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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- Do not cite references or include a bibliography.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

Lateefy, a new aromatic semidwarf rice

I. M. Bhatti, director, and A . A. Soomro, rice botanist, Rice Research Institute (IRRI), Dokri, Pakistan

In 1983 Pakistan released Lateefy, an aromatic semidwarf rice, for general cultivation in Sind Province. It was developed at the RRI in Dokri. It is expected to replace local tall, scented Sugdasi and Basmati rices.

Lateefy is from a cross between IRRI line IR760-A1-22-2-3 and Basmati 370, a tail, scented variety from Punjab. Selection emphasized semidwarf plant type, grain characters, aroma, and early maturity. The selected line (IR760-A1-22-2-3/Basmati 370)-6-2-2-1 was tested at Dokri and in farmers' fields. It performed significantly better than Jajai 77, a leading scented tall Sugdasi type, and Basmati 370.

Lateefy yields twice more than Jajai 77 and Basmati 370, has more stem borer resistance, and matures 3 wk earlier. Grain quality equals or surpasses that of those varieties (see table). Lateefy is expected to meet local and export standards for aromatic rice. □

Comparative qualities of Lateefy, Jajai 77, and Basmati 370.

Character	Lateefy	Jajai 77	Basmati 370
Plant height (cm)	109	176	172
Maturity (d)	126	142	147
Fertilizer use (kg NPK/ha)	90-67-0	45-23	45-23
Paddy grain yield (t/ha)			
With fertilizer	5.6	2.1	2.3
Without fertilizer	3.3	1.2	1.3
Stem borer resistance	Comparatively more resistant	Highly susceptible	Highly susceptible
Disease resistance			
Kernel smut	Resistant	Resistant	Resistant
Brown spot (Rati)	Resistant	Resistant	Resistant
Threshability	Hard	Easy	Easy
Grain quality			
Physical (milled rice)			
Average length (mm)	6.4	6.2	6.5
Average breadth (mm)	1.6	1.8	1.7
Average thickness (mm)	1.5	1.58	1.5
Length/breadth ratio	4.0	3.4	3.8
1000-grain weight (g)	13.9	14.0	15.0
Chemical			
Amylose content (%)	22	18	17
Gel consistency (mm)	50	58	52
Gelatinization temperature	I/L	HI/I	HI/I
Protein content (%)	7	7	7
Alkali spreading (%)	7	5	3
Cooking			
Proportionate elongation	1.59	1.52	1.70
Aroma	Strong	Strong	Strong (weak in Sind conditions)
Cooking quality	Good	Good	Good
Eating quality	Good	Good	Good

[a] L = low, H = high, I = intermediate.

BR-IRGA plantings in Rio Grande do Sul, Brazil

E. P. Silveira, researcher, Federal Agricultural Research System (EMBRAPA)–UEPAE/Pelotas, P.O. Box 553, 96100 Pelotas, Rio Grande do Sul, Brazil

BR-IRGA 409 and 410 are the new names for P790-B4-4-1T (IR930-2/IR665-31-1-4) and P798-B4-4-1T (IR930-53/IR665-31-2), two semidwarf lines developed at the International Tropical Agricultural Center (CIAT) in Colombia. They were introduced, selected, and released in 1978 and 1980 through the Rio Grande do Sul Rice Research Station, USAID, and the UEPAE-Pelotas/EMBRAPA rice research team.

Both varieties are between 100 and 110 cm tall, have long slender grains, mature in 110 to 130 d, and tolerate blast and Helminthosporium leaf spot. In 1983–84, BR-IRGA 409 was planted on 457,580 ha or 65% of the rice area in Rio Grande do Sul (see table).

In 5 yr, rice production in Rio Grande do Sul has increased about 50% partly as the result of increased area planted to rice, and also because of introduced varieties. ☐

Area, rice production, and yield of BR-IRGA 409 and BR-IRGA 410,1979-84, Rio Grande do Sul, Brazil.

Year	Area planted					Statewide	
	Total (thousand ha)	BR-IRGA 409 (thousand ha)	Proportion of total rice area (%)	BR-IRGA 410 (thousand ha)	Proportion of total rice area (%)	Production (million t)	Yield (t/ha)
1979-80	590	.45	.76	.028	.0047	2.183	3.7
1980-81	589	9.77	1.66	8.34	.142	2.356	4.0
1981-82	607	212.44	35.0	18.21	3.0	2.489	4.1
1982-83	670	435.22	65.0	33.48	5.0	2.479	3.7[a]
1983-84	704	457.58	65.0	35.2	5.0	3.168	4.5

[a] Flooding and low temperature damage.

Genetic Evaluation and Utilization
AGRONOMIC CHARACTERISTICS

Lodging of rice cultivars grown in pure and mixed stands at different fertility levels

D. C. Ghosh, associate professor of agronomy, Birsa Agricultural University, Kanke, Ranchi, Bihar; and M. Maji, College of Agriculture, Visva-Bharati, West Bengal, India

We studied the lodging behavior of tall and semidwarf rices grown in pure and mixed field stands at different fertility levels in 1979 and 1980 kharif. Soil was a lateritic acid with pH 6.0, 0.22% organic carbon, 0.02% total N, 9 kg P/ha, and 132 kg K/ha. The experiment was in a split-plot design with 3 replications and 4 fertility levels: no fertilizer control (F_0), 50-13-25 (F_1), 100-26-50 (F_2), and 150-40-75 (F_3) kg NPK/ha. Fertility levels were in main plots and rice cultivars and mixed stands in subplots. Semidwarf Pankaj and tall Mahsuri were grown. The mixed stand was obtained by planting two center rows of Mahsuri bounded by single rows of Pankaj, which gave a prismatic shape to the crop canopy. The crop received adequate weed, insect, and disease protection and was irrigated when necessary. Light transmission rate (LTR) at different growth stages and plant height at flowering were measured. Percentage of lodged area in each plot was recorded after flowering.

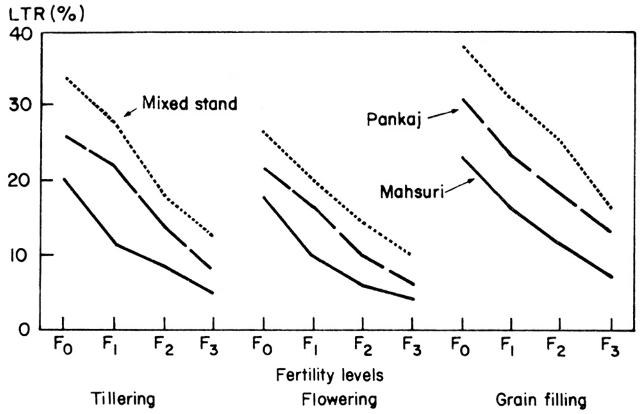
The pure stand of Mahsuri was more susceptible to lodging (see table) than Pankaj. Lodging increased with fertilizer application. Pure and mixed stands of Pankaj lodged only at the highest fertility level. Height of both tall and semidwarf cultivars was significantly less in the mixed

Lodging incidence and plant height of rice cultivars grown in pure and mixed stands.

Fertility level (kg NPK)	Incidence of lodging (%)						Plant height (cm) at flowering[a]			
	1979			1980			Pure stand		Mixed stand	
	Pankaj	Mahsuri	Mixed stand	Pankaj	Mahsuri	Mixed stand	Pankaj	Mahsuri	Pankaj	Mahsuri
0- 0- 0 (control)	0	0	0	0	0	0	80	100	76	97
50-13-25	0	9	0	0	5	0	95	120	89	112
120-26-50	0	70	0	0	65	0	104	126	96	118
150-40-75	16	94	9	10	91	6	109	130	99	118
	Mean						97	119	90	111
	CD at 5%	Cultivars and stand = 4.0, Fertility = 6.6								

[a] Av of 2 yr.

stand than in pure stands at all fertility levels except at zero added fertilizer. Higher fertility levels significantly increased plant height of both cultivars. The prismatic shape of the mixed stand canopy allowed more light to reach the plants and resulted in greater LTR than in pure stands of both cultivars at all growth stages (see figure). LTR was least in Mahsuri pure stand. LTR decreased gradually as fertility levels increased and decreased more in pure than in mixed stands. □



LTR in rice cultivars grown in pure and mixed stands at different fertility levels.

Dormancy of IR50 seeds

V. Krishnasamy, Seed Technology Department, Tamil Nadu Agricultural University, Coimbatore 641003, India

IR50 seeds obtained at harvest were evaluated for dormancy. Immediately after harvest, they had 14.7% moisture and 15% germination. But when stained with a 0.25% solution of tetra-zolium chloride, the seeds showed 92% germinability, which indicated the presence of dormancy.

The seeds were sun-dried for 3 d from 0930 to 1130 h and from 1400 to 1700 h, shade-dried, or dried at 40°C in a hot-air dryer. Moisture content and percentage germination were recorded 1, 7, 14, and 27 d after harvest (see table).

At 14 and 27 d after harvest, shade-dried seeds were soaked in water for 24 h and tested for germination (see table). □

Moisture content and gemination of IR50 seeds at different days after harvest, Coimbatore, India.

Days after harvest	Drying treatment	Moisture content (%)	Germination (%)
Fresh	–	15	15
1	Sun	12	22
	Shade	13	20
	At 40°C	13	26
7	Sun	9	85
	Shade	10	25
	At 40°C	9	70
14	Sun	10	87
	Shade	10	44
	At 40°C	10	86
	Soaking and leaching of shade-dried seed	–	78
27	Sun	9	85
	Shade	10	82
	At 40°C	10	83
	Soaking and leaching of shade-dried seed	–	83
CD (0.05)		3	4

Genetic Evaluation and Utilization

DISEASE RESISTANCE

Comparative biology, pathology, and karyology of rice and maize isolates of *Rhizoctonia solani* f. sp. *sasakii*

S. C. Ahuja, plant pathologist, Rice Research Station, Kaul; and M. M. Payak, head, Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi 110012, India

We compared six Indian isolates of maize and rice sheath blight (ShB) pathogen *R. solani* f. sp. *sasakii,* collected from Karnal (R_1), Solan (R_2), Sundernagar (R_3), Bajaura (R_4), Hyderabad (R_5), and Coimbatore (R_6). We evaluated range of nuclei, mean and mode of nuclear number per hyphal cell, in vitro response to temperature, fungicide and antibiotic response, and relationship of temperature levels to disease intensity.

We found that rice and maize ShB pathogens were identical based on positive cross-inoculation of the pathogen isolates; symptom similarity on *Saccharum officinarum, Paspalum scorbiculatum, Pennisetum purpureum, Zea maxicana, Zea mays* (varieties *indurata, indentata, saccharata,* and *everta*), *Setaria italica, Panicum miliaceum, Sorghum vulgare, Echinochloa frumentacea,* and *Pennisetum americanum;* similar sclerotial and mycelial characters; nuclear mode number (see table); similar range of nuclei per hyphal cell; similar response of in vitro growth to temperature (see table); and disease development on maize inbred Cuba 257.

Responses of rice (R_6) and maize isolates (R_1) to carbendazim, benodanil, and thiabendazole were also similar. Two isolates, however, responded differently to thiophanate-M, dichloroline, and aureofungin. The rice isolate was more sensitive to dichloroline and less to thiophanate-M than the maize isolate, which failed to grow at the lowest thiophanate-M concentration (35 µg ai/ml). □

Comparison of maize and rice isolates of *R. solani* f. sp. *sasakii*, New Delhi, India.

Isolate	Origin	Nuclei/hyphal cell		Mode nuclear no.	Growth rate (mm/24 h)		Disease developed[a] on maize inbred Cuba 257 at			Mean virulence on 7 hosts[c]
		Range	Mean		25°C	30°C	25°C	30°C	35°C[b]	
R_1	Maize	4-8	6.6	6	47	45	2.0	3.5	+[d]	2.6
R_2	Maize	3-13	6.6	6	37	37	1.5	1.5	+	2.0
R_3	Maize	3-11	6.3	6	46	47	2.0	2.0	+[d]	2.6
R_4	Maize	3-13	6.3	6	27	35	2.0	3.5	+[d]	2.9
R_5	Rice	3-16	7.0	6	46	44	1.0	2.0	+	2.5
R_6	Rice	3-9	5.4	6	47	47	3.0	3.0	+	2.7

[a]Disease recorded on maize inbred Cuba 257 on 1-5 scale. [b]+ = growth in traces. [c]Average of 4 readings each on 7 hosts. [d] production of infection cushions.

Genetic Evaluation and Utilization

INSECT RESISTANCE

Rice varietal reaction to leaffolder (LF) and yellow stem borer (YSB)

M. Subramanian and V. Jayaraman, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

We evaluated 6 promising 120- to 140-d rices for reaction to LF *Cnaphalocrocis medinalis* and YSB *Scirpophaga incertulas* in an adaptive research trial at Thozhudur, Thanjavur District, in 1983 thaladi when there was severe insect pressure.

Ten plants from nonreplicated plots of each variety were randomly chosen for scoring. LF reaction was based on the number of affected leaves in relation to the total leaves. YSB was scored based on the number of deadhearts as related to tillers/plant. Scoring was at flowering in Nov.

LF incidence ranged from 2 to 12%. Co 44, Pusa 169, AD9408, and Co 43 had resistant reaction. All varieties but Co 44 had fewer than 20% deadhearts, indicating YSB resistance (see table). □

Rice varietal reaction to LF and YSB incidence, Thozhudur, India.

Variety	Infestation (%)	
	LF[a]	YSB[b]
IET6262 (Pankaj/Vijaya)	11	11
AD9408 (IR20/IR8)	3	15
BS8 (IR36/Co 13)	12	8
Co 43 (Dasal/IR2O)	8	18
Co 44 (ASD5/IR20)	2	23
Pusa 169 (IR28/P140)	2	19

[a]Based on number of affected leaves in relation to total leaves. [b]Based on number of deadhearts as related to tillers/plant.

Rice resistance to brown planthopper (BPH) in the Solomon Islands

Dang Thanh Ho, entomologist, and Adah Taro, research assistant, SOLRICE, P. O. Box 5, Honiara, Solomon Islands

About two and one-half annual irrigated rice crops are grown under mechanized cultivation on the Guadalcanal Plains of the Solomon Islands. The local BPH *Nilaparvata lugens* Stål population is highly virulent and resistant varieties only last 1-3 yr. We continually screen varieties for BPH resistance.

BG379-5 (BG96-3/Ptb 33) is believed to possess the Ptb 33 resistance gene and was first screened for BPH resistance in the 1980 International Rice Brown Planthopper Nursery. It was highly resistant, scoring 1 on the 1-9 IRRI *Standard evaluation system for rice* and yielded 7-8 t/ha. It was released for commercial use on the Solomon Islands in1982 and until recently has shown BPH resistance.

To monitor BG379-5 performance, we conducted yield trials from Jul 1973 to Jul 1984. Seeds were planted monthly in randomly chosen 3- × 5-m plots with 4 replications. Thirty, 40, and 40 kg N/ha

Yield and resistance of BG379-5 to pests[a] on the Guadalcanal Plains, Solomon Islands.

Seeded	Harvested	Resistance[b] to			Yield (t/ha)	Remarks
		BPH	LR	ShB		
29 Jul 83	28 Nov 83	1.5	1.0	4.0	7.3	Heavy ShB incidence
11 Aug	12 Dec	1.0	1.0	–	4.6	Stunted and yellowing
20 Oct	16 Feb 84	2.0	1.0	2	3.8	Moderate army worm damage
29 Oct	5 Mar	1.4	1.0	3	5.3	–
26 Nov	28 Mar	1.4	1.0	–	6.2	Moderate brown spot incidence
17 Dec	18 Apr	3.0	1.5	5.3	4.8	Heavy army worm attack
20 Jan 84	18 May	4.5	1.0	2	5.0	–
10 Feb	7 Jun	7.3	1.0	–	4.0	60% hopperburned
19 Mar	16 Jul	7.0	1.0	–	4.9	–
6 Apr	21 Jul	6.0	1.0	–	3.4	–

[a] LR = leafroller, ShB = sheath blight. [b]Rated according to the *Standard evaluation system for rice:* 1 = most resistant, 9 = most susceptible.

was applied at 25-30, 45-55, and 70-75 d after seeding (DS).

We monitored BPH and populations of pests such as seed shrimp *Chrissia* sp. and *Cypris* sp., leaf miner *Hydrellia griseola* Fallen, armyworms *Mythimna separata* Walker and *Spodoptera exempta* Walker, and leafroller *Marasmia exigua.* At early rice growth, furadan 10G, fenitrothion 50% EC, and parathion 50% EC were applied at -2, +10-15, and +30-45 DS to control seed shrimp, leaf miner, and armyworm. BPMC 50% EC and fenitrothion/parathion were applied at 25-d intervals 45 DS to control BPH, armyworm, and leafroller. With regular insecticide application, BG379-5 maintained high BPH resistance until Apr 1984, after which it was heavily attacked by BPH, which occasionally caused hopperburn. In Jun 1984, 60% hopperburn was observed (see table).

Gradually reduced resistance has been typical of several resistant varieties during the last 10 yr. Leafroller and armyworm have occasionally reduced yields, but not seriously. □

Genetic Evaluation and Utilization

DEEP WATER

Effect of fertilizers on yield and yield components of medium deep water rice culture in northern Nigeria

N. A. Gill, National Cereals Research Institute, Rice Research Station (RRS), PMB 1022, Birnin Kebbi, Sokoto, Nigeria

We evaluated the effect of NPK on yield and yield components of a new deep water rice, BKN6986-38-1, at the RRS, Birnin Kebbi, in 1983. BKN6986-38-1 matures 3-4 wk earlier and has 34% higher average yield and better grain appearance than deep water variety FARO 14.

Treatments were 0, 35, or 70 kg/ha each of N, P, and K in 3^3 factorial arrangement in a randomized complete block design with 4 replications. Rice was planted in 3- × 5-m plots on an annually flooded clay soil that had been planted to rice for several years.

One-half N and all P and K were incorporated in wet soil with a hoe, 1 d before transplanting. The remaining N was drilled between rows 21 d after transplanting. NPK sources were ammonium sulfate, single superphosphate, and potassium chloride.

Three-week-old BKN6986-38-1 seedlings were transplanted at 25- × 30-cm spacing at 1 seedling/hill on 12 Aug, which was a late planting. Seedlings were irrigated and supplemental irrigation was applied as needed. The plots were flooded the 3d wk of Sep reaching a depth of 33 cm. The floodwater receded 1 mo later. The crop matured 15 Nov.

There was a highly significant yield increase with 35 kg N/ha and a further significant increase with 70 kg N/ha (see table). Grain yield significantly increased with 35 kg P/ha, but had no response to higher application. K at 35 kg/ha did not influence yield. At higher doses, it decreased yield but improved 1,000-grain weight. The interactions N × P, N × K, and N × P × K did not significantly affect grain yield.

There was a linear increase in panicles/m^2 with N application, but the number of filled grains was not significantly affected. □

Effect of NPK fertilizers on grain yield and yield components of deep water rice BKN6986-38-1, Birnin Kebbi, Nigeria, 1983.

Fertilizer dose (kg/ha) N - P - K	Grain yield (t/ha)	Panicles/m^2	Field grains/panicle	1000-grain wt (g)
0 - 0 - 0	1.7	133	107	28
0 - 0 - 35	1.3	75	97	27
0 - 0 - 70	2.1	138	90	26
0 - 35 - 0	2.3	149	124	29
0 - 35 - 35	3.0	173	112	29
0 - 35- 70	1.7	115	112	28
0 - 70 - 0	2.1	133	122	27
0 - 70 - 35	2.5	122	108	27
0 - 70 - 70	1.8	122	101	26
35 - 0 - 0	3.0	153	99	28
35 - 0 - 35	2.6	171	109	30
35 - 0 - 70	2.4	151	106	26
35 - 35 - 0	2.8	164	82	28
35 - 35 - 35	3.7	175	109	28
35 - 35 - 70	2.9	155	102	28
35 - 70 - 0	3.3	169	132	29
35 - 70 - 35	2.8	167	101	30
35 - 70 - 70	2.7	164	126	29
70 - 0 - 0	3.5	209	100	27
70 - 0 - 35	3.4	215	119	29
70 - 0 - 70	3.1	191	106	30
70 - 35 - 0	3.7	189	119	28
70 - 35 - 35	3.7	217	109	30
70 - 35 - 70	3.5	191	111	29
70 - 70 - 0	3.3	186	112	29
70 - 70 - 35	3.3	218	113	30
70 - 70 - 70	3.3	186	129	30
LSD for N** at 5%	0.3 t/ha	13.2/m^2	NS	N** (at 5%0.6 g
1%	0.4 t/ha	17.6/m^2		K** (at 1% 0.8 g
LSD for P* at 5%	0.3 t/ha			NP** (at 5% 1.02 g
				NK** (at 1% 1.40 g
Coefficient of variability	23.7%	17.1%	20.8%	4.4%

*Means significantly differ at 5% level. **Means significantly differ at 1% level. NS Means are not significantly different.

Deep water and lowland rice germplasm collection and evaluation in North Bihar

R. Thakur, senior rice breeder, Rajendra Agricultural University, Bihar Agricultural College, Sabour, Bhagalpur, India

North Bihar has more than 2 million ha of rice, 80% of which is grown in poorly drained and deep water areas. We began collecting germplasm from those areas in 1978 and have identified 350 varieties: 90 deep water rices and 260 lowland rices. All varieties identified, except intermediate TCA20-1, 20-2, 212, and 217, were tall. Some were evaluated for yield, yield characters, and drought tolerance.

Three deep water environments were identified, based on water depth: medium deep water (about 1 m); deep water (up to 2 m); and very deep water (4-5 m). Twenty very deep water varieties were identified.

Deep water rices had longer panicles with more grains per panicle than lowland varieties. Very deep water rices had the most grains per panicle (140-324). Lowland rices had 72-164 grains per panicle.

Drought can be a problem in these areas. In Mar 1979, 65 varieties were direct-seeded in deep water tanks. There was a severe drought in May-Jun and many entries died. TCA2, 4, 7, 8 (deep water varieties), and TCA9, 13, 14, 16, 20, 21, 26, 30, 35, and 38 had drought resistance.

Promising deep water and lowland cultures, North Bihar, India.

Collection no.	Grain color	Kernel color	Elongation	Suitability	Additional information
TCA4	Straw	Red	Better	D.W.	BB resistant
TCA11	Straw	Red	Better	D.W.	BB resistant
TCA176	Black	Red	Better	D.W.	
TCA177	Black	Red	Best	D.W.	BB resistant
TCA191-1	Black	Red	Best	D.W.	
TCA20-1	Straw	White	Better	D.W.	
TCA55	Straw	White		M.D.	Wider adaptability
TCA78	Black	Red	Good	M.D.	
TCA162	Gold	White	Better	M.D.	Long glume
TCA179-3	Black	Red	Better	M.D.	
TCA21/TCA22	Straw	Red	Good	S.D.	Sturdy stem
TCA43	Straw	White		S.D.	
TCA47	Gold	White		S.D.	
TCA148-3	White	White		S.D.	
TCAl27	Gold	Red	Good	S.D.	
TCA48	Gold	White		S.D.	
TCA49	Black	Red		S.D.	
TCA72	Straw	Red		S.D.	
TCA83	Straw	Red		S.D.	Wider adaptability
TCA20-2	Straw	White	Poor	S.D. & L.L.	Sturdy stem
TCA20-3	Straw	White	Poor	S.D. & L.L.	Sturdy stem
TCA190-1	Black	White	Poor	L.L. & S.D.	RTV resistant scented
TCA58	Straw	Red		L. L.	Wider adaptability
TCA108/TCA149	Straw	Red/White	Poor	L. L.	Wider adaptability
TCA212	Straw	White	Poor	L.L.	
TCA227	Brown	White	Poor	L. L.	

[a] D. W. = deep water, M. D. = medium deep, S. D. = shallow deep, and L. L. = lowland. BB = bacterial blight, RTV = tungro.

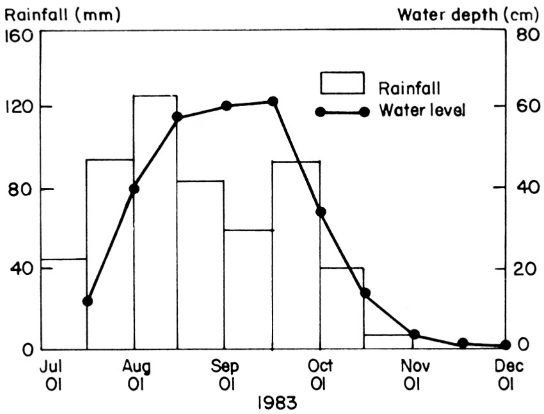
In 1979 and 1980, the varieties were entered in yield nurseries. Twenty-six cultures were identified as promising and entered in multilocation tests (see table). TCA47 and TCA148-3 yielded 3.1 t/ha in shallow or medium deep water. TCA177 yielded best in deep water and Barogar 5 and Barogar 6 yielded best in medium deep water — about 2.7 t/ha. Varieties tended to yield best under the water regimes from which they were collected. □

NC492, a promising rice for waterlogged fields in West Bengal

P. Basuchaudhury and D. K. Das Gupta, University College of Agriculture, Calcutta 19, India

We evaluated 18 elite rice cultures for growth and yield attributes in waterlogged fields (see figure) in the Gangetic Plains of West Bengal in kharif. Eight varieties had better than 70% survival (see table). Days to 50% flowering ranged from 118 to 150. OR330-40-3 flowered earliest and CR292-5258 and CR292-7050 flowered last.

Total dry matter production varied widely. BIET807 accumulated 1,308 g dry weight/m^2 and PLA1100, 242 g. Survival percentage appeared to substantially influence dry matter production, irrespective of days to flowering or maturity. Tilakkachari produced 255 panicles/m^2, followed by NC492 with



Changes in rainfall and water depth in the experimental field in 1983 kharif, Calcutta, India.

Survival, growth, yield, and yield attributes of rice varieties grown under waterlogged conditions, Calcutta, India.

Variety	Survival (%)	Grain yield (t/ha)	Days to 50% flowering	Dry matter production (g/m^2)	Panicles/ m^2	Spikelets (10^3/m^2)	Grains (10^3/m^2)	1,000-grain wt (g)
OR143-7	36	2.0	141	766	117	15	12	27
OR117-215	17	2.2	132	600	50	12	10	21
OR330-40-3	80	2.2	118	758	154	17	14	21
Janaki	87	2.1	122	875	200	15	13	21
BIET724	70	3.1	135	1002	172	20	15	26
BIET807	80	3.6	125	1308	200	23	18	24
BIET821	34	2.0	128	725	119	17	11	24
CR292-5258	31	2.2	150	489	144	20	15	18
CR292-7050	21	2.0	150	466	69	8	7	30
CR221-1030	87	3.5	134	792	182	22	19	22
CN499-160-2-1	29	2.2	134	617	126	12	9	18
CN499-160-13-6	83	2.1	135	608	200	21	17	17
CN505-5-32-9	12	1.2	140	325	50	11	8	20
CN506-147-2-1	93	2.4	142	880	200	19	15	25
CN506-147-14-2	14	3.3	135	685	90	19	16	23
PLA1100	12	0.8	144	242	27	7	5	20
NC492	90	4.9	130	1116	253	21	19	31
Tilakkachari	93	3.8	132	1205	255	25	17	26
Mean	53.8	2.5	134.8	747.7	144.9	16.99	13.4	23.02
CD at 5% P	21	0.6	4	200	52	3	3	3

253 panicles. Tilakkachari also produced the maximum spikelets. NC492 yielded highest with 4.9 t/ha, and PLA1100 lowest with 0.80 t/ha. NC492 had high total dry matter, high panicle number, the highest 1,000-grain weight, and high survival percentage. Survival of plants under waterlogged situation is the prime criterion for plant establishment and subsequent manifestation of yield potential. □

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Selection criteria for an F_4 population of a deep water rice cross

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At CRRI we crossed Pankaj, a high yielding semidwarf, with Nagaribao, a traditional deep water rice, to develop high yield deep water lines. Based on their performance, 817 F_3 lines were selected and planted in kharif in intermediate 15-50 cm water depth. Fifty-two plants of each line were planted at 20- × 25-cm spacing, giving an F_4 population of 42,484 plants. The parents also were grown. Deep water killed 1,285 plants in the F_4 population and very wide growth variation was observed among and within lines. Variation was less within lines than between lines.

From 245 lines we selected 980 plants with high vigor; thick to medium-thick culms; compact tillering; rapid internode elongation; nodal rooting; small erect leaves; medium to tall height; lodging resistance; awnless, nonshattering panicles; dormancy; and good panicle weight. Panicle weight was measured by dividing the total grain weight after removing the chaff by panicle length. We called that ratio C. Plants selected from the field by sight were tested for C factor and those with 0.1 C were judged panicle weight types. Of 980 selected plants, 522 had C 0.1. C is a desirable selection criterion for high yield in segregating generations of deep water crosses. C is 0.06 for deep water Nagaribao and 0.1 5 for high yielding variety Pankaj. □

Genetic Evaluation and Utilization

TEMPERATURE TOLERANCE

Evaluating rices for cold tolerance

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Low temperatures are a major constraint to rice production in the hill region of India, where they adversely affect spring-sown upland rice at germination and early seedling growth, and transplanted rice during ripening. We screened rices for low temperature tolerance in three experiments.

In the first, 135 varieties from different rice growing regions of the world, including some local hill collections, were evaluated for germination and seedling vigor in the spring of 1981 and 1982. On 2 Mar, 50 seeds of each variety were sown in 2 rows at 2-cm depth. The first seedlings emerged 18 d after sowing. L 62G, Heug Jodo, Jodo, Heugdo, IRAT102, Khonorullo, K78-28, Daegaldo, Mujudo, and L 62-2A had more than 75% germination at an average 11°C field temperature. Sixty more genotypes emerged at 13°C and the rest emerged when the average temperature rose to 15°C in the first week of Apr. Of the early-emerging genotypes, all but IRAT102, K78-28, and L 62-2A had good seedling vigor at low temperatures and maintained their vigor until panicle initiation.

Varieties VHC 1253, Lengkwang, Hawang Haedo,VL 206, L 105-8, VLK39, and Himdhan had poor early seedling growth but recovered rapidly when the temperature rose above 25°C. They reached a par in vigor with the earliest varieties in both years.

A similar set of varieties was evaluated under controlled conditions. Twenty-five seeds of each were placed in petri dishes containing a mixture of sand, soil, and water. The same set of 10 varieties that performed well in the first experiment had more than 80% germination at 11 °C.

The third experiment had 16 varieties planted in pots. At booting stage, one set of pots was transferred to 2,400 m altitude where night temperatures were 10° to 5 °C. Another set was maintained at 1,600 m altitude where night temperatures were 18° to 12 °C. Only L 62G, Khonorullo, L 62-2A, UPRH299, and L 12-1A had good spikelet fertility and leaf color at 2,400 m altitude. Olbyed, Gangweondo, JC99, and Nancee had normal leaf color. □

Pest Control and Management

DISEASES

Effect of urea foliar spraying on rice tungro virus (RTV) infection

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In Mar-May 1984 there was a severe outbreak of RTV on several rice varieties in North Arcot District, Tamil Nadu. We tested a 1% foliar spraying of urea for RTV control on susceptible IET1722 at different sites. Disease incidence was measured at first spraying (20 d after transplanting [DT] and 20 d before harvest, using the Standard evaluation system for rice.

At first spraying 5-10% RTV infection was recorded. Foliar application of 1% urea at 20, 30, 40, and 50 DT + phosphamidon (85% EC) 320 ml/ha at 20 and 35 DT effectively controlled RTV up to 10% infection. In phosphamidon-treated and control fields, disease spread was 41 and 72% with a corresponding yield reduction (see table). □

Effect of foliar application of urea on RTV infection, Tamil Nadu, India.

Treatment	Disease incidence (%) 20 d after transplanting	Disease incidence (%) 20 d before harvest	Mean yield (t/ha)
1% urea sprayed at 20, 30, 40, and 50 d + phosphamidon (85% EC) at 20 and 35 d after transplanting	7 - 8	7 - 10	4.2
Phosphamidon (85% EC) sprayed at 20 and 35 d after transplanting	6 - 7	38 - 41	2.4
No treatment control	5 - 9	60 - 72	1.2

New rice grassy stunt virus (GSV) strain in Thailand

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Rice plants with symptoms of an unknown disease and other virus diseases were collected at several sites in Thailand and tested for virus presence by immune electron microscopy (IEM) and the dipping method. For IEM, grids were treated with an antiserum to rice tungro spherical virus (RTSV) or rice tungro bacilliform virus (RTBV) at 1 : 1000 dilution. After incubation with sap of plant samples, grids were floated on anti-

Table 1. Detection by IEM technique and dipping method of viruses from rice plants with different virus symptoms. [a]

Variety	Symptoms (visual assessment)	Virus particles detected by dipping	Reaction of extracts in IEM to antiserum against RTSV	Reaction of extracts in IEM to antiserum against RTBV
Kaimukdum pl. no. 1	RSV	RSV	–	–
Kaimukdum pl. no. 2	RSV	RSV	–	–
Kaimukdum pl. no. 3	RTV	RTSV	+	–
Kaimukdum pl. no. 4	RTV	RTBV	–	+
Kaimukdum pl no. 5	RTV	RTSV, RTBV	+	+
Kaimukdum pl. no. 6	RSV	RSV	–	–
Kaimukdum pl. no. 7	RSV, unknown	RSV	–	–
Kaimukdum pl. no. 8	unknown	–	–	–
Apple Thong pl. no. 1	unknown	–	–	–
Apple Thong pl. no. 2	unknown	–	–	–
Number 20 pl. no. 1	unknown	–	–	–
Number 20 pl. no. 2	unknown	–	–	–
Number 20 pl. no. 3	unknown	–	–	–

[a] + and – indicate positive and negative reactions. RSV = rice ragged stunt, RTV = rice tungro virus.

sera at 1:10 dilution for decoration. The grids were stained with 2% uranyl acetate and examined under an electron microscope (Table 1). Results showed that the unknown disease was not caused by tungro infection.

Small leaf specimens (2 × 2 m^2) were collected from field plants with disease symptoms and crushed with 0.1M Tris-HCL buffer (pH 7.2) containing 0.02% PVP in test tubes using glass rods. Two drops of latex suspension sensitized with antiserum were added to the test tubes and they were shaken for 30 min, then left for 2 h before reaction reading. The latex particles formed aggregates in the positive reaction and remained a milky suspension in the negative reaction. All samples reacted to GSV antiserum (Table 2).

Table 2. Reaction of the unknown virus disease to antisera against GSV, RTBV, and RTSV by latex agglutination test.

Infected variety	Reaction to given antiserum			
	Buffer	GSV	RTSV	RTBV
RD7	–	+	–	–
RD23	–	+	–	–
IR46	–	+	–	–
BKNBR1141-4-2-4-2-2-2-1	–	+	–	–
TN1	–	+	–	–
Healthy TN1 control	–	–	–	–

Of 1,179 seeds collected from rice plants infected with the unknown disease, 1,091 germinated and grew as normal, healthy plants, indicating that the disease is not transmitted through seed. Four rice insects — *Nephotettix nigropictus, N. virescens, Recilia dorsalis,* and *Nilaparvata lugens* — were tested for disease transmission.

Only *N. lugens* transmitted the disease (38% of the time [367 infected plants/ 970 tested plants]). Disease incubation took 7-14 d. Forty-two to 70% of *N lugens* were transmitters. Shortest acquisition and inoculation feeding periods were 30 and 5 min. The vectors transmit the unknown disease persistently. Relationships between the unknown disease and *N. lugens* were similar to those of GSV and related viruses. The results indicate that the unknown disease is caused by a strain of GSV. ☐

Reaction of IR varieties to rice tungro virus (RTV) complex under greenhouse and field conditions as detected by latex test

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The reactions of 26 IR varieties to rice tungro virus complex were serologically analyzed using antisera against rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). A seedling in a test tube was inoculated for 1 d by an adult *Nephotettix virescens* that had been exposed to doubly infected (RTBV-RTSV) or singly infected (RTSV) TN1 plants. Using the latex test, inoculated seedlings were tested for the presence of RTBV, RTSV, or both viruses 30 d after inoculation. Leaf samples from each variety also were taken from the IRRI RTV nursery and tested for the virus particles.

When doubly infected plants were the virus source, infection percentage was 0-53 for RTBV-RTSV, 21-86 for RTBV, and 0-12 for RTSV (see table). Varieties with less than 10% RTBV-RTSV infection were IR20, IR26, IR28, IR29, IR30, IR34, IR40, IR50, IR52, IR54, IR58, and IR60. However, infection with RTBV-RTSV and RTSV in almost all the IR varieties was higher under field conditions than in the greenhouse test, probably because the plants were continuously exposed to viruliferous vectors and because RTSV exists as an independent disease at the IRRI farm. When RTSV alone was the virus source, percentage infection ranged from 0 to 12 in the greenhouse and 0 to 37 in the field. IR20, IR26, IR30, and IR40 were highly resistant to RTSV but were susceptible to RTBV. They all have TKM6 as a parent. ☐

Reaction of 26 IR varieties to RTV complex by test tube and field inoculation as detected by latex test, IRRI.

Variety	Greenhouse [a]						Field [b]			
	RTBV-RTSV source				RTSV source					
	Plants tested (no.)	With RTBV-RTSV (%)	With RTBV (%)	With RTSV (%)	Plants tested (no.)	With RTSV (%)	Hills tested (no.)	With RTBV-RTSV (%)	With RTBV (%)	With RTSV (%)
IR5	49	29	43	0	56	45	108	74	4	22
IR8	47	11	72	0	47	32	89	96	1	3
IR20	28	0	86	0	55	0	102	12	78	4
IR22	56	46	45	0	56	82	105	86	1	12
IR24	55	13	49	0	59	20	103	32	47	1
IR26	55	2	80	0	58	0	108	3	60	0
IR28	51	6	47	0	55	29	103	44	16	15
IR29	49	6	49	0	58	21	104	27	23	7
IR30	45	0	61	0	56	4	98	13	61	4
IR32	38	32	26	8	57	53	107	78	5	13
IR34	45	7	36	2	54	31	104	68	14	11
IR36	33	12	45	3	57	47	99	72	1	20
IR38	41	32	39	12	54	52	106	69	15	7
IR40	50	0	66	2	46	0	95	6	77	2
IR42	51	29	45	0	58	53	106	96	0	4
IR43	47	11	49	0	58	29	100	79	12	1
IR44	52	31	31	2	43	56	86	86	0	9
IR45	53	11	45	2	53	28	89	90	2	8
IR46	32	53	25	6	32	78	87	97	1	2
IR48	48	44	21	4	42	57	87	94	0	6
IR50	56	9	29	5	56	43	107	33	20	16
IR52	46	4	28	4	51	24	89	46	16	28
IR54	48	6	29	2	54	33	97	30	19	24
IR56	58	16	24	3	50	52	99	43	7	7
IR58	51	4	31	4	49	27	78	29	2	37
IR60	57	4	37	2	49	29	90	19	20	19

[a] 1 insect/seedling in test tubes for 3 trials. [b] RTV nursery, 1983 wet season and 1984 dry season, IRRI.

Efficacy of fungicides and application methods for controlling blast (Bl)

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B1 disease caused by *Pyricularia oryzae* Cav. is endemic to the northeastern hill region of India, where it causes significant yield losses to upland and lowland rice. Chemical control by conventional fungicide sprays and dusts is difficult because of high rainfall and many rainy days during wet season. We tested other fungicide application methods such as seed treatment and seedling root-dip.

In 1982 wet season, we set up a fungicide trial with eight treatments and three replications in a randomized block design at Barapani farm, Shillong. Pusa 33 was transplanted in 3.5 × 2-m plots at 15- × 10-cm spacing and fertilized with 60-60-40 kg NPK/ha. Combinations of carbendazim, benomyl, IBP, and isoprothiolane were applied as seed treatment, root dip, and spray. Seed treatments were carbendazim and benomyl at 1 g ai/kg seeds; root dips were IBP .08% ai and isoprothiolane 0.04% ai; and sprays were carbendazim 0.05% and benomyl 0.05% ai, applied at 300-800 g ai of the fungicides in 600 to 800 litres water/ha.

Efficacy of fungicides and application methods for controlling B1 disease at Barapani, Shillow, India, 1982.

Fungicide,[a] application method	Dose (ai)	Efficacy (%)	
		Leaf B1	Neck B1
Carbendazim 50 WP (seed treatment)	1 g/kg seeds	40	34
Carbendazim 50 WP (seed treatment and sprays at PI and heading)	1 g/kg seeds + 0.5 g/litre	30	18
Benomyl 50 WP (seed treatment)	1 g/kg seeds	30	37
Benomyl 50 WP (seed treatment and sprays at PI and heading)	1 g/kg seeds + 0.5 g/litre	30	16
IBP 40 EC (12 h root-dip and sprays at PI and heading)	0.8 ml/litre	40	20
Isoprothiolane 40 EC (12 h root-dip and sprays at PI and heading)	0.4 ml/litre	20	6
Isoprothiolane 40 EC (sprays at tillering, PI, and heading)	0.4 ml/litre	20	8
0 (control)	–	70	32
CD (5%)	–	–	20

[a] WP = wettable powder, EC = emulsifiable concentrate, PI = panicle initiation.

Data in the table show that seedling root-dip in isoprothiolane 40 EC for 12 h before transplanting, followed by one spray at panicle initiation and one at heading, can significantly reduce B1 incidence. A schedule of 3 sprays (20 d after transplanting, panicle initiation, and heading) of isoprothiolane was equally effective. IBP 40 EC root-dip followed by one spraying at panicle initiation and one at heading, and carbendazim and benomyl either as seed treatment alone of as seed treatment plus spraying at panicle initiation and heading reduced foliar B1 but not neck B1. □

Effect of K on bacterial blight (BB) development

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To test the effect of K on BB development, we fertilized a soil sample containing 100 ppm K with 200 ppm N and 66 ppm P. One-third of the total N from urea was topdressed 7 d before panicle initiation. Five potash treatments (see table) in six pot replications were compared for effect on BB development and some other yield components. Three BB-susceptible IR8 seedlings were transplanted in each plot and inoculated with *Xanthomonas campestris* pv. *oryzae* strain BXO9 at maximum tillering and at flag leaf stage by clipping.

Relation between different doses of K and response of BB-inoculated IR8 plants in t. aman season, 1983, Joydebpur, Bang1adesh.[a]

Treatment	Average lesion length (cm)		Average no. of		Average yield (g/pot)
	1st inoculation at maximum tillering	2d inoculation at flag leaf stage	fertile tillers	filled grains	
100 ppm K	30 a (7)	13 a (5)	81 a	71 b	34 a
183 ppm K	22 b (5)	8 b (5)	78 a	76 a	37 a
266 ppm K	20 bc (5)	6 b (5)	74 a	80 a	40 a
349 ppm K	19 bc (5)	6 b (5)	76 a	81 a	40 a
432 ppm K	16 c (5)	5 b (5)	78 a	79 a	43 a
CV%	12.6	34.0	13.6	7.4	12.4

[a] Data are averages of six replications. Figures followed by the same letter are not significantly different at P0.05 level. Values in parentheses are scores based on the *Standard evaluation system for rice* scale of 0-9.

Comparison of plants grown on treated soil and on soil with 100 ppm K showed that average lesion lengths both at maximum tillering and flag leaf stage were significantly lower on plants in potash-treated soil than on those grown in soil containing less K, indicating that plants grown in soil with 183 ppm or more K are more BB resistant. Percentage of filled grains was significantly lower in plants grown in soil containing less K than in those with added potash. Although yield was not significantly different between treatments, plants grown in the soil with 349 ppm added K yielded nearly 16% higher than those grown with 100 ppm K. □

Optimum age of rice for brown spot (BS) control by fungicide spray

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BS, caused by *Cochliobolus miyabeanus* (Ito and Kuribay) Dickson, is a major rice disease in Tamil Nadu. In North Arcot District, foliar application of various fungicides often does not control the disease.

We sought to determine optimum plant age for fungicide application to control BS in the field. Five treatments were in a randomized block design with four replications (see table). Disease intensity was scored as 0 = no disease, 1 = less than 1% of leaf area affected, 2 = 1-3% affected, 3 = 4-5%, 4 = 6-l0%, 5 = 11-15%, 6 = 16-25%, 7 = 26-50%, 8 = 51-76%, and 9 = 76-100%.

Trials from Aug 1981 to Jan 1982 with Ponni and ADT35 showed that spraying edifenphos at 500 ml/ha at 50 and 65 d after transplanting (DT) effectively reduced disease intensity and significantly increased yield. From Nov 1981 to May 1982, spraying Vaigai and Bhavani 25, 40, and 55 DT also was effective. Spraying TKM9 and ADT31 from Apr to Aug 1982 did not produce significantly different yields although all treatments significantly reduced disease intensity (see table). □

BS intensity and mean yield, Tamil Nadu, India.

Age (DT) at spraying	Aug 1981-Jan 1982				Nov 1981-May 1982				Apr-Aug 1982			
	Ponni		ADT35		Vaigai		Bhavani		TKM9		ADT3 1	
	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)
20, 35	7.0	4.4	3.0	2.7	5.0	8.0	6.0	6.1	2.0	4.8	2.0	2.5
35, 50	4.0	5.0	2.0	2.7	5.0	8.1	5.0	7.4	2.0	4.8	2.0	2.6
50, 65	2.0	5.7	1.0	3.3	4.0	7.9	5.0	7.1	2.0	4.7	2.0	2.5
25, 40, 55	3.0	5.2	1.0	3.1	3.0	9.5	3.0	7.8	1.0	4.8	2.0	2.5
Control	9.0	4.1	3.0	2.6	8.0	5.7	8.0	4.6	2.0	4.7	3.0	2.5
CD (P = 0.05)	2.6	0.3	9.8	0.1	2.4	0.8	0.5	0.9	0.4	NS	0.5	NS

Pest Control and Management

INSECTS

Entomopathogenic microorganisms of rice planthoppers and leafhoppers in China

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We studied pathogenic microorganisms of rice planthoppers and leafhopper pests in Hunan Province, China. Under optimum temperature and humidity, the pathogens significantly decrease pest populations. The fungal species usually are most abundant in rainy season and at later stages of rice growth. Up to 80% of the hopper population may be infected. At some sites there are high infection levels by entomopathogenic nematode species such as *Amphimermis unka.*

Various species of pathogenic fungi, two nematode species, and one species of bacterium have been identified as infecting hoppers. Several of the fungal species and the bacterium have been isolated on artificial solid media. The nematodes were identified under the microscope.

The following planthoppers and leafhoppers were examined: *Nilaparvata lugens, Sogatella furcifera, Nisia atrovenosa, Laodelphax striatellus, Saccharosydne procerus, Nephotettix cincticeps, Empoasca subrufa, Deltocephalus dorsalis,* and *Macrosteles fascifrons.* The following entomopathogenic fungi were isolated from them: *Entomophthora delphacis, Beauveria bassiana, B. tenella, Metarrhizium anisopliae,* and *Hirsutella saussurei.* Unidentified *Paecilomyces* spp., *Cephanosporium* spp., etc. also have been isolated. Surprisingly, several hoppers were infected with *Nomuraea rileyi,* a common entomopathogen of lepidopteran larvae in the rice ecosystem.

In addition to these entomopathogens, several other species of fungi have been isolated from the insects, e. g. *Penicillium* sp., *Aspergillus* spp., *Fusarium* spp., *Alternaria* spp., and a *Cladosporium* sp. However, their entomopathogenic nature has not yet been determined.

The bacterium was identified as *Serratia marcescens.* Preliminary infection tests both in the laboratory and in field cages show highly promising results. Applying a suspension of conidia of *B. bassiana* on different hopper populations resulted in 60-90% infection 15 d after incubation. □

Efficacy and residues of carbofuran 3G broadcast for yellow stem borer (YSB) control in India

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YSB *Scirpophaga incertulas* (Walk.) is a major rice pest in Punjab, India. We evaluated the efficacy of carbofuran 3G 0.75 kg ai/ha in 1, 2, or 3 applications for YSB control on cultivar PR4141. Deadhearts and whiteheads were recorded at 20-d intervals after the first insecticide application.

A 50-g grain sample from a 1.5-kg pooled sample drawn from 3 replications was hydrolyzed by refluxing in 0.25 N HCl, extracted with dichloromethane, and analyzed for insecticide residue by a gas chromatograph. Average carbofuran recovery in fortified samples was 87%.

YSB incidence and carbofuran residues in paddy grain samples, Ferozepur, Punjab, India, 1983.[a]

Carbofuran application	YSB incidence				Yield (t/ha)	Carbofuran residues (ppm) in paddy grains at harvest
	Deadhearts (%)		Whiteheads (%)			
	50 DT	70 DT	90 DT	110 DT		
30 – –	4.1 ab	8.7 cdef	39.6 cd	55.7 c	0.8 i	–
– 50 –	13.0 bcde	3.5 b	45.9 de	57.6 c	2.5 fgh	–
– – 70	8.3 bcde	10.7 efg	10.8 ab	14.2 ab	4.3 bcdef	–
30, 50 –	3.0 a	2.2 a	40.9 d	56.1 c	3.7 defg	0.036
– 50, 70	15.8 e	2.9 b	6.4 ab	8.8 a	5.8 ab	0.158
30 – 70	3.0 a	9.0 def	3.8 a	7.1 a	5.8 ab	0.100
30, 50, 70	5.1 abc	2.4 b	3.5 a	6.9 a	6.9 a	0.178
Control	17.6 de	24.9 h	78.4 f	82.7 d	0.6 i	–

[a] In a column means followed by a common letter are not significantly different at 5% level.

Although applying carbofuran 30 and 50 d after transplanting (DT) helped control YSB, application at 70 DT was essential to prevent whitehead damage. Maximum yield of 6.9 t/ha was obtained in plots with 3 applications at 30, 50, and 70 DT (see table).

Maximum carbofuran residue (0.178 ppm) was detected in grain samples from plots with 3 carbofuran applications. The lowest residue (0.036 ppm) was in the 30 and 50 DT treatment. In all treatments, carbofuran residue was below the 0.2 ppm tolerance limit. □

Genetic control of isocitrate dehydrogenase (IDH) and malate dehydrogenase (MDH) isozymes in rice brown planthopper (BPH)

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IDH and MDH of BPH are polymorphic, each with at least two electrophoretic variants. We made single-pair crosses of BPH to establish the genetic control of these enzymes.

One hundred pair of BPH biotype 1 were kept in separate test tubes with rice seedlings. The females were all newly emerged. After 3 d, the male parents were collected, frozen, and subjected to starch gel electrophoresis to determine their genotypes. The female parents were transferred individually to mylar cages and collected after 10 d, when they were frozen and subjected to starch gel electrophoresis for genotype identification. Newly emerged progenies from each cross were collected and identified.

The table summarizes the segregation results of the different crosses involving the electrophoretic variants of IDH and MDH. The data are consistent with our

Segregation observed and expected in different crosses made to determine the inheritance of IDH and MDH variation in rice BPH.

Cross		Phenotypes			X^2
Isocitrate dehydrogenase		Idh^{100}	$Idh^{93/100}$	Idh^{93}	
Idh^{100} × Idh^{100}	Obs.	97	–	–	
	Exp.	97	–	–	
Idh^{100} × Idh^{93}	Obs.	–	53	–	
	Exp.	–	53		
Idh^{100} × $Idh^{93/100}$	Obs.	37	33	–	0.23[a]
	Exp.	35	35	–	
Malate dehydrogenase		Mdh^{100}	$Mdh^{100/109}$	Mdh^{109}	
Mdh^{100} × Mdh^{100}	Obs.	177	–	–	
	Exp.	177	–	–	
Mdh^{100} × $Mdh^{100/109}$	Obs.	39	58	–	
	Exp.	48	48	–	3.72[a]
$Mdh^{100/109}$ × $Mdh^{100/109}$	Obs.	24	43	20	
	Exp.	22	43	22	0.38[a]

[a] Not significant at the 5% probability level.

hypothesis that the migration differences observed for both enzymes are each controlled by a single locus with 2 co-dominant alleles. For IDH, these alleles are Idh^{100} and Idh^{93}. For MDH, they are Mdh^{100} and Mdh^{109}. The heterozygotes for the two alleles at the Idh and Mdh loci had an intermediate band in addition to the parental ones, indicating that IDH and MDH isozymes are dimers. We also noted the presence of other rare variants for IDH and MDH which could be codominant with the other alleles of each enzyme. □

Oviposition of brown planthopper (BPH) on some common weeds, wild rices, and rotation crops

S. M. Zaheruddeen and P. S. Prakasa Rao, Central Rice Research Institute, Cuttack, 753006, India

BPH *Nilaparvata lugens* Stål usually lays its eggs in small groups inside the leaf sheath and midrib of rice plants by making an incision and inserting eggs inside the tissues.

We studied BPH oviposition on 52 common rice weeds, 17 wild rices, and 21 crop plants in no-choice tests. Five pair of 1-wk-old BPH adults were confined on young, potted test plants for 4 d. The test plants were examined for oviposition sites and egg hatching every day for 4 d after the first nymphs hatched. If nymphs did not appear, plants were examined with a microscope for unhatched eggs. We had the following results.

There was no oviposition on weeds *Chrysopogon aciculatus, Cynodon dactylon, Eleocharis dulcis, Fimbristylis bisumbellata, F. miliacea, Cyperus kyllingia, Scirpus articulatus, S. supinus, Alternanthera sessilis, Cleome viscosa, Eclipta alba, Euphorbia hirta, Gomphrena celosioides, Marsilea* sp., *Trianthema portulacastrum,* and *Vernonia cinerea.* There was also none on crop plants Indian mustard and East Indian lemon grass.

Oviposition was inside the leaf sheath tissue on the following: weeds *Brachiaria ramosa, B. distachya, Dichanthium caricosum, Digitaria ciliaris, Echinochloa colona, E. stagnina, Eragrostis gangetica, E. pilosa, E. tenella, Leersia hexandra, Leersia perrieri, Leptochloa panicea, Panicum repens, Paspalum scrobiculatum, Paspalidium flavidum, Pennisetum pedicellatum, Rottboellia exaltata,* and *setaria pallide-fusca;* wild rices *Oryza alta, O. australiensis, O. barthii, O. eichingeri, O. collina, O. glaberrima, O. grandiglumis, O. meyeriana* ssp. *granulata, O. latifolia, O. minuta, O. nivara, O. officinalis, O. perennis, O. punctata, O. ridleyi,* and *O. rufipogon;* and on crop plants wheat, barley, oats, finger millet, foxtail millet, koda millet, proso millet, little millet, and Japanese millet.

Oviposition was inside the stem tissue just below the flower head in the weeds *Cyperus compressus, C. difformis, C. distans, C. iria, C. rotundus,* and *C. tenuispica.*

The insect oviposited inside the tender stem tissue of the weeds *Bergia ammannioides, Commelina benghalensis, Heliotropium indicum, Hydrolea zeylanica, Ipomoea reptans, Ludwigia perennis,* and *Sphenoclea zeylanica;* and on crop plants maize, sorghum, pearl millet, peanut, mungbean, black gram, sunn hemp, and jute.

On crop plants sugarcane and napier grass, oviposition was inside the growing bud tissue.

The insect laid naked egg clusters on the leaf lamina of the weeds *Eleusine indica* and *Dactyloctenium aegyptium.* In these weeds the egg groups were deposited on the external surface of the leaf lamina in groups of 7-12, were visible (see figure), and hatched normally. This unusual behavior resulted in exposed eggs which may be available for predators, or contact with insecticides. Irrespective of the site and method of oviposition, all the eggs laid hatched normally at about the same time. □

BPH egg clusters on leaf lamina of a grass weed.

Occurrence of black bug in Tamil Nadu

S. Uthamasamy and V. Mariappan, Tamil Nadu Rice Research Institute, Aduthurai 612101, Tamil Nadu, India

The black bug *Scotinophara lurida* was found in large numbers in 1984 Apr-Jul in Tiruchirapalli District, where about 4,000 ha of rices ADT36, Co 29, and BCPl are grown. There were more black bugs on ADT36 than on Co 29 and BCP1. The bug infested all varieties and caused bugburn in many fields. It infested the crop from 30 d after transplanting to harvest, during which time the population substantially increased. At late flowering stage the population averaged 20 bugs/hill.

Farmers indicated that black bug had regularly infested fields for 3 yr. In Jul-Sep, the insect infested about 800 ha. Farmers often don't see the bug because it lives at the base of the tillers.

Spraying 600 ml fenthion/ha controlled black bug. □

Gall midge (GM) ***Orseolia oryzivora*** **H & G in Zambia**

M. S. Alam, Kaung Zan, and K. AIluri, International Institute of Tropical Agriculture (IITA), Oyo Road, P. M. B. 5320, Ibadan, Nigeria

GM has been reported in eight countries in Africa: Guinea Bissau, Senegal, Mali, Upper Volta, Ivory Coast, Nigeria, Cameroon, and Sudan. It is a localized pest of lowland irrigated rice except in Upper Volta where it is one of the most serious and widespread insect pests in irrigated and rainfed lowland rice.

In Apr 1984 IRRI and IITA organized a monitoring tour in Zambia and Tanzania. The tour group visited five rice projects in Zambia and observed GM in all lowland irrigated rice. GM incidence was very high in Turners Asbestos Products Projects and at the National Irrigation Research Station.

The GM collected from Zambia was identified as *Orseolia oryzivora* by the Commonwealth Institute of Entomology, London. This species was identified from the collections in the Lake Chilwa area of Malawi in 1974. These findings suggest that GM is distributed throughout the Guinea savannas of Africa. □

Chemical control of grasshoppers in Pakistan

M. A. Zafar, senior subject matter specialist in plant protection, Agricultural Adaptive Research Farm (AARF), Sheikhupura, Pakistan

In some years, grasshopper *Hieroglyphus* spp. cause significant losses to rice nurseries and crops in Pakistan. In 1982 we tested four dusts in doses generally recommended in treatments for grasshopper control at AARF.

Grasshoppers were collected from rice fields and reared at room temperature to achieve a large population of adults of uniform age and size, The dusts were cotton dust (6.3% BHC + 10.4% DDT + 83.3% sulfur), BHC l0%, 1:3 mixture of BHC 10% + DDT l0%, and carbaryl 10%. They were sprinkled on the grasshoppers and rice leaves. In the first trial, 100 grasshoppers were kept in a glass jar without food for 24 h, then were released on fresh food. In the second trial grasshoppers were caged on dusted leaves of plants. Insect mortality was recorded 1, 3, 6, 12, and 24 h after treatment. The experiment was in a randomized block design with three replications.

With direct dusting, all grasshoppers died in 3 h. With foliar dusting, they died in 12 h. All the dusts were effective (see table). □

Grasshopper control with different insecticide dusts.[a] AARF, Pakistan.

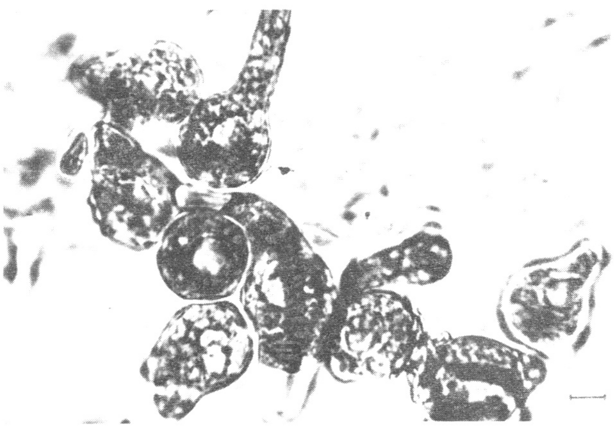
Dust	Dosage	Mortality (%) at indicated hours after treatment				
		1	3	6	12	24
	g/100 grasshoppers	*Direct dusting on grasshoppers*				
Cotton dust[b]	10	13.7	100	100	100	100
BHC 10%	10	22.3	100	100	100	100
BHC 10% + DDT 10% 1:3 mixture	10	18.0	100	100	100	100
Carbaryl 10%	10	16.3	100	100	100	100
Untreated control	–	0.0 a	0.0a	0.6a	0.0a	1.3a
LSD at 5%		7.4	20.9	21.3	28.6	16.8
	kg ai/ha	*Feeding on dust-impregnated nursery leaves*				
Cotton dust[b]	7.20	3.0	42.7	85.0	100	100
BHC 10%	0.75	8.7	49.7	88.3	100	100
BHC 10% + DDT 10% 1:3 mixture.	0.31 + 0.94	5.0	41.0	76.3	100	100
Carbaryl 10%	2.00	8.3	46.3	81.7	100	100
Untreated control	–	0.0a	0.0a	0.3a	1.6a	1.3a
LSD at 5%		6.0	9.3	13.7	15.4	33.8

[a]In each column, averages followed by common letters are significantly similar at 95% level of confidence. [b]Cotton dust is a brand name for the mixture of BHC + DDT + sulfur (3:5:40); the dose of 7.2 kg ai/ha is based on the 48% active ingredient in the formulation.

***Entomophaga grylli* destruction of locust *Oxya-hyla intricata* in Vietnam**

J. Weiser, V. Matha, N. D. Tryachov, and I. Gelbic, Institute of Entomology, Academy of Science, Prague, Czechoslovakia

The fungus *E. grylli* (Fres.) Batko is the most common Entomophthorales fungus and often is associated with locust and grasshopper outbreaks. Data from Southeast Asia describe an outbreak of *E. grylli* in a *Patanga succinata* population on maize east of Lopburi Province in Thailand. By the end of the rainy season, the fungus had destroyed 90% of the locust population and was found in 9 other acridid pests in Thailand.

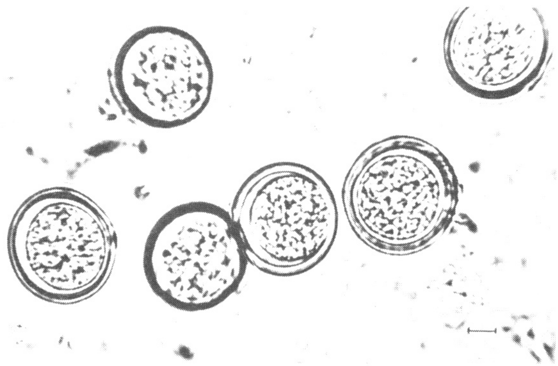


1. Germinating conidia of *E. grylli* on the wing of *O. intricata* Scale = 10 µm.

O. intricata Stål is widely distributed in Southeast Asia — Burma, Thailand, Vietnam, West Malaysia — and some parts of South China. It damages rice and several other crops.

In autumn 1983, dense *O. intricata* populations seriously damaged rice around Hanoi, Vietnam. *E. grylli* infected 85-90% adults and nymphs, which died on the plants. Masses of conidiophores with conidia appeared on the intersegmental membranes (Fig. 1) and on all thin cuticular areas of the head. Conidia of the papillata type of Lakon, 30-40 × 25-36 µm spread over dead insects and plants. Their length-to-breadth ratio varied. Uniform resting pores 30-40 µm in diam developed inside the infected locusts (Fig. 2).

E. grylli may be an important natural enemy of this locust in local outbreaks. □



2. Resting spores of *E. grylli* from the interior of dead *O. intricata.* Scale = 10 µm.

Effect of planting time on rice panicle bug incidence

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Rice panicle bug *Leptocorisa acuta* (Thumb) is becoming a major rice pest in Tamil Nadu in the Dec-May and Apr-Aug cropping seasons. Adults and nymphs suck sap from developing grains and cause significant yield loss.

We studied the effect of planting time on panicle bug incidence in a field trial with seven planting dates and four replications in 1983-84 Dec-May season. Twenty-five-day-old, short-duration TM8089 seedlings were planted in 9-m^2 plots at 20- × 10cm spacing. Plots were fertilized with 100 kg N/ha (50% basal and 2 equal splits topdressed) and 22-42 kg PK/ha. No crop protection was practiced.

Feeding activity was assessed at harvest by counting the insect's stylet sheaths in the grains obtained from five randomly selected panicles from each plot. Undamaged and damaged grains were counted and damage percentage was calculated. Grain yield also was recorded (see table).

The crop planted on 30 Jan had lowest grain damage and yielded highest. At 20-30% grain damage, yield ranged from 4.3 to 4.5 t/ha. When damage exceeded 30%, yield fell to 3.1-3.7 t/ha. Very early and very late crops were prone to panicle bug attack. □

Effect of planting time on rice panicle bug incidence Tirur, India.

Planting date	Damage grain (%)	Grain yield (t/ha)
31 Dec 83	34	3.1
10 Jan 84	29	4.4
20 Jan 84	42	3.7
30 Jan 84	17	5.4
10 Feb 84	23	4.5
20 Feb 84	25	4.3
1 Mar 84	34	3.7

A new record of rice shoot fly in the northwestern hills of India

D. K. Garg, Vivekananda Laboratory for Hill Agriculture, Indian Council of Agricultural Research, Almora 263601, India

During a survey of rice nurseries in experimental field plots at Hawalbagh in 1983 kharif (May-Oct), we found plants of various entries yellowed and dried in patches. Plants had deadhearts and small, whitish maggots were recovered from the base of the stems. The maggots were reared in petri dishes and flies emerged and were identified as rice shoot fly *Atherigona oryzae* Mall. This is the first recorded occurrence of *A. oryzae* in the northwestern hills of India.

Newly hatched shoot fly maggots bore into the stems of young plants and feed inside the central shoot, severing the apical parts of the plant from the base. The leaf whorl fails to unfold, dries, and falls off.

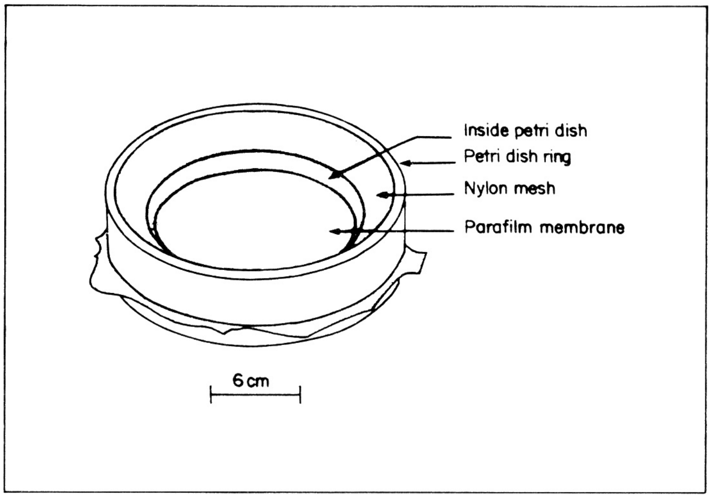
Preliminary field observations showed that maximum infestation was 3-4 wk after sowing. Rice planted early, in the first week of May, was more severely damaged than normal plantings in the last week of May. There was no infestation in the transplanted crop. □

Mortality of adult brown planthoppers (BPH) in different types of cages used for bioassays of entomopathogenic fungi

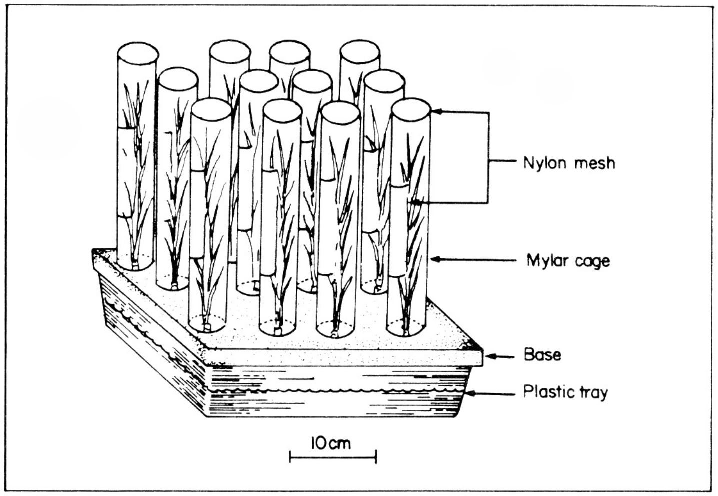
R. M. Aguda, senior research assistant, IRRI; M. C. Rombach, research associate, Boyce Thompson Institute (BTI) and Collaborative research fellow, IRRI; B. M. Shepard, entomologist, IRRI; and D. W. Roberts, insect pathologist, BTI

Many hyphomycetous fungal pathogens of the BPH *Nilaparvata lugens* Stål and related leafhopper species have been collected and isolated on artificial media. A suitab1e bioassay test is necessary to determine the most virulent species and strains of these entomopathogens for use in a biological control program against BPH. In addition, standardized bioassay techniques that minimize mortality are essential to developing programs for subsequent production and field application of the fungi.

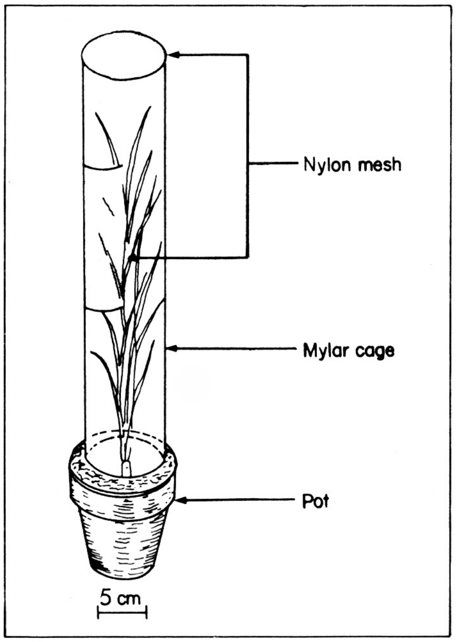
Entomopathogenic fungi invade the insect host through the cuticle, grow in the body cavity, and eventually kill the host. BPH fungal pathogens normally kill the host in 2-7 d. During this time,



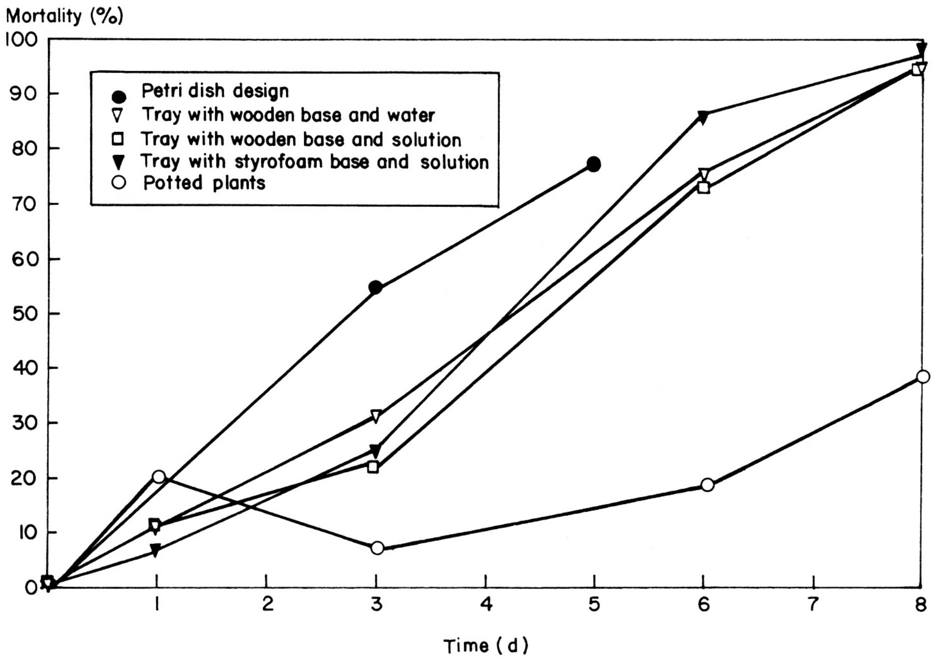
1. A petri dish cage containing a parafilm sachet with 10% sucrose solution as food source.



2. Rice plants rooted in a plastic tray with a nutrient salt solution or water The cages are attached to a wooden or Styrofoam base.



3. Rice plants covered with mylar cages in clay pots.



4. BPH mortality in different types of cages.

the BPH must be caged on suitable food until the fungus has time to act.

We tested three cage types for suitability in reducing mortality of the control BPH during the bioassay test period. The first (Fig. 1) was constructed from petri dishes and the BPH fed on a sachet containing a 10% sucrose solution. The second (Fig. 2) used living rice plants placed on trays and rooted in a nutrient salt solution or water. Plants in each replication were covered with cylindrical mylar cages attached at the base by masking tape and vented with nylon screen. The two design had wood or Styrofoam bases.

A third cage (Fig. 3) consisted of potted plants covered by mylar cages. Pots were set inside plastic trays and flooded with water up to the soil surface in each pot. Plants (cultivar IR1917) were about 30 d old. Initially, at least 20 cages of each type each contained 25-35 newly emerged BPH adults. At each interval, 10 cages of each type were evaluated for BPH mortality.

There were no significant differences in BPH control mortality in cages with wood or styrofoam bases or with water versus the nutrient salt solution at 1 d (Fig. 4). But after 3 d incubation at ambient room temperature, mortality was unacceptably high (more than 20%) in all cages except those with potted plants. Mortality in the petri dish-sucrose cages was highest, with more than 50% of the BPH population dying after 3 d. Hopper mortality on potted plants did not exceed 20% even after 6 d. □

Cryptoblabes gnidiella, an azolla pest on rice in India

S. Sasmal and J. P. Kulshreshtha, Entomology Division, Central Rice Research Institute (CRRI), Cuttack 753006, India

Use of azolla, an N-fixing fern, is increasing in India. Effective insect control is essential to successful azolla cultivation. *Cryptoblabes gnidiella* Lep. Pyralidae is a major pest of azolla and sorghum in India, but has not been reported to attack rice.

During azolla multiplication in transplanted rice fields at CRRI in 1983 rabi and kharif, *C. gnidiella* larvae moved from the azolla mat onto rice tillers, joined 3-4 leaves or folded a single leaf, formed a pupal case, and pupated (see figure). The larvae did not feed on the rice leaves. Three to seven larvae pupated in each rice hill depending on the level of azolla infestation. Infested plants looked similar to leaffolder-infested plants. The pupal period lasted 7 to 12 d. □

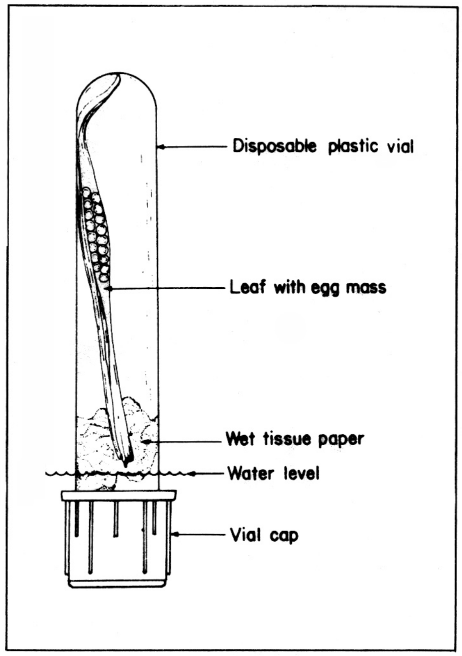
Rice leaves folded by mature *C. gnidiella* larvae, Orissa, India, 1983.

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

A method for holding eggs of rice insect pests for parasite emergence

A. T. Barrion, and J. A. Litsinger, Entomology Department, IRRI

The most common technique for holding insect eggs for parasite emergence is placing the cut plant part in a petri dish lined with moistened cotton or filter paper, or inside a test tube with a small amount of water at the bottom and plugged with cotton on top. Two problems occur: 1) rice leaves dry in a week, and 2) parasites become tangled in the cotton wadding. We developed an improved method (see figure) that keeps leaves green for 15 d, which is sufficient for parasite emergence. The freshly cut leaf with eggs is put inside a vial which is plugged with wet tissue paper. The vials are kept open end down in a jar or basin with 5 mm water for continual wetting. □



Setup for prolonged rearing of insect eggs on a cut rice leaf.

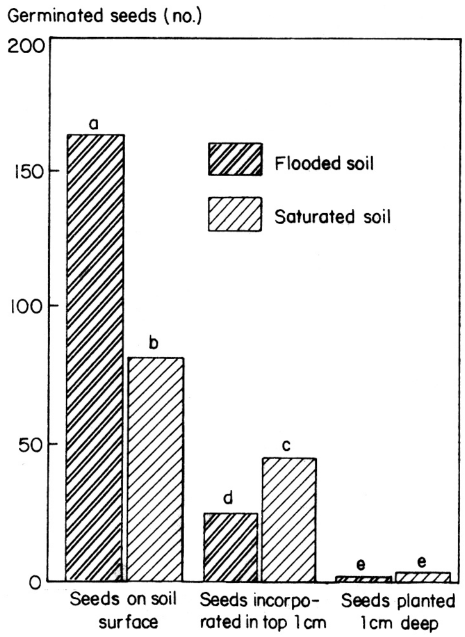
Effect of soil moisture and burial on germination of *Cyperus difformis* seeds

R. T. Lubigan, IRRI; B. L. Mercado, University of the Philippines at Los Baños; and K. Moody, IRRI

Cyperus diffomis L. is one of the commonly occurring annual sedge weeds in transplanted rice in South and Southeast Asia because it is a prolific seed producer. We studied the effect of seeding depth, moisture regime, and light on *C. difformis* germination.

Soil was placed in 10.2-cm-high, 7.6-cm-diam plastic cups. Ten mg of seeds were broadcast on the soil surface, mixed with the top 1 cm of soil, or planted 1 cm below the surface. The soil was saturated or flooded with 1 cm of water. The treatments were replicated three times in a randomized complete block design. Germinated seeds were counted 15 d after seeding. We studied the effect of different light intensities on germination in a separate experiment and found that light is needed for germination.

Under flooded and saturated conditions, seed germination was highest when seeds were broadcast on the soil surface and least when the seeds were placed 1 cm below the soil, indicating that light is needed for germination (see figure). This observation was confirmed in the other study where no seeds germinated when soaked seeds were kept in the dark.



Germination of *Cyperus difformis* seeds as affected by seeding method and moisture regime. Means with a common letter are not significantly different at the 5% level.

When the seeds were broadcast on the soil surface, germination was significantly higher in flooded soil than in saturated soil, indicating that high moisture favors germination. For seeds mixed in the top 1 cm of soil, germination was significantly higher in saturated than in flooded soil, indicating the need for oxygen in addition to light for germination. Flooding restricts oxygen diffusion into the soil profile. Therefore, the oxygen content of soil close to the surface was probably higher under saturated than under flooded conditions.

Few seedlings emerged when the seeds were placed 1 cm deep. Lack of light, low oxygen concentration, increasing carbon dioxide concentration, and toxic gaseous products of anaerobic decomposition were probably involved. Thus, germination of *C. difformis* can be substantially reduced by flooding and deep plowing. □

Pest Control and Management

WEEDS

Effect of preemergence herbicides on *Echinochloa crus-galli* (L.) Beauv. and *Cyperus difformis* L. in transplanted rice

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In 1982 monsoon season we studied the efficacy of individual and combinations of herbicides molinate + 2,4-D, oxyfluorfen, oxadiazon, thiobencarb, butachlor, pendimethalin, and 2,4-D sodium salt.

Weeds in the experiment field were grasses *Echinochloa crus-galli* (L.) Beauv., *E. colonum* (L.) Link, *Paspalum* sp.; sedges *Cyperus difformis* L., *C. iria, Fimbristylis miliacea* L., and *Scirpus* sp.; and broadleaves and aquatics *Eclipta* alba (L.) Hassk, *Ammannia baccifera* L., *Marsilea quadrifolia* L., *Monochoria vaginalis* L., *Rotala densiflora,* and *Ludwigia parviflora. E. crus-galli* and *C. difformis* predominated and were effectively controlled by the herbicide treatments.

Effect of preemergence herbicides on weeds and transplanted rice, Coimbatore, India.[a]

Treatment	Herbicide dose (kg ai-ae/ha)	Weeds/m^2 at 30 DT: *E. crus-galli*	Weeds/m^2 at 30 DT: *C. difformis*	Weeds/m^2 at 30 DT: Total grass, sedge, and broadleaves	Total weed dry matter (g/m^2) at 30 DT	Productive tillers (no./m^2)	Grain yield (t/ha)
Molinate + 2,4-D	1.5 0.5	4	–	25	3	396	4.7
Molinate + 2,4-D	2.0 0.5	7	9	29	6	420	5.0
Molinate + 2,4-D	2.5 0.5	5	12	49	7	400	4.4
Oxyfluorfen	0.15	27	12	49	16	380	4.4
Oxadiazon	0.75	–	4	19	8	444	5.4
Thiobencarb	1.5	5	15	44	9	416	5.1
Butachlor	1.5	12	17	77	8	420	4.8
Pendimethalin	1.25	7	13	25	5	464	5.5
2,4-D sodium salt	0.8	9	19	43	7	424	4.0
Hand weeding at 15 and 35 DT		21	4	112	6	420	5.0
Unweeded control		57	52	128	14	336	3.5
CD		3	3	29	2	44	0

[a] DT = days after transplanting.

Molinate + 2,4-D gave a broad spectrum of weed control. Molinate + 2,4-D, oxadiazon, and pendimethalin reduced weed dry matter production and increased productive rice tillers. Preemergence application of pendimethalin at 1.25 kg/ha followed by one hand weeding gave the highest grain yield (5.5 t/ha), followed by oxadiazon 0.75 kg/ha (see table). □

Major lowland rice weeds of Koraput District, Orissa

G. K. Patro and U. C. Panigrahi, Regional Research Station, P. B. No. 10, Sunabeda 2, Orissa, India

Rice is the major kharif crop in the lowlands of Koraput District. Weed population in blocks throughout the district was randomly sampled in 1982 and 1983 and the following weed groups were identified as the most common and problematic in rainy season. There were 31 problem weeds — 12 sedges, 10 grasses, 8 broad-leafed weeds, and 1 fern.

Sedges. *Cyperus rotundus, C. iria, C. imbricatus, C. amabilis, C. exaltatus, C. diffomis, C. compactus, C. articulatus, Fimbristylis dichotoma, F. miliacea, Rhynchospora corymbosa, Scirpus articulatus.*

Grasses. *Echinochloa colona, E. crus-galli, Brachiara distachya, Leptochloa chinensis, Digitaria sanguinalis, Eleusine indica, Dactyloctenium aegyptium, Panicum texanum, Eragrotis atrovirens, Oryza sativa* (wild rice).

Broad-leafed weeds. *Commelina diffusa, Ludwigia perennis, Sesbania exaltata, Aeschynomene indica, Heteranthera reniformis, Oxalis corniculata, Hydrolea zeylanica, Portulaca oleracea.*

Fern. *Marsilea quadrifolia.* □

Environment and Its Influence

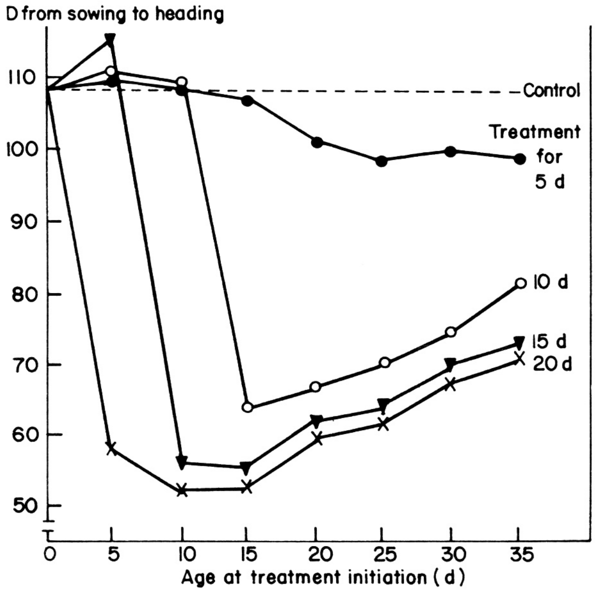
Flowering response of BPI-76 to 8-hour photoperiod

Sheng-Xiang Tang, China National Rice Research Institute, Hangzhou, China; and T. T. Chang, IRRI

We reexamined the effect of 8 h daylength on the flowering behavior of photoperiod-sensitive BPI-76 at 29-21 °C day/night temperature. Seedlings were sown in mid-Jul 1983 and grown under natural daylength. Plants aged 5, 10, 15, 20, 25, 30, and 35 d were subjected to 8-h daylength for 5, 10, 15, and 20 d. After the treatments, plants grew to flowering under natural daylength.

Five-day-old seedlings treated for 5, 10, and 15 d had delayed heading of 1.3, 1.9, and 5.7 d compared with untreated plants (108.5 d after sowing). Twenty-day treatment caused plants to head significantly earlier—at 56.3 d after sowing.

Ten-day-old seedlings treated for 15 d and 15-d-old seedlings treated for 10 d headed 50.7 and 44.8 d earlier than untreated plants. Treating 10- to 35-d-old seedlings for 5 d had almost no effect (see figure).



Number of days from sowing to heading of BPI-76 at an 8-h daylength for 5, 10, 15 and 20 d at various seedling ages, IRRI.

The short-day treatment for 20 d appeared to have the most distinct effect of shortening growth duration, and 15-d-old seedlings were most susceptible to 10-20 d short-day treatment. Our findings agreed with an earlier study by Vergara and Lilis. □

Effect of 24-hour photoperiod during booting on panicle development of four rices

Sheng-Xiang Tang, China National Rice Research Institute, Hangzhou, China; and T. T. Chang, IRRI

Photoperiod-sensitive varieties BPI-76, Wan-Xian 9, and Nong-Hu 6, and photoperiod-insensitive Lian-Tang-Zao were subjected to 10-h daylength after seeding in a 26°C glasshouse. At panicle initiation, one set of plants was exposed to 24-h photoperiod (10-h natural daylength plus 14-h artificial light at 1000 lux). A control set was continually exposed to 10-h daylength. Panicle development of 5 main shoots of dissected plants was examined by microscope every 2 d. The codes for describing floral stages in the apical bud ranged from 1 to 8.

The 24-h photoperiod delayed floral development 4 d after treatment in Nong-hu 6, but did not affect Wan-Xian 9 and BPI-76. The inhibitory effect gradually increased with the number of exposure days. Twenty days after treatment, the floral stage of BPI-76 reached 7.8 in the control but only 5.6 in treated plants. Similar differences were obtained in Wan-Xian 9 and Nong-Hu 6. The inhibiting effect appeared to be stronger in the sinica variety Nong-Hu 6 than in the other indica varieties. The treatment did not affect panicle development of Lian-Tang-Zao (see table).

Panicle development of rice plants under 10-h and 24-h photoperiod, IRRI.

Exposure days	Panicle development stage							
	Lian-Tang-Zao		Wan-Xian 9		BPI-76		Nong-Hu 6	
	10-h	24-h	10-h	24-h	10-h	24-h	10-h	24-h
0	1.1	1.1	0.8	0.8	1.0	1.0	0.9	0.9
2	2.4	2.3	2.2	2.2	2.3	2.4	2.5	1.5
4	2.9	2.9	3.4	3.4	2.7	2.7	3.1	2.1
6	3.5	3.4	4.0	3.6	3.2	3.0	3.3	2.7
8	4.3	4.5	4.8	3.7	3.8	3.2	3.8	2.8
10	4.4	4.8	5.8	3.9	4.0	3.3	4.2	2.9
12	4.7	4.9	6.3	5.3	4.9	3.9	5.8	3.6
14	5.9	6.1	7.7	6.0	6.1	4.0	6.9	3.6
16	6.6	6.7	7.7	6.4	6.4	4.2	7.2	3.9
18	7.4	7.7	8.0[a]	6.9	7.3	4.7	7.5	4.6
20	7.7	7.9	8.0	7.6	7.8	5.6	7.7	4.8

[a] Stage 8 = just heading.

The 24-h photoperiod prolonged the booting period and decreased the uniformity of panicle exsertion in the photoperiod-sensitive varieties, indicating that short photoperiod during booting favors rapid, uniform panicle development. □

Soil and Crop Management

Nitrogen sources for lowland rice

V. Velu and K. M. Ramanathan, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

We evaluated different fertilizer N sources for efficiency in a flooded lowland soil in a farmer's field in Mahendrapalli, Kullankar, India, in 1981-82. IR20 was planted and 60-13-25 kg NPK/ha was applied. Soil was a silty clay with pH 7.2, EC 0.8 mmho/cm, 1.9% organic matter, and 329, 21.3, and 159 kg available NPK/ha.

Rice yield and available soil N at different crop stages as influenced by the different N fertilizers are in the table. Urea supergranule (USG) gave better yield than farmyard manure (FYM) and the no-N control, but was on par with lac-coated urea, urea best split, neem cake-coated urea, and basal urea. Thorough incorporation of basal urea may have reduced N losses and made it perform better than was expected. We concluded that applying N as any of these sources could increase rice yields.

In terms of maintaining soil fertility, USG was superior to other treatments. It was on par only with lac-coated urea. ☐

Effect of different N sources on rice yield and available soil N.

Treatment	Grain yield (t/ha)	Soil available N (kg/ha)			
		Tillering	Panicle initiation	Post-harvest	Mean
Control (0, 30, 30 kg NPK/ha)	5.0	319	313	312	314
Urea best split (50% basal + 25% at tillering + 25% at panicle initiation)	6.3	353	336	321	337
50% N as FYM at puddling + 50% N as basal urea	5.8	355	350	345	350
USG	6.5	421	364	342	376
Neem cake-coated urea at planting	6.1	366	347	323	345
Lac-coated urea at planting	6.3	396	342	323	357
Urea N at planting	5.9	382	333	328	348
		Stages	Treatments	$S \times T$	
CD	0.6	13	23	39	
CV%	6.0	–	7.0	–	

An integrated nutrient supply system for higher rice production

P. A. Joseph, junior assistant professor, and T. F. Kuriakose, rice project coordinator, Agricultural Research Station, Mannuthy, Kerala, India

Eupatorium odoratum is a noxious, fast growing weed in the humid tropics. We studied the value of *E. odoratum* compost for improving rice production.

Eupatorium and/or gliricidia compost was prepared with cow, goat, pig, or poultry manure (see table). The NPK contents of the composts, determined by chemical analysis, were almost identical.

A field experiment to determine their effect on rice growth was conducted in a randomized complete block design with three replications. Jyothi, a 110-d rice, was transplanted in Sep 1983. Different composts were applied basally at 6 t/ha and 70-35-35 kg NPK/ha was applied to provide adequate fertilization. Control plots received only NPK.

All composts in combination with NPK increased grain yield compared with NPK application alone (see table). Ordinary farm compost made from farm waste and cow manure performed best, but was on par with eupatorium or gliricidia with pig manure and 50% eupatorium + 50% gliricidia with goat manure. ☐

Average grain yield of rice as influenced by various composts, Kerala, India.

Treatment	NPK (%) in the composts			Yield (t/ha)
	N	P	K	
Eupatorium + cow manure	0.8	0.29	0.42	5.5
Gliricidia + cow manure	0.78	0.26	0.43	5.1
Eupatorium 50% + gliricidia 50% + cow manure	0.66	0.25	0.39	5.3
Eupatorium + goat manure	0.58	0.26	0.46	5.1
Gliricidia + goat manure	0.70	0.29	0.50	5.4
Eupatorium 50% + gliricidia 50% + goat manure	0.8	0.23	0.37	5.6
Eupatorium + poultry manure	0.65	0.33	0.40	5.2
Gliricidia + poultry manure	0.6	0.22	0.60	5.1
Eupatorium 50% + gliricidia 50% + poultry manure	0.58	0.26	0.46	5.1
Eupatorium + pig manure	0.72	0.20	0.56	5.5
Gliricidia + pig manure	0.8	0.32	0.66	5.7
Eupatorium 50% + gliricidia 50% + pig manure	0.65	0.21	0.56	5.4
Ordinary farm compost	0.8	0.33	0.95	6.2
70 - 35 - 35 kg NPK/ha	–	–	–	3.7
CD (0.05)				0.7

Effect of chemical seed treatments on productivity of upland rice

C. Kundu and S. Biswas, Rice Research Station, Chinsurah, India

Studies at the College of Agriculture, Calcutta University, showed that soaking stored seeds of various crops in water or solutions of certain chemicals for 2 to 3 h followed by drying greatly minimized the loss of vigor and viability during subsequent storage under natural conditions. We evaluated the hydration-dehydration seed treatment with and without chemicals and dry-dressing with calcium peroxide for improving yield of upland rice.

Five-month-old IR50 and CR237-1 seeds were soaked for 2.5 h in water or chemical solutions of different concentrations and then dried to their original weight. Seeds were dry-dressed in the calcium peroxide treatment. The experiment was under strict rainfed conditions in a randomized block design with three replications. Varieties were direct-seeded in lines at 20-cm between-row spacing.

The treatments significantly increased the number of panicles/m^2 and yield of both varieties (see table). The sodium chloride treatment was best, followed by ethephon. Both treatments were significantly better than hydration alone. Simple hydration increased yield about 10% over the untreated control. The physicochemical basis of the beneficial effects is not yet understood. □

Effect of seed treatment on rice growth and yield, Chinsurah, India, 1983.

Treatment	Panicles/m^2		Yield (t/ha)	
	CR237-1	IR50	CR237-1	IR50
Control	377	441	2.5	2.2
Water	405	472	2.7	2.5
Disodium phosphate (2×10^{-3} M)	426	510	3.0	2.7
Sodium chloride (5×10^{-3} M)	438	539	3.1	2.8
Potassium meta bisulfide (5×10^{-3} M)	419	490	2.9	2.5
Calcium peroxide (100 mg of CaO_2/g of seed)	414	464	2.9	2.5
Ethephon (10 ppm)	452	531	3.1	2.0
CD (0.05)	28		0.2 t/ha	

Efficiency of modified-urea materials applied at different N levels in lowland rice in the Cuu Long Delta

B. K. Singh, Pham Sy Tan, and Nguyan Thi Thu Hong, Cuu Long Delta Rice Research Center, Oman, Hau Giang, S. R. Vietnam

In 1983 wet season, we evaluated the efficiency of prilled urea (PU), sulfur-coated urea (SCU), and urea supergranules (USG) at 29, 58, 87, and 116 kg N/ha in lowland transplanted rice in a randomized complete block design with 3 replications. A no-N control was included to compute the efficiency of the treatments. The soil of the experimental plot was clayey with 0.18% total N, 0.04% total P, 0.77 meq Al^{3+}/100 g soil, and pH 4.6. Twenty-eight-d-old seedlings of early-maturing OM33 were transplanted on 1 Aug 1983 at 20- × 20-cm spacing using 2 seedlings/hill. All plots received 18 kg P/ha as superphosphate at transplanting. PU was broadcast in 2 splits: 2/3 at transplanting + 1/3 at panicle initiation. SCU was broadcast at transplanting, and USG was placed 8-10 cm deep in the center of 4 hills in alternate rows 6 d after transplanting. The soil was flooded from transplanting to maturity. The crop was harvested on 27 Oct 1983.

Effect of modified-urea materials, applied at varying N rates, on grain yield and yield attributes of rice at Oman, Vietnam, 1983 wet season.

N level (kg/ha)	Form of urea material	Panicles/ m^2	Spikelets/ panicle	Unfilled spikelets (%)	1,000-grain wt (g)	Grain yield (t/ha)
0 (control)	None	256	62	17	26	3.1
29	PU	293	68	17	27	3.6
	SCU	309	73	19	27	4.4
	USG	311	72	20	27	4.3
58	PU	304	71	20	27	3.9
	SCU	339	72	25	27	4.1
	USG	342	74	22	27	4.1
87	PU	349	73	22	27	4.3
	SCU	347	73	26	27	3.8
	USG	346	76	24	26	3.9
116	PU	357	70	27	28	3.9
	SCU	356	73	28	28	3.8
	USG	345	71	27	27	3.7
LSD (0.05)		41	9	7	NS	0.5

[a]PU = prilled urea, SCU = sulfur-coated urea, USG = urea supergranules.

At 29 kg N/ha, rice yields with SCU and USG were similar and significantly superior to those with PU (see table). At 58, 67, and 116 kg N/ha, PU, SCU, and USG did not differ significantly. Applying 29 kg N/ha as SCU or USG gave a yield response similar to that with 87 kg N/ha as PU. We observed a decreasing trend in grain yield with SCU and USG after 29 kg N/ha. With PU, yield increased to 87 kg N/ha and was significantly higher than that obtained with 29 kg N/ha. Plant height, spikelets/panicle, and 1,000-grain weight were not affected by N sources. Panicles/m^2 increased with increasing N supply. Reduced grain yield with SCU and USG at higher N levels was caused by a higher percentage of unfilled spikelets.

The grain yield-predicting equations for different urea materials were as follows:

PU : $\hat{Y} = 3021 + 28.35\ X - 0.1765\ X^2$

SCU : $\hat{Y} = 3323 + 29.15\ X - 0.2253\ X^2$

USG : $\hat{Y} = 3281 + 28.99\ X - 0.2253\ X^2$

where Y is expected grain yield (kg/ha) and X is kg N/ha. □

Effects of Zn application on direct-seeded rice in some alkaline soils in West Bengal

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As a part of the program to introduce modern rice varieties (MV) and optimum management practices to increase rice production in an integrated rural development project in West Bengal, we organized demonstration trials using different short-duration MVs in 1982 prekharif. The local farmers primarily grow a nondescript variety called IRRI that came from Bangladesh. It has short duration and fairly stable yields but is highly susceptible to many diseases and insect pests.

Nonreplicated demonstration trials were laid out in seven villages and compared IR36, IR50, and MWl0 with the local IRRI.

Each variety was planted on 400 m^2 in each trial plot. Results from 16 trial plots grown by farmers of diverse socio-economic groups were averaged (see table). Because the local variety had Zn deficiency symptoms, Zn was applied in the trials.

Yield and ancillary characters of direct-seeded shortduration MVs and the effect of Zn application, West Bengal, India.[a]

Variety	Plant ht (cm)		Effective tillers/ hill		Spikelets (no./ panicle)		Spikelet sterility (%)		Grain yield (t/ha)		Straw yield (t/ha)		Duration (d)	
	C	T	C	T	C	T	C	T	C	T	C	T	C	T
IR36	85	90	18	22	75	132	18	18	3.6	4.6	2.8	3.2	103	105
IR50	90	90	28	28	183	185	55	20	3.0	4.0	2.5	2.8	105	105
MWl0	100	107	24	25	154	162	40	10	4.1	4.8	5.2	5.2	103	105
IRRI	75	82	16	18	102	105	22	12	2.7	3.0	3.0	3.2	105	107

[a] C = water-sprayed plot, T = Zn-sprayed plot.

Soils varied from heavy clay to loam, pH from 7.0 to 8.0, EC_e from 0.02 to 0.18 dS/m, organic carbon from 0.17 to 0.50%, available P from 18 to 70 kg/ha, and available K from 99 to 330. Five t farmyard manure/ha and 12-11-21 kg NPK/ha were applied basally. Aldrin 5% at 35 kg/ha was applied at land preparation. Seeds pretreated with 1 g carbendazim/kg were dibbled, 5-6 seeds/hole, at 20- × 5-cm spacing and thinned to 3 seedlings/hole 15 d after emergence. Manual weeding was done at 20 and 40 d after sowing when 25 and 13 kg N/ha were applied. $ZnSO_4$ at 1% was sprayed on plants 30 and 45 d after sowing as a half-plot treatment. Water was sprayed in the other half-plot. Plots were sown from 12 May to 2 Jun 1983. Yield data were recorded from the subplot and from 10 randomly selected plants from each subplot. Each subplot was considered a replication.

All three MVs yielded more grain than IRRI. MW10 yielded more straw than the other varieties. Applying Zn decreased spikelet sterility in IR50 and MW10, but not in IR36, perhaps because IR36 flowered unevenly. Zn application did increase the number of effective tillers and spikelets per panicle in IR36. Applying 16 kg $ZnSO_4$/ha in two 8-kg applications increased net profit on the rice crop by $100/ha. □

Rice ratoon crop root systems

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

Ratooning, the ability of the rice plant to regenerate tillers after harvest, is affected by many main crop environmental factors and cultural practices. Of several factors that determine ratooning potential, root vigor and distribution are probably very important.

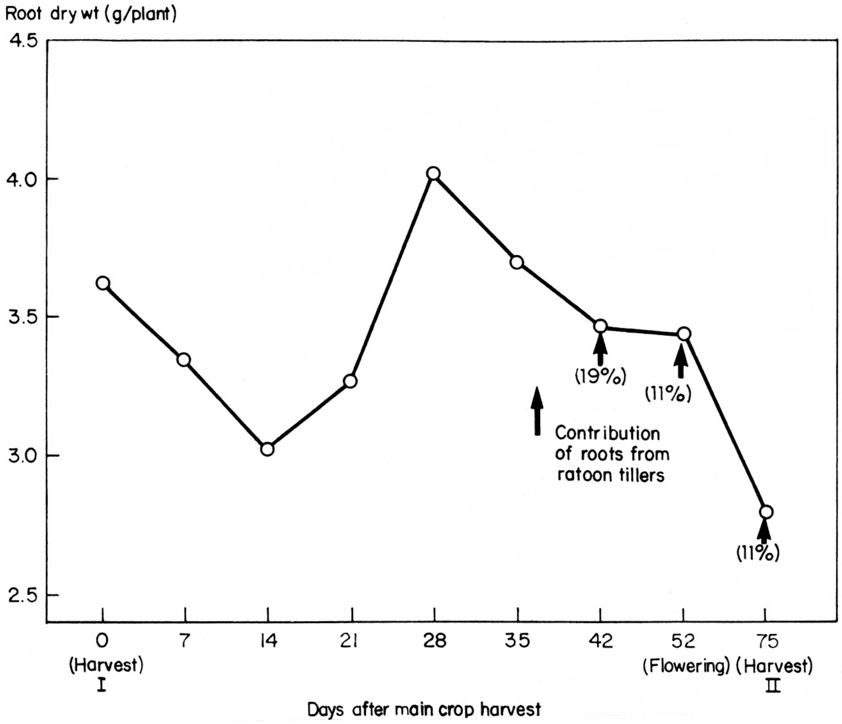
We investigated the root distribution and changes in root dry weight of an IR44 ratoon crop at the IRRI farm in 1983 wet season. Mature plants were ratooned by cutting the stalks 15 cm above the ground. Immediately after, 40 kg N/ha was topdressed. During main crop harvest wooden planks were used to minimize root damage. Ten plants were randomly selected at each sampling date, and plant and soil were removed to about 20-cm depth. Roots were washed and rated for distribution, then clipped and dried at 70°C to a constant weight. Roots from the mother culms and those from the ratoon tillers were separated 42 d after harvest (DH), at ratoon flowering (53 DH), and at ratoon harvest (75 DH).

At main crop harvest and up to 35 DH, 70-80% of the roots were reddish brown. A few plants had pale brown roots at main crop harvest. The proportion of black (dead) roots increased with age. Some (1 to 5%) white (new) roots developed from nodes close to the ground. A fairly high (40 to 80%) amount of dead roots was observed from 35 to 75 DH. Beyond 42 DH, most plants had well-developed white roots from ratoon tillers, but some ratoon tillers lacked roots, indicating complete dependence on the main crop roots for nutrients.

Root dry weight differed significantly during ratoon development and growth. Root dry weight declined from 0 to 14 DH (see figure) because the nutrients for initial ratoon growth are supplied by the mother culms and roots. Part of the decrease may also be attributed to the death and decay of old roots. Root dry weight increased from 14 DH to 28 DH, and then declined gradually up to 75 DH. New roots developed 14-28 DH, but they grew very slowly. Plants exhibited roots from the ratoon tillers at 21 DH. Rooting was more profuse and rapid from lower ratoon tillers than from upper tillers. The mean dry weight of roots from ratoon tillers was 11-19% of the total dry weight at 42 DH, ratoon flowering, and harvesting.

Total root dry weight decreased after 28 DH perhaps because main crop roots were decaying as evidenced by 75 to 85% dead roots at ratoon harvest.

Ratoon tiller development in IR44 appears to depend on the main crop root system for nutrients at least up to 21 DH. Thereafter, the requirements were partially supplemented by new roots from ratoon tillers. However, the contribution of new roots seems very low. It is suggested that care be taken to avoid damaging main crop roots at harvest. □



Root production in the ratoon crop of IR44, IRRI.

Effects of N application on rice yield under drought

K. M. Ramanathan, professor of soil science and agricultural chemistry, Tamil Nadu Rice Research Institute (TNRRI), Aduthurai 612101, Tamil Nadu, India

We studied the interaction of N and K on rice yield in a field experiment at TNRRI, Sep 1982-Jan 1983 season. Zero, 50, 100, or 150 kg N/ha and 0, 41.5, or 83 kg K/ha with 22 kg P/ha were applied in 3 replications to IR20.

Soil was an Adanur series, very deep, noncalcareous grey brown, clay loam, with sand layers below 110 cm. Soil had pH 6.7, 2.23% organic matter, 0.11% total N, 36.0 meq CEC/100 g, 67.0 kg available P/ha, 0.45 meq exchangeable K/100 g, and 38.9% water-holding capacity.

There was an unusual drought in the Cauvery Delta during the study. We studied the effect of fertilization on rice grown under drought conditions. The crop was irrigated for only 2 wk after transplanting. Drought developed gradually. Surface irrigation was provided at wide intervals. Water stress was acute from heading to harvest.

Grain yield (mean of three replications) is shown in the table. Under drought conditions, N application considerably decreased yield. There also was a marginal yield decrease with increasing N application. K application did not affect rice yield. □

Grain yield of rice under different N fertilization and drought conditions.

N level (kg/ha)	Grain yield (t/ha)
0	2.6
50	2.1
100	2.1
150	1.9
CD	0.4

Evaluation of soil zinc fertility parameters for rice

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We evaluated equilibrium soil-solution Zn concentration in µg/10 ml (intensity, C), Zn remaining adsorbed on soil in µg/g (capacity, q), Zn supply parameters (unitless unified terms of intensity, capacity, and buffering capacity factors, SP), and corrected supply parameters (unitless new parameter, CSP) at 15° and 30°C and their averages as soil Zn fertility index in a pot experiment.

Twenty Mollisols were equilibrated in duplicate for 2 h with 0.01*M* $CaCl_2$ solution (soil solution ratio 1:10) at 15° and 30°C, and C was determined. Using C, q at 15° and 30°C were calculated: q_{30}°c = (K, .C at 30°C)/(K_2 + C at 30°C) and q_{15}°c = (q_{30}°c + C at 30°C) –(C at 15°C), where K_1 was adsorption maxima (µg/g) and K_2 was constant relative to adsorption energy (µg/ 10 ml). The K_1 = (intercept)$^{-1}$ and K_2 = (K_1, slope) were estimated for each soil at 15° and 30°C in a separate Zn adsorption study in the range of 5 to 30 µg added Zn/g soil from the equation (Zn adsorbed by soil, µg/g) = ($1/K_1$) +(K_2/K_1) (Zn in solution, µg/10 ml)$^{-1}$ Expected interaction term of intensity, capacity, buffering capacity (b = (K_2/K_1). (q_2/C_2), unitless), a better Zn fertility index, SP at 15° and 30°C were calculated: SP = $(q.C)^{1/2} . (K_1 . K_2)^{-1/4}$. Because SP reflected the physicochemically defined soil Zn supply, but not Zn supply to the crop under the influence of Cu, Fe, and Mn, which may compete with Zn at root exchange sites, SPs were corrected to CSP = (SP). $(\Sigma M_{Zn}.M^{-1}{}_{Cu, Fe, Mn})$, where M was μmoles of *0.005M* DTPA (pH 7.3)-extractable respective soil nutrients.

Each of 20 soils was used at 5 kg/pot. Twice replicated treatments were 0,5, 10, or 15 ppm Zn as $ZnSO_4$. Six 20-d-old Jaya seedlings were grown for 60 d in each of 160 pots, and percent yield was calculated for each soil:

$$\% \text{ yield} = \frac{\text{yield with 0 ppm Zn (g)}}{\text{yield with adequate Zn (g)}} \times 100.$$

Percent yield varied from 73 to 103%. None of C and q at 15° and 30°C and their averages were related to percent yield, showing that neither measure could define Zn fertility (Table 1). Percent yield and SP correlations were not significant because of widely spaced ideal bands of points in plots of percent yield versus SP. Bands merged in an ideal curve in plots of percent yield versus CSP and were significantly correlated, thus emphasizing the need to correct SP. Critical limits of soil Zn as CSP at 15° and 30°C and average CSP were 1.45, 1.27, and 1.17. Because CSPs included a factor of competitive influence of Cu, Fe, and Mn on Zn availability, they appeared to be a potentially better fertility index than SPs.

All CSPs correlated well with Zn concentration in III 1 b , which is normally recommended tissue for analysis of Zn nutrition status (Table 2). In relation to CSP, tissues could be arranged in reliability order for tissue analysis, CSP at 15°:IIIlb >S>IIlb> ls,CSP at 30°C:S> IIIlb and average CSP:S>IIIlb> 1s. Zinc concentration in Ilb, IVlb, R, and WS did not correlate significantly to CSP, thus were unsuitable for tissue analysis. Total Zn uptake correlated significantly with CSP, except CSP at 15°C. Because of the highest correlation coefficient, the CSP at 15°C and analysis of IIIlb were recommended to know Zn status in soils and plants. ☐

Table 1. Correlation coefficients (*r*) between percent yield and Zn fertility parameters.

Zn fertility parameters	Range	*r*
C at 15°C (μg/10 ml)	0.07-2.74	0.121
C at 30°C (μg/10 ml)	0.13-0.77	0.122
Average C (μg/10 ml)	0.13-1.50	0.142
q at 15°C (μg/g soil)	5.41-30.28	0.056
q at 30°C (μg/g soil)	5.34-29.70	0.068
Average q (μg/g soil)	5.37-29.99	0.068
SP at 15°C (unitless)	0.53-4.29	0.237
SP at 30°C (unitless)	0.57-2.76	–0.109
Average SP (unitless)	0.69-2.76	0.129
CSP at 15°C (unitless)	0.32-2.48	0.783*
CSP at 30°C (unitless)	0.35-2.49	0.563*
Average CSP (unitless)	0.42-2.21	0.758*

*Significant at p = 0.05.

Table 2. Correlation coefficients (*r*) between Zn concentration in rice tissues and significant Zn fertility parameters.

Tissue	*r*		
	CSP at 15°C	CSP at 30°C	Average CSP
First leaf blade from top (Ilb)	0.320	0.370	0.384
Second leaf blade from top (IIlb)	0.534*	0.424	0.438
Third leaf blade from top (IIIlb)	0.790*	0.465*	0.711*
Fourth leaf blade from top (IVlb)	–0.051	0.071	0.007
Leaf sheath (1s)	0.446*	0.440	0.507*
Stem (S)	0.593*	0.733*	0.735*
Root (R)	0.022	0.124	0.078
Whole shoot (WS)	0.263	–0.014	0.149
Total Zn uptake in shoot	0.373	0.484*	0.475*

*Significant at p = 0.05.

Effect of applying lac-coated or noncoated urea on rice grain yield

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We compared the efficiency of lac-coated (33% N) and noncoated (46% N) urea in 1981 and 1982 wet seasons. Soil was a clay loam (Typic Aquept) with pH 5.8, 0.63% organic carbon, and electrical conductivity 0.09 mmho/cm. Jaya was planted in poorly drained soil at the Regional Research Station, Semiliguda. There were nine treatments in a randomized block design with four replications. Lac-coated urea was applied at transplanting. Noncoated urea was applied at transplanting, and at 21 and 55d after transplanting (DT). The crop received 60-17-25 kg NPK/ha.

Applying lac-coated urea at 40 kg N/ha at transplanting followed by noncoated urea at 20 kg N/ha at 55 DT significantly increased grain yield over other treatments (see table). ☐

Effect of lac-coated and noncoated urea on grain yield of Jaya, Orissa, India.

Treatment (kg N/ha)			Rice yield (t/ha)	
Transplanting	21 DT	55 DT	1981	1982
40	20	0	3.8	4.0
40	0	20	4.0	4.3
20	20	20	4.2	4.3
60	0	0	4.0	4.1
40[a]	20	0	3.9	4.4
40[a]	0	20	5.1	4.6
20[a]	20	20	4.5	4.4
60[a]	0	0	4.4	4.3
Control			3.1	3.2
CD at 5%			0.6	0.2

[a] Lac-coated urea.

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Rice response to Cu application

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To evaluate rice response to Cu application, Saket 4 was transplanted in a Gangetic alluvium-Typic Hapludalf, loam, pH 7.3 that was moderately deficient in DTPA extractable Cu (0.47 ppm). Zero, 10, 20, or 40 kg Cu/ha as copper sulfate and 120 kg N/ha as urea (split applied at 60 + 30 + 30), 60 kg P/ha as superphosphate, and 60 kg K/ha as muriate of potash were applied to all the plots. Plant samples were collected 40 and 80 d after transplanting and grain and straw samples at harvest. Cu content was determined by atomic absorption spectrophotometer.

Pooled averages of the data presented in the table indicate that applying Cu increased dry matter production at all growth stages. Maximum increase was recorded with 20 kg Cu/ha. Grain production also increased by 14%.

Cu concentration in the rice plants decreased gradually toward maturity and reached minimum levels in the straw. Cu content of plants and of grains at 80 d were similar. Applying 20 and 40 kg Cu affected Cu content similarly, indicating that the 20 kg application was sufficient for these cropping conditions. Maximum Cu uptake was with 40 kg Cu/ha. □

Effect of Cu application on dry matter production, grain yield, and Cu content and uptake by rice, Varanasi, India.

Cu (kg/ha)	40 d after transplanting			80 d after transplanting			Straw			Grain		
	Dry matter (t/ha)	Cu content (ppm)	Cu uptake (g/ha)	Dry matter (t/ha)	Cu content (ppm)	Cu uptake (g/ha)	Dry matter (t/ha)	Cu content (ppm)	Cu uptake (g/ha)	Dry matter (t/ha)	Cu content (ppm)	Cu uptake (g/ha)
0	0.5	24	13	2.9	11	32	4.4	6	24	2.9	11	31
10	0.6	28	17	3.4	13	44	4.9	7	33	3.2	14	46
20	0.7	34	24	3.8	14	54	5.1	7	37	3.4	15	51
40	0.7	35	24	3.7	14	54	5.2	7	39	3.3	16	51
LSD (0.05)	.02	1.2	0.8	.08	0.4	2.0	.12	0.3	2.0	.06	0.4	1.6

Unicellular mucilaginous blue-green algae BGA): impressive blooms but deceptive biofertilizers

P. A. Roger, Maitre de Recherches ORSTOM, visiting scientist; S. Ardales, research assistant; and I. Watanabe, soil microbiologist, IRRI

Certain mucilaginous N_2-fixing BGA develop impressive blooms in rice fields. Because of their high water and ash content, however, their N contribution may be low. The figure shows a bloom that has been observed annually since 1980 in no-N plots of the IRRI farm in dry season. It comprises *Aphanothece* as dominant genus and *Nostoc* and *Gloeotrichia* as associated genera. Highest fresh weight biomass recorded was 58 t/ha, but 98.6% water and 54% ash contents limited N content to 13 kg/ha.

BGA bloom comprising *Aphanothece, Nostoc,* and *Gloeotrichia* genera.

In 1984 dry season, we studied the effects of such a bloom on rice yield. The experiment was in a Latin square of 16 4- × 4-m plots, with control and BGA treatments. After 2 plowings and harrowings, IR60 was transplanted at 20- × 20-cm spacing. A basal application of 30 kg P/ha, 30 kg K/ha, and 0.5 kg ai furadan/ha was made in all the plots at transplanting. Two days later, half of the plots were inoculated with 20 g/m^2 of a dry algal inoculum collected from the same plots in May 1983. At the time of application, the inoculum contained 2.2 × 10^6 colony-forming units of N_2-fixing BGA per g dry weight. The dominant strains in the inoculum were

Aphanothece sp. (2×10^6/g), *Nostoc* (1.3×10^5/g), and *Calothrix* sp. (4×10^4/g).

Twenty-eight days after inoculation (30 days after transplanting [DT]), floating colonies were harvested and fresh weight, dry weight, and N content determined. The same BGA developed in inoculated and noninoculated plots, *Aphanothece* sp. being dominant. BGA harvested from control plots and inoculated plots were combined and redistributed evenly in the BGA-treated plots after these were drained. The following day (31 DT), the algal material was incorporated with a rotary weeder. Thirty days later (60 DT) the procedure was repeated. At maturity, grain and straw yield and grain protein content were measured.

Thirty days after transplanting, the biomass of mucilaginous BGA in inoculated plots was about twice that in the control (see table). *Aphanothece* was dominant in all plots, giving the BGA biomass a high water content (99.4%). Fresh weight biomasses of 18.7 and 33.0 t/ha produced only 1.5 and 2.6 kg N/ha.

Incorporating mucilaginous BGA in the surface soil negatively affected further development of BGA, as shown at 60 DT by a BGA biomass about 10 times lower in treated plots than in the control. At this time *Nostoc* sp. and *Aphanothece* sp. dominated.

BGA biomass produced in the plots, BGA biomass incorporated in treated plots, and rice yield.[a]

			Produced in control (A)	Produced in BGA-treated (B)	Level of significance of the difference (A – B)	Incorporated in BGA-treated plots (A + B)
BGA biomass	30 DT	fw (t/ha)	18.7	33.0	10%	51.7
		dw (kg/ha)	74.8	132.0	10%	206.8
		N (kg/ha)	1.5	2.64	10%	4.8
	60 DT	fw (t/ha)	7.5	0.6	1%	8.1
		dw (kg/ha)	75.2	6.2	1%	81.5
		N (kg/ha)	1.72	0.14	1%	1.86
	30 DT + 60 DT	fw (26.2)	26.2	33.6	ns	59.8
		dw (kg/ha)	149.9	138.2	ns	288.1
		N (kg/ha)	3.22	2.78	ns	6.0
Rice yield	Grain	t/ha	3.24 ± 0.29	3.31 ± 0.20	ns	
	straw	t/ha	2.41 ± 0.21	2.38 ± 0.14	ns	
	protein	% dw	1.45 ± 0.06	1.41 ± 0.06	ns	

[a]Each value is the average of eight replications. fw = fresh weight, dw = dry weight.

Productivity in the control, in terms of dry weight and N, was similar during the 1st and 2d months of growth. Total productivity (sum of biomasses harvested at 30 and 60 DT) was similar in control and BGA-treated plots, the higher productivity in treated plots during the 1st month of growth being balanced by lower productivity during the 2d. From 60 DT to harvest, biomass of mucilaginous BGA was very low.

Total BGA biomass incorporated in treated plots was equivalent to 60 t fresh weight/ha (52 t at 30 DT and 8 at 60 DT), corresponding to only 6 kg N (4.14 at 30 DT and 1.86 at 60 DT). Previous experiments had shown that about 20-30% of the N of incorporated BGA is available to the plant. This suggests that in the present experiment about 2 kg N was available to the plant, which was not enough to significantly increase the yield in treated plots.

Correlation between the different variables measured in the 8 replications of the control and BGA-treated plots were significant only for grain and straw yield. The absence of correlation between BGA biomass produced in control plots and rice yield indicates that N and growth-promoting substances exudated by the algae, if any, did not affect rice growth. □

Azolla diseases in Manipur, India

S. Balou, Horticulture Department, and N. Iboton, Botany and Plant Pathology Department, Manipur Agricultural College, Iroisemba, India

Azolla (*A. pinnata*) is often inoculated immediately after Jul transplanting in northeast India. We surveyed azolla diseases to determine causes of azolla decline at or shortly before inoculation. Two disease pathogens were isolated: *Rhizoctonia solani* Kuhn and *Sclerotinia sclerotiorum* (Lib.) de Bary, *S. sclerotiorum* for the first time in Manipur. *R. solani* was found in 18 of 20 villages and *S. sclerotiorum* in 7 of 20. Because of the occurrence of *R. solani,* azolla inoculation should be restricted in Manipur Valley rice fields because diseased azolla may be a primary inoculum for rice sheath blight disease. □

Influence of moisture regime on total biomass production of rice

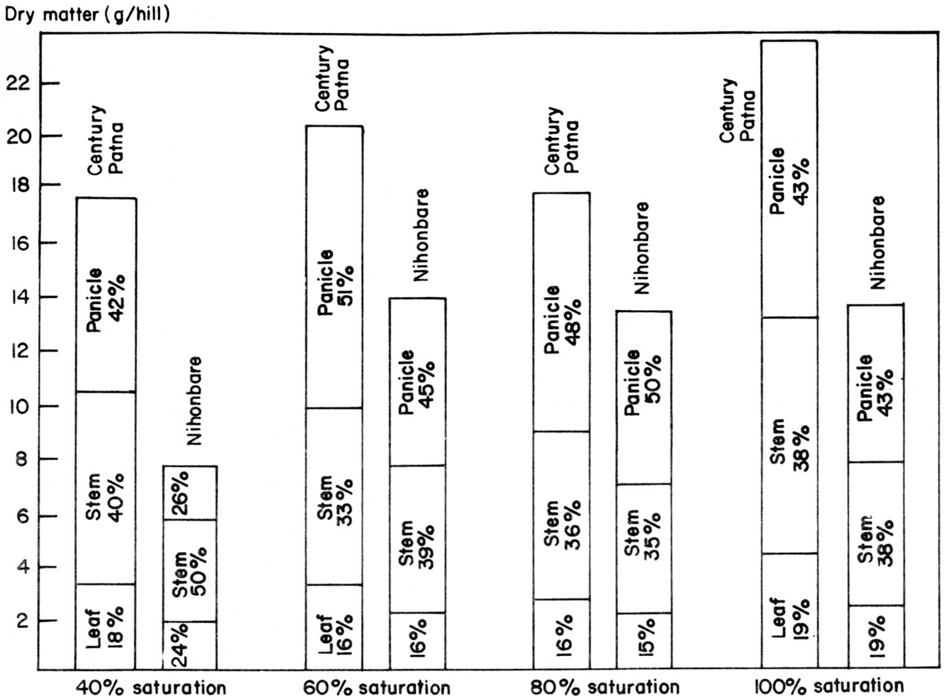
S. V. Subbaiah, All India Coordinated Rice Improvement Program, Hyderabad, India; U Sai Kaung Nyunt, Agricultural Corporation, Hsenwi, Shan State, Burma; D. M. Martinez, Instituto Agrario Dominicano, Santo Domingo, Dominican Republic; and N. Chida, Tsukuba Agricultural Training Center (TATC), Tsukuba City, Japan

A simulated field experiment was conducted to determine the influence of moisture regime on biomass production of rice. The experiment was under a vinyl roof at TATC, Japan, in 1982 wet season. The experiment was in a factorial randomized complete block design in 4 bottomless, 2- × 1- × 0.6-m, rectangular

Total dry matter production of 2 rices at Tsukuba, Japan.

Variety	Dry matter production (g/hill) at moisture regime (%) of			
	40	60	80	100
Century Patna	16	19	18	20
Nihonbare	7	11	14	14

CD at 5% level for varieties × treatments 2



Influence of different moisture regimes on dry matter content of leaf, stem, and panicle.

iron tanks with automatic irrigation control.

Soil had high moisture holding capacity. NPK was applied at 150 kg/ha. Soil was maintained at 40, 60, 80, or 100% saturation during growth of varieties Century Patna and Nihonbare.

Total dry matter production for both varieties is in the table. Century Patna yielded the highest dry matter at 100% saturation. Panicle weight, except that of Nihonbare at 40% saturation, was more than 40% of total dry matter produced (see figure). □

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Effect of amendments on rice harvest index and its relationship with Fe:Mn uptake in sodic soil

B. M. Sharma and J. S. P. Yadav, Central Soil Salinity Research Institute (CSSRI), Karnal 132001, Haryana, India

Gypsum, pyrite, and farmyard manure (FYM) are commonly used amendments to reclaim sodic soils. Rice tolerates sodicity and often is recommended as the first crop in reclamation programs.

We evaluated the effect of amendments on harvest index (HI) and ratio of Fe:Mn uptake in rice in a pot experiment at CSSRI, Karnal. The soil was highly sodic with pH 10.6, 96.5% exchangeable sodium, 0.22% organic carbon, 4.2% $CaCO_3$, CEC 10.9 meq/100 g soil, 20.4% clay, and gypsum requirement of 25 t/ha. Gypsum and pyrite each at rates equivalent to 0, 50, and 100% gypsum requirement were applied alone or combined with 0, 6.25, or 12.5 g FYM/kg soil.

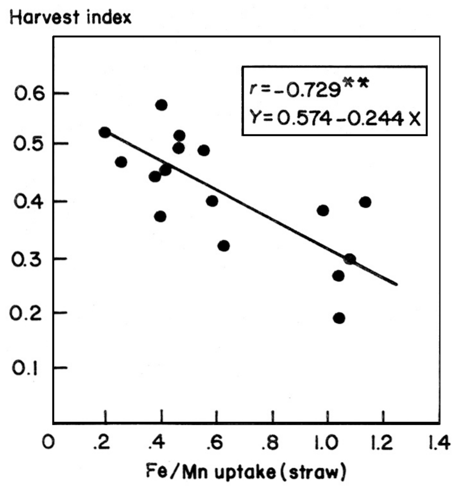
After applying the amendments, the soil was leached with water to remove soluble reaction products. Recommended doses of N (75 ppm) and Zn (20 ppm $ZnSO_4$) were applied as urea and zinc sulfate. Pusa 2-21 was planted and grown to maturity.

Treatment results are in the table. HI was lowest in the control, and increased when 50% of the gypsum requirement was applied. If more gypsum was applied, HI declined. Adding FYM increased HI at all gypsum levels, although higher doses began to reduce the index. At equivalent doses, HI for pyrite treatments was generally lower than for gypsum. FYM plus a 50% gypsum requirement dose of pyrite had little effect on HI.

HI increased as Fe:Mn decreased. There was a significant negative correlation between HI and Fe:Mn uptake by straw (see figure); however, the relationship was insignificant for rice grain. □

Effect of gypsum, pyrite, and FYM on rice HI, Karnal, India.

FYM (g/kg soil)	HI				
	Control	Gypsum (% gypsum requirement)		Pyrite (% gypsum requirement)	
		50	100	50	100
0	0.20	0.42	0.39	0.46	0.33
6.25	0.30	0.58	0.49	0.46	0.40
12.5	0.39	0.51	0.40	0.47	0.28



Relationship between HI and Fe:Mn uptake in rice, Karnal, India.

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

Water balance analysis of the effect of drought on upland rice

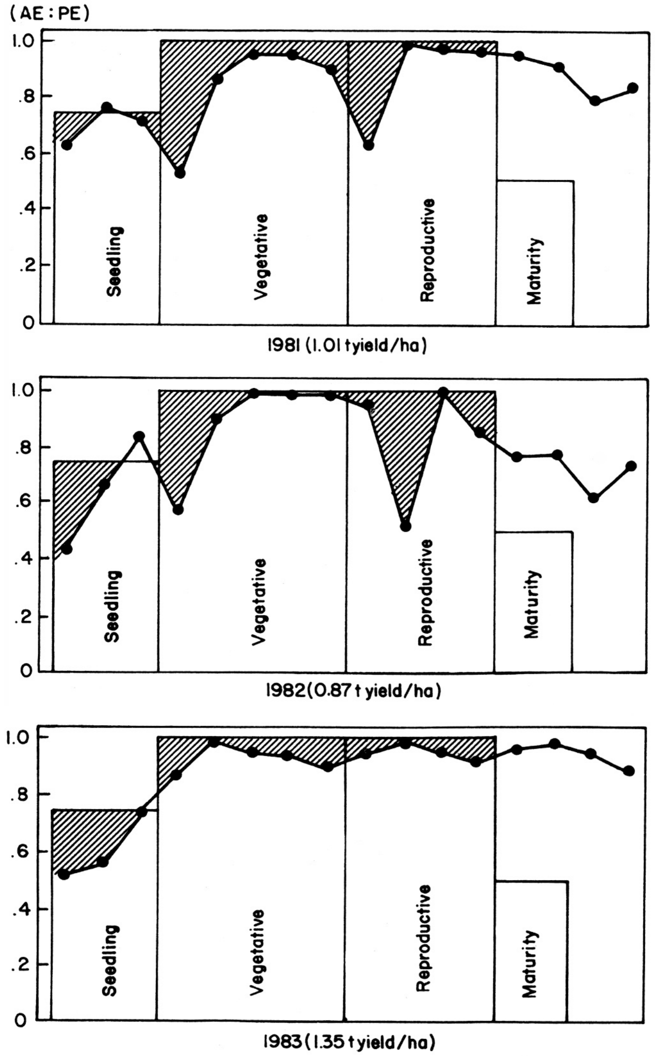
S. R. Patel and A. S. R. A. S. Sastri, Zonal Agricultural Research Station, Jawaharlal Nehru Agricultural University, Raipur, India

In central India, there are about 0.9 million ha of upland rice. Soils are black with 60% clay. Rice yields are 0.3 to 0.6 t/ha.

For better water management, it is important to know the duration and intensity of water stress during different growth stages. We analyzed the water stress pattern resulting from drought during growth stages from 1981 to 1983 based on the ratio of actual evapotranspiration to the potential evapotranspiration (AE:PE) determined by water balance computations. The Purva grain yield for the analysis was from cropping pattern experiments under upland conditions.

The drought period was initiated when the actual AE:PE values fell below optimum, which are 0.75, 1.00, 1.00, 0.50 during seedling, vegetative, reproductive, and maturity stages (see figure).

Drought intensity varied in the first three growth stages. It was highest (more hatched area) in 1982 followed by 1981; yields were 0.9 and 1.0 t/ha. In 1983, mild drought occurred at vegetative and reproductive stages and rice yielded 1.3 t/ha.



Drought during different physiological stages of upland rice Raipur, India.

This suggests that under upland conditions in central India, rice production without a suitable water harvesting or soil water conservation practice is not practical. □

Rice-Based Cropping Systems

Deep water rice and fish culture

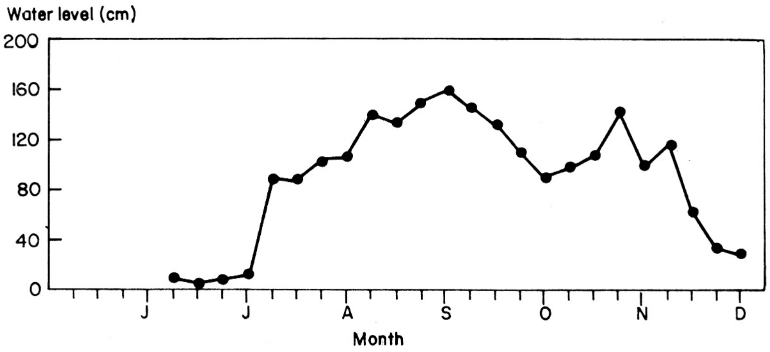
S. K. Datta, D. Konar, S. K. De, P. K. Banerjee, Operational Research Project (ORP), Pandua, West Bengal; and P. K. Pandit, Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India

We evaluated an integrated system of deep water rice and fish culture followed by lowland rice culture to increase farm productivity at ORP, West Bengal.

A 0.2-ha renovated, 2.5-m-deep plot for deep water rice cultivation was constructed with a 12 × 8 × 1.5 m central tank. Soil was a clay loam with pH 7.0-7.5. The tank was thoroughly plowed, 10 t farmyard manure/ha was incorporated, and Jaladhi 1, a recommended deep water rice, was direct-seeded in early Jun 1983. Standard cultivation was practiced. Water depth reached a maximum 160 cm and varied as shown in Figure 1.

In late Jul, carp fingerlings - silver carp *Hypophthalmichthys molitrix,* Mrigal *Cirrhinus mrigala,* Catla *Catla catla,* and Rohu *Labeo rohita* — were released in the plot at 9,000/ha in the ratio 6:6: 1:1. Each morning, they were fed an inexpensive 1:1 mixture of rice bran and oil cake at 5% total body weight.

In late Dec, mature rice panicles were harvested and fish were harvested periodically by drag net. Only 75% of the fish were table-sized in the first harvest (Fig. 2). The plot was allowed to dry gradually and the remaining small fish were moved to the central tank where they were fed regularly. Final fish harvest was in late Feb.



1. Weekly variations in water levels of deep water rice plots in kharif, West Bengal, India.

2. Harvesting Jaladhi 1 and carp in kharif, West Bengal, India.

IR36 was transplanted in the same plot during boro in mid-Jan 1984, after the plot was thoroughly puddled. Two seedlings at 15- × 15-cm spacing/hill were transplanted and 120 kg N/ha was applied in 3 doses: half at land preparation and half in equal splits, 1 mo after transplanting and 1 wk before flowering. PK at 18-33 kg/ha were added at land preparation. Standard cultivation methods were practiced and the tank water was used for irrigation as needed. IR36 was harvested in mid-May.

Twenty plants of each rice variety were randomly selected for analysis and uprooted at harvest. Growth and yield data for 20 randomly selected fishes from each of the 4 carp species were recorded at harvest, and total yields of fish and rice were determined (see table).

Jaladhi 1 and 1R36 yielded normally (see table). Fish yield was 1.1 t/ha in 7 mo. Catla performed best. □

Growth and yield of fish and 2 rice crops in a low-lying deep water plot at ORP, Pandua, West Bengal, India.

Character	Rice			
	Early Jun-late Dec 1983		Boro (mid-Jan - mid-May 1984)	
	Jaladhi 1		IR36	
Plant height (cm)	295		68	
Stem length (cm)	268		47	
Internodes/stem	16		4	
Effective tillers/plant	3		9	
Panicle length (cm)	24		20	
Grains/panicle	143		79	
Grain yield (t/ha)	2.1		4.2	
	Fish (late Jul 1983 - late Feb 1984)			
	Silver carp	Mrigal	Catla	Rohu
Recovery (%)	45	69	87	40
Increase in length (mm)	95	104	90	115
Increase in weight (g)	34	86	275	96
Fish yield (t/ha)	0.2	0.4	0.4	0.1

Announcements

T. T. Chang named IRRI principal scientist

T. T. Chang, geneticist and head of the International Rice Germplasm Center, has been named IRRI principal scientist.

Chang is an internationally known crop scientist and a fellow of the American Society of Agronomy and the Institute of Biology, London. He is noted for his work with the International Board for Plant Genetic Resources and his research to identify the origins of rice.

Chang holds degrees from the University of Nanking, Cornel1 University, and the University of Minnesota. He joined IRRI in 1961. □

M. S. Swaminathan receives honorary degree

M. S. Swaminathan, IRRI director general, has been named honorary doctor of technology by the Asian Institute of Technology at Bangkok, Thailand. □

New IRRI publications

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

IRRI highlights 1984

Multilanguage publication in agriculture; workshop report and description of participating agencies

Mahadevappa receives agriculture award

M. Mahadevappa, long-time IRRI collaborator and Kannada translator of *A farmer's primer on growing rice,* has received the 1984 Rajyothsava Award for Agriculture from the government of Karnataka, India. □

Deposit promising genetic materials with the IRRI International Rice Germplasm Center (IRGC)

Many IRRN authors discuss new or unusual rice varieties and lines in their articles. IRRN readers frequently write to T. T. Chang, head of the IRGC, requesting seeds of the rices mentioned in those articles. Unfortunately, the seeds of many of those varieties have not been deposited with the IRGC.

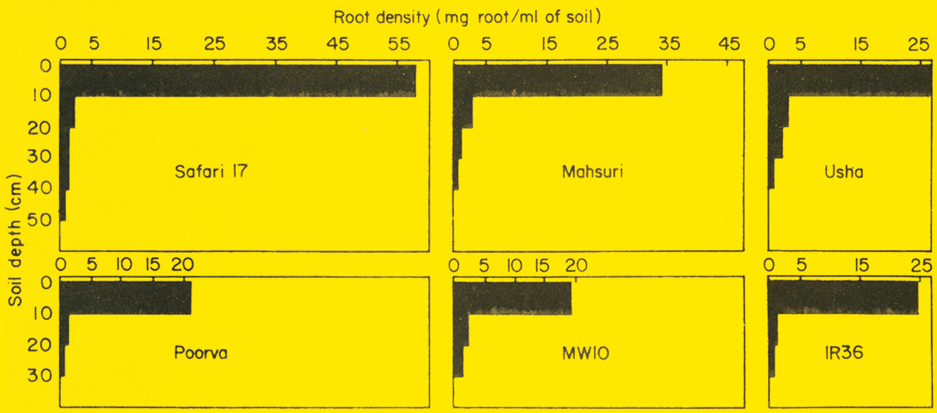
Chang asks that contributing authors deposit (via airmail) their new, promising, or unusual rice strains with the IRGC so that the primary objective of exchanging useful information and valuable genetic materials through the IRRN can be fulfilled.

Please write Dr. T. T. Chang, International Rice Research Institute, P. O. Box 933, Manila, Philippines, for a Philippine seed import permit for such donations to the IRGC. □

ERRATA

I. K. Jaggi and D. C. Bisen. Root growth and water extraction pattern of six rices in rainfed conditions. 9 (5) Oct 84.

Page 9: The figure reproduced below replaces Figure 1 of the article.



R. S. Rekhi, J. Singh, and O. P. Meelu. Effect of green manure and nitrogen on mole rat damage and leaffolder (LF) incidence in rice. 10 (1) Feb 85.

Page 26: The N content percentages on the figure should read "1.0, 0.8, 0.6."

R. Velusamy and S. Chelliah. Field screening for resistance to leaffolder (LF). 10 (1) Feb 85.

Page 9: In paragraph 2, line 3 should read "60-60-60 kg NPK/ha was incorporated." In line 6, 60-cm should read "10-cm."

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