relative humidity. Gravid female moths collected from the field were the source of insects. Females laid eggs singly or in groups of 2-9 on upper and lower rice leaf surfaces, but mostly on the upper leaves touching the margins of the main veins. Groups of two eggs were most common. Sometimes, eggs were laid on leaf sheaths. Incubation took 4 d (see table). The first-instar larvae fed in groups. They scraped the leaf surface and preferred young seedlings. The second-instar larvae folded leaves and fed within the fold. Feeding was always on parenchyma cells (between veins). No feeding was observed on bundle sheath and sclerenchyma cells. The larvae passed through 6 instars in 23 d.

Pupation occurred within a silken cocoon, most commonly between two adjacent leaves tied together with silk. Pupation also occurred at the basal part of the inner tillers and lasted 9 d.

Adult emergence was most frequent from 2200 to 2400 h. Ma1e:female was 2:1 (n=80). Females laid about 120 eggs. Total development period and percent survival at different stages of development are in the table. □

Life cycle of the rice leaffolder *Marasmia patnalis* reared on TN1, IRRI greenhouse, 1984.

Character	Duration [a] (d)		Survival (%)
	Av	Range	
Egg	4	4-5	92
Larva	23	21-25	88
Prepupa	1	1-2	[b]
Pupa	9	7-11	74
Total development period	37	33-43	
Adult longevity			
Male	3	4-3	
Female	5	6-7	

[a] n = 60 males and 60 females. [b] No data.

Effect of sequential release of resistant rices on brown planthopper (BPH) biotype development in the Solomon Islands

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New BPH *Nilaparvata lugens* Stål biotypes on some varieties may develop in six to nine generations in laboratory tests. In the Solomon Islands, planting varieties with different resistance genes for the last 10 yr produced a highly virulent BPH population,

IRRI resistant varieties were introduced in 1974. IR26, IR28, IR30, IR1628, and GPL 2S were planted from 1974 to 1977, until BPH biotype 2 developed (Table 1). IR36 and IR42 were planted in 1978, but were phased out because of susceptibility to leafroller *Susumia exigua* and root rot. Mala was then planted until 1981.

Field screening in 1980 indicated that BPH biotype 2 was dominant. In mid-1984, BG379-5 suffered heavy hopper-burn and was replaced by resistant MTU5249, which is still planted. In 1984 seedling screening, BPH biotype 3 was identified (Table 2). ASD7 and BG379-5 were susceptible, but Ptb 33 was only slightly damaged.

As BPH biotypes have changed, fewer varieties of the International Rice Brown Planthopper Nursery (IRBPHN) of the International Rice Testing Program have maintained BPH resistance in the Solomon Islands. Only 12% of the 1984 IRBPHN were moderately to highly resistant to our present BPH population, compared with 39% in 1980.

Table 1. Effects of sequential release of resistant rice varieties on BPH biotype development in the Solomon Islands, 1974-84.

Year	Variety	Resistance gene	Virulence [a]	Remarks
1974	IR26	*Bph 1*	Biotype 2	Susceptible
1975	IR1628	Unknown	–	Susceptible to sclerotinia root rot
1976	IR28, IR30, GPL 2S	*Bph 1*	Biotype 2	–
1977	BG94-1	Unknown	–	Susceptible to leafroller
1978	IR36	– *bph 2*	–	IR36 and IR42 were used in only 2 croppings and were very susceptible to leafroller
	IR42	– *bph 2*		
	Mala	Unknown		
1979	IR42, Mala		–	–
1980	Mala	–	Biotype 2 [b]	Hopperburned in late 1980, but tolerant of high *N. lugens* population
Early 1982	BG379-5	Unknown	–	Hopperburned in March 1984
1984	BG379-5	–		–
	IR9852-22-3	Unknown (with IR36 as parent)	Biotype 3	–

[a] *N. lugens* virulence at the end of the resistance life. [b] As ASD7, resistant in 1980.

Table 2. Results of seedling bulk test for BPH resistance in November 1984 [a], Solomon Islands.

Variety	Score [b]	Remarks
TN1	9	Susceptible check
Mudgo	9	*Bph 1*
ASD7	9	*bph 2*
Ptb 33	3.6	*Bph 3*
Babawee	7	*bph 4*
MTU5249	1.6	Parentage: MTU4569/ARC6650 currently resistant commercial variety
BG379-5	9	Parentage: BG96-3*2/Ptb33, commercial variety from 1982 to March 1984
ARC6650	1.6	Parent of MTU5 249
BG367-2	.3	Parentage: BG280-1*2/Ptb 33, most resistant variety in 1984 IRBPHN

[a] Av of 3 replications. Screening made in seedboxes using *N. lugens* from commercial fields. Seedlings were infested with nymphs and adults 9 d after germination. [b] Scored according to 0-9 scale of the *Standard evaluation system for rice.*

The quick breakdown in resistant varieties was caused by several factors: 1) intensive staggered cropping within a small (1,000 ha) area; 2) destruction of natural enemies *Cyrtorhinus* sp., spiders, and egg parasites of BPH because of heavy insecticide use to control BPH, leafroller, and armyworm; and 3) failure to control BPH or BPH resurgence because of ineffective coverage of aerial insecticide sprays, especially at late crop stages.

To combat these problems, increasing emphasis is placed on pest control through integrated pest management and a substantial reduction in the use of highly toxic, broad-spectrum insecticides. We also are changing from continuous cropping to planting two crops per year with a fallow period. New resistant varieties are being introduced. ☐

Chemical control of rice gall midge (GM) and leaffolder (LF)

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We evaluated the effectiveness of chlorpyrifos seedling root dip and granular carbofuran application for controlling GM *Orseolia oryzae* (Wood-Mason) and LF *Cnaphalocrocis medinalis* Guenee in 1981-83 kharif.

Ten days after sowing the nursery, carbofuran 3% granules were applied: 40 kg/ha in 1981 and 20 kg/ha in 1983. The nursery was unprotected in 1982.

At transplanting, we compared 12-h and 3-h seedling root dips in chlorpyrifos 0.02% in a 1% urea solution. In 1983, we also evaluated a root treatment with chlorpyrifos 0.02%-treated carbono phosphate slurry. The amount of carbono phosphate needed for P fertilizer for the main field area (at 300 kg/ha, equal to 60 kg P/ha) was mixed 3:1 with wet clay and water was added to make a thick slurry. Chlorpyrifos 20 EC was mixed in the slurry at 0.02% concentration. The roots of seedlings were uniformly coated with the slurry and planted after 5-10 min. At planting, the field was puddled and had little standing water.

Carbofuran 3% granules at 20 kg/ha were applied to all chlorpyrifos-treated plots 20 d after transplanting (DT). Water was impounded for 3 d after granular application. The trial was in a randomized block design in 4 replications with an untreated control. Jaya was planted in 10- × 5-m plots at 20- × 15-cm spacing. Soil was a sandy loam.

GM damage was recorded at 45 and 60 DT and LF damage at 75 DT. All treated plots were GM free in 1981 and 1983. In 1982, damage until 45 DT was low, but beyond 60 DT, there was no significant difference between treated and untreated plots (Table 1). This was primarily because the unprotected seedlings from the nursery had 5.4% GM infestation.

LF was effectively controlled in all treated plots (Table 1), which had more productive tillers and significantly higher yield than the untreated control (Table 2). ☐

Table 1. Chemical control of GM and LF at Goa, India, 1981-83.[a]

Treatments[b]	Silvershoot (%) 45 DT	Silvershoot (%) 60 DT	LF damage (%)	Productive tillers/hill (no.)
		1981		
A	0.0 a	0.0 a	0.5 a	8.9 a
B	0.0 a	0.0 a	1.0 a	7.3 b
Control	16.0 b	35.7 b	7.7 b	4.7 c
		1982		
A	6.0 a	34.7 b	3.6 a	7.1 a
B	4.7 a	21.7 a	3.9 a	6.5 a
Control	36.7 b	28.1 a	33.1 b	4.9 b
		1983		
A	0.0 a	0.0 a	0.0 a	7.3 a
B	0.0 a	0.0 a	0.0 a	7.3 a
C	0.0 a	0.0 a	0.0 a	7.1 a
Control	10.8 b	18.0 b	15.9 b	6.7 a

[a]In a column in a particular year, means followed by a common letter are not significantly different at the 5% level. [b]A = NP + RD with chlorpyrifos 0.02% for 12 h fb 20 kg carbofuran 3% gr 20 DT. B = NP + RD with chlorpyrifos 0.02% for 3 h in 1% urea solution fb 20 kg carbofuran 3% 20 DT. C = NP + RT with chlorpyrifos 0.02% treated CP slurry for 5-10 min fb 20 kg carbofuran 3% gr on 20 DT. NP = nursery protection with carbofuran 3% gr @ 40 kg and 20 kg/ha, respectively during 1981 and 1983. RD = root dip, RT = root treatment, fb = followed by, CP = carbono phosphate, gr = granule, DT = days after transplanting.

Table 2. Yields and economics of insect control in chemical control trials at Goa, India, 1981-1983.[a]

Treatment[b]	Yield[c] (t/ha)	Gross profit[d] ($/ha)	Cost of insecticide application[e] ($/ha)	Net gain[f] ($/ha)	Gain from insecticides[g] ($/ha)	Benefit:cost[h]
			1981			
A	4.7 a	611	43	568	217	6.1
B	4.4 a	572	44	528	177	5.0
Control	2.7 b	351	0	351	–	–
			1982			
A	3.4 a	442	37	405	249	7.7
B	3.3 a	429	38	391	235	7.2
Control	1.2 b	156	0	156	–	–
			1983			
A	3.5 a	455	40	415	90	3.3
B	3.6 a	468	41	427	102	3.5
C	3.5 a	455	40	415	90	3.3
Control	2.5 b	325	0	325	–	–

[a]At conversion rate of US$1 = Rs 13.02. [b]See Table 1 for treatment details. [c]In a column in a particular year, means followed by a common letter are not significantly different at the 5% level. [d]Grain yield in kg/ha at 14% moisture × 0.13. [e]$1.96 for labor + cost of insecticide including the cost of urea. [f]Gross profit – cost of insecticide application. [g]Net gain of treatment - net gain of control. [h](Gross profit of treatment – gross profit of control) + cost of insecticide application.