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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 guidelines and style:

Style

- Use the metric system in all papers. Avoid national units of measure (such as cavan, 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 he 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 the full name 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 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.

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, or 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 for commercial chemicals and, when feasible, equipment.
- Do not include references in IRRN contributions.
- Pest surveys should be quantified with data (% infection, degree of severity, etc.).

Genetic evaluation and utilization

OVERALL PROGRESS

Selection for plant height during rapid generation advance in rice breeding

B. S. Vergara, S. K. Bardhan Roy, and G. Pateña, Plant Physiology Department, International Rice Research Institute

Plants grown under low temperature conditions are shorter than those grown at higher temperatures. When grown in low temperature areas, cultivars such as IR8 become very short and the semi-dwarf plant type is inappropriate and inadequate. Selection of cold-tolerant lines for optimum plant height is possible under IRRI farm conditions with the use of lines with plant height of more than 130 cm. Whether such selection is possible or not during rapid generation advance (RGA) in the greenhouse needs to be studied.

In the RGA method for cold-tolerant crosses, many factors affect the expression of plant height. High temperature and close spacing may result in tall plants, while low nutrient level and short growth duration may result in short plants. These factors interact during RGA, especially in the F_2 when plants are generally sown at closer spacing.

A correlative study using two crosses – K78-13/JR5908 and Fujisaka 5/KnlB-361-1-8-6-9 – was run through RGA. Plant height and growth duration of the individual plants in different generations ($F_2 - F_4$) Were measured. Plant height of both greenhouse and field-grown F_4 were also measured. The correlation values (r) for plant height among the different generations are in the table. Although the correlations among the generations are highly significant because of the large number involved, the low values show that selection for plant height should not be done during RGA. A nutrient deficiency condition may inhibit the elongation of late-maturing lines during RGA.

At F_2 of both crosses, the correlation values between plant height and growth duration were as follows:

K78-13/1R5908	0.12939**
Fujisaka 5lKnlB-361-1-8-6-9	0.30620**

The low negative values of correlation indicate that the late-maturing lines are not necessarily tall, or nutrient deficiency inhibited the height expression of the late-maturing lines, which are usually tall. Since growth duration is of primary importance in cold-tolerant rices, selection for earliness should take precedence over selection for optimum height. ■

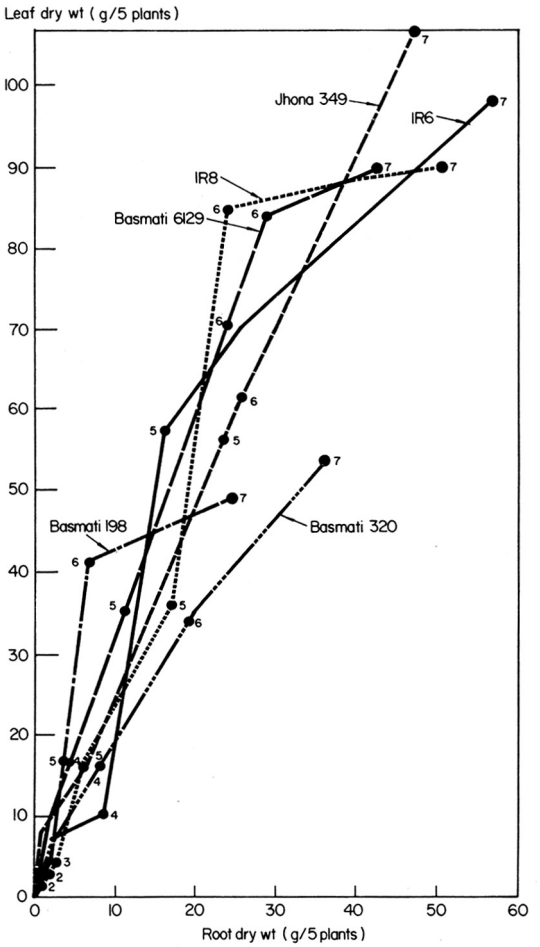
Crosses	F_2 vs F_3	F_3 vs F_4	F_4 greenhouse vs F_4 field
K78-13/IR5908	0.29537**	0.45626**	0.39191**
Fujisaka 5/KnlB-361-1-8-6-9	0.40056**	0.60491**	0.08347**

** = significant at 1% level.

Varietal differences in leaf and root production

Mujibur Rahman Khan, Bangladesh Rice Research Institute, Joydebpur, Dacca; and Mohammad Amin Khan, University of Agriculture, Lyallpur, Pakistan

Balanced growth of leaf and root systems is recognized as important for efficient uptake of water and nutrients by roots and their use by leaves in both normal and stress conditions. Experiments conducted with six rice varieties at the University of Agriculture indicate marked varietal difference in balanced growth of leaves and roots at various growth stages (1–7), at 15-day intervals. The relationship between leaf and root growth was



Relationship between leaf dry weight and root dry weight. 1 = 15 days after sowing (DS), 2 = 30 DS, 3 = 45 DS, 4 = 60 DS, 5 = 75 DS, 6 = 90 DS, 7 = 105 DS.

most balanced in Jhona 349, a reportedly salt-resistant variety. The low-yielding Basmati 320 and Basmati 198 deviated most by producing either low leaf-to-root weights for the former or low root-to-leaf weights for the latter (see figure). IR8, Basmati 6129, and IR6 also showed moderately good relationships in terms of root-to-leaf weight production. Varietal screening for balanced growth of root-to-leaf weight may be helpful in identifying gene pools suitable for growth in diverse situations. ■

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

Diallel analysis of plant height, tiller number, and panicle length in rice

Mujibur Rahman Khan, Bangladesh Rice Research Institute, Dacca; and Moharnmad Amin Khan, University of Agriculture, Lyallpur, Pakistan

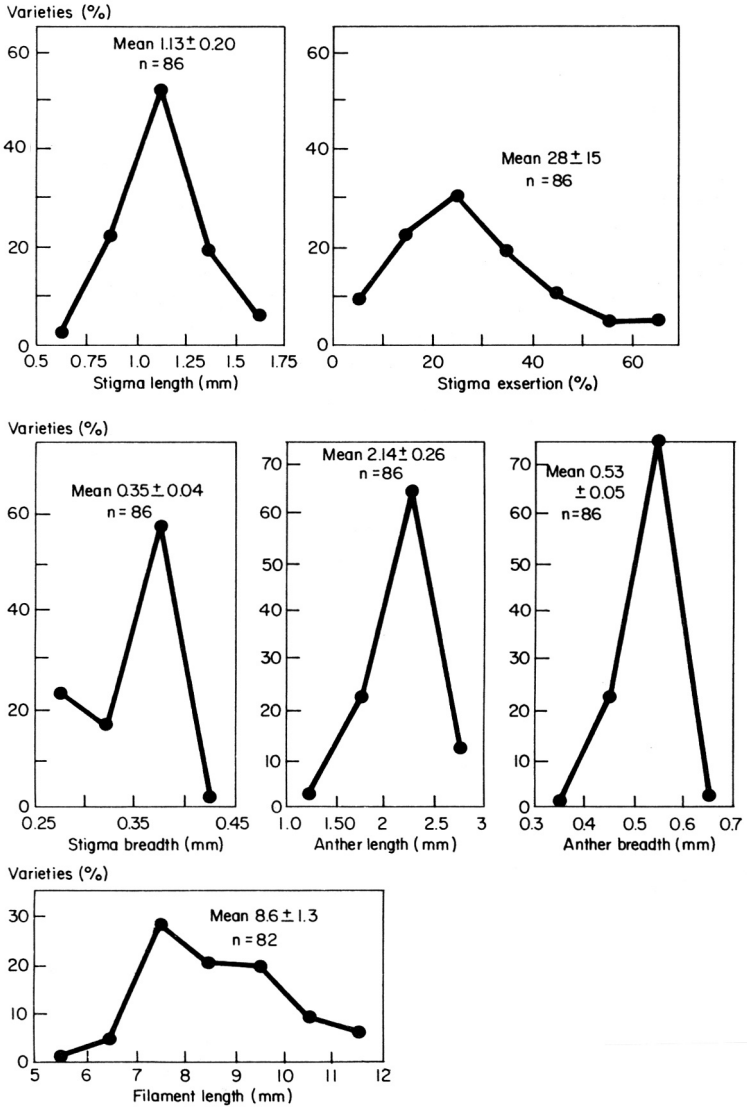
Genetic information obtained by diallel analysis of some rices revealed additive type of gene action for plant height and tiller number and complete dominance type of gene action for panicle length in a study conducted with some traditional and modern rices and their F_1 progenies. Jhona 349, a traditional type, possessed most of the dominant alleles for plant height and tiller number, whereas IR6 possessed an excess of the dominant alleles for panicle length. IR6, IR8, and Basmati 320 had most of the recessive alleles for plant height and tiller number, while Jhona 349 had an excess of the recessive alleles for panicle length. Basmati 320 and IR8 had also many dominant alleles for panicle length.

Diallel analysis of the same rices and their F_1 progenies revealed overdominance type of gene action for number of spikelets per panicle, number of grains per panicle, and additive type of gene action for panicle weight. IR6 and IR8 had most of the dominant alleles for number of spikelets per panicle and number of grains per panicle, while Jhona 349 had an excess of dominant alleles for grain weight. Basmati 320 had an excess of the recessive alleles for number of spikelets per panicle and number of grains per panicle. Basmati 320, IR6, and IR8 had most of the recessive alleles for grain weight.

Rice cultivars possessing some desirable floral traits influencing outcrossing

S. S. Virmani, G. S. Khush, and Ran-Cui Yang, Plant Breeding Department, International Rice Research Institute

Although F_1 hybrid rice varieties have been successfully developed and cultivated in China, the ease and cost of the production of hybrid seed would determine to what extent the approach can be employed to develop high yielding hybrids in other rice-growing countries of the world. The floral structure of rice is not well-adapted to cross-pollination and less than 1% natural outcrossing is observed normally. On male-sterile plants, however, up to 33–45% seed set has been obtained in China. Several floral traits – stigma size, stigma exsertion, duration of opening of spikelet, and anther size and filament length – are known to influence outcrossing in rice. In the hybrid rice research program at IRRI, 86 elite breeding lines were studied for stigma length, stigma breadth, stigma exsertion, anther length, anther breadth, and filament length. There was sufficient



Variability in floral traits influencing outcrossing among 86 selected rice varieties and breeding lines. IRRI, 1980.

variability among rice varieties with regard to the floral characteristics studied (see figure). Eleven rice cultivars possessing some desirable floral traits influencing outcrossing were identified: BG90-2, BPI 121-407, CR179-1-717, IR46, IR2307-247-2-2-3, IR8236-B-B-572-1, IR13188-9, IR13423-10-2-3, IR17492-18-1-2-2, IR17494-32-2-2-1-3, and IR17494-32-3-1-1-3. These cultivars are being used in the IRRI hybrid breeding program. ■

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Bacterial foot rot of rice

T. W. Mew, plant pathologist; and M. B. Rosario, research assistant, International Rice Research Institute

Bacterial foot rot disease was first found infecting a few plants of IR36 in IRRI fields in 1977; its incidence has not increased since. A similar disease was reported in Korea and in India in 1979. Although the disease may have spread fairly widely, difficulty of recognition and identification of the causal bacterium may have handicapped realization of its presence.

Previous reports indicated that the causal pathogen was bacterial. IRRI studies indicate that the disease 1S caused by bacteria quite similar to *Erwinia chrysanthemi,* which causes bacterial cornstalk rot. Isolates from both rice and maize incited typical stalk rot on both crops by cross inoculation. Their general bacteriological characteristics are also similar to those of *E. chrysanthemi.* Four colony variants, distinguished on peptone sucrose agar medium, all incited the disease on rice as well as on maize. A distinct blue pigment was produced on slices of maize stalks by the maize isolates — but not by the rice isolates — at 20°C but not at higher temperatures. The blue pigmentation may be a specific characteristic of the maize isolates different from that of the rice isolates. However, other tests, including colony morphology on crystal violet pectate medium, growth at 36°C, α-methyl glucoside and phosphatase reactions all indicated that the rice isolates from the Philippines were similar to those from Japan and Korea, and those of *E. chrysanthemi* cause cornstalk rot. Bacterial foot rot of rice is therefore similar to the foot rot of rice found in Japan. ■

Coefficient of correlation between two scoring systems and the reaction of resistant varieties in Japan to pathotypes of *Xanthomonas oryzae* in the Philippines

O. Horino, visiting plant pathologist; T. Aballa, research aide; R. Reyes, research assistant; and T. W. Mew, plant pathologist, International Rice Research Institute

The coefficients of correlation between Ezuka and Horino's scale for bacterial blight resistance and that of the IRRI Standard Evaluation System for Rice (SES) for bacterial blight were compared on infection incited by the clipping and pin-pricking inoculations. The results were highly significant.

Using the two scoring systems, 48 varieties from Japan and the Philippines classified into different varietal groups according to resistance to virulence of the bacteria were tested in the greenhouse and in the field against 4 Philippine pathotypes of *X. oryzae.* The varieties

of the Kogyoku group were susceptible to all pathotypes, except 70X-37 which was resistant to type I. The Rantai-emas group varieties were susceptible to types I to IV, but only Zenith and Nigeria 5 were resistant to type III and I, respectively. Of the 10 varieties of the Wase Aikoku group, 2 – Shin 2 and Lead Rice - were susceptible to all the pathotypes, and 6 – Nagomasari, Ortiglia, Chukei 314, Kuntlan, Chugoku 45, and 70X-46 – were resistant to all types. TKM6 was resistant to type I but susceptible to the three others, while Nakashin 120 was resistant to types I, II, and III, but susceptible to IV. Three varieties – Jamica, Zenith G713, and Himekei 16 – belonging to the Java group showed resistant reactions to the four types. Amareriyo of this varietal group was susceptible to all types, but its susceptibility was moderate. Seven IRRI varieties, which have the dominant gene *Xa 4* for resistance, were resistant to type I, but susceptible to types II, III, and IV.

The results revealed that the reaction patterns of 48 varieties to Philippine pathotypes do not coincide with those of known varietal groups in Japan and that different genes may be involved in each variety's resistance. ■

Interaction between the Philippine and Japanese pathotypes of *Xanthomonas oryzae* and differential varieties of Japan and IRRI

O. Horino, R. Reyes, and T. W. Mew, Plant Pathology Department, International Rice Research Institute

Nine rice differentials with specific genes for resistance were evaluated in Japan and the Philippines against local pathotypes. Five (Kinmaze, Kogyoku, Rantai-emas 2, Wase Aikoku 3, and Java 14) were from Japan and four (IR8, IR20, IRI 545-339, and DV85) were from IRRI. Kogyoku, which conveys the *Xa 1* gene for bacterial blight resistance, and Te-tep (*Xa 1* and *Xa 2)* were as susceptible to all four Philippine pathotypes as Kinmaze, the variety carrying no gene for resistance in Japan.

But Wase Aikoku 3 with the *Xa 3* gene, and Java 14 carrying *Xa 1, Xa 3,* and *Xa-kg* genes for resistance in Japan were resistant to the four Philippine pathotypes.

IRRI differentials, however, showed different reactions to the Japanese pathotypes. IR8, carrying no functional resistance gene in the Philippines, was resistant to pathotypes II, III, and V in Japan. IR20, conditioned by a dominant gene *Xa 4* for resistance, was resistant to pathotypes I and V, but susceptible to pathotypes II, III, and IV. IRl545-339 and DV85, conveying their resistance by *xa 5* (a recessive gene) and *Xa 7* (dominant gene) were resistant to all five Japanese pathotypes.

The results indicate that rice differentials developed in Japan and at IRRI react distinctly to the pathotypes in Japan and the Philippines. Likewise, the five pathotypes in Japan and four in the Philippines were individually distinct in virulence to the combined set of rice differentials. ■

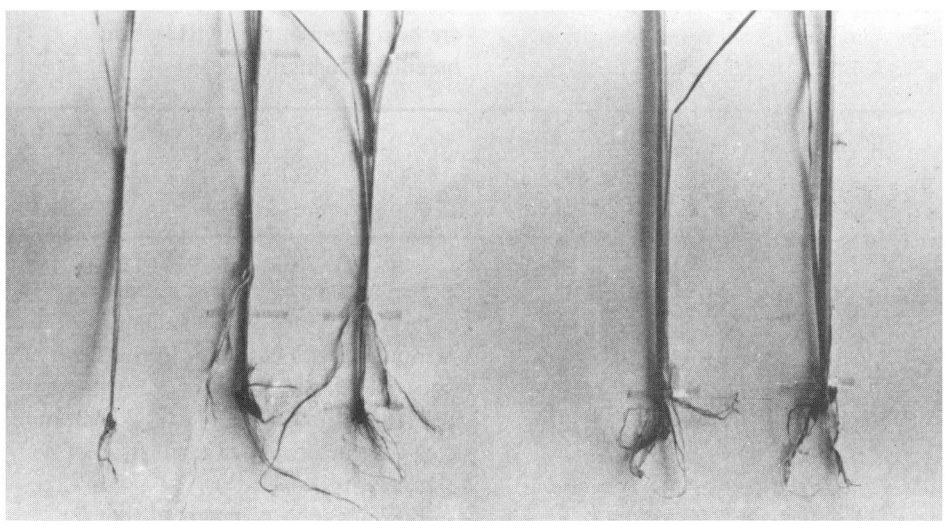
A screening method for bakanae resistance

Suree Sukapanpotharam and Aruni Chantarasnit, Rice Division, Department of Agriculture, Bangkok 9, Thailand

A greenhouse method was developed to screen rice cultivars for resistance to bakanae disease *Fusarium moniliforme* (Sheld.). Before inoculation, seeds are surface-sterilized with hot water (54°C) for 15 minutes. Inoculum is prepared by mixing a culture *F. moniliforme* growing in a petri dish with 50 cc of distilled water (enough to inoculate 4 rice entries, 50 seeds each). After filtration, the seeds are covered with the spore suspension in a petri dish for 10 minutes, then the inoculum is drained and the seeds are placed on moist germination paper for 4 days. The germination percentage is recorded, then the sprouted seeds are transferred to aluminum trays, each holding 10 entries. These are cultured in the greenhouse for 4 weeks before reactions are recorded on a scale of 1 (resistant) to 9 (dead).

By the end of the 4-week period, most susceptible plants are dead, but those still alive show conspicuous yellowish-green symptoms and abnormal elongation and development of adventitious roots at the lower nodes (see photo). For comparison, 50 sterilized seeds of each entry are planted as a check of germination and disease symptoms caused by organisms other than *F. moniliforme.*

Forty varieties and 434 breeding lines from yield trials were screened by this method. The varieties MR7 and MN62M, and 6 experimental lines were found resistant (15% or less affected plants). Of 359 F_4 lines from crosses involving Norin 12 as a resistant parent, 130 had low infection. ■



Cultivars that are susceptible (left) and resistant (right) to bakanae.

Screening for resistance to bacterial blight of rice under rapid generation advance

M. Eunus, Bangladesh Agricultural University, Mymensingh, Bangladesh; H. Ikehashi, National Institute of Agricultural Science, Tsukuba, Japan; and B. S. Vergara and J. Peralta, Plant Physiology Department, International Rice Research Institute

No effective or economical chemical control measures are available so far for bacterial blight (BB) caused by *Xanthomonas oryzae* (Uyeda and Ishiyama) Dowson, one of the most serious rice diseases in Asia. The use of resistant cultivars seems to be the most efficient and economical control measure.

The feasibility of screening rices resistant to BB in rapid generation advance (RGA) facilities at IRRI was determined using 43-day-old seedlings of IR28, IR1545-339-2-2, and CH1039.

Two strains of BB — PXO 61 and PXO 86 — were used for inoculation. IR28 is resistant to PXO 61 but susceptible to PXO 86, IR1545-339-2-2 is resistant to both strains, and CH1039 is susceptible to both.

The BB suspension, applied by the clipping technique, contained 10, 10^{-1}, and 10^{-2} cells/ml.

The plants were grown in a shallow box (55 × 40 × 9 cm) in the RGA facilities. Nitrogen levels were 0, 2, and 4 g ammonium sulfate/week per box from 7 days after germination.

As expected, IR1545-339-2-2 was resistant to all levels of PXO 61 and PXO 86 irrespective of nitrogen levels, while CH1039 showed susceptibility to all concentrations of both strains (see table). lR28 showed resistance to PXO 61 as expected, but failed to show severe lesion development when inoculated with PXO 86 strain, especially at low nitrogen levels. This could be due to several factors including the depressed growth of the variety.

Irrespective of nitrogen application, lesion development increased with the increased concentration of strains. Strain PXO 61, on the average, showed smaller lesions than did PXO 86. Of all the concentrations, 10 cells/ml seemed to be the most effective for lesion development.

The results showed very little delay in flowering as a result of nitrogen level or inoculation by BB. Screening rices resistant to BB seems feasible under RGA. ■

Length of lesions caused by 2 strains of *Xanthomonas oryzae* at 3 concentrations of inoculum on 3 rices grown under RGA conditions. IRRI, 1980.

Nitrogen level[a]	Variety or line	PXO 61					PXO 86				
		Av lesion length (cm)				Expected reaction	Av lesion length (cm)				Expected reaction
		10^0	10^{-1}	10^{-2}	Mean		10^0	10^{-1}	10^{-2}	Mean	
0	IR28	1.3	1.3	1.2	1.3	R	2.8	2.9	2.8	2.8	S
	IR1545-339-2-2	1.3	1.3	1.2	1.3	R	1.5	1.2	1.3	1.3	R
	CH1039	14.8	11.6	9.1	11.8	S	13.4	9.6	8.7	10.6	S
	Mean	5.8	4.7	3.8	4.8		5.9	4.6	4.3	4.9	
2	IR28	1.5	1.4	1.2	1.4	R	4.7	4.6	3.5	4.3	S
	IR1545-339-2-2	1.5	1.3	1.3	1.4	R	1.7	1.7	1.4	1.6	R
	CH1039	15.5	16.7	10.3	14.2	S	17.8	18.7	13.8	16.8	S
	Mean	6.2	6.5	4.3	5.7		8.1	8.3	6.2	7.6	
4	IR28	1.7	1.4	1.2	1.4	R	6.0	5.5	4.9	5.5	S
	IR1545-339-2-2	1.4	1.3	1.2	1.3	R	2.3	1.7	1.5	1.8	R
	CH1039	17.5	16.3	16.0	16.6	S	19.2	18.3	17.5	18.3	S
	Mean	6.9	6.3	6.1	6.4		9.2	8.5	8.0	8.5	

[a]0, 2, 4 grams ammonium sulfate/box per week.

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Screening for brown planthopper resistance

K. Natarajan and K. C. Chandy, Entomology Division, All India Coordinated Rice Improvement Project (AICRIP), Aduthurai 612101, Tamil Nadu, India

Two hundred and four cultivars from AICRIP and IRRI were field-tested for resistance to brown planthopper (BPH) in a randomized replicated trial at the AICRIP center, Aduthurai, in kuruvai 1978. The planting time was adjusted so that BPH infestation was high at flowering. For each variety 2 rows of 17 hills, 1 seedling/hill, were planted. The susceptible checks TN1 and Jaya were planted as skip rows after every 10 cultivars, and 8 rows of Jaya were planted 1 month earlier around the test varieties. The border rows of Jaya were sprayed with 0.02% methyl parathion at 10-day intervals to encourage BPH buildup. Estimates of BPH damage were made on 2 dates about 1 week apart during peak BPH infestation; 5 plants/row of each cultivar were evaluated.

No cultivar was immune to BPH attack, but 11 showed some field

Reaction of rice varieties to brown planthopper (BPH) attack at Aduthurai, India.

Cultivar	Source	BPH population (mean no./ seedling)
ARC6564	AICRIP MR5	2.5
ARC6519	AICRIP MR6	3.0
ARC14636	AICRIP BPHS88	3.0
ARC14166-A	AICRIP MR16	2.8
T1426	AICRIP MR3	3.1
Manohar Sali	AICRIP BPHS122	2.9
Parakulaw	AICRIP MR4	2.8
IET6187	AICRIP BPHRVT (Kh '78)	2.7
PTB33	IRRI-IRTP No. 03302	2.0
Hondarawala (Acc. 15634)	IRRI-IRTP No. 04861	2.0
PTB19 (Athikraya) (Acc. 61 07)	IRRI-IRTP No. 01151	1.9
TN1 (susceptible check)		21.4
Java (susceptible check)		122.3

resistance (see table).

Varieties with large space between tillers because shoots grow obliquely from the base had lower BPH populations; ARC14766-A had 3 BPH/hill of 2 seedlings. Conversely, varieties with compact tillers had the maximum BPH population. ■

Varietal resistance to rice weevil

S. S. Virmani, rice breeder, International Institute of Tropical Agriculture, Central Agricultural Experiment Station, Suakoko (presently visiting scientist, Plant Breeding Department, International Rice Research Institute); P. K. B. Menon, professor of biology, Cuttington University College, Suakoko; and A. S. Gobeh, research assistant (Entomology), Central Agricultural Experiment Station, Suakoko, Bong County, Liberia

The rice weevil *Sitophilus oryzae* is a widespread pest of stored grain in the tropics. The pest caused severe damage in the seed store at the Suakoko Experiment Station, where temperature and humidity were not controlled. Some cultivars were consistently more damaged than others in the same storage conditions.

To study varietal differences in rice weevil damage, 500 healthy grains of 18 varieties were infested with 100 insects each under controlled conditions. Damage was recorded as percentage of grains damaged 8-9 weeks after infestation. Varietal differences in resistance to the pest were contrasting. P14, IRAT10, IR937-55-3, Juma 1, TOS2581, and TOS4030 were found susceptible; M4, M18, and TOS2583 were moderately susceptible; and IR5, Suakoko 8, Gissi 27, LAC23, M55,OS6, 63-83, IRAT13, and IR1754-F5B-23 were resistant (see table).

Varietal differences in damage caused by the rice weevil and hairiness of grain surface. Liberia.

Variety or line	Damage (%)	Grain surface	Weevils (no.) found on 10 panicles before harvest
P14	66.5	Glabrous	–
IRAT10	30.0	”	–
IR937-55-3	31.0	”	–
Juma 1	20.6	”	6
TOS2581	32.1	”	14
TOS4030	25.0	”	–
M4	14.8	Hairy	–
TOS2583	12.1	Glabrous	9
M18	10.0	Hairy	5
IR5	0.6	”	–
Gissi 27	2.0	”	–
Suakoko 8	2.0	”	–
LAC23	0.5	”	–
IR1754-FSB-23	0.7	Glabrous	10
M55	3.9	Hairy	7
IRAT13	2.7	”	8
OS6	1.5	Glabrous	9
63-83	2.4	Hairy	2

Weevils on IR5 and LAC23 were found dead within 2-3 weeks. Seven of the nine resistant varieties had hairy grain surfaces; all susceptible varieties had glabrous grain surfaces; moderately susceptible varieties had either hairy or glabrous grain surfaces.

The resistance mechanism appears to be either morphological or biochemical in nature or both in different varieties.

Pest infestation in the field occurred before harvest. Rice varieties with smooth grain surfaces attracted more weevils than varieties with hairy grain surfaces (see table).

A Hymenopteran parasite and a Heteropteran predator attacked the rice weevil larvae during storage. ■

Assessment of yield losses caused by the earhead-cutting caterpillar *Mythimna separata Walker*

D. J. Pophali, P. D. Deshmukh, U. K. Kaushik, S. K. Shrivastava, G. L. Patidar, and G. A. Gangrade, Operational Research Project on Integrated Control of Rice Pests, College of Agriculture, Raipur, Madhya Pradesh, India

The earhead-cutting caterpillar *Mythimna separata* (Lepidoptera: Noctuidae) is a serious pest of paddy at crop maturity. During the day the pest hides in the dry soil but at night the larvae climb the plant and cut down the rachillae either for food or as a behavioral habit.

Eleven paddy varieties, which are known to be gall midge resistant, were assessed for grain loss by picking up the cut portions of the panicles in three 1- × 1-m^2 plots (see table). The insect population varied from 12 to 14 larvae/m^2 at harvest, despite their migration to adjoining unharvested areas. The weight of the cut-down grain in various varieties was assessed against total yield of the fields.

Grain loss due to earhead-cutting caterpillar *Mythimna separata* larvae. Madhya Pradesh, India.

Variety	Yield (t/ha)	Calculated loss (t/ha)	Percent yield loss due to larvae
R35-2750	4.91	0.36	7.4
R35-2751	4.71	0.49	10.5
R35-2752	4.87	0.30	6.2
R-2384	4.20	0.39	9.4
RP-9-4	4.61	0.31	6.8
RPW6-12	4.31	0.26	6.1
BKN680-52	1.56	0.34	22.0
ORS-GR-181	2.95	0.50	16.8
W-13400	4.03	0.27	6.8
RPW6-17	5.69	0.20	3.6
Surekha	3.87	0.36	9.3

All the varieties suffered damage from larvae of the earhead-cutting caterpillar. Grain loss varied from 0.20 to 0.50 t/ha, which was 3.6 to 22.0% of production. ■

GENETIC EVALUATION & UTILIZATION

Drought resistance

A simple method to characterize rice root systems in relation to drought resistance

J. C. O'Toole, M. A. Maguling, IRRI; and Nawarat Vaivananda, Rice Division, Department of Agriculture, Bangkok, Thailand

According to surveys by economists and anthropologists, rainfed rice farmers believe there is a correlation between the force required to pull seedlings in the seedbed and a variety's drought resistance. This intuitive relationship prompted us to devise a technique to measure this force, test various cultivars, and compare the information with current dry season drought field screening results.

We found that the pulling force could be estimated by the use of a hand-held spring balance with maximum reading indicator and a clamp device fabricated from aluminum and provided with soft rubber or fine sandpaper pads to grip the seedling (Fig. 1).

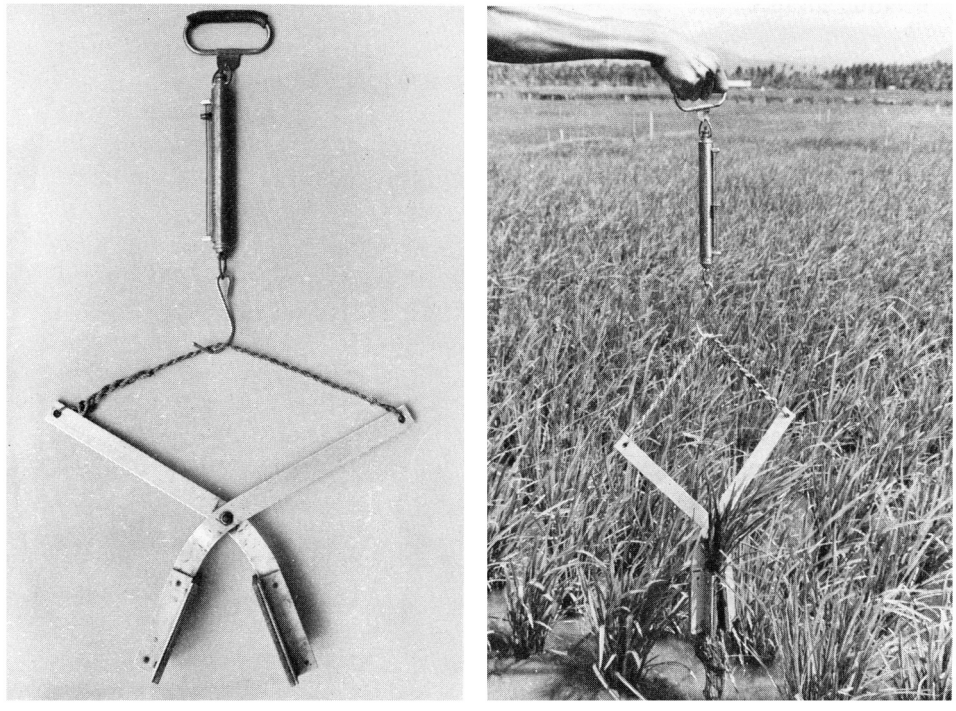
The ratio of varietal variance to total variance was greatest about 35 days after the entries were direct seeded into a well-puddled soil.

Care in site selection, soil preparation, thinning to single plant per hill, and minimizing border effects between hills sampled all helped decrease sampling variation. Variation within the test varieties required 4 replications with 8 observations per replication to attain a CV of 10% or less. With experience, this sampling requirement should decrease.

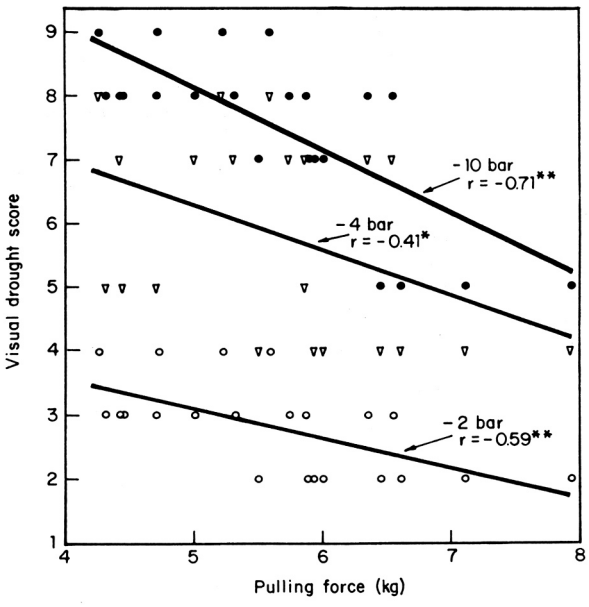
The table illustrates the varietal differences among 20 selected varieties recently tested at IRRI in the 1980 dry season. Field screening results from dry season upland trials are correlated with the root pulling force (Fig. 2), illustrating the value of this technique as a drought screening tool for use at

Varietal differences in the force required to pull up 40-day-old seedlings from puddled soil seed bed. MGL2 and IR20 are check varieties. IRRI, 1980 dry season. Entries connected by a common line are not significantly different at the 5% level.

Variety or line	Root pulling force (kg)
MGL2 (check)	28.7
IR5853-198-1-2	26.8
IR5853-118-5	25.8
IR5853-162-1-2-3	23.1
IR5853-165-1-1-2	22.7
IR42	22.7
IR442-2-58	20.0
Nam Sagui 19	19.4
IR8	19.0
RD8	19.0
RD19	18.8
RD6	18.2
RD9	18.0
KDML 105	18.0
IR36	17.5
RD1	17.1
RD7	16.6
TN1	16.2
RD4	15.9
IR20 (check)	12.8



1. Instrument scale with heavy duty handle and clamp device used to measure force (kg) required to pull rice plants from the soil. IRRI, 1980.



2. Relationship between pulling force of several rice varieties and their drought resistance score at three progressively severe soil moisture levels (–2, –4, and –10 bar soil matric potential at 15-cm depth) in dry season upland field drought screening at IRRI. 1980.

irrigated sites where special field or greenhouse drought-screening facilities are not available.

This technique should also find application as an indicator of variety suitability to other problems that affect root system development such as tolerance for problem soils, insect or disease resistance, or the effect of agronomic practices such as direct seeding or root zone application of fertilizer. ■

Method for screening rice seedlings for drought tolerance during rapid generation advance

M. Eunus, Bangladesh Agricultural University, Mymensingh, Bangladesh; B. S. Vergara and J. A. Peralta, Plant Physiology Department, International Rice Research Institute; and H. Ikehashi, National Institute of Agricultural Science, Tsukuba, Japan

Rapid generation advance (RGA) shortens the growth duration of a population and conserves the potential variability of a given cross. If selection of desirable types becomes possible during RGA, the produced materials would be of greater value to the breeders. Methods for screening varieties for cold tolerance and submergence tolerance at the seedling stage during RGA have already been developed. This study was undertaken to develop a method for screening drought tolerance at the seedling stage without delaying the flowering of the rices under RGA.

Of the traits required for photoperiod-sensitive rices for rained wetland areas, seedling drought tolerance in broadcast-seeded rice is important to ensure stand establishment. In deepwater areas where rice is grown by broadcasting seeds in dry soil, the seedlings invariably suffer from water stress. Sometimes the whole crop is reseeded because mortality due to water stress is high. Thus, it is imperative that the rices for these areas have drought tolerance.

The reproducibility of several greenhouse techniques for screening rices for drought tolerance encouraged US to develop a corresponding technique for use at the seedling stage of plants in RGA.

The procedure follows:

1. Sow pregerminated seeds 2 to a pot. (Ten varieties with known reactions to drought were used in the preliminary tests. The pots were 5.2 cm in diameter and 5.0 cm high with bottom drainage holes. Fertilizer was added at the rate of 2 g each of solophos and muriate of potash per 4 kg of soil. Each pot contained 70 g soil.)

2. Place the pots in a box lined with plastic for ease in maintaining flooded conditions during the growth of the plants.

3. After 5 days of germination, thin to 1 plant/pot.

4. Apply ammonium sulfate at the rate of 35 mg/pot at 14 and 35 days after sowing. The later 3 successive top-dressings can be applied at 15-day intervals.

5. Raise the seedlings under well-watered conditions until 18 days after sowing and then withhold water for 5 days.

(In the RGA greenhouse [27 to 38°C], withholding of water longer than 5 days killed most of the varieties used. The moisture content of the soil at 7 days of moisture stress was 8.7%. In cooler climates, a longer stress period may be necessary. Accurate measurement of drought stress is not necessary; the important thing is to be able to eliminate the susceptible lines during RGA.)

6. Rewater the plants after 5 days of treatment and score for percentage of survival of the population or select the surviving plants 7 days after rewatering.

7. Remove the dead plants to decrease the space needed for growing the surviving plants.

8. After scoring the plants, start the short-day treatment.

The results of the tests showed that drought stress did not delay flowering; however, it reduced plant height, panicle length, and panicle weight, and increased spikelet sterility. During RGA such plant characters are relatively unimportant because no selections based on them are made. ■

Individuals, organizations, and media who wish additional details of information presented in IRRN should write directly to the authors.

Deep water

Deepwater rice yields in Bangladesh

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A severe drought from April to early June 1979 caused poor seedling stands and delayed sowing on the lower Ganges floodplain. Flooding in July damaged the late-planted broadcast aman (b. aman or deepwater rice) crop. Except for the later flood inundation and recession, the 1979 flooding pattern was similar to that of 1978.

The overall mean yield for 101 crop-cuts in 1979 was 2.1 t/ha (range, 0.6–3.7t/ha), 2% higher than farmers' estimates. The mean yield on the Meghna floodplain was significantly higher than that on the Lower Ganges and Lower Jamuna floodplains.

Thirty-three varieties were sampled, eight of them for the first time. The varieties were largely zone-specific and strongly photoperiod sensitive; the mean yields of 6 exceeded 2.5 t/ha. The highest yields were associated with water depths of 1.2 to 1.8 m; late-maturing varieties yielded less than medium- and early-maturing varieties.

Two-thirds of the fields were pure stands of b. aman, a fourth were mixed with aus, and only 6% were mixed with other crops (millet, sesame, chili); three fields were planted to deepwater rice after boro. Yields of b. aman were 25% higher in pure stands but mixed aus – b. aman stands outyielded pure stands in total grain by 0.5 t/ha. Fertilizer was applied to 31% of the pure stands and 30% of the mixed stands, and was used most frequently on the Meghna floodplain. It increased yields in pure stands by 14%.

The ear-cutting caterpillar and ufra nematode caused little damage in the areas sampled. Whiteheads, caused mainly by stem borers, increased in 1979 to 5.4% (101 counts), but early stem damage was lower than in 1978. Rat activity was severe, especially on the Meghna floodplain; 13% of the fields suffered serious grain loss at harvest. Mealy bugs, encouraged by the early drought, caused damage on all floodplains.

Yields in 1979 were 11% lower than in 1978; the largest decline, 0.4 t/ha, was in the Ganges floodplain. Farmers reported total crop loss on 3% of their field. These mean yields are still almost double those quoted in government statistics.

Comparing 1979 and 1978 data at 12 common sites with 21 common varieties, there was little change in the proportion of mixed aus - b. aman cropping, fertilizer use, and weeding intensity; from 88 to 89% of the fields were double- or triple-cropped. The 1979 drought reduced the amount of mixed nonrice cropping, especially on the Ganges floodplain, and delayed sowing of b. aman on the Jamuna and Ganges floodplains.

In 3 years of crop-cut sampling (1977–1979), 45 b. aman varieties were used. Yields exceeded 3.5 t/ha for 7 varieties; the 6 top varieties – Gila Mite, Pankaish, Khama, Kartik Sail, Chota Bawalia, Sarsari – averaged more than 2.5 t/ha, and yielded more than 3 t/ha in 25% of the fields sampled (see table). ■

The ten highest yielding broadcast aman varieties in 1977, 1978, and 1979. Bangladesh.

Variety	Samples (no.)	Mean[a] yield (t/ha)	Frequency ⩾ 3 t/ha (%)	Floodplain
Gila Mite	4	3.0	25	Meghna
Pankaish	13	2.8	31	Meghna
Khama	16	2.6	31	Meghna
Kartik Sail	9	2.6	33	Meghna
Chota Bawalia	15	2.5	13	Jamuna
Sarsari	24	2.5	25	Ganges
Bawalia	7	2.5	29	Jamuna
Lakshmi Digha	17	2.4	6	Ganges
Digha	10	2.3	10	Jamuna
Hijal Digha	6	2.3	0	Jamuna

[a]Analysis of variance was nonsignificant.

Performance and head rice yields of genotypes under flash flood and waterlogged conditions

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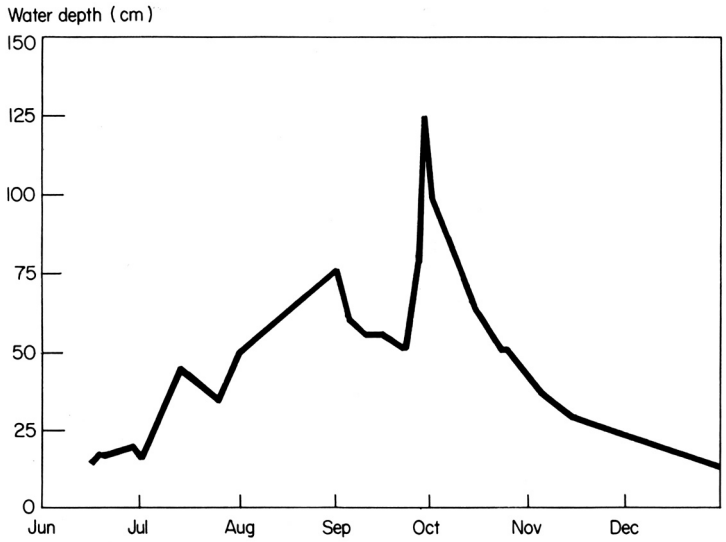
Twenty-six cultivars of long growth duration developed at Chinsurah were tested under typical rainfed wetland conditions in a replicated yield trial in 1978 kharif.

The water depth during most of the crop-growth period exceeded 50 cm (see figure). Water depth was maximum – 125 cm – during the September flood at 135 days after transplanting; the semidwarf lines remained fully submerged for 1 week.

Despite floods at the end of the vegetative phase, 4 tall indicas – Kumargore, OC1393, Patnai 23, and NC1281 – and 2 intermediate Chinsurah lines – CN603 and CNM539 – yielded from 2.5 to 3.6 t/ha (see table). Pankaj yielded only 1 t/ha.

Head rice (husk removed) is the ultimate product of grain yield. The 7 lines differed considerably in husk content. The husk content was 13% for CN603 and 21% for Kumargore, a tall



Water depth during the crop-growth period at the Chinsurah Rice Research Station, West Bengal, India. 1978.

Yield, grain characteristics, and field tolerance for stem borers of some wetland rice cultures. Chinsurah, India.

Variety	Grain yield [a] (t/ha)	Grain wt loss (%) due to husk removal	Estimated kernel yield (t/ha)	100-grain wt (g)		Stem borer damage [b]
				Rough rice	Head rice	
Kumargore	3.6	21	2.8	3.2	2.5	1
OC1393	3.0	20	2.4	3.0	2.4	3
NC1281	2.5	27	1.8	2.4	1.8	3
Patnai 23	2.5	18	2.1	3.0	2.5	3
CNM539	2.5	27	1.8	1.8	1.3	3
CN603	2.5	13	2.1	3.1	2.7	3
Pankaj (check)	1.0	19	0.8	2.5	2.0	5
C.D. (5%)	1.0		0.7			

[a] Mean of 3 replications. [b] At 40 days after transplanting; 1 = resistant, 3 = moderately resistant, 5 = moderately susceptible, 7 = susceptible, and 9 = highly susceptible.

indica. Although the bold-grained Kumargore had a high rough rice yield, its kernel yield after husk removal was reduced to 2.8 t/ha. Based on kernel yield, Kumargore was statistically similar to OC1393 and CN603, and superior to other entries.

CN603 is of intermediate height with more culm stiffness than most tall indicas. It has long slender grains with white kernels. Most traditional indica cultivars in West Bengal have bold, red kernels.

In addition to flood submergence and water stagnation the trial was subjected to severe stem borer incidence at early tillering. Kumargore was tolerant of stem borers; CN603 and CNM539 were moderately tolerant. ■

GENETIC EVALUATION & UTILIZATION

Cold tolerance

Selection for cold tolerance at seedling stage during rapid generation advance

G. Patena, S. K. Bardhan Roy, and B. S. Vergara, Plant Physiology Department, International Rice Research Institute

During the rapid generation advance (RGA) of breeding materials for low temperature areas, screening for cold tolerance at different growth stages may be desirable. The easiest stage to screen is at seedling stage when bulk materials can be easily handled and very little space is needed. The possibility of screening for cold tolerance at the seedling stage during RGA was tested. A preliminary trial used a susceptible cultivar, IR8 (a semidwarf indica), and a cold-tolerant cultivar, Fujisaka 5 (a japonica). Screening for cold water tolerance at the seedling stage involved germinating the seeds in pots and subjecting the 10-day-old seedlings to 12°C water for 10 days, IR8 turned brown, but Fujisaka 5 remained green. However, such treatment delayed flowering by 7 days in Fujisaka 5 and by as much as 22 days in lR8 (Table 1), and partially defeated the purpose of the RGA in shortening the life cycle, especially in IR8.

The possibility of screening for cold tolerance at the seedling stage of segregating F_3, materials with a consequent delay in heading date was studied using the crosses IR20654 (K78-13/IR5908-125-1) and IR22553 (Fujisaka 5/Kn1B-361-1-8-6-9).

The seeds were sown in plastic pots (46 x 46 mm top, 36 x 36 mm bottom) filled with soil and added fertilizer. Ten days after sowing, the plants were subjected to 12°C cold water for 10 days. The plants were scored for leaf yellowing: a score of 1 was best, and 9 indicated almost dead or dead plants. Each F_3 line had a corresponding untreated plant, which was grown to maturity, and the flowering dates of both sets were noted.

A number of F_3 plants (4% in IR22553 and 14% in IR20654) had scores of 1 to 3. Removal of the susceptible lines (score 7 to 9) eliminated 87 and 58% of the F_3, plants in the two crosses studied and increased the available greenhouse space for use within 30 days after sowing.

The results show that cold water treatment at the seedling stage generally delayed the heading date of the two

Table 1. Growth duration of 2 rice varieties subjected to low water temperature at seedling stage. IRRI, 1980.

Variety	Growth (days)		Cold tolerance score [a]
	Treated plants	Untreated plants	
Fujisaka 5	52*	45	1.2
IR8	102*	80	7.7

*Significant at .05 level. [a] Standard Evaluation System for Rice scale of 1–9: 1 = Plants have natural color and normal rate of growth and flowering. 9 = Plants stunted with yellow to brown leaves and much delayed in development and poor panicle exsertion.

Table 2. Effect of a 10-dav 12°C water treatment 10 days after sowing on the growth duration of 2 rice varieties. IRRI, 1980.

Observation	IR22553		IR20654	
	Plants (no.)	% of the population	Plants (no.)	% of the population
Delayed flowering	203	46	362	38
Same flowering duration	103	23	307	32
Early flowering	73	17	137	14
Dead	63	14	148	16
Total number tested	442		954	

Table 3. Effect of 10-day 12°C water treatment 10 days after sowing on the yellowing of leaves of 2 rice varieties. IRRI, 1980.

Score	F_3 plants[a] (no.)	
	IR22553	IR20654
1-3 Green	17 (+5)	129 (+3)
5 Light green	39 (+5)	261 (+9)
7-9 Yellow - dead	386 (+6)	564 (+8)
Total	442	954

[a]Figures inside the parentheses show the average number of days heading was delayed.

crosses studied (Table 2). Some lines, however, actually headed earlier as a result of the treatment. Since the plants are still segregating, it is not possible to definitely say that the treatment caused earliness or delay in heading.

In general, the plants damaged severely by the cold water treatment showed greater delay in heading (Table 3). In both crosses, the difference in average flowering date between the treated plants and the control is small for plants with a score of 1 to 3. Screening for cold tolerance at the seedling stage can be conducted during the RGA of F_3 plants without any great delay in heading of the tolerant lines. ■

Pest management and control DISEASES

Yellow wilt of rice in the lower Amazon Basin, Brazil

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The yellow wilt problem of rice was noted in a few mechanically cultivated fields of irrigated rice in the lower Amazon Basin in the second crop season of 1978. The disorder became more serious in the first and second crop seasons of 1979 on IR22 in the varzea marshland soils.

The rice plant's growth usually proceeded normally until 1 or 2 weeks before the flowering-milk stages; then the older leaves began to die rapidly and the younger leaves turned yellow brown and gradually died back from the tips. About 1 or 2 weeks before harvest, the yellow-brown leaves suddenly withered. Ripening was accelerated and at harvest the affected plants looked dehydrated, dirty, weak, and droopy; and had no green or light-yellow leaves.

Such crops had many decayed and dead roots and were usually attacked by *Helminthosporium* leaf spot, *Cercospora* leaf spot, *Pyricularia* neck blast, or *Rhizoctonia* sheath blight, or two or more of the diseases. But such attacks appeared secondary. Yields were low because of thc low photosynthetic activity of the leaves and the poor root systems. The appropriate harvest time was difficult to determine because the leaves dried and died before maturation, and the same panicles contained green as well as ripe grains. Grain quality was usually poor. In cases where the disorder occurred before flowering, plant growth was poor. A yellow-brown discoloration appeared on the tips of green leaves, and the older leaves dried and died, starting from the tips. At flowering the panicles varied in height and few leaves remained green. Leaves then withered more rapidly. Drainage for harvesting accelerated the withering. The symptoms usually occurred on plants grown in soils of low organic matter. The name *yellow wilt* was used because of the yellowing and wilting symptoms.

A combination of factors including iron toxicity, potassium deficiency, and disease incidence was suspected to cause yellow wilt. Recent studies show that the yellow wilt disorder is associated with potassium deficiency in the soil solution and low potassium content of the plants.

Increasing the supply of potassium fertilizer from the previous recommendation of 20-30 kg/ha to 70-90 kg/ha and split application of potassium noticeably alleviated the disorder.

Three tentative remedies have been recommended:

1. submergence of the varzea marshland soils for at least 1 month before planting;
2. increase in potassium fertilizer up to 70-90 kg/ha and splitting its application; and
3. application of higher levels of potassium fertilizer, but avoidance of excessive nitrogen dressing, at about the maximum-tillering stage. ■

Experimental observations on rice sheath rot disease

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Semidwarf rice cultivars are often susccptible to sheath rot disease caused by *Acrocylindrium oryzae,* but tall cultivars are relatively resistant. Therefore research was conducted to determine if the semidwarfs' susceptibility could be altered by use of a growth substance to change the host plants' growth pattern.

Two consecutive foliar sprays of gibberellic acid (GA, 100 µg/ml) applied

at 7 and 3 days before inoculation (by the method of Purkayastha and Ray Chaudhuri) to 9-week-old semidwarfs Jaya and TN1 significantly reduced sheath rot disease. The treatment also increased plant height. For Jaya, the control was 54.6 cm high; the plant with 100 ppm GA was 83.8 cm. For TN1, the control was 57.2 cm; the plant with 100 ppm GA was 76.7 cm. The length of internodes also increased (Jaya: 7.1 cm for the control, 12.9 cm with 100 ppm GA; TN1: 6.4 cm for the control, 10.81 cm with 100 ppm GA). Low concentrations of GA stimulated mycelial growth (increase of 11.44% with 0.1 µg/ml and 4.8% with 1 µg/ml); higher concentrations (10 and 100 µg/ml) inhibited growth (4.5% and 9.3% reduction, respectively) of the pathogen *in vitro*. Although 100 ppm GA inhibited pathogen growth and decreased disease intensity considerably, it is not clear whether that was a direct effect of GA on the pathogen within the host tissue or was due to changes induced by GA in the plants' growth pattern. Amin and associates pointed out in 1974 that dwarf cultivars were prone to sheath rot probably because of their short internodes. Treatment of noninoculated (healthy) leaf sheaths with GA (100 µg/ml) initially enhanced the amino acid level (Jaya, 7.6%; TN1, 9.3% increase in relation to untreated, non-inoculated control) but decreased it considerably 7 days after inoculation of untreated plants (Jaya, 29.4%; TN1, 32.3% decrease in relation to untreated, non-inoculated control, on the basis of detected amino acids and amides). In the case of GA-treated plants, the amino acid level also decreased 7 days after inoculation (Jaya, 19.3%; TN1, 23.1%).

The amino acids and amides were estimated by the method described by Purkayastha and Mukhopadhyay in 1976. In addition, total phenol contents of leaf sheaths were measured by the method of Folin-Denis. Colorimetric studies revealed that total phenol levels were markedly higher in untreated infected leaf sheaths (by 145.9% in Jaya and by 126.7% in TN1) than in the control and slightly after GA (100 µg/ml) treatment. But ferulic acid significantly increased in treated leaf sheaths. The application of GA may cause biochemical changes in host plants, but it undoubtedly creates a condition unfavorable for the growth of invading parasites. ■

Effect of chemicals on parasitic nematode populations and yields in continuously cropped uplands

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After monitoring nematode populations at Makassa, the upland experimental site of the Rokupr Rice Research Station, a progressive buildup of parasitic nematode populations was noted. In the 1979 cropping season, the 6th successive year that the site was planted to rice, the number of plant parasitic nematodes averaged 1,034/100 cc of rhizospheric soil among plots planted to cultivar TOX502-13-SLR. The recovered nematodes and their relative proportions were *Pratylenchus* sp., 2%; *Helicotylenchus* sp., 25%; *Criconemoides* sp., 21%; *Tylenchus* sp., 16%; *Rotylenchulus* sp., 5%; and *Aphelenchus* sp., 4%. The corresponding figure per 10-g root sample was 219, distributed as follows: *Pratylenchus,* 34%; *Helicotylenchus* sp., 32%; and *Criconemoides,* 34%.

A study to determine the effects of DD, Mocap, and carbofuran on nematode populations and yields was conducted in the 1979 season. DD was applied by pouring a measured quantity into previously prepared holes, 20–30cm deep and 15 cm apart, 2 weeks before seeding. A 1:2 Mocap-sand mixture was prepared and broadcast evenly before sowing. Carbofuran granules, also applied before sowing, were broadcast evenly without mixing with sand.

The cultivars LAC23 and TOX502-13-SLR were used separately. Plots were laid in a randomized complete block design with four replications. The plants were raised following recommended cultural and management practices.

At harvest, the nematode populations in rhizospheric soil and on roots were determined.

All three chemicals significantly reduced parasitic nematode populations in rhizospheric soil and in the roots of both cultivars (Table 1). More nematodes were recovered from the rhizospheric soil than from the roots. All chemicals significantly increased the yields of TOX502-13-SLR, but only DD significantly increased the yields of LAC23 (Table 2). ■

Table 1. Number of plant parasite nematodes in rhizospheric soil and roots at harvest, Sierra Leone.

Treatment	Application	Plant parasitic nematodes (no./100 cc rhizospheric soil)		Plant parasitic nematodes (no./10-g root)	
		TOX502-13-SLR	LAC23	TOX502-13-SLR	LAC23
Control	–	1034	710	219	188
DD	303 liters/ha	689	460	123	102
Mocap	56 kg/ha	597	542	132	106
Carbofuran	31 kg/ha	653	494	120	101
LSD (0.05)		176	49.6	27.4	28.5
CV (%)		14.9	3.2	11.6	11.4

Table 2. Grain yield of two cultivars, Sierra Leone.

Treatment	Yield (t/ha)	
	TOX502-13-SLR	LAC23
Control	1.4	1.9
DD	2.5	3.6
Mocap	2.1	2.4
Furadan	2.2	2.8
LSD (0.05)	0.5	1.1
CV (%)	16.5	26.5

Soil amendments in plant disease control

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The use of nonedible oil cakes and other agricultural and industrial by-products as important tools in biological control of plant pathogens has been recently recognized. Soil amendments encourage growth and multiplication of soil microflora and thus kill pathogens in soil by competition or antibiosis.

A field experiment at RRS in Moncompu during the 1978–79 punja (Oct–Jan) season studied the effect of various nonedible oil cakes and other by-products on the intensity of sheath blight and sheath rot disease of rice.

The intensity of both diseases was lower in amended plots than in unamended plots. The results indicate that the oil cakes and other organic materials tested were equally efficient in suppressing sheath blight and sheath rot (see table). The benefit may be due to stimulation of soil saprophytes leading to a reduction in the pathogen population or to better plant tolerance because of increased nutrition offered by the amendment.

Oil cakes are also useful as insect and rodent repellent and as nitrogen inhibitor. Amending the soil with nonedible cakes will be a good practice in rice cultivation. ■

Effects of treatment with various by-products on the intensity of sheath blight and sheath rot. Kerala, India.

Treatments	Disease score[a] (0-9)	
	Sheath blight	Sheath rot
Neem cake (*Azadirachta indica*), 1 t/ha	2.33	1.93
Marotti cake (*Hydrocarpus* sp.), 1 t/ha	2.33	2.33
Rubber seed cake (*Hevea brasiliensis*), 1 t/ha	2.73	2.46
Puma cake (*Callophyllum inophyllum*), 1 t/ha	2.86	2.06
Coconut pith (*Cocos nucifera*), 2 t/ha	2.46	2.60
Sawdust, 2 t/ha	3.40	3.00
Rice husk (*Oryza sativa*), 2 t/ha	2.86	2.73
Untreated control	7.26	7.00
C.D. (0.05)	1.67	1.72

[a]Standard Evaluation System for Rice scales. Sheath blight: 1 = lesions limited to lower 114 of leaf sheaths. 9 = lesions reaching top of tillers; severe infection on all leaves. Sheath rot: 1 = less than 1% [of tillers affected] (= to resistant check). 9 = 50-100% (= no susceptible check).

Ecology of the rice sheath blight pathogen: saprophytic surival

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It has been well established that the sclerotial bodies of the rice sheath blight pathogen *Thanatephorus cucumeris* serve as the primary inoculum source for initial infection. In temperate regions these sclerotia, usually numbering 1,000/m ^{2}, overwinter in the soil after the rice harvest. An initial attempt at IRRI, a tropical region, indicated that in a field of more than 50% infection, only a small number of sclerotia could be recovered. Previous results indicated that many of the sclerotia in the field were colonized by bacteria, many of which were antagonistic to the fungus.

The saprophytic survival of the pathogen was therefore studied by burying healthy rice straw pieces (2–3 cm apart from the internode) in unsterilized soil of dryland origin. The soil was mixed with different amounts of inoculum and incubated for 1 month under conditions of submergence, and 100% and 50% moisture saturation. The percentage of rice straw colonization by the fungus was lower under submergence than in 50% saturation. When infected rice straw pieces were buried in soil of dryland origin, recovery of the fungus was lower in unsterilized than in sterilized soil. In unsterilized soil and at 50% moisture saturation, a high percentage of the straw was colonized by not only the fungal pathogen, but also by a *Trichoderma* sp. When sterilized rice straw was mixed with the *Trichoderma* and the sheath blight pathogen, the straw decomposed fast when mixed with *Trichoderma* alone. Speed of decomposition was lower with *Trichoderma* plus sheath blight pathogen, and slowest with the sheath blight pathogen alone. In a mixture, a large number of dead sclerotial bodies of *T. cucumeris* were recovered, and the mycelium was found coiled with the *Trichoderma* mycelium. ■

Reaction of wetland rice to *dirty panicle* disease and the influence of soil type and fertilization

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Dirty panicle disease of rice is becoming a major disease in Nigeria with the introduction of improved varieties and high-input technology. The disease has been observed on rainfed dryland rice, but incidence is higher on rainfed wetland rice. Although the precise extent of damage is not known, national rice pathologists associate the disease with a loss in quality of parboiled-milled rice because of the black grains.

In the 1979 wet season (Jun–Oct), the disease was widespread in trials at the Badeggi Rice Research Station and in neighboring rainfed wetland rice farmers' fields. A cooperative investigation was initiated on an acid Oxisol (Agaie soil series) to evaluate the performance of 5 recommended rice cultivars with 12 fertilizer treatments (see table) when exposed to dirty panicle disease under rainfed wetland conditions. Twenty-one-day-old seedlings of each cultivar were transplanted in a 30- × 36-m plot divided into 12 equal parts, 6 × 3 m each. The cultivars were scored for dirty panicle disease incidence during the grain-maturing stage.

IR8 and FARO15 (IR8/BG79) were least infected, suggesting varietal resistance. IR20 and SML140-10 were moderately susceptible, and MAS2401

Reaction of wetland rice cultivars to dirty panicle disease and the influence of fertilization on the disease. Badeggi, Nigeria, 1979 wet season.

Fertilizer	Reaction to dirty panicle disease[a]					
	SML140-10	MAS2401	FARO15	IR8	IR20	Mean
$N_0P_0K_0$	2.5	5.5	1.5	1.5	3.5	2.9
$N_{120}P_{60}K_0$	2.5	3.5	1.5	1.5	2.5	2.3
$N_{120}P_{60}K_{60}$	2.5	8.5	1.5	3.5	2.5	3.7
$N_{120}P_{30}$ + $_{30}K_{60}$	2.5	8.5	5.5	1.5	1.5	3.9
$N_{120}P_{60}K_{30}$ + $_{30}$	3.5	5.5	2.5	1.5	3.5	3.3
$N_{120}P_{30}$ + $_{30}K_{30}$ + $_{30}$	5.5	4.5	2.5	1.5	4.5	3.7
$N_{120}P_{60}K_{60}$ + Zn[b]	2.5	4.5	1.5	1.5	2.5	2.5
$N_{120}P_{60}K_{60}$ + lime[c]	2.5	3.5	1.5	1.5	2.5	2.3
$N_{120}P_{60}K_{60}$ + ash[d]	2.5	3.5	1.5	1.5	2.5	2.3
$N_{120}P_{60}K_{60}$ + Mg[e]	1.5	2.5	1.5	1.5	2.5	1.9
$N_{120}P_{60}K_{60}$ + Si[f]	1.5	2.5	1.5	1.5	2.5	1.9
$N_{120}P_{60}K_{60}$ + Zn + Mg + Si	2.5	2.5	2.5	1.5	2.5	2.3
Mean	2.8	4.6	2.1	1.7	2.8	

[a] 1–3 = resistant, 4–6 = moderately susceptible, 7–9 = susceptible. [b] 2% ZnO as zinc sulfate. [c] 5 t slaked lime/ha. [d] 5 t straw ash/ha. [e] 40 kg MgO/ha as magnesium sulfate. [f] 80 kg SiO_2/ha as sodium metasilicate.

was susceptible. Unbalanced fertilization (application of NPK only) increased disease incidence in resistant, moderately susceptible, and susceptible cultivars; however, liming or application of straw ash or Mg or Si (in addition to NPK) reduced the disease incidence significantly in all cultivars (see table).

Isolations from infected panicles suggest that the primary causal organisms of dirty panicle disease are *Curvularia* spp., particularly *C. lunata, Helminthosporium oryzae,* and *Nigrospora* spp. (most prevalent in susceptible cultivars). ■

Ecology of the rice sheath blight pathogen: parasitic survival

T. W. Mew, plant pathologist; N. G. Fabellar, research aide; and F. A. Elazegui, senior research assistant, International Rice Research Institute

The host range of *Thanatephorus cucumeris* (Frank) Donk, the rice sheath blight pathogen, is wide and includes many weed species. In an initial field experiment with direct-seeded and unweeded IR36, both rice and weeds became infected when the inoculum of the fungus was broadcast on the field. Many weed species including *Echinochloa colona, E. glabrescens, E. crus-galli* ssp. *hispidula,* and *Monochoria vaginalis* were as susceptible as rice. A subsequent survey of the IRRI farm showed many weeds of the Gramineae family in the rice fields naturally infected with the rice sheath blight pathogen (see table). The symptoms were identical to those on rice. In fallow or idle fields under wetland conditions, sclerotial bodies and sometimes the basidial stage of the fungus could be observed on those weeds. A pathogenicity test of isolates obtained from the weeds suggested that they were highly virulent to rice. These weeds obviously are not only hosts for the fungus but also and, perhaps more important, the source of inoculum to infect the rice crop. ■

Some weed hosts of sheath blight organism at IRRI, 1979.

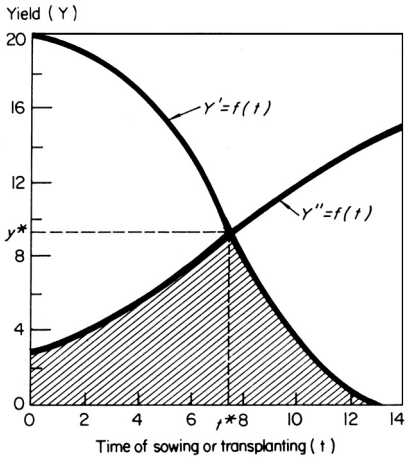
Species name	Family	Plant part isolated	Where collected
Chloris sp.	Gramineae	Sheath	Dryland
Cleome rutidosperma	Capparidaceae	Leaf, pod, seed	Wetland
Digitaria sp.	Gramineae	Blade	Wetland
Echinochloa colona	Gramineae	Blade	Wetland
		sheath	Dryland
E. crus-galli ssp. *hispidula*	Gramineae	Sheath	Wetland
Leptochloa chinensis	Gramineae	Sheath	Wetland
Monochoria vaginalis	Pontederiaceae	Leaf	Wetland
Paspalidium flavidum	Gramineae	Sheath	Wetland
Paspalum distichum	Gramineae	Blade, sheath	Wetland
Rottboellia exaltata	Gramineae	Blade	Dryland
Cynodon dactylon	Gramineae	Blade	Dryland

A theoretical model for ufra control

P. G. Cox, plant pathologist, BRRI/Office of Development Agency Deepwater Rice Pest Management Project, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Bangladesh

Cox and Rahman have suggested that ufra disease of deepwater rice in Bangladesh, caused by the stem nematode *Ditylenchus angustus* Filipjev, might be controlled by any procedure that prolongs the overwinter decay phase of the nematode population in infested crop residues left in the field from the previous season. Such methods include the sowing of early maturing varieties (even though they might have to be harvested from a boat), late sowing (risking early flood damage), or transplanting after the floods arrive (if floodwaters do not rise too quickly). A cost is clearly associated with each procedure. The optimum extension of the decay phase will be determined by a trade-off between the yield gain through pest control and the yield loss associated with adoption of the procedure, even in the absence of any disease (see figure).

The function $Y' = f(t)$ shows the potential yield that might be expected in the absence of disease as a result of postponing the time of sowing or transplanting. The yield falls off as the ground becomes too wet for sowing (even using pregerminated seed), or as the water becomes too deep for transplanting or, in shallow situations, as flowering time approaches. The function $Y'' = f(t)$ shows how the potential yield increases, in the absence of physiological losses, as the time of sowing or transplanting is postponed as a result of ufra control through prolongation of the overwinter decay phase. If the crop technology is



A theoretical model for ufra control. The yield response to late sowing or transplanting in a field affected by ufra is a trade-off between two potential yield functions. Bangladesh.

changed to achieve this effect (e.g. by shifting to a variety that flowers earlier or by the use of pregerminated seed instead of dry seeding), the maximum yields associated with the two functions may not coincide. The base yield of the function *Y",* if the crop is sown at the usual time, may not be zero.

The boundary of the shaded area in the figure defines the yield response that may be achieved by use of the practice. If the functions Y'and Y"overlap, there will be an interior solution for the optimum time of sowing or transplanting (t*), which gives the maximum attainable yield (y*). The precise location of the functions defining the trade-off will depend on the variety used, the management level, the initial inoculum level, and the flood pattern. The future development of ufra control strategies by postponing the time of sowing or transplanting must consider the conditions under which an interior solution is generated. The model does not take into account additional benefits realized only in successive years as the initial level of inoculum is progressively reduced. ■

Ripcord — a synthetic pyrethroid against rice tungro virus

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The possibility of controlling or minimizing incidence of tungro virus was tried by controlling the vector insect through the following insecticides: carbofuran 3% *G,* carbofuran 50% SP, FMC 35001 (carbosulphan) 24% EC, Ripcord (cypermethrin-synthetic pyrethroid) 5% EC, and Dursban (chlorpyriphos) 20% EC. Three methods of application were tried: root soaking, root-zone placement, and foliar spray. Tungro incidence was assessed on tungro-susceptible variety ADT31 60 and 75 days after transplanting (DT). At harvest the nonproductive population stunted by tungro was also assessed.

Data on rice tungro virus incidence. Tamil Nadu, India.

Treatment[a]	Rice tungro (%)		Stunted unproductive population (%)
	60th DT	75th DT	
1. RS with FMC 35001 at 0.04% + 1% urea + RZP of carbofuran at 0.25 kg a.i./ha on 20th DT	77	82	68
2. Treatment 1 + FS with FMC 35001 at 0.5 kg ai/ha on 45th DT	79	82	74
3. Treatment 1 + FS with FMC 35001 at 0.5 kg ai/ha on 25 th and 45 th DT	75	79	68
4. RS with Ripcord at 0.01% + 1% urea + RZP of carbofuran at 0.25 kg ai/ha on 20th DT	79	81	72
5. Treatment 4 + FS with Ripcord at 50 g ai/ha on 45 th DT	77	85	65
6. RS with Ripcord at 0.01% + 1% urea + FS with Ripcord at 50 g ai/ha on 25th and 45th DT	28	52	15
7. RS with carbofuran SP at 0.04% + 1% urea + RZP of carbofuran at 0.25 ai/ha on 20th DT	77	84	66
8. Treatment 7 + FS with carbofuran SP at 0.5 kg ai/ha on 45 th DT	72	84	66
9. RS with carbofuran SP at 0.04% + 1% urea + FS with carbofuran 50 SP at 0.5 kg ai/ha on 25th and 45 th DT	52	70	38
10. RS with chlorpyriphos at 0.04% + 1% urea + RZP of carbofuran at 0.25 kg ai/ha on 20th DT	80	91	68
11. Treatment 10 + FS with chlorpyriphos at 0.5 kg ai/ha on 45th DT	75	84	64
12. RS with chlorpyriphos at 0.04% + 1%. urea + FS with chlorpyriphos at 0.5 kg ai/ha on 25th and 45th DT	76	82	64
13. Control	96	98	81
CD (P-0.05%)	6.8	8.9	5.4

[a]RS = root soaking, RZP = root-zone placement, FS = foliar spray, DT = day(s) after transplanting.

Root soaking with Ripcord along with 1% urea followed by foliar spray with Ripcord on the 25th and 45th DT gave low tungro incidence (see table). The synthetic pyrethroid Ripcord can be effective in reducing tungro incidence if used as foliar spray from 10 to 15 DT 3 times at 10- to 15-day intervals. ■

Chemical control of Helminthosporiose of rice

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Helminthosporiose of rice, caused by *Helminthosporium oryzae,* is widespread in Kerala; its incidence is severe during the rabi (Oct–Jan) cropping season.

A field experiment on chemical control of the disease was conducted at the Pattambi RRS in the 1977–78 kharif and rabi seasons. Seven fungicides — edifenphos EC, zineb, mancozeb, captafol, copper oxychloride, Aureofungin sol, and IBP — were sprayed on plants of the susceptible variety Benibhog three times at 14-day intervals beginning at 30 days after transplanting. The disease incidence was recorded 10 days after the final spraying and graded using the Standard Evaluation System for Rice.

Plants treated with zineb had the lowest disease index in both seasons and a corresponding increase in grain yield.

Control of helminthosporiose of rice. Rice Research Station, Pattambi, Kerala, India.

Treatment	Dose/ha	1977–78 seasons			
		Kharif		Rabi	
		Disease index (%)	Yield (t/ha)	Discease index (%)	Yield (t/ha)
Edifenphos	0.5 liter	53	1.9	57	1.3
Zineb	2.0 kg	49	2.0	53	1.4
Mancozeb	2.0 kg	54	1.9	56	1.4
Captafol	2.0 kg	55	1.8	59	1.3
Copper oxychloride	2.0 kg	53	1.8	58	1.3
Aureofungin sol	0.05 kg	56	1.9	58	1.3
IBP	1.0 liter	50	2.0	58	1.4
Control	–	59	1.7	67	1.2
CD (0.05)		n.s.	n.s.	6.71	0.114

Plants treated with mancozeb, edifenphos, and IBP were amply protected but did not give commensurate yield increases (see table). ■

Herbicides in plant disease control

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A field experiment during punja season (Oct—Feb) in cultivators' fields in Kuttanad area, Alleppey, Kerala, under the Operational Research Project, studied the influence of herbicides on sheath blight and sheath rot control. The average disease scores of sheath blight and sheath rot are given in the table.

Results indicate that spraying the foliage with benthiocarb (Saturn) reduced sheath blight and sheath rot.

Weeding is a problem for rice cultivation in Kuttanad. Because of the high labor cost involved in mechanical weed control, most farmers use chemical weed control. The information obtained through the present trial indicates that benthiocarb (Saturn) has an additional advantage of controlling sheath blight and sheath rot. These diseases are severe in this locality. ■

Average scores of sheath blight and sheath rot with different herbicides. Kerala, India.

Treatment	Sheath blight score (0–9)	Sheath rot score (0–9)
2,4-D spray at 1 kg a.i./ha	2.30	2.40
2,4-D at 1 kg mixed with 50 kg urea/ha applied to soil	3.35	3.15
Weedon (18%), 5 kg mixed with 50 kg urea/ha applied to soil	2.81	2.93
Benthiocarb (Saturn) granules at 2 kg a.i./ha applied to soil	3.15	2.75
Foliar application of benthiocarb at 2 kg a.i./ha	1.50	1.98
Hand weeding (control)	3.20	2.65

Symptoms of ufra disease of deepwater rice in Bangladesh

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Three symptom types are proposed for ufra (caused by the stem nematode *Ditylenchus angustus* Filipjev) as it occurs under Bangladesh field conditions. The symptoms are based on the extent of panicle emergence (see figure). In ufra 1, the panicle fails to emerge; in ufra 2 the panicle exhibits partial emergence; and in ufra 3, the panicle emerges properly, but the grain remains unfilled. The categories *thor* ufra and *pucca* ufra by Butler correspond approximately to ufra 1 and ufra 3, respectively, although ufra 1 includes all panicles that fail to emerge, whether or not they also exhibit the spiral distortion characteristic of severe attack. The newly proposed

The symptoms of ufra (left to right): ufra 1, ufra 2, and ufra 3. Bangladesh Rice Research Institute, Dacca, Bangladesh.

symptom type, ufra 2, is intermediate between ufra 1 and ufra 3, but appears to be distinct. The proportion of panicles in a defined area classified as ufra 2 has been found useful as a disease index. ■

Components of yield loss from ufra

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Ufra (caused by the stem nematode *Ditylenchus angustus* Filipjev) sometimes occurs in well-defined patches within a field in southern Bangladesh. At harvest the patches are often visible from a distance because stems bearing healthy panicles lodge whereas diseased stems, supporting empty heads, remain erect. There is a distinct gradient in disease intensity across a single field.

A field of this type, about 6.5 km west of Chandina in Comilla District, was selected in November 1978. Crop-cuts of 4 m^2 were made in different parts of the field: 3 where disease intensity was highest, 3 where it was moderate, and 3 where it was lowest.

Results of selectivc crop-cuts (4 m^2) in a farmer's field ncar Chandina, Cornilla District, Bangladesh, 29 Nov 1978.

Sample no.	Panicles (no./4 m^2)					Disease indcx			Y ield
	Ufra 1	Ufra 2	Ufra 3	Whitehcads	Total	Ufra I	Ufra II	Ufra III	(t/ha)
1	9	45	42	10	140	6	32	30	0.15
2	13	32	58	2	147	9	22	39	0.35
3	8	40	35	5	198	4	20	18	0.51
4	7	26	78	23	220	3	12	35	0.54
5	4	19	196	6	284	1	7	69	0.85
6	7	13	77	9	236	3	6	33	0.88
7	1	2	111	7	346	0	1	32	1.42
8	0	4	69	9	305	0	1	23	1.70
9	0	0	116	20	536	0	0	22	2.92

All the panicles in each quadrat were harvested; classified as either Ufra 1, Ufra 2, ufra 3 (see preceding article), whiteheads (probably due to stem borer activity), or healthy; and counted. The disease indices ufra I, II, III were defined as the number of ufra I, ufra 2, and ufra 3, expressed as a percentage of the total number of panicles present in the specified area. Each crop was threshed to estimate yield corrected to 14% moisture content (see table).

Both Ufra I and ufra II increased more or less continuously, with yield loss up to severe levels of the disease. Ufra III first increased, then dwindled as the disease intensity (as measured by ufra I or ufra II) increased. Ufra III appears unsuitable as a disease index. Ufra II is suggested as a measure of disease level because it estimates a larger proportion of the yield loss directly at moderate disease levels, it assumes nonzero values at lower loss levels, and ufra 2 is easier to detect in the field than ufra 1. The disadvantages of using ufra II as a disease index are that, even at barely detectable levels, a substantial yield loss has already occurred (this is even more true of ufra I), and the symptom type ufra 2 resembles and may be confused with fungal sheath rot associated with *Sarocladium* spp.

But the loss of panicle density (panicles/m^2) is the major component of the yield loss, about equal to the loss associated with the sum of all three symptom types. For any given disease level, half of the yield loss is represented by non-present panicles and half by panicles that produce no grain. Similar results were obtained in two other fields with distinct ufra patches at the same site in 1977, and in three other fields at different locations in 1978 (one along the Dacca-Narsingdi Road, and two east of Hajiganj, southern Comilla). No fields were examined in 1979 because of the difficulty of finding suitable ones. ■

Simulation of an ufra attack

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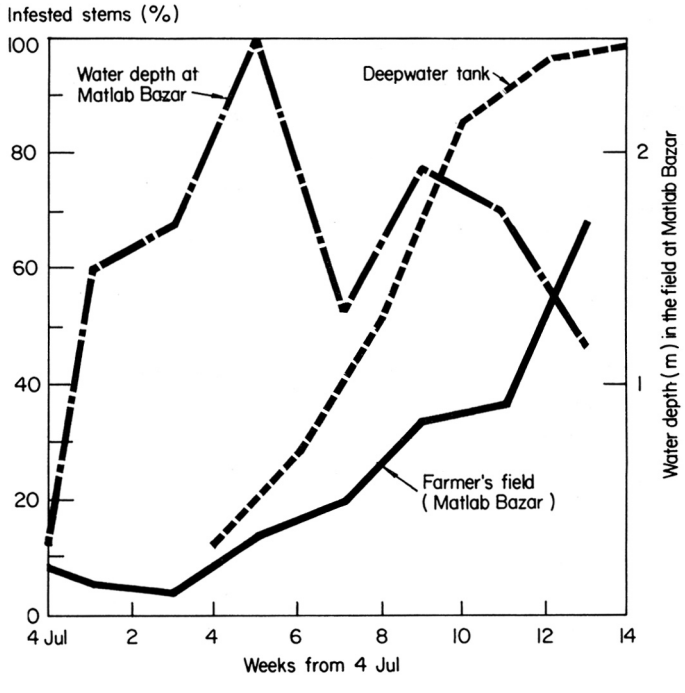
Ufra (caused by the stem nematode *Ditylenchus angustus* Filipjev) is a serious disease of deepwater rice in southern Bangladesh. To make progress in understanding the disease, it is important to be able to simulate natural infestation under controlled conditions. A special deepwater tank has been built at BRRI for use in studying the disease. In 1979, the first year of the tank's use, an ufra patch in deepwater rice was successfully reproduced.

On 10 April 1979, the deepwater rice variety Gorcha was sown in an 8- x 8-m plot in the tank and simultaneously inoculated with 100 infested panicles kept from the previous season (1.6 panicles/m^2). The plot was drenched with water from the main supply to the tank soon after sowing. The tank was flooded in early June and the water depth maintained at about 0.5 m. Every 2 weeks, a random sample of 100 stems was collected with the collector's eyes



The growth of the nematode population (percentage of infested stems) in a farmer's field at Matlab Bazar and in the deepwater tank at BRRI.

closed. The percentage of infested stems and the average number of nematodes per stem (P_t) were estimated using the procedure described by Cox and Rahman (IRRN 4 [3]:10–11).

In early July, a field with plants showing symptoms of ufra attack (a faint chlorotic splash pattern on the young leaves), sown in early March, was found at Matlab Bazar in south Comilla. Samples were taken from this field on alternate weeks (see figure).

The percentage of infested stems first decreased as the water level rose from less than 0.3 m to more than 2.5 m. Some heavily infested stems were submerged, providing a source of nematodes for secondary infestation by waterborne inoculum. After that, the growth of the percentage of infestation was similar in the tank and in the field. The 3-week lag between the 2 growth curves represents the difference in time of flooding. The growth in average number of nematodes per stem also corresponded closely. ■

Pest management and control INSECTS

Rice root weevil in Haryana

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The rice root weevil, formerly a minor pest, has destroyed rice crops in Haryana in the past 3-4 years.

The attack is mainly by *Hydronomodius molitor Faust (Coleoptera: Curculionidae)*. Another allied species, *Bagous* sp., occurs with it. Its infestation of rice in India may be the first so far recorded. The grubs of the two species are similar in appearance, but the adults can easily be distinguished. *H. molitor* adults are shorter than *Bagous* adults (4.0–4.5 cm vs 4.5–5.0 cm long), and thicker.

These species and the white grub *Holotrichia insularis* Br. are comparable in nature of damage and life cycle. The grubs feed on rice roots from July to mid-September, then rest in the deeper soil layers during later months. They begin to attack within 2 weeks after transplanting in July, completely checking plant growth. Attacked plants do not tiller and remain stunted; their leaves turn yellow. Yield losses in attacked fields amount to 30–50% or more. Normally 1–2 grubs/plant in the initial growth stage will cause economic damage. Incidence is maximum in August. During the hot summer months the grubs are found in earthen cocoons, 14–30 cm deep, in compact soil. The adults emerge in June–July and feed on grasses in the absence of rice, then lay eggs in the rice fields.

Incidence of root weevils[a] in Haryana, India.

Grubs (no./plant) in		
1977-78	1978-79	1979-80
14.2	18.1	4.2
13.7	11.3	7.9
18.9	24.7	3.2
17.3	10.7	5.4
15.1	15.8	4.2
14.5	14.8	4.0
13.8	7.1	5.1
21.4	14.2	5.8
17.4	19.4	4.5
14.3	17.5	4.2

[a]Av, 9 plants.

The yearly grub incidence in August in fields near the Kaul Rice Research Station averaged 13.7–21.4 grubs/plant in 1977–78; 7.1–24.7 grubs/plant in 1978-79; and 3.2–7.9 grubs/plant in 1979–80 (see table). The lower incidence in 1979–80 may be attributed to drought that season.

The Commonwealth Institute of Entomology identified the insects. ■

Present and future gall midge control strategies in South China

Shin-Foon Chiu, Plant Protection Department, South China Agricultural College, Kwangchow, China

A change in the cropping patterns of South China to two or three rice crops per year has resulted in outbreaks of gall midge *Orseolia oryzae*. In the past when rice was not available year round, the gall midge overwintered as larvae in the weed *Leersia hexandra* and in wild rice *Oryzae rufipogon*. But gall midge survival on these alternate hosts was low and the gall midge problem was less.

Control strategies based on 5 years of experiments have been implemented over the past 2 years to significantly decrease gall midge damage. These strategies combine cultural control, chemical control, and conservation of natural enemies. The development of host plant resistance and population forecasting with pheromones is being studied.

Cultural control involves timing the rice crops during periods of the year when the relative humidity is unfavorable to the gall midge. A high relative humidity (about 94%) is essential for larvae to hatch and penetrate into the rice tissue. Periodic draining of the fields during periods of favorable relative humidity is practiced. The continuous rice cycle is also broken by crop rotation or the establishment of rice-free fallow periods. The overwintering weed *L. hexandra* is removed by hand from the fields and field borders during the fallow periods.

Chemical control involves spraying or dusting during the peak of adult emergence, the rice tillering stage. The most effective insecticides are pyridofenthion, diazinon, dimethoate mixed with trichlorfon, and pyrimioxythion (N-23) [0-0-diethyl-0 (2-methoxy-4-methyl-pyrimidyl-6, phosphorothionate]. A seedling dip with 0.1% trichlorfon is generally recommended to conserve natural enemies of the gall midge.

Root-zone application and soil incorporation of granules are popular among rice farmers in Kwangtung, Kiangsu, and other provinces. Root-zone application of pyrimioxythion or carbofuran, either in the seedbed or the field, was effective and is safe to parasites

and spiders. Stems of a tobacco cultivar containing 4% nicotine may be mixed with pyrimioxythion for root-zone application. Tobacco stems and leaves alone are effective if applied 5–6 days before the peak of emergence.

Five species of hymenopterous species have been found in Kwangtung: *Platygaster* sp. (polyembryonic), *Platygaster* sp; (monoembryonic), *Nenanastatus cinctinventris* Gir., *N. orientalis* Gir., and *Obtusiclava oryzae* Subba Rao. *Platygaster* (polyembryonic) usually predominates, but *Nenanastatus* increases to 70–80% during seedling and tillering stages of the late crop (both in seedbeds and in the field).

As much as 90% gall midge parasitization occurs in the late crop. Irrational insecticide application, however, kills natural enemies and may encourage gall midge resurgence. Gall midge parasitization in the overwintering generation in wild rice reached 65% in 1976 investigations in San-Huan brigade, Hua County, Kwangtung. Parasitization reached 32–33% in the first and second generations of the early crop, but dropped to 2–5% in late-crop seedbeds (compared with 44% in untreated fields) because of frequent applications (4- to 5-day intervals) of methyl parathion-BHC and dimethoate. The order of toxicity to *Platygaster* sp. as contact poisons was pyrimioxythion > trichlorfon > dimethoate > 2, 5-dimethylphenyl-N-methylcarbamate > chlordimeform.

The growing of gall midge-resistant varieties such as Bao Tou San 2 and Qui Yang Nai 121 is being investigated. Resistant varieties have been tested and biotype variations are being determined in cooperation with the International Rice Testing Program. Research indicates that resistance is antibiotic — under the same infestation conditions larvae were still in the first instar 7 days after hatching in Bao Tou San 2, but all larvae had molted into the second instar in a susceptible variety.

Preliminary experiments on the use of pheromone traps for monitoring and as a control measure are promising. An extract by dichloromethane of the virgin female attracts males at night. Large numbers of males and females have been caught in light trap-pheromone extract combinations. The sex pheromone is being purified and identified; it seems to be an ester. ■

Root-zone application of systemic insecticides for insect control in China

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The effectiveness of thiocyclam hydrogen oxalate (Evisect) for the control of the yellow stem borer and rice thrips. Dosage: 1.5 kg a.i./ha. Root-zone application is better than broadcast.

Results of 5 years' experiments in South China indicated that root-zone application of systemic insecticides effectively controlled almost all potential insect pests of rice: the yellow stem borer *Tryporyza incertulas,* the striped stem borer *Chilo suppressalis,* the pink borer *Sesamia inferens,* the rice leaf folder *Cnaphalocrosis medinalis,* the rice gall midge *Orseolia oryzae,* the brown planthopper *Nilaparvata lugens,* the green leafhopper *Nephotettix* spp., the rice thrips *Baliothrips biformis,* and the rice root weevil *Echinocnemus squameus.*

In extensive trials of 14 compounds, 1 root-zone application of carbofuran granules at 1.5 kg a.i./ha effectively controlled gall midge, yellow stem borer, pink borer, rice thrips, green leafhopper, and brown planthopper. Root-zone carbofuran remained effective against borers 40–60 days; they remained effective against the brown planthopper 30 days after application. One application of carbofuran granules by soil incorporation in rice seedbeds gave good field control of 1 gall midge generation and 2 other pests. The rice seedlings carried the insecticide into the paddy after transplanting with no adverse effects on the egg-larval parasite *Platygaster* spp. This method of carbofuran application is popular among rice farmers in Kwangtung, Kiangsu, and other provinces.

Although carbofuran is a broad-spectrum insecticide, its effectiveness against the leaf folder is low. In fields with heavy leaf folder infestation, application of carbofuran mixed with padan, or dimehypo, or chlordimeform is recommended.

Nereistoxin made from a marine annelid has served as a base for a group of useful insecticides. When applied in the root-zone, the nereistoxin derivatives padan, dimehypo, and thiocyclam hydrogen oxalate ("Evisect," see photo) (San 1551) have recently been found to be good systemic insecticides for control of stem borers, leaf folder, and thrips. These compounds, selective contact and stomach insecticides, act as synaptic blocking agents. Their mode of action differs completely from those of organo-phosphorus and carbamate compounds. The long residual action of soil-applied padan — as long as 50 days after treatment — was outstanding for yellow borer control.

Most farmers in China still rely mainly on cultural practices and insecticides for pest control because biological control agents — including *Trichogramma, Bacillus thuringiensis,* spiders, and

ducks — possess limitations and have been used only in certain regions, and breeding for insect resistance is in its infancy. ■

Gall midge life cycle and plant injury in South China

Shin-Foon Chiu, Plant Protection Department, South China Agricultural College, Kwangchow, China

In Kwangtung Province, South China, the gall midge *Orseolia oryzae* undergoes 9–10 overlapping generations a year to cause its greatest damage to the third irrigated rice crop. A life cycle is completed in 21–38 days.

The larvae feeding within the culm base cause the formation of galls or silver shoots. It is not clear whether feeding activity or a salivary gland substance by the maggot stimulates growth to form a gall. Gall formation is caused by the suppression of leaf primordial differentiation in the growing point and the development of radial ridges from the innermost leaf primordium, followed by leaf sheath elongation. This occurs in the tillering stage. After panicle initiation, larvae no longer cause damage because the growing point has changed (see figure). ■

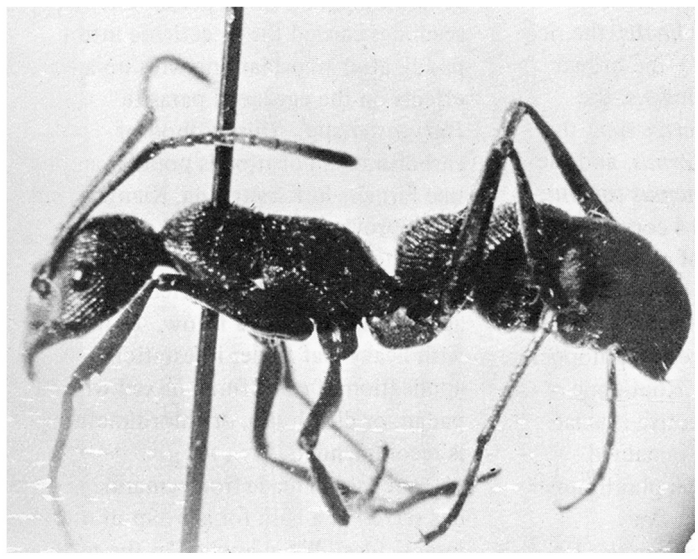
Stage	Duration (days)	Status of gall formation	Diagram showing gall formation	Av length (mm) of the gall	Outer appearance of the rice plant	Type of gall
1st-instar larvae	Early period 1–3	Newly hatched larvae entering the growing point 1			Normal 1	
	Middle period 3–4	Oval-shaped chamber formed by the inner young leaf 2				
	Late period 5–6	Multiplication and thickening of the cells on the upper layer of the oval-shaped chamber 3			Practically normal. But the heart leaf turns green and the base of the plant swells. 2	
2d-instar larvae	Primary period 0.5	Multiplication and thickening of the sponge-shaped cells in the ova-shaped chamber 4		1.6		
	Middle & late period 1–1.5	A gall has completely formed 5			Features of type A galls: 1. The leaves turn deep green and become harder and stand straight. 2. No heart leaf, or the heart leaf shortened. 3. The distance of auricle from the top leaf gets longer, the angle of leaf blade tends to extend, resulting in abnormal growth of the blade. 4. The base of the plant markedly swells.	
3d-instar larvae	3–4	The length of the gall is equal to that of the insect body 6		2.4		
Pre-pupa	2	The gall begins to elongate 7		5.5		
Duration of pupae	1st stage pupae 1.4	The gall markedly elongates		9		
	2d stage pupae 1.4			28		
	3d stage pupae 1.4			53	Feature of type B galls: The galls elongate.	
	4th stage pupae 1.4	The gall elongates very rapidly		96		
	5th stage pupae 1.4			105		

Diagram showing the process of gall formation and the characteristics of the injury due to the rice gall midge. Observations were made on the injury of rice seedlings by 3d generation of rice gall midge in Du-yan Commune, Sin-hui County, Kwangtung Province, China, 1976.

Ants — a natural enemy of *Cnaphalocrosis medinalis* larvae in dryland rice

Alberto T. Barrion, research assistant; and J. A. Litsinger, entomologist, International Rice Research Institute

In dryland areas of Batangas province, Philippines, where 1 crop of rice/year is grown, the leaf folder *Chaphalocrosis medinalis* (Guenee) is the most important insect pest attacking the aboveground portions of the rice plant. But investigation of folded leaves in the 1978 season revealed very few larvae. Possible explanations were sought through field observations. Ants were found to leave their nests in underground tunnels and



Adult of *Diacamma* sp. [120 X](Hymenoptera:Formicidae). IRRI.

move up the rice foliage. They enter folded leaves and prey on larvae, carrying them between their mandibles back to the tunnels. One *Diacamma* sp. worker (see photo) was observed to transport 4–10 larvae/hour; its greatest activity is from 0900 to 1030 and from 1600 to 1730 hours. Six ant species – *Camponotus* nr. *devestivus* Wheeler, *C.* nr. *nawai* Ito, *Diacamma* sp., *Odontomchus* sp., *Odontoponera transversa* (F. Smith), and *Solenopsis germinata* (F.) (identified by Dr. R. Sonobe, Japan) – were found to prey on the leaf folder larvae, but *Diacamma* was the most abundant. Because of its greater prevalence, that species appears to be a better predator of the leaf folder than the carabid beetle *Chlaenius* sp. that we found during the 1977 season.

Pest management and control WEEDS

The black beetle: an efficient weed feeder in Bangladesh

Shamsul Alam and A.N.M. Rezaul Karim, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Bangladesh

A black beetle *Haltica foveicollis* (Jac) (Chrysomelidae: Coleoptera) has been observed since 1969 to be a voracious feeder of the weed *Ludwigia octovalvis* (Jacq.) Raven in rice fields at the BRRI farm, Joydebpur. The insect was recently found to feed extensively on another unidentified broadleaf weed of wheat and lentil fields. The beetle's grubs and adults nibble on the weed leaves and stunt the growth of the weeds so they cannot compete with the crops. In wheat and lentil fields at Madhabdi, many beetle grubs eat the weed leaves without damaging the crops. The beetle virtually controlled the weeds in the lentil fields.

The adult beetles are shiny bluish-black, 4.5 to 6 mm long, and about 3 mm wide. They are found in nonirrigated and in dryland fields. Peak beetle populations have been observed in February–March, June–July, and October–November. The adult beetles are phototropic. More than 700 beetles/night have been caught in light traps at Joydebpur during the third week of February.

Some insects are known as important biological agents in the control of certain weeds. Considering its abundance and feeding habit, the black beetle *H. foveicollis* appears to be a potential control agent of the weeds mentioned.

Effect of weed management and water regime on the yield of farmers' bora rice

Nizam Uddin Ahmed, senior scientific officer; M. Zahidul Hoque, head; Akhter Hossain Khan, scientific officer; Rice Cropping Systems Division, Bangladesh Rice Research Institute, Dacca; and Shah Ahmed Ali Khan, extension officer, DND project, BWDB, Dacca, Bangladesh

Because the intensity of weed problems depends on the agroecological situation, the control measures vary from place to place. To compare the farmers' weed control practices with the unweeded check and other research-managed weeding treatments superimposed in farmers' fields, trials were conducted with transplanted boro rice in several farmers' fields at two test sites in Bangladesh. At Salna, Joydebpur, Dacca, there was little or no standing water most of the time during crop growth because the fields were not regularly irrigated. At Shimrail in Dacca-Narayanganj-Demra (DND) irrigation project of BWDB, the fields had 5–10 cm standing water almost all the time during crop growth.

Average grain yield of boro rice as affected by water regime and weed control practices at 2 test sites. 1979–80 boro season, Dacca, Bangladesh.

Weed control practice[a]	Salna[b]		DND[c]	
	Grain yield (t/ha) of Pajam	Change in yield from unweeded check (%)	Grain yield (t/ha) of BR3	Change in yield from unweeded check (%)
Unweeded check	2.78	100	3.75	100
Weeded once 3 WT	3.22	116	3.95	105
Weeded twice, 3 and 5 WT	3.89	140	4.01	107
Weed free	4.38	158	3.87	103
Farmers' weeding practice	3.14	113	3.81	102

[a] WT = weeks after transplanting. Farmers' weeding practice = 2 weedings: 4 and 6 WT at Salna; 4 and 7 WT at DND. [b] Av of 4 replications in 2 fields having little or no standing water during crop growth. [c] Av of 3 replications in 3 fields having 5 to 10 cm standing water during crop growth.

Except for the weeding operations in the superimposed treatments, farmers did all field operations including weeding in their respective fields. Crop-cuts were made in both the research-managed and farmer-managed plots and grain yields were adjusted at 14% moisture content.

Results indicate (see table) that with inadequate water management at Salna, farmers achieved a 13% yield increase over the control by weeding twice (4 and 6 weeks after transplanting [WT]); but by keeping the fields weed free, they could achieve a 58% yield increase. At DND with better water management, the grain yield from the unweeded plot was reasonably good and farmers' weeding did not cause much increase in yield. Maximum yield increase (7%) over the control was obtained by weeding twice – 3 and 5 WT. The data from the two sites indicate that proper water management during crop growth can considerably reduce the weeding requirements in rice fields. It was also noted that in cases of short water supply, better weed management is required for maximum rice yields. ■

Pest management and control OTHER PESTS

Crabs as pests of wetland rice

P. B. Chatterjee and S. Dutta, Operational Research Project on Integrated Control of Rice Pests, Pandua, Hooghly, West Bengal, India

Crabs, a noninsect invertebrate pest of wetland rice, cause much damage in West Bengal. The peak season of their activity is generally from July to October. Two species of freshwater crabs have been identified: *Paratelphusa hydrodromus* Herbst. and *P. spinigera* Wood-Mason (family Potamidae). Their presence in fields is indicated by burrows with mud rims around the opening.

The crabs are mainly carnivorous, but they also feed on rice nursery seedlings and newly planted ones. They cut at the basal regions of both tender seedlings and older plants. The nocturnal pests often carry young seedlings back to their burrow. Heavily infested rice fields may suffer 60–80% seedling loss. The crabs' burrows also cause leaks in bunds and irrigation systems. ■

Snails — a new pest of azolla

P. B. Chatterjee and S. Dutta, Operational Research Project on Integrated Control of Rice Pests, Pandua, Hooghly, West Bengal, India

A snail was found to damage plants of the water fern *Azolla pinnata,* which harbors the blue-green alga *Anabaena azollae,* during an attempt at its large-scale multiplication for application in rice fields. The snail, identified as *Lymnaea* (*Pseudosuccinea*) *luteola Lamarck,* is quite common in West Bengal wetland rice fields. Conchlike in appearance, its average weight is 0.3 g. The snail floats in water and adheres to the lower surface of the free-floating azolla. About 800 snails/m^2 were observed in a heavily infested rice field. The snails feed voraciously on the host, leaving no remnants. Their peak period of activity is from July to October. The snail is not noticed in the field during the dry winter months from November to January. ■

Soil and crop management

Residual effect of azolla application on rice yield

B. P. R. Subudhi and P. K. Singh, Central Rice Research Institute, Cuttack, India

Field trials on different manuring rates of azolla, both incorporated and unincorporated, suggest that 10 t of incorporated azolla/ha increases rice yields by about 40% over the untreated control and is comparable to the application of 40 kg N/ha as ammonium sulfate. To study the residual effect of that treatment used in three subsequent seasons, the rice variety Vani was again transplanted in the 1978 wet season in the respective plots.

Tillering in azolla-incorporation treatments was superior to that in the other treatments. Residues of 5, 10, 15, and 20 t of incorporated azolla/ha increased yields by 7.7%, 23.8%, 24.5% and 40.1%, respectively, over the control (see table). Inorganic nitrogen fertilizer treatments of 20,40, and 80 kg N/ha increased yields by 12.0%, 14.3%, and 13.8%, respectively. Treatments of azolla incorporated with nitrogen and azolla unincorporated gave higher yields than the control, but less than yields from only incorporated azolla. The straw yield of the azolla incorporated treatment was almost similar to that of the nitrogen treatment; the straw yield of the azolla-unincorporated treatment was significantly higher than that of all other treatments.

Although the organic carbon content

Residual fertility effect of azolla and inorganic nitrogen fertilizer on rice yields (variety, Vani).

Treatment[a]	Organic carbon in soil (%) at 1978 dry-season harvest	Yields, 1978 wet season			
		Grad[b]		Straw[c]	
		t/ha	% over control	t/ha	% over control
Control	0.61	1.9	–	1.6	–
5 t azolla inc./ha	0.63	2.0	7.7	1.8	7.4
10 t azolla inc./ha	0.76	2.3	23.8	1.8	6.0
15 t azolla inc./ha	0.73	2.4	24.5	1.8	7.4
20 t azolla inc./ha	0.85	2.7	40.1	1.8	9.0
20 kg N/ha	0.67	2.1	12.0	1.7	4.5
40 kg N/ha	0.66	2.2	14.3	1.8	9.0
60 kg N/ha	0.66	2.1	11.5	1.7	3.0
80 kg N/ha	0.63	2.2	13.8	1.7	4.5
20 kg N + 5 t azolla inc./ha	0.68	2.2	18.0	1.8	6.0
30 kg N + 7.5 azolla inc./ha	0.76	2.2	18.6	1.9	11.8
40 kg N + 10 t azolla inc./ha	0.86	2.0	7.6	1.8	8.9
3 t azolla uninc.	0.69	2.0	4.3	1.9	14.8
4.5 t azolla uninc.	0.73	1.3	2.3	2.1	29.5
6 t azolla uninc.	0.76	2.1	10.3	2.3	40.2

[a]inc. = incorporated, uninc. = unincorporated. [b]At 14% moisture. [c]Sun-dried.

in the soil of the incorporated azolla and azolla incorporated with nitrogen treatment was almost the same before the residuals study, the azolla-incorporated treatment yielded higher. ■

Azolla manuring and grain yield of rice

S. Srinivasan, Paddy Experiment Station, Aduthurai 612101, Tamil Nadu, India

Azolla at 10, 20, and 30 t/ha tested at this station gave significant increase in grain yield. To determine the response of the highest level of azolla that would give a significant yield increase, a replicated trial was conducted during 1979 thaladi season. Azolla at 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 t/ha was applied in the plots, and incorporated.

Data on grain yield of rice. Aduthurai, Tamil Nadu, India.

Azolla manure (t/ha)	Grain yield (t/ha)
0	3.9
10	4.4
20	5.0
30	5.6
40	6.2
50	6.7
60	7.3
70	7.6
80	7.8
90	8.0
100	8.0
C.D = (*P* = 0.05%)	465

A week later, the short-duration variety ADT31 was planted. Data on grain yield are in the table.

Yield increases in the short-duration ADT31 were significant up to 60 t azolla/ha. ■

Clay mineralogies and available phosphorus and exchangeable potassium status of some Philippine rice soils

M. I. Bajwa, postdoctoral fellow; and F. N. Ponnamperuma, principal soil chemist, International Rice Research Institute

Clay fractions of 160 surface soil samples from 12 major rice-growing provinces in the Philippines were analyzed by x-ray diffractometry. The dominant compositions were vermiculite, beidellite, montmorillonite; all three minerals with and without halloysite; halloysite; and x-ray amorphous materials.

Table 1. Clay mineralogy in relation to exchangeable potassium in Philippine soils. IRRI, 1980.[a]

Exchangeable K (meq/100 g)	Dominant minerals	Major minerals	Minor minerals
< 0.1	Vermiculite, beidellite	–	Occasional halloysite
0.1–0.2	Vermiculite, beidcllite	–	Montmorillonite
0.2–0.5	Montmorillonite, halloysite, x-ray amorphous material	Montmorillonite, halloysite, x-ray amorphous material	–
> 0.5	Montmorillonite	Hydrous mica	Feldspars

[a]Dominant = > 50%, major = 20–50%, minor = < 20%, – = not observed.

Table 2. Clay mineralogy in relation to available phosphorus in Philippine rice soils. IRRI, 1980.

Olsen P (ppm)	Dominant/major minerals[a]	Minor minerals
< 5	Halloysite/kaolinite/x-ray amorphous material	Vermiculite/beidellite/ montmorillonite
5–10	Vermiculite/beidellite/ montmorillonite	Halloysite/kaolinite/x-ray amorphous material
> 10	Vermiculite/beidellite/ montmorillonite	Hydrous mica/feldspars

[a]Dominant = >50%, major = 20–50%, minor = <20%.

All soils with dominant vermiculite or beidellite, the exchangeable potassium content was less than 0.1 meq/100 g; when those 2 minerals were accompanied by montmorillonite as a minor component, the exchangeable potassium value rose to 0.2 meq/100 g. In almost all other soils the exchangeable potassium content exceeded 0.2 meq/100 g, reflecting an adequate level of available potassium (Table 1).

All soils containing halloysite or x-ray amorphous material had (Olsen) available phosphorus values below 10 ppm, indicating an inadequate available phosphorus status. The mean for samples with dominant halloysite was 2 ppm; the mean for samples with x-ray amorphous material or with halloysite as a secondary component was about 5 ppm. Olsen phosphorus values for almost all other soils containing dominant beidellite, vermiculite, or montmorillonite ranged from 10 to 50 ppm (Table 2), showing a high available phosphorus status.

Farmers' experience and trials by the Philippine Bureau of Soils showed severe potassium deficiency and lack of response to potassium fertilizers on many soils in Zambales, Pampanga, TarIac, and Nueva Ecija Provinces, in which vermiculite and beidellite were dominant. Phosphorus deficiency appeared related to the presence of halloysite or x-ray amorphous material in the clay fraction. Soils in which montmorillonite is dominant apparently have adequate supplies of both available phosphorus and potassium.

Because soils with dominant vermiculite and beidellite clay mineralogies fix potassium and ammonium fertilizers and those with dominant halloysite and x-ray amorphous material may inactivate phosphate fertilizers, fertilizer management practices suited to such soils should be developed. ■

Development of semidwarf dryland rice cultivars tolerant of iron chlorosis

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In Maharashtra State, the high yielding semidwarf varieties such as IR8, TN1, Jaya, and their progeny are traditionally

grown in the high rainfall zone with lateritic soils (Oxisols) as a wetland, transplanted crop.

Recently rice cultivation in the arid to semiarid regions of the state was boosted with the construction of dams and a network of irrigation systems. Soils of the region are typical Vertisols, medium to deep black, having about 40–65% montmorillonitic clay, and are calcareous (pH of 8.0–9.2). Fertile soils and abundance of sunshine and irrigation water have created a good potential for rice cultivation in this nontraditional area, which is about 300,000 ha. Extension of rice cultivation to these lands during the past 4–5 years has not been successful because of the lodging habit and low fertilizer response of the tall local cultivars, and iron chlorosis encountered by the high yielding semidwarf varieties and their derivatives. In these calcareous and aerobic soils available iron is low. Submerging the soils can increase iron availability. But puddling the soil and transplanting spoil the soil structure so that the soil becomes useless for crops in the following season. Thus, a rice crop on these soils must be a drilled dryland crop.

All the semidwarf varieties and derivatives tried so far have the Dee-Geo-Woo-Gen dwarfing gene, which probably has tight linkage with the gene or genes that confer susceptibility to iron deficiency. The local tall cultivars are efficient in extracting iron from these soils, and hence do not normally show symptoms of iron chlorosis. To develop alternative sources of the dwarfing habit, the local tall cultivars were subjected to mutagenesis. Semidwarf mutants isolated in the M_2 generation were evaluated in the M_5 along with the checks in 22.5-cm spaced rows fertilized with 80 kg N and 40 kg P_2O_5/ha. The salient features of some of the semidwarf mutants and the tall checks are presented in the table. The mutants are tolerant of iron chlorosis, are nonlodging, and have good yield potential. Preliminary indications are that they are fertilizer responsive. Experiments on the agronomic manipulation of the mutants and their evaluation on a wider scale are under progress. ■

Salient features of the semidwarf mutants and local tall cultivars. Maharashtra, India.

Strain	Plant ht (cm)	Lodging score (0–4)	Days to maturity (seed to seed)	Effective tillers (no./m²)	Yield (t/ha)
		Local			
Tuljapur 1	98	4	101	269	2.5
Jalgaon 5	115	4	104	258	2.8
Ambemohor	117	4	104	265	3.8
		Semidwarf mutants			
A-1	78	0	105	290	3.5
A-7	81	0	108	254	3.3
A-20	90	1	106	225	3.3

Effect of flooding depth on nitrogen, phosphate, and potash availability and change in electrochemical behavior of puddled and unpuddled soils

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

A field experiment on water management of rice was conducted at Pantnagar, India. Total nitrogen content and availability of phosphorus and potassium increased with water depth (Table 1, 2).

pH decreased slightly with increasing depth of submergence in puddled soil, but not in unpuddled soil. The specific conductance value, however, increased with depth of flooding in both puddled and unpuddled soils. No change in the specific conductance value was observed in the saturation and rainfed treatments (Table 1, 2). ■

Table 1. Effect of depth of submergence on availability of nitrogen, phosphate, and potash; and on pH and specific conductance in puddled soils. 1973 wet season, Pantnagar, India.

Depth of submergence	Total nitrogen (%)	Available nutrients (kg/ha)		soil pH	Specific conductance (mmho/cm) at 25°C
		P_2O_5	K_2O		
15 cm – 1 cm	0.156	105.5	168.2	7.5	0.65
5 cm – field capacity	0.151	99.0	165.3	7.5	0.50
1 cm – field capacity	0.149	81.7	161.8	7.7	0.45
36 cm total water use (50% of total water use)	0.147	81.7	161.9	7.7	0.45
Rainfed	0.148	81.8	161.8	7.7	0.45

Table 2. Effect of depth of submergence on availability of nitrogen, phosphate, and potash; and on soil pH and specific conductance in unpuddled soils. 1973 wet season, Pantnagar, India.[a]

Depth of submergence until 21 DSE	Depth of submergence from 21 DSE to maturity	Total N (%)	Available nutrients (kg/ha)		Soil pH	Specific conductance (mmho/cm) at 25°C
			P_2O_5	K_2O		
1 cm – FC	15 cm – 1 cm	0.18	85.9	156.5	7.6	0.60
1 cm – FC	5 cm – FC	0.15	82.4	141.1	7.6	0.60
1 cm – FC	1 cm – FC	0.11	76.3	127.7	7.7	0.45
5 cm – 1 cm	15 cm – 1 cm	0.18	94.6	164.4	7.6	0.63
5 cm – 1 cm	5 cm – FC	0.16	78.8	151.2	7.6	0.50
5 cm – FC	15 cm – 1 cm	0.13	76.6	120.9	7.7	0.45
5 cm – FC	5 cm – FC	0.18	81.7	168.0	7.5	0.62
5 cm – FC	5 cm – FC	0.14	77.6	164.6	7.6	0.52
5 cm – FC	1 cm – FC	0.13	75.8	141.1	7.7	0.45

[a] DSE = days after seedling establishment, FC = field capacity.

Blue-green algae multiplication in freshwater ponds and ditches

S. Srinivasan, Paddy Experiment Station, Aduthurai 612101, Tamil Nadu, India

An easy method of multiplying blue-green algae (BGA) was standardized in 1977 — the algae are simply incubated in the rice field with water. Further study showed that abundantly available small, shallow, stagnant ponds and ditches in almost all the villages of Tanjore district in Tamil Nadu can be used as multiplication sites of BGA during summer (Mar-Jun). A survey showed species of *Gloeotrichia, Nostoc, Aphanothece, Cylindrospermum, Anabaena, Aulosira, Plectonema,* and *Scytonema* growing in freshwater tanks and ditches. The details for multiplication follow:

1. If the channel water is stopped, multiplication can be carried out; otherwise, the water inlet and outlet have to be closed.
2. The composite BGA inoculum is applied at 3 kg/40 m^2.
3. No fertilizer application is necessary.
4. No daphnid problem was observed under this system of multiplication. Only very small conical types of snails and water beetles were observed. Because the damage caused was negligible, no pesticidal application was warranted.
5. Within a month, depending on the suitability of inoculum, the BGA growth over the water surface was dense or sparse.
6. The BGA floating on the water surface was collected and dried in the sun by spreading over a thin layer of powdered soil on a threshing floor.
7. Subsequent harvests were once in 3–5 weeks. Fresh application of inoculum was not necessary.
8. The yield ranged from 10 to 40 kg/40 m^2. A higher yield of BGA was obtained with *Gloeotrichia, Nostoc,* and *Aphanothece.*
9. If subsequent BGA multiplication is done in the same place, fresh application of BGA inoculum is not necessary.

If the Government undertakes the inoculation of shallow ponds and ditches with useful composite BGA for one season, the farmers can simply collect the algal seed material in the following years. ■

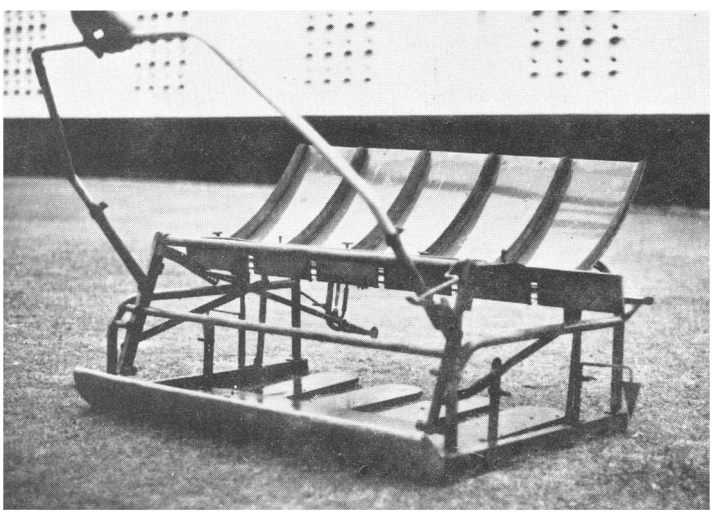
Announcements

Philippine Inventors Contest prize for transplanter

John A. Mc Mennamy, formerly head, Design Engineering Section, and lgnacio Manalili, assistant design engineer, International Rice Research Institute, were recently awarded a silver medal and ₱10,000 in cash in the Philippine Inventors Contest for their work on the design and development of a five-row manually operated transplanting machine for rice paddy (photos 1, 2).

This year's theme for the annual Philippine Inventors Contest was "Inventions for Food and Energy for Basic Human Needs." Designs of inventions covering applications in agriculture and industry were judged on degree of originality and creativity, extent of usefulness, and potential for commercial viability. The design for the IRRI transplanting machine was recently released for commercial production. One man can transplant from 1/4 to 1/3 ha/day with the machine. Total labor requirements are reduced from about 120 labor days/ha with conventional hand transplanting methods, to less than 60 labor days/ha with the manually operated machine. For more information, contact the IRRI Agricultural Engineering Department. ■

1. Rice transplanting machines being tested at IRRI.



2. The manually operated five-row machine is composed of a sled, seedling tray, and simple three-position picking mechanism activated by depressing the handle.

Dr. S. S. Saini honored for boosting rice production

Dr. Sohan Singh Saini recently received a citation from the Punjab Agricultural University (PAU), Ludhiana, India, and a cash award in recognition of his outstanding research contributions in rice production.

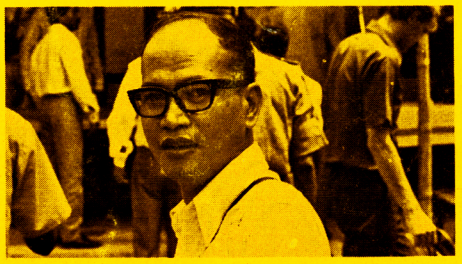
Dr. Saini, senior rice breeder at PAU, currently works with the Government of the Democratic Republic of Afghanistan under the Indian Technical and Economic Cooperation (ITEC) Program. The 13 improved varieties he developed have helped boost Punjab rice production by about 70%.

Dr. Saini has 37 years experience in rice improvement. He has guided many students and has published more than 100 research articles. ■

Philippines honors Dr. Benito S. Vergara for contributions to farmers

Dr. Benito S. Vergara, IRRI plant physiologist, recently received a *Pro Patria* award.

The award, which was presented by Philippine President Ferdinand E. Marcos, honors outstanding agricultural scientists and other individuals who have made significant contributions to agricultural science in the Philippines. ■



Dr. Benito S. Vergara visiting the Habiganj Rice Research Station, Bangladesh.

Insecticide evaluation report for 1979 now available

The 1979 report of insecticide tests conducted by IRRI entomologists includes results of the greenhouse and field evaluation of coded and commercial insecticides applied by various methods. It covers results of insecticide tests on irrigated and rainfed rice and those conducted in the cropping systems program on mungbean, sorghum, cowpea, maize, and peanuts. This report contains 118 tables, 31 figures, and an index listing the 112 insecticides tested. Copies can be obtained by writing the Entomology Department, IRRI, Box 933, Manila, Philippines. ■

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