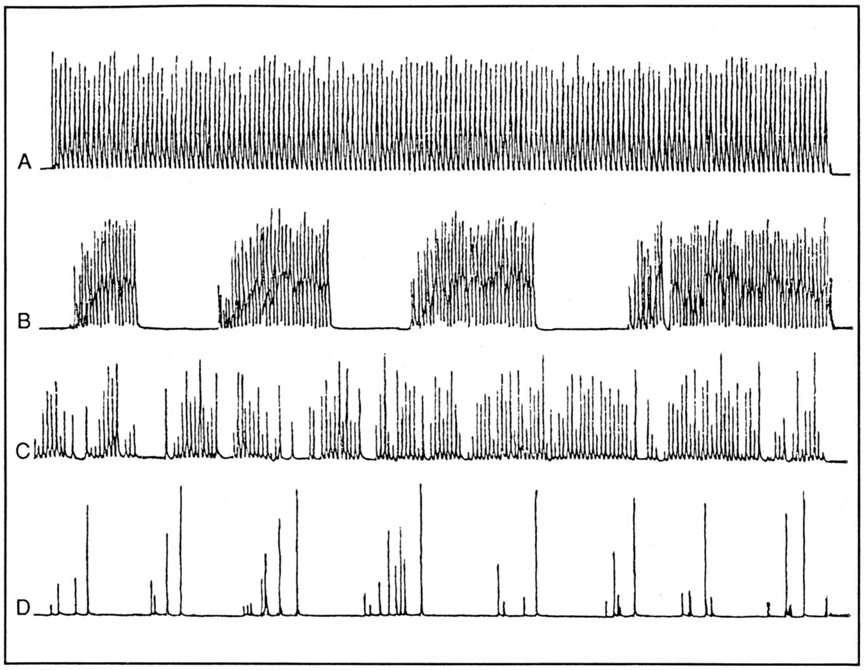
caged on 30-d-old TN1 plants for 4 d before mating experiments.

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)

K. L. Heong and E. G. Rubia, Entomology Department, IRRI

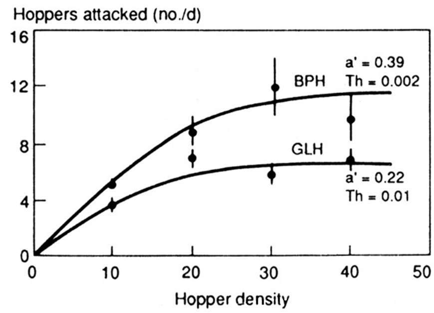
Functional response of a predator-prey relationship can be defined as the change in number of prey attacked per unit time by a single predator as prey density changes. The number attacked will reach a plateau beyond which the predator cannot increase its rate of attack further.

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* adult females exposed to adult hoppers in the greenhouse experiments. The *L. pseudonnnulata* used were captured from ricefields. Spiders of similar size were selected and starved for 3 d. They were released in 19-cm-diam, 54-cm-high mylar cages at 10 hopper densities, with 10 replications.

Responses were fitted to Holling's type II curve (see figure). Since *L. pseudoannulata* is a sit-and-wait hunter that does not actively seek out prey, one would not expect it to show a type III functional response.

L. pseudoannulata spiders searched more efficiently for BPH than for GLH. They also had lower handling time, resulting in a higher plateau of prey attacked. This implies that BPH is the preferred prey. ☐



Functional response of *Lycosa pseudoannulata* on BPH and GLH. IRRI, 1989.

Insects feeding on rice grain in Bhutan

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Insects feeding on developing grain are common in southern Bhutan. We measured the density of this group of pests in 13 fields in 9 areas Oct-Nov 1988. Insect samples were taken from crops between flowering and the hard dough stage.

Each field was sampled five times, using 10 net sweeps while walking across the field/sample. Insects were preserved in 70% alcohol and brought to the laboratory.

Species collected included

Leptocorisa spp., 40%
Paromius sp., 26 %
Menida sp., 24%
Nezara sp., 2%
Cletus sp., 3%
Others, 6%

Very high densities were found in some areas with visible grain damage (see table). ☐

Numbers of grain feeders collected from different areas of southern Bhutan, Oct-Nov 1988.

Location	Variety planted	Growth stage	Grain feeders[a] (no./10 sweeps ± SE)
New area Bhur	Modern	Soft dough	14.8 ± 3.2
	Traditional	Soft dough	29.0 ± 1.8
Lalai	Traditional	Soft dough	5.2 ± 1.0
	Traditional	Soft dough	3.0 ± 1.1
	Traditional	Soft dough	1.3 ± 0.2
Taklai	Traditional	Soft dough	8.2 ± 2.6
Surey	Traditional	Hard dough	1.3 ± 0.6
	Traditional	Hard dough	59.4 ± 18.2
Lodrai	Modern	Hard dough	56.4 ± 18.0
Bhur Farm	Modern	Flowering	25.2 ± 3.0
Leopani	Traditional	Flowering	8.4 ± 2.5
Patabari	Traditional	Soft dough	3.4 ± 0.5
Hiley	Traditional	Hard dough	6.0 ± 2.9

[a]Av of 5 replications/location. Leptocorisa, 40% (*L. acuta* = 70% and *L. oratorius* = 30%); Nezara, 2%; Cletus, 3%: *Menida,* 24%; *Paromius.* 25%; others, 6%.

Predatory coccinellids in ricefields at Agricultural College and Research Institute, Madurai

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We surveyed the experimental farm for predatory coccinellids in rice and in cowpea, black gram, and soybean. Eight species of predatory coccinellids were found feeding on brown planthoppers, whitebacked planthoppers, and leafhoppers in rice and aphids *Aphis craccivora* in pulses.

Menochilus sexmaculatus (Fabricius) 4.3%
Rodolia concolor (Lewis) 8%
R. pumila (Weise) 8%
R. cardinalis (Lewis) 8%
Scymmus sp. (Kamiya) 10%
Micraspis discolor (Fabricius) 5%
Hormonia octomaculata (Fabricius) 9%
Sticholotis punctata (Crotch) 25%
S. substriata (Crotch) 25% ☐

Vertical distribution of two hopper species on rice plants

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The rice canopy is the habitat of several species of hemiptera: *Nilaparvata lugens, Nephotettix virescens, Sogatella furcifera, Cyrtorhinus lividipennis,* and *Nisia atrovenosa.* The predominant species, brown planthopper (BPH) *N. lugens* and green leafhopper (GLH) *N. virescens,* are usually found at the base of the rice canopy. This raises questions about interspecific competition.

We introduced varying densities of 1-d-old female BPH and GLH adulls separately and in combination on 35-d-old TN1 potted rice plants and recorded vertical distributions (see figure). At low densities, more than 80% BPH remained at the base of the plant close to the water surface. At