The Effect of the Hoja Blanca Virus on its Insect Vector

Peter R. Jennings and Alicia Pineda T.

Leader, InterAmerican Rice Program, and Laboratory Technician, respectively, Centro Internacional de Agricultura Tropical, Apartado Aéreo 67-13, Cali, Colombia.

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ABSTRACT

The hoja blanca virus of rice had a deleterious effect on its vector, *Sogatodes oryzicola*. Viruliferous insects laid one-third as many eggs and hatched fewer nymphs than did virus-free insects. Fertility of both females and males was reduced by the virus. The per cent of nymphs reaching adulthood and the longevity of vectors were also reduced. The results explain the low incidence of vectors found in wild type populations of *S. oryzicola*, and suggest an explanation for the apparent cyclical nature of the hoja blanca disease. Phytopathology 61:142-143.

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The hoja blanca virus (HBV) transmitted by *Sogatodes oryzicola* (Muir) causes a sporadic but severe disease of rice (*Oryza sativa* L.) in northern Latin America (1). Only 5 to 15% of insects collected during epidemics can transmit the virus (1). This percentage seems to be constant over wide geographical locations. Active colonies of 90 to 95% vectors can be developed through controlled matings and selection of viruliferous progeny, but such colonies return to the level of 5 to 15% vectors following a few cycles of random mating, suggesting that viruliferous insects are less fit than nonviruliferous ones. The implication that the virus has a deleterious influence on the insect was investigated in this study.

MATERIALS AND METHODS.—Rice cultivars used throughout the study were Bluebonnet 50, susceptible to both the vector *S. oryzicola* and HBV, and Mudgo, resistant to both. Fifteen- or 30-day-old seedlings of these cultivars were raised individually in 10-cm diam pots, and desired numbers of insects were caged on them within plastic tubes.

Separate colonies of viruliferous and nonviruliferous insects were maintained in small cages. First instar nymphs, recognizable by their size and shape, were collected from these cages. Adult insects were collected from among the nymphs as they molted.

RESULTS.—*Number of eggs laid by viruliferous and nonviruliferous insects.*—Pairs of viruliferous (V) and nonviruliferous (NV) adult insects were caged individually on 15-day-old seedlings. Each pair was passed daily to a new seedling of the same cultivar until the female died. Five days after insect transfer, each seedling was dissected under a microscope and the eggs laid were counted (Table 1).

The results from both cultivars show that nonviruliferous females laid 3 to 4 times as many eggs as viruliferous females. The nonviruliferous insects survived longer by a factor of 2 to 3 times. The number of eggs laid per day by each nonviruliferous female was greater than that of the viruliferous insects.

Number of nymphs hatched by nonviruliferous and viruliferous females.—Proven female vectors and nonvectors were paired with proven male vectors and nonvectors giving four cross combinations: V × V, V × NV, NV × V, and NV × NV. Twenty pairs of each cross combination were caged individually on single 30-day-old plants of the two cultivars. The nymphs were counted and removed daily, thus accounting for all eggs that hatched (Table 2).

Survival of the viruliferous females was less than that of the nonviruliferous females on both cultivars. When both insects of the pair were viruliferous, nymphal production was reduced to 62 and 5/female on Bluebonnet 50 and Mudgo, respectively. This compares with 156 and 17 produced by virus-free insects on the same cultivars. Approximately 3 times as many nymphs were produced by virus-free pairs as by viruliferous insects. Nymphal production per day of female survival showed a similar trend.

It is evident from the NV × V and V × NV matings that the HBV affected fertility of both females and males on both cultivars. A direct comparison of females only, males being constant (V × NV vs. NV × NV and V × V vs. NV × V), showed a nymphal production ratio of 1.0:1.9 by viruliferous and nonviruliferous females, respectively. Similarly, a comparison of viruliferous and virus-free males (females held constant) gave a nymphal production ratio of 1.0:1.6 in favor of the nonviruliferous males.

Longevity of nonviruliferous and viruliferous insects.—One hundred first instar nymphs from V × V and NV × NV matings were placed singly on 15-day-old seedlings of Bluebonnet 50 and Mudgo. Nymphal survival, duration of nymphal period, adult longevity, and transmission of HBV were recorded (Table 3).

Eighty-four per cent of the insects from the cross of V × V transmitted HBV to Bluebonnet 50. No HBV was transmitted by the virus-free insects. The HBV had a modest but consistent effect on all phases

TABLE 1. The effect of the hoja blanca virus on eggs laid by *Sogatodes oryzicola* on Bluebonnet 50 and Mudgo rice (*Oryza sativa*)

	Bluebonnet 50		Mudgo	
	V[a]	NV	V	NV
No. females	46	45	50	48
Mean days female survival	5.1	14.3	2.9	5.9
No. eggs per female	44.4	190.9	13.3	29.4
Eggs per female per day	8.7	13.4	4.6	5.0

[a] V = viruliferous; NV = nonviruliferous insects.

TABLE 2. The effect of the hoja blanca virus on nymphs of *Sogatodes oryzicola* hatched on Bluebonnet 50 and Mudgo rice (*Oryza sativa*)

	Bluebonnet 50				Mudgo			
	V × V[a]	V × NV	NV × V	NV × NV	V × V	V × NV	NV × V	NV × NV
Mean days female survival	8.2	9.4	12.2	13.4	3.3	2.5	4.9	3.1
No. nymphs per female	61.6	84.5	113.9	156.3	5.2	10.5	11.6	16.5
No. nymphs per female per day	7.5	9.0	9.3	11.7	1.6	4.2	2.4	5.3

[a] V × V = Viruliferous female paired with viruliferous male; V × NV = viruliferous female paired with nonviruliferous male; NV × V = nonviruliferous female paired with viruliferous male; NV × NV = nonviruliferous female paired with nonviruliferous male.

of the insect life cycle on both cultivars. Viruliferous insects showed a reduced per cent of nymphs reaching adulthood, a reduced longevity of insects reaching adulthood (including nymphal stage), and a reduced longevity of all insects (including nymphs not reaching adulthood). On both cultivars, virus-free insects lived about 4 days longer than viruliferous insects.

Several hundred first-instar nymphs from three colonies containing 0, 65, and 96% HBV vectors were placed singly on 15-day-old Bluebonnet 50 seedlings and survival was recorded. Results were similar to those in Table 3. Mean days survival of all insects in the three colonies was 22.7, 18.8, and 17.0, respectively.

DISCUSSION.—All data obtained show clearly that the HBV affected its insect vector. Virus-free females laid 3 times as many eggs, and 3 times as many nymphs hatched as compared with viruliferous females. The fertility of both females and males was reduced by HBV. Maramorosch (2) cites work showing that nonviruliferous females laid twice as many eggs as viruliferous individuals. The virus had a deleterious effect on the per cent of nymphs that reach adulthood, and on the longevity of the vectors. It is concluded that viruliferous insects are less fit for propagation of the species than nonviruliferous ones, and that the HBV causes a disease of its insect vector.

TABLE 3. The effect of the hoja blanca virus on insect longevity of *Sogatodes oryzicola* on Bluebonnet 50 and Mudgo rice (*Oryza sativa*)

	Bluebonnet 50		Mudgo	
	V × V[a]	NV × NV	V × V	NV × NV
% Nymphs reaching adulthood	74.3	87.8	15.5	32.3
Mean days adult longevity	26.0	30.0	23.7	27.6
Mean days survival all insects	23.2	27.4	7.8	12.9

[a] V × V = Viruliferous female paired with viruliferous male. NV × NV = nonviruliferous female paired with nonviruliferous male.

These results may explain the low incidence of vectors in field populations of *S. oryzicola*. Vector percentages of 5 to 15% were reported by several workers in Cuba, Venezuela, and Colombia during the epiphytotic of hoja blanca from 1956 to 1964 (1). More recently, the disease has largely disappeared from these areas. There has been no major change in rice cultivars to explain this reduction in incidence. Populations of *S. oryzicola*, in Colombia, do not appear to have diminished.

We speculate that the deleterious effect of HBV may have purged the vast majority of vectors from wild type populations following the epiphytotic years. This would result in a greatly reduced incidence of hoja blanca. Our preliminary survey of areas in the Cauca Valley of Colombia, where hoja blanca is presently at an exceedingly low incidence, indicates that the percentage of actual and potential vectors in field populations of *S. oryzicola* is less than 1%.

LITERATURE CITED

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