International Rice Research Newsletter

VOLUME 11 NUMBER 2 APRIL 1986

Published by the International Rice Research Institute, P.O. Box 933, Manila, Philippines

Contents

Guidelines and Style for IRRN Contributors

Articles for publication in the International Rice Research Newsletter (IRRN) should observe the following guidelines and style.

Guidelines

- Contributions should not exceed two pages of double-spaced typewritten text. Two figures (graphs, tables, or photos) may accompany each article. The editor will return articles that exceed space limitations.
- Contributions should be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses should be done.
- Announcements of the release of new rice varieties are encouraged.
- Pest survey data should be quantified. Give infection percentage, degree of severity, etc.

Style

- For measurements, use the International System. Avoid national units of measure (cavan, rai, etc.).
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha, 2 h/d.
- Express yield data in tonnes per hectare (t/ha). With small-scale studies, use grams per pot (g/ pot) or g/ row
- Express time, money, and common measures in number, even when the amount is less than 10 For example: 8 min, $2, 3 kg/ha, 2-wk intervals.
- Write out numbers below 10 except in a series containing 10 or higher numbers. For example: six parts, seven tractors, four varieties. *But* There were 4 plots in India, 8 in Thailand, and 12 in Indonesia.
- Write out numbers that start sentences. For example: Sixty insects were put in each cage. Seventy-five percent of the yield increase is attributed to fertilizer.
- Place the name or denotation of chemicals or other measured materials near the unit of measure. For example: 60 kg N/ ha, not 60 kg/ha N; 200 kg seed/ ha, not 200 kg/ ha seed.
- Use common names — not trade names — for chemicals.
- The US$ is the standard monetary unit in the IRRN. Data in other currencies should be converted to US$.
- When using acronyms, spell each out at first mention and put the specific acronym in parentheses. After that, use the acronym throughout the paper. For example: The brown planthopper (BPH) is a well-known insect pest of rice. Three BPH biotypes have been observed in Asia.
- Abbreviate names of months to three letters: Jun, Apr, Sep.
- Define in the footnote or legend any nonstandard abbreviations or symbols used in a table or figure.
- Do not cite references or include a bibliography.

Genetic Evaluation and Utilization

OVERALL PROGRESS

BU79, a promising induced rice genotype

N. G. Hajra and S. G. Hajra, Regional Research Centre, Kunjaban, Tripura (West), and E.H. Mallick, Rice Research Station, Bankura 722101, India

BU79 is a small-grained, high yielding mutant induced from Pankaj by 12 h treatment with ethyl methane sulphonate. It has significantly better tillering, longer panicles, and more fertile grains per panicle than Pankaj.

BU79 was evaluated in multilocation yield trials at Burdwan, Suri, and Rampurhat in West Bengal in 1981. It yielded significantly more than Pankaj and Mahsuri at all locations (see table). BU79 is a suitable substitute for Pankaj and similar long duration rices.

Yield performance of BU79 in multilocational yield trial.

Variety	Yield (t/ha)			
	Burdwan	Suri	Rampurhat	Mean
BU79	5.6	5.1	5.0	5.2
Pankaj	4.8	4.6	4.5	4.6
Mahsuri	4.3	4.0	4.1	4.1
CD (P = 0.05)	0.6	0.4	0.3	

Karna: a high-yielding semidwarf for Karnataka

B. S. Naidu, B. Vidyachandra, M. G. Rao, and T. G. Reddy, Regional Research Station (RRS), V.C. Farm, Mandya, India

KMP39 (IET7209) has been released as Karna for southern Karnataka, India. It was developed at RRS, Mandya, from the F_2 of Jaya/ W 1263 that was received through the All India Coordinated Rice Improvement Project.

Karna is a semidwarf and matures in 130-135 d. Plant type is similar to, but slightly taller than, that of Jaya. Karna has compact tillering, medium panicles, erect flag leaves, and late senescence.

Spikelets are straw colored and awnless. The stigma is colorless and anthers are yellow. Kernels are 6.38 mm by 2.39 mm, with length-to-breadth ratio of 2.67. Grains are medium-slender and translucent and cook flaky with moderate volume expansion.

In 55 All India National Screening Nursery trials in 1979, Karna [tested as

Table 1. Bl scores for Karna at Ponnampet, Karnataka, India.

Year	Variety	Bl score	
		Leaf Bl	Neck Bl
1980	Karna	1.0	2.3
	Intan	3.0	5.0
1981	Karna	2.0	3.0
	Intan	3.0	6.0
1982	Karna	2.0	–
	Intan	9.0	–
Av	Karna	1.6	2.6
	Intan	5.0	5.5

Table 2. Karna grain yield in varietal yield trials in Karnataka in 1979-84.

Year	Yield (t/ha)	
	Karna	IR20
1979	4.6	4.1
1980	4.1	3.9
1981	5.9	4.9
1982	4.5	4.3
1983	4.7	4.2
1984	5.2	4.5
Av	4.8	4.2

Table 3. Karna grain yield in wet rice farm trials in Karnataka, 1981-83.

Year	Yield (t/ha)	
	Karna	IR20
1981	5.6	4.8
1982	6.3	6.0
1983	6.5	6.0
Av	6.1	5.6

IET7209 (KMP39)] showed resistance to blast (Bl), brown spot, stem borer, and gall midge. It was highly resistant to Bl in trials at Ponnampet, Karnataka, the hotspot for B1 (Table 1).

In 1979-84 yield trials at Mandya, Karna yielded an average 4.8 t/ha compared with 4.2 t for IR20 (Table 2). In 1981-83 field trials at 30 sites, Karna yielded an average 6.1 t/ha compared with 5.6 t for IR20 (Table 3). At Mudgere, where Bl is endemic, it yielded an average 4.9 t/ha compared with 4.3 t for IR20.

Mutagen-caused molecular losses in rice and reversal by gibberellic acid (GA)

E.H. Mallick, Rice Research Station, Bunkura, India, N.G. Hajra, and S.G. Hajra, Regional Research Centre, Kunjaban, Tripura (West), India

Dehusked IR8 seeds were treated with a 1% aqueous solution of ethyl methane sulphonate (EMS), methyl methane sulphonate (MMS), and ethylene glycol (EG) for 6 and 12 h to determine their effect on germination, cell wall permeability, α-amylase activity, and amino acid and RNA contents. Reversal of mutagen effects was studied by GA (100/µg/ml) treatment.

Among the different mutagens, MMS significantly inhibited germination, α-amylase activity, RNA and amino acid content in both treatments, and substantially increased cell wall permeability. EG reduced germination and other molecular degradation less than MMS or EMS, but significantly reduced amino acid content.

Applying GA to seeds treated for 6 h reversed the mutagens' effects and improved germination percentage and other molecular contents (see table). Mutagen treatment for 12 h could not be reversed by GA treatment.

Change of molecular contents during germination after different mutagen treatments.[a]

Treatment	Germination (%)		Leakage of ions (mmho)		OD values					
					α-amylase activity		Amino acid		RNA	
EMS 6 h	69**		0.026*		0.21		0.067**		0.41*	
MMS 6 h	46**		0.035**		0.25		0.047**		0.37**	
EG 6 h	96		0.013		0.17		0.086**		0.57	
GA 6 h	100		0.014		0.04**		0.163		0.78	
EMS 6 h + GA 6 h	88*	(27.53)	0.014	(46.15)	0.18	(14.28)	0.143	(113.43)	0.69	(68.29)
MMS 6 h + GA 6 h	63**	(36.95)	0.018	(48.57)	0.21	(16.00)	0.102	(117.02)	0.65	(75.67)
EG 6 h + GA 6 h	98	(2.08)	0.012	(7.69)	0.16	(5.88)	0.150	(74.41)	0.71	(24.56)
EMS 12 h	56**		0.034**		0.23		0.052**		0.40*	
MMS 12 h	40**		0.043**		0.26		0.041**		0.32**	
EG 12 h	95		0.022*		0.18		0.068**		0.55	
GA 12 h	100		0.015		0.04**		0.162		0.82*	
EMS 12 h + GA 6 h	59**	(5.35)	0.026*	(23.52)	0.22	(4.34)	0.057**	(9.61)	0.44*	(10.00)
MMS 12 h + GA 6 h	46**	(15.00)	0.032**	(25.58)	0.24	(7.69)	0.045**	(9.75)	0.36**	(12.50)
EG 12 h + GA 6 h	98	(3.15)	0.017	(22.72)	0.17	(5.55)	0.073**	(7.35)	0.57	(3.63)
Control 0 h	99		0.010		0.15		0.168		0.62	
6 h	99		0.011		0.15		0.168		0.62	
12 h	99		0.012		0.15		0.167		0.63	

[a] p value: *0.05; **0.01. Figures in parentheses indicate percent reversal by GA treatment.

KMS5914-4-6 (Sona Mahsuri): a semitall, fine-grain, high yielding rice variety to replace Mahsuri in Karnataka

B.S. Naidu, B. Vidyachandra, M.G. Rao, and T.G. Reddy, Regional Research Station, V.C. Farm, Mandya, India

Sona Mahsuri (KMS5914-4-6) is replacing popular variety Mahsuri in Karnataka. It was developed from Sons/Mahsuri, received through the All India Coordinated Rice Improvement Project. Further selections were made for tight panicles and lodging resistance.

Sona Mahsuri is semitall and matures in 140-145 d. Plant type and panicle characters are similar to those of Mahsuri. It has compact tillering, fairly tight spikelets, and stiff straw.

Sona Mahsuri spikelets are brown and awnless. Kernels are medium-slender and 5.56 mm by 2.1 mm.

Table 1. Leaf B1 teaction of Sona Mahsuri at Ponnampet, 1982-84.

Year	Bl rating	
	Sona Mahsuri	Intan
1982	4.0	9.0
1983	2.0	5.7
1984	1.6	3.0
Av	2.5	5.9

Length-to-breadth ratio is 2.56; that of Mahsuri is 2.45. Grains are translucent without abdominal chalkiness, and cook flaky with good volume expansion.

In blast (Bl) screening trials at Ponnampet, the Bl hotspot in Karnataka, Sona Mahsuri was moderately resistant, with an average rating of 2.5 compared with 5.9 for Intan (Table 1).

In 26 trials since 1980, Sona Mahsuri has yielded an average 5.8 t ha. In 12 trials, it yielded 6.0 t/ha compared to 5.4 t for Jaya (Table 2). In 1981-83 field trials at 14 sites in Mandya and Mysore, Sona Mahsuri yielded an average 6.5 t/ha compared with 5.4 t ha for Mahsuri. At 6 other sites, it yielded an average 7.5 t/ha compared with 6.9 t for Prakash (Table 3).

Sona Mahsuri is gaining popularity and may soon be released for cultivation.

Table 2. Sona Mahsuri grain yield in yield trials at Mandya, 1980-84.

Year	Yield (t/ha)	
	Sona Mahsuri	Saya
1980	5.8	5.2
1982	6.1	6.0
1983	6.3	5.4
1984	5.8	5.0
Av	6.0	5.4

Table 3. Sona Mahsuri grain yield in farm trials at Mysore and Mandya.

Year	Grain yield (t/ha)	
	Sona Mahsuri	Check
		Mahsuri
1981	6.5	3.5
1982	7.0	6.5
1983	6.4	6.2
Av	6.6	5.4
		Prakash
1982	7.6	7.3
1984	7.5	6.6
Av	7.5	6.9

Individuals, organizations, and media are invited to quote or reprint articles or excerpts from articles in the IRRN.

IR13540-56-3-2-1: a promising rice for irrigated land in Bihar

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IR13540-56-3-2-1 (R. Heenati/ IR30 (BPHS)// IR2823-399-5) was chosen in 1981 kharif from the International Rice Yield Nursery - Medium. It matures in 130–135 d, is semidwarf, has good grain quality, and is suitable for irrigated, transplanted culture. IR13540-56-3-2-1 is moderately resistant to bacterial blight and will be a good substitute for Jaya and Sita, which have become susceptible.

In state trials from 1982 to 1984, IR13540-56-3-2-1 yielded consistently and 27% higher than Jaya and 20% more than Sita (Table 1, 2). It has been proposed for 1985 minikit trials in farmers' fields.

Table 1. Performance of IR1 3540-56-3-2-1 in state variety trials in Bihar, India.

Trial location	Grain yield (t/ha)			CD at 5%
	IR13540-56-3-2-1	Jaya	Sita	
	1982 kharif			
Patna	5.4	3.4	3.6	1.0
Pusa	4.0	3.4	3.3	–
Sabour	3.6	2.1	3.1	0.5
Dhangain	6.3	5.1	5.6	0.8
Tilaundha	2.7	2.2	2.3	0.7
Mean	4.4	3.2	3.6	–
	1983 kharif			
Patna	7.3	4.2	4.0	1.3
Pusa	2.7	3.1	2.5	0.8
Sabour	3.6	2.7	3.0	0.5
Dhangain	4.8	4.4	4.9	0.9
Tilaundha	2.7	2.9	3.1	0.4
Mean	4.2	3.5	3.5	
	1984 kharif			
Patna	4.2	3.6	3.7	0.9
Sabour	3.6	2.9	2.9	0.4
Dhangain	5.5	3.8	4.1	1.0
Mean	4.4	3.4	3.6	

Table 2. Mean yield of IR13540-56-3-2-1 and check varieties, 1982-84, Bihar, India.

Variety	Site					Mean
	Patna	Pusa	Sabour	Dhangain	Tilaundha	
			Yield (t/ha)			
IR13540-56-3-2-1	5.6	3.4	3.6	5.5	2.7	4.2
Jaya	3.7	3.1	2.6	4.4	2.6	3.3
Sita	3.8	2.9	3.0	4.9	2.7	3.5
			Increase (%)over Jaya			
IR 13540-56-3-2-1	51	10	38	23	4	27
			Increase (%) over Sita			
IR13540-56-3-2-1	47	17	20	12	0	20

Response of selected minikit rice varieties to nitrogen and tungro virus (RTV) on the Cauvery Delta

P. Balasubramaniyan and S. Sankaran, Tamil Nadu Rice Research Institute (TNRRI), Aduthurai 612101, India

Medium-duration IET7301, IET7303, IET7573, and IET7230 were compared with IR20 and Co 43 at TNRRI in Sep-Jan 1984. N was applied at 0, 40, 80, and 120 kg/ha. There was widespread RTV incidence and varieties were scored for infection.

Soil was a clay loam with low available N, medium P and K, and pH 7.5. N was applied 50% basal and 25% at tillering and panicle initiation. P and K were applied basally at 50 kg/ha.

Table 1. Grain yield and RTV infection of varieties, Aduthurai, India.

Variety	RTV infection (%)	Grain yield (t/ha)
IET7301	21-30	2.1 b
IET7303	6-10	3.8 a
IET7573	41-60	1.3 c
IET7230	41-60	0.6 c
Co 43	31-40	2.2 b
IR20	31-40	0.6 c

IET7303 had least RTV infection and yielded highest, followed by IET7301. IR20 had severe RTV infection and low

Table 2. Effect of N on grain yield,[a] Aduthurai, India.

N level (kg/ha)	Grain yield (t/ha)
0	1.4 c
40	1.8 b
80	2.0 a
120	2.1 a

[a]Average of all varieties.

yield (Table 1). N level did not influence RTV, but significantly influenced grain yield. Highest yield was with 120 kg N/ha, which was at par with yield at 80 kg N/ha (Table 2). N × varietal interaction was not significant.

Genetic Evaluation and Utilization
AGRONOMIC CHARACTERISTICS

Seed dormancy in rice varieties

P. S. S. Murthy, plant physiologist; and M. D. Babu and S. S. R. Prasad, research assistants, Agricultural Research Station (ARS), Maruteru, Andhra Pradesh, India

Dormancy of seeds within the same panicle varies with spikelet position on the panicle. We studied within-panicle dormancy patterns of 10 popular kharif rices at ARS in 1982 kharif. Panicles were collected at harvest and divided equally into top, middle, and bottom parts. They were sown in soil and watered as necessary.

Dormancy was lowest in the top 1/3 of panicles and gradually increased in the middle and bottom parts (see table). This was attributed to the different age of seeds at different panicle levels. Anthesis and fertilization occur in an acropetal succession; therefore the top spikelets are fertilized earliest and are oldest.

Seed dormancy at different spikelet levels within rice panicles, Maruteru, India.

Variety	Dormant seeds (%)			Variety	Dormant seeds (%)		
	Top	Middle	Bottom		Top	Middle	Bottom
MTU5293	50	60	90	MTU5182	40	70	90
MTU2716	40	70	90	MTU2400	40	70	90
MTU2077	60	50	90	BPT11503	50	70	80
MTU4569	40	70	90	PLA1100	50	70	80
MTU5201	40	65	95	Mean	46	66.5	88.5
MTU2067	50	70	80	CD (5%):	V : ns	P = 3	V × P : ns
				CV (%):	15.3		

Genetic Evaluation and Utilization
DISEASE RESISTANCE

High yielding, semidwarf, blast (Bl)-resistant NLR9672-96 and NLR27999 for southern Andhra Pradesh

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NLR9672-96 and NLR27999 were developed for B1 resistance and suitable grain quality for southern Andhra Pradesh. NLR9672-96 is a secondary selection from NLR9672, from Bulk H/9 and Milekkunning. NLR27999 was selected from a segregating generation of RP31-49-2/BCP 1. Milekkunning and RP31-49-2 were parents for B1 resistance. NLR9672-96 matures in 150-160 d and NLR27999 in 160-170 d. Both are weakly photoperiod sensitive and have short, bold grains with dirty brown glumes. Milled rice is white and translucent, and meets local consumer requirements. Threshability of both varieties is good, and both shed fewer grains than locally grown NLR9672. Both have seed dormancy at maturity and lodging resistance. NLR9672-96 has a droopy flag leaf and NLR27999 an erect, medium flag leaf.

The varieties are moderately resistant to leaf and neck B1 and bacterial blight and resistant to brown planthopper.

Table 1. Yield attributes of NLR9672-96 and NLR27999, Nellore, India.

Variety	Duration (d)	Plant height (cm)	Panicles/m^2	Grains/panicle	1000-grain weight (g)
NLR27999	160-170	113	289	291	22
NLR9672-96	150-160	119	282	301	21
NLR9672	150-160	100	248	339	23
NLR9674	160-170	104	269	326	22

NLR27999 can be planted as late as October without yield reduction. Both varieties yield better than local varieties, even when 60-d-old seedlings are planted. They have good tillering ability, and a high number of panicles/m^2, and grains/panicle. The 1,000-grain weight is similar and slightly less than that of local varieties (Table 1).

NLR9672-96 and NLR27999 were evaluated in replicated kharif varietal, multilocation, and minikit trials from 1981 to 1984. Check varieties were locally popular NLR9672 and NLR9674. The new rices yielded significantly more than the checks (Table 2). In 1983 trials at 5 sites, NLR27999 yielded an average 13% more than NLR9672. In 1984, NLR27999 yielded 6% more and NLR9672-96 17% more than NLR9672. In minikit trials, NLR27999 yielded 23% more and NLR9672-96 25% more than NLR9672. The new varieties are becoming popular with farmers.

Table 2. Performance of NLR9672-96 and NLR27999 at Nellore, India.

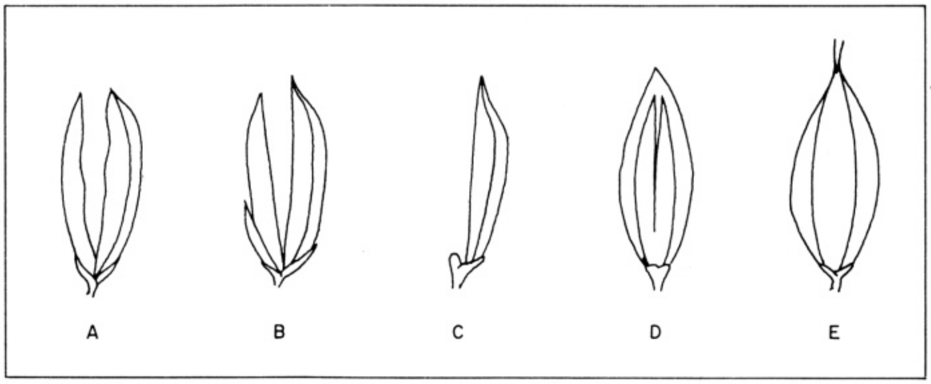
Variety	Grain yield [a] (t/ha)						
	1981	1982	1983	1984	1983 (MLT)	1984 (MLT)	1984 (MT)
NLR27999	4.3	5.6	–	6.5	6.2	5.1	5.3
NLR9672-96	–	–	3.8	6.5	–	5.6	5.4
NLR9672	3.7	4.8	3.4	–	5.5	4.8	4.3
NLR9674	3.8	5.5	2.6	4.0	–	4.6	–
CD	0.23	0.25	0.19	0.35	–	0.38	–
CV%	4.0	3.24	15.0	11.24	–	16.08	–

[a] MLT = multilocation trial, mean of 5 locations; MT = minikit trial, mean of 4 locations.

Abnormal spikelet on IR58

M. Komatsu, Japan Overseas Cooperation Volunteers, Meralco Corporate Farm Management, Inc., San Mateo, Isabela, Philippines

IR58 developed 10-70% abnormal spikelets in the Jun-Sep 1984 crop in Isabela, Philippines. Incidence was highest in San Mateo, Kauayan, and Ramon municipalities. Spikelets remained open after flowering and had the following shapes: the tip of the palea and lemma bent inward; an extra lemma developed on the base outside the palea; there was no palea; the palea was malformed and the lemma was torn in two; the lemma had two awns and no palea (see figure). Flowering and ovary development seemed normal, but the abnormal spikelets bore empty or tapering grains.



External shape of abnormal spikelet. Isabela, Philippines.

Transplanting began in late June. Days were cloudy and rain often fell before sunset. Day temperature was 30-33° C, and night temperature 27-30° C. Lowest temperature was 25° C. Days were sunny when panicles began to form in mid-Aug.

No other varieties had abnormal spikelets. In 1985 dry season, few farmers planted IR58.

Reaction of rices to natural infection of leaf scald (LSc)

Syaharuddin Rahamma, Maros Research Institute for Food Crops (MORIF), South Sulawesi, Indonesia

LSc caused by *Rhynchosporium oryzae* is one of the most important wet season rice diseases in South Sulawesi. It caused serious losses on variety Bakka in 1976 in Gowa and Takalar districts and IR36 and IR50 in 1981-82 wet season at Maros Research Station.

Response of 10 cultivars to natural infection of LSc, South Sulawesi, Indonesia.

Variety	Score [a]
Bahagia	1
BR51-114-3-2-1	1
BR168-2B-23	1
BR189-103-2-1-4-2-1	1
CR1002	1
DV85	1
IR9101-37-1	1
IR92 17-58-2-2	1
IR15314-30-3-1-3	1
IR15429-268-1	1
1R8192-200-3-3-1-1 (resistant check)	3
IR36 (susceptible check)	8

[a] 1980 *Standard evaluation system for rice* 1-9 scale.

In 1983-84 we evaluated 100 cultivars for reaction to natural LSc infection under lowland conditions and 90-60-0 kg applied NPK/ha. Two rows of 10 plants of each test variety were planted at 20- × 20-cm spacing. Two rows of resistant IR8 192-200-3-3-1-1 and susceptible IR36 were planted after every 10 test varieties.

Forty-six varieties had some resistance. Ten varieties had resistance scores 1 to 3. Resistant check IR8192-200-3-3-1-1 scored 3 (see table).

Reaction of rices to bacterial blight (BE) at different growth stages

S.N. Shukla, Plant Pathology Division, Central Rice Research Institute, Cuttack 753006, India

We evaluated 37 rice varieties at maximum tillering and flowering for reaction to a local isolate of BB *Xanthomonas campestris* pv. *oryzae.* Reaction patterns differed (see table). Kogyoku, Chugoku 45, and DV85 were resistant (score 1 to 3) at both growth stages. Te-tep, IR1545-339, Sateng, IR8, IR22, IR24, IR26, IR34, IR42, IR52, Zenith, Cempo Selak, and Java 14 were susceptible (score 6 and above) at both stages. IR20, IR28, IR36, IR44, IR46, IR54, IR56, and IR58 developed resistance with age, but IR32, IR40, and IR60 became susceptible with age. IR38, IR43, IR48, and IR50 were susceptible at maximum tillering and resistant at flowering. IR29 scored moderate (4) at both stages. PI 231129 and IR5 were resistant at maximum tillering and CAS209 scored 4. The three did not flower; hence, their reaction at flowering was not recorded.

BB reaction of rice varieties at maximum tillering and flowering, Cuttack, India.

Variety	BB reaction[a]	
	Maximum tillering	Flowering
Kogyoku	2	1
Te-tep	7	6
Chugoku 45	3	3
IRl545-339	7	7
Zenith	7	7
DV85	1	1
Sateng	6	7
PI 231129[b]	1	–
CAS209[b]	4	–
Cempo selak	7	7
Java 14	7	7
IR5[b]	3	–
IR8	8	9
IR20	4	3
IR22	8	6
IR24	7	7
IR26	6	6
IR28	5	3
IR29	4	4
IR30	6	5
IR32	3	5
IR34	6	6
IR36	6	3
IR38	7	3
IR40	3	5
IR42	7	7
IR43	7	3
IR44	6	3
IR45	7	3
IR46	7	4
IR48	7	3
IR50	7	3
IR52	7	7
IR54	5	3
IR56	5	3
IR58	5	3
IR60	3	4

[a] *Standard evaluation system for rice.* 1980. [b] Reaction at flowering not known.

Field evaluation of rices for tungro virus (RTV) resistance

M. Suriachandraselvan, R. Saroja, F. Vivekanandan, J. Venkatakrishnan, and K. Nilakantapillai, Paddy Experiment Station, Tamil Nadu Agricultural University, Tirur 602025, Tamil Nadu, India

In 1984-85 kharif, Chingleput District, Tamil Nadu, had a RTV outbreak that destroyed large areas of Vaigai, IET1444, Kanchi, ADT36, and TKM9. During the outbreak we evaluated 37 rices for RTV resistance. The experiment was in a randomized block design with three replications. Twenty-five-day-old seedlings were transplanted on 28 May in 3.1- × 2.2-m plots at 20- × 10-cm spacing. P and K were applied basally at 22 and 41.5 kg/ ha and 100 kg N/ ha was topdressed in 4 equal splits 10, 17, 24, and 31 d after transplanting (DT).

Green leafhopper (GLH) population was recorded 30 DT and RTV incidence 45 DT (see table). Nine entries showed RTV resistance (1-30% infection). IR56 and BG367-3 had less than 10% infection, and TM4966 13.1%. There seemed to be no correlation between GLH infestation and RTV incidence.

Reaction of 37 rices to RTV infection,[a] Tirur, India.

Variety	Parentage	GLH (no./hill)	RTV (%)
IR56	IR4432-53-3-3/PTB 3//IR36	5	6
BG367-3	BG280-1-2/PTB33	3	9
TM4966	TKM8/ADT9//CR141-192/IR26	15	13
PY3	IR3403-267/PTB33//1R26	4	17
TKM7	Pureline selection	8	18
TKM5	Pureline selection	8	20
IR36	IR1561-228-1-2//IR24-4/*O. nivara*///CR94-13	7	23
TM9400	IR8/Kalinga I//IR34/CH1039	13	25
TM1324	TKM9 mutant 20 Kr	15	27
TM10265	ADT31/IR8	11	37
IR58	IR28/Kwang chang Ai//IR36	6	39
IR60	IR4432-53-33/PTB33//IR36	9	44
Kannagi	IR8/TKM6	27	46
TKM6	GEB24/Co 18	8	49
IR50	IR2153-14/IR28//IR36	10	51
TM4660	ADT31/CH46	25	53
TM10253	ASDl/AS3704	10	55
TM1323	TKM9 mutant 20 Kr	20	58
TM10173	IET4786/IR36	19	59
ADT36	Tiruveni/IR20	17	62
TM10142	Pusa 33/ADT9	10	63
TM4345	Pelita I/IR8	18	65
TKM9	TKM7/IR8	18	65
IR52	Nam Sagui 19/IR2071-88//IR2061-214	6	65
TM4116	IR262/CH1039/Pusa 33/1ET2222	21	69
TKM3	Pureline selection	8	71
IET1444 (Rasi)	TN1/Co 29	25	71
TM9395	IR8/GEB24//CH1039/TKM9	16	78
TM10570	TKM9 white rice mutant (natural)	12	78
Co 33 (Karuna)	IR8/ADT27	20	83
Co 37 (Vaipi)	TN1/Co 29	31	84
TM10182	BC11-6-3/ADT16	16	90
TKM8	TKM6/TN1	14	93
TM8089	Selection from TKM9	17	94
Co 34 (Kanchi)	TN1/Co 29	26	94
TKM4	Pureline selection	8	96
TM7878	HZ31.2/CR126-42-l//JSS2-102/Kalinga I	14	97

[a] CLH population was recorded at 30 DT and RTV infection at 45 DT.

Genetic Evaluation and Utilization

INSECT RESISTANCE

Effect of percentage of susceptible plants on damage ratings in seedbox screening for green leafhopper (GLH) resistance

H. R. Rapusas and E.A. Heinrichs, Entomology Department, IRRI

The percentage of resistant and susceptible entries varies in greenhouse screening of rice germplasm and breeding lines at IRRI. Entries from the germplasm collection generally are susceptible. Many breeding lines were bred for GLH *Nephotettix virescens* resistance and have resistance or moderate resistance.

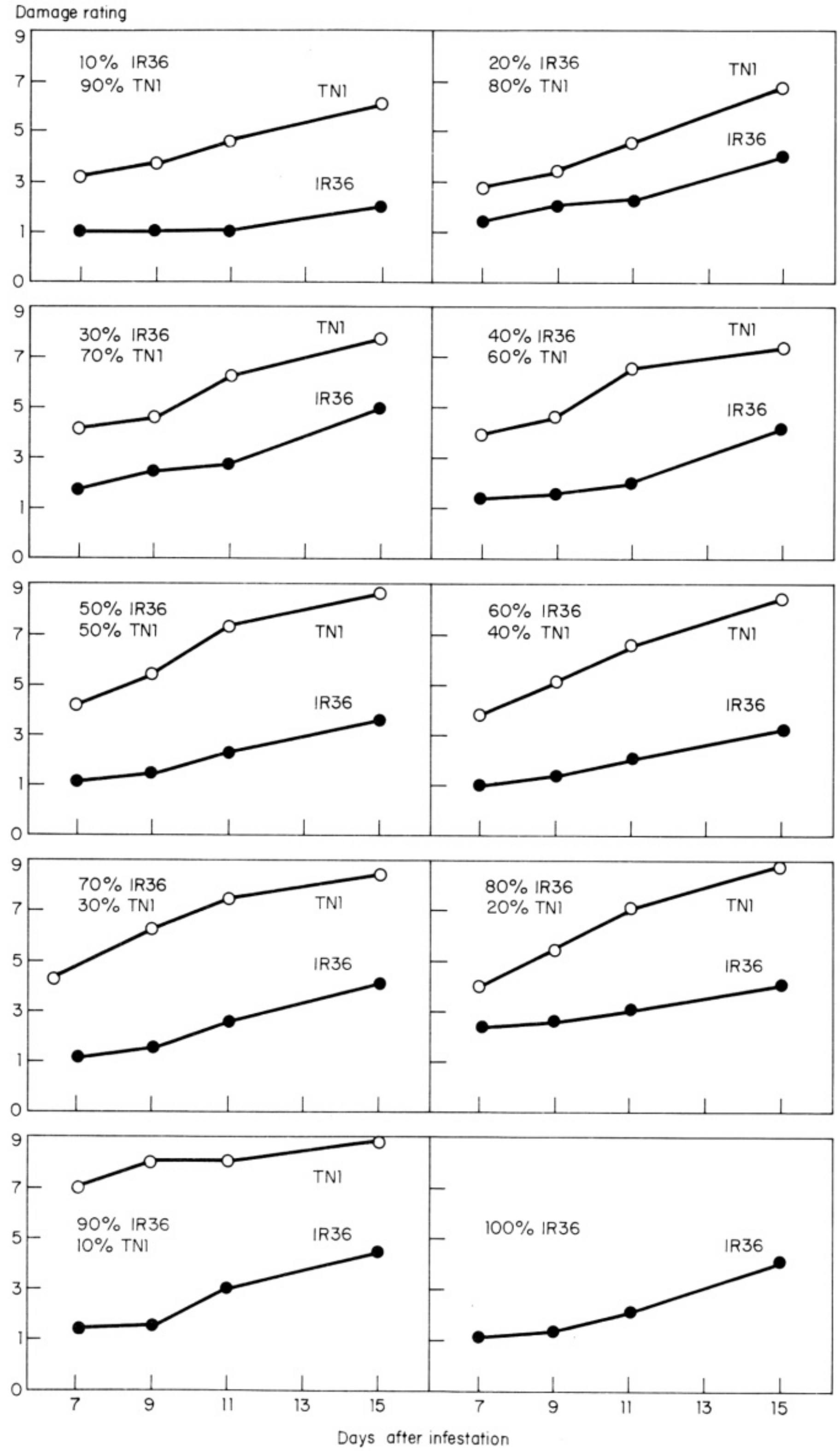
In greenhouse screening, one row each of the susceptible and resistant check is planted in each seedbox with the test entries. Thus, if most test entries are resistant, it seems likely that GLH will concentrate on the few rows of susceptible entries. If most entries are susceptible, the population would be distributed across the susceptible entries, thus reducing the number of GLH per susceptible entry.

We determined the effect of the percentage of moderately resistant and susceptible rows of test entries on the reaction of a susceptible and a moderately resistant cultivar to GLH infestation.

Twelve 60- × 40- × 10-cm seedboxes were prepared and filled with fine soil.

Combinations of moderately GLH-resistant IR36 and susceptible TN1 in seedbox screening tests at IRRI.

Treatment no.	Rows (no.) IR36	Rows (no.) TN1	Percent TN1	Percent IR36
1	1	9	90	10
2	2	8	80	20
3	3	7	70	30
4	4	6	60	40
5	5	5	50	50
6	6	6	40	60
7	7	3	30	70
8	8	2	20	80
9	9	1	10	90
10	10	0	0	100



Damage rating of susceptible TN1 and moderately resistant IR36, at 7 to 15 DI with GLH nymphs, as affected by the percentage of TN1 and IR36 rows in the seedbox.

Treatments were replicated four times with three seedboxes per replication. Each seedbox was divided into 4 sections to accommodate 10 treatments in a randomized complete block design.

Ten 10-cm-long rows were sown 5 cm apart in each section. Twenty seeds of moderately resistant IR36 or susceptible TN1 were sown in each row (see table). Six days after sowing (DAS) seedlings were thinned to 15/row.

The next day each section was covered with a mylar film cage and the seedlings were infested with 3 3d-instar nymphs of TN1-reared GLH per seedling. Damage was recorded 7, 9, 11, and 15 d after infestation (DI).

The figure shows that the percentage of susceptible TN1 and moderately resistant IR36 did not substantially affect the damage ratings of either cultivar. Damage was significantly different only when there was 10% IR36:90% TN1. At that ratio, TN1 damage rated 6 at 15 DI compared to 8-9 in other treatments. When the percentage of TN1 decreased, damage rating per plant increased at 5 to 11 DI because of greater insect density on the few susceptible plants.

For a mass screening program with the objective of rejecting the bulk of susceptible material, the differences observed in this study are insignificant.

Reaction of IR varieties to Angoumois grain moth

E. B. Medina and E. A. Heinrichs, Entomology Department, IRRI.

The Angoumois grain moth *Sitotroga cerealella* O. is a major pest of stored rice. IRRI varieties have been bred for resistance to several field insects, but not for resistance to storage pests. We evaluated IR varieties IR5 to IR54 for susceptibility to the Angoumois grain moth.

To disinfest grain, rough rice was frozen for 1 wk. Moisture content of each variety was reduced to 13%. Fifteen pair of moths were placed in each replication of 30 g of grain for 7 d, and then removed. Grain was kept in glass jars in the laboratory until insects began to emerge. The emerging insects were removed each day and counted.

The susceptibility index was based on total emerging adults and mean development period in days (D).

$$\text{Susceptibility index} = \frac{\text{Natural log F}}{\text{D}} \times 100$$

Grain weight loss was determined by weighing grains before and after the experiment.

Insect emergence was lowest in IR42 and IR46. The susceptibility indices differed significantly among varieties. IR50 and IR30 had the highest values; IR42 and IR46, the lowest (see table). Grain weight loss was lowest in IR22, IR42, and IR46.

Mean number of insects that emerged.[a]

Variety	Insects that emerged (no.)[b]	Susceptibility index[b]	Grain weight loss[c] (g)
IR5	52 cde	3.56 cd	0.76 cdefg
IR8	29 hijh	1.87 efg	0.67 efg
IR20	31 fghij	2.25 efg	0.50 fg
IR22	76 jk	1.6l fg	0.44 g
IR24	41 efghi	2.76 def	0.70 defg
IR26	29 ghijk	1.98 efg	0.46 g
IR28	30 ghijk	1.94 efg	0.58 efg
IR29	60 bcde	3.86 cd	1.28 ab
IR30	84 ab	5.25 b	1.38 a
IR32	28 jk	2.01 efg	0.60 efg
IR34	27 ijk	1.80 efg	0.64 efg
IR36	55 cde	3.64 cd	0.98 cd
IR38	43 defgh	2.88 de	0.72 defg
IR40	64 bcd	4.47 bc	1.06 bc
IR42	17 l	1.32 g	0.46 g
IR43	46 dcf	3.41 cd	0.82 cdef
IR44	31 fghij	2.02 efg	0.72 defg
IR45	44 defg	2.92 de	0.86 cde
IR46	19 kl	1.32 g	0.46 g
IR48	67 bc	4.26 bc	1.34 ab
IR50	120 a	7.52 a	1.52 a
IR52	30 jk	1.96 efg	0.58 efg
IR54	29 ghijk	1.87 efg	0.64 efg

[a]Av of 5 replications. In a column, means followed by a common letter are not significantly different at the 5%; level by DMRT. [b]Susceptlhility index is significantly correlated with loss of grain weight. $r = 0.922$. [c]Per 30-g weight before treatment.

Seedbox screening tests to determine resistance to brown planthopper (BPH)

Zhang Zhi-Tao, E. A. Heinrichs, and F.G. Medrano, Entomology Department, IRRI

We compared the standard seedbox screening test (SSST) and the modified seedbox screening test (MSST) for identifying sources of resistance to BPH *Nilaparvata lugens* (Stal) biotype 2. Twenty-five *O. sativa* varieties (see table) were sown 15 seeds/row in 20-cm-long rows in 60- × 40- × 7 cm seedboxes. Plant damage was rated by the *Standard evaluation system for rice.*

In SSST, each seedling was infested with 8 2d- to 3d-instar nymphs 7 d after sowing (DAS). The nymphs killed susceptible cultivars 8-9 d after infestation (Dl).

In MSST, each entry was infested with 3 2d- to 3d-instar nymphs at 10 DAS. The insects matured and produced F1 progeny that killed susceptible test plants at 25 DI.

Varieties that were susceptible in SSST and resistant in MSST were evaluated to determine their effect on

Damage ratings of selected cultivars to BPH biotype 2 in the SSST and MSST, IRRI.

IRRI accession no.	Variety	Damage rating [a] SSST	Damage rating [a] MSST
4907	Birado	MR	R
4914	Toma 112	S	MR
4936	Ngasein thidat	S	S
5216	Mantika	S	S
5837	MTU14	S	R
5856	DA26	S	S
5886	Ngathalun CWR l0/9	S	S
5955	Hin trang	S	S
6002	Guttikusma	S	R
6008	Radin Siak 34	S	R
6029	Ptb 17	S	MR
6039	AKP8	S	S
6066	Bilugyun C32-1	S	S
6068	D52-37	S	S
6114	Molagasamba 18	MR	R
6145	MTU7	S	R
6162	American HS 1	S	R
6274	Ptb 9	MR	R
6291	Ptb 8	S	R
6339	BAMl2	S	R
6353	MO 1	S	R
(R check)	IR60	R	R
(R check)	ASD7	MR	R
(MR check)	Triveni	S	MR
(S check)	IR26	S	S

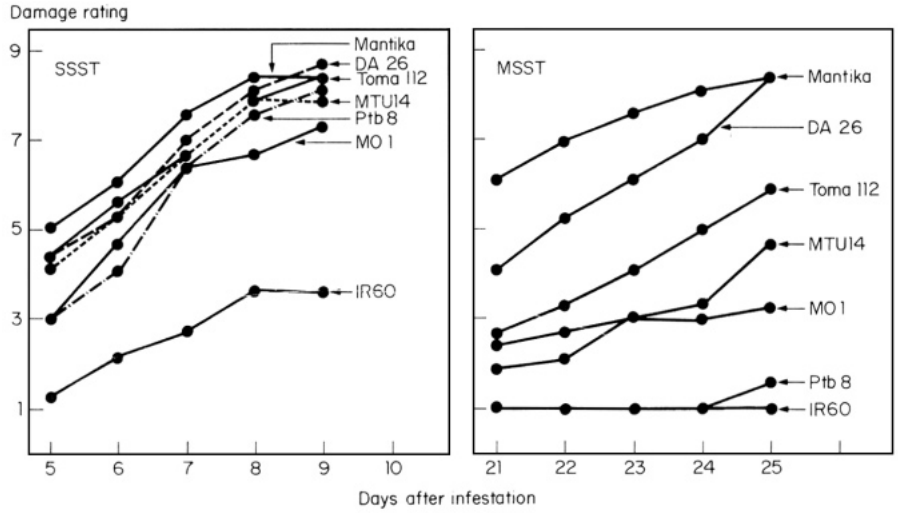
[a] R = resistant with rating of 1-3, MK = moderately resistant with rating of 5, and S = susceptible with rating of 7-9.

BPH biotype 2 population growth. Ten newly hatched nymphs were used to infest 25-d-old potted plants in a mylar film cage. BPH progeny per cage was counted at 35 DI.

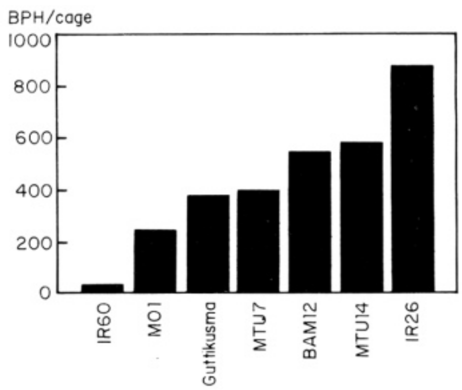
Nine varieties were susceptible in both tests; 11 were susceptible in SSST but moderately resistant or resistant in MSST; and 4 were moderately resistant in SSST and resistant in MSST. Plant damage ratings of some varieties in SSST increased together, indicating insignificant differences in resistance (Fig. 1). In the MSST, the damage ratings of those varieties were significantly different, and older and younger plants had different resistance levels.

MO 1, Guttikusma, BAM12, MTU7, and MTU14, which were susceptible in SSST but resistant in MSST, have different levels of antibiosis, as shown by lower BPH population growth than in susceptible IR26 (Fig. 2). Antibiosis in those cultivars is apparently a factor that is measured in MSST but not in SSST.

MSST is a fast screening technique that can be used to mass screen varieties at tillering. Resistance at this stage is expected to be influenced by minor genes and increases with age. MSST, therefore, may identify more durable resistance than SSST, which identifies the major gene for resistance.



1. Plant damage rating of rice varieties on SSST at indicated days after infestation with BPH biotype 2.



2. Varieties susceptible to BPH in MSST but resistant in MSST. IR60 is the resistant check; IR26, the susceptible check.

Mahaveera: a gall midge (GM)-resistant rice for coastal Karnataka

B. Vidyachandra, B. L. Hanumantharaju, P. S. Rai, and B. S. Naidu, Regional Research Station University of Agricultural Sciences, V. C. Farm, Mandya 571405, Karnataka, India

Mahaveera (IET2886/Annapurna) was released for cultivation in coastal Karnataka, where it will replace GMR 17 in transplanted uplands. Mahaveera (KKP 2) matures in 110 d and yields 4.1 t/ ha, 37% more than GMR 17. Grains are long, bold, red kerneled, and suitable for parboiling, with 72% hulling. It is GM resistant, with 0.02% silvershoots compared to 33% for susceptible Annapurna and 4% for GMR 17 (see table).

GM incidence and yield performance of Mahaveera, 1979-83, Mandya, India.

Year	Silvershoots (%) Mahaveera	Silvershoots (%) Annapurna	Silvershoots (%) GMR17	Yield (t/ha) Mahaveera	Yield (t/ha) Annapurna	Yield (t/ha) GMR17
1979	0	32	1	4.3	3.3	3.5
1980	0	54	12	4.9	3.3	3.3
1981	0.1	30	4	4.4	3.4	3.5
1982	0	22	9	4.4	3.4	3.5
1983	0	28	5	2.7	1.9	1.6
Mean	0.02	33	6	4.1	3.1	3.0

Reaction of rice varieties in the 1984 International Rice Whitebacked Planthopper Nursery (IRWBPHN)

J. Singh, Plant Breeding Department, Punjab Agricultural University, Ludhiana, India; and A. M. Romena, Entomology Department, IRRI

We screened rice varieties entered in the 1984 IRWBPHN 1984 for resistance to whitebacked planthopper (WBPH) *Sogatella furcifera* H. in the IRRI greenhouse (see table).

Seeds of 85 entries were sown 9 Oct in 60- × 40- × 10- cm wooden seedboxes filled with fertile soil. The experiment was in a completely randomized block design with three replications. One row of 25 seeds/variety was 1 replication. Susceptible TN1 and resistant IR2035-117-3 were checks. Seven-day-old seedlings were each infested with about 5 2d-and 3d-instar WBPH nymphs. Damage was rated by the *Standard evaluation system for rice* 8 d after infestation (DI) when TN1 was hopperburned, and 10 DI when most varieties were hopperburned.

At 8 DI, 55%, of all entries were resistant. At 10 DI, only 18% were resistant. Of the varieties tested, IR2035-117-3 has *Wbph 1* and *Wbph 2* genes for resistance. It, however, rated only moderately resistant. Several of its progeny were resistant. IR17307-11-2-3-2 was also resistant. It has IR2070-423 and N22 (with *Wbph 1*) as parents.

Entries with WBPH resistance at 10 DI in the 1984 IRWBPHN, IRRI.

Designation	Cross	Origin
ADR52		India
Balamawee		Sri Lanka
Chempan		India
Cheriyachittari		India
CI 5662-2		Japan
IR15527-21-2-3	IR2035-117-3/ IR30//IR2037-64-2-2	IRRI
IR15529-253-3 -2-2-2	IR2035-117-3/ IR2061-522-6 -9//IR2037-64-2-2	IRRI
IR15795-151-2 -3-2-2	IR2035-117-3/ 2*IR36	IRRI
IR15797-74-1-3-2	IR2035-117-3/ IR2153-26-3-5 -6//IR2061-465-1-5-5	IRRI
IR17307-11-2-3-2	IR2070-423/N22 //2*IR2070-423-2///IR2070-423-2-5-6	IRRI
Latighawar		Nepal
Sinna Sivappu		Sri Lanka
Sufaida 172		Pakistan
Valsara champara		India
WC1240		India

Screening wild rices for resistance to *Marasmia patnalis* Bradley

E. B. Medina, A. M. Romena, and E. A. Heinrichs, Entomology Department, IRRI

We screened 227 wild rices for resistance to rice leaffolder *Marasmia patnalis* Bradley using the screening method developed for *Cnaphalocrocis medinalis* Guenée.

In the first test, entries were sown in seedboxes; 15 d after sowing (DAS), the plants were transplanted in 12-cm-diameter pots at 5 plants/pot. Test entries and one pot of susceptible TN1 (*Oryza sativa*) and resistant TKM6 (*O. sativa)* were covered with a fiberglass screen cage. Ten pair of adults were released in each cage and allowed to oviposit on the plants. Twenty-one days later, the pots were removed from the tray and damage on each leaf was determined based on the *Standard evaluation system for rice.* The experiment was in six replications,

Entries that scored 0-3 were retested in 6 replications, with each pot representing 1 replication. Treatments were in a randomized complete block design. At 21 DAS, plants were infested with 2 1st-instar larvae/tiller. Damage was recorded 17 d later.

Of the 227 wild rices, 19 were resistant, 48 were moderately, resistant. and 160 were susceptible (see table).

Accessions 101232 and 101236 that were highly resistant to *C. medinalis* were also resistant to *M. patnalis.* The *O. brachyantha* accessions from West Africa were more resistant to *M. patnalis* than any *O. sativa* accessions that we have screened.

Wild rices resistant to *Marasmia patnalis.* **IRRI.**

Species	Origin	IRRI accession no.	Damage rating [a]
O. rufipogon	Thailand	100192	3
O. stapfii	Nigeria	100936	3
O. rufipogon/O. nivara	India	102177	3
Oryza sp.	Bangladesh	102471	3
O. rufipogon	Burma	100926	3
O. barthii	Guinea-Conakry	100929	3
O. sativa/O. rufipogon	Nigeria	100938	3
O. brachyantha	Sierra Leone	101231	3
O. brachyantha	Sierra Leone	101232	1
O. brachyantha	Sierra Leone	101235	1
O. brachyantha	Mali Republic	101236	1
O. barthii	Mali Republic	101940	3
O. barthii	Mali Republic	101941	3
O. brachyantha/O. barthii	Upper Volta	101954	3
O. nivara	Sri Lanka	103419	3
O. nivara/O. sativa	Sri Lanka	103791	3
O. sativa/O. rufipogon	Sri Lanka	103793	3
O. rufipogon/O. nivara	Burma	103799	3
O. rufipogon	Bangladesh	103844	3
TKM6 (resistant check)	India	237	3
TN 1 (susceptible check)	Taiwan	105	9

[a] By the *Standard evaluation system for rice.*

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Genetic Evaluation and Utilization
COLD TOLERANCE

Agronomic traits of cold-tolerant rices

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In 1984, we evaluated 90 transplanted rice varieties for cold tolerance at Upper Shillong Farm (elevation 1900 m). Temperatures were low from panicle initiation through harvest. Entries included local and improved indicas and japonicas.

Maximum and minimum values for agronomic traits are in the table. K 332 had minimum days to 50% flowering; Namyi for minimum flag leaf angle; and Chhanapaddy for minimum grain sterility. The three are indica varieties.

There were significant positive relationships between grain yield and plant height (0.477), effective tillers per plant (0.321), flag leaf angle (0.387), grains per panicle (0.726), and harvest index (0.602). Percent sterility and grain yield were significantly and negatively related (-0.594).

PK2-26-1, Ryllo red A, and Namyi may be suitable donors for cold tolerance breeding programs.

Agronomic traits of cold-tolerant rices, Shillong. India.

Character	Range		Mean	Correlation coefficient with grain yield[a]
	Minimum	Maximum		
Days to 50% flowering	121 (K332)	170 (Khamang, Kba-saw rit) B_2 & B_4	159.31	0.224
Plant height (cm)	60 (K332)	110 (Zichum)	88.77	0.477**
Leaf area index	1.84 (Ryllo red)	6.70 (PK2-26-1)	3.27	0.143
Tillers per plant	4 (Kba-sawrit B_4)	16 (PK2-26-1)	7.91	0.207
Effective tillers per plant	4 (Kba-saw rit B_4)	16 (PK2-26-1)	7.38	0.321*
Flag leaf angle (°)	70 (Namyi)	115 (PK2-3-1)	63.27	0.387**
Panicle length (cm)	15 (K-333)	24 (Dullo-8, CH-l039	20.73	0.238
Grains per panicle	2.3 (Muzudo)	84.4 (Ryllo red A)	42.61	0.726**
Sterility (%)	27 (Chhanapaddy)	98 (Muzudo)	52 .30	–0.594**
Harvest index	0.01 (Borkat)	0.70 (Ryllo red 6)	0.35	0.602**
Grain yield (t/ha)	(1.0 (Borkat)	2.5 (PK2-26-1)	0.91	

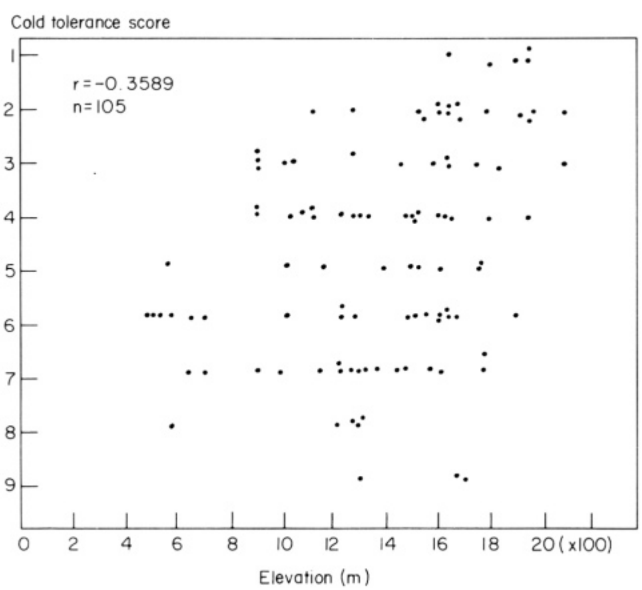
[a]Significant at 1% (**)and 5% (*) levels

Cold tolerance of Yunnan rices at different elevations

Li Taigui and Wang Qinggang, Plant Physiology Department, China National Rice Research Institute, Hangzhou, Zhejiang, China

We tested 105 rice varieties from Yunnan Province for cold tolerance at early seedling, seedling, booting, and flowering stages at the Institute of Crop Germplasm Resources, Beijing.

Hei-Gu, Wu-Chew-Ma-Xian-Gu. Hong-Mang-Da-Ding, and Bi-Jing no. 7 had greatest cold tolerance at all stages. Bi-Gu, Lao-Lai-Hong, Bang-Tou-Nuo, Xiao-Ai-Jiao-Nuo, Da-Bai-Gu, Ziao-Hoang-Gu, Huang-La-Gu, Shi-Li-Xiang, Hai-Gu, Jiu-Gu, Han-Gu, Yu-Gu, and Lao-Lai-Bai had cold tolerance at flowering.



Correlation between cold tolerance and elevation at which rice varieties are planted.

Cold tolerance at early seedling, seedling, and flowering stages were highly and significantly correlated with the elevation at which they were planted.

Correlation coefficients were 0.456**, 0.399**, and 0.527**.

Average cold tolerance of varieties was calculated for several growth stages: S = s1 + s2 + s3 + ... sn/n. There was a highly significant correlation between average score and elevation (see figure). Japonicas tend to have cold tolerance above 1,500 m elevation, indicas below 1,000 m, and japonica/indica between 1,000 and 1,500 m.

Agronomic characteristics also change with elevation. Lemma, palea, and apiculus colors are more intense and flag leaves shorter with increasing elevation.

Genetic Evaluation and Utilization
DEEP WATER

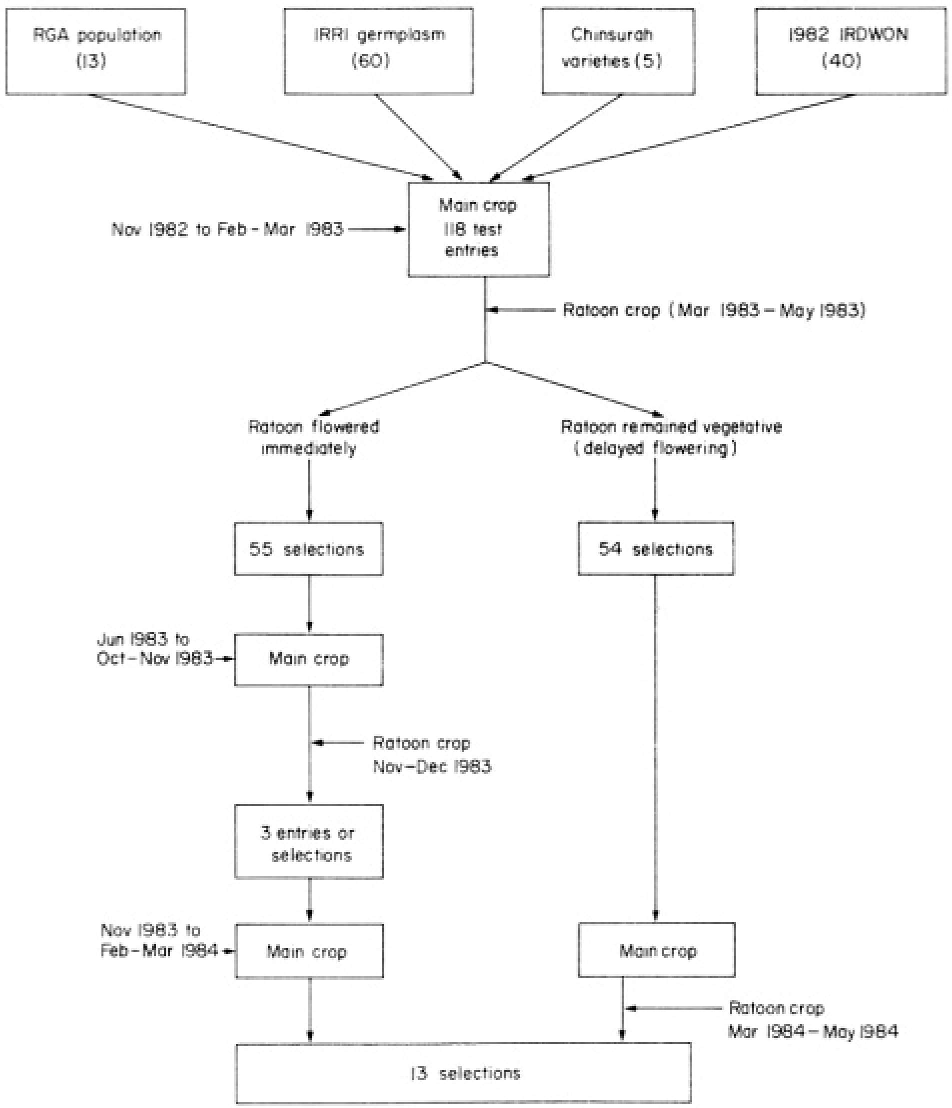
Selecting deep water rices with ratooning ability

J. S. Chauhan, F. S. S. Lopez, and B.S. Vergara, IRRI

Cropping intensity in deep water rice areas is low because long-duration, photoperiod-sensitive varieties are needed. Boro or winter rice often is harvested too late to allow proper establishment of deep water rice. Photoperiod-sensitive rices with good ratooning ability, submergence tolerance, and elongation ability have potential as a dry season crop and as a deep water ratoon.

We evaluated 118 entries for ratooning ability in an unreplicated trial in Nov 1982-May 1983 at IRRI (see figure). At maturity, plants were cut to 15-cm height and 15 d later were scored for ratooning ability. Of the selections, 109 were evaluated in 1983 wet season and 1983-84 dry season to confirm their performance and ascertain the photoperiod sensitivity of the ratoons.

In the Nov 1982 planting, main crop flowering, maturity, and height varied substantially, perhaps because they were first planted at IRRI in dry season and have not been selected for uniformity. Within a variety, many hills did not produce ratoon tillers. Several plants, however, had good ratooning ability, which was based on high tiller number (≥=16), at least 3 leaves per tiller before flowering, and freedom from virus diseases. Some entries flowered immediately after ratooning, others remained vegetative, and a few showed segregation for flowering. We selected entries that flowered soon after ratooning and those that flowered late.



Selection of deep water rices with ratooning ability, IRRI, 1982-84

Early flowering ratoons were evaluated in Jun-Dec 1983. The main crop lodged seriously, and the ratoon crop had generally poor regeneration (0-10%). Only Raj Bhawalia (Acc. 26517A) had relatively high regeneration. We attributed the poor ratooning to lodging during early growth.

Ratoons with delayed flowering were

Characteristics of outstanding selections in main and ratoon crops, IRRI, 1983-84 dry season.

Selection	Accession no., parentage	Main crop							Ratoon crop			
		Days to flowering	Ht (cm)	Panicles/ plant	Yield/ plant (g)	Lodging score	Cold tolerance score[a]	Elonga- tion	Regen- eration	Ratoon rating	Tillers/ plant	Flowering[b]
Gowai 50-9	Acc. 6493 A	104	141	15	18	3	9	1	93	1	17	+
Gowai 476	Acc. 6501 A	126	163	15	20	9	5	1	80	1	24	−
Cholamon 658	Acc. 6517 A	133	177	19	21	7	5	1	85	1	20	−
Lalamon 245	Acc. 6558 A	125	155	14	15	9	5	1	99	1	30	+/–
Kalamon 243	Acc. 6599 A	125	165	14	11	7	7	1	96	1	26	–
Karkati 87	Acc. 6618 A	117	152	21	15	9	5	1	97	1	35	−
Raj Bhawalia	Acc. 26517 A	98	156	15	9	7	5	1	98	1	18	+
Sechi Amon	Acc. 26522 A	111	170	18	13	9	5	1	82	1	23	–
BKNR76014-1-9-2		104	171	11	29	5	9	7	84	1	19	–
CN691-3		120	117	20	32	0	7	7	95	1	24	−
CN658-R-R-R	Jaladhi 2/CR1005	125	140	22	16	3	3	7	97	1	27	–
CN658-R-R-R	Jaladhi 2/CR1005	111	125	11	20	3	7	7	83	1	23	–
CN665-R	Pankalash/OC1393	125	156	10	15	5	5	7	83	1	24	–

[a]At seedling stage. [b]+ = flowered, – = flowering, +/– = segregating.

evaluated in 1983-84 dry season (Nov-May). Some entries were common in both seasons. Most selections ratooned well, but the extent of regeneration and crop vigor varied widely. Thirteen selections were made from 12 entries based on consistent performance for at least 2 seasons (see table). Regeneration was 80-99%. A few entries compensated for relatively low regeneration by producing more tillers per hill. There were 17-35 ratoon tillers per plant. Of the 13 selections, 10 did not flower, 2 flowered, and 1 segregated for flowering.

Although some entries ratooned well in both seasons, the different dry season and wet season responses of many selections suggest the important influence of environmental factors on ratooning ability. Although early lodging reduced ratooning, lodging in late reproductive phase (1983-84 dry season) did not seem to influence ratooning ability.

Evaluation of the 9th International Rice Deep Water Observational Nursery (IRDWON) in waterlogged coastal soils

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The IRDWON comprised 124 entries and local check Kalamota (Sel). Seeds were sown 26 Jun 1984 and transplanted on 24 Jul in unreplicated plots. Entries each were transplanted in 5.0- × 0.75-m plots at 25-cm spacing. Water depth was 39.4±1.45 cm in Aug, 3 1.6±1.8 cm in Sep, 20.8±1.2 cm in Oct, and 20.0 cm in Nov.

Grain yield, plant survival percentage, flowering duration, plant height, and panicles per plant were recorded from five randomly selected plants from each entry. IR21567-9-2-2-2-1-3 yielded highest and 5% more than the local check (see table). Leb Mue Nahng 111 and RD19 yielded 0.04 and 0.98 t/ha. IR21567-9-2-2-2-1-3 and NC493 will be evaluated in local yield trials.

Performance of some promising rice entries in the 9th IRDWON, Canning, India.

Entry	Plant height (cm)	Panicles, plant (no.)	Plant survival (%)	Days to flowering	Grain yield (t/ha)
IR21567-9-2-2-2-1-3	124	9	92	113	5.5
NC493	184	10	100	129	5.1
BR222-B-358	151	11	97	126	4.7
B4259-48-1-3-1-3	118	7	95	133	4.5
IR331339-6-1-6	124	14	87	125	4.5
Checks					
Leb Mue Nahng III	169	6	75	137	0.0
RD19	107	14	18	149	0.0
Kalamota (Sel.)	166	9	100	131	5.2

Deep water rice yield trials on the Cuu Long Delta

Bui Chi Buu and Nguyen Van Luat, Cuu Long Delta Rice Research Institute (CLRRI), O Mon, Hau Gang, Vietnam

We compared 11 popular varieties and 2 promising lines in a yield trial for deep water rice at CLRRI in 1984 monsoon season (see table). Twenty square meter plots were arranged in a randomized complete block design with three replications. Rice was transplanted at 30 × 30 cm spacing, and received 30-30-0 kg NPK/ha. Maximum water depth was 95 cm on 12-15 Nov.

The lines had good plant type, but did not yield well because of photoperiod insensitivity and high sterility. Trang Chum, Radine China 4, and Chum

Yield performance and agronomic characteristics of deep water rices, 1984 monsoon season, 0 Mon, Vietnam.

Designation	Plant ht (cm)	Flowering date	Panicles/ m^2	Filled grains/ panicle	Sterility (%)	1000-grain wt (g)	Yield[a] (t/ha)
Trang Chum	208	26 Dec	63	147	10	26.7	4.0 a
Radine China 4	168	15 Dec	48	235	10	22.3	4.0 a
Chum Ruot Mua	149	20 Nov	54	173	8	23.2	3.6 a
Mot Bui Sel. 28	132	1 Dec	39	145	12	25.0	3.0 b
Ba Thiet	146	11 Nov	45	135	17	26.0	3.0 b
Lua Phi	138	29 Nov	40	180	13	23.6	2.8 b
Trang Lun	137	16 Dec	40	149	5	23.2	2.7 b
Lem Lun	149	18 Dec	49	130	17	30.0	2.7 b
Mot Bui Sel. 139	141	1 Dec	51	143	17	23.5	2.5 b
523 (IR8608/Truong Hung)	145	10 Oct	45	90	20	30.0	2.5 b
Trai May	166	20 Nov	54	129	15	26.8	1.8 c
Tat No	148	10 Dec	40	130	27	23.5	1.6 c
522 (Trai May Cut/424)	140	10 Oct	45	139	18	25.3	1.4 c
							F= 19.679**
							CV = 11.67%

[a] Values followed by the same letter are not significantly different at the 5% level.

Ruot Mua yielded best. They flowered after the peak water level and had low sterility. Radine China 4, which has tolerance for acid sulfate soil, had the most filled grains per panicle.

The International Rice Research Newsletter (IRRN) invites all scientists to contribute concise summaries of significant rice research for publication. Contributions should be limited to one or two pages and no more than two short tables, figures, or photographs. Contributions are subject to editing and abridgment to meet space limitations. Authors will be identified by name, title, and research organization.

Genetic Evaluation and Utilization

ADVERSE SOILS TOLERANCE

Effect of Zn on electrical conductivity (EC), endosperm weight, germination, and vigor of three rices

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We studied the effect of Zn on physiological parameters related to seed and seedling growth of Jaya, IR20, and Kanchi in 1980-81. Rice seeds were soaked in water in a 2.5, 5, 10, 15, and 20 ppm Zn solution for 16 h. EC of the leachates and endosperm weight after seed soaking, percent germination, and seedling vigor were recorded. Seedling vigor was computed as germination percentage × mean dry weight of a normal seedling.

EC of the leachates increased with increasing Zn concentration, and appeared to affect germination. An increase in leachates lowered percent germination. Jaya had highest EC. Maximum endosperm weight for all varieties was with 5 ppm Zn. IR20 had significantly higher endosperm weight at 5 to 10 ppm Zn than the other varieties. Increased endosperm weight may influence seedling vigor, presumably through auxin-mediated metabolism.

Effect of Zn on EC, endosperm weight, germination, and vigor of Jaya, IR20, and Kanchi, Tamil Nadu, India.

Treatment	EC (mmho/cm)	Endosperm weight (mg)	Germination (%)	Vigor[a]
		Jaya		
Water	0.370	23.5	92	152
Zn (ppm)				
2.5	0.325	22.5	96	162
5.0	0.430	29.3	99	173
10.0	0.485	23.3	92	170
15.0	0.495	19.5	91	132
20.0	0.490	20.7	90	123
		IR20		
Water	0.125	29.7	100	150
Zn (ppm)				
2.5	0.100	31.3	100	158
5.0	0.110	37.0	100	184
10.0	0.130	36.0	100	172
15.0	0.170	30.6	96	143
20.0	0.220	34.0	92	139
		Kanchi		
Water	0.110	28.1	100	172
Zn (ppm)				
2.5	0.110	27.6	100	182
5.0	0.090	28.8	100	189
10.0	0.120	27.8	98	188
15.0	0.150	28.4	97	189
20.0	0.140	28.2	97	162
Variety CD (P = 0.05)	0.021	0.00027	3	–
Treatments CD (P = 0.05)	0.030	0.00038	4	–

[a] Vigor index = Germination percentage × mean dry weight (mg) of a seedling from a standard germination test.

Jaya and IR20 germination declined as Zn increased. Kanchi had 97%

germination even at 20 ppm Zn. Values for vigor, which is considered a reliable index of seed potency, indicated that all the varieties performed best at 5 ppm Zn. Higher concentrations (15 and 20 ppm) reduced Jaya and IR20 vigor, but not that of Kanchi (see table).

EC of the seed leachates after soaking in Zn was negatively correlated with germination and seedling vigor. Zn had little effect on endosperm weight, but germination percentage was closely related to seed treatment.

Genetic Evaluation and Utilization

HYBRID RICE

Ratoon regeneration in rices and their single-cross hybrids after three cuttings

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Sixteen single-cross hybrids of 15 rice varieties were planted in Aug 1982 at Main Research Station, Bangalore. F2 seeds were harvested on 24 Jan, 20 Aug, and 10 Dec 1983. After the third ratooning, stubble was left in situ or transplanted in single rows containing 30 slips. Thirty-five days after cutting and transplanting, plant height and number of tillers per plant were recorded (see table). Plant height was measured from the ground to the tip of the topmost leaf.

Hybrids had greater regeneration capacity than varieties. Hybrid TNl/Type 3 had the best regeneration ability. Among varieties, Type 3 had good regeneration. Many varieties could not be propagated in situ after the third cutting. Vegetative propagation of single-cross hybrids allows continuous production of F2 seeds and maximizes the population size of the second segregating generation of any cross.

Plant height and tillers per plant on 20 plants 35 d after thud cutting.

	Plant height (cm)		Tillers (no.)	
	In situ	Transplanted	In situ	Transplanted
Cross				
TNl/Type 3	56.2±3.6	67.4±1.7	24.7±4.0	14.8±4.7
Jaya/Type 3	54.9±1.9	53.0±1.4	31.9±5.5	7.2±0.4
PKl50/Basumathi	54.5±3.6	21.0±3.5	31.1±4.1	2.0±0.4
Mashuri/Doddi	51.l±1.4	45.9±2.5	19.1±3.1	3.6±0.4
Mashuri/Prakash	46.9±1.9	39.8±2.3	22.2±3.7	5.4±0.5
IET7031/Telahamsa	44.1±1.8	35.1±2.6	20.4±2.9	1.9±0.5
SHM 1/Intan Mutant 1	44.2±1.7	32.8±8.6	7.1±1.4	3.3±0.5
Type 3/Telahamsa	44.3±1.8	47.0±1.5	22.8±1.6	10.5±0.7
TNl/TeIahamsa	39.4±1.4	30.1±1.5	18.3±2.2	3.8±0.7
Jaya/Telahamsa	35.6±2.1	30.5±4.2	12.3±1.5	2.6±0.5
Jaya/Mashuri	38.5±1.3	34.3±1.7	20.3±2.7	4.8±0.5
Jaya/IET7031	38.4±2.3	32.3±2.4	16.0±1.1	2.5±0.5
PK150/IR36	37.9±2.6	28.2±1.9	18.2±1.9	4.4±0.6
Mangla/Telahamsa	37.1±0.9	33.4±1.6	19.0±3.2	3.0±0.4
PK177/Intan Mutant 1	36.8±1.5	34.6±1.3	14.2±1.5	5.1±0.6
IET703l/Mangla	36.4±4.3	30.6±2.9	6.6±3.9	3.1±0.6
Variety				
Type 3	52.3±3.9	53.9±2.1	14.8±2.6	3.8±0.4
Jaya	29.8±3.5	31.7±2.1	7.7±0.9	3.2±0.4
Mangla	36.7±2.9	34.3±1.9	3.7±2.2	4.2±0.3
Telahamsa	37.4±0.9	27.2±1.6	15.3±3.1	2.5±0.3
Mashuri	42.4±2.2	36.4±1.6	–	4.3±0.4
TN1	–	29.1±1.9	–	4.1±0.5
Prakash	–	34.3±2.1	–	4.7±0.4
Intan Mutant 1	–	45.3±2.6	–	4.7±0.7
Doddi	–	50.6±1.5	–	3.9±0.7

Performance of male-sterile and maintainer lines and crosses

Bui Ba Bong, Nguyen Van Luat, and J. Chandra Mohan, Cuu Long Delta Rice Research Institute (CLRRI) O Mon, Hau Giang, Vietnam

We evaluated Chinese cytoplasmic male-sterile (cms) lines V20A and Zhen Shan 97A and corresponding maintainers V20B and Zhen Shan 97B in 1983 wet and 1984 dry season at CLDRRI. In wet season, they matured early and had low phenotypic acceptability (scale 5),

Table 1. Agronomic traits of cms lines and maintainers at O Mon, Hau Giang, Vietnam.

Line	Duration (d)	Plant height (cm)	Panicles/m^2	Grains/ panicle	Sterility (%)	1,000-grain weight (g)	Yield (t/ha)
			1983 wet season				
V20A	89	75	304				
V20B	91	67	274	74	38	29	2.9
Zhen Shan 97 A	93	73	218				
Zhen Shan 97B	97	69	212	137	27	27	2.2
			1984 dry season				
V20A	90	71	363				
V20B	97	71	284	74	16	30	2.3
Zhen Shan 97A	93	68	297				
Zhen Shan 97B	103	74	269	97	26	28	2.8

Table 2. Seed set on cms lines due to cross-pollination with maintainers and elite lines, O Mon, Hau Giang, Vietnam.

Cross	Seed set (%) on cms lines
1983 wet season	
V20A/V20B	4
Zhen Shan 97A/Zhen Shan 91B	2
V20A/NN3A (IR36)	10
V20A/NN4B (IR42)	3
V20A/IR54	2
97A/NN3A	9
97A/NN4B	2
97A/IR54	4
1984 dry season	
V20A/V20B	43
Zhen Shan 97 A/Zhen Shan 97B	36
V20A/NN3A	21
V20A/NN6A (IR2307.247.2.2.3)	30
V20A/IR56	32
V20A/OM33 (IR9224.73.2.2.2.3)	26
V20A/IR8423.132.6.2.2	34
V20A/NN7A (IR9129.192.2.3.5)	35
97A/NN3 A	35
97A/NN6A	33
97A/IR56	41
97A/OM33	26
97A/IR8423	35
97A/NN7 A	40

less panicles/m^2, and high sterility (Table 1). The maintainers had high 1,000-grain weight. V20B and Zhen Shan 97B yielded less than 3 t/ha in both seasons. The lines were resistant to blast but highly susceptible to stem borer and sheath rot. Panicles of cms plants often showed incomplete exsertion.

Outcrossing pollination between cms lines, maintainers, and some elite lines was evaluated in the greenhouse in 1983 wet season and in the field in 1984 dry season. Female-to-male ratio was 4:1. Twenty-day-old seedlings were transplanted at 20- × 15-cm spacing. Maintainers were sown 5 d later than cms lines and sowing time of elite lines was adjusted to synchronize flowering. Ropes were pulled across plots to encourage cross-pollination, but we did not clip leaves or apply gibberellic acid to improve panicle exsertion.

Filled and unfilled grains were counted on 20 plants of each cms line. Cross pollination was 2-10% in wet season and 21-43% in dry season (Table 2).

Genetic Evaluation and Utilization

TISSUE CULTURE

Phylogenetic mutation for grain type in japonica rice after mutagen treatment of fertilized egg cells

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Fertilized egg cells of japonica Taichung 65 were treated with 0.5 or 1.0 mM N-methyl N-nitrosourea (MNU) 12 h after anthesis by panicle dipping method for 1, 2, and 3 h. Each treatment had 500 fertilized egg cells. Seeds from treated panicles were harvested 40 d after treatment and the M_1 was planted in the field.

Mutants with indica grain type (1ength:breadth >2.0) are shown in Table 1, and grain characters of some mutants are in Table 2. Length:breadth of grains of indica mutants was 2.71 to 3.47, compared to the parent ratio of 1.72.

Different grain types of mutants. 1 = parent, 2 = long grain, 3 = awned spikelets.

Table 1. Frequency of progenies with indica grain type in M_1 population.

MNU treatment	M_1 plants (no.) tested	M_1 plants (no.) with indica grain type	Frequency (%)
Control (water)	200	0	0.000
0.5 mM for 1 h	510	0	0.000
2 h	1261	9	0.714
3 h	577	2	0.347
1.0 mM for 1 h	540	4	0.740
2 h	881	11	1.248
3 h	512	3	0.586

Table 2. Grain characters of indica mutants in M_1.

Mutant line	Grain size (mm) (length × breadth)	Length:bread th	100-grain weight (g)
T3 - 995	7.01 × 2.25	3.11	2.0
T4 - 1462	7.14 × 2.06	3.47	2.2
T5 - 2020	6.23 × 2.27	2.74	2.0
T5 - 2123	6.29 × 2.28	2.76	2.1
T6 - 2282	7.20 × 2.12	3.40	2.2
T6 - 2284	6.96 × 2.08	3.35	2.0
T6 - 2396	2.96 × 2.04	3.41	2.1
T6 - 2423	6.13 × 2.26	2.71	2.0
T7 - 2974	6.33 × 2.29	2.77	2.1
T7 - 2918	5.64 × 2.03	2.78	1.6
Parent	5.00 × 2.91	1.72	2.4

The figure shows grain size of the panicles of indica mutants and the parent. Sixty seeds from each mutant progeny were planted and their grain shape evaluated. Grain shape did not segregate.

Similar changes in grain type have been reported to be induced by mutagen treatment of seeds. Such phylogenetic mutants can help understand differentiation and evolutionary relationships among rice genotypes.

Pest Control and Management

DISEASES

Cow dung extract for controlling bacterial blight (BB)

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BB caused by *Xanthomonas campestris* pv. *oryzae* is becoming a serious pest in Kerala. In 1982-83, we compared cow dung and urine with recommended antibiotics for controlling BB.

Susceptible Triveni and Cul. 1907 were planted at 15- × 10-cm spacing in 4.95- × 2.10-m plots in 4 replications. NPK was applied at 70-35-35 kg/ ha.

Five foliar sprays were applied 10 and 15 days after clip inoculation of BB at maximum tillering, cow dung slurry was topdressed, and cow dung was applied basally. Disease reaction was scored by the *Standard evaluation system for rice* on the 3 top leaves of 10 randomly selected plants in each treatment.

A foliar spray of cow dung extract (20 g/ litre) controlled BB as well as penicillin, paushamycin, and streptomycin (see table).

Different treatments for controlling BB, Pattambi, India.

Treatment	Dose/ha	Disease index (%)		
		Triveni		Cul. 1907
		1982 kharif	1982-83 rabi	1983 kharif
Penicillin (100 ppm)	50 g	38	22	31
Paushamycin (250 ppm)	750 g	37	42	26
Streptomycin (100 ppm)	500 g	39	19	32
Cow dung extract (20 g/litre)	10 kg	41	25	26
Cow urine (20 ml/litre)	10 litres	50	31	45
Cow dung slurry topdressing	5 t	43	36	31
Cow dung basal application	10 t	46	32	44
Untreated check	–	62	50	75
CD (P = 0.05)	–			

Effect of fertilizers, nutrients, and soil amendments on tungro virus (RTV)

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In Oct 84-Jan 85 we studied the effect of fertilizers, nutrients, and soil amendments on RTV at TNRRI. AD36364 was planted in a field experiment with seven treatments with four replications arranged in a randomized block design. At 20 and 35 d after transplanting, ammonium chloride, ammonium sulfate, and urea were topdressed in equal splits at 50 kg N/ ha and diammonium phosphate and Zn sulfate were applied as foliar sprays at 3 and 5% concentration. Lime was applied between plant rows at 500 kg/ha. No insecticide was applied.

Effect of fertilizers, nutrients, and soil amendments on RTV infection, Aduthurai, India.

Treatment	RTV infection (%)		Yield (t/ha)
	Initial	Final	
Ammonium chloride (50 kg N/ha)	43	75	1.5
Ammonium sulfate (50 kg N/ha)	44	77	1.6
Urea (50 kg N/ha)	48	76	1.5
Diammonium phosphate (3% spray)	51	72	1.7
Zn sulfate (5% spray)	45	76	1.5
Lime (500 kg/ha)	48	78	1.5
Control (no treatment)	47	79	1.4

Percent RTV infection and yield are in the table.

Average RTV infection, assessed visually and by iodine test, increased uniformly in all treatments and reached 79%. There were significant differences in plant height. Plants that received diammonium phosphate and ammonium sulfate grew tallest. There were no significant differences in yield, but plots with diammonium phosphate yielded highest.

Chemical control of blast (Bl) in Punjab, Pakistan

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Bl caused by *Pyricularia oryzae* Cav. seriously damages rice in Punjab. To evaluate and demonstrate chemical control of Bl and generate adaptive research recommendations, we tested two chemicals at two application rates (see table) for Bl control in replicated experiments at AARF and three

Effect of fungicides on B1 incidence and rice yield, Punjab, Pakistan.[a]

Fungicide	Formulation (g/litre water)	One spray			Two sprays			Three sprays		
		% B1 incidence	Yield (t/ha)	Benefit-cost ratio[b]	% B1 incidence	Yield (t/ha)	Benefit-cost ratio	% B1 incidence	Yield (t/ha)	Benefit-cost ratio
Phthalide 30 WP	1.5	33 a	1.4 a	3.0:l	23 b	2.0 b	10.0:1	14 a	2.4 bc	10.4:l
Phthalide 30 WP	2.5	29 a	1.4 a	3.5:1	8 a	2.5 a	11.5:l	4 a	3.2 a	12.1:l
Kasugamycin 2 WP	1.5	48 b	1.3 a	1.2:l	30 b	1.9 b	8.4:1	23 b	2.2 c	8.7:1
Kasugamycin 2 WP	2.5	46 b	1.4 a	2.1:l	16 ab	2.1 ab	8.4:1	10 a	2.9 ab	9.8:1
Check	–	59 c	1.2 a	–	68 c	1.2 c	–	65 c	1.2 d	–
Cd_1	–	11	0.2	–	14	0.4	–	9	0.6	–

[a] Av of 4 trials. In a column numbers followed by common letters are statistically identical at 95% level of confidence. [b] Benefit-cost ratios were calculated by dividing extra benefits attained from the enhanced yield by the extra costs incurred for each treatment. The costs included fungicide price at $l0/kg, application costs ($2.25/spray). Benefits included the price of enhanced yield over that of the check @ $6/40 kg paddy.

farmers' fields in Sheikhupura District.

Basmati 370 was transplanted in 25.5-m^2 plots the first week of August. One, 2, or 3 sprays of 250 litres fungicide/ ha were applied in 3 replications. Phthalide 30 WP and kasugamycin 2 WP at 1.5 and 2.5 g/litre water were compared with the check. A single fungicide spray was applied 60 d after transplanting (DT). In trials with 2 or 3 applications, the first application was at 45 DT, with succeeding applications at 15-d intervals.

Leaf B1 incidence was recorded 10 d after the last spray by counting and calculating percentages of leaves with B1 lesions from five randomly chosen plants from each plot. Internodal and nodal Bl incidence was recorded at crop maturity from 2 randomly selected 1-m quadrats in each plot.

All treatments significantly reduced B1 incidence (see table). One spray did not significantly increase yield over that of the check, but two and three sprays did. Two and three applications had higher benefit-cost ratio than one application.

Chemical control of sheath blight (ShB)

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ShB caused by *Thanatephorus cucumeris* (Frank) Donk. is spreading in major rice growing areas in Thailand. There are few resistant varieties; therefore chemical controls are needed. In 1984, we tested 13 fungicides for ShB control at Bangkhen Rice Experiment Station. Susceptible RD7 was planted in 1.5- × 3-m plots in a randomized complete block design. Plants were inoculated at tillering by inserting a pack of mycelia grown on sterilized rice grain. Fungicides were sprayed 3 and 10 d later. Disease intensity was recorded 3 wk after inoculation by measuring lesion length on leaf sheaths of each tiller.

All fungicides significantly reduced disease intensity. Pencycuron 25% WP, Jingunmycin 5% liquid, validamycin 3% liquid, carbendazim 60% WP, and mepronil 75% WP, were most effective (see table).

Effectiveness of certain chemicals against ShB of rice.

Fungicide	Application rate (g ai/ha)	Lesion length (cm)
Pencycuron 25% WP	315	29.2 a
Jingunmycin 5% liquid	50	29.6 a
Validamycin 3% liquid	45	29.8 a
Carbendazim 60% WP	600	32.5 a
Mepronil 75% WP	1225	33.7 a
Iprodione 50% WP	500	39.5 b
Propiconazole 25% EC	250	41.3 b
Thiophanate-methyl 50% ULV	500	44.1 bc
Thiabendazol 90% WP	900	48.6 cd
Polyoxin + IBP 42% WP	630	49.7 d
Polyoxin Z 2.2% WP	33	56.9 e
Polyoxin D 2% WP	30	60.0 ef
Furmecyclox 40% WP	600	63.7 f
Control	0	73.5 g

CV = 7.0%

Sclerotia distribution of *Rhizoctonia solani* and its relation to sheath blight (ShB) in Arkansas rice fields

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We studied the relationship between inoculum density and ShB development and the factors that influence sclerotia distribution and density in rice fields.

Rice production fields with a history of severe ShB inzcidence were selected for sclerotia distribution studies. One-litre soil samples were taken 2-3 wk after rice emerged, but before permanent flooding, at 114-cm intervals and 1.5-cm depth.

Samples were air-dried in open pots and suspended in 2.5 litres of water for 5 min. The supernatant was washed through a 4-mm mesh sieve over 0.50-mm mesh sieve. The process was repeated with the material left in the pot, but with only 3 min suspension.

Sclerotia number per litre surface soil and diseased plants per 0.3 m^2 from fields with a history of ShB infection in Arkansas.

Variety	Year	Field	Position[a]	Samples (no.)	Sclerotia/litre			Diseased plants[b]/0.3 m^2		Field elevation (cm)
					Minimum	Maximum	Average	Maximum	Average	
STBN	1980	1		53	1	81	16.7	18	6.8	
STBN		2		40	4	29	12.8	28	8.7	
STBN		3		96	3	33	12.3	20	2.0	36
STBN		4		30	7	66	21.5	20	7.8	
STBN	1981	1		80	5	46	21.0	14	0.7	
STBN		2		50	0	22	7.0	10	0.6	
Mars		3		80	2	36	20.6	10	1.2	30
Mars		4		80	0	22	5.7	18	2.0	72
Mars		5		60	0	7	1.5	0	0	
STBN		6		80	0	85	32.2	33	14.7	90
STBN	1982	1	a	45	5	56	25.5	28	4.4	
STBN		1	b	45	0	20	4.1	28	4.4	

[a] = sclerotia in soil sample; b = sclerotia floating in water; STBN = Starbonnet. [b] Minimum no. was zero.

Material retained in the 0.50-mm mesh sieve was removed to a 250-ml plastic beaker, flooded onto another 0.50-mm mesh sieve, and washed and collected on filter paper in a Buchner funnel. Sclerotia were separated from debris and other fungal sclerotia by size, color, shape, and texture.

In 1982, floating sclerotia also were collected with all floating material within a 0.3-m^2 area using a fine-mesh screen. The material was poured onto filter paper and examined for presence of sclerotia.

When rice headed, disease incidence for each sample site was determined by counting the plants with ShB symptoms within 0.3 m^2.

Sclerotia population per litre of soil and number of diseased plants per 0.3 m^2 are in the table. In all fields surveyed in 1980 and 1982, higher sclerotia populations matched field margins. Three of four fields in 1980 and four of six in 1981 had more sclerotia at lower elevations.

Similarly, sites with many diseased plants had many sclerotia per 0.3- m^2 area. There were some exceptions, however. In 1980, one field with many sclerotia at a low elevation site had high disease incidence at high elevation but within the field edges. In 1981, a field with many sclerotia at a high elevation site had high disease incidence at low elevations.

When the number of diseased plants per 0.30 m^2 was regressed on the number of sclerotia per litre of soil for individual fields, no relationship was detected. However, when a regression was calculated among fields (with an average for each field), correlation coefficient was 0.15 in 1980 and 0.45 in 1981. No relationship was detected in 1982 when diseased plants per 0.30 m^2 was regressed with floating sclerotia per litre of soil and floating sclerotia per 0.3-m^2 water surface area.

Distribution of *Rhizoctonia solani* sclerotia and diseased rice plants followed a general pattern. There were more sclerotia and diseased plants at low elevations in each field. Because water flows from high to low elevation within fields and from levee gates to the whole length and width of bays during first flooding, it may be that the flow pattern carries sclerotia to low elevations and field margins. Spring storms and temporary flooding for soybean cultivation could cause similar results.

Soil was sampled before permanent flooding, and disease was rated at 2-cm internode elongation. Therefore, floating sclerotia could have moved in floodwater, thus resulting in the lack of relationship between average sclerotia per litre of soil and average diseased plants per 0.3 m^2. It may be for the same reason that there is no relationship between number of floating sclerotia and diseased plants. The fact that some fields had high inoculum concentration and few infected plants and vice versa may be due to differences in biotic and abiotic factors among fields.

Standardized test tube inoculation for bakanae disease (Bak)

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We attempted to standardize test tube inoculation for rapidly screening rice varieties for resistance to Bak caused by *Fusarium moniliforme.* Susceptible BR1 was used in two experiments to standardize spore concentration and seed-soaking duration. A sterile-water control was maintained in both experiments.

Twelve spore concentrations were evaluated (Table 1). Seeds were soaked

Table 1. Effect of spore concentration of *Fusarium moniliforme* on shoot and root elongation in rice, Joydebpur, Bangladesh.

Spore conc (thousand/ml)	Mean shoot length (cm)	Mean root length (cm)
0.0	6.4 e	4.5 ab
0.6	6.2 e	4.6 ab
1.2	6.4 e	4.9 a
1.8	6.4 e	4.5 ab
2.5	6.6 e	4.3 ab
3.0	7.1 de	4.9 a
6.0	8.5 d	4.8 a
31.0	10.7 c	5.5 a
62.0	12.5 b	5.0 a
125.0	15.2 a	4.5 ab
250.0	15.3 a	3.4 b
500.0	11.5 bc	0.9 c
LSD at 5%	1.3	1.2
CV (%)	8.1	17.0

for 48 h and 10 sprouted seeds were placed in each test tube and inoculated with 5 drops of the spore suspensions.

In experiment 2, seeds were soaked for 0, 24, 48, 72, or 96 h, and inoculated as above with a 125 × 10^3 spores/ml suspension (Table 2). Shoot and root length were recorded 7 d after inoculation with different spore concentrations and 10 d after inoculation with different seed soaking.

Shoot elongation was significantly higher with 31 × 10^3 spores/ml or more (Table 1). Maximum elongation was with 125 × 10^3 spores/ml with moderate root growth. Roots were shortest at 500 × 10^3 spores/ml. Results suggest the fungus may have released fusaric acid at higher spore concentrations. Soaking seeds for 48 h gave highest shoot elongation (Table 2).

To screen rices for Bak resistance, seeds should be soaked for 48 h and inoculated with 125 × 10^3 spores/ml.

Table 2. Effect of seed soaking duration before Bak inoculation on shoot and root elongation, Joydebpur, Bangladesh.

Treatment	Soaking period (h)				
	0	24	48	72	96
	Shoot length (cm)				
Control	7.1	7.2	8.5	8.2	9.8
Inoculated	10.6	12.8	20.6	19.3	18.9
	Root length (cm)				
Control	4.3	4.3	4.3	4.1	4.7
Inoculated	2.6	2.5	4.4	3.8	5.3

Effect of phosphorus on bacterial blight (BB)

P. Thyagarajan, K.M. Ramanathan, and V. Mariappan, Tamil Nadu Rice Research Institute, Aduthurai, India

BB at different intensities damages rice in Tamil Nadu. We studied the effect of P on BB. ADT36 was planted and monocalcium phosphate, diammonium phosphate, and rock phosphate were applied at 0, 22, and 44 kg P/ha, with or without 7.5 t farmyard manure and 10 t green manure/ha.

At flowering, BB incidence was 5 on a 0-9 scale in all treatments. The number of diseased tillers, however, varied among treatments (see table). Plots with monocalcium phosphate, alone or with organic manures, had more infected tillers than plots with diammonium phosphate or rock phosphate. Plots with diammonium phosphate and green manure had more infected tillers than those with rock phosphate. Treatments with P fertilizer had more grains per tiller, less chaffiness, and higher 1,000-grain weight.

Effect of P fertilizer [a] on BB, Aduthurai, India.

P source and parameters	0 kg P/ha			22 kg P/ha			44 kg P/ha		
	No M	With FYM	With GM	No M	With FYM	With GM	No M	With FYM	With GM
Monocalcium phosphate									
BB-infected tillers (no.)	33	27	56	30	24	47	32	40	59
Filled grains per tiller (no.)	59	68	62	61	76	62	62	77	66
Chaff (%)	37	34	32	37	28	34	35	21	38
1,000-grain wt (g)	20	21	22	22	21	33	26	22	33
Diammonium phosphate									
BB-infected tillers (no.)	28	22	31	47	56	47	58	59	53
Filled grains per tiller (no.)	59	66	64	63	78	64	60	85	67
Chaff (%)	36	33	35	31	29	35	26	26	31
1,000-grain wt (g)	21	20	26	22	22	36	26	22	36
Rock phosphate									
BB-infected tillers (no.)	28	27	26	26	32	40	27	33	39
Filled grains per tiller (no.)	66	66	64	66	78	74	69	80	78
Chaff (%)	36	34	35	27	31	33	30	28	31
1,000-grain wt (g)	20	20	25	22	23	35	26	23	35

[a] M = organic manure, FYM = farmyard manure, GM = green manure.

Blast (Bl) epidemic in Chitwan Valley, Nepal

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B1 caused by *Pyricularia oryzae* is a serious problem in Nepal. In May-Jul 1985, we surveyed farmers' rice nurseries in Chitwan District for B1 incidence.

Weather conditions favored B1 during the nursery period. Average monthly maximum and minimum temperatures were 30 and 23°C, with 95% average relative humidity. B1 infection, calculated by number of infected seedlings, was 75-100% in late Jun in Saradanagar, Rampur, Kiranganj, Mangalpur, and Ratnanagar. High yielding Masuli was grown in almost all the surveyed areas.

Individuals, organizations, and media are invited to quote or reprint articles or excerpts from articles in the IRRN.

Effect of planting date on tungro virus (RTV) incidence

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We studied the effect of planting date on RTV incidence in 1984-85 kharif. The field trial was in randomized block design with four replications and seven treatments. Twenty-five-day-old IR50 seedlings were planted in 9-m^2 plots at 20- × 10-cm spacing at 10-d intervals beginning 20 May. Plots received a basal 50-11-41.5 kg NPK/ ha and 50 kg N/ ha was topdressed in equal splits 15 and 35 days after transplanting (DT). No plant protection measures were taken.

RTV incidence at 45 DT by the *Standard evaluation system for rice,* green leafhopper (GLH) collected in a light trap from 0 to 30 DT, and grain yield were recorded (see table). Early plantings had lowest RTV incidence. Jun-Jul crops were severely infected and yielded low. There was a large GLH outbreak in Jul and Aug.

Effect of planting time on RTV incidence, 1984-85 kharif, Tirur, India.

Planting date	GLH light trap catch (no.) 0-30 DT	RTV (%) 45 DT	Yield (t/ha)
20 May 1984	381	2	3.1
30 May	936	3	4.0
10 Jun	39,453	51	2.2
20 Jun	54,625	65	1.7
30 Jun	151,496	74	0.8
10 Jul	170,158	82	0.6
20 Jul	160,400	86	0.9

Bacterial blight (BE) pathotype in Haryana

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BB caused by *Xanthomonas campestris* pv. *oryzae* occurs in kresek and blight forms in Haryana. The blight form is most serious in Kurukshetra, Karnal, and Ambala Districts. Two BB pathotypes have been identified at the All India Coordinated Rice Improvement Project, Hyderabad.

We sought to identify the BB pathotype in Haryana. In 1982-84, BB differential varieties were inoculated with naturally occurring BB inoculum by clipping. Disease incidence was recorded 14 d after inoculation using the *Standard evaluation system for rice.* Reactions indicated that pathotype 1 is dominant (see table).

Reactions[a] of BB differentials to BB isolates, Kaul, India.

Variety	Known reaction to		Reaction			
	Pathotype I	Pathotype II	Blight, 1982	Blight, 1983	Kresek, 1984	Blight
CAS209	–	–	S	S	S	S
DV85	R	S	R	MR (5)	MR (5)	–
IR1545-339-2-2	MS-S	S	S	S	S	S
IR20	MS-S	S	S	–	S	S
IR8	S	S	S	S	S	S
Jaya 14	–	–	S	S	R	S
Kinmaze	–	–	S	S	MS	–
Kogyoku	S	S	R	R	–	S
TN1	S	S	S	S	S	S
Nigeria 5	–	–	R	S	R	–
Tetep	–	–	–	MR (5)	S	S
Wase Aikoku	S	R	S	–	–	S
Malagkit Sungsong	MS-S	R	–	–	–	S
Cemposelak	MS-S	R	S	–	–	S
Chugoku 45	S	R	–	–	S	S
Sayaphal	R	R	–	–	–	R

[a] All India Coordinated Rice Improvement Program results; – = not tested, R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible.

Pest Control and Management
INSECTS

Interspecific hybridization between four green leafhopper (GLH) species

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We studied interspecific hybridization between temperate *Nephotettix cincticeps* (NC) and three tropical GLH species: *N. virescens* (NV), *N. nigropictus* (NN) and *N. malavanus* (NM). Insects were reared on susceptible Nipponbare, at 25° C.

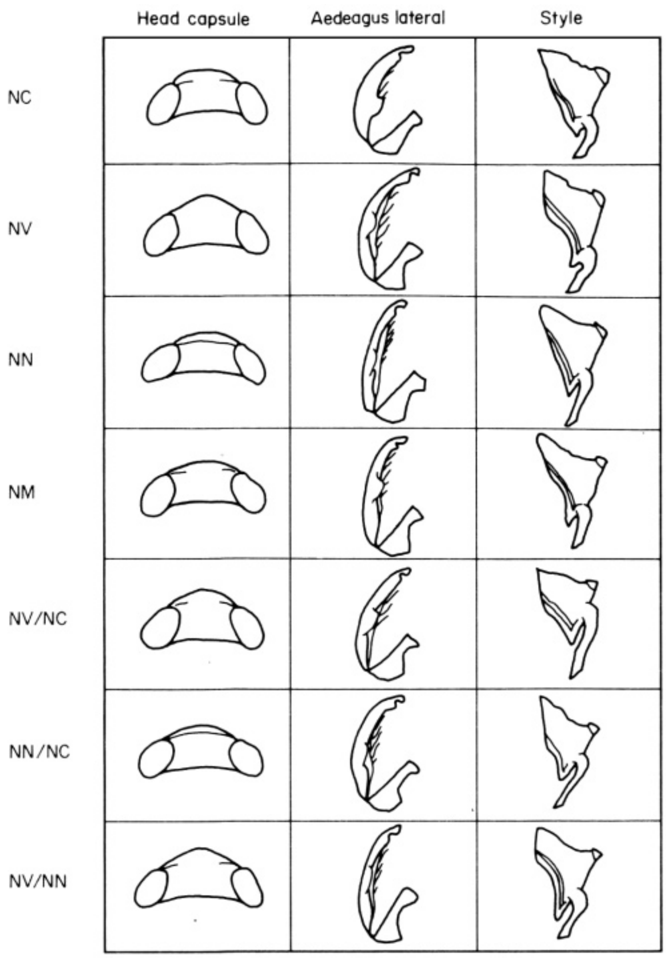
Direct and reciprocal crosses were made by placing a pair of newly emerged adults of 2 species inside a 20- × 170-mm test tube with a 30-d-old rice seedling. Eggs laid were counted and incubated on moist filter paper in a petri dish, and nymphs that hatched were reared individually until adults emerged. External and internal morphological characters of emerged adults were compared with those of the parents.

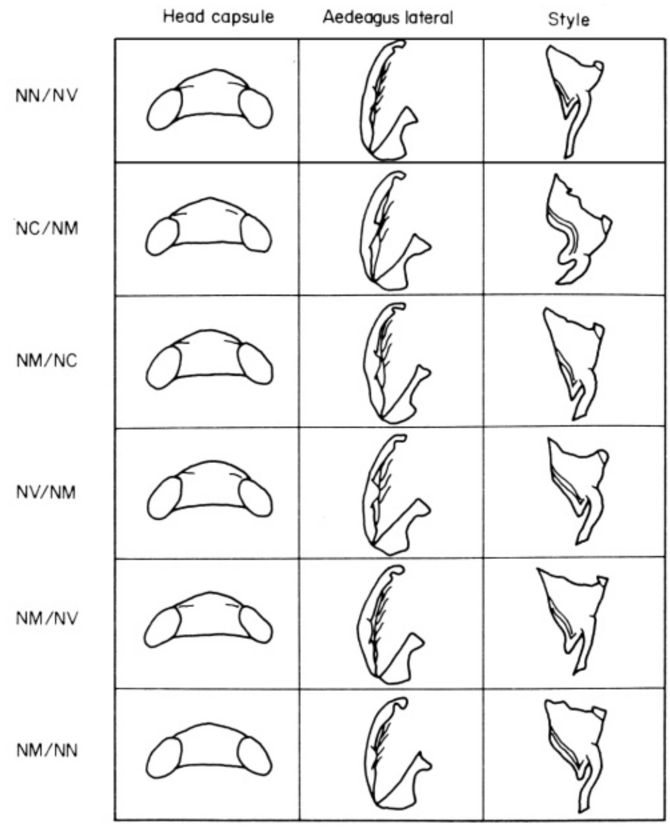
Among parental crosses, NV laid the most eggs, but NM eggs had highest

Fertility of interspecific crosses between 4 GLH species, Kyoto, Japan.

Cross Female/male [a]	Total eggs laid	Total eggs hatched	Hatching (%)
NC/NC	92	87	94
NV/NV	118	111	94
NN/NN	93	87	93
NM/NM	81	84	96
NV/NN	38	26	68
NN/NV	36	7	19
NV/NC	49	30	61
NC/NV	14	0	0
NV/NM	80	13	16
NM/NV	42	11	26
NN/NC	27	4	15
NC/NN	25	0	0
NN/NM	18	0	0
NM/NN	58	12	21
NC/NM	48	9	19
NM/NC	45	10	22

[a] NC = *N. cincticeps,* NV = *N. virescens,* NN = *N. nigropictus,* NM = N. malayanus.





Morphology of the head capsule and male genitalia of 4 GLH species and their interspecific hybrids. NC = *N. cincticeps,* NV = *N. virescens,* NN = *N. nigropictus,* NM = *N. malayanus.*

hatchability percentage (see table). Of 12 interspecific crosses, 9 produced hybrid progeny. Females from crosses with NC females and NN and NV males and crosses between NN females and NM males laid sterile eggs. Hatching percentage was generally low among interspecific crosses. Eggs from crosses of NV females and NN males had the highest hatchability percentage (68%). Although crosses of NV females and NC males had 61% hatching percentage, the reciprocal cross produced no fertile eggs.

The figure compares external morphology of the head capsule and the internal structure of the aedeagus and style of the male genitalia of hybrid adults with those of their parents. Hybrid external morphology and genitalia were intermediate between those of the parents.

Intraspecific and interspecific feeding of whitebacked planthopper (WBPH) predators

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In rice ecosystems, predators help keep WBPH *Sogatella furcifera* (Horvath) populations below economic thresholds. Major predators include wolf spider *Lycosa pseudoannulata* Boes et Str. (Lycosidae: Araneae), mirid bug *Cyrtorhinus lividipennis* Reuter (Hemiptera: Miridae), ladybird beetle *Synharmonia octomaculata* (F.) (Coleoptera: Coccinellidae), and rove beetle *Paederus fuscipes* Curt. (Coleoptera: Staphylinidae).

Because predators feed on more than one insect species, we studied the extent to which the four adult predators feed on their own species. Each test lasted 5 d. Mortality of predators and prey was recorded daily, and dead insects were replaced after each observation.

When 10 *L. pseudoannulata* were caged together, they were cannibalistic and had 24% mortality. When 10 *C. lividipennis, S. octomaculata,* or *P. fuscipes* were caged with 1 *L. pseudoannulata,* the spider killed 60% of the *C. lividipennis* but no *S.*

Feeding rate per day of adult predator on fourth-instar WBPH,[a] IRRI, 1985.

Predator	Predators released (no.)	*S. furcifera* mortality/ predator per day
Lycosa pseudoannulata	1	5.9 a
Cyrtorhinus lividipennis	5	1.4 d
Synharmonia octomaculata	3	2.4 b
Paedems fuscipes	5	1.9 c
Check	–	0.2 e

[a] In a column, means followed by a common letter are not significantly different at 5% level by DMRT. Av of 5 observations recorded daily and 4 replications. Sixteen WBPH nymphs were released with a mouth aspirator. Dead predators and prey were replaced daily after each observation.

octomaculata or *P. fuscipes.* Except for the spider, no predator was cannibalistic. When 1 spider was caged with 10 *C. lividipennis* and 10 WBPH, *C. lividipennis* had 41% mortality and WBPH only 27%.

We also studied the feeding activity of the predators on WBPH. *L. pseudoannulata* ate the most (5.9) WBPH per day (see table). Feeding rate of the other predators ranged from 1.4 to 2.4 WBPH per day.

These laboratory studies were under conditions that may differ from those in the field, and only adult stages were tested. In the field, it is likely that intraspecific and interspecific predation also occurs at immature stages.

Effect of custard apple oil, neem Oil, and neem cake on green leafhopper (GLH) population and on tungro (RTV) infection

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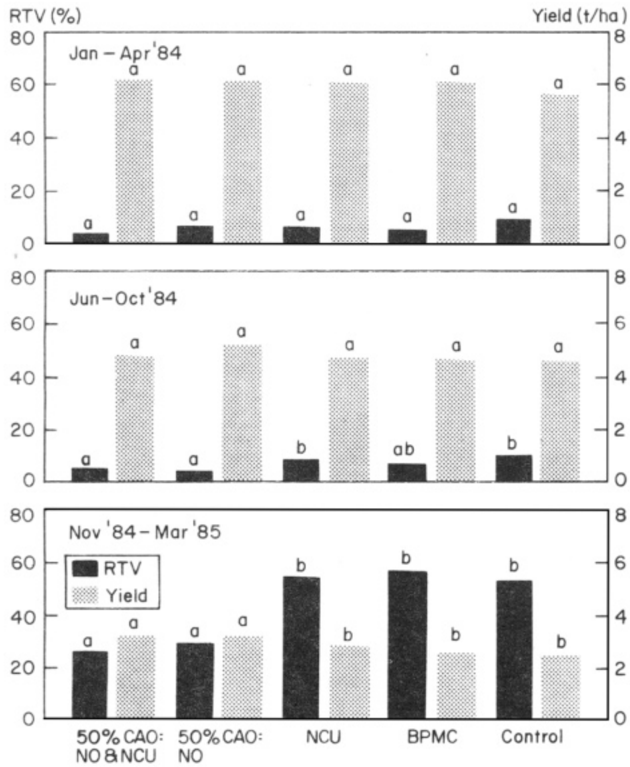
In laboratory studies at IRRI, mixtures of seed oils of custard apple *Annona squamosa* L. and neem *Azadirachta indica* A. Juss were significantly more effective in reducing GLH survival and its transmission of RTV than spray application of individual oils.

In field trials, we sprayed a 1:4 (vo1:vol) mixture of custard apple and neem seed oils at 50% concentration on RTV-susceptible IR42 plants. The mixture was applied with an ultralow-volume applicator at weekly intervals from seedling to maximum tillering stages at 8 litres/ha. A 3:10 (weight:weight) neem cake-urea mixture also was applied at 60, 30, and 30 kg N/ha at seedling stage, maximum tillering, and panicle initiation. The treated control was sprayed with BPMC at 0.75 kg ai/ha and the untreated control with the emulsifier at weekly intervals from seedling to maximum tillering.

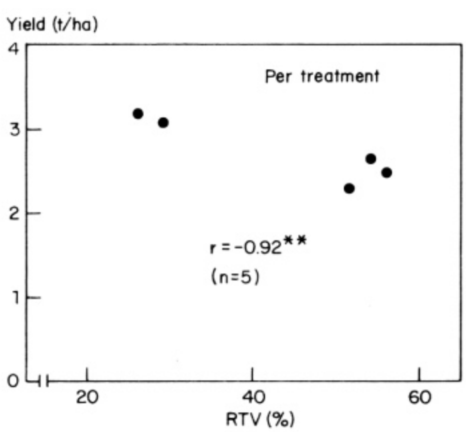
For three consecutive croppings in 1984-85, IR42 treated with the oil mixture alone or in combination with neem cake + urea had relatively low GLH populations, consistently low RTV infection, and high yields (Fig. 1). At 9% RTV infection in Jun-Oct 1985, plants with the oil mixture alone or with neem cake + urea had significantly less RTV infection than the untreated control, but yields were not significantly different.

At ³ = 50% RTV infection in Nov 1984-Mar 1985, test plants yielded significantly higher and had markedly lower RTV infection when they received the oil mixture alone or neem cake + urea than the insecticide-treated and the untreated controls.

The positive correlation between RTV infection and yield (Fig. 2) during this cropping period indicates that the level of RTV infection was the major yield determinant and that either the oil mixture alone or oil + neem cake + urea effectively controlled the vector and the disease. Neem cake + urea alone was ineffective.



1. Comparison of yield and RTV infection in field plots planted to RTV-susceptible IR42 and treated with either custard apple oil and neem oil (CAO:NO), neem cake + urea (NCU), their combination (CAO:NO and NCU), BPMC, or a detergent-water solution (control). Average of 4 replications. Means followed by a common letter are not significantly different at the 5% level by DMRT. IRRI, 1984-85.



2. Correlation between RTV and yield for the Nov 1984-Mar 1985 crop, IRRI.

Activation of prophenol oxidase enzyme by brown planthopper (BPH) in response to insecticide

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It has been proposed that the prophenol oxidase activation system of insects recognizes pathogens such as bacteria and fungi because it is activated by the lipopolysaccharide from bacteria and B-1, 3 glucan from fungus cell walls.

Adult brachypterous BPH *Nilaparvata lugens* were collected from pots and anesthetized with chloroform. Haemolymph was collected in 0.01 M phosphate buffer by pressing the BPH under a cover glass. Clumped cells and plasma were separated and homogenized in 0.01 M phosphate buffer. The homogenate contained prophenol oxidase.

The effect on prophenol oxidase of insecticides BHC and carbaryl and known activator chymotrypsin (Sigma) was observed. We incubated 100 μl of the enzyme source with 100 μl of the insecticides (1 mg/ ml dissolved in 0.01 M phosphate buffer). The reaction mixtures were incubated for 30 min and 100 μl of 10 mM substrate dihydroxy phenyl alanine (Sigma) was added. Enzyme activity was measured at 480 nm after adding 1.7 ml of 0.01 M phosphate buffer. An appropriate blank and control were maintained. BHC, chymotrypsin (1 mg/ml), and carbaryl were tested separately for activation capacity.

BHC had greater activating capacity than carbaryl, and chymotrypsin more than the insecticides (see table). Thus, a preliminary defense mechanism is set up against the stress caused by insecticide application.

Prophenol oxidase activation by carbaryl, BHC, and chymotrypsin, Coimbatore, India.

Activator	Prophenol oxidase activity (OD/mg protein per 30 min)
Carbaryl	0.186
BHC	0.244
Chymotrypsin	0.337

[a] Values were confirmed by 3 different determinations.

Mass rearing *Tyrophagus palmarum*

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Tyrophagus palmarum Oudemans (Acaridae: Astigmata) mite infests rice seedlings and leaf sheaths in the nursery and field. We developed a mass rearing technique to provide enough *T. palmarum* mites for biological studies.

Oatmeal agar (OMA) medium with 4% oatmeal, 2% agar agar, and 2% sucrose was prepared and autoclaved at 15 lb pressure for 30 min. Ten ml of the medium was poured into sterile 5-cm petri plates. Each petri plate was inoculated with *Fusarium moniliforme* and kept at room temperature (26±3°C). When petri plates were covered with fungus mycelia, two newly emerged female mites were released on the fungus and incubated in darkness at 85 ± 3% relative humidity and room temperature 26 ± 6°C. F1 progeny developed after 12 d and adults and juveniles were counted. Two subsequent generations also were counted (see table).

The mite generally reproduces parthenogenetically and produces mostly females. Mite population was highest in the 2d generation and declined thereafter, as more fungus was eaten. The culture can be continued by inoculating freshly prepared fungi in the petri plates.

To select the best growth medium and standardize the rearing technique, we screened 10 culture media: oatmeal agar 2% and 4%, peptone 2% and 4%, malt extract 2% and 4%, potato dextrose agar, nutrient agar, Elliott's agar, and Czapek's Dox agar. Oatmeal agar 4% was the most suitable medium for fungus and mite multiplication. *F. moniliforme* produced higher mite populations than *Curvularia* sp., *Alternaria padwickii, Aspergillus niger,* and *Helminthosporium oryzae.*

Cultured mites were tested for the ability to infest. When adult mites were released on l0-d-old potted Karuna seedlings, symptoms (yellowing and drying) developed 15 d later and were similar to those that developed under natural conditions.

Juvenile and adult populations[a] of *T. palmarum* mite in 3 generations, Cuttack, India.

Generation no.	Eggs (no.)	Larvae (no.)	Nymphs (no.)		Adults (no.)
			Protonymphs	Deutonymphs	
1	36	8	10	24	167
2	153	73	46	96	864
3	28	12[b]	93[b]	641[b]	3

[a]Av of 10 replications. [b]Inactive forms.

Host plant range of the planthopper *Nisia atrovenosa*

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The planthopper *Nisia atrovenosa* lives on weedy bunds of irrigated transplanted rice in Koronadal, South Cotabato, Mindanao. Its host range is unknown; its pest status is not understood. We studied the growth and longevity of *N. atrovenosa* on different weed species and rice. Growth was measured as the percentage of nymphs that reached adulthood and their growth period.

N. atrovenosa has a limited host range. It was successfully reared on *Cyperus rotundus* and *C. iria* (see table). More nymphs reached adult stage on *C. rotundus* than on *C. iria,* suggesting that *C. rotundus* may be the planthopper's main host. Development stopped at the first nymphal instar on *Digitaria ciliaris, Brachiaria distachya, Cynodon dactylon, Leersia hexandra, Paspalum distichum,* and *Leptochloa chinensis,* and at the second nymphal instar on *Fimbristylis miliacea, Echinochloa glabrescens, Eleusine indica,* and *Oryza sativa.* On *C. compressus* and *C. brevifolius,* it developed to a late nymphal stage but did not reach adulthood.

Results suggest that *N. atrovenosa* is not a rice pest. This was further

Development of *N. atrovenosa* on different host plants[a], South Cotabato, Philippines, 1985.

Host plant	Nymphs becoming adults (%)	Developmental period (d)	Nymphal longevity[b] (d)
C. rotundus	85	18	10.3 a
C. iria	40	19	18.7 a
C. compressus	–	–	13.7 b
C. brevifolius	–	–	12.6 b
Fimbristylis miliacea	–	–	4.5 c
Echinochloa glabrescens	–	–	5.0 c
Eleusine indica	–	–	5.3 c
Digitaria ciliaris	–	–	1 d
Brachiaria distachya	–	–	1 d
Cynodon dactylon	–	–	1 d
Leersia hexandra	–	–	1 d
Paspalum distichum	–	–	1 d
Leptochloa chinensis	–	–	1 d
Oryza sativa	–	–	4.7 c

[a]Av of 4 replications, 10 1st instars/replication. [b]Separation of means by Duncan's multiple range test at the 5% level.

confirmed in a trial where it died on 200 rice varieties from IRRI's germplasm collection. *N. atrovenosa* may significantly reduce *C. rotundus* growth, and has potential as a biocontrol agent for that weed.

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Field evaluation of commercial insecticides for controlling yellow stem borer (YSB) in the Philippines

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Most modern rices have low to moderate resistance to YSB *Scirpophaga incertulas.* Insecticides are needed to control high YSB populations. We evaluated commercial insecticides for YSB control in the IRRI greenhouse, and then tested them in fields at the MRRTC, which is a YSB hot spot in dry season (Dec-Mar).

In 1980, we evaluated 15 foliar sprays and 8 granular insecticides on susceptible IR29. A foliar spray of chlorpyrifos + BPMC controlled deadhearts most effectively; and endosulfan and azinphos ethyl effectively controlled whiteheads (Table 1). Granular treatments showed fewer deadhearts with carbofuran (Table 2). Diazinon also was effective up to 20 d after treatment. No treatment significantly decreased whiteheads.

In 1981, 15 insecticides were applied as sprays and 4 as granules. Carbofuran granules prevented deadhearts most effectively and triazophos effectively controlled whiteheads (Table 3).

Table 1. YSB control with 15 foliar sprays, MRRTC, Philippines, 1980 DS.[a]

Treatment[b]	Deadhearts (%) 20 DT	Deadhearts (%) 40 DT	Whiteheads (%) 115 DT
Chlorpyrifos + BPMC 3 1.5 EC	6.9 a	2.8 a	4.8 ab
Monocrotophos 16.8 EC	7.3 ab	12.8 cd	3.2 ab
Endosulfan 35 EC	9.1 abc	14.9 cde	2.6 a
Fenthion 50 EC	9.8 abc	12.6 cd	3.6 ab
Carbophenothion 40 EC	9.9 abc	17.0 cdef	4.4 ab
B. thuringiensis	10.2 abc	18.1 def	5.6 ab
Diazinon 20 EC	10.5 abc	15.8 cdef	2.6 a
Phosphamidon 50 EC	10.7 abc	7.7 b	3.3 ab
Phosmet 50 WP	10.9 abc	19.7 ef	4.9 ab
Azinphos ethyl 40 EC	11.1 abc	11.1 bc	2.5 a
Fenitrothion 30 EC	11.1 abc	12.1 bcd	4.6 ab
Metalkamate 23 EC	11.3 abc	15.3 cdef	6.7 b
Dimethoate 40 EC	12.2 abc	16.7 cdef	5.2 ab
Untreated check	13.1 abc	22.6 f	3.9 ab
Methomyl 19.8 EC	13.4 abc	17.0 cdef	3.0 ab
BPMC 50 EC	14.4 c	14.6 de	5.2 ab

[a]Av of 4 replications. Separation of means in a column by DMRT at the 5% level. DT = days after transplanting. [b]All insecticides were applied at 0.75 kg ai/ha except *B. thuringiensis,* which was applied at 0.4 kg formulation (600 IU/mg) per ha. Insecticides were applied at 10, 25, 45, 60, and 75 DT.

Table 2. YSB control with granular insecticides,[a] MRRTC, Philippines, 1980 DS.

Treatment[b]	Rate (kg ai/ha)	Deadhearts 20 DT	Deadhearts 40 DT	Whiteheads (%) 115 DT
Carbofuran 3 G (SI)	1.0	1.4 ab	0.2 a	3.7 a
Carbofuran 3 G	1.0	1.0 ab	0.7 a	3.0 a
Gamma BHC + carbaryl 6 + 6 G	1.0	3.5 bc	11.6 d	4.6 a
Diazinon 5 G	1.0	0.6 a	5.4 bc	4.2 a
Gamma BHC + MIPC 6 + 4 G	1.0	1.9 ab	7.2 cd	5.0 a
Carbofuran 3 G	1.5	0.3 a	0.1 a	3.2 a
Gamma BHC + carbaryl 8 + 8 G	1.5	5.6 c	5.9 bc	3.4 a
Diazinon 5 G	1.5	0.9 a	3.5 b	4.4 a
Gamma BHC + MIPC 6 + 4 G	1.5	4.7 c	5.6 bc	3.0 a
Control	–	6.1 c	18.0 e	3.8 a

[a]Av of 4 replications. Separation of means in a column by DMRT at the 5% level. [b]All treatments were applied to field water, except one treatment of carbofuran, which was soil incorporated (SI) before transplanting. Insecticides were applied at 10, 25,45, 60, and 75 d after transplanting (DT).

Table 3. YSB control with insecticides,[a] MRRTC, Philippines, 1981 DS.

Treatment[b]	Application method	Deadhearts (%) 20 DT	Deadhearts (%) 40 DT	Whiteheads (%)
Chlorpyrifos + BPMC	Spray	11.1 a	8.1 bc	7.5 cd
Triazophos	Spray	12.1 ab	8.4 b	1.7 a
Diazinon	Spray	14.2 abc	24.0 def	5.8 abcd
B. thuringiensis[c]	Spray	15.0 abc	32.1 fgh	6.1 abcd
Acephate	Spray	15.5 abcd	16.9 cde	3.8 abc
Azinphos ethyl	Spray	17.5 abcde	11.9 bcd	5.9 abcd
UCX 2001	Spray	18.4 abcdef	9.7 bc	4.6 abc
Monocrotophos	Spray	20.3 abcdefg	31.4 fgh	4.4 abc
Aktrion	Spray	23.8 bcdefg	36.2 fgh	7.9 cd
Phosphamidon	Spray	25.1 cdefg	29.7 fgh	7.0 bcd
MTMC	Spray	27.8 defg	31.4 fgh	7.0 bcd
Carbaryl XLR	Spray	29.3 efg	38.5 gh	6.1 abcd
Propoxur	Spray	29.7 efg	29.9 fgh	14.7 d
MIPC	Spray	29.8 efg	34.3 fgh	7.3 bcd
Endosulfan	Spray	31.0 efg	25.5 defg	7.3 bcd
BPMC	Spray	32.1 g	28.8 fgh	7.3 bcd
Carbaryl	Spray	33.7 g	26.8 efg	4.8 abc
Carbofuran	Granular broadcast	10.8 ab	0.6 a	1.9 ab
Diazinon	Granular broadcast	17.2 abcde	33.1 fgh	7.2 cd
Gamma BHC + carbaryl	Granular broadcast	25.1 cdefg	35.1 fgh	8.3 cd
Gamma BHC	Granular broadcast	27.8 cdefg	40.6 h	7.4 cd
Endosulfan	Granular broadcast	30.7 fg	32.8 fgh	5.4 abc
Untreated check		32.3 g	38.9 h	7.7 cd

[a] In a column, means followed by a common letter are not significantly different at the 5% level by DMRT. [b] Insecticides were applied at 10, 25, 45, 60, and 75 d after transplanting (DT). All were applied as foliar spray except for the granular formulations which were broadcast into the field water. Sprays were applied at 0.75 kg ai/ha and granules at 1.0 kg ai/ha. [c] 30 billion spores/g.

Results show that spraying chlorpynfos + BPMC and broadcasting triazophos and carbofuran granules on field water or incorporating them in soil provide the most effective YSB control. Soil incorporation of carbofuran before transplanting is the most efficient way to control deadhearts as only one application is required. But because it provides no control at whitehead stage, it may be necessary to spray triazophos or another insecticide for whitehead control.

Pest Control and Management
WEEDS

Herbicides for weed control in transplanted rice

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In the hill region of Karnataka, India, labor for manual weeding is scarce and expensive. Labor costs are $1-1.25/d. Hence, manual weeding has become a problem. We evaluated herbicides for weed control in rice in 1983 kharif at RRS, Mudigere. Six herbicides at 2 application rates were compared with an unweeded check and hand weeding on 20 and 40 d after transplanting. The experiment was in a randomized block design with three replications. Herbicides were evenly mixed in sand and applied 2 d after planting.

Weeds were *Echinochloa colona, Cyperus iria, Rotala indica, Scheonopectum corymbosus, Zizania* sp., *Geissaspis tenella, Eriocaulon hookerianum, Pennisetum* sp., *Sacciolepis interrupta, Eragrostis unioloides,* and *Paspalum conjugatum.*

Butachlor 1.0 kg ai/ha, thiobencarb 1.75 and 2.00 kg ai/ha, and pendimethalin 1.75 kg ai/ha controlled weeds most effectively (see table). Weed dry weights in those treatments were 0.18 to 0.25 g/m^2 and were comparable. The treatments also had significantly higher grain yield than the unweeded check. Weeds signicantly reduced plant height, straw yield, and effective tillers. In the unweeded check, plant height was 60 cm, yield 6.5 t/ha, and effective tillers/plant 7. In treated plots they varied from 77 to 81 cm, 8.3 to 9.7 t/ha, and 10 to 13 tillers/plant. Oxyfluorfen was toxic to rice.

Herbicides for weed control in transplanted rice, Karnataka. India.

Treatment	Rate (kg ai/ha)	Grain yield (t/ha)	Weed dry weight (g/m^2) at harvest
Thiobencarb	2.00	5.8	0.2
Butachlor	1.25	5.1	0.5
Oxyfluorfen	0.12	5.5	2.3
Hand weeding 20 and 40 d after planting	–	5.5	0.2
Anilofos	0.50	5.4	1.o
Oxadiazon	0.50	5.2	1.7
Pendimethalin	2.00	5.2	1.1
Pendimethalin	1.75	5.1	0.2
Anilofos	0.40	5.1	2.4
Oxadiazon	0.40	5.1	1.2
Thiobencarb	1.75	5.0	0.2
Butachlor	1.00	4.8	0.2
Oxyfluorfen	0.09	4.7	3.5
Unweeded check	–	4.4	58.2
CD 5%		0.2	0.3

Lowland rice field weeds in Nueva Ecija, Philippines

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We surveyed rice field weeds in barangays Malimba, Mangino, Santa Cruz, and Santo Cristo Norte of Gapan, Nueva Ecija, in Feb 1984. Seventy-eight randomly selected fields were visited during heading to flowering after weed control; 66 were wet seeded (pregerminated seed sown on puddled soil) and 12 were transplanted. The percentage cover was determined visually for all weed species.

Twenty-six weed species of 21 genera and 13 families were identified (see table). Fifty percent of the weed species belonged to Poaceae and Cyperaceae. Seventeen species were found in transplanted rice and 25 in wet seeded rice; 16 were common to both cultures. *Echinochloa colona* was the only species in transplanted rice that was not found in wet seeded rice.

E. glabrescens was observed in all the fields surveyed. *Monochoria vaginalis* occurred in 77% of the fields, *Fimbristylis miliacea* in 59%, and *Paspalum distichum* in 58%. For three of these species, infestation was greater in wet seeded than in transplanted rice.

In addition to weed species that commonly occur in wet seeded and transplanted rice, we identified the following potential problem weeds: *Scirpus supinus, Lindemia anagallis,* and *Marsilea minuta.*

Percentage of fields[a] infested with weeds and the severity of infestation in transplanted and wet seeded rice in Gapan, Nueva Ecija, Philippines.

Weed species	Family	Transplanted (12)		Wet seeded (66)	
		Fields infested (%)	Cover (%)	Fields infested (%)	Cover (%)
Echinochloa glabrescens Munro ex Hook. f.	Poaceae	100	9	100	21
Monochoria vaginalis (Burm. f.) Presl	Pontederiaceae	92	7	74	12
Fimbristylis miliacea L.	Cyperaceae	50	8	61	18
Paspalum distichum L.	Poaceae	50	7	59	6
Scirpus supinus L.	Cyperaceae	8	45	56	21
Ludwigia octovalvis (Jacq.) Raven	Onagraceae	50	1	39	2
Lindernia anagallis (Burm. f.) Pinnell	Scrophulariaceae	25	39	42	12
Eclipta alba (L.) Hassk.	Asteraceae	33	<1	24	7
Cyperus difformis L.	Cyperaceae	17	3	30	3
Cyperus rotundus L.	Cyperaceae	17	<1	26	14
Marsilea minuta L.	Marsileaceae	33	18	21	22
Cyperus iria L.	Cyperaceae	33	11	21	4
Hedyotis corymbosa (L.) Lam.	Rubiaceae	17	21	21	10
Sphenoclea zeylanica Gaertn.	Sphenocleaceae	8	<1	18	1
Paspalum scrobiculatum L.	Poaceae	–	–	14	4
Ischaemum rugosum Salisb.	Poaceae	–	–	9	6
Ipomoea aquatica Forsk	Convolvulaceae	8	<1	6	<1
Portulaca oleracea L.	Portulacaceae	8	15	6	<1
Eichhornia crassipes (Mart.) Solms	Pontederiaceae	–	–	8	2
Echinochloa colona (L.) Link	Poaceae	25	10	–	–
Echinochloa crus-galli (L.) Beauv. ssp. *hispidula* (Retz.) Honda	Poaceae	–	–	5	<1
Alternanthera sessilis (L.) Dc.	Amaranthaceae	–	–	3	17
Sphaeranthus africanus L.	Asteraceae	–	–	3	<1
Commelina diffusa Burm. f.	Commelinaceae	–	–	3	<1
Fimbristylis acuminata Vahl	Cyperaceae	–	–	2	<1
Fuirena ciliaris (L.) Roxb.	Cyperaceae	–	–	2	<1

[a] Number of fields surveyed is in parentheses.

Pest Control and Management
OTHER PESTS

Bird damage to rice in Visveswaraiah Canal Tract (VCT)

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Birds *Ploceus philippinus* L. (baya weaver bird), *P. manyar* Horsfield (streaked weaver bird), *Lonchura striata* L. (whitebacked munia), *L. malacca* L. (black-headed munia), *L. punctulata* L. (spotted munia), and *Estrilda amandava* L. (red munia) feed on rice grains in VCT, Mandya. We recorded bird populations, feeding rate, and habitat preference in rice fields in May-Jun 1985 and calculated the relative economic importance of each species.

Table 1. Feeding rate, flock size, and abundance of rice birds, VCT, Mandya,[a] India.

Bird	Feeding rate (pecks/min) ($\bar{x}$ ± SD)	Flock size (max - min)	Population (%)	Habitat preference
Streaked weaver bird	8.2 ± 2.4	46-15	69	Wet
Baya weaver bud	6.0 ± 0.9	17-4	8	Wet
Blackheaded munia	6.0 ± 1.7	33-14	19	Wet
Whitebacked munia	3.0 ± 1.0	3-2	<1	Dry
Spotted munia	2.5 ± 1.2	5-2	<1	Dry
Red munia	3.6 ± 0.8	9-3	3	Wet
CD at 5% by ‘F’ test	ns	ns	18	–

[a] Numbers in a column are ± of 15 observations recorded from fields adjacent to patches of marsh and sugarcane.

Streaked weaver bird, which prefers a wet habitat, was the most abundant and most serious pest (Table 1). Red munia was the least serious pest. Whitebacked munia and spotted munia preferred dry conditions, and caused little damage.

VCT has large areas of rice fields interspersed with sugarcane fields at a 5:1 ratio, and 0.5 to 1 ha marshy patcher covered with *Typha* sp. The patches of sugarcane and the marsh determined bird distribution and concentration because they provide roosting, nesting, and shelter. We therefore recorded panicle damage in rice fields at various distances from marshland and sugarcane fields. Table 2 shows that 35-37% of bird damage was within 10 m of sugarcane and marsh. Damage was greatest in rice immediately adjacent to sugarcane and marsh.

Table 2. Panicle damage[a] on rice fields at various distances from marsh and sugarcane, VCT, Mandya, India.

Time	Panicle damage (%)					
	Among fields[b]			Within a field[c]		
	< 10 m	10 to 20 m	> 20 m	Edge	Center	Rear
May 1985	37	0	0	45	<1	<1
May 1985	35	0	0	47	<1	<1

[a]At each location, ± panicle damage is from 15 randomly chosen units. [b]Distances from patches of marsh and sugarcane. [c]Edge = 4 rows adjacent to marsh or sugarcane plot; centre = in between edge and rear; rear = last 4 rows of rice from marsh or sugarcane.

Soil and Crop Management

Nutrient management in late kharif rice

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We studied nutrient management in late kharif rice at TNAU in 1975. Soil had pH 8.1, ECe 0.2 mmho/cm, low N, high P and K, 88 ppm Fe, and 4 ppm Zn. All plots received the recommended 120-26.4-50.4 kg NPK/ ha. The experiment was in split-plot design with IR8, IR20, and Bhavani each sown in main plots on 15 Aug, 1 Sep, and 15 Sep. Subplots were control, 30 kg N/ ha, 30-6.6 kg NP/ha, 50 kg ferrous sulfate/ ha, and 50 kg ferrous sulfate and 25 kg Zn sulfate/ha.

Grain yield decreased when sowing was later than 15 Aug (see table). The 15 Aug crop had greater leaf area index, longer panicles, and more filled spikelets than other crops. IR20 yielded more than Bhavani and IR8 in the 15 Sep sowing. Applying Fe and Zn increased yield 20% over that of the control. Sowing date and fertilizer application were not significantly interactive, indicating that grain yield of the 15 Sep crop would not reach that of the 15 Aug crop, even with additional fertilizer application.

Influence of sowing date, variety, and fertilization on grain grain in Tamil Nadu, India.

Sowing date	Variety	Yield (t/ha)					
		30 kg N	30 kg N 6.6 kg P	50 kg ferrous sulfate	50 kg ferrous sulfate 25 kg Zn sulfate	Control	Mean
15 Aug	IR8	4.5	4.3	3.9	4.4	3.5	4.1
	IR20	4.6	4.7	4.9	5.1	4.3	4.8
	Bhavani	5.0	5.0	5.0	5.5	4.7	5.0
	Mean	4.7	4.7	4.6	5.0	4.1	4.6
1 Sep	IR8	2.5	2.0	1.9	2.4	2.2	2.2
	IR20	2.8	2.6	2.9	3.0	2.5	2.8
	Bhavani	3.2	3.3	3.0	3.6	2.7	3.2
	Mean	2.8	2.6	2.6	3.0	2.5	2.7
15 Sep	IR8	0.9	0.9	1.0	1.4	0.8	1.0
	IR20	2.7	2.9	2.8	3.0	2.6	2.8
	Bhavani	1.7	2.1	1.8	2.2	1.9	1.9
	Mean	1.8	1.9	1.9	2.2	1.8	1.9

	CD (P = 0.05)
Sowing dates	216
Varieties	216
Ameliorative treatments	173
Sowing date × variety interaction	373

Sowing date for photoperiod-sensitive Caribe 7

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Caribe 7 grows in low-lying fields where deep water may prevent other varieties from being grown. It is photoperiod

Performance of Caribe 7 at different sowing dates, Havana, Cuba.

Date	Yield[a] (t/ha)
15 Apr	4.5 ab
15 May	4.4 b
15 Jun	5.5 a
15 Jul	2.5 c

[a]Means followed by a common letter are not significantly different (P = 0.05).

sensitive and is planted to mature when water recedes and soil begins to dry. We determined yield potential of Caribe 7 then sown on 15 Apr, 15 May, 15 Jun, and 15 Jul.

Yield increased slightly from the Apr to Jun plantings, after which it decreased sharply (see table). Caribe 7 flowered between 13 and 25 Oct, when there were about 7 sunshine hours, irrespective of planting date.

Response of lowland rice to zinc fertilizer

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We studied the effect of Zn sulfate on IR50 grain yield at TNRRI in Jun-Sep 1984. Soil was an alluvial clay loam (Adanur series) with 0.9 ppm available DTPA-extractable Zn, 35 meq cation exchange capacity, 100 g, and pH 6.9.

The experiment was in a randomized block design with three replications. Zn sulfate was incorporated at 0, 2.75, 5.75, 8.25, 11, 13.75, and 16.5 kg Zn/ha just before transplanting. Recommended NPK was applied.

Applying Zn significantly increased grain yield. IR50 responded up to 8.25 kg Zn/ha (see table).

Effect of Zn application on rice yield, Aduthurai, India.

Treatment (kg Zn/ha)	Grain yjeld (t/ha)
0	3.1
2.75	4.1
5.75	4.7
8.25	4.7
11	4.7
13.75	4.7
16.5	4.7
CD	0.2

Rice-Based Cropping Systems

Irrigated rice-based crop sequences for eastern Madhya Pradesh

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Rice is a major Jun-to-Oct crop in eastern Madhya Pradesh. Most land is fallow after rice, but some areas have assured irrigation. We evaluated different irrigated crops to follow rice in rabi (Nov-Apr) and summer (Mar-Jun) in 1981-82 and 1982-83 (Table 1,2). Soil was a clay loam. Medium-duration (125-130 d) Kranti and Asha were transplanted from Jul to mid-Aug. Rice received 80-23-25 kg NPK/ ha and yielded 44.5 t/ ha. Rabi crops were sown from mid-Nov to mid-Dec and harvested from mid-Mar to late Jun. Summer crops were planted from mid-Feb to mid-Mar and harvested from mid-May to mid-Jun. Fertilizer rates for rabi and summer crops are in the tables.

Cereals and vegetables also performed well. The study suggested that extending irrigation to the area could increase cropping intensity 200-300%.

Table 1. Grain and green pod yield of rabi and Summer season crops following rice, 1982-83, Bilaspur, India.

Crop sequence	Rabi Fertilizer (kg/ha) N	P	K	Rabi Yield (t/ha)	Summer Fertilizer dose (kg/ha) N	P	K	Summer Yield (t/ha)
Rice -wheat - mungbean	100	22	24.9	3.3	20	17.6	16.6	0.9
Rice - gram - okra	20	13.2	16.6	2.5	50	11	20.75	7.7 [a]
Rice -mustard - mungbean	20	13.2	0	0.7	20	17.6	16.6	1.2
Rice - arhar - cowpea	60	8.8	16.6	1.1	20	17.6	16.6	5.2 [a]
Rice - safflower - cowpea	60	17.6	0	1.0	20	17.6	16.6	4.2 [a]
Rice - potato - mungbean	150	35.2	33.2	39.0	20	17.6	16.6	1.3
Rice - onion - mungbean	100	22	83	31.0	20	17.6	16.6	0.9
Rice - garlic - mungbean	100	22	83	6.2	20	17.6	16.6	1.2
Rice - chili (Jawla)	125	22	41.5	18.7	20	17.6	16.6	–
Rice - chili (Japanese longi)	125	22	41.5	10.3	20	17.6	16.6	–

[a] As green vegetable.

Table 2. Grain yield of rabi season crops following rice, Bilaspur, India.

Crop sequence	Fertilizer dose (kg/ha) N	P	K	Yield (t/ha) 1981-82	1982-83
Rice - wheat	100	22	24.9	3.4	2.4
Rice - cotton	60	13.2	12.45	1.8	2.0
Rice - groundnut	20	13.2	16.6	2.4	3.0
Rice - maize	100	22	24.9	3.2	3.3
Rice - sorghum	80	17.6	24.9	1.9	2.6
Rice - black soybean	20	35.2	16.6	1.0	1.7
CD (0.05%)				0.5	0.6

Announcement

The following new IRRI publications are available for purchase from the Communication and Publications Department, Division R, IRRI, P.O. Box 933, Manila, Philippines.

- *A farmer's primer on growing rice* (Chinese, Thai, Pangasinan, Waray, and Kishiwahili eds.)
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- *Research highlights 1985*

ERRATUM

J. Singh, H.R. Kapusas, and A. Romena. Reaction of rices to *Sogatella furcifera* in free-choice and no-choice seedling bulk tests. 10 (6) (Dec 1985), 14. In the third column, sentence 2 of the last paragraph should read "ADR52 damage rating was lowest (3), but was statistically comparable with that of IR2035-117-3 (4)."

The International Rice Research Institute
P.O. Box 933, Manila, Philippines

ISSN 0115–0944