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Contents

Guidelines and Style for IRRN Contributors

Articles for publication in the International Rice Research Newsletter (IRRN) should observe the following guidelines and style.

Guidelines

- Contributions should not exceed two pages of double-spaced typewritten text. Two figures (graphs, tables, or photos) may accompany each article. The editor will return articles that exceed space limitations.
- Contributions should be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses should be done.
- Announcements of the release of new rice varieties are encouraged.
- Pest survey data should be quantified. Give infection percentage, degree of severity, etc.

Style

- For measurements, use the International System. Avoid national units of measure (cavan, rai, etc.).
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ ha, 2 h/d.
- Express yield data in tonnes per hectare (t/ ha). With small-scale studies, use grams per pot (g/ pot) or g/ row.
- Express time, money, and common measures in number, even when the amount is less than 10. For example: 8 min. $2, 3 kg/ha, 2-wk intervals.
- Write out numbers below 10 except in a series containing 10 or higher numbers. For example: six parts, seven tractors, four varieties. *But* There were 4 plots in India, 8 in Thailand, and 12 in Indonesia.
- Write out numbers that start sentences. For example: Sixty insects were put in each cage. Seventy-five percent of the yield increase is attributed to fertilizer.
- Place the name or denotation of chemicals or other measured materials near the unit of measure. For example: 60 kg N/ ha, not 60 kg/ ha N; 200 kg seed/ ha, not 200 kg/ ha seed.
- Use common names — not trade names — for chemicals.
- The US$ is the standard monetary unit in the IRRN. Data in other currencies should be converted to US$.
- When using acronyms, spell each out at first mention and put the specific acronym in parentheses. After that, use the acronym throughout the paper. For example: The brown planthopper (BPH) is a well-known insect pest of rice. Three BPH biotypes have been observed in Asia.
- Abbreviate names of months to three letters: Jun, Apr, Sep.
- Define in the footnote or legend any nonstandard abbreviations or symbols used in a table or figure.
- Do not cite references or include a bibliography.

Genetic Evaluation and Utilization

OVERALL PROGRESS

IRRI varieties and advanced lines used in China

C. S. Ying, China National Rice Research Institute, Hangzhou; and S. Z. Yuan, Crop Germplasm Resources Institute, Chinese Academy of Agricultural Sciences, Beijing, China

From 1971 to 1982, 3,335 varieties and advanced lines were introduced in China from IRRI. Some are highly resistant to blast (Bl) and bacterial leaf blight (BB), and have good plant type with high yield potential. Those varied lines are grown by farmers and used for rice improvement programs in China. They are IR8, IR24, IR661 selection, IR26, IR28, IR29, IR30, IR36, IR1529-680-3, IR2061-464-2-4-5, IR2061-465-1-5-5, and IR1561-228-3-3. The most widely used varieties are IR8, IR24, IR661 sel., IR26, and IR1529-680-3 (Table 1).

Many IRRI varieties have been used in rice improvement programs for conventional breeding, radiation breeding, and hybrid rice development.

Xiang-Ai-Zao is from IRg/Xiang-Ai-Zho 4. It is an early-season indica bred by the Rice Research Institute (RRI) of Hunan Academy of Agricultural Sciences (HAAS), and grown on more than 65,000 ha in 1978. Many new indica semidwarfs have been developed from IR8 parentage.

Yuan-Feng-Zao is a new variety developed by irradiating IR8 seeds with 35,000 r units of Co^{60} gamma rays. Yuan-Feng-Zao is a first-season indica with 107-110 d duration. It is suitable for large areas along the Yangtze River. It is grown on about 1,200,000 ha.

Hybrid rice is planted on about 5.3 million ha in China. Most hybrids are indicas and involved IRRI varieties as restorer lines (Table 2).

The best hybrid combinations involve the Shan-you system, especially Shan-you 6, which has resistance or tolerance to BB and tolerance to brown planthopper, and stable yield. Its restorer line is IR26. Shan-you 6 is grown as a single crop or second-season rice on about half of the hybrid rice areas along the Yangtze River. □

Table 1. Summary of data on 5 superior varieties grown in China.

Variety	Release year	Planted area (ha)	Yield potential (t/ha)	Main advantage	Main growing area
IR8	1968	913,000	7.5 to 9.0	High yielding	South, Central, and Southwest China
IR24	1973	433,000	7.50	Good plant type	Central and South China
IR661 selection	1973	62,000	7.50	Good plant type	Central and part of South China
IR26	1975	70,700	6.0 to 7.5	Highly resistant to both B1 and BB	Central China
Xiao-jia-huo (IR1529-680-3)	1975	63,000	6.0 to 7.5	Highly resistant to B1 and BB	South China

Table 2. Major combinations of indica hybrid rice grown in China.

Hybrid rice	Combination
Shan-you 2	Zhen-shan 97A/IR24
Shan-you 3	Zhen-shan 97A/IR661 Sel.
Shan-you 6	Zhen-shan 97A/IR26
Wei-you 2	V20A/IR24
Wei-you 3	V20A/IR661 Sel.
Wei-you 6	V20A/IR26
Si-you 2	V41A/lR24
Si-you 3	V41A/IR661 Sel.
Si-you 6	V41A/lR26
Nan-you 2	Er-Jiu-Nan 1A/IR24
Nan-you 3	Er-Jiu-Nan 1A/IR661 Sel
Nan-you 6	Er-Jiu-Nan 1A/IR26

Performance of some new rices in Chinsurah

S. K. Sinha and S. Biswas, Rice Research Station (RRS), Chinsurah, Hooghly 712102, India

We evaluated the performance of some new, high yielding rices in kharif and boro at RRS, Chinsurah (see table).

CN758-1-1-1, a longer duration variety, performed best in both seasons. BG367-7 and BG367-4 yielded well in kharif but not in boro. IR50 yielded well in both seasons, and has good grain type and short duration, which favor its use in a multiple cropping sequence.

Performance of rice varieties in kharif and boro at RRS, Chinsurah, India.

Variety	Seedling mortality [a] (%) in boro	Grain yield (t/ha) kharif	Grain yield (t/ha) boro	Grain type
CN758-1-1-1	0	5.5	5.8	Long slender
CN8341-1-3-7	0	4.8	4.3	Long slender
IR50	50	4.8	5.1	Long slender
BG361-7	0	5.1	4.2	Long bold
BG367-4	5	5.2	4.1	Long bold
IR9209-48-3-2	0	4.3	3.4	Long slender
HPU741	0	3.6	4.4	Long slender
KPG14	0	3.5	4.8	Long slender
IET6155	0	4.1	4.5	Long slender
IET6988	0	3.9	4.7	Medium slender
HPU71	0	3.6	3.4	Long slender

[a] Seedling mortality in kharif was zero.

Cold was a major constraint to IR50 in boro. Almost all IR50 seedlings turned yellow-brown and about 50% died of cold. The problem is being combatted by doubling the boro seed rate. Cold also increased seedling mortality after transplanting, but seedlings regained normal color as temperature increased during the growing season. BG367-7 and BG367-4 seedlings were slightly discolored, but seedling mortality was not significant. Cold did not affect seedlings of other varieties.

Varietal grouping by days to 50% flowering showed no significant differences between IR50, BG367-7, BG367-4, and IR9209-48-3-2 in kharif, but days to 50% flowering changed in boro. Flowering of IR50, IET6988, and HPU71 was delayed in boro. BG367-7 and IET6155 flowered earlier in boro than in kharif. □

High yielding rices Paiyur 1 and PY1

K. Ganesan, W. W. Manuel, and C. K. Rajagopalan, Paddy Experiment Station (PES), Ambasamudram 627401, Tamil Nadu, India

We evaluated the yield potential of new rice varieties Paiyur 1 and PY1 at PES, Ambasamudram, in 1981-82 and 1982-83. Paiyur 1 (IR1721-14/IR1330-3-3-2) and PY1 (IR8/Ponni) yielded 4.5 t/ha, 8% more than Mashuri, the locally popular high-yielding rice (Table 1, 2). Paiyur 1 and PY1 are tall with medium-slender white rice. They have been recommended for general cultivation in Tamil Nadu in Sep-Oct. □

Table 1. Performance of Paiyur 1 at Ambasamudram, India.

Variety	Grain yield [a] (t/ha) 1981-82 MLT	1981-82 ART	1982-83	Flowering time (d)	Plant ht (cm)	Panicles/hill	Panicle Wt (g)
Paiyur 1	5.2	4.3	3.9	105	123	5	1.7
IR20	3.1	3.3	2.8	97	89	5	1.3
Mashuri (Ponni)	4.4	3.9	4.0	105	124	6	1.4
Mean + SD	4.5						
CD (P= 0.05)		0.5	0.8				

[a] MLT = multilocation trial, ART = adaptive research trial.

Table 2. Performance of PY1 at Ambasamudram, India.

Variety	Grain yield (t/ha) 1981-82	Grain yield (t/ha) 1982-83	Flowering time (d)	Plant ht (cm)	Panicles/hill	Panicle wt (g)
PY1	5.1	3.9	107	112	5	2.0
IR20	3.8	2.8	101	90	6	1.3
Mashuri (Ponni)	4.3	4.0	107	120	4	1.6
CD (P = 0.05)	0.8	0.8				

Performance of IET7564, a short-duration culture

J. Venkatakrishnan, P. Vivekanandan, K. N. Pillai, and D. S. Aaron, Paddy Experiment Station (PES), Tirur 602025, Tamil Nadu, India

IET7564 (IRAT8/N22) is a 100-d variety developed at the All India Coordinated Rice Improvement Project, Hyderabad. It has a medium-fine, white grain. It was tested at PES for suitability for sornavari season.

IET7564, IET7566, IET7613, and IET4786 were sown on 20 May 1983 transplanted on 17 Jun, and harvested in Sep. Checks were TKM9, IR50, ADT36, and PY2. NPK was applied at 100-50-50 kg/ha. TKM9 yielded highest and IET7564 lowest (see table). □

Grain yield and duration of rices grown in 1981 sornavari, Tirur, India.

Variety	Grain yield (t/ha)	Duration (d)
TKM9	5.6	111
IR50	5.1	113
ADT36	5.0	117
IET4786	4.6	118
PY2	4.6	108
IET7566	4.0	113
IET7613	3.6	113
IET7564	2.6	100

TKM9

P. Vivekanandan, J. Venkatakhrishnan, K. N. Pillai, and D. S. Aaron, Paddy Experiment Station, Tirur, Tamil Nadu, India

TKM9 has short bold, red unscented grains. Amylose content is 25% with low gelatinization temperature and high alkali digestion. The variety has some sheath blight resistance.

In 1982, TKM9 was entered in the International Testing Program trials to test its performance in the International Rice Yield Nursery very early group. It was evaluated with 25 elite breeding lines and IR50 (international check) at 22 sites in 11 countries. TKM9 yielded an average 4.6 t/ha and ranked third following IR50 and IR9729-67-3 (Table 1).

Table 1. TKM9 performance in international yield trials, Tamil Nadu, India.

Variety	Av yield (t/ha)	Av days to flowering
IR50	4.9	86
IR9729-67-3	4.8	80
TKM9	4.6	84
BG367-7	4.6	84

Table 2. TKM9 performance in India and Bangladesh.

Variety	Av yield (t/ha)	Av days to flowering
TKM9	4.6	82
BG367-7	4.4	80
IR15429-268-1-2-1	4.4	75
IR9729-67-3	4.4	76
IR50	4.4	82

At 8 sites in India and Bangladesh, TKM9 yielded better than IR50 with 4.6 t/ha (Table 2). IR9729-67-3, IR50, and TKM9 either produced the highest or were statistically equal to the highest yielders in more than 10 of 22 sites. □

Genetic Evaluation and Utilization
DISEASE RESISTANCE

Varieties with different resistance to tungro (RTV) and green leafhopper (GLH)

G. Dahal and H. Hibino, Plant Pathology Department, IRRI

We tested eight RTV-resistant varieties, with varying levels of resistance to vector GLH *Nephotettix virescens,* for reaction to rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) and their vector. TN1 was the susceptible check.

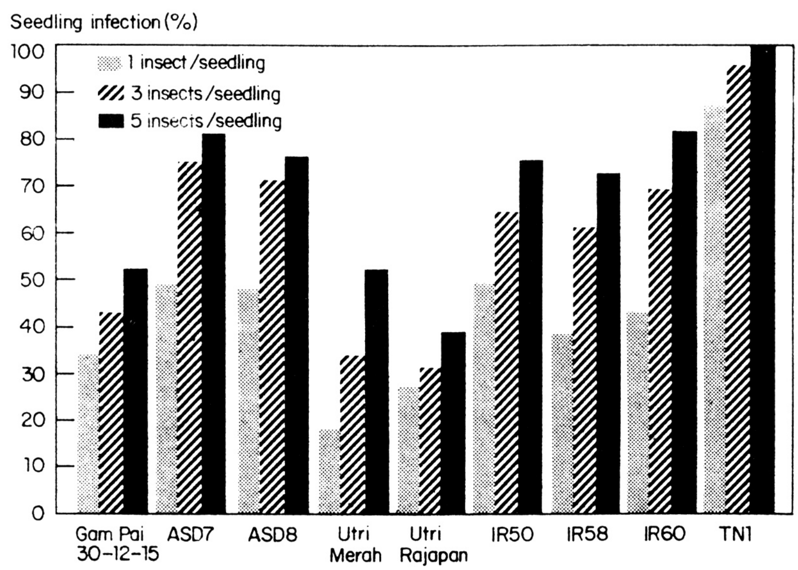
Reaction to GLH was evaluated by preference, percent nymphal survival, adult life span, and feeding site. Feeding site was determined by the color reaction of honeydew spots on filter paper treated with bromocresol green.

Reaction to viruses was determined by inoculating 1-wk-old seedlings with 1, 3, or 5 GLH from RTBV- and RTSV-infected TN1 plants. Seedling infection percentage was scored by visual observation and infected seedlings were tested by latex test using antisera 1 mo after inoculation.

Utri Merah, Utri Rajapan, and TNl were preferred by GLH; the hoppers had high nymphal survival and long life span (Table 1). GLH preferred IR60, but had high mortality and short life span on that variety. ASD7 and ASD8 were least preferred and GLH on them had low nymphal

Table 1. Reaction of 9 rice varieties to GLH, IRRI.

	Preference	Nymph survival (%)	Average life span	Feeding site
Gam Pai 30-12-15	No	Low	Short	Xylem
ASD7	No	Low	Short	Xylem
ASD8	No	Low	Short	Xylem
Utri Merah	Yes	High	Longer	Xylem, phloem
Utri Rajapan	Yes	High	Longer	Xylem, phloem
IR50	No	Low	Short	Xylem
IR58	No	Low	Short	Xylem
IR60	Yes	Low	Short	Xylem
TN1	Yes	High	Longer	Xylem, phloem



Seedling infection percentage of 9 rice varieties inoculated in the test tube with 1, 3, or 5 GLH exposed to TN1 plants infected with RTBV and RTSV.

survival and shorter life span. GLH fed on xylem in all varieties tested. However, they also fed on phloem in Utri Merah, Utri Rajapan, and TN1.

Regardless of the number of GLH inoculated, Utri Merah, Utri Rajapan, and Gam Pai 30-12-15 had low seedling infection (see figure). Most seedlings of the test varieties, except TNl, were infected with RTBV alone (Table 2). However, a few seedlings of Gam Pai 30-12-15, Utri Rajapan, IR50, IR58, and IR60 were infected with both RTBV and RTSV.

Although most RTV-resistant varieties also have GLH resistance, Utri Rajapan and Utri Merah were GLH susceptible despite strong RTV resistance. They can be a good source of RTV resistance because their resistance may be stable and consistent. □

Table 2. Presence of RTBV and RTSV in RTV-infected seedlings in the fire.

Variety	Plants tested [a] (no.)	Plants (no.) with viruses [b]		
		RTBV + RTSV	RTBV	RTSV
Gam Pai 30-12-15	30	2	25	0
ASD7	30	0	25	0
ASD8	30	0	23	0
Utri Merah	30	0	25	0
Utri Rajapan	25	1	22	0
IR50	30	1	24	0
IR58	30	4	24	0
IR60	30	5	24	0
TN1	30	18	2	0

[a]The test plants were inoculated plants with 1 or 3 or 5 insects per seedling. [b]Presence of viruses was detected 4 wk after inoculation.

Reaction of rice varieties to sheath blight (ShB)

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ShB has become a serious rice disease in much of India. In 1982 and 1983 kharif we screened rices for ShB resistance under lowland and rainfed upland conditions. Seedlings were planted in two 2-m-long rows at 20- × 15-cm spacing. Each test variety was surrounded by highly susceptible Pankaj and Jaya. At tillering stage, the test plants were inoculated just above the water level with a pure culture of ShB. Reactions were recorded using the Standard Evaluation System for Rice (SES).

IR8, IR42, IR32, Shangsanba, Tumai Angouba, Milyang 58, and Suweon 294 had ShB resistance (see table). Varieties were more susceptible to ShB under rainfed upland conditions. □

Reaction to ShB of rice varieties under lowland and rainfed upland conditions, Wangbal, India.

Score [a]	Varieties	
	Lowland conditions	Rainfed upland conditions
0	IR8, IR42, IR46, IR32, KD-2-6-3 (Moirangphou/Lawagin), Acham, Shangsanba, Tumai Angouba, Milyang 58, Suweon 294	IR8, IR42, IR32, Shangsanba, Tumai Angouba, Milyang 58, Suweon 294
1	–	KD-2-6-3, IR46, Acham
3	US2, IR840-85, Milyang 54, Suweon 287, IR1561-228-3-1, RP9-4, RP-8-9, Punshi, Phou-oibi	–
5	IR1421-11, IR350, RPW-6-13, Tetep, Tadukan	–
7	IR54, IR34, IR43, CR238-27-40-28	Milyang 54, Suweon 287, IR840-85, Tetep, Tadukan, IR1421-11, IR34, IR43
9	Pankaj, Jaya	RP8-9, RP-9-4, US2, CR238-27-40-28, Punshi, Phou-oibi, Pankaj, Jaya, IR54, IR350, RPW6-13, IR1561-228-3-1

[a]By the 1980 SES.

BG90-2 released in China

C. S. Ying, China National Rice Research Institute, Hangzhou; and H. Jiang, Jiangsu Provincial Academy of Agricultural Sciences, Nanjing, China

The first formal rice germplasm exchange between the People's Republic of China and IRRI was in 1972. Since then many varieties and advanced lines from IRRI and other countries have been sent to China. One of those varieties and lines is BG90-2 from Sri Lanka. In 1983, BG90-2 was grown on about 140,000 ha in Jiangsu Province and other provinces in the Nanjing region along the Yantze River. This area produces more than 50% of the midseason rice grown in China.

BG90-2 has high, stable yield potential with normal fertilization, yielding 6.7 to 7.5 t/ha. It yields l0-15% and 7-10%

Morphoagronomic characteristics of BG90-2 at different sites in China.

City, province	Plant ht (cm)	Growth duration (d)	Seeding to full heading (d)	Panicle length (cm)	Grains/ panicle	Fertile grains/ panicle	Sterility (%)	1,000-seed wt (g)
Nanjing, Jiangsu	113	154	115	26	161	128	20.3	26.6
Hangzhou, Zhejiang	104	136	105	29	234	134	42.8	25.9
Changsha, Hunan	96	131	107	28	140	105	25.0	25.8
Guangzhou, Guangdong	109	146	–	24	133	90	32.0	26.0

more than the local modern improved variety Nanjing 11 and hybrid Nanyou 6.

BG90-2 has high, stable BB resistance, and is a source of BB resistance in breeding programs. It is one of 12 best resistant sources among 10,688 accessions screened by the Plant Protection Institute of the Guangdong Provincial Academy of Agricultural Sciences. BG90-2 also has good morphoagronomic characters (see table). □

New sources of resistance to major rice diseases

W. W. Manuel, K. Ganesan, C. K. Rajagopalan, and A. Mariappan, Tamil Nadu Agricultural University (TNAU), Paddy Experiment Station, Ambasamudram 627401, Tamil Nadu, India

We evaluated 46 rice varieties at TNAU, Coimbatore, for reaction to brown spot (BS), bacterial blight (BB), and sheath rot (ShR) under artificial screening conditions using the Standard Evaluation System for Rice. AS18699 and AS19703 had multiple disease resistance (see table). □

Reaction of rice varieties to BS, BB, and ShR, Coimbatore, India.

Variety	Reaction [a]		
	BS	BB	ShR (% infection)
AS688	5	5	2
AS6520	3	3	10
AS18696	5	3	NT
AS18699	3	3	9
AS19103	3	3	2
AS19789	5	5	4
AS19903	5	3	NT
AS22954	3	5	NT
AS23598	5	3	15
AS23972	3	5	7

[a] 3 = moderately resistant, 5 = moderately susceptible, 7 = susceptible; NT = not tested.

Reaction of ASD varieties to various rice diseases

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In 1983-84, 15 rice varieties released by the Paddy Experiment Station, Ambasamudram, were screened for disease resistance by artificial inoculation in the greenhouse at TNAU. Varieties were evaluated for resistance to brown spot (BS), bacterial blight (BB), sheath rot (ShR), blast (Bl), and rice tungro virus (RTV) using the Standard Evaluation System for Rice (SES). ASD5 and ASD11 had multiple disease resistance (see table). □

Disease resistance of ASD varieties, Coimbatore, India.[a]

Variety	Disease rating [a]				
	Bl	BS	BB	RTV	ShR
ASD1	3	5	5	5	5
ASD2	3	5	5	5	3
ASD3	3	5	7	5	3
ASD4	5	5	7	5	3
ASD5	3	3	3	1	3
ASD6	3	5	3	5	3
ASD7	5	3	5	5	3
ASD8	5	5	5	5	5
ASD9	5	3	5	3	3
ASD10	5	5	5	3	5
ASD11	3	3	3	3	3
ASD12	3	5	5	3	3
ASD13	NT	3	3	NT	NT
ASD14	7	3	5	3	5
ASDl5	7	5	7	5	5

[a] By the 1980 SES scale: 0-3 = resistant, 5 = moderate, 7 = susceptible, 9 = highly susceptible, NT = not tested.

Reaction of IR varieties to rice yellow dwarf (RYD)

R. D. Daquioag and H. Hibino, Plant Pathology Department, IRRI

Reactions of 26 IR varieties to RYD infection were tested in the greenhouse. Newly emerged *Nephotettix virescens* nymphs had 25-d acquisition access on RYD-infected TN1 plants. Six-day-old seedlings were confined with 2 viruliferous insects per seedling in test tubes for 1 d. Inoculated seedlings were transplanted in clay pots, kept in screened trays, and scored 40-60 d after inoculation. Percentage infection of IR varieties was 20-76%. TN1 was 97% infected. Six IR varieties had RYD infection lower than 30% and were considered resistant (see table). □

IR varieties with low percentages of RYD infection, IRRI, 1984.

Variety	Total tested [a] (no.)	Plants infected (%)
IR7	108	20
IR24	104	24
IR26	102	24
IR29	104	25
IR30	100	27
IR43	107	21
TN1 (check)	95	97

[a] Based on 6 trials, each involving 20 seedlings/variety.

Genetic Evaluation and Utilization

INSECT RESISTANCE

Behavior of two green leafhopper (GLH) colonies on three rice varieties

H. R. Rapusas, J. M. Chen, and E. A. Heinrichs, IRRI

We sought to determine if selection of a GLH *Nephotettix virescens* biotype on a variety with a major gene for resistance results in cross adaptation to another variety with the same major resistance gene.

The response of two GLH colonies—one from susceptible TN1 and selected on moderately resistant TAPL #796 for 18 generations, and another reared on TN1 for at least 100 generations—was determined based on survival, development period, and growth index on varieties TAPL #796, IR36, and TN1. TAPL #796 and IR36 have the *Glh* 6 gene for resistance.

Thirty-day-old potted plants of the test varieties were enclosed with 10- × 90-cm mylar film cages and arranged in a randomized complete block design on a water tray in the greenhouse. Each variety was replicated 10 times with 1 pot equaling 1 replication.

Plants in each cage were infested with 10 first-instar GLH nymphs from the respective colonies and regularly observed for the emergence of adults. When adults emerged, the date was recorded and the insects were counted and removed from the cage once a day until adult emergence was complete. The total number of adults that emerged from each cage was determined and percentage survival was computed as

$$\frac{\text{number of adults that emerged}}{\text{number of nymphs infested}} \times 100$$

The mean developmental period (1st instar to adult) on each variety was calculated and the growth index was computed as

$$\frac{\text{\% survival}}{\text{mean development period (d)}}$$

Survival of the TAPL #796 was significantly higher than that of the TN1 colony on TAPL #796 (see table). There was no significant difference between the two colonies on IR36 and TN1, and survival of the TAPL #796 colony on TAPL #796 and IR36 did not differ significantly. Development of the TAPL #796 colony was significantly shorter than that of the TN1 colony on TAPL #796 and IR36, but no difference was observed on TN1. The growth index of the colonies significantly differed only on TAPL #796. The growth index of the TAPL #796 colony was significantly higher on TAPL #796 than on IR36.

Survival, development period, and growth index of 2 GLH colonies on 3 rice varieties,[a] IRRI.

Variety	Survival (%)		Development period (d)		Growth index	
	TAPL #796	TN1	TAPL #796	TN1	TAPL #796	TN1
TAPL #796	90.0 ab	50 c	15.5 c	20.0 a	5.80 a	2.57 b
IR36	57.5 bc	74 abc	17.5 b	19.9 a	3.27 b	3.73 b
TN1	88.0 ab	100 a	14 c	15.8 c	6.04 a	6.12 a

[a] Under each parameter, means followed by a common letter are not significantly different at the 5% level.

The results indicate a degree of insect adaptation to TAPL #796 after 18 generations on the variety. Although TAPL #796 and IR36 have the same gene for GLH resistance, these varieties may have different levels of resistance to the insect or may possess minor genes, which result in little cross adaptation, as indicated by the differences in the reaction of the TAPL #796 colony. □

A new brown planthopper (BPH) resistant rice for Pondicherry, India

M. Bhagavandoss, B. Rajendran, S. Chelliah, and R. S. Purushothaman, Krishi Vigyan Kendra, Pondicherry, India

Land in the Union Territory, Pondicherry, is intensively cropped with a rice-based multiple cropping system, which has increased pest problems. BPH *Nilaparvata lugens* is a major pest from Jun to Sep, and causes 30-40% damage to the rice crop. Recommended controls have not solved the problem. Almost all varieties grown are highly susceptible to BPH.

We identified BPHR-5 (IR13427-45-2) as having BPH resistance and good yield potential. BPHR-5 is a multiple cross of IR3403-267, IR36, and Ptb 33, and is rated 3 for BPH resistance, based on the Standard Evaluation System for Rice (SES).

BPHR-5 is a medium-dwarf, 95-cm-tall variety. Tillers are semierect, compact, and lodging resistant. It matures in 115-120 d when transplanted and grows well in navarai and sornavari seasons. The boot leaf is slightly broad and semierect with late senescence. Grains are coarse, long-slender, with a 5.28 length-breadth ratio. They are opaque white and 1,000 weight is 25 g. BPHR-5 yields 4.8 t/ha in farmer fields and produces better than other varieties tested (Table 1, 2). In one area with heavy BPH pressure, BPHR-5 yielded 5.8 t/ha versus 0.0 for Vaigai and 0.2 for PY2.

After performance trials, BPHR-5 was approved for release as BPH-resistant variety Pondicherry 3 (PY3) by the State Seed Subcommittee of Pondicherry. □

Table 1. BPH resistance and yield potentials of BPHR-5 in Pondicherry, India.

Site	Yield (t/ha)				Resistance to BPH[a]			
	BPHR-5	IR50	Vaigai	PY2	BPHR-5	IR50	Vaigai	PY2
Lawspet	5.8	–	–	2.1	3	9	9	5
Adingapattu	5.9	–	4.7	–	1	–	3	–
T. N. Palayam	6.8	5.4	–	5.5	1	3	–	3
Mettupalayam	5.1	–	4.5	5.0	3	–	3	3
KVK Farm	5.2	3.7	1.1	4.5	1	5	7	3

[a] By the 1980 SES scale.

Table 2. Mean yield of BPHR-5 in outstation trials, Pondicherry, India.

Site	Yield (t/ha)	
	BPHR-5	Vaigai
Bhavanisagar	7.3	5.7
Ambasamudram	4.6	4.6
Paiyur	4.2	4.1
Perumangudi	6.8	–
Vilangudi	7.5	–
Viswanathapuram	6.7	–

Evaluation of rice cultivars for yellow stem borer (YSB) resistance

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We screened 44 rice cultivars for field resistance to YSB *Scirpophaga incertulas* Walker in 1983-84. On 27 Jul, 37-d-old seedlings were transplanted in 3- × 1.5-m subplots at 20- × 20-cm spacing. There were 7 rows and 15 plants/row for each entry. Deadhearts were counted 55 d after transplanting and whiteheads just before harvest. Infestation was scored, using the 1980 Standard Evaluation System for Rice. Basmati 370, the susceptible check, developed 37.8% deadhearts and 60% whiteheads.

Only IR13639-34, BG276-5, and DR83 were moderately resistant (see table). Varieties were more susceptible to whiteheads than to deadhearts. □

Reaction of rice cultivars to YSB, Sind, Pakistan.

Cultivar	Deadheart score	Whitehead score
B441-B-126-3-2-1	5	7
B2850-B-SI-2-3	7	7
IR13635-8	3	9
IR13635-45	1	7
IR13639-34	1	3
IR13639-37	1	7
IR13641-33	1	9
IR19632-174	1	7
IR19362-183	5	9
AusBalam	3	7
RNR74802	1	7
IR1552	3	7
UPR103-44-2	1	9
Chianung Sen Yu 23	3	9
IR19782-2-3-3	1	5
CO21	1	7
DM27	1	7
IR8608-75-3-1-3	1	7
IR29	1	7
B4069C-Sm-162-2-1	1	9
B414c-Sm-162-2-1	1	9
Chianung Sen Yu 28	1	9
IR25588-32-2	1	5
IR26621-105-2-1-2	1	5
IR9782-111-2-1-2	1	7
IR9852-22-3	1	7
Nanjing 22-3	1	9
R22-2	1	9
SI-PI-682144	1	7
SI-PI-693033	1	5
SI-PI-692106	1	9
Suweon 294	1	5
TNAU633	1	9
UPR254-24-1	1	7
UPR79-106	1	5
BR160-2B-4-8-HR16	0	5
PNA237-F4-130-1	1	5
PNA237F4223-1	3	7
RP1890-418-241	1	7
BG276-5	1	3
DR83 (IR2053-261-2-3)	1	3
Sind Basmati (Lateefy)	3	9
IR6	1	9
IET4094 (DR82)	1	7

Field screening for resistance to leaffolder (LF)

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LF *Cnaphalocrocis medinalis* is a serious rice pest in Tamil Nadu, particularly after high N application. We developed a field screening technique to evaluate rices for LF resistance.

Fields were bordered by coconut trees and partly shaded. A basal application of 60-26-41 kg NPK/ha was incorporated before planting. Five border rows of susceptible CO 36 were planted at 20- × 60-cm spacing. Alternate 5-m-long rows of test entries and CO 36 were planted at 10 cm hetween-plant spacing. One row of resistant TKM6 was included in each replication. Fifteen days after planting, phorate granules at 1.0 kg ai/ha were applied to the susceptible border rows. The experiment was in a randomized block design with five replications.

Reactions of rice accessions to LF infestation in the field, Coimbatore, India.

Accession	Damage rating[a]
ARC6650	1 a
ARC10550	1 a
Ptb 33	1 a
TKM6	1 a
IR4707-106-3-2	3 a
Muthumanikam	3 a
W1263	3 a
V. P. Samba	3 a
GEB24	3 a
T7	3 a
CO 36	9 b

[a] Means of 5 replications. Means followed by a common letter are not statistically different at 5% level by DMRT.

Sixty kg N/ha in split doses was applied to induce LF infestation. When the CO 36 had at least 50% infested leaves, test entries were rated on a 1-9 scale (see table).

Applying phorate granules induced 100% LF infestation in CO 36. Utilizing ARC10550, IR4707-106-3-2, Muthumanikam, V. P. samba, and T7 as donors, breeding lines with LF resistance were developed at Coimbatore and are being evaluated at different centers. □

Genetic Evaluation and Utilization
ADVERSE SOILS TOLERANCE

Performance of rice genotypes in coastal saline soils

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Rice genotypes traditionally grown in coastal saline soils may have poor yield potential but may contain valuable genes for salinity tolerance.

We evaluated 23 genotypes collected from coastal saline areas of Balasore and Puri districts, Orissa, for salt tolerance and grain yield in Jun-Nov. In 1982, 23 genotypes and the local check CSR6 were transplanted in a randomized complete block design with 3 replications. The mean ECe at transplanting was 9.7 dS/m and that of standing water (15 cm) 4.4 dS/m. At flowering, salinity of soil at 15 cm ranged from 6.7 to 9.3 dS/m.

Plant survival ranged from 53% for Ratnachuri to 98% for CSR6. Survival of Patini, Katkichandi, Patnai, Velki, and Valuki was similar to that of CSR6. Spikelet sterility, a common problem in saline soils, ranged from 14.5 (CSR6) to 50.4% (Pakhira). Velki (15.0%), Valuki (15.9%), and Patini (16.5%) had spikelet sterility near that of CSR6. In 1983, the trial was repeated with nine genotypes and check varieties CSR1, CSR3, and CSR6. In situ soil salinity ranged from 4.5 to 5.4 dS/m at flowering. Panicle length of Panionla (28.0 cm) was significantly high but similar to that of Chakra kunda (27.2 cm) and CSR6 (27.7 cm). Rhas Panjara produced the most (141) spikelets/panicle, followed by Chakra kunda (139), Panionla (133), Patini (131), and CSR6 (113). Spikelet sterility was lowest for Velki (12.8%), Valuki (13.1%), CSR1 (14.7%), and CSR6 (15.9%) and maximum for Panionla (35.8%).

Although Valuki yielded highest (3.4 t/ha), it was similar to Velki (3.4 t/ha) and CSR6 (3.2 t/ha), indicating their suitability for cultivation in rainfed, coastal saline fields.☐

Genetic Evaluation and Utilization
DEEP WATER

Performance of some rice plant types under two water depths

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We sought to identify suitable rice varieties and lines for double- and single-cropped lowlands in Kolleru. Flooding occurs annually and rice must tolerate 30- to 100-cm water depths.

Growth duration and plant height of 10 tall and short varieties and lines were evaluated at 5- (control) and 60-cm water depths in 1983 kharif. Plots were flooded 40 d after transplanting and water depth was maintained for 75 d.

At 60-cm depth, plant height increased from 8 to 36 cm over the control, depending on variety. Grain yield was 1.0 to 2.3 t/ha at 60 cm and 4.0 to 6.0 t/ha in the 5-cm plots (see table). Growth duration increased from 4 to 17 d as compared with the control.

Grain yield and characters of rice varieties for deep water areas, 1983 kharif, Pulla, Andhra Pradesh, India.

Variety	Grain yield (t/ha)	Flowering duration (d)			Plant ht (cm)		
		60 cm	5 cm	Increase over control (%)	60 cm	5 cm	increase over control (%)
PLA1100	2.3	152	135	17	138	110	28
IET6314	1.9	134	124	10	149	113	36
MTU5293	1.9	135	132	3	133	119	14
IET5656	2.0	135	131	4	150	124	26
Pankaj	1.9	145	133	12	148	130	18
CN540	1.9	130	121	9	164	142	22
NC492	2.2	139	130	9	182	174	8
Swarna	1.5	131	123	8	139	109	30
MTU7633	1.3	131	127	4	134	106	28
IR42	1.0	131	115	16	118	108	10

We found IET5656, IET6314, MTU5293, and CN540 of appropriate duration for double-cropped lowlands, Pankaj , PLA1100, and NC492 can be single-cropped. MTU5293 is a brown planthopper-tolerant variety. ☐

Pest Control and Management
DISEASES

Polyethylene mulching to control sheath rot (ShR)

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We found that 7 d of mulching with transparent polyethylene sheets killed *Sclerotium oryzae,* which causes ShR, and increased rice yield.

In May 1980-83 at RRI, 3- × 1-m plots of wet soil with 80-90% of moisture holding capacity and pH 7.2 were covered with 400-µm-thick transparent polyethylene sheets. After 7 d, the plastic mulch was removed, and IR6 was transplanted in 1980 and Jhona in 1982 and 1983. The experiment was in a ran-

Effect of polyethylene mulching on ShR infestation, number of culms, disease severity index, and yield, Kalashah Kaku, Pakistan.

	Nonmulched			Mulched		
	1980 (IR6)	1982 (Jhona)	1983 (Jhona)	1980 (IR6)	1982 (Jhona)	1983 (Jhona)
No. of culms/hill	21	12	9	21	11	10
Disease severity index	2	1	1	1	1	1
Yield (t/ha) after 7-d mulching	3.6	3.8	1.4	4.4	3.9	1.7
Yield difference after mulching (t/ha)				0.8 or 22.8%	0.2 or 7.5%	0.4 or 23%

domized block with four replications. A control plot was maintained without polyethylene mulch. The crops received normal management and rice was harvested after 5 mo.

Mulching eliminated the natural population of 11 sclerotia/g soil. Loss of sclerotia viability corresponded with an increase in soil temperature from 36°C (nonmulched) to 48°C (mulched) at the 5-cm depth, and from 32°C (nonmulched) to 38°C (mulched) at 20-cm depth.

Plastic mulching increased rice yield 23% over the control (see table). There was no significant difference in the number of culms and in disease severity index. □

Phage sensitivity and lysotype distribution of *Xanthomonas campestris* pv. *oryzicola*

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Bacteriophages (phages) of plant pathogens are useful tools for detecting bacteria and differentiating them into strains based on sensitivity to lysis of the phage. Phage-typing of tropical *X.c.* pv. *oryzicola,* the bacterial leaf streak (BLS) pathogen, has identified various natural lysotypes. Differences in phage-host interaction and distribution were also reported. We studied changes in the phage population of *X.c.* pv. *oryzicola.*

The sensitivity of 44 isolates to 10 phages collected at IRRI was determined by a spot test. One ml of the test bacterial suspension, obtained from a 48-h culture, was mixed with 10 ml of PSA and aseptically seeded in petri plates. Phage suspensions were independently spotted on the seeded medium with a pipette. After 24 h, positive and negative reactions were recorded.

Based on phage sensitivity, the isolates of *X.c.* pv. *oryzicola* were differentiated into 18 lysotypes (see table). Only BLS37, BLS45, BLS93A, and BLS51 isolates were resistant to the phages. They were collected in Isabela, Nueva Ecija, IRRI, and Camarines Sur. Our findings differ from those reported for the Philippines in the 1960s. □

Lysotypes of *X. c.* pv. *oryzicola* differentiated by phage reaction, IRRI.

Lysotype	Bacteriophage reaction [a]										Host bacterial isolate
	1	2	3	4	5	6	7	8	9	10	
A	+	+	+	+	+	+	+	+	+	+	BLS1, BLS126
B	+	+	+	+	+	+	+	+	–	+	BLS3, BLS119, BLS125
C	+	+	+	–	+	+	+	+	+	+	BLS56, BLS101, BLS128
D	+	+	+	+	+	+	+	+	+	–	BLS22
E	+	–	+	+	+	–	+	+	+	+	BLS124
F	–	+	–	+	+	+	+	+	+	+	BLS79
G	+	–	+	–	+	+	+	–	+	+	BLS53
H	+	–	+	–	+	–	+	+	+	+	BLS94, BLS95
I	–	–	+	–	+	+	+	+	+	–	BLS28
J	+	–	+	–	+	–	–	+	+	+	BLS30
K	–	–	+	–	+	–	–	+	+	+	BLS48
L	+	+	+	–	+	+	–	+	–	–	BLSM
M	+	+	+	–	+	+	–	–	–	–	BLS54, BLS103
N	+	+	–	–	+	–	–	–	–	–	BLS69
O	–	–	–	–	+	+	–	–	+	+	BLS92
P	–	–	+	–	+	–	–	–	–	–	BLS2, BLS58, BLS64, BLS68, BLS66, BLS81, BLS86, BLS88, BLS93, BLS96, BLS99, BLS102, BLS109, BLS120, BLS123, BLS127
Q	–	–	–	–	+	–	–	–	–	–	BLS17, BLS78
R	–	–	–	–	–	–	–	–	–	–	BLS37, BLS45, BLS93A, BLS51

[a] + = sensitive, – = resistant.

Assessment of virulence of the bacterial blight (BB) pathogen by infectivity titration

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Graded doses of inoculum were applied to compatible varieties to assess the virulence of strains within a race group of the BB pathogen. This infectivity titration method could help estimate the relative virulence of two or more strains of a BB pathogen by identifying the dose of the strain that would induce BB lesion development on the host, and by explaining the interaction between rice and the BB system.

Table 1. Relationship of induction of positive infection[a] and challenge doses of strains in virulence group I of *Xanthomonas campestris* pv. *oryzae* on IR8 at 2 growth stages, IRRI.

Strain	Intersection (a)	Slope (b)	ED_{50} [b]	
			Cells[c] (no./ml)	95% fiducial limit
		Maximum tillering		
PXO 52	–1.768093	1.180282	5.4×10^5 a	$4.0 \times 10^5 - 7.2 \times 10^5$
PXO 61	–1.485948	1.123830	5.9×10^5 a	$2.6 \times 10^5 - 1.3 \times 10^6$
PXO 80	–1.034755	1.143749	1.9×10^5 b	$4.5 \times 10^4 - 7.5 \times 10^5$
PXO 84	–1.448995	1.175264	3.1×10^5 ab	$1.0 \times 10^5 - 9.4 \times 10^5$
PXO 85	–0.863743	1.002507	7.1×10^5 a	$5.2 \times 10^5 - 9.6 \times 10^5$
		Flowering		
PXO 52	–0.694496	1.030680	3.3×10^5 a	$5.3 \times 10^4 - 2.3 \times 10^6$
PXO 61	–0.589263	1.011782	3.3×10^5 a	$1.0 \times 10^5 - 1.2 \times 10^6$
PXO 80	0.490349	0.855707	1.9×10^5 a	$3.6 \times 10^4 - 9.1 \times 10^5$
PXO 84	–0.195718	1.013959	1.3×10^5 a	$3.3 \times 10^4 - 4.7 \times 10^5$
PXO 85	–0.853099	1.029445	4.8×10^5 a	$1.7 \times 10^5 - 1.5 \times 10^6$

[a] Scored at 14 d after inoculation. [b] Based on bacterial cell number in the inoculum suspension. [c] Separation of ED_{50}s at the same stage by Duncan's multiple range test at 5% level.

Five strains of BB races 1, 2, and 3 were pin-prick inoculated into IR8 (race 1) and IR36 (races 2 and 3). Six doses each of the inoculum were used for each strain. The experiment was in a split-plot design with five replications. Host response was recorded on an all-or-none basis — healthy leaves or leaves with water-soaked BB lesions. Plant response records for each infection data were evaluated by probit analysis. The median effective dose (ED_{50}, the number of bacterial cells per plant that cause 50% of the inoculated rice leaves to respond, and the shape of the log dose/probit response curve were estimated by maximizing the likelihood function. The precision of estimates was determined using variance formulas. ED_{50} values were based on the original number of cells in the inoculum at inoculation. Young, fully expanded leaves were observed at maximum tillering and flag leaves at booting.

Based on ED_{50}s, there were significant differences in virulence levels of different strains within the race group. However, virulence ranking was inconsistent with growth stage. Likewise, the range of bacterial cell numbers among the strains varied according to plant age. Among the strains, PXO 80 of race 1 and PXO 78 of race 2 were most virulent and differed significantly from the other strains of each race group at maximum tillering (Table 1, 2). There was no significant difference in virulence among race 3 strains (Table 3) except PXO 87 at flowering stage.

Tables 1, 2, and 3 showed the probit slopes resulting from the infectivity titrations of all isolates. The slopes were less than 2, indicating *X. c.* pv. *oryzae* cells probably act independently during growth *in vivo,* conforming to the hypothesis of independent action. Furthermore, the slope-probit regression also indicated that the host response could be heterogeneous in resistance, especially at booting, because slope values for each strain were much below 2. This may also be related to the nature of resistance of the varieties as they mature.

It seemed that varieties have more uniform susceptibilities at maximum tillering than at booting. Results also indicated that the dose-response probability function characterized by the ED_{50} point may be useful to evaluate not only host resistance but also virulence of a bacterial pathogen such as *X. c.* pv. *oryzae* on a self-pollinated host. □

Table 2. Relationship of induction of positive infection [a] and challenge doses of strains in virulence group II of *Xanthomonas campestris* pv. *oryzae* on IR36 at 2 growth stages, IRRI.

Strain	Interaction (a)	Slope (b)	ED_{50} [b] Cells [c] (no./ml)	ED_{50} [b] 95% fiducial limit
Maximum tillering				
PXO 63	–1.283629	1.193854	1.8×10^5 c	$1.4 \times 10^5 - 2.4 \times 10^5$
PXO 78	0.778038	0.864323	7.7×10^4 d	$5.4 \times 10^4 - 1.1 \times 10^5$
PXO 82	0.124390	0.913277	2.2×10^5 bc	$9.1 \times 10^4 - 4.9 \times 10^5$
PXO 83	–0.844036	1.026089	4.9×10^5 a	$2.4 \times 10^5 - 1.0 \times 10^6$
PXO 86	–0.290847	0.948272	3.8×10^5 ab	$2.7 \times 10^5 - 5.2 \times 10^5$
Flowering				
PXO 63	–1.216944	1.091421	4.9×10^5 ab	$3.6 \times 10^5 - 6.8 \times 10^5$
PXO 78	–1.018771	1.029397	7.0×10^5 ab	$5.2 \times 10^5 - 9.6 \times 10^5$
PXO 82	–1.534185	1.169987	3.8×10^5 b	$1.3 \times 10^5 - 1.1 \times 10^6$
PXO 83	–0.154857	0.922782	3.9×10^5 b	$7.1 \times 10^4 - 1.8 \times 10^6$
PXO 86	0.216349	0.780476	1.3×10^6 a	$2.5 \times 10^5 - 5.7 \times 10^6$

[a]Scored at 14 d after inoculation. [b] Based on bacterial cell number in the inoculum suspension. [c] Separation of ED_{50}s at the same stage by Duncan's multiple range test at 5% level.

Table 3. Relationship of induction of positive infection [a] and challenge doses of strains in virulence group III of *Xanthomonas campestris* pv. *oryzae* on IR36 at 2 growth stages, IRRI.

Strain	Interaction (a)	Slope (b)	ED_{50} [b] Cells [c] (no./ml)	ED_{50} [b] 95% fiducial limit
Maximum tillering				
PXO 22	–0.172836	0.852449	1.2×10^6 a	$2.5 \times 10^5 - 4.7 \times 10^6$
PXO 79	1.113828	0.711859	2.9×10^5 a	$6.5 \times 10^4 - 1.0 \times 10^6$
PXO 81	–0.288778	0.975468	2.6×10^5 a	$5.5 \times 10^4 - 1.1 \times 10^6$
PXO 87	0.923749	0.690078	8.1×10^5 a	$1.6 \times 10^5 - 3.3 \times 10^6$
PXO 88	1.491207	0.648439	2.6×10^5 a	$1.4 \times 10^4 - 1.4 \times 10^6$
Flowering				
PXO 22	–0.841707	0.981978	8.9×10^5 b	$7.8 \times 10^4 - 6.2 \times 10^6$
PXO 79	–1.379009	1.063169	9.9×10^5 b	$4.6 \times 10^5 - 2.0 \times 10^6$
PXO 81	0.043882	0.867777	5.1×10^5 b	– –
PXO 87	–2.754767	1.110812	9.5×10^6 a	$7.2 \times 10^6 - 1.3 \times 10^7$
PXO 88	–1.363441	1.092269	6.7×10^5 b	$3.2 \times 10^5 - 1.4 \times 10^6$

[a] Scored at 14 d after inoculation. [b]Based on bacterial cell number in the inoculum suspension. [c] Separation of ED_{50}s at the same stage by Duncan's multiple range test at 5% level.

Outbreak of rice tungro virus (RTV) in North Arcot District

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An RTV outbreak in North Arcot District, Tamil Nadu, in Feb-May 1984 resulted in severe infection of nearly 1,800 ha.

Locally grown rice varieties had markedly different infection severities. Disease incidence was recorded based on the Standard Evaluation System for Rice. IET1722 and Co 37 were highly susceptible to RTV, with 60-80% infection (see table). IR50 was RTV-resistant. □

RTV infection in North Arcot, Tamil Nadu, India.

Variety	Range of RTV infection (%)
IET1722	60-80
Co 37	60-80
TKM9	29-40
Co 43	15-20
IR20	15-20
IR50	0-12

Evaluation of pyroquilon seed treatment for blast (Bl) control in upland rice

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We tested the effectiveness of pyroquilon (CGA49104), a systemic seed dressing fungicide, for Bl control. A field trial in a randomized complete block design with three replications was laid out in cerrado soil in Goiânia. Six plots each 5 m long with 50 cm spacing were seeded on 6 Nov 1983. Seeds of rice IAC25, IAC164, L 50, IAC47, CNA104, and B-34-2 were treated with different doses of pyroquilon and benomyl slurry. Untreated checks were maintained.

Heavy Bl incidence was obtained by planting four closely spaced spreader rows of susceptible rice varieties around each block. Lesions/leaf and percent leaf area affected, were recorded 29, 34, 38, 42, 46, and 50 d after seeding (DS). Percent panicle Bl was also recorded.

At 29 DS pyroquilon significantly reduced Bl infection in all varieties as compared to the benomyl-treated and the untreated control (see table). Varieties did not significantly differ in panicle Bl or yield but were significantly different in susceptibility to leaf Bl. At 38 DS, pyroquilon treatment reduced leaf B1 from 28 to <5% in susceptible IAC47 and IAC25. Treatment of moderately resistant CNA104-B-34-2 kept disease level at 5% until 50 DS although differences were significant only at 29 DS.

Effect of pyroquilon seed treatment on leaf Bl in 6 upland rice varieties, Goiania, Brazil.

Treatment [a]	Sporulating lesions (no./leaf) 29 DS	Leaf area affected [b] (%)			
		34 DS	38 DS	42 DS	46 DS
Medium-duration varieties					
IAC47					
Pyroquilon	0.05 a	3 a	4 a	24 a	39 a
Benomyl	1.17 b	23 b	28 b	42 a	44 a
Untreated control	1.42 b	22 b	29 b	39 a	41 a
CNA104-B-4-1-1					
Pyroquilon	1.03 a	1 a	1 a	2 a	5 a
Benomyl	1.33 b	4 a	3 a	7 a	7 a
Untreated control	1.08 b	4 a	4 a	7 a	13 a
CNA104-B-34-2					
Pyroquilon	0 a	0 a	0 a	1 a	2 a
Benomyl	0.21 b	2 a	1 a	2 a	4 a
Untreated control	0.31 b	1 a	2 a	4 a	6 a
Short-duration varieties					
IAC25					
Pyroquilon	0.03 a	0 a	2 a	16 a	26 a
Benomyl	1.60 b	20 b	28 b	34 b	34 a
Untreated control	1.50 b	16 b	23 b	30 b	38 a
IAC164					
Pyroquilon	0.05 a	1 a	3 a	15 a	24 a
Benomyl	0.84 ab	10 ab	14 ab	14 a	17 a
Untreated control	1.20 b	16 b	17 b	24 a	32 a
L 50					
Pyroquilon	0.04 a	0 a	1 a	11 a	23 a
Benomyl	0.63 b	8 ab	13 a	13 a	26 a
Untreated control	0.52 b	12 b	15 a	16 a	18 a

[a] Dosage = pyroquilon 400 g ai/100 kg seed, benomyl 400 g ai/100 kg seed. [b] In a column treatment means by variety followed by the same letter are not significantly different at the 5% level.

We also tested pyroquilon in a Bl nursery experiment. Seeds of IAC25, IRAT112, IAC47, and CNA104-B-34-2 were treated with carbofuran, pyroquilon, or pyroquilon + carbofuran. An untreated control was maintained. Leaf Bl severity and dry matter production were recorded. Differences between the chemical treatments, varieties, and interactions were significant. The correlation between biomass and leaf Bl was negative and highly significant ($r = -0.91^{**}$).

Seed treatment with carbofuran did not affect the efficiency of pyroquilon treatment for Bl.□

Races of the rice bacterial blight (BB) pathogen in the Philippines from 1980 to 1982

C. M. Vera Cruz and T. W. Mew, Plant Pathology Department, IRRI

In 1980-82, leaves naturally infected with 209 BB isolates were randomly collected from native, local, traditional, and IR lines or varieties. The rices, usually with the *Xa 4* gene for resistance, came from various Philippine sites. The pathogen was isolated in the laboratory.

To determine BB race frequency, the isolates were tested for their reaction on IR8, IR20, IR1545-339, CAS 209, and DV85, each of which has different genes for BB resistance. In the greenhouse, 40-d-old plants of each variety were arranged in rows and inoculated with each isolate by clipping the 2 youngest, fully expanded leaves of each tiller. Disease level based on lesion length was recorded 14 d after inoculation and converted to percentage leaf area infected as described in the Standard Evaluation System for Rice.

Most isolates collected since 1980 belonged to race 2, followed by race 3, both of which are virulent to rices with the *Xa 4* gene for resistance. Such rices include IR20, IR36, and all IRRI released varieties (Table 1). Race 1, the predominant race before wide cultivation of BB-resistant varieties, had markedly decreased frequency (Table 1). Previously

Table 1. Race frequency of the field population of *X. campestris* in the Philippines with specific virulence to a set of differential varieties, IRRI.

Race	Reaction to differential varieties [a]	Frequency [b] (%)		
		1980	1981	1982
1	SRRSR	1.9	0	0.8
2	SSRRR	75.9	87.5	85.4
3	SSRSR	14.8	3.1	9.8
4	SRSSR	0	3.1	0.8
5	SRRRR	0	6.3	1.6
6	SSSSMS	7.4	0	1.6

[a] Differential varieties corresponding to the reaction pattern of each race: IR8, IR20, IR15-45-339, Cas 209, DV85. [b] Number of isolates tested each year: 1980 = 54, 1981 = 32, 1982 = 123.

Table 2. **Frequency distribution of races of *X. campestris* in different regions of the Philippines, 1980-82, IRRI.**

Region	Year	Isolates (no.)						Total
		Race 1	Race 2	Race 3	Race 4	Race 5	Race 6	
Ilocos region	1981	0	6	0	0	0	0	6
Mt. Province	1981	0	0	0	0	2	0	2
	1982	0	0	0	0	2	0	2
Nueva Ecija	1980	0	31	0	0	0	0	31
	1981	0	2	0	0	0	0	2
	1982	0	1	0	0	0	0	1
Central Luzon (other than Nueva Ecija)	1981	0	7	0	0	0	0	7
Laguna and Quezon	1980	1	2	0	0	0	4	7
	1981	0	1	0	1	0	0	2
	1982	1	41	0	1	0	2	45
Bicol region	1980	0	0	5	0	0	0	5
	1981	0	2	0	0	0	0	2
	1982	0	4	10	0	0	0	14
Visayas region	1980	0	1	0	0	0	0	1
	1981	0	5	0	0	0	0	5
	1982	0	4	1	0	0	0	5
Davao	1980	0	7	3	0	0	0	10
	1981	0	5	1	0	0	0	6
	1982	0	43	1	0	0	0	44
Cotabato	1982	0	7	0	0	0	0	7
Mindanao (other than Davao and Cotabato)	1982	0	5	0	0	0	0	5
Total		2	174	21	2	4	6	209
Percent		0.95	83.3	10.0	0.95	1.9	2.9	

undescribed races 5 and 6 were also identified. In 1980-82, an average of 80% of the rice growing areas in the Philippines was planted to modern varieties, including IR varieties.

We grouped the populations by collection site. Race 2 was found everywhere but in Mountain Province (Table 2). Only Laguna (including IRRI) showed races virulent not only to IR20 but also to IR1545-339, with *xa 5* gene, and moderately virulent to DV85, with *xa 5* and *Xa 7* genes, infrequently: 3.7% for IR1545-399 and 2.9% for DV85. The previously dominant race 1 had markedly decreased frequency. In Bicol, particularly in Camarines Sur, race 3 dominated. In Davao, race 2 had overtaken the previously dominant race 3. □

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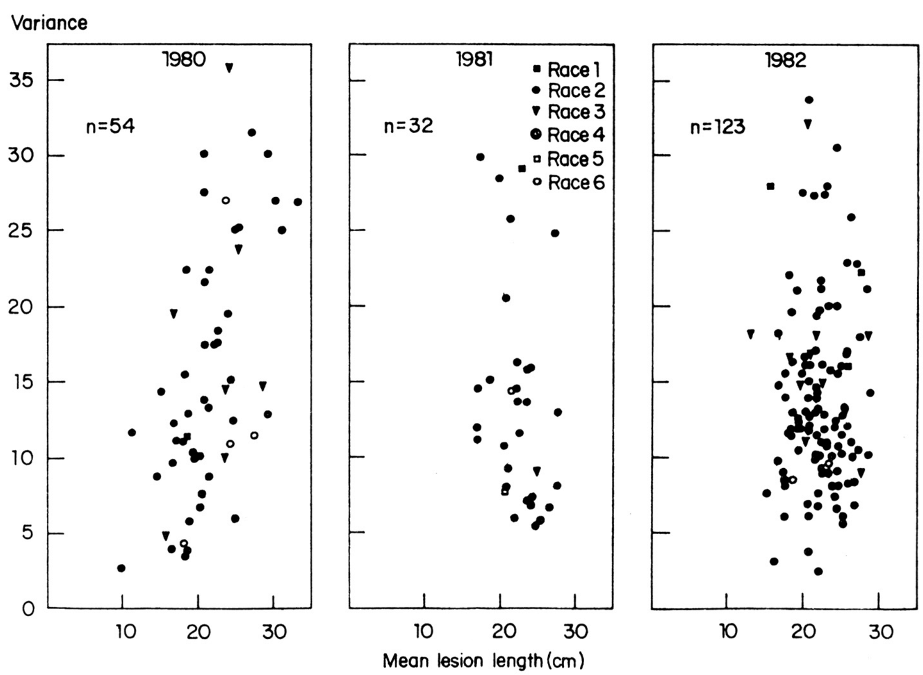
Variability of field population of the bacterial blight (BB) pathogen of rice

C. M. Vera Cruz and T. W. Mew, Plant Pathology Department, IRRI

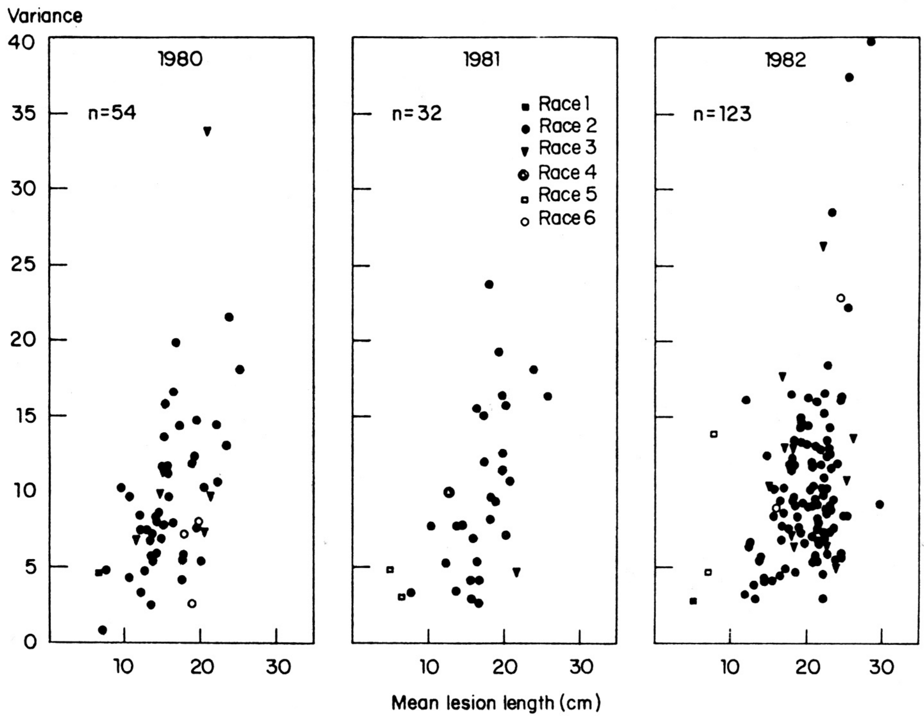
Previous studies have shown that length of lesions induced by isolates of the rice BB pathogen varied in individual varieties. We sought to determine the extent of variability of the BB pathogen in a population by studying the virulence of an isolate as expressed in lesion variance caused by the isolate on a variety.

The isolates were inoculated on IR8 and IR1545-339 40 d after sowing by clipping the 2 youngest fully expanded leaves of each active tiller. Lesions of each isolate on each variety were measured on 20 leaves 14 d after inoculation and evaluated for variance.

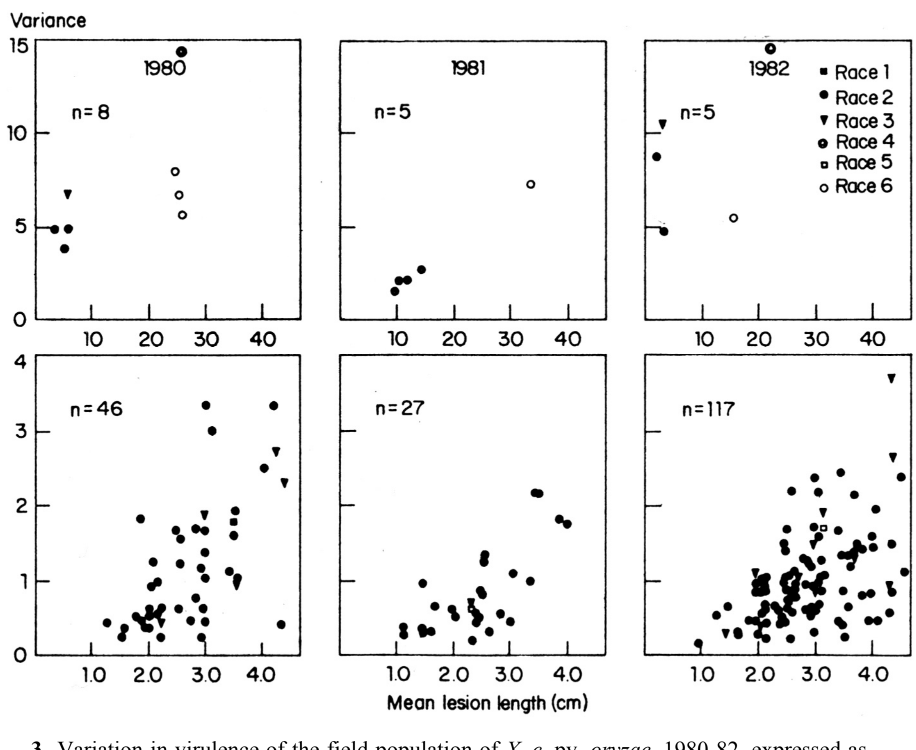
Scatter-diagrams of lesion variance on IR8, IR20, and IR1545 are shown in Figures 1, 2, and 3. Lesion variance was high on IR8, which is susceptible to all isolates, and on IR20, which is susceptible to races 2, 3,6, and variable to race 4. On IR1545, which is resistant to all but races 4 and 6, lesion variance was lower than on IR8 and IR20, but increased propor-



1. Variation in virulence of the field population of *X. c.* pv. *oryzae,* 1980-82, expressed as variance of lesions induced on IR8, IRRI.



2. Variation in virulence of the field population of *X. c.* pv. *oryzae,* 1980-82, expressed as variance of lesions induced on IR20, IRRI.



3. Variation in virulence of the field population of *X. c.* pv. *oryzae,* 1980-82, expressed as variance of lesions induced on IR1545, IRRI. One extreme value (20.76 cm^2) in 1982 was not plotted.

tionally with mean lesion length induced by races 4 and 6. This may indicate the inherent variability of the BB pathogen as affected by the nature of resistance of the variety.

The *Xa 4* gene for resistance of IR20 was overcome by the predominant pathogen race. □

Ufra incidence in summer rice in West Bengal

H. S. Chakrabarti, D. K. Nayak, and A. Pal, Rice Research Station, Chinsurah, Hooghly, West Bengal, India

Ufra disease, caused by the nematode *Ditylenchus augustus* (Butler) Filipjev, usually affects the winter rice crop. But in 1984, it was recorded in the summer crop on a Ganges River island in Hooghly, West Bengal. The crop was flooded because of a high tide for 5-6 d in mid-Mar. There was a marked increase in disease 1 wk after partial submergence, when the crop was at tillering-to-stem extension.

Symptoms were leaf yellowing, especially of young leaves; twisted bases of young leaves; distorted leaf sheaths (Fig. a); and swollen lower nodes with irregular nodal branching (Fig. b). At later growth, panicles wrinkled and emerged only partially. Sometimes they did not emerge. Spikelets were partially

Infected plant parts with ufra symptoms: a. twisted base of a younger leaf; b. swollen node with nodal branching, wrinkling, and panicle distortion; and c. sterile spikelets, West Bengal, India.

filled or sterile (Fig. c). *D. augustus* was confirmed by microscope examination.

IK36 and IET4094 had only 40% infection; IR50, IET6141, Ratna, Saket 4, China Boro, and IRRI had 80% infection. Disease intensity was 20% less when the same cultivars were partially submerged for 2-3 d.

Because flooding increased ufra incidence, an expected high tide might be used to predict an outbreak in the Gangetic estuarine area. □

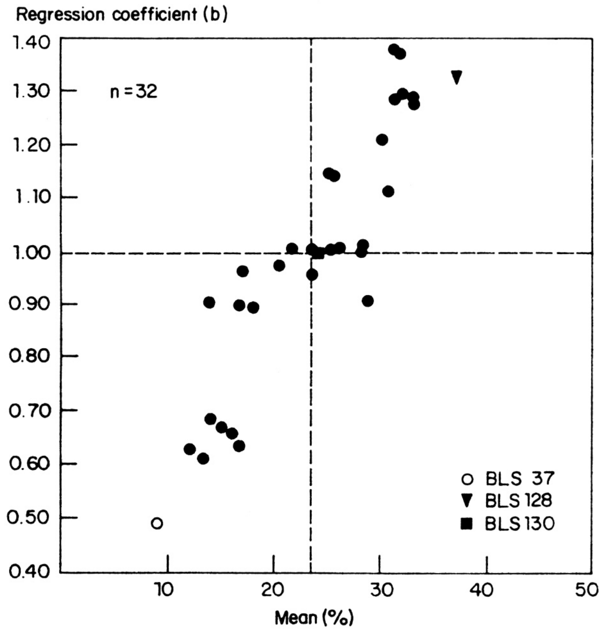
Pathogenic variability in *Xanthomonas campestris* pv. *oryzicola*

T. Adhikari and T. W. Mew, Plant Pathology Department, IRRI

Bacterial leaf streak (BLS), caused by *X. c.* pv. *oryzicola* (Fang et al) Dye, is an important rice disease in the tropics. Virulence of the bacterium on rice cultivars is not clearly understood. We studied the interaction between the bacterial isolates and the rice cultivars to determine virulence patterns in the Philippines.

Forty-four isolates from various sites in the Philippines were evaluated on susceptible IR50, then 32 isolates were selected and inoculated on 8 IR cultivars. In all experiments, 35-d-old seedlings were spray-inoculated. Virulence was evaluated based on percentage of affected leaf area. Differences among isolates and cultivars were significant, but interaction was not (see table).

To determine the extent of variation in virulence we computed a linear regression. The distribution of virulence of isolates on test cultivars, based on the regression coefficient (b) and mean percentage of affected leaf area, showed three distinct virulence patterns (see figure). Virulence pattern 1 consisted of seven weakly virulent isolates. Virulence 2 had intermediate reaction, and virulence 3 was the most virulent to the test cultivars. Isolate BLS 128, from IRRI, was the most virulent and BLS 37, from Isabela, was least virulent. IR38 was resistant to all isolates. □



Scatter diagram of the distribution of 32 *X. campestris* isolates based on regression coefficient (b) and mean percentage of leaf area infection on 8 rice cultivars.

Analysis of variance of partitioned sum of squares[a] for isolate of *X. campestris* pv. *oryzicola* and isolate × cultivar effects for percentage leaf area affected, IRRI.

SV	DF	MS	F
Isolate (1)[a]	31	881.702558	2.30**
G_1	(6)	99.488097	<1
G_2	(16)	402.660041	1.05 ns
G_3	(7)	97.320313	<1
G_1 Vs, G_2 Vs, G_3	(2)	9806.023920	25.55**
Error (b)	31	383.726562	
1 × V	217	121.455294	1.16 ns
G_1 × V	(42)	40.025510	<1
G_2 × V	(112)	103.507730	1
G_3 × V	(49)	124.133450	1.10 ns
Error	(c)217	104.253852	

[a] **significant at P = 0.01. G_1 = isolates BLS37, BLS109, BLS88, BLS17, BLS58, BLS53, and BLS45; G_2 = isolates BLS95, BLS2, BLS123, BLS103, BLS102, BLS64, BLS119, BLS130, BLS99, BLS94, BLS64, BLS101, BLS129, BLS93A, BLS66, BLS69, and BLS92; and G_3 = isolates BLS48, BLS124, BLS3, BLS127, BLS128, BLS1, and BLS96.

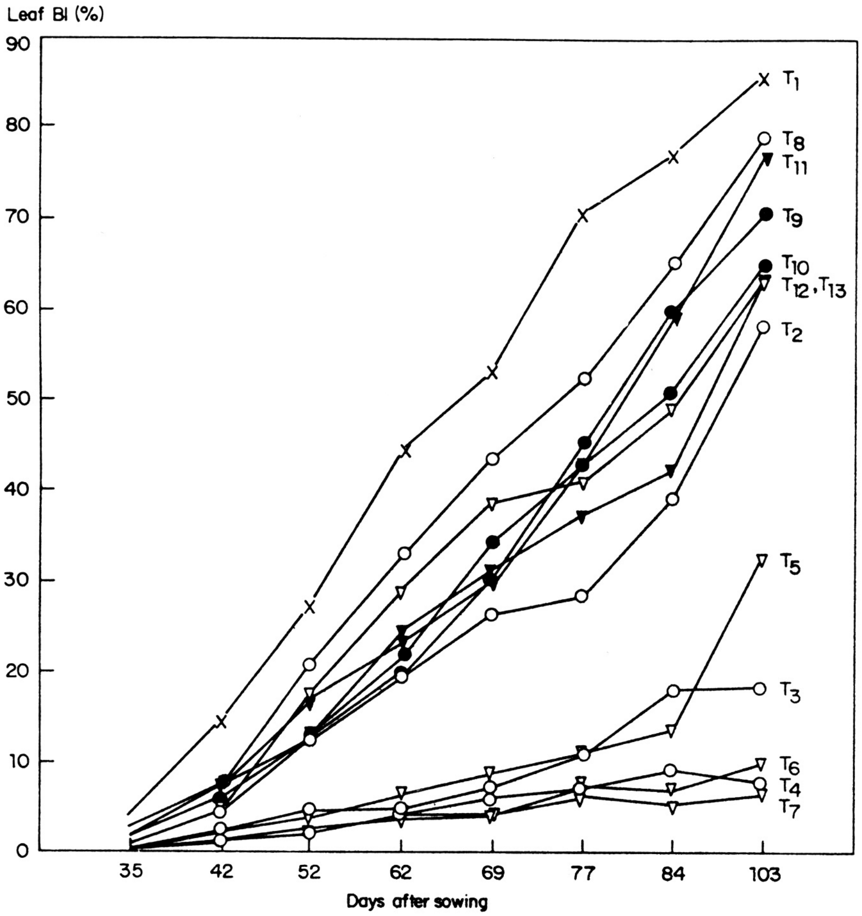
Efficacy of the systemic fungicide CGA49104 for controlling rice blast (Bl)

J. C. Bhatt, scientist S-1, Plant Pathology; and J. P. Tandon, ex-director, Vivekananda Parvatiya Krishi Anusandhan Shala (VPKAS), ICAR, Almora 263601, India

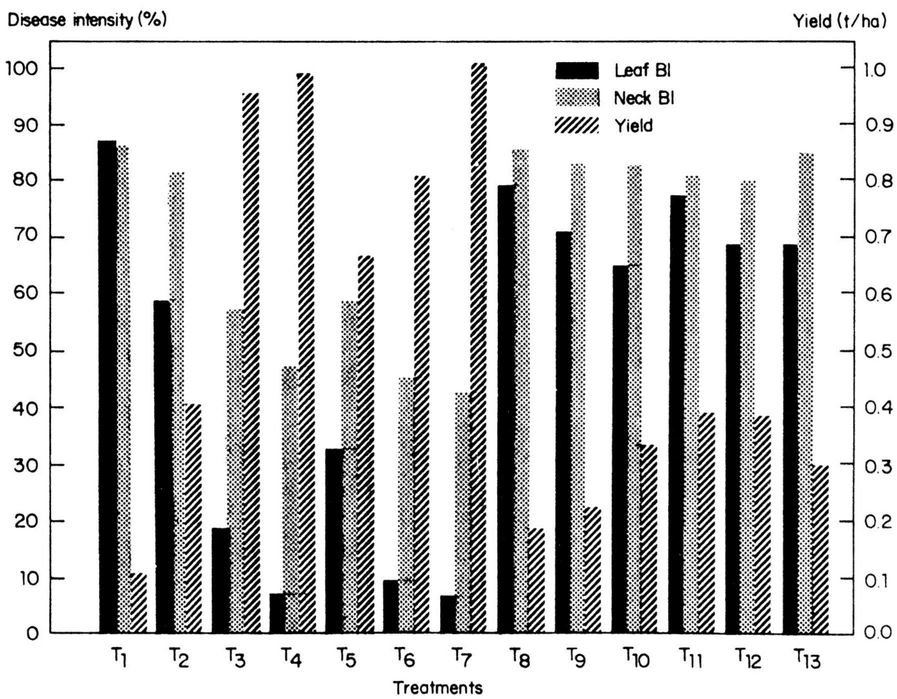
We tested the systemic fungicide seed treatments carbendazim 50 WP and CGA49104 50 WP for control of B1 under hill conditions at VPKAS farms, Hawalbagh, in 1983 kharif.

The experiment was in a randomized block design with three replications. VL501, a Bl-susceptible, short-duration variety, was planted in 2.25- × 1.20-m plots under rainfed conditions. Seeds were treated with dry and slurry formulations of the fungicides at 2, 4, and 6 g ai/kg seed. Appearance of leaf Bl, development until crop maturity, neck Bl intensity, and grain yield were recorded for the different treatments: T_1 = untreated check; T_2, T_3, T_4 = dry CGA49104 at 2, 4, and 6 g ai/kg seed; T_5, T_6, T_7 = CGA49104 slurry at 2, 4, and 6 g ai/kg seed; T_8, T_9, T_{10} = carbendazim dry at 2,4, and 6 g ai/kg seed; and T_{11}, T_{12}, T_{13} = carbendazim slurry at 2, 4, and 6 g ai/kg seed.

Carbendazim was not effective, but CGA49104 at 6 and 4 g ai/kg seed in either form effectively reduced Bl intensity and increased yield (Fig. 1, 2). However, CGA49104 was not effective in another experiment where seedlings of Thapachini, a local Bl-susceptible variety, were dipped in 125, 250, and 500 ppm concentrations each for 8, 4, and 2 h before transplanting. □



1. Development of leaf Bl in different treatments until crop maturity, Almora, India.



2. Percentage of leaf and neck Bl and yield levels under different fungicide treatments, Almora, India

Occurrence of sheath blotch (SBl) in India

S. C. Ahuja and D. Singh, Rice Research Station (RRS), Kaul, Kurukshetra, India

SBl, caused by *Pyrenochaeta oryzae* Miyake, is common at light to moderate severity in Ambala, Kurukshetra, Karnal, Sonipat, and Jind districts.

In trials at RRS Kaul during 1979 kharif, SBl appeared between maximum tillering and booting on sheaths just below the ligules as a brown spot surrounded by water-soaked areas. Spots bleached in the middle, became milky white, and were studded with numerous black pycnidia (Fig. 1).

Damage varied with variety. On Jaya, symptoms were limited to the sheaths just below the ligules. On Pusa 2-21, the fungus penetrated deep into sheaths and damaged the culm, causing it to break. At RRS Kaul, the disease reduced panicle emergence in late lines PAU 35-5-32 and RP6-56-516 because the base of the flag leaf sheath rotted (Fig. 2).

The pathogen isolated from diseased tissues did not produce pycnidia on PDA, paddy grains, or typha leaves. Three varieties were inoculated at two growth stages: at maximum tillering stage by inserting a rice grain culture or typha leaf-

1. Blotch on sheath with a white center studded with black pycnidia. Note the spot on the junctura and leaf sheath.

2. Flag leaf sheath showing SBl with pycnidia and a partially emerged panicle and unfilled grain.

piece culture between sheath and culm or spraying the three upper leaves with a mycelial suspension, and at booting by inserting a rice grain culture in the boot or spraying the three upper leaves with mycelial suspension.

SBl symptoms developed from all inoculation methods. Brown spots appeared on leaf sheaths 3 d after inoculation. Alternating brown and yellow bands developed on the leaves. Pycnidia formed only on the leaf sheaths. Later tests showed that resistant, intermediate, and susceptible varieties could be identified by inserting typha leaf-piece culture at maximum tillering stage and observing the reaction.☐

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

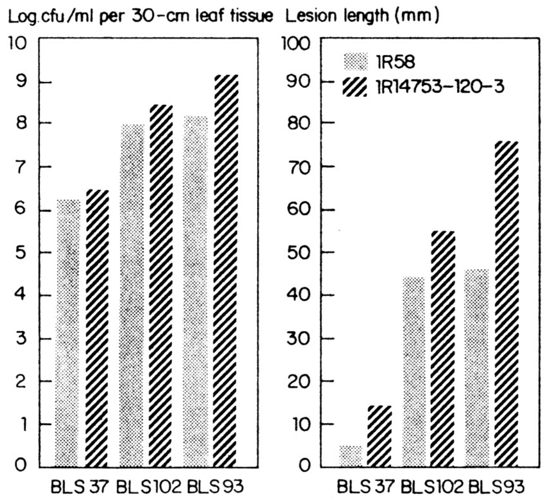
A quantitative method for assessing virulence of *Xanthomonas campestris* pv. *oryzicola*

T. B. Adhikari and T. W. Mew, Plant Pathology Department, IRRI

Bacterial leaf streak (BLS) caused by *X. c.* pv. *oryzicola* is an important rice disease in tropical Asia. Symptoms are narrow, translucent streaks between the leaf veins and bacterial ooze.

In a preliminary study, susceptible lesions induced by some isolates produced more bacterial ooze, suggesting the possible relation of ooze production and isolate virulence in the host-parasite interaction.

We assessed the virulence of isolates BLS37, BLS93, and BLS102 on resistant IR58 and susceptible IR14753-120-3 using the following parameters:



Ooze production of *Xanthomonas campestris* pv. *oryzicola* isolates in resistant IR58 and susceptible IR14753-120-3 rice varieties 15 d after inoculation.

- incubation period, the time interval between inoculation and visible symptoms;
- latent period, the time from inoculation to first ooze production;
- ooze production, ooze produced per 30 cm^2 leaf surface; and
- lesion length, measured in millimeters.

Inoculated plants were kept in the greenhouse and visible infection and ooze production were monitored daily. The ooze was carefully isolated by scraping the lesion surface with camel-hair brush 15 d after inoculation and immediately placed in a test tube containing 5 ml of peptone sucrose broth. Tenfold series of dilution were made and 0.1 ml suspension was plated on PSA medium. Colonies were counted 3 d later.

Irrespective of rice cultivar, isolate BLS93 had shorter incubation period and latent period (see table), higher ooze pro-

Mean incubation period and latent period for 3 *X. campestris* pv. *oryzicola* isolates on 2 rice cultivars, IRRI.

Variety	Isolate	Incubation period (d)	Ooze observed (d) after incubation	Latent period[a] (d)
IR58	BLS93	6.5	2.5	9.0
	BLS102	7.0	2.0	9.0
	BLS37	8.0	2.0	10
IR14753-120-3	BLS93	5.0	3.0	8.0
	BLS102	6.0	2.0	8.0
	BLS37	8.0	2.0	10

[a] Incubation period + days when ooze was observed after incubation period.

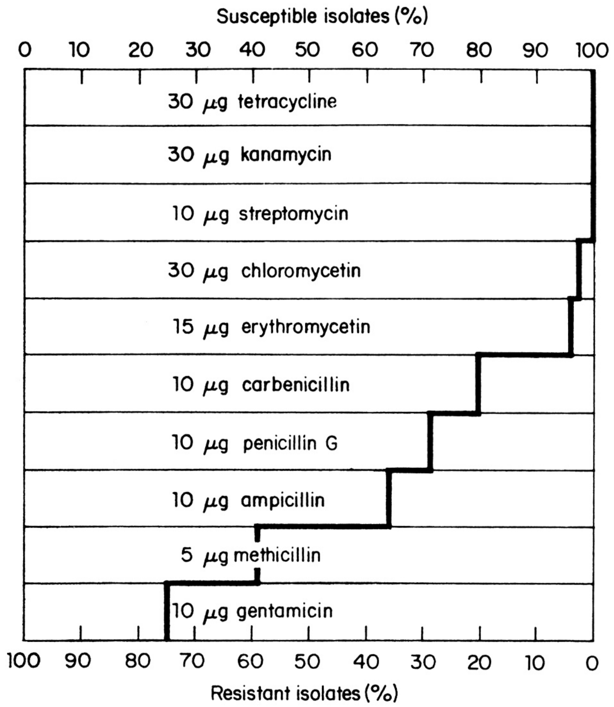
duction, and longer lesions (see figure) than avirulent isolate BLS37. BLS102 had an intermediate reaction. In all isolate-cultivar combinations, ooze production was directly related to lesion length, with longer lesions producing more ooze. However, the resistant cultivar had less ooze and shorter lesions than the susceptible.

Comparison of latent period, ooze production, and lesion length could be important factors contributing to variation in virulence of the isolates or components of BLS resistance. The latent period and ooze production might be used to compare virulence of different isolates on the same cultivar. □

Antibiotic sensitivity of *Xanthomonas campestris* pv. *oryzicola* in vitro

T. B. Adhikari and T. W. Mew, Plant Pathology Department, IRRI

Sensitivity to antibiotics among strains of phytopathogenic bacteria is well documented, but little information is available for *X. campestris* pv. *oryzicola,* the bacterial leaf streak pathogen. Such information is useful in grouping bacteria. We tested the sensitivity of *X. c.* pv. *oryzicola* isolates to 10 antibiotics: ampicillin (10 µg), carbenicillin (100 µg), chloromycetin (30 µg), erythromycin (15 µg), kanamycin (30 µg), gentamicin (10 µg), methicillin (5 µg), penicillin (G) (10 µg), streptomycin (10 µg), and tetracycline (30 µg). Disks containing the different antibiotics were placed on PSA medium. After 72 h of incubation at 28°C, an inhibition zone equal to or larger than 12 mm was regarded as a sensitive reaction.



Sensitivity and resistance of 44 isolates of *Xantomonas campestris* pv. *oryzicola* to antibiotics, IRRI.

All isolates were sensitive to 30 µg tetracycline, 30 µg kanamycin, and 10 µg streptomycin (see figure). Sensitivity to the other antibiotics varied. Seventy-five percent of the isolates were not sensitive to 10 µg gentamicin. □

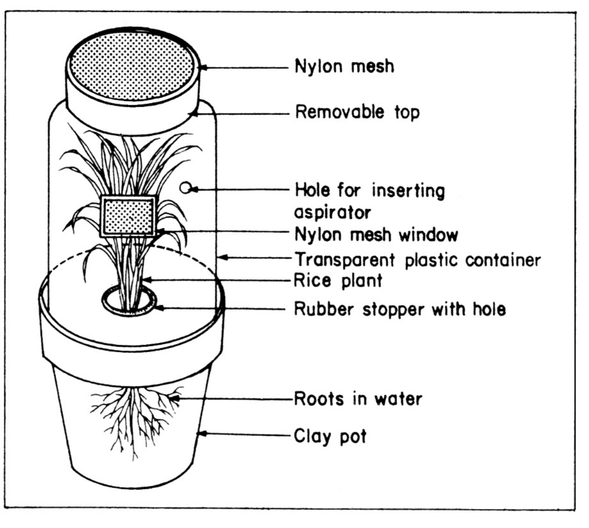
Pest Control and Management

INSECTS

Parasitism of nematodes on three species of hopper pests of rice in Laguna, Philippines

N. P. Pena and B. M. Shepard, Entomology Department, IRRI

We determined the parasitism of nematodes on brown planthopper (BPH) *Nilaparvata lugens,* whitebacked planthopper (WBPH) *Sogatella furcifera,* and the green leafhopper (GLH) *Nephotettix* spp. by weekly sampling from rice fields Laguna, Philippines, 29 Jun-5 Oct 1982 (wet season).



1. Cage for rearing hoppers parasitized by nematodes.

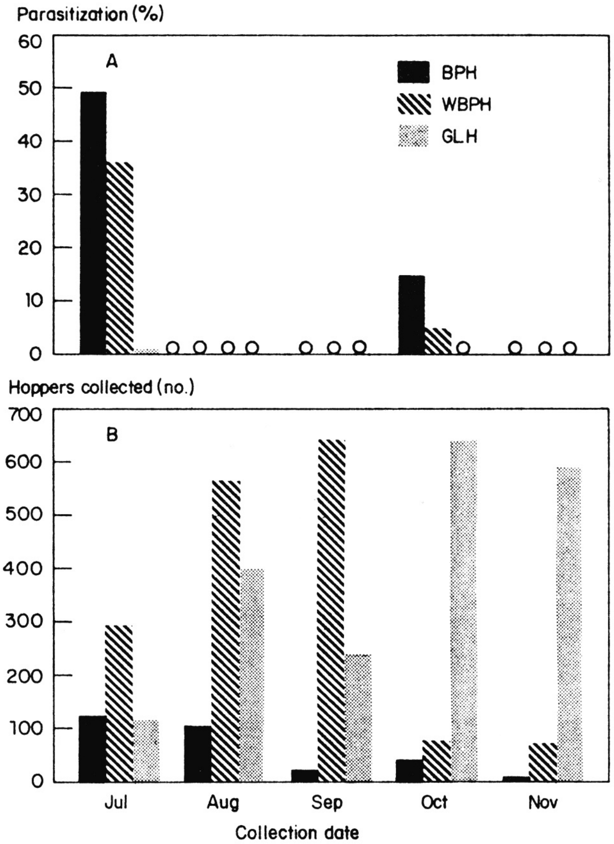
Samples from IR20 were taken with a D-Vac suction sampler. All hoppers were brought to the laboratory and caged (Fig. 1) until nematode parasites emerged. Three weeks later, all live insects were dissected.

During dry season (21 Dec 1982-15 Mar 1983), weekly sampling was carried out in the same area. Wet season (Jul-Nov 1983) sampling was conducted every 2 wk in Liliw, Kalayaan, Magdalena, Mabitac, Siniloan, Famy, Santa Maria, Victoria, Calauan, Parian, Pakil, and Cabuyao – all in Laguna.

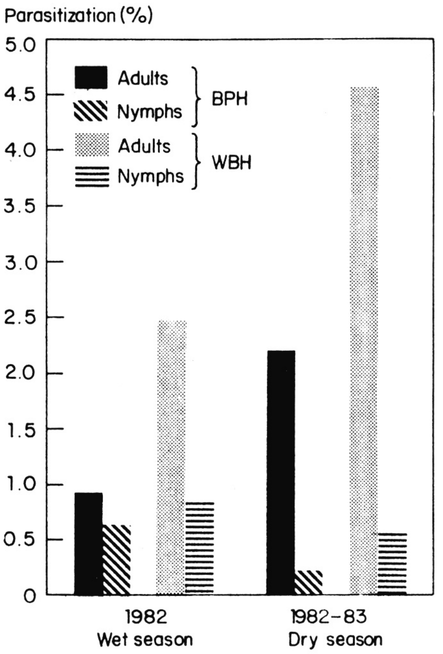
In 1982 wet season, parasitization of BPH or WBPH never exceeded 2.5% (Fig. 2). Parasitization was higher on adults than on nymphs.

Parasitism was slightly higher in 1982-83 dry season. More nematode parasites were found on WBPH (4.6%) than on BPH (2.5%) and adults were more frequently parasitized (Fig. 2).

In July 1983, average percent parasitization was almost 50% for BPH and 36% for WBPH (Fig. 3A). Parasitization of GLH was almost nil. No nematode parasites were found in Aug and Sep, but in Oct, BPH parasitization increased to 15% and that for WBPH to 4%. Seasonal population density of hoppers is in Figure 3B.



3. Nematode parasitization of hoppers (A) and hopper population and density (B) in Laguna, Philippines, 1983-84 wet season.



2. Nematode parasitization of BPH and WBPH during 2 cropping seasons. Liliw, Laguna, Philippines.

Parasitism of nematodes on BPH, WBPH, and GLH from different sites in Laguna, Philippines, 1983 wet season.

Site	BPH Total collected	BPH Mean parasitism (%)	WBPH Total collected	WBPH Mean parasitism (%)	GLH Total collected	GLH Mean parasitism (%)
Liliw	73	53	201	33	92	1
Kalayaan	28	57	74	27	239	0
Magdalena	0	0	0	0	49	0
Mabitac	27	15	38	8	402	0
Siniloan	3	0	47	0	1414	0
Famy	11	0	71	0	144	0
Santa Maria	1	0	11	0	221	0
Victoria	67	0	9	0	31	0
Calauan	15	0	278	0	388	0
Parian	3	33	2	100	5	0
Pakil	24	38	49	20	10	0
Cabuyao	26	15	870	1	221	0
Total	278	$\bar{x}$ = 19.24	1650	$\bar{x}$ = 17.22	3216	$\bar{x}$ = 0

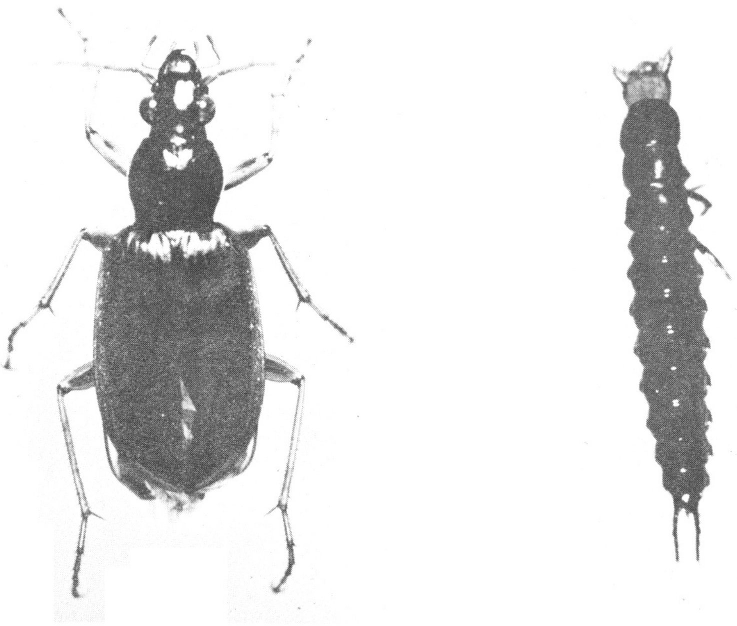
Parasitization of BPH, WBPH, and GLH by nematodes during the 1983 wet season in 12 sites is in the table. Parasitization varied at different sites, but BPH and GLH collected from Liliw and Kalayaan had consistently highest levels – 53% and 57%. Parasitization of WBPH also was generally higher at those sites. At five sites, we found no nematode parasites.

Parasitism of nematodes may regulate BPH and GLH populations in some areas, especially in wet season. It may be possible to establish nematodes in areas where they were not found. Although parasitization of WBPH sometimes reached 33%, this level may not have a significant impact of their populations.□

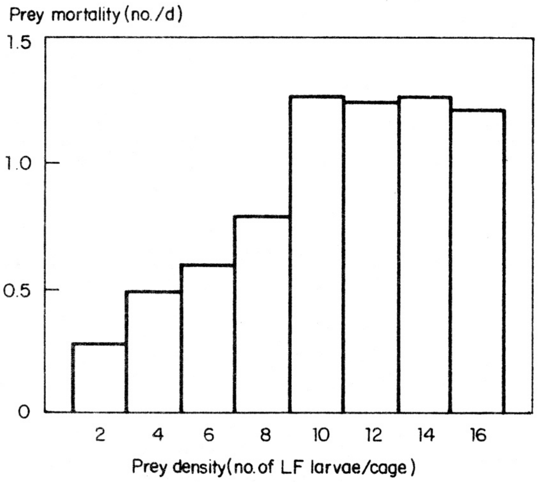
Chlaenius spp. (Coleoptera:Carabidae), a leaffolder (LF) predator

A. T. Barrion and J. A. Litsinger, Entomology Department, IRRI

Chlaenius ground beetles (*C. posticalis* Motschulsky, *C.* nr. *circumdatus* Chaudori, and *Chlaenius* sp.) prey on LF *Cnaphalocrocis medinalis* larvae in upland rice fields near Tanauan, Batangas, Philippines. The arboreal *Chlaenius* larvae (Fig. 1) actively search rice plants for LF larvae and were often found alone within folded leaves, presumably having consumed the LF.



1. Adult and larva of *C. posticalis,* the most common species found in dryland rice fields of Batangas. The adults are ground dwellers and do not prey on LF.



2. Predation rate of *C. posticalis* larvae on LF. One carabid larva was held per cage with prey replaced daily over 1 wk, IRRI headhouse.

Density dependent relationship of *Chlaenius* spp. ground beetle predators on host population in sunny and shaded upland rice fields[a], Tanauan, Batangas, Philippines.

Rice field	LF		Carabid predator (no. of larvae/m^2)	Prey:predator ratio
	Larvae (no./m^2)	Damaged leaves (%)		
Open	3.5 ± 2.3	65 ± 31	0.9 ± 0.9	3.9
Coconut shaded	9.8 ± 4.9	95 ± 40	1.9 ± 1.2	5.2

[a] Av of 4 fields. Values are averages of 5 1-m^2 sample sizes (X ± SE) per field.

In the headhouse, where predator and prey were caged at constant but variable densities, last-instar *C. posticalis* larvae exposed to 10 or more LF/cage became satiated at 1.3 last-instar LF larvae/d (Fig. 2).

LF population was highest in coconut-shaded rice fields, which in turn sustained higher carabid larval populations (see table). A more favorable prey:predator ratio occurred in sunny fields.

Chlaenius spp. did not prevent extensive leaf damage, but their activity reduced damage and population buildup. □

Rice water weevil host plants in Cuba

R. Meneses-Carbonell, Rice Experiment Station, Sur del Jibaro, Sancti-Spiritus, Cuba

Rice water weevil *Lissorhoptrus brevirostris* (Suffr.) is the most-difficult-to-control rice pest in Cuba because of its habits, adult longevity of up to 714 d, and host plant range.

L. brevirostris lives in a variety of weeds on levees and in irrigation channels where weed control is difficult. If climatic conditions are unfavorable, as in Nov-Mar, the insect remains dormant on such weeds as *Brachiaria mutica,* but does not die, even without feeding for 205 d.

New records of rice water weevil host plants in Cuba, 1983.

Host plant
Paspalum virgatum L.
Paspalum notatum Fluegge
Paspalum conjugatum Berg.
Panicum maximum Jacq.
Panicum repens L.
Leptochloa filiformis Lam. (Beauv.)
Ischaemum rugosum Salisb.
Oryza latifolia Desv.
Cyperus odoratus L.
Eichhornia crassipes (Mart.) Solms

We sampled rice fields at Sur del Jibaro once a month to record *L. brevirostris* hosts. Weeds with foliage damaged by *L. brevirostris* were collected, and their roots were dissected to determine the presence of rice water weevil larvae and pupae.

In 1979, host plants of rice water weevil were reported; 16 were grasses, including *Paspalum distichum, B. mutica, Echinochloa crus-galli, E. colona, Leptochloa fascicularis,* and *Leptochloa* sp. Other principal hosts were *Cyperus iria* and *C. esculentus.* Because the irrigation system in Sur del Jibaro uses dams, *Eichhornia paniculata* and *E. crassipes* also are important host plants.

Among the new *L. brevirostris* host plants that we identified, graminaceous species were more abundant (see table). Both adults and larvae fed on those weeds. □

Accelerative effect of juvenoids and precocene-II on diapause breaking of the larvae of three stem borers (SB)

S. Chakravorty, M. K. Ghosh, and N. Roychoudhury, Entomology Laboratory, Zoology Department, University of Kalyani, Nadia, West Bengal 741235, India

Larvae of *Scirpophaga incertulas, Chilo auricilius,* and *C. partellus* were collected by incising the tillers of rice stubble in Dec to Feb 1982-83. Juvenoids hydroprene, methoprene, and precocene-II were applied topically in acetone dilutions at 1µl of the solution/larva. One µl pure acetone was applied in the control treatment. Larvae were reared in individual 5- × 0.5-cm glass tubes plugged with moist cotton and wrapped with black paper. The tubes were put inside a rearing chamber kept at 23 ± 1°C, 70-80% relative humidity, and an 11-13 h lightdark cycle,

In the control treatment, *S. incertulas, C. auricilius,* and *C. partellus* moths developed in Feb-Mar, Feb, and Jun. In treated populations, moths developed earlier (see table), suggesting that these chemicals may accelerate diapause breaking of these stem borer larvae. The intensity of their effect may differ by species. □

Moth appearance from overwintering larvae treated topically with juvenoids and precocene-II, West Bengal, India.

Species	Dose[a] (µg/ individual)	Individuals (no.)		Moth appearance (%), 1982-83									
		Treated	Molted	Dec		Jan		Feb		Mar		Apr-May	Jun
				1-15	16-31	1-15	16-31	1-15	16-29	1-15	16-30		1-15
S. incertulas	H 10	8	3	67	33								
	H 100	36	12	8	8	83							
	M 10	10	2	100									
	M 100	37	9	67	33								
	C	25	12						17	75	8		
C. auricilius	H 100	40	32		53	47							
	H 200	48	40		100								
	P 50	26	20		50	50							
	P 100	46	23		44	57							
	P 150	46	24		63	38							
	C	25	21					100					
C. partellus	H 100	30	20					60	25	15			
	H 200	35	20		14	86							
	P 50	10	7				71	29					
	C	10	10										100

[a]H = hydroprene, M = methoprene, C = control, P = precocene-II.

Life cycle of *Marasmia patnalis,* a leaffolder (LF) of rice in the Philippines

R. C. Joshi, E. Baldos and E. A. Heinrichs Entomology Department, IRRI

From Oct to Mar 1984, caterpillars of *Marasmia patnalis* Bradley (Lepidoptera: Pyralidae) were observed folding and damaging rice leaves at IRRI. This LF species is widely distributed in Southeast Asia. However, it has escaped attention of rice entomologists because of superficial similarity to the more commonly known LF *Cnaphalocrocis medinalis.*

We studied the life cycle and habits of *M. patnalis* in the greenhouse at 26-34°C with 70-80% relative humidity. Gravid female moths collected from the field

Life cycle of LF *Marasmia Patnalis* reared on TN1 rice, IRRI, 1984.

Character	Duration[a] (d)		Survival (%)
	Range	Average	
Egg	4-5	4	92.3
Larva	21-25	23	88.0
Prepupa	1-2	1	–[b]
Pupa	7-11	9	74.0
Total development period	33-43	37	
Adult longevity			
Male	4-3	3	
Female	5-7	5	

[a]n = 60 males and 60 females. [b]No data.

were used for biological studies. More eggs were laid on the upper than the lower leaf surfaces. Eggs were laid singly or in groups of 2 to 9, groups of 2 being most common. Sometimes eggs were found on leaf sheaths. Incubation period was 4 d (see table). The larvae passed through 6 instars in 23 d. The first-instar larvae, feeding in groups, scrape the leaf surface. They prefer young rice seedlings. The second-instar larvae fold leaves and feed within the fold. Feeding by all instars is on parenchyma tissue (between veins). Larvae did not feed on bundle sheath and sclerenchyma tissue.

Pupation is within a silken cocoon, most commonly between two leaves that have been tied together. Pupation occurs in 9 d at the base of inner tillers.

Adult emergence was most frequent at 2200-2400 h. Male to female ratio was 2:1 (n = 80). Females laid about 120 eggs. Development period and percent survival at different stages are in the table. □

Oviposition of rice whorl maggot as influenced by azolla

V. D. Viajante and E. A. Heinrichs, Entomology Department, IRRI

Interest in azolla, which covers the water surface in flooded rice fields, as an N source is increasing. Oviposition by RWM *Hydrellia philippina* is higher on plants growing above open water. Close planting decreases oviposition and subsequent RWM damage.

In 1983 dry season, we studied the effect of azolla growth on RWM oviposition on rice plants. Plots (6 × 8 m) with azolla and without azolla were arranged in a randomized complete block design. Water depth was increased to 5 cm and azolla was incorporated. In 3 d, the water surface was covered with azolla growth.

Before transplanting, water was drained slowly from the azolla plots to prevent azolla loss. Different transplanters were assigned to azolla-inoculated and uninoculated plots. Three days after transplanting (DT) water depth was increased to 5 cm and maintained there throughout the study period. Azolla was added to maintain a complete surface cover.

Plants in plots without azolla had four times more RWM eggs than those in inoculated plots (see table). As a result of the higher egg population, larval damage was significantly higher on plots without azolla. Percent damaged leaves on the azolla-inoculated plots was about 50% of that of the azolla-free plots. It is evident that azolla can be used in an integrated pest management program as a cultural method for controlling RWM. □

Effect of azolla on RWM oviposition, IRRI, 1983 dry season. [a]

	Eggs (no./hill)					Damaged leaves/ hill (%)
	5 DT	10 DT	15 DT	20 DT	25 DT	25 DT
With azolla	2.9	3.6	3.7	5.4	8.0	38
Without azolla	9.2	16.1	17.3	17.7	16.8	71
Difference [b]	6.3**	12.6**	13.6**	12.3**	8.8**	33**

[a] Av of 8 replications. Sample size = 10 randomly selected hills/plot. b** = Significantly different at the 1% level by LSD.

Biology of the rice green leafhopper (GLH)

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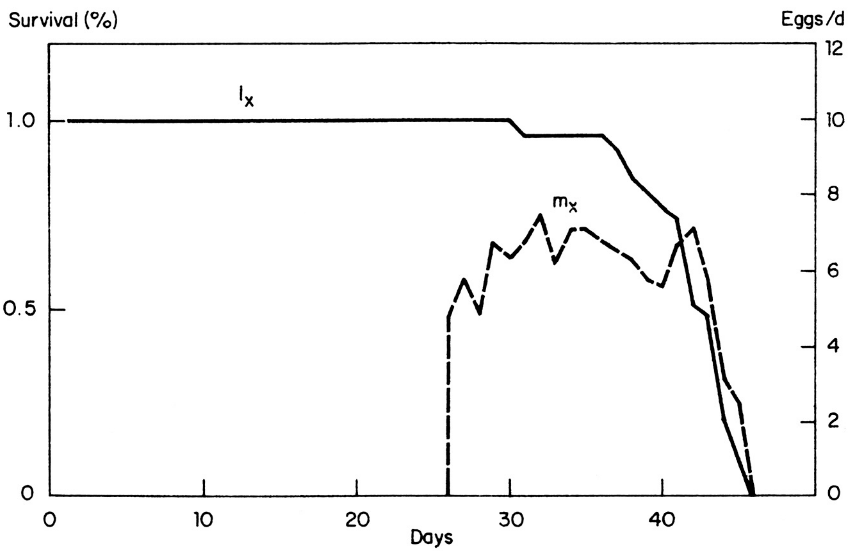
The biology of the rice green leafhopper *Nephotettix malayanus* Ishihara and Kawase, found mainly on graminaceous weed *Leersia hexandra* Sw was studied in a 25±°C room using a susceptible japonica variety. GLH were originally collected in the subtropical Ryukyu Islands in southwestern Japan.

The mean incubation period of GLH eggs was 8.24 d. Female nymphs developed in 23.2 d, and the male in 21.9 d. Preovipositional period was 4.9 and females laid an average 117 eggs. Males lived 14.4 d and females 19.5 d.

A GLH generation is about 34 d and net reproductive rate is 101.97. The calculated capacity for population increase was 0.136.



Survival (l_x) and fertility (m_x) curves of GLH, Kyoto, Japan.

The figure shows that GLH can live 46 d in the absence of natural enemies. The fertility curve (m_x) gives the mean number of eggs laid/d and shows that oviposition peaked 33 d after hatching. □

Influence of source and level of nitrogen application on pest incidence

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In a field experiment, we compared the effect of ammonium chloride and urea N at 50, 100, 150, or 200 kg N/ha on pest incidence in 1983-84 samba.

Thirty-d-old IR20 seedlings were planted in 8- × 6-m plots at 20- × 15-cm spacing. One-half N was applied basally and one-half in split doses 25 and 45 d after planting (DT). At planting, 22 kg P and 42 kg K/ha were applied. The crop was treated with carbofuran 3 G at 0.5 kg ai/ha 22 DT. The experiment had eight treatments in four replications.

Leaffolder (LF) damage was recorded on 20 hills/plot 60 DT. Gall midge (GM) infestation, number of silvershoots. and number of tillers on 20 hills/plot were recorded at 60 DT. At harvest, number of whiteheads and productive tillers on 20 hills/plot were recorded to determine stem borer (SB) infestation (see table).

Increasing N application increased LF and SB incidence, but N source did not affect pest population.

GM intensity was greatest at low N application. Urea N plots had significantly higher GM incidence than ammonium chloride plots. All pest incidence was low at the recommended application of 100 kg N/ha. □

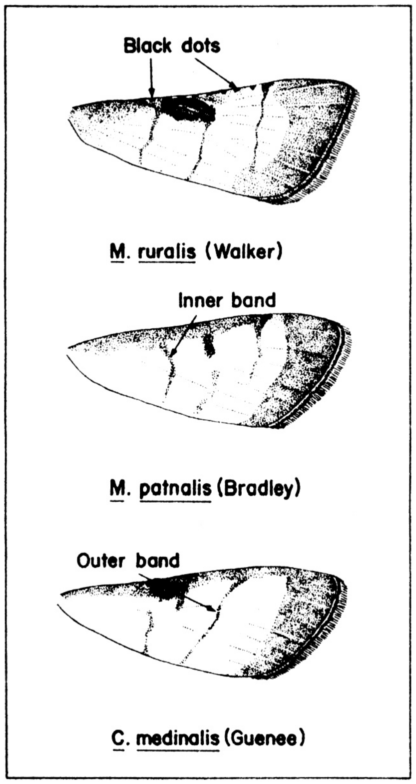
Effect of N source and level on pest incidence in 1983-84 samba, Tirur, India.

N	LF damage (%)			GM silvershoots (%)			SB whiteheads (%)		
(kg/ha)	Urea	Ammonium chloride	Mean	Urea	Ammonium chloride	Mean	Urea	Ammonium. chloride	Mean
50	19	17	18 a	28	24	26 b	23	22	23 a
100	21	21	21 a	23	22	22 a	25	25	25 ab
150	30	28	29 b	20	21	21 a	27	26	27 b
200	40	38	39 c	23	19	21 a	30	29	30 c
Mean	27	26		24 b	21 a		26	26	
CD for source : ns					1.76		ns		
CD for N levels: 3.93					2.49		2.83		
CD for interaction: ns					ns		ns		

Identification of rice leaffolders (LF) by wing markings

A. T. Barrion and J. A. Litsinger, Entomology Department, IRRI

Cnaphalocrocis medinalis (Guenée) is the only reported LF pest of rice in the Philippines. Recently, two *Marasmia* species with similar appearance were found to damage rice leaves. We developed an illustrated key (see figure) based on wing markings to identify each species. □



Wing markings of LF in the Philippines.

Scarabaeid beetle outbreak in upland rice

S. Sharma, Indian Council for Agricultural Research Complex for NEH Region, Nagaland Centre, Medziphema 79106, India

The scarabaeid beetle *Alissonotum simile* Arrow (Coleoptera:Scarabaeidae: Dynastinae) severely damaged (90%) upland rice Nagaland special, a local tall variety around Medziphema in Kohima District in Apr-Jun 1982. This is the first recorded incidence of the scarabaeid beetle in northeastern India. *A. simile, A. piceum* (F.) and *A. impressicole* (Arr.) have been recorded in sugarcane fields in Bihar, Assam, and West Bengal where they damage new shoots beneath the soil and cause deadhearts. In severe cases the shoots may be cut.

Both grubs and adults damaged rice, but adult beetles did more harm by cutting young plants just below the soil surface. Rice plants at maximum tillering were heavily attacked. The larvae fed on roots, but caused little damage. □

Influence of water regime on rice whorl maggot oviposition

V. D. Viajante and E. A. Heinrichs, Entomology Department, IRRI

Rice plants grown with continuous standing water the first 3-4 wk after transplanting have more *Hydrellia philippina* (RWM) damage than plants in fields where the soil is saturated, but without standing water. We evaluated RWM oviposition on plants in saturated and flooded plots.

Fifteen-day-old IR36 seedlings were transplanted at 25- × 25-cm spacing in 6- × 25-m plots. Saturated and flooded treatments were in a randomized complete block design. In flooded plots, water was maintained at a 5-cm depth from transplanting to 25 d after transplanting (DT). There was no standing water in the saturated plots.

RWM flies preferred the flooded plots for oviposition (see table). There were three to six times more eggs in flooded plots than in saturated plots. □

Effect of water regime on RWM oviposition on rice, IRRI, 1983. [a]

Water regime	Eggs (no./hill)				
	5 DT	10 DT	15 DT	20 DT	25 DT
Saturated	4.0	3.0	2.4	3.6	2.9
Flooded	12.8	17.7	13.8	12.7	12.3
Difference [b]	8.8**	14.7**	11.4**	9.1**	9.4**

[a] Av of 8 replications. Sample size = 10 randomly selected hills/plot. [b] ** = Significantly different at the 1% level by LSD.

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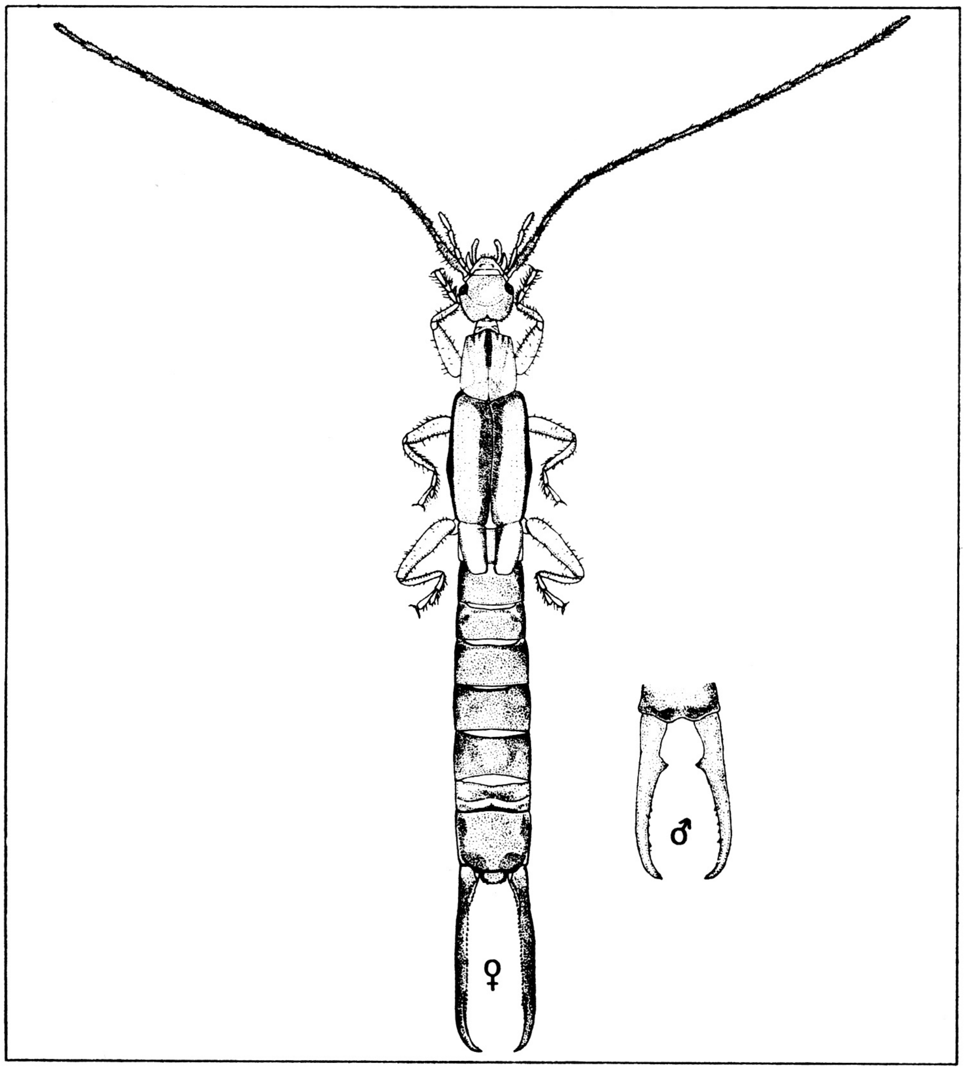
Proreus simulans (Dermaptera:Chelisochidae), a predator of rice leaffolder (LF) and skipper larvae

A. T. Barrion and J. A. Litsinger, Entomology Department, IRRI

Adult *P. simulans* (Stal), an important earwig predator of oriental maize borer *Ostrinia furnacalis* (Guenée) larvae, were collected from flooded, rainfed lowland rice fields at Brooke's Point, Palawan, Philippines. They were found inside leaves folded by LF *Cnaphalocrocis medinalis* (Guenée) and within the feeding chambers (groups of leaves joined by silk) of rice skipper *Pelopidas mathias* (F.). Larvae were consumed whole, partially eaten, or injured by *P. simulans* forceps.

P. simulans is about 19 mm long with red-brown lateral margins on the wing covers (elytra) and yellow legs with fine hairs (see figure). P. simulans was previously thought to inhabit upland environments, notably sugarcane fields, from which they enter maize fields to reproduce. At Brooke's Point, no sugarcane was near the rice fields. Tall grasses, dominated by *Scirpus grossus* L., were noted in nearby swampy areas and may serve as the refuge of the predator. □



P. simulans kills larvae with the long forceps that it projects forward over its body by arching its abdomen. The male has a prominent pair of spines on the inside of the forceps.

ERRATUM

G. Ram and A. K. Rawat. Effect of blue green algae (BGA) on rice yield at different locations and residual effect on gram. 9(6) (Dec 1984).

Page 25: In Table 2, the 1981 data for Sarkanda should read 2.4, 2.8, 3.0, 3.0, 3.3, 3.6, 3.9, 3.9, and 0.4.

Sensitivity of brown planthopper (BPH) to four carbamate insecticides at IRRI

L. T. Fabellar and O. Mochida, Entomology Department, IRRI

Previous field and laboratory studies on insecticide susceptibility of BPH at IRRI showed that field-collected BPH were less sensitive or resistant to some insecticides than the insecticide-free greenhouse populations.

For further comparison, BPH were collected in Oct 1982 from IRRI fields where insecticides had been continuously applied. The BPH were reared in the greenhouse for five generations without insecticides. The sensitivity of the 5th-generation BPH to four carbamates was compared with that of the original greenhouse culture. Twenty 2- to 7-d-old brachypterous adult female BPH were used in each replication. A 0.1 µl of a serial dilution of each insecticide was topically applied with a Burkard microapplicator. Control insects were treated with acetone alone.

The mortality was checked on TN1 24 h after caging. LD_{50} values of both field-collected and greenhouse populations were 0.28 to 3.32 for all insecticides except for BPMC which was 10.38 for the field-collected population. The highest estimated resistance ratio (ERR) of 5.61 was obtained for field-collected BPH treated with BPMC, indicating that the field-collected BPH were significantly less sensitive (or resistant) to BPMC than the greenhause population (see table). □

Sensitivity level of greenhouse and field-collected BPH to 4 carbamate insecticides. IRRI, Jan 1983.

Insecticide	LD_{50}[a] (µg/g) Field-collected BPH	Greenhouse BPH	ERR[b]
BPMC	10.38 a	1.85 b	5.61
Carbaryl	2.36 a	2.65 a	0.89
Carbofuran	0.85 a	0.28 a	3.04
MTMC	2.79 a	3.32 a	0.84

[a] Av of 3 replications at 25-27°C with 60-80% relative humidity and 12-h daily illumination. In a row, LD_{50} values followed by a common letter are not significantly different at 5% level.

[b] $\text{ERR} \frac{LD_{50} \text{ value (field-collected)}}{LD_{50} \text{ value (greenhouse)}}$.

Pest Control and Management

OTHER PESTS

Effect of green manure and nitrogen on mole rat damage and leaffolder (LF) incidence in rice

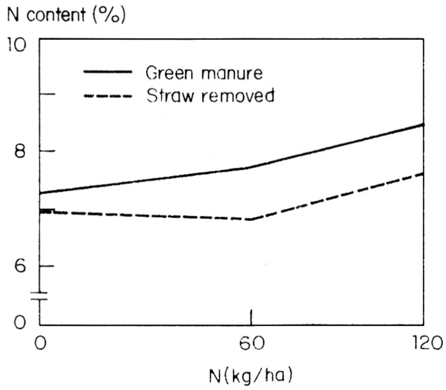
R. S. Rekhi, J. Singh, and O. P. Meelu, Punjab Agricultural University (PAU), Ludhiana, India

We studied the effect of combined green manure and N application to rice on incidence of mole rat *Bandicota bengalensis* (Gray) (Rodentia:Murinae) and LF *Cnaphalocrocis medinalis* (Guenee) at the Department of Soils experimental farm, PAU, in 1983 wet season. The experiment was laid out in a factorial randomized block design with three replications. Plot size was 10- × 2.8-m. Soil was a loamy sand, Typic Ustochrept, with pH 8.2, EC 0.17 dS/m, 0.17% organic carbon, and CEC 4.5 meq/100 g soil. Mungbean *Vigna radiata* (cultivar G-65) was sown the 3d wk of Apr.

In one set of plots, the mungbean crop was harvested and removed from the field. In the other, mungbean pods were picked and plants were incorporated as green manure 1 d before transplanting rice. The succeeding rice crop received 0, 60, or 120 kg N/ha with and without green manure incorporation. Thirty-five-day-old PR106 seedlings were transplanted the last wk of Jun. N was applied in 3 equal splits at transplanting and 3 and 6 wk after transplanting. A basal dose of 13-25 kg PK/ha also was applied.

On 9 Sep, the number of rat-damaged tillers was recorded. LF incidence was recorded on 4 Oct by counting the LF-damaged leaves on 10 hills from each plot. Plant samples were analyzed for N content by semimicro-Kjeldahl digestion and distillation.

When no N was applied, rat damage and LF incidence did not differ significantly for green manure and straw-removed treatments (see table). Rat damage increased with N rate in green manure treatments, and LF incidence increased with N rate in both green manure and straw-removed treatments. Higher pest incidence with N + green manure may be attributed to the higher plant N content (see figure). □



Effect of mung straw green manure and N on N content of rice straw.

Effect of mung straw green manure and N on rat damage and LF incidence in rice. Ludhiana, India.[a]

N (kg/ha)	Rat damage (tillers/m^2) Green manure	Straw removed	Difference	LF incidence (damaged leaves/l0 hills) Green manure	Straw removed	Difference
0	0.7 b	0.1	0.6 ns	11.3 c	7.0 b	4.3 ns
60	2.3 b	0.8	1.5 *	22.7 b	9.3 b	13.4 *
120	11.9 a	1.0 ns	10.8 **	65.0 a	25.3 a	39.7 **

[a] In a column, means followed by the same letter are not significantly different at 5% level. * = significant at 5% level, ** = significant at 1% level, ns = not significant.

Meloidogyne oryzae, a pest of irrigated rice in Surinam

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We studied rice root-knot nematode *M. oryzae* populations in Nickerie, the main rice cultivating area of Surinam. Rice cultivation on heavy clay soils in the coastal plain is completely mechanized. Root-knot nematode infestation was mainly on higher land within flooded fields. Thorough flooding reduced infestation and plants recovered slightly. Heavily infested rice plants were stunted, with galled roots and yellow-brown leaves. In nematode-infested fields, crop growth often was limited by P deficiency, weed competition, or acid soil.

Adult females and egg masses were embedded in the roots. *M. oryzae* life cycle took about 4 wk at a mean 27°C. Infestation was concentrated in areas where rice had been planted for at least 30 yr — the last 10 with 2 crops annually.

Greenhouse trials determined if *M. oryzae* reduced growth and yield of rice. Three plants per pot were sown in a 10- × 30-cm polyvinyl chloride containers filled with heavy clay soil (pH = 5.5). Ten thousand *M. oryzae* eggs were added to 30 pots and 30 were left uninoculated. Fifteen pots of each group were flooded to ≤ 5 cm and 15 pots were kept without standing water. Although no differences in plant growth were apparent at 45 d after sowing, rice yield was 15% lower in flooded inoculated soil and 9% less in inoculated soil without standing water than in nematode-free pots. Yield was negatively correlated with the number of galls, eggs, and second-stage larvae in the roots ($r = -0.74$; $r = -0.59$ $p<0.01$) in the flooded pots.

Five rice varieties (Diwani, Camponi, Pisari, SKK, and Holland) were good *M. oryzae* hosts, as were weeds *Fimbristylis miliacea, Echinochloa crus-pavonis, E. colonum, Hymenachne amplexicaulis,* and *Eleocharis* sp. The nematode also reproduced on wheat, potato, tomato, sorghum, and plantain, but not on maize, cotton, peanut, sweet pepper, sweet potato, watermelon, or tobacco.

Deep flooding seems to control *M. oryzae* in irrigated rice fields. Because irrigation water is not always available, we tested different seed treatments for nematode control.

In greenhouse trials, carbofuran at 2.4, 4.8, and 7.2 g ai/kg seed reduced galls by 57, 79, and 80%. Oxamyl was ineffective. □

Irrigation Water Management

Water harvesting for rainfed rice cultivation

J. S. Urkurkar, A. S. R. A. S. Sastri, and B. R. Chandrawanshi, Zonal Agricultural Research Station, Jawaharlal Nehru Agricultural University, Raipur, India

Eight percent of 4.7 million ha of rice in central India is rainfed. Drought is a major cause of unstable yields. We developed a water harvesting technique to stabilize yields.

A series of 8 high and low beds (560 m^2 each) were constructed. Soybean was grown on raised beds and rice in the sunken beds. We estimated the percentage of runoff from high to low beds based on rainfall intensity, infiltration rate, and water balance computations with effective rainfall and Penman's potential evapotranspiration (see table).

About 46% of total rainfall can be harvested as induced runoff. Soybean, which has low water requirement, grows well on the raised beds which feed water onto lower beds where rice is planted. Using this system over 3 yr, soybean and rice yielded an average 2.3 and 2.6 t/ha versus no-treatment fields with 1.5 t/ha. □

Runoff and grain yield using water harvesting.

Year	Seasonal rainfall (mm)	Runoff[a] (mm)	Total water available (mm)		Yield (t/ha)	
			Soybean	Rice	Soybean	Rice
1981	1119	512.7	607	1632	2.2	2.8
1982	792	375.9	416	1168	2.2	2.2
1983	1263	568.4	695	1831	2.4	3.0

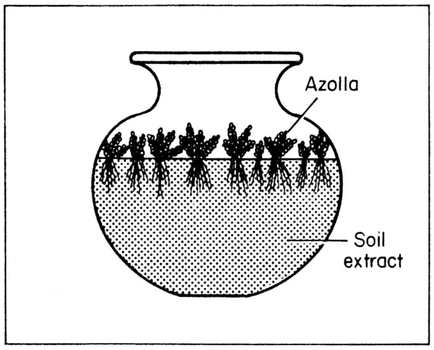
[a] Runoff was estimated by analyzing intensity of rainfall and infiltration rate as well as through water balance technique.

Soil and Crop Management

Summer storage of azolla in mud pots

S. Venkataramanan and S. Kannaiyan, Agricultural Microbiology Department, Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

Maintaining azolla populations at high summer temperatures is a major constraint in azolla cultivation. In Apr 1983 we evaluated 2-, 3-, 5-, 8-, or 10-litre mud pots filled with 1, 2, 4, 6, or 8 litres of water or soil extract for azolla



Mud pot for growing azolla during summer, Tamil Nadu, India

Azolla growth in mud pots in summer, Tamil Nadu, India.

Pot capacity (litre)	Pot surface area (cm^2)	Mean azolla growth in water (g)	Mean azolla growth in soil extract (g)
2	176.8	21	23
3	314.3	23	25
5	452.6	25	26
8	616.0	14	19
10	804.5	13	14
CD		1.867	2.146

storage (see figure). The mud pots were made of fine alluvial soil and fired for 3 to 4 d. Similar pots are used to store and cool water in the local villages.

The soil extract was prepared by mixing 1 kg of clay soil with 1 litre of water and then filtering through muslin, Five ppm superphosphate was added to water and 10 ppm to soil with 20 ppm of carbofuran and carbendazim. Each pot was inoculated with 20 g fresh azolla fronds, and kept in sunlight. Temperature was 35 to 39 °C. The biomass was recorded 10 d after inoculation. The 3- and 5-litre pots encouraged azolla growth (see table). Black rot developed in 8- and 10-litre pots because of the cooling effect. Pots with soil extract solutions were best for azolla maintenance at high temperatures. □

Yield response of rice to phosphorus

A. U. Bhatti and J. K. Khattak, Northwest Frontier Province (NWFD), Agricultural University, Peshawar; and A. H. Gurmani, Agricultural Research Station, Dera Ismail Khan, Pakistan

We studied yield response of rice to P application at the Government Seed Farm, Rakh Mangan, in Dera Ismail Khan. Soil was a clay with 15% $CaCO_3$, pH 7.7, 0.8% organic matter, 5 ppm Olsen P, 150 ppm available K, and 0.04% N. Pretreatments were 0, 10, 20, or 30 ppm of fertilizer P to ensure that soils varied in initial available P content.

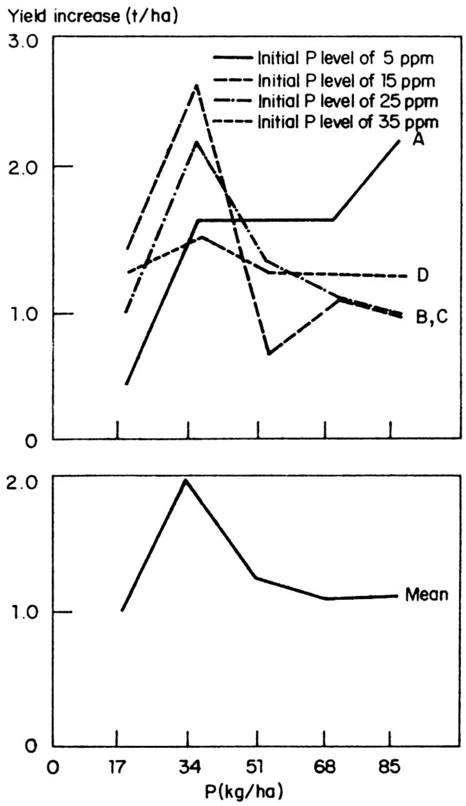
P treatments were in a randomized complete block design with 3 replications in 5- × 2-m plots. P was thoroughly mixed into the surface soil with basal doses of N and K. Plant height, panicles/m^2, and grain and straw yield were recorded and a combined analysis of the data was done by keeping soil types in main plots and P treatments in subplots.

Rice yielded significantly highest (7.4 t/ha) with 34 kg P/ha + NK (see table). Soil and treatment interactions also were significant. Straw yield and plant height were not significantly affected by P. Effect on number of panicles/m^2 was significant, and highest at 85 kg P/ha. The response to P treatment at initial soil P level was somewhat linear. As the initial soil P level increased, response to P treatment beyond 34 kg P/ha decreased (see figure). □

Yield response of rice to P, Dera Ismail Khan, Pakistan.

Treatment (kg/ha)			Grain yield (t/ha) at P content of				Mean yield (t/ha)	Mean straw yield (t/ha)	Mean panicles/m^2	Mean plant height (cm)
N	P	K	5 ppm	15 ppm	25 ppm	35 ppm				
0	0	0	4.4	4.1	4.8	3.3	5.1 d	7.7 b	248 c	100
100	0	75	5.5	5.1	5.5	5.5	5.4 c	12.4 a	325 ab	111
100	17	75	5.9	6.5	6.5	6.7	6.4 b	13.1 a	305 b	109
100	34	75	7.1	7.7	7.7	7.0	7.4 a	12.8 a	320 ab	111
100	51	75	7.1	6.1	6.8	6.7	6.7 b	12.9 a	320 ab	114
100	68	75	7.1	5.8	6.5	6.7	6.5 b	13.4 a	301 ab	115
100	85	75	7.7	5.5	6.4	6.7	6.6 b	13.7 a	331 a	112
Mean			6.40 a	5.82 b	6.31 ab	6.08 b				
Fertilizer					Significant			Significant	Significant	ns
Interactions (fertilizer × soils)					Significant			ns	Significant	ns
Soils					Significant			ns	ns	ns

Means followed by similar letters do not differ significantly from one another.



Response curves of P for rice at different initial soil P levels, Dera Ismail Khan, Pakistan.

Management of aged seedlings of medium-duration rices

P. Balasubramaniyan, assistant professor, Tamil Nadu Rice Research Institute, Aduthurai 612101, India

We studied the response of 50-d-old IR20 seedlings in a factorial randomized block

Management of 50-d-old IR20 seedlings, Aduthurai, India, 1983–84 thaladi.

Basal N (kg/ha)	Grain yield (t/ha) 10 × 10 cm	15 × 10 cm	20 × 10 cm
50	3.0	2.8	2.9
62.5	3.1	3.0	3.1
75	3.3	3.4	3.7
Mean	3.1	3.1	3.2

CD (P = 0.05)

Spacing : NS
Nitrogen : 0.34
S × N : 0.58

design with 4 replications of 3 spacings (10- × 10-cm, 15- × 10-cm, and 20- × 10-m) and 3 basal N rates: recommended dose. 50 kg N/ha; 25% more N, 62.5 kg N/ha; and 50% more N, 75 kg N/ha. All treatments were topdressed with urea at 50 kg N/ha in 2 splits at 15-d intervals. Soil was clay loam with pH 7.5, low available N, and medium P and K.

Planting aged seedlings at close spacing did not significantly increase yield. Basal application of 75 kg N/ha gave significantly higher yield. Interactions between spacing and N application rates were significant. At 10- × 10-cm spacing, there was no significant yield difference between N application rates, but at 15- × 10-cm and 20- × 10-cm, yield increased significantly with more N. The 20- × 10-cm spacing and basal 75 kg N/ha gave the highest yield (see table). □

Stubble management for summer lowland rice

G. S. Thangamuthu, Agronomy Department, Tamil Nadu Agricultural University (TNAU), Coimbatore 641012, India

We evaluated stubble management to reduce the required fertilizer application for lowland rice in Jan-Feb 1982-84 at TNAU. Co 43 was planted the first season and IR20 the second. The soil was a clay loam with pH 8.0-8.5 (1:2.5 soil water ratio). Temperature varied from 17°C to 30°C during the cropping season.

N content of the stubble was 0.4-0.5% by weight. Stubbles of different heights were left in the field after harvest and plow-incorporated, then 22 kg P as powred rock phosphate and 42 kg K as muriate of potash were applied. One week to 10 d after stubble incorporation, the field was plowed again, leveled, and the second rice crop planted. Results showed that with stubble incorporation chemical N application could be reduced without yield loss (see table).

In both years, 45-cm-tall stubble with 50% of the normal N fertilizer yielded highest among treatments and at par with the recommended application of 100-22-42 kg NPK/ha. □

Effect of stubble incorporation on N application and grain yield, Coimbatore, India.

Treatment	Grain yield (t/ha)	
	Summer 1982-83	Summer 1983-84
Recommended dose (100-22-42 kg NPK/ ha)	5.2	6.5
15-cm stubble + 25% N	4.3	5.1
30-cm stubble + 25% N	3.2	5.2
45-cm stubble + 25% N	4.0	5.0
15-cm stubble +50% N	3.8	5.0
30-cm stubble + 50% N	5.0	5.2
45-cm stubble + 50% N	5.4	6.6
15-cm stubble + 75% N	4.4	5.6
30-cm stubble + 75% N	4.4	5.3
15 cm stubble + 15% N	4.1	5.8
CD	0.6	0.7

Response of lowland rice to fertilizer application

H. S. Baddesha and M. S. Maskina, Soils Department, Punjab Agricultural University, Ludhiana 141004, India

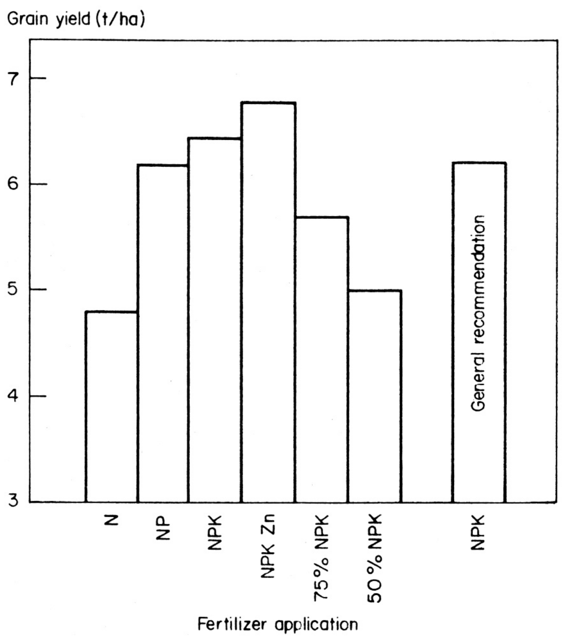
Often, a rice crop does not yield well even after liberal application of NPK. Next to N, P deficiency can be a major constraint to yield. Experiments to identify reasons for low yield indicate Zn deficiency limits rice production in Punjab. S deficiency can also be a constraint.

We studied the response of rice to balanced nutrient application based on general recommendations and soil analysis

Soil characteristics of fields at experiment sites in Punjab, India.

Site	Texture	pH	E. C. (mmho/cm)	Organic carbon (%)	Available P[a] (kg/ha)	Available K[b] (kg/ha)
1	Sandy loam	8.7	0.20	0.48	7.5	465
2	Sandy loam	9.0	0.30	0.38	10.0	450
3	Sandy loam	9.0	0.30	0.33	10.0	420
4	Sandy loam	9.2	0.30	0.21	10.0	412
5	Sandy loam	8.8	0.30	0.45	12.5	262

[a]Determined in Olsen's extract (0.5 N $NaHCO_3$ solution: pH 8.5). [b]Extracted with neutral normal ammonium acetate solution.



Response of rice to fertilizers (mean of 5 sites).

at five sites in farmer fields in Punjab. NPK was applied at 120-13-24 kg/ha, based on the general recommendation. When fertilizer application was based on soil analysis, 25% more N and P and 25% less K were applied, except at site 5 (see table). Soils were deficient in DTPA extractable Zn and 10 kg Zn/ha was applied. Soils were medium-textured and alkaline with low electrical conductivity, organic carbon, and available P and high available potash.

Data in the figure show the yield differences obtained by applying N, NP, NPK, and NPKZn. Application of NP increased yield 1.4 t/ha (30%) than applying N alone. Soils with P deficiency responded significantly to P application. Response to applied K was small. When 50 kg $ZnSO_4$/ha + NPK were applied, yield increased 0.6 t/ha (12%) over yield with NPK alone.

Our research showed that applying only N fertilizer is not sufficient to maximize rice yield. A balanced application of nutrients, including Zn and S, based on soil analysis, results in optimum yield. □

Rice-Based Cropping Systems

Rice and air-breathing fish culture: effects of seasonal variations on the yields of grain, straw, and fish

S. K. Datta, D. Konar, S. D. De, and P. K. Banerjee, Operational Research Project (ORP), Pandua, West Bengal, India; and P. K. Mukhopadhyay and P. K. Pandit, Central Inland Fisheries Research Institute, Barrackpore, West Bengal, India

We studied the effects of seasonal variations on the yields of mixed cultures of air-breathing catfish Singhi (*Heteropnaustes fossilis*) and Magur (*Clarias batrachus*) and high yielding rices at ORP in pre-kharif (Mar-Jun), kharif (Jun-Nov), and boro (Nov-Apr) rice seasons. Rices Ratna, Pankaj, and Jaya were grown.

Experiments consisted of a control treatment of rice without fish and plots of rice with air-breathing fish. Plots were 35 × 10 m with a shallow 75- × 40-cm-perimeter canal, bounded by a dike. Equal numbers of Magur and Singhi fingerlings were stocked at 1 fish/m^2 7 d after transplanting. Before stocking, they were treated with a 100 ppm solution of formalin for 30 s. Each morning, fish were fed a low-cost 1:2 mixture of fishmeal and rice bran mixed with cowdung at 5% body weight. Fish were harvested with rice by draining the plots.

Soil was a clay loam with pH 6.5-7.0. Farmyard manure at 9 t/ha was applied to all plots during land preparation. The plots were plowed and 100 kg N/ha was applied: 1/2 at land preparation and 1/2 in equal splits 1 mo after transplanting and 1 wk before flowering. PK at 18-33 kg/ha was applied during tillage. Seedlings at 2/hill were transplanted at 15- × 15-cm spacing. Standard cultivation methods were practiced and field water level was maintained at 8-10 cm. Plankton consisted mainly of *Spirogyra, Volvox, Ulothrix, Euglena, Pinularia, Monia, Cyclops, Keratella,* and *Brachionus.*

Combined rice and fish culture produced best in all seasons. Grain and fish yield were maximum in boro followed by pre-kharif and kharif (see table). Straw yield was maximum in kharif. Of the three varieties, Jaya performed best.

Stem borer population was highest in the control and least in rice-fish plots. □

Effects of seasonal variations on the yield of grain, straw, and fish at ORP, Pandua, West Bengal, 1983-84.

Yield factor	Yield (t/ha)					
	Prekharif (Ratna)		Kharif (Pankaj)		Boro (Jaya)	
	Without fish	With fish	Without fish	With fish	Without fish	With fish
Grain	3.2	3.8	3.0	3.1	5.9	6.4
Straw	8.1	8.1	8.9	9.7	5.0	5.8
Fish	–	0.4	–	0.4	–	0.5

Announcements

Meelu elected to ARRW Executive Committee

O. P. Meelu, senior research fellow, Multiple Cropping Department, IRRI, was elected Councilor (North Zone) to the Association of Rice Research Workers of the Central Rice Research Institute, Cuttack, India, for 1984 and 1985. Meelu is actively engaged in research on fertilizer efficiency in rice and rice-based cropping sequences at Punjab Agricultural University. □

New IRRI publications

New IRRI publications are available for purchase at the Communication and Publications Department Division R, IRRI, P. O. Box 933, Manila, Philippines.

An overview of upland rice research. Proceedings of the 1982 Bouaké, Ivory Coast, upland rice workshop

Genetic evaluation for insecticide resistance in rice, by E. A. Heinrichsm, F. Medrano, and H. Rapusas

Publications on international agricultural research and development

Blue-green algae book published

A checklist of blue-green algae in the Philippines is a compilation of all blue-green algae found in the Philippines from 1876 to 1983, including 361 species and varieties in 59 genera, 12 families, and 4 orders. Thirty-four percent was presumed to be N fixers.

Price (₱35 in the Philippines, $7 for foreign orders) includes surface postage and handling. Address orders to National Institutes of Biotechnology and Applied Microbiology, F. E. Marcos Foundation, Inc., University of the Philippines at Los Baños, College, Laguna 3730, Philippines. □

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