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Contents

Guidelines and Style for IRRI 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- Do not cite references or include a bibliography.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

New upland rice varieties for Senegal

A. Faye, rice breeder. and M. Gning, research assistant, ISRA-CRA-Djibélor, Ziguinchor, Senegal

DJ.11.509 and IRAT133 are upland rices that have been tested for 4 yr by the National Rice Improvement Program in collaboration with the West Africa Rice Development Association at the ISRA Sefa Station. Results of direct-seeded varietal trials comparing the two rices with local 144 B/9 are in the table.

The new upland varieties have short duration (90–100 d) and are adapted to the local short rainy season (see table). They require specific crop management because their vegetative period is short and tillering time is very limited. The new varieties performed well except in 1980 and 1982 when the local variety outyielded them.

The varieties were selected from TUNSART/TN1/H4 crossed in Senegal, and IRAT10 crossed at the Institut de Recherches Agronomiques Tropicales, Bouaké, Ivory Coast. DJ.11.509 is a semidwarf photoperiod-insensitive line and has highly synchronized flowering. It has longer grains than IRAT10. IRAT133 has intermediate plant height and photoperiod insensitivity. It has excellent early seedling vigor and intermediate tillering capacity.

Results of variety test of IRAT133 and DJ.11.509 in Senegal.[a]

Variety	Grain yield (t/ha)			
	1979 (911.9 mm)	1980 (699.3 mm)	1981 (1021.6 mm)	1982 (794.4 mm)
IRAT133	3.0	2.0	3.8	2.8
DJ.11.509	4.8	2.9	2.9	2.2
144 B/9	3.0	2.2	2.2	2.4

[a] Values in parentheses indicate rainfall.

Land races of aromatic rice discovered in Taiwan

W. L. Chang, Vocational Assistance Commission for Retired Servicemen, 54 Kuan-Chien Road, Taipei, Taiwan

Until recently, aromatic rice was not extensively grown in Taiwan, although rice has been grown there for thousands of years. Breeding for scented rice began at Chiayi Agricultural Experiment Station in 1977. Several promising aromatic strains, both sinica (keng) and indicas, were developed. Among them, Chianung-yu 269 (source of aroma: Taishosen from Japan), a sinica type, and Chianung-sen-yu 43 (source of aroma: IR841 from IRRI), an indica, are expected to be named as varieties in 1985.

In 1983, we discovered at Hualien District Agricultural Improvement Station that traditional aromatic rices were widely grown, though on limited hectarage, in many parts of the district. Farmers who planted the aromatic rice belong to the Ai-mei aboriginal tribe, one of several tribes in Taiwan. Other tribes do not plant aromatic rices.

The aromatic rices grown by Ai-mei farmers are tall and leafy with large panicles and long-awned grains. Yields are low (see table). Although the exact number of land races in the area has not been determined, there are large intra- and inter-varietal differences; therefore

Major agronomic characters of traditional and improved aromatic rices in Taiwan. [a]

Variety or selection	Days to heading	Plant ht (m)	Grain yield (t/ha)	Yield components			Panicles		Awn	Grain size			Pericarp color	Lodging
				Panicles per plant	Grains per panicle	1000-grain wt (g)	Length (m)	Weight (g)		Length (cm)	Width (cm)	L/W		
Katupa-ai (Native)[b]	56	151	3.0	4.6	143	29.0	24.6	3.7	Long	0.78	0.37	2.11	Red	Severe
Chianung-yu 269 (japonica)[c]	64	100	5.3	11.3	131	24.2	18.3	3.1	None	0.69	0.33	2.09	White	Light
Chianung-se-yu 43 (indica)[c]	66	103	5.8	8.9	136	25.3	23.3	3.5	None	0.85	0.26	3.27	White	None

[a]Data collected in the second crop, 1984, at Hualien District Agricultural Improvement Station experimental farm at Chi-an, Hualien. [b]Glutinous. [c]Improved selection.

these rices offer vast genetic diversity for breeding programs. Unfortunately, the area planted to aromatic rices is decreasing because of low yields and the difficulty in processing caused by long awns. Steps must be taken to save this valuable germplasm.

The traditional aromatic rices grown in Hualien probably are land races indigenous to Taiwan, although their existence and production have not been documented. Their origin is unclear, but it is likely that early Ai-mei settlers brought the seeds with them when they migrated to Taiwan.

Performance of three elite rice mutants

M. A. Azam, L. Hakim, A. J. Miah, M.A. Mansur, and H. R. Akand, Bangladesh Institute of Nuclear Agriculture (BINA), P. O. Box 4, Mymensingh, Bangladesh

BINA instituted a mutation breeding program in 1973 with local Nizersail to develop early-maturing semidwarfs with high yield potential. In the M_2, several mutants were isolated from the gamma irradiated progenies. Subsequent generations were evaluated and Mut NS1, Mut NS2, and Mut NS5 were selected in 1981. They were evaluated for various agronomic characters at three Bangladesh sites and compared with Nizersail and BR4.

Varieties were planted at 20- × 15-cm spacing in a randomized block design with 3 replications. Plant height, crop duration, effective tillers per plant, grains per panicle, 1,000-grain weight, and yield were recorded (see table),

Characteristics of mutants derived from Nizersail, Mymensingh, Bangladesh. [a]

Mutant, variety	Plant ht (cm)	Crop duration (cm)	Effective tillers plant	Grains/ panicle	1000-grain wt (g)	Grain yield (t/ha)
Mut NS1	148 a	145	10	184	18.2	5.2 d
Mut NS2	131 c	136	13	134	19.3	4.2 c
Mut NS5	91 e	136	12	110	20.1	5.3 ab
Nizersail	145 ab	155	13	118	18.5	4.3
BR4	115 d	148	10	153	21.7	5.5 a

[a] Separation of means in a column at 5% level.

Mut NSI and Mut NS2 were tall add Mut NS5 was semidwarf. All three matured earlier than Nizersail and BR4. Mut NSl and Mut NS5 yielded significantly higher than Nizersail, but similar to BR4. Both seem promising for a rice - wheat sequence.

Intensity and duration of dormancy in some rices

B. K. Mandal and A. K. Mitra, Rice Research Station, Chinsurah 712102, India

Seed dormancy in rice is a desirable trait, particularly in prekharif and kharif (wet) seasons, for preventing losses to preharvest sprouting of seeds. If intensity and duration of dormancy are high, farmers who intend to use the seed for the succeeding rice crop have problems.

We studied intensity and duration of dormancy of seeds of 12 photoperiod-sensitive tall indica rices collected from

Intensity and duration of dormancy of 12 photoperiod-sensitive rice cultivars, Chinsurah, India.

Group	Cultivar	Germination (%)		Dormancy	
		Control (30°C)	Treated (50°C)	Intensity[a]	Duration (wk)
Weak, short-duration dormancy	NC1281	19	94	Weak (2)	8
	Seetasail	30	97	Weak (2)	9
	OC1393	7	96	Weak (3)	10
Weak, long-duration dormancy	NC324	5	85	Weak (4)	16
	Badsabhog	10	83	Weak (4)	16
	Rupsail	23	88	Weak (3)	16
	Kalma 222	6	80	Weak (4)	15
Moderate, long-duration dormancy	Randhunipagal	1	78	Moderate (6)	16
	Kataribhog	13	77	Moderate (5)	16
	NC678	5	77	Moderate (5)	18
	Kumargore	2	76	Moderate (10)	14
	Patnai 23	12	73	Moderate (5)	18

[a] Figures in parentheses indicate number of days required to attain 80% germination following 50°C heat treatment.

fully mature panicles at harvest and subjected to 50°C heat treatment. The intensity of dormancy was determined by length of time required to break dormancy by heat treatment, and duration was determined by the time required to attain 80% germination at 30° C (control).

Wide variability in germination among control and heat-treated seeds was observed (see table). Test varieties fell into three distinct groups: weak, short-duration dormancy (NC1281, Seetasail, and OC1393); weak, long-duration dormancy (NC324, Badsabhog, Rupsail, and Kalma 222); and moderate, long-duration dormancy (Randhunipagal, Kataribhog, NC678, Kumargore, and Patnai 23). Kumargore might be considered a fourth type because it has strong, long-duration dormancy.

Rices with weak, short-duration dormancy may be used as donors for incorporating seed dormancy in cultivars to be developed for areas where preharvest germination is a problem and seeds are needed for the succeeding rice crop.

Assessment of dormancy in some late-duration rices

C. Kundu, A. Ghosh, R. Ghosh, and S. Biswas, Rice Research Station, Chinsurah 712102, India

We assessed dormancy in some late-duration, high yielding varieties (HYVs) and indigenous improved varieties (IIVs) grown under medium low-lying situations in kharif where mature crops often lodge under water.

Seed samples were collected 30 d after flowering and sundried to 13-14% moisture content. Percent germination, dormancy period, and dormancy intensity were recorded. Percent dormancy was calculated based on thrice replicated germination tests (100 seeds in each petri plate) at weekly intervals in an incubator at 30°C. Dormancy period was calculated from harvest to 80% germination. Intensity was determined by exposing the seeds to 55° C temperature for 4 d, followed by germination testing. Intensity was classified as strongly dormant (when it could not be broken), moderately dormant (when 50% was broken), and weakly dormant (when dormancy broke completely) after the treatment.

Among the HYVs studied (Table 1) CN499-160- 134, CN499- 160-2-1, CN506-147-2-1, and CN506-147-14-2 were strongly dormant: they showed no trace of germination until 50 d or longer after harvest, and were dormant till 80 d. Dormancy broke only after 7 d at 55°C. CR292-7050, CR292-5258, and CR301-3066 were weakly dormant. Other cultures had dormancy ranging from 10 to 32 d.

Among the IIVs studied (Table 2), FR13A was completely dormant for 65 d. Other test varieties had 30-52 d dormancy. FR13A, SR26B, and NC492 had strong dormancy. FR13A required 9 d at 55° C for dormancy to break.

Table 1. Dormancy at harvest and after heat treatment, and intensity and period of dormancy of some HYVs, Chinsurah, India.

Culture	Dormancy				
	Immediately after harvest (%)	After heat treatment (%)	Intensity[a]	Period (d)	
				Complete	Up to 80% germination
CR292-7050	0	–	–	–	–
CN499-160-13-6	100	7	SD	50	80
CN499-160-2-1	100	5	SD	50	80
CN505-5-32-9	100	91	WD	30	55
CN506-147-14-2	100	0	SD	52	75
CR292-5258	0	–	–	–	–
CN506-147-2-1	100	2	SD	60	85
OR330-40-3	100	95	WD	10	25
OR117-215	100	57	MD	25	42
BIET821	100	62	MD	30	55
CR301-3066	0	–	–	–	–
BIET807	100	68	MD	32	55
PLA100	100	88	WD	20	45
CR221-1030	100	97	WD	10	30
BIET724	100	90	WD	20	50
OR143-7	100	100	WD	15	35

[a] WD = weakly dormant, MD = moderately dormant, SD = strongly dormant.

Table 2. Dormancy at harvest and after heat treatment, and intensity and period of dormancy of some IIVs, Chinsurah, India.

Culture	Dormancy				
	Immediately after harvest (%)	After heat treatment (%)	Intensity[a]	Period (d)	
				Complete	Up to 80% germination
Janaki	100	90	WD	35	60
Tilakkachari	100	56	MD	35	57
Agnivan	100	88	WD	50	70
NC678	100	93	WD	30	42
Raghusal	100	61	MD	42	55
Rupsal	100	97	WD	30	40
OC1393	100	54	MD	35	60
Bhasamanik	100	60	MD	35	55
NC492	100	3	SD	45	75
FR43 B	100	49	MD	40	65
SR26 B	100	0	SD	52	65
FR13 A	100	0	SD	65	90

[a] WD = weakly dormant, MD = moderately dormant, SD = strongly dormant.

Genetic Evaluation and Utilization

AGRONOMIC CHARACTERISTICS

Evaluation of rice germplasm for some panicle and grain characteristics

A. Faye, rice breeder; and J. P. Coly, research assistant, ISRA-CRA-Djibélor B. P. 34, Ziguinchor, Senegal

Collection, maintenance, and characterization of important traits are extremely useful to any crop breeding program. Many rice varieties were collected from different parts of the Casamance region in southern Senegal, and agronomic traits were characterized at Djibélor Agricultural Research Center.

Variations in panicle type, secondary ramification of panicle branches, lemma and palea pubescence, and grain awning were low. Variability in shattering, panicle fertility, endosperm type, and 1,000-seed weight is shown in Tables 1 and 2.

Table 1. Variability of panicle and grain traits of some rices from southern Senegal, expressed as varietal frequency on a 1-9 scale according to IBPGR-IRRI Rice Advisory Committee handbook.

Character	Varietal frequency on the scale								
	1	2	3	4	5	6	7	8	9
Shattering	97		81		36				
Panicle fertility	128		74				12		
Endosperm type	110	100	4						

Table 2. Variability in 1,000-seed weight of rice from southern Senegal.

Character	Varietal frequency in the range								
	19	19.1-21.0	21.1-23.0	23.1-25.0	25.1-27.0	27.1-	29.1-	31.1-	33.1
1,000-seed wt	6	13	31	47	47	23			

Agronomic and yield characteristics of Topolea rices in western Romania

L. A. Ykoye, V. Caraus, and Gh. Urdea, Department of Seed Production and Multiplication, Institutul Agronomic Timisoara, Intreprenderea Agricola de Stat (IAS), Banloc, Romania

We evaluated eight production-intensive Topolea rice lines in western Romania (Banloc rice fields). The lines have favorable, modem agronomic characteristics and were developed at IAS from local and introduced parents (Table 1). The lines were derived from hybrid combinations of three to four genotypes from different ecogeographic zones, including southwest Europe, southeast Europe, and northeast Asia.

All but Topolea 57-77, released in 1977, were released in 1976. Careful evaluation from 1979 to 1981 compared varietal performance with that of high-yielding local varieties Timis and Diamant. The new Topolea lines yielded higher (Table 2).

Topolea lines have semidwarf stature, with height ranging from 50 to 59 cm (av 55 cm). Timis grows to 63 cm. The lines have short, dense, heavy panicles, averaging 127 spikelets/panicle, each panicle weighing 1.9 g. Duration ranges

Table 1. Topolea hybrid combinations, Banloc, Romania.

Line	Parentage	Year in control field
Topolea 57/17	Shin-Ei/Balila//Mimasari/Balila	1977
Topolea 58/76	Balico//Balila/Sesia 28 L.64///Krasnordar 424	1976
Topolea 60/76	Mimasari/Balila//Krasnordar 424	1976
Topolea 64/76	Shin-EilBalilallKrasnordar 424/Shin-Ei	1976
Topolea 66/76	Shin-Ei/Balila//Beco/Mantovo Vialone	1976
Topolea 70/76	Yuukara//Mimasari/Balila	1976
Topolea 71/76	Mimasari/Balila//G. Marchetti/Mantovo Vialone	1976
Topolea 88/76	Mimasari/Balila//Krasnordar 424/Shin-Ei	1976

Table 2. Yield and agronomic characteristics of Topolea limes, Banloc, Romania.

Line, variety	Plant ht (cm)	Panicle length (cm)	Spikelets (no./panicle)	Panicle wt (g)	Duration (d)	Av yield 1979-80 (t/ha)
Topolea 57/77	56	13	122	1.8	113	8.4
Topolea 58/76	54	14	102	1.4	105	7.6
Topolea 60/76	59	14	120	2.1	119	8.6
Topolea 64/76	53	14	112	1.7	114	8.1
Topolea 66/76	53	13	150	2.3	121	8.0
Topolea 70/76	50	14	107	1.8	115	7.3
Topolea 71/76	58	15	157	2.0	123	7.7
Topolea 88/76	56	15	146	2.4	113	8.5
Av	55	14	127	1.9	115	8.0
Timis[a]	63	18	84	1.7	105	6.4
Diamant[a]	–	–	–	–	–	7.7

[a] Varieties that are presently most productive. Diamant is the recently certified and approved variety.

from 105 to 123 d and is shorter in tropical zones. Average yield is 8.5 t/ ha, versus 6.4 and 7.7 t/ ha for Timis and Diamant.

Topolea lines are lodging resistant, strongly resistant to cryptogamic diseases, and are N fertilizer responsive.

Complete slide sets of photos printed in Field problems of tropical rice, revised 1983, are available for purchase at $50 (less developed country price) or $60 (developed country price), including airmail postage and handling, from the Communication and Publications Department, Division R, IRRI, P. O. Box 933, Manila, Philippines. No orders for surface mail handling will be accepted.

Genetic Evaluation and Utilization

GRAIN QUALITY

Grain quality of hybrid indica rices in China

Zhang Yun-Kiong, China National Rice Research Institute (CNRRI), Hangzhou, China

About 8.8 million ha of irrigated land in China are planted to F_1 hybrids that yield 15-20% more than the best semidwarfs. Hybrids also produce high quality milled rice.

We evaluated 15 hybrid indica rice and 2 semidwarfs for grain quality at CNRRI in 1984. Grain was harvested, dried to about 12% moisture content, and analyzed by IRRI methods.

Length width of milled hybrid rice ranged from 2.3 to 3.2, averaging 2.7 (see table). Grains were medium-long or long. Chalkiness varied widely. All hybrids except Wei You 35 had fewer opaque areas than the semidwarfs. Shan You 32 and Shan You 36 were slightly chalky.

Amylose content (AC) varied from 17% to 30% in 14 nonwaxy hybrid rices. Four hybrids, including Shan You 2 and Zhong You 2, had intermediate AC. Shan You 85 and Jun You 85 had low AC. The hybrids had intermediate to low gelatinization temperature (alkali spreading value of 4-7 in 1.7% KOH), and softer gel consistency. Shan You 2 had the best elongation ability (180%).

Analysis showed that most indica hybrids had better appearance and cooking and eating quality than the two commonly planted semidwarfs.

Quality analysis of 15 indica hybrid rices in China, 1984. [a]

Variety	Parentage	Milled rice			Chalkiness (scale)	Amy1ose content (%)	Alkali spreading value (scale)	Gel consistency (mm)	Grain elongation (%)
		Length (mm)	Width (mm)	(Length: width)					
Shan You 2	Zhen Shan 97A/IR24	57	24	2.4	5	22	6.0	36.5	180
Shan You 6	Zhen Shan 97A/IR26	59	24	2.5	5	27	6.0	39.0	170
Shan You 32	Zhen Shan 97A/IR32-5	73	23	3.2	1	26	6.5	36.0	150
Shan You 36	Zhen Shan 97A/IR36	59	24	2.5	1	25	6.0	35.5	160
Shan You 50	Zhen Shan 97A/IR50	58	22	2.6	3	31	6.0	39.5	160
Shan You 85	Zhen Shan 97A/Tai 8-5	65	23	2.8	5	17	5.0	41.5	150
Wei You 6	V20A/IR26	66	25	2.6	3	28	5.5	42.5	150
Wei You 35	V20A/Zhai Zao 26	60	23	2.6	7	22	5.0	44.0	150
Wei You 64	V20A/Ce 64	67	23	2.9	5	27	5.5	50.0	150
Wei You 98	V20A/T 0498	65	22	3.0	5	26	7.0	46.5	140
Xie You 64	Xie Qing Zao A/Ce 64	67	21	3.2	3	26	5.5	52.5	140
Zhang You 2	ZMYY A/IR24	69	26	2.8	3	23	6.5	46.5	150
Jun You 85	Jun Xie A/Tai 8-5	58	24	2.4	5	17	5.0	50.5	160
Qing You Zao	Qing Si Ai A/Houmeizao	57	25	2.3	3	20	6.0	33.0	170
Mei You 85	Mei Nou A/Tai 8-5	63	23	2.7	Waxy	–	4.0	122.5	170
Zhen Zhu Ai 11	Nonhybrid	56	23	2.4	7	27	5.0	32.0	150
Gui Chao 2	Nonhybrid	48	27	1.8	7	26	5.0	30.5	150

[a] Av of 2 replications.

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

Genetic Evaluation and Utilization

HYBRID RICE

Performance of IRRI hybrid rices in Andhra Pradesh

I.N. Rao, G.M. Rao, P.S.S. Murthy, and K. V. Seetharamaiah, Agricultural Research Station, Maruteru 534122, Andhra Pradesh, India

We evaluated yield potential and heterosis in morphophysiological attributes of 11 IRRI hybrid rice lines in Andhra Pradesh in 1984 dry season. Seeds were sown on 2 Jan and 20-d-old seedlings were transplanted at 20- × 15-cm spacing in a randomized block design with three replications. NPK was applied at 120-13-25 kg NPK/ha.

The hybrids were compared with IR50, IR54, and IR36 and local BPT1235. Yield components, leaf area index, and harvest index were recorded and heterosis in different characters was calculated based on the performance of the best check, IR36 (see table).

Yield potential of hybrids HR6, HR8, and HR10 was significantly higher than that of IR36 and HR1 performed at par. The other hybrids had high spikelet sterility and low panicle number and harvest index. HR4, HR5, and HR9 yielded 0.8-1.4 t/ha, had high negative heterosis in panicle number and spikelet fertility and 60-81% spikelet fertility. All the hybrids matured 8-12 d earlier than IR36, which matured in 112 d.

HR6, HR8, and HR10 had significant positive heterosis in yield (11% to 23%) because of positive heterosis in panicle number and spikelets per panicle, grain weight, total biomass, and leaf area index. Heterosis was positive but not significant for harvest index. Almost all the hybrids had negative heterosis in spikelet fertility. Spikelet sterility in general was higher (>30%) even in standard checks, because there were many cloudy days during the crop season.

Standard heterosis for yield and yield components of some hybrid rices, Andhra Pradesh, India.[a]

Hybrid no. and parentage	Yield (t/ha)	Standard heterosis (%)							
		Yield	Panicles/m^2	Spikelets/ panicle	Spikelet fertility %	1000-grain weight	Total dry matter at harvest	Harvest index	Leaf area index
MR365A/IR13420-6-3-3-1	4.7	+ 7 (NS)	– 4 (NS)	+12 (NS)	–25 (S)	+ 3 (NS)	+40 (NS)	+13 (NS)	+47 (S)
MR365A/IR13525-2-2-3-3-2-2	3.8	–14 (S)	– 4 (NS)	+ 9 (NS)	–27 (S)	+ 1 (NS)	+20 (NS)	+ 7 (NS)	+18 (NS)
IR10179-2-3-1A/IR13524-21-2-3-3-2-2	2.8	–14 (S)	–10 (NS)	+ 2 (NS)	–32 (S)	–10 (S)	–20 (S)	– 3 (NS)	+ 9 (NS)
MR365A/IRl8349-22-1-2-1-1	0.8	–82 (S)	–18 (S)	+51 (S)	–73 (S)	+13 (S)	–26 (S)	+ 3 (NS)	+50 (S)
MR365A/IR21015-180-3-3	1.1	–75 (S)	–13 (S)	– 5 (S)	–44 (S)	+13 (S)	+23 (NS)	+ 3 (NS)	+53 (S)
MR365A/IR50	4.9	+11 (S)	+ 5 (NS)	+18 (NS)	–11 (NS)	+19 (S)	+12 (NS)	+13 (NS)	+53 (S)
IR747 B26-3-A/IR50	3.5	–20 (S)	+ 9 (NS)	–18 (NS)	– 3 (NS)	–21 (S)	+20 (NS)	0 (NS)	– 6 (NS)
V20 A/IR9761-19-1	5.0	+14 (S)	+20 (NS)	+ 9 (NS)	+ 1 (NS)	+25 (S)	+40 (NS)	+13 (NS)	+62 (S)
V20 A/IR13419-113-1	1.4	–68 (S)	–14 (NS)	+49 (NS)	–62 (S)	+ 9 (S)	+49 (S)	+10 (NS)	+53 (S)
97A/IR2307-247-2-2-3	5.4	+23 (S)	+33 (NS)	+17 (NS)	– 3 (NS)	+ 9 (S)	+22 (NS)	+13 (NS)	+94 (S)
IR10154-23-3-3A/IR15795-232-33	4.0	– 9 (S)	– 2 (NS)	–12 (NS)	– 4 (NS)	+ 3 (NS)	+ 6 (NS)	– 7 (NS)	+76 (S)
IR36 (check)	4.4								
CD	0.3		49	39	11.1	1.8	0.4	NS	0.5
CV %	4.5		5.2	13.7	9.6	3.8	9.1	11.3	8.7

[a] S = significant, NS = nonsignificant.

Natural outcrossing of cytoplasmic male sterile V20A

T. S. Silitonga, Plant Breeding Division, Bogor Research Institute for Food Crops (BORIF), Merdeka 99, Bogor, West Java, Indonesia

Natural outcrossing of male sterile parents is important for hybrid rice production. In 1982 dry season, the cytosterile line V20A was planted with the maintainer line V20B.

Seed set on cystosterile line V20A in relation to direction and distance from the pollen source, Bogor, Indonesia, 1982 dry season.

Direction	Seed set (%) at given distance from pollen source					Mean seed set (%)
	30 cm	50 cm	70 cm	90 cm	110 cm	
Northwest	14	7	5	7	5	8
Southwest	5	7	7	4	5	6
Northeast	8	7	5	3	3	5
Southeast	5	7	4	5	2	5
Mean	8	7	5	5	4	6

To synchronize flowering, V20A was seeded 3 d earlier and 3 d later than V20B and transplanted at the same time in an isolated plot at 1 seedling/hill. The maintainer line and pollen source was planted in a 3- × 3-m plot at 20- × 20-cm spacing. The cytosterile line was planted at 30- × 20-cm spacing in 5 rows on each side of the pollen-source plot. The 1st row of 10 plants was 30 cm from the pollen source; the 2d. 50; the 3d, 70; the 4th, 90; and the 5th, 110.

One primary panicle of each male sterile plant was bagged before flowering. The others remained uncovered for natural outcrossing. The flag leaf was clipped for supplementary pollination.

At maturity, V20A plants were harvested individually and seed set was counted to determine the extent of outcrossing. The bagged panicles did not set any seed, but seed set on uncovered panicles varied with the direction of planting and distance to the pollen source (see table). Low seed set probably was caused by poor V20A panicle exsertion.

Isolation of maintainers and restorers for three different male sterile lines

S. N. Ratho and K. Pande, Central Rice Research Institute, Cuttack 753006, India

Thirty-six early- and medium-duration rice, (33 improved Indian varieties and 3 from IRRI) were crossed as male parents with each of 3 cytoplasmic, genetic sterile lines — V20A, Wu 10A, and Pankhari 203A — to identify their maintainers and restorers. The F_1 hybrids were grown in the field and in pots in a screenhouse. The main panicles of each plant were bagged and percent spikelet fertility was estimated.

Varieties were classified as effective restorers (>8% spikelet fertility), weak or partial restorers (20 to 80%), weak maintainers (5 to 20%), and effective maintainers (<5%).

IR36, IR50, Karjat 184, Vani, Pusa 33, Aswathi, and Prasad were effective restorers for V20A and Pallavi, Bharathi, Rajeswari, MW 10, Krishna, Archana, and Madhu were effective maintainers (see table). None of the varieties were effective restorers for Wu 10A, but IR30, IR36, Pushpa, Sita, Pragati, Prasad, CR190-103, Rajeswari, and Jamuna were effective maintainers. Similarly, no effective restorers were identified for Pankhari 203A, but 15 were effective maintainers.

IR30, Pushpa, and CR190-103 were maintainers for both Wu 10A and Pankhari 203A. MW 10 and Archana were both maintainers for V20A and Pankhari 203A. Rajeswari was a maintainer for all the three male sterile lines.

IR36 and Prasad were restorers for V20A and maintainers for Wu 10A. Similarly, Vani and Pusa 33 were restorers for V20A and maintainers for Pankhari 203A. The results indicate that the cytoplasm of the three male sterile lines interact differently in the pollinator varieties used in this study.

Restorers and maintainers for V20A, Wu 10A, and Pankhari 203A male sterile lines at CRRI, Cuttack, India.[a]

Variety	V20A	Wu 10A	Pankhari 203A
Pallavi	M	PR	WM
Gaur-1	WM	PR	M
IR30	–	M	M
Karuna	PR	WM	PR
IR36	R	M	PR
Karjat 184	R	WM	PR
Vani	R	WM	M
Rasi	WM	PR	–
Bharathi	M	WM	PR
IR50	R	PR	PR
Indira	–	WM	M
Palman 579	–	WM	WM
Kanchan	–	WM	WM
Pusa 33	R	PR	M
Prabhat	–	PR	M
Pushpa	–	M	M
Sita	–	M	–
Aswathi	R	PR	WM
Sona	–	PR	M
Palghat 60	PR	WM	–
Pragati	–	M	–
Prasad	R	M	–
Vaigai	–	WM	–
CR190-103	–	M	M
Rajeswari	M	M	M
Kranti	PR	PR	PR
MW10	M	PR	M
Kumar	PR	WM	M
Ratnagiri	–	PR	M
Gaur-10	PR	–	PR
Krishna	M	PR	–
Archana	M	WM	M
Madhu	M	WM	WM
Jamuna	–	M	WM
Karikalan	WM	–	M
Ratna	PR	–	WM

[a]R= restorer (80 to 100% spikelet fertility); PR = partial restorer (20 to 80% spikelet fertility); WM = weak maintainer (5 to 20% spikelet fertility); M = maintainer (0 to 5% spikelet fertility); – = damaged seedlings.

Pedigree of AR-11 series, upland rices of northeast India

T. C. Chaudhuri, Tea Board, Darjeeling Tea Research Centre, Kurseong 734203, India

Juming is a traditional rice cultivation system used by tribes in the northeastern hills of India. No systematic breeding program had attempted to improve local varieties, although some plains varieties were introduced. Although collection, screening, and selection of upland germplasm at Arundhuti Nagar Research Station at Agarthala in Tripura did not produce significant results, several hybridizations were attempted. The AR-11 series was developed and became popular. Now, AR-11 varieties are widely planted.

Narkeljuri is a local tall (120 cm) upland rice of Tripura; susceptible to lodging, blast (Bl), and *Helminthosporium* diseases; and low tillering (1 to 2). It has light green, narrow, long boot leaves, and genes for cluster grains; is photoperiod sensitive, and moderately tolerant of moisture stress; matures in 110 d (May-Jul); and yields 0.8 t/ha. It was crossed with semidwarf high yielding Bala, a South India variety.

The F_1 had intermediate idiotype, was almost sterile (5% of the embryos developed), and multiplied by repeated cloning.

Only 20 F_2 plants grew. The F_2 progeny was highly sterile and segregated widely for plant height (90 to 140 cm), leaf length and color (dark to light green), leaf pose (drooping. semierect to erect), pigmentation (absent, light to dark), number of tillers (1 to 10), spikelet characters, and cluster grains (1 to 10/ cluster).

The F_3 consisted of 300 seedlings. Fifty F_3 plants were selected for height (90 to 100 cm), moisture stress and lodging resistance, tillering, boot leaf (wide, dark green, erect), leaf pose (45º), pigmentation, cluster and noncluster grains, good panicle length and number of grains, and yield. Disease and insect resistance, seed-to-seed duration (90-100 d), and grain characters were important.

Fifty different lines were raised to F_4 plants, and 200 individual progenies were screened as in F_3.

The F_5 were 200 different lines. Within each bulk progeny, rigorous roguing was practiced for unwanted segregants. Bulk progenies were selected for uniformity and good yield (av 1.5 t/ha).

Fifty miniplots from individual bulk progenies were raised in F_6 and rogued as in F_5. Fifteen bulk progenies were selected for good idiotypes, including 86- to 90-d maturity; 85- to 90-cm height; resistance to moisture stress, lodging, Bl and *Helminthosporium* diseases; erect, broad, dark green boot leaves; good yield; and fine, coarse grains.

Fifteen miniplots from individual bulk progenies were raised in F_7 and observed for idiotype, yield, and disease resistance. Six AR-11 strains were successfully grown in multilocation trials.

Genetic Evaluation and Utilization
DISEASE RESISTANCE

Relative amounts of tungro (RTV)-associated viruses in selected rices and their relation to RTV symptoms

G. Dahal, research scholar, and H. Hibino, plant virologist. Plant Pathology Department, IRRI

Seedlings of 8 rice varieties with different levels of resistance to green leafhopper (GLH) and RTV were inoculated, 7 d after soaking, with GLH that had fed on TN1 plants with both rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV), or RTSV alone. Infected seedlings were selected, symptoms were observed, and relative amount of virus antigens was determined by latex test/ ELISA about 1 mo after inoculation.

RTBV-infected IR50, IR58, IR60, and TN1 had mild stunting and red or orange leaves at later growth stages. Those infected with RTBV + RTSV were severely stunted, had red or orange leaves, and some interveinal chlorosis (Table 1). ASD7 and ASD8 plants with RTBV had the same symptoms as those infected with RTBV and RTSV. In contrast, when Utri Merah and Utri Rajapan (IRRI Acc. 11684) were infected with both viruses, they showed little stunting, no leaf discoloration, and only occasional interveinal chlorosis. Their symptoms were similar to those of other varieties infected with RTBV alone. Doubly infected Gam Pai 30-12-15 generally had mild symptoms with little stunting but occasional orange or yellow leaves and interveinal chlorosis. None of the test varieties with RTSV had visible symptoms except occasional slight stunting.

The relative amounts of RTBV and RTSV antigen were designated as

Table 1. Symptoms of nine rices infected with RTBV + RTSV, and RTBV or RTSV alone at seedling stage.

Variety	Symptoms [a]		
	RTBV + RTSV	RTBV	RTSV
Gam Pai 30-1 2-15	s, Rt, Dc, Ic	s, Ic	No
ASD7	S, Rt, Dc, Ic	S, Rt, Dc, Ic	No
ASD8	S, Rt, Dc, Ic	S, Rt, Dc, Ic	No
Utri Merah	s, Dg, Ic	s, Dg, Ic	No
Utri Rajapan	s, Dg, Ic	s,Dg,Ic	No
IR50	S, Rt, Dc, Ic	s, Dc	No
IR58	S, Rt, Dc, Ic	s, Dc	No
IR60	S, Rt, Dc, Ic	s, Dc	No
TN1	S, Rt, Dc, Ic	s, Dc, Ic	No

[a] S = severe stunting, s = mild stunting, Rt = reduced tillering, DC = leaf discoloration, Ic = interveinal chlorosis, No = no symptoms.

Table 2. Absorbance of crude extracts of plants infected with RTBV + RTSV, and RTBV or RTSV alone in ELISA (av of 4 plants).[a]

Variety	Absorbance at 405 nm			
	Plants infected with RTBV + RTSV		Plants infected with RTBV [b]	Plants infected with RTSV [c]
	RTBV [b]	RTSV [c]		
Gam Pai 30-12-15	1.04	0.34	0.37 ± 0.13	0.21 ± 0.1
ASD7	–	–	1.21 ± 0.11	0.89 ± 0.3
ASD8	0.65	0.64	0.98 ± 0.17	1.41 ± 0.1
Utri Merah	–	–	0.33 ± 0.3	0.10 [d]
Utri Rajapan	0.29	0.17	0.29 ± 0.16	0.51 ± 0.3
IR50	0.33	0.42	0.67 ± 0.23	0.44 ± 0.02
IR58	0.60	0.22	1.02 ± 0.5	0.87 ± 0.9
IR60	0.68	0.36	0.75 ± 0.4	0.59 ± 0.4
TN1	1.07	0.47	1.12 ± 0.22	0.46 ± 0.03

[a] – = not tested. [b] Tested at 1:20 dilution. [c] Tested at 1:10 dilution. [d] From one individual only.

absorbance values at 405 nm in ELISA (Table 2). ASD7 and ASD8 tended to have high RTBV and RTSV absorbance. Utri Merah and Utri Rajapan had low absorbance. The results indicate a possible correlation between symptom severity and the level of virus antigens in the plant tissues.

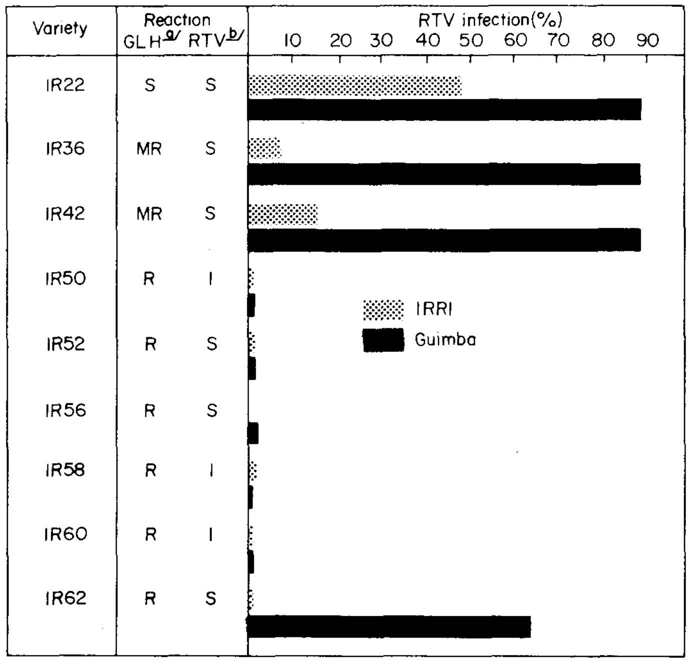
Reaction of IR varieties to tungro (RTV) under various disease pressure

R.C. Cabunagan, Z.M. Flores, and H. Hibino, Plant Pathology Department, IRRI

We conducted field trials to evaluate the reaction of IR varieties to RTV at IRRI and Guimba (Nueva Ecija, Philippines) in 1984 wet season. One 3-wk-old seedling was transplanted per hill and left for natural infection. Disease symptoms were recorded 1 mo after transplanting, and random leaf samples were tested by latex agglutination for the presence of RTV-associated viruses.

Varietal reaction differed with local disease pressure, as determined by RTV infection of the susceptible check. At IRRI, with low disease pressure, susceptible check IR22 had only 47% infection; IR36 and IR42, which are moderately resistant to green leafhopper (GLH), had 6 and 15% infection. Varieties with high GLH resistance had lowest RTV infection (see figure). Serological tests showed that IR22 generally was infected with both rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV), as were IR42 and IR36 at lower levels. The other varieties either were not infected or had only a low level of RTSV (see table).

At Guimba, IR62 as well as IR22, IR36, and IR42 had high RTV infection (see figure). RTV-associated viruses occurred in the same pattern as at IRRI (see table).



RTV infection of IR varieties under different disease pressures. IRRI and Guimba, Nueva Ecija, Philippines, 1984 wet season.

[a] Data from IRRI Entomology Department. [b] Greenhouse mass screening results, IRRI Plant Pathology Department: 0-30% infection, resistant (R): 31-60%, intermediate (I): 61-100%, susceptible (S).

Incidence of RTV-associated viruses in naturally infected IR cultivars as detected by latex agglutination. [a]

Variety	Plants infected (%)							
	IRRI [b]				Guimba			
	RTBV + RTSV	RTBV	RTSV	Healthy	RTBV + RTSV	RTBV	RTSV	Healthy
IR22	52	22	17	8	60	8	21	11
IR36	6	9	26	58	19	11	36	34
IR42	32	13	33	22	34	5	37	24
IR50	0	1	0	99	0	0	2	98
IR52	0	0	0	100	0	1	2	97
IR56	–	–	–	–	3	1	24	72
IR58	5	1	11	83	0	0	3	97
IR60	0	0	0	100	0	1	1	98
IR62	0	0	11	89	10	4	37	48

[a] RTBV = rice tungro bacilliform virus, RTSV = rice tungro spherical virus. [b] — = not tested.

The results show that varieties with high insect resistance can escape field infection better than those with low or moderate resistance.

Reactions of eight rices to tungro (RTV)

M.M. Rahman, research scholar; D.B. Lapis, research fellow; and H. Hibino, plant virologist, Plant Pathology Department, IRRI

Eight rice varieties were inoculated for 8 h in cages by the mass screening method or in test tubes with 1, 3, or 5 green leafhoppers (GLH) *Nephotettix virescens* per seedling. Seedling infection increased with GLH number. Regardless of GLH number, percentage infection was higher in test tube than in mass inoculation (Table 1).

ARC1 1554 was resistant regardless of insect number or inoculation method. Basmati 375A reaction changed from resistant to intermediate in the test tube when GLH number increased from 1 to 3 or 5, but was resistant at 5 GLH/ seedling in the mass-inoculation test. IR28 and Ptb 18 reactions changed from resistant to intermediate in the

Table 1. Reactions of 8 rice varieties to RTV infection with 1, 3, and 5 insects per seedling in mass screening and test tube inoculation.[a]

Variety	Mass screening			Test tube screening		
	1	3	5	1	3	5
ARC11554	R	R	R	R	R	R
Basmati 375A	R	R	R	R	I	I
Latisail	I	S	S	S	S	S
Peta	I	I	S	S	S	S
Ptb 18	R	I	I	R	S	S
TKM6	S	S	S	S	S	S
IR28	R	R	I	R	I	S
TN1	I	S	S	S	S	S

[a] Resistant (R) = 0-30% seedling infection, intermediate (I) = 31-60% seedling infection, and susceptible (S) = 61-100% seedling infection.

Table 2. Presence of RTBV and RTSV in RTV-infected plants of 8 rice varieties as detected by latex agglutination.

Variety	Plants tested (no.)	Plants (no.) that reacted to		
		RTBV+ RTSV	RTBV	RTSV
ARC11554	25	1	12	0
Basmati 375A	6	0	5	0
Latisail	31	18	10	1
Peta	31	15	11	2
Ptb 18	17	2	3	0
TKM6	33	4	25	0
IR28	30	5	21	0
TN1	29	19	9	0

mass inoculation and from resistant to susceptible in the test tube inoculation as GLH number increased.

Seedlings infected with RTV at 3 GLH/seedling were tested for RTV-associated viruses by latex agglutination. Many infected Latisail, Peta, and TN1 plants reacted to rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) (Table 2). Most ARCl 1554 and Basmati 375A plants reacted only to RTBV.

GLH fed on RTV-infected plants were given daily serial transmissions to 7-d-old seedlings of each variety. GLH retained the virus for 2 d on ARCl 1554, IR28, Peta, and Ptb 18; 3 d on Latisail; 4 d on TKM6; and 5 d on TN1.

Genetic Evaluation and Utilization

INSECT RESISTANCE

Genetic analysis of resistance to brown planthopper (BPH) in selected rices

R. Velusamy, postdoctoral fellow, Entomology Department, IRRI, and S. Chelliah, director, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

ASDl1, IET5741, IET6315, T7, and V.P. Samba were identified as BPH resistant in greenhouse screening at the Paddy Breeding Station, Coimbatore. We studied the genetics of resistance of those varieties by crossing each with Vaigai, a BPH susceptible variety.

The F1 seedlings were resistant to BPH in all the crosses, indicating the dominant nature of resistance in those varieties (see table). The F2 population segregated as 3:1 resistant:susceptible, indicating that resistance is conditioned by a single dominant gene. The F3 population was studied only in Vaigai/ V.P. Samba. It segregated as 1 resistant: 2 segregating: 1 susceptible, thus confirming the monogenic nature of BPH resistance in V.P. Samba.

Reaction to BPH in F1, F2, and F3 progenies of crosses between Vaigai and BPH-resistant varieties

Cross	F1 reaction	F2 seedlings			F3 families			
		Resistant (no.)	Susceptible (no.)	X^2 3:1	Resistant (no.)	Segregating (no.)	Susceptible (no.)	X^2 1:2:1
Vaigd/ASD11	Resistant	238	85	0.297	Not tested			
Vaigai/IET5741	Resistant	198	85	3.826	Not tested			
Vaigai/IET6315	Resistant	241	92	1.225	Not tested			
Vaigai/T7	Resistant	207	76	0.518	Not tested			
Vaigai/V. P. Samba	Resistant	236	83	0.234	53	106	41	2.16

Insect pest resistance of IR5-IR62

E.A. Heinrichs, F.G. Medrano. H.R. Rapusas, C. Vega, E. Medina, A. Romena, V. Viajante, L. Sunio, I. Domingo, and E. Camanag, Entomology Department, IRRI

We evaluated IR varieties for resistance to 15 insect pest species in the greenhouse, screenhouse, and field. Hopper resistance was determined in 7- to I0-d-old seedlings by the standard seedbox screening test. Stem borer resistance was evaluated by infesting plants 30 d after transplanting and determining percent deadhearts. Leaffolders *Cnaphalocrocis medinalis* and *Marasmia patnalis* were placed on 30-d-old plants in greenhouse tests. *Nymphula depunctalis* larvae were placed on 11-d-old plants in greenhouse tests. Screening for *Hydrellia philippina* was with natural field populations. *Stenchaetothrips biformis* were released in the greenhouse when plants were at the first-true-leaf stage. *Scotinophara latiuscula* nymphs were placed on 15d-old plants growing in seedboxes and *Leptocorisa oratorius* on plants at milk stage.

Recently recommended IR varieties are resistant to biotypes 1, 2, and 3 of *Nilaparvata lugens* (see table). Most varieties are resistant or moderately resistant to the *Nephotettix* species. Only a few varieties are moderately resistant to *Sogatella furcifera, Recilia dorsalis, S. biformis,* and *S. latiuscula.* Many are moderately resistant to *Chilo suppressalis,* but only a few are to *Scirpophaga incertulas.* Only IR40 is moderately resistant to *H. philippina* and no variety has resistance to *C. medinalis, M. patnalis, N. depunctalis.* and *L. oratorius.*

Resistance of IR varieties to insect pests,[a] IRRI, 1985.

Variety	Maturity[b] (DAS)	*N. lugens* biotype[c] 1	*N. lugens* biotype[c] 2	*N. lugens* biotype[c] 3	*Nephotettix*: *N. virescens*[c]	*Nephotettix*: *N. nigropictus*[c]	*Nephotettix*: *N. malayanus*[c]	*S. furcifera*[c]	*R. dorsalis*[c]	*S. incertulas*[d]	*C. suppressalis*[d]	*C. medinalis*[e]	*M. patnalis*[e]	*N. depunctalis*[e]	*H. philippina*[f]	*S. biformis*	*S. latiuscula*	*L. oratorius*
IR5	130	S	S	S	MR	MR	–	S	S	S	S	S	S	S	S	S	S	S
IR8	125	S	S	S	MR	MR	R	S	S	S	S	S	S	S	S	S	S	S
IR20	121	S	S	S	MR[g]	MR	R	S	S	MR	R	S	S	S	S	S	S	S
IR22	119	S	S	S	S	MR	R	S	S	S	S	S	S	S	S	S	S	S
IR24	118	S	S	S	MR	MR	R	S	S	S	S	S	S	S	S	S	S	S
IR26	121	R	S	R	MR	R	R	S	S	S	MR	S	S	S	S	S	MR	S
IR28	104	R	S	R	R	R	R	S	S	S	S	S	S	S	S	S	S	S
IR29	112	R	S	R	R	R	R	S	S	S	S	S	S	S	S	S	MR	S
IR30	105	R	S	R	R	R	R	S	S	S	MR	S	S	S	S	S	S	S
IR32	130	R	R	MR[h]	MR	MR	R	S	S	S	MR	S	S	S	S	S	S	S
IR34	122	R	S	R	R	MR	R	S	S	S	MR	S	S	S	S	S	S	S
IR36	110	R	R	MR[h]	MR	R	R	S	S	MR	R	S	S	S	S	S	S	S
IR38	123	R	R	MR[h]	MR	MR	R	S	S	S	MR	S	S	S	S	S	S	S
IR40	130	R	MR	S	MR	MR	R	S	S	MR	R	S	S	S	MR	S	S	S
IR42	132	R	R	S	MR	MR	R	S	S	S	MR	S	S	S	S	S	S	S
IR43	120	S	S	S	MR	R	–	S	S	S	MR	S	S	S	S	S	S	S
IR44	123	R	R	MR[h]	MR	R	R	S	S	S	R	S	S	S	S	S	S	S
IR45	120	R	S	R	MR	MR	R	S	S	S	S	S	S	S	S	S	S	S
IR46	112	R	S[i]	R	MR[d]	MR	R	S	S	S	S	S	S	S	S	S	S	S
IR48	127	R	R	S	MR	MR	R	MR	S	S	S	S	S	S	S	S	S	S
IR50	107	R	MR	R[h]	R	MR	R	S	S	MR	R	S	S	S	S	S	S	S
IR52	117	R	R	MR[h]	R	MR	R	MR	S	S	MR	S	S	S	S	S	S	S
IR54	120	R	R	S	R	MR	R	S	S	MR	MR	S	S	S	S	S	S	S
IR56	106	R	R	R	R	R	R	S	R	S	MR	S	S	S	S	S	S	S
IR58	108	R	R	R	R	R	R	S	MR	S	MR	S	S	S	S	MR	MR	S
IR60	110	R	R	R	R	R	R	MR	S	S	MR	S	S	S	S	MR	S	S
IR62	110	R	R	R	R	–[j]	–	MR	MR	S	MR	S	–	S	S	R	MR	S

[a]Based on replicated experiments. [b]DAS = days after seeding. [c]Based on greenhouse evaluation of seedlings. [d]Based on a screenhouse evaluation of 40- to 70-d-old plants. [e]Based on the reaction of 30- and 11-d-old plants in the greenhouse. [f]Based on field observations at 30 d after transplanting. Varieties with ratings as based on the standard evaluation system of 1-3 are considered resistant (R), 5-7 moderately resistant (MR), and 9 susceptible (S). [g]Occasional susceptible reactions. Least resistant of the IR varieties except IR22, which is highly susceptible. [h]Reaction to biotype varies, occasionally being susceptible and often resistant. [i]IR46 has field resistance to biotype 2. [j]Tests still to be conducted.

Green leafhopper (GLH) virulence on three rices

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

Varieties resistant to GLH *Nephotettix virescens* (Distant) are widely grown in Asia. We studied the extent of selection after rearing GLH on a resistant variety for six generations and determined its virulence on another variety with the same major gene for resistance.

GLH colonies were reared separately in the greenhouse on Ptb 8 and IR42 for 6 generations and on TN1 for more than 50 generations. Colony virulence was evaluated based on population growth on Ptb 8, 1R42, and TN1. Ptb 8 and IR42 have the *glh 4* gene for resistance to *N. virescens.*

Thirty-day-old potted plants of the test varieties were covered with 10- × 90-cm mylar film cages and arranged in a randomized complete block design with 10 replications on a water pan tray in the greenhouse. The plants in each cage were infested with 5 pair (male and female) of 3-d-old GLH adults and their progeny were counted 25 d later.

Significantly more progeny per female were produced by the Ptb 8 colony on Ptb 8 than on the IR42 and TN1 colonies (see table). The progeny produced by the IR42 colony also was highest on IR42, although it did not differ significantly from that produced on the Ptb 8 colony. The TN1 colony had the lowest population growth on the three varieties.

Results indicate that the *N. virescens* colonies were most virulent on the variety on which the colony was reared,

Population growth (progeny/female) of *N. virescens* colonies on three rice varieties.

Colony	Progeny/female[a] Ptb 8	IR42	TN1
Ptb 8	75 a (b)	30 ab (c)	116 a (a)
IR42	13b (c)	43 a (b)	79 b (a)
TN1	22b (b)	19 b (b)	65 b (a)

[a]Separation of means in a column or in a row (in parentheses) by Duncan's multiple range test at the 5% level.

indicating a certain degree of GLH adaptation to the variety. Although Ptb 8 and IR42 have the same major gene for GLH resistance, the rate of adaptation was faster on Ptb 8 than on IR42.

Reaction of rices to *Sogatella furcifera* in free-choice and no-choice seedling bulk tests

J. Singh, Plant Breeding Department. Punjab Agricultural University, Ludhiana. India, and H. R. Rapusas and A. Romena, Entomology Department, IRRI

We evaluated the reactions of N22, ARC10239, ADR52, Podiwi A8, N'Diang Marie, and IR2035-117-3 to *S. furcifera* in the IRRI greenhouse in 1984. TN1 was the susceptible check.

In the free-choice test, seeds were sown in 60- × 40- × 10-cm wooden seedboxes. One row of 25 seeds per entry was sown for each of 3 replications. Sevenday-old seedlings were infested with five 2d- and 3d-instar *S. furcifera* nymphs per seedling. Damage was rated at 8 d when susceptible TNl died and 10 d when most varieties showed hopperburn.

Reaction of rice varieties to *S. furcifera* in free-choice and no-choice tests, IRRI, 1984.

Variety	Damage rating [a]		
	Free-choice test		No-choice test
	8	10	
N22	5 (0.00) b	7 (0.57) ab	4 (–0.28) bc
ARC10239	4 (–0.38) ab	6 (0.31)a	5 (–0.05) c
ADR52	3 (–0.57) ab	3 (–0.57) a	3 (–0.46) b
Podiwi A8	4 (–0.19) b	6 (0.50) ab	7 (0.45) d
N'Diang Marie	5 (0.00) b	6 (0.38) ab	4 (–0.17) bc
IR2035-117-3	2 (–0.88) a	4 (–0.19) a	1 (–1.38) a
TN1	9 (1.49) c	9 (1.49) b	9 (1.27) e

[a] Test for paired values for no-choice and free-choice at P = 0.05 = nonsignificant. Figures in parentheses are transformed score values for ranked data.

Reaction was rated by the *Standard evaluation system for rice* 0 to 9 scale (see table).

In the no-choice test, 19-d-old potted plants were covered with a 10- × 90-cm mylar cage and arranged in randomized complete block design with 5 replications. Five pair of 3-d-old *S. furcifera* adults were released per cage. Damage was rated 21 d later (see table).

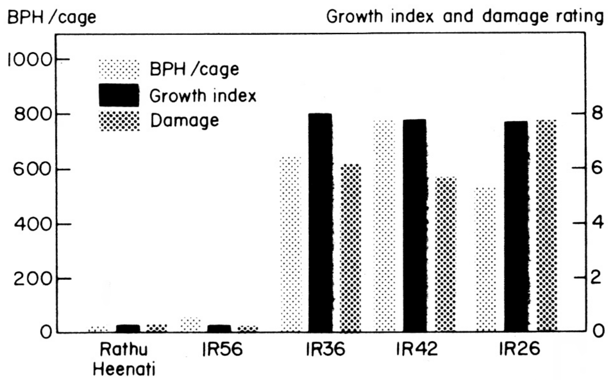
IR2035-117-3 was most resistant in both tests. At 10 d after infestation in the free-choice test, ADR52 performed as well as IR2035-117-3. TN1 was most susceptible, followed by Podiwi A8 and N22.

Response of resistant rices to brown planthoppers (BPH) collected in Mindanao, Philippines

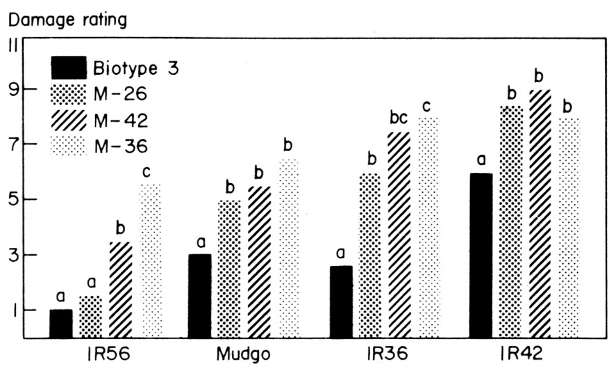
F. G. Medrano and E.A. Heinrichs, Entomology Department, IRRI

IR36 and IR42 (with *bph 2* gene for resistance to BPH *Nilaparvata lugens)* have been extensively grown in the Philippines, Indonesia, and Vietnam for about 7 yr. In 1982, they were attacked by BPH in Mindanao, Philippines. A BPH population was collected in Mindanao and evaluated at IRRI using the standard seedbox screening, population growth development, and growth index studies. IR26 with *Bph 1,* IR36 and IR42 with *bph 2,* and Rathu Heenati and 1R56 with *Bph 3* were screened for resistance.

In the population development study, 10 newly hatched nymphs were caged on 35-d-old potted test varieties. The number of BPH/cage was recorded 40 d



1. Resistance of selected varieties to Mindanao BPH, 1983.



2. Resistance of selected varieties to Mindanao BPH, 1984. M-36, M-25, and M-42 = Mindanao BPH reared on IR36, 1R26, and IR42, respectively.

later. In the growth index study, 10 newly hatched nymphs were caged on 40-d-old test plants. Growth index was computed by dividing percent adult recovery by the mean developmental period on each variety. In the seedbox screening test, varieties were sown in seedboxes and 7-d-old seedlings were each infested with 8 2d- to 3d-instar nymphs. The reaction of all varieties was rated by the *Standard evaluation system for rice* when IR26 seedlings died.

The Mindanao population multiplied on and killed IR26, IR36, and IR42 but not IR56 and Rathu Heenati (Fig. 1). Because the population had characteristics of biotype 2, which kills IR26, and of biotype 3, which kills IR36 and IR42, the population was believed to be a mixture of those biotypes. To verify that, colonies of the population were purified by rearing them separately on IR26 to maintain a biotype 2 culture and on IR36 and IR42 to maintain a biotype 3 culture. The 17th generation of colonies grown on IR26, IR36, and IR42 were compared with those of a greenhouse culture of biotype 3 reared on ASD7.

In the seedbox screening test, both *Bph 1* (Mudgo) and *bph 2* gene (IR36 and IR42) varieties were damaged by all of the Mindanao colonies (Fig. 2), indicating that the Mindanao collection represents a biotype different from previously identified biotypes 2 and 3.

Genetic Evaluation and Utilization
UPLAND RICE

Relation of seedling vigor to stand establishment in some upland rice genotypes

V. S. Chauhan, Vivekananda Laboratory for Hill Agriculture, Almora, 263601, India; P. C. Gupta, senior research fellow, Agronomy, and J. C. O'Toole, agronomist, IRRI

Seedling vigor influences early crop establishment, especially in suboptimum environments, and has been used as a criterion to measure plant establishment in several crops.

We studied the relation of seedling vigor to stand establishment in eight upland rice varieties — Kinandang Patong, Nam Sagui 19, UPLRI 5, IR43, IR20, ITA118, IR6115-1-1-1, and ITAl 16 - which represent dwarf, intermediate, and tall statures. The varieties were planted in a randomized complete block design with four replications on the IRRI upland farm on 28 Jun and 13 Jul (wet season) 1983. Each plot included eight 4-m-long rows at 25-cm spacing. Seedling rate was 100 kg/ ha. We measured seedling height at 15 and 30 d after sowing, growth rate at 15-d intervals, number of seedlings/m^2, and plant dry weight (g/m^2) 30 d after seeding. Seedling vigor was visually assessed by the *Standard evaluation system for rice* 1-9 scale.

In the laboratory we recorded 1,000-seed weight (g), seed germination, and 3d germination count (TDGC). To test seed germination, 25 seeds of each variety in 4 replications were put in petri dishes at 32° C in a germinator. Germination counts were recorded 24, 48, 62, and 96 h after planting and germination at 72 h was expressed as TDGC. Index of germination speed and correlation coefficients were calculated using standard statistical methods.

Among the laboratory determinations, only the correlation between speed of germination and TDGC was positive and significant (r = 0.88). IR20, followed by Nam Sagui 19, had the highest TDGC and speed of germination index. In the seedling vigor characters studied in the field, seedling vigor score was significantly correlated (r = 0.95) with seedling dry weight in the 13 Jul planting when there was mild soil moisture stress. Nam Sagui 19 had the highest seedling vigor rating (1) and also the highest seedling dry weight (50 g/m^2). The study suggests the possibility of using TDGC in the laboratory as a measure to determine seed vigor and proves the usefulness of seedling vigor scoring (1-9 scale) for upland rices. Tall plants such as Nam Sagui 19 seem to have superior seedling vigor under field conditions.

Genetic Evaluation and Utilization
DROUGHT TOLERANCE

DJ.12.519, a promising rice cultivar for rainfed, shallow, drought-prone areas in Senegal

A. Faye, rice breeder, and M. Gning, research assistant, ISRA-CRA-Djibélor BP34, Ziguinchor, Senegal

We evaluated DJ.12.519 (D.25.4/Se 288D) for rainfed, shallow, drought-prone conditions at the Djibélor Agricultural Research Center in Senegal. Its performance was tested at Djibelor and Diana-Bâ from 1981 to 1983 in station trials with Ikong Pao as a check (see table).

DJ.12.519 mean yield over 3 yr was 3.1 t/ha in Djibélor and 4.0 t/ha in Diana-Bâ. Ikong Pao yielded 2.0 t/ha and 2.7 t/ha at the stations. DJ.12.519 is a semidwarf, with high tillering ability and duration of 105-110 d. It is a good substitute for Ikong Pao, which has become susceptible to neck blast.

Grain yield of DJ.12519 and local Ikong Pao for drought-prone areas in Senegal. [a]

Variety	Yield (t/ha)					
	1981 (1029 mm, 80 d)		1982 (943.8 mm, 72 d)		1983 (769.2 mm, 71 d)	
	Djibélor	Diana-Bâ	Djibélor	Diana-Bâ	Djibélor	Diana-Bâ
DJ.12.519	3.6	4.1	4.3	5.1	1.3	2.9
Ikong Pao	3.4	3.0	2.2	3.8	0.3	1.3

[a]Values in parentheses indicate rainfall (mm) and no. of rainy days.

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Genetic Evaluation and Utilization
ADVERSE SOILS TOLERANCE

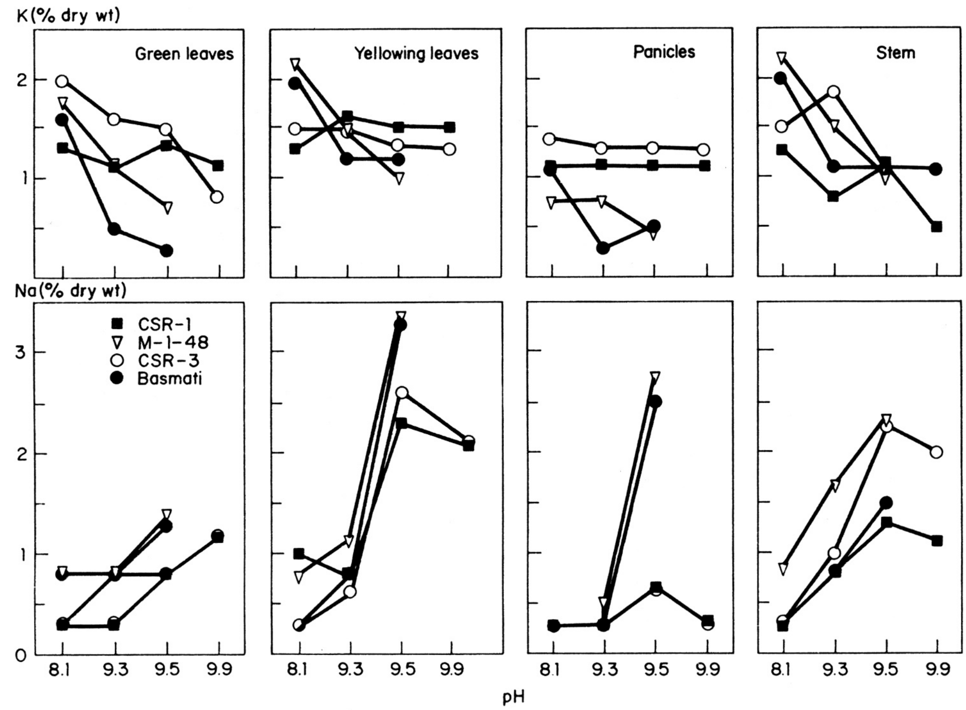
Accumulation and distribution of Na and K ions in rice genotypes with different sodicity resistance

S. K. Sharma, Division of Genetics and Plant Physiology, Central Soil Salinity Research Institute, Karnal 132001, India

In glycophytes, salinity or sodicity resistance is commonly correlated with the ability to restrict the entry of ions into the shoot. Rice is not known to possess much exclusion and selectivity at the root level, but some recent reports suggest that salt-resistant varieties are able to maintain younger leaves at lower Na concentrations under NaCl salinity. However, no information exists about such distribution patterns under sodic stress.

Sodicity-resistant CSR-1 and CSR-3 and sensitive Basmati 370 and M-1-48 were grown on sodic soils artificially prepared by adding $NaHCO_3$ to create pH 9.3, 9.5, 9.9, and a sodic soil of pH 8.1 which correspond to 35, 45, 72, and 8 exchangeable sodium percentage (ESP). Plants were grown in 17-kg-capacity porcelain pots. CSR-1 and CSR-3 are selections from local indicas, Basmati 370 is a local selection for long grain and aroma, and M-1-48 is used as a check.

Resistant varieties had better survival, establishment, growth, and yield. Sensitive varieties had seed sterility and grain filling problems even at moderate pH 9.5 and yielded nothing at the highest pH.



Na and K concentrations in younger green leaves, senescing yellow leaves, panicles, and stems of 4 rice varieties at grain filling stage, Karnal, India.

Plant growth and distribution patterns of Na and K were monitored. Sensitive varieties had reduced growth and yield, higher Na concentrations, and lower K concentrations in all plant organs (see figure). Resistant varieties showed better growth and yields, relatively lower increases in Na concentrations, and less K depletion. Highest Na concentrations under sodic conditions were in the following order: senescing yellow leaves > panicles > stem > young green leaves.

Very high Na concentrations accompanied by low K concentrations in sodicity-sensitive varieties appear to be the primary reason for their poor growth and yield ability.

Genetic Evaluation and Utilization

DEEP WATER

Internode elongation in advanced progenies of RD19/Desaria-8

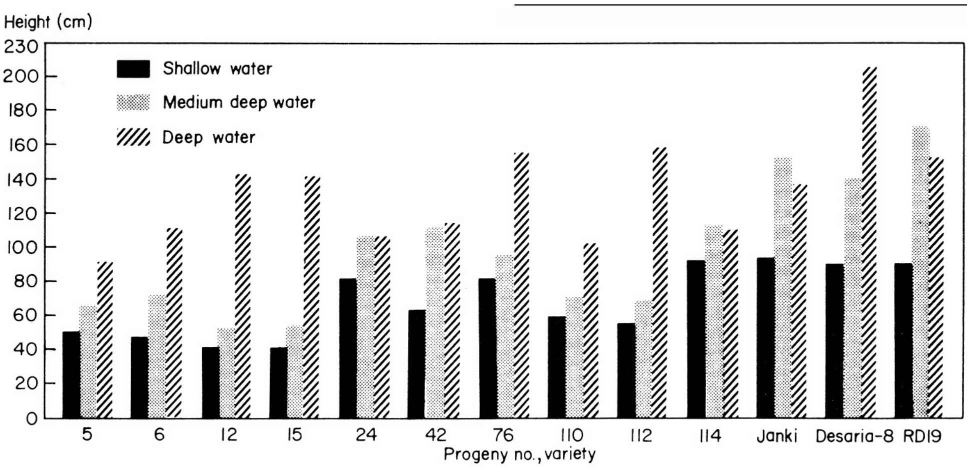
R. Thakur and A. K. Roy, Rajendra Agricultural University, B.A.C., Sabour, Bhagalpur, India, and D. HilleRisLambers, Plant Breeding Department, IRRI

Traditional deep water rices have poor plant type. RD19, which has improved plant type and elongation gene(s), has limited elongation ability; thus, it has limited potential in the deeper water areas of Bihar, India. We crossed Desaria-8, a local cultivar with very rapid stem elongation, with RD19 to develop a variety with better plant type. Ten F_6 progenies were studied in 3 water regimes: 5-15 cm (shallow), 2545 cm (medium deep), and 25-105 cm (deep) at BAC Farm in 1984 wet season. Main tiller height and number and length of internodes of five randomly selected plants of each line were recorded (see table).

Height of most progenies increased progressively from shallow to medium deep water, but the amount of increase varied. The most pronounced increase was found in progenies 12, 15, 76, and 112 (see figure). Those with highest elongation were of semidwarf stature at normal water depth but grew to 140-150 cm in deep water. Janki (Chenab 64-

Internode characteristics of progeny of RD19/Desaria-8.

Progeny no., variety	Total no.	Shortest		Longest	
		Length (cm)	Position	Length (cm)	Position
		Shallow water internodes			
5	4	5.0	4	29.5	1
6	5	3.0	5	24.5	1
12	5	3.5	5	19.5	1
15	5	3.5	5	16.5	1
24	6	4.9	6	41.0	2
42	7	3.0	7	21.0	2
76	7	5.0	7	22.5	1
110	7	3.5	7	21.0	2
112	6	3.0	7	31.5	2
114	8	3.0	8	26.5	2
Janki	8	2.1	8	28.0	1
Desaria-8	7	4.1	7	27.2	1
RD19	7	4.1	7	25.3	2
		Medium deep water internodes			
5	5	3.5	5	43.1	1
6	5	5.5	5	28 5	1
12	5	3.0	5	44.0	1
15	5	4.0	5	39.2	1
24	6	4.7	6	35.1	2
42	6	5.0	5	30.0	2
16	6	7.0	6	28.0	1
110	7	4.5	7	20.0	2
112	6	3.0	6	34.3	2
114	7	3.0	7	24.0	2
Janki	7	7.0	7	32.5	1
Desaria-8	9	5.5	9	28.0	2
RD19	7	7.5	7	35.0	2
		Deep water internodes			
5	6	6.0	1	51.5	1
6	6	5.4	5	68.0	1
12	12	3.0	12	44.0	1
15	12	4.5	12	34.1	1
24	11	4.5	11	29.5	1
42	7	3.0	7	34.7	2
16	10	6.5	10	37.5	1
110	12	4.0	12	21.4	1
112	10	4.0	10	19.9	1
114	11	5.5	11	21.8	1
Janki	10	4.0	10	32.5	1
Desaria-8	13	3.5	13	35.5	1
RD19	11	4.5	11	32.5	2



Increase of plant height at different water levels.

117) and RD19 attained maximum height with medium deep water. The main tiller usually was taller than the primary secondary tillers.

The number of internodes was generally similar in shallow and medium deep water and considerably higher in deep water (see table) although height in medium deep water was 10-40% more than that in shallow water. Height was not strongly related to the number of internodes, but was to elongation. In deep water, the upper internodes were longest in all but one line. In RD19 and progeny no. 42, the second internode was longest.

In shallow and medium deep water, the second internode from the top was the longest in half the lines (see table). The contribution of longest internode to the final height varied from 26 to 61%. That the top three internodes elongated more than the rest should be considered in further studies.

Pest Control and Management

DISEASES

Tungro (RTV) spread in rice fields

M.M. Rahman, M.A. Nahar, and S.A. Minh, Plant Pathology Division, Bangladesh Rice Research Institute, Joydebpur, Dhaka, Bangladesh

We studied the spread of RTV in transplanted aman season by transplanting 21-d-old susceptible Purbachi seedlings in 10- × 10-m plots. The center 2- × 2-m of each plot was planted with RTV-inoculated seedlings. Number and position of RTV-infected plants were recorded 5 times at weekly intervals, beginning 21 d after transplanting (DT). Disease spread was recorded by time, direction, and distance from the center plot.

RTV spread was positively correlated with wind direction. The rate of dispersal was slow before 35 DT and high at 50 DT. Percentage of infected plants was highest within 1 m of the center plot (see table).

Tungro dispersal in rice fields, Joydebpur, Bangladesh.

Direction	Distance (range in m)	Infected plants [a] (%)				
		21 DT	28 DT	35 DT	43 DT	50 DT
East	0-1	1	0	0	6	33
	1-2	0	0	0	4	24
	2-3	0	1	1	7	22
	3-4	0	0	0	7	19
West	0-1	2	1	0	15	24
	1-2	0	0	0	9	32
	2-3	0	0	0	8	27
	3-4	0	0	1	6	30
North	0-1	0	1	1	14	21
	1-2	1	0	2	5	31
	2-3	1	0	0	7	28
	3-4	0	0	1	3	21
South	0-1	1	1	0	15	31
	1-2	1	1	0	9	23
	2-3	0	1	0	3	21
	3-4	0	0	0	5	11
Northeast	0 -1.4	0	0	0	11	36
	1.4-2.8	0	0	0	2	32
	2.8-4.2	0	1	0	4	18
	4.2-5.7	0	0	0	6	19
Northwest	0 -1.4	4	0	0	6	40
	1.4-2.8	0	0	0	12	23
	2.842	0	1	1	8	29
	4.2-5.7	0	2	1	10	24
Southeast	0 -1.4	0	1	0	6	26
	1.4-2.8	0	0	0	6	22
	2.8-4.2	0	0	1	3	13
	4.2-5.7	0	0	0	4	5
Southwest	0 -1.4	0	1	0	10	33
	1.4-2.8	0	0	0	10	23
	2.8-4.2	0	1	0	3	18
	4.2-5.1	0	0	0	2	16

[a] Mean of 2 replications. Percentage infected plants in 2-m^2 plots east, west, north, and south of the center plot; and in 1-m^2 plots northeast, northwest, southeast, and southwest of the center plot.

Effect of planting time on stem rot (SR) incidence

H. Chand and R. Singh, Haryana Agricultural University Rice Research Station (HAURRS), Kaul 132012, Kurukshetra, Haryana, India

Four years of insect pest surveys in Haryana indicate that SR is a serious constraint to rice production. It is most common in Kurukshetra, Kamal, and Ambala districts, where all the cultivated varieties are affected.

We studied the effect of planting time on SR incidence in 1984 at HAURRS. One-month-old Jaya, Jhona 349, Pusa 33, Basmati 370, HAU 118-110, and HAUK 2313-39 seedlings were planted in 2.5-m^2 infected plots on 18 Jul, 3 Aug, and 18 Aug at 20- × 15-cm spacing. The experiment was in a split-plot design with three replications and disease incidence was determined by the 1980 *Standard evaluation system for rice.*

The Jul planting had highest SR incidence, perhaps because of high (28°C) temperatures and relative humidity (81%) prevailing during the susceptible stage of the crop. Disease incidence in all the

Effect of planting time on SR incidence at Kaul, India.

Variety	Infected tillers (%)				Reduction in disease (%) over 18 Jul planting	
	18 Jul	3 Aug	18 Aug	Mean	3 Aug planting	8 Aug planting
Jaya	59	35	3	32	40	95
Jhona 349	19	80	25	61	–2	68
Pusa 33	66	62	5	44	6	92
Basmati 310	25	15	1	14	42	95
HAU 118-110	11	5	3	6	53	76
HAUK 2313-39	24	19	3	15	19	86
Mean	44	36	7			

	CD at 5%
For comparison of means of 2 planting dates	4.52
For comparison of means of 2 varieties	2.14
For interaction (planting date × variety)	4.14

varieties except Jhona 349 was significantly less in the 3 Aug planting. This was attributed to lower temperatures (23ºC) and relative humidity (69%) during susceptible stages (see table).

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Pest Control and Management

INSECTS

Influence of plant density on oviposition by whorl maggot (RWM)

V.D. Viajante and E.A. Heinrichs, Entomology Department, IRRI

We studied the influence of spacing of transplanted and wet seeded IR36 on the number of RWM *Hydrellia philippina* Ferino eggs laid per plant and the degree of RWM damage.

The experiment was in a split-plot design with planting methods as main plots and plant and seed density as subplots. In transplanted plots, hill spacings were 10 × 10, 20 × 20, and 40 × 40 cm. In wet seeded plots, seed rates were 160, 120, and 80 kg/ ha. Three seedlings per hill were transplanted 15 d after sowing. Pregerminated seeds were sown in wet seeded plots on the same day. Plots were flooded 3 d after sowing and transplanting. Number of eggs was counted in a 1-m quadrat and expressed on a per area and per plant basis.

For both planting methods, eggs were most abundant by area on the more densely spaced plants (see table).

RWM damage and egg density as affected by plant density in transplanted and wet seeded IR36.[a] IRRI, 1983 DS.

Plant density	Eggs (no.) at indicated days after transplanting or sowing: Per m^2			Per plant			Damaged leaves (%) 23 DT/DS
	8	18	28	8	18	28	
				Transplanted			
Spacing							
10 × 10 cm	124 c	481 c	179 b	1.2 a	4.9 a	1.8 a	54 a
20 × 20 cm	319 b	192 b	135 b	12.8 b	7.7 b	5.4 a	65 ab
40 × 40 cm	183 a	139 a	70 a	29.3 c	22.1 c	112 b	15 b
				Wet seeded			
Seed rate (kg/ha)							
160 kg/ha	189 c	223 b	110 b	0.39 a	0.41 a	0.23 a	21 a
120 kg/ha	132 b	204 b	81 b	0.66 b	1.02 a	0.44 a	37 a
80 kg/ha	61 a	119 a	76 a	1.36 c	2.38 b	1.52 b	52 b

[a] Av of 4 replications. In a column under each planting method, means followed by a common letter are not significantly different at the 5% level by DMRT.

Effect of nitrogen and carbofuran on gall midge (GM) and white stem borer (SB) infestation in Nigeria

M. N. Ukwungwu, National Cereals Research Institute (NCRI), Badeggi, P.M.B. 8, Bida, Nigeria

In 1984 wet season we studied the effect of N fertilizer and granular carbofuran application on GM *Orseolia oryzivora* Harris and Gagne and white SB *Maliarpha separatella* Ragonot infestation on rice plants at Badeggi, Nigeria. The site was on the irrigated lowland research farm of NCRI.

The field trial was in a split-plot randomized block design with three replications on an acid Oxisol (Agaie soil series). Three-week-old FARO 15 seedlings were planted in 15-m^2 plots at 20- × 2 km spacing. N as ammonium sulfate was applied at 0, 50, 100, or 150 kg/ ha as 50% basal and 25% each at active tillering and panicle initiation. Basal P and K were 40 kg/ ha. Carbofuran granules (1.0 kg ai/ha) were applied at 1, 30, and 60 d after transplanting (DT); 1 and 30 DT; 30 and 60 DT. GM damage was measured at 70 DT as the number of onion shoots to total tillers in 50 hills/plot. SB damage was measured by dissecting stems from 20 hills/plot at 10 d before harvest.

GM and SB damage increased with applied N, but the number of tillers/hill and panicles/ hill did not increase significantly beyond 0 kg N/ha. Yield did not differ significantly at different N levels (see table).

Applying carbofuran significantly influenced GM and SB damage. Applying carbofuran at 1 and 30 DT significantly reduced GM damage. SB damage was significantly reduced with applications at 1 and 30 DT or 30 and 60 DT. There were no significant differences in yield components or total yield (see table).

Effect of N and carbofuran on GM and SB infestation, Badeggi, Nigeria, 1984 wet season. [a]

Treatment	GM damage (% onion shoots)	SB-damaged stems (%)	Yield components and total yield		
			Tillers/hill	Panicles/hill	Yield (t/ha)
N level (kg/ha)					
0	4.2 a	35.3 a	7.3 b	6.8 b	2.59 a
50	4.6 a	36.4 ab	8.8 a	8.1 a	2.12 a
100	4.8 a	39.3 bc	9.5 a	8.7 a	2.13 a
150	1.2 b	40.1 c	9.8 a	8.7 a	2.82 a
Carbofuran application [b] (1.0 kg ai/ha)					
1	6.0 cd	39.7 b	9.3 a	8.4 a	2.19 a
30	4.7 abc	31.6 ab	8.1 a	7.5 a	2.71 a
60	5.6 bcd	38.3 ab	9.3 a	8.7 a	2.58 a
1 and 30	3.6 a	35.3 a	9.3 a	8.1 a	2.88 a
30 and 60	4.1 ab	34.5 a	8.6 a	7.7 a	2.83 a
Untreated	7.2 d	41.0 b	8.5 a	1.3 a	2.51 a

[a] Separation of means in a column by DMRT at the 5% level. [b] Days after transplanting.

Effect of insecticides and variety on stem borer (SB) incidence

M. N. Ukwungwu, Entomology Division, Rice Research Program, National Cereals Research Institute, Budeggi, P.M.B. 8, Bida, Nigeria

We studied the effect of some insecticides and varieties on SB incidence at Badeggi in 1983 wet season. The field trial was in a split-plot randomized block design with four replications. Twenty-one-day-old FARO 11 and FARO 13 seedlings were transplanted in 25-m^2 plots at 25- × 25-cm spacing. Insecticides were applied 10, 30, 50, and 70 d after transplanting (DT). Deadhearts due to *Diopsis thoracica* infestation in each plot were recorded 40 DT. Bored stems from *Maliarpha separatella* infestation were assessed by dissecting 20 randomly selected hills from each plot at 10 d before harvest (see table).

Carbofuran controlled *D. thoracica* most effectively, followed by BHC and decamethrin. Number of bored stems did not significantly differ among insecticide treatments. Carbofuran-treated plots had significantly fewer borers per plant than other plots, and yield was significantly higher.

FARO 11 had more deadhearts than FARO 13, but the difference was insignificant. FARO 11 had significantly more borers per plant.

Effect of insecticides and varieties on SB incidence, Badeggi, Nigeria, 1983 wet season.

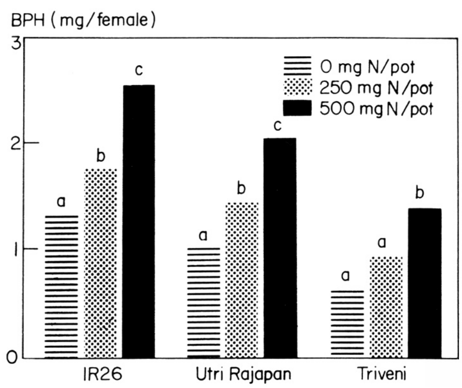
Treatment			Deadhearts 40 DT (%)	Bored stems at harvest (%)	Borers (no/20 hills)	Grain yield (t/ha)
Insecticide	Formulation	Rate (kg ai/ha)				
BHC	20 EC	2.00	9	22	32	3.3
Decamethrin	2.5 EC	0.50	9	20	29	3.3
Diazinon	60 EC	2.00	21	22	28	2.1
Isoprocarb	75 WP	1.33	13	21	20	2.6
Carbofuran	10G	1.00	4	19	13	3.9
Control			17	22	32	2.8
LSD (P=0.05)			10	ns	10	0.6
Variety						
FARO 13			10	19	19	3.3
FARO 11			14	23	33	2.9
LSD (P=0.05)			ns	2	6	ns
Interaction (P=0.05)			14	ns	ns	ns

Influence of N fertilizer on the population development of brown planthopper (BPH)

E. A. Heinrichs and F. G. Medrano, Entomology Department, IRRI

We studied BPH *Nilaparvata lugens* biotype 2 reactions to different levels of N fertilizer on selected rices. BPH reared on IR26 were tested on susceptible IR26; Utri Rajapan, tolerant with no antibiosis; Triveni, moderate tolerance and antibiosis; and IR60, high antibiosis.

The N solution was prepared by mixing 125 g of ammonium sulfate containing 20% N in 375 ml water. In each of 2 clay pots lined with polyethylene bags and containing 2.5 kg



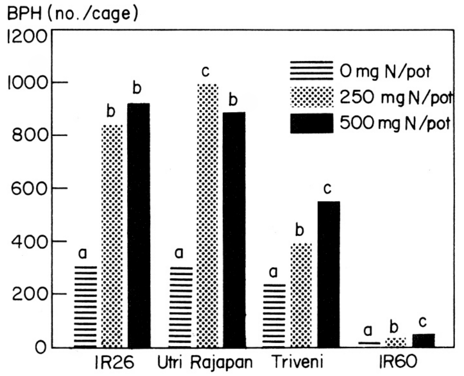
1. BPH weight on selected varieties grown under different N fertilizer rates, IRRI.

rice soil, we mixed 5 ml or 10 ml of the fertilizer solution corresponding to 250 mg and 500 mg N/ pot, or 100 and 200 kg N/ ha. A clay pot with no applied N was the control. Treatments were replicated seven times, with one pot as a replication.

Three 7-d-old seedlings were transplanted in each pot. At 20 d after transplanting (DT), potted plants were covered with mylar film cages and infested with 20 newly hatched BPH nymphs per cage. After 18 d, or when insects reached adulthood, all but 3 pair (male and female, randomly selected) of BPH were removed. The six were left to develop a population in each cage. The insects removed from the cages were collected in vials, oven dried, and individually weighed. Because survival on IR60 was very low, no weights were recorded. For the population growth test, BPH reared on IR26 plants in a separate cage were used to reinfest IR60 at 3 pair/ cage.

To determine the effect of BPH feeding rate at different N levels, one seedling was planted in a clay pot. At 30 DT, we recorded honeydew excretion (mm^2) by 5 adult females on filter paper treated with bromocresol green.

BPH weight (Fig. 1), feeding rate, and population growth (Fig. 2) increased with N application on IR26, Utri Rajapan, and Triveni. Population growth on IR26 and Utri Rajapan, without antibiosis, increased threefold with added N, and twofold on moderately resistant Triveni (Fig. 2). On IR26, Utri Rajapan, and Triveni, weight per female increased at both 250 and 500 mg N/ pot. Although IR60 was



2. BPH population development on selected varieties grown under different N fertilizer rates, IRRI.

highly resistant at the high N level and the BPH number remained low, the population doubled with applied N.

Insecticides to control thrips and caseworm in rice nurseries

S. Uthamasamy, S. Suresh, and A. A. Kareem, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

Thrips *Stenchaetothrips biformis* (Bagnell) and caseworm *Nymphula depunctalis* (Guen.) severely damage rice seedlings. We evaluated seed treatment and soil application of insecticides before and after sowing for their control. CR1009 was planted in 4-m^2 plots. Thrips population was recorded on 10 randomly chosen seedlings/ plot at 20 and 30 d after sowing (DAS). At 30 DAS, percent caseworm damage was recorded for 10 seedlings/ plot based on total leaves and damaged leaves.

Broadcasting carbofuran 3 G at 0.5 kg ai/ ha before sowing and at 10 DAS controlled thrips most effectively. Broadcasting carbofuran at 10 DAS controlled caseworm most effectively (see table).

Control of thrips and caseworm in rice nurseries, Tamil Nadu, India, 1984. [a]

Treatment	Thrips (no./seedling)		Caseworm (% damaged leaves)
	20 DAS	30 DAS	30 DAS
Seed soaking [b] in chlorpyriphos, 0.2% for 3 h	0.5 c	0.9 bcd	12.0 b
Seed soaking [b] in chlorpyriphos, 0.1% for 3 h	0.4 bc	0.8 abcd	15.0 bc
Broadcasting carbofuran 3 G, 0.5 kg ai/ ha before sowing	0.1 a	0.4 ab	10.3 ab
Broadcasting phorate 10 G, 1.0 kg ai/ ha before sowing	0.2 ab	1.2 cd	12.3 b
Broadcasting carbofuran 3 G, 0.5 kg ai/ ha at 10 DAS	0.2 ab	0.3 a	4.8 a
Broadcasting phorate 10 G, 1.0 kg ai/ ha at 10 DAS	0.2 ab	0.6 abc	19.0 c
Untreated check	0.4 bc	1.3 d	13.5 bc
CD (0.05)	0.3	0.5	5.6

[a] Values are means of 4 replications. DAS = days after sowing. Means in a column followed by a common letter are not significantly different at 5% level. [b] 12 ml (0.2%) and 6 ml (0.1%) of chlorpyriphos 20 EC used in 1.2 liters of water for soaking 1.0 kg seed.

Insect pests of early season rice nurseries in the Imphal Valley

R. N. Barwal, Indian Council of Agricultural Research (ICAR) Complex for NEH Region, Bishnupur, Shillong 793013, India; and A. C. Sharma and K. V. P. Rao, ICAR Complex, Manipur Centre, Imphal 795001, India

In the Imphal Valley, cold weather prevents germination of rice seed in Feb

Varietal response to root aphid *Rhopalosiphum rufiubdominalis* (Sasaki) in winter rice nurseries, Imphal, India.

Variety	Aphid burns	
	No.	Area [a] (%)
Prasad (IR1561-2166)	8a	2 (7.99)
Punshi (IR661-1-140-3-2/Phouren)	8 ab	2 (7.87)
P-33 (TNl/Basmati 370)//(Ratna)	9ab	3 (9.13)
RCM-1 (Moirangphou/Jaya)	11 b	4 (1 1.06)
CH-1039	17 c	8 (16.52)
CD (P=0.05)	3	3

[a] Values in the parentheses are arc sin percent transformation. Means followed by a common letter are not significantly different.

and Mar and is a major constraint to the early rice crop. We tested a new nursery-raising method and thereby identified a new rice pest.

Five recommended high yielding rices (see table) were sown in early Feb 1983. Seeds were sown in 1-m^2 plots and were covered with 1 cm layer of soil and 1 cm of cow dung compost. Covering the plots with a polythene sheet for 2 wk significantly raised the temperature (14-40° C vs outside temperatures of 4-21° C). When the sheet was removed, we found a serious infestation of rice root aphid *Rhopalosiphum rufiabdominalis* (Sasaki). The nursery remained yellowish with stunted growth until the end of Feb, and circular dead spots called *aphid burns* developed. When we pulled the seedlings, we found that Ch-1093 was most susceptible (see table). Sprinkling the nursery with phosphamidon at 0.05% concentration effectively controlled the aphids.

When similar nurseries were grown on a raised trench (30 × 30 × 150 cm), *Rhopalosiphum maidis* (Fitch) became at pest. Other insects associated with this nursery technique were phytophagous beetle *Luperodes* sp. and predator beetles, *Micraspis inops* var. *vincta* (Gorham) and *Paederus* sp. A fungivorous and phoretic mite, *Uroovovella* sp., was also found in the root zone.

Movement of BPMC in rice

P.K. Garg, A.K. Halve, A, Shanker, S. Y. Pandey, and K. Sivasankaran, Research and Development Centre, Union Carbide India Limited, Shamla Hills, Bhopal 462013, India

Because downward movement of BPMC (2-Sec-butyl phenyl N-methyl carbamate) in rice has been reported, we quantified movement of BPMC from rice leaves to stems.

We conducted 2 greenhouse pot trials in 0.3 × 0.4 × 0.2 m^3 trays. The upper leaves of 30- and 60-d-old TN1 plants were treated with 0.2% and 0.4% solutions of BPMC 50EC with an atomizer at constant volume basis while the lower 15 cm of stems was protected with a thermocole. Leaves and stems of all plants were sampled at 0, 1, 3, and 4 d after treatment. Thirty-day-old plants also were sampled after 5 and 6 d. Treatments were in a complete randomized block design with three replications. Foliage and stem samples were separately analyzed by spectrophotometrics.

BPMC residues in rice leaves and stems, Bhopal, India.

Sampling interval (d)	BPMC residue[a] (ppm)							
	30-d crop				60-d crop			
	0.2% concentration		0.4% concentration		0.2% concentration		0.4% concentration	
	Foliage	Stem	Foliage	Stem	Foliage	Stem	Foliage	Stem
0	8.4	BDL	21.6	BDL	9.5	BDL	41.5	BDL
1	7.3	0.8	17.6	2.1	8.0	0.9	34.8	3.6
2	3.8	0.9	13.8	2.3	4.7	1.0	24.4	4.2
3	2.4	0.5	7.2	1.3	2.7	0.6	19.2	4.2
4	1.1	0.3	3.1	0.7	1.4	0.4	4.4	1.6
5	0.4	BDL	0.9	0.6	–	–	–	–
6	0.3	BDL	0.4	0.2	–	–	–	–

[a] Av of 3 replications. BDL = below detectable level (less than 0.10 ppm).

On treatment day, BPMC deposits on leaves of 30-d plants treated with 0.2 and 0.4% solutions were 8.4 and 22 ppm. Corresponding values for 60-d plants were 9 and 41 ppm (see table). Residue on the leaves degraded gradually, persisting for 4-6 d. About 9% of the insecticide had moved to the stem 24 h after treatment. BPMC concentration in stems increased to about 11% 2 d after treatment and then gradually decreased. The decrease may be due to dilution as a result of plant growth or may be because dissipation exceeded the downward movement of BPMC. Neither plant age nor dosage significantly affected downward movement.

Insect pests of upland rice in Uttar Pradesh

P. M. Nigan and R. A. Verma, Rice Research Station, C. S. Azad University of Agriculture and Technology, Kalyanpur Kanpur 208024, India

Upland rice in Uttar Pradesh is attacked by green leafhopper *Nephotettix virescens* (Distant), brown planthopper *Nilaparvata lugens* (Stal), leafroller *Cnaphalocrocis medinalis* (Guenee), butterfly *Melanitis leda ismene* (Cramer), rice bug *Leptocorisa acuta* (Thunberg) (-*varicornis* Fab.), stem borer *Scirpophaga incertulas* (Walker), armyworm *Mythimna separata* (Walker), and aphid *Hysteroneura setariae* (Thomas). Of those, *N. virescens, L. varicornis, S. incertulas,* and *M. separata* are of major importance. In recent years, *M. separata* has become increasingly important, with severe infestations causing 60-80% yield losses. Losses to *L. acuta* are 15–20%, to *S. incertulas* 10-15%, and to *N. virescens* 5-10%.

Efficacy of three synthetic pyrethroids for caseworm control

S. Suresh, C. Anilkumar and A.A. Kareem, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

Caseworm *Nymphula depunctalis* severely damages rice nurseries and young transplanted rice in thaladi (Nov-Dec) in Thanjavur district. Phosphamidon, monocrotophos, and endosulfan are recommended controls. We tested three synthetic pyrethroids for

Synthetic pyrethroids for caseworm control, Aduthurai, India, 1984.[a]

Insecticide	Formulation (EC)	Dose (g ai/ha)	Damaged leaves before treatment (%)	Mortality[b] (%) after	
				24 h	48 h
Fenvalerate	20	100	81	97 a	91 a
	20	15	81	94 ab	94 a
Cypermethrin	25	80	80	95 a	91 a
	25	60	66	95 ab	94 a
Deltamethrin	2.8	15	82	94 ab	95 a
	2.8	11.25	90	91 ab	92 a
Endosulfan (standard check)	35	500	78	81 b	81 b
Untreated check			86	6 c	5 c

[a]Mean of 3 replications. [b]In a column, means followed by a common letter are not significantly different at the 5% level.

caseworm control. IR50 was planted in 40 m^2.

Pretreatment caseworn damage was recorded on 12 randomly selected hills/plot. Damage between plots did not significantly differ. Results were recorded by counting live and dead larvae 24 and 48 h after treatment.

All pyrethroid treatments were superior to the control and the standard check (see table). Fenvalerate 20 EC sprayed at 100 g ai/ ha gave 97% mortality at 24 and 48 h after treatment.

Pest Control and Management

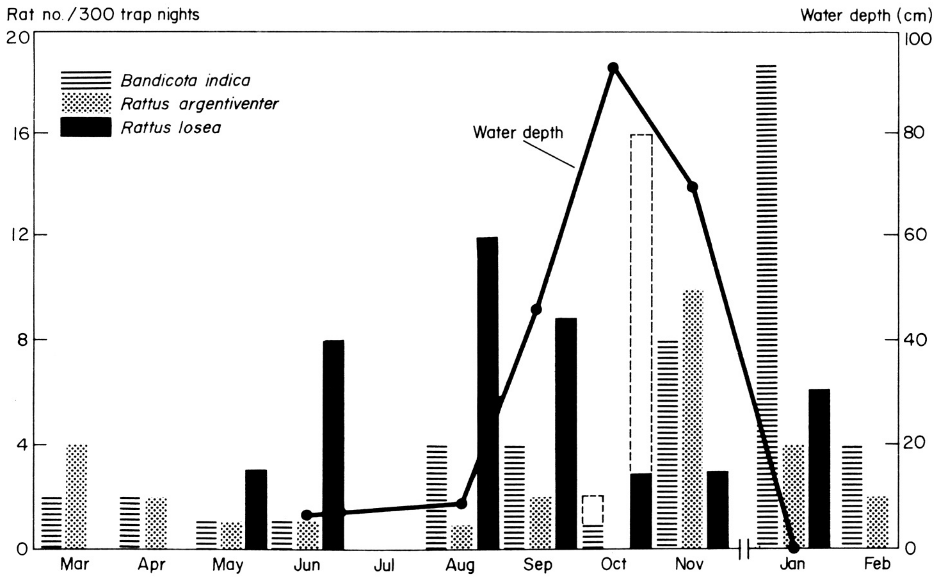
OTHER PESTS

Survey of rodents and rodent damage in deep water rice

S. Somsook, K. Tongtavee, H.D. Catling, T. Keawta, and S. Hongnak, Zoology Section, Entomology and Zoology Division, Department of Agriculture, P. O. Box 9-34, Bangkok 10900, Thailand

We studied rodent activity in several deep water rice fields at Huntra Station, Ayutthaya Province, from Mar 1984 to Feb 1985. One hundred live traps baited with fresh fish were set on 3 consecutive nights at 4-6 wk intervals. In the same fields, stem damage caused by rodents was estimated several times. During the deepest flooding, a large, adjacent field also was sampled.

Rats *Bandicota indica, Rattus losea,* and *Rattus argentiventer* were active in the fields. Rat populations were influenced by food availability and floodwater level (see figure). At peak flooding, when all dikes were submerged, we trapped no *R. argentiventer,* but the other species remained active. *B. indica* and *R. losea* continued to live and reproduce in the field. Stem cutting by rats began in Jun and continued through stem elongation at 95 cm water depth. The cumulative seasonal damage probably exceeded 10% of the stems.



Species composition and numbers of rats, Huntra, Thailand, 1984-85. The dashed bars shown for Oct represent rat numbers in an adjacent farmer's field.

Soil and Crop Management

Nitrogen fertilizer efficiency in two major rice soils of Bangladesh

M. I. Ali, principal scientific officer, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh

We evaluated N fertilizer efficiency in Grey Floodplain (Mymensingh) and Red Brown Terrace (Madhupur) soils in Bangladesh in boro, aus, and transplanted aman. BR-3 was planted at both sites. Soil at Mymensingh was a silt loam with pH 6.8, 0.57% organic C, CEC and exchangeable K 9.2 and 0.25

Table 1. Method, time, and rate of N application at 2 sites in Bangladesh.

Treatment [a]	Portion at time of application [b]				Basal application	N rate (kg/ha)	
	Basal	15 DT	30 DT	5-7 DBPI		Boro	Aus/Aman
Control	–	–	–	–	–	–	–
U11	1/3	–	1/3	1/3	B&I	31	31
U12	1/3	–	1/3	1/3	B&I	62	62
U13	1/3	–	1/3	1/3	B&I	93	93
U14	1/3	–	1/3	1/3	B&I	155	124
U21	–	–	1/2	1/2	–	31	31
U22	–	–	1/2	1/2	–	62	62
U23	–	–	1/2	1/2	–	93	93
U24	–	–	1/2	1/2	–	155	124
USG11	All	–	–	–	DP	31	31
USG12	All	–	–	–	DP	62	62
USG13	All	–	–	–	DP	93	93
USG14	All	–	–	–	DP	155	124
U32	–	1/3	1/3	1/3	–	62	62
USG22	1/2	–	–	1/2	DP	62	62
SCU12	All	–	–	–	B&I	62	62

[a] U = prilled urea, USG = urea supergranule (1G.), and SCU = sulfur-coated urea. [b] Basal = immediately before transplanting for B&I and immediately after for DP, DT = days after transplanting, DBPI = days before panicle initiation, B&I = broadcast and incorporated during final land preparation, DP = deep point, after pushing into mud to depth of 10 cm.

Table 2. Effect of N application levels and methods on rice grain yield on 2 Bangladesh soils. [a]

Treatment	Grain yield (t/ha)							
	Mymensingh				Madhupur			
	Boro	Aus	Aman	Mean	Boro	Aus	Aman	Mean
Control	3.0 e	1.7 h	3.1 c	2.6	2.1 jk	3.0 g	4.4 g	3.2
U11	3.5 de	2.4 fg	3.4 ab	3.1	2.8 hi	3.0 g	5.0 def	3.6
U12	4.5 cd	2.5 ef	3.5 ab	35	3.5 fg	3.4 defg	4.9 f	3.9
U13	5.8 ab	2.7 def	3.5 ab	4.0	3.4 gh	3.5 cdefg	5.5 abc	4.1
U14	6.5 a	3.2 abcd	3.5 ab	4.4	5.7 ab	3.8 abcd	5.8 ab	5.1
U21	3.6 de	2.6 ef	3.3 bc	3.2	2.7 ij	3.1 fg	5.4 abcd	3.7
U22	4.0 cde	2.8 def	3.5 ab	3.4	3.5 fg	3.6 abcde	5.2 cd	4.1
U23	4.3 cd	3.3 abc	3.5 ab	3.7	4.1 ef	3.7 abcd	5.5 abc	4.4
U24	6.0 ab	3.4 ab	3.5 ab	4.3	5.3 b	4.1 a	55 abc	5.0
USG11	4.2 cde	2.6 ef	3.5 ab	3.4	3.6 fg	3.3 defg	5.4 bcde	4.1
USG12	5.1 bc	2.9 bcde	35 ab	3.9	4.7 cde	3.3 defg	5.6 abc	45
USG13	6.1 ab	3.6 a	3.5 ab	4.4	4.8 cd	4.0 abc	5.8 ab	4.8
USG14	6.8 a	3.5 a	3.7 a	4.7	6.2 a	4.0 ab	5.9 a	5.4
U32	3.4 de	2.8 cde	3.3 bc	3.2	2.8 i	3.3 defg	5.3 cdef	3.8
USG22	4.3 cd	3.0 bcde	3.4 ab	3.6	4.6 de	3.6 bcdef	5.2 cdef	4.5
SCU12	3.4 de	1.9 gh	3.4 bc	2.9	2.0 k	3.1 efg	5.0 ef	3.4

[a] Figures in a column followed by the same letter are not significantly different from each other.

meq/100 g soil, and 10-12-2.2 ppm available P-S-Zn. Soil at Madhupur was a silt loam with pH 5.7, 0.50% organic C, CEC and exchangeable K 7.2 and 0.17 meq/100 g soil, and 149-3.1 ppm available P-S-Zn. Time, method, and placement of N fertilizer is in Table 1. Each plot received a basal application of 20-30-20-5 kg P-K-S-Zn/ha.

Grain yield data for both sites are in Table 2. Treatment effects were significantly different in all crops. Usually, yield increased with increasing N application up to 155 or 124 kg N/ha regardless of management.

Single deep point placement of urea supergranules (USG) was superior to equal amounts of prilled urea (PU) applied in 2 or 3 splits in both soils. USG superiority was most pronounced in boro, perhaps because there was greater horizontal and upward movement of N from deep-placed USG in boro, which resulted in better N utilization. Broadcast, split-applied PU may have had higher volatilization losses in the alternate wetting and drying in boro.

Averaging data from three rice crops showed USG performed best at all N doses (Table 2). In both soils, USG at 62 kg N/ ha gave the highest grain production per kg N applied. Sulfur-coated urea produced the lowest yields at both sites.

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Effect of crop establishment techniques and seed rate on upland rice yield and weed growth

J. K. Kehinde, Rice Research Program, National Cereals Research Institute, Moor Plantation, Ibadan, Nigeria

Upland rice farmers in Nigeria generally dibble rice seeds at no specific seed rate after land preparation. To determine the effect of establishment methods on rice yield and weed growth, three crop establishment methods (broadcasting, dibbling, and drilling) were tried at 45, 90, or 135 kg seeds/ha under upland conditions.

The experiment was in a split-plot, randomized block design with three replications. Establishment techniques

Table 1. Effect of seed rate on weed growth and yield of FARO 11, Ibadan, Nigeria.

Seed rate (kg/ha)		Dry weed weight (g/m²)	Grain yield [a] (t/ha)
45		0.5 1	1.1
90		0.39	0.9
135		0.35	0.7
LSD	0.05	0.64	0.3

[a] Drought at flowering stage caused generaly poor grain yield.

formed the main plot and seed rates the subplot. Seeds of FARO 11 were drilled along furrows made 25 cm apart or dibbled 25 cm within and between rows.

For initial weed control, a combination of thiobencarb + propanil at 3 kg ai/ha was applied to all treatments 7 d after sowing. Weed weight and grain yield were determined at maturity and grain yield was adjusted to 14% moisture content.

Seed rate and crop establishment techniques did not significantly reduce weed weight; however, weed weight declined progressively as seed rate increased.

Highest yield was with 45 kg seeds/ha (Table 1), probably because of less competition among rice plants than at higher rates. Crop establishment techniques did not significantly affect grain yield (Tab1e 2); however, dibbling gave the highest yield.

Table 2. Effect of crop establishment techniques on weed growth and yield of FARO 11, Ibadan, Nigeria.

Establishment method	Dry weed weight (g/m2)	Grain yield[a] (t/ha)
Drilling	0.43	0.8
Dibbling	0.63	1.0
Broadcasting	0.19	0.7
LSD 0.05	0.64	0.4

[a] Drought at flowering stage caused generally poor grain yield.

Response of lowland rice to phosphorus fertilizer

M. S. Maskina, O.P. Meelu, and H.S. Badesha, Punjab Agricultural University, Ludhiana 141004, India

Next to N, P is the second major nutrient element that limits rice yield. Response to P varies with soil characteristics. In Punjab, the rice area has expanded to include light-textured soils that often are P deficient. We studied the response of rice to P in farmer fields at five sites around the State. Soil characteristics of the fields are given in Table 1. N at 120 kg/ha was applied to all fields in 3 equal splits. Different levels of P and 12.5 kg K/ha were incorporated during the last puddling, and 35-d-old PR106 seedlings were transplanted.

Table 1. Chemical characteristics of soils at five sites in the Punjab.

Classification	Texture	pH	Organic C (%)	EC (mmho/cm)	Available P (kg/ha)
Haplustalf	Sandy loam	8.4	0.54	0.35	5.6
Ustochrept	Sandy loam	8.4	0.65	0.38	38.8
Haplustalf	Sandy loam	8.3	0.51	0.40	11.6
Ustochrept	Sandy loam	9.0	0.40	0.24	1.8
Ustochrept	Clay loam	8.5	0.41	0.35	12.1

Applying 13.5 kg P/ha increased rice yield by 300 to 740 kg/ha at 3 sites, but the differences were not significant. At 2 sites, there was a significant response to 19.5 kg P/ha. Mean values for all sites showed that applying 19.5 kg P/ha increase rice yield by 330 kg (Table 2). Rice did not respond to 26 kg P/ha.

Although the response to fertilizer P was not substantial, the results indicate that P application is necessary to achieve optimum rice yield in Punjab. Because rice - wheat is a common rotation, P not utilized by the rice crop is utilized by the succeeding wheat crop.

Table 2. Response of rice to fertilizer P at 5 sites in the Punjab.

P	Yield (t/ha)					
(kg/ha)	1	2	3	4	5	Mean
0	8.0	8.5	6.9	6.8	1.2	7.5
13.5	8.4	9.3	6.8	1.0	1.5	1.8
19.5	1.9	9.2	1.6	1.2	1.5	1.8
26.0	8.5	9.0	1.5	1.2	1.1	7.9
CD at 5%	ns	ns	0.5	0.2	ns	

Effect of split-applied N on rice yields

S. Ramasamy, V. Sivasubramanian, and S. Sankaran, Tamil Nadu Rice Research Institute (TNRRI), Aduthurai 612101, India

We evaluated the effect of split application of N fertilizer on rice yield at TNRRI. Nine N application times were tested with ADT36 (105-110 d variety) in 1984 wet season (Jun-Sep) in a randomized block design. Soil was clay loam with 0.13% N, 1.2% organic matter, and cation exchange capacity 23 ml/litre.

Prilled urea (at 75 kg N/ha) was applied in 2 or 3 splits at planting, 5 d after transplanting (DT), 10 DT, and 15 DT with 50 + 25 + 25% splits or 4 equal splits. This was compared with 0 fertilizer N and all basal N. PK at 38 kg was applied to all plots.

Grain yield was maximum (5.4 t/ha) with 3 splits (see table), and was significantly superior to that of both checks.

Basal 25% N appeared adequate if applied before 10 DT followed by splits. Basal 50% N was also adequate if applied after 10 DT and followed by splits.

Effect of split application of 75 kg N/ha on grain yield of a short-duration rice variety, Aduthurai, India.

Treatment	Grain yield[a] (t/ha)
0 N (check)	3.6 h
All N at planting (check)	4.4 g
50% at planting + 2 equal splits	4.9 ef
25% at planting + 2 equal splits	5.1 bcd
50% at 5 DT + 2 equal splits	5.2 abcd
25% at 5 DT + 3 equal splits	5.3 ab
50% at 10 DT + 2 equal splits	5.4 a
25% at 10 DT + 3 equal splits	5.0 def
50% at 15 DT + 2 equal splits	5.0 def
25% at 15 DT + 3 equal splits	4.8 f

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

Flowering behavior of ratoons of F_2 rice segregates

S. K. Bardhan Roy and J. Mondal, Rice Research Station (RRS), Chinsurah, West Bengal 712102, India

Photoperiod-sensitive traditional indicas such as FR13A and Achra l08/1 that flower in Mar-Apr at RRS, Chinsurah (22° 58'N) can be ratooned and will flower in Oct when daylength is similar (11 h to 11 h 30 min). Few traditional varieties show similar type of behavior.

We tested crosses of FR13A, Achra l08/1, IR36, and IR50 for flowering behavior of their ratoons when sown in November.

Seeds of the crosses were sown 15 Nov 1983 and transplanted in mid-Jan 1984. Plants that flowered in Apr were ratooned at the end of May, and remaining plants in vegetative stage were uprooted. Flowering behavior of ratooned plants was recorded. Plants that flowered between Jul and Sep and in Oct were separated (see table). Of the plants obtained from different crosses, 36-50% flowered twice and fitted the desired behavior. However, crosses between photoperiod-insensitive types failed to produce desirable plants.

Flowering behavior of F_2 segregates and their ratoons, Chinsurah, India, 1984.

Cross	Plants (no.)	Plants flowering in Mar-Apr (no.)	Ratooned plants flowering in Oct		Plants flowering in intermediate months [a]	
			No.	%	No.	%
FR13A/Achra 108/1	106	88	44	50	44	50
FR13A/IR36	106	102	42	41	60	59
FR13A/IR50	106	103	48	41	55	53
Achra 108/1/IR36	106	96	35	36	61	63
Achra 100/1/IR50	106	102	40	39	62	61
IR36/IR50	106	106	–	–	–	–

[a] Jul-Sep.

Effect of salinity on rice dry matter accumulation and sodium uptake

S.K. Dutt and A. R. Bal, Central Soil Salinity Research Institute (CSSRI), Regional Station, Canning, P.O. Canning Town, 24 Parganas, West Bengal, India 743329

Soil salinity constrains rice growth in parts of many countries. It is important to identify salt-tolerant rices and criteria for salt tolerance. We evaluated eight high yielding rice varieties with known levels of salt tolerance and sensitivity to quantify dry matter accumulation and the pattern of Na^+ uptake. The experiment was at CSSRI in Canning.

Soil salinity levels (ECe 3, 8, and 12 mmho/cm) were created by adding saline river water. The average composition (mg/litre) of river water at a salinity level of 35 mmho/cm at 25° C was Na^+ = 7571, K^+ = 269, Ca^{2+} = 403, Mg^{2+} = 778, Cl^- = 1334, SO_4^{2-} = 969, and pH = 7.8. Thirty-day-old seedlings were transplanted in 18-kg porcelain pots with 6 replications. N, P, and K were applied at 120-60-60 kg/ha as urea, single superphosphate, and muriate of potash.

Table 1. Effect of salinity stress on dry matter production of rice varieties at peak tillering stage, West Bengal, India.[a]

Variety	Dry matter production (g/pot) at ECe (mmho/cm) of		
	3.0 (control)	8.0	12.0
CSR-1	28	27 (2)	19 (31)
CSR-6	18	11 (39)	10 (46)
CST14-2	20	15 (27)	11 (43)
CST438-1	23	17 (29)	13 (44)
CST202-2	13	8 (43)	6 (53)
CST100-1	19	12 (36)	9 (56)
Jaya	18	10 (44)	7 (68)
M1-48	14	7 (51)	9 (75)

CD at P = 0.05
Variety = 0.442 g
Salinity = 0.270 g
Variety × salinity = 0.766 g

[a] Figures in parentheses indicate reduction percentage over control.

Table 2. Effect of salinity stress on accumulation of Na^+ by rice plants at peak tillering, West Bengal, India.

Variety	Na^+ accumulation (% of dry matter) at ECe (mmho/cm) of		
	3.0	8.0	12.0
CSR-1	0.21	0.29	0.36
CSR-6	0.24	0.35	0.44
CST14-2	0.23	0.27	0.41
CST438-1	0.21	0.29	0.41
CST202-2	0.31	0.38	0.46
CST100-1	0.23	0.33	0.44
Jaya	0.25	0.39	0.50
M-1-48	0.27	0.61	1.15

CD at P = 0.05
Variety = 0.018% Na
Salinity = 0.011% Na
Variety × salinity = 0.031% Na.

Dry matter accumulation decreased significantly as soil salinity increased. CSR-1 (var. Damodar) had least dry matter reduction at peak tillering (Table 1). At moderate salinity (8.00 mmho/cm), dry matter reduction in CSR-1 (var. Damodar) was 2%. M-1-48 dry matter production declined 51%.

We analyzed plant tissue accumulation of Na^+ at peak tillering. Plant tissue accumulated more Na^+ as soil salinity increased (Table 2). Susceptible varieties accumulated the highest levels, and dry matter production decreased as tissue accumulated more Na^+.

Results indicated that rice varieties that accumulate less Na^+ in the shoots at peak tillering stage are more tolerant of salinity than varieties that accumulate higher amounts of Na^+.

Azolla and NH_4NO_3 as organic and inorganic nitrogen sources for rice plants

C.S. Johal, W. Achtnich, and A.M. Moawad, Institut für Pflanzenbau und Tierhygiene in den Tropen und Subtropen, 3400 Gottingen, West Germany

We compared azolla-N and NH_4NO_3-N availability to rice plants in the greenhouse. Soil, Dransfelder II, was

Effect of *Azollo mexicana* and NH_4NO_3 treatments on dry matter production and N uptake of rice, Göttingen, West Germany.[a]

Treatment	Straw		Grains		Total		Increase[b] (%)				
							1		2		3
	DM (g/pot)	N (mg/pot)	DM (g/pot)	N (mg/pot)	DM (g/pot)	N (mg/pot)	DM (g/pot)	N (mg/pot)	DM (g/pot)	N (mg/pot)	
Azolla (t/ha)											
A0	2.16	7.61	1.58	12.91	3.74	20.52	–	–	–	–	–
A10	2.70	11.48	1.66	14.95	4.36	26.42	17	29	17	29	30
A20	2.92	14.28	1.99	17.56	4.91	31.84	31	55	13	21	28
A30	3.47	16.35	2.21	20.35	5.68	36.69	52	79	16	15	27
A40	4.02	20.45	2.72	25.46	6.75	45.91	80	124	12	25	32
A50	5.55	26.12	3.35	33.56	8.90	59.68	138	191	32	30	39
A60	5.95	29.14	4.32	42.70	10.27	71.84	175	250	15	20	43
A70	5.00	25.09	3.14	36.01	8.14	61.10	118	198	–21	–15	29
CD (5%)	.82	4.82	.54	6.03	1.15	9.31					
N (kg/ha)											
N0	2.16	7.61	1.58	12.91	3.74	20.52	–	–	–	–	–
N30	2.81	10.40	1.79	15.21	4.60	25.61	23	25	23	25	26
N60	3.24	12.11	2.48	20.43	5.71	32.55	53	56	24	27	30
N90	4.83	19.68	2.72	23.23	1.55	42.91	101	109	32	32	37
N120	4.98	16.76	3.80	31.58	8.18	48.34	135	136	16	13	35
N150	5.37	20.61	3.92	36.59	9.28	57.20	148	179	6	18	37
N180	6.03	24.85	4.56	41.26	10.59	66.12	183	222	14	16	38
N210	5.74	23.58	4.66	42.33	10.40	65.92	178	221	–2	–	32
CD (5%)	0.67	3.50	0.65	5.14	1.01	6.10					

[a] Each value is a mean of 4 replications. [b] DM = dry matter production, N = nitrogen uptake. 1 = increase over control, 2 = increase over corresponding control, 3 = N uptake of the applied N (A10 = N30).

andy and had low plant status. Before the 2-kg pots were filled with sieved soil, the soil was mixed with monocalcium-phosphate (MCP) at 90 kg P/ ha. Four days after transplanting, 80 kg K/ ha as K_2SO_4 and 40 kg Mg/ha as $MgSO_4$ were applied. *Azolla mexicana* (6/62) from Brazil was grown in water tubs and mixed into the soil 1 wk before transplanting at 10, 20, 30, 40, 50, 60, and 70 t fresh weight/ha. In parallel treatments, NH_4NO_3 was applied at 30, 60,90, 120, 180, and 210 kg N/ ha, 1 wk after transplanting. Three 50-d-old IR28 seedlings were transplanted in each pot and ripened to maturity. Pots remained submerged throughout the experiment. Grain and straw yield are in the table.

Maximum yield was achieved with 60 t azolla/ ha and 180 kg N/ ha as NH_4NO_3 (see table). Yields at 10 t azolla/ ha and NH_4NO_3 at 30 kg N/ ha were generally comparable. Highest N concentrations in straw and grain were in azolla treatments because there was more growth and yield in NH_4NO_3 treatments. Total N uptake in straw was significantly more in azolla treatments; that for grain was higher in the NH_4NO_3 treatments. The percentage uptake of applied N varied from 2743% in azolla treatments and 30-38% in NH_4NO_3.

Effect of slow-release urea materials on rice yield

S. Rajagopalan and S. Palanisamy, Paddy Experiment Station, Amhasamudram, Tamil Nadu. India

In Tamil Nadu, rice fields are alternately submerged and drained, which encourages nitrification of applied fertilizers and reduces recovery of fertilizer N by 30-40%. We studied the effect of slow-release N fertilizers on TKM9 grain yield in 1984 kharif.

Soil was sandy loam with pH 4.9 and 288-33-112 kg available NPK, ha. The

Effect of slow-release urea materials on growth, yield components, and grain yield of TKM9 at various N levels, Ambasamudram, India.

N level and urea source[a]	Height (cm)	Panicles/ hill	Panic1e length (cm)	Panicle wt (g)	Filled grains /panicle	1000-grain wt (g)	Grain yield (t/ha)	Straw yield (t/ha)	Increase (%) over N1 F1
N1 F1	81	8.2	19	1.7	70	25.0	5.3	5.6	…
N1 F2	80	8.8	19	1.8	73	25.6	5.4	5.9	2
N1 F3	81	8.7	19	1.8	70	25.4	5.5	6.4	4
N1 F4	82	9.2	20	1.9	80	26.2	6.1	6.9	15
N2 F1	82	8.6	19	1.7	70	25.2	5.4	5.7	2
N2 F2	81	8.6	19	1.7	73	25.4	5.6	6.2	5
N2 F3	82	9.2	19	1.7	71	25.5	5.5	6.5	4
N2 F4	83	10.0	21	1.9	85	26.2	6.2	1.5	17
CD at 5%	1.32	0.87	0.56	0.07	5.88	0.66	0.26	0.99	

[a] N levels: N1 = SO kg, N2 = 75 kg. Urea sources: F1 = prilled urea, F2 = neem cake-coated at 20%, F3 = coal tar-coated at 1%, F4 = USG.

trial was in a split-plot design with three replications. N was applied as neem cake-coated urea at 20%, coal tar-coated urea at 1%, urea supergranules (USG), and prilled urea. When N was split applied, 50% was basal and the rest was in 2 equal splits 15 and 35 d after transplanting.

Maximum plant height was with 75 kg N/ ha as USG, which was at par with 50 kg N as USG. USG and coal tar-coated urea produced maximum panicles per hill and panicle length. USG produced best grain filling and highest weight followed by neem cake-coated urea (see table).

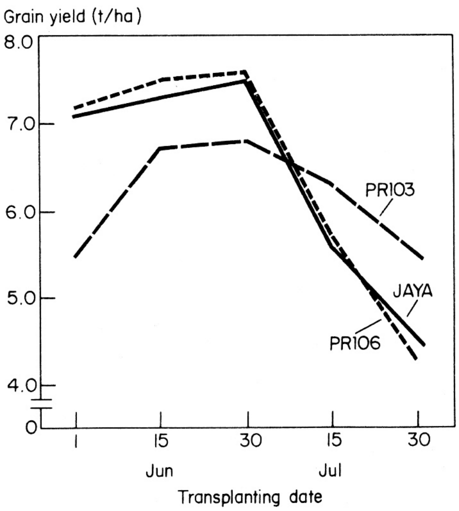
The interaction of N level and sources significantly influenced grain yield (see table). USG performed best, followed by neem cake-coated urea.

Effect of transplanting schedule and postharvest time intervals for threshing on rice grain yield and head rice recovery

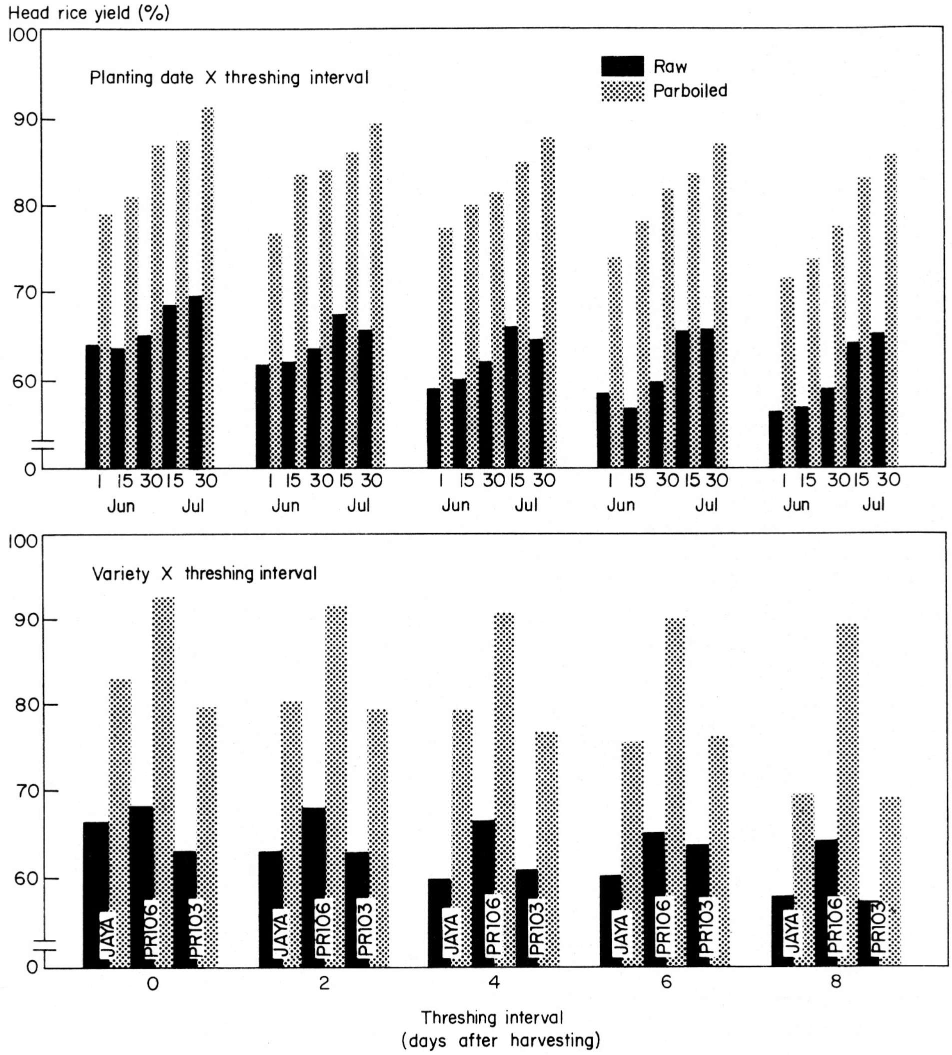
P. S. Gill and H. N. Shahi, Punjab Agricultural University (PAU), Rice Research Station (RRS), Kapurthala 144601, India

We evaluated the effect of transplanting schedule and postharvest time intervals for threshing on grain yield and head rice recovery of different rices at the PAU RRS, Kapurthala.

Thirty-five-day-old seedlings of medium-duration Jaya; medium-duration, fine-grained PR106; and short-duration, long-and-slender grained PR103 were transplanted on 1 and 15 Jun (early), 30 Jun, 15 Jul (optimum), or 30 Jul (late). The experiment was in a randomized block design with four replications. At harvest, the main plot was divided into five subplots. The harvested crop was left in the field in small piles for threshing at different times.



1. Effect of transplanting schedule on grain yield of three rices.



2. Effect of transplanting schedule and postharvest time intervals for threshing on head rice recovery (raw and parboiled) of 3 rices.

All varieties yielded highest when planted on 30 Jun (Fig. 1). Yield reduction was most severe when PR 103 (short duration) was transplanted 1 Jun and medium-duration Jaya and PR106 were transplanted 15 and 30 Jul. At optimum transplanting time, varieties had high dry matter production, tiller and spikelet fertility, and 1,000-grain weight.

Labor shortages often require a harvested crop to remain in the field for several days before threshing. The difference in day and night temperature and night dew formation cause cracks and fissures in the grain, and therefore breakage during milling. Threshing within 2 d of harvesting gave significantly higher head yield than delayed threshing (Fig. 2).

The early transplanted crop matured on 23 Sep. It was exposed to high temperatures and heavy dew formation during late development and at harvest, which caused more suncracks and poor head recovery percentage. PR106 had 4-15% higher head yield (Fig. 2) under different treatments than Jaya and PR103. Head yield was significantly higher with parboil milling than with raw milling. Our findings suggest that proper manipulation of preharvest and postharvest agronomic practices can ensure greater head rice recovery without requiring additional economic liability.

Effect of levels and modified forms of urea and ammonium chloride on lowland rice

V. Murali, R. Kulandaivelu, and T. Y. Reddy, Agronomy Department, Tamil Nadu Agricultural University, Coimbatore 3, India

We studied the effect of levels and forms of urea and ammonium chloride on lowland rice yield in a 1983 field experiment. Co 37 was planted in kharif and IR20 in rabi. Soil was a clay loam. In kharif it contained 225-19.1-470 kg available NPK/ha, with pH 8.2 and EC 0.3 mmho/cm. In rabi it contained 201-18.9-515 kg available NPK with pH 8.2 and EC 0.25 mmho/cm.

Treatments included three forms each urea and ammonium chloride: supergranules, granulated compost, and prilled. N was applied at 0.40, 80, or 120 kg/ha. Ammonium chloride supergranules were made locally with a hand-operated granulizer. Granulated compost was made by mixing urea or ammonium chloride with farmyard manure using a fishmeal pelletizer.

Prilled urea and ammonium chloride were applied in equal splits at last puddling and maximum tillering. Supergranules and granulated compost were placed at 5-cm depth 10 d after transplanting. PK at 26 and 48 kg/ha was applied as superphosphate and muriate of potash at last puddling. PK content of farmyard manure was considered in the granulated compost treatments.

Applying 120 kg N/ha in any form gave significantly higher yields than other N levels. Urea and ammonium chloride performed equally well, and supergranules performed better than granulated compost, perhaps because the compost took longer to decompose and release N to the crop (see table).

Yield and yield components as influenced by levels and modified forms of N fertilizer, Coimbatore, India.

N source and level (kg/ha)	Kharif (Jun-Sep)			Rabi (Oct-Feb)		
	Panicles/ m^2	Grains/ panicle	Grain yield (t/ha)	Panicles/m^2	Grains/ panicle	Grain yield (t/ha)
Ammonium chloride						
Prilled	421	85	4.3	435	83	3.7
Granulated compost	421	84	3.9	435	82	3.6
Supergranules	438	87	4.8	458	86	4.2
Urea						
Prilled	421	84	4.3	436	83	3.7
Granulated compost	421	84	3.9	435	82	3.6
Supergranules	438	87	4.8	459	86	4.2
CD 5%	11	0	0.1	0.3	0.2	0.1
Levels of N	345	80	3.1	318	79	2.7
40	406	82	4.2	435	82	3.7
80	458	86	4.6	411	86	4.3
120	485	92	5.5	488	87	4.8
CD 5%	8	0.2	0.5	0.3	0.3	0.1

Efficiency of different nitrogen fertilizers on rice

S. S. Kolhe and B. N. Mittra, Agricultural Engineering Department, Indian Institute of Technology, Kharagpur 721302, India

We studied the efficiency of different N fertilizers on rice in 1980 wet season (Jul-Oct). Pusa 33 was planted on a lateritic sandy clay loam with pH 5.4, 0.380% organic C, CEC 8.70 meq/100 g soil, 0.041% total N, 4 ppm available P, and 0.048% total K. A no-N control and three sources of N were applied at three levels (see table). All plots received 26-50 kg PK/ha at transplanting. The experiment was in a split-plot design with four replications with N sources in main plot and N levels in subplots.

Influence of different N sources and levels on rice grain yield, Kharagpur, India.

N (kg/ha)	Grain yield (t/ha)					
	Control (no N)	Urea at planting	Urea in 3 splits	Urea supergranule (1-g size)	Sulfur-coated urea	Mean
40		2.8	2.8	3.4	2.6	2.9
80		3.3	3.5	3.8	3.5	3.5
120		3.7	4.3	4.4	4.2	4.1
Mean	2.3	3.3	3.5	3.9	3.4	

LSD (P = 0.05)	
For sources including control	0.25
For N level	0.14
For two sources means for the same level	0.34
For two levels means for the same source	0.29

Urea supergranules (USG) produced significantly higher yields (3.9 t/ha) than the other N sources (see table). Yields with split-applied urea and sulfur-coated urea were similar, and significantly higher than with urea at transplanting. Yields varied from 2.3 to 4.4 t/ ha. USG performed best at 40 kg N/ha, but at higher N levels was as effective as split-applied urea and sulfur-coated urea.

Residual effect of three N sources and application rates on irrigated lowland rices

A. Buntan, C. J. S. Momuat, and I. T. Corpuz, Maros Research Institute for Food Crops (MORIF), Maros, South Sulawesi, Indonesia

Much of the available information on residual effects of N fertilizers is from studies conducted on upland or nonsubmerged soils. N fertilizer behavior in lowland or submerged conditions is distinctly different.

We studied the residual effects of N on irrigated wetland rice in an experiment after the International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFFER) trial. Soil was a plinthic Vertic Tropaquept, fine clayey, nonacid, and isohyperthermic at Maros, South Sulawesi, Indonesia. IR30 was planted. Treatments of the previous experiment are in the table.

During vegetative growth, there were no distinct visual differences among the treatments. Grain yield, panicles/ m^2, percent filled grains, 100-grain weight, plant height at harvest, and soil pH at harvest indicated no significant differences among the treatments (see table). Even at the highest application rate (116 kg N/ ha), urea, sulfur-coated urea, and urea supergranules had no carry-over effect on the following rice crop.

Grain yield, yield components, and soil pH as affected by residual N from 3 sources at 3 rates on irrigated lowland rice, Maros, Indonesia.

N rate (kg/ha)	Previous treatment[a]		Grain yield (t/ha)	Productive tillers/m^2	Filled grain (%)	100 grain wt (g)	Height (cm)	soil pH at harvest
	Source	Method						
	Control		3.7	248	90	2.0	72	5.8
29	U	2/3 AP, 1/3 PI	3.5	216	91	2.0	67	5.9
29	SCU	BI, AP	3.8	237	90	2.0	70	5.9
29	USG	Hand placed 10-12 cm deep	3.8	255	90	2.0	71	5.9
58	U	2/3 AP, 1/3PI	4.3	263	91	2.0	72	5.9
58	SCU	BI, AP	3.6	254	92	2.0	71	5.9
58	USG	Hand placed 10-12 cm deep	3.3	235	90	1.9	68	6.0
87	U	2/3 AP, 1/3 PI	3.9	262	91	1.9	70	5.8
87	SCU	BI, AP	4.2	263	92	2.0	75	5.9
87	USG	Hand placed 10-12 cm deep	3.6	226	91	2.0	69	5.9
116	U	2/3 AP, 1/3 PI	3.6	228	90	1.9	71	6.0
116	SCU	BI, AP	4.3	249	91	2.0	75	5.9
116	USG	Hand placed 10-12 cm deep	3.8	258	91	2.0	74	5.9
	Test of significance		ns	ns	ns	ns	ns	ns
	CV (%)		16.2	12.6	10.8	8.6	12.0	10.0

[a] U = urea, SCU = sulfur-coated urea, USG = urea supergranule, AP = at planting, PI = panicle initiation, and BI = broadcast and incorporated.

A simple solution to sulfur deficiency, and an extension technique

C. J. S. Momuat, A. Buntan, S. Andyantoro, and I. T. Corpuz, Maros Research Institute for Food Crops (MORIF), Maros, South Sulawesi, Indonesia

In Apr 1983, a farmer leader from a barrio near MORIF came to the Institute with a problem. He had applied 2 bags of urea/ ha 10 d earlier but plants had remained yellow and stunted.

We visited the field and identified S deficiency as the problem. Instead of telling the farmer to apply ammonium sulfate, we established a simple

Mean results of a simple experiment to solve sulfur deficiency in a farmer's field, South Sulawesi, Indonesia.

Parameter	Control	Urea	Ammonium sulfate	Urea + S	LSD (%)
Dry wt (g/5 hills) 30 d after fertilizer application	78	83	265	257	46
Plant ht (cm) at harvest	58	62	76	74	10
Panicles (no./m^2)	214	270	388	350	78
Spikelets (no./panicle)	92	102	116	108	ns
Filled grains (%)	84	85	86	86	ns
Grain weight (g/1000)	21	21	22	21	ns
Grain yield (t/ha), 14% moisture	2.5	3.0	5.0	4.8	0.85
Straw yield (t/ha), sun-dried	3.1	3.4	4.9	4.9	0.78
Maturity (days from planting to harvesting)	98	98	90	90	

experiment. Treatments were a control and applications of urea, ammonium sulfate, and urea + S to equal 100 kg N and 120 kg S/ ha. The experiment was in a Latin square. Establishing the plots was not difficult because rice was planted in rows at equal spacing. The fertilizers were broadcast on the surface when the rice was 30 d old.

Three days after fertilizer application, the rice plants in the ammonium sulfate treatment were distinctly darker green than in the urea treatment. Plants in the urea + S treatment turned green 7 d after application.

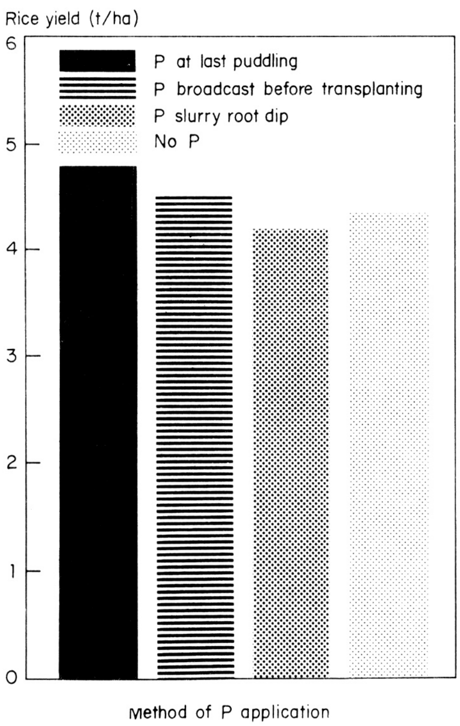
Three days after the problem was reported, it was idenfified and a solution was provided — applying 100 kg ammonium sulfate/ ha. The farmer saw how ammonium sulfate, compared with other treatments, dramatically improved the growth and development of his rice plants. There was a need, however, to point out that it was the S in ammonium sulfate that solved the problem. Both ammonium sulfate and S significantly increased IR50 yield, and shortened the period to crop maturity (see table).

Response of rice to phosphorus application methods

S.K. Saggar, M.S. Maskina, and O.P. Meelu, Punjab Agricultural University, Ludhiana 141004, India

We tested different methods of application to improve rice response to P fertilizer on light-textured soils. Soil was a loamy sand (Ustochrept) with pH 8.4, EC 0.20 mmho/cm, 0.23% organic C, and 6 kg Olsen's extractable P/ ha. Treatments were 13.1 kg P/ ha incorporated at last puddling, 13.1 kg P/ ha broadcast before transplanting, and a nursery root dip in 0.7% P slurry. N at 120 kg/ ha was applied in 3 equal splits and potash was applied at 13 kg K/ ha as a basal dose. Jaya seedlings aged 30 d were transplanted.

Grain yield was highest when P was incorporated at last puddling (see figure). Yields after the slurry treatment were 150 kg/ ha less than the control, perhaps because of heat damage or chemical injury from the concentrated slurry. The slurry-treated plants wilted before transplanting and took more time than the normal seedlings to recover.



Effect of methods of P application on rice yield, Ludhiana, India.

Effect of injured seedling roots on rice yield

M.S. Maskina, O.P. Meelu, and H.S. Baddesha, Punjab Agricultural University (PAU), Ludhiana 141004, India

Most rice grown in northern India is transplanted. Nurseries are grown using the wetland method. A fine, surface crust makes it difficult to uproot seedlings. Seedlings are uprooted manually, and because of the dense root mass and the crust, seedling roots often are damaged. Farmers think that root damage at transplanting reduces yields.

We studied the effect of seedling root damage on yields at the PAU Farm in 1982 and 1983. Treatments were:

- roots were handled carefully to avoid injury,
- roots were trimmed from the base of plants,
- 50% of the roots were removed, or
- all but 1 root was removed.

Effect of sodium, root injured on rice yield, Ludhiana, India.

Treatment	Grain yield (t/ ha)	N uptake (kg/ ha)
All roots	5.9	78
Trimmed roots	5.6	70
50% roots	5.8	74
1 root	5.7	68

Thirty-five-day-old seedlings were transplanted the second week of Jul. The crops received 120 kg N/ ha in equal splits at transplanting, 21 d after transplanting (DT), and 42 DT. PK at 13-12.5 kg/ ha were applied basally at transplanting. Soil was a loamy sand (Typic Ustochrept) with 5 mm percolation/ h, pH 8.5, EC 0.15 mmho/ cm, 0.23% organic C, and 0.06% total N.

Results (see table) showed that root injury did not affect grain yield. However, seedling N content and uptake were significantly lower when roots were trimmed at transplanting.

Yield response of IR32 to inorganic and organic fertilizers

R. le Cerff, R. Mufran, A. Buntan, and I. T. Corpuz, Maros Research Institute for Food Crops (MORIF), Maros, South Sulawesi, Indonesia

We studied the effect of applying NPKS as urea, TSP, KCl, and elemental S with rice straw, rice straw ash, rice hull ash, and carabao manure. Soil was a very fine, mixed, nonacid, isohyperthermic, alluvial Vertic Tropaquept. The surface 0-12 cm was clayey, with pH 6.5, 2.6% organic matter, 110 ppm available P (Olsen), CEC 32.0 meq/ 100 g, and 24.1,

IR32 grain yield as affected by NPKS, rice straw, carabao manure, rice straw ash, and rice hull ash application, South Sulawesi, Indonesia.

Treatment	Mean grain yield[a] (t/ha)
Control	2.4 b
NPKS	5.7 a
NPKS + rice straw	5.2 a
NPKS + carabao manure	5.1 a
NPKS + rice straw ash	5.8 a
NPKS + rice hull ash	5.6 a
Rice straw	2.7 b
Carabao manure	2.4 b
Rice straw ash	3.4 b
Rice hull ash	2.8 b
CV (%)	12.8

[a]Separation of means by DMRT at the 1% level.

5.6, and 0.8 meq exchangeable Ca, Mg, and K per 100 g.

NPKS rates were 120 kg urea, 25 kg TSP, 50 kg KCl, and 30 kg S/ha. N was applied 1/3 at planting and 2/3 5-7 d before panicle initiation. PKS were applied at planting. Six tonnes of rice straw or carabao manure/ha or 2 t rice straw ash or rice hull ash/ha were broadcast and incorporated just before planting. Treatments (see table) were in a randomized complete block design with four replications.

One month after planting, the rice plants in all the treatments that received NPKS alone or with straw, carabao manure, straw ash, or hull ash were darker green, taller, and had more tillers than the control and the treatments without NPKS.

Applying rice straw, carabao manure, rice straw ash, or rice hull ash did not significantly increase yield (see table).

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Soil physics and rice.

ERRATUM

Y. Prasad and R. S. Singh. Screening for brown spot (BS) resistance in deep water rice. 10 (3) (Jun 85): 7.

In the table, change
BKNFR2606-3-2-1-2 to
BKNFR76026-3-2-1-2
BKNFR76052-100-1-5-1 to
BKNFR76029-100-1-5-1
BKNFR76025-100-1-5-2 to
BKNFR76029-100-1-5-2.

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

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