Feeding behavior of three *Nephotettix* species on selected rices and graminaceous weeds

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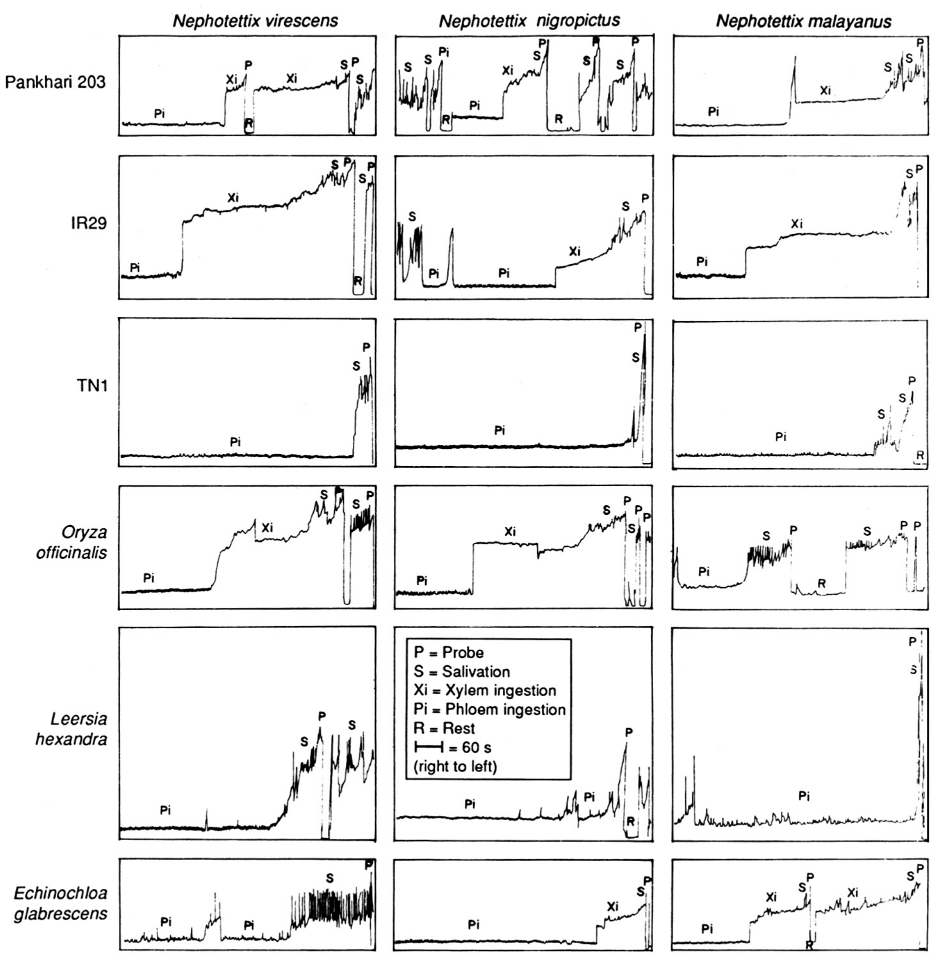
Most studies on green leafhoppers (GLH) involve *Nephotettix virescens,* because it occurs abundantly in many Asian rice-growing countries and because it transmits rice tungro viruses (RTV) more efficiently than other *Nephotettix* species. However, in recent surveys in RTV-infected ricefields in Palawan, Negros Occidental, Nueva Ecija, and Isabela Provinces of the Philippines, *N. nigropictus* comprised 41% and *N. malayanus* 10% of the *Nephotettix* populations. Higher populations of these two species can aggravate RTV incidence and cumulative populations can worsen RTV outbreaks. Graminaceous weeds *Leersia hexandra* and *Echinochloa glabrescens* are alternate hosts of these *Nephotettix* species and of RTV.

RTV transmission is linked to insect ability to feed in the phloem of the host plant. We examined the feeding behavior of the three GLH species on GLH-resistant rice varieties Pankhari 203 and IR29 and susceptible TN1, on resistant wild rice *Oryza officinalis* (IRRI acc. # 100896), and on *L. hexandra* and *E. glabrescens* weeds.

Feeding response of 2-d-old GLH females on 30-d-old plants were monitored for 3 h with an electronic recorder. Each plant type was tested seven times for each GLH species, using fresh insects and fresh plants. A bromocresol-green-treated filter paper disk placed below each feeding insect collected its honeydew. The disk turned blue when the insect fed in the phloem and dull-white when it fed in the xylem.

Feeding response on test plants (probing, salivation, xylem drinking, and phloem ingestion) was the same for the three GLH species (see figure). Durations of each feeding event differed for different GLH species and for different plants. In general, the insects probed more frequently, salivated longer, did more xylem drinking, but did less phloem ingestion on resistant rices and on the wild rice than on susceptible hosts (TN1 for *N. virescens* and *N. nigropictus* and *L. hexandra* for *N. malayanus).* Blue color reaction of the honeydew on the treated filter paper also confirmed phloem feeding.

The ability of the GLH species to ingest phloem sap from resistant rices and graminaceous weeds renders GLH-resistant rices vulnerable to transmission of phloem-specific tungro viruses. It also implies that RTV can be transferred from weeds to rice and back again. □



Waveforms recorded with an electronic monitoring device during probing by *N. virescens, N. nigropictus,* and *N. malayanus* on resistant Pankhari 203 and IR29 and susceptible TN1 rice plants, wild rice *O. officinalis,* and graminaceous weeds *L. hexandra* and *E. glabrescens,* IRRI, 1989. Charts are to be read from right to left.

Effect of neem oil on courtship signals and mating behavior of brown planthopper (BPH) females

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We noticed a decrease in the buildup of BPH *Nilaparvata lugens* population on neem-treated rice plants. We examined whether courtship signals and mating behavior of BPH females were adversely affected by neem oil. Before mating, planthoppers emit signals which are recognized by both sexes.

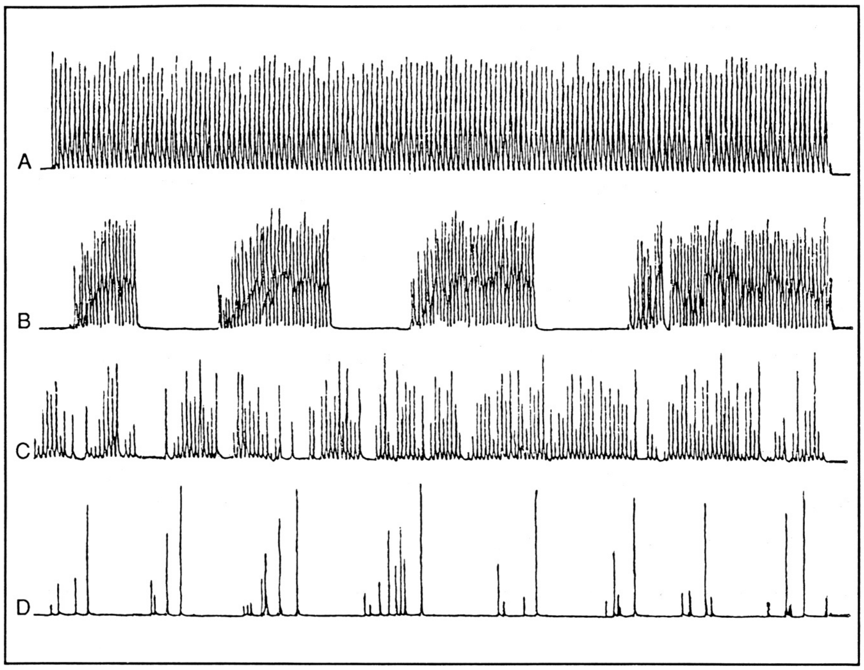
Fifth-instar BPH nymphs were caged on 30-d-old TN1 rice plants. Females were isolated 3 h after emergence and subjected to -40 °C for 2 min. Neem oil was topically applied on their dorsum at 1, 2.5, or 5 μg/ female. Control females were treated with 0.1 μl acetone. The females were caged on 30-d-old TN1 plants for 4 d before mating experiments.

In a separate trial, 30-d-old TN1 plants were sprayed with 3, 6, or 9% neem oil emulsified with 1.6% Teepol. Control plants were sprayed with Teepol in water. One hour after spraying, 20 newly emerged females were caged on treated and control plants for 4 d before the mating experiment.

Courtship and mating behavior of individual females was recorded, the signals transferred to a strip chart recorder through a wave detector and filter, and the charts analyzed for wave pattern and pulse repetition frequencies (PRF).

Both topical application and foliar sprays of neem oil disrupted normal courtship signal production and mating behavior of BPH females. Normally, a virgin, mature female and a mature male call alternately before mating. Many treated females (8-25%) did not emit signals and failed to mate; others (8-58%) emitted abnormal signals (see figure for altered waveform .patterns) that could not be recognized by mature BPH males. Other females emitted normal signals, but PRF tended to increase and the duration of each call decrease significantly as neem oil concentration increased (see table).

Males often failed to copulate with treated females because the female continuously moved their abdomens. The premating period, from the time a female and a male meet to the start of copulation, was extended with neem-treated females. ☐



Effect of neem oil on signal wave patterns on *N. lugens* female. A = control (acetone), B = foliar treatment with 9% neem oil, C = topical treatment with 5.0 µg neem oil, D = topical treatment with 25% neem oil. Time marks at 1-s intervals. RC of filter: 0.007 s.

Effect of neem oil on courtship signals and mating behavior of *N. lugens* females.[a] IRRI, 1988.

Treatment	PRF of signal[b] (Hz)	Duration of female call[c] (s)	Premating period[d] (s)	Duration of mating[e] (s)
Topical (µg/female)				
1.0	21.5 b	75.9 a	113.5 a	66.5 a
2.5	21.9 b	38.7 b	230.0 ab	72.8 a
5.0	20.3 ab	14.8 c	314.6 b	65.0 a
0 (control)	18.7 a	84.2 a	89.8 a	76.9 a
Foliar (%)				
3	20.8 b	52.1 b	91.2 a	64.2 a
6	20.8 b	27.0 bc	268.0 b	66.7 a
9	21.2 b	20.2 c	219.5 ab	55.5 a
0 (control)	19.1 a	82.8 a	94.8 a	65.5 a

[a]In a column, means followed by a common letter are not significantly different at the 5% level by DMRT. [b]Av of 8 replications. [c]Av of 36 replications. [d]Av of 12 replications. [e]Av of 10 replications.

Functional response of *Lycosa pseudoannulata* on brown planthoppers (BPH) and green leafhoppers (GLH)

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Functional response of a predator-prey relationship can be defined as the change in number of prey attacked per unit time by a single predator as prey density changes. The number attacked will reach a plateau beyond which the predator cannot increase its rate of attack further.

Three Holling's response curves have been identified. In type I, prey intake is proportional to prey density to satiation (e.g., filter feeders). In type II the number of attacks per predator shows a negatively accelerating rise to the plateau. In type III, a lag in rate of attack due to learning is followed by an exponential increase in attack rate (e.g., vertebrates). Type II response is typical of invertebrates, although type III response has been shown. The curves are described by Royama's random predator equation, characterized by searching efficiency and, the handling time (time spent pursuing, subduing, eating, resting, and waiting).

We evaluated the functional responses of spider *L. pseudoannulata*