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Contents

Guidelines and Style for IRRN Contributors

To improve communication and to speed the editorial process, the editors of the *International Rice Research Newsletter (IRRN)* request that contributors use the following style and guidelines:

Style

- Use the metric system in all papers. Avoid national units of measure (such as cavans, rai, etc.).
- Express all yields in tons per hectare (t/ha) or wlth small-scale studies in grams per pot (g/pot) or grams per row (g/row)
- Define in footnotes or legends any abbrebiations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N ha; not 60 kg ha N.
- The US dollar is the standard monetary unit for the *IRRN.* Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- When using abbreviations other than for units of measure, spell out in full the first time of reference, with abbreviations in parenthesis, then use the abbreviation throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested. Three levels of N were . . . *or* Biotypes of the brown planthopper (BPH) differ within Asia. We studied the biotypes of BPH in . . ,
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example: 8 years; 3 kg/ha at 2-week intervals, 7%; 4 hours.
- Write out numbers below 10 except in a series containing 10 or some numbers higher and some numbers lower than 10. For example: six parts; seven tractors; four varieties. *But* There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

Guidelines

- Contributions to the IRRN should generally be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses are required for most data.
- Contributions should not exceed two pages of double-spaced, typewritten text. Two figures (graphs, tables, photos) per contribution are permitted to supplement the text. The editor will return articles that exceed space limitations.
- Results of routine screening of rice cultivars are discouraged. Exceptions will be made only if screening reveals previously unreported information (for example, a new source of genetic resistance to rice pests).
- Announcements of the release of new rice varieties are encouraged.
- Use common — not trade — names (or commercial chemicals and, when feasible, equipment.
- Do not include references in IRRN contributions.
- Pest surveys should have quantified data (% infection, degree of severity, etc.)

Genetic evaluation and utilization

OVERALL PROGRESS

Performance of IR36 in Bihar, India

R. C. Chaudhary, S. Saran, and V. N. Sahai, Rajendra Agricultural University, Bihar Agricultural Research Institute, Mithapur, Patna 800001, India

IR36, an early-maturing, high yielding variety, was introduced in Bihar in an IRTP nursery (IRYN-E) in 1977 kharif. From 1977 to 1982 it yielded an average 3.3 t/ha in wet season, while check variety Ratna yielded 2.7 t/ha (Table 1). In the adaptive research farm test during 1981 wet season, IR36 yielded higher than check CR44-35 at four locations (Table 2). In 1979 and 1982 dry seasons, it performed satisfactorily (Table 3).

IR36 matures in 115-120 days and has good grain quality. It has resisted insect and disease problems in Bhar, including bacterial blight, tungro, and brown planthopper. Its short duration makes it useful for multicropping in irrigated systems. Those traits encourage IR36 adoption for general cultivation in Bihar. ☐

Table 1. Average yield of IR36 at six sites in Bihar, 1977-82 wet season.

Location	Yield (t/ha)		%increase over the check
	IR36	Ratna (check)	
Patna	3.3	2.5	29.2
Pusa	2.9	3.0	–2.8
Kanke	2.6	2.3	10.6
Sabour	2.4	2.8	–14.5
Telaundha	2.9	2.4	23.5
Dhangain	5.3	5.6	6.0

Table 2. Performance of IR36 in adaptive research farms, 1981 wet season.

Location	Yield [a] (t/ha)	
	IR36	CR44-35 (check)
Araria	3.8	3.6
Barbat	2.7	2.0
Nagri	4.2	3.7
Simdega	3.7	3.4

[a] Percentage increase over the check is 15.1.

Table 3. Performance of IR36 in Bihar in 1979 and 1982 dry season.

Test entry	Yield (t/ha) at	
	Patna	Pusa
	1979	
IR36	4.9	3.9
CR44-35 (check)	3.7	3.0
CD at 5%	ns	1.1
	1982	
IR36	5.6	2.4
Cauvery (check)	5.4	3.5
CD at 5%.	7.6	8.8

Preparation of *Oryza pollen* grains for scanning electron microscope analysis

Xue-Bin Xu (Hsae-Pin Hsu), IRRI; Li-Qing He and Hui-zhen Han, South China Agricultural College, Guangzhou, China; and B. S. Vergara, IRRI

The morphological features of the pollen grains of different species in the genus *Oryza* are almost uniform. The grains are usually spheroid or ovoid with a single aperture that has a conspicuous operculum at or near its center. Descriptions of rice pollen grain surfaces vary and can be studied best using a scanning electron microscope (SEM).

There are many methods of preparing pollen grains for SEM examination. Some scientists indicate that a fresh pollen grain can be observed directly; others write that acetolysis is necessary. We studied sample preparation for SEM as follows, using pollen grains from six *Oryza* species.

Pollen collection and preservation

A1. Anthers and pollen grains were air-dried.

A2. Anthers and pollen grains were fixed in Carnoy's fluid for 2-3 hours, and transferred to 70% ethanol.

A3. Samples were fixed in 4% glutaraldehyde for 16 hours (0-4ºC), washed with phosphate buffer 1 or 2 times, stored in the same solution, and placed in vials and kept in the refrigerator.

Methods of cleaning or dehydrating pollen grains after treatment A

B1. Sample was placed in acetolysis mixture (9 parts acetic anhydride and 1 part sulfuric acid) and heated in a 100°C water bath for about 1 minute, then washed in distilled water 3-4 times and air-dried;

B2. Sample was washed with glacial acetic acid, then was washed 3 times with distilled water and air-dried.

B3. Sample was dehydrated serially using different ethanol concentrations.

B4. Untreated pollen grains were spread on double stick tape directly from the anthers.

Determining necessity for critical point drying after treatment B

C1. Critical point dryer was not used.

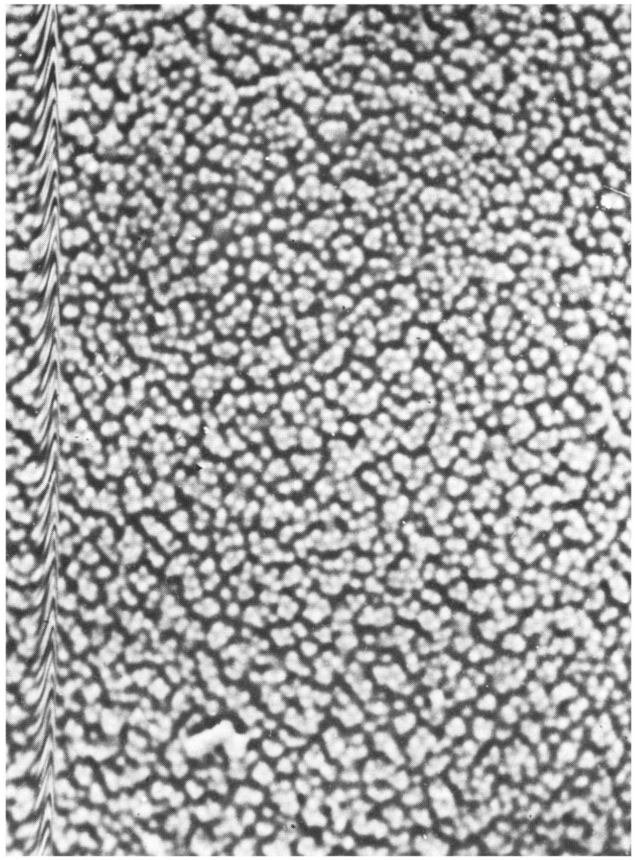
C2. Critical point dryer was used.

All the methods tried for pollen collection and preservation can be used depending on convenience. If Bl is used to clean specimens, critical point drying to maintain the shape of the pollen grain is not necessary. Samples did not collapse under the SEM even at 12.5 or higher KV. The 2000X to 10000X photomicrographs showed the surface sculpture clearly (Fig. l), but all the opercula were lost.

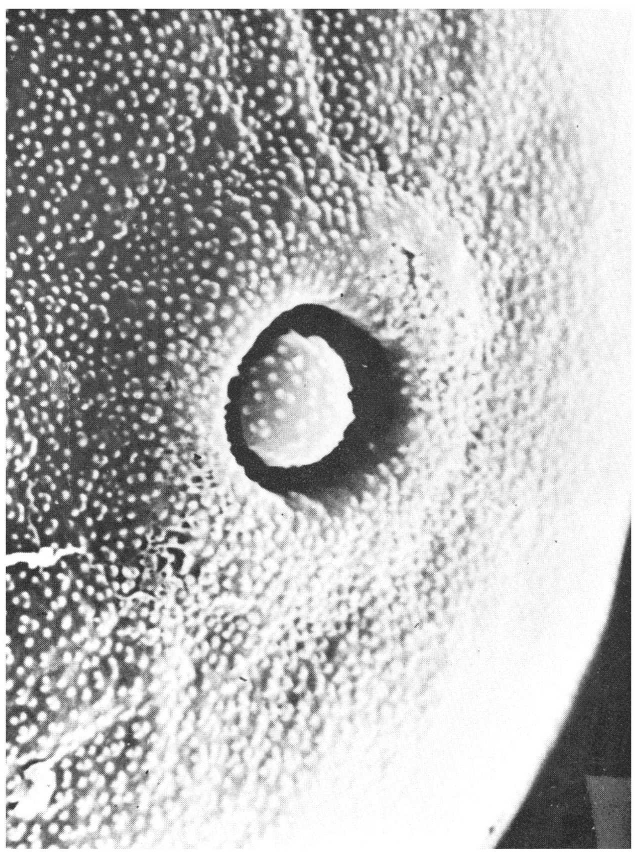
B3 can be used after A2 or A4, but it must be followed by critical point drying. The pollen grains, including opercula, can be observed with clear surface sculpture at 7000X (Fig. 2). When magnified l0000X, their image is less clear than that of acetolyzed samples (B1). Perhaps the matrix was not removed and affected clarity. B3 granules seem smaller and shallower than those of B1. To compare surface textures of pollen grains, however, 4500X is sufficient magnification.

Pollen grains from B2 and B4, if not followed by critical point drying, collapsed and cracked easily when exposed to the vacuum and the electron beam of the SEM except at l000X for a very short time, where the texture of the exine cannot be seen clearly.

Acetolysis with 2000 to 4500X magnification is best for comparing surface structure of different *Oryza* pollen grains. □



1. Pollen grain of *Oryza barthii* showing surface texture (7000 X). Samples were acetolyzed without critical point drying.



2. Pollen grain of *Oryza longistaminata* showing intact operculum after glutaraldehyde fixation and serial dehydration in ethanol (7000 X). Critical point drying was used.

Performance of CR1009 in multilocation trials

J. Venkatakrishnan, P. Vivekanandan, K. Neelakanda Pillai, and D. S. Aaron, Paddy Experiment Station, Tirur 602025, Tamil Nadu, India

CR1009 (Pankaj/Jagannath) is a promising, long-duration semidwarf cultivar that was developed at the Central Rice Research Institute, Cuttack. It has good tillering capacity and produces short, bold, white grains.

CR1009 performance was compared with that of CO 25, also a long-duration variety, in samba (Aug-Feb) in multilocation trials in Chingleput District, Tamil Nadu. At 3 sites, CR1009 had from 17.6 to 49.1% higher grain yield than CO 25 (see table). Crop duration ranged from 165 to 180 days. □

Performance of CR1009 in multilocation trials at Chingleput, Tamil Nadu, India.

	Peruvoyal		Perittivakkam		Sivapuram	
	CR1009	CO 25	CR1009	CO 25	CR1009	CO 25
Sowing date	27 Aug 1982		03 Sep 1982		14 Sep 1982	
Planting date	28 Oct 1982		25 Oct 1982		31 Oct 1982	
Duration (days)	180	180	165	165	169	169
Grain yield (t/ha)	4.6	3.9	4.0	2.7	4.1	3.4
% increase over CO 25	17.6		49.1		21.8	
Ht at maturity (cm)	59	112	84	135	64	114
Productive tillers/m^2	915	175	990	805	680	520
Panicle length (cm)	16.3	18.5	17.5	19.1	18.9	17.9
Grains (no.)/panicle	61	64	62	72	67	71
1000-grain wt (g)	19.0	21.0	19.7	16.4	21.5	20.0

Mashuri vs local varieties on Cuu Long Delta, Vietnam

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Much of the Cuu Long River Delta (Vietnamese part of the Mekong Delta) is planted to late-maturing local varieties with yields of 1.5 to 4 t/ha. At RRI, we have identified some modern varieties that can be grown successfully on the Delta.

We compared Mashuri, introduced in the 1980 IRTP nursery, to popular local varieties Trang Chum, Trang Lun, Tieu Doi, and Nang Huong. Mashuri yields in 3 consecutive years were encouraging (Table 1). Mashuri had shorter duration, more grains/panicle, lodging resistance, wide adaptability, and good grain quality compared with local varieties.

Mashuri, Trang Chum, and Trang Lun are susceptible to brown planthopper and sheath blight and have resistance to leaf blast and bacterial leaf blight (Table 2). Mashuri is expected to withstand most pest attacks during the growing season.

Provincial agriculture departments and RRI are implementing large-scale seed multiplication programs. □

Table 1. Characteristics and yield of Mashuri and local varieties grown on the Cuu Long Delta.

Variety	Characteristic	Duration (d)	Plant ht (cm)	Panicles/m^2	Grains/ panicle	Lodging (0-9)	Yield[a] (t/ha)		
							1980	1981	1982
Mahsuri		150	132	264	230	3	3.7 a	4.0 a	5.4 a
Trang Lun	Acid sulfate tolerance	190	148	247	86	4	3.1 b	3.8 a	5.5 a
Trang Chum	Deepwater	180	137	204	124	5	3.1 b	3.7 a	–
Tieu Doi	Salinity tolerance	176	116	192	152	7	–	–	5.0 a
Nang Huong	Good quality	173	157	145	107	9	–	–	2.1 b

[a]In a column, means followed by the same letter do not differ significantly at 5% level.

Table 2. Reaction of Mashuri to rice insects and diseases on Cuu Long Delta.[a]

Variety	Brown planthopper (BPH)		Leaf blast (B1)		Bacterial leaf blight (BLB)		Sheath blight (ShB)	
	Infested (%)	Reaction	Scale (0-9)	Reaction	Scale (0.9)	Reaction	Scale (0-9)	Reaction
Mashuri	88	HS	2-6	R-MS	4	MS	9	HS
Trang Lun	85	HS	4-5	MS	3	MR	7	S
Trang Chum	85	HS	4-6	MS	3	MR	7	S
Resistant[b]	26	MR	1	R	1	R	7	S
Susceptible[b]	100	HS	4-9	MS-HS	8	S	9	HS

[a]Artificial infestation, using IRRI test and scoring procedures. R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, HS = highly susceptible. [b]Resistant check for BPH = IR36, B1 = Tetep, BLB = Cempo Selak, ShB = IET4699. Susceptible check for BPH = TN1, B1 = NN7A, BLB = IR8, ShB = IR36.

Agronomic characteristics

Off-season growing of photoperiod-sensitive rices in Los Baños at 13°40'N

R. Herrera and D. HilleRislambers, Plant Breeding Department, IRRI

Photoperiod-sensitive rices, often planted late in the wet season by farmers and researchers, grow well into the dry season.

Farmers in Bangladesh grow a photoperiod-sensitive transplanted crop of Nizersail after aus (early wet season) rices. Photoperiod sensitivity speeds flowering, allowing the transplanted crop to flower before harmful cold temperatures occur late in the season.

Plant breeders in Barisal, Bangladesh, plant varieties near the end of the year to help assess flowering behavior: early flowering indicates photoperiod sensitivity. Breeders at IRRI and elsewhere plant photoperiod-sensitive and insensitive progenitors twice annually to facilitate single and double crosses.

When a hybridization block is planted at bimonthly intervals in the slowly increasing day lengths during the off season, day length a few weeks after seeding determines whether a photoperiod-sensitive variety will flower or not (Table 1). With every successive planting date, more photoperiod-sensitive entries fail to flower.

Experience from two dry seasons is summarized in Table 2. These data may be useful for off-season seed increases. Some extrapolation from an entry in Table 2 to a similar variety from the same region and cultural type should be possible. Note that early failures to flower often refer to Sri Lankan and South Indian varieties. □

Table 1. Factors affecting flowering behavior of photoperiod-sensitive rices when planted in the increasing day lengths of the off season.

Factor	Effect
Planting date (environmental)	A late date may postpone flowering altogether.
Basic vegetative phase (BVP) (genotypic)	A long BVP has an effect similar to that of delayed planting date.
Cold temperature (environmental)	Cold temperatures lengthen BVP and delay or postpone flowering.
Nutrition (environmental)	Low nutritional status lengthens BVP and delays or postpones flowering.
Critical day length (genotypic)	Longer critical day lengths enable plants to continue to flower longer into the dry season.

Table 2. Earliest off-season planting dates at which hybridization block entries of 1981-82 and 1982-83 failed to flower.

Seeding date[a]		
	1981-82	
6 Jan (1981-82)	ASD5	Hondarawala
	BKNFR76046-70-2-5-3	Nam Sagui 19
	GEB 24	PTB 18
21 Jan (1981-82)	BKN6721-5-7-4	IR13365-253-3-2
	BKN7022-6-4	IR5533-13-1-1
	Chamara	IR11288-B-B-118-1
	CR1030	Khao Dawk Mali 105
	FR43B	MTU 7029
	IR1820-52-2-4-1	Niaw San Pahtong
	IR11288-BB-69-1	Patnai 23
	IR13358-85-1-3	Peta
7 Dec (1981-82)	Molaga Samba	
	Balaratawee	
22 Dec (1981-82)	Hathili	
	PTB 21	
	Raminad Str. 3	
	1982-83	
16 Jan (1982-83)	BR118-3B-17	IR17494-32-3-1-1-3
	BR10	IR3273-289-2-1473
	CN540	IR4547-4-1-2
	CR 1009	Pelita I/1
	IR5	SPR7210-1-10-2-1
	IR43	UBN 6721-11-1-6
1 Dec (1982-83)	No record of failure to flower	
16 Dec (1982-83)	BKNFR 76026-3-2-1-2	
	SPR7411-7-2-1	
	TOX896-R-R-R-102	
31 Dec (1982-83)	RD19	

[a] Days after transplanting = days after seeding + 20.

IR50 – an early-maturing, fine-grained rice for kar season

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IR50, a semidwarf rice variety with long, slender white grains and high tillering potential, was released for general cultiva-

Comparative performance of IR50 at Ambasamudram, Tamil Nadu, India.

Variety	Grain yield (t/ha)			Total duration (d)	Plant ht (cm)	Panicles (no./hill)	Panicle wt (g)
	1981	1982	Mean				
IR50	6.2	5.7	6.0	110	78	10	1.1
ADT31	6.5	6.0	6.2	110	94	8	1.5
TKM9	6.5	5.3	5.9	109	88	9	1.6
IET4786	6.4	5.2	5.8	109	91	9	1.0
m + σ	6.4	–	–	–	–	–	–
CD (P = 0.05)		0.55	–	–	–	–	–

tion in Tamil Nadu in 1983. It performed well at PES in kar season (Jun-Sep) when planted at 20- × 10-cm spacing with 2 seedlings/hill in observational plots in 1981 and in a randomized block design with 3 replications in 1982. NPK was applied at 100-22-42 kg NPK/ha.

IR50 performance equaled that of standard local varieties. Average grain yield was 5.96 t/ha in 110 days, 2.2% more than IET4786, also a fine-grained variety (see table). □

Intensity of dormancy in Maruteru rices

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The length of time required to break seed dormancy by artificial means differs markedly among rice varieties. Intensity of dormancy is usually tested by heating freshly harvested seeds to 50°C for 4 d. We studied the intensity of dormancy of Maruteru rices.

Seeds of 26 rice varieties grown in a field trial in 1982 kharif were dried to 12% moisture content, then heated to 50°C for 4 d in a thermostatically controlled electric hot air oven. The varieties were classified by seed germination percentage.

Strongly dormant varieties (less than 50% germination) were MTU8, MTU11, MTU13, MTU16, MTU23, MTU6182, and MTU8089.

Weakly dormant varieties (80% or higher germination) were MTU3, MTUl0, MTU19, MTU2716, MTU3626, MTU4392, MTU4569, MTU4870, MTU5182, MTU5194, MTU5195, MTUS196, MTU5249, MTU5293, MTU6024, MTU7029, MTU7030, MTU7633, and MTU8002. □

GENETIC EVALUATION AND UTILIZATION

Hybrid rice

A new source of cytoplasmic-genetic male sterility in rice

M. A. Hassan and E. A. Siddiq, Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi, India

Commercial exploitation of heterosis in rice *Oryza sativa* L., as recently demonstrated in China, has widened the scope of hybrid rice in the tropical rice world. The present study was prompted by a report from IARI, New Delhi, that IARI 10061, IARI 10560, Tadukan, Culture 340, IR8, Jaya, and Chitrikar might be sources of cytoplasmic-genetic male sterility and that improved Sabarmati and IARI 657 might be sources of nuclear genes for male sterility. Studies of reciprocal cross combinations indicate that pollen sterility was higher in the F_1 of IARI 10560/Improved Sabarmati. IARI 10560 had higher pollen sterility when it was used as female parent with Improved Sabarmati as male parent. Pollen sterility increased in backcross generations, but was higher when IARI 10560 was the female parent (see table).

IARI 10560 is a spontaneous dwarf identified in the Northeastern Indian collection of rice. Improved Sabarmati has a cytoplasmic background of TN1 and nuclear genes, most of them derived by backcrossing, of Basmati 370, a variety with strong genetic male sterility.

High levels of pollen sterility in improved Sabarmati and high reciprocal differences in crosses with IARI 10560 cytoplasm indicate the presence of cytoplasmic factors for sterility in the latter.

Furthermore, the increasing trend of sterility in the subsequent backcross generations (59.1% in BC_2) suggests that IARI 10560 may be a potential source of sterile cytoplasm. □

Pollen sterility of IARI 10560/Improved Sabarmati.

Generation	Cross	Plants (no.)	Pollen sterility (%)	
			Range	Mean
F_1	IARI 10560/Improved Sabarmati	3	17 - 100	41
BC_1	IARl 10560/Improved Sabarmati/1	2	36 - 59	48
BC_2	IARl 10560/lmproved Sabarmati/2	4	47 - 74	59
F_1	Improved Sabarmati/IARl 10560	3	8 - 19	15
BC_1	Improved Sabarmati/IARI 10560/1	3	13 - 23	17
BC_2	Improved Sabarmati/IARI 10560/2	2	20 - 30	25

GENETIC EVALUATION AND UTILIZATION

Germplasm

Rice germplasm conservation and evaluation activities at J. N. Agricultural University campus, Raipur, MP, India

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The Jeypore tract of Orissa State has a large ecogenetic diversity of rice germplasm. An adjacent, area, Bastar district of MP, has equally diverse germplasm. Germplasm from Bastar district was first studied in 1971, when R. H. Richharia, agricultural adviser to the Government of MP, started a systematic survey of the state's rice varieties. Material he collected formed the nucleus for the breeding activities of the MP Rice Research Institute. The Institute was founded in 1976 and merged with J. N. Agricultural University in 1979.

Genetic material is divided by maturity and grown in six groups (Table 1). The germplasm collection, which includes many duplicates, now numbers 20,008. Sorting for duplicate samples and characterizing accessions by 15 morphological traits started last season and has been completed for 4,500 varieties.

Although lack of greenhouses has made it difficult to screen for insect resistance, several accessions have been tenta-

Table 1. Number of accessions maintained in different maturity groups, ZARS, Raipur, India.

Maturity	Duration (d)	Total accessions (no.)
Extra early	to 95 d	486
Very early	96 - 110 d	1,194
Early	111 - 125 d	3,386
Medium	126 - 140 d	4,476
Late	over 140 d	9,191
Released varieties and elite breeding lines		1,275
Total		20,008

Table 2. Germplasm accessions evaluated for various stresses, ZARS, Raipur, India.

Stress	Accessions (no.)		Important varieties
	Evaluated	Identified as tolerant	
Drought (vegetative stage)	486	16	Budali, Nawa Sungo Sukulpora
Bacterial leaf blight	6129	25	Karhani, Tikurdhan Liktimati
Gall midge			
Tiller midge	4400	26	Jhitpiti, Sakkar, Chinee, Shikya
Panicle midge	450	4	Madhuri, RP1831-20-4, RP1831-25, OB677

tively identified as having some tolerance for harmful insects and diseases (Table 2). The accessions are undergoing further tests and collaborative evaluation for other resistance traits. Some have been used in hybridization studies. In 1982, 2,717 samples were supplied to various scientists and institutions for testing. They included IRRI (470), CRRI, Cuttack (250), and AICRIP, Hyderabad (467). □

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Screening for rice cultures with resistance to brown spot

K. Ranganathan, associate professor of Plant Pathology; R. Rajamanickam, assistant plant pathologist; and P. Vidhyasekaran, professor of Plant Pathology, Tamil Nadu Rice Research Institute (TNRRI), Aduthurai, India

In 1982 kharif 343 rice cultures were evaluated for resistance to brown spot (BS) at TNRRI, under the All India Coordinated Rice Improvement Project. The Standard Evaluation System for Rice (0-9 scale) was used to rate resistance. Five cultures showed resistance to BS (see table). They had similar reaction to BS in trials at Gurudaspur, Pusa, and Pantnagar.

Reaction of rice cultures to brown spot disease, 1982, Aduthurai, India.

IET no.	Designation or cross	Disease index	Disease reaction[a]
7804	OR158-5/Rasi	3	R
8141	IR20/IR8	3	R
8156	IR20/IR8	3	R
8166	Jaya mutant	3	R
8311	Imp. Sona/Pak basmati	3	R
	Susceptible check Benibhog	9	HS

[a]R = resistant, HS = highly susceptible.

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Electronic device to record feeding behavior of whitebacked planthopper on susceptible and resistant rice varieties

Z. R. Khan, postdoctoral fellow in Entomology, IRRI; and R. C. Saxena, associate entomologist, IRRI, and principal research scientist, International Centre of Insect Physiology and Ecology, Nairobi, Kenya

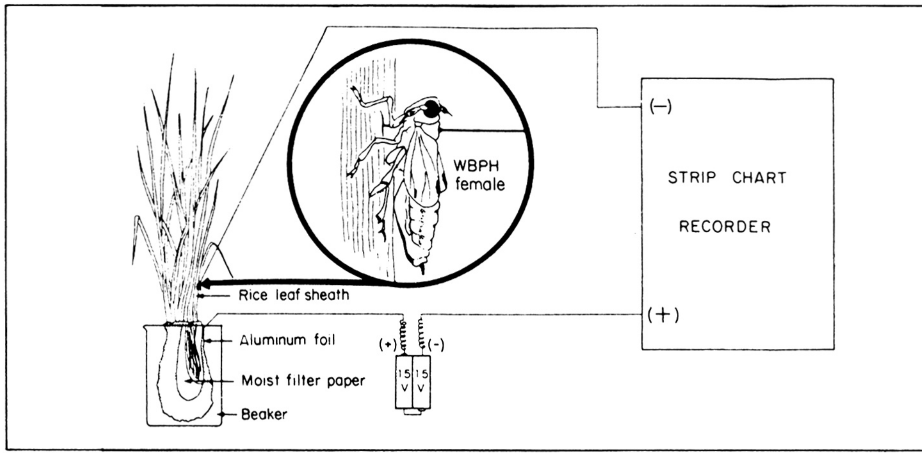
Breeding for resistance to whitebacked planthopper (WBPH) *Sogatella furcifera* is a major objective of the IRRI rice improvement program. The mechanism of WBPH resistance is largely undescribed and its evaluation involves time-consuming methodologies. Techniques for rapid evaluation of WBPH resistance are needed.

We used an electronic device, designed to record the feeding characteristics of aphids, to study WBPH feeding behavior on susceptible and resistant rice varieties. The technique uses the feeding insect as part of an electrical circuit and records the amplified voltage changes produced by the flow of salivary and substrate liquids through the insect stylets.

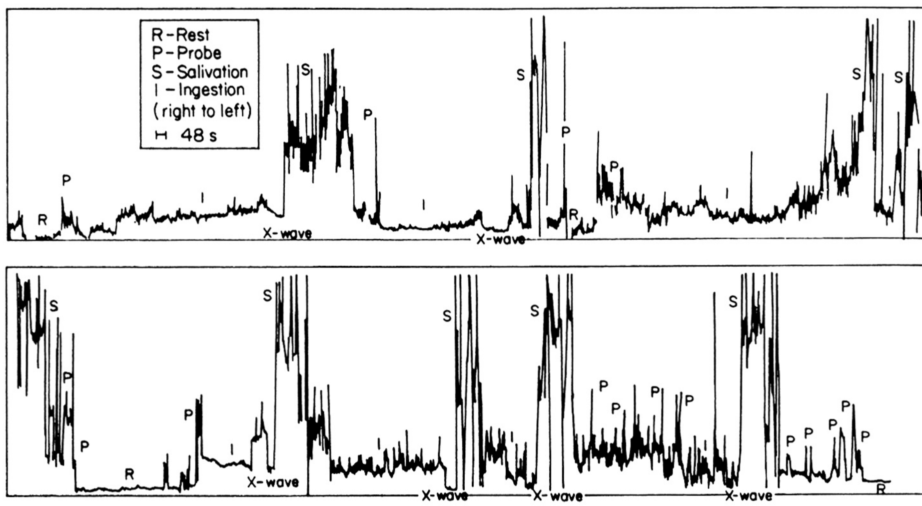
A 10-cm-long, fine (20 µm) copper wire was attached by Duco cement to the dorsum of an 8- to 10-h-old brachypterous female and a small quantity of EKG electrolyte paste was applied to complete the electrical circuit. The insect was starved for 2 h and then placed on the leaf sheath of a 45-d-old rice plant. The copper wire was directly connected to the –ve input terminal of a D. C. chart recorder (Unicorder Pantos®, Nippon Denshi, Kagaku, Japan). The voltage source consisted of two 1.5 V penlight batteries connected in a series. The +ve terminal of the battery was connected with the leaf sheath substrate by aluminum foil and moistened filter paper (Fig. 1). The –ve battery terminal was connected directly with the +ve input terminal of the chart recorder and the recorder pen was adjusted to the base line of the chart to monitor the insect's feeding activity for 60 min. Chart speed of 1.25 cm/min was adequate for distinguishing various waveforms and associated voltage reversals observed during insect feeding.

The waveforms recorded for WBPH showed distinct differences in feeding activities on susceptible and resistant plants (Fig. 2). On susceptible TN1, the insect probed readily and fed for longer durations. On resistant IR2035-117-3, the insect made brief and repeated probes, consequently reducing the effective ingestion period. On both susceptible and resistant plants, however, S-X-I sequence was obtained, which indicated phloem feeding. This sequence has already been identified for phloem-feeding aphids and leafhoppers.

The electronic measuring system can also be used to record the feeding activities of other sucking insect pests of rice and to locate their specific feeding site in the plant tissue. □



1. Schematic diagram of circuit and equipment for recording whitebacked planthopper feeding on rice plant, IRRI, 1983.



2. Waveforms recorded during whitebacked planthopper feeding on susceptible TN1 (top) and resistant IR2035-117-3 (bottom) rice varieties using an electronic monitoring device, IRRI, 1983.

Source of resistance to brown planthopper in rice

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Seedlings of 465 rice accessions from the All India Coordinated Rice Improvement Project, IRRI, and TNAU were evaluated for resistance to brown planthopper (BPH) under greenhouse conditions at TNAU. Pregerminated seeds of test accessions were sown 3 cm apart in 20-cm rows in 50- × 40- 10-cm wooden flats filled with 5-7 cm of soil. Each flat contained 17 rows. One row of the susceptible check TN1 and the resistant check ASD11 were planted at random in each wooden flat. The accessions were not replicated.

One week after sowing, seedlings were thinned to 20/row and the flats were transferred to GI trays (62 × 47 × 51 cm) filled with water. Ten days after sowing, seedlings were infested with 4 to 5 second- and third-instar nymphs per seedling and covered with a fiberglass mesh cage. Damage was rated on the 1-9 scale when 90% of the TN1 seedlings were dead.

Thirty accessions were rated as highly resistant and 100 as resistant. The most promising accessions are listed in the table. □

Sources of resistance to brown planthopper. TNAU, India.

Accession	Origin
Grade 1	
ARC6650	India
ARC10550	India
ARC11342	India
ARC14529	India
BG367-9	Sri Lanka
BG379-5	Sri Lanka
BKNBR1139-24-3	Thailand
IR17494-32-3-4	Philippines
IR17496-32-3-4	Philippines
KAU1626-2	India
KAU10667	India
RD4	Thailand
Sinna Sivappu	Sri Lanka
Suduru Samba (Acc. 36581)	Sri Lanka
Sulai	Sri Lanka
T1477	India
Velathil Cheera	India

Continued on next page

Table continued.

Accession	Origin
Grade 3	
ADR52	India
ASD11	India
Babawee	India
Balamawee	India
BG12-1	Sri Lanka
BG367-4	Sri Lanka
BG367-5	Sri Lanka
BKNBR1030-11-2	Thailand
BKNBR1088-83	Thailand
IET5741	India
IET6315	India
IET6859	India
IET6860	India
IET7004	India
IR13427-60-1	Philippines
Ptb 8	India
Ptb 15	India
Ptb 19	India
Ptb 33	India
Rathu Heenati	India
T	India
Veillailangayan	India
V. P. Samba	India

Evaluation of short-duration rice varieties for thrips resistance

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Twenty-three short duration (110-115d) rice cultures were field screened for resistance to rice thrips *Stenchaetothrips biformis* in 1982 wet season. Thirty-day-old seedlings were transplanted 30 Jul in a randomized block design in 12.12 m^2 plots with 3 replications at 20- × 15-cm spacing. Rice was grown with recommended agronomic practices and 120-13-25 kg NPK/ha were applied. Thrips damage, on a whole-plot basis, was scored 20 d after transplanting using the 1980 Standard Evaluation System for Rice.

All varieties showed some damage (see table). B441-B-126-3-2-1 and BG367-7 scored 2.0 (resistant). Moderate resistance was shown by IR9129-129-2, IR9129-169-3-2-3-3, IR9201-3-3-1-2, BG367-4, IR19743-25-2-2, IR8608-23 1-2-2-3-2, BKNLR75091-CNT-B3-RST-40-1-3, and IR19791-12-1-2-2-2. The susceptible check HM95 scored 7.0 and the popular short-duration variety PR103 scored 4.0. ☐

Reaction of short-duration rice varieties to rice thrips.

Culture	Cross	Damage rating[a]
B441-B-126-3-2-1	C4-63GB/B531-B-TK-39	2.0
IR8608-23 1-2-2-3-2	CR94-13/IR1561-228-3-3	3.3
IR9209-48-3-2	IR2061-465/IR2053-521// IR2020-625	4.3
IR9761-19-1	IR30/IR2508-48-3// IR2071-625-1-252	5.0
IR9129-7-1	IR20/IR2053-521-1-1// IR2071-625-1	4.0
IR9129-169-3-2-3-3	IR20/IR2053-521-1-1// IR2071-625-1	3.0
IR9129-129-2	IR20/IR2053-521-1-1// IR2071-625-1	3.0
IR9129-192-2	IR20/IR2053-521-1-1// IR2071-625-1	4.3
IR9201-3-3-1-2	IR2053-521-1-l/IR2061-464-2//IR36	3.0
IR9224-117-2-3-3	IR2153-14-4-6-2/IR28//IR2071	4.3
PAU502-94-1	IR8/Shensi var//IR28	4.7
R155-355	–	4.0
UPR82-1-1	–	4.3
BG276-5	OB678/BG 34-82*	3.8
BG367-4	BG280-1*2/PTB33	3.0
BG367-7	BG280-1*2/PTB33	2.0
BKNLR75091-CNT-B3-RST-40-1-3	KDML105/IR206l//KDML105/IR26	3.3
IR50	IR2153-14-1-6-2/IR28//IR36	4.3
IR19728-9-3-2	IR8608-298-3-1/IR10179-23	4.3
IR19743-25-2-2	IR9129-192-2-3/IR10176-79	2.7
IR19762-2-3-3	IR9201-91-2-2/IR10183-7	3.7
IR19791-12-1-2-2-2	IR9703-41-3/IR10176-79	3.3
Sonalee	–	3.7
Checks		
PR103	IR8/IR127-2-2	4.0
HM95	Jhona 349/TN1 (IrrF$_2$)	7.0

[a] Based on the 1980 Standard Evaluation System for Rice rating: 0 = no damage, 9 = complete plant wilting followed by severe yellowing and scorching.

Performance of gall midge-resistant rice cultivars at Goa, India

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Rice gall midge (GM) *Orseolia oryzae* is endemic to Goa, India, where it severely damages high yielding Jaya and IR8. Because popular GM-resistant varieties Vikram and Shakti are late maturing, we attempted to identify a GM-resistant variety similar to Jaya in yield and duration.

Performance of gall midge-resistant cultivars in Goa, India.

Cultivar	Yield (t/ha)			Grain quality[a]	Days to maturity
	1980	1981	Av of 2 yr		
CR94-721-3	5.1	4.1	4.6	MB	130
CR94-72-1-1	4.7	4.0	4.4	SB	130
CR94-MR-1550	4.7	3.4	4.0	SB	125
CR94-ORS-1512-6-1	4.4	3.4	4.0	SB	120
CR94-ORS-214-1	3.9	3.2	3.5	SB	120
CR95-26-1	4.8	3.0	3.9	LB	142
Shakti (CR93-4-2)	4.7	3.8	4.2	LB	142
Vikram (RPW6-13)	4.7	4.2	4.5	LB	142
Jaya (susceptible check)[b]	3.6	2.9	3.2	LB	127
CD 5%	0.53	0.55	0.5		

[a] SB = short bold, MB = medium bold, LB = long bold. [b] Silvershoot percentage was zero for all test cultivars, but ranged from 12.8 to 17.5 for Jaya.

Six resistant lines, mostly cross combinations of CR94 (CR55-36/IR8) and CR95 (Leuang 152/1R8) from the Central Rice Research Institute, Cuttack, were tested in 1980-81 with two popular GM-resistant varieties in a replicated randomized block design. Plot size was 30 m², spacing was 20 × 15 crn.

All GM-resistant lines showed resistance, but the susceptible check Jaya had damage ranging from 12.8%, to 17.5% silvershoots. CR94-721-3 and CR94-72-1-1 yielded more than Jaya and matured at the same time as Jaya (127-130 d) (see table). ☐

Rices with multiple disease and insect resistance in hilly regions of Uttar Pradesh

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Rice is the most important kharif cereal crop in the hills of UP. Several diseases and insects reduce yield. Of more than 60 rice pests recorded in this region, blast (B1) caused by *Pyricularia oryzae,* brown spot (BS) caused by *Helminthosporium oryzae,* sheath rot (ShR) caused by *Acrocylindrium oryzae,* and leaf scald (LSc) caused by *Rhynchosporium oryzae* are the most serious diseases, and stem borer (SB) *Sesamia inferens,* and leaf-folder (LF) *Cnaphalocrocis medinalis* are important insects. B1 and SB are the most serious pests.

Many genotypes have been evaluated for Bl resistance under heavy disease pressure at VLHA from 1977 to 1981. Several promising lines have been identified. In 1982 these lines were screened for BS resistance in artificial epiphytotic conditions. Most lines with B1 resistance have also been evaluated for resistance to SB in the field. Resistance levels were scored by the 1980 Standard Evaluation System for Rice. The most important lines with multiple pest resistance are shown in the table.

Dissi hatif (73127), Tetep, VL-8, Ta-poo-cho-z, and IR9202-21-1 had multiple resistance to the maximum number of diseases and insects. ☐

Reactions of rice varieties with resistance to Bl, SB, and other pests in UP.

Cultivar	Reaction						
	Artificial epiphytotic conditions			Field conditions			
	Bl	Neck Bl	BS	ShR	LSc	SB	LF
Dissi hatif (73127)	1	1	6	1	3	1	1
Tetep	0	1	5	3	3	1	1
VL-8	3	1	6	3	3	1	3
IR9202-21-1	2	1	8	3	3	3	3
IR3273-339-2-5	1	3	8	1	5	1	1
IR4547-6-2-5	1	1	5	3	5	1	1
Ta-poo-cho-z	0	1	6	3	3	1	1
IR1416-128-5-8	2	3	7	5	3	1	1
Milyang 46	2	3	6	3	5	1	1
Camponi SML	1	3	8	7	3	3	3
RP1057-35-1-1	4	3	7	3	5	3	1
Milyang 47	3	3	8	3	5	3	1
Colombia II	2	1	7	5	5	3	3
IR1544-238-2-3	2	3	7	5	5	3	3
IR5031-Plp-4B	2	3	7	5	5	3	3
IR5908-84-2-3-3	2	3	6	7	5	1	1
Toride 1	4	3	8	5	5	3	1
Zenith	4	3	8	5	5	3	–
Susceptible check [a]	9	9	9	7	7	7	5

[a] Susceptible checks were China 1039 for B1, BS, SB, and LF; and Bala for LSc and ShR.

Varietal screening for brown planthopper resistance in China

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Rice varieties from the International Rice Brown Planthopper Nursery (IRBPHN) were screened at seedling stage and in the field for resistance to brown planthopper (BPH) *Nilaparvata lugens* (Stål) at Hunan Academy of Agricultural Science from spring 1980 to fall 1982. IRBPHN experimental procedures were followed.

Of 313 rice varieties screened, 37 cultivars were resistant at the seedling stage and 53 showed resistance in the field (see table). Resistance was scored by

Varieties resistant (score 1) to the brown planthopper at seedling stage and in field tests at Changsha, Hunan, China, 1980–82.

Variety or line	Origin	Resistance [a]								Duration [b] (days)
		Seedling stage				Field				
		1980	1981	1982	AV	1980	1981	1982	AV	
ASD7	India					R [c]	R	R	R	120-128
Mudgo	India	R [c]	R	MR	R	R [c]		MR	R	135
IR46	IRRI						R [d]	MR [d]	R	NH
Rathu-Heenati	Sri Lanka	R	R	MR	R	R	R	MR	R	NH
Hondarawala	Sri Lanka	R	R	R	R	R	R		R	NH
Sinna Sivappu	Sri Lanka	R	R	MR	R	R	MR		R	NH

Continued on next page

Table continued.

Variety or line	Origin	Resistance[a]								Duration[b] (days)
		Seedling stage				Field				
		1980	1981	1982	AV	1980	1981	1982	AV	
BG367-9	Sri Lanka	R	MR		R	R	R		R	126-127
BG379-1	Sri Lanka	R			R	R	R		R	NH
PTB33	India	R	R	MR	R	R	R	MR	R	NH
IR13525-43-2-3-1-3-2			R	R	R					124
IR15318-2-2-2-2	IRRI					R	R		R	NH
IR13240-39-3	IRRI					R	R	MR	R	107-132
IR13429-86-2	IRRI					R	R		R	NH
IR13540-56-3-2-1	IRRI						R	MR	R	NH
IR15529-253-3-2-2-2	IRRI						R	R	R	124
Surya Medal	Indonesia	R				R				HNR
Sudu Hondarawala	Sri Lanka					R				NH
B2980B-SR-2-1-1-1-2-1	Indonesia	R				R				137
BG367-8	Sri Lanka	R				R				137
BG379-2	Sri Lanka	R				R				HNR
BG379-3	Sri Lanka	R				R				HNR
BKnbr 1030-11-2	Thailand					R				135
BKnbr 1088-77	Thailand	R								NH
IR9209-26-2-2-2-3	IRRI	R								137
IR9224-223-2-2-2-1	IRRI	R				R				128
IR9752-1-2-1	IRRI					R				NH
IR9752-71-3-2	IRRI					R				137
IR9761-8-2	IRRI					R				137
IR9829-91-2-3	IRRI					R				137
IR13240-53-6-3-3	IRRI	R				R				137
IR13429-198-2	IRRI	R				R				128
IR13429-3-2	IRRI	R				R				138
IR13524-5-2-3-3	IRRI	R				R				NH
IR14252-13-2-2-5	IRRI	R				R				NH
IR15314-44-3	IRRI					R				HNR
IR15314-30-3-1-3	IRRI	R								HNR
IR15315-43-1	IRRI	R				R				NH
IR15496-21-9-2-3	IRRI	R				R				NH
IR15539-37-2-2	IRRI	R				R				HNR
IR17491-5-4-3-3	IRRI					R				HNR
IR17492-17-12-2	IRRI	R				R				HNR
IR17492-18-10-2-2-2	IRRI	R				R				HNR
IR17492-32-3-1-1-3	IRRI	R				R				NH
IR17494-32-3-4	IRRI	R								NH
IR17496-2-25-1	IRRI	R								NH
IR19657-87-3-3	IRRI	R								NH
IR19661-13-3-2	IRRI	R				R				NH
IR19670-177-1	IRRI	R				R				NH
KAU10666	IRRI	R				R				116
ARC6650	India					R				NH
Karuhondarawala	Sri Lanka					R	R			NH
Sudurusamba	Sri Lanka		R				R			NH
PTb19	India		R				R			NH
Cheng Cheongbyeo	Korea							R		121
Mudukiriyal	sri Lanka							R		NH
B27916-Mr-257-3-2	Indonesia							R		NH
Chianung sen yu 13	Taiwan, China							R		124
IR13429-196-1	IRRI							R		118
IR19791-12-1-2-2-2	IRRI							R		118
M61b-1184-1	Indonesia			R						NH
M61b-5-1-1	Indonesia							R		NH

[a]R = resistant, MR = moderately resistant. [b]NH = not heading, HNR = heading, not ripe. [c]b = av of 3 replications. [d]= av of 4 replications.

the Standard Evaluation System for Rice. Some scores were averaged over 3 years.

Among the resistant varieties were cultivars from India, Sri Lanka, Indonesia, Thailand, IRRI, Taiwan, China, Japan, Burma, Malaya, Malagasy, and Pakistan. Mudgo, BG367-8, and BG367-9 have suitable characteristics and are being used in the breeding program. ☐

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Rice cold tolerance evaluation in Banaue, Philippines

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One of the main IRRI field testing sites for cold tolerance is in Banaue, Philippines (latitude 17ºN, elevation 1,120 m). Genetic and variety evaluation studies were conducted to assess Banaue as a selection environment for cold tolerance.

IRRI cold tolerance nurseries are screened in a cool dry season (DS) from Jan to Jun and a cool wet season (WS) from Jul to Nov. Temperature and rainfall patterns are in the figure.

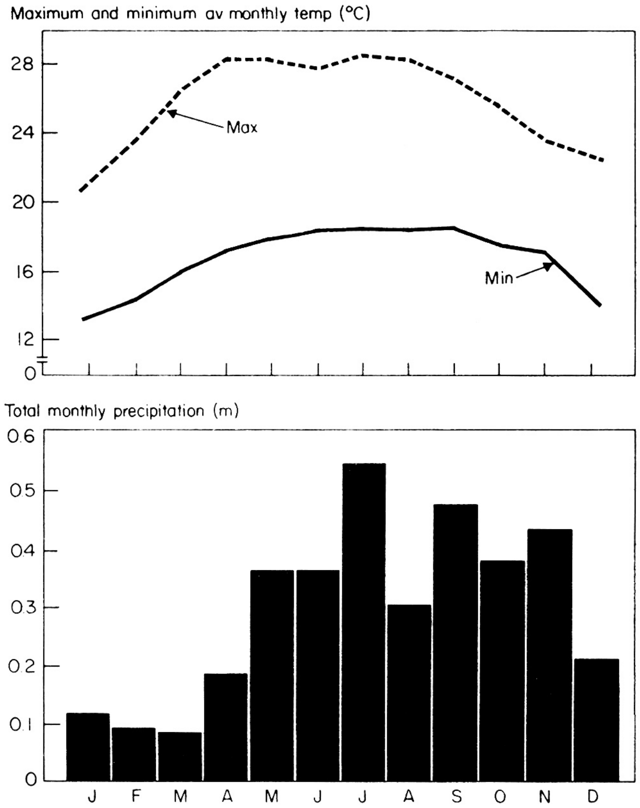
The heritability of four plant traits was calculated from the cross Leng Kwang/MRC-603-303//Kn1b-361-1-8-6-9. The F_2 population was grown in 1980 WS and 1981 DS. The correlation of F_3 lines across seasons for seven traits was also calculated (see table).

Results of these analyses and observations of nurseries and crosses suggest that progress can be made in either season for selection for highly heritable traits such as heading date, plant height, and panicle exsertion. Less heritable traits such as panicle number per plant, yield, and phenotypic acceptability score are better selected in DS and probably should only be selected in later generations. Cold-induced spikelet sterility is moderately heritable, particularly in DS. Spikelet fertility would best be selected for directly or by selection for phenotypic acceptability, which correlates with fertility in DS.

For all the traits measured, the DS is the best cold tolerance selection environment.

WS in Banaue is a poor selection environment. Heritability of traits in WS is low and shows poor correlation with that in DS. Spikelet fertility is seriously reduced by low temperature, high humidity, wind, and typhoons. Yields of advanced breeding lines in WS averaged 0.7 t/ha in the past 4 years, as compared with 5.4 t/ha in DS. In 2 of the last 9 years, virtually no seed was harvested in WS.

While breeding progress can be made for cold tolerance in Banaue, alternate sites or testing procedures may improve the efficiency of the program, particularly in WS. If no better testing site than Banaue can be found, improvements in the program should have the effect of increasing cold stress in the DS and decreasing cold stress in the WS. This might be accomplished by planting at higher elevations in the DS and lower elevations in the WS or by planting one month earlier in both seasons. □



Two-year average maximum and minimum temperatures and total monthly precipitation in Banaue (elevation 1,120 m).

Heritability values and correlation coefficients between the wet (WS) and dry season (DS) among F_2 and F_3 progenies of a cross in Banaue.[a]

Trait[b]	F_2-F_3 heritability (%)		F_3-F_3 correlation coefficients between 1980 WS and 1981 DS (r)
	WS	DS	
Heading date	–	–	0.85**
Plant height	43**	54**	0.61**
Panicle exsertion	–	–	0.42**
Panicle number	5	8	0.27**
Phenotypic acceptability	–	–	0.16
Yield of plant	6	20**	0.16
Spikelet fertility (%)	14*	31**	0.12

[a] * = significant at P = 0.5, ** = significant at P = 0.1, – = data not taken in the F_2. [b] All traits measured by the 1980 Standard Evaluation System for Rice, except spikelet fertility which was measured as %.

A new cold-tolerant cultivar for Tripura

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In Tripura, rice is harvested in Oct or Nov and fields remain fallow until transplanting starts in Feb. Three rice crops are not easily grown on the same land because temperature varies from 5 to 15ºC during fallow and farmers have no suitable cold-tolerant variety.

We have used three cold-tolerant parents from IRRI to develop varieties with cold tolerance at early growth stages.

The crosses were evaluated and selected during boro. In 1981, 61 promising fixed strains were selected. Five-day-old germinated seeds of the strains were subjected to cold treatment in the refrigerator at 4ºC for 10 d using the method outlined by T. G. Li and B. S. Vergara. They were scored for cold tolerance and seedling vigor 10 d after removal from the refrigerator (Table 1).

Sixty-eight percent of the entries had less than 30% seedling death and moderate seedling vigor (5-10 cm high) after cold treatment (Table 2). The same cultures were field evaluated in 1981-82 boro for flowering duration, plant height, number of tillers, panicle length, and single-plant weight. Five promising entries — C-10, C-14, C-13, C-9, and C-23 — were selected for further evaluation.

They were planted in mid-Nov 1982 in a replicated randomized design with Kalinga, a cold-tolerant culture of the region, as control. C-10 yielded better than the other test varieties and the control (Table 3).

C-10 is a cross of the Bhutan variety Thimpu, with IR9129-102-2, which was then crossed with KN-1B. It is a photoperiod-insensitive semidwarf that matures in 140-145 d. C-10 has good early seedling vigor, moderate tillering ability, highly synchronized flowering, late leaf senescence, fully exserted and compact panicles, and high fertility. Average yield is 6.5 t/ha. Insect and disease incidence was negligible.

This promising culture has been proposed for a minikit test program in Tripura. □

Table 1. Criteria for scoring for cold tolerance.

Score	At early seedling stage	Seedling vigor or seedling height (cm)
1	All germinated, none died	Above 10
3	Less than 30% died	8-10
5	30 to 50% died	5-7
7	Over 50% died	3-4
9	100% died	Less than 1

Table 2. Cold tolerance and seedling vigor of selected varieties at early seedling stage.

Index no.	IR no.	Cross	Total strains	Strains (no.) with given score: At early seedling stage 1	3	5	7	9	For seedling vigor 1	3	5	7	9
TRC245	IR26216	Thimpu/IR5853-118-5//KN-1B	23	1	12	3	6	1	1	3	8	10	1
TRC246	IR26226	Thimpu/IR9129-102-2//KN-1B	34	1	23	6	4	0	2	3	12	17	0
TRC247	IR26237	Toyonishiki/IR9093-195-1//KN-1B	4	0	3	1	0	0	0	0	1	3	0

Table 3. Performance of promising cold tolerant varieties, Tripura, India.

Character	C-10	Kalinga (control)
Days to heading	117	117
Days to maturity	145	148
Plant height (cm)	85	82
Tillers/plant	10	11
Plant type	Semidwarf	Semidwarf
Leaf senescence	Late	Medium
Panicle length (cm)	28	20
Filled grains/panicle	223	87
Fertility (%)	93	84
1,000-grain wt (g)	26.44	26.15
Yield/m^2 (g)	720	520
Yield (t/ha)	6.5	4.50
Awned or awnless	Awnless	Awnless
Kernel length (mm)	7.72	7.94
Kernel width (mm)	2.94	2.71
Length-breadth ratio	2.62	2.92
Grain shape	Medium	Medium
Grain husk color	Light yellow	Straw
Endosperm color	Waxy white	Light brown

GENETIC EVALUATION AND UTILIZATION

Adverse soils tolerance

Breeding for salt-tolerant rice strains

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Various studies have identified Jhona 349 (Pakistan) as relatively salt tolerant and Magnolia (USA) as salt sensitive. The two cultivars were crossed and the resulting F_1 and F_2 were grown under saline conditions. P57, with relative salt tolerance, was selected in F_3, from which seven relatively salt-tolerant progeny were isolated in F_4. The progeny were tested at various salinity levels for 5 years (1976-80) in artificially salinized 6 × 6 × 1 m field basins with drainage systems (Table 1).

We conducted a microyield trial in 1981 to test those strains against standard salt-tolerant strains Damodar, Getu, and Giza 159 (from Egypt). The first two were developed in India by pureline selection from local germplasm. The field was artificially salinized (pH 8.7, ECe 5.2 dS/m, SAR 44.6, ESP 39.6, TSS 42.6, CA^{++} + Mg^{++} 5.5, and Na^{+} 71.6 meq/liter. Artificial salinity was developed by adding a 1:4:5:10 of magnesium sulfate, sodium chloride, calcium chloride, and sodium sulfate – salts usually present in saline soils of Pakistan. The crop was irrigated from a tubewell with saline sodic water containing HCO_3 meq/liter, TSS 35 meq/liter (Ca^{++} + Mg^{++} 4.8, Na^{+} 30.2) with a SAR of 19.5. Net plot size per entry was 4 m^2. Hills of one seedling each were spaced at 23 × 23 cm in a completely randomized block design with four replications.

NR74-108 yielded significantly more than the other strains, including Damodar and Getu (Table 2). NR74-108 is a semitall rice with stiff straw and medium-long grain that does not shatter. It flowers in 121 d. It may be suitable for cultivation on marginal saline soils and may be used as a donor of salt tolerance genes. □

Table 1. Response of plant progenies to salinity[a] (percent reduction over control[b]).

Cultivar	Florets/ panicle	Panicle fertility (%)	Yield per plant (g/m^2)
NR74-79	15 g	9 g	42 h
NR74-92	38 ab	20 b	70 b
NR74-93	33 cd	13 ef	61 e
NR74-96	36 bc	16 cd	65 d
NR74-97	30 d	15 de	67 cd
NR74-106	37 b	18 bc	54 f
NR74-108	18 f	13 f	49 g
Jhona 349 (resistant parent)	25 e	20 b	68 bc
Magnolia (susceptible parent)	40 a	30 a	80 a

[a]pH 8.7, ECe 7.2 dS/m at 25°C, SAR 59.7, ESP 44.3. [b]pH 7.7, ECe 2.3 dS/m at 25°C, SAR 8.4, ESP 12.0. Figures followed by different letters are significantly different at 5% level of significance.

Table 2. Performance of salt-tolerant rice strains in saline fields.[a]

Cultivar	Yield g/m^2	Plant ht (cm)	Productive tillers/ plant	Panicles/m^2	Days to flowering	Panicle length (cm)	Florets/ panicle	Panicle fertility (%)	1000-grain wt (g)
NR74-108	34 a	101 b	10 cd	228 e	121 c	25 ab	109 d	89 a	23 ab
NR74-79	32 b	111 a	11 bc	252 d	125 b	27 a	135 b	84 bc	23 a
Damodar	28 c	93 d	14 a	333 b	120 c	20 cde	127 c	86 ab	15 d
Giza 159	21 d	74 e	12 ab	285 c	117 d	22 bc	133 b	81 d	19 c
Cetu	27 e	92 d	13 a	341 a	152 a	21 cd	151 a	82 cd	16 d
Jhona 349	28 f	96 c	8 de	204 f	114 e	18 de	105 e	83 bcd	23 a
Magnolia	17 g	96 c	7 e	184 g	103 f	17 e	103 e	67 e	22 b

[a] Figures followed by different letters are significantly different at 5% level.

PBN1, a semidwarf upland rice cultivar tolerant of iron deficiency

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PBN1 (Prabhavati) is a semidwarf (75 cm) recommended for cultivation in iron-deficient black soils (calcareous vertisols with 40-65% montmorillonitic clay and pH 8.0-9.2) in Maharashtra State. It is an induced mutant of the tall local cultivar Ambemohor obtained through ethyl methanesulfonate (0.2%) seed treatment.

PBN1 is nitrogen-responsive and is suitable for direct seeding in uplands. It tolerates iron chlorosis and has dark green foliage. Its roots have more efficient iron-reductive capacity than high yielding semidwarfs with Dee-geo-woo-gen in their parentage. Maturity ranges from 115 to 120 days, which helps it fit well in the rice - wheat, rice - legume, or rice - oilseed double-cropping sequence in the canal command areas. Grain is medium coarse, translucent, and scented.

PBN1 was evaluated under direct seeding in uniform variety trials (irrigated black soils) at three sites for three seasons (see table). It yielded 20% more than the

Performance of PBN1 under direct seeding in UVT on irrigated black soils.

Cultivar	Grain yield[a] (t/ha)				Days to maturity	Lodging score[b]
	1980	1981	1982	Weighted mean		
PBN1	2.5	3.1	4.1	3.3	119	0
PBN4	1.7	2.4	3.1	2.5	117	1
PBN7	2.1	2.6	3.3	2.8	116	0
PEN20	1.5	2.6	2.8	2.4	119	1
PBN30	2.3	2.5	3.3	2.7	115	3
Ambemohor (local)	2.3	2.4	3.4	2.8	116	4
Jalgaon 5	2.3	2.9	3.2	2.9	116	4
Tuljapur 1	2.6	2.5	3.0	2.7	113	4
SE ±	0.21	0.26	0.34	.24		
CD (0.05)	0.64	0.81	0.97	.73		

[a] Av of 3 sites. [b] By the 1980 Standard Evaluation System for Rice.

local check Ambemohor (see table). In minikit trials conducted in farmer fields in 1981 (28 trials in 3 districts) and 1982 (76 trials in 6 districts), PBN1 yielded 2.5 t/ha in 1981 and 4.1 t/ha in 1982. Ambemohor yielded 2.3 and 3.4 t/ha. □

Screening rice varieties for salt tolerance in Bangladesh

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Salinity limits rice cultivation on about 1 million ha of land in southern Bangladesh.

We developed a simple, low-cost screening method to identify rice varieties with salt tolerance. Nearly neutral dried soil was placed in a petri dish and an NaCl solution was added to the soil to adjust the electrical conductivity to 10 dS/m and salinity level was monitored throughout the experiment. Twenty seeds of each variety or line were sown in the petri dish. IR9884-54-3 was used as resistant check and Pajam, the susceptible check. Germinated seeds were grown in the petri dish 21 d. Salt injury was scored by the IRRI Standard Evaluation System for Rice.

In the 1982 screening of 50 varieties or lines, 3 aus season varieties (BR1, BR203-26-2, and BR201-193-1) and 4 aman varieties (BR4, BR10, Rajasail, and Kajalsail) were salt tolerant (Table 1).

Those varieties and lines were tested in a saline field in replicated yield trials. In 1983 aus, BR201-193-1 and BR203-26-2 were tested with local check variety Chicknal. They were direct seeded by dibbling at 20- × 15-cm spacing and fertilizer 60 kg N and 40 kg P/ha were applied. They yielded more than twice the local check variety (Table 2).

In 1983 BR4 and BR10 were tested in t. aman under uniform conditions. The local variety Kajalsail was used as check. BR4 and BR10 yielded best (Table 2). □

Table 1. Salt-tolerant varieties or lines isolated in Bangladesh.

Variety, line	Score[a]
Aus	
BR1	3
BR203-26-2	3
BR201-193-1	4
IR9884-54-3 (resistant check)	3
Pajam (susceptible check)	9
Aman	
BR4	4
BR10	4
Rajasail	3
Kajalsail	3
IR9884-54-3 (resistant check)	3
Pajam (susceptible check)	9

[a]Visual scoring 1-9: 1-4 = almost healthy plant, 7-9 = almost dead plant.

Table 2. Yield and related characters of salt-tolerant rice.

Variety, line	Flowering date	Duration (d)	Plant ht (cm)	Panicles/m^2	Yield (t/ha)
		Aus[a]			
BR201-193-1	7 Jun 83	112	121.0	425	3.96
BR203-26-2	17 Jun 83	127	104.0	457	6.65
Chicknal (check)	15 May 83	90	97.0	247	1.50
		Aman[b]			
BR4	26 Oct 82	138	102.0	344	3.60
BR10	22 Oct 82	137	98.0	378	4.0
Kajalsail (check)	5 Nov 82	154	140.0	210	1.6

[a]Seeded 9 Mar 83. [b]Seeded 30 Jun 82.

Salinity-mediated enhancement of harvest index of rice — selection criterion for salt tolerance

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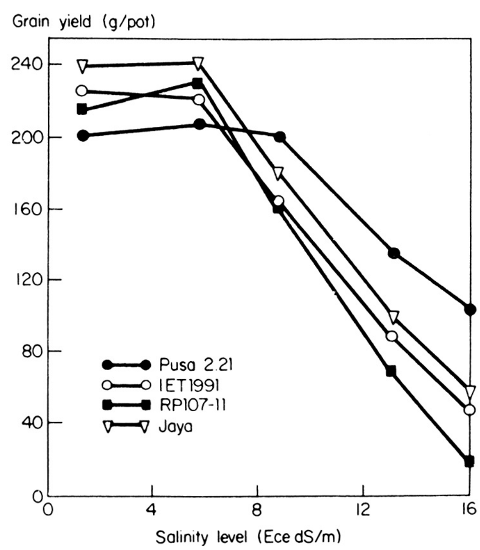
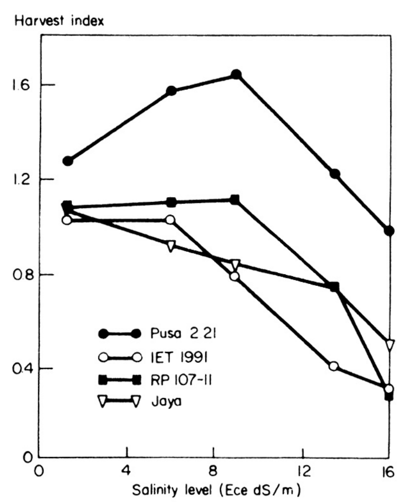
Soil salinity inhibits rice production in almost every country. It is important to develop salt-tolerant rice varieties to increase rice production in areas with saline soil.

We studied the effects of saline soils on harvest index (HI) (grain:straw) of rice at the Salinity Institute, Karnal. Four rice varieties were planted at 5 salinity levels (ECe 1.2, 5.6, 8.7, 13.0 and 16.0 dS/m) in 18-kg porcelain pots. NaCl:$CaCl_2$ at 4:1 was mixed in sandy loam soil. The soil was saturated and 35-day-old seed-



1. Yield reductions of rice varieties by salinity.



2. Trend of change in harvest index of rice varieties by salinity.

lings were planted at 3 seedlings/hill, 4 hills/pot. Treatments were replicated four times, Before transplanting, 15 g ammonium sulfate, 8 g superphosphate, and 3 g muriate of potash were added to each pot. An additional 7 g of ammonium sulfate was topdressed at maximum tillering and at heading. Standing water level was kept at 4 cm by adding tubewell water.

Salinity as high as ECe 5.6 dS/m did not adversely affect grain yield (Fig. 1), but increasing salinity abruptly reduced yield of Jaya, RP107-11, and IET1991 (Sona). Pusa 2-21 yield did not decline sharply with increased salinity. At the highest salinity level Pusa 2-21 showed the least yield reduction and yielded highest.

In addition to affecting plant growth and yield, salinity altered the grain-straw ratio. HI increased from 1.3 to 1.6 in Pusa 2-2 1 with salinity to ECe 5.6 dS/m and remained at similar or slightly higher values up to ECe 8.7 dS/m (Fig. 2).

HI decreased steadily for Jaya as salinity increased. RF107-11 HI did not change up to ECe 8.7 dS/m, but later declined sharply. IET1991 had lowest HI under saline conditions. ☐

GENETIC EVALUATION AND UTILIZATION

Drought tolerance

Breeding varieties for rainfed upland situations

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About a decade ago rice breeding programs in India began to emphasize development of drought-tolerant early-maturing varieties for drought-prone uplands. In 1975 AICRIP began breeding for such lines to produce reasonably good yields.

In 1975, 35 crosses of high yielding varieties Rasi, RP79-5, Cauvery, Akashi, and OR34-16 were made with the following drought-tolerant parents: 63-83, TOS4020, TOS4617, Rikuto Norin 21, Kinandang Puti, IRAT8, Merikrak, Mettasanna, Tellavadlu, N22, Fine gora, Black gora, Sarya, Kalamsu, RPA5824, CR143-2-10, IET5850, and JBS446.

F_1 and F_2 populations (more than 5,000 plants/cross) were transplanted and selected for early vigor, tillering precocity, synchronous flowering, and early maturity. Beginning with F_3, selections were alternately direct-seeded and transplanted. Reaction to blast (B1) and rice tungro virus (RTV) was studied at F_4-F_6, and drought tolerance was evaluated at every stage. Homogeneous selections were bulked and yield tested in F_5.

Nine cultures from six crosses had consistently better performance than

Table 1. Promising short-duration upland cultures developed at AICRIP. [a]

IET no.	Designation and cross	Direct seeding Maturity (days)	Direct seeding Yield (t/ha)	Transplanting Maturity (days)	Transplanting Yield (t/ha)	Grain type [b]	Drought sustenance	Seed dormancy (days)	Reaction [c] to Blast	Reaction [c] to RTV
7564	RP1667-301-6-1196-1562 (IRAT 8 / N22)	90	4.5	95	5.4	LS	23	6	R	MR
7566	RP1670-1418-2205-1585 (M63-83 / Cauvery)	95	4.4	99	5.4	LB	22	6	R	S
7613	RP1670-1418-2205-1582 (M63-83 / Cauvery)	90	3.5	95	4.5	LB	23	6	R	S
7617	RP1888-4259-1529-126 (RP79-5 / Tellavadlu)	90	4.0	98	5.2	LB	25	5	R	S
7633	RP1451-1196-1562-4218 (Rasi / Fine gora)	90	3.8	98	4.6	LS	21	6	R	MR
7265	RP1899-1481-78-1 (IET5850 / OR34-16)	95	3.5	100	4.6	LB	25	5	R	S
7614	RP1451-1712-4319 (Rasi / Fine gora)	90	3.5	100	4.4	LS	24	5	R	S
7635	RP1667-4218-1 (IRAT8 / N22)	89	3.3	100	4.4	LS	23	7	R	MR
7261	RP1897-3790-30-1 (Rasi / Mettasanna)	100	4.1	105	4.5	LS	22	–	R	MR
	Akashi	100	3.0	105	4.0	SB	15	10	R	S
	N22	100	2.6	105	2.8	SB	16	15	–	S
	ADT31	120	2.1	125	3.4	LB	10	–	–	S
	IET7281 (IR50)	110	2.4	115	4.1	LS	10	–	–	–
	Tellahamsa	110	2.0	115	3.0	LS	11	–	–	S
	Sattari	90	1.9	90	2.8	SB	12	–	–	S
	Cauvery	108	3.1	110	4.1	LB	10	–	MR	S
	Rasi	110	3.2	115	4.2	MS	15	5	R	S
	CD (0.05%)		1.25		2.24					

[a] Rainfall during the season was 469.5 mm. [b] LB = long bold, LS = long slender. SB = short bold. [c] R = resistant, MR = moderately resistant, S = susceptible.

Table 2. Performance of IET7564 and IET7566 in direct-seeded upland trials at different locations.

Variety	Kanke	Tuljapur	Dehradun	Rewa	Varanasi	Derol	Barchara (Cuttack)	Hazaribagh
IET7564								
Yield (t/ha)	1.7	1.0	1.2	2.2	1.5	1.4	1.4	2.4
Days to flowering	64	64	68	61	67	56	68	57
IET7566								
Yield (t/ha)	2.0	1.0	1.4	1.5	1.5	1.7	1.5	2.7
Days to flowering	64	65	80	65	69	64	75	65
Local check[a]								
Yield (t/ha)	1.4	1.0	0.5	2.0	1.5	1.6	–	1.4
Days to flowering	83	85	14	65	64	69	–	72
Seeding date	2 Jul 1982	–	20 Jun 1982	16 Jul 1982	21 Jul 1982	11 Jul 1982	13 Jun 1982	7 Jul 1982
Total rainfall (mm)	749	545.9	859.8	1259	851.3	656.0	76 5	714.5
Rainy days (no.)	59	45	44	44	40	24	41	–
Drought spell (Stage)	Vegetative	Vegetative	Vegetative	–	–	Vegetative	Vegetative	Vegetative

[a] The local check was RAU4045 at Kanke, Tuljapur 1 at Tuljapur, Ramjawain at Dehradun, RWR212 at Rewa, Bakki at Varanasi, Sathi 5436 at Derol, and Brown gora at Hazaribagh.

check varieties in direct-seeded and transplanted conditions. They matured earlier, showed Bl resistance, had good drought tolerance (days to wilting), and possessed seed dormancy. IET7564, IET7633, IET7635, and IET7261 are resistant to RTV (Table 1). All cultures were entered in the national program. In 1982 kharif, IET7564 and IET7566 were evaluated at other research centers (Table 2).

In demonstration plots (200 m^2) at AICRIP, direct-seeded IET7564 and IET7566 matured in 90 and 95 days and yielded 3.7 and 4.7 t/ha. IET7564 ranked first in the 1982 kharif national uniform variety trial, based on yield at 15 sites that suffered various levels of drought. It outperformed local and national checks at Bhubaneswar, Jeypore, and Sambalpur in Orissa; Jabalpur, Rewa, and Waraseoni in Madhya Pradesh; Faizabad and Varanasi in Uttar Pradesh; and Kanke and Hazaribagh in Bihar (Table 2).

IET7564 and IET7566 performed well in minikit tests on rainfed uplands in Tanjavur (Tamil Nadu) and in East and West Godavari (Andhra Pradesh). □

Pest management and control DISEASES

Detection of spherical and bacilliform virus particles in tungro-infected rice plants by leafhopper transmission

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Rice tungro disease is a virus complex caused by rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). Green leafhopper (GLH) *Nephotettix virescens* can transmit both virus particles. GLH can transmit RTSV from plants infected with RTSV alone, but cannot transmit RTBV from plants infected with RTBV alone. RTBV can be transmitted by GLH carrying RTSV.

Rice plants infected with RTSV do not show definite symptoms and may look healthy. Plants infected with RTBV are moderately stunted and discolored. If infected with both particles, plants show severe stunting and discoloration.

Virus particles present in the infected plant can be detected by serology and electron microscopy, but both methods require expensive and sometimes sophisticated equipment that is unavailable at most institutions in developing nations. We developed a simple method of detecting rice tungro virus particles in infected plants on the basis of symptomatology and transmission characteristics of each particle.

Rice plants infected with both particles or RTBV alone were identified first. One-month-old TN 1 plants previously inoculated with tungro using *N. virescens* were sorted by symptoms. Plants with typical tungro symptoms were separated from those without symptoms and exposed to virus-free adult leafhoppers for 24 h acquisition access.

Insects from each virus source plant were then used to inoculate 7-d-old TN1 seedlings in test tubes. The inoculated seedlings were transplanted in pots and kept in the greenhouse for symptom development. Infected rice plants that gave positive transmission were identified as infected with both RTSV and

RTBV. Those that gave negative transmission were identified as plants infected with RTBV alone.

Plants infected with RTSV alone were identified next. Virus-free leafhoppers were given 24 h access to each healthy-looking plant inoculated with RTSV alone, followed by an 8 h or overnight acquisition access to previously identified RTBV-infected plants. The insects were then used to inoculate 7-d-old TN1 seedlings as above. Plants that gave positive transmission were identified as RTSV-infected while those that gave negative transmission were identified as healthy plants.

In this experiment, TN1 seedlings were inoculated with tungro using plants infected with both virus particles. Sixteen inoculated plants with moderate stunting and discoloration were tested: 2 plants had both RTBV and RTSV and 14 had RTBV alone. Fourteen symptomless plants inoculated with RTSV done were used for RTSV detection: 12 plants had RTSV and 2 were healthy.

To test the accuracy of this method, the virus particles present in each plant were counterchecked serologically with a latex test. Results of the serological test showed that the method was accurate.

This method takes about 10 d to detect RTBV-infected plants and another 10 d to detect RTSV. In contrast, results by serology and electron microscopy are obtained in only a few hours. □

Quality of rice grains from sheath rot-affected plants

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Sheath rot caused by *Acrocylindrium* (= *Sarocladium*) *oryzae* Sawada is a major rice disease in India. We recorded changes in grain quality caused by the disease.

Trials with ADT31 and ADT36, both popular varieties in Tamil Nadu, were conducted during 1982 kuruvai. The disease intensity was arbitrarily classified into 5 grades (0, 3, 5, 7, 9) based upon the lesions on the leaf sheath near the panicle. 0 indicated no infection; 9 indicated the boot leaf sheath was completely infected and the panicle could not emerge. No grains formed in plants scoring 9.

Rice grains were harvested from individual plants with various disease intensity levels. Grains also were collected from healthy plants. One hundred panicles were collected for each disease intensity category.

Discolored and healthy grains from each panicle were counted. The 1,000-grain weight was measured by taking 4 samples in each category. Germination of seeds from each category was assessed by using the roll towel method and 400 seeds for each infection level. Protein content of ADT36 grains was assessed by estimating total nitrogen content by the micro-Kjeldahl method and multiplying it by 6.25. Two independent experiments, each with four replications, were conducted.

Changes in rice grain quality due to sheath rot incidence in 2 rice cultivars.

Disease intensity grade	Discolored grains				1000-grain wt (g)		Seed germination (%)		Protein content (%) of ADT36
	no./panicle		%/panicle						
	ADT31	ADT36	ADT31	ADT36	ADT31	ADT36	ADT31	ADT36	ADT36
0	1	2	0.9	1.4	15.7	15.7	94	97	8.0
3	19	54	18.1	38.3	12.3	15.3	89	92	7.5
5	60	78	66.7	67.8	6.3	11.5	76	81	4.4
7	85	94	97.7	93.1	4.9	8.7	58	63	2.2
9	[a]								

[a] No grains were formed.

Disease of the boot leaf sheath caused discolored grains (see table). Although many different causes of grain discoloration have been reported, this is the first time that *Acrocylindrium oryzae* has been reported as a cause. Attempts to isolate the fungus from the discolored grains failed, which suggests that the fungus causes grain discoloration by inducing a physiological change.

The disease reduced the 1,000-grain weight and caused poor grain filling, which reduced seed germination (see table). Protein content of the grains was also affected. □

Leaf scald disease of rice in Karnataka, India

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Leaf scald disease of rice caused by *Rhynchosporium oryzae* was observed for the first time in Karnataka in Oct 1982 on Intan rice. Intan was very susceptible to the disease and had lesions covering more than 50% of the leaf area. Seed

Table 1. Incidence of *Rhynchosporium oryzae* on seeds from Karnataka State districts, India (400 seeds tested per sample following blotter method).

District	Samples tested (no.)	Infected samples (no.)	Samples (no.) at given range (%) of infection						
			0.5-5	6-10	11-20	21-30	31-40	41-50	51-64
Belgaum	2	2	2	–	–	–	–	–	–
Bellari	1	0	–	–	–	–	–	–	–
Chikmagalur	3	1	–	–	–	–	1	–	–
Chitradurga	4	3	2	–	1	–	–	–	–
Dharwar	5	1	–	–	1	–	–	–	–
Hassan	7	4	3	1	–	–	–	–	–
Kodagu	5	5	–	–	2	–	1	1	1
Mandya	3	2	2	–	–	–	–	–	–
Mysore	20	19	9	7	1	2	–	–	–
Total	50	31	18	8	5	2	2	1	1

Table 2. Incidence of *Rhynchosporium oryzae* in parts of rice seed.

Variety	Infection (%) in			
	Husk	Endo-sperm	Embryo	Whole seed
IR8	12	14	12	13
Intan	30	17	10	64
Palguna	13	17	14	22
Average	18	16	12	33

samples collected from around the state showed that the fungus is widely seed-borne. Of 50 seed samples collected from 9 districts and tested by the standard blotter method, 37 were infected with the fungus. Infection ranged from 0.25 to 64% (Table 1). Infection was highest on Intan.

IR8, Intan, and Palguna seeds were evaluated to determine where the fungus is carried. The husk, endosperm, and embryo were separated after seeds were soaked in sterile water for 4 h and surface sterilized with 0.5% NaOCl for 10 min. *R. oryzae* was counted using the standard blotter method.

The fungus may be present in all parts of the seed. Average infection figures are in Table 2. The deep-seated nature of the fungus indicates that it can survive longer with the seed, which may be the primary source of infection. ☐

Effect of organic and inorganic chemicals on in vitro growth of *Xanthornonas campestris* pv. *oryzae*

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The in vitro effect of 235 chemical compounds on the growth of 34 *X. campestris* pv. *oryzae* strains was tested in agar media. The chemicals tested were alcohols, aldehydes, organic and inorganic salts and acids, oximes, quaternary ammonium compounds, amines, glycosides, ketones, oxides, phenolic compounds, and sulfoxides. The chemicals were tested at a concentration of 0.005% (wt/vol), and those that prevented development of all 34 strains at 0.005% were tested at lower concentrations. A multipoint inoculator was used to inoculate the media.

The most active products against *X. campestris* pv. *oryzae* in vitro were ZnO, 8-hydroxyquinoline, and methylglyoxal (all inhibitory between 0.0005% and 0.001%); Cd $(NO_3)_2$ Cd $(OOC.CH_3)_2$, o-phenanthroline, 7-chloro-6-fluoro-l, 4-dihydro–4-oxo-l-ethyl-3-quinoline carboxylic acid (CGA 78039), and formaldehyde (inhibitory between 0.0001% and 0.0005%). Salts of copper, nickel, and cobalt were inhibitory for all strains at concentrations between 0.001% and 0.005%. Promising compounds will be tested further in field trials at IRRI. ☐

Production of inocula of *Rhizoctonia solani* on different media and media effect on disease development

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Since its inception, BRRI has screened rice varieties for resistance to sheath blight (ShB) caused by *Rhizoctonia solani.* We first used inocula prepared in potato dextrose agar (PDA) and later used inocula grown in rice:rice hull (R:RH). R: RH medium, although inexpensive and easy to prepare, often was contaminated by fungi or bacteria (probably spore forming), even after double sterilization. We tested a new media for large-scale production of *R. solani* inocula.

The media and varieties used are in Tables 1 and 2. Equal amounts of inocula were raised for inoculum production and for inoculating the rice plants. Growth characters of the fungus on different media, lesion length development/d (growth rate), and disease index (DI) at maturity were recorded for all varieties and media used.

R: RH and rice straw (RS) media gave

Table 1. Effect of inocula prepared in different media on *Rhizoctonia solani* growth and sheath blight development.

Media	Growth character				Sheath blight development	
	Mycelial	Sclerotial initiation [a]	Sclerotia production	Contamination %	Rate (mm/d) [b]	DI [c]
R:RH (1:2)	Slow	11	Low	Moderate	13.7 a	5.1 a
RS	Slow	11	Low	Low	12.3 a	4.8 a
RC (green)	Medium	6	High	Nil	14.1 a	4.6 ab
WH	Fast	5	Moderate	Nil	13.8 a	5.0 a
RC:WH (1:l)	Fast	5	High	Nil	12.1 a	4.7 ab
RC:WH (2:l)	Fast	5	High	Nil	14.9 a	5.0 a
RC:WH (1:2)	Fast	5	Moderate	Nil	13.0 a	4.8 a
PDA	Very fast	2	High	Low	13.4 a	4.4 b

[a] Indicates days after inoculation. [b] Measured as mean lesion length development in mm/day. [c] Dl = disease index (severity), measured on a scale of 0-9.

Table 2. Effect of inocula of *Rhizoctonia solani* prepared in three media on sheath blight development on 8 rice varieties.

Variety inoculated	Disease development as lesion length in mm/day [a]				Disease [b] reaction
	PDA	WH	RC	Mean	
BR1	16.0	21.7	25.5	21.1 a	S
IR8	20.4	18.7	18.6	19.2 ab	MS
Chianung Sen Yu-6	19.2	19.1	19.2	19.2 ab	MS
BR3	19.6	17.0	20.1	18.9 ab	MS
Dular	18.5	17.6	17.7	17.9 b	MR
Dharial	19.0	18.7	16.1	17.9 b	MR
BR8	13.8	12.6	13.4	13.3 b	MR
BR9	11.6	12.0	12.6	12.1 b	MR

[a] Mean of 32 isolates. [b] S = susceptible, MS = moderately susceptible, MR = moderately resistant.

slow mycelial growth, late sclerotial initiation, low sclerotia production, and higher contamination (Table 1). Fungus growth on PDA was significantly better. However, the media appeared to have no significant effect on rate of disease development, although DI was less for PDA inocula than for other inocula. When 8 rice varieties were inoculated at boot stage with inocula from 32 isolates grown in PDA, water hyacinth (WH), and rice culm (RC), type of media had less effect on rate of disease development. However, varieties significantly differed in mean rate of disease development. This varietal difference was correlated with varietal disease reaction (Table 2). The findings suggest that RC, WH, or a mixture of RC and WH in any proportion are appropriate for large-scale production of *R. solani* inocula. □

Effect of rice plant age on rice tungro virus symptoms

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We conducted a pot culture experiment with susceptible TN1 to determine the influence of rice plant age at the time of tungro (RTV) infection on incubation period and nitrogen metabolism. Plants were inoculated with viruliferous *Nephotettix virescens* when they were 15, 30, 45, 60, and 75 d old. Incubation period, and leaf and grain nitrogen content are in the table.

Symptoms appeared 18.3 d after inoculation of 75-d-old plants vs 8 d for 15-d-old plants. There were significantly fewer leaves/tiller on plants inoculated at 15 d and leaf length was 53.6% less. As plant age at infection increased, there was a gradual increase in leaf length, but the leaves of all infected plants were significantly shorter than those of healthy plants. Infection of 75-d-old plants did not significantly reduce leaf length. Leaf nitrogen content was significantly higher for infected plants than for healthy ones. Nitrogen content of grains was significantly lower in plants infected at age 60 d than in healthy plants. □

Effect of age of tungro virus infection on rice plants.

Age at inoculation (d)	Incubation period (d)	Leaves/tiller	Leaf length (cm)	Leaf nitrogen (%)	Grain nitrogen (%)
15	8.0	4.9	22.9	1.3	1.0
30	9.0	5.4	30.0	1.3	1.2
45	9.5	5.5	34.3	1.2	1.2
60	15.0	5.7	40.2	1.1	1.3
75	18.3	5.6	47.5	0.9	1.4
Control	–	5.7	49.4	0.7	1.4
Critical difference (P = 0.05)	1.6	0.3	3.3	0.08	0.07

Effect of growth regulators on tungro infection

R. Rajasegar and R. Jeyarajan, Plant Pathology Department, Tamil Nadu Agricultural University, Coimbatore 641003, India

When growth regulators indole-3-acetic acid (IAA) and gibberellic acid (GA) were applied to detached rice leaves or sprayed on rice plants, they prevented rice tungro virus (RTV) infection. We evaluated the effect of IAA and GA root or seedling dip on RTV infection.

Roots of 15-day-old TN1 seedlings raised inside an insect-proof cage were washed with water, then immersed in GA and IAA solutions at different concentrations for 1 h. The roots of control plants were dipped in water. Seedlings were transplanted in earthen pots and after 3 d were inoculated with RTV by viruliferous *Nephotettix virescens.* After 24 h inoculation feeding, insects were removed from the seedlings.

In another experiment, the entire seedling was immersed for 1 h in the growth regulator solutions and then inoculated. The control seedlings were dipped in water. The number of infected plants in each treatment was counted (see table). Percent of infected plants after root dipping gradually decreased as IAA concentration increased. At 400 ppm IAA, only 40% of the plants developed RTV symptoms. Against tungro, IAA was more effective than GA. □

Effect of plant growth regulators on RTV infection, Coimbatore, India.

Treatment	RTV infection (%)	
	Root dip	Plant dip
IAA 200 ppm	55	45
IAA 300 ppm	50	30
IAA 400 ppm	40	25
GA 400 ppm	65	40
Control	90	80
CD (P = 0.05)	10.2	5.9

Axonopus compressus, a grass host for *Rhizoctonia solani*

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Axonopus compressus is a common perennial grass weed that grows on boundary ridges of rice fields and in farmyards in Jalpaiguri and Cooch Behar districts of West Bengal. Both districts have more than 3,000 mm annual rainfall. Soil is generally acidic. In Aug-Sep 1982, *Rhizoctonia solani,* a rice sheath blight pathogen, was found infecting *A. compressus* and border rows of rice plants. On artificial inoculation, isolates of *R. solani* from *A. compressus* and rice plants infected both plant species. *R. solani* apparently survives and multiplies on *A. compressus,* from which infection spreads to rice. □

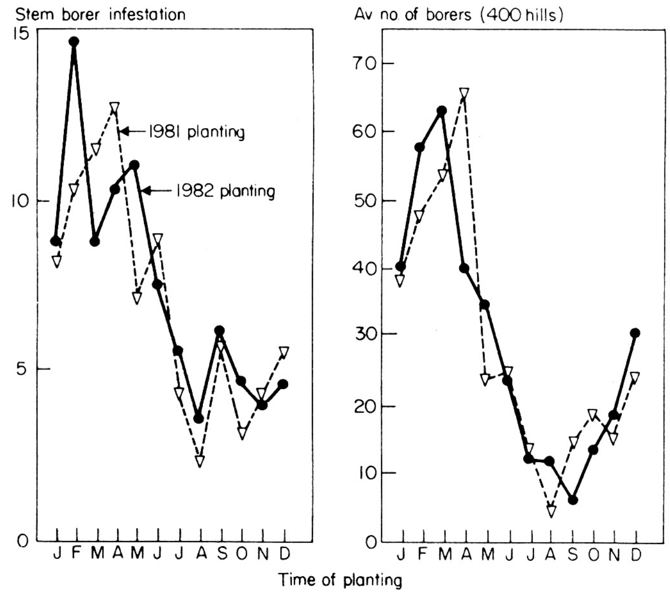
Pest management and control INSECTS

Planting time and stem borer incidence in Badeggi, Nigeria

M. N. Ukwungwu, National Cereals Research Institute, Rice Research Station (RRS), Badeggi, Nigeria

We measured rice stem borer (SB) incidence on susceptible variety FARO 11 in 1981 and 1982 at the Badeggi RRS. FARO 11 was transplanted on d 12 or 13 of each month in 5- × 5-m plots, at 20- × 20-cm spacing, in 4 replications. SB incidence was recorded as the number of damaged stems to total tillers by dissecting 10 hills from each plot at 10-d intervals, from transplanting to harvest.

Results (see figure) showed that SB infestation was high for crops planted in Feb, Mar, and Apr and low for the Aug crop, in 1981. In 1982, SB incidence was high in Feb, Apr, and May crops and low for the Aug crop. Insect buildup begins in the wet season (Jun-Oct) and reaches its peak during dry season (Nov-May).



Stem borer incidence in different months in Badeggi, Nigeria.

The insects of major importance were *Maliarpha separatella* Ragonot (about 70% of total borers collected) and *Chilo* spp. □

Biology of the white leafhopper on rice

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The white leafhopper (WL) *Cofana spectra* (Distant) is becoming an important rice pest in Tamil Nadu. It causes stunting and yellowing of plants, and severe infestations cause plant death. We studied the biology of *C. spectra* at the Paddy Breeding Station, Coimbatore, on potted TN1 rice plants. An average of 50 insects were observed for each parameter. The findings are summarized in the table.

Biology of *Cofana spectra* on rice, Coimbatore, India.

	Max	Min	Mean	S. D.
Egg				
Length (mm)	1.29	1.07	1.19	0.07
Width (mm)	0.39	0.31	0.35	0.01
No./cluster	19.0	5	10.84	3.46
Period (d)	10.0	9.5	9.6	0.27
Nymphal duration (d)				
Stage 1	9.0	7.0	8.4	0.81
Stage 2	6.0	3.0	4.7	0.73
Stage 3	7.0	4.0	5.4	0.75
Stage 4	8	5.0	6.7	1.18
Stage 5	3	1.0	2.7	0.66
Total	33	25.0	27.5	1.93
Sex ratio (female:male)	–	–	1:0.99	–
Fecundity (no. of eggs laid)	52	36	43.8	5.16
Adult longevity (d)				
Female	13	8	10.5	1.46
Male	9	5	7.1	1.19

Stenchaetothrips biformis (Bagnall): correct name for rice thrips

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Rice thrips, a serious pest of young rice plants, is often referred to by incorrect names. Recent literature has used *Baliothrips biformis* (Bagnall).

Two leading authorities on world Thysanoptera, Bhatti and Mound (1980, Bull. Ent., 21:1-22), have transferred *biformis* to the genus *Stenchaetothrips* and used that genus in subsequent publications. *Stenchaetothrips biformis* (Bagnall) is the correct name for rice thrips. Frequently used names for rice thrips such as *Bagnallia bifomis* Bagnall, *Thrips oryzae* Williams, *Thrips holorphnus* Karny, *Chloethrips blandus* zur Strassen, and *Thrips dobrogensis* Knechlet should not be used. □

Comparative cytology of brown planthopper populations infesting *Leersia hexandra* Swartz and rice in the Philippines

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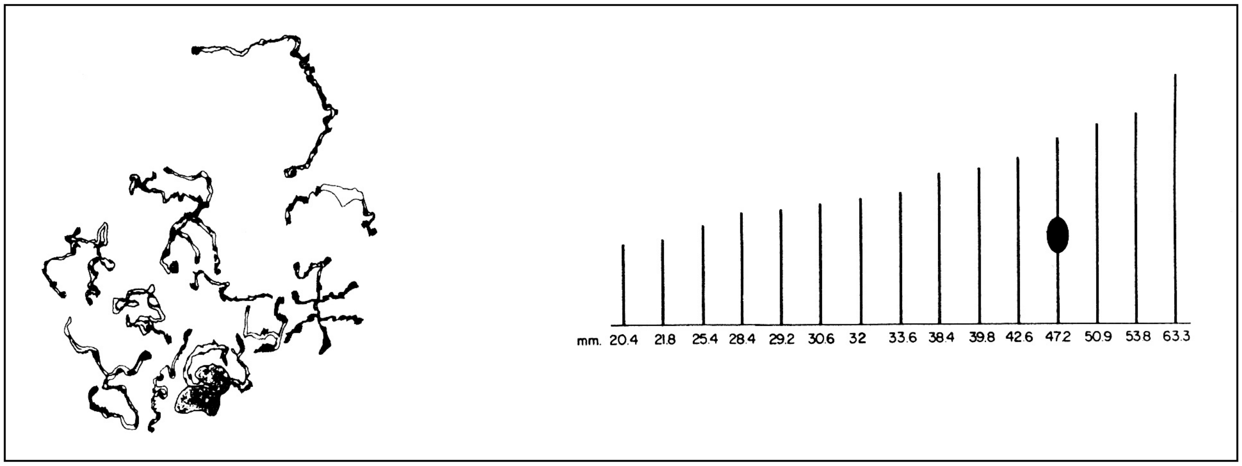
A brown planthopper (BPH) *Nilaparvata lugens* (Stål) population was observed thriving on a weed grass, *L. hexandra,* growing on the IRRI experimental farm. The BPH population was unique in its strong specificity for the weed host. Individuals died when caged on rice *Oryza sativa* L. plants.

Morphological and morphometric evaluation of rostral, leg, and antennal characters of grass-infesting individuals

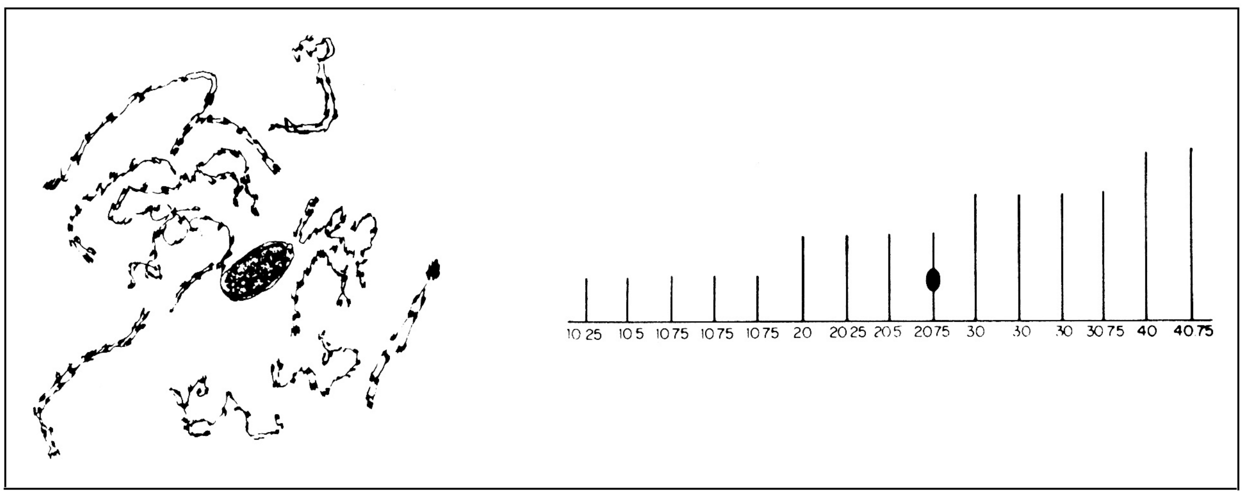
Table 1. Cytological variations in BPH populations infesting rice and grass hosts, IRRI, 1982-83.

Character	Grass-infesting BPH			Rice-infesting BPH			Difference[a]	
	n	$\bar{x}$	SEM	*n*	$\bar{x}$	SEM		
Meiotic cells (no.)	15	81	13.8	15	241	14.5	–160	**
Nonmeiotic cells (no.)	15	89	13.4	15	193	52.7	–104	ns
Meiotic index	15	0.489	0.0365	15	0.651	0.0517	– 0.162	*
Interphase nuclei								
Length (µ)	20	9.7	0.22	20	9.4	0.15	0.3	ns
Width (µ)	20	7.6	0.28	20	6.8	0.25	0.6	*
Leptotene nuclei								
Length (µ)	15	38.2	1.39	15	20.1	1.14	18.1	**
Width (µ)	15	30.6	1.08	15	14.3	0.86	16.3	**
Anaphase I clumps								
Pole A length (µ)	11	11.1	0.89	11	9.8	0.31	1.3	ns
Pole A width (µ)	11	4.9	0.57	11	4.2	0.33	0.1	ns
Pole B length (µ)	11	10.3	0.66	11	9.0	0.43	1.3	ns
Pole B width (µ)	11	4.7	0.59	11	4.6	0.24	0.1	ns
Telophase I clumps								
Pole A length (µ)	15	7.7	0.39	14	6.1	0.41	1.6	**
Pole A width (µ)	15	4.8	0.34	14	4.3	0.29	0.5	ns
Pole B length (µ)	15	7.7	0.41	14	6.1	0.35	1.6	**
Pole B width (µ)	15	5.0	0.30	14	4.3	0.32	0.7	ns
Sperm length (µ)	25	25.1	0.56	25	12.9	0.22	12.2	**

[a] ns = no significant difference, * = significant at 5% level, ** = significant at 1% level.



1. Karyotype (1500 X) and idiogram (mm) of rice-infesting *N. lugens,* IRRI, 1982-83.



2. Karyotype (1500 X) and idiogram (mm) of grass-infesting *N. lugens.* IRRI, 1982-83.

indicated that the population was significantly different from populations of biotypes 1, 2, and 3. We categorized the grass-infesting population as a primitive, nonvirulent *N. lugens* biotype. To further ascertain its taxonomic status, we studied its cytology and compared it with that of the field population of rice-infesting BPH.

The testicular cells of brachypters sampled from grass and rice hosts were examined using the standard cytological techniques for planthoppers (Table 1).

The two BPH populations differed significantly in frequency of actively dividing cells or meiocytes, meiotic index, width of interphase nuclei, length and width of leptotene nuclei, lengths of telophase I clumps, and sperm lengths, but not in other cellular features (Table 1). Male rice BPH undergo more frequent meioses and yield more but shorter spermatozoa than the male of the grass-infesting BPH.

Substantial variation between BPH populations was observed during the pachytene stage ('Table 2). Karyotypes and idiograms of the two BPH populations show clear individual chromosomes of different relative mean lengths (rml) (Fig. 1, 2). For instance, the chromosome with the nucleolus organizing region (site of ribosomal RNA synthesis) measured 47.20 mm for the rice BPH vs 20.75 mm for the grass-infesting BPH. The rice BPH generally had longer chromosomes (rml 20.40 to 63.30 mm) than the grass-infesting BPH (rml 10.25 to 40.75 mm). The nucleolar organelle of the rice BPH was either a darkly stained body or two fused nucleoli, whereas that of the grass-infesting BPH was simply a densely stained ovoid body.

Chromosomal behavior was similar for both populations, except that the intensive coiling of the rice BPH chromosomes during diakinesis resulted in shorter and more highly heterochromatic chromosomes than those of the grass-infesting BPH (Table 3).

Table 2. Variations in the mean relative lengths of pachytene chromosomes of BPH populations infesting rice and grass hosts, IRRI, 1982-83.

Autosome no.	Mean relative length (mm) of pachytene chromosomes				
	Grass-infesting BPH		Rice-infesting BPH		Difference[a]
	$\bar{x}$	SEM	$\bar{x}$	SEM	
1	10.0	0.00	18.0	1.61	– 8.0**
2	10.3	0.21	22.3	1.26	–12.0**
3	10.4	0.27	25.3	1.17	–14.9**
4	10.4	0.27	28.2	1.89	–17.8**
5	11.0	0.36	29.5	1.56	–18.5**
6	20.0	0.00	30.7	1.43	–10.7**
7	20.3	0.21	32.7	1.84	–12.4**
8	20.5	0.22	35.3	0.80	–14.8**
9	21.0	0.06	38.4	1.87	–17.4**
10	30.0	0.00	40.3	1.82	–10.3**
11	30.0	0.00	42.7	1.71	–12.7**
12	30.2	0.17	47.5	2.20	–17.3**
13	30.8	0.17	51.2	2.33	–20.4**
14	40.0	0.00	54.5	2.79	–14.5**
15	40.7	0.21	64.2	2.31	–23.5**

[a] ** = significant at 1% level, av of 6 samples.

Table 3. Variations in the means of absolute chromosome length during diakinesis of BPH populations infesting rice and grass hosts, IRRI, 1982-83.

Autosome no.	Absolute chromosome length (μ)				
	Grass-infesting BPH		Rice-infesting BPH		Difference[a]
	$\bar{x}$	SEM	$\bar{x}$	SEM	
1	1.6	0.13	1.4	0.07	0.2ns
2	1.9	0.18	1.6	0.07	0.3ns
3	2.1	0.18	1.8	0.06	0.3ns
4	2.3	0.15	2.0	0.00	0.3**
5	2.5	0.17	2.1	0.05	0.4ns
6	2.8	0.17	2.3	0.08	0.5*
7	3.0	0.18	2.4	0.10	0.6*
8	3.2	0.19	2.7	0.08	0.5*
9	3.4	0.20	2.8	0.09	0.6*
10	3.7	0.18	3.0	0.10	0.7**
11	3.9	0.18	3.4	0.12	0.5*
12	4.4	0.23	3.5	0.13	0.9**
13	4.8	0.25	3.7	0.08	1.1**
14	5.4	0.28	4.2	0.12	1.2**
Sex chromosomes	3.8	0.12	3.1	0.15	0.7**

[a] ns = no significant difference, * = significant at 5% level, ** = significant at 1% level, av of 15 samples.

Those cytological criteria may be used as complementary taxonomic indices for characterizing and differentiating grass-infesting BPH from rice BPH. These observations further confirm the uniqueness of the grass-infesting population and justify its categorization as an additional *N. lugens* variant or biotype. Thus, despite their taxonomic similarities, a distinct cytological incongruity and a certain degree of genetic isolation between the two *N. lugens* populations can be inferred. □

Efficacy of nursery protection and seedling root dip for gall midge control

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In Goa, gall midge (GM) *Orseolia oryzae* is a serious insect problem, especially in kharif. We attempted to develop an inexpensive control.

In 1981 kharif, we used susceptible Jaya to test eight treatments: a) carbofuran alone (1.25 kg ai/ha), b) 500 kg neem cake/ha + carbofuran, c) 1,000 kg neem cake/ha + carbofuran, d) 1,500 kg neem cake/ha + carbofuran, e) 2,000 kg neem cake/ha + carbofuran, f) treatment a + chlorpyrifos 0.02% seedling root dip in 1% urea solution for 3 h at planting, g) treatment a + chlorpyrifos 0.02% seedling root dip for 12 h at planting, and h) control. Neem cake and carbofuran granules were applied in the nursery at 20 days after sowing (DS) and water was impounded until seedlings were pulled and planted at 27 DS.

The comparative efficacy of different treatments was rated by GM damage and the grain yield (see table).

The carbofuran nursery treatment + chlorpyrifos seedling root dip was superior to nursery treatments with carbofuran alone or a combination of carbofuran and neem cake for controlling GM and encouraging higher grain yield. Irrespective of the combination of nursery treatments, neither carbofuran alone nor in combination with neem cake, even at 2,000 kg neem cake/ha, affected GM. Nursery treatment with carbofuran at 1.25 kg ai/ha + chlorpyrifos 0.02% seedling root dip for 12 h before planting provided best and most economic control. □

Effect of different treatments on GM damage and rice grain yield at 50 DT.[a]

Treatment	Gall midge damage (%)	Productive tillers/hill	Grain yield (t/ha)
Carbofuran 1.25 kg ai/ha	35 c	5.4 b	2.7 d
Carbofuran + 500 kg NC/ha	34 c	5.4 b	2.6 d
Carbofuran + 1000 kg NC/ha	35 c	5.4 b	2.5 d
Carbofuran + 1500 kg NC/ha	41 c	5.3 b	2.9 c
Carbofuran + 2000 kg NC/ha	35 c	5.6 b	2.8 cd
Carbofuran + RD with chlorpyrifos 0.02% in 1% urea solution for 3 h at planting	22 b	6.8 a	3.8 b
Carbofuran + RD with chlorpyrifos 0.02% for 12 h at planting	8 a	6.9 a	4.0 a
Control	42 c	4.0 c	2.1 c

[a]In a column, data with common letters are not significantly different at 5% level. NC = neem cake, DT = days after transplanting, RD = root dip.

Characterization of the brown planthopper population on IR42 in North Sumatra, Indonesia

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Rice resistance to brown planthopper (BPH) is an important component in the integrated management of BPH in Indonesia. However, new BPH biotypes that defeated resistance traits of some rice varieties have evolved.

Drastic shifts of BPH biotypes that have occurred in North Sumatra, a BPH epidemic area in Indonesia, have followed shifts in rice varieties planted. Biotype 2 developed in 1977 on IR26, which has the *Bph 1* gene. Until 1981, that biotype was effectively suppressed by IR36, which has the *bph 2* gene. However, recently introduced IR42 with the *bph 2* gene was damaged by a new biotype.

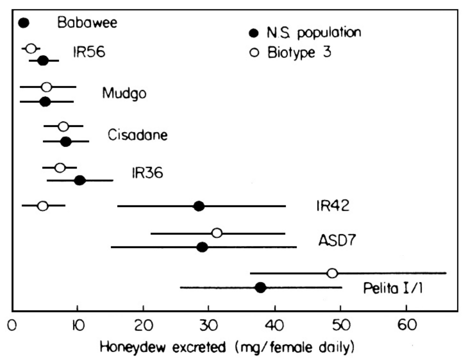
We compared the BPH population collected from IR42 in North Sumatra (hereafter the N. S. population) with that of the known biotypes by two honeydew tests: one with filter paper and one with parafilm envelopes. The N. S. population was reared for about 20 successive generations on IR42 at the Bogor Food Crops Research Institute. Biotypes 1, 2, and 3 have been maintained as isolated inbred populations on Pelita I/1, Mudgo, and ASD7, respectively, since 1977.

Relative amounts of honeydew excreted by 4 BPH biotypes on 7 rice varieties, 1983.[a]

Variety	Honeydew[a]			
	Biotype 1	Biotype 2	Biotype 3	N.S.[b]
TN1	19.0	18.5	17.7	10.2
Pelita I/1	21.8	15.6	16.5	10.4
IR26	3.8	14.9	2.6	4.1
Cisadane	±	±	4.8	3.6
IR42	±	±	3.6	11.1
IR36	±	±	±	2.1
IR56	±	±	±	±

[a] Five adult females were confined on a plant at about 30 days after transplanting for 22 hours at room temperature. Values indicate the areas of water blue filter paper impregnated with honeydew in cm^2 (av of 3 replications). Excretion of only a small number of droplets is indicated by ±. [b]North Sumatra population.

Table 1 shows estimates by the filter paper method of the relative amounts of honeydew excreted by adult females of the three biotypes and the N. S. on selected rice varieties. The N. S. population was differentiated from biotype 2 by a poor ability to feed on IR26, and from biotypes 1 and 3 by an improved ability to feed on IR42 (see table). N. S. feeding characteristics were further confirmed by the parafilm envelope method and compared to those of BPH biotype 3. The N. S. population excreted as much honeydew on *bph 2*-resistant varieties ASD7 and IR42 as on susceptible variety Pelita I/1, but excreted strikingly less honeydew on Babawee, IR56, Mudgo, Cisadane, and IR36 (see figure). This indicated that the N. S. population belongs to biotype 3, which has specific ability to feed on *bph 2*-resistant varieties.



Means and 95% confidential ranges of the amount of honeydew excreted by adult females of the N. S. population and biotype 3 at Bogor on 8 rice varieties at about 45 days after transplanting. About 20 insects were used for each variety, 1983.

However, the N. S. population has a significantly higher ability to feed on IR42 than does biotype 3 at Bogor. N. S. insects excreted nearly 30 mg honeydew/female per d, while those from the biotype 3 culture excreted only 5 mg (see figure). These different BPH responses seem to indicate that there are different genetic factor(s) in each host variety that cause a distinct reaction to IR42 on each biotypic population, although IR42 and ASD7 have been said to possess the same *bph 2* gene. □

Life history and plant host range of the rice green semilooper

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We used a greenhouse mass-rearing technique to study the life history of the rice green semilooper *Naranga aenescens* Moore. Development from egg to adult takes 18-21 d. Eggs are laid either singly or in clusters of 2-13 and hatch in 3-4 d. Larvae undergo 5 instars over 12-13 d, pupation takes 3-4 d, and adult moths live 5-6 d.

Of the 19 plant species tested, *Leersia hexandra* and *Echinochloa indica* were equally suitable to rice as hosts, but more eggs were laid on rice in a no-choice test (see table). Complete egg-to-adult development but low survival occurred on *Cyperus diffusa, Paspalum conjugatum, Paspalum paspalodes, Leptochloa chinensis, Echinochloa colona,* and sorghum. Larvae died during the first and second stadia in *Cyperus difformis, Echinochloa glabrescens, Fimbristylis littoralis, Panicum repens, Rottboellia exaltata, Imperata cylindrica, Commelina diffusa, Paspalidium flavidum, Cyperus rotundus,* and maize. □

Comparison of 16 weed and 3 crop species as *Naranga aenescens* host.[a]

Plant species	Eggs laid[b] (no./female)	Larval development (d)	Pupal development (d)	Egg-to-adult survival (%)
Oryza sativa (rice)	454 a	14 a	4.3 ab	44 a
Leersia hexandra	66 bcde	13 a	4.3 ab	56 a
Eleusine indica	22 de	13 a	6.3 bc	36 a
Paspalum paspalodes	121 bc	19 a	3.3 a	5 b
Cyperus diffusa	112 bc	26 b	4.7 abc	3 b
Sorghum bicolor (sorghum)	60 bcd	15 a	11.7 d	7 b
Paspalum conjugatum	36 bcde	26 b	6.7 c	3 b
Echinochloa colona	97 bc	25[c]	5.0[d]	1 b
Leptochloa chinensis	14 ef	15[c]	5.0[d]	5 b
Imperata cylindrica	161 ab	[e]		
Rottboellia exaltata	140 bc	[e]		
Echinochloa glabrescens	136 abc	[e]		
Paspalidium flavidum	82 bcd	[e]		
Panicum repens	53 bcde	[e]		
Zea mays (maize)	52 bcde	[e]		
Cyperus rotundus	45 de	[e]		
Commelina diffusa	30 cde	[e]		
Fimbristylis littoralis	9 fg	[e]		
Cyperus difformis	2 g	[e]		

[a]Vegetative-stage plants were used. Av of 3 replications, 1 moth pair/cage (replication). In a column, means followed by a common letter are not significantly different (P = 0.05). [b]No-choice test as one plant species/cage. [c]Larval development attained in one replication only; not included in statistical analysis. [d]Pupal development obtained only in one out of 3 replications; not included in statistical analysis. [e]Larvae died during first instar.

Influence of weather on populations of rice white leafhopper in light traps

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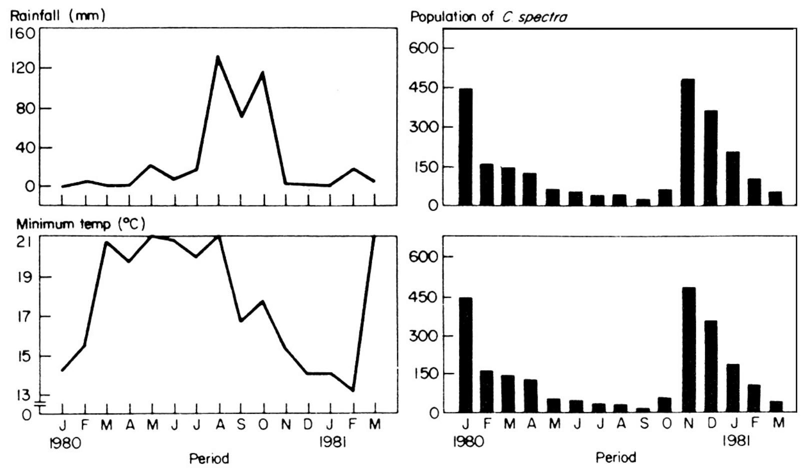
A modified Robinson's light trap with a 125-W mercury vapor lamp was used to trap white leafhopper (WL) *Cofana spectra* (Distant) at the Paddy Breeding Station, Coimbatore, for 15 mo. Daily number of trapped WL was recorded as well as maximum and minimum temperature, relative humidity, and total rainfall. There was a highly significant negative



Association between light trap population of *C. spectra* and minimum temperature and rainfall. Light trap population represents total adults trapped in 4 wk.

Table 1. Relation between light trap catches of *C. spectra* and weather factors.

Weather factor	*r* value[a]
Max temp	–0.179
Min temp	–0.628**
Relative humidity	–0.147
Total rainfall	–0.270*

[a] *Significant at 5% level, **significant at 1% level.

Table 2. Partial regression coefficients, standard error and proportional contribution of weather factors to regression of light trap population of *C. spectra*.

Weather factor	Partial regression coefficient	Standard error	Proportional contribution to R^2 (%)
Max temp	–7.816	6.468	2.42
Min temp	–26.365**	4.960	36.16
Relative humidity	–4.558	3.183	2.34
Total rainfall	–0.575	0.560	3.17

Constant term 'a'= 1305.255, R^2 = 0.4411. **Significant at 1% level.

relation (r = −0.628** between minimum temperature and WL population (Table 1, figure). A significant negative relation (r = −0.27*) existed between total rainfall and WL population.

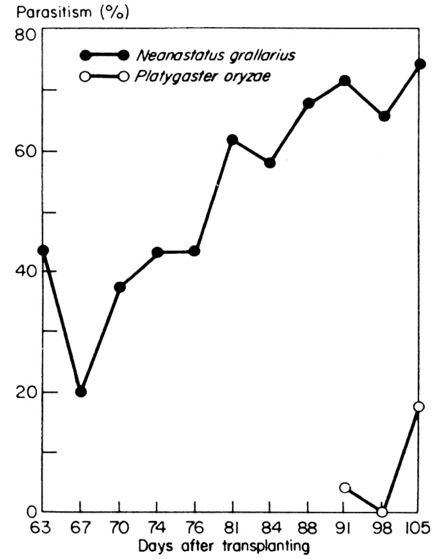
The partial regression coefficient and the proportional contribution of the different weather factors on the light trap WL population are in Table 2. Minimum temperature affected WL population most. □

Parasitization of gall midge by *Neanastatus grallarius* (Masi)

K. Potineni and R. K. Agarwal, Entomology Department, College of Agriculture, Raipur, M.P., India

Rice gall midge (GM) *Orseolia oryzae* (Wood-Mason) was heavily parasitized by two chalcid parasites — *Neanastatus grallarius* (Masi) and *Platygaster oryzae* (Cameron) — in the GM-endemic area, College of Agriculture, Raipur, during 1981 kharif.

Parasitization ranged from 21 to 94% when 75 midges were observed each day in Oct and Nov. *N. grallarius* (Hymenoptera: Eupelmidae) parasitized GM pupae 1 mo earlier than *P. oryzae* and was present through the third week of Nov, peaking at 75% parasitism (see figure). This is the first record of heavy parasitization of GM by *N. grallarius* in India. □



Parasitism of chalcids on rice gall midge, Raipur, India.

Pest management and control NEMATODES

Nursery application of carbofuran for control of rice root nematode

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Rice root nematode *Hirschmanniella oryzae* causes substantial economic losses in lowland rice areas. The nematode damages the crop in the nursery and in the field. In 1981-82 samba we compared a nursery application of carbofuran 3% G broadcast at 1.275 kg ai/ha for control of rice root nematode with an untreated plot in a randomized block design with 16 replications in Panayapuram and Rachandarthirumalai villages of Tiruchi, Tamil Nadu.

Ponni and IR20 were planted in 3.75- × 2.5-m flooded plots at 15- × 10-cm spacing. Ponni was transplanted at 40 d and IR20 at 30 d. Carbofuran was applied 7 d before transplanting. Root samples were collected from the nursery by pulling 10 plants, at random, before pesticide application and at transplanting. Samples were taken from the field 15, 30, and 60 d after transplanting and just before harvest.

Nematode population was estimated by the Baermann pan technique using 5 g root/sample. The nematode population data were analyzed after $\sqrt{x + 0.5}$ transformation. Grain yield was recorded. Results of the pooled analysis of infestation and yield are in the table.

Carbofuran application significantly reduced the rice root nematode population in the nursery and up to 30 d after transplanting. □

Rice root nematode population[a] and grain yield after carbofuran application, Tiruchi, India.[b]

Treatment	Nematode population/5-g root						Grain yield/plot (kg)
	Nursery		Days after transplanting			Before harvest	
	Before treatment	7 DAT[c]	15	30	60		
	Panayapuram						
Carbofuran 3% G, 1.275 kg ai/ha	11.09	0.70	5.67	7.26	12.50	14.43	7.5
Untreated control	11.23	13.91	14.30	16.44	14.82	15.00	6.9
	Rachandarthirumalai						
Carbofuran 3% G, 1.275 kg ai/ha	6.39	0.70	3.69	6.02	12.90	15.90	4.6
Untreated control	6.18	7.14	8.51	13.53	14.98	16.43	4.4
C. D. for population, 2.66	C. D. for yield, 0.196						

[a]Transformed values. [b]Mean for 16 replications. [c]Days after treatment.

Pest control and management OTHER PESTS

Rat activity in the deepwater rice area of Bangladesh

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Rats are serious pests of deepwater rice (DWR) in Bangladesh. In Apr to Dec 1982, we surveyed DWR areas of Tangail, Narsingdi, Manikganj, and Daudkandi to learn more about rat activity. In addition to DWR, boro rice and rabi crops — wheat, watermelon, and bitter gourd — are grown in these areas.

Rat activity was measured by counting active rat burrow openings and recording the presence or absence of rat damage in preflood, flood, and postflood periods in fields and along shoulders of the highways that bisect the areas. Snap traps were used to catch rats for species identification. Three 1,500-m^2 plots were surveyed at each site during each crop season. Plots were 15-100 m from the highway.

Bandicota bengalensis was the only rat species trapped. During preflood (Apr to mid-Jun) rats were found on highway shoulders and in all fields, but activity was concentrated in fields with boro rice and rabi crops (see table). Rats used highway shoulders as their main shelter during flood time (mid-Jun to Sep) and attacked floating DWR plants from there. When floodwater receded, they moved back to the dry DWR fields and made burrows, where they stored ripe rice panicles. The study suggests that rat damage could be effectively reduced by using poison baits and rat traps on highway shoulders during the flood. □

Rat activity in deepwater rice areas in Bangladesh during preflood, flood and postflood periods, BRRI, 1982.[a]

Site	Preflood					Flood[b]		Postflood		
	Burrow openings/ha			Rat damage		Burrow openings/ha	Rat damage in	Burrow openings/ha		Rat damage in
	Highway shoulders	DWR fields	Boro and rabi crop fields	DWR fields	Boro and rabi crop fields	Highway shoulders	DWR fields	Highway	DWR	DWR fields
Tangail	2	2	42	–	+	106	+	4	162	+
Narsingdi	0	0	57	–	+	131	+	0	182	+
Manikganj	0	6	53	–	+	151	+	2	215	+
Daudkandi	4	0	46	–	+	86	+	0	141	+
Mean	1.5	2.0	49.5			118.5		1.5	177.5	

[a]Rat activity was measured by counting active rat burrow openings and by checking the presence (+) or absence (–) of rat damage. [b]Deepwater rice fields had 1-2.4 m water during flood time.

Irrigation and water management

Water use and costs of irrigating rice in Southwest Louisiana

Michael E. Salassi, graduate research assistant, Agricultural Economics Department, Mississippi State University, Mississippi, USA

Southwest Louisiana is a major rice producing area in the United States. Topography is flat with poor surface and internal drainage. Generally, one rice crop is grown annually. Soils range from fine-textured, poorly drained clays in marshlands to coarser-textured, moderately well-drained silt loams along the northern and eastern fringes of the rice area.

An impervious subsoil 30 to 45 cm below the soil surface and a slow rate of surface water runoff cause poor soil aeration and a low soil moisture supply capacity. Rice irrigation wells are 75 to 100 m deep.

We conducted a survey to obtain data on water use and costs for rice irrigation from wells in southwest Louisiana. Specifications and annual volume of water pumped are in Table 1. The annual volume of water pumped — 736.7, 919.2, and

Table 1. Specifications and water use of representative rice irrigation wells in southwest Louisiana, 1982.

Well type	Diameter (cm)	Av well depth (m)	Flow rate (liters/s)	Average area irrigated (ha)	Annual volume of water pumped (million liters)
I	20.3	91.4	126.2	80.9	736.7
II	25.4	91.4	157.7	101.2	919.2
III	30.5	91.4	220.8	141.6	1,287.7

Table 2. Total annual irrigation costs/ha for rice utilizing different power sources, southwest Louisiana, 1982.

Well type	Annual irrigation costs (US$)			
	Diesel	LP gas	Natural gas	Electricity
I	50.96	50.46	35.59	25.45
II	50.31	49.88	34.84	24.77
III	48.05	47.99	32.99	23.11

1,287.7 million liters, respectively — was based on a gross estimate of about 92 cm of irrigation water applied to rice fields throughout the growing season.

Total annual irrigation costs were estimated for different power sources (Table 2). Diesel and LP gas were the most expensive fuels. Electricity was the least expensive. □

Soil and crop management

Urea supergranule for alternately wet and dry fields

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Efficiency of applied nitrogen fertilizer must be increased. Recent International Network on Soil Fertility and Fertilizer Evaluation for Rice studies proved that deep placing urea supergranules (USG) at low doses in rice increased nitrogen efficiency in most soils. We tested USG deep placement in fields that are continuously flooded and alternately wet and dry. Rice was planted late in a split-plot design with four replications on a silt loam soil (Aquic Hapludoll).

Deep point placement was superior to urea best split application under recommended water management (0 to 5 cm flooding) for timely and late planting. However, brown planthopper damage to the timely crop reduced the advantage of deep placed USG over broadcast urea.

When fields were intermittently wet and dry, rice yield was reduced for both fertilizer application methods. In this experiment, deep placement of USG had no advantage over broadcast application in alternatively wet and dry fields (see table). Work on this subject is continuing.

Effect of method of urea application, water management, and planting dates on yield of rice variety Jaya, Pantnagar, India, 1982 rainy season.

Management condition	Grain yield[a] (t/ha)	
	USG	Urea
Timely transplanting (at 25 days)		
Flooding (0-5 cm water)	5.3[b]	4.9[b]
Alternate wetting and drying	4.6	4.3
Late transplanting (at 50 days)		
Flooding (0-5 cm water)	5.8	4.7
Alternate wetting and drying	4.6	4.2
Mean	5.1	4.5
LSD 5% USG as urea	0.3	
CV	8%	

[a]USG = deep point placement, urea = split broadcast. [b]Brown planthopper reduced yield about 15% in USG and 10% in urea treatment (estimate).

Integrating brackish water aquaculture with rice cultivation on coastal saline soils

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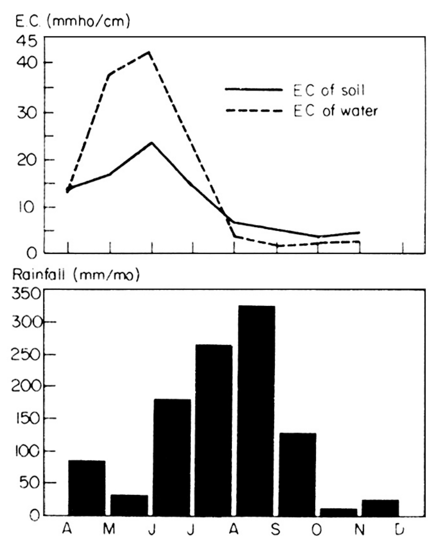
Only one rice crop, usually during kharif, is grown in areas with coastal saline soils in India. Land usually remains fallow for the rest of the year because of high soil salinity and lack of good irrigation water. We studied the efficiency of short-term brackish water aquaculture during the summer fallow assisted by saline tidal water from nearby estuaries and its effect on the yield of the subsequent kharif rice crop. Possible freshwater aquaculture was also studied.

We used two 0.01 5-ha rice plots at the RRS, CSSRI, Canning, on a low-lying coastal area of West Bengal. In Apr 1982 rice plots were filled with saline tidal water from the nearby river using a sluice gate. Brackish water aquaculture of tiger prawn (*P. monodon*) and mullet (*L. parsia*) was managed for 86 d, until Jun 1982. Aquaculture yielded an average 0.65 t of fish and prawn/ha (see table). Water salinity of the culture system varied from 12.5 to 40.0 mmho/cm, which increased soil salinity from 7.8 mmho/cm



Salinity cycle in brackish water rice and fish culture system.

Production of integrated rice culture and aquaculture on saline coastal soils in West Bengal, India, 1982.

Production (t/ha)			
Summer fallow period Apr- Jun 1982		Kharif, Sep-Nov 1982	
		CSR1	3.12
		SR 26 B	3.20
		Assam (S)	2.88
Brackish water fish and prawn	0.65	Freshwater fish and prawn	0.51

to 24 mmho/cm (see figure).

After the aquaculture harvest, monsoon precipitation (av 1,750 mm/yr, of which 80% occurs from Jun to Sep) lowered soil salinity through runoff and leaching. However, late, low precipitation during 1982 delayed soil desalinization. ECe had dropped to 7 mmho/cm by Aug, when one-month-old seedlings of CSRl, SR26B, and Assam (S) were transplanted in each plot. Standard cultivation practices were followed. As the monsoon continued, ECe declined to an average between 4.8 and 5.8 mmho/cm for the rice growing season. During the rice season, plots were used to grow some freshwater fishes and prawns (*L. rohita, C. catla, C. mrigala, H. molitrix,* and *M. rosenbargii*), stocked at 23,500/ha.

Rice was harvested in late Nov 1982. Average yield was 3.1 t/ha. Fishes and prawns, harvested at the same time, yielded 0.5 1 t/ha after 83 d of growth (see table).

Integrating brackish and freshwater aquaculture with rice culture on saline coastal soils yielded 1.16 t fish and prawn/ha and did not reduce rice yield. ☐

Nitrogen requirement of rice nurseries

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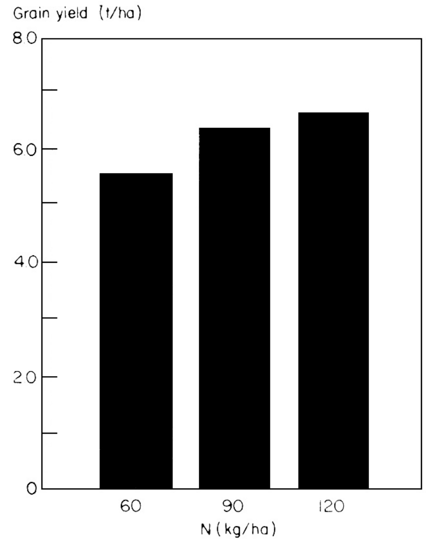
Recent experiments show that modern varieties can be transplanted, without yield loss, as late as 60 d after nursery establishment, or about 30 d older than is generally recommended. Maintaining nurseries for that length of time brings increased fertilizer requirements. We studied the nitrogen requirements of rice nurseries at PAU farm in 1981 and 1982.

Soil was loamy sand (Typic Ustochrept) with pH 8.4; low organic carbon. 0.23%; and 87-8-86 kg available NPK/ha. Nitrogen was applied as urea at 60, 90, or 120 kg/ha in 3 equal splits: at sowing, and at 15 and 30 d after sowing. Ten kg P and 15 t farmyard manure/ha were applied basally. Nurseries were grown on 10- x 2-m beds planted with 1 kg seed. Nursery health was evaluated visually and by measuring seedling height and dry matter production.

Ninety and 120 kg N/ha produced better growth and healthier seedlings, but results of those 2 treatments did not differ.

Forty-five-day-old seedlings grown at different nitrogen levels were evaluated for yield. Seedlings were transplanted and received recommended doses of 120-26-25 kg NPK/ha. Data show that the nursery grown with 90 kg N/ha yielded 600-700 more rice than the nursery that received 60 kg N/ha (see figure). Yields for 90 and 120 kg N/ha did not differ. ☐



Effect on rice yield of N levels applied to the nursery, 1981-82.

Folcystein as a biostimulant in rice production

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We evaluated the yield biostimulant folcystein, derived from L-cystein with 50 g ai/liter and 1.0 g folic acid/liter, for drilled lowland rice at Culiacan Experiment Station (CAEVACU), Mexico. A foliar spray of folcystein was applied 80 d after seeding (1 wk after panicle initiation) at concentrations of 0, 200, 400, 500, 800, and 1000 ml/ha, equivalent to 50 mg ai/ml derived from L-cystein and 1 mg folic acid/ml, in a randomized block design with 3 replications.

Table 1. Effect of different levels of folcystein on rice yield, 1976.

Folcystein (ml/ha)	Treatment mean [a] (t/ha)
400	7.2 a
800	6.1 a
1000	5.8 a
600	5.0 b
200	4.9 b
0	4.8 b

[a] Av of 3 replications. Any two means having a common letter are not significantly different at 5%. level. $S\bar{x}$ = 496.95

Plots were 4.5 m^2 with five 6-m rows with 25 cm within-row spacing. Local variety Bamoa A75, with 130 d duration, was seeded at 80 kg/ha. Urea 46%, N was

Table 2. Doses and timing of application of folcystein, treatment mean, and statistical significance, 1982.

Doses (ml/ha) and timing of application [a]	Treatment no.	Treatment mean [b] (t/ha)
400 E_1	3	5.9 a
200 E_1	2	5.7 ab
200 E_2	7	5.6 ab
400 E_2	8	5.5 ab
600 E_1	4	5.3 b
800 E_2	10	5.2 b
600 E_2	9	5.1 b
0.0 E_1	1	5.1 b
0.0 E_2	6	5.1 b
800 E_1	5	5.0 c

[a] E_1 = maximum tillering (45 days after seeding [DS]); E_2 = panicle initiation (75 DS). [b] Av of three replications. Any two means having a common letter are not significantly different at 5% level. $S\bar{x}$ = 189.5 kg.

broadcast at 100 kg N/ha 35 d after seeding (DS) and at 50 kg N/ha 65 DS.

A second evaluation of folcystein in summer 1982 tested doses of 0, 200, 400, 600, and 800 ml/ha, applied at maximum tillering and at panicle initiation. The experiment was in a randomized complete block design with three replications. Plot size was 4.5 m^2. Local recommended variety Culiacan A82 (135 d duration) was seeded at 140 kg/ha. Nitrogen fertilization was the same as in the first trial.

In the first trial, the 400 ml dose increased yield the most (Table 1). Analysis of variance showed there were statistical differences between doses (D), and nonsignificant difference for timing of application (E) and the interaction D × E, for the second trial. The indication is that folcystein could be applied at any of the two times. Three statistical groups were formed based on Duncan's Multiple Range Test (Table 2).

Although treatments 3, 2, 7, and 8 belong to the same group, in terms of yield and income after subtracting cost of the product and aerial application, the dose of 400 ml/ha at E_1 is the best choice, and is an effective yield stimulator. □

Environment and its influence

Seasonal influence and effect of growth regulators on rice spikelet sterility

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We studied the influence of seasons and growth regulators on spikelet sterility in rice *Oryza sativa* L. in field trials at CRRI in 1977 rabi and kharif. Four modern rice varieties — Ratna, Pusa 2-21, Pallavi, and IET2233 — were grown in three replications in a split-plot design.

The following were applied as a foliar spray to the whole plant 3 d after anthesis: auxin H-61 (1:2000 concentration), 2,4-D (100 ppm), GA-3 (100 ppm), kinetin (100 ppm), and control (distilled water spray). The crop was grown under normal fertilization — 60-13-25 kg NPK/ha. Irrigation and plant protection were supplied when necessary.

Effect of growth regulators on spikelet sterility of 4 rices, 1977, Cuttack, India.[a]

Treatment	Sterility (%)							
	Ratna		Pusa 2-21		Pallavi		IET2233	
	K	R	K	R	K	R	K	R
Control	40.5	24.5	35.4	18.4	28.4	12.3	30.2	14.8
Auxin H-61	39.9	18.6	35.6	20.4	26.8	14.0	31.4	16.0
2,4-D	36.9	20.4	34.6	19.7	27.9	13.0	30.4	15.4
GA	41.5	24.6	36.2	19.7	29.1	13.1	31.8	15.3
Kinetin	26.3	16.7	26.4	16.8	20.9	10.4	25.4	12.7
Mean	37.4	21.7	34.2	19.0	26.9	12.9	30.0	15.1

	V		G		VG	
	K	R	K	R	K	R
SEM +	1.01	0.46	1.18	1.11	2.10	2.22
CD 5%	3.20	1.12	2.43	2.24	NS	4.49
CD 1%	5.88	1.71	3.28	3.00	NS	6.00

[a] K = kharif (wet), R = rabi (dry), V = variety, G = growth regulators.

Spikelet sterility was 92% higher in kharif than in rabi for the 4 varieties (see table). Ratna and Pusa 2-21 had higher sterility than IET2233 and Pallavi in both seasons.

Kinetin significantly reduced spikelet sterility of all varieties in both seasons and was significantly superior to other growth regulators. □

Announcements

IRRI-Tanzania sign technical and scientific cooperation agreement

The Government of Tanzania and IRRI have signed a memorandum of understanding that calls for a 5-year program of scientific and technical cooperation.

The objective is to enhance Tanzania's capabilities for research on rice and rice-based cropping systems. Priority will be on genetic evaluation and utilization of rice varieties appropriate to Tanzanian rice growing areas, development of improved rice-based farming systems to increase land use intensity and extend the rice growing area, training of Tanzanian scientists, and development and testing of appropriate machinery for small-scale farming.

Collaborative activities under the program will be based upon mutually agreed upon 2-year work plans to be developed by the Tanzanian Ministry of Agriculture and IRRI. Research, training, and rice production programs are priority items in the initial work plan. □

Book catalog

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Rice processing book

Rice processing in Peninsular Malaysia: an economic and technical analysis is the first comprehensive text to provide both an economic and technical analysis of the rice processing industry in Peninsular Malaysia. It describes rice milling, storage, drying, choice of techniques, and policy in concise and easy to understand terms. *Rice processing* is a useful supplementary text for undergraduate students of agricultural marketing, agricultural engineering, and food processing. It includes an extensive bibliography. Price is $25 for the paperback edition and $40 for the hardback. Order from Oxford University Press, Singapore Office, 10 New Industrial Road, Singapore 1953. □

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