, mientras que aquellos alimentados en pasto sano murieron en una semana. También se encontró que los saltahojas alimentados primero en caña de azúcar infectada con "hoja blanca" por 5 semanas, sobrevivieron significativamente más tiempo en pasto Bermuda sano que aquellos alimentados originalmente en plantas de caña sana y pastos infectados. Estos resultados indican evidentemente los efectos benéficos de plantas infectadas sobre el desarrollo de M. hiroglyphicus.