frequency and low egg hatchability percentage (see table). In the reciprocal cross, female B1 × male BL, there was a high mating frequency and egg hatchability, but survival of F_1 hybrids remained low. These results show there are pre- and post-mating barriers between the two populations.

Host specificity tests showed the ability of the F_1 progenies to feed and survive on rice (TN1) plants was dominant over that on the grass. Dominance was observed to the 3d generation of the genetic cross and the 1st generation of the backcross progenies (see figure), indicating that host specificity was controlled by a single major autosomal gene.

Preliminary cytological examinations of F_1 hybrids showed that the B1 parent contributed more to the total genome of the progenies. Chromosomal aberrations
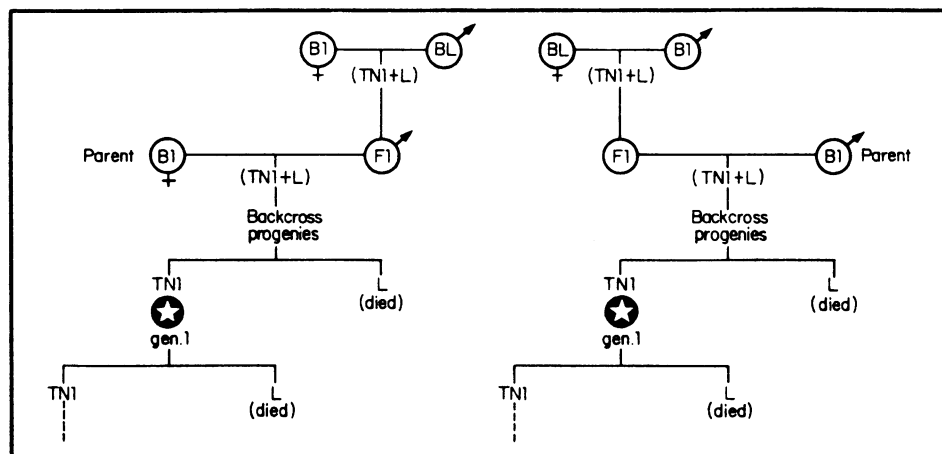
Scheme of direct crosses, reciprocal crosses, and backcrosses involving *N. lugens* biotype 1 (Bl) and the grass-infesting biotype (BL), IRRI.

were also observed, which further confirmed the existence of some degree of reproductive isolation between the BPH populations.

Intraspecific matings were also possible between B1 and B2 or B3. However, mating frequency and egg hatchability were significantly higher in conbiotic crosses than in interbiotypic pairs. These discrepancies indicate the presence of some restrictions to the normal gene flow between those biotype populations. □

Enzyme polymorphism in rice brown planthopper (BPH)

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Using horizontal starch gel electrophoresis, we analyzed enzyme polymorphism in BPH biotype 1 and 3 populations. Polymorphism was noted in 6 of 11 enzymes: catalase (CAT), esterase (EST), isocitrate dehydrogenase (IDH), malate dehydrogenase (MDH), malic enzyme (ME), and phosphoglucose isomerase (PGI). We carefully evaluated PGI, IDH, and MDH.

For each of those three enzymes, the variability of the main bands was explained by the polymorphism of one gene coding for dimeric enzymes. This was established by using two indirect lines of evidence: 1) the inferred heterozygous genotypes for a particular locus displayed an additional intermediate band more intense than both parental bands, and 2) the inferred genotype distributions observed in the two populations did not deviate significantly from the distributions predicted by the Hardy-Weinberg expectation (Table 1).

Table 1. Observed frequencies of genotypes in 3 protein loci of BPH biotype 1 and biotype 3. IRRI, 1983.

Locus	Genotype	Biotype 1			Biotype 3		
		Observed	Expected[a]	c^2	Observed	Expected	c^2
Pgi	105/105	30	22	9.01[b]	5	2	6.75[b]
	100/105	50	64	(df = 4)	16	23	(df = 4)
	100/100	54	47		80	77	
	95/105	0	2		0	0	
	95/100	3	3		1	1	
	95/95	1	0		0	0	
	Total[c]	138			102		
Idh	100/100	149	149	0[b]	154	154	0[b]
	93/100	12	12	(df = 1)	1	1	(df = 1)
	93/93	0	0		0	0	
	Total[c]	161			155		
Mdh	100/100	147	148	0.084[b]	153	153	0[b]
	100/109	14	13	(df = 1)	1	1	(df = 1)
	109/109	0	0		0	0	
	Total[c]	161			154		

[a]Compared with Hardy-Weinberg expectation. [b]Not significant at the 5% probability level. [c] Sample size.

Table 2. Allele frequencies in 3 protein loci of BPH biotype 1 and biotype 3. IRRI, 1983.

Locus		Allele frequency			Heterozygosity[a] (H)
		1	2	3	
Pgi	Biotype 1	0.018	0.583	0.398	0.38
	Biotype 3	0.005	0.868	0.128	0.17
Idh	Biotype 1	0.037	0.963	–	0.07
	Biotype 3	0.003	0.997	–	0.01
Mdh	Biotype 1	–	0.957	0.043	0.09
	Biotype 3	–	0.997	0.003	0.01
					$\overline{H}1 = 0.07$
					$\overline{H}3 = 0.02$

[a] The 5 other invariant loci were included in the calculation of $\overline{H}$.

The PGI gene had three alleles: Pgi[35], Pgi[100], and Pgi[105] designated as 1, 2, and 3, respectively. The IDH gene had two alleles: Idh[93] and Idh[100], designated as 1 and 2. The MDH gene had two alleles: Mdh[100] and Mdh[109], designated as 2 and 3.

The allele frequencies and the heterozygosities of the two populations are in Table 2. Biotype 1 had a slightly higher mean heterozygosity ($\bar{H}$) (0.068) than biotype 3 (0.023), mainly because of a higher number of heterozygotes at locus PCI.

As far as those three loci are concerned, biotype 1 exhibits more genetic variation than biotype 3. A more conclusive statement regarding the extent of variation could be obtained by increasing the number of protein loci investigated. □

Effect of temperature on brown planthopper (BPH) feeding

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We studied the effect of temperature on BPH feeding. BPH were collected from the stubble in rice fields on 5 Oct, after the crop was harvested and when mean temperature fell below 16 to 13°C.

Two 4th-instar nymphs and 2 adult BPH were placed in a mylar film cage and allowed to feed on 15-d-old plants of susceptible Milyang 23 for 24 h at a constant temperature. Area (mm^2) of the honeydew spots excreted by BPH on Toyo No. 2 filter paper dipped in a solution of bromocresol green (2 mg/ml ethanol) was measured.

BPH feeding significantly decreased at lower temperatures (see table). At 9°C there was no feeding activity at nymph or adult stages. □

Area of honeydew spots excreted by BPH at different temperatures, Suweon, Korea.

Temp (°C)	Area (mm^2)[a] in 24 h		
	Nymphs	Adults	Mean
26	30.1 a	22.9 a	26.5
20	7.8 b	19.5 a	13.7
16	3.2 bc	3.5 b	3.4
13	5.4 bc	4.4 b	4.9
9	0.0 c	0.0 b	0.0

[a] Mean for 2 replications. In a column, means followed by a common letter are not significantly different at the 5% level.

Pest management and control WEEDS

Weed control in dry-seeded lowland rice With bentazon and bentazon combined with 2,4-D

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Dry-seeded lowland rainfed rice has good potential in northeastern India, but heavy weed infestation is a serious constraint. In 1983, we evaluated bentazon and bentazon + 2,4-D for weed control.

In northeastern India, the typical dry-seeded field weed flora is 68-75% sedges, 15-20% broadleaf weeds, and 5-10% grasses. Bentazon was applied by a knapsack sprayer at 1.5 and 2.0 kg/ha alone or in combination with the amine salt of 2,4-D at 1.0 kg/ha with 1,000 litres of water/ha as a directed spray 15 d after rice germination.

Bentazon alone and bentazon + 2,4-D did not have a phytotoxic effect on rice seedlings. Bentazon + 2,4-D significantly reduced weed population and weed dry matter accumulation compared with bentazon alone and grain yield was similar to that with conventional hand weeding (see table). With unchecked weed competition, grain yield was reduced 33.3%. □

Effect of different bentazon concentrations and bentazon combined with 2,4-D on rice grain yield and weed mortality, Bhubaneswar, India.[a]

Treatment	Weeds (no./m^2) at 25 DAS	Weed dry wt (g/m^2) at 90 DAS	Grain yield t/ha
Bentazon @ 1.5 kg/ha	101.2	87	3.3 c
Bentazon @ 2.0 kg/ha	79.6	69	3.6 b
Bentazon @ 1.5 kg/ha + 2,4-D @ 1.0 kg/ha	59.4	57	3.9 a
Bentazon @ 2.0 kg/ha + 2,4-D @ 1.0 kg/ha	47.8	53	4.0 a
Conventional hand weeding (25 and 45 DAS)	398.6	28	4.2 a
Unweeded control	415.2	210	2.8 d
CD at 5%	19.4	10.4	0.27

[a] DAS = days after seeding.

Effect of rice crop residue management on weed growth in lowland rice

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At TNAU, Coimbatore, in 1981 summer and monsoon seasons, we found that incorporating rice crop residues reduced weed dry matter production (DMP). Treatments were in a randomized split-plot design with three replications.

In summer, treatments were control, no residue incorporated (S$_0$); 10 t rice