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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 containing some numbers 10 or higher and some numbers lower than 10. For example: six parts; seven tractors; four varieties. *But* There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.
- Type all contributions double-spaced. ■

Genetic evaluation and utilization

OVERALL PROGRESS

Karnataka male-sterile rice—KMS1

M. Mahadevappa, Leonardo Magaling, and W. R. Coffman, International Rice Research Institute

A male-sterile rice plant isolated at Mandya, Karnataka, India, in 1972 was multiplied clonally at IRRI in February 1979. We designated it KMSl (for Karnataka male-sterile). In greenhouse and field observations, female fertility appeared normal; seed-setting was 90% by hand pollination and 4–42% through natural cross-pollination. As in previous observations in India, there was no seed-set when the panicles were covered. But unlike in India, a few (1–2%) stainable pollen grains were observed under the microscope, although meiosis in those grains appeared normal. The new environment may possibly have induced this difference. As has been reported in barley, the pressure exerted by a few stainable pollen grains may not be adequate for the anthers to dehisce and shed pollen; thus, seed-setting failed when the panicles were covered.

Data gathered from 53 stubbles planted among 32 tall and 23 semidwarf rices in the IRRI observational yield trial and hybridization block in the 1979 dry and wet seasons showed that natural cross-pollination can produce 4 to 24% seed-set. Seed-setting was higher in the dry season (17–42%) than in the wet (4–37%).

KMSl ratoons vigorously like its male parent, C435, and is relatively free from virus attack, although it has been maintained clonally since 1972.

When KMSl was backcrossed to its female parent IR8, the 64 progenies were fertile to varying degrees. When backcrossed to the male parent the three progenies tended to be sterile. Because the number of backcross progeny for the latter was small, we again backcrossed the male parent. The progenies (IR30638) are being grown for observation in the 1980 dry-season F_1 nursery. IR30638 was also crossed with the monogenic recessive male-sterile IR36. the F_1s (IR30431) are being planted in the 1980 dry-season nursery.

Since 1973, KMSl has been widely used in hybridization work in Karnataka. IRRI is investigating the mechanism responsible for male sterility. ■

GENETIC EVALUATION AND UTILIZATION

Disease Resistance

Varietal reaction of rice cultivars to *Pyricularia oryzae* in Argentina

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In December 1978, 197 rice experimental lines and traditional varieties were artificially inoculated in the field. The nursery plot design, the soil fertilization, and the seeding methods were based on the techniques suggested by S.H. Ou of IRRI.

Because of a lack of natural field infection, the seedlings were sprayed at the fourth-leaf stage with a *P. oryzae* conidial suspension that had been prepared with strain cultures of the pathogen V3-78-1, V3-78-2, CU3-78, G4-78, LP5-78, and SF4-78. Such strains were isolated from infected material sent from various places in the provinces of Entre Rios, Buenos Aires (La Plata), and Santa Fe of Argentina.

The misato agar and barley seeds sterilized in misato solution were used as sporulating media. The suspension was adjusted to conidial concentration at

200,000 spores/ml, and an adhesive, Triton × 100, at a drop in 100-ml concentration, was used.

After the preliminary treatment, a wet chamber was devised to assure infection. The plot was covered with transparent polyethylene. The incubation period was 60 hours, during which dewing was superficial. At the end of this period, the seedlings continued to grow under dry, barren conditions.

Cultivar reaction was evaluated, by type of lesion, on the Standard Evaluation System for rice. Observations at: 1) the seedling (4-leaf) stage, 2) the tillering stage, 3) the flag leaf stage, and 4) the panicle stage were recorded. The responses were later compared to establish the infection evolution in the nursery.

Some cultivars kept their behavior throughout their development, but others either lost or gained resistance instead. The table summarizes the results.

Blast disease evolution caused by *P. oryzae* during the development of 197 cultivars, Argentina.

Cultivars		Blast disease[a] reaction	
no.	%	Tillering stage	Panicle stage
29	15	R	R
17	9	R	S
2	1	S	S
5	2	S	R
12	6	I	I
28	14	I	R
62	31	I	S
17	9	R	I
0	0	S	I
25	13	No records	

[a]R = resistant, S = susceptible, I = intermediate.

Forty percent of the cultivars tested became susceptible during their development; only 16% gained resistance, but 22% retained their original reaction and 9% acquired an intermediate response at the end of the panicle initiation stage.

On the basis of these results, the germplasm resistant to *P. oryzae* was then selected.

The following lines are particularly recommended as parents because of their resistant response throughout the test: H114-3-3-2-1, H114-5-2-1-1, H114-5-11-l-l, H114-23-1, H114-21-1, H115-13-1, Montiel, H115-19-l, [a] H118-1-1-1-1, H124-36-1, Lucas P.A., H118-2-1-1-1, H118-10-1, H119-3-1-1-2, [a] H119-11-1, H124-5-1-1-2, H124-5-2-2-1, [b] H124-5-3-1-1-1, H124-5-3-1-1-2, H124-6-1-1, H124-6-1-3-1-2, H124-6-1-3-2, H124-8-1-1, H124-8-1-3-1, H124-8-1-3-2, [b] H124-40-2-1, H124-40-2-2, H124-40-4-2, H127-29-1, H135-15, and H135-35.

The following cultivars, which respond to lesions from type 4 to type 6, are recommended for commercial use, mainly because of their horizontal resistance, but are not recommended as resistant progenitors: Sel. 5/CI 9703//Sesc. . . , Bluebonnet 50, H114-5-5-1-l [a], H115-20-1, H119-2-1-3, H119-2-1-4, and Inga.

This method proved useful because it allowed evaluation of 197 cultivars in the presence of a *P.* oryzae attack, identifying the inferior lines that should be eliminated. For the 1978—79campaign, 158 lines were eliminated. ■

[a]Outstanding for cultural features and commercial quality.

[b]Recommended for resistance because they are highly resistant, keeping lesion type 1 from tillering to panicle stages.

Fungal fluids induce rice seedling resistance to brown spot disease

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Biological induction in plants of resistance to their pathogens is of scientific interest. At this laboratory, a high degree of protection against the brown spot pathogen was induced in 3-week-old seedlings of Dharial, Dular, and Lathisail by inoculation with spore suspension (concn 5×10^5 spores/ml) of a mildly virulent isolate 2 days before challenge inoculation. Initial studies indicated that cell-free spore germination fluid or spore extract of a mild isolate could also induce resistance, although less effectively. This prompted investigations with fungal fluids, such as culture filtrate, replacement culture filtrate, and extracts from freshly collected and dried or freeze-dried mycelium of both isolates. The fluids were used either as foliage spray on 3-week-old seedlings 2 days before inoculation with the virulent isolate, or for seed soaking for 24 hours before sowing in pots or field plots. The plants grown in pots were artificially inoculated 3 weeks later. Those plants grown in the field were left exposed to natural infection.

Reduction in symptoms achieved with mild isolate inoculum in different treatments ranged from 62 to 79%. Preinoculation treatments with different fluids reduced symptoms by 6–52%. Fluids from the mild isolate were distinctly more effective than those from the virulent isolate. Results were best with the replacement culture filtrate, closely followed by the mycelial extract. Culture filtrate was less effective. Extracts from oven-dried or freeze-dried mycelium were significantly less effective than extracts from freshly harvested mycelium. Seed-soaking gave considerable protection for as long as 3 weeks. That induced protection was slightly less effective than foliage spray applied 2 days before inoculation, but its persistence appeared significant.

In experiments with spore germination fluids obtained from both virulent and mild isolates, spraying fluids obtained from a suspension of 10^6 spores/ml of the isolates gave substantial protection (see table). With germination fluids obtained from higher concentrations, symptom reductions increased progressively (up to 81%) for the mild isolate, but declined steadily to 18% with comparable fluids of the virulent isolate. Fungitoxicity of leaf diffusates from plants in different treatments ran almost parallel to their effects in inducing resistance. Such observations imply that some fungal metabolite present in different fluids induces resistance in rice plants to *H. oryzae* through production of fungitoxic substance in the plant tissue. When the germination fluid was exposed to different treatments, its resistance-inducing ability was often inhibited. Results indicate that the

Comparative ability of different concentrations of spore germination fluids of two isolates of *Helminthosporium oryzae* to induce fungitoxicity and resistance in rice plants (variety, Dharial) to the same pathogen. Kalyani, India.

Treatment	Concn (no. of spores/ml)	Mean germ tube growth in leaf diffusate (µm)[a]		Mean disease index/plant[a]	
Water (control)		591		24.6	
Germination fluid (virulent isolate)	10^6	286	(–51.6)	12.3	(–50.0)
	2×10^6	390	(–34.0)	14.2	(–42.3)
	3×10^6	470	(–20.5)	20.0	(–18.7)
Germination fluid (mild isolate)	10^6	285	(–51.8)	9.5	(–61.4)
	2×10^6	224	(–62.1)	7.2	(–70.7)
	3×10^6	138	(–76.6)	4.6	(–81.3)
Germination fluid (mild isolate)	3×10^6				
Exposed to ultraviolet light for 30 min		541	(–8.5)	22.3	(–9.3)
Exposed to 70°C for 30 min		629	(+6.4)	21.6	(–12.2)
Treated with activated charcoal		411	(–30.5)	15.8	(–35.8)
Dialysed at 10°C for 20 h		133	(–77.5)	4.8	(–80.5)

[a]Values in parentheses indicate percentage reduction or increase compared with the control.

inducer is sensitive to ultraviolet light and temperature of 70°C, and that it is adsorbed by activated charcoal, but stands dialysis. ■

Identification of races of *P. oryzae* in Argentina

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The blast disease of rice, caused by *Pyricularia oryzae,* has recently become a limiting factor in Argentine rice production. Numerous races of the highly variable blast fungus have been reported in India, Japan, Korea, Philippines, USA, and elsewhere. Isolates of *P. oryzae* were obtained from different provinces of Argentina and inoculated onto the international rice blast differentials (IRBD) and four commercial varieties to determine the occurrence and distribution of blast races in Argentina. This is the first report of race identification and distribution of *P. oryzae* in Argentina.

Table 1. Reaction of the international differential varieties set to 12 monosporic cultures of *Pyricularia oryzae* in Argentina.

Isolate	Reaction[a] of differential varieties								Race identified
	Rami-nad	Zenith	NP125	Usen	Dular	Kanto 51	Sha-tiao-tsao	Ca-loro	
$CU_{3\text{-}78}$	S	S	S	S	S	S	S	R	IA_2
$F_{3\text{-}79}$	S	S	S	S	S	R	S	R	IA_6
$CH_{3\text{-}79}$	R	S	S	S	R	S	S	R	IB_{10}
$V_{3\text{-}78\text{-}1}$	R	R	R	R	R	R	R	R	II_1
$V_{3\text{-}78\text{-}2}$	R	R	R	R	R	R	R	R	II_1
$LP_{5\text{-}78}$	S	S	R	S	S	R	S	R	IA_{38}
$LP_{5\text{-}79}$	S	S	S	S	R	S	S	S	IA_9
$X_{3\text{-}79}$	R	R	R	R	R	S	R	S	IF_3
$6F_{3\text{-}79}$	R	S	S	S	R	S	S	S	IB_9
$CH_{3\text{-}79\text{-}B}$	R	R	R	S	R	S	R	S	ID_{11}
$SF_{4\text{-}78}$	S	R	R	R	R	R	S	R	IA_{126}
$G_{4\text{-}78}$	R	R	R	–	R	R	R	–	No id

[a]R = resistant, S = susceptible.

Twelve monosporic cultures of *P. oryzae* were prepared from diseased rice specimens collected in Concepcion del Uruguay ($CU_{3\text{-}78}$, $G_{4\text{-}78}$), Villaguay ($V_{3\text{-}78\text{-}1}$, $V_{3\text{-}78\text{-}2}$), Santa Fe ($SF_{4\text{-}78}$), Formosa ($6F_{3\text{-}79}$, $F_{3\text{-}79}$), Chaco ($CH_{3\text{-}79}$, $CH_{3\text{-}79\text{-}B}$), Buenos Aires-La Plata ($LP_{5\text{-}78}$, $LP_{5\text{-}79}$), and an isolate of unspecified origin ($X_{3\text{-}79}$). The isolates were maintained in potato sucrose agar (PSA) and transferred to Misato agar (MA) for spore production. The IRBD varieties Raminad Strain 3, Zenith, NP125, Usen, Dular, Kanto 51, Sha-tiao-tsao (CI8970S), and Caloro plus commercial varieties Lucas, Cali, Montiel, and Nancay were inoculated with 3×10^5 spores/ml of each isolate. Spore suspensions of each isolate were produced from monosporial cultures on MA at 24°C and 16 hours light. The spore suspension was uniformly atomized on the leaves of plants at the 3-4 leaf stage. The inoculated plants were maintained in the moist chamber for 48 hours at 21°C (night) to 30°C (day), then transferred to the greenhouse where the same temperature regimes were maintained; RH varied from 54 to 85%. Varietal reactions to each isolate were recorded 12 days after inoculation. Lesion types were recorded using the International Standard Evaluation System and races identified using the 1969 method of Ling and Ou.

Table 2. Reaction of the commercial varieties to 10 races of *P. oryzae.* Argentina.

Races	Reaction[a] of commercial varieties			
	Nancay	Montiel	Lucas	Calá
IA_2	S	–	S	S
IA_6	S	–	S	S
IB_{10}	S	–	S	S
II_1	–	–	–	–
IA_{38}	R	S	–	–
IA_9	S	S	S	–
IF_3	R	R	R	–
ID_{11}	R	R	R	–
IB_9	S	S	S	–
IA_{126}	R	R	R	–

[a]R = resistant, S = susceptible.

Ten races were identified (Table 1) which conform to the International Race Groupings IA, IB, ID, IF and a proposed

Table 3. Distribution and prevalence of races of *P. oryzae* in Argentina.

Region	Races
Entre Rios:	
Concepcion del Uruguay	IA_2, Unidentified
Villaguay	II_1
Chaco	IB_{10} and ID_{11}
Formosa	IA_6 and IB_9
Santa Fe	IA_{126}
Buenos Aires:	
La Plata	IA_{38} and IA_9
Unknown	IF_3

new group, II, characterized by a resistant reaction on all eight IRBD varieties. No isolates of IC, IE, IG, or IH were detected. Isolate G4-78 was not identified. The most prevalent race group was IA (40%) followed by IB (16%), II_1 (16%), and ID and IF (8%). The four commercial varieties were susceptible to most races (Table 2). The geographical distribution of races is shown in Table 3. The prevalent races in Argentina are similar to those in Colombia as reported by Galvez in 1971. No correlation between colony type and pathogenicity was obtained. ■

Correlation of rice varietal reaction to brown spot disease and postinfectional production of fungitoxic substance

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There is good evidence that rice plants produce phytoalexin-like fungitoxic substances. A basic postulate of the phytoalexin concept is that host varieties differ in speed of phytoalexin production when infected; resistant varieties produce more than susceptible varieties. Our two experiments on brown spot disease of rice provide some relevant information.

Pot-grown, 3-week-old plants representing 9 varieties were artificially inoculated with a virulent isolate of *Helminthosporium oryzae;* symptoms were assessed 4 days later to compute a disease index on the basis of both the number and size of lesions. Diffusates from the leaves of both uninoculated and inoculated plants (collected 3 days after inoculation) were assayed for toxic action against spore germination of the pathogen.

Reactions of rice cultivars to infection with *H. oryzae* and fungitoxicity in diffusates from infected plants. West Bengal, India.

Cultivar	Experiment 1			Experiment 2		
	Mean lesion size, length x breadth (mm)	Mean disease index/ plant	Inhibition (%) of germ tube growth [a]	Mean no. of spots/ plant	Mean disease index/ plant	Inhibition (%) of germ tube growth [a]
Benibhog	2.61 x 0.51	10.4	6.2	41.7	11.9	8.3
Dharial	2.13 x 0.58	9.4	21.2	37.5	10.4	25.2
Dular	2.15 x 0.40	1.2	25.4			
Badkalam				40.4	9.6	34.1
IR8				36.8	8.2	35.9
Padma				34.6	5.2	41.5
Lathisail	2.10 x 0.32	4.1	55.4			
AC1351				41.4	4.8	70.0
CH13	1.83 x 0.25	3.5	65.9	34.5	3.6	71.8

[a] Values indicate percentage reduction in germ tube growth in the diffusate from inoculated plants in terms of that in the diffusate from uninoculated plants.

The general trend in both experiments was the same (see table). The diffusate from inoculated Benibhog plants, which had the highest mean disease index and lesions of largest mean size, exhibited the least fungitoxicity. CH13 plants had the lowest disease index and the smallest mean size of lesions. The CH13 leaf diffusate showed the highest fungitoxicity. Other varieties between these two extremes showed an inverse correlation between disease index and fungitoxicity in leaf diffusate, but the differences between different varieties were not always proportional. Varieties differed little in number of lesions, although they differed in mean lesion size. Resistant varieties generally developed more of the smaller spots and fewer of the larger spots than the susceptible ones. It is apparent that the production of fungitoxic substance is more rapid in incompatible than in compatible host-parasite interactions. This may explain the occurrence of more of the smaller-sized spots in the former. Observations are in agreement with the phytoalexin concept. ■

Sources of resistance to major rice diseases in the Punjab, India

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In 1979 kharif we screened 282 of our breeding lines for resistance to bacterial blight, sheath blight, sheath rot, and stem rot. Ten plants of each line were artificially inoculated with pure cultures of the pathogens of those diseases separately. Plants were inoculated at maximum tillering for bacterial blight, at booting for sheath blight and sheath rot, and at heading for stem rot. Inoculation methods were clipping for bacterial blight; Amin's stem tape-inoculation technique for sheath blight; inserting pearl millet grain culture inside the flag leaf sheath, just above the floret, for sheath rot; and injecting sclerotial suspension into the base of the stem at water level for stem rot. Disease reactions were recorded 15 days after inoculation for bacterial blight, 20 days for sheath blight and sheath rot, and 30 days for stem rot. The Standard Evaluation System scale was used for bacterial blight and sheath blight evaluation. For sheath rot, a 1–9 scale suggested by Satyanarayana and Reddy (IRRN 4 [Apr 1979] 6) was used. For stem rot the following scale was designed:

R = resistant (Sclerotia not formed)

MR = moderately resistant (Few sclerotia visible inside the stem)

M = intermediate (Many to abundant sclerotia visible inside the stem)

MS = moderately susceptible (Abundant sclerotia visible with partial rotting of stern)

S = susceptible (Abundant sclerotia visible, stem completely rotten)

We found 31 lines to be moderately resistant or resistant to at least one disease. Five were moderately resistant to bacterial blight; 2 were resistant and 12 moderately resistant to sheath blight; 2 were resistant and 10 moderately resistant to sheath rot; and 4 were moderately resistant to stem rot (see table). Of the three lines possessing multiple disease resistance, PAU50-B-25-1 (MR to bacterial blight and sheath blight) and PAUl3-8-3-1-1 (MR to sheath blight and sheath rot) have long slender grains with average yields equal to those of Jaya, IR8, and PR106. These two lines have the potential to replace existing semidwarf varieties that have become susceptible to diseases.

A resistant reaction was recorded for 2 lines each against sheath blight and sheath rot, while a moderately resistant reaction was found for 5 lines against bacterial blight, 12 lines against sheath blight, 10 lines against sheath rot, and 4 lines against stem rot. The largest number of lines gave at intermediate reaction to bacterial blight, sheath blight, and sheath rot. For stem rot, the largest number of lines were moderately susceptible. The resistant and moderately resistant breeding lines will be used as donor parents. ■

Reaction of promising breeding lines to major diseases. Punjab Agricultural University, India

Designation	Cross	Reaction[a]			
		Bacterial blight	Sheath blight	Sheath rot	Stem rot
PAU13-8-3-1-1	Basmati 370/IR8	MS	MR	MR	S
PAU13-8-3-6-2-1-2	”	M	M	M	MR
PAU14-3-15-B-8-1-2	IR8/Basmati 370	M	MR	M	MS
PAU29-295-3-B-2-1	Basmati 370/Hamsa	MS	MR	M	MS
PAU41-10-1-3-262-1-5	Phulpattas 72/Mutant 65	MS	R	M	MS
PAU50-B-25-1	Jaya/IR579	MR	MR	M	MS
PAU50-B-51-1-1-20-62-1	”	M	M	MR	MS
PAU122-73-1-4-1	Basmati 370 mutant/Basmati 370	MS	M	R	S
PAU143-B-41-1-1-1	Norin 18/Hybrid 27	MS	MS	MR	S
PAU164-102-1-2-1-1-1	PAU29-108/Palman 579	MS	M	MR	MS
PAU269-1-9-1-3	Sona/Basmati 370	MS	M	M	MR
PAU311-12-2-1	Basmati 370/Basmati 21	MS	M	MR	MS
PAU317-B-2	Jhona 349/Jaya	S	R	M	MS
PAU321-B-19	Palman 579/Basmata 21	MR	M	M	MS
PAU322-B-11	HM95/Basmata 21	MR	M	M	MS
PAU391-B-12	Sabarmati/Ratna	MR	M	M	S
Pusa 37-6-2-3	IR82/BJ 1	MS	MS	R	S
RP633-519-1-3-8-1	IR8/BJ 1//IR22	MR	S	MR	MR
IR5853-229-1	Nam Sagui/IR2071-88//IR2061-214-3-6-20	M	M	MR	S
VI-158	–	MS	M	M	MR
CIAT 4	–	M	MR	M	S
Mehran 69	–	M	MS	MR	MS

[a]R = resistant, MR = moderately resistant, M = intermediate, MS = moderately susceptible, S = susceptible.

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Varietal screening for brown planthopper resistance

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In a greenhouse screening at the AICRIP headquarters, Hyderabad, of 2,360 rice varieties from different sources, 136 were identified as highly resistant and 69 as moderately resistant to the brown planthopper (BPH).

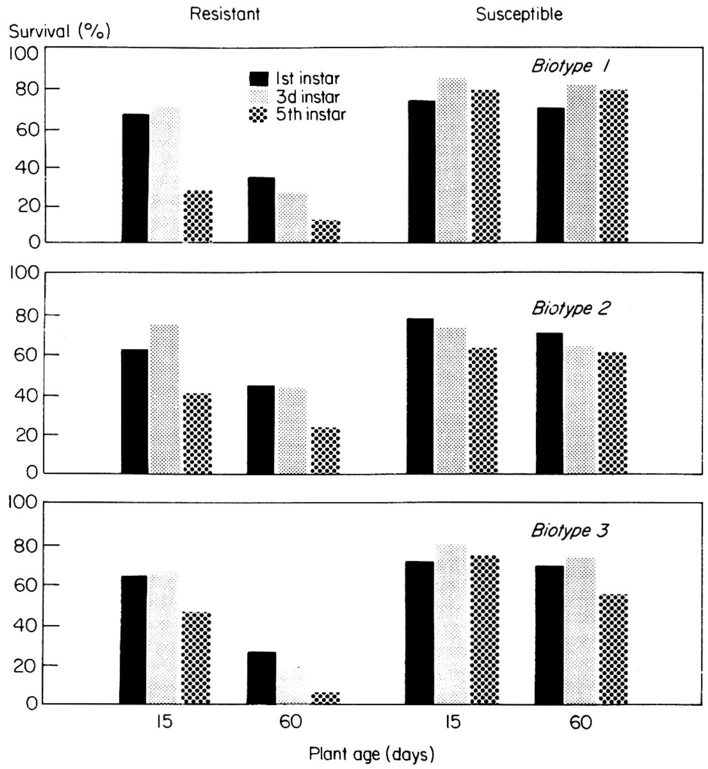
Among those identified as resistant, several were from Northeast India, South India, and Sri Lanka The highly resistant varieties are listed in the table. ■

Some varieties found highly resistant (score 1) to thc brown planthopper in greenhouse tests at All India Coordinated Rice Improvement Project, Hyderabad, India.

Variety	Origin	Variety	Origin
Djawa Sredek	Indonesia	Company Chittari	India
Gapita	”	Enna Patta	”
Mawee	Sri Lanka	Kula Peruvala	”
Umsum	Korea	MHL 1	”
Lua Ngu	Vietnam	Pandi	”
Nang Lay	”	Parakulam	”
Nganetie	Laos	Pokkali	”
Lal Dhapa (ARC7327)	India	PTB21	”
IC25 11 3	”	PTB33	”
IC25 172	”	S 61	”
T2755	”	S 2204	”
JBS1168	”	T3	”
Manoharsali	”	T10	”
PTB28	”	T16	”
A-1	”	T27	”
ADT 8	”	T1415	”
AE 1443	”	T1421	”
Chennellu	”	T1465	”
Chenninayakan	”	T1471	”
Cheriya Chittari	”	Vella Chenipan	”

Influence of the stage of the brown planthopper *Nilaparvata lugens* and plant age on insect survival on resistant varieties

F. G. Medrano and E. A. Heinrichs, assistant scientist and entomologist, Entomology Department, International Rice Research Institute



Reaction of BPH nymphs at three stages on resistant and susceptible rice varieties. IRRI, 1979.

Data on the survival, population buildup, and feeding activity are commonly used to study the nature of resistance of rice varieties to the brown planthopper (BPH) *Nilaparvata lugens.* In our studies we have been egg caging BPH on TN1 for oviposition, placing the 1st-instar nymphs on the test varieties and determining their survival rate after 30 days. We wanted to see if we could use 5th-instar nymphs to save time and determine if they would be more sensitive than earlier-instar nymphs. A study was conducted to test three age groups of the BPH to determine which stage was most sensitive to the resistant variety and thus would detect varietal differences most precisely.

The 1st, 3d, and 5th instars of biotypes 1, 2, and 3 were tested. Test insects were maintained on 50- to 60-day-old TN1 plants until used in the test. Ten insects were placed on 15- or 60-day-old plants in mylar film cages 7 cm in diameter and 65 cm high. Ten cages were used for each variety, each cage serving as a replicate. Resistant varieties tested were ASD7, IR26, IR42, Mudgo, and Rathu Heenati against biotype 1; ASD7, IR42, and Rathu Heenati against biotype 2; and IR26, Mudgo, and Rathu Heenati against biotype 3. TN1 was the susceptible variety. Survival was based on number of insects alive 8 days after infestation.

Survival of the 5th-instar nymphs was significantly lower than that of the 1st and 3d instars on the 15-day-old resistant plants (see figure). On 60-day-old resistant plants, survival of all instars was low. The 5th instar showed maximum differences in survival of the biotypes when comparing the resistant and susceptible varieties. But the 1st and 3d instars generally gave maximum differences when survival was compared on 15- and 60-day-old plants. We propose 1) that 5th-instar nymphs be used on 15-day-old plants to compare survival rates on varieties and to detertnine comparative levels of resistance, and 2) that 3d-instar nymphs be used to compare resistance levels on various ages of rice varieties. ■

Multiple pest resistance in some tall traditional varieties

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Sixty-six tall traditional varieties identified as resistant or moderately resistant to brown planthopper (BPH) at Hyderabad, India, were screened for reactions to the whitebacked planthopper (WBPH), gall midge (GM), rice tungro virus (RTV), and bacterial blight (BB). All were susceptible to BB but resistant to one or more of the other stresses (see table). Varieties that showed resistance to BPH, WBPH, GM, and RTV were: Chennellu, Pandi, PTB19, PTB21, T1471 Valsara Champara, and Vellathil Cheera.

Reactions of some tall varieties to 3 insects and 1 disease at Hyderabad, India.

Designation	Origin	Reaction[a] to			
		BPH	WBPH	GM	RTV
ARC6564	India	R	R	S	R
ARC6650	”	R	MR	S	R
ARC10945A	”	R	S	S	R
ARC11704	”	R	MR	R	S
ARCl3349	”	MR	MR	S	MR
ARCl3788	”	MR	MR	S	R
ARC14342A	”	R	S	S	R
ARCl4394	”	R	MR	S	MR
ARC14529A	”	R	R	S	R
ARC14539B	”	MR	R	S	S

Continued on next page.

Reactions of . . . . (continued)

ARC14636	”	MR	MR	S	S
ARC14766	”	R	R	S	R
ARC14950B	”	MR	S	R	S
A-1	”	R	MR	R	R
ADR52	”	R	MR	R	R
Chemban	”	MR	R	R	S
Chempan	”	R	R	S	R
Chemparampandi	”	R	R	S	S
Chennellu	”	R	R	R	R
Chennirayenam	”	R	MR	R	S
Cheriya Chittari	”	R	R	S	S
Chittari	”	R	MR	S	R
Chuvanna kumbolan	”	MR	MR	R	S
Eswara Mangalam	”	R	R	S	S
GS 531	”	R	R	S	S
Kodiyan	”	MR	R	S	S
Kula peruvala	”	R	MR	S	S
LXH/2-281	”	R	R	S	R
Lalbasumati	”	R	R	S	S
Luangu	Vietnam	R	S	S	R
Mawee	Sri Lanka	R	MR	S	R
Malalwariyan	”	MR	S	R	R
Mudukiriyal	”	R	R	S	S
Pandi	India	R	R	R	R
Parakulam	”	R	S	R	S
Podwi-A8	Sri Lanka	R	R	S	S
PTB247	India	R	MR	S	R
PTB12	”	MR	S	R	R
PTB19	”	R	R	R	R
PTB21	”	R	R	R	R
PTB33	”	R	R	S	S
PTB33A	”	R	R	S	R
S 61	”	R	S	S	R
Siam 7	”	R	MR	S	R
Sulai	Sri Lanka	MR	MR	S	R
T 10	India	R	S	R	S
T 12	”	R	S	S	R
T 16	”	R	S	R	S
T 27	”	R	S	S	R
T 1415	”	R	S	S	R
T 1421	”	R	S	S	R
T 1425	”	MR	R	R	S
T 1426	”	R	MR	R	R
T 1432	”	R	S	R	S
T 1471	”	R	R	R	R
T 1477	”	MR	R	S	R
T 2755	”	MR	S	S	R
Valsara Champara	”	R	R	R	R
Vella Chenipan	”	R	S	R	R
Vellathil Cheera	”	R	R	R	R
Vellai Langayan	”	MR	R	S	S
Vellutha cheera	”	R	MR	R	S
W 128	”	MR	S	S	R
AC No. 710	”	MR	S	R	R
AC No. 5352	”	R	R	S	S
AC No. 8895	”	R	S	S	R

[a] BPH = brown planthopper, WBPH = whitebacked planthopper, CM = gall midge, RTV = rice tungro virus, R = resistant, S = susceptible, MR = moderately resistant.

GENETIC EVALUATION AND UTILIZATION

Cold tolerance

Cold-tolerant rice in Bangladesh

Md. Anwarul Kabir, Tulsi Das, Q. A. Hoq, M. K. Chowdhury, and M. A. Hamid, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Bangladesh

During the I979 transplanted aman season, 113 lines were screened at BRRI for cold tolerance at the reproductive stage. The experimental materials were seeded on 14 August and planted on 15 September 1979. Each line was planted in a 5.4-m-long plot with 4 rows spaced 25 × 15 cm, using 1 seedling/hill. The resistant check (China 1039) and the susceptible check (1R8) were planted after every 10th plot. Fertilizer was applied at 90-65-45 kg NPK/ha with a split of N (50% + 25% + 25%). During the reproductive phase, the temperature ranged from 27.3° to 13.7° C. Considering panicle emergence, flowering uniformity, sterility, and yield, the following lines were selected:

BK51-282-8/HR5, BR51-282-8/HR26, BR51-282-8/HR34, HP46 (HPV13), IR7682-135-3-2, IR8866-26-2, IR8866-30-2, IR8866-30-3, and IR3941-27-1. ■

Pest management and control DISEASES

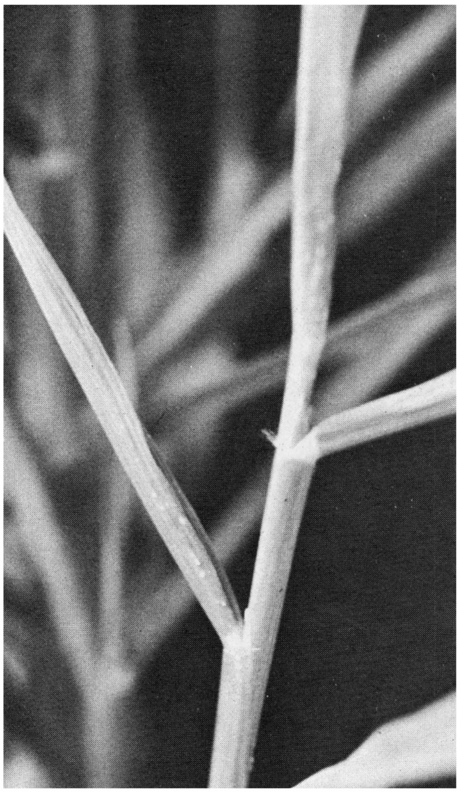
Gall dwarf – a new rice virus disease in Thailand

Methie Putta and D. Chettanachit, Rice Pathology Branch, Division of Plant Pathology and Microbiology, Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand; T. Morinaka, Tropical Agriculture Research Center, Ministry of Agriculture, Forestry, and Fisheries, Japan; A. Parejarearn, and S. Disthaporn, Rice Pathology Branch, Thailand

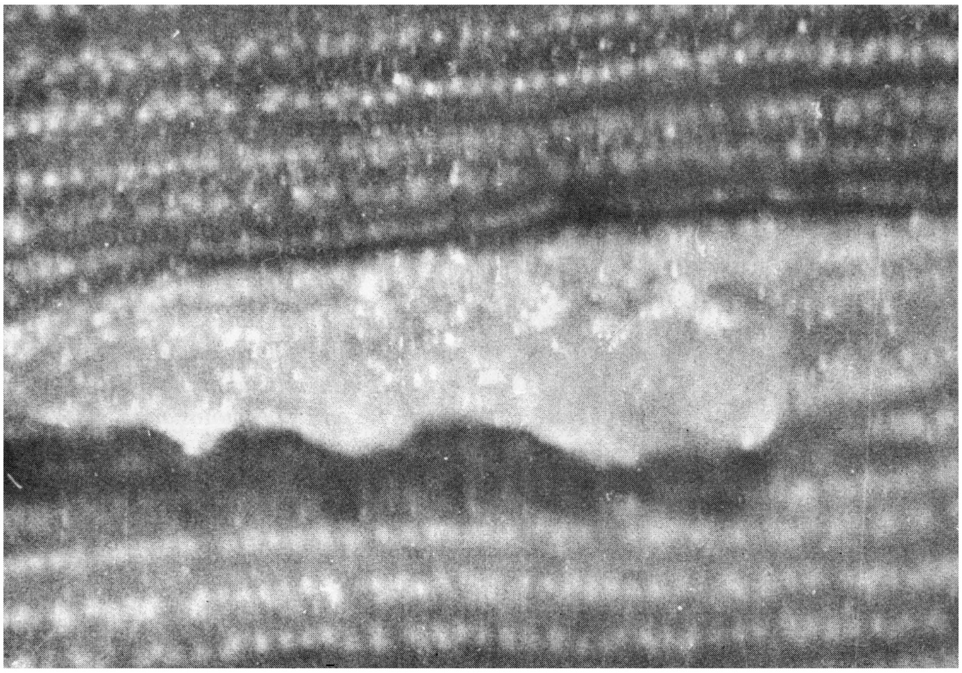
In August 1979, a number of rice insects and a few severely stunted and dark-green rice plants resembling those infected with rice dwarf virus disease were collected from Uthai Thani province, 250 km north of Bangkok, Thailand. An experiment on the transmission of the disease, its symptoms on host plants, and observations by electron microscope were conducted at the Rice Pathology Branch, Bangkhen, Bangkok. The results follow:

1. Symptoms of the diseased plants resembled those of rice ragged stunt.

1. Healthy plant (left) and stunted plant (right) infected with the rice gall dwarf disease.



2. Galls appeared on gall dwarf infected plant.



3. Gall or vein swelling magnified 125 + 40.

The plants were stunted and twisted, with short dark green leaves (photo 1). Vein-swellings were round, like galls, and appeared on the outer surface of the leaf blades and sheaths (photos 2, 3). The number of galls increased as the symptoms developed. The diseased plants exhibited reduced tillering and produced few panicles.

2. Spherical virus particles were found in the dip preparation from galls of the diseased plants.

3. The zigzag-wing rice leafhopper *Recilia dorsalis* and the rice green leafhopper *Nephotettix nigropictus* were able to transmit the disease in a persistent manner (Table 1, 2). The incubation periods were about 9–25 days in both vector species and 12–25 days in the rice plants.

This new rice virus disease found in Thailand was named *gall dwarf.* ■

Table 1. Insect transmission tests of gall dwarf isolate from insect. Thailand.

Natural insects collected from Uthai Thani, Thailand by H. Inoue in August 1979	Inoculated to healthy plants (infection)[a]	Symptom
Nephotettix nigropictus	2 of 8	Gall dwarf

Back Transmission

Transmission tested by	Infection[a]	Symptom
Nilaparvata lugens	0 of 32	–
Recilia dorsalis	3 of 67	Gall dwarf
Nephotettix nigropictus	1 of 7	Gall dwarf

Result of serial daily transmission by a single insect.[b]

Insect	Insect no.	Result at given no. of transfers																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Recilia dorsalis	2	○	○	○	W	○	○	○	○	○	○	○	○	○	○	○	○	●	D		
	41	○	○	○	○	○	○	○	○	○	●	●	●	●	●	●	D				
	67	○	○	W	⊙	○	W	○	●	●	●	●	○	D							
		Acquisition feeding for 2 days and inoculation feeding for 1 day. Total insects used = 67																			
Nephotettix nigropictus	4	○	○	○	○	○	○	○	○	W	○	◉	W	●	●	●	●	●	○	●	E
		Acquisition feeding for 1 day and inoculation feeding for 1 day. Total insects used = 7																			

[a]Number of plants showing infection with positive results and total no. of plants tested.
[b]● transmitted the disease.
○ failed to transmit.
W seedling wilted.
D insect died.
◉ insect molted and transmitted the disease.
⊙ insect molted but failed to transmit the disease.
E insect escaped.

Table 2. Insect transmission tests of gall dwarf isolate from the plant. Thailand.

	Transmission tested by	Infection[a]	Symptom
Severely stunted and dark-green rice plants resembling those with rice dwarf virus disease collected from Uthai Thani, Thailand, by T. Omura in August 1979	*Nilaparvata lugens*	3 of 43	Rice ragged stunt virus
	Recilia dorsalis	1 of 44	Gall dwarf
	Nephotettix nigropictus	0 of 47	–

Back Transmission

Transmission tested by	Infection	Symptom
Nilaparvata lugens	0 of 41	–
Recilia dorsalis	5 of 40	Gall dwarf
Nephotettix nigropictus	0 of 53	–

Result of back-transmission by single insect, *Recilia dorsalis*.

Insect no.	Result[b] at given no. of transfers				
	1	2	3	4	5
10	○	○	●	○	D
13	○	W	○	○	●
29	○	○	○	●	D
32	○	○	●	○	○
38	○	●	●	●	●

[a] Number of plants showing infection with positive results and total no. of plants tested.
[b] Acquisition feeding for 1 day, inoculation period for 7 days and inoculation feeding for 2 days (1 insect/plant). Total insects used = 40. For explanation of symbols, see footnote to Table 1.

Observations on rice gall dwarf, a new virus disease

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Galls found on the leaves and leaf sheaths of dark-green, dwarf rice plants in fields at Uthai Thani, Thailand, in August 1979 were presumed to be of a new virus disease that was named rice gall dwarf.

Leafhoppers *Nephotettix nigropictus* at early instars were used in a transmission test. After 1 day of acquisition feeding the insects were serially transferred to rice test seedlings 2 times/week. The insects transmitted rice gall dwarf in a persistent manner; of the 16 tested, 4 transmitted the disease. The minimum latent period of the virus in the insects was 14 days; the maximum, 20 days.

Seedling inoculation at the first- to third-leaf stages showed the following symptoms: dwarfing, appearance of galls along the leaf blades and sheaths, dark-green discoloration, twisting of the leaf tips, reduction in number of tillers, and death of the entire plant at later infection stages. Dwarfing and discoloration are the the characteristic symptoms of the diseased plants in the field, except those infected at later growth stages. No yellowish-white specks — the typical symptom of rice dwarf virus (RDV) disease — were observed on the leaf blades.

The dwarfing, caused by incomplete emergencee of the younger leaves, was particularly conspicuous in the plants inoculated at earlier growth stages.

The galls or vein-swellings appeared on the undersurface of the leaf blades and on the upper parts of the leaf sheaths. The galls were light green and rather translucent at first, but later became brownish. They were more abundant in early infected plants, some of whose leaves had more than 10 galls. The galls varied from 0.4 to 0.5 mm in width and 0.4 to 8 mm in length.

The discoloration of infected plants was another characteristic symptom. Infected hills were easily recognized by their dark-green color in the field and in the transmission test.

Another minor symptom was the twisting of the tips of newly developed leaves — supposedly because of an alternating, uneven growth of the leaf blades on both sides of the midrib.

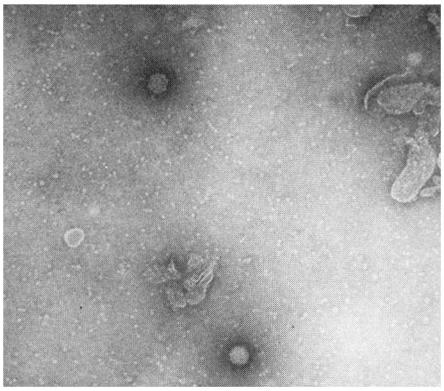
The plant's leaf tip began to dry; eventually, the entire plant dried and died.

Spherical particles about 65 nm in diameter (vs 70 nm in RDV), were always observed in the leaf-dip preparations of gall dwarf-infected tissues (photo 1). They were more abundant in the preparations from galls than in those from nongall leaf tissues. The particles had a capsid-like structure. Ultrathin sections showed virus particles in the phloem cells of the diseased plant (photo 2).

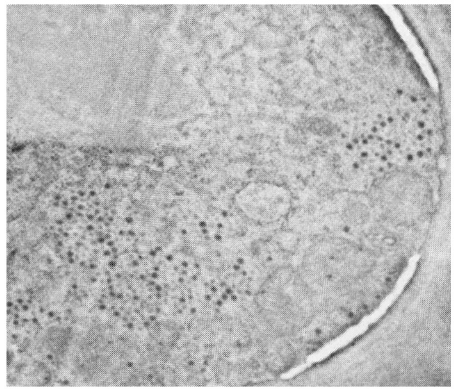
The clumping technique was used in an immunoelectron microscopic test to study the serological relationship of the particles with RDV. Particles that consistently appeared in preparations of grids with RDV and RDV antiserum were many and clumped while those observed on the grids with specimens infected with rice gall dwarf disease and RDV antiserum were few and dispersed.

Among the rice virus diseases, rice black-streaked dwarf and rice ragged stunt have a symptomatology similar to that of rice gall dwarf disease. But rice gall dwarf induces the formation of numerous small galls; the other diseases produce a few elongated swellings of the veins. It is difficult to distinguish rice gall dwarf disease from rice ragged stunt in the field. Plants with rice gall dwarf disease, however, have no ragged leaf blades and their leaves become dark green unlike those of plants infected with ragged stunt.

The causal agent of rice gall disease is presumably a virus with spherical particles about 65 nm in diameter, capsid-like in structure. Three rice viruses are reported among the plant reovirus group — RDV, rice black-streaked dwarf virus, and rice ragged stunt. Only the virus particles of RDV have a capsid-like structure. But immunoelectron microscopic examination revealed that the particles associated with rice gall dwarf disease are not serologically related to RDV, suggesting that rice gall dwarf is a new virus disease. ■



1. Electron micrograph showing virus particles in a dip preparation from the sample infected with rice gall dwarf disease.



2. Electron micrograph showing virus particles in a phloem cell of a rice plant infected with rice gall dwarf disease.

Chlorotic streak, a new virus disease of rice

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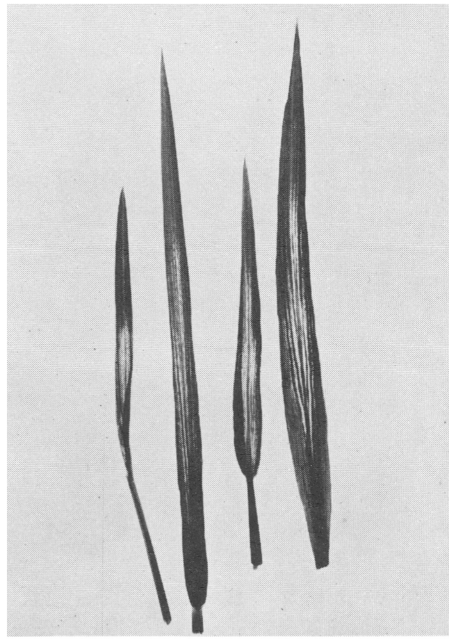
Since 1978, we have observed a new virus disease of rice on the CRRI farm and in farmers' fields surrounding Cuttack. In the field the disease occurs in patches (Fig. 1) ranging in size from about 1 to 10 m^2. Its severity decreases from the center to the outer edges of the affected patch. The diseased plants in the center are much more severely damaged than those on the edge, indicating that a slow-moving agent spreads the disease.

In artificially inoculated plants, the symptoms were stunted plant growth (Fig. 2), chlorotic streaking, striping, or mottling (Fig. 3) of the newly emerging leaves; difficult emergence of leaves and panicles; and brown discoloration and grain sterility. Chlorotic streaks also appeared on the leaf sheaths. Other symptoms observed occasionally were twisting, curling, crinkling, blunt edges, wavy margin, ragging, tearing, raised blisters, rough surface, and dark green color of the leaves; swelling and irregular

1. Diseased patch of rice chlorotic streak in farmers' field. The circle represents the diseased patch.

2. Healthy and diseased plants of IR26. The infected plant is stunted.

3. Chlorotic streaks and mottling on the leaves, the characteristic symptoms of the disease.



growth of the veins; and stimulation of new tillers. Nodal branching and aerial root formation were also observed. The symptoms varied widely among varieties and ages of infected plants. Some infected plants recovered from the disease.

Both persistent and nonpersistent attempts at transmission by *Nephotettix virescens, N. nigropictus* and *Nilaparvata lugens* and by mechanical means and the seed were unsucccssful. The constant association of the rice mealy hug *Heterococcus rehi (Ripersia oryzae)* with the disease in the field encouraged us to conduct transmission tests with the insect. In all three tests, each involving 100 test seedlings, transmission with the mealy bug was positive. About 30-40% of the seedlings of Jaya and IR26 are infected when each seedling was inoculated by three infective nymphs; none of the check seedlings showed symptoms. Transmission appeared to be nonpersistent. The transmission pattern, virus-vector relationships and structure of the virus are being investigated in greater detail.

Previously reported virus and mycoplasma diseases of rice are transmitted by leafhoppers, planthoppers, and beetles, and through mechanical inoculation, but not by the rice mealy bug. The symptoms of the new virus disease arc distinctly different from those of the reported diseases. We have therefore named the disease *Chlorotic streak* on the basis of its characteristic symptoms. ■

Ecology, epidemiology, and supervised control of rice brown leaf spot

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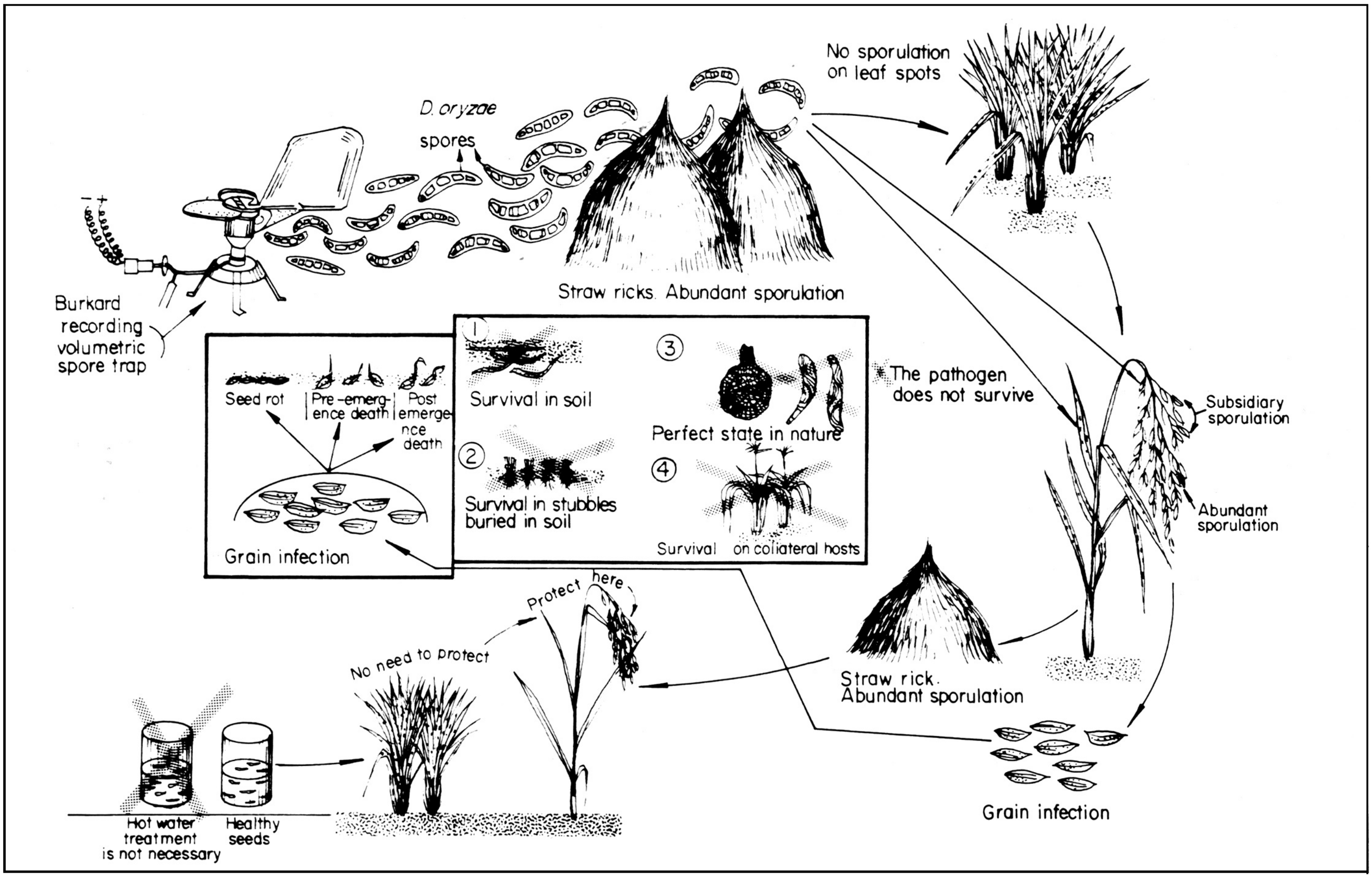
The ecology, epidemiology, and supervised control of brown leaf spot of rice caused by *Drechslera oryzae* has been studied in Karnataka. The following observations on brown spot epidemiology were made:

1. The glume blotch phase of the disease, which is the most serious, causes large yield losses.
2. The disease is not strictly seedborne in the sense that seedborne inoculum does not cause the usual disease symptoms such as leaf spotting and glume blotching.
3. The seedborne inoculum causes pre-emergence death of the seedlings only.
4. The pathogen is not soil borne; it survives only 4-6 weeks in puddled or semidry soil. It is highly aerobic and subject to biological antagonism in the soil.
5. The perfect state of the fungus was not found in nature, nor were any collateral hosts found although about 50 grass species were examined.
6. The leaf spots do not sporulate. Sporulation occurred, however, when the leaves were treated with warm water, indicating an inhibitory, water-soluble component in the spot. The leaf spots do not supply the inoculum for glume infection.
7. All the straw samples collected from several straw ricks in farmers' holdings yielded viable *D. oryzae.*
8. Studies using a suction-type volumetric spore trap for 365 days indicated year-round presence of *D. oryzae* spores in the atmosphere.
9. The numher of such spores varied seasonally. The lowest number was 500,000/liter of air in February-March and the highest, 17,000,000/liter of air in November.
10. There was diurnal variation in spore numbers. The maximum was from 0300 to 0900 hours and the minimum, from 1500 to 2100 hours.
11. Seed treatment with hot water does not ensure disease control, and spraying the crop at any stage before heading has no practical value.



Ecology, epidemiology, and control of brown leaf spot of rice caused by *Drechslera oryzae* (Breda de Haan), Subram and Jain in Karnataka.

12. Spraying with a suitable fungicide at heading and during the grain-maturation stage gave excellent disease control.

13. Supervised control of disease development leads to economy in fungicide use and more effective control of the glume blotch phase.

14. Brestan + Dithane M-45 (1:5 proportion) at the 0.2% level has effectively controlled the disease.

The figure shows the ecology and epidemiology of the disease. ■

Sheath blight control with soil fungicides

V. P. Sukumara Dev, assistant professor, Plant Pathology Division, Rice Research Station, Pattambi, Kerala 679306, India

A field trial was established to study the efficiency of certain soil and foliar fungicides against sheath blight disease caused by *Rhizoctonia solani* at the Rice Research Station, Pattambi, in 1977—78 kharif and rabi. The fungicides thiram, PCNB, and IBPl7G were applied to the soil before transplanting. A single edifenphos spray was applied at the maximum tillering stage, except in plots treated with IBPl7G. Benomyl, carboxin, carbendazim, and IBP 48 EC were sprayed 3 times at 14-day intervals,

Sheath blight control with soil fungicides, Rice Research Station, Pattambi, Kerala, India.

Treatment	Dose/ha	1977-78			
		Kharif		Rabi	
		Disease incidence (%)	Mean yield (t/ha)	Disease incidence (%)	Mean yield (t/ha)
Thiram + edifenphos	20 kg 0.5 liter	44	3.9	35	2.6
PCNB + edifenphos	20 kg 0.5 liter	54	3.8	36	2.5
IBP17G	35 kg	65	3.7	51	2.5
Benomyl	0.5 kg	62	3.4	47	1.9
Carboxin	0.5 kg	70	3.4	52	2.3
Carbendazim	0.5 kg	59	3.6	40	2.1
IBP 48 EC	1.0 liter	72	3.5	45	2.2
Control		74	3.3	57	1.9
CD (0.05)		8.245	0.406	6.55	0.379

beginning at 35 days after transplanting. The disease incidence was recorded at the heading stage as percentage of infected tillers, based on random observations of all the tillers in 20 hills/ plot.

All fungicides reduced the disease incidence significantly (see table). The treatment thiram + edifenphos was most effective, followed by PCNB + edifenphos. Among foliar fungicides, carbendazim performed best. ■

Pest management and control INSECTS

Notes on *Athetis pectinicornis,* a pest of water lettuce and water hyacinth in Bangladesh

Shamsul Alam, M. S. Alam, and M. S. Ahmed, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

The free-floating water lettuce *Pistia stratiotes* L. is a small aquatic perennial with a tuft of long, very fibrous roots. In certain situations it seriously interferes with the rice crop and is a preferred host of several species of mosquitoes, which in turn serve as principal vectors of malaria, encephalomyelitis, and rural filariasis.

Water hyacinth *Eichhornia crassipes* (Mart.) Solms seriously interferes with irrigation and navigation in many areas by blocking the canals with its diverse growth. It also impedes water flow in rivers, canals, and waterways. In Bangladesh, dhaincha *Sesbania cannabina* Pers. is sometimes cultivated on the border of rice fields to check the weed's entrance into the field.

In April and May 1978, caterpillars of *Athetis pectinicornis* Hamps. (Noctuidae; Lepidoptera) were found feeding on the leaves of these two weeds in several places in Dacca city. The insect appears to be a natural control agent of water lettuce and water hyacinth, and deserves the attention of entomologists and weed management specialists.

The pest species was identified by Commonwealth Institute of Entomology, London, U.K. ■

Evaluation of depth and effective zone of placement of carbofuran for brown planthopper control

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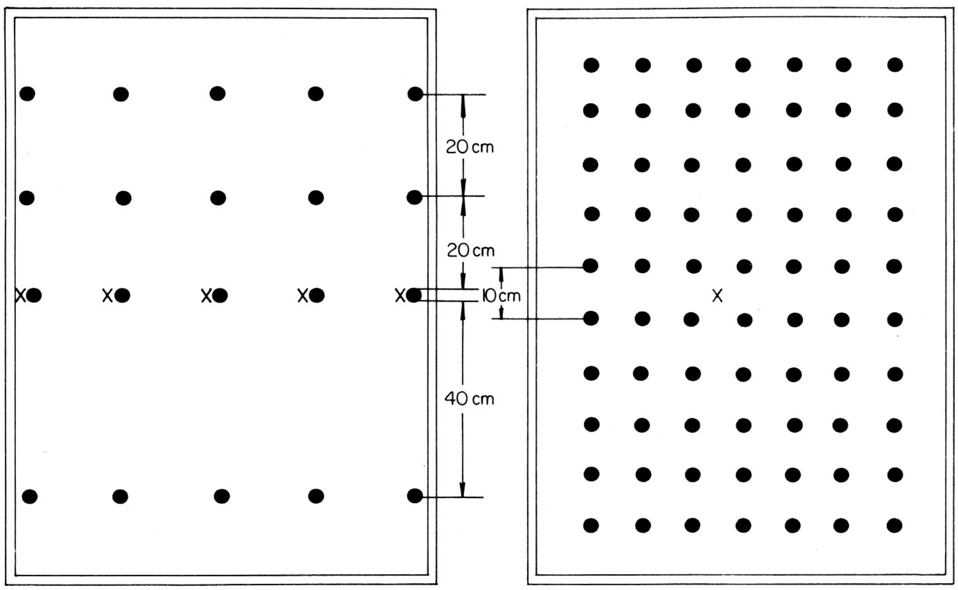
Carbofuran at 2.0 kg a.i./ha was placed in capsules, which were set near root zones of potted plants at depths of 1.25, 2.50, 3.75, and 5.00 cm from the soil surface. Ten adult brown planthoppers were released onto the plants at 5, 10, 15, 20, and 25 days after treatment. Mortality was recorded 24 hours after insect release.

Regardless of placement depth, 80 to 100% mortality was recorded.

The effective zone for insecticide placement was studied in a 90- × 90-cm iron tray, with plants spaced at 20 × 20 cm. Carbofuran at 2.0 kg a.i./ha was used. The relative position of hills, interspacing between hills, and the exact placement points of insecticide in the root zone are shown in the figure. The plants were removed 5 days after application.



Representation of the relative position of rice hills and actual points of insecticide placement in the root zone. • = plant hill, x = insecticide placement.

Root portions of the plants were wrapped with wet cotton, covered with polyethylene, and kept in glass chimneys. Both ends of the chimneys were tied with fine muslin. BPH adults were confined on the plants and mortality was recorded 48 hours later.

The insecticide did not move laterally from its placement point in the root zone. Bioassay tests of plants failed to show insecticide even after 48 hours of exposure of BPH adults.

Carbofuran at 2.0 kg a.i./ha (calculated on the basis of the diameter of the tray) was placed as a lump in the center of 4 hills spaced 10 × 10 cm in a 90- × 90-cm iron tray. Insect releases and observations were the same as in the previous experiment.

When the total amount of insecticide required to treat 1 m^2 was centrally placed as 1 lump, it had no effect on the next plants, 10 cm from the central 4 hills. That showed that the insecticide did not move laterally from its placement point. ■

Biological efficacy, cost, and mammalian toxicity of insecticides recommended for rice in the Philippines

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More than 50 commercial insecticides are sold in the Philippines, but only 15 are currently registered for use on rice. For an insecticide to be registered the chemical company manufacturing it must submit data on its performance against each insect pest for review by an interagency committee composed of government officials. Factors that affect registration are efficacy, human safety (during application and residues at harvest), and effect on nontarget organisms such as fish and animals. Once the criteria are satisfied for each insecticide, the company sets a price on the retail product. If approved, the price is used as a basis for credit costing in the government's Masagana 99 rice production programs.

IRRI has evaluated insecticides against the major rice insect pests in the Philippines since 1962; evaluation data are available to any chemical company or national program that wishes to use them for product registration. IRRI annually publishes the Insecticide Evaluation Report, a compilation of all the chemical control experiments performed that year. The publication is available on request from the IRRI Entomology Department.

IRRI data have been used extensively in the development of the list of recommended insecticides for rice in the Philippines. They cover the whorl maggot *Hydrellia sasakii,* stem borer *Tryporyza incertulas* and *Chilo suppressalis,* brown planthopper *Nilaparvata lugens,* whitebacked planthopper *Sogatella furcifera,* green leafhopper *Nephotettix virescens,* leaf folder *Cnaphalocrosis medinalis,* and rice bug *Leptocorisa oratorius.*

Sprayable and granular insecticides are evaluated at 0.75 kg a.i./ha and 1 kg a.i./ha dosages. The 1980 list of recommended insecticides in the Philippines shows that for each insect pest there is a wide range of chemicals to choose from in terms of cost and safety. The table lists the relative safety of the insecticides to the applicator, cost per application, and efficacy against the various rice insects. ■

Efficacy, cost, and mammalian toxicity of insecticides recommended for rice in the Philippines, 1980.

Insecticide[a]	Formulation[b]	LD_{50} [c] Oral	LD_{50} [c] Dermal	Cost[d] of application ($/ha)	Efficacy[e] Whorl maggot	Stem borers	Brown planthopper	Whitebacked planthopper	Green leafhopper	Leaf folder	Rice bug
Relatively safe sprayables											
Acephate	75% WP	890	2000	30.0	No	No	Yes	Yes	Yes	No	Yes
MTMC	50% WP	600	1000	13.2	No	No	Yes	Yes	Yes	No	No
BPMC	50% EC, 50% WP	400	340	11.2	No	No	Yes	Yes	Yes	Yes	No
Carbaryl	85% WP	300	500	8.4	No	No	No	No	Yes	No	Yes
Diazinon	60% EC	300	460	18.4	No	Yes	No	No	No	Yes	Yes
Moderately safe sprayables											
MIPC	50% WP	180	500	11.1	No	No	Yes	Yes	Yes	No	No
Chlorpyrifos	15.8% EC	100	2000	39.9	No	Yes	No	No	No	Yes	Yes
Triazophos	40% EC	80	11000	31.0	Yes	Yes	No	No	Yes	Yes	Yes
Endosulfan	35% EC	70	350	15.5	No	Yes	No	No	Yes	Yes	Yes
Dangerous sprayables											
Carbofenothion	48% EC	32	3100	13.2	No	No	Yes	Yes	Yes	No	No
Monocrotophos	30% EC	20	350	24.2	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phosphamidon	50% EC	15	125	13.7	No	Yes	No	No	No	Yes	Yes
Azinphos-ethyl	40% EC	13	220	15.5	No	Yes	No	No	Yes	Yes	No
Relatively safe granules											
Diazinon	5% G, 6% G, 10% G	300	460	21.9	Yes	Yes	Yes	Yes	Yes	No	No
Moderately safe granules											
γ-BHC	6% G	88	1000	9.9	No	Yes[f]	No	No	No	No	No
Endosulfan	5% G	70	350	13.3	No	Yes	No	No	No	No	No
Dangerous granules											
Carbofuran	3% G	11	10220	37.0	Yes	Yes	Yes	Yes	Yes[g]	Yes	Yes

[a]Determination of safety is based on oral LD_{50} (mean lethal dose) values. [b]WP = wettable powder, EC = emulsifiable concentrate, G = granules. [c]Technical (100%) insecticide. [d]September 1979 retail prices, sprayables – 0.75 kg a.i./ha; granules – 1 kg a.i./ha. [e]Efficacy tests on whorl maggot and stem borers were conducted in the field. Whorl maggot efficacy = damage rating of 4 or less when control = 9; stem borer efficacy = significantly fewer deadhearts than the control; brown planthopper efficacy was based on greenhouse and field trials where efficacy was ⩾ 80% mortality in the greenhouse and ⩾ 60% mortality in the field; whitebacked planthopper, green leafhopper, leaf folder and rice bug efficacy was based on greenhouse trials where efficacy was ⩾80% mortality. Rice bug efficacy data from greenhouse trial were based on manufacturers' recommended dosages. [f]Not effective against the pink stem borer. [g]If incorporated into the soil.

Seasonal distribution of rice stem borers in the Mekong Delta of Vietnam

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After the brown planthopper, the stem borer is the most destructive insect pest of rice in the Mekong Delta. Studies of the population dynamics of major insect pests of rice by the Plant Protection Department showed that *Tryporyza incertulas* was the most damaging of the four stem borer species in the area and *Chilo polychrysus* was second. From the beginning of the rainy season, at the early vegetative stage of the 1978 summer-autumn crop, *C. polychrysus* comprised 95% of the stem borer population at Cho Gao, a high yielding area of Tien Giang Province (Table 1). *Tryporyza incertulas* then gradually assumed predominance from the flowering stage of this crop (Table 2) and completely predominated later in the local crop (Jul–Dec) and winter-spring crop 1978–79 (86% of the population at Chau Thanh, Ben Tre Province and 96% of that at Cho Moi, An Giang Province.

Table 1. Distribution of stem borer [a] species in some high-yielding areas of the Mekong Delta of Vietnam.

Location	Distribution (%)			
	Chilo polychrysus	*Tryporyza incertulas*	*Chilo suppresalis*	*Sesamia inferens*
	1978 summer-autumn crop			
Cho Gao, Tien Giang	95	5	0	0
Phu Tan, An Giang	48	31	16	6
	1978-79 winter-spring crop			
Cho Gao, Tien Giang	20	54	15	11
Cho Moi, An Giang	0	96	0	4
Chau Thanh, Ben Tre	4	86	0	10
Chau Thanh, Hau Giang	32	51	0	17

[a] Mean of 100 larvae found by dissecting infested plants at 30–40 days after transplanting.

Table 2. Distribution of stem borer [a] species at 2 different stages of the 1978 summer-autumn crop and 1978-79 winter-spring crop. Mekong Delta, Vietnam.

Growth stage [b]	Distribution (%)			
	Chilo polychrysus	*Tryporyza incertulas*	*Chilo suppressalis*	*Sesamia inferens*
	1978 summer-autumn crop			
40 DT	90	8	1	0
70 DT	22	66	5	7
	1978–79 winter-spring crop			
40 DT	0	96	0	4
70 DT	50	26	11	14

[a] Mean of 100 larvae found by dissecting infested plants at 40 and 70 days after transplanting. [b] DT = days after transplanting.

The data show that competition for host plants between these predominant species is high. *Chilo polychrysus* apparently prefers the low water level of rice fields at the beginning of the rainy season and, because of its gregarious living habit, cannot tolerate the high rainfall and deep water that occur later. *Tryporyza incertulas* can even live below the water level but because it cannot stand dryness, it takes over in areas of local and deepwater rice. ■

A spray volume calculation chart for 19-, 16-, and 10-liter capacity knapsack sprayers

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Spraying is the most common method Asian rice farmers use to apply insecticides. Knapsack sprayers with 19-, 16-, or 10-liter capacities are popular. Good insect control can be achieved with contact or stomach poisons if rice foliage is covered by the spray solution.

Spraying rice is time-consuming and laborious, and requires much water. In irrigated rice areas, water is usually available in the rice field or from nearby canals. But in rainfed areas, a water source may be far away, and refilling may require many trips. Dosage calculations have been based on 1,000-liters/ha, a spray volume often stipulated in insecticide recommendations.

Recent IRRI studies, however, have shown that the stipulated amount is unrealistically high. For each application, farmers spraying 1 ha would have to refill their 19-, 16-, and 10-liter sprayers 53, 63, and 100 times, respectively. Farmers rarely do that and it is unnecessary. For example, excellent brown planthopper control can be achieved at booting with perthane sprayed at the low volume of 190 liters/ha.

But for safety, farmers are advised to apply 300–500 liters/ha to further dilute the insecticide spray. Low spray volumes (300 liters/ha) are adequate when rice plants are small (before maximum tillering) but volumes must be higher (500 liters/ha) when the rice canopy has closed.

Spray-volume calculation requires knowledge of the field area, sprayer capacity, and number of sprayerloads per field. Farmers generally possess such knowledge and a chart has been developed for use by extension workers in helping farmers improve their proficiency in insecticide application.

The following formula is used to determine the spray volume in liters per hectare:

$$\left.\begin{array}{l}\text{No. of sprayerloads)}\\ \text{per field x sprayer)}\\ \text{capacity (liters))}\end{array}\right. \times \frac{1}{\text{area of field (ha)}}$$

Calculation of spray volume for knapsack sprayers of 19-liter (5-US gallon), 16-liter (4.2-US gallon). and 10-liter (2.6-US gallon) capacities. IRRI, 1980.

Sprayerloads (no./field)	Spray volume (liters/ha) when field size is											
	0.2 ha	0.4 ha	0.6 ha	0.8 ha	1.0 ha	1.2 ha	1.4 ha	1.6 ha	1.8 ha	2.0 ha	2.2 ha	2.4 ha
19-liter capacity hackpack sprayer												
5	475	238	158	119	95	79	68	59	53	48	43	40
10	950	475	317	238	190	158	136	119	106	95	86	79
15	1425	713	475	356	285	238	204	178	158	143	130	119
20	1900	950	633	475	380	317	271	238	211	190	173	158
25	2375	1188	792	594	475	396	339	297	264	238	216	198
30	2850	1425	950	713	570	475	407	356	317	285	259	238
35	3325	1663	1108	831	665	554	475	417	369	333	302	277
40	3800	1900	1267	950	760	633	543	475	422	380	345	317
45	4275	2138	1425	1069	855	713	641	534	475	428	389	356
50	4750	2375	1583	1188	950	792	679	594	528	475	434	396
16-liter capacity backpack sprayer												
5	400	200	133	100	80	67	57	50	44	40	36	33
10	800	400	267	200	160	133	114	100	89	80	73	67
15	1200	600	400	300	240	200	171	150	133	120	109	100
20	1600	800	534	400	320	267	229	200	178	160	145	133
25	2000	1000	667	500	400	333	286	250	222	200	182	167
30	2400	1200	800	600	480	400	343	300	267	240	218	200
35	2800	1400	934	700	560	466	400	350	311	280	255	233
40	3200	1600	1067	800	640	533	457	400	356	320	291	267
45	3600	1800	1200	900	720	600	514	450	400	360	327	300
50	4000	2000	1334	1000	800	667	571	500	444	400	364	333
10-liter capacity backpack sprayer												
5	250	120	83	63	50	42	36	31	28	25	23	21
10	500	250	167	125	100	83	71	63	56	50	45	42
15	750	375	250	188	150	125	107	94	83	75	68	63
20	1000	500	333	250	200	167	143	125	111	100	91	83
25	1250	625	417	313	250	208	179	156	139	125	114	104
30	1500	750	500	375	300	250	214	188	167	150	136	125
35	1750	875	583	438	350	292	250	219	194	175	159	146
40	2000	1000	667	500	400	333	286	250	222	200	182	167
45	2250	1125	750	563	450	375	321	281	250	225	205	188
50	2500	1250	833	625	500	417	357	313	278	250	227	208

To use the chart, first determine the size of the sprayer and refer to that section designated 19-, 16-, and 10-liter capacity. To find the spray volume for 0.1- to 2.5-ha fields, refer to the column heads designating the area of the field in hectares. Along the left margin is the number of sprayerloads per field, from 5 to 50 in increments of 5. You may need to round off. Follow the appropriate row for sprayer size and column for field area to find the spray volume.

For example: • with a 19-liter sprayer and a 1.4-ha field, 30 sprayerloads/field will apply 407 liters/ha; • with a 10-liter sprayer and a 0.8-ha field, 10 sprayer-loads/field will apply 125 liters/ha. In this case, the farmer should increase his spray volume to 20 or 25 sprayerloads/ha and apply 250 to 313 liters/ha. ■

A rapid technique for estimating brown planthopper feeding activity

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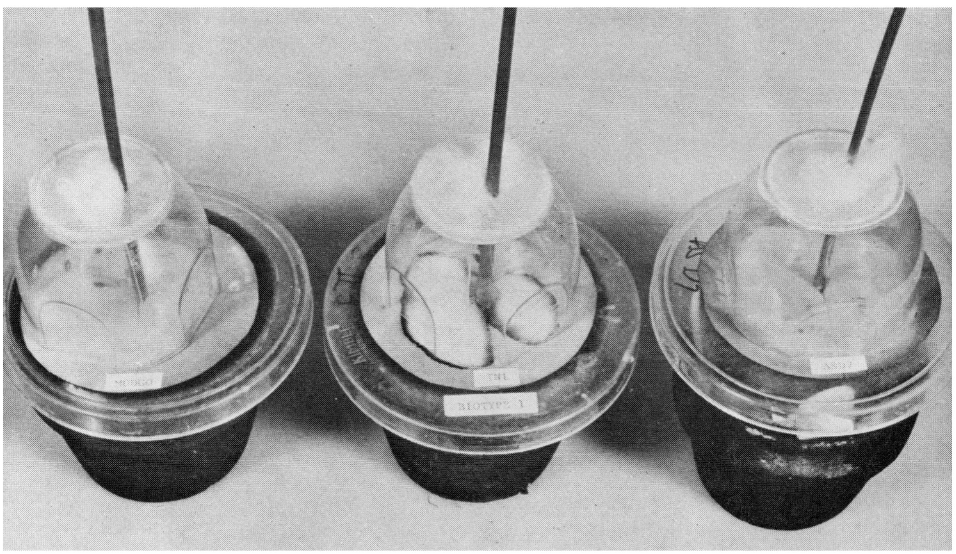
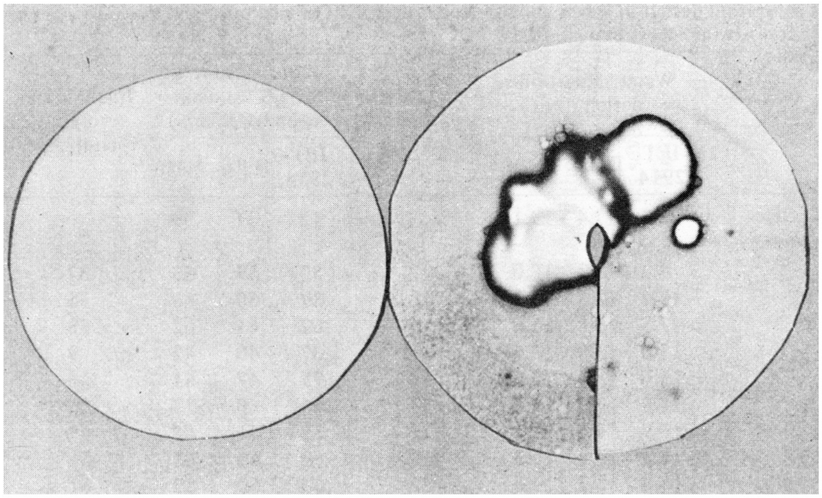
Various techniques are being evaluated to determine the level of brown planthopper (BPH) resistance in rice varieties more accurately than by screening seedlings in seedboxes. One common technique is to measure BPH feeding activity. It involves the measurement of honeydew excreted by BPH adults. The area of the spots produced by honeydew excreted on filter paper is measured. Filter paper is placed around the base of the test plant in a feeding chamber; then, 4- to 5-day-old females, previously starved for 4 or



1. Chamber used to evaluate brown planthopper feeding activity. Note the bromocresol-treated *filter paper on the inverted petri dish.*



2. Bromocresol-treated filter paper that has not (left) and that has (right) been exposed to brown planthopper honeydew.

5 hours, are allowed to feed for 24 hours. Honeydew excreted by BPH is absorbed on the filter paper. After the feeding duration, the filter paper is removed and treated with 0.001% ninhydrin in acetone solution and oven-dried at 100°C for 5 minutes. The honeydew spots appear as violet or purple because of' their amino acid content. The area of ninhydrin-positive spots is traced on paper and placed on millimeter-square graph. The squares are then counted. (Spots must be traced within a few days because they fade rapidly.)

The technique has been modified to estimate BPH feeding activity during the feeding period as the filter papers are treated before placement in the feeding chamber and spots appear as soon as the honeydew makes contact. The new technique is a modification of that used in aphid feeding studies using filter papers treated with bromocresol blue. Whatman No. 1 filter paper is impregnated twice with bromocresol green solution (2 mg/ml ethanol). The filter paper is allowed to dry for 1 hour, then re-treated with the solution. This turns the filter paper to orange. Insects are placed in the feeding chamber through a hole at the top, which is then plugged with cotton (photo 1). The filter paper is removed 24 hours later (photo 2). The stained filter paper can be stored as long as 3 months after the test, or until enough time is available to trace the spots and measure their area. The treated filter paper should not be moistened because water can cause spots to form. ■

Soil and crop management

Effect of seed pretreatment on rainfed dryland rice production and on water saturation deficit in leaves

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The effects of seed pretreatment on germinability, plant growth, and grain production in direct-seeded dryland rice were studied during three seasons from 1976 to 1979. In laboratory trials, the increases in shoot length (16 to 48%) and root length (5 to 33%) at 4 and 6 days after the start of the experiments were significant. In field experiments, the plants grown from pretreated seeds significantly outscored those from untreated seeds in plant height and population per unit area. The increases in tiller number per unit area of the pretreated vs untreated seeds (control) were 22% when seeds were pretreated

Table 1. Effects of seed treatments on grain yields of rice varieties (V) at 14% moisture. West Bengal, India.

Seed treatment (T)	Grain yields (t/ha)										
	1976				1977			1978			
	1ET 2914	Dular	IR442-58	Mean	IET 2914	Dular	Mean	IET 2914	Dular	Mean	
Control (untreated)	1.8	1.7	1.7	1.7	1.9	1.8	1.9	1.9	1.8	1.8	
Soaking in distilled water											
24 h	1.9	1.8	1.9	1.9	2.4	2.2	2.3	2.2	2.1	2.2	
48 h	2.0	1.9	2.0	1.9	2.4	2.3	2.4	2.2	2.2	2.2	
24 h double[a]	1.9	1.8	1.9	1.9	2.3	2.1	2.2	2.0	2.0	2.0	
NaCl	1.8	1.8	1.8	1.8	2.4	2.1	2.2	2.1	2.1	2.1	
NaH_2PO_4	2.0	1.9	1.9	1.9	2.4	2.2	2.3	2.2	2.2	2.2	
Na_2HPO_4	2.1	2.0	2.0	2.0	2.5	2.3	2.4	2.3	2.3	2.3	
$Al(NO_3)_3$	1.9	1.9	1.9	1.9	2.3	2.2	2.3	2.2	2.1	2.1	
$CoNO_3$	1.9	1.8	1.9	1.9	2.4	2.1	2.3	2.0	2.1	2.0	
Agromin	1.9	1.8	1.8	1.8	2.4	2.1	2.2	2.2	2.0	2.1	
Fungicide treated	1.8	1.8	1.8	2.1	1.9	2.0	2.0	2.0	2.0	2.0	
Mean	1.9	1.8	1.9	1.8	2.3	2.1	2.2	2.1	2.1	2.1	
	V	T	V x T	V	T	V x T	V	T	V x T		
S Em (±)	0.01	0.03	0.03	0.04	0.03	0.05	0.05	0.06	0.08		
CD at 5%	0.05	0.07		0.12	0.09			0.16			
CV		7.0			15.0			19.4			

[a] The 24-h soaking was repeated.

with Na_2HPO_4 (10^{-3} m) in 358 ppm solution for 6 hours; 22% with soaking in 200 ppm solution of Agromin (a chemical formulation consisting of

7 nutrient ingredients — Zn, Fe, Cu, Mn, Mg. B, Mo in chelated form) for 20 hours; and 18% with Al $(NO_3)_3$ in 200 ppm solution for 20 hours. Before planting, the treated seeds were sun-dried to their original moisture status. The increases in plant dry-matter accumulation ranged from 13 to 54%. Ash-free root weights also increased (13 to 63%); the increments over the control treatment were 63% with Na_2HPO_4, 40% with NaH_2PO_4, 40% with Al $(NO_3)_3$, and 37% with water soaking. The last treatment consisted of soaking seeds in distilled water for 24 or 48 hours and then drying to the original moisture status ("24 hours double" means that the 24-hour soaking was repeated). All seeds except those in the untreated control were treated with fungicide (Agrosan at 2 g/kg). Grain yields were 14 to 26% higher in crops raised from pretreated seeds (Table 1). The seeds were treated with NaCl (38 ppm for 6 hours), NaH_2PO_4 (156 ppm for 6 hours), and $CoNO_3$ (200 ppm for 20 hours) solutions and then dried to original moisture level. Close and significant relationships were found for grain yield and root-to-shoot ratio (r =0.86), percentage of total available carbohydrate (TAC) in roots (r = 0.90), ash-free

Table 2. Water saturation deficit in leaves and ash-free root weight of rice varieties (V) at 30-45 cm depth, 50 days after sowing. West Benzal, India.

Seed treatment (T)	Water saturation deficit (%)			Decrease (%) from control	Ash-free root wt (mg/5 cm diam cylindrical core			Increase (%) over control
	IET 2914	Dular	Mean		IET 2914	Dular	Mean	
Control (untreated)	20.9	17.4	19.1		42	37	39	
Soaking in distilled water								
24 h	19.2	12.7	16.0	17	50	57	53	37
48 h	18.2	13.3	15.7	18	87	50	68	75
24 h double[a]	17.3	13.8	15.6	19	62	61	62	58
NaCl	17.0	13.7	15.5	19	37	48	42	9
NaH_2PO_4	15.6	15.5	15.6	19	75	47	61	56
Na_2HPO_4	14.8	12.8	13.8	28	86	60	73	86
$Al(NO_3)_3$	15.9	14.5	15.2	21	52	71	61	57
$CoNO_3$	18.5	14.3	16.3	15	60	62	61	56
Agromin	16.3	13.3	14.8	23	68	50	59	51
Fungicide treated	18.0	16.5	17.3	10	62	31	46	19
Mean	15.5	14.3			63	52		
	V	T	V x T		V	T	V x T	
S Em (±)	1.0	0.7	1.2		7.4	8.1	11.5	
CD at 5%		2.0				23.0		

[a]The 24-h soaking was repeated.

deep-root weight (r = 0.79), and water saturation deficit in leaves (r = –0.66 for IET2914 and –0.74 for Dular). The relationships were also close and significant for shallow root (0–15 cm) weight and TAC content (r = 0.79); deep root (15–45 cm) weight and water saturation deficit (r = –0.78); and chlorophyll stability index and root weight (r = –0.78).

The increased vigor of the plants from pretreated seeds was due mainly to the better root growth, particularly of deep roots, which decreased the water saturation deficit (Table 2) and chlorophyll stability index values of leaves. The roots and shoots of plants from pretreated seeds also contained more TAC. ■

Time of fertilizer nitrogen application in rice culture

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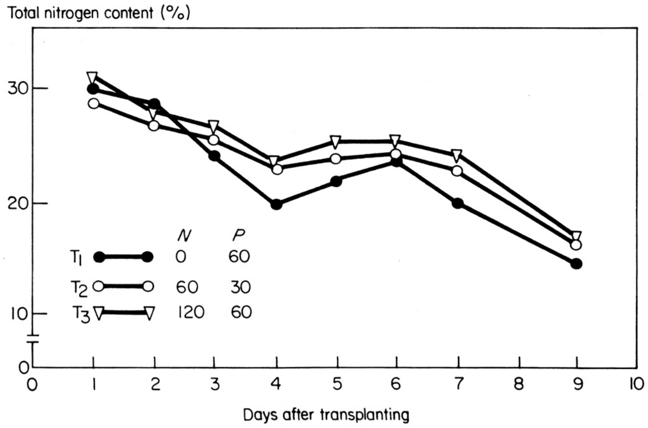
The notoriously low utilization of fertilizer nitrogen by rice is thought to be largely caused by nitrogen losses in the soil-plant system. Of the various factors that affect nitrogen efficiency, the time of application is important. After transplanting, rice seedlings take a few days to recover (the "transplanting shock period"), and then start growing. Nitrogen applied during this period may be poorly utilized by the plants and much is probably lost to leaching, denitrification, and volatilization.

A field experiment was conducted during summer (Apr-Jun), 1978, to determine the best time of first nitrogen



Relationship between nitrogen content of the rice plant and days after transplanting. Ludhiana, India.

application to rice for higher yields. The soil — Fatehpur loamy sand — had a pH of 8.1 and was low in organic carbon. After transplanting, rice seedling samples were taken daily from selected treatments for 9 days and analyzed for total nitrogen content using the Technicon Nitrogen Autoanalyzer following the 1966 technique of Warner and Jones.

The nitrogen content of rice plants tended to decrease during the first 4 days after transplanting (see figure). A gradual increase on the 5th and 6th days of sampling was followed by a sharp decline. The differential nitrogen concentration of the rice plant with time may be explained by the plant's physiology during this period. In the first 4 days after transplanting. the roots were inactive. That might have limited the plant's water and nutrient absorption as reflected in the plants' withering. and yellowing, and their reduced nitrogen content. After 4 days, plant roots recovered from transplanting shock and regulated the water and nutrient supply. That condition was indicated by a return of greenness and increased nitrogen content in the plants. After 6 days, nitrogen was appropriated in the synthesis of metabolites and for fast plant growth. During this time the nitrogen supply probably was not commensurate with the rapid plant growth; thus the nitrogen content of the plants decreased sharply because of the "dilution effect."

To increase the efficiency of fertilizer use, it may be beneficial to apply nitrogen 5 days after transplanting. This observation is supported by results of a replicated field experiment conducted on Fatehpur loamy sand in the 1978 kharif (Jul-Oct) (see table).

Comparison of basal and delayed application of first dose of nitrogen on two rice cultivars. Ludhiana, India.

Treatment [a]	Yield (t/ha)	
	Palman 579	PR106
T_1	5.4	6.4
T_2	5.7	6.6

[a] T_1 = 40 kg N/ha at transplanting + 40 kg N 3 wk after transplanting (WT) + 40 kg N 6 WT. T_2 = 40 kg N/ha at 7 days after transplanting + 40 kg N 3 WT + 40 kg N 6 WT.

The data show that application of nitrogen at 7 days after transplanting gave 0.3 t/ha more yield than its application at transplanting. Therefore, fertilizer use efficiency may be higher if the first dose of nitrogen is applied 5–7days after transplanting. But further large-scale field testing in different environments is needed. ■

Effect of fungicide seed treatment on rice seedling growth

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The seedborne nature of sheath blight disease of rice caused by *Rhizoctonia solani* Kuhn has been established. Seeds of ADT3 1 were collected from sheath blight-affected fields, treated with test fungicides, and stored in polythene bags for 3 days. The test fungicides thiophanate, captafol, fenaminosulf, triarimol, PCNB, carbendazim, captan, chloroneb, carboxin, benomyl, triphenyltin acetate, Agrosan, thiram, oxycarboxin, MEMC, chlorothalonil were used at 0.05, 0.1, and 0.2% levels. The treated seeds were tested for germination, seedling growth, and vigor. Some treated seeds were stored for 8 months and then tested for viability.

Benomyl, chlorothalonil, and carboxin increased seed germination considerably over the control. Oxycarboxin, carboxin, ehlorothalonil, and benomyl significantly increased shoot growth. Carbendazim, triarimol, captafol, thiram, oxycarboxin, chlorothalonil, benomyl, and captan at 0.2%) increased the root growth of rice seedlings. Seedlings from the treated seeds were more vigorous than the control. Seeds treated with oxycarboxin and MEMC maintained more than 90% seed viability after 8 months of storage. ■

Azolla manuring for rice

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In earlier trials Srinivasan and Pari showed that azolla incorporation 1 week before planting at 10, 20, and 30 t/ha (nitrogen levels as high as 100 kg/ha) gave yields equal to 25, 50, and 75 kg N/ha, respectively. They also found that growing azolla until harvest but without incorporation gave no beneficial effects.

Because the field cannot be kept fallow for growing azolla after the kuruvai harvest, it was decided to grow azolla among the planted crop and incorporate it after it covered the surface. Three replicated trials were laid out during 1978 thaladi with inoculum levels of 1, 2, and 3 t/ha at nitrogen levels of 0 to 100 kg/ha in slabs of 25 kg. P_2O_5 and K_2O were uniformly applied at 50 kg/ha before planting. The test variety was IR20. Azolla was sown 1 week after planting: the water level was maintained at 5 cm. The inoculum levels at 1, 2, and 3 t/ha covered the field 55, 33, and 15 days after application, respectively. Azolla was incorporated after the water was drained.

In the trial where azolla inoculum was applied at 3 t/ha, a yield increase equal to that of 25 kg N/ha was observed (see table). In trials with inoculum levels of 1 and 2 t/ha there was no appreciable yield increase because of the delayed incorporation of azolla (62 and 40 days after planting, respectively). ■

Effect of azolla manuring on grain yield of rice. Aduthurai, India.

N levels (kg/ha)	Yield (t/ha) at azolla inoculum level of		
	1 t/ha	2 t/ha	3 t/ha
0	2.9	2.8	2.9
0 + azolla	3.0	3.1	3.4
25	3.5	3.3	3.2
25 + azolla	3.5	3.5	3.6
50	3.6	3.5	3.1
50 + azolla	3.8	3.8	4.0
75	4.0	3.9	4.2
75 + azolla	4.1	4.0	4.6
100	4.4	4.3	4.7
100 + azolla	4.4	4.5	5.2
CD (P = 0.05%)	0.4	0.5	0.3

Soil loss due to roguing in rice seed production plots

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The roguing of offtypes is a standard practice in pure seed production programs. The major roguing operation takes place after flowering. Uprooting the entire plant speeds the removal of rogues, but a considerable amount of topsoil sticking to the roots is also removed from the plot in the process.

We randomly sampled rogues uprooted from our rice seed-production plots, collected them on the roadside, carefully removed the soil sticking to the roots, and later air-dried it. The soil was a red sandy loam. On weighing the air-dried soil, we noted that an average of 0.7 kg of dry soil was removed for each hill uprooted.

At a 20– × 10-cm spacing the plant population in our plots is 500,000 hills/ha. If a modest 10% of the hills are removed as rogues, the estimated soil losses would be 35 t/ha in a single crop season. To avoid this staggering loss of topsoil, we suggest that plants be rogued by cutting them close to the base. ■

Introduction of puddling, an Asian technique, in rice production in Colombia

G. A. Villegas V., rice specialist, technical manager, National Rice Growers Federation, Bogotá, Colombia

Rice production in Colombia is characterized by high yields and high production costs. In the same period that yields increased by 77% (the national average for irrigated rice is 5.5 t/ha), production costs increased by 670%, (up to about US$1,200/ha). Those trends make further yield increases difficult.

Therefore the National Rice Growers Federation (FEDEARROZ) is investigating the introduction of puddling techniques from Asia into Colombian rice Fields. In 1979 an intensive program, conducted to provide technical assistance to farmers, included help with plot design. mechanization, and crop management. About 5,000 ha are now puddled.

Puddling has increased the average yield in that area by about 7% and lowered production costs by about 20%. ■

Rice-based cropping systems

Traditional cultural practices in rainfed wetland rice cultivation in Moyna Basin, Midnapore, West Bengal, India

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Little is known about traditional cultivation practices for the traditional tall indicas cultivated in deepwater areas. In the 1977 wet season the problems and behavior of the varieties were surveyed in the 4,000-ha Moyna Bee1 basin area in Midnapore District, West Bengal. A water regime of about 1.5–2 m is usually reached in about 50% of the basin area during the peak precipitation period; the water remains stagnant for 3-4 months. The average annual precipitation is about 1,800 mm, most of which falls from June to October. Two factors govern successful rice cultivation in such lands; proper land preparation at sowing, and proper stand establishment before inundation of the rice plants.

The land in the basin area can be classified into three main water depth categories: 1.0 m, 1–1.5 m, and more than 1.5 m.

The soil in the 1.0-m depth category remains moist until March. After harvest, the stubble (91–122 cm long) is left to dry. The dry stubble is burned to destroy hibernating insects and wild rice seeds, and to facilitate tillage in the black peat soil. The presoaked seeds are then sown at 125 kg/ha and the land is plowed once and then laddered. Pregerminated seeds are then sown again at the same rate; the land is plowed again and laddered 10-12 times to level and compact the soil. Depending on soil condition, the field is further laddered until the topsoil consists of fine particles.

Land in the 1- to 1.5-m category is plowed twice and then kept fallow for 10–15 days. If there is no rain, dry seeds are sown in dry soil. The field is laddered after the rains come and germination begins. If soil moisture conditions permit, laddering is done three or four times.

Where water depth exceeds 1.5 m, dry seeds are generally sown after the harvest of the dry season crop; the land is then alternatively plowed and laddered. Dry or germinated seeds are generally broadcast, depending on the soil moisture content.

For fertilizer, Moyna Basin farmers apply bonemeal at 125 kg/ha, and decomposed farmyard manure and ash at 2.5 t/ha immediately after sowing. Progressive basin area farmers report that a rainless period of 1-1.5 months is desirable for proper soil condition and minimum weed growth. Weeding is generally practiced when water accumulates 1.5–2 months after sowing.

A good stand is usually established about 2 months after sowing, before much water has accumulated. When the crop has attained a good stand, the plants can withstand submergence and waterlogging. Average yields of 3 t/ha are common.

The following traditional varieties are predominant in the basin:

For areas where water depth is about 1.0 m: Amol, Kamod, Gaira, Bhuto, Bakui.

For areas where water reaches 1.5 m and deeper: Pankalas green, Pankalas pigmented, Tangra, Bauskata.

In the basin where water reaches 1.5 m or deeper, rice plants were uprooted and their tillering patterns and nodal rooting were studied. Tillering was from the base only and nodal roots were present. The traditional varieties can yield about 3 t/ha, provided fields are inundated about 2 months after sowing. In the past, when water in such areas had currents, varieties with nodal tillers were grown. But since channels and bunds for flood prevention had been installed, farmers have preferred basal tillering rices that yield better and are harvested more easily. ■

Early mungbean cultivars for intensive cropping before rainfed wetland rice in the Philippines

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About 57% of the total Philippine rice crop is rainfed wetland (including some nonbunded dryland fields); only about 43% is irrigated. The rainfed wetland rice areas are generally planted to a single crop of rice, although some areas grow a second crop with low management. Most of the research to intensify cropping and production of rainfed wetland rice is concentrated on the introduction of additional crops (e.g. rice, mungbean, cowpea, soybean, sorghum, and vegetables) to follow the first rice crop. The few attempts to grow upland crops before rainfed wetland rice have shown mungbean to be most promising. Other promising crops are sesame, bush sitao, and green corn.

Ten promising early-maturing mung bean cultivars were evaluated for adaptability to intensive cropping before rainfed wetland bunded rice in replicated trials at IRRI and at outreach sites in Manaoag (Pangasinan Province), and Oton (Iloilo Province). The trials were planted with high tillage in late April to early May and harvested 60-64 days later. The farmers' local variety served as the check, but at IRRI the variety CES87 was used. Yields for all locations averaged 1.1 t/ha – 144% higher than the Philippine national yield average of 450 kg/ha. CES ID-21 (released by the Philippine Seedboard as Pag-asa) yielded significantly the highest, followed by M350 (1.4 and 1.2 t/ha). Average yield was highest in Los Baños (1.4 t/ha) and lowest in Pangasinan (0.8 t/ha). The average number of days to maturity ranged from 60 to 64 days after emergence. H70-16, a selection from Burma, was the earliest; M350, CES 1K-CES 1K-25Y, and Dau Mo were the latest. CES ID-21 matures in 63 days (see table). It is resistant to Cercospora leaf spot disease and has short plant type. Multiple regression analysis showed that yield was significantly related to maturity, plant height, and disease resistance (r^2 = 0.65, r^2 = 0.66, and r^2 = 0.72. No significant relationship was found between Cercospora leaf spot and plant height, indicating that both factors controlled a different component of yield variance. ■

Yield and days to maturity of 11 elite early mungbean cultivars before rainfed wetland bunded rice at 3 Philippine sites, 1979 wet season.[a]

Cultivar	Yield (t/ha)				Maturity (days)[c]			
	Los Baños	Iloilo	Panga-sinan	Av[b]	Los Baños	Iloilo	Panga-sinan	Av
CES 1D-21 (Pag-asa)	1.5 a	1.6 a	1.1 a	1.4 a	61 c	66 ab	61 ab	63 ab
M350	1.5 a	1.3 b	0.8 bc	1.2 ab	65 a	66 ab	61 ab	64 a
CES 55	1.5 a	1.3 bcd	0.8 bcd	1.2 ab	61 c	63 c	60 b	61 ab
CES J-2Y	1.5 a	1.1 fg	0.8 b	1.2 ab	61 c	63 c	61 ab	62 ab
EG MG 174-3	1.5 a	1.2 defg	0.8 b	1.1 ab	62 b	64 c	62 ab	63 ab
H70-16	1.5 a	1.2 def	0.6 e	1.0 b	61 c	59 d	60 b	60 b
CES N-6Y	1.4 ab	1.1 fg	0.7 de	1.1 b	61 c	64 c	61 ab	62 ab
Local check[d]	1.5 a	1.0 g	0.5 f	1.0 b	61 c	67 a	61 ab	63 ab
CES 1K-25Y	1.1 bc	1.1 efg	0.7 cd	1.0 b	65 a	66 ab	62 a	64 a
MG 50-10AY	0.9 c	1.3 bc	0.8 bcd	1.0 b	61 c	59 d	66 b	62 ab
Dau Mo	0.9 c	1.2 cde	0.7 de	0.9 b	65 a	66 ab	62 a	64 a
Av	1.4	1.2	0.8	1.1	62	64	61	63
CV (%)	12.6	9.3	15.2	(a) 23.9	0.7	1.5	2.0	(a) 2.7
				(b) 12.2				(b) 1.2

[a]Any two means having a common letter in a column do not differ significantly at the 5% level. [b]Average yield and maturity were analyzed using split-plot, with location as the main plot and cultivars as subplots. [c]From emergence until harvest. [d]Local check was CES87 (recommended Philippine Seedboard variety) for IRRI, and farmers' cultivars for Iloilo and Pangasinan.

Announcements

Illustrations for translations of *A farmer's primer on growing rice* available at IRRI

Several national rice improvement programs have requested IRRI's cooperation in the translation and local printing of *A farmer's primer on growing rice.*

Therefore, IRRI is providing black-and-white prints of all illustrations and artwork in the 221-page manual, with all English text blocked out, to rice agencies interested in publishing local editions. Translations of the text can be added to the illustrations and reproduced by offset printing.

The cost is US$16/set (actual reproduction cost plus one copy of the primer plus airmail postage).

The book answers questions such as why a farmer incubates seed, why he or she applies fertilizer, or how and when that fertilizer should be incorporated. *A farmer's primer* was designed to help the progressive farmer or rice specialist understand and explain *why* and *how* the improved rice varieties and technology increase production.

Dr. Benito S. Vergara, IRRI plant physiologist, authored the handbook during a sabbatic leave at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Philippines.

Individuals or organizations in developing nations may purchase *A farmer's primer* at US$2.20/copy (postpaid, via surface mail) or at $4.30/copy (postpaid, via airmail) (₱15.50 or ₱25.50 in the Philippines). Those in highly developed nations may order the book at the price $5.20/copy (surface mail) or $7.30 (airmail).

Interested organizations may write to: Office of Information Services, International Rice Research Institute, Box 933, Manila, Philippines. ■

Major IRRI publications available as *basic sets*

Libraries or individuals in developing nations can purchase a *basic set* of IRRI books and technical publications for $240, excluding air freight. Among the set of 67 books, about 80 periodical issues, and assorted pamphlets are monographs such as *Rice improvement* and *Statistical procedures for agricultural research;* symposia and workshop proceedings such as *Soils and rice, Nitrogen and rice,* and *Brown planthopper: threat to rice production in Asia,* and a complete series (25 issues) of *International Bibliography of Rice Research,* its *Cumulative indexes,* and *International bibliography on cropping systems.*

Periodicals in the set include all issues of the *IRRI Research Paper Series* (about 50 in May 1980) and all 1979–80 issues of the *IRRI Reporter* and *International Rice Research Newsletter.*

IRRI is compiling the sets of publications mainly to help libraries in the rice-growing countries rapidly and inexpensively establish a basic collection of rice literature.

The price for highly developed nations is $600.

To help potential buyers estimate air freight charges, we list the charges for some countries: Indonesia, about $75; India, about $95; Liberia, $270; Germany, $215; and Colombia, $198.

For a pro forma invoice that includes exact air freight charges, write to Office of Information Services, International Rice Research Institute, P. O. Box 933, Manila, Philippines.

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