Varietal resistance to the brown planthopper in Thailand

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About 5,000 rice varieties and lines were screened in the greenhouse for their resistance to the brown planthopper (BPH) *Nilaparvata lugens* Stål in Thailand during 1972–1976. The free choice test, in which two-leaf stage seedlings were exposed to a heavy population of first- and second-Instar BPH nymphs, was used. About 100 varieties and lines were selected as resistant and used for hybridization in rice breeding programs in Thailand. Those that showed promise were further studied to confirm their resistance and to investigate the mechanism of resistance.

The main mechanisms of plant resistance to the BPH were identified as nonpreference and antibiosis. The varieties that were less preferred by the nymphs also were not preferred by the adults. More eggs were laid on the preferred varieties.

In addition, nymphs caged on resistant varieties had higher mortality than those caged on a susceptible variety. Significantly fewer adults eventually developed on the resistant varieties than on the susceptible variety Taichung Native 1. Also, the insects took longer to reach the adult stage on the resistant varieties, where the nymphal duration was extended from 4 to 13 days. Adults (male and female) lived longer and produced more progeny when reared on the susceptible variety Taichung Native 1 (TN1) than when reared on resistant varieties. The number of progeny produced on susceptible variety TN1 was 4 to 88 times higher than that produced on the resistant varieties.

The BPH in Thailand was investigated. Insects were collected from five sites in different regions of Thailand and mass reared on TN1 in separate cages in the greenhouse. The biotype of these insects was identified by its ability to infest the seedlings of a set of 10 differential rice varieties. The reactions of the 10 differential varieties to the populations of insects from all sites were mostly the same. That indicated that the insects from all sites tested at this time were of the same biotype.

THE INCIDENCE OF THE BROWN PLANTHOPPER (BPH) *Nilaparvata lugens,* formerly not a serious problem in Thailand, began to increase in 1973 with the introduction of double cropping and high yielding varieties. Maximum damage is observed in the dry season (April). Infestation occurs in portions of most

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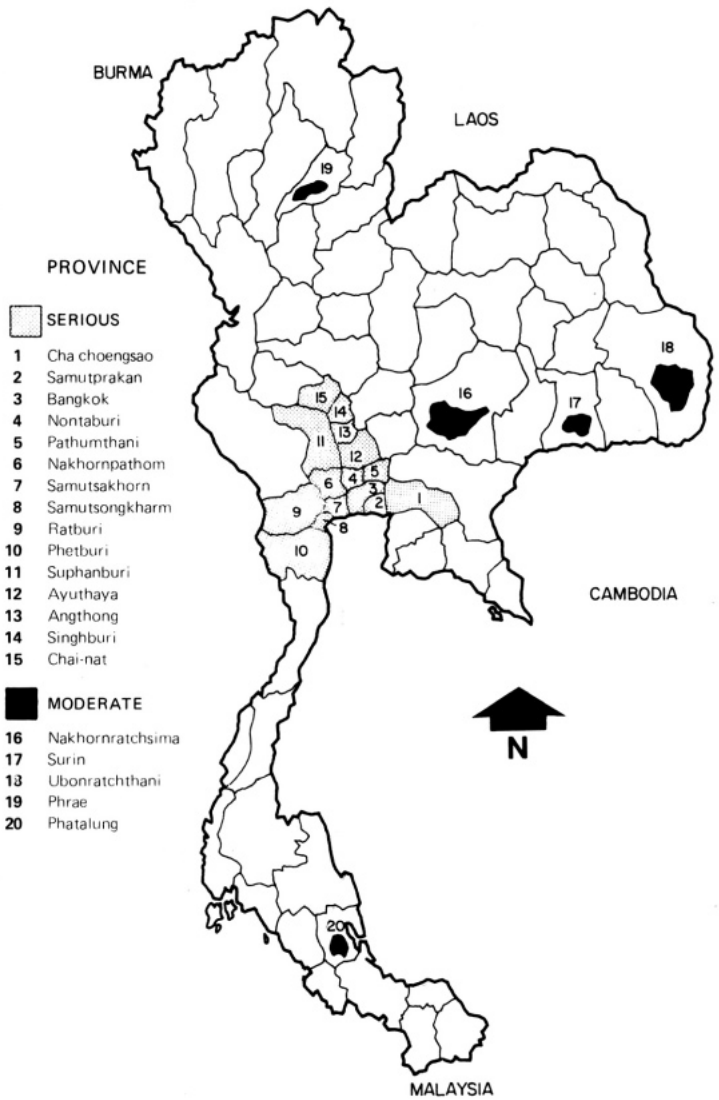

1. Distribution of brown planthoppers in Thailand, 1976 dry season.

provinces of the central plain near Bangkok (Fig. 1). In the 1975 dry season, insect outbreaks occurred in Phrae province in the north, Nakhornratchsima, Surin, and Ubonratchthani provinces in the northeast, and Phatalung province in the south. Outbreaks continue to increase with the expansion of irrigated rice growing areas and the continuous cultivation of high-yielding varieties. In an effort to check the outbreaks in widely grown varieties, a team consisting

of a rice breeder and an entomologist monitors insect buildup and suggests control measures. Control measures include insecticides and use of resistant varieties. One resistant variety, RD9, was released in 1975.

SCREENING FOR RESISTANCE

Rice varieties have been screened for resistance to the BPH in Thailand since 1972. The main purpose of screening is to facilitate the quick rejection of most of the BPH-susceptible lines. The screened materials are Thai local varieties and breeding lines, the germplasm bank of the International Rice Research Institute (IRRI), and IRRI's breeding lines. Because BPH are generally easy to mass-rear and because the natural field population is usually low, screening is done in the greenhouse. The methodology used in screening is the same as that described by Choi (this volume).

Retesting of selected varieties

Varieties that show resistance in the preliminary screening are rescreened. Because the purpose of mass screening is to reject the bulk of susceptible lines, the test of each selected variety is replicated two times. Records are made not only of damage, but also of the number of insects present on each variety 24 hours or more after infestation, and of the damage they cause at 5-day intervals. Those varieties showing promise are further studied to confirm their resistance and to investigate the mechanism of resistance. Table 1 shows the varieties and lines selected as resistant to the BPH.

MECHANISMS OF RESISTANCE

Painter (195 1) defined resistance as the "relative amount of heritable qualities possessed by the plant, which influence the ultimate degree of damage done by the insect." He divided plant-resistance mechanisms into three main categories: nonpreference, antibiosis, and tolerance. In our program in Thailand we have studied two mechanisms of resistance: nonpreference and antibiosis.

Nonpreference

Nymphs. Seeds of varieties selected from the general screening were sown in wooden flats. Insects per plant were counted at 2-day intervals for 1 week, starting 24 hours after infestation. Plant damage was recorded 10 days after infestation. Differences in nymphal preference were evident at 3 days after infestation (Table 2). There were more insects on TN1, the susceptible check, than on resistant varieties. Nymphs consistently showed nonpreference for some varieties, such as Ptb 33, Ptb 21, Balamawee, and Mudgo, and were attracted to others like W1263, W1265, and RD9 at 7 days after infestation, when the susceptible check variety had been severely damaged. The resistant varieties were only slightly damaged even when more insects moved to them

Table 1. Rice varieties and lines classified as resistant to the brown planthopper in mass-screening tests. Thailand, 1972-76.

Variety or line	Cross	Origin
RD4	17-7(LT/IR8)W1252//RD2	Thailand
RD9	CNT3176/W1256//RD2	"
BKN6806-46-60	17-1(LT/IR8)/W1259//RD2	"
BKN6953-15-1	IR841/Mudgo/IR8	"
BKN6960-28	RD2/Ptb21	"
CNT7246-11-2-2	RD1/IR532-E-239	"
CNT7255-42-3	BKN6517-11-2-1/CR52-3	"
SPT7202-35	GP15/BKN806-46-62	"
SPT721-40	LY148/RD9	"
SPT7215-20	L152/RD9	"
SPT7329-18-1	KDML105/Sigadis//IR1541	"
SPT7342-20-1	Payah Chom/IR1541	"
BKNBR1008-5	RD3/RJ1//RD9	"
BKNBR 1009-8	DZ192/BKN6517-11-2-1//RD9	"
BKNBR 1030-3-1	BKN6625-109-1/RD9	"
BKNBR 1030-28-1	BKN6625-109-1/RD9	"
BKNBR 1031-15-1-3	BKN6517-63-4-3/RD9	"
BKNBR 1088-81	IR2039-203-3-I/RD1	"
BKNBR 1091-69-1	IR2039-119-3-1/RD1	"
BKNBR 1094-55-2	IR2031-352-3-2/BKN6805-2-7	"
BKNBR 1105-18	IR1529-680-3/RD9	"
Mudgo		India
Ptb 18	–	"
Ptb 19	–	"
Ptb 21	–	"
Ptb 33	–	"
W 1252	–	"
W 1256	–	"
W 1259	–	"
W 1263	–	"
ASD 7	–	"
CO 9	–	"
CO 22	–	"
Dalwa Sanam (MTU 15)	–	"
Hamsa	–	"
TR 26	–	"
Thriveni	–	"
ARC 6650	–	"
ARC 14529	–	"
ARC 14766	–	"
ARC 14771	–	"
CR94-13	–	"
RP9-6	IR8/W1251	"
IET5122(RP825-71-4-11)	–	"
IET5236(RP825-24-7-5)	–	"
IET5085(RP825-70-7-1)	–	"
Andaragahawewa	–	Sri Lanka
Babawee		"
Balamawee		"
Gangala		"
H-5		"
H-105		"
Kuruhondarawala		"
Muthumanikam		"
Murungakayan 3		"
Murungakayan 101b		"
Murungakayan 303b		"
Sudurvi 305		"
Sudurvi Samba		"

continued on opposite page

Table 1 continued

Variety or line	Cross	Origin
IR26	IR24/TKM6	Philippines (IRRI)
IR28	IR833-6-2-1-1///IR1561-149-1//IR24[4]/*O. nivara*	"
IR29	IR833-6-2-1///IR1561-149-1//IR2[4]/*O. nivara*	"
IR30	IR1541-102-6-3//IR20[4]/*O. nivara*	"
IR32	IR20[2]/*O. nivara*//CR94-13	"
IR34	IR833-6-2-1-1///IRI561-149-1//IR2[4]/*O. nivara*	"
IR36	IR1561-228/IR1737/CR94-13	"
IR1154-243-1	IR8[2]/Zenith	"
IR1514-A-E597-L	IR20/TKM6	"
IR1539-823-4-1	IR661-1-140-3//Mudgo/IR8	"
IR1628-632-1	IR661-1-140-3-2/IRI154-243	"
IR1632-93-2-2	IR241C013	"
IR2031-352-3-2	IR24[3]/*O. nivara*//IR1416-131-1///IR1330-3-2-2	"
IR2034-238-1-2-3	IR1539-60/IR1364-37-3-1//IR24[4]/*O. nivara*	"
IR2035-487-3-3	IR1416-128-5/IR1364-37-3-1//IR1539-260//IR24[3]/*O. nivara*	"
IR2039-1109-3-1	IR1330-5-3-3//IR24[4]/*O. nivara*	"
IR2039-203-3-1	"	"
IR2071-135-3-3	IR1561-228-1-2//IR24[4]/*O. nivara*///CR94-13	"
IR2071-251-1-1-3	"	"
IR2153-550-2-6	IR1541-102-6-3//IR20[4]/*O. nivara*	"
IR2328-27-3-6	IR1514A-E666/IR1364-37-3-1	"
IR2681-34-5	CR94-13/1/IR20[3]/*O. nivara*//IR1541-102-6	"
IR2798-86-6	IR1529-680-3/IR1913-41-2/IR1514A-E666	"
IR2863-38-1	IR1529-680-3/CR94-13//IR480-5-9-3	
TG37	B44/b/pn/83/2/1	Indonesia
Bala	–	"
B441b/190/1/1/3	C4-63gb/5316/TK1391	"
Bogor-1		"
Bogor-6		"
Bogor-20		
Bogor-26		
BR43-11-2	Lakhaya/IR8	Bangladesh
BR51-118-2		"
Chianung-shen-yu 11	IR9-60/IR8	Taiwan
C62-1-230	Kaohsiung-shen-yu12/IR22	
C62-1-373	"	"
HR1231-235-3	WX126-48-12/KR108-2	Korea
HR1231-258-2	"	
WR318-5-4-49-61-1	"	"
Iri 328		"
Dikwee		Nigeria

from the susceptible varieties that had been killed.

Adults. The varieties that were less preferred by the nymphs in the preceding experiment were also evaluated for their attractiveness to adult insects. Individual plants—varieties spotted at random—were grown 10 cm apart in

Table 2. Host preference of brown planthopper nymphs and damage to selected rice varieties.[a] Thailand, 1976.

Variety	Insects[b] (no./plant) at an interval after infestation of				Damage (grade)[c]
	1 day	3 days	5 days	7 days	
Ptb 33	2.8 a	1.0 a	0.9 a	0.8 a	0.1
Ptb 21	3.0 a	2.3 a	1.5 ab	1.3 a	0.1
Balamawee	3.2 a	2.4 a	2.0 bc	1.6 a	0.1
IR32	3.0 a	2.5 ab	2.5 bcd	2.4 bc	0.9
Babawee	4.3 a	3.1 b	2.0 bc	1.8 ab	0.6
ASD 7	4.5 a	3.4 b	3.4 def	3.1 d	0.6
IR34	4.6 a	3.5 b	2.9 cde	2.8 cd	1.2
W1256	4.9 a	3.7 b	3.3 def	3.4 d	1.5
RD9	5.1 a	3.9 h	3.2 f	3.2 e	1.5
W1263	4.8 a	3.8 b	4.1 ef	4.5 e	1.6
RD4	4.3 a	3.8 h	3.8 def	4.0 cd	1.8
Mudgo (resistant)	3.3 a	2.4 a	2.1 bc	2.0 ab	0.2
TN1 (susceptible)	5.8 a	10.0 c	7.5 g	1.0 a	9.0

[a]Mean of 4 replications, 20 seedlings/replication. One week after sowing, each plant was exposed to initial populations of 8 first-instar nymphs. [b]In each column, means followed by the same letter are not significantly different at the 5% level. [c]*Grade* of damage was recorded 10 days after infestation. A higher grade means greater susceptibility

wooden flats (60 × 45 × 10 cm), with five replications. Thirty days after sowing, the plants were pruned to two tillers per plant. The flats were randomly arranged on a galvanized iron tray in the screenhouse, and about 400 freshly emerged adults were released on them. Insects on each plant were counted at 5, 24, and 48 hours after infestation. Seven days after infestation, the plants were dissected under a binocular microscope to determine the number of eggs laid on each variety.

There were distinct differences in the number of adults recorded on different varieties at 6 hours after infestation (Table 3). These differences increased in later observations. The susceptible variety, TN1, had more insects than any resistant variety. The resistant varieties Ptb 33, Ptb 21, Balamawee, Babawee, Mudgo, IR32, ASD 7, and IR34 had fewer insects during every observation period. Significantly fewer insects were on Ptb 33 and Ptb 21 than on other resistant varieties at 2 days after infestation. There were 2 to 4.8 times more insects on TN1 than on resistant varieties. The varieties preferred by the adults were also generally preferred by the nymphs.

The varieties preferred for feeding or for shelter were also generally preferred for oviposition (Table 3). The nonpreferred varieties received fewer eggs per plant than the susceptible varieties. There were 3.7 to 8.8 times more eggs deposited on TN1 than on the resistant varieties.

Antibiosis

Antibiosis is that component of resistance that adversely affects the biology of the insects. It may cause the death of the insects (often as early instars), abnormal length of the life cycle, smaller body size, and decreased fecundity.

Table 3. Oviposition-host preference of brown planthopper adults for selected rice varieties.[a] Thailand, 1976.

Variety	Female insects (no./plant) at an interval after infestation[b] of				Eggs[c] (no./plant)
	6 hours	1 day	2 days	Mean	
Ptb 33	2.5 a	2.0 a	0.8 a	1.8	56 a
Ptb 21	3.0 ab	2.5 a	1.3 a	2.3	80 a
Balamawee	3.8 abc	3.0 a	2.5 b	3.1	83 a
Babawee	3.5 abc	3.0 a	2.8 h	3.1	84 a
IR32	3.8 abc	3.5 ab	3.0 b	3.4	90 a
ASD 7	4.5 abc	3.7 abc	3.0 b	3.7	100 a
IR34	4.5 abc	5.0 abc	4.8 c	4.8	104 a
W1256	5.0 bc	5.3 cd	5.5 cd	5.0	109 a
RD 9	5.0 bc	5.5 cd	5.5 cd	5.3	115 a
W1263	5.3 bc	5.5 cd	5.8 d	5.5	128 a
RD4	7.0 c	6.3 d	5.5 cd	6.3	134 a
Mudgo (resistant)	4.2 abc	3.5 ab	2.5 b	3.4	78 a
TN1 (susceptible)	9.5 d	13.5 e	14.0 e	12.3	492 b

[a]Average of 5 plants/variety. Thirty-day-old plants were exposed for 7 days in the screenhouse to an initial population of 400 male and female adults. [b]In each column, means followed by the same letter are not significantly different at 5% level. [c]Seven days after infestation

Survival and nymphal development. Resistance of the rice varieties to the first-instar BPH nymphs should reduce insect populations that might otherwise cause damage in later stages. The survival of first-instar nymphs on plants of selected varieties grown individually in pots was studied. At 30 days after seeding, 10 first-instar nymphs were placed with the plants in cylindrical mylar cages. The mortality of the caged nymphs was recorded at regular intervals until they became adults. Survival of nymphs was lower on all varieties tested than on the susceptible check TN1 (Table 4). Between 38%

Table 4. Survival and development of first-instar brown planthopper nymphs on selected rice varieties.[a] Thailand, 1976.

Variety	Survival (%) of nymphs at an interval after infestation[b] of				Nymphs developing into adults (%)	Nymphal stage (days)
	3 days	6 days	9 days	12 days		
Ptb 33	62 a	48 a	44 a	38 a	14 a	26
Ptb21	64 a	52 a	48 a	48 ah	20 ab	25
Balamawee	86 ab	62 ab	62 ab	48 ab	26 abc	24
Babawee	84 ab	74 abc	74 bc	64 abc	34 bcd	23
IR32	82 ab	78 abc	78 bc	72 bcd	40 bcde	22
IR34	90 h	82 bc	74 bc	70 bcd	44 cde	20
W1256	84 ab	74 abc	74 bc	72 bcd	46 cde	19
ASD 7	82 ab	78 abc	78 bc	72 bcd	48 cde	21
RD9	88 b	84 bc	82 bc	72 bcd	48 cde	18
W1263	92 b	84 bc	82 bc	76 bcd	54 de	17
RD4	94 b	86 bc	86 bc	84 cd	54 de	17
Mudgo (resistant)	84 ab	72 ab	64 ab	64 abc	35 bcde	24
TN1 (susceptible)	96 b	96 c	96 c	96 d	96 f	13

[a] Average of 10 replications; in each, 10 freshly hatched nymphs were caged with a 30-day-old seedling.
[b] In each column, means followed by the same letter are not significantly different at the 5% level.

Table 5. Life span and fecundity of brown planthopper on selected rice varieties. Thailand, 1976.

Variety	Life span (days)				Progeny (no./female)	
	Male		Female [b]			
	Range	Mean [c]	Range	Mean [c]	Range	Mean [c]
Ptb 33	1-4	2.8 a	1-7	3.6 a	0-15	3.2 a
Ptb 21	1-5	3.0 a	1-8	3.8 a	0-18	4.0 a
Balamawee	2-7	4.2 a	2-8	4.4 a	0-20	5.0 a
Babawee	2-8	4.6 a	2-10	5.2 a	0-38	7.2 a
IR32	1-11	4.8 a	1-13	5.4 a	0-50	12.2 ab
ASD 7	2-10	5.4 a	2-13	6.2 a	0-68	18.8 ab
IR34	2-13	6.0 a	2-15	7.6 a	0-89	20.6 ab
W1256	2-14	6.0 a	2-18	8.6 a	0-104	22.8 ab
RD9	2-15	6.8 a	2-20	9.0 a	0-139	40.0 ab
W1263	2-16	7.6 a	2-20	9.8 a	0-186	52.8 ab
RD4	2-24	8.2 a	2-25	10.6 a	0-290	78.0 ab
Mudgo (resistant)	1-7	3.6 a	2-7	4.4 a	0-22	4.2 a
TN1 (susceptible)	10-25	17.2 b	11-31	23.0 b	211-331	280.2 c

[a]Average of 10 replications; in each, one pair of newly emerged adults was caged with a 30-day-old Plant. [b]Brachypterous form. [c]Any two means followed by the same letter are not significantly different at the 5% level.

and 84% of the nymphs on resistant varieties survived at 12 days after caging, while nearly 100% of those on TN1 survived. The varieties Ptb 33, Ptb 21, Balamawee, Babawee, and Mudgo caused highest nymphal mortality. At 12 days after infestation, although nymph survival on some of the resistant varieties was not significantly lower than that on TN1, the percentage of nymphs that became adults on them was significantly lower. Also, the insects took longer to reach the adult stage on the resistant varieties. About 14% to 54% of the nymphs became adults on resistant varieties; 96% became adults on TN1. Duration of the nymph stage was extended from 4 to 13 days on resistant varieties.

Longevity and fecundity of adults. Ten plants each of selected resistant and susceptible varieties were grown individually in pots. Thirty-day-old potted plants were caged, each with a pair of newly emerged adult insects in a cylindrical mylar cage. The life span of the insects and the number of progeny they produced were recorded.

The insects lived longer and produced more progeny when reared on susceptible TN1 than when reared on resistant varieties (Table 5). The females generally outlived the males when reared on the same variety. They produced from 4 to 88 times more progeny on susceptible TN1 than on the resistant varieties, where many females died before they could lay eggs.

Rice varieties with sources of resistance to the BPH were identified. The resistance appears to be associated with one or more of the following factors:

1. nonpreference of the insect for the variety as a site for feeding and oviposition,

2. ability to withstand insect damage, and
3. high mortality of first-instar nymphs caged on resistant plants, relatively short adult life, and relatively few progeny.

GENETICS AND BREEDING FOR RESISTANCE

In Thailand, the inheritance of resistance to the BPH in rice was first studied in lines such as W1252, W1259, and W1263, introduced from India by Sristaporn (1976). Because of their high resistance to rice gall midge, these lines, including W 1256, had been used as donor parents in the Thai hybridization program since 1968. Subsequently, promising lines with BPH resistance and gall midge resistance derived from W1252 and W 1256 were released as RD4 and RD9, respectively.

RD4, released in 1973, has waxy grain and is recommended primarily for use in the rice gall midge areas of north and northeast Thailand. Because the gelatinization temperature of its grain starch is high, RD4 has not become popular among the farmers even though its yield is far superior to that of local varieties in areas under heavy gall midge attack. Furthermore, the BPH has thus far not been a serious problem in north and northeast Thailand.

RD9 was released in 1975 for use as a deterrent to the BPH in the Central Plain. Its major weakness is susceptibility to bacterial blight. It is most popular in those areas where the BPH occurs frequently. In such areas. its most noticeable advantage is its freedom from infection by grassy stunt, which badly affects susceptible varieties such as RD7. Work is under way to determine whether mixing RD7 and RD9 can significantly reduce the BPH population and provide more protection against bacterial blight.

To study the inheritance of BPH resistance, seeds of W1252, W1259, and W1263, and F_1 and F_2 of RD/W1252, RD1/1259, and RD1/1263 were germinated in petri dishes and planted in wooden flats. Nymphs of first- and second-instar BPH were then released on the seedlings at the two-leaf stage. Ten days after infestation, the seedlings were classified as resistant or susceptible according to the grading system of International Rice Research Institute (Choi, this volume). W1252, W1259, W1263. and F_1 progeny of the crosses were resistant, but RD1 was susceptible. F_2 segregated in a ratio of 3 resistant to 1 susceptible, suggesting that the BPH resistance in W1252, W 1259, and W 1263 is conditioned by a single dominant gene.

At present, other sources of resistance are being used in the breeding program. Many promising resistant lines have been identified.

INSECT BIOTYPES

Biotypes of the BPH in Thailand were studied in 1975. Until then no rice varieties resistant to BPH had been grown. The resistant variety RD9 was released in 1975 and was commonly grown in farmers' fields in 1976.

In a study to determine whether the BPH that occur in different regions of Thailand belong to the same biotype or of to different biotypes, insects were collected from three sites in the Central Plain (Pathnumthani, Nontaburi, and Chachoengsao provinces), one site in the northeastern region (Ubonratchthani province), and one site in the southern (Phatalung province) region. Insects from each area were mass-reared on TN1 in separate cages in the greenhouse. The biotype of the insects was identified by their ability to infest the seedlings of a differential set of rice varieties: CO9, Gangala, Murungakayan 101b, Chianung-shen-yu 11, Ptb 21, IR34, RD4, RD9, Mudgo (resistant check), and TN1 (susceptible check). The screening method cited earlier in this paper was used. The reactions of the 10 differential rice varieties to the BPH populations from all areas were the same. The resistant check variety Mudgo showed resistance to the insects from all areas. The same was true of the test varieties CO9, Ptb 21, Murungakayan 101b, Gangala, Chianung-shen-yu 11, IR34, and RD9. The susceptible check variety TN1 showed susceptibility to insects from all areas. The moderately resistant variety RD4 showed the same reactions to insects from all areas.

The results indicate that the insects from all areas tested were of the same biotype. However, insects should be collected again from areas where a rice variety resistant to the BPH (RD9) has been intensively grown.

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Appendix 1. Some factors affecting resistance of selected rice varieties to the brown planthopper *N. lugens.*[a] Thailand, 1976

Variety	Preference				Survival (%) of caged nymphs at		Nymphs(%) developed into adults	Nymph stage duration (days)	Longevity (days)		Progeny produced per female
	Plant damage[b]	Nymphs[c] (no./plant)	Adults[d] (no./plant)	Eggs (no./plant)	3 days[e]	12 days[e]			Male	Female	
Ptb33	0.1	1.0 a	0.8 a	56 a	62 a	38 a	14 a	26	2.8 a	3.6 a	3.2 a
Ptb 21	0.1	2.3 a	1.3 a	80 a	64 a	48 ab	20 ab	25	3.0 a	3.8 a	4.0 a
Balamawee	0.1	2.4 a	2.5 b	83 a	86 ab	48 ab	26 abc	24	4.2 a	4.4 a	5.0 a
Babawee	0.6	3.1 b	2.8 b	84 a	84 ab	64 abc	34 bcd	23	4.6 a	5.2 a	7.2 a
IR32	0.9	2.5 ab	3.0 b	90 a	82 ab	72 bcd	40 bcde	22	4.8 a	5.4 a	12.2 ab
ASD 7	0.6	3.4 b	3.0 b	100 a	82 ab	72 bcd	48 cde	21	5.4 a	6.2 a	18.8 ab
IR34	1.2	3.5 b	4.8 c	104 a	90 b	70 bcd	44 cde	20	6.0 a	7.6 a	20.6 ab
W1256	1.5	3.7 b	5.5 cd	109 a	84 ab	72 bcd	46 cde	19	6.0 a	8.6 a	22.8 ab
RD9	1.5	3.9 b	5.5 cd	115 a	88 b	72 bcd	48 cde	18	6.8 a	9.0 a	40.0 ab
W1263	1.6	3.8 b	5.8 d	128 a	92 b	76 bcd	54 de	17	7.6 a	9.8 a	52.8 ab
RD4	1.8	3.8 b	5.5 cd	134 a	94 b	84 cd	54 de	17	8.2 a	10.6 a	78.8 ab
Mudgo (R)	0.2	2.4 a	2.5 b	78 a	84 ab	64 abc	36 bcde	24	3.6 a	4.4 a	4.2 a
TN1 (S)	9.0	10.0 c	14.0 e	492 b	96 b	96 d	96 f	13	17.2 b	23.0 b	280.2 c

[a]In a single column, any two figures that are followed by a common letter are not significantly different at the 5% level. [b]On a scale of 0–9, recorded 10 days after infestation; larger number indicates greater damage. Average of 4 replications, 20 seedlings per replication. [c]Number of nymphs per plant were recorded at 3 days after infestation. [d]Number of adults per plant was recorded at 2 days after infestation. [e]Afterinfestation