Effect of Neem Oil, Monocrotophos, and Carbosulfan on Green Leafhoppers, *Nephotettix virescens* (Distant) (Homoptera: Cicadellidae) and Rice Yields in Thailand[1]

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ABSTRACT. Field trials were conducted in Thailand to determine the effect of Thai neem seed oil, monocrotophos (Azodrin), and carbosulfan (Posse) on rice yields (*Oryza sativa* L., variety RD7). Neem-treated plots did not yield significantly more rice than control plots. Plots treated with monocrotophos or carbosulfan had significantly higher yields than control plots or neem-treated plots.

The rice yields were correlated with the levels of three insect species: *Nephotettix virescens* (Distant) (Homoptera: Cicadellidae), *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae), and *Chilo* sp. (Lepidoptera: Pyralidae). Only *N. virescens* exceeded its economic threshold. More than 95% of the variation in yield data could be explained by the *N. virescens* levels 36 days after transplanting. *N. virescens* populations were reduced by applications of monocrotophos and carbosulfan. *N. virescens* was not effectively controlled by neem seed oil.

N. virescens control with monocrotophos or carbosulfan at economic threshold appears to significantly increase rice yields.

KEYWORDS: Neem, rice yield, *Nephotettix virescens*, monocrotophos, carbosulfan.

Extracts of the Thai neem tree, *Azadirachta indica* var. *siamensis* Valeton have been reported to disrupt the normal feeding behavior of several insect species (Sombatsiri and Tigvattanont 1983). Neem oil, produced at the village level in developing countries, can supposedly reduce dependence on imported synthetic insecticides and supplement income (Ahmed and Grainge 1985, 1986). As a Peace Corps Volunteer aiding economic development in rural Thailand, I assessed the potential of Thai neem oil for rice pest control.

One objective of my study was to determine the effect of two synthetic insecticides and crude Thai neem oil on grain yield and on three rice pest species: the green leafhopper (GLH) *Nephotettix virescens* (Distant) (Homoptera: Cicadellidae), the brown planthopper (BPH) *Nilaparvata lugens* (Stål) (Homoptera: Delphacidae), and the rice stem borer (STB) *Chilo* sp. (Lepidoptera: Pyralidae). The other objective was to assess the effect of these rice pests on grain yield. Pest surveillance systems are based on the assumption that the yield of a crop can be increased by taking action

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TABLE 1. Mean number of *Nephotettix virescens* per sweep per 25 m^2 plot center in Amphur Sribrajan, Suphanburi, Thailand*.

		Population of green leafhoppers at DAT							
Treatment	**Rate**	**1**	**5**	**16**	**19**	**32**	**36**	**47**	**50**
Azodrin	0.3 liter AI/ha	0.6a	0.1a	0.3a	0.1a	1.2b	2.8b	1.1a	0.9a
Posse	0.3 liter AI/ha	0.7a	0.1a	0.7a	0.8a	4.7ab	3.9b	1.4a	0.9a
Low Thai Neem	15 kg/ha	0.7a	0.1a	1.1a	0.5a	6.4ab	10.6a	1.6a	0.9a
Medium Thai Neem	35 kg/ha	1.0a	0.1a	0.8a	0.8a	8.8a	7.4ab	1.7a	0.8a
High Thai Neem	50 kg/ha	1.2a	0.2a	0.8a	0.5a	4.6ab	10.4a	2.1a	0.6a
Control	____	0.6a	0.2a	0.8a	0.5a	9.3a	11.6a	2.1a	1.0a

*Means within a column followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test (ANOVA). DAT = days after transplanting. Treatments were applied 2, 17, 33 and 48 DAT.

against a pest at the economic threshold. The Thai Department of Agricultural Extension and the Thai-German Plant Protection Programme promote pest surveillance as a means of determining when to take pest control action.

This paper describes the results of the first experiment to evaluate the effectiveness of Thai neem oil for rice pest control under field conditions.

MATERIALS AND METHODS

In Amphur Sribrajan, Suphanburi, Thailand on 7 April 1986 twenty-five-day-old seedlings of rice variety RD7 were transplanted to 10 × 10 m plots with 3 seedlings per hill at 25 × 25 cm spacing (i.e. 270,000 plants per hectare). Treatments in this experiment consisted of monocrotophos (Azodrin), carbosulfan (Posse), and three different concentrations of Thai neem oil. Controls were sprayed with water containing 1.25 cc sticker/spreader per liter of water, the same amount of sticker/spreader used in each of the treatments. Each treatment was replicated 3 times and arranged in a randomized complete block design. Plots were 1 m apart and blocks were 5 m apart. The areas between plots and between blocks were planted with rice and left untreated.

TABLE 2. Grain yield of rice RD7 in different *N. virescens* control treatments in Amphur Sribrajan, Suphanburi, Thailand*.

Treatment	Rate	Mean yield in kg/25 m^2 plot	% Moisture
Azodrin	0.3 liter AI/ha	15.5b	16.9a
Posse	0.3 liter AI/ha	15.3b	17.5a
Low Thai Neem	15 kg/ha	6.7a	16.9a
Medium Thai Neem	35 kg/ha	9.4a	17.4a
High Thai Neem	50 kg/ha	8.5a	17.1a
Control	____	6.4a	16.9a

*Means within a column followed by the same letter are not significantly different at the 5% level by Duncan's Multiple Range Test. (ANOVA).

Neem seeds were collected in February 1986 in Suphanburi. Neem oil was produced by as inexpensive a method as possible, so that the technology might be easily transferred to Thai rice farmers. Neem seeds were dried in the shade on burlap, because azadirachtin, one of the antifeedant triterpenoids in neem oil, decreases in antifeeding potency when exposed to sunlight (Stokes and Redfern 1982). Seeds were then ground with a hand-powered coffee grinder. Ground seeds were stored in coffee tins until needed. Crushed seeds were soaked in a solution of 1.25 cc sticker/spreader per liter of water in the following ratios: 0.03 kg/liter, 0.07 kg/liter, and 0.10 kg/liter. After 12 to 24 hours the mixture was filtered through cheese cloth. The solid residue was discarded, and the remaining solution applied to the field immediately after stirring.

TABLE 3. Percent yield gain of rice RD7 and area under curve of *N. virescens* populations for each treatment.

Treatment	Rate	% Yield gain	Area under curve
Azodrin	0.3 liter AI/ha	142.19	464
Posse	0.3 liter AI/ha	139.06	938
Low Thai Neem	15 kg/ha	4.69	1581.5
Medium Thai Neem	35 kg/ha	46.88	1466
High Thai Neem	50 kg/ha	32.81	1603
Control	____	0.00	1930.5

TABLE 4. Determination coefficient (r^2), probability level, and treatment regression values between yield gain and area under population curves of *Nephotettix virescens* (GLH), *Nilaparvata lugens* (BPH), and *Chilo* sp. (STB) in rice RD7.

Pest	r^2	Prob. Level	Slope	Intercept
GLH	.8906	.00466	−0.1	212.0
BPH	.2000	.93256	−0.3	76.0
STB	.2925	.26786	18.4	−9.2

Both of the synthetic insecticides were applied at 0.3 liters of active ingredient per hectare; a concentration consistent with the manufacturer's recommendations. Thai neem oil, monocrotophos, and carbosulfan were applied at approximately 5 liters of solution per plot with a hand pump sprayer.

Plots were treated 2, 17, 33, and 48 days after transplanting (d.a.t.). Each plot was surveyed for GLH, BPH, and STB the day before and 2 to 3 days after each treatment application. GLH population densities were estimated with sweep net collections. Ten sweeps were made in the 5- by 5-m center of each plot. BPH and STB densities were estimated by directly counting their numbers on every other hill along one diagonal of the 5- by 5-m center of each plot. Ten hills were surveyed per plot.

Yield data were collected from the 25 m^2 center of each plot. Grain moisture was determined with the air-oven method of Xuan and Ross (1972). Analysis of variance (ANOVA) with Duncan's multiple range test ($P = 0.05$) was used to detect differences in yield due to treatment effect (Sokal and Rohlf, 1981).

The average number of each species surveyed was calculated for every survey date, according treatment. Regression analyses were performed on the area under the insect population curve (AUIPC) for each species for each treatment, versus the yield gain for each treatment. Yield gain was computed as a percentage using the formula $\%G = (T\text{-}C)/C$, where T is the average yield for a treatment, and C is the average yield for the untreated control plots. If the AUIPC for a species versus yield gain had a high r^2 value and was significant ($P < 0.05$), then the effect of that species (for each survey day) on yield was measured using regression analysis (Teng and Bissonnette 1985). Differences in insect density due to treatment (within each survey day) were detected by ANOVA with Duncan's multiple range test (P = 0.05).

RESULTS

Throughout the experiment, the number of GLH in neem-treated plots and control plots did not differ significantly. At 32 d.a.t. monocrotophos-treated plots had significantly less GLH than control plots. At 36 d.a.t. monocrotophos and carbosulfan had significantly less GLH than control plots (Table 1).

Plots treated with Thai neem oil did not produce significantly more rice than control plots (Table 2). Monocrotophos- and carbosulfan-treated plots had yields significantly higher than the control plots (Table 2). There was a yield gain of 149.19% in monocrotophos plots, and of 139.06% in carbosulfan plots (Table 3). Percent yield gain caused by pest suppression can be satisfactorily explained by the regression model for AUIPC of GLH. BPH or STB levels could not explain the differences in yield (Table 4). The GLH population 36 d.a.t. explained more than 95% of the variation in the yield data (Table 5).

TABLE 5. Determination coefficient (r^2), probability level, and regression values between yield gain and *N. virescens* population levels according to treatment on different DAT in rice RD7*.

DAT	r^2	Prob. Level	Slope	Intercept
1	.0663	.62231	−52.6	104.8
5	.2892	.27108	−668.0	150.0
16	.6190	.06335	−195.0	207.2
19	.0257	.76147	−39.8	82.2
32	.5475	.09268	−15.7	152.8
36	.9547	.00078	−16.8	191.9
47	.6564	.05062	−132.1	281.2
50	.0072	.87305	39.5	27.4

*DAT = Days After Transplanting.

DISCUSSION

BPH and STB were not numerous and apparently had no effect on the yield. Neither species reached its economic threshold established by the International Rice Research Institute (IRRI) (Reissig *et al.*, 1986). Therefore, in this field trial, BPH and STB did not achieve pest status.

Monocrotophos and carbosulfan treatments each reduced the density of GLH and, apparently as a result, increased the grain yield. When the economic threshold of two GLH/sweep is reached, IRRI recommends spraying a systemic insecticide (Reissig *et al.*, 1986). This recommendation is consistent with the data. The first treatment application after the GLH exceeded the economic threshold was 33 d.a.t. (Table 1). This application most likely caused the reduction in GLH in the monocrotophos and carbosulfan plots that was observed 36 d.a.t. Since GLH levels 36 d.a.t. explained more than 95% of the variation in yield data (Table 5), it was the application 33 d.a.t. that probably resulted in the increased yields in plots treated with synthetic insecticides.

Contrary to my expectations when I began this investigation, there was no evidence that applications of crude Thai neem seed oil improved yield or controlled pests in rice. Based on the results of this experiment, Thai rice farmers should continue using monocrotophos or carbosulfan to control GLH in rice when the pest reaches the economic threshold.

In Thailand, as in many developing nations, the majority of poisoning cases are of farmers exposed to pesticides (Kritalugsana 1988). This problem results from the improper use of these chemicals. Industrialized nations use 80% of the world's agrochemicals, yet only 1% of the human deaths due to acute pesticide poisoning are in those same countries (Jeyaratnam, 1988). Vorley (1988) makes the point that the insecticides which farmers already prefer must be incorporated into IPM systems until inexpensive, selective insecticides are developed. If synthetic insecticides are used prudently, they can be an important part of an IPM system (Soekarna, 1988).

Developing effective, safer insecticides is a laudable long term goal. In the meantime, educating farmers in the proper application, storage, and disposal of insecticides is the most important way to reduce the incidence of pesticide poisoning.

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