

Screening methods and sources of varietal resistance

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The methodology of mass screening rice at the seedling stage and the sources of resistance to the brown planthopper that have been identified are discussed

The insect can be efficiently mass-reared on the susceptible varieties on 40- to 50-day-old potted plants or on seedling mats. Many countries have adopted the basic screening procedures developed by the International Rice Research Institute.

A large number of varieties or lines that are sources of genetic resistance to the insect are available in the rice germplasm. However, their resistance in one country does not necessarily hold true in other countries.

THE INTERNATIONAL RICE RESEARCH INSTITUTE (IRRI) initiated studies on varietal resistance to the brown planthopper (BPH) in 1966. Since then, it has developed and documented efficient mass-screening techniques for evaluating tens of thousands of varieties from worldwide germplasm collections in the seedling stage in the greenhouse.

The basic techniques have been introduced in Japan (Kaneda and Kisimoto 1977), Korea (Choi et al 1977), Taiwan (Cheng and Chang 1977), India (Kalode and Krishna 1977), Thailand (Pongprasert and Weerapat 1977), Sri Lanka (Fernando et al 1977), Indonesia (Harahap 1977), and the Solomon Islands (Stapley et al 1977). With those techniques, the varieties from the germplasm collections and the bulk of those countries breeding materials have been satisfactorily screened in the seedling stage for resistance to the BPH.

This paper reviews the details of mass-screening techniques presently used and the resistant sources identified so far.

SCREENING METHODS

Mass-rearing of the brown planthopper

Mass-rearing of the BPH is essential to mass screening of varieties. The insect is mass-reared on the susceptible variety Taichung Native 1 or on other equally

susceptible varieties that provide food and sites for oviposition. The original colony is started by caging a pair (♀♂) of adults (virus-free insects from areas harboring the grassy stunt virus) on the rice plant.

Two methods of mass-rearing are employed.

Rearing on old potted plants. Pathak and Khush (1977) at IRRI described this method, and most countries use it. The insects are reared on 40- to 50-day-old plants inside a 0.5- × 0.5- × 1-m cage. This standard cage uses a wooden or steel frame, bottom, and door. Its roof and a side wall are covered with glass, but the remaining two sides are covered with either fine-mesh wire screen or nylon cloth. The screen permits aeration and prevents condensation of moisture on the glass walls.

The potted plants are changed as needed. Each cage can accommodate several potted plants that usually support 2,000 to 3,000 late-instar nymphs. Eggs of about the same age are obtained by placing the plants overnight in a cage containing adult insects.

Rearing on seedling mats. Insects are mass-reared on seedlings in a transparent acrylic (plastic) cage. The top and three sides of the cage are covered with fine-mesh nylon cloth. Japan (Kaneda and Kisimoto 1977) and Korea (Choi et al 1977) use this method. Choi et al (1977) have also described it. Seedling mats are prepared by placing the pregerminated seeds on moistened gauze on enameled trays. The mats can be easily cut into the desired size several days later when the seedlings have grown and their roots have become entangled in the gauze. The adult insects are caged on the seedling mats. The ovipositing insects are removed 1 or 2 days later and the seedling mats with eggs are taken out of the cages. A fresh seedling mat is put on one side inside the cage as nymphs appear. Each cage can accommodate one seedling mat (about 20 × 25 cm) that can support 1,000 to 2,000 late-instar nymphs.

Insects are reared in this method in insectaries at 26–27°C and with 15-hours light in Japan (Kaneda and Kisimoto 1977) and at 25–30°C and with 24-hours light in Korea (Choi et al 1977).

Rearing on old potted plants and on seedling mats provide a continuous supply of test insects. The use of rice seedling mats is feasible in insectaries in the off-season in the temperate zone, but their efficiency is inferior to that of potted plants in the greenhouse. In Korea, the former method is used in summer, and the latter, during other seasons.

Screening procedures. In many countries, varietal screening for resistance to the BPH is usually conducted at the seedling stage in the greenhouse. Basic screening procedures standardized by IRRI (Pathak and Khush 1977) have been adopted in different countries.

The test varieties or lines are seeded in rows 5 cm apart in 60- × 45- × 10-cm seedboxes. Each line is planted in a 20-cm-long row along the width of the seedbox. A susceptible check variety (usually Taichung Native 1 or one of the equally susceptible varieties) and a resistant check variety (always Mudgo, except in certain biotype studies) are planted at random in each seedbox. At

7 days after seeding, the test plants are thinned to 20 to 30 seedlings per row. Initial evaluation uses only one replicate.

Sometimes germination is not uniform because the seeds germinate poorly or are infected with soil-borne disease. The problems can be overcome by pregerminating the seeds and disinfecting them with fungicides like phenyl mercuric acetate (Choi et al 1977).

The pregerminated seeds are planted individually at uniform spacing within each row. Although laborious, this method is superior to direct seeding in ensuring a uniform stand of seedlings and eliminating thinning work.

The seeded boxes are placed on a galvanized iron tray on a table inside a screened room. The screened room may be a section of a greenhouse. About 5 cm of standing water on the tray provides high humidity suitable for insect survival and eliminates the need for watering the plants, which may disturb the insects feeding on them.

If a screened room is not available, each seedbox may be put in a wooden cage covered with fine-mesh cloth (Choi et al 1977). In Taiwan, the seeded boxes are covered with a nylon net after infestation (Cheng and Chang 1977).

About 7 days after seeding at the one- and the two-leaf stage, the seedlings are infested by scattering a large number of insects on them. The heavily infested plants from the mass-rearing cage are gently tapped over the seedlings. The insects should be on the test varieties as uniformly as possible. Generally second- and third-instar nymphs are used for infestation. An average of 5 insects/seedling constitutes an optimum population to differentiate the resistant and susceptible lines.

The insects' preference or nonpreference for the test varieties is recorded. But the final rating for resistance is based on the extent of damage the different test varieties suffer. Up to 1975, a scoring system with a scale of 0 to 5 was used. In 1976, IRRI revised the scoring system (IRTP 1975). At present, plant damage is rated on the standard scoring system of 0–9 (Table 1).

The final damage rating is taken when about 90% of the plants of the susceptible check variety are killed—usually about 7 to 10 days after infestation.

Table 1. Standard for rating damage by brown planthopper (revised by IRRI-IRTP 1975; Pathak and Khush 1977).

Grade of damage	Symptom	Rating ^a
0	No visible damage	HR
1	Partial yellowing of first leaf	R
3	First and second leaves partially yellow	MR
5	Pronounced yellowing and some stunting	MS
7	Wilting and severe stunting	S
9	All test plants dead	HS

^aHR = highly resistant; R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible; HS = highly susceptible.

The varieties or lines that fall into grade 1 to 3 (or 0 to 2 under the former scoring system) are further evaluated for consistency of resistance in a repeat screening using the same technique, with four replicates per entry.

The selected lines or varieties are tested further to evaluate the nature and causes of their mechanisms of resistance.

SOURCES OF RESISTANCE

Since 1966, rice entomologists and breeders at IRRI have given much attention to the search for sources of resistant genes and the use of resistance in their breeding programs. Since then, screening for BPH resistance has been done on tens of thousands of varieties and lines from IRRI's worldwide germplasm collections and on its breeding lines. From these screening studies, a large number of varieties originating from indica rice were identified as resistant.

Using the mass-screening technique, many Asian rice-growing countries have also screened their available rice germplasm and breeding lines and incorporated the sources of resistance compatible with other desirable plant characters in their breeding programs.

More than 500 varieties or lines have been found resistant to the BPH (Table 2) in the Philippines (IRRI 1972, 1973, 1974, 1976; IRTP 1975, 1976a, b; Pathak and Khush 1977), Japan (Kaneda and Kisimoto 1977), Korea

Table 2. Resistant sources and their reaction to the brown planthopper in different countries.

Variety and line	Origin	IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
AC-1613	India	R	-	-	-	-	-	-	-	-
ADR 52	"	-	-	-	-	-	-	R	-	-
ADT 4	"	-	-	-	MR	-	-	-	-	-
ADT 19	"	R	-	-	-	-	-	-	-	-
Anbaw C7	Burma	MR(R)	-	-	MR	-	-	-	-	-
Andaragahawewa	S. Lanka	R	R	-	R	-	R	S	-	-
Anethoda	Nigeria	R	-	-	-	-	-	-	-	-
ARC 1040	India	-	-	-	-	-	-	R	-	-
ARC 5757	"	-	-	-	-	-	-	R	-	-
ARC 5839	"	-	-	-	-	-	-	R	-	-
ARC 5918	"	-	-	-	-	-	-	R	-	-
ARC 5984	"	-	-	-	-	-	-	R	-	-
ARC 5987	"	-	-	-	-	-	-	R	-	-
ARC 6563	"	-	-	-	MR	-	-	-	-	-
ARC 6650	"	R	R	-	MR	R	MR	R	-	-
ARC 7320	"	-	-	-	-	-	-	R	-	-
ARC 7327	"	-	-	-	-	-	-	R	-	-
ARC 10410	"	-	-	-	MR	-	-	-	-	-
ARC 10550	"	S	S	-	S	S	S	R	-	-

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Table 2 continued

Variety and line	Origin	IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
ARC 10595	"	-	-	-	MR	-	-	-	-	-
ARC 10834	"	-	-	-	MR	-	-	-	-	-
ARC 10945A	"	-	-	-	-	-	-	R	-	-
ARC 11354	"	S	S	-	S	S	S	R	-	-
ARC 11704	"	-	-	-	-	-	-	R	-	-
ARC 13788	"	-	-	-	-	-	-	R	-	-
ARC 14203	"	-	-	-	-	-	-	R	-	-
ARC 14342	"	MR	S	-	R	S	MR	R	-	-
ARC 14394	"	MS	S	-	S	S	S	MR	-	-
ARC 14529	"	R	S	-	S	R	R	MR	-	-
ARC 14529A	"	-	-	-	-	-	-	R	-	-
ARC 14539B	"	-	-	-	-	-	-	R	-	-
ARC 14636A	"	-	-	-	-	-	-	R	-	-
ARC 14766	"	R	MR	-	S	R	R	R	-	-
ARC 14766A	"	-	-	-	-	-	-	R	-	-
ARC 14771	"	MR	S	-	S	R	S	MR	-	-
ARC 14988	"	-	-	-	-	-	-	R	-	-
ARC 15152	"	-	-	-	-	-	-	R	-	-
ARC 15570A	"	S	S	-	S	S	S	R	-	-
ASD 7	"	R	R	MR	MR	R	R	S	-	-
ASD 9	"	R	-	-	-	-	-	-	-	-
B441b/190/1/1/3	Indonesia	-	-	-	-	R	-	-	-	-
B2360-8-5-LR-4-3	"	-	-	-	-	-	R	-	-	-
B3753-5-Pn-4-1	"	-	-	-	-	-	R	-	-	-
B3753-8-Pn-2-3	"	-	-	-	-	-	R	-	-	-
Babawee	S. Lanka	R	R	-	R	S	S	MR	-	-
Bakatabe	Indonesia	-	-	-	MR	-	-	-	-	-
Bala	India	MR	R	-	MR	M	S	S	-	-
Balamawee	S. Lanka	R	R	-	R	R	-	R	R	-
Bangkok	"	MR	-	-	-	-	-	-	-	-
Batapolawee	"	-	-	-	-	-	-	-	R	-
Batia Sira	India	-	-	-	-	-	-	R	-	-
Bello	GOA?	MR	-	-	-	-	-	-	-	-
Berawee	S. Lanka	-	-	-	R	-	-	-	-	-
Berlin	Costa Rica	MR	-	-	-	-	-	-	-	-
Bhadoia 293	Pakistan	MR	-	-	-	-	-	-	-	-
Bir-co-yuan li	Taiwan	MR	-	-	-	-	-	-	-	-
BJ 1	India	MR	-	-	-	-	-	-	-	-
BKN 1105-18	Thailand	-	-	-	R	-	-	-	-	-
BKN 6806-46-60	"	-	-	-	R	-	-	-	-	-
BKN 6953-15-1	"	-	-	-	R	-	-	-	-	-
BKN 6960-28	"	-	-	-	-	R	-	-	-	-
BKN BR 1008-5	"	-	-	-	-	R	-	-	-	-
BKN BR 1009-8	"	-	-	-	-	R	-	-	-	-
BKN BR 1030-3-1	"	-	-	-	-	R	-	-	-	-
BKN BR 1030-28-1	"	-	-	-	-	R	-	-	-	-
BKN BR 1031-15-1-3	"	-	-	-	-	R	-	-	-	-
BKN BR 1088-81	"	-	-	-	-	R	-	-	-	-
BKN BR 1091-69-1	"	-	-	-	-	R	-	-	-	-
BKN BR 1094-55-2	"	-	-	-	-	R	-	-	-	-
Bogor-1	Indonesia	R	R	R	R	R	R	MR	-	-
Bogor-6	"	R	R	MR	R	R	MR	M?	-	-

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Table 2 continued

Variety and line	Origin	IRRI (Philippines)								
		IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
Bogor-7	"	R	MR	-	MR	R	MS	M?	-	-
Bogor-8	"	R	R	R	R	MR	MR	M?	-	-
Bogor-12	"	R	R	R	R	R	MR	R	-	-
Bogor-14	"	MR	R	MS	R	MR	MS	M?	-	-
Bogor-16	"	R	MR	S	R	MR	MS	S	-	-
Bogor-18	"	R	R	R	R	S	R(M)	S	-	-
Bogor-20	"	R	R	R	R	R	MR	MS	-	-
Bogor-22	"	MR	R	-	R	R	MR	S	-	-
Bogor-25	"	MS	R	-	R	R	MR	S	-	-
Bogor-26	"	R	R	-	R	R	MR(M)	S	-	-
Bogor-29	"	R	R	-	R	R	MS	M	-	-
Bogor-31	"	R	R	-	R	MR	MS	M	-	-
Bogor-32	"	MR	R	R	R	MR	MR(M)	S	-	-
Bogor-34	"	M	R	-	R	MR	MR(M)	S	-	-
Bolibod	Philippines	MR	-	-	-	-	-	-	-	-
BR 43-11-2	Thailand	-	-	-	-	R	-	-	-	-
BR 51-118-2	"	-	-	-	-	R	-	-	-	-
BR 1030-3-1	"	R	R	R	R	R	MR	S	-	-
BR 1030-3-2	"	R	R	-	R	R	R	MS	-	-
BR 1030-11-2	"	R	R	R	R	MR	MS	MS	-	-
BR 1030-18-1	"	R	R	R	R	R	R	S	-	-
BR 1030-21-1	"	R	R	R	R	R	R	S	-	-
BR 1030-28-1	"	R	R	R	R	MR	MR	S	-	-
BR 1030-31-1	"	R	R	-	R	R	R	S	-	-
BR 1030-65-1	"	R	R	-	R	M	MR	S	-	-
BR 1030-76-1	"	R	R	-	R	R	R	S	-	-
C 33-18	"	-	-	-	MR	-	-	-	-	-
C 62-1-230	Taiwan	R	R	-	-	R	R	S	-	-
C 62-1-373	"	R	R	-	-	R	R	MS	-	-
C 84-35	S. Lanka	-	-	-	MR	-	-	-	-	-
C 409	Burma	MR	-	-	-	-	-	-	-	-
C 5298	India	MR	-	-	-	-	-	-	-	-
Cesariet	"	-	-	-	MR	-	-	-	-	-
Channinyakan	"	-	-	-	-	-	-	R	-	-
Cheenadi	S. Lanka	-	-	-	-	-	-	-	R	-
Chemban	India	-	-	-	-	-	-	MR	-	-
Chempan	"	-	-	-	-	-	-	MR	-	-
Chemparam Pandi	"	-	-	-	-	-	-	R	-	-
Chennellu	"	-	-	-	-	-	-	R	-	-
Cheriyia Chittari	"	-	-	-	-	-	-	R	-	-
Che shau nan bir	China	MR	-	-	-	-	-	-	-	-
Chetteri	India	-	-	-	-	-	-	R	-	-
Chianung shen-yu 10	Taiwan	-	R	-	-	-	-	-	-	-
Chianung shen-yu 11	"	R	R	-	MR	R	S	S	-	-
Chiu shih tsi	China	MR	-	-	-	-	-	-	-	-
C 15402-1	U.S.A.	MR	-	-	-	-	-	-	-	-
C 18636-1	Indonesia	R	-	-	-	-	-	-	-	-
CNT 7246-11-2-2	Thailand	-	-	-	-	R	-	-	-	-
CNT 7255-42	"	-	-	-	-	R	-	-	-	-
CO 3	India	R	-	-	-	-	-	-	-	-
CO 9	"	MR	R	-	MR	R	R	MS	-	-

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Table 2 continued

Variety and line	Origin										
		IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands	
CO 10	"	MR(R)	-	-	-	-	-	-	-	-	-
CO 13	"	-	S	-	MR	-	-	-	-	-	-
CO 20	"	MR	S	-	-	-	-	-	-	-	-
CO 22	"	R	R	-	MR	R	-	-	-	-	-
Company Chittari	"	-	-	-	-	-	-	R	-	-	-
CR 57-29	"	MR	-	-	-	-	-	-	-	-	-
CR 94-13	"	R	R	-	R	R	MR	S	-	-	-
Ctg 408	Pakistan	MR	-	-	-	-	-	-	-	-	-
Dampata Podiwee	S. Lanka	-	-	-	R	-	-	-	-	-	-
Dd 21	Bangladesh	MR	-	-	-	-	-	-	-	-	-
Dd 48	"	MR	-	-	-	-	-	-	-	-	-
Dd 68	"	MR	-	-	-	-	-	-	-	-	-
Dd 91	"	MR	-	-	-	-	-	-	-	-	-
Dd 106	"	MR	-	-	-	-	-	-	-	-	-
DF1	"	R	-	-	R	-	-	-	-	-	-
Dikwee	S. Lanka	R	R	-	MR	R	R	S	-	-	-
Dikwee 328	"	R	-	-	-	-	-	-	-	-	-
DJ 9	Bangladesh	R	-	-	R	-	-	-	-	-	-
DJ 29	"	R	-	-	-	-	-	-	-	-	-
DJ 66	"	MR	-	-	-	-	-	-	-	-	-
DJ 72	"	MR	-	-	-	-	-	-	-	-	-
Djawa Sredek	Indonesia	-	-	-	-	-	-	R	-	-	-
DK1	Bangladesh	MR	-	-	-	-	-	-	-	-	-
DNJ 80	"	R	-	-	R	-	-	-	-	-	-
DNJ 174	"	MR	-	-	-	-	-	-	-	-	-
DNJ 177	"	MR	-	-	-	-	-	-	-	-	-
DS1	"	MR	-	-	-	-	-	-	-	-	-
Dumali	Philippines	MR(R)	-	-	-	-	-	-	-	-	-
DV 29	Bangladesh	MR	-	-	-	-	-	-	-	-	-
DV 86	"	MR	-	-	-	-	-	-	-	-	-
DV 88	"	MR	-	-	-	-	-	-	-	-	-
DV 110	"	MR	-	-	-	-	-	-	-	-	-
DV 114	"	MR	-	-	-	-	-	-	-	-	-
DZ41	"	MR	-	-	-	-	-	-	-	-	-
DZ 98	"	MR	-	-	-	-	-	-	-	-	-
DZ171	"	MR	-	-	-	-	-	-	-	-	-
Early No. 3 (PI 208449)	India	MR	-	-	-	-	-	-	-	-	-
EK 1240	"	-	-	-	R	-	-	-	-	-	-
EK 1236	"	-	-	-	R	-	-	-	-	-	-
EleSamba	S Lanka	-	-	-	-	-	-	-	-	R	-
Elwee	"	-	-	-	-	-	-	-	-	R	-
Ennapatta	India	-	-	-	-	-	-	R	-	-	-
Gadi	Indonesia	-	-	-	MR	-	-	-	-	-	-
Gangala	S Lanka	R	R	R	R	R	MS	M	-	-	-
Gambada Samba	"	MR	-	-	-	-	-	-	-	-	-
Gapita	Indonesia	-	-	-	-	-	-	R	-	-	-
Ginmasari	Japan	MR	-	-	-	-	-	-	-	-	-
Girasal	GOA	MR	-	-	-	-	-	-	-	-	-
GS531	India	-	-	-	-	-	-	-	MR	-	-
H 5	S Lanka	R	R	-	MR	R	MR	S	-	-	-
H 105	"	R(MR)	R	-	R	R	R	S	-	-	-
Hal Suduwee	"	-	-	-	-	-	-	-	-	R	-

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Table 2 continued

Variety and line	Origin	IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
Hamsa	India	MR	R	-	-	R	R	S	-	-
Hathiel	S. Lanka	R	R	-	MR	-	-	-	-	-
Hathiyal	"	-	-	-	-	-	-	R	-	-
Hattathawee	"	MR	-	-	-	-	-	-	-	-
Heenhoranamawee	"	MR	-	-	MR	-	-	-	-	-
Heen Rath	"	R	-	-	-	-	-	-	-	-
Heen Rathkunda	"	-	-	-	-	-	-	-	R	-
Heenukkullama	"	R	-	-	-	-	-	-	-	-
Hill sel x PN bmt 54V-103	U.S.A.	MR	-	-	-	-	-	-	-	-
Hondarawala	S. Lanka	MR(R)	-	-	-	-	-	-	-	-
Hondarawala 378b	"	R	-	-	R	-	-	-	-	-
Hondarawala 3786	"	R	-	-	-	-	-	-	-	-
Hondarawala 502b	"	MR	-	-	R	-	-	-	-	-
Hondarawala 5026	"	R	-	-	-	-	-	-	-	-
Horana Mawee	"	R	-	-	-	-	-	R	-	-
HR 12	India	-	-	-	R	-	-	-	-	-
HR 19	"	-	-	-	R	-	-	-	-	-
HR 106	"	-	-	-	MR	-	-	-	-	-
HR 1231-235-3	"	R	R	R	R	R	R	S	-	-
HR 1231-258-2	"	MR	R	R	R	R	R	S	-	-
Hsin hsin bir	China	MR	-	-	-	-	-	-	-	-
Hunykkulama	S. Lanka	R	-	-	R	-	-	-	-	-
Hwang mu	China	MR	-	-	-	-	-	-	-	-
IET 5085	India	R	MR	-	M	MR	S	MS	-	-
IET 5118	"	MR	MR	-	R	M	R	M	-	-
IET 5119	"	MR	MR	-	R	M	S	MR	-	-
IET 5120	"	R	MR	-	R	S	MR	MR	-	-
IET 5122	"	R	MR	-	R	MS	R	M	-	-
IET 5236	"	R	MR	-	MR	MA	S	MS	-	-
IR4-93	Philippines	R	-	-	-	-	-	-	-	-
IR8 M16	India	R	MR	-	S	MR	S	S	-	-
IR18	Philippines	-	-	-	MR	-	-	-	-	-
IR26	"	R	R	-	R	MR	MR	MS	-	MR
IR28	"	R	-	-	MR	R	-	-	-	M
IR29	"	R	-	-	-	R	-	-	-	-
IR30	"	R	-	-	MR	R	-	-	-	S
IR32	"	R	-	-	MR	R	R	-	-	R
IR34	"	R	-	-	MR	R	-	-	-	M
IR36	"	R	-	-	-	R	R	-	-	R
IR38	"	R	-	-	-	-	-	-	-	R
IR40	"	R	-	-	-	-	-	-	-	-
IR42	"	R	-	-	-	-	-	-	-	-
IR747B2-6	"	R	R	-	-	-	-	-	-	-
IR747-13-6-3	"	-	-	-	MR	-	-	-	-	-
IR781-144-1-IR8/2	"	-	-	-	-	-	-	R	-	-
IR789-63-1	"	R	-	-	-	-	-	-	-	-
IR1154-243	"	R	-	-	-	-	-	-	-	-
IR1154-243-1	"	R	MR	R	S	M	MR	S	-	-
IR1330-3-2	"	R	-	-	-	-	-	-	-	-
IR1513A-E597	"	R	R	-	-	MR	R	S	-	-
IR1514A-579	"	R	-	-	-	-	-	-	-	-
IR1514A-E597-1	Philippines	-	-	-	-	R	-	-	-	-

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Table 2 continued

Variety and line	Origin									
		IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
IR1514A-E597-2	"	R	-	-	-	-	-	R	-	-
IR1514A-E666	"	-	-	-	MR	-	-	-	-	-
IR1539-823-1	"	R	-	-	-	-	-	-	-	-
IR1539-823-4	"	R	-	-	-	-	-	-	-	-
IR1539-823-4-1	"	R	R	-	R	R	MR	MS	-	-
IR1541	"	-	-	-	R	-	-	-	-	-
IR1544-340-6	"	R	-	-	-	-	-	-	-	-
IR1561-228-3	"	R	-	-	-	-	-	-	-	-
IR1561-288	"	-	-	-	R	-	-	-	-	-
IR1614-138-4	"	R	-	-	-	-	-	-	-	-
IR1614-389-1	"	R	-	-	-	-	-	-	-	-
IR1628-632-1	"	R	R	-	-	R	MR	S	-	-
IR1632-93-2-2	"	R	R	-	-	R	R	S	-	-
IR1702-74-3	"	R	-	-	-	-	-	-	-	-
IR1702-158-3	"	R	-	-	-	-	-	-	-	-
IR1712-217-2	"	R	-	-	-	-	-	-	-	-
IR1712-238-3	"	R	-	-	-	-	-	-	-	-
IR1820-52-2	"	R	-	-	-	-	-	-	-	-
IR1857-1	"	-	-	-	-	-	-	-	-	-
IR1909-1-3-3	"	-	-	-	-	-	-	R	-	-
IR2003-97-7	"	R	-	-	-	-	-	-	-	-
IR2003-P16-7	"	R	-	-	-	-	-	-	-	-
IR2006-P12-12	"	R	-	-	-	-	-	-	-	-
IR2006-P111-6	"	R	-	-	-	-	-	-	-	-
IR2014-P136-10	"	R	-	-	-	-	-	-	-	-
IR2016-P7-4	"	R	-	-	-	-	-	-	-	-
IR2018-P43-2	"	R	-	-	-	-	-	-	-	-
IR2031-238-5	"	R	-	-	-	-	-	-	-	-
IR2031-352-3-2	"	-	-	-	-	R	-	-	-	-
IR2031-354-1	"	R	-	-	-	-	-	-	-	-
IR2031-724-2	"	R	-	-	-	-	-	-	-	-
IR2034-238-1-2-3	"	R	-	-	-	R	-	-	-	-
IR2034-289-1	"	R	-	-	-	-	-	-	-	-
IR2035-290-2	"	R	-	-	-	-	-	-	-	-
IR2035-487-3-3	"	-	-	-	-	R	-	-	-	-
IR2038-158-2	"	R	-	-	-	-	-	-	-	-
IR2039-119-1	"	-	-	-	-	R	-	-	-	-
IR2039-203-3-1	"	-	-	-	-	R	-	-	-	-
IR2039-269-1	"	R	-	-	-	-	-	-	-	-
IR2042-101-2	"	R	-	-	-	-	-	-	-	-
IR2049-104-2	"	R	-	-	-	-	-	-	-	-
IR2061-213-2-16	"	-	-	-	-	-	R	-	-	-
IR2061-214-3	"	R	-	-	-	-	-	-	-	-
IR2061-464-4	"	R	-	-	-	-	-	-	-	-
IR2061-465-1-5-5	"	-	-	-	-	-	-	-	-	R
IR2070-24	"	R	-	-	-	-	-	-	-	-
IR2071-1-1-1	"	-	-	-	-	-	-	-	-	R
IR2070-88	"	R	-	-	-	-	-	-	-	-
IR2071-135-3-3	"	-	-	-	-	R	-	-	-	-
IR2071-137-5-5-1	"	R	-	-	-	-	-	-	-	R
IR2071-251-1-1-3	"	-	-	-	-	R	-	-	-	-
IR2071-486-1-2	"	-	-	-	-	-	R	-	-	-
IR2071-586-5-6-3-4	"	-	-	-	-	-	-	-	-	R

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Table 2 continued

Variety and line	Origin									
		IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
IR2071-621-2-3	"	-	-	-	-	-	R	-	-	-
IR2151-957-5	"	R	-	-	-	-	-	-	-	-
IR2153-43-2-3	"	-	-	-	-	-	R	-	-	-
IR2153-381-8-1	"	-	-	-	-	-	-	-	-	M
IR2153-550-2-6	"	-	-	-	-	R	-	-	-	-
IR2172-64	"	-	-	-	-	-	R	-	-	-
IR2307-72-2-2-1	"	R	R	-	R	MR	MR	S	-	-
IR2307-10-1-2-3	"	-	-	-	-	-	-	-	-	R
IR2307-112-3	"	-	-	-	-	-	-	-	-	R
IR2307-247-2-2-3	"	-	-	-	-	-	-	-	-	R
IR2307-281-5-32	"	-	-	-	-	-	-	-	-	R
IR2328-27-3-6	"	-	-	-	-	R	-	-	-	-
IR2681-34-5	"	-	-	-	-	R	-	-	-	-
IR72771-119-3-1	"	-	-	-	-	-	-	-	-	R
IR2777-103-2-2-3	"	-	-	-	-	-	-	-	-	R
IR2796-125-3-2-2	"	-	-	-	-	-	-	-	-	MR
IR2798-86-6	"	-	-	-	-	R	-	-	-	-
IR2823-399-5-6	"	-	-	-	-	-	-	-	-	R
IR2863-38-1	"	-	-	-	-	R	-	-	-	-
IR2863-38-1-2	"	-	-	-	-	-	-	-	-	R
IR2863-39-2-1	"	MR	-	-	-	-	-	-	-	-
IR3634-62-2	"	-	-	-	-	-	-	-	-	MR
IR3941-25-1	"	-	-	-	-	-	-	-	-	R
IR4409-65-3	"	-	-	-	-	-	-	-	-	R
IR4409-80-2	"	-	-	-	-	-	-	-	-	R
IR4417-177-1-4	"	-	-	-	-	-	-	-	-	R
IR4422-29-6	"	-	-	-	-	-	-	-	-	R
IR4422-143-2-1	"	-	-	-	-	-	-	-	-	R
IR4427-16-2-4	"	-	-	-	-	-	-	-	-	R
IR4427-23-2-3	"	-	-	-	-	-	-	-	-	MR
IR4427-58-5-2	"	-	-	-	-	-	-	-	-	R
IR4427-118-5-2	"	-	-	-	-	-	-	-	-	MR
IR4427-279-4-1	"	-	-	-	-	-	-	-	-	MR
IR4432-28-5	"	R	-	-	-	-	-	-	-	-
IR4432-38-6	"	R	-	-	-	-	-	-	-	M
IR4432-52-6-4	"	R	-	-	-	-	-	-	-	R
IR4432-103-6-4	"	R	-	-	-	-	-	-	-	-
IR4492-7-2-1	"	-	-	-	-	-	-	-	-	MR
IR4531-6-1-1	"	-	-	-	-	-	-	-	-	R
IR4580-5-3	"	-	-	-	-	-	-	-	-	R
IR4707-7-3	"	-	-	-	-	-	-	-	-	R
IR4707-123-3	"	-	-	-	-	-	-	-	-	R
IR4816-70-1	"	-	-	-	-	-	-	-	-	R
IR5257-77-2	"	-	-	-	-	-	-	-	-	R
IR5311-46-3	"	-	-	-	-	-	-	-	-	R
IR5853-76	"	-	-	-	-	-	-	-	-	R
Iri 328	Korea	R	MR	-	R	R	MR	S	-	-
Iri 329	"	R	R	-	R	MR	R	S	-	-
JBS 34	India	-	-	-	R	-	-	-	-	-
JBS 1168	"	-	-	-	-	-	-	R	-	-
KahataKeralla	S. Lanka	-	-	-	-	-	-	-	R	-
KahataSamba	"	R	-	-	-	-	-	-	-	-
Kalimekri391	Pakistan	MR	-	-	-	-	-	-	-	-

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Table 2 continued

Variety and line	Origin	IRRI (Philippines)								Solomon Islands
		Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka		
Kaluhan diran	S. Lanka	-	-	-	-	-	-	-	R	-
Kalu Hathiya	"	-	-	-	-	-	-	R	-	-
Kaluheenati	"	-	-	-	R	-	-	-	-	-
Kalu Kuruwee	"	MR	-	-	-	-	-	-	-	-
Kalu Samba	"	R	-	-	-	-	-	R	-	-
Kam-Ban-Gan	Hongkong	-	-	-	MR	-	-	-	-	-
Kao sen yu 12	S. Lanka?	-	-	-	MR	-	-	-	-	-
Karayal	S. Lanka	R	-	-	MR	-	-	-	-	-
Karekagga	S. Lanka	MR	-	-	-	-	-	-	-	-
Karia	Fiji Is	MR	-	-	-	-	-	-	-	-
Karuth Vellathan	S. Lanka	-	-	-	-	-	-	R	-	-
Ka ying 20	China	R	-	-	-	-	-	-	-	-
Kinko	Japan	MR	-	-	-	-	-	-	-	-
Kin shan zim	China	MR	-	-	-	-	-	-	-	-
Klewer	Indonesia	-	-	-	MR	-	-	-	-	-
Kodiyam	India	-	-	-	-	-	-	R	-	-
Kosatawee	S. Lanka	R	-	-	R	-	-	-	-	-
Kula Peruvela	"	-	-	-	-	-	-	R	-	-
Kuruhon darawala	"	R	R	-	R	R	-	-	-	-
LxH/2-281	India	-	-	-	-	-	-	R	-	-
Lal Basumati	Pakistan	-	-	-	-	-	-	R	-	-
Lamong peuteuj	Indonesia	-	-	-	R	-	-	-	-	-
Leb Mue Nahng	India	S	S	-	S	MS	S	M	-	-
Lekam Samba	S. Lanka	R	-	-	R	-	-	-	-	-
Lien chan shoa thou	China	MR	-	-	-	-	-	-	-	-
Loku Samba	S. Lanka	-	-	-	-	-	-	R	-	-
Lua Ngu	Vietnam	-	-	-	-	-	-	R	-	-
Lun yah tsan	China	MR	-	-	-	-	-	-	-	-
M 302/Mas 24 (1900)	S. Lanka	-	-	-	MR	-	-	-	-	-
Madael	"	-	-	-	-	-	-	R	-	-
Madayal	S. Lanka	R	-	-	R	-	-	-	-	-
Madayal b	"	R	-	-	-	-	-	-	-	-
Mahadikwee	"	R	-	-	R	-	-	-	-	-
Malkora	"	MR(R)	-	-	-	-	-	-	-	-
Manoharsali	India	-	-	-	-	-	-	R	-	-
Mawee	S. Lanka	-	-	-	-	-	-	R	R	-
Mgl 2	India	R	R	-	R	-	-	-	-	-
Ml 329	S. Lanka	R	-	-	MR	-	-	-	-	-
MR 329 b	"	R	-	-	-	-	-	-	-	-
Milketan 20	Philippines	-	-	-	MR	-	-	-	-	-
Milyang 30	Korea	R	R	-	R	MR	R	S	-	-
Milyang 34	"	-	R	-	-	-	-	-	-	-
Milyang 36	"	-	R	-	-	-	-	-	-	-
Moddai Samba	S. Lanka	-	-	-	-	-	-	-	R	-
MR 1523	India	-	-	-	-	-	-	R	-	-
MTU 9	Pakistan	MR(R)	-	-	MR	-	-	-	-	-
MTU 15	India	R	R	-	MR	R	R	S	-	-
MTU 16	"	-	-	-	-	-	-	R	-	-
Mudgo	"	R	R	R	R	R	R	S	-	-
Mudukmel	S. Lanka	-	-	-	-	-	-	-	R	-
Mudu Kiriyal	"	R	-	-	R	-	-	R	-	-

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Table 2 continued

Variety and line	Origin	IRRI (Philippines)									Solomon Islands
		Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka			
Muhudu Kiriyal	"	MR	-	-	-	-	-	-	-	-	-
Murunga 137	"	-	R	-	R	-	-	-	-	-	-
Murunga 307	"	-	-	-	R	-	-	-	-	-	-
Murunga-kayan	"	R	R	-	MR	-	-	-	-	-	-
Murunga-kayan 3	"	R	R	-	S	R	MR	S	-	-	-
Murungakayana 101b	"	R	R	-	R	R	R	S	-	-	-
Murungakayan 104	"	R	-	-	-	-	-	-	-	-	-
Murungakayan 302	"	R	-	-	-	-	-	-	-	-	-
Murungakayan 303	"	R	R	-	-	-	-	-	-	R	-
Murungakayan 303b	"	R	R	-	-	R	MS	S	-	-	-
Murungakayan 304b	"	R	-	-	R	-	-	-	-	-	-
Murungakayan 307	"	-	-	-	R	-	-	-	-	-	-
Muthumanikam	"	R	R	-	R	R	MS	S	-	-	-
Nang Lay	Vietnam	-	-	-	-	-	-	R	-	-	v
Ngane Tia	Laos	-	-	-	-	-	-	R	-	-	-
Niao uao	Taiwan	MR	-	-	-	-	-	-	-	-	-
<i>O. australiensis</i>	Australia	R	-	-	-	-	-	-	-	-	-
<i>O. brachyntha</i>	?	R	-	-	-	-	-	-	-	-	-
Oenji Hore	Indonesia	-	-	-	R	-	-	-	-	-	-
Okshitmayin	Burma	R	-	-	-	-	-	-	-	-	-
<i>O. latifolia</i>	?	R	-	-	-	-	-	-	-	-	-
<i>O. punctata</i>	India	R	-	-	-	-	-	-	-	-	-
Ottavai	S. Lanka	MR	-	-	-	-	-	-	-	-	-
Ovarkaruppan	"	R	-	-	R	-	-	-	-	-	-
Ovarkaruppan b	"	R	-	-	-	-	-	-	-	-	-
Pakheng kang	Laos	-	-	-	MR	-	-	-	-	-	-
Palasithari 601	S. Lanka	R	R	-	R	S	S	S	-	-	-
Pandi	Indonesia	-	-	-	-	-	-	R	-	-	-
Pandorai	India	-	-	-	MR	-	-	-	-	-	-
Panneti	S. Lanka	R	-	-	R	-	-	-	-	-	-
Pantong 32	Malaysia	-	-	-	MR	-	-	-	-	-	-
Pappakee	"	MR	-	-	-	-	-	-	-	-	-
Parakulam	S. Lanka	-	-	-	-	-	-	-	R	-	-
Parduriwee	"	-	-	-	-	-	-	-	-	R	-
Pawakkulama B	"	R	-	-	R	-	-	-	-	-	-
Pelopor	Indonesia	-	-	-	R	-	-	-	-	-	-
Periamorungan B	S. Lanka	R	-	-	MR	-	-	-	-	-	-
PK-1	"	R	-	-	R	-	-	-	-	-	-
PK-1 b	"	R	-	-	-	-	-	-	-	-	-
Podimawee	"	R	-	-	-	-	-	-	-	-	-
Podowee	"	R	-	-	-	-	-	-	-	-	-
Podwi 48	"	-	-	-	-	-	-	R	-	-	-
Ptb 9	India	-	-	-	R	-	-	-	-	-	-
Ptb 12	"	-	-	-	-	-	-	MR	-	-	-
Ptb 18	"	R	R	-	R	R	-	-	-	-	-
Ptb 19	"	R	R	R	R	R	MR	R	-	-	-
Ptb 20	"	R	-	-	-	-	-	-	-	-	-
Ptb 21	"	R	R	-	R	R	MS	MS	-	-	-
Ptb 27	India	R	-	-	-	-	-	-	-	-	-
Ptb 28	"	-	-	-	-	-	-	R	-	-	-
Ptb 33	"	R	R	R	R	R	R	R	-	-	-
Ptb 39	"	S	S	-	S	S	S	M	-	-	-
Pulot Etam	Malaysia	-	-	-	MR	-	-	-	-	-	-

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Table 2 continued

Variety and line	Origin									
		IRRI (Philippines)	Korea	Japan	Taiwan	Thailand	Indonesia	India	S. Lanka	Solomon Islands
Pusmaraga	S. Lanka	MR	-	-	-	-	-	-	-	-
Radin Bilis	Indonesia	-	-	-	-	MR	-	-	-	-
Rata-thavalu	S. Lanka	-	-	-	-	-	-	-	R	-
Rathkunda"		MR	-	-	-	-	-	-	-	-
Rathu Heenati"		R	R	-	R	-	-	R	-	-
Rathu Heenati b'		R	-	-	-	-	-	-	-	-
Rathu Hondarawala		-	-	-	-	-	-	-	R	-
RD4	Thailand	R	R	R	-	R	R	S	-	-
RD9 "		R	MR	-	R	MR	MR	S	-	-
RDR1	India	-	-	-	R	-	-	-	-	-
Rexoro x Zenith	USA.	MR	-	-	-	-	-	-	-	-
Ro wuan shun 21-3	China	R	-	-	-	-	-	-	-	-
RP 4-10		-	-	-	-	-	-	-	-	-
(T90 x IR8)	India	-	R	-	-	-	-	-	-	-
RP 9-6 "		R	R	-	-	R	R	S	-	-
Rusty Late	China	MR	-	-	-	-	-	-	-	-
S 2204	China	-	-	-	-	-	-	R	-	-
Samba	S. Lanka	R	-	-	MR	-	-	-	-	-
Saraya"		MR	-	-	-	-	-	-	-	-
Senawee	S. Lanka	R	-	-	R	-	-	R	-	-
Seratoes Hari	Indonesia	MR	-	-	-	-	-	-	-	-
Seruvellai	S. Lanka	R	-	-	R	-	-	-	-	-
Siam7	Thailand	-	-	-	-	-	-	R	-	-
Sigadis	Indonesia	R	-	-	-	-	-	-	-	-
Sinna Karuppan	S. Lanka	R	-	-	R	-	-	-	-	-
Sinnakayam B"		R	-	-	-	-	-	-	-	-
Sinnanayam 398"		-	-	-	-	-	-	R	-	-
Sinna Sivappu"		R	-	-	R	-	-	R	-	-
Sinna Suappu'		R	-	-	-	-	-	-	-	-
Sinnavellai "		R	-	-	-	-	-	-	-	-
Shinchiku-iku		-	-	-	-	-	-	-	-	-
No. 74	Taiwan	MR	-	-	-	-	-	-	-	-
SLO 12	India	R	-	-	R	-	-	-	-	-
SPT 721-40	Thailand	-	-	-	-	R	-	-	-	-
SPT 7202-35"		-	-	-	-	R	-	-	-	-
SPT 7215-20"		-	-	-	-	R	-	-	-	-
SPT 7329-18-1"		-	-	-	-	R	-	-	-	-
SPT 7342-20-1"		-	-	-	-	R	-	-	-	-
Sudhu-balawee	S. Lanka	MR(R)	-	-	-	-	-	-	-	-
Sudu Heenati'		-	-	-	MR	-	-	-	R	-
Sudu Hondarawala'		R	-	-	R	-	-	-	-	-
Sudunisamba"		-	-	-	R	R	-	-	-	-
Suduru Samba'		R	R	R	R	R	R	R	R	-
Sudurvi "		MR	-	-	-	-	-	-	-	-
Sudurvi 305"		R	R	-	R	R	-	R	-	-
Sudurvi 306"		-	-	-	R	-	-	-	-	-
Sulai"		MR	-	-	MR	-	-	-	-	-
Suweon 271	Korea	-	R	-	-	-	-	-	-	-
Suweon 272"		-	R	-	-	-	-	-	-	-
Su Yai 20	China	-	-	-	R	-	-	-	-	-
T 3	India	-	-	-	-	-	-	R	-	-
T 5"		-	-	-	MR	-	-	-	-	-
T 10"		-	-	-	-	-	-	R	-	-

continued on next page

(Song et al 1972; Choi 1975; Choi et al 1977), Taiwan (Cheng and Chang 1977), Thailand (Pongprasert and Weerapat 1977), Indonesia (Harahap 1977), India (Kalode and Krishna 1977), Sri Lanka (Fernando et al 1977), and the Solomon Islands (Stapley et al 1977). Varieties resistant in a country were not, however, necessarily resistant in other countries. For example, the varieties ASD7 and Mudgo are resistant in the Philippines (IRRI), Japan, Korea, Taiwan, Thailand, and Indonesia, but susceptible in India.

The different reactions could be due to the presence of different populations of BPH in different locations and countries. In the future, the sources of resistance so far identified should be retested against the different biotypes to tackle the development of biotypes capable of surviving on the resistant plants.

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