Varietal resistance to the brown planthopper in the Solomon Islands

J. H. Stapley, Yin Yin May-Jackson, and W. G. Golden

Trials were conducted on the Guadalcanal Plains in 1976–77 to assess agronomically desirable lines of lowland rice (*Oryza sativa* L.) for resistance to the brown planthopper *Nilaparvata lugens* Stål. Resistance was evaluated on the basis of hopperburn damage and the size of planthopper populations. One hundred and nineteen varieties from Bangladesh, Sri Lanka, Indonesia, and the Philippines were screened. The varieties IR2307-281-5-3-2, IR2071-137-5-5-1, IR2071-586-5-6-3-4, IR2071-588-1-1-1, IR4409-80-2, IR4417-177-1-4, IR4492-7-2-1, and IR4707-123-3 were selected as the most suitable for local conditions but none were considered totally resistant to the Guadalcanal brown planthopper biotype.

RICE-GROWING WAS INITIATED in Guadalcanal in 1960. From the outset, the brown planthopper (BPH) was recognized as a major limiting factor (Khush 1974; Nishida 1975). This was evident from trials from 1960 to 1966 by the Solomon Islands Department of Agriculture and the Commonwealth Development Corporation. Large-scale commercial production of dry rice by Guadalcanal Plains Ltd. started in 1965 on 1,200 ha and changed to irrigated rice in 1971 covering 320 ha. The BPH was controlled by aerial spraying until the introduction from the International Rice Research Institute (IRRI) of varieties carrying genes for BPH resistance. By 1974, all previously resistant varieties (IR1514A-E666, IR1516-228-3-3, IR1539-523-1-4, IR1541-76-3-3, and IR1416-389-1-1) had proved susceptible to BPH attack (Stapley 1974). This study reports our continued efforts to control the BPH in rice on Guadalcanal.

VARIETY TRIALS

In 1976 a total of 119 rice lines and varieties from Bangladesh, Sri Lanka, Indonesia, and the Philippines (IRRI) were screened in cages and in the field for BPH resistance. Screening in cages was done according to established IRRI

Principal research officer. Ministry of Agriculture and Lands; and entomologist and director of research, Brewer Solomons Associates, Honiara, Solomon Islands.

procedures (IRRI 1976), with IR747-B2-6-3 as the susceptible check instead of TNl. For field screening, 1- × 3-m varietal plots were set up in commercial rice bays. A number of plots with susceptible varieties were included to attract the BPH in large numbers.

Rice lines from Bangladesh, Sri Lanka, and Indonesia, and some lines from the Philippines were susceptible (Table 1). Of the IRRI varieties tested, IR26, IR28, and IR30 (all with the dominant *Bph 1* gene) were susceptible; but IR1628-632-1, IR32, and IR36 (with the recessive *bph 2* gene) were tolerant. BPH populations on IR32 and IR36 were lower than those on IR1628-632-1. IR38 was resistant. In cage and field screenings, IR34 was tolerant of the biotype existing on Guadalcanal in 1976. Yet at IRRI, it is susceptible to biotype 2. The biotype issue remains confusing, but in general, lines with the dominant *Bph 1* gene are susceptible to the existing biotype while some lines with the recessive *bph 2* are resistant.

In 1974, observations were made on experimental plots to assess varietal resistance to the BPH. Twelve varieties were planted in a randomized block design in 4- x 6-m plots with four replicates. When hopper damage was observed, the plots were uniformly sprayed with MIPC insecticide (2-isopropyl

Table 1. Reactions of selected rice varieties to the brown planthopper (BPH), Metapona, 1976.

Variety or line	Origin	Grade of damage[a]		
		Trial 1	Trial 2	Trial 3[b]
Biplab	Bangladesh	4	—	—
B 462c/PM/31/2/1	Indonesia	—	6	—
B 796c/MR/12/2/5	"	—	7	—
B 796c/MR/143/2/5	"	—	6	—
B1742c/MR/51/1	"	—	6	—
B2931b/11/9/3/1	"	—	3	1
IR22	Philippines	—	3	3
IR24	"	—	2	1
IR26	"	3	2	2
IR28	"	4	7	4
IR30	"	8	6	1
IR32	"	1	4	1
IR34	"	4	7	1
IR36	"	1	4	1
IR38	"	1	1	–
IR262-9	"	9	3	—
IR747-B2-6-3	"	—	6	3
IR1561-228-3-3	"	—	3	2
IR1623-632-1	"	—	5	3
IR2006-P3-33-2	"	5	—	—
IR2061-465-1-5-5	"	2	2	1
IR2071-137-5-5-1	"	1	—	—
IR2071-586-5-6-3-4	"	1	—	—
IR2071-588-1-1-1	"	1	—	—
IR2153-43-2-5-4	"	7	—	—
IR2153-381-1-8-1	"	4	6	2
IR2307-10-1-2-3	"	1	1	1

continued on opposite page

Table 1 continued

Variety or Line	Origin	Grade of damage[a]		
		Trial 1	Trial 2	Trial 3[b]
IR2307-84-2-1-2	Philippines	8	–	–
IR2307-112-3	"	1	1	1
IR2307-211-6-6-2	"	6	2	1
IR2307-217-2-3	"	7	–	–
IR2307-247-2-2-3	"	1	1	1
IR2307-281-5-3-2	"	1	1	1
IR2688-33-4-2-3	"	8	–	–
IR2771-119-3-1	"	1	1	1
IR2777-103-2-2-3	"	1	–	–
IR2796-44-2	"	3	–	–
IR2797-80-2-2	"	7	–	–
IR2797-125-3-2-2	"	3	–	–
IR2823-103-5-1	"	9	–	–
IR2823-399-5-6	"	1	–	–
IR2843-26-3-2	"	8	–	–
IR2863-38-1-2	"	1	–	–
IR3351-38-31-1	"	7	–	–
IR3464-126-1-3	"	8	–	–
IR3525-46-1-4	"	7	–	–
IR3634-62-2	"	3	–	–
IR3941-25-1	"	1	–	–
IR4409-65-3	"	1	–	–
IR4409-80-2	"	1	–	–
IR4417-177-1-4	"	1	–	–
IR4422-29-6	"	1	–	–
IR4422-143-2-1	"	2	–	–
IR4427-16-2-4	"	2	–	–
IR4427-19-6-1	"	4	–	–
IR4427-23-2-3	"	3	–	–
IR4427-58-5-2	"	1	–	–
IR4427-118-5-2	"	3	–	–
IR4427-279-4-1	"	3	–	–
IR4427-315-2-3	"	7	–	–
IR4427-367-5-2	"	7	–	–
IR4432-38-6	"	4	–	–
IR4432-52-6-4	"	1	–	–
IR4437-46-3-3	"	1	–	–
IR4442-165-2-4	"	6	–	–
IR4492-7-2-1	"	2	–	–
IR4531-6-1-1	"	2	–	–
IR4531-6-1-3	"	6	–	–
IR4531-9-1-1	"	6	–	–
IR4580-5-3	"	1	–	–
IR4707-7-3	"	1	–	–
IR4707-123-3	"	1	–	–
IR4816-70-1	"	1	–	–
IR5257-77-2	"	1	–	–
IR5311-46-3	"	1	–	–
IR5853-76	"	1	–	–
GPL 2S (IR1416-138-3-1)	Solomon Islands	9	6	3
BG32-2	Sri Lanka	5	2	1
BG34-8	"	5	7	1
BG94-1	"	4	2	1
BG94-2	"	5	–	–
A 16-14	"	4	2	1
TN1	Taiwan	9	–	–

[a]Grade 0 = 0; 1 = 1-100 BPH, 2 = 100-250 BPH, 3 = 251-500, 4 = 500-750, 5 = 750-1000, 6 = 1001-2000, 7 = 2000-4000, 8 = 4000-8000, 9 = 8000. [b]Trial 3 was sprayed every 3 or 4 weeks.

Table 2. Variety trial (irrigated rice) at Metapona, late 1974.

Variety/line	Brown planthoppers (no./sq m at 40 days)	Days to maturity	Yield (t/ha)
IR747B2-6-3	4166	91	1.7
IR1416-138-3-1	3333	[a]	[a]
IR1614-138-1-1-3	2778	[a]	[a]
IR1561-228-3	5000	[a]	[a]
IR1416-389-1-1	4166	[a]	[a]
IR26	2778	120	3.8
IR1628-632-1	3722	109	5.9[b]
IR2035-255-2-3-1	4444		
IR1416-138-3-1 (selection)	6666	112	3.9
IR2061-464	3333	95	4.4
IR2061-214-3-3-28	4722	91	4.2
IR661-1-1-140-3	4166		

[a]Yields could not be measured because of severe 'hopperburn, [b]The crop lodged.

phenyl-N-methyl carbamate). Other observations were made in the commercial fields. In particular, studies were made of the relationship of location, age of plantings, and varieties grown to the size of BPH populations.

At 30 days the plots were heavily and uniformly attacked by BPH. Certain cultivars would have failed completely had they not been sprayed with MIPC on the 40th day. That one spray effectively eliminated the BPH and some plants recovered. Shortly afterwards, all plots were invaded by the predators, *Cyrtorhinus lividipennis* and *C. chinensis*. As a result, all the rice plots survived until harvest. The results from this trial are shown in Table 2.

Fluctuations of populations of the BPH and its predators on three varieties (IR28, IR1628-632-1, and IR36) in commercial fields at Metapona were observed during 1976. Large populations of the BPH developed on IR28, 30 days after sowing. They increased rapidly and were not controlled by *Cyrtorhinus*. In contrast, BPH populations on the relatively tolerant varieties, IR1628-632-1 and IR36, were initially low, and *Cyrtorhinus* maintained them at economically acceptable levels.

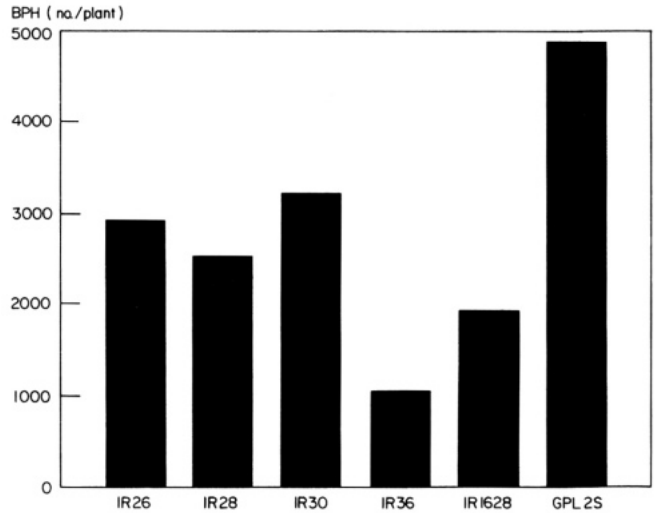
The maximum numbers of BPH during peak infestations of single plants in commercial rice fields before spraying are given in Fig. 1. The survival rate and population buildup of BPH were much lower on tolerant than on susceptible varieties.

BPH and *Cyrtorhinus* spp. populations in variety trials with and without insecticide treatment were determined from September to December 1976 (Table 3). The fields were sprayed with insecticides every 4 weeks. Maximum infestation by the BPH occurred 50 to 60 days after sowing, depending on the growth duration of each variety. *Cyrtorhinus* controlled BPH populations on tolerant varieties without insecticide sprays, but was unable to do so on susceptible varieties which had large numbers of the insect. On the resistant variety IR38, pest populations were too small to attract significant numbers of predators.

Table 3. Population development of the brown planthopper (BPH) and *Cyrtorhinus* (C) on selected rice cultivars.

Variety/line	Cultivar reaction to BPH[a]	Insects (av. no /sq m)							
		With insecticides[b]				Without insecticides			
		7 DAS[c]		50-60 DS[c]		7 DS[c]		60-60 DS[c]	
		BPH	C	BPH	C	BPH	C	BPH	C
BG 33-2	S	41.0	0	3083.0	63.3	46.7	0	4577.3	86.7
BG 34-8	S	25.6	0	1116.6	52.2	26.6	2.2	27401.7	159.9
BG 94-1	S	81.1	1.0	1166.6	55.6	86.7	1.1	766.6	193.3
GPL 2S	S	52.2	0	8165.9	118.9	166.7	22.3	11659.9	199.4
IR24	S	41.1	0	8165.9	117.8	55.6	0	8221.4	35.6
IR262-9	S	33.3	0	10115.7	103.3	17.8	8.9	13987.5	46.7
IR1561-228-3-3	S	218.9	2.0	2999.7	74.4	188.9	19.9	4206.2	28.9
IR1628-632-1	T	33.0	0	3216.3	44.4	22.2	0	966.6	217.8
IR2061-465-1-5-5	T	22.2	0	1333.2	63.3	24.4	0	164.4	31.1
IR2153-381-1-8-1	T	174.4	2.0	116.7	25.6	222.2	2.0	31.1	22.2
IR2307-10-1-2-3	T	141.1	2.0	116.7	33.3	133.3	1.0	141.1	53.3
IR2307-112-3	T	111.1	2.0	549.4	36.7	146.7	6.7	68.9	2.2
IR2307-211-6-6-2	T	14.4	0	116.7	18.9	11.1	4.4	64.4	24.4
IR2307-247-2-2-3	T	166.7	1.0	216.6	29.9	144.3	15.6	146.7	31.1
IR2307-281-53-2	T	188.9	2.0	2949.7	58.9	168.9	2.2	86.7	55.6
IR2771-119-3-1	T	166.7	2.0	266.6	27.8	122.2	2.0	146.7	77.8

[a] S = susceptible, T = tolerant. [b]Orthene 75 SP applied at 4 weeks interval. [c]DS = days after sowing



1. Maximum number of brown planthoppers recorded on single plants in commercial rice fields.

DISCUSSION

Our experiences during the past year have shown that BPH can be successfully controlled in commercial rice production only by giving due attention to varieties, biological control, and the use of selective insecticides. Not one of these factors alone effects acceptable control.

Our search for varieties that have resistance to the BPH continues; no line tested in the Solomon Islands so far is immune or highly resistant to attack. But, we feel that even if lines with high resistance should be found, intensive cultivation may select BPH biotypes that have the ability to overcome that resistance.

Cyrtorhinus spp. is able to effectively control the BPH only if it enters the rice fields before panicle initiation and while BPH numbers are relatively low, as when such tolerant varieties as IR1628-632-1 and IR36 are grown. On varieties that allow large BPH populations to develop rapidly, correspondingly large numbers of *Cyrtorhinus* become established, but the crop can nonetheless be badly damaged.

Our approach to BPH control is, therefore, the growing of tolerant or resistant varieties or both, careful maintenance of predators, and the judicious use of selective insecticides. These approaches, we feel, can be developed and integrated into an effective system of brown planthopper control.

REFERENCES CITED

IRRI (INTERNATIONAL RICE RESEARCH INSTITUTE). 1976. Preliminary report of the first International Rice Brown Planthopper Nursery (IRBPHN)—international rice testing program. Los Baños, Philippines.

KHUSH, G. S. 1974. Trip report to British Solomon Islands and Fiji, November 20–26, 1975. International Rice Research Institute, Los Baños, Philippines.

NISHIDA, T. 1975. Report on the brown planthopper, *Nilaparvart lugens* Stål on Guadalcanal, British Solomon Islands. Hawaiian Agronomics Inc. Hawaii, USA.

STAPLEY, J. H. 1974. Annual report of theentomologist for 1974. Ministry of Agriculture and Rural Economy, Honiara, Solomon Islands.