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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 cavans, rai, etc.).
- Express all yields in tons per hectare (t ha) or, with small-scale studies, in grams per pot (g pot) or grams per row (g row).
- Define in footnotes or legends any abbreviations or symbols used in a figure or table
- Place the name or denotation of compounds or chemicals near the unit of measure. For example 60 kg N ha; not 60 kg ha N.
- The US dollar is the standard monetary unit for the IRRN. Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg ha,
- When using abbreviations other than for units of measure, spell out the full name the first time of referance, 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 attributed to fetilizer use.

Guidelines

- Contributions to the IRRN should generally be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analysis are required for most data.
- Contributions should not exceed to 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 routlne 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

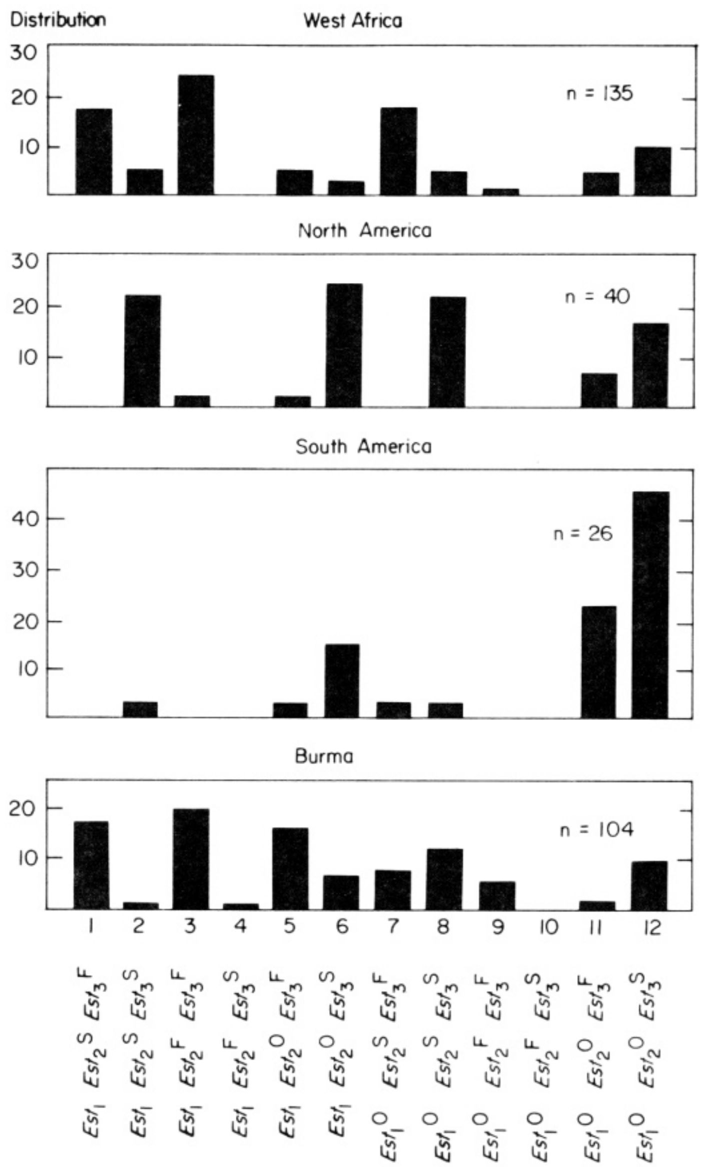
OVERALL PROGRESS

Varietal groups of rice cultivars in West Africa and the Americas

M. Nakagahra, Hokuriku National Agricultural Experiment Station, Inada, Joetsu, 943-01, Japan

Rice groups classified by genotypic analysis for esterase isoenzymes corresponded well to the conventional varietal groups and geographic distributions of land races. Genotype 1 dominated in India and Sri Lanka, and corresponded to indica (aman, aus, and boro paddy in West Bengal); genotype 3. common in South China and Vietnam, corresponded to sinica (Chinese hsien rices); and genotype 6 in northern areas such as North China and Japan corresponded to japonica (Chinese keng type). Genotypes 7, 8, 9, 11, and 12, scattered in hilly areas of Southeast Asia, corresponded to javanicas.

The cultivars in the Americas and Africa showed unusual enzyme geno-



Esterase genotype distribution in West Africa and the Americas.

types. In West Africa, half were genotypes 1 and 3. The others, which may be major traditional cultivars, comprised genotypes 7, 12, 11, 8. The latter group may belong to a member of hill rices in Southeast Asia (see figure).

North America, particularly Texas State, showed variations of isoenzyme genotypes between japonica and javanica. Consequently their origin may not be India and South China.

South America, particularly Brazil, showed simple variation. Most cultivars belong to genotypes 12 and 11, corresponding to the typical javanicas. A similar variation is found only on Sumatra island in Asia. West Africa and the Americas have a particular type of esterase isoenzyme genotypes. These are not indica (Indian rices) or sinica (Chinese hsien), but are more closely related hill rices or javanicas found in Upper Burma, northern Thailand, Laos, Sumatra, and southern Yunnan Province of China.

GENETIC EVALUATION AND UTILIZATION

Agronomic characteristics

Performance of IR42 and IR48 in Cuu Long Delta, Vietnam

Nguyen van Luat, Bui Ba Bong, Nguyen Minh Chau, and J. Chandra Mohan, Cuu Long Delta Rice Research Institute (RRI), O Mon, Hau Giang, Vietnam

IRRI early and intermediate maturity varieties and breeding lines have revolutionized rice cultivation in Vietnam. Two rice crops each year are now grown where one low-yielding, late-maturing local variety once grew. More than a dozen IRRI lines have been named and released for large-scale cultivation.

More than 65% of the rice area in Cuu Long Delta (Vietnamese portion of Mekong Delta) is planted to IRRI varieties. Some popular varieties in large-scale cultivation are: NN3A (IR36). NN6A (IR2307-247-2-2-3), NN7A (IR9129-192-2-3-5), NN8A (IR2070-199-3-6-6), and NN2B (IR2823-399-5-6). Average yields are 3.5-4.0 t/ha.

NN4B (IR42) and NN5B (IR48) were introduced in 1981. Their performance, particularly in adverse soils, is encouraging (Table 1). Both varieties have intermediate maturity (130-145 days), tolerance for soil stresses, semitall plant height (100-120 cm), and resist lodging. NN4B yields higher on saline soils than the popular local variety Than Nong Do. NN5B yields more than local varieties Tieu Mo and Bay Danh on acid sulfate soils. Both varieties have yielded more than an earlier IRRI line, NN2B, on alluvial soils. In seed multiplication plots at 10 sites, yields were 4-9 t/ha.

Both varieties resist brown planthopper, and NN5B resists rice blast (Table 2). Neither variety, however, resists sheath blight. Both varieties are popular with farmers because they are generally free of pest damage in normal field conditions.

Because NN4B and NN5B are popular, produce high yields, and are insect and disease resistant the Cuu Long RRI is making special efforts to rapidly multiply seeds on a large scale.

Table 1. Yield level[a] of NN4B and NN5B in early mua season (May-Oct), Cuu Long, Delta, Vietnam.

Variety	Hau Giang Province (alluvial soil)			Long An Province (acid sulfate soil), rainfed wetland		Minh Hai Province (saline soil), rainfed lowland, 1980	Average yield (t/ha)
	Irrigated, 1980	Rainfed 1979	Rainfed 1981	1980	1981		
NN4B (IR42)	6.63 a	3.38 a	3.13 b	2.91 b	3.00 b	3.96 a	3.84
NNSB (IR48)	6.45 a	3.45 a	4.18 a	3.53 a	4.20 a	3.54 b	4.22
Check[b]	4.20 b	2.85 b	3.13 b	2.60 b	2.90 b	3.15 c	3.18

[a] In a column, means followed by the same letter do not differ significantly at 5%. [b] Variety check: alluvial: NN2B; acid sulfate: Tieu Mo (1980), Bay Danh (1981); saline: Than Nong Do.

Table 2. Reaction of NN4B and NN5B to rice pest in Cuu Long Delta, Vietnam.[a]

Variety	Brown planthopper		Leaf blast		Bacterial leaf blight		Sheath blight	
	Infested (%)	Reaction	Scale (0-9)	Reaction	Scale (0-9)	Reaction	Disease index (%)	Reaction
NN4B (IR42)	14	R	4-7	MS-S	3	MR	90	HS
NNSB (IR48)	30	MR	1	R	5	MS	80	S
Resistant check[b]	26	MR	1	R	1	R	100	HS
Susceptible check[b]	100	HS	4-9	MS-HS	8	S	100	HS

[a] Artificial infestation, using IRRI test and scoring procedures. R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, HS = highly susceptible. [b] Resistant check for BPH: IR36, LB: Tetep, BLB: Cempo Selak, ShB: IET4699. Susceptible check for BPH: TN1, LB: NN7a BLB: IR8, ShB: IR36.

CR289-1008 and CR289-1208—very early-maturing rices

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Rice varieties with 10- to 12-week crop cycles are grown in India in rainfed dryland conditions during monsoon season. They yield low and do not perform well in intensive cropping systems.

CR289-1008 and CR289-1208 are shortduration varieties evolved from the cross ARC12422/ARC12751 through hybridization. They mature at 75 and 80 days, respectively, and yield 2.4 to 3.5 t/ha (see table).

CR289-1008 has medium stature, produces long slender grains, and lodges partially at maturity. CR289-1208 is a semidwarf variety that produces coarse grains with golden-brown hulls. It does not lodge. Both varieties are photoperiod insensitive and perform well in rainfed dryland and irrigated conditions.

The short crop cycle of CR289-1008 and CR289-1208 requires specific crop management. Because the vegetative phase is short, tillering time is limited. Proper seed rate is necessary to maintain optimum density of ear-bearing tillers, and direct seeding in dry or puddled soil may be needed to ensure ample vegetative growth and full panicle size. The initial vegetative stage of the crop also needs special weed control and fertilizer management efforts because vegetative growth overlaps panicle development.

Very short-maturity varieties such as CR289-1008 and CR289-1208 might help produce four crops a year in an intensive rice-based cropping system if suitable infrastructure is available.

Performance of CR289-1008 and CR289-1208 in wet and dry season, Cuttack, India.

Variety	Plant ht (cm)	Duration (days)	Yield (t/ha)[a]		
			1980 wet season	1981 dry season	1982 dry season
CR289-1008	108	75	2.8	2.4	3.1
CR289-1208	77	80	3.3	2.7	3.5

[a]Seeded on 5 July 1980, 1 March 1981, and 1 February 1982.

GENETIC EVALUATION AND UTILIZATION

Grain quality

KMP-1 (Mandya Vani)—a new short duration, high yielding, superfine paddy released in Karnataka, India

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KMP-1 is a new rice variety released in Karnataka, India, in 1982. It is a cryptic genetic variant isolated from the cross CR1014/IR8. It matures in 120-125 days and yields 5.5-6.5 t rough rice/ha. In 16 varietal experiments from 1979 to 1980, KMP-1 gave an average yield of 5.5 t/ha (Table 1). In rice minikit trials during 1980-82 KMP-1 produced 22.9% higher yield than Telhamsa and 8.36% more than Pushpa Paddy. KMP-1 is blast tolerant, has limited grain shattering, and long panicles with superfine spikelets, and cooks flaky with good volume expansion.

KMP-1 milling properties and cooking quality compare favorably with those of well-known varieties Sona, IR20, Basmati 370, J192, and Mahsuri. KMP-1 length-breadth ratio is 3.7, compared with 3.6 for Sona. Hulling and milling qualities are equal to those of IR20, but KMP-1 recorded 2.6% less head rice than IR20.

Table 1. Grain yield (av of 1979-81) for KMP-1 and check varieties, Karnataka, India.

Trials (no.)	Check variety	Yield (t/ha)		Check (%)
		KMP-1	Check	
5	Jaya	5.1	5.5	93.1
3	Rasi	5.0	4.8	104.6
1	Prakash	5.6	6.7	82.7
3	Mangala	4.9	4.6	106.7
1	Ratna	5.7	5.5	103.5
2	IR20	6.6	6.4	102.5
Average		5.5		

Table 2. Chemical properties and cooking quality of KMP-1 and selected varieties, Karnataka, India.

Variety	Abdominal white[a]	Kernel elongation	Volume expansion	Alkali value	Amylose (%)	Protein (%)	cooking quality
Sona	Wb	1.7	4.0	6.7	23.6	8.7	Good
KMP-1	Abs	1.8	4.9	4.5	26.7	8.4	Excellent
IR20	Abs	1.6	4.2	4.5	24.3	8.3	Excellent
Basmati 370	Abs	2.0	4.2	4.5	23.9	7.8	Excellent
Mahsuri	Abs	1.9	3.8	4.5	26.4	7.6	Excellent
J-192	Abs	1.6	4.1	4.5	24.6	–	Excellent
Experimental mean (X)		1.7	4.1	4.7	23.7	7.8	–
Sem (+)		0.02	0.09	0.16	0.28	0.09	–

[a]Wb= white belly, Abs = absent.

KMP-1 kernel elongation ratio is 1.8, compared with 1.7 for Sona and 2.0 for Basmati 370. It recorded a volume expansion ratio of 4.9, compared with 4.2 of IR20 and 4.1 of J-192. Alkali value and amylose content equal those of IR20 (Table 2).

KMP-1 is gaining popularity, especially in the traditionally fine-grain rice growing districts of Karnataka.

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Reaction of tall and dwarf rice varieties to bacterial leaf blight

C. A. Mary, V. P. S. Dev, K. Karunakaran, and M. B. Jalajakumari, Rice Research Station (RRS), Pattambi, Kerala, India

A collection of 104 rice varieties, 74 dwarf and 30 tall, were evaluated for reaction to bacterial leaf blight *Xanthomonas oryzae* (BLB) during 1981-82 kharif at the Pattambi RRS.

Varieties were dry seeded in dryland nursery beds, then irrigated and maintained under wet conditions. Fertilizer was applied at 120-60-40 kg NPK/ ha. At panicle initiation, plants were clip inoculated with BLB suspension. Disease incidence was recorded 15 days after 50% flowering, using the Standard Evaluation System for Rice.

No entry was free of infection, 33 showed resistant to moderately resistant reactions, 58 moderately susceptible to susceptible, and 13 highly susceptible (see table). Of the tall varieties tested, 50% were susceptible or highly susceptible; 65% of these were local varieties.

Reaction[a] of rice varieties or cultures to bacterial leaf blight. 1981-82 kharif, Pattambi Rice Research Station, Kerala, India.

Resistance rating	Dwarf varieties	Tall varieties
R	IR8-68, IR5, Jayanthi, Bhadra, Jagannath, Sakthi	H4, Pokkali, Malinga, Mashoory, Bluebonnet, Mala, Bhavani
MR	IR8, IR20, IR22, IR26, IR42, Cul. 4, Cul. 23178, Cul. 23332-2, Cul. 23372, BR51, Hema, Pankaj, Annapoorna, Rasi, Jamuna, Suma, Pennai, Suphala	Kolappala, Vyttila I
MS	IR28, IR30, IR32, IR34, PR106, Cul. 1-5-4, Cul. 1999, Au-1, Jaya, Sona, Vijaya, Vani, Rohini, Jyothy, Karuma, Cauveri, Madhu, Hamsa, Supriya, Kumar, Parijath, Rajendra, Kalinga I	H105, Basmathi, Ptb 1, Ptb 2, Ptb 5, Vyttila-11
S	IR36, Cul. 3, Cul. 1180, Cul. 12035, Cul. 12814, Cul. 1065, Cul. 7944, MN54-42, Aswathy, Sabary, Satya, Soorya, Suhasini, Rajeswari, DGWG, Triveni, Bala, Krishna, Ratna, Anupama, Kannagi, Kalinga 11	Purple, Chennellu, Ptb 8, Ptb 9, Ptb 22, Ptb 28, Ptb 32
HS	IR1552, T(N) 1, Bharathy, Kanchi, Padma	Suvarna modan, Cul. 25064, Cul. 1907, Ptb 10, Ptb 26, Ptb 29, Ptb 30

[a]R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, HS = highly susceptible.

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Sesamia inferens — a serious pest of rice in Uttar Pradesh Hills, India

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Stem borer epidemics in pockets of the Uttar Pradesh Hills occur regularly in irrigated valleys and in direct-seeded dryland rice. In a survey of the Kumaon hills and of experimental fields of VLHA, 50-60% infestations were recorded.

The pest has been identified as *Sesamia inferens* Wlk (pink stem borer). In other parts of India, *Tryporyza incertulas* Wlk (yellow stem borer) has been reported a major problem. Pink stem borers also attack several other crops grown in this region: ragi *(Eleusine coracana),* Japanese barnyard millet *(Echinochloa, frumentacea),* and maize *(Zea mays).*

Low infestation on rice occurs in early July, when larvae cause deadhearts in seedlings. Severe infestations occur in September, with maximum whiteheads in late September.

To identify sources of pink borer resistance, a large number of genotypes were screened. Some promising entries that showed low infestation were also screened under partially artificial conditions. IR8866-30-3, IR9202-56-1, and IR5908-21-2-1 showed high resistance.

In experiments on chemical control, sprays of chlorpyriphos 20 EC, monocrotophos, and carbaryl 50 WP were effective.

Resistance of RD4 and RD7 mutants to rice gall midge

Weerawooth Katanyukul, Entomology Department, IRRI; Sawang Kadkao and Chintana Tayathum, Entomology and Zoology Division; and Pricha Khambanonda and Malee Chombhubol, Rice Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

Rice gall midge of Thailand is the most virulent biotype in Asia. Eswarakora, a rice variety from India, is the only known resistance source, but its crosses usually have poor grain quality. Because most farmers in the gall midge endemic areas have limited capital to purchase insecticide, resistant varieties are the most practical control method.

RD4, a gall midge-resistant rice variety released in 1973, did not gain popularity because it has poor cooking and eating quality. Seed was treated by gamma irradiation to improve rice quality. After selection for 9 generations, 24 lines of mutants that met grain quality standards were screened for gall midge resistance in a greenhouse at Pan Rice Experiment Station, Cheingrai, in 1980; Fourteen entries were selected and retested in 1981 in farmers' fields in Ban Parauk, Cheingrai. The experiment was in a randomized complete block with two replications. Each entry was planted in 2 rows of 20 hills. Silvershoots from every other hill, 20 hills/entry, were counted at 40 and 60 days after transplanting (DT). Grain quality was assessed after harvest.

All 14 entries of RD4 mutants were highly resistant to gall midge. Percentage of silvershoots at 60 DT ranged from 0.4 to 1.9. That for susceptible check RD1 was 20.5% (Table 1). RD4 mutants also yielded high compared to the original RD4 variety, have good grain quality, and are promising substitutes for RD4 in the glutinous rice eat-

Table 2. Rice gall midge reaction of RD7 mutants and resistant varieties in a greenhouse test at the Rice Protection Research Center, Bangkhen, Thailand, 1981.[a]

Mutant, variety	Silvershoots (%)	Reaction[b]
RD7'77G, CO-53-10-4-1	65.4	S
RD7'77G, CO-53-10-4-4	70.0	S
RD7'77G, CO-53-10-6-1	63.6	S
RD7'77G, CO-53-10-6-2	64.0	S
RD7'77G, CO-55-3-5-1	11.3	MR
RD7'77G, CO-77-4-1-1	51.3	S
RD7'77G, CO-77-9-1-1	5.9	R
RD7'77G, CO-317-8-1-1	54.8	S
RD7'77G, CO-317-8-1-2	62.9	S
RD7'77G, CO-317-8-1-4	53.9	S
RD7'77G, CO-317-8-1-5	49.5	S
RD7'77G, CO-317-13-6-1	51.8	S
ARC10660	51.5	S
ARC10659	50.6	S
ARC10654	45.4	S
ARC5984	45.6	S
Banglei	48.1	S
Ritiang	57.8	S
Nagarsal	57.9	S
PTB21	46.9	S
PTB18	31.2	S
Leaung 152	47.9	S
T1426	56.2	S
Eswarakora	24.1	S
W1263	9.2	MR
RD1 (susceptible check)	44.8	S
RD4 (resistant check)	12.6	MR
MN62M (resistant check)	15.5	MR

[a]AV of 2 replications. [b]Resistant (R) = 0-5% silvershoots, moderately resistant (MR) = 6-15%, susceptible (S) = 16% or more.

Table 1. RD4 mutant grain and yield quality and field reaction to rice gall midge, Ban Parauk, Cheingrai, 1981.[a]

Mutant, variety	Silvershoots (%)		Reaction	Yield (kg/40 hills)	Grain quality[b]	
	40 DT	60 DT			Grain shape	Cooking
RD4'76-G2-CO-2-1-3-15-4	1.3	1.6	R	1.2	2.96	6.9
RD4'76-G2-CO-2-1-3-7-5	0.5	0.4	R	1.5	2.96	7.0
RD4'76-G2-CO-2-1-3-11-9	0.3	0.7	R	1.4	2.96	7.0
RD4'76-G2-CO-2-1-17-5-4	1.3	1.1	R	1.6	2.94	6.9
RD4'76-G2-CO-2-1-17-7-7	1.4	1.9	R	1.5	3.04	6.8
RD4'76-G2-CO-2-1-17-8-2	0.3	1.2	R	1.5	2.98	7.0
RD4'76-G2-CO-2-1-17-16-9	0.6	1.0	R	1.5	2.93	6.8
RD4'76-G2-CO-2-1-17-17-2	0.7	1.9	R	1.6	2.99	6.9
RD4'76-G2-CO-2-7-2-5-3	0.6	1.9	R	1.5	2.97	7.0
RD4'76-G2-CO-2-7-3-2-6	1.1	1.3	R	1.5	2.90	7.0
RD4'76-G2-CO-2-7-3-4-4	1.0	1.3	R	1.5	2.95	7.0
RD4'76-G2-CO-2-7-3-4-18	0.5	1.7	R	1.7	2.92	7.0
RD476-G2-CO-2-7-3-5-6	0.7	1.4	R	1.4	3.03	7.0
RD4'76-G2-CO-2-7-4-8-16	1.8	0.6	R	1.6	2.87	7.0
RD1 (susceptible check)	13.2	20.5	S	1.3	3.15	6.0
RD4 (resistant check)	1.2	2.9	R	1.6	3.00	4.0
RD9 (resistant check)	1.4	5.4	R	1.5	3.17	7.0

[a]Resistant (R) = 0-5% silvershoots, moderately resistant (MR) = 6-15%, susceptible (S) = 16% or more. [b]Grain shape = length and width ratio: over 3 = slender, 2.1-3.0 = medium; cooking quality (alkali digestion): 7 = very good, 6-7 = fair to good, 4-5 = poor to fair.

ing areas of north and northeast Thailand.

During 1981, 12 nonglutinous lines from RD7 mutants plus resistant varieties from India were screened in a greenhouse at the Rice Protection Research Center, Bangkhen, using gall midges from a mass rearing culture. Two RD7 mutants — RD7'77G CO-55-3-5-1 and RD7'77G CO-77-9-1-1— were resistant to gall midge (Table 2). All Indian rice varieties except W1263 were susceptible, confirming the results of the International Gall Midge Biotype Collaborative Project.

Evaluation of National Screening Nursery against rice thrips

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National Screening Nursery entries were field tested for resistance to rice thrips *Baliothrips biformis* Schmutz at the RRS, Kapurthala. Thirty-five-day-old seedlings of each entry were planted 1 seedling/hill in two 5-m rows. Hills were spaced 15 × 15 cm with 20 cm between rows in each selection and 40 cm between selections. TN1 was included as the susceptible check. Entries were scored for thrips damage 20 days after transplanting (growth stage 2) by the Standard Evaluation System for Rice (1980).

Of 384 entries, 3 were scored 1; 19, 2; 107, 3; 186, 4; 59, 5; 6, 6; and 2, 7. Average score was 4. The 3 entries given a score of 1 (most resistant) were IET8200 (Hansraj/Saket 4), IET8258 (Hema/Vikram//Rajeswari/CR57-1523) and IET8283 (Tellahamsa/CR126-42-5).

GENETIC EVALUATION AND UTILIZATION

Adverse soils tolerance

Salt tolerance of mangrove swamp rice varieties

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Development of salt-tolerant rice varieties would help stabilize rice production and make expansion of cu1tivab1e land possible in mangrove swamps of West African countries where salinity is a major limiting factor. Studies to develop improved salt-tolerant varieties adapted to mangrove conditions were started in 1979.

A method to rapidly evaluate rice variety and breeding line salt tolerance by comparing seedling root growth in salin-

Root lengths, root increments, and tolerance ratios (TR) of salt-tolerant and some moderately tolerant mangrove swamp rice varieties[a], Rokupr, Sierra Leone.

Variety	Root length (cm) in culture solution		Root increment (cm)	Root length (cm) in 80 mM NaCl solution		Root increment (cm)	TR
	7 DS	11 DS		13 DS	17 DS		
Tolerant							
Pa Merr 108A	2.9	7.9	5.0	8.6	11.1	2.5	0.50
Pa Foday Yoreh 260	1.3	5.5	4.2	5.9	8.0	2.1	0.50
Gassiline 193B	1.9	6.8	4.9	6.9	9.2	2.3	0.47
Pa Fant 213	1.3	6.7	5.4	7.1	9.3	2.2	0.41
Pa Rice Mill 199	1.9	8.2	6.3	8.5	11.1	2.6	0.41
Pa Bathurst 32A	1.4	4.9	3.5	4.8	6.2	1.4	0.40
Ginsa Killing 408	1.6	7.0	5.4	7.2	9.7	2.5	0.46
Majako 334	4.8	8.5	3.7	8.7	10.4	1.7	0.46
Janeh Kano 469	2.7	6.7	4.0	6.9	8.7	1.8	0.45
Banjul Ba 355	1.8	6.2	4.4	6.5	8.3	1.8	0.41
Kaopa Wolengo 443	3.0	6.5	3.5	7.0	8.4	1.4	0.40
Moderately tolerant							
SR 26[b]	2.6	7.2	4.6	8.0	9.8	1.8	0.39
BD 2[b]	2.2	6.9	4.7	7.7	9.5	1.7	0.36
Rok 8[b]	4.6	7.9	3.3	8.5	9.5	1.0	0.30
Rok 4[b]	5.0	8.7	3.7	9.4	10.4	1.0	0.27
Rok 5[b]	3.4	7.9	4.5	8.2	9.4	1.2	0.27
Rok 9[b]	4.9	8.3	3.4	8.6	9.5	0.9	0.27
Phar Com En[b]	3.2	7.4	4.2	8.2	9.2	1.0	0.24
Atahna 311A	3.8	8.0	4.2	8.2	9.6	1.4	0.33
Pa Sorro 104A	1.8	7.7	5.9	8.8	10.1	1.3	0.22
Nkumbandingo 405	3.5	10.7	7.2	10.9	12.0	1.1	0.15
Checks							
Pokkali (tolerant)	5.5	10.0	4.4	10.2	12.5	2.3	0.52
IR28 (sensitive)	2.0	6.5	4.5	6.4	6.6	0.2	0.04

[a]DS = days after sowing. TR = $\frac{\text{root increment over 4 days in salinized culture solution}}{\text{root increment over 4 days in nonsalinized culture solution}}$. [b]Recommended variety.

ized and nonsalinized culture solution was tested, found suitable, and used to screen 510 accessions of traditional varieties from mangrove swamp areas of Sierra Leone, Gambia, and Guinea Bissau.

Root length of seedlings was measured 7 and 11 days after germination. The seedlings were then placed in saline (80 mM NaCl) culture solutions. Root length was measured 13 and 17 days after germination. Salinity tolerance was calculated as the tolerance ratio (TR) of root growth after 4 days in saline solution to root growth after 4 days in nonsaline solution.

The TR ranged between –0.46 and 0.52. Because of root shrinkage in saline solution, highly salt-sensitive varieties yielded negative values. Pokkali, the tolerant check, gave the highest TR (0.52). Eleven varieties had TR larger than 0.40 (see table). Forty-six varieties had TR greater than 0.15. They were rated moderately tolerant. The remaining 453 varieties exhibited low tolerance — 342 had TR lower than IR28, the sensitive check variety.

Several varieties recommended for mangrove swamp cultivation were included in the screening. They were all moderately tolerant. Several extensively cultivated local varieties — Pa Sorro (Sierra Leone), Nkumbadingo (Gambia), and Atahna (Guinea-Bissau) — were also moderately tolerant.

Results show most traditional swamp varieties have little or no salinity tolerance. Findings suggest that mangrove swamp rice cultivation has avoided high salinity periods. Transplanting is delayed until salt dissipates at the beginning of the season and cultivation is limited to areas where the crop can mature before salt returns.

Results indicated that if new varieties with better salt tolerance were developed, expansion into marginal areas could result.

Pest management and control DISEASES

Morphology and serological relationship of grassy stunt-associated filamentous nucleoprotein and rice stripe virus

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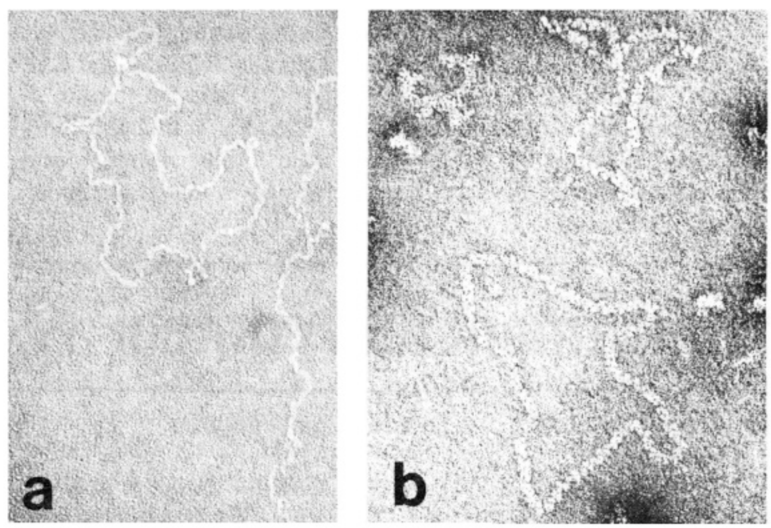
The rice stripe virus (StV). transmitted by planthopper *Laodelphax striatellus,* is a branched filament. Filamentous particles are also found in grassy stunt (RGS)-infected rice leaves. StV particles and rice grassy stunt (GSV)-associated filamentous particles (GSV-f) are similar in morphology.

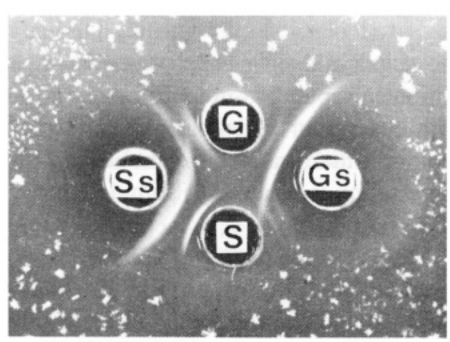
Purified GSV-f and StV were stained with uranium acetate and examined in an electron microscope. GSV-f had a circular filament, 6-8 nm in diameter and 1,000-3,000 nm long (Fig. la). StV had a circular helix 11-13 nm in diameter that varied in length (Fig. 1b). The loosened helix was a coiled filament 6-8 nm in diameter.

The serological relationship between GSV-f and StV was examined in precipitin ring interface and agar gel diffusion tests. In the ring interface test purified GSV-f reacted with diluted anti-GSV-f serum up to 1/1,280. It reacted with anti-StV serum up to 1/80 dilution. Purified StV reacted with diluted StV serum up to 1/1,280 and with anti-GSV-f serum up to 1/20. Fractions purified from virus-free rice leaves reacted weakly with both sera at 1/10.

In the agar gel diffusion test, 0.8% agar gel containing 0.1% SDS was used. Two bands, one distinct and one faint,



1.a. Electron micrograph of rice grassy stunt-associated filamentous particles (X120,000). b. Electron micrograph of rice stripe virus (X120,000).



2. Agar gel diffusion test with purified grassy stunt-associated filamentous particles (G) and rice stripe virus (S), and their antisera (Gs and Ss, respectively).

were produced between homologous combinations of virus and antiserum. Two faint bands were produced between heterologous combinations (Fig. 2), indicating that GSV-f and StV are distantly serologically related. Morphological similarity and serological relationship between GSVf and StV indicate that GSV-f may cause GSV.

Changing trends of rice diseases in Manipur

S. Amu Singh, district agricultural officer, Tengnoupal, Chandel, Manipur 795127, India

In Manipur, rice production increased dramatically in 1973 and gained further momentum in 1974 when the introduction of several high-yielding varieties encouraged double-cropping and increased use of fertilizers and pesticides. During field inspections and surveys in major rice belts of the state, changes in the status of some rice diseases and occurrence of a few diseases hitherto unknown in the state were observed.

Rice blast caused by *Pyricularia oryzae* was not a serious disease before high yielding varieties were cultivated. The disease now occurs every year in all rice belts. Varieties IR24, Punshi, and Phouoibi are susceptible; CH988, CH1039, P33, Moirangphou, Phouren, and Kumbi are resistant. Neck rot is more prevalent and damaging than leaf blast because of low temperature at late flowering stage.

Brown spot caused by *Helminthosporium oryzae* is a minor disease of rice although it occurs every year.

Leaf scald caused by *Rhynchosporium oryzae* was first observed in 1973 at Seed Multiplication Farm, Mantripukhri, and later in 1976 at Rice Research Station (RRS), Wangbal. The leading high yielding varieties IR24, Punshi, Jaya, and Phouoibi, improved varieties CH1039 and CH988, and local Moirangphou are highly susceptible. A common weed, *Echinochloa crus-galli,* is an alternate host.

Stack burn caused by *Trichoconis padwickii* was recorded first at RRS Wangbal in 1980 on KD2-6-3 and KD5-3-3 and in farmers' fields on Punshi, Ratna, and Phouoibi. It attacks fields as far east as Ukhrul, where popular local variety Lamyang was infected in June 1982.

Narrow brown leaf spot caused by *Cercospora oryzae* was recorded at Wangbal in 1980 on Punshi, KD5-3-14, and KD5-3-8 and has now infected CH988 and CH1039. It is a minor disease.

Incidence of sheath blight caused by *Corticium sasakii* is increasing. The disease probably occurred in the state before it was first reported in 1979.

Occurrence of bacterial blight and leaf streak caused by *Xanthomonas campestris* pv: *oryzae* and *X. c.* pv. *oryzicola,* respectively, was associated with the introduction of TN1 in Manipur in 1967. Bacterial leaf streak (BLS) was observed on CH988 at Lilong in 1974. In 1975-76 it was reported on local variety Somthum in the hill area of Henglep. BLS occurs most frequently, usually infecting nurseries and ripening CH988 and CH 1039 crops. Crop damage is not severe.

Pest management and control INSECTS

Whitebacked planthopper outbreak in Kathmandu Valley, Nepal

Bishnu K. Gyawali, Entomology Division, Khumaltar, Lalitpur, Nepal

Whitebacked planthopper *Sogatella furcifera* is considered a minor rice pest in Nepal, but caused hopperbum on 2,709 ha in Kathmandu, Bhaktapur, and Lalitpur during the 1982 wet season.

Sweep net samples taken from highly infested fields at Sundarijal, Kathmandu District, ranged from 1,100 to 1,700 per sweep. Methyl parathion (0.05%) controlled the pest effectively.

Losses to gall midge

Prem Chand and R. C. Acharya, Ranchi Agricultural College, Kanka, Bihar 834006, India

Rice gall midge *Orseolia oryzae* is an important pest of wet season rice on Chhotanagpur Plateau of Bihar. Gall midge attacks cause silvershoots and infestation is believed to stimulate profuse tillering.

To assess the degree of association between silvershoots, profuse tillering, and panicles, 27 randomly selected, gall midge-infested hills of the variety Sita were studied. Observations were recorded after panicle emergence about 1 month after insecticide application.

Total correlation coefficient was determined between silvershoots and tillers, silvershoots and panicles, and tillers and panicles. A partial correlation between silvershoots and panicles was also determined, after eliminating the effect of tillering. Pooled estimates of total and partial correlation coefficients were calculated using a multiple covariance model.

Results indicate that tillering is positively correlated with silvershoots. The pooled correlation coefficient was 0.48 and significant at $p = 0.05$. Tillers were also positively correlated with panicles. Pooled correlation coefficient was 0.55 and significant at $p = 0.01$. There was no correlation between silvershoots and panicles.

Absence of correlation between silvershoots and panicles, and presence of a positive correlation between silvershoots and tillering indicate that silvershoots stimulate tillering. However, it can also be argued that hills containing more tillers have greater probability of attack. An estimate of partial correlation coefficient between silvershoots and panicles was –0.32, significant at $p = 0.05$.

Partial regression analysis using covariance model $y = f\,(\text{Tr.}; X_1\ X_2\ X_3)$ was done to estimate losses caused by silvershoots. The resulting partial regression equation was $y = 1.84 - 0.40\ X_1 + 0.46\ X_2$, where y stands for panicle, X_1 for silvershoot, and X_2 for tiller. The estimate of *R,* the multiple correlation coefficient, was 0.78 and significant at $P = 0.01$.

Both the partial regression coefficients were also significant at $P \leq 0.01$. The partial regression equation suggests that the expected net effect of a unit increase in the number of silvershoots is a 0.40 reduction panicle number.

Leaffolder population monitoring using a sex pheromone

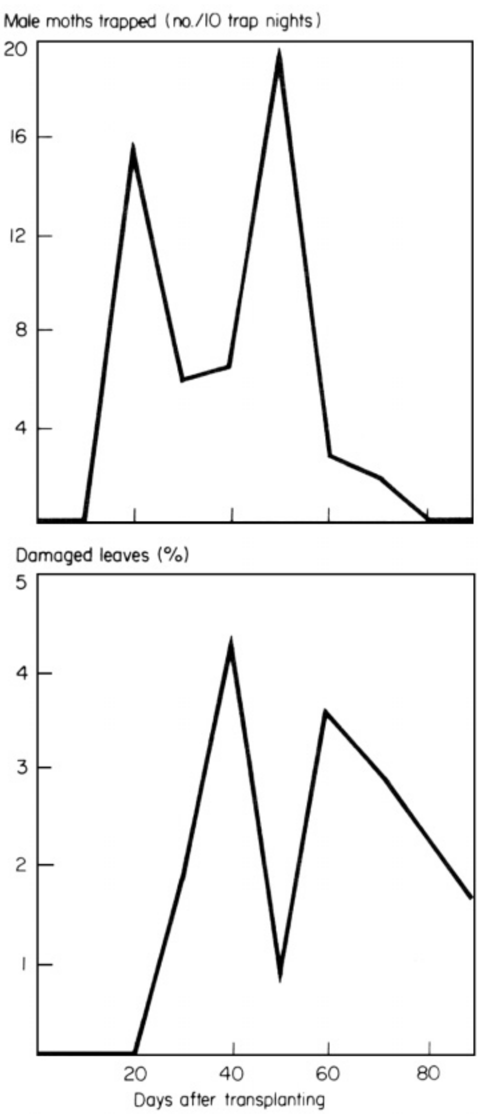
C. Kudagamage, entomologist, Cenrtal Rice Breeding Station, Batalagoda, Ibbagamuwa, Sri Lanka

Rice leaffolder *Cnaphalocrocis medinalis* Guenée is an important rice pest in Sri Lanka. Insecticides are the only practical control and proper timing of application is essential to obtain maximum control benefits.

In a preliminary study, the synthetic female sex pheromone of *C. medinalis* was tested for usefulness as a monitoring device to determine the correct time of insecticide treatment.

Traps consisted of rubber septum dispensers containing the pheromone placed about 5 cm above a circular tray containing water with a small amount of detergent. They were placed about 25 m apart in a 1-ha field planted to Bg 380-2. Trapped moths were counted daily. Crop damage was estimated at 10-day intervals until harvest.

Peak crop damage was observed 10-20 days after the peak moth count (see figure). Peak moth count may represent the period of mating and oviposition followed by hatching and early larval feeding, which would be the most suitable time for insecticide treatment. Pheromone traps can be used to determine the correct time of insecticide application for leaffolder control.



Comparison of *Cnaphalocrocis medinalis* damage to transplanted rice and moth catches in a sex pheromone trap.

Insect damage on azolla in Thailand

Weerawooth Katanyukul, Entomology Department, IRRI; Chantani Hengsawad, Entomology, and Zoology Division, and Prayoon Sawartdi, Withaya Seetanun, and Chaisak Phaewpolsong, Rice Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

Caseworm *Nymphula enixalis* (Swinhoe) and chironomids *Chironomus glauciventris* Kieffer and *C. (Polypedium) anticus* Johannsen are the most important insects attacking azolla in Thailand. During 1979-80 yield loss assessments to determine the significance of insect damage on azolla were conducted at Sakolnakorn, Ubolratchatani, and Sanpahtawng (Cheingmai) rice experiment stations, Azolla was grown in two 10- × 20-m^2 field plots. One plot was sprayed with 0.3 kg ai monocrotophos/ha at 7 and 14 days after inoculation; the other was not treated.

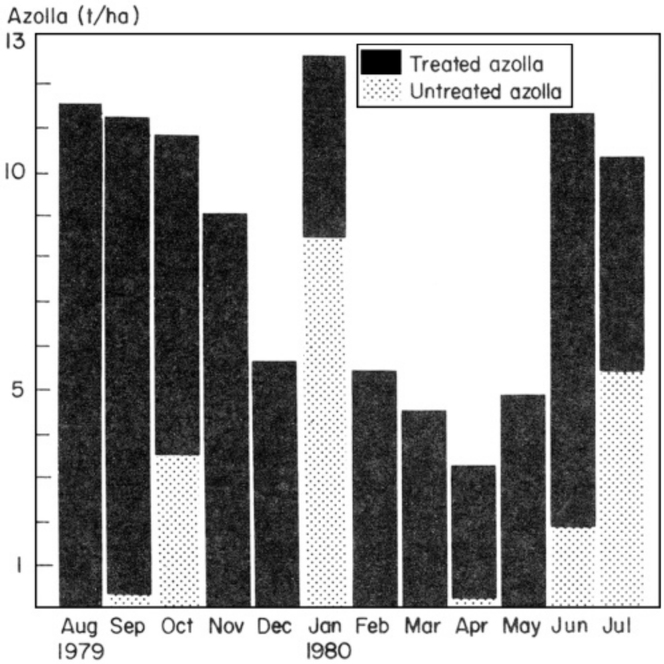
Insects caused significant yield losses. Thirteen of 34 crops were destroyed or produced no yield (see table). Yield from treated plots averaged 10.5 t/ha; that from untreated plots had an average 51% yield loss.

Azolla yields differed significantly between sites. Yields were greater at Ubolratchatani, where insect damage was less severe. Damage was most severe at Sanpahtawng where 50% of cultivated azolla produced no yield and average yield loss was 80%. More insect damage occurred during the summer

Yields and yield losses of azolla cultivated at 3 rice experiment stations in Thailand, 1979-80.

Site	Total crops	Crop failure[a]	Azolla fresh weight (t/ha)		Yield loss (%)
			Treated[b] plot	Untreated plot	
Ubolratchatani	12	4	13	8.2	37
Sakolnakorn	10	3	9.8	5.6	43
Sanpahtawng	12	6	8.5	1.7	80
Total or average	34	13	10.5	5.1	51

[a]No. of crops from untreated plots that produced no yield. [b]0.3 kg ai monocrotophos/ha was applied 7 and 14 days after planting.



Fresh weight of azolla from insecticide-treated and untreated plots at Sanpahtawng Rice Experiment Station, Cheingmai, Thailand.

months February-May (see figure). Severe insect damage and high summer temperatures caused yields in treated plots to be lower than 6 t/ ha. At Sanpahtawng and Sakolnakorn azolla was attacked mostly by a webworm. The key pest at Ubolratchatani was the caseworm.

Changing trends of insect pests of rice in Manipur

S. Amu Singh, district agricultural officer, Tengnoupal, Chandel, Manipur 795127, India

During the past 8-9 years several new insect pests have begun to harm rice in Manipur. Some are spreading to new areas and some that were minor pests are now major pests. Changing trends and their possible causes are discussed below.

Rice leaf butterfly *Melanitis leda ismene,* reported in 1973 in the central district, now infests several high yielding and local varieties in five other hill districts in the state. The pest is more abundant in wetland rainfed conditions where water supply is more or less assured. However, it also infests several local paddy varieties grown in shifting cultivation in dryland rainfed conditions.

The slug caterpillar *Latoia [=Parasa] bicolor* was first noticed in 1980 in cooler regions of East District, Ukhrul. Primary areas of infestation are Kamjong and Phungyar subdivisions, where several local varieties are monocropped in shifting cultivation in rainfed dryland conditions. The insect is a voracious leaf feeder. It has not been found in other rice belts of the state.

Rice hispa *Dicladispa armigera* was first found in the warmer Jiribam subdivision adjoining Silchar district of Assam. In 1972, it appeared in cooler areas of Chingai in East District, Ukhrul. By 1973 the pest had reached the central valley of Imphal where 200 acres of paddy grown in rainfed transplanted wetland conditions were infested. The pest is most dominant in Imphal West-I and West-II subdivisions where several high yielding varieties and local varieties are grown.

Rice thrips *Baliothrips biformis* attacked large areas of nursery and transplanted paddy at Sowumbung and Sagolmang in Imphal East subdivision in 1975 kharif. It has also been observed in Tengnoupal. Rice fields are susceptible at early tillering stage during long dry spells. Plants grown in dry, poor soils are most often attacked.

Rice leaf miner (prob. *Pseudonapomyza asiatica)* was observed in 1973 in the cold area of Mao in the north district. A local dryland variety grown on terraced rainfed fields at an altitude of about 2,000 m was affected. Until 1979 the pest was unknown in other rice growing areas of Manipur. In 1980 it attacked local variety Phouren during early tillering stage at Shamurou in Imphal West-II.

Rice bug *Leptocorisa acuta* is occasionally a serious pest of first crop paddy (Mar-Apr to Jun-Jul) and causes minor damage to the second crop (Jul-Aug to Nov-Dec). The insect is more active in warm, humid conditions at flowering to dough stage. Low temperature at flowering stage during the second crop does not favor insect multiplication.

Rice hairy caterpillar *Psalis pennatula* has been an important rice pest for only 2-3 years. In a few pockets of Tengnoupal district a heavy infestation, sometimes 10-15 caterpillars/ hill of Moirang-phou, occurred in July 1982 and caused complete plant defoliation. Sporadic caterpillar infestations are reported during the early monsoon rains.

Changing insect pest trends may be caused by changing cultivation patterns and new agricultural strategies. The area planted to high yielding varieties has increased from 12,000 ha in 1973 to 72,530 ha in 1982. Similarly, the area of minor irrigation in the state increased from 1,700 ha in 1973 to 45,000 ha in 1982. Consumption of NPK rose from 1,820 t in 1973 to 3,000 t in 1982.

Effect of meteorological factors on oviposition and nymphal hatching of, rice tungro virus vector *Nephotettix virescens*

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The effect of meteorological factors on oviposition and nymphal hatching of *Nephotettix virescens,* a vector of rice tungro virus, was studied in the nethouse for 2 years. Seeds of Taichung Native 1, Jaya, and IR20 were sown and transplanted in earthen pots at monthly intervals. Fifteen plants of each cultivar were grown in insect-proof cages measuring 60 × 60 × 40 cm. Four plants were used for oviposition and four for nymphal hatching. Twenty 10-day-old *N. virescens* females were released in each cage, then removed after 24 hours. Four days later, half of the plants were dissected and eggs were counted under a microscope. Cultivars in the remaining cages were observed daily for 15 days and the emerging nymphs were counted.

Maximum temperature range was 27 to 37°C, minimum temperature ranged from 12 to 26°C, relative humidity varied from 60 to 87%, daily rainfall range was 0.0 to 15.5 mm, and sunshine varied from 3.4 to 9.9 hours.

Varietal preference for oviposition differed little. The number of eggs and nymphs per leafhopper was greater during monsoon season (July-October) than in winter (November-February) and summer (March-June) seasons (Table 1). Monthly data show there are oviposition/ hatching peaks in September and March. The September peak was largest.

Table 1. Reproduction of *Nephorettix virescens* over 3 seasons on 3 rice varieties, Cuttack, India.

Season	Eggs (no./female)			Nymphs (no./female)		
	TN1	Jaya	IR20	TN1	Jaya	IR20
Winter (Nov-Feb)	4.1	3.4	4.1	2.0	2.0	2.5
Summer (Mar-Jun)	2.9	3.4	3.5	1.3	1.4	1.7
Monsoon (Jul-Oct)	7.1	6.9	7.4	3.1	3.0	3.2

Table 2. Relationship between meteorological factors and eggs and nymphs of *Nephotettix virescens*, Cuttack, India.[a]

Meteorological factor	Correlation coefficients					
	Eggs			Nymphs		
	TN1	Java	IR20	TN1	Jaya	IR20
Relative humidity	0.5725**	0.5165**	0.5450**	0.5268**	0.4902*	0.2886
Rainfall	0.4753*	0.4173*	0.4805*	0.2455	0.2547	0.2979
Sunshine hours	–0.4922*	–0.4240*	–0.5137*	–0.2714	–0.2487	–0.2402

[a]*Significant at P = 0.05, **significant at P = 0.01.

The number of eggs in all the cultivars was positively correlated with relative humidity and rainfall and negatively with hours of sunshine. Number of nymphs was positively correlated with relative humidity in Taichung Native 1 and Jaya (Table 2). This relationship indicates that relative humidity is more important in oviposition and nymphal hatching. No temperature correlation was found.

Seasonal and monthly data indicated that optimum maximum temperature is 32°C, minimum temperature is 26°C. High relative humidity (84%), low intensity of rainfall, and limited sunshine hours (5.2 h) appeared to encourage oviposition and nymphal hatching.

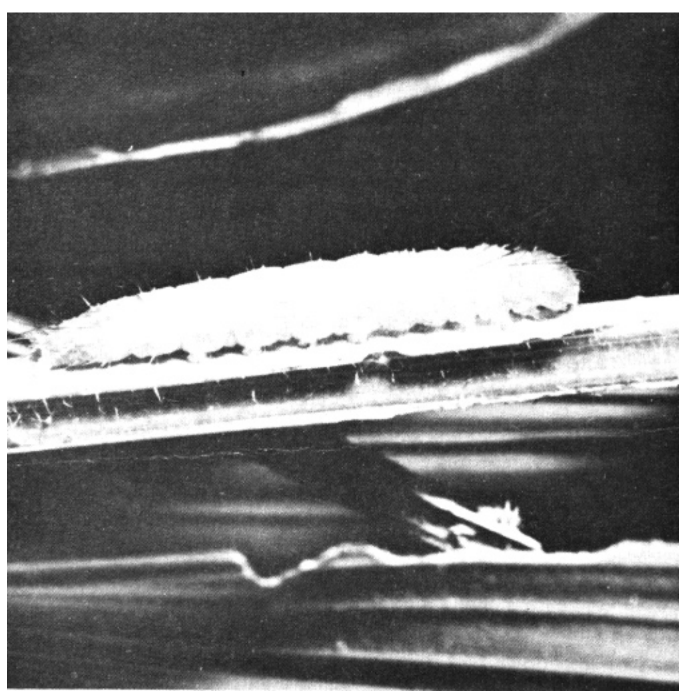
Life cycle of the green hairy caterpillar and its chemical control

L. M. Sunio, S. Valencia, and E. A. Heinrichs, IRRI

The green hairy caterpillar *(Noctuidae: Ribula nr. atimeta)* causes serious defoliation at the seedling stage of rice in the Philippines. Its life cycle was examined in artificial infestations in the greenhouse. Pairs of unequal size pupae were clipped to the tillers of 20day-old Taichung Native 1 (TN1) plants. The smaller of each pair was assumed to be male. Mylar cages kept emerging moths on the plants.

Female moths lay single eggs, an average of 128 each, or more than 16-224 per female. Eggs are laid in rows on both sides of a leaf, usually near the tip. The egg is round, 1 mm in diameter, and greenish when freshly laid. Incubation is 3-5 days.

Five larval instars last an average 13.5 days. A full-grown larva is 16 mm long with setae along the length of its body (see figure). Pupation averages 5 days. Preoviposition is 14 days and oviposition averages 3.7 days. The life span is 4.1 days for males, 5.2 days for females.



Green hairy caterpillar *(Rivula nr. atimeta).*

Nine insecticides were evaluated against the green hairy caterpillar. To determine contact toxicity, compounds were sprayed on third-instar larvae in petri dishes using a Potter's spray tower. After spraying, the larvae were transferred to untreated TN1 leaves in petri dishes.

To determine foliar toxicity, 25 ml insecticide solution was sprayed on 30-day-old plants using a bottle atomizer. Treated leaves were cut, placed in petri dishes, and infested with 10 third-instar larvae each.

Monocrotophos, diazinon, and azinphos ethyl were effective as both contact and foliar sprays (see table). Brodan, carbofuran, and methyl parathion were effective as foliar sprays.

Effect of selected insecticides on control of hairy caterpillar, 48 hours after treatment, at IRRI.

Insecticide[a]	Mortality[b] (%)	
	Contact spray	Foliar spray
Monocrotophos 16.8 EC	100.0 a	100.0 a
Diazinon 20 EC	100.0 a	100.0 a
Azinphos ethyl 40 EC	100.0 a	100.0 a
Carbofuran 20 F	32.5 b	95.0 a
Brodan (20% chlorpyrifos + 10.5% BPMC) EC	42.5 b	100.0 a
Methyl parathion 50 EC	7.5 c	82.5 a
Metalkamate 30 EC	2.5 c	0.0 c
Ethylan 45 EC	0.0 c	30.0 b
Mipcin 50 WP	0.0 c	0.0 c
Control (untreated)	0.0 c	0.0 c

[a]At 0.04% solution. [b]Av of 4 replications. In a column, means followed by a common letter are not significantly different at the 5% level.

Chemical control of azolla insects

Weerawooth Katanyukul, Entomology Department, IRRI, and Thamnoon Bhudhasamai. Entomology and Zoology Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

Insect damage is the most important limiting factor in production of azolla as a supplementary nitrogen source for rice cultivation in Thailand. Two insecticide trials were conducted on azolla at Bangkhen Rice Experiment Station in 1980. The first experiment examined plant soaking in a 0.01% concentration of insecticide for 10 minutes before field inoculation and postinoculation sprays. The second compared 7 insecticides including *Bacillus thuringiensis* (Bactospine) applied after field inoculation. Both experiments involved 3- × 5-m^2 plots in a randomized complete block design with 3 replications.

Webworm *Cryptoblabes* sp. and caseworm *Nymphula enixalis* were the major insect pests. Azolla was damaged by insects and high temperatures during April, and by competition with blue-green algae. Monocrotophos spray gave the best insect control and highest yield (Table 1). Monocrotophos plant soak was moderately effective within 10 days after azolla release into the field. Carbaryl was ineffective. Broadcast carbofuran provided poor insect control and azolla development. Results of the second trial confirmed that monocrotophos was the most effective insecticide among those tested for controlling defoliating insects (Table 2). Carbosulfan

Table 2. Effect of foliar insecticides sprayed on azolla insect pests at Bangkhen Rice Experiment Station, Bangkok, Thailand, August 1980.

Treatment[a]		Insect infestation[b] (grade)		Fresh weight[c] (t/ha)
		10 DI	17 DI	
Monocrotophos	56% WSC	0	0	23.8 a
Carbosulfan	20% EC	++	0	21.5 ab
Chlorpyrifos	20% EC	++	0	21.0 ab
Malathion	83% EC	+++	+	17.2 abc
Fenitrothion	86% EC	++	0	15.0 bc
Bactospeine	16,000/mg	++	++	14.9 bc
Dimethoate	40% EC	++	+++	11.0 cd
Untreated control		++	+++	7.4 d

[a]Insecticides were applied 1 and 10 days after field inoculation at 0.3 kg ai/ha. Bactospeine was used at 1 kg formulated product/ha. [b]Incidences of webworm and caseworm were estimated at 10 and 17 days after inoculation: 0 = no damage, + = light, ++ = moderate, +++ = severe. DI = days after inoculation. [c]Means followed by a common letter are not significantly different (P = 0.05).

Table 1. Effect of insecticide treatments on insects and azolla development at Bangkhen Rice Experiment Station, Bangkok, Thailand, April 1980.[a]

Treatment[b]	10 days		20 days	
	Azolla development (%)	Insect infestation	Azolla development (%)	Insect infestation
Monocrotophos spray at 1 and 10 days	70 a	0	75 a	0
Monocrotophos dip before planting	38 bc	+	0 c	+++
Monocrotophos dip and spray at 10 days	45 b	+	43 ab	++
Carbaryl spray at 1 and 10 days	23 c	++	13 bc	+++
Carbaryl dip before planting	25 c	++	0 c	+++
Carbaryl dip and spray at 10 days	23 c	++	27 bc	+++
Carbofuran broadcast at 1 and 10 days	20 c	++	0 c	+++
Untreated control	25 c	++	0 c	+++

[a]Azolla development was estimated by surface area covered by azolla. In a column, means followed by a common letter are not significantly different (p = 0.05). Insect infestation scale: 0 = no damage, + = light, ++ = moderate, +++ = severe. [b]Foliar insecticides were sprayed at 0.5 kg ai/ha, 0.01% of insecticide solution was used for dipping, and carbofuran was applied at 1 kg ai/ha.

and chlorpyrifos were also effective. Yields of azolla treated with the three insecticides were three times greater than those of the untreated check. Bactospeine provided some insect control and caused significant yield differences compared to the check.

To reduce the cost of insecticide application, it is recommended that azolla stock culture be sprayed 2-3 days before it is transferred to the propagation field. Another application is necessary 7 days later. Because azolla cultivation should begin after transplanting rice, insecticide applications also affect rice insects.

Efficacies of new granular and spray insecticides on rice pests

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During rainy and winter seasons of 1981-82 four granular and six spray insecticide formulations were field tested for control of seasonal pests on varieties Jaya and Tella Hamsa. Treatments were in a randomized block design and three replications.

Granular formulations of endosulfan, thiocyclam hydrogen oxalate, bendiocarb, and phorate were applied at 1.0 and 0.5 kg ai/ha and compared with maximum protection and an untreated control. Spray formulations of fenvalerate, isofenphos, bendiocarb, carbosulfan, thiocyclam hydrogen oxalate, and phosalone were applied at 0.5 and 0.35 kg ai/ha and compared with an untreated check.

Insecticides were applied at 30, 50, and 90 days after transplanting (DT) after pretreatment insect counts were recorded. Counts were made by dividing the plot into four quadrats and randomly selecting six hills from each quadrat. Tillers and deadhearts (DH) were counted to determine percent DH; panicle bearing tillers and whiteheads (WH) were counted to determine percent WH; and leaves and leaffolder-damaged leaves (LFDL) were counted for percent LFDL. Grain yields were calculated after eliminating two border rows from all sides.

During both seasons, yellow stem borer *Scirpophaga incertulas* was the predominant pest. Leaffolder *Cnaphalocrocis medinalis* caused 20% leaf damage on the rainy season crop.

Thiocyclam hydrogen oxalate was

Efficacies of granular and spray insecticide formulations, Warangal, India, 1981-82.[a]

Insecticide	Dosage (kg ai/ha)	Rainy season: Yellow stem borer deadhearts (%) 50 DT	Rainy season: Yellow stem borer deadhearts (%) 90 DT	Rainy season: Leaffolder damaged leaves (%) 60 DT	Rainy season: Yield (t/ha)	Winter season: Yellow stem borer deadheats (%) 30 DT	Winter season: Yellow stem borer deadheats (%) 50 DT	Winter season: Yellow stem borer deadheats (%) 90 DT	Winter season: Yield (t/ha)
Granular formulation									
Endosulfan	1.0	13.4 ab	8.1 a	16.7 c	2.7 d	12.7 bc	6.5 b	9.9 ab	4.2 b
-do-	0.5	13.7 a	9.6 a	16.8 bc	3.3 c	17.8 b	9.5 a	8.1 bcd	3.4 c
Evisect	1.0	3.0 e	0.8 d	3.0 f	4.4 a	8.0 cd	0.3 d	3.5 c	5.3 a
-do-	0.5	3.7 e	1.3 d	4.1 f	4.2ab	10.4 cd	0.7 d	4.4 e	5.0 a
Bendiocarb	1.0	9.0 c	8.5 a	11.9 d	3.3 c	17.8 b	9.7 a	11.0 a	2.0 cd
-do-	0.5	11.4 b	7.9 a	16.1 c	2.6 d	23.7 a	7.6 ab	6.9 d	2.3 e
Phorate	1.0	9.0 c	5.7 b	6.8 e	3.0 cd	6.0 d	0.4 d	7.3 cd	5.2 a
Maximum protection treatment[a]	1.0	6.2 d	3.8 c	5.9 e	3.8 b	6.3 d	2.8 c	2.6 f	5.1 a
Untreated control A	–	14.1 a	8.7 a	20.1 a	2.1 e	27.2 a	7.7 ab	9.3 abc	2.2 e
Untreated control B	–	14.1 a	9.6 a	19.2 ab	1.7 e	27.0a	8.6 ab	9.5 abc	2.7 de
Spray formulation									
Fenvalerate	0.3	15.4 ab	7.9 bc	1.9 fg	2.8 b	7.9 cde	8.3 de	8.7 bcde	4.3 bc
-do-	0.15	17.8 a	12.7 a	2.5 ef	1.8 ef	12.6 b	17.6 abc	8.0 cde	3.9 d
Isofenphos	0.5	4.1 e	3.6 ef	6.6 c	3.9 a	–	–	–	–
-do-	0.35	9.8 c	5.1 c	8.5 b	2.9 b	–	–	–	–
Bendiocarb	0.5	14.2 b	6.2 cd	2.2 efg	1.8 ef	12.6 bc	14.6 bc	11.0abc	4.1 cd
-do-	0.35	13.8 c	6.4 cd	2.0 g	2.2 cde	13.9 b	14.4 bc	12.6 a	3.9 d
Carbosulfan	0.5	6.5 d	3.1 fg	2.9 e	2.5 bcd	3.7 f	2.7 f	7.4 e	5.0a
-do-	0.35	9.2 c	3.4 fg	0.9 f	3.0 b	8.0 ef	8.9 e	12.1 ab	4.5 b
Evisect	0.5	6.6 d	2.2 g	1.7 g	3.8 a	9.8 bcde	4.3 f	3.7 f	5.1 a
-do-	0.35	6.4 d	2.5 fg	2.8 ef	2.7 bc	8.0 de	6.0 ef	7.8 de	4.5 b
Phosalone	0.5	14.5 b	8.6 b	4.5 d	1.7 ef	12.1 bcd	12.2 cd	10.7 abcd	4.0 cd
Maximum protection treatment[b]		6.5 d	0.8 h	1.9 fg	3.0 b	6.7 ef	9.8 ef	1.7 g	5.1 a
Untreated control		17.6 a	12.6 a	9.9 a	1.5 f	21.6a	21.2a	10.7 abcd	2.9 c

[a]In a row, means followed by a common letter are not significantly different at the 5% level. [b]Involves seedling root dip with 0.02% chlorpyrifos; carbofuran application at 1 kg ai/ha, at 20, 40, and 60 days after transplanting (DT); and quinalphos spray at 0.3 kg ai/ha, at 75 DT.

most effective against stem borer and leaffolder. Treated plants yielded 4–5 t/ha compared with 1.9-2.5 t/ha for the untreated control. It was most effective in both seasons and at both dosages.

Isofenphos (0.5 kg ai/ha) and thiocyclam hydrogen oxalate 90 SP successfully reduced yield losses to yellow stem borer and leaffolder (see table). Carbosulfan, an analogue of carbofuran, was effective against stem borer and leaffolder. Fenvalerate, a synthetic pyrethroid, was effective against leaffolder at reproductive phase of the crop under rainy season conditions. Bendiocarb and phosalone were least effective.

Seasonal incidence of rice whorl maggot at Tirur, India

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In the Chingleput district of Tamil Nadu, rice is planted continuously, depending on availability of water from lift irrigation wells. Seasonal incidence of rice whorl maggot was studied in 36 planting dates 10 days apart at Tirur PES. The first planting was 10 May 1980, the last 30 April 1981. Six varieties were evaluated without chemical protection.

Seasonal incidence of rice whorl maggot at Tirur, India, 1980-81.

Planting date	Damage mean (%)
10-5-1980	8.7
20-5	6.5
30-5	7.8
10-6	6.8
20-6	5.0
30-6	4.4
10-7	16.7
20-7	18.4
30-7	13.2
10-8	10.1
20-8	12.9
30-8	10.9
10-9	13.6
20-9	10.1
30-9	15.4
10-10	20.6
20-10	26.3
30-10	20.6
10-11	14.0
20-11	14.5
30-11	13.6
10-12	15.8
20-12	26.9
30-12	33.3
10-1-1981	32.6
20-1	27.6
30-4	17.4
10-2	18.7
20-2	10.1
2-3	11.2
11-3	12.6
21-3	11.7
31-3	11.3
10-4	14.0
20-4	10.2
30-4	14.4
CD (4.99)	

Whorl maggot damage to tillers was assessed 30 days after transplanting (DT).

Whorl maggot damage was less than 10% in May-June plantings, 10-20% in July, August, September, February, March, and April plantings, and above 20% in October, December, and January plantings (see table). Pest damage was significantly less on crops planted on 20 and 30 June, and significantly higher on crops planted 20 December to 20 January. The varieties were equally susceptible.

A new scarabaeid beetle pest of dryland rice in Bangladesh

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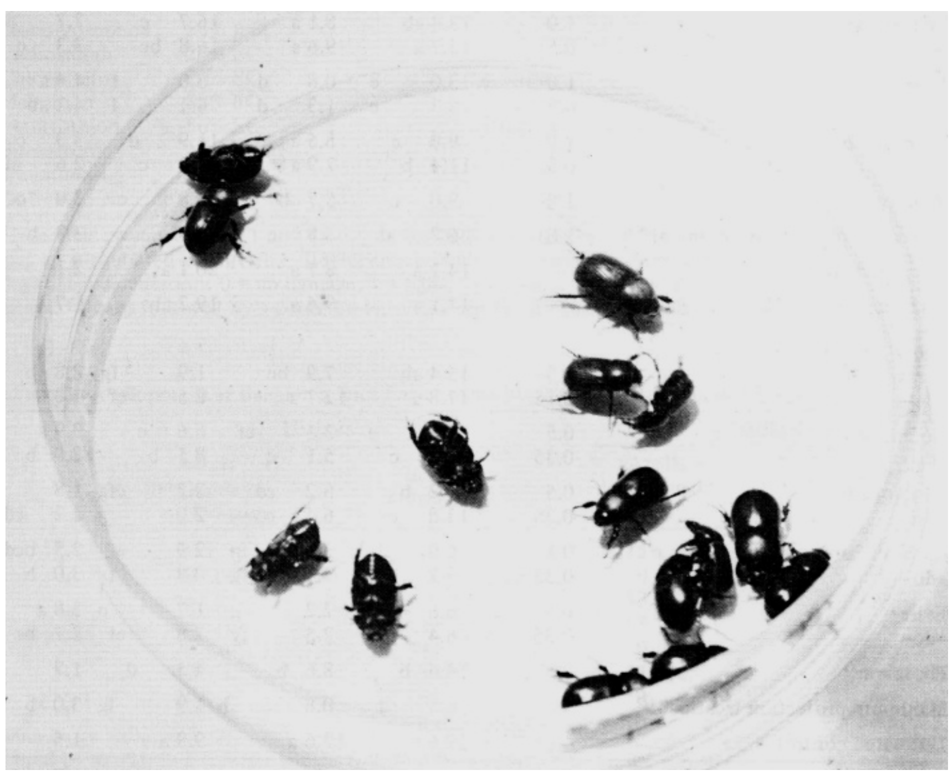
Since 1978 a scarabaeid beetle, *Heteronychus liioderes* Redtenbacher, has caused severe damage to dryland rice in Noakhali, Chittagong, Comilla, and Mymensingh, and on the islands of Sandwip and Hatiya.

Farmers on Sandwip Island, where the beetle is called *talkora* reported a serious outbreak of the pest during April and May 1980 in aus rice (March-August). Aman (July-December) and boro (November-June) crops have also been attacked during dry periods.

Adult beetles are black and about 16 mm long (Fig. 1). They damage plants



1. Scarabaeid beetles, genus *Heteronychus,* that have damaged dryland rice in Bangladesh.

2. Adult scarabaeid beetles chew the base of rice stems just above the roots.

by chewing the base of the stem just above the roots (Fig. 2). Although the Indian beetle usually damages rice seedlings, the pest attacks dryland rice at all stages in Bangladesh. If plants are attacked after flowering, whitehead-like damage occurs. In early stages of an attack, rows of dead hills are observed near levees. Whole fields are later damaged. Beetles are found in sandy or sandy loam soils.

Although no control experiment has been conducted, aldrin, dieldrin, heptachlor, carbofuran, fenitrothion, and malathion have been tentatively recommended for control. If irrigation water is available, flooding the fields for a few days is also successful.

Granular insecticides for control of major rice insects in Thailand

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Insecticide plays a major role in rice insect control in Thailand. Insecticide importation was 10,045 t in 1980 and has increased 2-3 times during the last 6 years. About 20% of the insecticide was used for rice. Monocrotophos has been used for many years as a foliar spray but is now widely distributed in local markets in granular form. This study evaluated the effectiveness of monocrotophos and other granular insecticides for rice insect control.

In a greenhouse test monocrotophos effectively controlled brown planthopper (BPH) and gall midge (GM) as compared to carbofuran (see table). Diazinon also caused high BPH mortality and was moderately effective for GM. In a field experiment, contradictory results were found. Monocrotophos and diazinon did not control GM but carbofuran, followed by chlorpyrifos and quinalphos, was effective. Although stem borer incidence was low, carbofuran-treated plants had fewest deadhearts. Diazinon-treated plants had more deadhearts than the untreated check at 60 days after transplanting. Carbofuran treatment produced the highest grain yield. Diazinon and monocrotophos treatments did not produce yields significantly different from the untreated check. Reasons for contradictory greenhouse and field results for monocroto-

Effect of granular insecticides on rice gall midge, brown planthopper (BPH), and stem borers in Thailand, 1981.[a]

Treatment	Greenhouse		Field				
	Silver shoots (%)	BPH mortality (%)	Silvershoots (%)		Deadhearts (%)		Grain yield (t/ha)
	20 DI	4 DAT	30 DT	60 DT	30 DT	60 DT	
Carbofuran	1 a	94 a	4 a	1 a	0.9 a	0.4 a	2.14 a
Chlorpyrifos	52 cd	–	6 ab	5 ab	2.6 a	5.1 ab	1.91 b
Quinalphos	26 bc	–	4 a	13 b	1.0 a	4.7 ab	1.87 b
Diazinon	20 b	100 a	15 bc	49 c	2.4 a	12.7 c	1.24 cd
Cartap	–	–	21 cd	63 d	0.6 a	5.4 ab	1.10 d
Monocrotophos	8 ab	98 a	26 d	50 c	1.0 a	7.6 bc	1.21 cd
Untreated control	65 d	14 b	22 d	41 c	1.9 a	6.1 ab	1.34 c

[a]Greenhouse tests were conducted at the Rice Protection Research Center, Bangkhen. The field trial was at Chumpae Rice Experiment Station, Khonkaen. Insecticides (1 kg ai/ha) were applied to 20-day-old rice planted in clay pots for greenhouse trial, and 3 times at 15, 30, and 45 DT in the field trial. In a column, means followed by a common letter are not significantly different ($P = 0.05$). DI = days after infestation. DAT = days after treatment. DT = days after transplanting.

phos and diazinon are unknown. Past experience with diazinon for BPH control also yielded different greenhouse and field trial results. Diazinon has always given poor BPH control in the field. Whether or not monocrotophos is an effective BPH control in the field needs further assessment.

Orthoptera pests of transplanted rice in hills of Uttar Pradesh

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Grasshoppers, crickets, and a mole cricket have been found to cause heavy damage to transplanted rice in the hills of Uttar Pradesh. Damage is most severe in the nursery. Sometimes, the leaves of seedlings are completely eaten, leaving only the midrib and stalks. Before infesting a rice crop, nymphs and adults generally feed on grasses growing on rice field bunds or on sorghum and millet.

Ten orthopteran pests have been identified from 4 years' observations and the intensity of damage determined (see table).

Identification of species was confirmed by the Commonwealth Institute of Entomology, London.

Orthopteran species causing rice seedling damage in the Uttar Pradesh hills, India.

Family	Species	Intensity
Acrididae	*Acrida exaltata* (Walk.)	Moderate
	Catantops pinguis innotabilis	Low
	Hieroglyphus banian (F.)	High
	Oxya fuscovittata (Marschall)	High
Pyrgomorphidae	*Atractomorpha crenulata* (F.)	High
	Chrotogonus sp.	Moderate
Gryllidae	*Trigonidium cicindeloides* (Serville)	Moderate
	Teleogryllus occipitalis (Serville)	Low
Tettigoniidae	*Euconocephalus* sp.	Moderate
Gryllotalpidae	*Gryllotalpa* sp.	Low

Soil and crop management

Upland rice varietal reactions to aluminum toxicity on an Oxisol in Central Brazil

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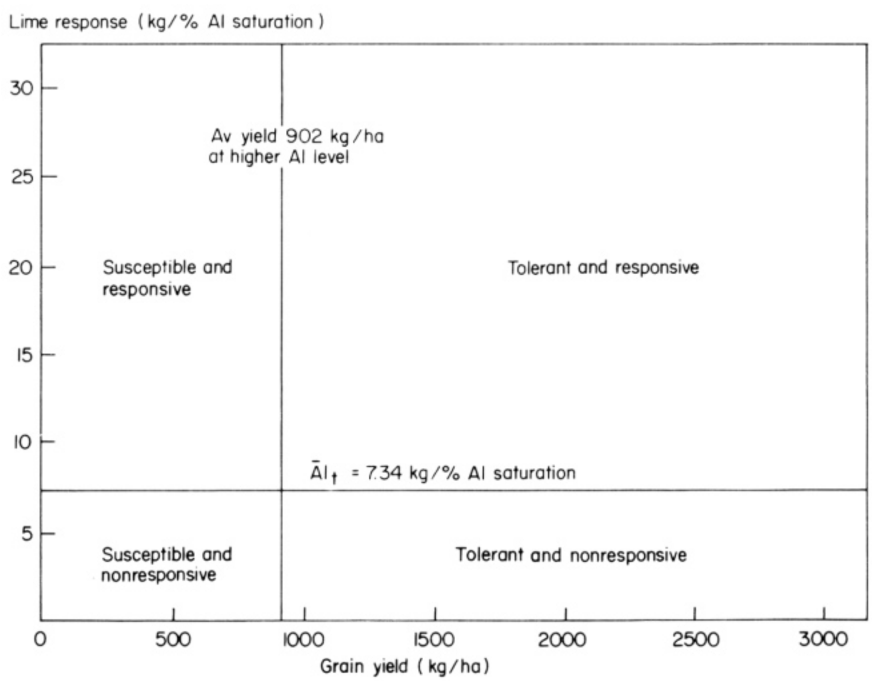
Brazil is the world's largest upland rice producer. About 70% of this production comes from the central region (22% of the country's area) which is a tropical savanna locally called *cerrado.* Aluminum toxicity causes serious yield reductions in this region. A CNPAF research program was initiated to identify rice cultivars tolerant of aluminum toxicity in the field.

Soil at the experimental site had pH 5.2, 0.52 ppm available phosphorus, 0.25 meq exchangeable Ca + Mg/100 g soil, 15 ppm available potassium, and 0.55 meq exchangeable aluminum/100 g soil.

Either no lime was applied to plots, or lime was applied at 3 t/ha. All plots were fertilized with 50 kg N/ ha, 44 kg P/ha, 50 kg K/ha, and 5 kg Zn/ha. They were plowed and disked 50 days before sowing and lime was broadcast and mixed with a rototiller. Fertilizers were broadcast before sowing and disked into the top 15 to 20 cm soil. Seeds of 142 varieties were planted in



Varietal evaluation at high and low levels of aluminum, Goiás, Brazil.

$$\text{Lime response} = \frac{\text{yield in limed plot} - \text{yield in unlimed plot}}{\text{Al saturation of limed soil} - \text{Al saturation of unlimed soil}}$$

Al saturation values were measured at flowering.

two 6-m rows 50 cm apart in a split-plot design with 2 replications. Fifty to 60 seeds/ linear meter were used. Grain yield was used to rate tolerance and susceptibility. Tolerance for aluminum toxicity (Al_I) was calculated as:

$$Al_I = \frac{\text{Yield in limed plot} - \text{yield in unlimed plot}}{\text{Difference of Al-saturation without and with lime at flowering}}$$

The yield of the high-aluminum plot and its Al_I, are plotted in the figure. Average yield at the high-aluminum level and Al_I were calculated. The diagram is divided into quadrants representing the four groups of cultivars by lines of average yield on high-aluminum plots and average Al_I.

Cultivars that yielded well under high aluminum level and responded well to added lime were: Fernandes, IAC46, Santa Amẽlia, IAC21, IAC 1246, IACl131, KN361-1-8-6, IR2070-199-3-6-6, IAC101, IRAT104, Paulista, IR4727-217-3, IR4227-240-3-2, IAC165, CN770532, CN770527, CN770820, CN770167, CN770610, CN771204, Dular, Pinulot 330, Catgo, and Chatão.

Cultivars that produced well under high aluminum level but did not respond to added lime were IRAT13, IAC120, 6 Meses, IAC12, IPSL2060, Grão de Ouro, Rendimentos, Bicudo, Salumpikit, Mogi, Sequeiro do Paraná, IAC5544, EEPG569, IR4829-2-1, IAC5100, Montanha Liso, Pratão Goiano, Seleção Amarelão, CN770867, CN770858, CN770643, CN770614, CN770893, CN770546, CN770602, CN770531, DJ29, AG10-37, IAC5032, and Canta Galo.

Cultivars that produced less under higher aluminum level but responded to added lime were: IAC47, Amarelão, IAC25, Taiwan, Três Potes, Arcos Branco, Baixada, BKN6652-249-1 -1, Dourado Precoce, IET6058, C22, Precoce Amarelo, Cana Roxa, Lageado, KN144, IR5793-54-2, C12, Serra Azul, B1293b-PN-24-2-1, H14, IR3483-180-2, IR4707-207- 1, IR4227-9-1-6, Azucena, CTG 15 16, CN770530, CN770191, CN770447, Batatais, Catalão 101, Prata, Taquari, Rondon, Campineiro, and Milagres.

Effect of ferrous sulfate application on rice yield and iron uptake

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A pot culture experiment was conducted on calcareous (pH 8.7, organic carbon 0.56%, $CaCO_3$ 4.7% and 11.4 ppm DTPA-Fe) and noncalcareous (pH 8.5, organic carbon 0.17%, $CaCO_3$ 0.25%, and 8.7 ppm DTPA-Fe) soils (Aeric Fluvaquent) during summer 1979 to study the effect of Fe SO_4 $7H_2O$ soil applications (0, 15, 30, and 60 ppm) on the yield and Fe uptake of rice in submerged conditions.

Grain yield increased 35% at 15 ppm and 70% at 30 ppm added Fe for calcareous soil and 100% and 200% for noncalcareous soil (see table). Straw yield increased significantly up to 15 ppm added Fe in noncalcareous soil and up to 30 ppm in calcareous soil. The significant decrease in yield at higher rates may be attributed to the antagonistic effect of Fe on the availability of other nutrients. Fe application of up to 30 ppm increased Fe uptake in straw and grain in both soils. Uptake in grain continued to increase up to 60 ppm Fe in calcareous soil. Total Fe uptake was greater in calcareous soil than in noncalcareous soil, which was the reverse of yield trends.

Effect of different rates of iron on dry matter yield (grain and straw) and iron uptake by PR-106, Punjab, India.

Rate of iron (ppm)	Yield (g/3-kg pot)				Iron uptake (mg/3-kg pot)			
	Calcareous soil		Noncalcareous soil		Calcareous soil		Noncalcareous soil	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
0	1.7	5.4	1.7	10.1	0.27	2.85	0.22	1.79
15	2.3	7.9	3.4	14.0	0.44	3.52	0.52	3.32
30	2.9	11.3	5.1	11.7	0.74	7.06	1.04	4.43
60	2.5	9.0	2.8	10.4	0.98	5.92	0.53	2.32
C.D. (0.05)	0.4	1.0	0.5	1.7	0.17	0.49	0.19	0.34

Effect of phosphorus fertilization and soil moisture regimes on phosphorus content of rice crop

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Table 1. Characteristics of 4 acid soils in Assam, India.

Soil	PH	Texture	Organic carbon (%)	Total P (ppm)	Available P (kg/ha)
Dergaon	5.0	Sandy loam	0.93	875	4.2
Golaghat	4.3	Clayey	1.57	1000	3.8
Tengakhat	4.5	Sandy loam	1.53	1563	3.9
Titabar	4.9	Clayey	1.33	1250	2.3

Different phosphorus (P) application rates were tested for their effect on rice plant P concentrations at different development stages and moisture regimes. Soils from 4 areas in Assam, India, were studied in the greenhouse at 3 levels of applied P: 0, 26.4 kg, and 52.8 kg/ha (Table 1). Moisture regimes

Table 2. Effect of P fertilization and moisture regimes [a] on P concentration and dry matter yield in some acid soils of Assam, India, 1978. [b]

Location of soil	P concentration (%)						Dry matter yield (g/pot)					
	Continuous submergence			Continuous moist			Continuous submergence			Continuous moist		
	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha
Titabar	0.136	0.182	0.215	0.093	0.090	0.114	13.13	28.80	34.13	6.97	20.83	17.87
Dergaon	0.171	0.307	0.326	0.093	0.131	0.156	21.80	23.60	36.10	9.87	14.57	13.50
Golaghat	0.185	0.264	0.310	0.110	0.117	0.139	23.20	34.27	30.80	13.10	16.00	16.87
Tengakhat	0.250	0.327	0.361	0.088	0.133	0.151	41.53	48.57	47.77	13.70	20.37	19.27
Mean of all soils	0.186	0.270	0.303	0.096	0.118	0.140	24.92	33.81	37.20	10.91	17.94	16.87
	C.D.(5%)	Moisture regimes: 0.0089					C.D.(5%)	Moisture regimes: 3.17				
		Phosphorus levels: 0.0109						Phosphorus levels: 3.88				

[a] Continuous submergence: 5-7 cm standing water; continuous moist: moisture tension, 0 bar. [b] At max tillering stage. Av of 3 replications.

Table 3. Effect of P fertilization and moisture regimes [a] on P concentration of grain and yield of rice grain in some acid soils of Assam, India, 1978. [b]

Location of soil	P concentration (%) in grain						Grain yield (g/pot)					
	Continuous submergence			Continuous moist			Continuous submergence			Continuous moist		
	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha	0 P	26.4 kg P/ha	52.8 kg P/ha
Titabar	0.276	0.278	0.324	0.235	0.213	0.211	13.30	21.83	22.90	4.43	6.47	9.57
Dergaon	0.248	0.312	0.366	0.190	0.168	0.264	15.37	18.47	18.50	6.77	9.70	11.13
Golaghat	0.215	0.312	0.367	0.191	0.142	0.215	16.63	21.97	24.30	7.33	11.10	10.17
Tengakhat	0.292	0.349	0.373	0.157	0.188	0.247	22.60	24.33	27.77	7.63	11.30	10.63
Mean of all soils	0.258	0.315	0.358	0.193	0.178	0.234	16.97	21.65	23.37	6.54	9.64	10.37
	C.D.(5%)	Moisture regimes: 0.021					C.D.(5%)	Moisture regimes: 1.30				
		Phosphorus levels: 0.026						Phosphorus levels: 1.60				

[a] Continuous submergence: 5-7 cm standing water; continuous moist: moisture tension, 0 bar. [b] At grain ripening. Av of 3 replications.

were continuous moist and continuous submergence.

Phosphorus application significantly increased P concentration in dry matter at maximum tillering stage at both moisture regimes (Table 2), but P concentration was higher in continuous submergence. Dry matter yield increases corresponded with increased P concentration under continuous submergence in all four soils. Results were similar in continuous moist condition, but P concentration and dry matter yield were lower at each level of P application.

P applied to submerged soils caused significant increases in P concentration of grain at ripening stage and increased yield (Table 3). However, in continuous moist condition, there was no such consistency. In 3 of 4 soils, 26.4 kg P/ ha decreased P concentration and increased yield, which suggests that yield increase was achieved by dilution of the plant P concentration. At 52.8 kg P/ha, there was a significant increase in the P concentration in all the soils except that from Titabar. Grain yield increased in Titabar and Dergaon and decreased slightly in Golaghat and Tengakhat.

Results suggest that phosphorus application and continuous submergence improve rice crop performance.

Use of azolla and commercial nitrogen fertilizer in Jorhat, India

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Complementary use of azolla and commercial nitrogen fertilizer for rice culture is receiving interest because of the global energy crisis. A 2-year experiment at Jorhat showed that incorporating 5 t fresh azolla/ha just before planting increased yields of Pusa 33 (1979) and Pusa 2-21 (1980) 44% over the control (no nitrogen, no azolla) (see table).

Mean grain yield of rice as affected by incorporation of azolla with and without nitrogen fertilizer, Jorhat, India.

Nitrogen applied (kg/ha)	Azolla incorporation		Yield (t/ha)	
	t/ha	Time	Pusa 33 (1979)	Pusa 2-21 (1980)
0	0	–	1.8	1.7
0	1 [a]	After planting	2.5	2.3
0	5	Before planting	2.6	2.5
0	10	Before planting	3.0	2.9
30	5	Before planting	3.4	3.3
30	10	Before planting	3.7	3.5
30	0	–	2.8	2.4
60	0	–	2.9	3.0
LSD (5%) in t/ha			0.6	0.4

[a] Fresh azolla was inoculated after planting, allowed to grow and then incorporated after 20 days.

Application of 30 kg N (urea)/ha increased yield by 55% in 1979 and 42% in 1980. Application of 30 kg N/ha and 5 t azolla/ha increased yields 86.4% over the control in 1979 and 92% in 1980.

Results showed that inoculating fields with 1 t fresh azolla/ha after planting and incorporating after 20 days increased yield by 38% in 1979 and 36.5% in 1980. Increased yield caused by raising azolla application from 5 t/ha to 10 t/ha was significant only in 1980. Rice yields were significantly higher from 30 kg N/ha and 10 t fresh azolla/ ha than from single applications of nitrogen in both years.

Effects of growth regulators applied to the main crop on ratoonability of IR9784-52-2-3-2 in pots

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A rice ratoon crop begins growth using carbohydrates left in the stubble and roots after the main crop is harvested. If leaf senescence is early in the main crop, less carbohydrate is accumulated and fewer ratoon tillers grow.

Growth regulators have been reported to delay leaf senescence in certain crops. Growth regulators at various concentrations applied to the main crop at various growth stages were tested for their effect on the ratoon crop in a pot experiment at IRRI during the 1981 dry season.

Aqueous solutions (1, 10, and 100 ppm) of indoleacetic acid (IAA), naphthaleneacetic acid (NAA), gibberellic acid (GA3), and dichlorophenoxy acetic acid (29–D) were sprayed (3 ml/plant), and carbofuran at 1 kg ai/ ha was broadcast in prill form.

The growth regulators did not significantly affect the yield of the main crop or the ratoon crop (see table).

Effect of growth regulators applied to the main crop on yield and yield components of the ratoon crop of IR9784-52-2-3-2, IRRI, 1981 dry season.[a]

Growth regulators	Concn (PPm)	Time of application[b]	Grain yield (g/plant)	Panicles (no./ plant)	Filled gras (no./ panicle)	100-gain weight (g)
1AA	1	F	15.0	26	28	1.94
		LMS	13.4	25	29	1.91
	10	F	16.7	27	31	1.94
		LMS	14.1	26	29	1.94
	100	F	17.4	27	35	1.94
		LMS	15.3	25	29	1.95
NAA	1	F	13.0	22	38	1.94
		LMS	12.7	22	30	1.95
	10	F	14.6	26	32	1.93
		LMS	15.3	28	28	1.91
	100	F	15.7	26	33	1.91
		LMS	15.9	26	30	1.94
GA3	1	F	15.5	26	31	1.91
		LMS	13.8	24	30	1.96
	10	F	15.0	26	27	1.95
		LMS	18.5	28	30	1.95
	100	F	13.8	24	32	1.96
		LMS	14.9	29	26	1.93
2,4-D	1	F	13.8	24	34	1.93
		LMS	12.3	26	29	1.93
	10	F	16.4	26	33	1.94
		LMS	15.6	26	32	1.92
	100	F	15.9	27	32	1.93
		LMS	16.3	23	31	1.94
Carbofuran	1 kg ai/ha	F	12.3	24	28	1.94
		LMS	15.2	24	29	1.97
Control			17.2	29	32	1.91

[a]Analysis of variance indicated nonsignificant treatment differences at 5% probability level. [b]F = flowering, LMS = late milk stage.

Studies on multiplication of azolla

B. K. Mandal and A. K. Bharati, Agronomy Department, Biddhan Chandra Krishi Viswavidyalaya Kalyani, Nadia, West Bengal, India

Azolla *Azolla pinnata* is a floating fern with nitrogen-fixing blue-green algae *Anabaena azollae* in its leaves. Phosphorus (P) fertilizer is necessary for good azolla yields. Azolla is attacked by the larvae of Lepidoptera (Nymphula) and Diptera (Chironomus) insects that roll the leaves and feed on the plants.

Azolla was multiplied in plots with 5, 10, and 15 cm standing water using 4.4, 8.8, and 13.2 kg P/ha per week and 2 levels of carbofuran (5 and 10 kg/ha). Fifty-four 1-m^2 plots were inoculated with 300 g freshly collected azolla plants. Breeding plots were harvested weekly and fresh weight was recorded. Total N and P contents were determined (see table).

Results showed that P is essential for azolla multiplication. Plants with P deficiency had reddish brown fronds and roots, and roots were long, fragile, and easily detached. Best growth was obtained by applying 8.8 kg P/ha and 10 kg carbofuran/ha weekly to plots with 10 cm standing water. There was no significant growth difference between plots at 5 cm and 15 cm water depth.

Application of 8.8 kg P/ha and 10 kg carbofuran/ha per week increased N

Effect of phosphorus (P), water depths, and carbofuran on biomass production, nitrogen (N) fixation, and P content of *Azolla pinnata*, West Bengal, India. [a]

Treatment	Fresh weight (g/m^2 per week)	N_2 content (g/m^2 per week)	P content (g/m^2 per week)
Dose of P (kg/ha)			
4.4	1016.4	2.22	0.09
8.8	1203.6	2.84	0.22
13.2	1068.1	2.35	0.18
Mean	1096.0	2.47	0.16
S.Em (±)	0.22	0.034	0.02
C.D. at 5%	0.63	0.097	0.05
Water depth (cm)			
5.0	1084.4	2.48	0.16
10.0	1115.8	2.47	0.17
15.0	1087.8	2.47	0.1 6
Mean	1096.0	2.47	0.16
S.Em (±)	0.22	ns	ns
C.D. at 5%	0.63	-	-
Carbofuran (kg/ha)			
5.0	1087.0	2.41	0.17
10.0	1105.0	2.54	0.16
Mean	1096.0	2.47	0.16
S.Em (±)	0.18	0.028	ns
C.D. at 5%	0.57	0.079	

[a] ns = nonsignificant.

content in azolla plants. P content was also highest at this level of application, but was not affected by carbofuran application. Water depths did not affect N or P content.

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

Rice-based cropping systems

Transplanting time and grain yield relationships of late rice for a triple-cropping system

Cai Yi-zhong and Ding Chang-ling, Institute of Crop Breeding and Cultivation, Shanghai Academy of Agricultural Sciences, Shanghai, China

Production duration for late rice is short in the triple-crop system (barley - early rice - late rice) used near Shanghai. Late rice yield is high and stable with early transplanting, but yields decline if transplanting is late. An experiment to explore the relationship between transplanting time and late rice variety yields was conducted in Shanghai in 198 1.

Three japonica varieties — Nong Fu No. 6, late maturity; Jia Nong No. 15, medium maturity; and Hua Han-zao, early maturity — were transplanted on 2, 6, 10, and 14 August in 10-m^2 plots with 3 replications.

Delayed transplanting significantly reduced grain yields for all varieties (see table). From 2 to 14 August, yield decreased 11.3 kg/ day for Nong Fu No. 6, 17.5 kg/day for Jia Nong No. 15, and 7.2 kg/day for Hua Han-zao.

Yields of late rice at different transplanting times, Shanghai, China.

Variety	August transplanting date	Yield (t /ha) Replication 1	Replication 2	Replication 3	Mean
Nong Fu No. 6	2	4.4	4.6	4.7	4.6
	6	3.6	3.6	3.6	3.6
	10	2.9	3.3	3.0	3.1
	14	2.4	2.4	2.5	2.4
Jia Nong No. 15	2	4.7	4.7	5.0	4.8
	6	4.2	4.0	4.0	4.1
	10	3.3	3.4	3.0	3.2
	14	1.8	1.6	1.4	1.6
Hua Han-zao	2	4.8	5.0	4.9	4.9
	6	4.2	3.9	3.8	4.0
	10	3.8	3.8	4.1	3.9
	14	3.6	3.5	3.3	3.5

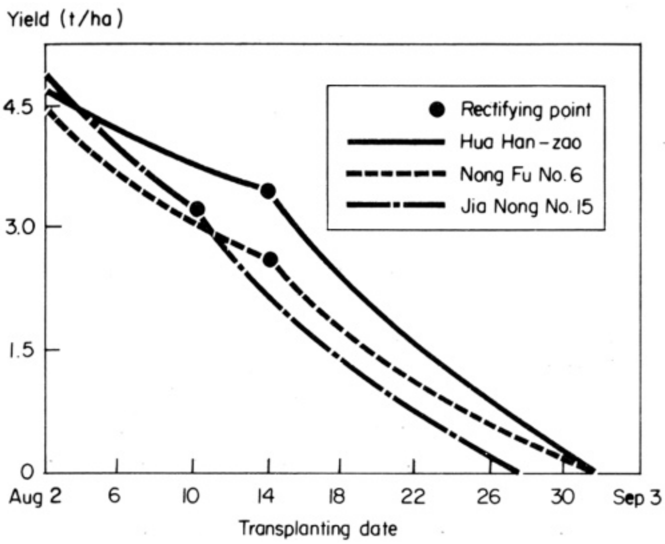
Variety	Calculated *F* (treatment)	Tabular *F* (at 1%)
Nong Fu No. 6	143.79**	7.59
Jia Nong No. 15	227.30**	7.59
Hua Han-zao	49.48**	7.59

The relationship between transplanting time and yield is illustrated by the equation:

$$W = \frac{1}{A+Bt\ 1}$$

(W = yield, A, B = parameter, t 1 = transplanting time 2-14 August)

The coefficients of correlation (R) were 0.9749** for Nong Fu No. 6, 0.9620** for Jia Nong No. 15, and 0.8421** for Hua Han-zao. All were significant at the 1% level. However, cold injury causes a deviation from calculated data if transplanting time is too late. A rectifying equation is:



Theoretical curve of transplanting time - yield relationship for late rice in Shanghai, China.

$$RE = 1 - ct2 \ \left(\frac{1}{c} \geqslant t2 \geqslant 0\right)$$

where c = parameter, $t2$ = planting time. Then:

$$W = \frac{1 - ct2}{A + Bt1} \ \left(\frac{1}{c} \geqslant t2 \geqslant 0\right)$$

more closely approximates reality (see figure). A linear equation:

$Wt = W0 - b\ t$ (W = yield, t = planting time, b = parameter)

can also describe the relationship. The coefficients of correlation (r) were significant for all three test varieties.

Because it is simple to calculate and easy to memorize, this equation may be of practical value in estimating yield-transplanting time relationships.

Announcements

IRRI is awarded the Third World Prize for 1982

The 1982 Third World Prize has been awarded to the international Rice Research Institute.

The annual Third World Prize, which includes an award of $100,000, was established by the Third World Foundation for Social and Economic Studies, a charity registered in London under the laws of England and Wales.

The objectives of the Third World Foundation are to work for the intellectual, economic, and social advancement of the people of the Third World through publications and research; to assist in the evolution of a fundamentally just and equitable relationship between the Third World and the developed countries; and to create greater awareness of the problems of poverty, hunger, and ignorance.

The Prize is conferred on individuals or institutions for outstanding contributions to Third World development, particularly in the economic, social, political, and scientific fields.

The first Prize was awarded in 1980 to the Venezuelan economist Dr. Raul Prebisch. The 1981 Prize was awarded to Mwalimu Julius K. Nyerere, President of Tanzania.

The presentation of the Prize takes place at a specially arranged ceremony, preferably in a Third World country. The recipient or a representative of the institution awarded the Prize delivers the annual Third World Lecture, focusing on the work for which the Prize was awarded.

Beachell named agronomy fellow

Henry M. (Hank) Beachell, formerly of IRRI, has been named a Fellow by the American Society of Agronomy for international service in agronomy.

Beachell is a world renowned rice breeder whose career spans more than 51 years. A native Nebraskan, he obtained a BS degree from the University of Nebraska and a MS degree from Kansas State University. From 1931 to 1963 he headed the rice breeding program at the Texas Agricultural experiment Station in Beaumont, Texas.

He joined IRRI in 1963. From 1972 to 1982 he was IRRI rice breeder at the Central Research Institute for Agriculture, Bogor, Indonesia.

Beachell helped develop early-maturing long-grain rice varieties that established the U. S. as a producer of the world's finest long-grain rice. He played a major role in developing and promoting IR8 and other high yielding varieties that brought about the rice green revolution in Asia.

British Institute of Biology honors IRRI geneticist

Dr. T. T. Chang, IRRI geneticist and Rice Genetic Resources Program leader, has been elected a Fellow of the Institute of Biology (IOB), London, UK. The IOB has a membership of 23,000 professional biologists. Dr. Chang joined the IRRI staff in 1961. He has won awards from the City of Philadelphia (1969) and the American Society of Agronomy (1978, 1980).

Field problems revised

A revised edition of *Field problems of tropical rice* will be released by IRRI in early 1983.

Like the original edition, the 120-page

revision is designed to facilitate lowcost translation and copublication of local editions by agricultural programs, international agencies, and publishers in developing nations. The first English edition, published in 1970, has been copublished in Burmese, Bengali, Hindi, Indonesian, Pilipino, Portuguese, Spanish, Tamil, Telegu, Urdu, and Vietnamese.

Persons or organizations interested in purchase or copublication of *Field problems* or other IRRI books should write to: Information Services Department, IRRI, P.O. Box 933, Manila, Philippines.

New IRRI publications

New IRRI publications are available for purchase from the Information Services Department, Division C, IRRI, P.O. Box 933, Manila, Philippines:

A plan for IRRI's third decade
Drought resistance in crops, with emphasis on rice
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International bibliography of rice research for 1981
Japan's role in tropical rice research
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