Studies on insect pests of upland rice

Mano **D.** *Pathak and* **Arnold** *Dyck*

COMMON **INSECT** PESTS

Most of the insects found on lowland rice are also found on upland rice. Important upland rice pests found on the **IRRI** farm include: the stem borer *(Chilo suppressalis, Tryporyza incertulas, Sesamia inferens,* and *Chilotraea polychrysa);* the green leafhopper *(Nephotettix nigropictus* and *N. virescens);* the brown planthopper, *Nilaparvata lugens;* the rice leaf folder, *Cnaphalocrosis medinalis* (Guenee); the rice seedling fly, *Atherigona* spp.; and the mole cricket, *Gryllotalpa africana* (P. de Beauv.). Soil insects which can not survive in flooded fields, such as the mole cricket, termites, the rice root aphid, *Tetraneura nigriabdominalis* (Sasaki), and root worms, are mostly confined to upland rice.

In an extensive survey of upland rice fields in Batangas and Quezon provinces, and in Bicol, Philippines, we observed several species of grasshoppers and stem borers, leaf folders, white-backed planthoppers, green leafhoppers, zigzag leafhoppers, brown planthoppers, white rice leafhoppers, termites, and some root worms. We also found several insect predators that were present in the crop throughout the growing season, but that reached distinct peaks in density.

Much of the insect control technology developed for lowland rice, including varietal resistance and foliar insecticide sprays, may also be used for upland rice.

CONTROL **MEASURES**

Furrow placement **of** insecticides. We evaluated the effectiveness of several systemic insectides placed at the bottom of furrows before seeding upland rice. We expected the roots of the germinating rice to absorb the chemicals, controlling the insect pests by a systemic effect. The compounds carbofuran, chlordimeform, acephate, and gamma-BHC + MTMC, each used at 2 kg a. i./ha, provided significant brown planthopper control for up to 50 days after seeding (Table 1). Corbofuran, propoxur, **AC** 64,475,

Table 1. Effect of placing insecticides in the furrows before seeding for the control of upland rice pests. Line used: IR442-2-58. IRRI, 1973 wet season.[a]

Insecticide[b] (2 kg a.i./ha)	Brown planthoppers[c] (no./1-m row)				Hopperburned area (%) 66 days	Green leafhoppers (no./10 sweeps)			Leaves damaged by leaf folders (%) 52 days
	50 days	58 days	62 days			35 days	50 days	57 days	
	N	N	N	A					
Carbofuran	48	147	203	3	1	0	0	0	5
Propoxur	86	700	785	27	65	1	3	0	13
AC 64, 475	54	520	695	36	41	2	2	0	9
Phentriazophos	66	686	885	44	51	2	5	2	8
γ-BHC + MTMC	52	139	481	15	4	3	9	0	8
BPMC	52	462	644	38	36	5	12	1	9
JF 4089	60	780	721	18	87	5	10	3	13
Formetanate	32	562	1112	32	72	6	14	2	9
Chlordimeform	43	301	507	10	26	2	8	3	9
Thiadiazinthion	64	826	1005	18	84	1	2	0	12
Acephate	52	430	386	7	20	9	16	2	10
Untreated control	103	532	1484	36	93	4	12	9	14

[a]Because stem borer and virus incidence during the experiment was low, there was no difference among various treatments. There were large numbers of leaf folder (*C. medinalis*) adults (about 10-20/10 sweeps) but there was no consistent difference among various treatments. [b]Also applied as a side dressing at 55 days after seeding. [c]N = nymphs; A = adults.

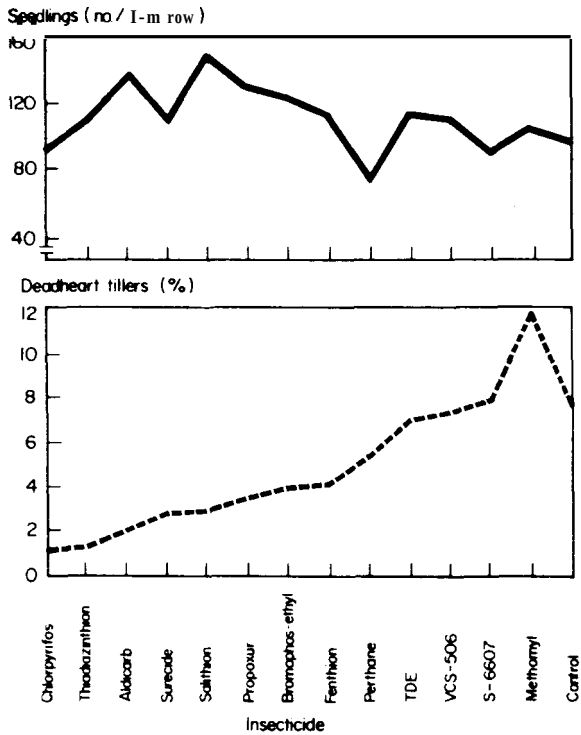
phentriazophos, and thiadiazinthion were all effective against the green leafhopper. Carbofuran also effectivelv controlled the rice leaf folder.

Seed treatment. Treating rice seeds with insecticide can be a practical method of controlling seedling pests of upland rice. We tested about 50 insecticides as seed treatments in laboratory and field experiments. Each test compound was thoroughly mixed with IR8 seed at the rate of 2 kg a.i./100 kg of seed. The wettable powder and emulsifiable concentrate formulations were first mixed with enough water to saturate the seeds. We added methyl cellulose to the mixture to make a sticker solution of 1 percent.

Table 2. Mortality of green leafhopper *(Nephotettix virescens)* adults 24 hours after they were caged on rice seedlings grown in test tubes from seeds treated with various insecticides. IRRI, 1967.[a]

Insecticide[b]	Seed germination (%)	Leafhopper mortality (%)	
		11 days after sowing	20 days after sowing
Phenthoate 50 EC	50	78	28
Azinphosmethyl 5 G	60	100	100
Cyanox 5 G	60	73	38
Methomyl 5 G	60	10	0
Aldicarb 10 G	100	100	84
Bromophos-ethyl 80 EC	80	14	49
Methyl parathion 10 G	50	86	76
Metalkamate 10 G	20	100	100
Perthane 45 EC	90	42	37
TDE 50 WP	100	14	34
Salithion 5 G	80	4	6
Surecide 5 G	100	29	52
Propoxur 5 G	100	100	78
Chlorphyrifos 24 EC	40	92	91
VCS 506 36 EC	70	5	10
Thiadiazinthion 10 G	90	100	97

[a] Avg of 10 replications. Each replication contained 10 adult insects. [b] At 2 kg/100 kg of rice seeds. Seeds treated with mecarbam, A 3010, E 605, Cytrolane, No. 6538, and dimethoate did not germinate.



1. The effectiveness (29 days after seeding) of various insecticides when used as a seed treatment at the rate of 2 kg/ 100 kg of seed in protecting the crop from stem borers.

Using a fine droplet atomizer. we sprayed this solution on the seeds as they were rotated in a cement mixer. We preferred the wettable powder formulation rather than the emulsifiable concentrate or granules for the seed treatment.

The treated seeds were grown in 2.5- x 30-cm test tubes in laboratory experiments. At 11 and at 20 days after sowing, green leafhopper *(Nephotettix virescens)* adults were caged on the seedlings. Insect mortality was recorded at 24 hours after caging.

As seed treatments, azinphosmethyl, metalkamate, chlorpyrifos, and thiadiazinthion killed more than 00 percent of the leafhoppers that were caged on the seedlings in the test tubes at 20 days after sowing, while several other compounds killed more than

Table 3. Effect of seed treatment on insects caged on seedlings of direct-seeded rice 20 to 43 days after seeding. IRRI, 1971 wet season.

Insecticide	Mortality[a] (%)						
	Greenhouse					Upland field	
	Green leafhopper			Brown planthopper		Green leafhopper	Brown planthopper
	20 days	34 days	43 days	21 days	36 days	26 days	25 days
Carbofuran	100	38	93	95	45	32	100
TBPMC	100	68	34	55	5	0	4
XMC	93	0	–	8	0	0	6
C-17475	38	0	–	0	0	5	0
C-17018	38	0	–	3	0	3	0
Thiadiazinthion	98	70	95	0	3	7	26
Chlorpyrifos	43	3	–	8	3	4	6
C-10015	75	28	13	5	3	3	5
Dimethoate	35	8	–	0	0	21	4
Propoxur	42	8	5	13	5	4	63
Disulfoton	5	0	–	0	0	8	2
MIPC	3	0	–	8	8	8	0
Control	–	–	–	–	–	–	–

[a] 24 hours after the insects were caged; values adjusted using Abbott's formula.

Table 4. The effect (at 50 and at 90 days after transplanting) of insecticidal sprays containing 0.05% a.i. every 15 days. IRRI, 1966 dry season.

Insecticide	Dead hearts (%) 50 days	White heads (%) 90 days	Tungro-infected hills (%)	Grain yield (t/ha)
Monocrotophos	2	8	4	5.7
Phosphamidon	4	8	8	4.9
Chlorfenvinphos	1	9	2	5.2
R-5092	2	9	5	4.6
GS 13005	2	7	8	5.2
Endosulfan	2	10	6	4.8
S-6538	1	8	7	5.4
Azinphosmethyl	2	9	2	4.9
Methyl parathion	2	6	7	4.9
SD-8211	2	8	6	4.8
Fenthion	2	11	4	4.7
M-2840	2	11	7	5.2
Dicrotophos	3	12	3	5.1
Bromophos	3	13	9	3.9
Fenitrothion	2	9	5	4.6
Mecarbam	2	12	8	4.3
UC 8305	2	11	6	4.3
Fitios	4	13	10	4.0
Malathion	4	13	8	3.8
SD 8447	3	11	10	4.4
Fentin acetate	3	10	24	3.8
Naled	3	12	16	3.6
Control	5	14	33	2.8

50 percent (Table 2). Although we do not know whether the mortality was due to the systemic effect of the compounds or to the vapors emitted by the toxicants, the results indicate that seed treatment may be a practical way to protect seedbeds or direct-seeded rice from the green leafhopper.

For the upland field experiments, we air-dried the treated seeds for 48 hours and drilled them at the rate of 80 kg/ha in rows 30 cm apart in 4- x 8-m plots. Four replications were planted using a randomized complete block design: untreated seeds were planted as controls.

To determine the effect of different treatments on seed germination and on insect damage to seedlings, we counted the seedlings in a meter-long area in each of three randomly selected rows at 13, 29, and 40 days after sowing. We also graded the crop visually for percentage of germination and for green crop growth at 10 and at 29 days after seeding.

The seeds treated with dimethoate, Cytrolane, AC 47,031, and mecarbam did not germinate; fewer than 10 percent of those treated with metalkamate, **A-3010,** A-605, and S-6626 germinated. In all other test plots, germination was almost normal. At 13 days after seeding, we found 13 compounds that effectively protected the crop from dead heart damage by stem borers. At 29 days after seeding, we found that seeds treated with chlorpyrifos. thiadiazinthion, aldicarb, Surecide, Salithion, and propoxur produced plants with significantly lower percentages of dead hearts than seen in the control plants (fig. 1). The compounds chlorpyrifos, thiadiazinthion, and Surecide effectively controlled the green leafhopper as well (Table 2, fig. 1). These results suggest that a simple and practical method may be found to protect direct-seeded rice from ants, mole crickets, soil grubs, and other soil insects.

In another experiment, the same insecticides were used at 1 kg a.i./100 kg of rice seed. We first coated the seeds with a sticker solution of 2 percent methyl cellulose, then we applied the insecticides. Last, we coated the seeds with activated charcoal which absorbs surface moisture and prevents the seeds from lumping together. The seeds were treated by rolling them with the various chemicals in a plastic bucket. The untreated controls received the same treatment, but without insecticide.

We planted the treated seeds directly in 15-cm clay pots at 15 seeds per pot. We also directly seeded them with a seeder in an upland rice field in 2- x 4-m plots using three replications. We bioassayed both the potted seedlings and the upland plots by caging green leafhoppers and brown planthoppers on them.

In the pot experiment, carbofuran, **TBPMC,** and thiadiazinthion caused high mortality of the green leafhoppers caged on the

Table 5. Summary of the effects of selected insecticides applied as foliar sprays. IRRI, 1968 to 1972 wet and dry seasons.

Insecticide	Trials[a] (no.)	Whorl maggot damage[b] (grade)	Dead hearts (%)	Virus-infected hills[c] (%)	White heads (%)	Mean hopperburned area (%)	Mean yield (t/ha)
Metalkamate	2	2.0	1.8	9	0.7	2	4.72
Carbofuran	3	1.0	0.5	14	0.2	4	4.53
Monocrotophos	7	1.0	1.5	14	0.3	6	4.41
Carbaryl	2	2.0	0.5	15	0.5	5	4.20
Promecarb	2	2.0	2.1	3	1.1	8	4.12
MIPC	4	1.5	2.4	15	1.2	4	4.07
C-10015	2	2.0	2.7	38	1.4	6	3.61
Vamidothion	2	1.0	2.8	49	1.6	14	2.28
Control	7	4.0	5.8	20	1.3	17	3.20

[a]Each trial consisted of four replications. Insecticide concentration ranged from 0.04 to 0.05% applied every 10 to 14 days.
[b]On a scale of 0 to 5. Larger number means greater damage. [c]Mostly grassy stunt.

Table 6. Effectiveness of foliar sprays containing 0.05% a.i. insecticide applied at 15-day intervals in preventing hopperburn and leaf folder damage in upland rice (line IR442-2-58). IRRI, 1973 wet season.

Insecticide	Hopperburned area[a] (%) 70 days	Leaf folder damage[b] 57 days
Chlordimeform	0a	0.9 a
Metalkamate	0a	3.4 bc
Acephate	0a	0.5 a
Monocrotophos	1 a	0.5 a
BPMC	8 ab	4.6 de
Chlorpyrifos	17 abc	0.5 a
Fenthion	28 abc	3.6 bcde
Fenitrothion	39 bcd	3.5 bcd
Endosulfan	51 cde	4.5 cde
Azinphos ethyl	76 de	2.8 b
Surecide	90 e	0.6 a
Untreated control	42 bcde	4.8 e

[a] Any two numbers followed by the same letter are not significantly different at 5% level. [b] On a scale of 0 to 5. Larger number means greater damage.

seedlings up to 43 days after seeding. Carbofuran and TBPMC also effectively controlled the brown planthopper, but for shorter durations (Table 3).

The insecticides were much less effective in the upland field tests. Although the plots treated with several of these insecticides grew more luxuriantly than did the untreated controls, the differences subsided within 40 to 50 days after seeding.

Foliar sprays. Most available insecticides have been tested as foliar sprays on lowland rice and are expected to perform similarly under upland conditions (Tables 4 and 5).

Using 0.05 percent solutions, we sprayed selected compounds on upland rice fields every 15 days in an experiment at IRRI and found several, including chlordimeform, metalkamate, acephate, and monocrotophos. that effectively controlled both the brown planthopper and the leaf folder (Table 6). But the foliar sprays have short residual periods and are easily washed off by rain. Be-

Table 7. Effectiveness of foliar sprays (0.05% solution at 250 gal/ha) in controlling the brown planthopper in upland rice. IRRI, Oct. 22 – Nov. 5, 1972[a]

Insecticide	Brown planthoppers[b] (no./25-cm row)				
	Nymphs		Adults		Nymphs
	1 day before spraying	2 days after spraying	14 days after spraying	21 days after spraying	35 days after spraying
Perthane	184	1	4	5	13
Chlordimeform	160	1	2	6	16
Metalkamate	135	1	2	4	12
MIPC	88	2	4	7	24
Acephate	167	10	13	7	31
Monocrotophos	107	17	26	9	53
CPMC	189	20	16	6	32
Phentriazophos	180	21	28	8	96
Carbaryl	139	47	38	4	56
Dicrotophos	108	52	64	8	78
Methyl parathion	87	54	78	8	49
Untreated control	141	84	104	8	14

[a]Avg of four replications. [b]Visually counted.

Table 8. Effectiveness of foliar sprays (0.05% solution at 250 gal/ha) in controlling grasshoppers in upland rice. IRRI, Oct. 22 – Nov. 5, 1973.

Insecticide	Grasshoppers (no./10 sweeps)		
	1 day before spraying	2 days after spraying	21 days after spraying
Methyl parathion	1	1	6
Chlordimeform	1	2	5
MIPC	3	2	6
Carbaryl	3	3	3
Metalkamate	6	4	7
Acephate	2	2	5
Dicrotophos	5	0	4
Monocrotophos	4	0	2
Phentriazophos	3	2	2
CPMC	5	5	8
Perthane	4	6	4
Untreated control	2	5	7

Table 9. Effectiveness of foliar sprays (0.05% solution at 250 gal/ha) in controlling green leafhoppers in upland rice. IRRI, Oct. 22 – Nov. 5, 1973.

Insecticide	Green leafhoppers (no./10 sweeps)		
	1 day before spraying	2 days after spraying	21 days after spraying
Methyl parathion	3	0	6
MIPC	2	0	6
Acephate	3	0	6
Phentriazophos	4	0	2
Perthane	1	0	6
Monocrotophos	3	0	3
Dicrotophos	3	0	7
Metalkamate	2	0	6
Carbaryl	2	0	6
CPMC	2	0	8
Chlordimeform	1	1	10
Untreated control	1	2	11

cause they do not readily penetrate to the base of the rice plant where brown planthoppers feed, sprays generally give poor control of this insect. The brown planthopper seems to be increasing and the pest problem spreading; hopperburn damage is now a common sight in Asia.

In an experiment, we sprayed selected compounds into the brown planthopper's normal feeding area. The lower half of the rice plants were sprayed by keeping the spray nozzle at about the middle height of the plant. This method is quite effective for brown planthopper control (Table 7). The compounds Perthane, chlordimeform, metalkamate, and MIPC were most effective against the insects. Monocrotophos and dicrotophos were effective against grasshoppers for as long as 21 days after spraying (Table 8). Most of the insecticides tested effectively controlled the green leafhopper; phentriazophos and monocrotophos were effective even at 21 days after the spray (Table 9).