the environment. Therefore, we need to characterize parental lines, especially restorers, using biotechnological tools.

DNA was extracted from commonly used parental stocks (CMS lines IR58025A and IR62829A; their isonuclear maintainer (B) lines IR58025B and IR62829B; and elite restorer (R) lines IR40750, IR9761, IR34686, and IR10198. These extracted DNA samples were amplified by polymerase chain reaction using 20 arbitrary oligo-nucleotide primers. The amplified products were analyzed on agarose gel and scored for the presence or absence of bands. With selected primers (OPA-7, OPA-12, OPA-20, OPB-19, OPU-17, and OPW-4), sufficient polymorphism could be detected to allow identification of individual stocks. The isonuclear maintainer and the CMS lines were, however, indistinguishable. The randomly amplified polymorphic DNA (RAPD) analysis is a potentially simple, rapid, and reliable DNA finger-printing method for identifying parental stocks and determining the parentage of rice hybrids. As this molecular technique verifies the degree of dissimilarity between the parental lines, the RAPD analysis may also help in identifying new potential combina-tions based on genetic divergence. ■

Exploiting the in vitro ovary culture technique to breed rice hybrids

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The thermosensitive genic male sterility (TGMS) system has a high potential to develop two-line hybrids, which are more economical for seed production. The ovary culture technique can also help to improve or develop new lines for several economic traits. We therefore cultured unpollinated ovaries from plants of five crosses involving TGMS UPRI 95-140 (P1), the good ideotype UPRI 95-117 (P2), and maintainers UPRI 95-139 (P3) and UPRI 95-130 (P4). Quality rices—Basmati 385 (P5), Haryana Basmati 1 (P6), and UPRI 95-145 (P7)—were also cultured. The cultured ovary from hybrid plants P1 / P2 pretreated at 8 °C for 14 d on an N6 medium supple-mented with 500 mg lactoprotein hydrolysate (LH) L^{-1}, 4 mg 2,4-D L^{-1}, 2 mg NAA L^{-1}, and 1 mg BA L^{-1} produced 0.5% calli. Regeneration of these calli on an MS medium containing 500 mg casein acid hydrolysate L^{-1}, 0.5 mg NAA L^{-1}, and 1.5 mg BA L^{-1} produced four clumps of completely green plantlets and one partially green plantlet. One of these green plantlets showed the TGMS trait. It was completely spikelet sterile during the panicle heading period between 15 Jun and 5 Sep, but was partially fertile and set seed after 18 Sep. Seed set was 0.5, 1.7, 4.8, 12.3, and 6.4% at heading on 18 Sep, 1 Oct, 12 Oct, 26 Oct, and 1 Nov 1995, respectively. The ovary culture-derived line was dwarf, with an intermediate plant type, and flag leaf and panicle length similar to those of the female parent. But this line produced more spikelets.

The unpollinated ovaries of F_1 plants derived from maintainer / quality rices cultured on an N6 medium supplemented with 0.5 mg 2,4-D L^{-1}, 4 mg NAA L^{-1}, and 1.0 mg BA L^{-1} produced calli. Callus induction was 3.33, 2.67, 1.33, and 2.00% for P5 / P3, P3 / P5, P6 / P4, and P7 / P4, respectively. But plantlets were regenerated only from P5 / P3 (46.7%) and P3 / P5 (50.0%) on an N6 regeneration medium supplemented with 500 mg LH L^{-1}, 0.5 mg NAA L^{-1}, and 2 mg kinetin L^{-1}. The performance of seven H1 clones of the former cross showed four clones with long, bold grain and a nontranslucent endosperm, whereas clones 6 and 7 had long, slender grains and a translucent endosperm free of an opaque area and were comparable in quality with Basmati 385. Exploitation of these lines to improve quality and yield potential in a hybrid rice breeding program is in progress. ■

Pest resistance — diseases

A variety with durable resistance to rice blast

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San-Huang-Zhan No. 2 (SHZ), a rice variety developed by the Guangdong Academy of Agricultural Sciences, was cultivated on 1,533 ha in 1986. It then spread from 8,000 ha in 1987 to 10,977 ha in 1995 and showed excellent resistance to blast in an environment favorable to blast in Guangdong, China. Therefore, we assumed that SHZ is a variety with durable resistance to blast.

Looking at the resistance performance of SHZ, we found that its resistance spectrum (RS) was more than 95% from 1985 to 1995 (Table 1). In 1995, the RS of SHZ was 99.5% under artificial inoculation with 220 isolates in Guangdong and 95.2% with 124 isolates of *Pyricularia grisea* from eight rice-growing zones in China. Furthermore, we screened a stable isolate (GD-V1) that is compatible to SHZ to investigate the reaction of SHZ compared with the reaction of the resistant check IR36 and the susceptible check B40. Entries were inoculated at the 5-leaf stage. Lesion density (LD) and lesion size (LS) were scored by the method of Roumen and diseased leaf area (DLA) was measured by the method of Notteghem. To make a better comparison, we converted the observed data (OD) of LD, LS, and DLA into relative value (RV) on the basis of B40, and computed the mean of LD, LS, and DLA. At the same time, resistance of the varieties was assessed in fields in eight rice-growing zones in China by the Standard of the National Blast Co-research Group. Results (Table 2) indicated that the resistance of SHZ and IR36 is different because SHZ

Table 1. Resistance spectrum (%) of San-Huang-Zhan No. 2 from 1985 to 1995 in Guangdong, China.

Year	1985	1986	1987	1989	1991	1992	1993	1994	1995
RS	100	100	98	95	96.5	98	98	98	99.5

Table 2. Qualitative and quantitative resistances of San-Huang-Zhan No. 2 (SHZ).

Cultivar	Resistance spectrum (%)		LD (lesions cm^{-1})		LS (mm)		DLA (%)		Field observation			
									LB[e]		PB[f]	
	Guangdong[a]	China[b]	OD[c]	RV[d]	OD	RV	OD	RV	Mean	Maximum	Mean	Maximum
SHZ	99.5	95.2	0.3	4	1.3	19	8.5	10	1.3	4	1	3
IR36 (check)	58.2	-	0.4	6	1.4	20	24.6	30	3.0	9	3.2	9
B40 (check)	-	-	6.6	100	6.9	100	82.0	100	-	-	-	-

[a]Including 220 isolates in Guangdong. [b]Including 124 isolates in China. [c]OD = observed data = mean of three experiments with 6 replications. [d]RV = relative value = tested data of cultivar/tested data of B40 × 100. [e]LB = leaf blast. [f]PB = panicle blast.

Table 3. Reaction to ZB13 blast isolate of F_1 and F_2 plants from crosses of San-Huang-Zhan No. 2 (SHZ).

Cross	F_1 reaction	F_2 reaction				
		R[a]	S	Expected ratio	χ^2	P
CO 39/SHZ	R	331	10	63:1	3.31	0.05-0.1
B40/SHZ	R	228	8	63:1	0.54	0.25-0.5
SHZ/CO 39	R	401	0			
SHZ/B40	R	601	0			

[a]R = resistant, S = susceptible.

exhibited a wide qualitative RS and a high quantitative resistance for three factors—LD, LS, and DLA—whereas IR36 appeared to have a narrow qualitative RS but high quantitative resistance under a wide range of populations of *P. grisea* in different latitudes of China. Quantitative resistance plays a key role in the durability of resistance.

The genetic experiment showed that three independently dominant genes control the blast resistance of SHZ and there is another gene present in the cytoplasm of SHZ as well (Table 3).

IR36 represents an indica variety with durable blast resistance under tropical irrigated conditions. Some researchers concluded that the partial resistance of IR36 is associated with blast durability. Other researchers showed that IR36 had at least three major genes for complete resistance to two Philippine blast isolates. The inheritance of partial blast resistance in IR36 is most likely polygenic. SHZ seemed to have three major genes for complete resistance to blast, but some questions remain. Is the durability of SHZ in China mainly due to major genes or not? What is the function of another gene present in the cytoplasm for blast durability? Further research is needed to answer these questions. ■

Multilocational evaluation of promising advanced breeding lines for resistance to rice tungro viruses

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An important objective of IRRI's breeding program for irrigated rice ecosystems is to develop varieties with resistance to rice tungro viruses in order to achieve durable resistance to tungro disease. We conducted this study to monitor tungro virus and leafhopper vector variability between test locations, based on the reaction of selected varieties and advanced breeding lines with different sources of resistance. The advanced breeding lines were IR68305-18-1 (IR64*4/Balimau Putih); IR71026-3-2-4-3-5-2 (IR1561-228-3-3*3/*Oryza longistaminata*); IR69705-1-1-3-2-1 (IR1561-228-3-3*2/Utri Merah); IR71030-2-3-2-1 (IR1561-228-3-3*6/ARC11554). IR64 was used as a susceptible check and IR62 as a vector-resistant check with field resistance to tungro.

The table shows locations, seasons, and years of tests. At each location, we used a randomized complete block design with four replications. The plot size was 8 m × 8 m with 2 m between plots. We transplanted 21-d-old seedlings at 20 cm × 20 cm spacing, with 2-3 seedlings $hill^{-1}$. The plants were exposed to natural infection with tungro viruses in the field. We assessed plants for disease symptoms and sampled leaves to detect tungro viruses by enzyme-linked immunosorbent assay (ELISA) at 30-35 and 55-60 d after transplanting (DAT). We recorded