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Contents

Style for IRRN Contributors

Units of measure and styles vary from country to country. 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 guidelines:

• 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, with small-scale studies, in grams per pot (g/pot) or grams per row (g/row).

• Define in footnotes or legends any abbreviations 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.

• 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 below10 except in a series containing some numbers 10 or 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.

• Type all contributions double-spaced. ■

Genetic evaluation and utilization

OVERALL PROGRESS

Performance of a male-sterile IR36/KN361 population in Thailand

Sommai Amonsilpa and Ben R. Jackson, Rice Division, Department of Agriculture, Bangkok, Thailand

Interest in male sterility of rice as a means of enhancing the recombination of genes for important quantitative characters and evaluation of hybrid vigor for yield has recently increased. Singh and Ikehashi (IRRN 4[3]:3 1979) reported the induction of a genetic male-sterile recessive mutant from treatment of IR36 with ethyleneimine at IRRI. A few male-sterile plants that showed normal meiosis with complete restoration of fertility in the F_1 were identified. Outcrossing with the male-sterile plants was reported to vary from 15 to 34%. This is the first report of the performance of this male-sterile source outside IRRI.

One hundred-twenty-one plants from a bulk seed population of the cross male-sterile IR36/KN361 obtained from IRRI in April 1979 were transplanted in a screenhouse at the Bangkhen Rice Experiment Station in the 1979 dry season. The purpose was to assess their performance and to begin incorporation of the male-sterile character into adapted Thai varieties.

Details of male sterility in individual plants were not carefully recorded but the following observations may interest rice breeders.

• Eleven panicles representing different plants were bagged before flowering; 7 of them produced no seed and the other 4 gave less than 5% seed set.

• The seed set of all 121 plants was estimated visually and by counting all the seeds produced by each plant. The seeds were classified as:

Highly sterile (0–100 seeds/plant)
Moderately sterile (101–1,000 seeds/plant)
Normal fertile (1,000–3,000 seeds/plant)

The proportions found for each classificationwere:

Highly sterile, 20 plants
Moderately sterile, 69 plants
Normal fertile, 32 plants

The easy recovery of highly sterile plants in a small population suggests that male sterility is a recessive character controlled by one or more genes. Many plants produced fewer than 10 seeds, which could have resulted from cross pollination. That suggests that rice breeders can incorporate male sterility into their own cultivars without undue difficulty. Through continuing studies we hope to obtain more precise data that will permit genetic analysis of male sterility under Thai conditions. ■

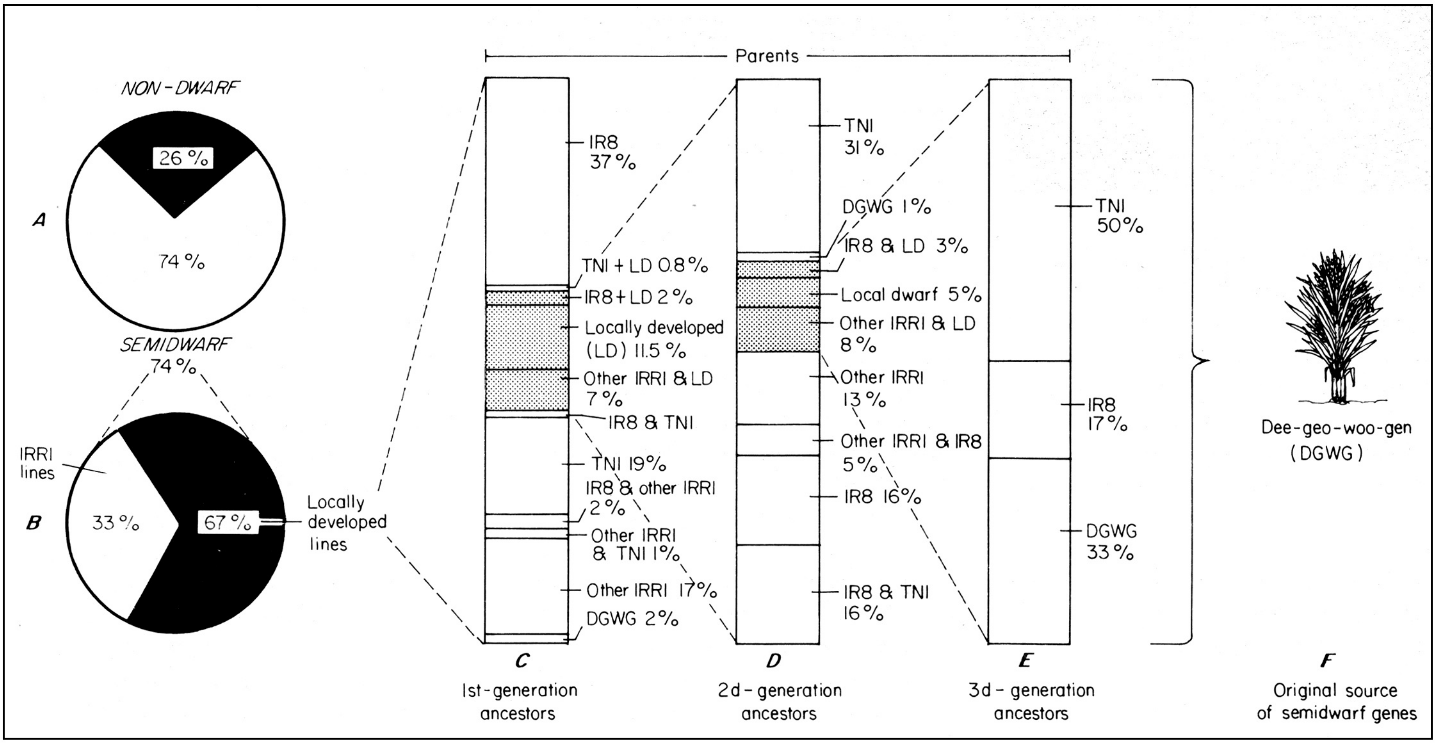
Sources of semidwarfism in locally developed varieties

T. R. Hargrove, editor, and V. L. Cabanilla, research assistant, Office of Information Services, International Rice Research Institute

A list of 370 improved rice varieties released in 36 countries in the post-IR8 era was compiled from records of the International Rice Genetic Survey (IRGS).

Seventy-four percent of the new varieties were semidwarfs. A third of the semidwarfs were IRRI lines or varieties released to farmers by national rice improvement programs; the other 183 cultivars were locally developed (LD) in national programs (see figure, A, B).

Using IRGS records we traced the ancestry of the 183 local semidwarfs, partly to determine the source of the dwarfing genes that gave them their short plant stature. IR8 (Peta/DGWG) was a parent of 40%; Taichung Native 1 (TN1) (DGWG/Tsai-yuan-chun), of 22%. The original semidwarfing gene source Dee-geo-woo-gen (DGWG) was a direct parent of only 2% (figure, C), although it appeared in the ancestry of almost all varieties. About 2 1% of the local



a. Plant height groups of 370 varieties released during post-IR8 era (1967–79). **b.** Ratio of 275 semidwarf varieties released during post-1R8 era that were developed at IRRI or in national programs (local). **c.** Sources of the dwarf genes in 183 locally developed rices released during the post-IR8 era. **d.** Sources of the dwarf genes in the ancestors of 38 local semidwarfs used as parents in varieties released in the post-IR8 era. **e.** Sources of the dwarf genes in the ancestors of 6 local semidwarfs. **f.** DGWG, the semidwarf gene-source for almost all semidwarf varieties.

semidwarf varieties were themselves progeny of locally developed semidwarfs.

We traced the parentage of the 2d-generation semidwarf parents and found that 47% were direct progeny of TNl and 40%, of IR8 (figure, D). But 16% were progeny of still earlier crosses made with local semidwarfs.

Traced back a 3d generation (figure, E), 50% of the local semidwarfs were progeny of TN1, 17% of IR8. A third of them were direct progeny of crosses made with DGWG.

The pattern we found substantiates earlier findings based on analysis of breeding records. TN1 was developed in Taiwan from a cross involving DGWG. TN1 was first grown by some farmers around 1956 and was officially released in 1960. IRRI scientists in 1962 crossed DGWG and Peta to give IR8, released in late 1966.

National rice breeders first adopted TN1 as a source of semidwarfism in their-hybridizations. When IR8 became available, many breeders dropped TN1 and adopted IR8 as a parent.

Although DGWG is four generations removed in some local semidwarfs, it is the ultimate dwarfism source of almost all the semidwarf rice varieties outside mainland China.

DGWG is thought to have originated in Taiwan or in Fujian, China. Dr. T. T. Chang, IRRI geneticist, brought DGWG and other semidwarf gene sources to IRRI in 1961. ■

MTU 6024 – a high yielding variety tolerant of the brown planthopper

C. Bhaskara Rao, rice breeder, G. Venkata Rao, former superintendent, V. Ramachandra Rao. research assistant, and P. S. N. Murthy, research assistant, Agricultural Research Station (ARS), Maruteru, Andhra Pradesh Agricultural University, India

MTU 6024 is a dwarf selection from the cross IR8/SLO 13, developed at Maruteru ARS, West Godavari. It was identified in the F_5 during 1974 kharif (May–Nov). The cultivar is weakly sensitive to photoperiod with 140 days maturity in early kharif. It tillers moderately, and has dark green leaves, late senescence, seed dormancy at maturity, and long, bold grain without white belly. It is tolerant of bacterial blight and brown planthopper.

With 40 kg N/ha, MTU 6024 yielded 6.1 t/ha – significantly higher than the medium-duration variety Prabhat (5.2 t/ha) in early 1976 kharif.

MTU 6024 is now in large-scale testing Farmers like it for its high yield, high milling recovery (75%), and excellent cooking quality. It was planted on an estimated 25,000 ha on the Godavari western delta alone in the early 1979 kharif. ■

Brazil releases two new rice cultivars

E. P. Silveira, researcher, Federal Agricultural Research System (EMBRAPA), Rua Goncalves Bias, 570, 90000 Porto Alegre, Rio Grande do Sul State, Brazil

BR2 is the new name given to IRRI line IR442-2-58 (IR95-31-4/Leb Mue Nahng), and BR-IRGA-409 the new name for P790-B4-51 (IR930-2/IR665-31-1-4), a semidwarf line developed at Centro Internacional de Agricultura Tropical (CIAT).

EMBRAPA introduced and released BR2 for upland conditions of Piaui State. BR2 matures in 120 days and has long, slender grains. In the field it has tolerance for or resistance to drought, blast, and lodging, and it yields from 2.6 to 4.2 t/ha.

BR-IRGA-409 was introduced, selected, and released through cooperative work among EEA-IRGA (the Rio Grande do Sul rice research station), a DNPEA-U.S. Agency for International Development Loan Agreement 512-L-007, and EMBRAPA. It has long slender grain, matures in 105 days, is tolerant of blast and Helminthosporium leaf spot, and has given consistent yields during the past 4 years (see table). BR-IRGA-409 gave stable yields of 6.7–6.9 t/ha at 40 and 80 kg N/ha; at the same levels Bluebelle yielded 4.1–6.3 t/ha; EEA 406, 4.6–6.3 t/ha; and ClCA 4, 4.7–7.0 t/ha. At 0, 30, 60, and 90 kg N/ha, it again performed well, with yields ranging from 5.1 to 8.5 t/ha. ■

Performance of BR-IRGA-409 at different locations and under different levels of nitrogen. Rio Grande do Sul State, Brazil, 1974–1978.

Variety	2- year mean yield (t/ha)					
	Preliminary yield trials		Regional yield trials			
	40 kg N/ha	80 kg N/ha	0 kg N/ha	30 kg N/ha	60 kg N/ha	90 kg N/ha
	Pelotas		*Cachoeiria do Sul*			
BR-IRGA-409	6.7	6.9	6.1	6.4	6.3	6.1
Bluebelle	5.9	6.3	3.2	3.9	3.7	3.9
EEA 406	6.2	6.3	5.2	5.1	5.6	5.7
CICA 4	5.4	7.8	5.7	5.9	6.4	6.4
	Cachoeirinha		*Palmares (CRI)*			
BR-IRGA-409	6.9	6.7	5.8	6.3	6.1	6.8
Bluebelle	4.1	4.3	3.6	3.9	4.4	5.2
EEA 406	4.7	4.6	–	–	–	–
CICA 4	4.7	5.3	4.6	4.8	5.0	5.1
			Pelotas			
BR-IRGA-409			5.1	5.4	5.3	5.5
Bluebelle			4.2	4.3	4.2	4.0
EEA-406			5.3	4.7	5.0	4.4
CICA 4			5.2	5.4	5.5	5.5
			Santa Vitória			
BR-IRGA-409			4.7	4.5	4.6	5.1
Bluebelle			3.1	3.3	3.9	3.8
EEA 406			4.7	4.7	4.6	5.1
CICA 4			3.3	4.0	4.5	4.2
			Uruguaiana			
BR-IRGA-409			7.8	7.9	8.5	7.3
Bluebelle			5.5	5.4	5.4	5.1
EEA 406			–	–	–	–
CICA 4			–	–	–	–

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Effect of different tungro-infected varieties as virus sources on the infectivity of *Nephotettix virescens*

A. Hasanuddin and K. C. Ling, Plant Pathology Department, International Rice Research Institute

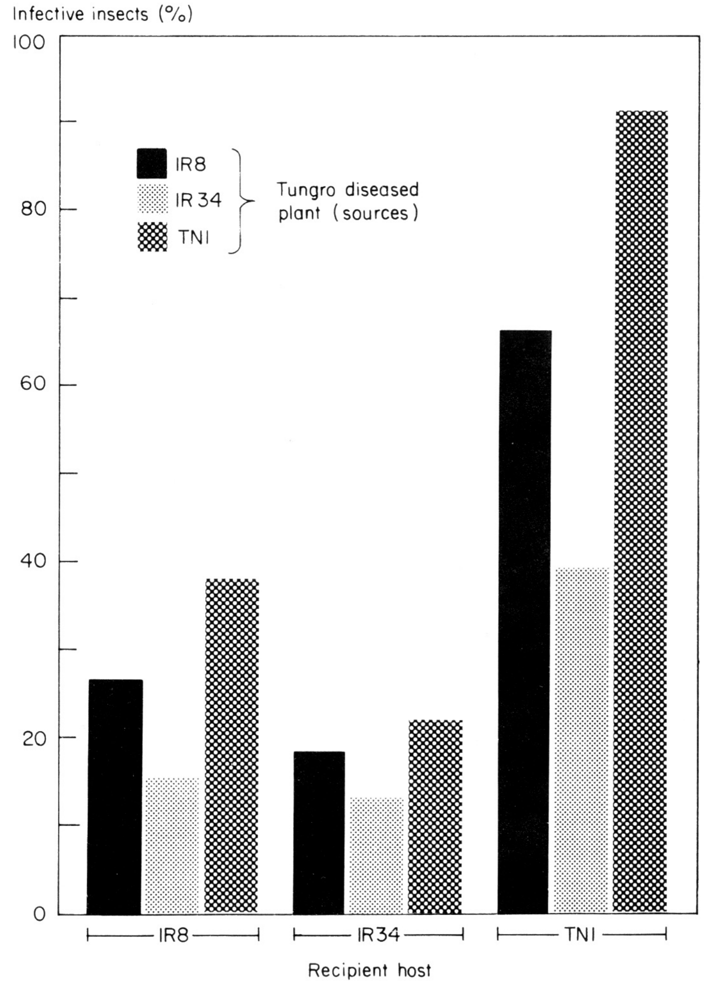
The infectivity of *Nephotettix virescens* after feeding on tungro-diseased plants of IR8, IR34, and TN1 was determined by the test-tube inoculation method. The diseased plants were inoculated 7 days after soaking, were kept in the greenhouse for 40 days, and then used as virus sources for 1,440 adult insects.

Infectivity of *Nephotettix virescens* fed on tungro-diseased rice plants of different varieties at acquisition access periods of 2,24, and 96 hours. IRRI, 1979.

Rice variety (tungro source)	Insects (total no.)	2h	24 h	96 h
		Infective insects (%)		
IR8	480	37 a	33 a	40 a
IR34	480	26 a	13 a	35 a
TN1	480	83 b	88 b	90 b
		Insect retention period (days)		
IR8	323	1.3 a	1.4 a	1.5 a
IR34	364	1.2 a	1.3 a	1.6 a
TN1	356	1.7 b	1.9 b	2.2 b
		Infected seedlings (%)		
IR8	3,317	7 a	7 a	7 a
IR34	3,277	3 a	2 a	7 a
TN1	3,213	18 b	23 b	27 b

Diseased TN1 plants consistently gave higher percentages of infective insects, longer retention periods, and greater percentages of infected seedlings than diseased plants of IR8 and IR34 as virus sources, regardless of acquisition access time (see table).

When 1,800 *N. virescens* adults acquired the virus from IR8, IR34, and TN1, then inoculated 1R8, IR34, and TN1 as recipient hosts, the insects' infectivity was not identical (see figure). Differences also occurred in retention period and percentage of infected seedlings. ■



Percentage of infective *Nephotettix virescens* vectors produced on 3 recipient hosts by 3 tungro source varieties. IRRI.

Seasonal incidence of tungro on selected varieties

S. Srinivasan, assistant plant pathologist, Paddy Experiment Station, Aduthurai 612101, Tamil Madu

Seven prerelease and three standard varieties (see table) were evaluated for tungro incidence in Aduthurai during kuruvai, samba, and thaladi seasons. Plantings were made on the 10th, 20th, and 30th of each month from June to November 1978 and percentages of infected plants were noted after 9 weeks.

Tungro occurred in plantings from July through November 1978.

IR34 was less affected than the other varieties. ■

Rice tungro virus incidence on various cultivars. Aduthurai. India.

Planting date	Rice tungro virus incidence (%)										
	ADT31	AD7486	AS3704	AD6120	AD6970	AD7211	AD5231	AD13893	IR34	IR20	Mean
10 Jun	–	–	–	–	–	–	–	–	–	–	–
20 "	–	–	–	–	–	–	–	–	–	–	–
30 "	2.6	–	–	–	–	5.7	–	2.5	1.7	–	1.3
10 Jul	5.2	–	2.6	1.6	3.9	15.2	–	8.2	6.7	1.5	4.5
20 "	6.4	2.6	5.9	5.2	6.6	19.9	1.2	13.2	14.1	4.3	7.7
30 "	9.7	4.4	8.5	7.7	12.1	15.4	4.1	17.4	8.0	5.8	9.3
10 Aug	13.8	12.3	3.9	6.6	8.9	6.2	16.8	8.6	6.5	14.8	9.8
20 "	18.5	5.3	14.8	16.1	9.2	7.2	12.4	19.6	6.8	6.0	11.6
30 "	34.9	4.1	13.1	17.4	29.0	4.7	2.7	58.9	5.0	5.4	29.1
10 Sep	64.6	4.9	19.2	17.3	88.3	69.6	39.1	92.4	14.2	6.0	41.6
20 "	92.4	27.5	72.9	63.5	61.3	86.6	81.9	92.0	19.2	86.1	68.3
30 "	98.6	99.8	83.9	97.4	81.9	93.3	28.4	94.7	30.6	90.9	80.0
10 Oct	100.0	84.9	94.3	61.8	100.0	68.4	42.0	84.8	45.6	53.0	73.5
20 "	95.6	56.7	91.9	78.8	93.7	24.4	43.1	52.4	36.8	20.5	59.4
30 "	100.0	64.9	100.0	68.0	100.0	65.5	83.3	82.9	36.1	50.9	75.2
10 Nov	91.5	26.2	89.0	67.0	76.6	28.9	57.4	23.4	24.2	13.3	50.0
20 "	84.5	20.5	85.3	78.8	65.6	17.5	19.1	84.6	22.1	12.4	49.0
30 "	85.4	16.0	82.7	25.3	71.7	14.3	17.7	44.3	19.0	17.9	39.4
Mean	50.2	23.9	42.6	34.0	44.9	30.1	24.4	43.3	16.4	21.6	

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Rice resistance to thrips

R. Velusamy and S. Chelliah, Agricultural Entomology Department, Tamil Nadu Agricultural University, Coimbatore 641003, India

The rice thrip *Baliothrips biformis* (Bagnall) sometimes reaches populations of economic significance in India. Thrips infest nursery seedlings and the early transplanted crop; they cause leaves to roll, then turn yellow. The plants wilt in severe cases.

From July to September 1979, thrips incidence was heavy in field nursery seedlings at Coimbatore. Based on the range of symptoms, a visual resistance rating scale was developed:

Damage	Rating scale	Grade
Rolling of terminal 1/3 area of 1st leaf only	1	Highly resistant
Rolling of terminal 1/3 to 1/2 area of 1st and 2d leaves	3	Resistant
Rolling of terminal 1/2 area of lst, 2d, and 3d leaves; yellowing of leaf tips	5	Moderately resistant
Rolling of entire length of all leaves with pronounced yellowing	7	Susceptible
Complete plant wilting followed by severe yellowing and scorching	9	Highly susceptible

Using the rating scale, 25-day-old seedlings of 66 rice cultivars were screened in the field nursery.

Identified as highly resistant were Balamawee, Suduru Samba, Sinna Sivappu, Thirrissa, H105, and Perunel. The resistance of the first three varieties to certain brown planthopper biotypes is of practical significance. Nine other varieties that were rated as resistant, and should be useful in resistance breeding programs, were ASD7, B2360-11-3-2-3, Babawee, CO29, IET4786, IR4432-52-6-4, Nira, PTB19, and Sudu Hondarwala. ■

Field reaction of rice cultivars to hispa and leaf folder

G. S. Dhaliwal, Punjab Agricultural University, Regional Rice Research Station, Kapurthala 144601, Punjab, India

A collection of 334 cultivars was assessed in the field in 1978 kharif for varietal differences in tolerance for rice hispa *Dicladispa armigera* and rice leaf folder *Cnaphalocrocis medinalis.* Fifty-day-old seedlings of the cultivars were transplanted in two lines, each 2.55-m long, at a spacing of 20 × 15 cm. The hispa- and leaf folder-damaged leaves on 10 hills of each variety were counted at 40 and 75 days after transplanting, respectively.

None of the tested varieties was completely free from insect attack. For rice hispa, the lowest infestation (5 damaged leaves/10 hills) was on IET4109. Cultivars that had comparatively less damage (fewer than 10 damaged leaves/10 hills) were PR299 A, PR385, PR506, PR515, PR285, PR409, PR520, PR440,1ET3578. IET5329, and 1ET6251. The most severely infested cultivars (more than 80 damaged leaves/ 10 hills) included PR274, PR437, and CRM5713-13. CRM5713-13 had the highest damage, 93 leaves/10 hills.

For the rice leaf folder, IET625 1 was the least damaged (16 leaves/l0 hills). The most severely infested cultivars were PR299A, PR515, PR437, PR476, 1870, 1991, CRM5710-8, and CRM5761-1. CRM5761-1 had the highest damage, 96 leaves/l0 hills. ■

GENETIC EVALUATION AND UTILIZATION

Deep water

Thailand releases two new deepwater rice varieties

C. Prechachat, C. Setabutara, K. Kupkanchanakul, S. Amonsilpa, N. Supapoj, T. Kupkanchanakul, C. Boonwite, W. Sirikant, A. Wiengweera, N. Kongseree, and A. Sariaabutr. Rice Division. Department of Agriculture, Ministry of Agriculture and Cooperatives, Bangkok, Thailand

Thai government officials formally approved the release of RD17 and RD19, new semidwarf rice varieties that are tolerant of water depths up to 1 meter, in December 1979. RD17 was previously known by its experimental line number BKN6986-66-2 and RD19, as BKN6986-147-2. Both varieties were selected from the cross IR262/Pin Gaew 56, made in 1969 at the Bangkhen Rice Experiment Station, with the objective of transferring deepwater tolerance and elongation ability from the Thai floating variety Pin Gaew 56 into progeny of the IR262 plant type. IR262 is a photoperiod insensitive semidwarf line obtained 13 years ago from IRRI.

Early generations were tested for deepwater tolerance at Klong Luang and Huntra Rice Experiment Stations and then selected for uniformity and yield at various rice stations and in farmers' fields in the Central Plain, where flooding occurs annually. Yields of the better lines, including RD17 and RD19, averaged 3 to 4 t/ha; Pin Gaew 56 generally yielded 1 to 2 t/ha less. The yields varied depending on maximum water depth and amount of fertilizer applied. RD17 often averaged 4 t/ha when water depths did not exceed 1 m. Neither variety is recommended for areas where water depths are expected to exceed 1 m.

Both RD17 and RD19 are intended for the monsoon season because they mature too late for the dry-season crop. Also water depth is usually not a problem in the dry season and the present improved varieties such as RD7 perform satisfactorily there.

RD17 is insensitive to photoperiod, has a stiff straw, matures in about 140 days, can elongate its stem at 5 cm/day, and has withstood submergence for 7 days without serious injury. Its drought tolerance at early growth stages is an additional advantage. When grown in 80 cm of water RDI7 has an average height of 160 cm (range, 150–170 cm). It is moderately resistant to bacterial blight but susceptible to the brown planthopper, stem borer, and gall midge. RD17 has brown rice kernels more than 7 mm long, with relatively low chalkiness and high amylose content. Its cooking and milling characteristics, however, are acceptable.

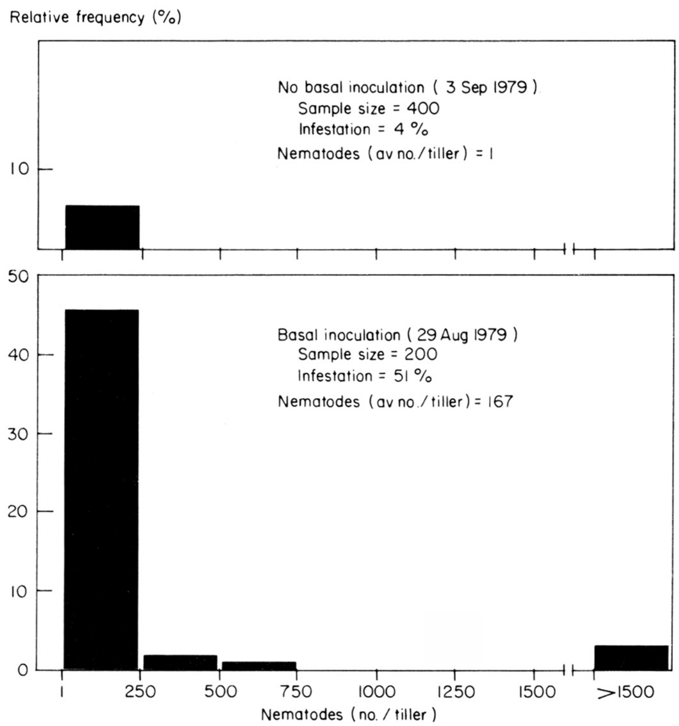
We believe that RD17 will become popular in occasionally flooded areas where farmers grow ordinary improved varieties. RD17's elongation ability would be flood insurance in such high-risk areas. Furthermore, its photoperiod insensitivity will permit many farmers in flood-prone areas to harvest a crop in about 140 days. RD19 is sensitive to photoperiod, and has slightly higher grain chalkiness and better drought tolerance in the vegetative stage than RD17. RD19 usually ripens around mid-December, if planted in July or August. RD19 has acceptable milling and cooking qualities. Its greatest potential is anticipated in areas where farmers now plant only tall, traditional, photoperiod-sensitive types because monsoon floods might destroy ordinary improved varieties. Furthermore, because of its better plant type, RD19 is expected to be more fertilizer responsive than traditional varieties. ■

Structural analysis of the nematode population and the source of ufra

P. G. Cox, L. Rahman, and M. A. Hannan, Bangladesh Rice Research Institute (BRRI)-Overseas Development Agency (ODA) Deepwater Rice Pest Management Project, BRRI, Joydebpur, Dacca, Bangladesh

Ufra caused by the rice stem nematode *Ditylenchus angustus* Filipjev is a serious disease of deepwater rice in southern Bangladesh. Cox and Rahman (IRRN 4:3 [June 19791, 10–11) have suggested how structural analysis of the nematode population (i.e. determination of the relative frequency with which different population sizes occur in individual tillers) might be used to identify the source of inoculum according to the presence of a distinct mode at high populations. The presence early in the season of heavily infested tillers might be evidence of primary infestation from diseased residues in the field at sowing, well before flooding.

At BRRI two blocks of deepwater rice (variety Gorcha) were broadcast on 10 April 1979 in a deepwater tank especially constructed for ufra research. At the time of broadcast the larger block (8 × 8 m) was inoculated with 100 infested panicles retained from the previous season; the smaller block



Structure of the ufra nematode population with and without basal inoculation. BRRI, 1979.

(8 × 4 m) was not inoculated. The tank was flooded from early June onward. Active *D. angustus* were collected from a farmer's field and dispersed in the tank on 16 June to simulate secondary infestation by water-borne inoculum. The structure of the nematode populations in the two blocks was analyzed at the end of August through the procedure described by Cox and Rahman.

The two population structures differed greatly (see figure). The plot with basal inoculation had a much greater percentage of infested tillers and average number of nematodes per tiller. The population structure in the inoculated plot also had a distinct right-hand mode representing about 2.5% of all tillers (av no. of nematodes/infested tiller in the RH mode, 5500; s.d, 3700). This mode did not occur in the uninoculated plot. The results support the idea of equating the presence of a distinct structural mode at high nematode populations with the outcome of primary crop infestation at about the time of sowing. They also demonstrate the possibility of maintaining different levels of infestation in a single infested tank despite biological continuity between the plots after the tank is flooded. ■

Pest management and control DISEASES

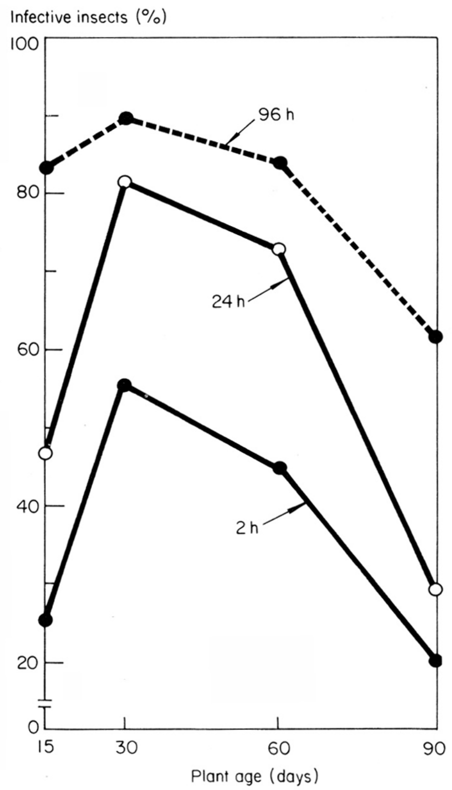
Effect of age of tungro-diseased plants on GLH infectivity

A. Hasanuddin and K. C. Ling, Plant Pathology Department, International Rice Research Institute

The infectivity of the green leafhopper (GLH) *Nephotettix virescens* was determined by the test-tube inoculation method after feeding the insects on tungro-diseased TN1 plants of different ages. Diseased plants were inoculated 7 days after soaking, kept in the green-house for 15, 30, 60, and 90 days, and then used as virus sources for 1,920 adult GLH.

The percentages of infective insects varied among those fed on diseased plants of different ages, regardless of acquisition access time (2, 24, or 96 hours) (see figure). At 96 hours access time, a higher percentage of the irlsects that fed on 30- and 60-day diseased plants became infective, had a longer infectivity retention period, and infected a greater percentage of seedlings than the insects that fed on 15- or 90-day diseased plants (see table).

The variation in the insects' infectivity indicated that diseased plants of different ages were not identical in quality as virus sources. ■



Effect of tungro-infectcd source plants of different ages on percentage of rice grecn leafhoppers infective at acquisition access periods of 2,24, and 96 hours.

Infectivity of *Nephorettix virescens* fed on tungro-diseased TN1 plants of different ages, at various acquisition access times.[a]

Diseased plant age (days)	Total (no.)	2h	24 h	96 h
			Infective insects (%)	
15	480 insects	25 a	48 a	81 b
30	480 insects	55 b	82 b	90 c
60	480 insects	46 b	74 b	85 c
90	480 insects	20 a	29 a	62 a
			Retention period (days)	
15	321 insects	1.2 a	1.4 a	1.8 b
30	345 insects	1.7 a	1.9 a	2.1 b
60	337 insects	1.7 a	1.9 a	1.8 b
90	363 insects	1.6 a	1.6 a	1.3 a
			Inficted seedtings (%)	
15	3,302 seedlings	5 a	9a	21 b
30	3,320 seedlings	13 a	20 a	28 c
60	3,304 seedlings	10 a	19 a	21 b
90	3,304 seedlings	5 a	6a	10 a

[a]Means followed by a common letter in each column are not significantly different at the 5% leveL

Checking infection of rice root nematode by nursery treatment and bare root dips to increase yield

T. Venkitesan, nematologist, and Job Satyakumar Charles, research assistant, All India Coordinated Research Project on Nematode Pests or Crops and their Control, College of Agriculture, Vellayani 695522; and V. Ramachandran Nair, agronomist, Agronomic Research Station, Karamana 695002, Kerala, India

Six pesticides — aldicarbsulfone, carbofuran, dimethoate, monocrotophos, phosphamidon, and quinalphos — were tested as bare root dip treatment for control of the rice root nematode *Hirschmanniella oryzae.* Seedlings of the rice cultivar Triveni were raised in nursery beds treated with and without 30 liters DBCP/ha. They were transplanted in 4-m^2 microplots in the field after a 12-hour bare root dip in 0.02% pesticide solution. Each treatment was replicated three times.

Differences in nematode population between the check plots and the plots planted to seedlings that received both the DBCP treatment and the bare root dip with phosphamidon were significant. At planting, soil from plots with the treated seedlings had 202 nematodes, and soil from the check plots had 185. At hervest the former had 79 nematodes and the latter, 273. At 35 days after transplanting the roots of treated seedlings had 4.7 nematodes/g root; the roots in the check plots had 10.2 nematodes/g root. At harvest the former had 3 nematodes/plant and the latter, 29/plant. Plots with the treated seedlings yielded 85% more than the check plots (1.5 kg vs 0.81 kg/plot). ■

Further studies on the potential of weeds to spread tungro in West Bengal, India

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In a previous study on the potential of weeds to spread rice tungro in West Bengal, no virus occurred naturally on the predominant graminaceous and cyperaceous weeds at the Kalyani virus experimental field. But *Echinochloa colona* and *Paspalum notatum* inoculated with the virus kept it for 3 months. In a further study of weeds' potential for spreading rice tungro virus, weeds were collected from different locations early in different crop seasons.

The following weeds were collected in April 1978 and in June 1978: *Echinochloa colona, Paspalum notatum, Cynodon dactylon, Echinochloa crus-galli, Eleusine indica, Cyperus iria, Imperata cylindrica, Setaria glauca, Sporobolus diander, Cyperus esculentus, Leersia hexandra, Dicanthium annulatum, Brachiaria ramosa,* and *Dactyloctenium aegyptium.* Only *L. hexandra* was not obtained in June but another species, *Digitaria sanguinalis,* was available. In November 1978 only nine weeds *(E. colona, C dactylon, P. notatum, S. diander, C. esculentus, D. annulatum, I. cylindrica, B. Ramosa,* and *Cyperus rotundus)* were collected. None showed any virus except a few collections of *E. colona* from the endemic fields of Malda.

The weeds were then inoculated with the tungro virus and their retention of the virus was indexed on TN1 seedlings (see table). The research was funded by the Indian Council of Agricultural Research, New Delhi. ■

Transmission of rice tungro virus from weeds collected 2 to 5 months after inoculation, Kalyani, West Bengal, India, 1978.

Weed	Transmission (%)											
	April				June				November			
	2 mo	3 mo	4 mo	5 mo	2 mo	3 mo	4 mo	5 mo	2 mo	3 mo	4 mo	5 mo
Echinochloa colona	15	10	5	X	20	10	X	X	20	10	X	X
Echinochloa crus-galli	X	X	X	X	X	X	X	X	X	X	X	X
Eleusine indica	X	X	X	X	25	15	10	X	X	X	X	X
Cyperus rotundus	X	X	X	X	X	Y	X	X	20	10	X	X
Cyperus iria	X	X	X	X	X	X	X	X	X	X	X	X
Cynodon dactylon	X	X	X	X	10	X	X	X	X	X	X	X
Imperata cylindrica	X	X	X	X	20	10	X	X	X	X	X	X
Paspalum notatum	X	X	X	X	30	20	10	X	10	X	X	X
Setaria glauca	X	X	X	X	X	X	X	X	X	X	X	X
Sporobolus diander	X	X	X	X	10	X	X	X	X	X	X	X
Cyperus esculentus	X	X	X	X	X	X	X	X	X	X	X	X
Leersia hexandra	X	X	X	X	X	X	X	X	X	X	X	X
Dicanthium annulatum	X	X	X	X	X	X	X	X	X	X	X	X
Brachiaria ramosa	X	X	X	X	10	X	X	X	X	X	Y	X
Dactyloctenium aegyptium	X	X	X	X	X	X	X	X	X	X	X	X
Digitaria sanguinalis	X	X	X	X	X	X	X	X	X	X	X	X

1979 setback for ufra

P. C. Cox, L. Rahman, and M. A. Hannan, Bangladesh Rice Research Institute (BRRI)/Overseas Development Agency (ODA) Deepwater Rice Pest Management Project, BRRI, Joydebpur, Dacca, Bangladesh

Ufra disease, caused by the rice stem nematode *Ditylenchus angustus* (Filipjev) is serious in deepwater rice in southern Bangladesh. It was particularly severe around the village of Kashimpur in Comilla district, almost at the northern limit of its distribution in southeastern Bangladesh, according to disease surveys in November 1977 and 1978. In 1979, the disease disappeared from the area; no plants with symptoms were found during September. The average number of nematodes per stern in 6 fields about 80 m apart along a linear transect at Kashimpur was estimated using the procedure described by Cox and Rahman (IRRN 4[3] June 1979:10) at about the end of September (i.e. just before panicle initiation) in 1979 and in 1979 (see

Average number of nematodes per stem in 6 deepwater rice fields along a transect at Kashimpur, Bangladesh, 1978 and 1979.

Date	Sample size (stems/field)	Nematodes (av no./stem)						
		1	2	3	4	5	6	7
2 Oct 1978	15	–[a]	1421[b]	9	49	786[bc]	250	989[b]
24 Sep 1979	50	4	–[a]	1	1	6	1	1

[a]No deepwater rice. [b]Includes stems containing more than 3,000 nematodes. [c]This crop was a total loss because of ufra in 1978.

table). Although *D. angustus* was present in 1979, its number was small. The 1979 population was uniformly distributed along the transect despite large differences between fields in 1978. No heavily infested stems, which might provide evidence of primary infestation from diseased crop residues, were found in any of the fields in 1979. A similar sequence of events was observed at another northerly site between Dacca and Narsingdi.

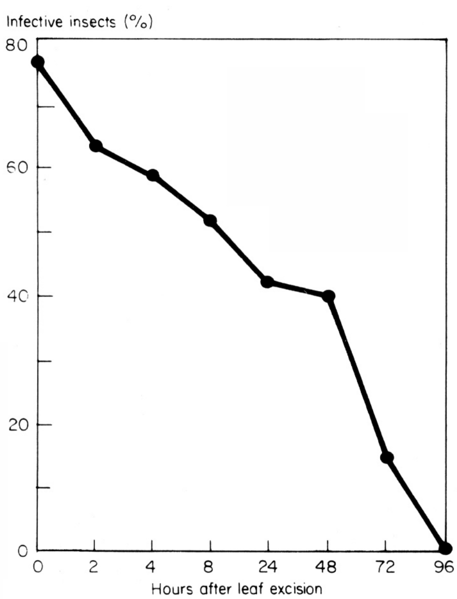
The nematode overwinters in diseased crop residues and is reactivated by spring rainfall at about the time of sowing — late March and early April.

It appears that the water came too late for ufra in 1979, when there was a spring drought in Bangladesh. The total April rainfall at Joydebpur was 35.5 cm in 1977, 18.0 cm in 1978, but only 1.8 cm in 1979. Matlab Bazar in south Comilla, deep inside the ufra-affected area, had plants exhibiting symptoms of ufra attack as early as July 1979. The deepwater rice there is sown a few weeks earlier than at Kashimpur as the fields soon become flooded by tidal movements from the river. These observations suggest that spring drought may hinder the northward migration of ufra and that control may be achieved, at least in part, by any procedure that prolongs the winter decay phase by even a few weeks. ■

Effect of length of time after leaf excision on tungro virus source

A. Hasanuddin and K. C. Ling, Plant Pathology Department, International Rice Research Institute

When 1,280 adult *Nephotettix virescens* were provided access to tungro-diseased leaves at 0, 2, 4, 8, 24, 48, 72, and 92 hours after excision, the percentage of infective insects varied. The percentage of infective insects gradually decreased as time after excision increased; no insects became infective when access was 96 hours after excision (see figure). But insects were still able to acquire the virus from excised leaves after 72 hours, indicating that partly dried leaves can also serve as a virus source for the insect vector. ■



Effect of time after leaf excision of tungro diseased plant on percentage of infective *Nephotettix virescens.* IRRI.

Sheath rot spreads in Bihar, India

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Sheath rot of rice caused by *Acrocylindrium oryzae* (revised as *Sarocladium oryzae)* was observed for the first time during 1977 kharif at ARI, Mithapur, Patna, in the National Screening Nursery (NSN) and International Rice Yield Nursery (IRYN) trials. The disease had not been reported previously in Bihar. Oblong or somewhat irregular lesions were observed on the uppermost leaf sheaths enclosing the young panicles. Most of the lesions were dark brown, and some had light grey centers. The panicles of some infected tillers emerged only partially. Of 56 IRYN entries, 35 were infected. In 1978, 31 5 of 645 NSN entries at Mithapur farm were infected.

In the 1979 kharif, sheath blight was reported in all four RAU regional research institutes. ■

Pest management and control

INSECTS

Dirty panicles and rice yield reduction caused by bugs

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Species of the rice bugs *Riptortus, Stenocoris,* and *Aspavia* attack the rice grain from flowering to harvest and cause considerable crop losses in West Africa. The symptom of bug infestation is grain discoloration, generally described as *dirty panicle.* At Rokupr the feeding behavior of rice bugs and the nature of the damage they cause on rice were studied in 1- × 1- × 1.6-m field cages. *Aspavia* sp. and *Stenocoris* sp. at various densities were caged with the rice varieties CP4 and ROK5 from late booting to harvest. The cages were checked daily and the different bug densities maintained until harvest. The grains were boiled for 5 minutes in 10% KOH solution; bug damage was then assessed.

Both nymphs and adults attacked the rice grains as soon as the panicle was exserted, and continued to feed on the developing grains until the hard dough stage. The bugs punctured the glumes and sucked the contents of the developing grain. *Riptortus* and *Stenocoris* fed on any site on the grain, but *Aspavia* tended to puncture the grain at the apical end. Only part of the grain milk was removed at each feeding and the same grain could be punctured several times. Fresh signs of *Riptortus* attack were stylet puncture marks, often with milk exudate, on the outer glumes. Those signs were not apparent in attacks

Percentage of grain discoloration recorded at 4 levels of bug infestation on the variety CP4, WARDA, Sierra Leone.

Bugs (no./cage) in 6 panicles	Grains discolored (no.)		Grains (%)			
			Discolored		Discolored due to bugs	
	Aspavia	*Stenocoris*	*Aspavia*	*Stenocoris*	*Aspavia*	*Stenocoris*
0	20.8	25.0	4.2	5.2	–	–
5	39.0	30.3	7.8	6.1	3.6	0.9
10	41.8	31.3	8.4	6.3	4.2	1.1
20	108.3	42.0	21.7	8.4	17.5	3.1

In this preliminary study, yield in grams per 500 grains (Y) and grain damage percentage (X) were linearly related as follows:

Aspavia sp. on variety ROK5

$$y = 10.5 - 0.12\ x\ (r = -0.98^{**}\ n = 8)$$

Aspavia sp. on variety CP4

$$y = 9.91 - 0.11\ x\ (r = -0.99^{**}\ n = 16)$$

Stenocoris sp. on variety ROK5

$$y = 9.2 - 0.15\ x\ (r = -0.90^{**}\ n = 8).$$

by *Stenocoris* or *Aspavia*. Two to three days after the grain had been punctured the glumes began to change color, first to light brown, 2nd gradually darkened. In severe cases the glumes became dark grey after about a week. Severity of damage depended on the stage of grain development at the time, and on the number of feedings on the grain. The nymphs preferred to feed on the grain immediately after flowering; the adult bugs preferred grain in the milk stage. Grains at the hard dough stage were rarely punctured.

In the cages without bugs, grain discoloration was noted but the incidence was lower than in cages with bugs. This indicates that other factors, probably pathogenic fungi, can cause grain discoloration. The number and the percentage of discolored grains, however, increased as the rice bug density increased. That might suggest that 3.6 to 17.5% of the dirty panicle syndrome due to *Aspavia* on the variety CP4 in this study was caused by bug damage (see table). ■

Nisaga simplex damage to rice in the hill tracts of South India

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The hairy caterpillar *Nisagu simplex* Walk. (Eupterotidae: Lepidoptera) is becoming increasingly important as a rice defoliator in the hilly tracts of Karnataka. The caterpillar damages extensive areas of rice in Coorg district.

The adult emerges in July and August. The females lay about 140 to 21 0 eggs in linear rows on leaf blades of grassy weeds on the bunds, or on the rice plants themselves. Eggs hatch in about 9 days. On hatching, the larvae are blackish, about 3 mm long, and have dark hairs on the tubercles. The larvae feed on the margin of the leaf blades. After the second molting, the general body color is a mixture of black and green.

During successive moltings, the larvae feed on the leaves and defoliate the plants, leaving only the midribs. The sixth-instar larvae are about 30 mm long; the body is covered with dark dense hair and its color changes to a mixture of grey and black. The fully grown larvae attain a length of 45–50 mm. The larval development is completed in about 60 to 65 days. The larvae enter the soil for pupation, which takes places in a loosely woven silken case covered with mud particles. The adults emerge in July and August; there is only 1 generation/year.

Dusting BHC 10% or parathion 2% is an effective control measure provided the field bunds and vacant lands adjoining the field are also dusted. ■

Distinct geographic populations of brown planthopper in India

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Preliminary differential reactions of some rice varieties tested in the International Rice Brown Planthopper Nursery (IRBPHN) indicated the existence in India of different biotypes of brown planthopper (BPH) (IRRN 1 [2] :8). Subsequent screening tests at Pantnagar indicated that PTB33, which is highly resistant at all sites where BPH occurs. is susceptible. This susceptible reaction to the naturally occurring BPH populations is of great interest.

The BPH is cultured on TN1, a susceptible variety, and every year it is either replaced or augmented with a field population.

Data on the differential reactions of some rice varieties (see table) at different locations are from past IRBPHN and BPH screening trials. They suggest that the population at Pantnagar and nearby areas is geographically distinct from the population in southern India. The resistant reaction of ARC10550 in all the Indian subcontinent countries and its susceptible reaction in all the other countries of the eastern hemisphere where BPH occurs divides the BPH into two major groups that can be further subgrouped on the basis of varietal reaction. The populations of Pantnagar and of southern India are examples of two different naturally occurring BPH biotypes. But detailed studies on its occurrence and migration in a one season crop are needed before we can say that the BPH in the entire northern part of the lndian subcontinent is distinct from that in the southern peninsular region. ■

Differential reactions[a] of selected rice varieties at different locations.

Variety	Rajendranager	Maruteru	Pantnagar
Sinna Sivappu	R	R	R
ARC6650	MR	R	S
ARC10550	R	MR	R
PTB33	R	R	S

[a]Reaction based on a 0–9 scale. R = 0–4, MR = 4–7, S = 7–9.

Seasonal abundance of the whitebacked planthopper and brown planthopper and predators in insecticide-free rice fields in Malaysia

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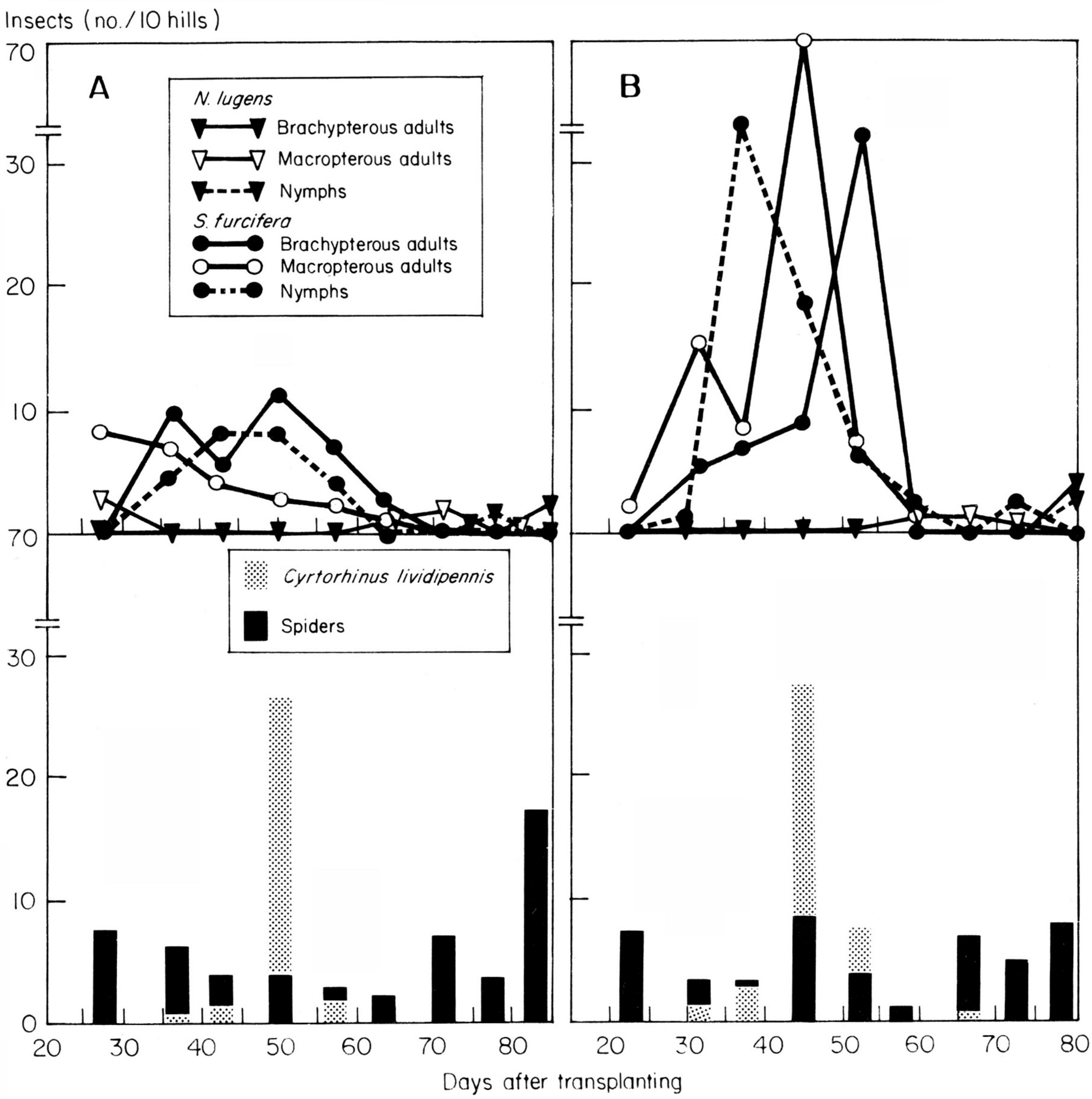
The large outbreak of the whitebacked planthopper (WBPH) *Sogatella furcifera* in the Muda Irrigation Scheme in June 1979 emphasizes the threat that both WBPH and brown planthopper (BPH) pose in Malaysia. WBPH has damaged paddy in Malaysia since 1925. Its frequent but innocuous position in the paddy ecosystem strongly suggests that it is controlled naturally except when some unknown factors trigger an outbreak.

To study this natural control, two 1-ha paddy fields in Telok Chengai were grown to the variety MR7, which is highly susceptible to BPH and WBPH. No insecticide treatment was used. Every week, samples from 20 hills/field were taken with a portable suction sampler. *Cyrtorhinus lividipennis, Paederus fuscipes, Casnoidea interstitialis,* and spiders were monitored together with WBPH and BPH at three growth stages. All of those predators fed on WBPH in the laboratory.

In one of the fields macropterous WBPH and BPH were found at 28 days transplanting (DT). But only WBPH were present from 36 DT to 65 DT (see figure, A). After 65 DT the WBPH population declined and low BPH population was observed in the ripening crop. The *C. lividipennis* population peaked at 50 DT, and declined as the WBPM population declined. The number of spiders declined initially but peaked toward the end of the season.

The buildup of *C. lividipennis* suggests that the mirid bug is important in maintaining a low WBPH population in the field. Spiders appear less effective but, unlike *C. lividipennis,* are always in the field and therefore are an important constant mortality factor in the paddy ecosystem. The populations of *P. fuscipes* and *C. interstitialis* were low.



Populations of *Sogatella furcifera, Nilaparvata lugens, Cyrtorhinus lividipennis,* and spiders in a field grown to brown planthopper-susceptible variety MR7 without insecticide treatment. Telok Chengai, Malaysia, 1979.

The insect populations in the other field were similar. But the level of WBPH was higher, about 10 WBPH/hill at 45 DT (see figure, B). That level is below the tentative economic threshold of 20/hill in the Muda Irrigation Scheme. Interestingly, only the two fields were untreated throughout the planting season. The surrounding 29 fields had more than 20 WBPH/hill and were subsequently sprayed. All of the affected fields were prophylactically treated with carbofuran granules at 30 DT. Such observations highlight the need for an integrated pest control approach in Malaysia. ■

Pest occurrence on split transplanted rice

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In West Bengal, split transplanting or clonal propagation of rice is practiced mostly in flood-prone areas where farmers generally face a shortage of seedlings after the floodwater recedes.

A preliminary investigation conducted at Pandua, a gall-midge endemic area, studied the effect of split transplanting on pest incidence in wetland rice. Thirty-day-old seedlings of Pankaj, an aman rice, were transplanted in the main field (T_1). The rooting tillers of Pankaj were split and transplanted in another field 20 days later (T_2). Subsequently two other fields were transplanted with 40- and 60-day-old tillers (T_3 and T_4), split from the first transplanted field. The spacing was 20 × 15 cm; 3 seedlings/hill were transplanted. The fertilizer dose was 75-25-25 kg NPK/ha. The field was 100 m^2 and the water level was maintained at 5-7 cm during the vegetative stage. No pesticide was applied. Split transplanting of seedlings 20 days after the first transplanting was the best treatment (see table). ■

Effect of split transplanting on blast disease incidence and gall midge infestation. Hooghly, India.

Split-transplant treatment	Tillers (no./m^2)	Blast infection in leaves (%)	Silver shoots (no./m^2)	Earhead lengths (cm)	Fertile grains/ earhead[a] (no.)	Yield/ 100 m^2
T_1 (control)	373	5	32	23.3	96.65	5.4
T_2 (20-day)	360	1	9	22.3	106.0	5.6
T_3 (40-day)	164	1	5	8.4	80.6	3.8
T_4 (60-day)	119	1	5	8.1	72.0	3.0

[a]Mean of 20 earheads.

Rice insects and their management in the Ord river irrigation area of Western Australia

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Both a wet and a dry season crop of rice are grown on the Ord, where rice production is still being developed. Rice is grown on about 400 ha each season. The rice pest complex in the two seasons differs; infestations are more severe in the wet season crops.

The rice white stem borer *Tryporyza innotata* is the most consistent and the most damaging insect in the wet season. Its natural control agents are being studied; the major ones are the egg parasite *Telenomus rowani* (see table) and the late larval parasite *Temelucha* sp., which cause roughly 40% parasitism over the season. *Bracon* sp., a parasite of early larval instars, is found, but usually in low abundance.

Other research is conducted on insecticide screening and time-of-application trials. seasonal abundance of moths for predictive insecticide application in commercial crops (granular lindane is used), and plant varietal resistance to stem borers. The army-worm *Pseudaletia separata,* a serious rice pest in the panicle dcvelopment-maturity stage, causes grain to fall. Other pests include the grain-sucking bug *Eysarcoris trimaculatus* and locusts (chiefly *Gastrimargus musicus, Locusta migratoria,* and *Austracris guttulosa*).

Dry season rice crops are attacked by *P. separata* and *E. trimaculatus,* but not as severely as the wet season crops. Rice bloodworms Chironomidae occasionally attack aerially sown, dry season crops.

Leafhoppers are found in Ord rice crops but so far have not caused damage nor transmitted serious diseases. ■

Egg parasitism of *Tryporyzo innotata* (98% by *Telenomus rowani).* The wet season experimental crops are sown early in December. Ord River, Australia, 1978–79.

Date	Eggs (no.)	Parasitism (%)
10 Jan 1978	5141	43
20 Jan	1628	57
25 Jan	600	94
13 Feb	991	61
22 Feb	1239	57
2 Mar	1561	80
27 Dec 1978	353	0
4 Jan 1979	447	0
10 Jan	643	0
1 Feb	438	15
7 Feb	1248	31
12 Feb	2782	20
15 Feb	836	36
22 Feb	3014	71
2 Mar	1051	55
14 Mar	1648	67
23 Mar	214	80
29 Mar	776	55
11 Apr	1485	71

Influence of nitrogen levels on rice hispa incidence

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In a field trial during 1978 kharif, the infestation by rice hispa *Didadispa armigera* increased with an increase in nitrogen level from 0 to 120 kg/ha. At 150 kg N/ha, however, infestation decreased considerably. The mean numbers of hispa-damaged leaves/l0 hills at 0, 30, 60, 90, 120, and 150 kg N/ha were 67, 90, 115, 145, 171, and 128, respectively.

The decrease in rice hispa incidence

at the highest nitrogen level of 150 kg/ha might have been due to some deleterious effect of excessive nitrogen on the feeding activity of the insect. Alternatively, it might also have been due to the plants' more bushy growth, which left few leaf tips exposed for egg-laying. Rice hispa prefers widely spaced exposed leaves to partly hidden leaf tips. ■

Brown planthopper outbreaks and associated yield losses in Malaysia

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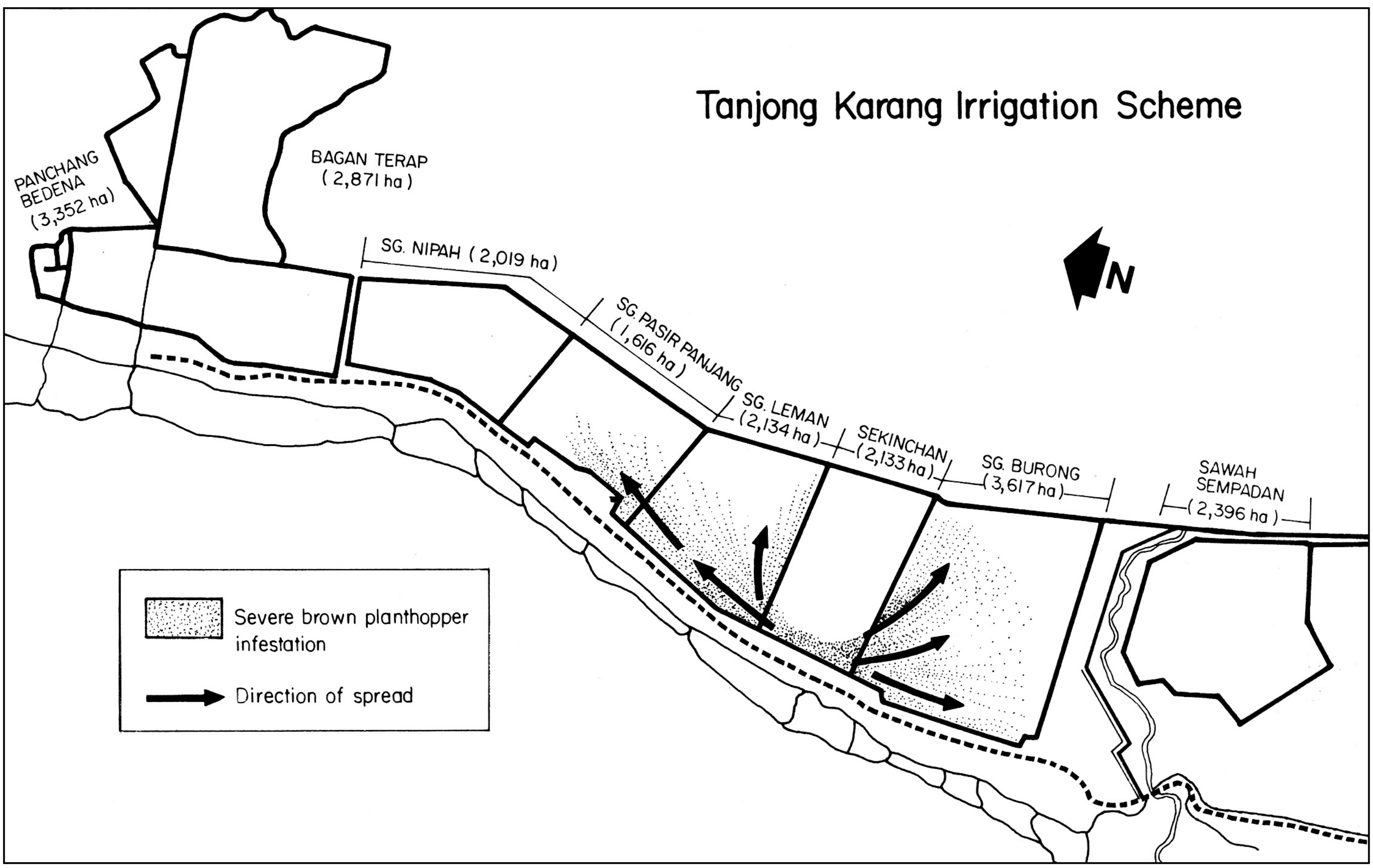
The effects of brown planthopper (BPH) outbreaks on plant growth and yield are complex and variable; they are largely governed by the time and duration of attack, intensity of injury, and environmental factors that affect both insect activities and plant growth. Attempts are frequently made to estimate yield losses to determine the actual importance of the pest.

One common method is to compare the yields of infested and pest-free crops. In a yield loss assessment during the 1977 BPH outbreak in Tanjong Karang, Malaysia, yields of 10.1- × 10.1-m plots were taken. For each locality from 6 to 15 plots were analyzed. The plots constituted fixed sample areas, randomly selected for the national crop-cutting survey. The yield reduction for the infested crops was measured against the yields for uninfested crops similarly sampled during a few earlier seasons.

In Tanjong Karang, the BPH outbreak was initially detected on 13 June in Sekinchan, where 20–30 BPH/hill were recorded (see map). From there the damage rapidly spread to surrounding areas. On 8 July from 500 to 1,000 BPH/hill were found on plants in Sungai Burong. Soon more than 405 ha were affected (about 28 ha were severely hopperburned), and the outbreak spread to other areas.

Although the BPH spread almost throughout the rice-growing areas in Tanjong Karang during the 1977 outbreak, crop damage was limited to a few localities (see map). Only 1,620 ha of the total 20,243 ha of double-cropped land were ultimately destroyed by hopperburn.

Yield losses were generally severe in all localities where BPH infestation and hopperburn were high. For example, in Sungai Burong, Sungai Leman, and Sungai Pasir Panjang, the severely



Tanjong Karang Irrigation Scheme.

Grain yield in various localities of Tanjong Karang (Malaysia) during season with and without brown planthopper (BPH) outbreaks. [a]

Locality	Grain yield (t/ha)							
	Crops without BPH infestation						Crops with BPH infestation	
	1974–75 MS	1975 OS	1975 –76 MS	1976 OS	Av MS	Av OS	1976–77 MS	1977 OS
Sawah Sempadan	3.09	2.87	2.91	3.08	3.00	2.97	3.56	3.24
Sg. Burong	3.08	4.15	3.73	3.58	3.40	3.87	2.54	1.80
Sekinchan	4.77	5.23	4.68	4.51	4.73	4.87	4.49	4.73
Sg. Lernan	3.88	3.18	3.77	4.25	3.82	3.72	2.56	0.92
Sg. Pasir Panjang	3.40	3.05	3.04	4.17	3.22	3.61	2.83	1.38
Average	3.64	3.70	3.63	3.92	3.63	3.81	3.20	2.41

[a] MS = main season, OS = off-season.

affected crops, on the average, yielded 53, 75, and 62% less than the uninfested crop (see table). In the 1976-77 main-season crops where infestation was less severe, yield reductions were 25.3, 33, and 12.0%, respectively. In Sekinchan, yield losses were only 3–5%, primarily because that area's paddy was heavily infested only at the late stage (near harvest). In Sungai Burong, Sungai Leman, and Sungai Pasir Panjang, the crops were affected about 1 to 1.5 months after transplanting.

The yield losses noted above, although a consequence of the BPH outbreak, were not only due to direct BPH damage. In some areas where insecticides were applied heavily, an upsurge of stem borers (mostly *Chilo polychrysus)* severely damaged crops.

The overall losses to the BPH outbreak were substantial. As much as 25% of the yield (or 870 kg/ha) was lost in 1977, but only about 1%, or 34 kg/ha was lost in the 1976–77 main season. The losses amounted to about $4.16 million and $0.17 million (at the minimum guaranteed price of $14.29/60.48 kg of paddy) for the 1977 off-season and 1976–77 main-season crops. Clearly, efforts to prevent epidemic outbreaks of BPH should be the core strategy in BPH management. It is more important to identify the root of the problems and to seek sound solutions than to repetitiously attempt to treat the symptoms, as is often done during BPH outbreaks. ■

Sheath rot outbreak in the Punjab

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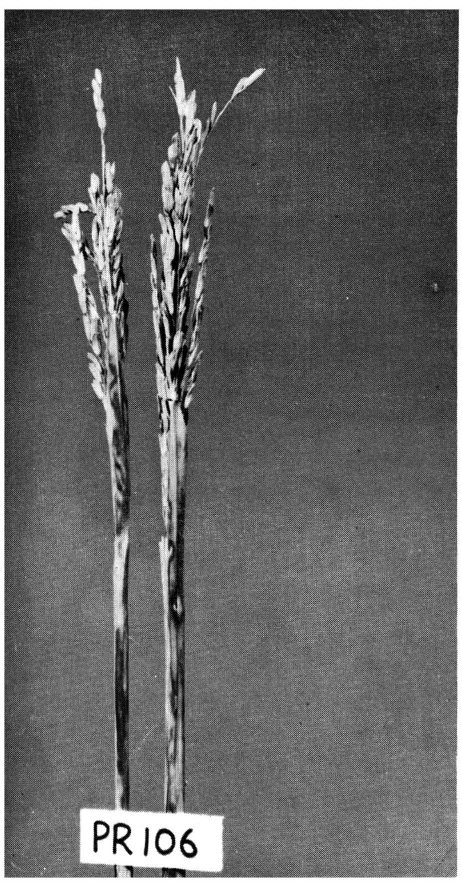
Sheath rot of rice caused by *Acrocylindrium oryzae* (Sawada) was first reported in India from Hyderabad, A.P., in 1974. In the 1978–79 kharif severe infection on semidwarf rice varieties at the PAU Research Farm, Kapurthala, was observed. The disease was also widespread at moderate to severe intensities in farmers' fields. Sheath rot was observed on improved varieties planted in the Punjab — IR8, Jaya, PR106, and PR103. The most susceptible was PR106 (see photo). Disease incidence and severity averaged 30% and 70% throughout the Punjab. Grain chaffiness was 15 to 35%. In severe cases, 100% seed sterility and no panicle emergence were observed.

Diseased portions of the flag leaf sheaths were used in pathogenicity tests.

Cultures of *A. oryzae* were grown on five substrates: pearl millet grains, paddy grains, paddy straw bits, paddy husk, and PDA. The cultures on the first 4 substrates were incubated for 15 days; the PDA culture was incubated for 8 days. PR106 plants were inoculated at the booting stage. Single grains, bits, or husks with the culture were inserted inside the flag leaf sheath just above the floret. For PDA culture, ½ ml of spore suspension was injected into each flag leaf sheath. Disease was recorded 20 days after inoculation.



Sheath rot damage on PR106.

Inoculation by inserting paddy and pearl millet grain culture produced typical disease symptoms, and infected 75% and 70% of the inoculated tillers, respectively. Other methods were less effective. Spore injection produced atypical symptoms. Carbendazim was effective (see table) against the disease. ■

Effect of fungicidal sprays on sheath rot. Punjab Agricultural University, India.

Treatment	Disease intensity (av for 100 plants)
Carbendazim @ 0.1%	3.3
Captafol @ 0.15%	4.0
Mancozeb @ 0.3%	4.8
Hinosan @ 0.1%	4.0
Control – water spray	6.5

Pest management and control WEEDS

Effect of depth of flooding on weeds rowing in association with flooded rice

G. L. Sharma, Agronomy Department, G. B. Pant University of Agriculture and Technology; S. C. Modgal, agronomy professor, Himachal Pradesh Agricultural University, Palampur 176062; and R. C. Gautam, Agronomy Department, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh, India

Flooding of rice checks weed germination and growth, although much of the applied water is wasted. Planting methods also indirectly affect weed growth. Drilled rice generally suffers more from weeds than does transplanted rice, even with flooding.

A 1972—73field experiment at Pantnagar studied the effect of depth of flooding and planting methods on weed growth.

In both years, dry weight and number of weeds decreased when flooding depth increased. Transplanting in puddled soil suppressed weed growth more than did direct drilling in unpuddled soil (Tables 1 and 2). Submergence created an unfavorable environment for most weed species. ■

Table 1. Effect of depth of flooding on weed dry weight and weed number in transplanted rice on puddled soil.[a] Pantnagar, India, 1972–73 wet season.

Depth of flooding	Weed dry wt (g/m^2)				Weeds (no./m^2)			
	19 72		1973		1972		1973	
	35 DT	Harvest	35 DT	Harvest	35 DT	Harvest	35 DT	Harvest
15 cm – 1m	1100	558	1927	640	51	32	72	30
5 cm–field capacity	1155	675	2003	651	68	38	95	58
1 cm–field capacity	3856	1975	2030	1000	197	121	152	62
32 cm total water (50% of total water use)	3891	1921	2100	1052	183	115	288	193
Rainfed	3902	1951	2119	1060	216	127	328	209
CD at 5%	194	137	100	61	–	–	–	–
CV (%)	5	6	2	3	–	–	–	–

[a] DT = days after transplanting.

Table 2. Effect of water management on weed dry weight and weed number in rice drilled on unpuddled soil.[a] Pantnagar, India, 1972—73wet season.

Water management treatment up to 21 DSE	21 DSE to maturity	Weed dry wt (g/m^2)				Weeds (no./m^2)			
		1972		1973		1972		1973	
		45 DS	Harvest	45 DS	Harvest	45 DS	Harvest	45 DS	Harvest
1 cm – FC	15 cm – 1 cm	3640a	750e	3820a	620f	258	48	384	56
1 cm – FC	5 cm – FC	3380b	990c	3650b	1070c	234	68	307	130
1 cm – FC	1 cm – FC	3280c	1290a	3420c	1233b	203	52	208	156
5 cm – 1 cm	15 cm – 1 cm	2100g	840d	2225h	870d	150	58	124	78
5 cm – 1 cm	5 cm – FC	2400f	700e	2860e	790de	202	52	104	71
5 cm – 1 cm	1 cm – FC	2500f	1140b	2557g	998c	124	68	104	79
5 cm – FC	15 cm – 1 cm	2680e	550f	1710f	718f	182	36	120	64
5 cm – FC	5 cm – FC	2160g	840d	2290h	1081g	126	56	128	117
5 cm – FC	1 cm – FC	2970d	1302a	2995d	1357a	170	80	222	170

[a] DSE = days after seedling establishment. DS = days after sowing. FC = field capacity. Any 2 means followed by the same letter do not differ significantly.

Soil and crop management

Fungi attack azolla in Bangladesh

A.K.M. Shahjahan, S.A. Miah, M.A. Nahar, and M.A. Majid, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Bangladesh

Of the six species of Azolla, *A. pinnata* is predominant in Bangladesh. The nitrogen that this aquatic fern supplies to rice plants comes from activity of the blue-green algae *Anabaena,* which lives symbiotically within the fern leaves. Therefore, attempts are being made to mass-cultivate the plant under controlled and field conditions.

Azolla growth throughout the year is not constant mainly because of temperature and humidity variations. Another factor that limits Azolla growth in Bangladesh is fungi attack. Two types of fungi were found to attack the fern leaves in multiplication tanks and pots during two different times of the year at BRRI. One such attack was in February–March and the other, in July–August 1979. During February–March azolla leaves blighted as the water in the tank

Azolla inoculated with *Rhizoctonia* sp. (left) and *S. rolfsii* (right) and their typical symptoms in petri dishes. Bangladesh Rice Research Institute.

was drying. A few days later, fungal growth was seen on the blighted and dried leaves. Isolation showed *Sclerotium rolfsii* to be associated with the growth.

In July–August, the symptoms were of the rotting type. They spread rapidly and covered the entire tank (46 × 91 cm) in 4–5 days. Samples were immediately collected and the causal agent was isolated and examined under a microscope. Mycelia were found branching at right angles over and within rotted leaves. On isolation from several such samples, the same fungus, which closely resembles *Rhizoctonia,* appeared on potato-dextrose agar. Specific identification has not yet been made. Their pathogenicity on azolla was proved by inoculation with these two fungi from the artificially produced symptoms and re-isolation (see photos). Further work on the problem is in progress. ■

Influence of moisture regimes on phosphorus uptake in acid soils

P. K. Bora, associate professor (soils), Assam Agricultural University, Jorhat 13, Assam; and N. N. Goswami, professor (soils), Indian Agricultural Research Institute, New Delhi 12, India

The rice crop's phosphorus uptake from fertilizer and natural soil sources was studied in a greenhouse experiment under continuously submerged (M1) and continuously moist (M2) conditions. Alluvial acid soils from Assam were collected at Sitabar (Soil 1), Dergaon (Soil 2), Golaghat (Soil 3), and Tengakhat (Soil 4) (see table). The uptake of fertilizer phosphorus was determined by radiochemical studies using Pusa 2-21 as test crop.

At the maximum tillering stage, the mean fertilizer phosphorus uptake in M1 was 300 times higher than in M2. At the grain ripening stage, a similar beneficial effect of M1 was recorded. M1 caused a significant increase (3 or 4 times more than M2) in soil phosphorus uptake at both stages. After the maximum tillering stage, the fertilizer phosphorus uptake was practically nil in M1 but was considerable in M2.

Fertilizer and soil phosphorus uptake by the rice crop in acid soils of Assam, India.[a]

Soil no.	Fertilizer phosphorus uptake (mg/pot)						Soil phosphorus uptake (mg/pot)					
	MTS			GRS			MTS			GRS		
	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean	M1	M2	Mean
1	16.6	4.8	10.7	19.5	7.0	13.3	47.0	14.7	30.8	58.6	14.9	36.1
2	23.0	5.9	14.4	23.6	10.0	16.8	71.5	14.6	43.1	52.4	18.2	35.3
3	21.2	5.4	13.3	26.5	8.1	17.3	70.9	16.1	43.5	66.2	15.7	41.0
4	29.7	7.0	18.4	21.8	10.0	15.9	136.0	21.1	78.5	87.5	19.4	53.5
Mean	22.6	5.8	–	22.9	8.8	–	81.3	16.6	–	66.2	17.1	–
CD (5%)												
Soil			3.8**			2.9*			11.5**			6.8**
Moisture			2.7**			2.1**			8.1**			4.8**

[a]MTS = maximum tillering stage, GRS = grain ripening stage, M1 = continuously submerged, M2 = continuously moist.

The results suggest that continuous submergence of rice is an effective management practice for increasing the efficiency of water-soluble phosphatic fertilizers for acid soils. They further indicate that natural soil phosphorus sources play a dominant role in rice production in Assam soils, which are rich in organic phosphorus fractions. ■

Relationship between blue-green alga growth and the standing crop in wetland rice fields

S. A. Kulasooriya, senior lecturer, University of Peradeniya, Sri Lanka; P. A. Roger, soil microbiologist, Office de la Recherche Scientifique et Technique Outre-Mer, France; and I. Watanabe, soil microbiologist, International Rice Research Institute

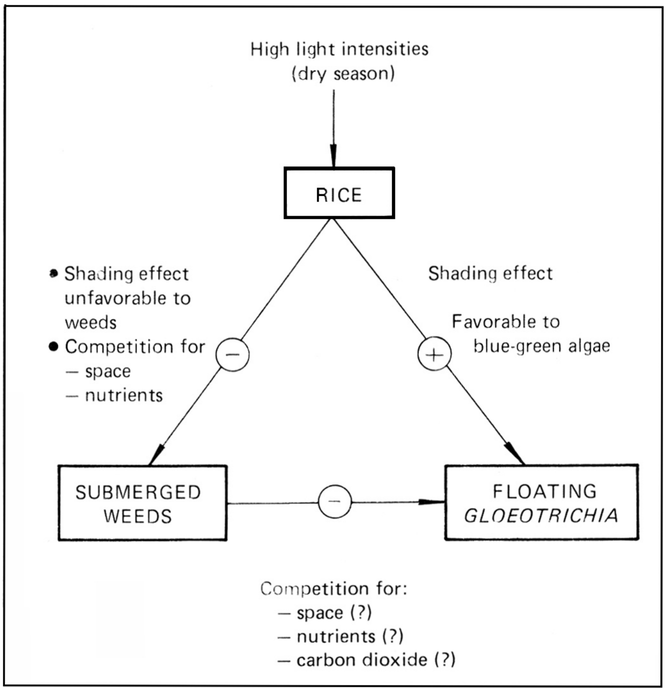
A 1979 dry-season experiment was conducted at IRRI to verify the observation that the presence of plants enhances the growth of *Gloeotrichia* sp., a nitrogen-fixing blue-green alga that forms floating masses in rice fields. A random block of 24 plots, 1.5 m^2 each, was used with 3 replications of 8 treatments: 1 treatment was unplanted, 1 was split bamboo (to simulate rice plants), 5 were planted with rice, and 1 was planted with *Cyperus iria.*

At harvest, data were collected on the fresh weight of *Gloeotrichia* sp., the fresh weight of submerged weeds (mostly *Najas* sp. associated with *Chara* sp.), and the acetylene-reducing activity (ARA) after 2 and 24 hours of *in situ* incubation under acetylene. As acetylene and ethylene diffuse slowly in and out of the water, the 1-hour activity was assumed to be caused by the floating algae and the 24-hour activity, by the total biotope activity.

ARA values ranged from 6 to 88 $\mu mol/m^2$ per ha for 1-hour measurements and from 94 to 4,166 $\mu mol/m^2$ per day for 24-hour measurements, with mean values of 32 $\mu mol/m^2$ per hour and 1,021 $\mu mol/m^2$ per day. A highly significant positive correlation between 1-hour ARA measurements and floating *Gloeotrichia* biomasses was found. This

Mean biomasses of *Gloeotrichia* sp. and submerged weeds in plots with and without rice. IRRI, 1979 dry season.

Biotype	Mean biomass (t/ha fresh wt)		
	With rice (15 plots)	Without rice (9 plots)	Significance of difference
Submerged weeds	2.9	7.5	0.01
Gloeotrichia	4.4	1.1	0.06



Possible interactions between rice, weeds, and algae.

correlation remained significant even for the 24-hour measurements, showing that *Gloeotrichia* floating masses were the principal nitrogen-fixing agents involved.

Although the unplanted plots had little floating algae, they had relatively high ARA. That was primarily because *Gloeotrichia* colonies epiphytic on *Chara* were relatively abundant in the plots. Closer observation showed that *Gloeotrichia* epiphytism was predominant on *Chara* and rare on *Najas.*

The weights of floating *Gloeotrichia* biomasses ranged from 0 to 14 t/ha (mean, 3.3 t/ha). The distribution was log-normal (L-shaped histogram and a mean close to the square root of the variance).

The fresh weights of submerged weed biomasses ranged from 0.2 to 11.8 t/ha (mean, 4.8 t/ha).

The presence of rice increases *Gloeotrichia* growth and decreases the growth of submerged weeds (see table).

Possible relationships between weeds and floating algae were tested by studying correlations between weed and *Gloeotrichia* biomasses and between weed biomasses and 1-hour ARA. Both correlations were significant and negative; the respective *r* values were 0.60 and 0.73 (r 0.05 = 0.67).

Although the results do not fully explain the relationships among the three biotypes, the figure shows some possible interactions.

The results confirm the observation that rice positively affects *Gloeotrichia* growth, either directly by protecting algae against high light intensity, which inhibits their growth or indirectly by limiting the growth of submerged weeds, which seem to compete with floating *Gloeotrichia.* ■

Soil fertility trials in farmers' fields in Sierra Leone

I. C. Mahapatra and S. R. Bapat, Rice Research Station, Rokupr, Sierra Leone

Soil is tested to provide farmers information that enables them to apply adequate – but not excessive – fertilizer to supplement available nutrients. The All Sierra Leone Coordinated Agronomic Trials conducted in farmers' fields in 1978 provided much data on soil fertility evaluation. The multilocational trials sought to determine if soil testing could help predict rice response to added fertilizer. We defined the "critical level" of a nutrient in a soil as the level below

Table 1. Critical levels of organic carbon, available phosphorus, and exchangeable potassium for dryland rice in Sierra Leone.

Nutrient	Critical level	Rice response (kg/ha)	
		Above critical level	Below critical level
Organic carbon	2.4 (%)	540	590
Av phosphorus	10.0 (ppm)	180	410
Exchangeable potassium	0.07 (meq/100 g)	255	605

Table 2. Critical levels of organic carbon, available phosphorus, and exchangeable potassium for rice in inland valley swamps in Sierra Leone.

Nutrient	Critical level	Rice response (kg/ha)	
		Above critical level	Below critical level
Organic carbon	3.6(%)	600	655
Av phosphorus	5.8 (ppm)	690	875
Exchangeable potassium	0.05 (rneq/100 g)	255	520

which the probability of a good response to added fertilizer is high, and above which the probability is low.

The critical level of a particular nutrient is determined as follows:

$$\text{Yield (\%)} = \frac{\text{Yield without nutrient}}{\text{Yield with applied nutrient}} \times 100.$$

The method consists of superimposing two intersecting lines on the soil test percent yield scatter diagram – one line parallel to the y-axis and the other to the x-axis, drawn in a manner that places the maximum number of points in the lower left and upper right quadrants. The point where the line drawn parallel to the y -axis cuts the x -axis is termed the critical level.

This approach was used with data from the field trials to establish critical levels for organic carbon, available phosphorus, and exchangeable potassium in Sierra Leone's two dominant rice ecologies: uplands (41 trials) and inland valley swamps (19 trials).

Tables 1 and 2 indicate that fields with less than 2.4% organic carbon, 10 ppm phosphorus, and 0.07 meq exchangeable potassium/100 g soil should respond positively to the corresponding plant nutrients. ■

Nitrogen management in coarse-textured lowland rice soils

M. A. Singlachar, rice agronomist, Y. S. Veeraraja Urs, junior agronomist, and A. M. Sudhakar, research assistant, University of Agricultural Sciences, Regional Research Station, V. C. Farm, Mandya 571 405, Karnataka, India

Field studies on nitrogen efficiency have been in progress at this center under the International Network for Soil Fertility and Fertilizer Evaluation in Rice (INSFFER) Program for the last two seasons. Under the program various nitrogen sources and application methods to rice have been tested on a red sandy loam soil (Alfisol) of intermediate fertility.

Among the several treatments listed, subsoil application of urea gave the best performance at both low and high nitrogen levels (see table). Mudball or supergranule application resulted in equivalent grain yields. The response to sulfur-coated urea (SCU) was equally encouraging.

Nitrogen efficiency was highest with mudball application. Supergranule and SCU application gave comparable N efficiency. ■

Effects of sources of nitrogen and methods of application on rice yields and nitrogen efficiency, Mandya, Karnataka, 1977 and 1978 kharif.

Source	Method	Grain yield[a] (t/ha) 1977 kharif Low N, 28 kg N/ha	1977 kharif High N, 56 kg N/ha	1978 kharif Low N, 27 kg N/ha	1978 kharif High N, 54 kg N/ha
Control	No nitrogen	2.42 (00)	–	3.50 (00)	–
Urea	Best split (50%, 25%, and 25% N, at planting, tillering, and PI stage)	2.78 (13)	3.21 (14)	4.72 (45)	4.60 (20)
Urea	Basal – band placement in every other row	2.88 (17)	2.84 (8)	–	–
Urea	Basal – mudball for every pair of rows, 10–12 cm soil depth	4.16 (62)	4.83 (43)	–	–
Urea	Basal – supergranules for every pair of rows, 10–12 cm soil depth	3.79 (49)	4.65 (40)	5.12 (60)	5.87 (44)
Urea	Basal – plow sole application	–	–	5.15 (61)	5.72 (41)
SCU	Basal – broadcasting and incorporation	3.74 (47)	4.25 (33)	4.36 (32)	5.44 (36)
SCU	Basal – plow sole application	–	–	4.87 (51)	5.94 (45)
SCU	Basal – broadcasting and incorporation	–	–	4.45 (35)	5.39 (35)

[a]Figures in parentheses indicate the nitrogen efficiency in kilogram grain/kilogram of applied N. Kharif = wet season. PI = panicle initiation.

	IR20	Rasi
General mean yield (t/ha)	3.55	5.03
CD at 0.05	0.63	0.64
CV (%)	12.70	10.00

Effect of azolla inoculation on rice yields

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The water fern azolla, in association with the blue-green algae *Anabaena azollae,* can fix atmospheric nitrogen and supply it to the rice crop after decomposition. The effects of azolla incorporation on rice yield were studied. A field experiment using IR20 was conducted in a randomized block design with four replications in the 1978–79navarai season. Treatments were:

- 0-50-50 kg NPK/ha
- 25-50-50 kg NPK/ha
- 50-50-50 kg NPK/ha
- 75-50-50 kg NPK/ha
- 100-50-50 kg NPK/ha
- 0-50-50 kg NPK/ha + azolla
- 25-50-50 kg NPK/ha + azolla
- 50-50-50 kg NPK/ha + azolla
- 75-50-50 kg NPK/ha + azolla
- 100-50-50 kg NPK/ha + azolla

Urea, superphosphate and muriate of potash were used as sources of N, P, and K. Seven days after transplanting, 300 g azolla/m^2 was inoculated. In about 2 weeks azolla covered the plot surface and was incorporated.

Azolla incorporation increased yields

significantly. Plots treated with 75-50-50 kg NPK + azolla yielded as well as those with 100-50-50 kg NPK alone (5.2 vs 5.4 t/haj, indicating that azolla might supplement 25 kg N/ha. The yield from 0-50-50 kg NPK + azolla (4.4 t/ha) was similar to that from 25-50-50 kg NPK/ha (4.6 t/ha).

A similar investigation was undertaken at the Ambasamudram Paddy Experiment Station in the 1978–79 kar season with the rice variety ADT31. The results show that the incorporation of azolla along with 50 kg N/ha gave yields equal to those with 75 kg N/ha alone (5.9 t/ha) indicating a saving of 25 kg N/ha. Azolla incorporation with 100 kg N/ha was superior to 100 kg N/ha alone (6.5 vs 6.3 t/ha). The results clearly indicated the positive effect of azolla inoculation in increasing grain yield. ■

Field conditions suitable for blue-green algae multiplication

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To determine the optimal field conditions for growth of blue-green algae, a trial was conducted in March 1979 in a field rich in the algae. Six conditions (see table) were tried with four replications. In the 10-m^2 bunded plots of the experiment, water height was maintained at 5 cm. Superphosphate was applied to the plots at 160 kg P_2O_5/ha. To control pests on the algae, 250 g carbofuran 3% G was applied to each plot. Seedlings of ADT31 were used for the planted field treatment.

Blue-green algae[a] yields. Tamil Nadu, India.

Treatment	Yield (kg/10 m^2)	Blue-green algae types in descending order of abundance
With fresh stubbles	5.84	M1, Ad, Pb
With stubbles up to soil surface	5.68	M1, Ad, Pb
Stubbles removed	3.96	M1, Ad, Pb
Stubbles incorporated	4.43	M1, Ad
Plowed, prepared without stubbles	3.16	M1, Ad
Planted field	6.23	M1, Ad
CD	0.36	

[a] Ml = *Microcoleus lacustris,* Ad = *Anabaena doliolum,* Pb = *Plectonema boryanum.*

Twenty days after the treatments began, blue-green algae floating on the water surface were collected, dried, and weighed.

Blue-green algae multiplication was highest in the planted field (see table). In the first three treatments, three types of blue-green algae – *Microcoleus lacustris, Anabaena doliolum,* and *Plectonema boryanum* – were observed. In the others, *P. boryanum* was not found. ■

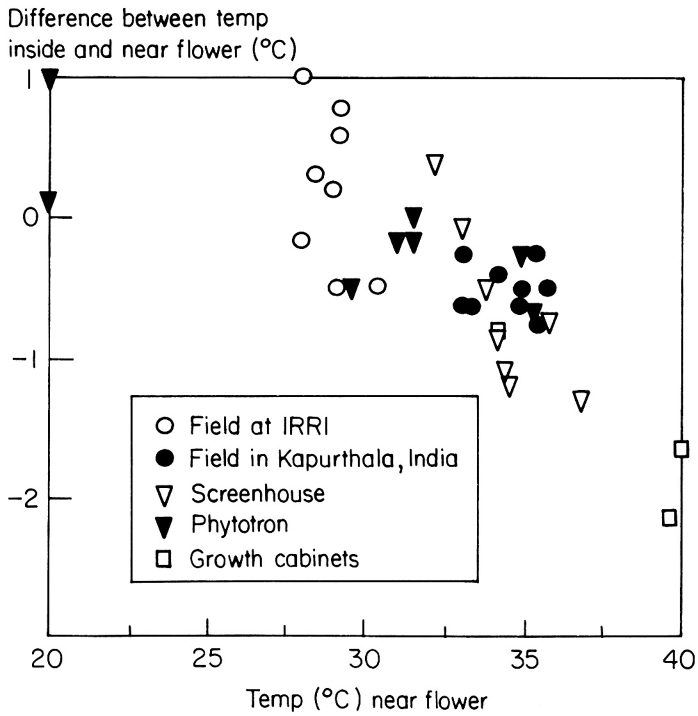
Environment and its influence

Effect of air temperature on rice flower temperature

I. Nishiyama, visiting scientist from the Tropical Agriculture Research Center, Japan (currently assigned to the Plant Physiology Department, International Rice Research Institute)

The temperature inside rice flowers was measured at different air temperatures on days of fine weather under flooding in phytotron glasshouse rooms, growth cabinets, screenhouses, and fields at IRRI and at the Regional Rice Research Station, Punjab Agricultural University, Kapurthala, Punjab, India.

When ambient air temperature was lower than 30°C, the temperature inside the flower was slightly higher (see figure). When it was higher than 30°C, the temperature inside the flower was lower. The difference increased with rising



Effect of air temperature on flower temperature in the rice plant.

temperature, reaching about 2°C at the ambient air temperature of 40°C.

Studies on leaf temperature in other species have yielded the following information:

- Leaf temperature is affected by solar radiation, ambient air temperature, air and soil moisture, and wind velocity.
- Leaf temperature is higher than ambient air temperature with high light intensity, without moisture stress and at lower temperatures. The difference decreases with rising temperature, and leaf temperature becomes lower than that of ambient air above a given temperature (changing point).
- The changing point depends on species and environmental factors, but it tends to be about 33°C under high light intensity without water stress.
- Leaf transpiration causes lowering of leaf temperature at higher air temperature.

Effect of air humidity on difference between inside and ambient temperatures of the rice flower (artificially lit growth cabinet). IRRI, 1979.

Vapor pressure deficit (mb)	Relative humidity (%)	Temperature (°C)		
		Inside flower	Near flower	Difference
12	79	33.1	33.9	–0.8
24	57	33.0	33.9	–0.9
36	36	32.6	34.5	–1.9

The figure shows that the same mechanism regulates temperature in rice flowers and in the leaves of other plant species. Furthermore it indicates that transpiration has the same order in the rice flowers and in the leaves.

Air humidity affects the temperature of the rice flower through transpiration (see table). Wind also affects it in some ways. Nevertheless, the figure provides a rough estimate of flower temperature in flooded fields on fine days.

The data will be useful in studies on sterility induced by high temperature at anthesis. Such sterility is the most serious damage caused by high temperature in the rice plant. The sensitive period is just before and during flower opening, and thus the sterility should be attributed to the temperature inside the flower at that time. Although estimation of flower temperature is not easy and has not been done, these data can be used for approximate estimation of the flower temperature from the air temperature around the flower. ■

Announcements

International rice workshop-monitoring tour in China

Thirty rice researchers from 8 countries recently participated in a 10-day international workshop and monitoring tour in the People's Republic of China.

The workshop-monitoring tour, the first to be held in China, was jointly sponsored by the Chinese Academy of Agricultural Sciences (CAAS) and IRRI. Its major purpose was to encourage cooperation through the International Rice Testing Program (IRTP).

From 22 to 26 October, the group met at the Guangzhou (formerly Canton) branch of CAAS. Papers were presented and collaborative rice research progress was discussed. Emphasis was on breeding to develop varieties with genetic resistance to insects and diseases, and on cultural practices to enable farmers to control pests without costly chemicals. The participants also visited rice-growing communes and rice research centers in southern China.

On 27 October the participants traveled by train to Ch'angsha, central China, where they observed research sites, communes, and the Hunan province branch of CAAS. They also saw part of the more than 5 million ha of hybrid rice now being grown in China.

The IRTP is a worldwide network coordinated by IRRI and financed by a grant from the United Nations Development Programme. Scientists from across the rice-growing world enter their best rice varieties in the IRTP. Seeds of these elite rices are sent to IRRI, which distributes them to peer scientists in about 75 nations for uniform testing under diverse environmental conditions. National scientists release the best IRTP lines to farmers under local names, or cross them with local varieties.

Participants from outside China were: N. C. Brady, IRRI director general; M. R. Vega, IRRI deputy director general; H. E. Kauffman, IRTP joint coordinator; D. V. Seshu, IRTP joint coordinator; Sermsak Awakul, assistant director, Rice Division, Department of Agriculture, Bangkok 9, Thailand; T. T. Chang, IRRI geneticist; Irwin Gunawardena, botanist, Central Agricultural Research Institute, Peradeniya, Sri Lanka; T. R. Hargrove, IRRI editor; E. A. Heinrichs, IRRI entomologist; M. B. Kalode, entomologist, All India Coordinated Rice Improvement Project (AICRIP), Hyderabad, India; G. S. Khush, IRRI plant breeder; K. C. Ling, IRRI plant pathologist; I. N. Oka, entomologist, Central Research Institute for Agriculture (CRIA), Bogor, Indonesia; H. K. Pande, director, Central Rice Research Institute, Cuttack, India; R. Seetharaman, director, AICRIP; B. H. Siwi, rice program leader, CRIA; S. M. H. Zaman, director, Bangladesh Rice Research Institute, Joydebpur, Bangladesh. ■

Some of the participants in the International Rice Research Workshop and Monitoring Tour, at the Guangdung Academy of Agricultural Sciences.

New publications available from IRRI

Twenty-one new publications are available from IRRI's Office of Information Services and Library and Documentation Center. Prices for these new publications are indicated in the table below. To facilitate purchase, you may clip out the ORDER FORM (back page) and send it, along with prepayment, to Division C, Office of Information Services, International Rice Research Institute.

Title	Price[a]			Cost of postage			
	Highly developed nations	Developing nations		Overseas		Philippines	
		Others	Phil.	Airmail	Surface	Airmail	Surface
	($)	($)	(₱)	($)	($)	(₱)	(₱)
Economic consequences of the new rice technology	6.90	2.75	20.00	8.00	0.50	37.00	1.20
Communication responsibilities of the international agricultural research centers	2.50	1.00	7.50	2.30	0.20	11.00	0.60
Research highlights for 1978	7.50	3.00	22.00	2.30	0.20	11.00	0.60
Anatomy of a peasant economy	4.30	1.70	12.00	2.30	0.20	11.00	0.60
Cropping systems development and research	6.30	2.50	20.00	8.00	0.50	37.00	1.20
Report of a cold tolerance workshop	5.50	2.20	16.00	2.30	0.20	11.00	0.60
Rainfed lowland rice	6.80	2.70	19.50	8.00	0.50	37.00	1.20
1978 international deepwater rice workshop	5.30	2.10	15.30	2.30	0.20	11.00	0.60
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