EVALUATION OF CHEMICALS FOR RICE INSECT PEST CONTROL AT IRRI

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Abstract

The main purpose of the insecticide evaluation activities at IRRI is not routine work for screening but to establish the methodology. From 1960 through the end of 1981, more than 1,000 kinds of chemicals were evaluated. Most of them were conventional insecticides and few are insectistatics including *Chilo* pheromones. Thirteen important pests are targeted for evaluation. Nine species are used in laboratory tests: rice bug (RB), brown planthopper (BPH), green leafhopper (GLH), whitebacked planthopper (WBPH), striped stem borer (SSB), yellow stem borer (YSB), leaf folder (LF), rice caseworm (RCW), and rice armyworm (RAW), whereas 8 in field tests: RB, BPH, GLH, WBPH, SSB, YSB, LF, and rice whorl maggot (RWM). Rearing methods of BPH, GLH, WBPH, SSB, YSB, LF, RCW, RB, and RAW have been developed at IRRI.

The rate of 0.75 kg a.i. in 1,000 l (for lab. test) and in 300 l water/ha (for field test) for insecticides other than synthesized pyrethroids is used. For pyrethroids a rate of 0.05 kg a.i./ha is used. For broadcast, root-zone, and soil incorporation treatments, rates of 0.75 or 1.0 kg a.i./ha are used. In the laboratory, chemicals are evaluated mostly in contact toxicity tests, foliar sprays on plants, broadcast, root-zone application of gelatine capsule granules and liquid solution, and soil incorporation of granules and liquid. Other methods such as dipping, etc. are tested experimentally. Insecticides showing 80% or more mortality are recommended for field tests.

In open fields, chemicals are evaluated by either natural infestation (usually in stem borers, LF, RWM, and RB) or caging insectary-reared insects (usually in BPH, GLH, and WBPH). Insecticides showing 40% or more mortality are considered to be promising.

Methodology for the evaluation of insectistatics has not been established.

Introduction

Grist and Lever (1969) designated about 897 species of insects as pests of rice in the world. Important insect pests frequently vary with the regions and cropping patterns using different cultivars under various climatic conditions.

The insecticide evaluation for rice insect pest control at IRRI is only a part of the research activities on chemical control of rice pests. The main purpose of the evaluation activities is not targeted to routine work for screening insecticides against certain pests in the Philippines but to establish the methodology for the evaluation of chemicals (not only insecticides but also insectistatics) used for the control of rice pests. IRRI has evaluated any chemicals provided by public and also private organizations from any countries without charge. However decisions on whether it is appropriate to register promising chemicals for pest control for commercialization do not depend on IRRI but on the government agencies of the respective countries. Table 1 shows the number of chemicals evaluated for insect pest control in rice crop since IRRI was established in 1960–1962.

Target insect pests for evaluation of chemicals

Thirteen important insect pests in the Philippines are targeted (Table 2). At present, however, 9 species are used as the materials for laboratory tests: rice bug (RB), brown planthopper (BPH),

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Table 1 Number of chemicals evaluated by the Entomology Department, IRRI, 1960–1981, excluding botanical insecticides.

Year	Conventional insecticides tested		Coded chemical	New types of chemical	Total
	Alone	Combination			
1962	–	–	–	–	–
1963	26	0	1	?[b]	27
1964	17	0	0	?	17
1965	11	1	5	4[c]	21
1966	20	4	12	?	36
1967	20	2	20	?	42
1968	24	6	4	1[d]	35
1969	13	6	10	?	29
1970	43	15	29	?	87
1971	32	8	21	?	61
1972	17	10	10	?	37
1973	55	16	14	?	85
1974	21	11	15	?	47
1975	15	7	16	1[e]	39
1976	35	6	25	1[e] + 1[f]	68
1977	29	8	8	1[e]	46
1978	49	18	15	1[e]	83
1979	81	11	18	1[e] + 2[g]	113
1980	77	7	17 + (1[h])	1[e] + 4[g] + 1[h]	107
1981	55	8	18	1[e] + 1[f] + 1[g] + 1[h]	85

a Based on IRRI Annual Reports of 1961–1975 and on Insecticide Evaluation Reports of 1976–80. The IRRI Annual Report 1961–62 indicated that screening of insecticides was initiated in late 1962 but gave not data. Some chemicals were tested repeatedly as standard checks or against insects over the years.

b A question mark indicates that we do not know whether the chemical is a coded chemical without details from the manufacturer.

c Chemosterilants. d Pheromones extracted. e Synthesized pheromones.

f Isoprothiolane (Fuji-one). g *Bacillus thuringiensis* products.

h Buprofezin (NNI-750/Applaud).

Table 2 Current target insect pests for the evaluation of insecticides at IRRI.

Scientific name		English name	Abbreviation
Plant suckers			
1. *Leptocorisa oratorius*	(Het., Alydidae)	Rice bug	RB
2. *Nephotettix* spp., *mainly N. virescens*	(Hom., Cicadellidae)	Green leafhopper	GLH
3. *Nilaparvata lugens*	(Hom., Delphacidae)	Brown planthopper	BPH
*4. *Scotinophara* sp.	(Het., Pentatomidae)	Rice black bug	RBB
5. *Sogatella furcifera*	(Hom., Delphacidae)	Whitebacked planthopper	WBPH
Stem borers			
6. *Chilo suppressalis*	(Lep., Pyralidae)	Striped stem borer	SSB
7. *Scirpophaga incertulas*	(Lep., Pyralidae)	Yellow stem borer	YSB
Leaf feeders			
8. *Cnaphalocrocis medinalis*	(Lep., Pyralidae)	Leaf folder	LF
9. *Hydrellia philippina*	(Dip., Ephydridae)	Rice whorl maggot	RWM
10. *Nymphula depunctalis*	(Lep., Pyralidae)	Rice caseworm	RCW
11. *Nythimna separata*	(Lep., Noctuidae)	Rice armyworm	RAW
*12. *Plusia* spp.	(Lep., Noctuidae)	Rice looper	RL
*13. *Spodoptera mauritia acronyctoides*	(Lep., Noctuidae)	Rice swarming caterpillar	RSC

* The insect is not used as the material for routine screening due to the lack of established methodology.

green leafhopper (GLH), whitebacked planthopper (WBPH), striped stem borer (SSB), yellow stem borer (YSB), leaf folder (LF), rice caseworm (RCW), and rice armyworm (RAW), whereas 8 for field tests: RB, BPH, GLH, WBPH, SSB, YSB, LF, and rice whorl maggot (RWM).

Rearing test insects

Methods of rearing the BPH, GLH, WBPH, SSB, YSB, LF, RB, RCW, and RAW have been developed at IRRI (Heinrichs *et al.*, 1981). Table 3 shows a summary of preparation of insects used for laboratory and field insecticide evaluation tests. Taichung Native 1 (TN1) is generally used.

Table 3 Summary of preparation of insect materials for laboratory and field insecticide tests at IRRI.

Pest species	Rearing	Insects used for test in	
		Laboratory	Field
Plant suckers			
1. BPH, GLH, WBPH	On rice plants in tillering stage	Insectary-reared adults	Insectary-reared adults
2. RB	On rice plants in milky stage	Two-day-old insectary-reared adults	Under natural infestation
3. RBB	–	–	–
Stem borers			
4. SSB, YSB	On rice plant stems	Newly-hatched larvae	Deadhearts/whiteheads under natural infestation
Leaf feeders			
5. LF	On rice plants	Newly-hatched larvae	Under natural infestation
6. RCW	On rice plants	Newly-hatched larvae	Under natural infestation*
7. RAW	On rice plants/ grasses	Fifth instar larvae	Under natural infestation*
8. RL	–	–	–
9. RSC	–	–	–
10. RWM	–	–	Usually under good natural infestation

* Usually no evaluation because of commonly low infestation at the experimental farm.

Laboratory evaluation of insecticides

Most candidate insecticides tested at IRRI are liquid solution, aqueous, emulsifiable concentrate (EC), flowable formulation (FL), soluble powder (SP), or wettable powder (WP), and others are granules (G). Evaluation is carried out in an insectary controlled at temperatures of 27 ±5°C with about 80% R.H. and a 12 hr daily illumination.

1 Contact toxicity

This method is applied to BPH, GLH, WBPH, and RB.

(1) About twenty 5-day-old adults of hoppers and 2-day-old adults of RB for each replication are anaesthetized with CO_2 gas to immobilize them temporarily before spraying. They are kept on filter paper in a petri dish 10 cm in diameter. (2) A solution of 2 ml* is sprayed directly on the insects using the Potter's spray tower at a pressure of 1,038 kg/cm^2. (3) Immediately after spraying, insects are transferred to pots with untreated 10- to 15-day-old Taichung Native 1 (TN1) seedlings and covered with mylar film cages. (4) Cumulative mortality is checked at 1, 4, 24, and 48 hr after treatment.

2 Foliar spray

The rates of insecticides are the same as in the contact toxicity tests.

* A 0.075% a.i. 2 ml solution spray in the contact toxicity test is equivalent to 0.75 kg a.i. in 1,000 l water/ha in the foliar spray and other treatments. A rate of 0.005% a.i. in 2 ml water is used for synthesized pyrethroids.

A BPH, GLH, and WBPH

(1) Three 30- to 35-day-old TN1 or Rexoro, both susceptible cultivars/pot are used. Four pots are placed on a rotating disc. (2) A solution of 25 ml is sprayed on the four pots prepared with rice plants. (3) Atomizer run by a motor air compressor at a pressure of 0.692 kg/cm^2 is used in spraying. (4) Ten to 20 adults are caged on treated and untreated plants at 1, 5, 10, 15, and 20 days after treatment in cylindrical mylar film cages. (5) Mortality is checked at 48 hr after caging up to when it becomes less than 40%.

B SSB and YSB

(1) Follow steps 1 to 3 in hopper test. (2) At 1, 5, 10, and 15 days after spraying, stems are cut at a length of 7.5 cm. Both ends of the stems cut are sealed by dipping them into hot paraffin wax and kept in vials 2.0 x 9.5 cm; one stem/vial/replication. (3) Ten to 20 freshly hatched larvae are kept on each sealed stem in a glass vial at the indicated days after treatment. (4) Forty-eight hr after introducing the larvae, dissect the stems using dissecting board to assess insect mortality.

C LF

(1) Thirty- to 35-day-old TN1 are used. Thin plants to 5 tillers/pot. Infest them with newly hatched larvae by placing 2 larvae each on the auricle of the leaf (10 larvae/5 tillers/pot) with a camel hairbrush 2 weeks before spraying the plants. (2) After folding the leaves or about 2 weeks after infestation, plants are sprayed with a test insecticide solution at a given rate. An insecticide solution of 6.25 ml is sprayed/pot. Untreated plants are sprayed with water alone.

D RCW

(1) Transplant 14-day-old seedlings in pots at 3 hills/pot and 2 plants/hill. Place one pot in each plastic tray and add water to cover pot. (2) Place 10 second instar larvae from the larva-rearing cage in each tray 2 weeks after transplanting. Cover infested plants with mylar film cage. (3) Remove the mylar film cage 1 day after larvae are established on the plants. (4) Place the plastic tray with the potted plants in water on the revolving disc and spray with a solution of 6.25 ml/pot. (5) After spraying, cover pot with a mylar film cage and place the tray in the insectary. (6) Remove the cases and larvae without cases from the tray and place them in a petri dish containing water, 48 hr after spraying. Living larvae can be identified by their movement. Where no movement is observed, open the cases to check whether a larva is in the case. When some larvae are missing, check the bottom of the tray. (7) To determine the residual effect of insecticides, fresh larvae can be added at various intervals.

E RB

(1) Insecticide-free rice plants in the milky stage, from the field, are transplanted in pots at the rate of one hill/pot. (2) Four pots with rice plants transplanted are sprayed on a rotating disc with a 25 ml insecticide using atomizer. (3) Sprays are directed to the panicles. (4) At 1, 5, 7, and 15 days after treatment, 5 panicles from each treated plant are kept in a plastic jar covered by a mylar film cage. Ten adults are released/5 panicles. Check mortality 48 hr after adults are released.

F RAW

(1) Thirty- to 35-day-old TN1 are potted. A 25 ml of test solution is applied to 4 pots by spraying at a pressure of 0.692 kg/cm^2. One day after treatment, 10 fifth instar larvae are released. Mortality is checked 24 and 48 hr after release.

3 **Dipping**

Ten to 20 RAW fifth instar larvae are dipped in a 200 ml solution for 30 seconds. Take them

out and keep them on dry filter paper for several minutes. Transfer them to a petri dish with dry filter paper and provide rice leaves as food. Mortality is checked at 1, 4, 24, and 48 hr after treatment.

4 Broadcast

Porcelain pots 20 cm high and 15.5 cm in diameter are used. Sow TN1 seeds in clay pots at the rate of 2–3 seeds/pot. Transfer 30- to 35-day-old seedlings from the clay pots to the porcelain pots at the rate of 1 hill/pot. Insecticides are broadcast in pots with 2 cm standing water, a week after transplanting. Mortality assessment varies with species of pests.

Hoppers: Release 20 adults/cage 1, 5, 10, 15, and 20 days after granule application. Assess the mortality 48 hr after caging.

Stem borers: Remove the plants from the porcelain pots at 1, 5, 10, and 15 days after granule application (as long as mortality remains above 40%). Cut and seal the stems with hot paraffin wax. Infest the stems with larvae and check mortality as shown in the foliar spray test.

LF: Apply granules in the standing water of potted plants about 2 weeks after the plants are infested with first instar larvae, or when leaves are rolled. Check the mortality 2 days after application.

RCW: Transplant 3 hills of two 14-day-old seedlings each into the soil in a plastic tray. After 2 weeks, place 10 second instar larvae in each tray and cover with a mylar film cage with open top. After 1 day, broadcast granules into the water within a mylar film cage. The rate of an insecticide is based on the surface area of the water within the mylar film cage. Record mortality 2 days after application.

RAW: Thirty- to 35-day-old TN1 are planted in porcelain pots. Broadcast granules in the water 2 cm in depth. Rate of an insecticide is based on the surface area of the pot mouth. Release 10 fifth instar larvae on the plants a day after application and check mortality 2 days after release.

5 Root-zone application

Two types of insecticides, granule and liquid, are used for this purpose. Place weighed granules in a gelatin capsule (1.5 cm long and 0.5 cm in diameter). Place a gelatin capsule into the soil near the root-zone of the plants (2 cm below the soil surface and 2 cm away from the plant) in a porcelain pot by hand. Inject FL, WP, SP, or EC formulation insecticide as a prepared solution (1 ml/pot) under the root system, using a glass syringe. Check mortality in hoppers and stem borers, 48 hr after caging at 1, 5, 10, 15, 20, 25, and 30 days after application (up to when mortality becomes less than 40%), as in broadcast application.

6 Soil incorporation

Granular insecticide is incorporated or mixed into the soil at about 10 cm in depth in porcelain pots. Thirty- to 35-day-old TN1 plants from clay pots are transferred to porcelain pots just after insecticide application. Check mortality as in broadcast application.

7 Other treatments

Fumigation, irrigation water treatment, seed treatment, root-soaking, root-coat treatment, etc. are considered and tested. But the methodology has not been established yet.

8 Data on the evaluation

Tables 4, 5, and 6 show the results on contact toxicity, foliar sprays, and broadcast treatment.

Table 4 Contact toxicity of insecticides against the whitebacked planthopper when treated in the Potter's spray tower (IRRI Insecticide Evaluation 1981, p. 23).

Chemicals[a]	Mortality (%)[b]			
	1 HT[c]	4 HT	24 HT	48 HT
M 9918 20 OE	100 a	100 a	100 a	100 a
Dioxacarb 50 WP	98 a	98 ab	99 a	100 a
M 10604 20 OE	79 b	82 c	84 b	89 b
Methidathion 40 EC	43 c	96 b	100 a	100 a
UC 27867 50 WP	41 c	69 d	75 b	88 b
RH 0308 48 EC	0 d	0 e	15 c	30 d
RH 0994 48 EC	1 d	1 e	11 c	41 c
Control	0 d	0 e	4 d	11 e

a Applied at the rate of 0.75 kg a.i./ha.
b Values in a column followed by the same letter are not significantly different at the 5% level by DMRT (P = 0.05).
c HT = Hrs after treatment with insecticides.

Table 6 Laboratory evaluation of granular insecticides broadcast against the yellow stem borer (IRRI Insecticide Evaluation 1981, p. 35).

Chemicals	Rate (kg a.i./ha)	Mortality (%)[a]		
		1 DAT[b]	7 DAT	14 DAT
Carbofuran 3 G[c]	1.0	45 a	88 a	100 a
Carbofuran 3 G[c]	1.0	22 b	85 a	95 abc
Carbofuran 3 G[c]	1.5	29 ab	88 a	99 ab
Diazinon 5 G	1.0	32 ab	44 c	32 e
Diazinon 5 G	1.5	49 a	51 bc	31 e
Control		8 c	11 d	9 f

a Mortality at 48 hr after placing 1st instar larvae on treated stem pieces at indicated days after treatment. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.
b DAT = Days after treatment.
c Carbofuran was incorporated into the soil.

Table 5 Laboratory evaluation of insecticides applied as foliar sprays against the yellow stem borer (IRRI Insecticide Evaluation 1981, p. 30).

Chemicals[a]	Mortality (%)[b]		
	1 DAT[c]	7 DAT	14 DAT
Carbofuran 12 FL	100 a	100 a	58 bcd
BPMC 10.5 + chlorpyrifos 21 EC	100 a	95 ab	60 bc
Phosmet 50 WP	100 a	95 ab	85 a
Fenitrothion 50 EC	100 a	91 ab	41 cdef
Monocrotophos 16.8 EC	100 a	90 ab	31 cdefg
Azinphos-ethyl 40 EC	100 a	79 bc	76 ab
Methomyl 20 EC	100 a	55 cd	25 efg
Dimethoate 40 EC	100 a	41 de	28 fg
Phosphamidon 50 EC	100 a	36 de	25 efg
Diazinon 20 EC	100 a	24 e	32 defg
Fenthion 50 EC	99 abc	42 de	32 defg
Carbophenothion 25 WP	99 abc	91 ab	58 bcd
Endosulfan 35 EC	89 bc	88 b	54 bcde
BPMC 50 EC	49 d	28 de	20 fg
Bacillus thuringiensis	40 d	19 e	15 fg
Control	8 e	14 e	9 g

a All chemicals applied at the rate of 0.75 kg a.i./ha except *B. thuringiensis* at 0.4 kg formulation (16,000 IU/mg) per ha.
b Mortality readings 48 hr after placing 1st instar larvae on treated stem pieces. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.
c Days after treatment when larvae were infested on stem pieces.

Field evaluation of insecticides

The rate of 0.75 kg a.i. in 300 l water/ha is used for insecticides other than synthesized pyrethroids. For pyrethroids 0.05 kg a.i./ha is applied. For broadcast, root-zone, and soil incorporation treatments, 0.75 or 1.0 kg a.i./ha are used. IR22 is generally used.

1 Foliar spray

Each test insecticide is sprayed by 15 l knapsack sprayer with a single-hole nozzle in the morning. Spraying is started 3–5 days after transplanting and done 4–5 times at an interval of 15 days.

A BPH and WBPH – Evaluation is done by visual counting or suction machine on natural populations or on caged insectary-reared populations. On natural populations, 20 hills are taken at random/plot. Counting is done 1 day before and 2 days after each application. On caged insects, one day after each application, 1 to 4 hills/plot are covered at random by mylar cages. Twenty BPH adults plus 20 GLH adults are confined within each mylar cage. Other 1 to 4 hills/plot are covered at random by cages. Twenty WBPH adults plus 20 GLH adults are released within

each cage. Two days after caging, check the mortality. Insects are caged at 1, 5, 10, 15, and 20 days after treatment.

B GLH – Evaluation on natural populations is done by 10 sweeps or 5 double strokes/plot weekly using an insect sweeping net (30.5 cm in diameter with a wooden stick 1 m long) from 10 days up to 60–65 days after transplanting. For evaluation on caged GLH, see the procedure for BPH and WBPH.

C Stem borers – Candidate insecticides are usually evaluated on the basis of natural infestation. In the case of low natural infestation at least 10 egg-masses are kept on 10 plants/plot. Deadhearts are counted twice 45 and 65 days after transplanting in the whole yield area (8 x 20 hills or 10 x 10 hills/plot). Whiteheads are once counted a week before harvest.

D RWM – In assessing RWM damage, visual grading is done in the field under natural infestation early in the morning or late in the afternoon twice 15 and 25 days after transplanting, using the standard evaluation system with a 0–9 scale (IRRI 1980, p. 28).

E LF – % LF damage is observed on 20 hills/plot sampled at random under natural infestation; total no. of damaged and folded leaves/(total no. of healthy leaves + total no. of damaged and folded leaves) x 100. Observations are done twice before panicle initiation (about 45 days after transplanting) and after the panicle emerged (65 days).

F RB – Adults and older nymphs are counted together at 1 m^2 at 2 different sites around the center of each plot, early in the morning twice during the flowering and milky stages.

2 Broadcast

Keep irrigation water 3–5 cm in depth. Broadcast granules into paddy water 3–5 days after transplanting. Broadcast granules again 25 days after 1st treatment. Follow the procedure of foliar sprays, otherwise not described here.

3 Root-zone application

Place a capsule with a granular insecticide about 2 cm to the side of the hill and 2 cm below the soil surface at the rate of 1 capsule/hill by hand. When liquid insecticides are tested, a 10-row IRRI-designed liquid injector (Fig. 1) is used to inject 4.5 ml/injection. Inject chemicals once 10 days after transplanting. One mechanical rice transplanter is used in injecting FL formulation insecticide together with seedlings into the root-zone area (Fig. 2).

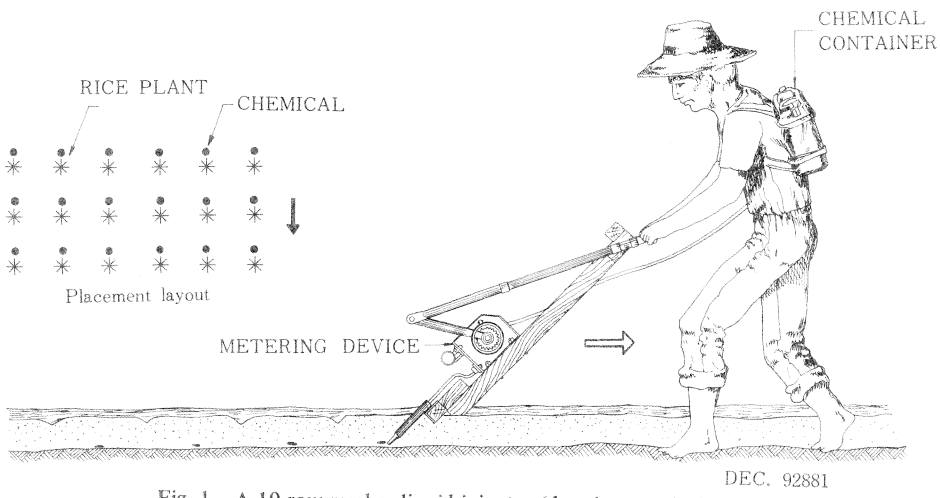

Fig. 1 A 10-row marker liquid injector (drawing supplied by Agricultural Engineering Department, IRRI).

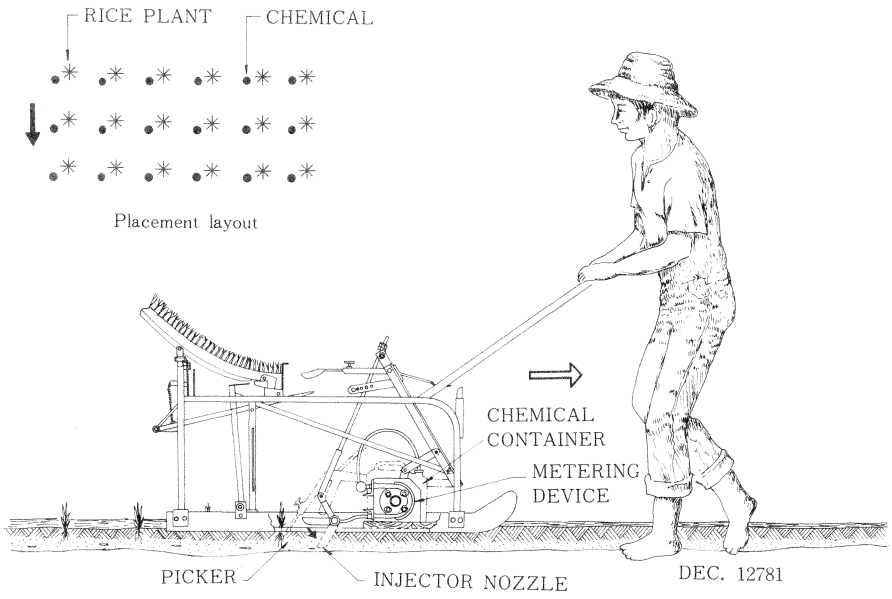

Fig. 2 A mechanical rice transplanter with an apparatus for injecting liquid insecticide (drawing supplied by Agricultural Engineering Department, IRRI).

4 Soil incorporation

Keep levees closed. Maintain 2–4 cm water in the field. Broadcast measured granules by hand as uniformly as possible. Incorporate the granules preferably with a roto-tiller or a mini-cultivator. Run the cultivator crosswise and level the field. If a harrow is used, run harrow crosswise and lengthwise. Transplant a day after incorporating granules. Impound water for at least 3 days after application. Follow the procedure of foliar sprays, otherwise not described here.

5 Data on the evaluation

Tables 7 and 8 show the results on foliar sprays and broadcast on YSB and RWM. When the mortality is 40–50% or more, the candidate chemical may be promising.

Table 7 Field evaluation of insecticides applied against the yellow stem borer on IR29 at Maligaya Rice Research and Training Center in dry season 1981 (IRRI Insecticide Evaluation 1981, p. 37).

Chemicals[a]	Application method	Deadhearts (%)[b] 40 DT	Deadhearts (%)[b] 65 DT	Whiteheads (%)
Phosphamidon	Spray	29.7 abc	14.4 bcd	7.0 abc
Endosulfan	Spray	25.5 bcde	13.1 cde	7.3 abc
Chlorpyrifos + BPMC	Spray	8.7 fg	9.5 defg	7.5 ab
Monocrotophos	Spray	31.4 abc	11.9 cdefg	4.4 bcd
Carbaryl XLR	Spray	38.5 ab	17.0 abc	6.1 abcd
B. thuringiensis[c]	Spray	32.1 abc	19.6 abc	6.1 abcd
Azinphos-ethyl	Spray	17.9 efg	6.9 gh	5.9 abcd
Diazinon	Spray	24.0 cde	12.4 cdefg	5.8 abcd
BPMC	Spray	28.8 abc	17.3 abc	7.3 ab
Triazophos	Spray	8.4 g	10.0 defg	1.7 d
MTMC	Spray	31.4 abc	19.0 abc	7.0 abc
Aktrion®	Spray	36.2 abc	17.5 abc	7.9 ab
Carbaryl WP	Spray	26.8 bcd	12.2 cdefg	4.8 bcd
MIPC	Spray	34.3 abc	17.0 abc	7.3 abc
Acephate	Spray	16.9 def	9.4 defg	3.8 bcd
Carbofuran G	Broadcast	0.6 h	3.8 h	1.9 cd
Diazinon	Broadcast	33.1 abc	12.8 cdef	7.2 ab
Endosulfan	Broadcast	32.8 abc	16.4 bcd	5.4 bcd
Control		38.9 a	21.4 ab	7.7 ab

a Chemicals were applied 5 times at 10, 25, 45, 60, and 70 days after transplanting.
b % days after transplanting. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.
c 30 billion spores/g.

Table 8 Field evaluation of granular insecticides broadcast against the rice whorl maggot and the stem borer at IRRI, 1977 wet season[a] (IRRI Insecticide Evaluation 1977, Table 14).

Chemicals[b]	Rice whorl maggot damage		Deadhearts (%)	
	22 DT	35 DT	40 DT	60 DT
AC 64475	0 a	0 a	0.1 a	2.0 ab
Isazophos	2 b	2 b	0.0 a	1.2 a
Carbofuran	3 b	2 b	0.0 a	0.8 a
Diazinon	3 b	2 b	0.5 bc	10.9 c
Ethoprop	3 b	2 b	0.2 ab	2.8 b
Acephate	5 c	3 c	1.0 cd	10.9 c
Bendiocarb	6 d	4 d	1.7 de	10.0 c
BPMC	6 d	5 e	2.8 e	12.0 c
Bufencarb	8 e	5 e	1.8 de	9.7 c
Control	8 e	7 f	5.5 f	11.2 c

a In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.
b Chemicals applied at 5, 25, 52, and 85 days after transplanting at 1.0 kg a.i./ha.
c Based on a scale of 0–9: 0 = no damage; 9 = > 50% of leaves damaged.

Evaluation of insectistatics or chemicals other than insecticides

Levinson (1975) named chemicals other than conventional insecticides used for insect pest management insectistatics. At IRRI 4 chemosterilants, *Chilo* pheromones, 2 insect growth regulators (isoprothiolane and buprofezin) and biological products (*Bacillus thuringiensis*) were tested (Table 1). Botanical insecticides* have also been tested.

Isoprothiolane, a fungicide, shows an insectistatic activity on BPH and WBPH (Araki *et al.*, 1975). Buprofezin affects BPH, GLH, and WBPH nymphs as a moulting disturber but shows no effect on stem borers, RB nymphs and adults, and natural enemies of hoppers (Kajihara *et al.*, 1982; Valencia *et al.*, 1982). In most cases, appropriate methodology for the evaluation of insectistatics seems to be different for each chemical and thus has been developed.

The publications of IRRI insecticide evaluation 1976–1981 (IRRI 1977–1982) include the data on such chemicals. Tables 9 and 10 indicate the results on buprofezin in laboratory and field tests.

* Neem oil extracted from the seed of the neem tree, *Azadirachta indica*, is one of the botanical insecticides tested at IRRI. Since it shows insecticidal antifeedant, and insect growth regulator and ovicidal effects it is being dealt with in this chapter, tentatively.

Table 9 Laboratory evaluation of residual activity of buprofezin on BPH third instar nymphs using 0.75 kg a.i./ha foliar spray (Valencia *et al.*, 1982).

Days after treatment	Mortality (%)[a]		Control
	Buprofezin	BPMC	
		Greenhouse	
1	100 a	96 a	10 a
6	100 a	56 b	14 a
12	71 b	21 c	11 a
		Field	
1	100 a	75 a	0 a
5	95 a	1 b	0 a
10	18 b	0 b	0 a

a In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 10 Field evaluation of the activity of different rates of buprofezin on BPH population, IRRI wet season 1981 (Valencia *et al.*, 1982).

	Means for BPH count after insecticide application[a]									
	1st application (20 DT[b])				2nd application (48 DT)			3rd application (62 DT)		
	2 DBFA[c]	5 DAT[d]	10	15	5	10	15	5	10	15
Buprofezin										
0.125 kg a.i./ha	30.69	11.02 a	11.51 a	10.48 ab	5.80 c	11.66 ab	5.52 d	3.32 b	2.46 b	2.69 bc
0.250 kg a.i./ha	26.19	10.36 a	11.21 a	9.49 b	6.15 c	11.94 ab	6.09 c	3.31 b	2.68 b	2.34 c
0.500 kg a.i./ha	27.62	10.09 a	11.60 a	10.20 ab	5.00 c	11.76 ab	6.29 c	3.47 b	2.80 b	2.49 bc
BPMC										
0.75 kg a.i./ha	25.55	10.99 a	12.09 a	12.06 a	6.50 b	7.86 b	7.09 b	3.28 b	3.05 b	4.72 b
Control	29.40	11.60 a	12.85 a	11.35 ab	16.41 a	18.50 a	15.99 a	13.70 a	13.20 a	14.71 a

a In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.
b Days after transplanting.
c Days before first application.
d Days after treatment.

General discussion

Tables 11 and 12 show that in two samples the effectiveness of each insecticide depends on the species of pests and also on the application methods.

Table 11 Selective insecticides (data from IRRI laboratory experiments 1977–81). + = Effective; – = Not effective; ? = No data.

Chemicals[a]	GLH	BPH	WBPH	LF	RB	SSB	YSB
Azinphos-ethyl 40 EC	+	–	–	+	?	?	+
BPMC 50 EC	+	–	–	?	–	?	+
Chlorfenvinphos 20 EC	+	–	–	+	?	?	?
Methomyl 20 EC	+	–	–	+	?	?	+
MIPC 50 WP	+	–	–	–	–	?	?
Methamidophos 60 EC	+	–	–	?	?	?	?
Pirimiphos-methyl 25 EC	–	–	?	?	+	?	?
Phosphamidon 50 EC	+	–	–	+	+	?	+
UC/MP 19779 48 EC	+	–	–	?	–	?	?
UC 21867 75 WP	+	–	?	?	?	?	?
UC 51762 75 WP	+	–	?	+	?	?	?
Cypermethrin 10 EC	+	–	–	+	–	?	?
NC 8265 75 EC	+	–	–	–	+	?	?
Dimethoate 40 EC	–	–	–	?	?	+	+

a Treated at a rate of 0.75 kg a.i./ha.

Table 12 Activity of insecticides against the brown planthopper as tested by four application methods at IRRI laboratory (Heinrichs, 1979).

Chemicals	Activity			
	Contact toxicity	Foliar spray	Broadcast	Root-zone
Rate (kg a.i./ha)	0.75	0.75	1	1
1) Carbamates				
BPMC	+	+	–	–
Carbaryl	–	+	+	–
Carbofuran	+	+	+	+
Bufencarb	+	+	+	–
Methomyl	+	–	+	–
MIPC	+	+	+	–
MTMC	+	+	–	–
Cartap	–	–	–	–
2) Organophosphates				
Acephate	–	+	+	–
Azinphos-ethyl	–	+	–	–
Carbophenothion	–	+	–	–
Chlorfenvinphos	–	–	–	–
Chlorpyrifos	–	+	–	–
Diazinon	–	+	–	–
Parathion-methyl	–	–	+	–
Monocrotophos	+	+	–	–
Vamidothion	–	+	–	–
3) Organochlorines				
Endosulfan	–	+	–	–
Perthane	–	+	–	–
4) Pyrethroids[b]				
NRDC 149	+	+	?	?
NRDC 161	+	+	?	?
WL 43467	+	+	?	?
Permethrin	+	+	?	?

a + = Effective; mortality counts of 80% or higher; – = Not effective. Mortality readings in the contact toxicity experiments taken at 48 hr after treatment. Readings in the foliar spray, broadcast, and root-zone experiments were at 1, 7, and 14 days, respectively, after BPH were caged on treated plants. ? = No data.

b Applied at 0.05 kg a.i./ha.

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Discussion

Ishikura, H. (Japan): 1. At IRRI you are using test insects reared on grown-up rice plants whereas in Japan test insects were reared on rice seedlings. Is there any difference in the susceptibility of test insects to insecticides between the two methods? 2. The screening system for pesticides you described is based on the damaging stage of the pest. However, I believe that the potency of insecticides for control cannot be satisfactorily evaluated by this screening procedure. For example in the case of the stem borer chlorphenamidine is not particularly effective against the larvae but is effective in preventing oviposition. Therefore a more elaborate system of screening that takes into account the behavior and the stages of growth of the pest would be desirable.

Answer: 1. We have no data on this particular aspect. We rear insects on grown-up plants because such a method is convenient, economical and suited to the tropical environment. 2. I agree with you. Indeed the effectiveness of insecticides varies and depends on the interaction between the stage of development of the pest and the plant, respectively. Effectiveness of insecticides also varies with the method of application. Thus the methods of application should also be taken into account, depending on the insecticide used and the occurrence of pest infestation and candidate insecticides should be evaluated under determined conditions.

Valencia, S.L. (IRRI): Comment: I should like to add that data on the standard evaluation of insecticides are available at the Department of Entomology IRRI.