

observe the traits of Zhushan A, to test its general combining ability (GCA) effects on some grain quality characters, and to determine the yield capacity of the new hybrids from Zhushan A.

Zhushan A has good plant type and is about 85 cm tall. It has dark green leaves, erect flag leaves, and long-slender grain (9.1 mm long × 2.6 mm wide). Its heading date was 78 d, which was 9 d longer than that of Zhenshan 97 A and 8 d shorter than that of Guang 41 A (Table 1). Pollen fertility was 0-0.1%. Like the Honglian-type CMS line Guang 41 A, Zhushan A had 9.7-63.3% stained sterile pollen. The sterility of Zhushan A is acceptable for commercial hybrid rice production in southern China.

In a 3 × 6 incomplete diallel experiment, the relative values of GCA effects of the parents were estimated by Bulmer's method. Zhushan A had higher GCA effects for grain length, length-width ratio, and milling rate of polished head rice than did Zhenshan 97 A and Guang 41 A, but lower GCA effects for chalkiness and grain width. Therefore, Zhushan A could be used to produce hybrids with lower chalkiness, grain length, grain width, length-width ratio in grain, and milling rates of polished head rice (Table 1).

Yield trials were laid out in a randomized complete block design with three replications. Four of the hybrid crosses from Zhushan A yielded 8.0-8.4 t/ha during the early cropping season (5.6-10.7% more than the national check Shanyou 63) and 6.9-7.1 t/ha during the late cropping season (2.5-5.4% more than the provincial check Shanyou 64) (Table 2). For the four hybrids, grain length was 6.1-6.8 mm; length-width ratio, 2.5-3.2; chalkiness, 0-1; amylose content, 19.7-23.5%; and grain quality, grade 1 or 2. In the 1993 early cropping season, Zhuyou 61 (Zhushan A/R61) yielded 7.7 t/ha, ranking first among 14 crosses in the united test of high-quality hybrid rice of southern China. Zhuyouqing (Zhushan A/Meiqing) ranked second in a regional test during the early cropping season in Guangdong Province.

Zhushan A has greater GCA for grain quality characters than do other CMS lines. The hybrid crosses derived from Zhushan A have good grain quality and higher grain yield, making the line valuable for use in breeding programs. ■

**Table 2. Grain yield and grain quality of several Zhushan A hybrids. Zhanjiang, China. 1991-93 early and late cropping seasons.<sup>a</sup>**

Character	Hybrid							
	Zhushan A/Meiqing		Zhushan A/R61		Zhushan A/R903		Zhushan A/R54	
	Early	Late	Early	Late	Early	Late	Early	Late
Grain yield (t/ha)	8.0	7.1	8.2	7.0	8.3	7.0	8.4	6.9
Check <sup>b</sup>	5.6	5.4	8.1 <sup>c</sup>	4.0	8.7*	3.7	10.7**	2.5
Grain quality								
Grain length (mm)	6.1	6.7	6.5	6.8	6.6	6.8	6.4	6.6
Length-width ratio	2.5	2.7	2.7	3.0	3.0	3.2	2.8	3.1
Chalkiness	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
Amylose content (%)	22.0	21.1	23.5	21.0	20.8	21.3	19.7	21.8
Quality grade <sup>d</sup>	2	1	2	1	1	2	2	1

<sup>a</sup> Early crop was seeded in February, late crop was seeded in July. <sup>b</sup> Shanyou 63 was the check for the early crop and Shanyou 64 for the late crop. <sup>c</sup> \*, \*\* = significant at the 5 and 1% level, respectively. <sup>d</sup> According to the national standard of high-quality rice in China, quality grade 1 = milling rate of brown rice >81% and that of polished rice >72%, half-transparent rice grain, length-width ratio is >3.0, and amylose content = 17-22%. Quality grade 2 = milling rate of brown rice >79% and that of polished rice >72%, half-transparent rice grain, length-width ratio = 2.5-3.0, and amylose content <25%.

## Integrated germplasm improvement—upland

### Turant Dhan: a very early rice variety released in Bihar, India

R. Thakur, A. K. Singh, R. S. Singh, and M. Mishra, Rajendra Agricultural University, Pusa 848125, Samastipur, India; and R. C. Chaudhary, IRRI

Flood or drought periodically affects rice in Bihar—especially in the northern areas. Sometimes floods and droughts occur at the same time in different parts of the state. Farmers require rice varieties that are suitable for pre-flood and post-flood conditions and for intermittent drought to enable a harvest on the available rainfall.

Varieties that are very early-maturing are the obvious choice for these situations. Sattari, Prasana, and Heera, which all have 70-75 d durations and were released in recent years, have not been accepted by farmers because of their poor yield and susceptibility to diseases and insect pests.

We began working to develop very early rice varieties in the early 1980s. Numerous early-maturing cultures from IRRI were evaluated. A hybridization program was undertaken that made use of available very early germplasm.

Culture ES18-5-1, with 70-75 d duration, was developed from the cross Sattari/Rasi. The culture consistently outyielded

**Table 1. Yields of ES18-5-1 in uniform varietal trials at different locations in Bihar, India. 1989-95.**

Year	Location	Yield (t/ha) (pre-flood)					
		ES18-5-1	Sattari	Prasana	Heera	CV (%)	LSD (5%)
1989-90	Dhangain	3.1	2.3	1.4	—	12.6	0.4
	Pusa	2.4	1.7	1.9	—	16.0	0.6
1990-91	Dhangain	2.8	2.7	2.1	—	11.9	0.8
	Sabour	2.2	1.9	1.2	—	19.9	0.4
	Pusa	2.0	1.2	1.7	—	8.8	0.2
1991-92	Dhangain	3.1	2.2	1.1	—	15.4	0.3
	Sabour	2.3	1.6	1.3	—	14.6	0.6
	Pusa	1.3	1.1	1.2	—	13.1	0.2
1992-93	Dhangain	2.1	2.5	1.6	0.6	ns <sup>a</sup>	
	Sabour	1.9	1.2	1.0	1.1	11.1	0.2
	Pusa	2.6	1.8	1.2	0.9	10.4	0.4
1993-94	Bikramganj	4.3	4.3	1.1	1.7	13.9	0.1
	Sabour	1.5	1.1	1.1	0.5	16.8	0.8
	Pusa	3.8	3.0	2.7	2.3	11.8	0.05
	Patna	1.6	2.3	1.4	0.5	ns	
1994-95	Pusa	2.9			2.0	13.8	0.6
	Pooled mean	2.5	2.0	1.5	1.2		

<sup>a</sup>ns = not significant.

**Table 2. Yield (t/ha) of ES18-5-1 in on-farm trials sown on different dates around Bihar, India. 1991-95.**

Year	10 Jul			25 Aug (postflood)		
	ES18-5-1	Sattari	Heera	ES18-5-1	Sattari	Heera
1991-92	2.6	2.1	1.6	2.4	1.5	1.1
1992-93	3.6	2.3	1.5	3.4	2.1	1.2
1994-95	3.2	2.4	1.7	2.7	1.8	1.3
Pooled mean	3.1	2.2	1.6	2.8	1.8	1.2

check varieties in multilocation state uniform varietal trials (very early) from 1989 to 1994 under pre-flood conditions. The pooled averages exhibited a 20.8%

yield increase over Sattari, 38.4% over Prasana, and 41.7% over Heera (Table 1).

Under late sown conditions (Aug 25) in on-farm trials, ES18-5-1 outyielded checks

across 3 yr. Yield increases were as high as 133.3% over Sattari and 55% over Heera (Table 2).

The culture was released as Turant Dhan for pre-flood and postflood conditions as well as for use under upland conditions. It is a semidwarf (90-95 cm) indica with sturdy stems. Turant Dhan has field resistance to brown spot and bacterial blight and is suitable for double cropping during the wet season. ■

## Integrated germplasm improvement—flood-prone

### Purnendu, a new deepwater (50-100 cm) rice variety in eastern India

S. Mallik, C. Kundu, S. K. B. Roy, S. D. Chatterjee, and B. K. Mandal, Rice Research Station (RRS), Chinsurah 712102, West Bengal, India

We developed the new variety Purnendu (CN573-221-7-1) by pedigree selection from the cross Patnai 23/Jaladhi 2.

Purnendu is suitable for intermediate and deepwater conditions where water is 50-100 cm deep or more.

Purnendu was evaluated as IET10029 across 36 locations in the national varietal testing program for several years. Its mean yield was 3.0 t/ha, with a potential yield of 5.3 t/ha. The mean yield of Purnendu was 78% more than that of Tilakkachari across 8 locations, 38% more than that of Sabita across 17 locations, and 67% more than that of Jalamagna across 111 locations (see table). In national testing, it ranked first in the 1987 preliminary variety trial-5 and second in the 1989 uniform variety trial-6 and 1990 and 1992 advanced variety trials-deepwater. It was approved for release in 1994 in Orissa, West Bengal, eastern Uttar Pradesh, Bihar, Andhra Pradesh, and Assam.

Purnendu is strongly photoperiod-sensitive and flowers around the end of October. It has very good tolerance for submergence with nominal elongation (similar to that of FR13A) and good kneeing ability. The variety possesses resistance to sheath blight, yellow stem

### Performance of Purnendu in national trials in India. 1986-92.

Year	Trial/site	Yield (t/ha)		Maximum water depth (cm)
		Purnendu	Standard check	
1986	<i>PVT-5<sup>a</sup></i>		<i>Tilakkachari</i>	
	Patna, Bihar	3.6	1.5	NA <sup>b</sup>
	Pusa, Bihar	2.4	2.3	40
	Ghagrahat, Uttar Pradesh	2.0	1.8	25
	Central Rice Research Institute (CRR) Chinsurah, West Bengal	1.0	0	90
1987	<i>PVT-5</i>			
	Pulla, Andhra Pradesh	2.6 <sup>e</sup>	0.8	75
	Chinsurah, West Bengal	5.1*	2.2	75
	CRR, Orissa	3.4*	2.1	85
1988	<i>UVT-5<sup>b</sup></i>		<i>Sabita</i>	
	Pulla, Andhra Pradesh	2.3*	1.4	90
	CRR, Orissa	3.0*	1.4	80
	N. Lakhimpur, Assam	4.2	3.3	103
	Patna, Bihar	2.2	1.6	70
	Pusa, Bihar	0.8*	0.5	170
	Sabour, Bihar	2.6	2.6	60
	Ghagrahat, Uttar Pradesh	1.7	1.6	64
1989	<i>UVT-5</i>			
	Chinsurah, West Bengal	4.2	3.8	55
	Patna, Bihar	3.9*	0.9	70
	Pusa, Bihar	3.8*	1.4	50
	Sabour, Bihar	4.5	3.9	75
	CRR, Orissa	3.4	3.3	90
	Pulla, Andhra Pradesh	3.4*	2.4	80
1989	<i>UVT-6<sup>c</sup></i>		<i>Jalamagna</i>	
	N. Lakhimpur, Assam	4.07	3.42	110
	Chinsurah, West Bengal	2.17*	0.62	65
	Kamardanga, West Bengal	3.19*	1.41	65
1990	<i>AVT-DW<sup>d</sup></i>			
	Pusa, Bihar	2.22*	1.61	95
	Chinsurah, West Bengal	1.80*	1.32	50
	N. Lakhimpur, Assam	4.01*	3.12	100
1991	<i>AVT-DW</i>			
	Chinsurah, West Bengal	2.32*	0.50	70
1992	<i>AVT-DW</i>			
	Pusa, Bihar	2.70	2.16	NA
	Motto, Orissa	3.42*	1.67	125
	Ghagrahat, Uttar Pradesh	4.73*	2.75	141

<sup>a</sup>PVT-5 = Preliminary variety trial-5. <sup>b</sup>UVT-5 = Uniform variety trial-5. <sup>b</sup>NA = not available. <sup>c</sup>UVT-6 = Uniform variety trial-6. <sup>d</sup>AVT-DW = Advanced variety trial - deepwater. <sup>e</sup>\*Significantly superior to standard checks at the 5% level.