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Style for IRRN Contributors

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

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

Genetic evaluation and utilization

OVERALL PROGRESS

An attempt to improve local rice varieties through hybridization

C. A. Razzaque and S. C. Debnath, Genetics and Plant Breeding Department, Bangladesh Agricultural University, Mymensingh, Bangladesh

In an attempt to improve yield, disease resistance, and quality, the local varieties Nizershail and Tepi Boro were crossed with some IRRI strains. The segregating generations were handled by a combination of pedigree and mass-selection breeding methods. Selection criteria were plant type and yielding ability. Seven F_6 lines are promising with respect to biochemical properties, diseasd reaction, plant type, and yield: AU16-1, AU21-6, AU16-19-20, AU16-21, AU41-15-18, AU19-3, and AU54-52 (see table). Two F_5 lines, 70.11 and 70.58, also look promising.

Performance of new lines with respect to yield, biochemical constituents, and disease reaction, compared with that of their local parents. Bangladesh Agricultural University.

Line or variety[a]	Parents	Season to which the line was adapted	Yield (t/ha)	Biochemical constituents (%)		Disease reaction[b]		
				Protein	Amylose	Bacterial leaf streak	Bacterial leaf blight	Stem rot
AU21-6	Nizershail/ IR532E-420	Aus	5.07	11.8	31	R	MR	R
AU16-1	Nizershail/ IR578-175-2-2	Aus	5.35	9.5	28	R	R	MR
AU16-19-20	”	Aman	5.02	6.5	29	–	–	–
AU16-21	”	Aman	5.62	7.8	30	–	–	–
AU41-15-18	Nizershail IR6-43-48	Aman	4.83	9.1	31	MR	–	–
AU19-3	Nizershail/ IR532E-420	Aman	4.81	9.8	27	–	–	–
AU54-52	”	Aman	4.95	9.6	25	MR	–	–
AU70-11	Tepi Boro/ IR140-136	Boro	4.95	–	30	MR	MR	R
AU70-58	”	Boro	5.26	–	30	MR	R	R
Nizershail	–	Aman	4.12	7.5	29	–	R	R
Tepi Boro	–	Boro	3.54	10.4	24	MR	R	MR

[a]AU = Agricultural University. [b]R = moderately resistant; R = resistant.

IRRI's genetic resources program

T. T. Chang, M. B. Parker, N. Baraoidan, D. Punzalan, R. Portes, C. Zuño, and C. C. Loresto, Plant Breeding Department, International Rice Research Institute

Since 1971 IRRI has collaborated with 12 national agricultural research centers in the field collection of indigenous rice germ plasm. Other workers who have cooperated in the canvassing of rice gene pools in remote areas include university faculty, missionary groups, international service corps, extension workers, and botanists of other crops. The primary objectives of field collection are to save unimproved varieties that are endangered by the spread of modern varieties and to assemble the minor rices that have not yet been collected.

Since 1972 more than 18,000 seed samples have been collected from South and Southeast Asia; IRRI's staff helped collect more than 7,500 of them. About 4,850 of the samples are reputed to have one or more special characters, such as resistance to or tolerance for pests, adverse soils, cool temperature, or drought.

In recent years, IRRI has initiated systematic seed exchange with China, India, and the USSR. Several rice research centers in India have provided IRRI with duplicate sets of their rice collections. More than 6,000 samples were thus acquired in 1976–77.

The IRRI germ plasm bank supplies thousands of seed samples to rice researchers every year. Distribution has increased markedly since IRRI expanded its Genetic Evaluation and Utilization Program in 1974 (see table).

Progress of the IRRI Genetic Resources Program in field collection, preservation, and seed distribution of *Oryza sativa* cultivars. IRRI, 1970–77.

Year	Samples collected in Asia (no.)	Distinct accessions in germ plasm bank (no.)	Samples distributed (no.)	
			Inside IRRI	To national programs
1970	–	12,800	16,000	5,660
1971	907	14,712	10,600	2,300
1972	4,177	16,893	2,740	2,500
1973	5,004	24,162	8,275	9,777
1974	2,149	26,818	19,236	2,603
1975	5 06	30,332	22,155	4,043
1976	1,670	34,229	40,200	4,819
Mid-1977	463	36,851[a]	26,303	3,628

[a]About 6,278 recently received seed samples are yet to be registered; 4,646 duplicate accessions and 1,822 nonviable seed samples were removed from the collection from 1972 to 1977.

To meet the expanded flow of seeds to and from IRRI, construction of a Rice Genetic Resources Laboratory began late in 1976. The new laboratory will expand storage and working areas and will include a new facility for long-term seed storage. When completed in November 1977, it will house the Plant Breeding Department and the International Rice Testing Program. In December 1977 a workshop sponsored jointly by the International Board for Plant Genetic Resources and IRRI will develop further plans for worldwide collaboration on the conservation of rice germ plasm.

Survey of environmental and biological problems related to rice growing in Asia

Thomas R. Hargrove, associate editor, International Rice Research Institute

Thirty-five rice breeders at 28 research centers in 10 Asian nations were asked to rank, in order of severity, the four most serious environmental and biological problems (drought, cold temperature, injurious soils, diseases and insects, etc.) that limit farmers' rice yields within the area served by each experiment station. At stations where more than one rice breeder was interviewed, the data were collected for the major subregion for which each breeder was responsible. The survey was in collaboration with Iowa State University, USA, and was partially funded by a Rockefeller Foundation grant.

Every breeder surveyed rated diseases and insects as one of his four major problems (see table). For all regions, pests received the highest mean seventy rating — 3.2 on a scale where 4 = the most serious problem and 1 = the fourth most serious. Drought was the second most important environmental stress. Considered a major problem in 82% of the areas, drought also received the second highest mean severity rating. Its overall rating was 2.2 out of a possible 4.

Rice breeders' perceptions of the biological and environmental stresses that most seriously limit rice production on farmers' fields within the areas served by their research centers. Thirty-five rice breeders at 28 agricultural experiment stations and universities in 10 Asian nations, 1975.

Biological/environmental factors	Mean severity rating[a]		Rated as major constraint[b] (%)
	All stations	Stations where a problem	
Diseases and insects	3.2	3.2	100
Drought	2.2	2.7	82
Injurious soils	1.2	2.2	57
Excessive monsoon cloudiness	1.3	2.4	40
Floods	0.6	1.7	38
Cold temperature	0.7	2.5	29
Deep water	0.4	2.6	15
Hot temperature	0.1	1.3	9
Waterlogged soil	0.1	2.5	6
Others[c]	0.1	1.5	6

[a]On a scale of 1–4: 4 = most serious environmental or biological stress; 1 = fourth most serious. Calculated for all 35 areas and also for only those in which each factor was considered one of the region's four major problems.
[b]Percent of 35 rice breeders that rated each stress as one of four most serious problems limiting rice production on farmers' fields within the regions served by the experiment stations.
[c]Typhoons and weeds.

When calculated for only those stations where drought was considered a serious problem, its mean severity rating was 2.7. Injurious soils (salinity, alkalinity, zinc deficiency, etc.) were rated as a major constraint in 57% of the regions. The severity rating for injurious soils was 1.2 for all stations and 2.2 for the stations where they were considered serious.

Excessive monsoon cloudiness was a serious constraint in 40% of the regions, and floods were a major problem in 38%. Cold temperature, rated as a problem in 29% of the areas, received a low overall severity rating of 0.7. But when calculated for only the stations where cold was a problem, its severity rating was high, 2.5. Deep water was defined as "water that reaches about 50 cm (too deep for semidwarf varieties to grow) during the monsoon season." Deep water received an overall severity rating of 0.4; but in the 15% of the regions where it was considered a problem, its severity rating was high, 2.6.

Comparison of rice hybridization methods

Sommai Amonsilpa, Bangkhen Rice Experiment Station, Rice Division, Department of Agriculture, Bangkok 9, Thailand

The Bangkhen Rice Experiment Station has made crosses for the Thai breeding program for years, but the pace of rice hybridization has increased markedly since the introduction of high yielding varieties. Along with a dramatic increase in the number of crosses, there has been a shift in the methods of emasculation, from hot air to scissors, and, more recently, to vacuum emasculator. Since the merits of each procedure have not been closely examined, it seems appropriate to assess the three methods.

Six hundred florets of the Thai variety RD1 were used as female parents and IR34 was used as the pollinator. Data were recorded on the time required by each of the three emasculation methods, the percentage of seed set when plants were emasculated by each method, and the percentage of seed set resulting from different pollination techniques.

Seed set was higher with the vacuum method than with either hot air or scissors. It was also higher when plants were pollinated twice on two successive days than when pollinated once. Adding a mature anther to the floret gave a higher seed set than dusting with pollen (see table). The conclusion is that the newer hybridization methods not only are faster but result in higher seed set.

Percent seed set when florets were emasculated and pollinated by different methods. Bangkhen Rice Experiment Station, Thailand.

Emasculation method	Av. seed set (%)			
	Pollen only		Pollen plus anther	
	One pollination	Two pollinations	One pollination	Two pollinations
Hot air	30	38	26	44
Scissors	18	44	58	66
Vacuum	40	52	50	64

Chi square = 102**

GENETIC EVALUATION & UTILIZATION

Agronomic characteristics

The term "intermediate-statured rice varieties" not a misnomer

K. I. James, P. A. Varkey, and R. Pushpakumari, Rice Research Station, Pattambi, India

In monsoon Asia, where rice growth depends on rain, tall varieties are better adapted than semidwarfs. Domesticated tall varieties are attractive because of their ability to withstand medium-deep water, their vigorous early growth, and their leaf canopy that suppresses lush weed growth. In Kerala, farmers want tall rices so they can feed its lengthy straw to cattle. However, tall varieties lodge when heavily fertilized, significantly reducing yields. Thus, there has been a keen desire to combine desirable characteristics of tall varieties with high yielding ability and a new type of architecture: intermediate plant height.

Although intermediate-statured selections are available, their yielding ability has not been comparable with that of semidwarfs. Rice breeders have lately been selecting intermediate-statured plants and studying their yield potential.

Entries with that plant type from the International Rice Yield Nursery (medium duration) were tested in replicated trials at the Rice Research Station, Pattambi. The check variety was Jaya, the most popular local semidwarf. Yields were categorized by plant height.

Taller rice cultivars yielded more than semidwarfs (see table). Among the intermediate-height cultures, IR2058-78-1-3-2-3 and BR 51-46-5 yielded highest, 5.1 t/ha. The growth duration of the two varieties from seeding to harvest was 125 days.

Ranges in plant height and yields of entries tested at Pattambi, India.

Plant ht (cm) 60–70 Cultivar	Yield (t/ha)	70–80 Cultivar	Yield (t/ha)	80–90 Cultivar	Yield (t/ha)	90–100 Cultivar	Yield (t/ha)
IET 2775	2.9	P881-19-22-12	2.7	BR 4	4.2	BR 51-46-5	5.1
IR8	3.4	IET 1785	3.9	IR2058	5.1	BR 51-74-6	4.0
IR26	2.3	IET 2080	3.4	IR2863	4.0	BR 52-87-1	4.5
		IET 2300	3.4	BG 374-1	4.7	P 901-22-11-2	4.4
		IET 2815	3.3	BG 374-2	4.0	B 44-b-50	3.7
		IET 4094	3.1	BG 375-1	4.6	B 541b-Kn	4.1
		IET 2911	3.7			B 542-b-pn-68	4.1
		IR2070-423-2-5-6	3.7			IR2823-399	4.8
		IR2071-596-5-6-3	3.1			C 168	3.9
		BG 96-3	4.1			WP 153	4.8
		IR2588-19-1-2-2	4.5				
		Taichung Sen Yu	4.2				
		Jaya	3.4				
Mean yield	2.9		3.6		4.4		4.4

Variability in heading duration among aus rice varieties in West Bengal, India

D. Mitra and S. Biswas, Rice Research Station, Chinsurah, West Bengal, India

In West Bengal, aus (early) paddy is sown in dry land from March to June in different districts. But the sowing time for each area generally is rather specific, and different types of varieties have adapted to each. Little is known about how these local aus types adapt to a changed growing environment in terms of uniformity of flowering. Data were collected on heading duration (the interval in days from start to completion of flowering) with the use of aus cultivars from distinct agroclimatic zones of West Bengal. Seed was sown in March at the Rice Research Station, Chinsurah. Heading duration was very short (4–6 days) in some varieties but rather long (16–18 days) in others (see table). In one variety it was as long as 19–21 days. The most frequent heading duration was 7–9 days. No relationship could be established (r = 0.186) between days to flowering and heading duration; both short and long heading durations were distributed among early-, medium-, and late-flowering types.

Heading duration[a] and growth duration to 50% flowering among aus varieties of West Bengal, India.

Heading duration (days)	Aus varieties (no.)									
	Early flowering			Medium flowering			Late flowering			
	60–66 days	67–73 day S	74–80 days	81–87 days	88–94 days	95–101 days	102–108 days	109–115 days	116–122 days	123–129 days
4– 6			15	8	16				2	
7– 9	1	4	33	26	35	6		2	1	
10–12	3	3	12	10	27	3	2	1	1	2
13–15		2	11	18	16	3				1
16–18			1	3	4	5	3	3		
19–21							1			

[a] Interval from start to completion of flowering.

Performance of northeastern hill rices in the northern plains of India

M. L. H. Kaul and N. K. Matta, Botany Department, Kurukshetra University, Kurukshetra – 132119, India

Rice has been cultivated for thousands of years in northeastern India, a place which is regarded as one of the primary centers of its origin. In a survey of the region, 22 varieties of cultivated rice were found: 1) Abar 'A', 2) Abar 'B', 3) Abar red 'A', 4) Abar red 'B', 5) Kba saw rit B-2, 6) Kba saw rit B-4,7) Dullo-6, 8) Dullo-8, 9) Dullo-11, 10) Dullo-l0, 11) Dullo-Am, 12) Ryllo red-2, 13) Ryllo red-3, 14) Ryllo red-4, 15) Ryllo red-5, 16) Ryllo white, 17) Theueru red, 18) Kba Thangamma, 19) Lyngsi, 20) Local Black 'A', 21) Kuki, and 22) Nonglwai. Through intensive cultivation, domestication, and selection, those varieties have adapted to the climatic conditions of the vast geographic area. Seed of the genotypes were sown at Kurukshetra, northern India — which has a dry, hot, semiarid climate — and their performance was compared with that of the commonly grown variety IR8.

All the genotypes are taller and mature earlier than IR8, but they give lower yields. Their grains are bold and medium in length (except those of Kba saw rit-2, which are slender with a length: breadth ratio of 3.04). Although most of these rices are tall, they do not lodge even when heavily fertilized. They are also resistant to shattering. The red-grained Theueru red was the earliest maturing variety with the highest grain yield per plant.

While the varieties do not differ greatly, some yield significantly higher than others, and some have higher protein content. The genes for earliness, lodging resistance, and nonshattering grains of these varieties are valuable to rice breeders of this region for incorporation into local rice strains that lack such traits.

GENETIC EVALUATION & UTILIZATION

Disease resistance

Rice ragged stunt disease in Indonesia

L. T. Palmer, IRRI-CRIA Project, and Y. Soepriaman, Central Research Institute for Agriculture, LP-3, Sukamandi, Indonesia

A new disease of the rice plant was observed at the Sukamandi Experimental Station, West Java, Indonesia, in May 1977. The disease has also been observed in Sumatra and Bali.

Symptoms of the disease are stunting; twisting and curling of the leaves, especially the flag leaf; ragged or serrated leaves; short flag leaf; presence of galls along the leaf veins; and green color, often darker than that of healthy plants. Other symptoms are branching of the tillers, incomplete panicle exsertion, and unfilled grains. These symptoms differ from those of grassy stunt.

Symptoms begin to appear at about 15 to 25 days after inoculation feeding with the viruliferous brown planthopper *Nilaparvata lugens.* In 4 separate experiments with 9 varieties, transmission by the brown planthopper averaged 17%. The disease is believed to be viral in nature.

Based on the symptomatology of the disease and its transmission by the brown planthopper, the disease is similar, if not identical, to ragged stunt disease reported in the Philippines.

In experiments, ragged stunt reduced the yield of Pelita I/1 by 43%. Total yield losses were common in severe cases.

Infection has been as high as 76% in varieties and lines growing under natural conditions. Rice varieties that showed susceptible reactions include Pelita I/1, Pelita I/2, C4-63, IR5, and IR8. Three promising lines – B2850bSi2-1, B2850bSi2-2, and B2850bSi2-3 – from the breeding department, LP-3 Sukamandi, have apparent resistance. They are F_4 lines from the cross of B541 b-Kn-91-3/IR2011-15-4-1-2.

Studies are under way to establish etiology, epidemiology, distribution, control, and other factors related to the disease.

Rice ragged stunt disease

K. C. Ling, plant pathologist, International Rice Research Institute

In January 1977, a rice malady was reported in North Cotabato, Mindanao, Philippines, by Mr. Tirona, plant protection officer, Philippine Bureau of Plant Industry (BPI). Scientists from BPI and the University of the Philippines at Los Baños observed the disease. In February, the disease was observed at IRRI, particularly in the hybridization block. Scattered diseased plants were later observed in various rice fields in the Philippines. In May, the disease was reported in Indonesia. It seems to be widely distributed in these two countries.

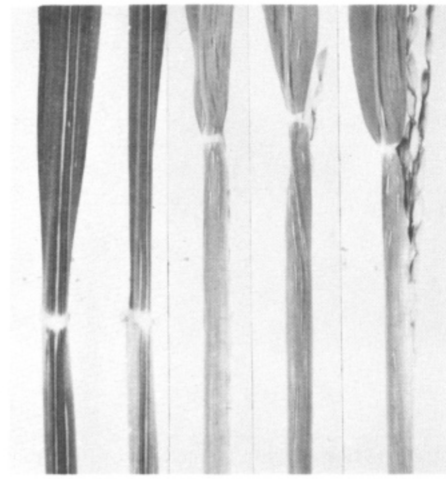
The disease may have long been present at a low level in rice fields, but may have gone unnoticed because the symptoms are not obvious at certain growth stages of the rice plant. In severe cases, more than 90% of rice hills in a field are diseased, and total yield loss results.

The predominant symptoms of the disease are stunting to various degrees at all growth stages (Fig. 1) and ragged, tattered, torn, or serrated leaves (Fig. 2). The disease has been called “ragged stunt,” “infectious gall,” and “Kerdil hampa.”

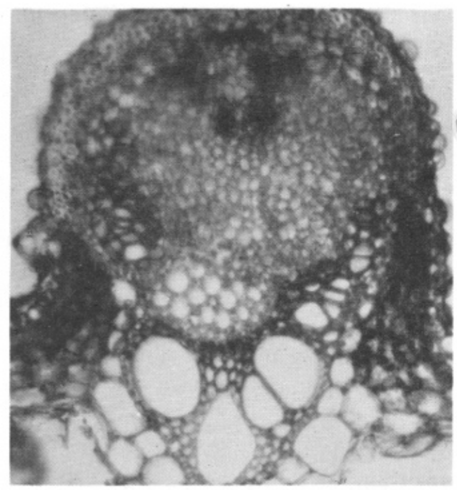
The diseased plants do not deviate markedly from healthy ones in color and tillering, but are stunted. Other symptoms vary according to the stage of plant growth. At early growth, the predominant symptom is ragged leaves, which gradually become fewer as the plants grow older. Another symptom is vein-swellings or galls (Fig. 3), the result of a proliferation of phloem cells (Fig. 4). The vein-swellings are about 1 mm or less wide and from about 1 mm to more than 1.0 cm long. They are pale yellow in

1. Healthy plant (left) and stunted plant (rlght) infected with ragged stunt disease.

2. Note the ragged leaves, a symptom of the disease.



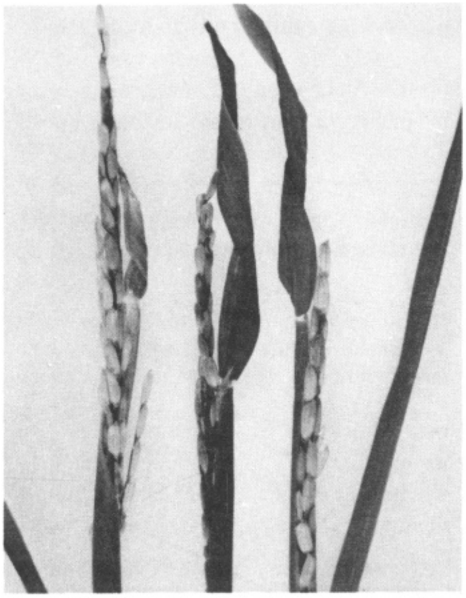
3. Vein-swelling on leaves, a symptom of the disease.



4. The cause of vein-swelling – a proliferation of phloem cells.

color or, less frequently, brown. The vein-swellings often appear on the upper portion of the outer surface of the leaf sheath, particularly adjacent to the collar, and less often on the lower surface of leaf blades. Diseased plants often flower late. Flag leaves are small and often twisted, malformed, or ragged (Fig. 5). Panicle emergence is often incomplete (Fig. 5), but tillers may produce more panicles, often at the upper nodes (Fig. 6). The panicles bear mostly empty grains. The diseased plants can survive for a long time after flowering – more than 6 months in the IRRI greenhouse.

Ragged stunt disease is systemic. When a diseased plant is ratooned, vein-swelling is the only symptom that can



5. Distortion of flag leaves and incomplete emergence of panicles are symptoms of ragged stunt disease.

6. Excessive panicles of infected plants at later growth stages are another symptom of ragged stunt.

be observed in the early regenerated growth; other symptoms appear at booting stage.

So far, studies of ragged stunt transmission through seeds and soil and by mechanical means have yielded no positive results, but the disease can be transmitted by the brown planthopper *Nilaparvata lugens.* The causal agent-vector interaction will probably be categorized in the persistent group. Although biotypes 1, 2, and 3 of the brown planthopper differ in their ability to attack rice varieties, no significant difference has been found in their ability to transmit ragged stunt.

The nature of the causal agent of the ragged stunt disease remains obscure. However, it is not a fungus, bacterium, nematode, or mite. It is probably a virus.

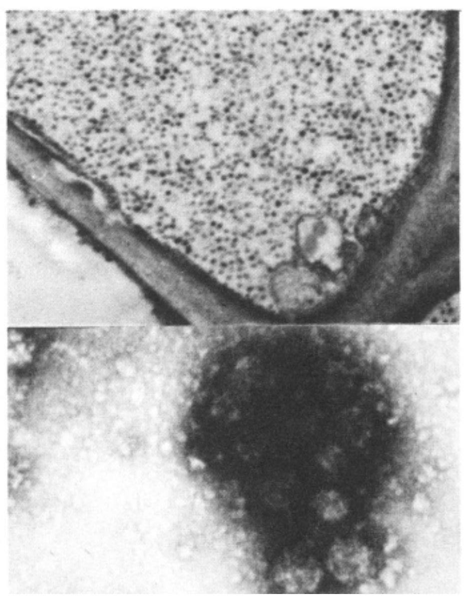
Under natural infection, the following varieties and lines of *O. sativa* were susceptible to ragged stunt: BG34-8, BG90-2, BG374-2, BKN6986-108-2, Gow Ruang 88, IR8, IR20, IR22, IR24, IR26, IR29, IR30, IR3839-1, IR4427-115-3-3-3-3,IR4547-16-3-7, IR4568-586-2-2, IR4625-169-3-3-3, IR4723-345-1-3-1, IR4744-32-1-3-3, KN-lB-461-8-6-9-2, Pelita I/1, and TN1. *O. latifolia* can also be infected.

Since the infection has been noted in rice seedbeds, protecting seedlings and plants during early growth would probably reduce the disease incidence.

Study indicates viral nature of rice ragged stunt disease

E. Shikata and Kulchawee Leelapanang, Hokkaido University; and E. R. Tiongco and K. C. Ling, International Rice Research Institute

Dip preparations and ultrathin sections of plants naturally infected with ragged stunt disease at the IRRI farm and artificially inoculated by viruliferous *Nilaparvata lugens* were studied with an electron microscope at Hokkaido University. Electron micrographs showed polyhendral particles of 50–70 nm. The particles appeared abundantly in phloem cells (see photo), and in cells of the vein-swellings, or galls.



Electron micrographs show virus particles in dip preparation (top) and in a phloem cell of an ultrathin section (bottom) of a rice plant infected with ragged stunt disease.

Although the determination of the infectivity of the particles is still under way, the electron micrographs serve as additional evidence that the causal agent of rice ragged stunt disease is a virus.

Resistance to bacterial leaf streak in India

R. A. Singh, B. Das, and K. S. Dube, Department of Plant Pathology, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145, India

Bacterial leaf streak, caused by *Xanthomonas translucens,* is sometimes widespread and damaging, causing losses comparable with those from bacterial blight; however, little has been done on the development of resistant varieties. Varieties have been screened by artificial inoculation under natural conditions at Pantnagar since 1973. These results are from kharif 1973 and 1975, when disease pressure was heavy.

Twenty-five-day-old seedlings were transplanted in a puddled field with four checks: IR22 (resistant), Krisna (moderately resistant), IR8 (susceptible), and Cauvery (highly susceptible). The entries were inoculated at 45 days after sowing by rubbing bacterial suspension in cotton wool on the undersurface of the leaves. A spray inoculation increased disease pressure. Observations were recorded at the maximum-tillering stage and at 14 days after flowering on a scale of 1–9 (see table).

The following entries were recorded as resistant or moderately resistant to bacterial leaf streak:

KHARIF 1973

Resistant – SMI-6, RP 633, RP 189-2, OR 10-58, and OR 10-237.

Moderately resistant – IR579-119-2-3, CR 10R-157, ARC 5983, entries no. 6328,6333,6334,6335, and 6336, RP 291-20, and RP4-13.

KHARIF 1975

Resistant – AD 1140, Hoyaku/ Kolumba 540-1, Jikoku/Kolumba 540-5, Jikoku/Kolumba 540-6, Jikoku/Kolumba 540-7, Shiranui/Goinchiew 35-4, FH 487, MR 249, RP 1017-334-3-6,

Lines (no.) and their reactions to bacterial leaf streak during 1973 and 1975 kharif, Pantnagar, India.

Reaction	Lines (no.) from AICRIP		IRRI[a]
	1973	1975	1975
Resistant	5	32	38
Moderately resistant	10	22	22
Moderately susceptible	22	64	21
Susceptible	25	933	252
Highly susceptible	23	230	7
Total	85	1281	340

[a]International Rice Observational Nursery.

RP 975-145-3-3, RP 572-9-2-1, RP 572-9-5-1, RP 633-367-1-2, RP 633-385-2-7, RP 2001-25-1, RP 2003-1-2-5, RP 2004-1-6-3, RP 2007- CRHP-1, R 32-2617, R 27-2546, RJR 107-305, 2-25 (upland paddy x BR 4-10), 24-7-3 (SR 3-9 x TN1), R 7-2-3-1, R 7-3-1-1, R 8-12-1-1, R 19-1-1-1, R 106-2-1-3-2, IR2071-557-6-4, IR2071-588-1-1-1, IR2071-875-2-3-4, IR2071-636-5-2-6, BR 3-12-B-15-40, BR 51-67-1/CI, BR 51-74-2, BR 44-11-1, BR 51-99-1, BR 51-243-1, BR 51-319-9, BR 52-8-1, B 459b-Pu-4-5-6-5, IR2031-238-4-2-2-3, IR2035-290-2-3-1, Purple check (15/IR1103-1), IR2070-210-3-3-4, IR2588-19-1-1, IR2681-34-5-6, IR2871-53-2, IR3264-13-158-2-935-3, IR3265-138-2-5, BG 11-11, Chianung-Seu Yu 8, SRR 6726-76-2-3, BIC-Md-3-3, IR2031-724-2-3-4, IR2071-636-5-5, IR2070-423-2-5-6, IR2035-290-2-1-3, IR2848-26-1, IR944-102-2-3-2, TN1, IR1539-823-1-4, IR26, IR5492-3-147 (Glb_2), IR1820-52-24-1, IR2070-24-1-4-5, and JPS.

Moderately resistant — CR 139-1058, RP 633-590-3-1-1-1, RP 632-94-1-2-1-1, RP 744-104-76-1, RP 744-104-76, UPR 4 D-25-2,45457 (TN1/Co 29) x Hansa, HPNS 32, TR 14, RP 633-308-1-2, RP 938-31-4-6, RP 2001-9-1, R 102-2609, R 106-2567, R 111-2583, R 32-2615, R 22-2522, 12-2 (TN1/BR4-10), 11-2 (TN1/BR 4-10), BR 1-2B-40-3, BR 43-1 1-2, BR 51-46-5, BR 51-49-6, 31-14 (upland paddy x BR 4-10), R 1-1-1-1, IR2070-414-3-9, BR 51-114-2, BR 51-331-4, Giza 172, B 1896-52-8-3-1, B441b-126-2-3-1, IR1544-181-1-1, IR2035-255-2-3-1, IR2063-65-2-1, IR2063-152-3-2, IR2063-185-2-2, IR2070-834-1-2, IR2153-550-2-6, IR2786-120-1, IR2843-26-3, IR2071-625-1-252, IR2070-743-6-3-2, SPR 6726-134-2-26, IR1545-339-2-2, and RP 633-200-1-7-4-1.

Methods to artificially inoculate and screen rice varieties for resistance to stem rot disease under field conditions

S. A. Miah, M. A. Nahar, and M. A. Haque, Plant Pathology Department, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Two methods of inoculation for stem rot were tested during 1975–76: 1) placing a mycelial mass on potato-dextrose-agar among the injured culms of the hills, and 2) placing inoculum from autoclaved rice grains in the hills and tying the hills as in the International Rice Sheath Blight Nursery (IRSHBN). Ten hills each of 104 varieties were inoculated; at grain maturity, the inoculated hills were cut at the base for evaluation. The rotten tillers were counted by pressing between the fingers. Thirty-two varieties and lines showed less than 30% culm rotting and were rated as resistant. The rices that showed less than 20% culm infection included IR32, IR1529-680-3-2, IR2053-87-3-1, IR2061-214-3-3-28, IR2061-214-3-3-32, and Mahsuri (Improved). The IRSHBN method of placing grain inoculum was more effective than the other as shown by the higher percentage of infection in 16 varieties (see table).

Two methods of artificial inoculation for stem rot disease. Bangladesh Rice Research Institute.

Cultivar	Rotten tillers (%) Mycelial mass	Grain inoculum	Av.
Chitraj	15	25	20
IR1817-2-143-3	20	25	23
IR944-85-1-2-1-1	21	23	22
IR910-12-3-1-1	9	36	23
BR9-17-6-4	12	29	21
BR13-231-1	25	31	28
IR579-80-1-2-1	27	31	29
IR20	25	38	32
IR781-177-3-2-2	28	39	34
Mukti	27	43	35
Kataktara	31	43	37
BR9-17-4-2	19	54	37
IR836-1-1-1	29	49	39
BR43-11-2	35	45	40
IR8	25	81	53
Chandina H/R 29-3	36	75	56

Sources of resistance to ufra disease of rice in Bangladesh

S. A. Miah and M. A. Bakr, Plant Pathology Department, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Eight species of wild rice and one cultivar were screened for resistance to ufra disease in the field and in pots. The wild rice species were *Oryza glaberrima, O. nivara, O. officinalis, O. perennis, O. rufipogon. O. sativa* var. *patua, O. spontanea,* and *O. subulata.* The *O. sativa* cultivar was R16-06. All plants were inoculated at the vegetative stage by introducing into the leaf sheath cavities about 1 ml of nematode suspension (approx. 1,000 *D. angustus*/ml) with a fine glass dropper. The inoculated potted plants were covered with polyethylene bags for 2 days to maintain proper humidity.

All the rices, except the wild species *O. subulata* and the cultivar R16-06, showed symptoms of ufra infection. *O. subulata* could not be infected at all. Although infection began on inoculated R16-06, the disease did not fully develop and no nematodes could be isolated from the plants at the mature stage. R16-06 is a deep-water rice that is sensitive to photoperiod, but its yield potential is low. *O. subulata* is a stiff-leaved rice. These two rices can be used as sources of resistance in future breeding programs for deep-water rice.

Rice disease survey: 1975

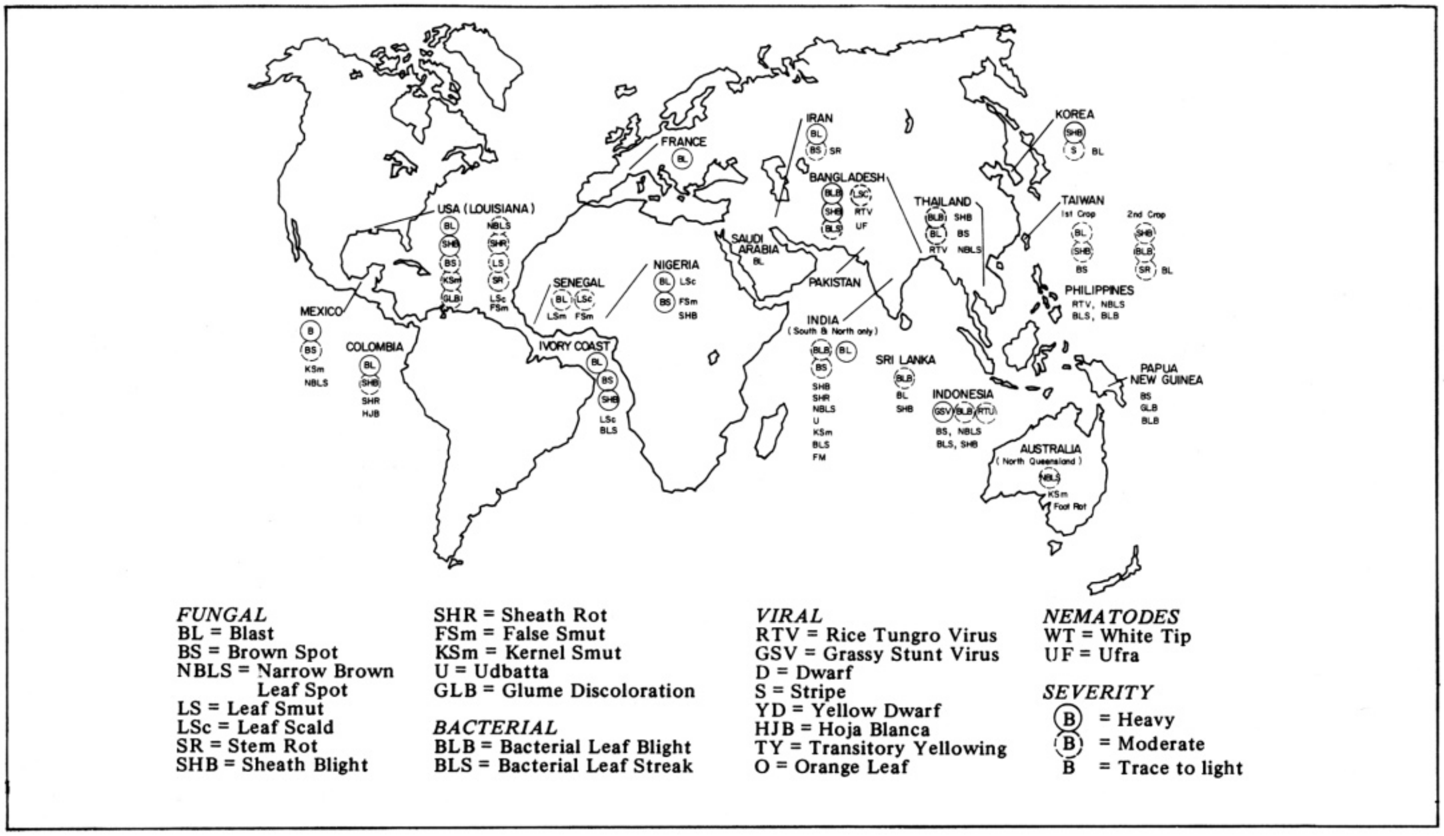
Summarized by H. E. Kauffman, joint coordinator and plant pathologist; T. Ebron, senior research assistant; and S. Merca, research assistant, International Rice Testing Program, IRRI

Scientists responded well to disease survey questionnaires sent out with the Rice Pathology Newsletter in late 1975. As in previous years, blast was the most widespread disease during 1975. It was the major disease in India, Iran, Senegal, Colombia, Mexico, USA, and France. Second in importance was bacterial blight, which was significant in most Asian countries. It was serious in Korea, Taiwan, and Bangladesh. There were no large outbreaks of tungro virus during 1975, but grassy stunt virus was closely associated with brown planthopper outbreaks and caused heavy losses in numerous areas of Java, Indonesia. Brown spot and narrow brown leaf spot, although widespread, generally caused minor losses.

Some scientists gave estimates of yield and monetary losses. Korea and Taiwan have organized surveys that provide reliable estimates. Other estimates are rough but they give a general idea of the serious losses caused by rice diseases. Blast, for example, was estimated to cause losses of more than US$8 million in each of three countries: Taiwan, Iran, and Mexico. Sheath blight also caused about the same loss in South Korea and Taiwan. Bacterial blight was estimated to cause an average loss of 4% in Bangladesh, which amounted to about US$96 million In Indonesia, grassy stunt virus caused more than US$20 million in crop losses. Even more important than the monetary figure is the amount of rice that was lost in countries where food is already scarce.

Respondents to the RPN rice disease survey: 1975.

Region, country	Respondent	Region, country	Respondent
East Asia		***West Asia***	
South Korea	B. K. Chung	Iran	M. Akhavizadegan M. Moafizad Plant Pest and Disease Institute
Taiwan	R. J. Chiu W. H. Tsai	Saudi Arabia	W. L. Chang
Southeast Asia		***Sub-Sahara Africa***	
Indonesia	A. Hasanuddin J. Soepriaman Sunendar L. T. Palmer	Ivory Coast	J. M. Bidaux
		Nigeria	Y. A. Awoderu
Philippines	D. Lapis B. S. Nunag, Jr. IRRI scientists	Senegal	J. C. Guard
		Europe	
Thailand	P. Weerapat	France	R. A. Marie
South Asia		***South and Central*** America	
Bangladesh	S. A. Miah	Colombia	M. J. Rosero
India	S. Kannaiyan G. Venkata Rao N. Shivanandappa B. M. Singh R. A. Shih Survey teams from Tamil Nadu Karnataka Punjab	Mexico	L. H. Aragon J. L. Armenta Soto F. M. Cabrera
		North America	
		(Louisiana)	M. C. Rush
		Oceania	
		Australia	W. Pont
Sri Lanka	H. Weeraratne	Papua New Guinea	J. T. Hale



Major rice diseases in the world's rice-growing countries in 1975 (from RPN disease survey).

Survey of insects and diseases in Asia

Thomas R. Hargrove, associate editor, International Rice Research Institute

In a 1975 IRRI survey, 35 rice breeders at 28 research centers in 10 Asian nations were asked to rank, in order of severity, the four most serious insects and diseases that limit farmers' rice yields within the area served by each experiment station. The project was conducted in collaboration with Iowa State University, USA, and was partially funded by The Rockefeller Foundation.

The rice stem borer was most widely considered a serious pest. In 60% of 35 regions, its severity rating was 1.6, one of the highest, on a scale where 1 = most serious pest and 4 = fourth most serious. But when severity rating was calculated only for the stations where the stem borer was one of the four most serious problems, it rated fourth highest, 2.7 (see table). That may indicate that although the stem borer limits yields across vast regions, other local pests are usually more serious in individual areas.

Bacterial blight disease, with an overall severity rating of 1.6, was considered a major problem in 57% of the regions. Where bacterial blight was serious, it received a rating of 2.8 — higher than that for the stem borer. The brown planthopper was a major pest in 46% of the regions. Its overall severity rating was 1.1 ; but in regions where it was a problem, it was rated 2.5. The fourth most common of the serious Pests was blast disease, cited in 43% of the regions. It received an overall severity rating of 1.4, but at stations where it was a major problem, it had the highest rating, 3.2.

Rice breeders' perceptions of the specific insect and disease pests that most seriously limit rice production in farmers' fields within the areas served by their research centers. Thirty-five rice breeders at 28 agricultural experiment stations and universities in 10 Asian nations, 1975.

Pest	Mean severity rating [a]		Breeders (%) who rated pest as one of 4 major constraints
	All stations	Stations where pest is a problem	
Stem borer	1.6	2.7	60
Bacterial blight	1.6	2.8	57
Brown planthopper	1.1	2.5	46
Blast disease	1.4	3.2	43
Gall midge	1.1	3.0	37
Tungro virus	0.7	2.3	29
Sheath blight	0.3	2.0	17
Green leafhopper	0.2	2.0	9
Helminthosporium	0.1	1.3	9
Striped virus [b]	0.3	3.0	9
Grassy stunt virus	0.1	1.0	6
Sheath rot	0.1	2.0	6
Other insects [c]	0.7	2.1	34
Other diseases [d]	0.4	2.1	20

[a]On a scale of 1-4: 4 = most serious insect or disease pest; 1 = fourth most serious. Calculated for all 35 areas and for only those regions in which each factor was considered one of four major pests.
[b]Only in Korea.
[c]Includes one rating each for whitebacked planthopper, leaf roller, paddy bug, seedling fly, stink bug, armyworm, gandhi bug, and two unspecified insects.
[d]Includes one rating each for bacterial leaf streak, black smut, sheath virus, glume blotch, stem rot, and two unspecified diseases.

GENETIC EVALUATION & UTILIZATION

Insect resistance

IR26 found susceptible to the brown planthopper in North Sumatra, Indonesia

O. Mochida, CRIA-IRRI, Sukamandi; I. N. Oka, Dandi S., Z. Harahap, Sutjipto P., Central Research Institute for Agriculture (CRIA), Bogor; and H. M. Beachell, CRIA-IRRI, Bogor, Indonesia

The brown planthopper (BPH) has severely attacked rice in North Sumatra since about 1970. IR26 was first grown from 5 kg of seed brought to N. Sumatra from IRRI in 1974. Seedlings were transplanted near Tebingtinggi on 15 May 1974 and 3 t were harvested. By the end of March 1975 (the following season), IR26 was grown on about 67 ha; about 200 t were harvested. IR26 was planted on about 860 ha in the 1975–76wet

Empty areas where IR34 was hopperburned during early growth stages.

season and on about 30,600 ha in the 1976–77 wet season.

IR26 was first reported to be damaged by the BPH in September 1976. In February 1977 hopperburn was confirmed in IR26 and IR34, and IR30 was severely attacked (see photo). At three locations, IR32 appeared resistant; at one location, IR36 seemed resistant. The highest BPH populations (adults + nymphs/hill) were 1,008 on IR26, 1,508 on IR30, 47 on IR32, 18 on IR34, and 40 on IR36. Most of the insects were in the first and second instars, except for two cases of more advanced insect development on IR26. No hill in 11 fields was found infected with symptoms of grassy stunt; 24% infection was observed in 1 field. On December 15, 1976, the Extension Service of the N. Sumatra provincial government estimated the total area of rice fields attacked as 43,618 ha, with 3,482 ha of hopperburn. On 31 January 1977, 43,783 ha of BPH damage was reported, with 7,597 ha of hopperburn. About 9,400 ha of the damage and 880 ha of the hopperburn were on IR26. This was the first report of large areas of IR26 being severely attacked by the BPH in Indonesia.

Population fluctuation of brown planthopper in Kuttanadu, Kerala, India

K. P. Vasudevan Nair and S. Sukumaran Nair, Rice Research Station, Moncompu, Kerala, India

The brown planthopper (BPH) *Nilaparvata lugens* is a major rice pest in Kerala. Its first reported outbreak was in the punja crop of 1973–74. It caused extensive damage in Kuttanadu, Alleppey district, and in the Kole areas of Trichur district.

These rice-growing tracts are waterlogged and the fields must be drained after the monsoon rains for paddy cultivation. Rice is extensively grown, mostly as a monoculture crop. After one or two rice crops, the fields remain under water for the rest of the year. Notable features of rice cultivation in these areas that may favor the BPH are widespread cultivation of susceptible high yielding varieties, such as Jaya and IR8; high seeding rates; excessive nitrogen use; indiscriminate insecticide application, which causes destruction of natural enemies; and favorable climatic factors.

The Rice Research Station, Moncompu, concentrates its efforts on the BPH problem through a multidisciplinary approach. To study the population fluctuations, we have recorded light-trap catches of BPH in Kuttanadu since January 1974.

The population peaks twice each year, in each cropping season. The maximum catch was recorded from January to March, with the highest peak in February. Interestingly, this peak coincides with the booting and postflowering stages of the main crop (0ct.–Nov. to Feb.–Mar.). Hopperburn and serious crop losses are common during this period. The BPH population begins to decline by late March when the harvest ends and continues to drop until July. The next peak is from July to September, during the autumn crop. But because of adverse climatic conditions, such as heavy rains and high winds, the population does not rise to alarming proportions during this period, and so the crop is safe. The light-trap studies also show that BPH are present throughout the year. Survival of the pest during the off-season, when there is no standing crop, should be further investigated.

Varietal resistance to the rice thrip, *Baliothrips biformis*

C. Kudagamage, research officer, Central Rice Breeding Station, Batalagoda, Ibbagamuwa, Sri Lanka

Baliothrips biformis is primarily a pest of seedling paddy which emerges in the drier months and infests the late-planted crops in both crop seasons in Sri Lanka. Depending on the degree of infestation, the insect can retard growth or kill the seedling. Breeding for thrip resistance would be the most economical means of control. Of the almost 800 indigenous varieties that underwent preliminary observation, those that showed reasonably good levels of resistance were field-tested in replicated trials during the 1976 and 1977 dry seasons. Damage was observed at 2 weeks after seeding or at the 3- to 4-leaf stage. The system of evaluation was as follows.

Reaction[1]	Damage
R	Leaves remained healthy except for very slight rolling of the first and second leaf.
MR	Slight rolling and withering of the first and second leaf.
MS	First and second leaf withered and dead; upper leaves slightly rolled.
S	Upper leaves rolled, withered, and with few white lesions; lower leaves dead.
HS	Upper leaves dying with pronounced white lesions, seedlings are stunted; Iower leaves dead.

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

Varieties found resistant and moderately resistant to the pest are listed below.

Variety	Reaction
Dahanala 2220	R
Dahanala 682	R
Kaluheenati 547	R/MR
Heenati 896	MR
Mudukiriyal 197	MR
Kalubalawee	MR
Demalakotan 1630	MR
Gonabaru	MR/MS

Serious attacks of rice gall midge in the central plain of Thailand

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The rice gall midge *Orseolia oryzae* has long been one of the most important rice pests in northern and northeastern Thailand, but not in the central rice-growing area. In June 1977, however, gall midge severely attacked the second crop of rice about 80 km east of Bangkok, in Bangkhanarg village, Bangnampriew district, Chachengsao province. A survey was conducted in the village in June and July.

Rice is irrigated throughout the year. A second crop of about 480 ha of high yielding varieties (mostly RD) has been directly sown during March and April since 1976. The insecticides carbofuran 3G and monocrotophos 50% E.C. were applied at about 45 and 60 days after sowing, but they were not effective because the application was late. Precipitation was 5.5 mm in March, 54.7 mm in April, and 121.0 mm in May.

From 85 to 95% of the hills were infested. From 1 to 11 galls per hill were found; the average was 3. The hills averaged four panicles each.

The severe outbreak may have occurred because 1) the village is adjacent to Prachinburi province where the insect was previously found at low levels; 2) the susceptible RD varieties are widely grown, supplying ample food; 3) rice is planted at high density by broadcasting; 4) irrigation throughout the year creates a suitable environment for gall midge reproduction; and 5) a high rate of fertilizer is applied.

Varietal reaction to rice @ midge, leaf rollers, and thrips

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In the Vaigai-Periyar river project of Tamil Nadu, the rice gall midge *Pachydiplosis oryzae* and the leaf roller *Chaphalocrosis medinalis* have become serious because of extensive and intensive cultivation of high yielding varieties.

The relative susceptibility or resistance of 85 prerelease cultures was assessed in a randomized field experiment with three replications at the Agricultural College and Research Institute Farm, Madurai, in 1975–76.Because a severe outbreak of the rice thrip *Baliothrips biformis* was noticed in the nursery stage, the varieties were also observed for their reactions to the insect. Eleven varieties had fewer infestations by the three pests than did the others (see table). The variety W. 1263 showed resistance to gall midge; Kakatiya, to leaf rollers; and PTB 21 and hang 152, to thrips.

Reaction of rice varieties to gall midge, leaf rollers, and thrips at Madurai, India.

Cultivar	Gall midge (% affected tillers)	Leaf roller (% affected leaves)	Thrips (n0./5 sweeps)
		Most resistant varieties	
W. 1263	1.0	6.4	10.5
Kakatiya	6.8	1.8	5.0
CR 57-49-5	7.5	3.2	3.0
Isawarakora	1.5	3.4	7.0
PTB 10	7.4	3.7	3.5
PTB 21	7.8	4.6	2.5
Leang 152	8.0	6.2	2.5
CR 58-51	8.1	6.9	6.0
CR 95-R-14-1	8.2	7.8	9.5
CR 57-29 (non-pigmented)	8.8	8.1	3.5
CR 57-29 (pigmented)	9.6	9.6	–
		Most susceptible varieties	
GMR 5	50.6	–	–
Cul. 4609	–	29.1	–
Co 36	–	–	66.5

GENETIC EVALUATION & UTILIZATION

Deep water

The influence of varying depths and durations of submergence on the adaptability of rice varieties to low-lying waterlogged conditions in West Bengal, India

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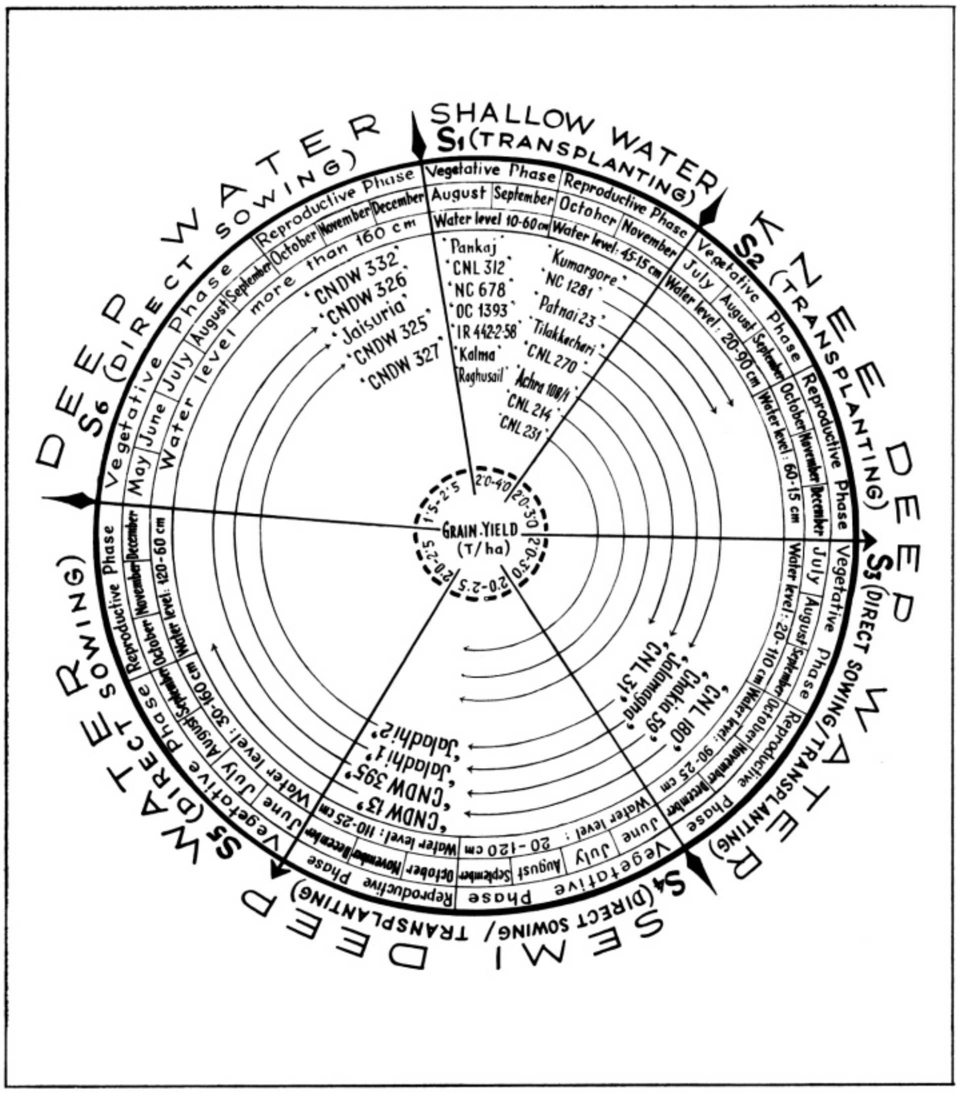
Three hundred rice varieties were tested in eight specially constructed fields under shallow water, knee-deep water, semideep water, and deep water conditions at the Chinsurah station during the 1974–75 monsoon season. The experiments were conducted in randomized blocks with two replications; each plot was 7 × 3 m. The soil was clay loam with a pH of 6.9. No manure was applied. The figure shows the extent of adaptability of promising low-lying varieties to varying waterlogged situations together with method of sowing, growth duration, and grain yield.

The findings suggest that Achra 108/1, CNL 214, and CNL 231 have a maximum degree of ecological adaptability to varying waterlogged conditions and can be grown in shallow water, knee-deep water, and semideep water. Similarly, Patnai 23, Tilakkachari, Kumargore, CNL 270, and NC 1281 are well adapted to shallow and knee-deep water. Pankaj, CNL 312, NC 678, OC 1393, IR442-2-58, Kalma, and Raghusail grew well only in shallow water. CNL 180, CNL 31, Chakia 59, and Jalamagna have moderate adaptability and were found suitable for knee-deep and semideep water. Varieties such as CNDW 13, CNDW 395, Jaladhi 1 and Jaladhi 2 show great ecological adaptability to the greatest depth and duration of submergence; they can grow in both semideep and deep water. Typical floating rice varieties such as

Extent of adaptation (indicated by arrows) of rice varieties and their yield potentials at varying depths and durations of waterlogged situations at vegetative and reproductive stages under direct-sown and transplanted conditions. West Bengal, India.



CNDW 332, CNDW 326, Jaisuria, CNDW 325, and CNDW 327 are only suitable for deep-water condition.

The results indicate that the genetic potential of individual varieties determines the ability to adjust to varying depths and durations of submergence under waterlogged conditions. Therefore, those traits can be introduced into improved varieties with greater yield potential. The figure gives information on varietal suitability for different low-lying, waterlogged situations. Grain characteristics of the promising varieties are available by contacting the authors.

Breeding for deep-water conditions

M. V. S. Sastry, T. E. Srinivasan, and U. Prasada Rao, All India Coordinated Rice Improvement Project, Hyderabad 30, India

A breeding program to develop varieties suitable for deep-water conditions was initiated at the All-India Coordinated Rice Improvement Project, Hyderabad. Selections from the F_3 of the cross Rp 31-49-2 (short statured)/Leb Mue Nahng (tall, deep water-tolerant) — originally selected at AICRIP headquarters — were tested at the Deep Water Rice Research Station, Chagraghat, at a water depth of 70–80 cm for 1 month. On the basis of tolerance, 114 single-plant selections were made and further screened at Hyderabad, along with IRRI materials. Two sets of 100 of each entry were sown in four earthen pots. In the first set, 10-day-old seedlings remained submerged for 1 week in the drain at a water level of 150 cm. The percentage of seedlings that survived and their growth (in centimeters per day) during submergence were recorded. In the second set, 30-day-old seedlings were kept submerged. The performance of promising lines is summarized in the table.

The performance of promising lines screened for deep-water conditions. All India Coordinated Rice Improvement Project, Hyderabad, India.

Designation	Cross	Seedlings submerged for 1 wk: loday-old survival (%)	loday-old Growth during sub-mergence (cm/day)	30-day-oId Survival (%)	30-day-oId Growth during sub-mergence (cm/day)
6204325	NP 31-49-2/ Leb Mue Nahng	94	2.9	91	2.9
6204314		81	2.4	90	3.3
6204435		90	0.4	87	3.1
KLG 6987-44-1	IR262/Khao Nahng Nuey	100	2.5	85	2.5
NP 31-492 (parent)	1 NP/Sigadis	0	0.0	41	0.6
Leb Mue Nahng	–	66	2.5	90	3.7

GENETIC EVALUATION & UTILIZATION

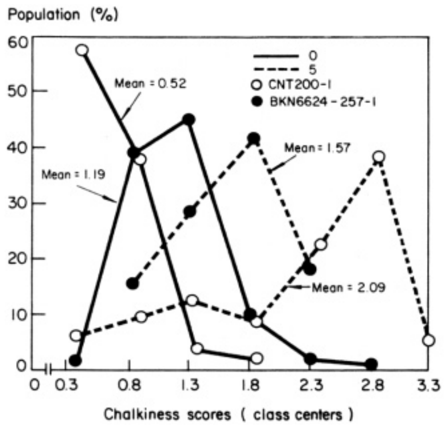
Grain quality

Selection for nonchalky grain in two Thai experimental rice lines

Kruawan Attaviriyasook, first grade official, Rice Grain Quality Section, Rice Division, Department of Agriculture, Ministry of Agriculture and Cooperatives; and B. R. Jackson, plant breeder, The Rockefeller Foundation, G.P.O. Box 2453, Bangkok, Thailand

Rice breeders in Thailand are sometimes disappointed in promising experimental lines because they discover, after several cycles of selection, that the milled grain is too chalky to meet the rigid grain-quality standards of the government.

In recent observations, the Thai lines CNT200-1 and BKN6624-257-1 showed unusually wide adaptation, excellent yield, good disease resistance, and acceptable grain length. Such characteristics should have easily qualified the lines for release as recommended government varieties. Unfortunately, their average chalkiness ratings exceeded the 1.5 score, the upper limit imposed by the government. Grain-quality researchers had previously observed wide ranges in chalkiness in seed from the two lines but assumed that the condition was due to environmental effects.



Distribution of chalkiness scores for two populations selected from the Thai experimental lines CNT200-1 and BKN6624-257-1, grown under monsoon season conditions. Bangkhen Rice Experiment Station, 1976.

A study made by Nakatat several years ago suggested that chalkiness might be controlled by several genes interacting with the environment. Since most pedigree lines are bulked in the early generation after hybridization, it was theorized that segregation for chalkiness might continue under selfing and eventually result in an array of genotypes, some chalky and others nonchalky. To test the hypothesis, nonchalky and chalky grains were randomly selected from a bulk sample of CNT200-1 and BKN6624-257-1 and planted at the Bangkhen Rice Experiment Station in the 1976 wet season.

The means of chalkiness scores of the two populations differed by 1.57. The distribution of the low chalkiness population was strikingly different from that of the chalky population. The two populations overlapped primarily because one family in the chalky population had unusually lower scores, averaging 0.60, than the other families, which tended to have average scores higher than 2.0.

BKN6624-257-1 was selected from a cross of IR262 and Niaw Sanpahtawng, a popular glutinous variety in North and Northeastern Thailand. Although the separation of the chalky and nonchalky populations was not as clear as that in CNT200-1, the means and distribution suggest that the selection had at least some effect. The result may be partly due to the effects of the waxy gene from the Niaw Sanpahtawng parent, since many of the milled seeds had an opaque appearance.

GENETIC EVALUATION & UTILIZATION

Adverse soils

Breeding for resistance to hydrogen sulfide injury in Tamil Nadu, India

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Subartesian wells irrigate an area of about 4,000 ha in Tamil Nadu. Hydrogen sulfide in the irrigation water of such wells hampers the initial establishment of rice and reduces yields by 40 to 55%. To develop rice varieties that will withstand this adverse situation, breeding programs were initiated at the All India Coordinated Rice Improvement Project, Aduthurai, Tamil Nadu.

Seven segregating populations were tested in a location where the irrigation water has hydrogen sulfide. The progeny of the cross combinations Tiruveni/IR30 and Tiruveni/Co 39 performed well under the adverse condition. Among varieties already released, Tiruveni, IR30, and ADT-9 appear promising. Further work is in progress.

Pest management and control

DISEASES

The appearance of tungro symptoms in boro paddy in W. Bengal, India

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Serious epidemics of tungro occurred in W. Bengal in 1969 and the disease has occurred sporadically since then. To combat its spread in India, extensive research has been conducted at the All India Coordinated Rice Improvement Project at Hyderabad, the Central Rice Research Institute at Cuttack, the Indian Agricultural Research Institute at New Delhi, and at Bidhan Chandra Krishi Viswavidyalaya (department of plant pathology) in W. Bengal. As a result, adequate cultivation practices were recommended such as removal of the virus sources from fields, growing tolerant or resistant varieties, and judicious pesticide application to control the vector.

Although no serious incidence of tungro has been reported in W. Bengal during the last 3 years, its presence is evident from symptoms in trial plots at the Chinsurah Rice Research Station and at the plant virus experimental fields at Kalyani. Because epidemics of tungro could spread under favorable conditions, rice fields around Kalyani were searched for tungro during the boro season, 1976–77 (the disease was found in a more or less epidemic form in one field).

In the field study at Kalyani, tungro-like symptoms were found in the first week of February 1977 on a few plants of the variety China (imported from Bangladesh) grown in lowland conditions. The leaves turned orange-yellow and the plants became stunted. The height of infected plants was reduced by 15 to 96%.

In transmission studies with TN1 seedlings, typical symptoms developed within 20 days of inoculation. The sweeping technique yielded no leafhoppers. Patches of diseased plants gradually appeared and the disease spread during March. At the end of March, the leafhopper population, primarily *Nephotettix virescens,* was high (12 adults/sweep). During early April, the entire field was diseased, and the leafhopper population remained high. The crop – harvested on 8 April – yielded a low 1.27 t/ha (the expected yield was 5.56 t/ha).

In the adjacent highland situation, Ratna was transplanted in the second week of February. The field remained normal and yields were optimum. Neither the sweeping technique nor the light trap yielded leafhoppers. The macroclimatic situation at Kalyani and that in the field being studied are similar because the two locations are no more than 1 km apart. But the microclimatic situation may differ, resulting in a buildup of hoppers at Kalyani.

In a study of the biology of *Nephotettix virescens,* 33.3% hatching was observed during December-January 1976. It took from 28 to 43 days for molting to be completed (1st-5th instar) and for adults to emerge. From 5 to 19% of the adults appeared.

Alternate hosts of rice tungo virus and its vectors

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Information on the survival of tungro virus and its vectors *Nephotettix virescens* and *N. nigropicrus* during off-seasons is vital to the understanding of its epidemiology. Seventeen wild species of rice, 20 of weeds, and 6 of cereal crops were tested to see if they might support tungro virus and its vectors during off-seasons.

The weed and cereal crop species showed no visible symptoms of tungro, nor did they act as symptomless carriers. But the virus infected and survived on nine of the wild rices: *Orvza glaberrima, O. nivara,* the introgressive form of *Oryza* sp., *O. barthii, O. perennis, O. eichengeri, O. australiensis, O. punctata,* and *O. brachyantha* However, the virus was recovered through back indexing with nonviruliferous *N. virescens* only from the first five species, even though the remaining four were clearly stunted. Some peculiar symptoms not common on rice cultivars were observed in some species, including veinal and interveinal necrosis.

In tests of vectors, plant species on which leafhoppers survived for more than 10 days were considered favorable food hosts; those that supported a complete life cycle were considered reproductive hosts. The most efficient tungro vector, *N. virescens,* had a more limited host range than the inefficient vector *N. nigropictus.*

The reproductive host species of *N. virescens* in order of decreasing favorableness were *O. sativa, O. glaberrima, O. nivara, O. perennis, Paspalum orbiculare,* and *Echinochloa colonum.* Its food hosts were the species *O. barthii, O. perreiri,* and *Eleusine indica.* The reproductive host species of *N. nigropictus* in order of decreasing favorableness were *Leersia hexendra, O. sativa, O. glaberrima, E. colonum, P. orbiculare, O. nivara, O. malampzhuaensis, O. perennis, O. punctata, O. officinalis, Ischaemum indicum, O. eichingeri,* and *O. minuta.* The food host species for this vector in order of decreasing- favorableness were *O. barthii, Eleusine coracana, Hordeum vulgare, Triticum vulgare, Zea mays, O. perreiri, E. indica,* and *O. alta.*

Geographic distribution of tungro virus disease and its vectors in India

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Because the tungro virus syndrome is complex, diagnosis of the disease can be

Positive identification of tungro virus disease by transmission tests in different locations in India.

Year	State	District	Locations where positive results were obtained[a]	Extent of disease
1971	Andhra Pradesh	West Godavari	Maruteru	Moderate
1972	Bihar	Sasaram	Sasaram	Mild
	West Bengal	Hooghli	Chinsurah	Mild
	Orissa	Cuttack	CRRI Farm	Mild
1973	Orissa	Cuttack	CRRI Farm, Imamnagar	Mild
		Sambalpur	Chiplima	Moderate
	West Bengal	Nadia	Ranaghat, Krishnagar, Habibpur	Severe
		Burdwan	Debipur, Bhatar Farm, Sarul, Pemra	Severe
		Hooghli	Chinsurah	Severe
	Tripura	West Tripura	Jangalia, Nalchar, Seasrimai, Vishalgarh, Gokulnagar	Severe
	Assam	Nowgong	Rangbeng	Moderate
		Cacher	Gusaipur	Moderate
	Manipur	Central	Samanroll, Wanghal	Mild
1974	Kerala	Allepey	Kuttanadu area	Moderate

[a]CRRI = Central Rice Research Institute.

confirmed only through transmission tests. This method showed the occurrence of tungro earlier in the Indian states of West Bengal, Bihar, Uttar Pradesh, Karnataka, and Kerala. From 1971 to 1974, the authors collected suspected tungro samples from 30 locations in 8 Indian states and conducted transmission tests on them.

Tungro disease in general was found to be a problem in northeastern, eastern, and southern India (see table). For still unknown reasons, it occurs in epidemic form only in certain years. Epidemics occurred in parts of northeastern and eastern India in 1969 and 1973, and in the Kuttanadu area of Kerala in 1974.

The two green leafhopper vectors of tungro, *Nephotettix virescens* and *N. nigropictus,* are found throughout India, and high populations are recorded in the states of Assam, Manipur, Tripura, West Bengal, Bihar, Uttar Pradesh, Madhya Pradesh, Orissa, and Andhra Pradesh. Although tungro is generally spread by N. virescens, it was associated with *N. nigropictus* in Kerala in 1974 and Manipur in 1973.

Incidence of sheath rot on three rice varieties

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Severe incidence of sheath rot *Acrocylindrium oryzae* was observed on three dwarf rice varieties – IR32, CR73-7, and Sona – at the Agricultural Research Station, Maruteru, Andhra Pradesh, during the rabi season (Dec.–Apr.) of 1972–73. Oblong, chocolate–colored spots, some with light centers, developed on the top leaf sheaths. Most of the leaf-sheath areas were dark brown because the spots had coalesced. The panicles of some diseased tillers emerged only partially. A white fungus growth consisting of hyphae, conidia, and conidiophores was observed on the inner surfaces of the infected sheaths.

The spots were from 4 to 18 mm long and from 2 to 7 mm wide (see table). In Sona, 31% of the tillers were infected; in IR22,9%; and in CR73-7, 10%. Disease incidence at the station was insignificant in 1974 and 1975.

Size of sheath rot spots and disease incidence in three rice varieties. Andhra Pradesh, India.

Variety	Size of sheath rot spot (mm)		Diseased hills	Diseased tillers
	Range	Av.	(%)	(%)
IR22	4–16 × 3–6	9.6 × 4.2	77	9
CR73-7	5–17 × 2–6	9.6 × 4.3	80	10
Sona	6–18 × 2–7	9.3 × 4.3	97	31

Chemical seed treatment to control Udbatta disease of paddy

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Udbatta caused by *Ephelis oryzae* is an increasingly important disease of paddy that causes considerable yield loss in Karnataka state. The disease affects both high yielding and local varieties. Estimated losses have been from 246.91 to 493.82 kg/ha, depending on disease incidence and intensity. The disease is reportedly borne in the seed, and symptoms show at the time of flowering.

The control measure currently recommended — keeping the seeds at 52–54°C for 20 min before sowing — is difficult for farmers to follow. Hence an experiment was conducted on chemical control. The treatments were Benlate, Bavistin, and Vitavax at 400 mg/kg of seed; hot water at 54°C for 20 minutes; and a control. Chemical-treated seeds were kept in cloth bags for 12 hours before sowing. Three-week-old seedlings were transplanted at 1 seedling/hill and observed for disease incidence at panicle initiation and grain formation stages.

Three seasons' data indicated that Benlate, Bavistin, and hot water were all superior to the control, while Benlate and Bavistin controlled the disease as well as hot water.

"Rice abortion" or sheath rot—a serious rice disease in Thailand

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"Rice abortion" is the name that Thai farmers have given to a widespread disorder of rice with characteristics similar to those of sheath rot disease. It was first reported in 1969 as a secondary factor associated with stem borers, and has become increasingly serious, especially in the major rice-growing area of central Thailand. In 1975 the disease completely destroyed about 500 ha in Chachoengsao province. In severe cases, more than 70% of the infected plants produced no panicles.

Infected panicles after artificial inoculation with *Acrocylindrium oryzae* in Thailand.

Replication	Infected panicles (%)		
	Spray suspension of spores	Injection suspension of spores	Check
1	80.9	78.1	0
2	73.3	69.7	0
3	72.4	77.8	0
4	65.9	77.3	0
Av.	73.1	75.7	0

The young panicles remained within the sheath, whose upper surface was entirely covered with dark-brown lesions.

We found that typical symptoms appeared after artificial inoculation by both spray and injection with a suspension of the fungus *Acrocylindrium oryzae* in the booting stage (see table). The experiment was conducted in nylon screen cages; insecticides were applied to eliminate mites or insects. The results indicate that the primary factor in rice abortion or sheath rot in Thailand is the fungus *Acrocylindrium oryzae.* The dispersion and severity of the disease may be related to the biological relationships between the sheath rot fungus and mites, the fungus and stem borers, or both.

Pest management and control

INSECTS

Occurrence of the rice tarsonemid mite at IRRI

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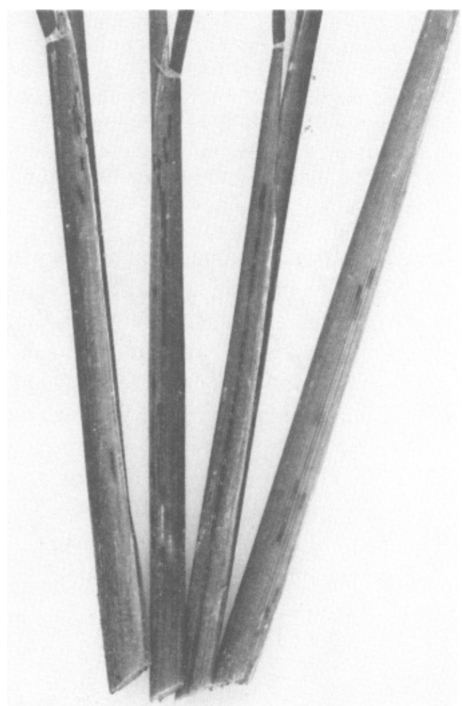
A phytophagous tarsonemid mite was found infesting rice plants on the IRRI farm. The mite, identified as *Steneotarsonemus spinki* by Dr. Robert L. Smiley of the US Department of Agriculture, lives in colonies within the intercellular air space of the upper part of leaf sheaths and, occasionally, in the basal part of the midrib of leaf blades. It causes necrotic streaks in the interveinal epidermis (see photo).

When a female mite is artificially inoculated into the intercellular air space of a leaf sheath, it becomes gravid and, in 2 days, begins to lay eggs randomly at the rate of about 15/day over a period of 5 or more days. The eggs are opaque, ovoid, and large (125 × 80 microns) in comparison with the size of the adult. They hatch into 6-legged larvae in 2 to 4 days. The newly emerged larvae are opaque-white, about 140 microns long, and rather inactive. After feeding, they grow to about 300 microns long, and their wrinkled integument smoothens as the cuticle becomes tightly stretched. Then the larvae enter a quiescent stage.

The average duration of the active larval stage is 1 day and that of the quiescent stage, 2 days. The life cycle is completed in 6 days. The adults are slightly tanned, and about 245 microns long. The females at the preovipositional stage are far more active than the males, and are mainly responsible for dispersal. The males are often observed carrying quiescent larvae on their backs. The species is facultatively parthenogenetic; the virgin females lay only a few eggs, which produce only males.



Necrotic streaks caused by the Tarsonemid mite on rice leaf sheaths.

Research on the ecology and natural enemies of the rice stem borer *Diopsis thoracica* in Malawi

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Diopsis thoracica flies spend the dry season in shady places along banks of streams, where they can be found in large swarms. In December, at the beginning of the rainy season, they move back to the rice fields. They lay eggs singly on rice stems or leaves, the highest numbers at about 25 days after transplanting. The larva enters the stem via the leaf sheath and develops there. The feeding larva causes yellowing of the terminal leaf (deadheart). Its occasional attack on older rice can cause whiteheads. Except when it attacks seedlings, the larva remains on the same stem until pupation; but just before pupation it may move to another stem or even another hill.

The eggs take an average of 3 days to hatch. The larval stage lasts approximately 38 days and the pupal stage 14 days. There is one main generation each rainy season and one partial second generation in later planted fields. In the dry season (Apr.—Nov.) the number of flies and the number of eggs laid in fields with a second crop are low.

Egg parasitoids seem to be the most important natural control against *D. thoracica.* Three species have been found: two species of the genus *Trichogramma,* which are presently being described; and *Trichogrammatoidea simmondsi,* which is less important. All 3 egg parasitoids were found to be susceptible to organophosphorous insecticides and chlorinated hydrocarbons. Application of phosphamidon in nurseries brought egg parasitism down to below 2%. Predation of eggs by small Carabid beetles and mites could reach 30%.

Up to 25% of the pupae were attacked by the parasitoid *Aprostocetus* sp. Adult flies were parasitized by six species of fungal pathogens. Crab spiders and Odonata were recorded as predators of the fly.

The effect of *D. thoracica* on transplanted rice is difficult to assess.

In one season approximately 10% of the seedlings were destroyed by larval attack. In the 1970–71 and 1971–72 seasons, when attacks were heaviest, even fields with almost 100% deadhearts recovered reasonably well. No significant differences in yield were found between sprayed and unsprayed fields. An attack by *Diopsis* larvae can have positive or negative effects on the growth of rice, depending on time and level of attack, general growing conditions, and rice variety.

Shirakiacris shirakii, a new pest of paddy inPakistan

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Several species of grasshoppers damage paddy in Pakistan but *Shirakiacris shirakii* was found for the first time. Its distribution is restricted to the hilly areas of Swat, Hazara, and had Kashmir, where the annual temperature is 17 to 18.5°C, annual precipitation is 950 to 1,730 mm, and elevation is 1,000 to 1,500 m. The pest is abundant in those areas. Adults are collected only from paddy, but nymphs are occasionally found on *Trifolium alexandrinum* and *Cynodon dactylon.* The insect remains associated with paddy throughout its life; nymphs feed on the leaves and adults feed on both leaves and grains. It seems to damage paddy considerably, especially in the earing stage when adults eat immature grains. The insect usually inhabits those fields where *Oxya multidentata* and *Hieroglyphus banian,* two other serious pests of paddy, are found. It feeds and develops on young maize and sorghum plants in the laboratory.

S. shirakii is a univoltine species. The eggs overwinter and hatch in May at about 24.5°C. Nymphs feed on rice nurseries and *C. dactylon,* and become adults in August or September. Oviposition begins a month later and continues until November. Several copulating pairs of *S. shirakii* have been seen on sunny November days in the harvested paddy fields, but on cloudy days they hide in rice stubble or plant trash. Females are mostly gravid during this period and die after laying eggs. Neither adults nor nymphs could be collected from December to April; they cannot tolerate the severe cold winter. Egg pods are laid before winter – usually in the fields, preferably in sandy soil but seldom on levees. Each egg pod is buried in the soil at a depth of 2.5 to 5 cm and contains 24 to 45 eggs, averaging 39. The eggs are deep brown in color, and the froth plug is dirty brown.

The incubation period at 31 ºC ranges from 17 to 23 days, averaging 20 days. Six instars of nymphal development are completed in 86 to 103 days (av. of 92 days), at about 23°C and 77% relative humidity.

Outbreak of rice hispa in Nellore district, AndhraPradesh,India

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Dicladispa armigera, commonly known as rice hispa, is a major rice pest. Until recently, it had not been observed in the southern districts, but a severe outbreak was noted at the Regional Rice Research Station farm and many other parts of Nellore during the late kharif season, 1975–76. The main crop in Nellore – the locally evolved variety Bulk H9 (Molagolukulu) – was heavily infested.

The pest appears to have migrated from the northern districts from mid-November 1975 to the end of January 1976, after heavy rains in late October and early November 1975. After the rains, the prevailing high humidity and intermittent bright sunshine seem to have favored hispa development in epidemic proportions. The maximum temperature during the day never exceeded 29°C, and the minimum ranged between 17 and 20°C until the end of January 1976. Toward the end of January, a decline in the beetle population occurred synchronously with the rise in temperatures and the lowering of the relative humidity. Hispa exhibited a marked preference for younger plants.

Entries in the International Rice Observational Nursery (IRON) and the National Screening Nursery (NSN) with less than 1% of the leaf area damaged by rice hispa. Andhra Pradesh, India.

IRON	
IR2053-375-1-1-5	RD5
IR2058-74-2-1-1	Chianung-Sen 11
IR2063-152-3-2	B 452b-290-2-1-3
IR2063-185-2-2	Pelita 1-2
IR2068-65-3	C 168-134
Purple check 15/	IR2153-26-3-5-6
IRI 103-1	Bahagia (R check)
IR2070-178-2-3	IR1545-339-2-2
IR2070-210-3-3-4	IR2070-199-3-6-6
IR2070-288-2-2-5	IR22 (S check)
IR2070-614-6-4	IR5491-4-80 (Glhl)
IR2070-796-1-4-3	RPW 6-2
IR2070-834-1-2	IR20
BW 196	IR2153-15-1-10-3
BKN 6323-17	IR2031-114-2-3-1
BKN 6819-33-3-2-1-3	IR2153-26-3-5-2
BKN 6819-33-3-2-2-3	M1 48
BKN 6820-4-1-3	IET 1444
BKN 6820-6-3-2	
NSN	
RP 633-382-1-1-5-7	R 19-1-1-1
RP 974-97-8-1	R 45-1-2-2
R 8-2-4-1	R 49-2-2-2-1-1-1
R 8-12-1-1	

Damage was also observed on many entries from the International Rice Observational Nursery (IRON) and the National Screening Nursery (NSN) trials, which were exposed to the large hispa population (see table). The severity of the epidemic is clear: more than 25% of the leaf area was lost in half of the IRON entries and in 95% of the NSN entries. Eight sprays were used consecutively from early November, almost at weekly intervals: Ambithion, Folithion, Sumithion, Sumithion with BHC, Sumithion with Endrin, and three sprays of Sevin with BHC. They were, however, effective only for 2 or 3 days. After that period, the hispa population rose to the original level, probably because of invasions of fresh insects from adjacent fields where no control measures were undertaken.

Various spray schedules were followed on the blast-susceptible variety BCP 1 to evaluate the effects of Phosvel 34% EC (*O·* 2,5 Dichloro-4 bromopheny 1) *O*-methyl phenylphosphonothionate) on blast. Although hispa severely damaged the unsprayed control plot as well as the surrounding plots, it produced no damage in any of the Phosvel-treated plots.

Effects of soaking seeds in chemicals on the control of root-knot nematode *Meloidogyne graminicola*

K. S. Krishna Prasad and Y. S. Rao, Central Rice Research Institute, Cuttack-753006, India

Seeds of IR8 were soaked in a 4-ml test solution of each of 32 chemicals at doses of 500, 1,000, and 2,000 ppm for 12 and 24 h, or equivalent to doses of 0.2, 0.4, and 0.8 g/100 g seed with water control. Treated seeds were sown in soil inoculated with infective larvae of *M. graminicola.* Nematicides and insecticides were effective to varying degrees in reducing the endoparasites and egg mass production. Among fungicides, only thiobendazole was effective (see table). Herbicides were phytotoxic; growth regulators and hormones were less effective; amino acids were ineffective. Oxamyl, fensulfothion, and phorate reduced endoparasites by more than 60% and egg masses by 80%. Carbofuran inhibited endoparasites, but was less effective in reducing egg mass production. Oxamyl at 500 and 1,000 ppm was as effective as other chemicals at higher doses either as 12- or 24-h seed-soak treatment. All herbicides affected seed viability and hormones, and growth regulators affected growth.

Effects of soaking seeds in pesticides on invasion and development of *Meloidogyne graminicola.* Minimum nematode incidence at 2,000 ppm.

Treatment	Endoparasites (no.)	Egg masses (no.)	Germination (%)
Nematicides and insecticides			
Oxamyl	15.0	2.2	100
DBCP	23.1	5.5	100
Chlorpyriphos	18.0	6.1	100
Phorate	18.5	3.2	100
Carbofuran	30.2	3.2	100
Mephospholan	31.2	9.2	100
Fensulfothion	18.0	3.5	100
Quinalphos	25.1	7.1	95
Fungicides			
Mebenil	52.5	15.0	100
Bavistin	54.0	16.2	100
Thiabendazole	39.5	14.1	85
Cela - 50	50.0	16.5	92
Control	51.2	17.7	100

Whitebacked planthopper outbreak in Bangladesh

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The whitebacked planthopper *Sogatella furcifera* is a minor rice pest in Bangladesh. Two outbreaks of the pest were recorded in deep-water rice in 1963 (March–December and May–June). In 1967, the pest occurred in aus rice (March—August)and in deep-water rice during July in Comilla district. During the early 1970's, the pest was the dominant hopper in the aus season in Mymensingh area, making up 61% of the total hopper population. But during the transplanted aman season (July—December), it ranked fourth and made up about 10% of the population.

In mid-April 1977, hopperbum due to *S. furcifera* was observed on the boro season crop (November—May)of IR8 in a patch of 55.74 sq m in the Mohammadpur area of Dacca. The crop was in the milky to dough stage; the plot was irrigated by sewage water. The population on 18 April was more than 1,000 adults and nymphs/hill. Loss was estimated at about 80% of the expected yield.

Parasites of grasshopper eggs associated with paddy in Pakistan

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Scelio spp. are important parasites of grasshopper eggs. Six species parasitize grasshoppers that attack paddy in Pakistan. The widely distributed and adaptable parasites can withstand severely cold winters by hibernating as first-instar larvae in the host eggs. In summer the parasite adults are found mostly in shady places where they are protected from excessive heat; when dense vegetation is lacking, they creep into crevices.

Scelio do not parasitize all eggs in large egg pods, but egg pods with no more than 25 eggs are completely parasitized. Freshly laid host eggs are preferred to old ones.

The patchy distribution of host eggs may not allow enough of the parasites to develop to provide a high level of grasshopper control. Although Scelio do not seem to play a dominant role, they are in position to eliminate many eggs in the late fall. That could reduce the nymphal population in the spring and result in fewer adults in the summer.

Subsequent infectivity of treated *Meloidogyne* larvae in chemicals

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Larvae of Meloidogyne graminicola were held in aerated distilled water for 24 h after direct contact for 48 h with nematicides, insecticides, fungicides, herbicides, amino acids, growth regulators, and hormones at different levels. The contact toxicity tests showed that the following chemicals resulted in more than 90% mortality: oxamyl (nematicide) and propanil (herbicide) at 50 ppm and above; fensulfothion (insecticide) at 100 ppm; quinalphos (insecticide) and DBCP (nematicide) at 200 ppm; ZR-777 (hormone) at 500 ppm; and cycocel (growth regulator) at 1,000 ppm. DL forms of amino acids, fungicides, and other growth regulators were ineffective. Carbofuran among insecticides and DBCP among nematicides were less effective than oxamyl or fensulfothion.

Inoculation of these larvae to roots of IR8 showed that root invasion was impaired by treatments at sublethal concentrations of propanil, fensulfothion, and oxamyl at 25 ppm; and of DBCP, phorate, and chlorpyriphos (insecticides) at 100 ppm. Carbofuran at 200 ppm adversely affected the larval penetration although it gave less direct contact mortality. ZR-777 and Diethyl sulfate (hormones) were effective at 250 to 500 ppm and above, while quinalphos, mephospholan (insecticides), 2,4-D, butachlor, MCPA (herbicides), IAA, IBA, NAA, maleic hydrazide, and gibberellic acid (growth regulators) had no persistent or inhibitory toxicity.

Soildrench pesticide treatment to control the root-knot nematode *Meloidogvne graminicola*

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Twelve pesticides were tested as postinoculation soil-drench treatments for effectiveness in control of the root-knot nematode *M. graminicola.* The doses 25, 50, 100, and 200 ppm were adjusted to 3.75 to 30 kg/ha. Phorate, oxamyl, fensulfothion, and carbofuran were significantly superior to DBCP, chlorpyriphos, quinalphos, and emphospholan. The fungicides mebenil, bavistin, thiabendazole, and cela-50 were less effective. Oxamyl and fensulfothion at 50 ppm and above, and DBCP and phorate at 100 ppm, were equally effective in reducing egg masses and endoparasites. Carbofuran significantly controlled egg mass production.

Preplanting and postplanting soil-drench treatments in the fields showed that oxamyl, phorate, carbofuran, and fensulfothion at 15 kg/ha were equally effective in reducing the development of the nematodes and the production of egg masses in roots. These treatments markedly reduced the larval population in the soils regardless of time of application. Oxamyl and fensulfothion inhibited giant cell development at sites of nematode establishment. The dimensions of the giant cells and developing nematodes were reduced in the postplanting soil application of these systemic pesticides.

Pest management and control
WEEDS

Sensitivity of rice field alga *Chara* sp. to different chemicals

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Green algae of different morphology and growth habit and belonging to different genera grow extensively in transplanted paddy fields in India; the most common is *Chara* sp. These organisms not only compete with rice plants for space and nutrients but appear to hinder tillering. Use of copper sulfate and other chemicals for their control has not been successful.

Some fungicides, insecticides, and synthetic detergents were screened for algicidal activity against *Chara* grown in waterlogged soil in pots. The water was replaced with chemical treatments of desired concentration and the time required for complete alga death was recorded. Nine of 16 fungicides were good inhibitors at low concentration. They include the organic tin compounds Brestan 60 and Brestanol (see table). The carbamates Dithane M-45 and TMTD were found to be inhibitory even at 0.007% concentration. Among the insecticides and detergents, thiodan and the two detergents are equally inhibitory. The algicidal properties of these chemicals at such low concentrations are encouraging.

Algicidal activity of some fungicides, insecticides, and other chemicals against *Chara* sp. (av. of four replications). West Bengal, India.

Chemical	Days after treatment until death at percent concentration of whole formulation							
	1	0.5	0.25	0.12	0.06	0.03	0.015	0.007
				Fungicides				
Blotox-50	2	2	3	3	4	4	4	ND[a]
Dithane 2-78	1	1	2	4	5	6	ND	
Dithane M-45	1	1	2	2	2	3	3	4
TMTD 75WPP	1	1	1	2	2	2	4	4
Starcraft 83WP	2	2	2	2	2	3	4	ND
Difolatan 80WP	1	1	1	2	2	3	3	4
Brestanol45	1	1	1	1	1	2	2	3
Brestan 60	1	1	1	1	2	2	3	3
Brassicol 75WP	2	2	2	3	3	4	5	ND
Hinosan 50EC	ND							
Bavistin	ND							
Topsin M	ND							
Allisan	ND							
Benodanil	ND							
Kasumin	ND							
				Insecticides and other chemicals				
Thiodan 35EC	1	1	1	2	2	2	3	3
Accothion 1000	1	1	2	2	3	4	ND	
Diazinon G.	2	3	ND					
Disyston G.	ND							
Sultaf. 80WP	ND							
Idet-20	0.5	0.5	1	1	2	2	3	3
Swascofix 45	0.5	0.5	1	1	2	2	3	3
Det. (Washing)	1	1	1	1	2	2	4	ND
Copper sulfate	1	2	2	3	3	3	4	4

[a]ND = no death.

Soil and crop management

Fertilizer nitrogen budget in rice fields

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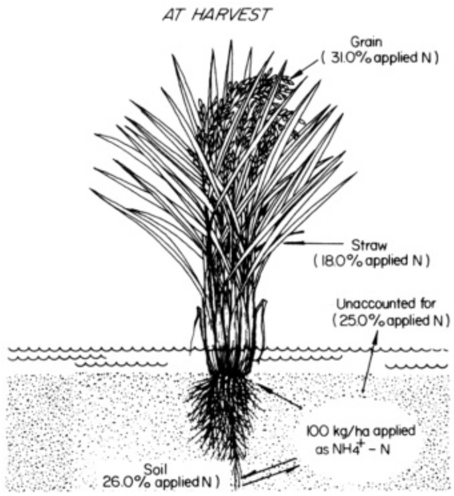
To improve the efficiency of fertilizer nitrogen use by rice, it is important to know what happens to N applied to the soil. Fertilizer labeled with ^{15}N is used to distinguish fertilizer N from soil N.

A field experiment to determine the fate of applied fertilizer N was conducted on Crowley silt loam at the Rice Experiment Station, Crowley, Louisiana. Ammonium sulfate enriched with ^{15}N was applied at 100 kg N/ha by deep placement (7 cm in the soil by the side of each row, 10 cm apart) at the beginning of the growing season. Fertilizer ^{15}N was measured in the soil-plant system at harvest.



The fate of applied fertilizer nitrogen. Rice Experiment Station, Crowley, Louisiana, USA.

About a third of the added fertilizer N applied to the rice was recovered in the grain, about a fifth was recovered in the straw, about a fourth remained in the soil and roots, and the remaining fourth was unaccounted for and presumably lost from the soil system (see figure).

Split application of nitrogen in direct-seeded rice

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Nitrogen has become costly in India in the last few years. Its proper use is essential to maximize profits. To increase crop yields, not only is the quantity of fertilizer important, but also the proper timing of its application. An experiment was designed through the All India Coordinated Rice Improvement Project to determine the best time of nitrogen application. The field trial was conducted during the 1974 and 1975 kharif seasons in the alluvial light soils of the Rice Research Station, Faizabad, where 1,260 and 1,248 mm of rain fell during the two respective crop seasons.

Grain yield of paddy under different nitrogen treatments, Faizabad, India.

Treatment	N application (kg/ha)	Amount of N applied (kg/ha) at			Paddy yield (t/ha)		
		Sowing	Tillering	Panicle initiation	1974	1975	Mean
T1	0	0	0	0	2.7	2.8	2.8
T2	60	60	0	0	3.5	3.9	3.7
T3	60	15	30	15	4.1	5.1	4.9
T4	60	20	20	20	4.6	4.9	4.8
T5	60	20	40	0	4.2	4.5	4.4
T6	60	0	20	40	3.9	3.9	3.9
T7	60	0	30	30	3.9	4.1	4.0
L.S.D. at 5%					0.54	0.58	

Treatment T3 (15–30–15) produced the maximum grain yield (4.7 t/ha and 5.1 t/ha), followed by T4 (20–20–20) and T5 (20–40–0) during both cropping seasons. During 1974, treatment T3 produced significantly higher yields than T1, T2, T6, and T7, while during 1975, T3 gave significantly higher yields than T1, T2, T5, T6, and T7 (see table). When all nitrogen was applied at sowing, it was subject to loss through runoff, leaching, and weeds in upland, well-drained, light soils. However, a small quantity of nitrogen is essential to give the plants a good start after germination.

Efficiency of some phosphatic fertilizers with varying soil and water-management practices

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Studies on the efficiency of some phosphatic fertilizers in relation to soil and water management practices were conducted in the red loam soil (pH 6.3) of Kanhe Bihar, India. Phosphatic fertilizers were superphosphate, rock phosphate, yellow phosphorite, and ash-colored phosphorite. Liming and application of farmyard manure were the soil management practices under saturated, flooded-granulated, and flooded-puddled conditions. Among other data, the dry matter yield and the phosphorus content and its corresponding uptake were determined.

Dry-matter yield using superphosphate (44 g/plot) was significantly superior to that with rock phosphate (32 g/plot), ash-colored phosphate (30 g/plot), or yellow phosphorite (29 g/plot). The application of well-rotted farmyard manure significantly increased the dry-matter yield with the phosphates that were not water soluble, but had no effect with superphosphate. Lime significantly reduced yield with all phosphates. Flooded-puddled paddy gave 64.7% more dry-matter yield than flooded-granulated paddy, and 52.9%

more than saturated paddy. Flooding under puddled conditions was superior under all the soil-management practices. Under all water regimes, superphosphate was better than other phosphates. Farmyard manure gave better results in saturated conditions.

The phosphorus content due to superphosphate (0.103%) was significantly higher than that due to rock phosphate (0.079%), yellow phosphorite (0.077%), and A.C. phosphorite (0.072%). Application of farmyard manure increased the phosphorus content, while various water regimes had no effect. Superphosphate application gave higher phosphorus content under all soil-management practices. Phosphorus uptake by paddy straw was significantly higher due to superphosphate. The mean uptake was 44.6 mg/pot in superphosphate, followed by 27,23, and 23 mg/pot due to rock phosphate and yellow and ash-colored phosphorite. Lime application depressed the phosphorus uptake (20 mg/pot) and farmyard manure increased it (42 mg/pot). Flooded-puddled conditions increased phosphorus uptake.

Increasing rice yields under gall midge-infested conditions by increasing seedlings/hill

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Heavy gall midge infestation generally occurs during September and October in Northeast Thailand. The pest attacks only young rice buds and does not damage maturing rice plants. An experiment investigated whether rice yield under gall midge-infested conditions could be increased by increasing the number of rice seedlings. The experiment was designed in a split plot and replicated three times. Five rice varieties were studied: RD 9 and Meuy-Nong 62 M (resistant varieties), Kee-Tom-Laung (susceptible local variety), Dok-Ma-Li 105, and Niew-San-Pa-Tong (susceptible recommended varieties). Each variety was planted in a 6- × 12-sq-m-plot. The main plot was equally divided into three subplots where rice was transplanted at 3, 5, and 7 seedlings/hill. Gall midge-damaged tillers were observed at the peak of infestation (Sept. 14, 1976).

The percentage of damaged tillers did not significantly differ among hills with different numbers of seedlings (see table). In most cases, the average number of tillers and panicles significantly differed within each variety. Rice planted at 5 and 7 seedlings/hill produced more tillers and panicles than rice planted at 3 seedlings/hill. Overall mean rice yields did not differ significantly, probably because some varieties were resistant to gall midge and infestation on susceptible varieties was not heavy. However, the poor-tillering variety Kee-Tom-Laung gave higher yields at 5 and 7 seedlings/hill than at 3 seedlings/hill.

Gall midge infestation, yield components, and grain yields of five rice varieties at different numbers of seedlings per hill at Phibun Mangsahan, Ubon Ratchatani, Thailand, 1976.

Treatment		Damaged tillers (%)	Tillers (no./hill)	Panicles (no./hill)	Grains (no./panicle)	Yield (t/ha)
Kee-Tom-Laung	3 seedlings	15.5	7.4	5.2	68	1.3
KeeTom-Laung	5 seedlings	10.6	8.5	5.8	81	1.6
Kee-Tom-Laung	7 seedlings	15.5	10.0	6.1	81	1.7
RD 9	3 seedlings	1.6	11.8	11.6	62	1.3
RD 9	5 seedlings	2.3	15.5	12.5	56	1.4
RD 9	7 seedlings	1.2	13.8	12.2	57	1.3
Meuy-Nong 62 M	3 seedlings	2.8	10.6	6.5	83	1.6
Meuy-Nong 62 M	5 seedlings	2.8	9.6	7.3	79	1.7
Meuy-Nong 62 M	7 seedlings	3.6	11.2	8.6	77	1.8
Dok-Ma-Li 105	3 seedlings	12.7	13.2	9.0	85	2.0
Dok-Ma-Li 105	5 seedlings	13.8	13.9	9.3	87	1.9
Dok-Ma-Li 105	7 seedlings	17.9	15.7	10.5	89	2.0
Niew-San-Pa-Tong	3 seedlings	13.5	7.4	6.0	102	1.6
Niew-San-Pa-Tong	5 seedlings	17.1	10.6	6.9	101	1.7
Niew-San-Pa-Tong	7 seedlings	13.1	11.8	7.5	102	1.8
LSD (5%)		n.s.[a]	1.79	0.58	n.s.[a]	n.s.[a]

[a]Not significant.

Effect of root pruning and number of seedlings per hill on the growth performance of BR3 and Habiganj Boro VI in Bangladesh

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During the boro season (Nov.—Apr.)in Bangladesh, farmers uproot seedlings by cutting the roots inside the soil or by pulling the Seedlings without watering the seedbeds. To compensate for seedling mortality, the farmers transplant 5 or 6 seedlings/hill. This study was conducted to determine the effect of root pruning in relation to the number of seedlings per hill on the growth performance of BR3, a semidwarf rice, and of Habiganj Boro VI (HbjB VI), a traditional variety with long droopy leaves.

All seedlings recovered at the same time, whether or not their roots were pruned. Both the pruned and unpruned seedlings produced considerable roots. Pruned seedlings of HbjB VI produced more roots than the unpruned seedlings, but in BR3 unpruned seedlings produced more roots than the pruned seedlings. Root production per seedling decreased as the number of seedlings per hill increased. In both varieties, the relative tillering rate (RTR) decreased as seedlings per hill increased. The RTR value of HbjB VI dropped sharply as the number of days after transplanting increased, but that of BR3 changed less drastically during the early stage. The difference may indicate that the RTR value of a variety depends on its plant type. The number of panicles per square meter tended to increase as seedlings per hill increased, but the increment did not contribute to yield. With root pruning, BR3 yielded less than the control; the trend was reversed in HbjB VI. Symptoms of nitrogen deficiency in both varieties appeared earlier with increased number of seedlings per hill.

A test of tillage practices in Thailand

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Sandy, relatively infertile soil was used in a test of four tillage practices in Khonkaen province, Thailand. The practices and the yields of the local, sticky rice Kao Yai were: no tillage with weeds controlled by paraquat, 0.14 kg/sq m; 2 plowings by water buffalo and 1 harrowing, 0.19 kg/sq m; 1 plowing by water buffalo and 1 harrowing, 0.20 kg/sq m; and 2 plowings by power tiller and 1 harrowing, 0.22 kg/sq m.

The only significant differences in yield were between no tillage and tillage with a power tiller.

Zinc deficiency in Sierra Leone rice

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Zinc deficiency on lowland rice had been reported from the Philippines, Thailand, Korea, Japan, Pakistan, Colombia, Brazil, and Nigeria. In Sierra Leone, the zinc status of rice soils was cloudy since no systematic work had been done on zinc nutrition of rice based on soil and plant analysis. Therefore, a cooperative research project with FAO/IAEA, Vienna, was initiated in June 1975 to delineate the zinc-deficient soils.

Rice plant and soil samples were collected from 25 sites from various agroecological zones of Sierra Leone — inland valley swamps, mangrove swamps, and bolilands. Samples were taken at midtillering and at panicle-initiation stages. Available zinc in soils was extracted with 0.005 M DTPA and 0.05 M HCl, while plant samples were digested with $HNO_3 + H_2SO_4 + HClO_4$ mixture and analyzed by atomic absorption spectrophotometer.

The 0.05 M DTPA-extractable zinc ranged from 0.01 to 1.62 ppm with an average of 0.59 ppm, while 0.05 M HCl extractable zinc ranged from 0.30 to 6.18 ppm with an average of 1.47 ppm. HC1 seemed to extract more zinc than M DTPA. Based on critical levels established by scientists at the Philippine Bureau of Soils and at IRRI, the zinc levels of those soils are very low, low, and adequate.

The plant zinc values ranged from 13 to 40 ppm (av. = 26.7 ppm) and 16 to 32 ppm (av. = 22.5 ppm) at 30 and 60 days after transplanting. The zinc values at a later growth stage were lower than at the earlier, perhaps because of a dilution effect. Also 21.7 and 34.8% of the total sites were deficient in zinc at two growth stages, respectively.

The zinc deficiency symptoms were also observed by scientists at the Rice Research Station, Rokupr, in upland rice soils where phosphorus was applied at 80 and 120 kg P_2O_5,/ha.

Nutritional disorders of upland rice in Sierra Leone

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In the 1974 crop season, bronzing was widespread in trials at the Rokupr Rice Station and in irrigated fields at Mange. A cooperative investigation was initiated to determine the effects of soil problems and nutritional imbalances on bronzing. Soil and plant samples for analysis were obtained from rice fields at the maximum-tillering stage. The plant samples were analyzed by the methods used at the Service Analytical Laboratory, International Institute for Tropical Agriculture, Ibadan, Nigeria.

The pH of the experimental soils ranged from 4.9 to 5.5; organic carbon, from 0.77 to 2.0%; nitrogen, from 0.10 to 0.30%; and available phosphorus, from 0.63 to 18.90 ppm.

The plant nitrogen content vaned from 0.80 to 2.16% with an average of 1.27%, which was in the deficient range. Phosphorus values ranged from 0.07 to 0.18% with an average of 0.10%, indicating that 60% of the sites were in the deficient range. The potash values varied from 0.35 to 2.13% with an average of 1.09%, which is slightly higher than the critical level. Four sites were deficient in potash (see table).

The average values of sulfur (0.23%), calcium (0.52%), and magnesium (0.17%) were above the critical level.

Iron concentration levels averaged 955 ppm, which is in the excessive range. All sites were in the toxic range in iron. Bronzing may be due to an excess of iron in these soils (similar results were found in a nutritional survey of citrus orchards in Sierra Leone). Manganese levels averaged 406 ppm. All sites were in the excessive range.

The copper levels averaged 9.5 ppm, and the zinc levels 65 ppm — both above the critical level.

Mineral composition of upland rice plants at the maximum-tillering stage. Rice Research Station, Rokupr, Sierra Leone.

Sites	N (%)	P (%)	K (%)	S (%)	Ca (%)	Mg (%)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)
1	1.31	0.11	1.50	0.29	0.54	0.13	1100	1000	10	38
2	1.37	0.07	0.88	0.17	0.35	0.10	900	650	10	40
3	1.02	0.12	1.00	0.26	0.34	0.12	1100	154	10	52
4	1.14	0.08	0.46	0.21	0.65	0.23	450	340	5	42
5	1.14	0.07	1.38	0.16	0.73	0.22	700	580	10	102
6	1.14	0.09	0.88	0.22	0.33	0.10	600	306	10	36
7	0.80	0.07	1.00	0.16	0.36	0.26	1250	274	10	134
8	1.20	0.08	0.35	0.16	0.48	0.22	1350	78	10	62
9	2.16	0.18	2.13	0.38	0.55	0.21	950	388	10	106
10	1.37	0.15	1.38	0.26	0.91	0.13	1150	298	10	38
Av.	1.27	0.10	1.09	0.23	0.52	0.17	955	406	9.50	65

Ratooning of paddy

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(adapted from an article in the *Aduthurai Reporter*)

A number of cultures and varieties proposed for introduction in Tamil Nadu were observed at Aduthurai during 1976 to ascertain adaptability. Each entry was sown in a 5-sqm plot at a seeding rate of 10 g/sq m. Seedlings from a third of the plot were pulled and planted *in situ* on the 25th day, those from another third on the 40th day, and those from the remaining third were allowed to grow undisturbed as a broadcast crop. NPK was applied at 50–50–50 kg/ha on the 25th day after sowing, and nitrogen at 25 kg/ha on the 40th and 60th days.

The main crop was cut at 15 cm from ground level. The ratoon crop was not fertilized and was harvested at 55 to 60 days. Ratooning ability was calculated by yield instead of by the IRRI method based on number of tillers.

Two short- and 11 medium-duration varieties yielded more than 5 t/ha as main crop, and 2.5 t/ha and above as ratoon crop in all three methods of cultivation (see table).

RP 1045-5-6-2, IET 2885, GMR 13, and IR1529-680-3 ratooned well after any main-crop treatment. ADT 30 as main crop yielded less than 5 t/ha but had more than 90% ratooning potential.

Between cultivation methods of the main crop for the purpose of ratooning, transplanting at 25 days was superior to both broadcasting and transplanting at 40 days. The latter was on par with broadcasting.

The total yields of main and ratoon crops were:

	Yield (t/ha)
Broadcast	9.6 a
Transplanted at 25 days	11.1 ab
Transplanted at 40 days	9.9 b
L.S.D. (P=0.05)	1.2

Grain yield (t/ha) of main and ratoon crops. Tamil Nadu, India.

Variety	Parents	Grain yield (t/ha) at given cultivation method: Broadcast		Transplanted: On 25th day		Transplanted: On 40th day	
		Main crop	Ratoon crop	Main crop	Ratoon crop	Main crop	Ratoon crop
85–115 days							
ADT 30	IR262/ADT 27	4.1	3.9	4.3	4.4	2.4	3.4
ADT 31	IR8/Cult. 340	5.5	2.9	7.9	2.8	4.6	2.4
CR 146-224	CR 10-114/CR 115	7.6	*a*	10.2	3.3	5.4	2.8
120–135 days							
RP 1045-5-6-2	RP 31-49-2/LZN	10.6	4.4	9.4	4.8	9.5	4.7
RP 1045-10-6-2-1		6.1	3.3	6.1	3.1	5.3	4.0
IET 2885 (RPW 6-1 3)	IR8/Siam 29	6.4	3.0	11.2	4.0	9.2	3.3
GMR 13 (RP 9-6)	IR8/W 1251	6.2	5.2	1.7	4.5	6.4	5.2
IR1529-680-3	IR24/Sigadis^2/TN1	8.5	3.2	6.9	3.4	6.0	3.6
1R20	IR262/TKM 6	6.0	2.1	5.5	2.1	7.5	2.9
CR 1001	CR 70/Pankaj	6.8	2.1	1.6	3.5	5.9	3.3
CR 1003	”	5.3	2.5	6.3	4.5	5.1	4.5
Ponni	Tg. 65/Mayang Ebos -8)	*b*	2.3	6.9	4.0	5.9	3.6
AD 54-1 (BB)	Bhavani/Ponni	5.1	1.1	1.0	3.1	5.9	3.9
AD 2114	IARI 6609/Peta	8.0	*a*	5.2	3.3	6.3	3.4

[a]Damaged by rats. [b]Affected by pests and diseases.

Rice-based cropping systems

Effect of tillage method and rice stubble on bean fly *Ophymyia phaseoli* infesting cowpea planted after lowland rice

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Rice followed by cowpeas and rice followed by mung beans are common cropping patterns in low land rainfeed areas of the Philippines. Farmers normally do not till the soil for the second crop, but broadcast legume seeds directly into standing rice stubble.

The Philippine cropping systems program is testing the performance of improved varieties of grain legumes under several tillage practices. We sampled the insect populations in EG2 cowpeas in fields where four methods had been used to establish the crop after rice: 1) plowing and harrowing twice; 2) plowing furrows between alternate rows of rice with rice stubble cut to ground level; 3) plowing furrows between alternate rows of rice with uncut stubble; and 4) no tillage with seeds dibbled in rows at the base of rice hills with rice stubble uncut. Half of the

Effect of tillage method, height of rice stubble, and insecticide on bean fly population infesting cowpeas planted after lowland rice. IRRI, 1977.

Tillage	Rice stubble	Bean fly counts[a] Adults (no./18-m row) 5 DE	10 DE	15 DE	Larvae + pupae (no./25 plants) 21 DE		Infested plants (%) 21 DE	
		Untreated plots			Treated plots[b]	Untreated plots	Treated plots	Untreated plots
Plowed and harrowed twice	Plowed under	15 a	12 a	1 a	10 ab	19 a	52 bc	88 a
Furrows plowed between rice rows	Cut to 1 cm	8 a	2 a	1 a	5 bc	9 abc	37 cd	62 b
Furrows plowed between rice rows	30–40 cm[c]	1 b	2 b	1 a	5 bc	6 bc	30 de	29 de
No tillage; seed dibbled in rows	30–40 cm[c]	0 b	2 b	2 b	3c	3 c	17 e	20 de

[a]Within counting dates means followed by a common letter are not significantly different at the 5% level. DE = days after crop emergence.
[b]0.25 kg cyanophenphos (Surecide 25 EC) a.i./ha sprayed at 5 and 15 DE.
[c]Ratoon crop.

plots received insecticide sprays (Surecide 25 EC) at 5 and 15 days after emergence at the rate of 0.25 kg a.i./ha. The trial was replicated three times.

The population of the bean fly *Ophiomyia phaseoli* was low in plots with standing rice stubble and where the rice had ratooned (see table). In the early growth stages of cowpeas, the rice stubble evidently interfered with the host-seeking responses of the bean fly. At 5 days after cowpea emergence (DE), significantly fewer adults were observed ovipositing in cowpeas among the 30- to 40-cm rice stubble. At 10 DE bean fly oviposition was restricted to the rice that had ratooned in the treatment where stubble was cut to ground level.

As forms of cultural control, rice stubble and ratoon rice were as effective as insecticide protection in preventing bean fly buildup at the crucial early stages of cowpea growth. At 21 DE no significant difference was observed between plots that had been treated with insecticide and those that had not been in terms of the number of larvae and pupae per 25 plants and the percentage of infested plants in 30–40 cm stubble. The bean fly population was high in the untreated plots that received the high tillage treatment (19 larvae + pupae/25 plants and 88% infested plants). Infestation levels were intermediate in the plots where stubble was cut (9 larvae + pupae/25 plants and 62% infested plants).

Promising varieties of rainfed legumes grown at zero tillage after paddy rice

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The inclusion of upland crops such as legumes increases overall crop productivity in rice-based cropping systems. Legumes, particularly soybeans, mung beans, and cowpeas, augment the nutritional output of cropping patterns. To ensure the success of subsequent cropping patterns, scientists must first identify high yielding varieties of suitable legumes.

Ten promising varieties each of soybeans, mung beans, and cowpeas were evaluated at zero tillage under rainfed conditions after a crop of paddy rice at IRRI in mid-December 1976. The legumes were planted immediately after rice harvest to capitalize on the

Origin and agronomic data of promising varieties of soybeans, mung beans, and cowpeas planted after paddy rice at zero tillage under rainfed conditions. IRRI, 1976–77 dry season.

Crop, variety	Origin	Seed yield (t/ha)	Yield advantage over check (%)	Maturity (days)	Ht (cm)
Soybeans					
Kuro daizu	Japan	1.77	88	19	59
Bethel	USA	1.25	33	81	40
UPLB-SY 2	Philippines	1.22	30	76	49
Multivar 80	USA	1.21	29	77	43
TK 5 (check)	Taiwan	0.94	–	80	36
Mung beans					
CES 1D-21	Philippines	1.43	25	78	61
EG Glabrous # 3	Philippines	1.35	18	73	69
CES 55	Philippines	1.24	9	72	78
Dau Mo	Vietnam	1.22	7	73	69
CES 87 (check)	Philippines	1.14	–	71	18
Cowpeas					
EG #3	Philippines	1.47	30	75	51
EG #2	Philippines	1.44	27	74	49
TVU 4-b-b-10-b	IITA[a], Nigeria	1.29	14	75	65
All season	USA	1.18	4	75	78
EG # 1 (check)	Philippines	1.13	–	76	77

[a]International Institute of Tropical Agriculture.

substantial supply of residual moisture and the low initial weed population. Rice was cut close to the ground and gramoxone herbicide was applied. Seed of soybeans and mung beans were dibbled. Plots were weeded twice by hand. Insects were adequately controlled by two sprayings of carbofuran, followed by three sprayings of methomyl whenever initial pest damage was observed.

Varieties that yielded significantly higher than others were soybean Kuro daizu; mung beans CES 1 D-21, E.G. Glabrous #3, CES 55, and Dau Mo; and cowpeas E.G. #3, E.G. #2, and TVu4-b-b-10-b (see table). Yields were almost as high as those of the same crops grown with good tillage under upland conditions. Yields of the high yielding legumes ranged from 4 to 88% higher than those of the checks. All crops matured within 71 to 81 days; mung beans generally matured earliest, followed by cowpeas, then soybeans. Soybean plants were shorter and matured earlier than usual because of photoperiod reaction. The cowpea crop, which was not mulched, did not grow as tall as mung beans. The mung bean crop, which was mulched, had a better supply of moisture.

A novel strategy of intercropping in traditional lowland rice fields to maximize food production

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Intercropping is well suited for small farmers who seek to maximize production by having one or more crops on every square meter of land all year round. Little work has been done on intercropping in lowland rice fields where the traditional practice is to raise two or more crops of rice in tandem sequence. The feasibility of raising high-value crops in the traditional wetlands was studied during the rabi season (Feb.–May) of 1976–77 at the Rice Research Station, Pattambi.

A rice field of 574.8 sq m was divided into two parts. In one (245.5 sq m), the rice variety Triveni was transplanted. In the other part (329.3 sq m) the intercropping study was conducted. Ash gourd, cucumber, okra, and cowpea were planted on raised beds 16.5 m long, 1.5 m wide, and 10 cm high. The distance between two beds was 2 m. Four such beds occupied 99 sq m. On all sides of the beds, Triveni was transplanted as in the other portion of the field. The net area of rice in the intercropped field was 230.3 sq m.

Cucumber and ash gourd were raised in polythene cups and 18- to 20-day-old seedlings were transplanted in the raised beds immediately after planting rice to reduce the cropping time in the main field. Okra was seeded directly between each two cucumber and ash gourd seedlings. Cowpea was sown on the borders of all beds. Vegetables were not irrigated, as sufficient moisture was available in their root zones by capillary rise from the rice fields where the soil was kept under shallow submergence (2–5 cm).

The rice crop yielded 107.8 kg grain (4.4 t/ha) and 169.0 kg straw (6.9 t/ha), while the rice crop surrounding the vegetables produced 96.1 kg grain (4.2 t/ha) and 139.1 kg straw (6.1 t/ha). Vegetable production from the intercropped area was 307.1 kg (31.0 t/ha). Thus, the total food production with intercropping was 12.24 tons vs. 4.39 tons from the sole crop of rice, an increase in overall productivity of 170.8%. The study indicates a tremendous potential for increasing food production from wetland rice fields. The investigation is being continued on a large scale at Pattambi.

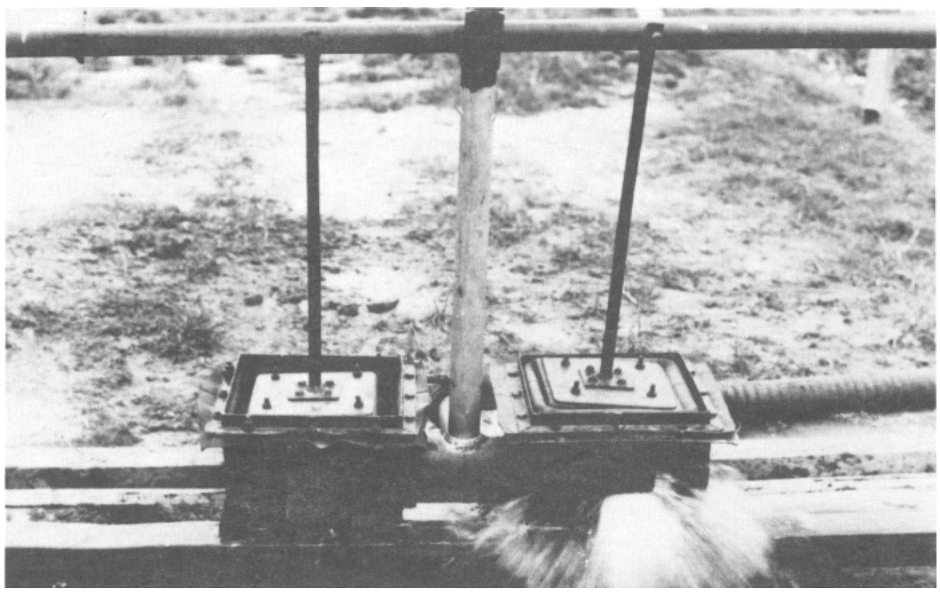
Machinery development & testing.

Manually operated diaphragm pump developed at BRRI

Mohammad Abdul Baqui, scientific officer, and Fred E. Nichols, agricultural engineer, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

The agricultural engineering division of the Bangladesh Rice Research Institute (BRRI) has developed a manually operated diaphragm pump for low-cost irrigation. The pump has an average discharge capacity of 8,925 liters/hour and an optimum lifting head of 4.65 m (see table). It is made of steel sheets.

The cost of making one unit is roughly Tk 545 (US$37) — low enough that poor



Upward movement of the handle causes the pump's diaphragm to expand and thus draw water from a well or a stream through a common manifold and into the pump chamber. Compression of the diaphragm forces the water from the chamber. Directional movement of water is controlled by a set of simple flapper valves on the inlet and outlet side.

Test results of diaphragm pump using 2-inch discharge and suction pipes with 25.4 x 25.4-inch boxes (no. of strokes taken at normal operating conditions). Bangladesh Rice Research Institute.

Observation (no.)	Vertical lift (m)	Frictional loss (m)	Total head (m)	Length of stroke (cm)	Discharge (liter/ stroke)	Strokes (no./min)	Discharge (liter/ min)	Discharge (liter/h)
1	1.86	1.05	2.9	5.8	5.4	65	348	20,893
2	2.79	0.93	3.1	5.8	5.4	62	303	19,732
3	3.70	0.68	4.4	5.8	5.4	50	265	15,897

farmers can buy one to irrigate their fragmented holdings. The pump can be handled by only two men. Its most significant feature is ease of operating. Even unskilled persons can operate it and repair it with locally available inner tubes. The pump may help to extend the area of modern rice cultivation in Bangladesh, which is seriously handicapped because of nonavailability or high cost of irrigation water during the boro (winter) season.

Too late for

Genetic evaluation and utilization

OVERALL PROGRESS

Rice breeding in China

Notes from a seminar given by Mr. Lin Shih-Cheng, plant breeder and member of the Rice Research Team of the Agricultural Association of The Peoples Republic of China, visiting IRRI, 17 October 1977

Rice breeding in the People's Republic of China recently reached a new plateau with the exploitation of hybrid vigor, or heterosis, to increase yields. Because rice is a self-pollinated crop, to exploit the hybrid vigor of the F_1 for rice production, one must find three lines for seed production – the cytoplasmic male-sterile line or A-line, the maintainer or Bline, and the fertility-restorer or R-line.

The program in China to utilize hybrid vigor began in 1964 when instructors and students at the Chan-yang Agricultural School, Hunan province, found a male sterile rice plant in a field and began to study it. To obtain three lines, they crossed the male-sterile plant with thousands of cultivars but were unable to find a maintainer.

In 1970, an instructor at the Chan-yang School discovered a wild male-sterile rice plant on Hainan island. By continuously backcrossing it with cultivated varieties, and selecting progeny lines, stable male-sterile lines and maintainer lines were developed by 1972. In 1973, after testing many crosses, the Kiangsi Agricultural College found a restorer with strong hybrid vigor. At the same time, several other restorers with strong hybrid vigor were isolated; Restorer 1 (Thai 1) was isolated in Kiangsi province; Restorer 2 (IR24), in Kwangtung; and Restorer 3 (IR661), in Hunan. The major hybrids have been tested in different areas with good results. In 1976, hybrid rice was planted on 133,000 ha in China – 87,000 ha were in Hunan. The hybrids generally yielded from 20 to 30% higher than conventional varieties. In some fields, yields reached about 10 t/ha. Yields of 11.3 to 12 t/ha have been reported.

Hybrid rices have strong root systems, high absorption capacity, high tillering ability, high vegetative vigor, and large panicles. During later growth, the dry matter accumulation is far higher than respiration losses. For that reason, hybrid rice yields higher than conventional varieties under the same environmental conditions.

Hybrid rice offers better chances for incorporating multiple disease and insect resistance and for increasing the spectrum of resistance to certain diseases such as blast because the resistance to most major pests is controlled by dominant genes that are easy to incorporate into F_1 hybrids.

The success of using hybrids for rice production depends on the ability to multiply the male-sterile lines and to mass-produce hybrid seed. Valuable developments in China include the use of more female plants (rows), tearing of the leaf sheath that encloses the panicle, cutting the flag leaves, applying growth regulators, and supplementary pollination. In Hunan, 3,300 ha of hybrid seed produced an average of 530 kg hybrid seed/ha. In Han-yan county, 465 ha produced 750 kg seed/ha. Because hybrid rice has high tillering ability, only 1 or 2 seedlings/hill are planted. Only 7.5 to 15 kg seed/ha are needed for planting, so 1 ha of a hybrid seed farm supplies enough seed to plant from 30 to 50 ha of farm fields. Hybrid rice is now growing or is being tested on large areas in Kiangsi, Kwangtung, Kwangsi, Fukien, Hsinkiang, and Liaoning provinces, as well as in Hunan. Yields have increased significantly in these regions.

Problems that remain to be resolved or improved upon include:

1. The male-sterile cytoplasm of both indica and keng (japonica) rices comes from wild rice or from ordinary cultivars. The use of hybrid rice is still limited because of the difficulties of obtaining the restorers and the insufficient combinations with strong hybrid vigor. By crossing the variety Ping-ai 58 (female) with a wild rice from South China and then making other crosses, a sterile line of "type 0" (like type 0 blood) was recently developed in Kangsi. Its sterility is stable and many restorers have been found. In fact, many keng or indica rices can be used as restorers and they have strong hybrid vigor.
2. The most common hybrid rices, Nan-u 1, Nan-u 2, and Nan-u 3, have low disease resistance, which should be improved.
3. The long growth duration of the hybrid rices now used make them unsuitable for the cropping patterns in many areas.

Chemically and naturally male-sterile lines have been used to develop hybrid vigor in China. Using chemically male-sterile rice has the following advantages: 1) Selection and maintenance of natural male-sterile lines is not necessary; 2) Male parents may be freely used, which extends the possible combinations and facilitates the selection of lines with strong hybrid vigor; 3) Because the F_2 seeds will not segregate into sterile and nonsterile lines, its hybrid vigor can still be used.

Chemical emasculation, using zinc methyl arsenate, is extensively used in Kwangtung, Kwangsi, Kiangsi, and other provinces. The chemical is sprayed on leaves and stems at booting stage. When the chemical is properly used, 90% or more of the plants are sterilized. But efficiency is low if the chemical is used improperly, or if rain falls after application.

The most common breeding method used in China is hybridization followed by pedigree selection. In the 1960's many research stations used radiation or mutation breeding, and developed some good varieties. Haploid breeding was initiated and widely used in the 1970's to shorten the breeding cycles. Some institutes have successfully simplified the culture medium, to enhance breeding by farmers. Research has been conducted on autotetraploid breeding, but no promising varieties have yet been developed. Distant or intergeneric hybridization has also been tried, such as corn-rice or bamboo-rice. Although cytogenetic studies are not yet complete, highly heritable variations are found in such distant crosses. For example, the progeny of bamboo-rice crosses is a perennial with a very hard stem.

CORRECTION: Table accompanying the item *Weed competition in transplanted rice,* IRRN 2:3 (June 1977) by Sadeli Suriapermana, Central Research Institute for Agriculture, Sukamandi, Indonesia, should read:

Effect of competition from various weed species on number of productive tillers and grain yield of transplanted rice IR34.

Competing weed species	Weed weight 70 DT[a] (t/ha)	Productive rice tillers (no./hill)	Rice yield (t/ha)
Salvinia natans	1.0	16.0	4.4
None	0	13.4	4.2
Marsilea minuta	2.5	13.7	3.4
Monochoria vaginalis	1.4	11.2	3.1
Cyperus sp.	4.5	9.6	2.9
Fimbristylis sp.	4.6	9.3	2.4
Echinochloa colona	7.6	7.1	2.4
M. vaginalis + *Cyperus* sp.	9.8	7.5	2.3
Cyperus sp. + *Fimbristylis* sp.	8.9	8.0	2.3
M. vaginalis + *Fimbristylis* sp.	6.3	7.6	2.0
All + natural weed flora	6.5	8.8	1.9

[a]DT = days after transplanting.

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