NIL/parent	Genotype	Test isolate																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
LTH	+	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
F-98-7	$Pi\text{-}K^m$	S	R	R	S	R	S	S	R	S	S	R	S	S	S	R	R	S	S	S	S	S	S	S	R	R	S	R	R	S	S
Tsuyuake	$Pi\text{-}K^m$	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
F-145-2	$Pi\text{-}b$	S	R	R	R	R	R	S	R	R	R	R	R	S	R	R	R	R	S	R	S	S	S	R	R	S	R	R	R	S	S
BL1	$Pi\text{-}b$	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
F-1281	$Pi\text{-}ta^2$	R	R	R	R	R	R	R	R	R	S	S	R	S	R	R	R	S	R	R	R	R	R	R	R	R	R	R	S	R	R
Pi No.4	$Pi\text{-}ta^2$	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R
F-124-1	$Pi\text{-}ta$	S	R	R	S	R	S	S	R	S	S	R	S	S	S	R	R	S	S	R	S	S	S	R	R	S	R	R	S	S	R
K1	$Pi\text{-}ta$	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R
F-129-1	$Pi\text{-}K^p$	S	R	R	S	R	S	S	R	S	S	R	S	S	S	S	S	S	S	R	S	S	S	R	R	S	R	S	S	S	R
K60	$Pi\text{-}K^p$	R	R	R	R	R	R	R	R	R	R	R	R	R	S	R	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R
F-80-1	$Pi\text{-}K$	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	S	R	S	R	S	S	S	S	S	S	S	S	S	S	R	S	S	R
Kusabue	$Pi\text{-}K$	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

[a]+ = no resistance gene. R = resistant, S = susceptible, NT = not tested, 1 = 840328, 2 = 850220, 3 = 840505, 4 = V85076, 5 = V85068, 6 = 8401, 7 = 55, 8 = 56, 9 = 57, 10 = P06-6, 11 = V86010, 12 = 86013, 13 = G907, 14 = 840775, 15 = 86046, 16 = 9021, 17 = 9022, 18 = NBG-A8401, 19 = 9081-25-3, 20 = V85016, 21 = BN111, 22 = CA34, 23 = CA79, 24 = CA36, 25 = C9228-33, 26 = B90169, 27 = CA77, 28 = CA57, 29 = C93, 30 = CA16.

incompatible isolates were found. This variety was recently test-inoculated with 30 Philippine blast isolates, which were selected based on differential reactions to Philippine varieties and sets of differential varieties at IRRI. LTH showed susceptible reactions to all isolates used. Thus, LTH appears to lack any known major genes for blast resistance. It was therefore used as the recurrent parent for developing a series of NILs.

Selected varieties with known resistance genes from Kiyosawa's differential varieties (KDV) (Kusabue, Tsuyuake, K1, Pi No. 4, K60, and BL 1) were crossed to LTH. The F_1s were test-inoculated with Japanese strain Hoku 1 and the resistant plants were backcrossed to LTH. Seven backcrosses were done, and in each backcross the resistant F_1s were screened by test inoculations and were then backcrossed to LTH. The derived BC_7F_1 plants were selfed in Beijing, and the BC_7F_2 seeds were sown in Hainan Province, China, in 1992. BC_7F_3 populations from each BC_7F_2 plant were inoculated with strain Hoku 1 to identify homozygous resistant lines in Beijing in 1993. These homozygous lines are F-80 from Kusabue; F-98, F-102, and F-105 from Tsuyuake; F-114, F-123, and F-124 from K1; F-128 from Pi No.4; F-129, F-131, and F-136 from K60; and F- 145 from BL 1. Finally, a set of NILs that includes F-98-7 ($Pi\text{-}K^m$), F-145-2 ($Pi\text{-}b$), F-128-1 ($Pi\text{-}ta^2$), F-124-1 ($Pi\text{-}ta$), F-129-1 ($Pi\text{-}K^p$), and F-80-1

(Pi-K) (Table 1) was established. This was confirmed by inoculating with Hoku 1 strain.

To evaluate the reactions of the derived NILs with the Philippine isolates, the NILs and the donor KDV were test-inoculated with 30 Philippine blast differential isolates from IRRI. Inoculation results showed that the NILs and the corresponding KDV donor parents exhibited different reactions while the donor Tsuyuake showed highly resistant reactions to isolates 840328, V85076, 8401, 55, 57, PO6-6, and 86-13 (Table 2). The same trend was observed in the other set of NILs and their corresponding donor parents. This indicated that the donor parents have additional unknown genes besides the known genes that were transferred to the isolines. Hence, the isolines exhibited clear-cut resistant or susceptible reactions, whereas the donors, having different genetic backgrounds and additional unknown genes, showed resistant reactions to all the isolates used. Because the isolines are capable of differentiating pathogenic races of blast fungus in both indica and japonica rice-growing areas, they may be considered as a new set of international differentials. ∎

Pest resistance—insects

Screening local varieties for resistance to whitebacked planthopper *Sogatella furcifera* in the Mekong Delta, Vietnam

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We tested 953 local rice varieties for resistance to whitebacked planthopper (WBPH). The bulk seedling test showed

Table 1. Population of WBPH settling on seedlings of susceptible and resistant rice varieties 2, 4, and 6 DAI.

Variety	Nymphs on 10 seedlings (no.)			Score
	2 d	4 d	6 d	
IR2035-117-3	15 a	12 a	16 a	0
BR46	20 ab	18 a	23 ab	1
Xoai cat	22 ab	20 a	21 ab	1
Base	22 ab	18 a	21 ab	1
Keo Cha A	24 ab	33 b	31 bc	3
Ba Khieu	30 abc	39 b	30 bc	1
La	29 abc	34 b	39 d	3
Rong Lem	38 bc	43 b	35 d	1
TN1	57 c	64 c	wilted	9
CV (%)	16	9.6	10	

Variety	Individuals settled on a hill (no.)				Eggs/hill (no.)
	24 h	48 h	72 h	96 h	
IR2035-117-3	2 a	1 a	1 a	2 a	152 a
BR46	5 ab	2 b	2 a	1 a	103 a
Ba Khieu	7 bc	8 c	5 bc	6 b	521 d
Rong Lem	8 bc	8 c	6 bc	4 b	572 d
Xoai cat	8 bc	8 c	5 bc	4 b	325 b
Base	8 bc	7 c	5 bc	4 b	410 c
La	10 c	8 c	4 b	6 b	267 b
Keo Cha A	15 c	13 d	14 d	13 c	804 d
TN1	19 c	30 e	37 e	43 d	2,974 e
CV (%)	29	10	27.6	21.6	6

that about 30% were moderately resistant to WBPH. Among these, seven varieties were tested for the nonpreference mechanism.

Two days after infestation (DAI), a significantly higher population of nymphs was found on susceptible Taichung Native 1 (TN1) than on the

other varieties. TN1 wilted 5 DAI. Insect settling response was significantly lower on Base, BR46, Xoai cat, and the resistant varieties than on the other varieties (Table 1).

Settling response of WBPH females and number of eggs laid/hill were lowest on BR46 (Table 2). Egg density varied significantly across the varieties and was positively correlated with the density of females settled on a hill.

The nonpreference mechanism due to pubescence and hardness of plant tissue makes local rice varieties unsuitable hosts for WBPH settling, feeding, and egg laying. ∎

Stress tolerance—adverse temperature

Influence of low night temperatures on rice spikelet differentiation in high-altitude swamps in Burundi

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Rice was only recently introduced in high-altitude swamps in Burundi. Several factors account for reduced yield, one of which is spikelet sterility. We conducted an experiment to determine the origin of sterility and the stage at which the plant is most sensitive to low night temperatures.

Plants grown from seedling stage to harvest in cylindrical plastic posts were used. Soil was taken from a fallow bean field. We compared varieties Yunnan 3, Tokombana, Kirundo 9, Facagro 71, and Facagro 57 at two sites at different altitudes: Bujumbura, located on Tanganyika plain at 800 m altitude with a warm, humid climate and temperature not below 15 °C; and Kizunga swamp, at 1900 m altitude on the Zire-Nile ridge, with a cold climate and night temperature often below 10 °C, which results in poor rice-growing conditions.

Five pots containing three plants each were prepared per variety for each of two treatments. In the first, plants were grown in Bujumbura from seedling to harvest. In the second, plants were grown in

1. Distribution of spikelet types in five varieties of rice grown in Bujumbura, Burundi.

2. Effect of 20 d at Kizunga during panicle initiation on the distribution of spikelet types.
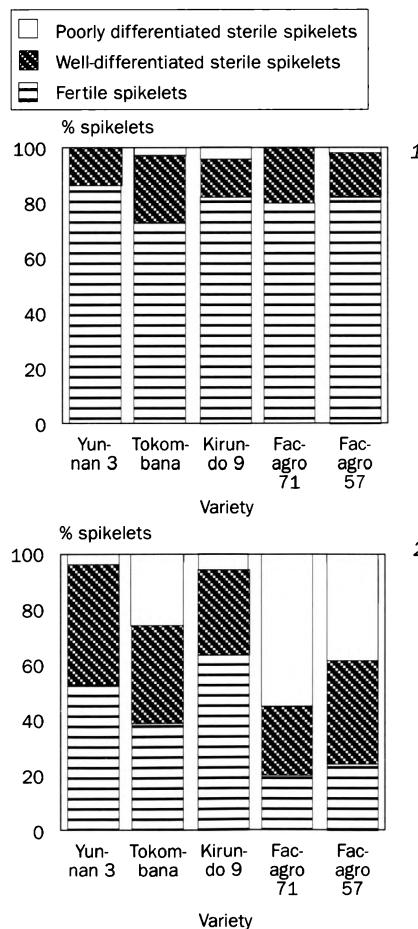
Bujumbura, transferred to Kizunga at panicle initiation for 20 d, and then returned to Bujumbura.

The second treatment caused very strong spikelet sterility in five varieties. Some sterile spikelets were poorly differentiated, characterized by small size and discolored glumes. Well-differentiated sterile spikelets stayed green until harvest. Different spikelet types were counted on 10 healthy panicles randomly selected (two per pot) per variety for each treatment (Figs. 1 and 2).

More than 70% of the spikelets were fertile in all varieties and the rate of poorly differentiated sterile spikelets was very low with the first treatment. In contrast, 20 d at Kizunga between panicle initiation and the end of microsporogenesis stage considerably increased the frequency of poorly differentiated sterile spikelets, especially in Facagro 71, Facagro 57, and Tokombana.

Glumes and floral organs of poorly differentiated sterile spikelets were observed under a binocular microscope. Three types of morphological abnormalities due to low night temperatures were detected: presence of a supernumerary envelope around the floral organs between two glumes, presence of two or more fused ovaries, and reduced number or size of stamens.

Sterility rises when rice is grown at high altitude with low night temperatures. When there is cold stress during panicle initiation and spikelet differentiation, morphological malformations of spikelets and flowers contribute to sterility. ∎