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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 involvingrice.
- 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) of 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- Do not cite references or include a bibliography.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

AGRONOMIC CHARACTERISTICS

Rapid generation advance of photoperiod-sensitive rice crosses under field conditions

S. K. Bardhan Roy and J. Mondal, Rice Research Station, Chinsurah, West Bengal, India

We evaluated segregating generations of Pankaj/Patnai 23 and Nagra 14-41/NC1281, two photoperiod-sensitive crosses intended for lowland conditions, for twice-yearly generation advance under field conditions. Patnai 23 and Nagra 14-41 are photoperiod-sensitive varieties, NC1281 is strongly photoperiod-sensitive, and Pankaj is a long-duration rice with weak photoperiod sensitivity.

The F_2 and F_4 populations were sown on 3 Jul and transplanted on 25 Jul in 1982 and 1983. Heading date, panicle length, and plant height were noted for each plant that flowered by 7 Nov. Four filled grains collected from each F_2 plant constituted the F_3 population. F_3 seeds were sown 12 Dec 1982 and transplanted on 7 Feb 1983. Heading date was recorded until 10 Jun, and four seeds per plant were harvested to grow the F_4 population. F_2 plants that flowered after 10 Jun were not included in the study.

Panicle initiation in the photoperiod-sensitive varieties occurred when day length was less than 11 h 58 min, which was in Sep-Oct in Chinsurah (22° 52'N). Short day length extended from Sep to Mar. The Nov/Dec sowing flowered early. Thus, seeds from the F_2 population were advanced in dry season as the F_3 population. Twelve percent of the F_2 plants and 36% of the F_3 from Nagra 14-41/NC1281 did not flower by 10 Jun. However, all progeny of Pankaj/Patnai 23 flowered appropriately in both seasons.

The above findings show the feasibility of advancing lowland/deepwater crosses by advancing 2 generations a year in the field. □

Distribution of panicle length and plant height in F_2 and F_4 of two crosses, West Bengal, India.

	Distribution (% of population)			
	Pankaj/Patnai 23		Nagra 14-41/NC1281	
	F_2	F_4	F_2	F_4
Panicle length [a] (cm)				
15-19	0	0	0	0
20-24	55	67	40	34
25-29	41	33	58	61
30-34	3	0	2	5
Mean	(24)	(24)	(26)	(25)
Plant height [b] (cm)				
100-119	22	34	2	28
120-139	41	42	56	52
140-159	31	23	40	20
160-169	6	1	2	0
Mean	(135)	(127)	(135)	(132)

[a] Av panicle length: Pankaj, 28 cm;Patnai 23, 25 cm; Nagra 14-41, 24 cm; NC1281, 27 cm. [b] Av plant height: Pankaj, 114 cm; Patnai 23, 138 cm; Nagra 14-41, 137 cm; NC1281, 139 cm.

Genetic Evaluation and Utilization
DISEASE RESISTANCE

Rices with multiple disease resistance

V. P. S. Dev and C. A. Mary, Regional Agricultural Research Station (RARS), Pattambi 679306, Kerala, India

In 1983 kharif, under the All India Coordinated Rice Improvement Project, 328 rice cultures of National Screening Nursery I were evaluated at RARS for resistance to blast (Bl), sheath blight (ShB), and bacterial blight (BB). B1 screening was done under upland conditions using the uniform B1 nursery pattern. Screening for ShB and BB was in transplanted fields with artificially induced disease. Each test entry was planted in two 2-m rows spaced at 20 × 15 cm for ShB and BB in 2 separate plots. Disease reactions were judged using the *Standard evaluation system for rice* scale.

Sixteen entries were resistant to both B1 and ShB, 6 entries to B1 and BB, and 39 entries to ShB and BB. Four entries had resistance to the three diseases (see table). ☐

Rices with multiple resistance to B1, ShB, and BB, RARS, Pattambi, India.

IET no.	Cross	Reaction[a] to BL	ShB	BB
8236	CR-151-79/CR1014	MR	MR	R
8288	Vikram/Benong III	MR	MR	MR
8314	IR32/IET6314	MR	MR	MR
8748	Jaya/T22A	R	R	MR

[a] MR = moderately resistant, R = resistant.

Genetic Evaluation and Utilization
INSECT RESISTANCE

Virulence of green leafhopper (GLH) *Nephotettix virescens* colonies on rice cultivars with the *Glh 2* or *Glh 5* gene for resistance

E. A. Heinrichs and H. R. Rapusas, IRRI

We have unsuccessfully attempted to select GLH colonies that are virulent on ASD7 (which has the *Glh 2* gene for resistance) and on ASD8 (with *Glh 5).* We sought to determine whether other colonies selected for 37 generations for virulence to Pankhari 203 *(Glh 1),* IR8 *(Glh 3),* Ptb 8 *(glh 4),* TAPL #796 *(Glh 6),* and Moddai Karuppan *(Glh 7)* had cross virulence to ASD7 or ASD8. Results were compared with colonies reared on susceptible TN1. Resistance scoring was based on population growth.

Six-day-old seedlings of the test cultivars were transplanted, 5 seedlings/pot, in 10-cm-diam clay pots. There were four replications, with each pot representing a replication. Two weeks after transplanting, the individual pots were placed in 10- × 90-cm mylar film cages to protect them from other pests, parasites. and predators. Ten days later, they were inspected and all parasites, predators, and other pests were removed from the cage. Then, 5 pair (male and female) of GLH adults from the different colonies were introduced into each cage. Twenty-five days after infestation, the GLH population in each cage was counted and progeny per female was calculated.

There were significant differences in the levels of resistance among the seven

Population growth of GLH on different rice cultivars, IRRI.

Cultivar	Gene	Population growth (progeny/female) on each colony[a] Pankhari 203	IR8	Ptb 8	TAPL 796	Moddai Karuppan	TN1
ASD7	*Glh 2*	1 a (a)	1 a (a)	1 a (a)	1 a (a)	1 a (a)	4 a (a)
Godalki	*Glh 2*	120 d(a)	55 c (a)	76 d (a)	84 d (a)	68 de (a)	82 d (a)
Lien-tsan 50	*Glh 2*	27 cd (c)	3 a (a)	4 b (a)	8 bcd (ab)	11 c (ab)	19 b (bc)
Palasithari 601	*Glh 2*	7 c (a)	3 a (a)	10 bc (a)	2 bc (a)	11 cd (a)	9 ab (a)
Ernest	*Glh 2*	10 c (ab)	1 a (a)	10 bc (b)	5 bcd (ab)	5 b (ab)	19 b (b)
Bignou	*Glh 2*	33 cd (b)	14 ab (ab)	16 bc (ab)	11 cd (a)	32 cde (b)	26 bc (ab)
Tilockkachari	*Glh 2*	1 b (a)	1 a (a)	1 a (a)	2 b (a)	1 a (a)	3 a (a)
ASD8	*Glh 5*	4 c (ab)	1 a (a)	3 b (a)	1 a (a)	2 ab (a)	20 b (b)
IR29 (resistant check)	Unidentified	23 cd (ab)	22 bc (ab)	25 cd (ab)	3 b (a)	75 de (c)	51 cd(b)
TN1 (susceptible check)	None	134 d (a)	75 d (a)	76 d (a)	97 d (a)	135 e (a)	63 d (a)

[a]Av of 4 replications in a column or in a row (in parentheses), means followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

cultivars with the *Glh 2* gene (see table). ASD7 and Tilockkachari were highly resistant to all GLH colonies, indicating no cross virulence of the colonies to those two varieties. Population growth on Godalki was similar to that on susceptible TN1 for all colonies. ASD8 was highly resistant to all colonies. The Moddai Karuppan colonies were more virulent on IR29 than the other colonies. The study indicated that none of the colonies selected on the various resistant cultivars were more suitable than the TN1 colony as a source of insects to begin a selection program on ASD7 or ASD8. ☐

Reaction to *Marasmia patnalis* Bradley of varieties resistant to *Cnaphalocrocis medinalis* Guenée

R. C. Joshi, E. Medina, and E. A. Heinrichs, IRRI

Leaffolders *C. medinalis* and *M. patnalis* are almost identical in external appearance and have recently caused similar damage in rice fields in Laguna, Philippines. We evaluated 30 rice varieties previously identified as highly susceptible or moderately resistant to *C. medinalis* for their reaction to *M. patnalis.*

First-instar larvae at 2 larvae/tiller were caged on 36-d-old rice plants kept in the greenhouse. Each accession was replicated six times and treatments were in a split-plot design with the leaffolder species as the main plot and rice varieties subplots. The 1980 *Standard evaluation system for rice* was used to score damage.

Damage from the two species was not significantly different at the 5% level. Damage ratings were correlated ($P > 0.05$). Varietal differences within a leaffolder species occurred (see table). Susceptible TN1, commonly used to screen varieties for *C. medinalis* resistance also can be used as a susceptible check for *M. patnalis.* Ptb 33, ASD5, TKM6, IR4707-106-3-2, Darukasail, and GEB24 are possible donors for resistance to the two leaffolder species. ☐

Reactions of rice varieties to *C. medinalis* and *M. patnalis,* IRRI, 1984.

Variety	Accession no.	Origin	Leaf damage[a]			
			C. medinalis		*M. patnalis*	
			Damage rating (%)	Scale	Damage rating (%)	Scale
TN1	105	Taiwan	27.3 d	–	25.5 f	–
ARC6650	12308	India	22.0 cd	9	22.4 ef	9
IR36	1187	Philippines	21.0 cd	9	22.3 ef	9
Shete	46671	India	21.1 cd	9	20.1 def	9
ARC5752	12119	India	20.6 cd	9	19.1 cdef	9
ARC10560	20992	India	19.8 cd	7	19.8 def	9
ARC10550	12507	India	19.7 cd	7	19.0 cdef	7
BKN-BR1008-21	–	Thailand	22.0 cd	9	15.1 bcdef	7
Khao-rad	48069	Thailand	17.4 abc	7	19.2 cdef	7
Balam	49020	Bangladesh	16.0 abc	7	19.6 def	9
Calixto	47166	Philippines	21.8 cd	9	13.6 bcdef	7
Khao-Ma Khaek	47852	Thailand	18.1 abc	7	17.0 cde	7
IR5685-26-1	39433	Philippines	19.0 bcd	7	15.5 bcdef	7
Gorsa	49088	Bangladesh	16.3 abc	7	17.8 cde	7
Karpur Kanti	46048	India	15.6 abc	7	17.9 cde	7
Bora	49157	Bangladesh	16.3 abc	7	15.2 bcdef	7
Biron	49154	Bangladesh	17.7 abc	7	13.5 bcdef	7
Yakadayan	36408	Sri Lanka	17.1 abc	7	13.3 bcdef	7
Muthumanikam	15327	Sri Lanka	18.1 abc	7	12.3 abcd	5
Vashaipoo Samba	–	India	14.8 abc	7	13.8 bcdef	7
CO 7	6041	India	12.9 abc	5	15.2 bcdef	7
ASD7	6303	India	16.5 abc	7	11.6 abcd	5
Kataribhog	46076	India	14.3 abc	7	12.9 abcde	7
W 1263	11657	India	15.9 abc	7	10.7 abcd	5
Ptb 33	19325	India	12.9 abc	5	13.3 bcdef	7
ASD5	5812	India	13.4 abc	5	11.6 abc	5
TKM6	237	India	13.3 abc	5	10.1 abc	5
IR4707-106-3-2	47459	Philippines	9.6 a	5	13.4 bcdef	7
Darukasail	45493	India	14.9 abc	7	7.9 a	5
GEB24	5909	India	9.7 ab	5	8.7 ab	5
Mean			17.2		15.6	

[a] Av of 6 replications. Separation of means in a column by Duncan's multiple range test at the 5% level.

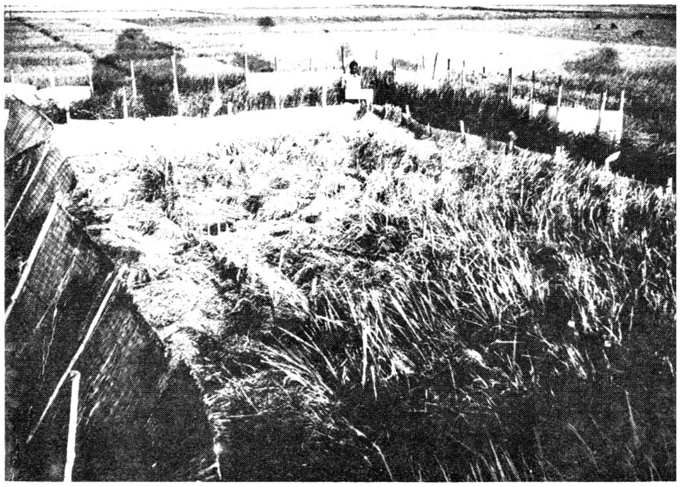
Testing for field resistance in rice under induced brown planthopper (BPH) outbreaks

P. S. Prakasa Rao, Central Rice Research Institute (CRRI), Cuttack 753006, India

From several years of research at CRRI, we have developed a reliable field method for inducing BPH hopperburn. This is helping us to identify promising field-resistant rices. The following steps ensure heavy BPH incidence.

- Two erect wind-breaker walls made of glass fiber-based bitumen felt or local bamboo mat (0.75 m high around test entries and 1.5 m high, around tall, long-duration varieties) are installed. They withstand high winds and keep the experimental area undisturbed by wind (Fig. 1).
- Three to five cm of standing water is maintained in treated plots.
- A lush rice canopy is maintained by applying up to 25 kg N/ha in convenient splits until 60 d after planting (DAP).
- Insect colonies are established by confining BPH for 24 h in cylindrical 50- × 15-cm fine wire mesh cages (Fig. 1).
- Progressive BPH colonization is provided between 10 and 60 DAP to reach 1 adult BPH/hill.
- Rice is transplanted at 10- × 10-cm spacing in two 1.5-m-long rows per

1. Field layout showing wind break double wall and colonization of adult BPH on plants in cylindrical cages. Cuttack, India.



2. BPH hopperburn in field planted test entries. Cuttack, India.

test entry with 2 rows of susceptible Jaya or TN1 on each side. Surface foliar sprays of 0.02% methyl parathion are applied weekly between 10 and 60 DAP to kill natural enemies. At transplanting, seedlings are dipped in the same solution.

Hopperburn appeared in patches by 80 DAP and by 95 DAP reached 100% in the susceptible check (Fig. 2). Monitoring data of insect buildup at weekly intervals showed that by 75 DAP 6 BPH adults, 75 BPH nymphs, and 1 mirid bug were present on each hill. Between 90 and 100 DAP, BPH adults and nymphs exceeded 500/hill. Beyond 80 DAP, hopperburn spread so fast that insect populations became irrelevant. BPH populations emigrated from the plots by 100 DAP.

In 1983, 10 known resistant cultures, IR36, and susceptible Ratna were evaluated. Based on percent hopperburned hills (see table), CR401-7, CR233-10, CR157-1900, and CR157-380-303 were on par and were outstandingly superior to IR36 in field resistance.

In 1984, CR333-6-1 was outstanding among 50 entries, followed by CR316-639, CR319-644, CR233-10, CR157-212, CR157-300, and CR157-1900, which were on par with the resistant check CR57-MR1523.

Because percent hopperburned hills in a test entry was recorded only when check entries were 100% hopperburned, single-replication testing appeared acceptable, which saves valuable resources. ☐

Relative performance of some rice cultivars under induced field outbreak of BPH, CRRI, 1983 dry season.[a]

Cultivar	Cross combination	Mean hopperburned hills[a]	
		%	Angles
CR407-6-2	CR94-1512-6/Ratna	92 d	76.85
CR407-19	CR94-1512-6/Ratna	100 de	90.00
CR157-392-212	Vijaya/PTB10	68 ab	56.06
CR157-1900	Vijaya/PTB10	54 ab	47.32
CRl57-380-303	Vijaya/PTB10	57 ab	49.25
CR404-56	CR94-1512-6/Pusa-2-21	95 de	82.79
CR233-10	Pelita/CR94-MR.1550	48 a	44.07
CR57-11-2	IR8/PTB21	59 ab	50.76
CR401-7	Vijaya/CR94-1512-6	45 a	42.40
CR190-103	CR129-118/CR57-49-2	61 ab	51.75
IR36		87 bc	71.98
Ratna (susceptible check)		100 de	90.00
	CD (0.05)		16.08
	CD (0.01)		21.86

[a]Mean of 3 replications. Separation of mean (angles) in a column by Duncan's multiple range test at the 5% level.

Evaluation of promising rice varieties for thrips resistance

Zhu Zhao-qi and Li Yi Wei, Plant Protection Research Institute, Jiangsu Academy of Agricultural Sciences, Nanjing, China

Thrips *Stenchaetothrips biformis* (Bagnall) is a major rice pest along the lower Changjiang River in China. Seedlings of the second rice crop often are damaged in Jun-Jul. We developed the following scale for evaluating thrips resistance.

Rating	*Damage*
1	No rolling of terminal of leaf; a few silvery spots on leaf surfaces.
3	Rolling of leaf terminals; light silvering of leaf tips.
5	Rolling of leaf terminals; yellow-reddish and scorched leaf tips.
7	Rolling of entire length of all leaves with pronounced rigidity.
9	All plants dead.

Seventy-five thrips-resistant rice varieties from IRRI were evaluated at Wu-Jiang district in Jiangsu Province. The varieties were sown on 10 and 15 Jun 1984. About 100 seeds of each entry were sown in moist soils in a 0.5-m-long row at 0.250 m row spacing. One week later, fields were flooded to a proper level.

Twenty-five-day-old seedlings of the test varieties were evaluated using the scale. Of 75 entries, 6 scored 1; 3, 3; 59, 5; and 7, 7 (see table). The six most resistant entries were from Sri Lanka. □

Thrips resistance rating of rice varieties, Jiangsu, China.

Reaction rating	Variety name[a]
1	Dahanala (15663), Dahanala 682 (50729), Kalubalawee (7717 & 15184), Kalu Heenati (15745 & 31431).
3	Kaluheenati (7750), Madael (15234), Wanni Dahanala (11726).
5	ADT22 (5901), ASD4 (5814), ASD7 (6303), Balamawe (15276), BJ1 (256, 3711, & 45195), BW78 (26915), Chandina (36420), CO 23 (6042), CO 27 (26843), Dahanala (15202 & 15650), Demala Kotan (40787), Gangala (7733,15207, & 15259), Gonabaru (7809), H105 (158), Heenati (8964), Herath Banda (15304, 15362, 15378, 15632, 15748, 31412, & 31431), Jeeraga Samba (49732), Kalubalavee (7702), Kaluheenati (11996), Kalu Heenati (15568, 31432, 31433, 31434, 31435, 36267, & 36268), Kaohsiung Sen Yu 185 (38892), Madael (7722, 7727, 11701, & 15426), MRC 505 (39519), Perunel (15473), Ptb 33 (19325), Sinna Sivappu (15444), Sudu Hondarawala (15541), Suduru Samba (11671, 15237, 15272, & 36390), Sudurvi 305 (3475), Thunmar hamara (15226), TKM 2 (6034), TKM 6 (237, 6216, 35185), TNR 1 (9913), Utri Rajapan (16684).
7	Kuribit Puti (26882), Nira (1749, & 6309), Suduru Samba (14354), Sugadas (or Godavari Samba 50163), TKM6 (28571), Wulan Rua (19194).
9	– – – –

[a] IRRI accession no. are in parentheses.

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.

Genetic Evaluation and Utilization
COLD TOLERANCE

VL Dhan 16: a medium-maturing, cold-tolerant rice for irrigated conditions

V. S. Chauhan and J. C. Bhatt, Vivekananda Laboratory for Hill Agriculture, Almora 263601, India

We evaluated many advanced breeding lines to identify a suitable cold-tolerant variety for irrigated valleys at 900 m to 1,500 m altitudes. Some selections from IR1846 (J. P. 5/Y. R. L. I) were promising. One selection performed well in regional and national trials. It was released by the State Varietal Release Committee in 1984 as VL Dhan 16.

VL Dhan 16 is medium tall, compact, and stiff-strawed with medium tillering and light green leaves. Panicles are long and compact with good spikelet fertility and threshability. The husk and apiculus are straw-colored. Grains are medium-sized with red kernels, nonglutinous endosperm, and good cooking quality. VL Dhan 16 has good blast and stem borer resistance and is cold tolerant.

In 14 multilocational yield trials during 4 yr, VL Dhan 16 was compared with VL-8 (improved medium-maturity check), VLK 39 (improved early check), and Thapachmi (a local check) (see table). □

Grain yield of VL Dhan 16 in multilocational trials,[a] Uttar Pradesh, India.

Variety	Grain yield (t/ha)				
	1980 (2)	1981 (4)	1982 (4)	1983 (4)	Mean
VL Dhan 16	4.3	5.4	4.5	4.2	4.6
VL 8	4.3	3.7	3.2	2.8	3.5
VLK 39	3.6	3.9	3.4	2.5	3.4
Thapachini	3.5	3.8	3.8	2.8	3.5

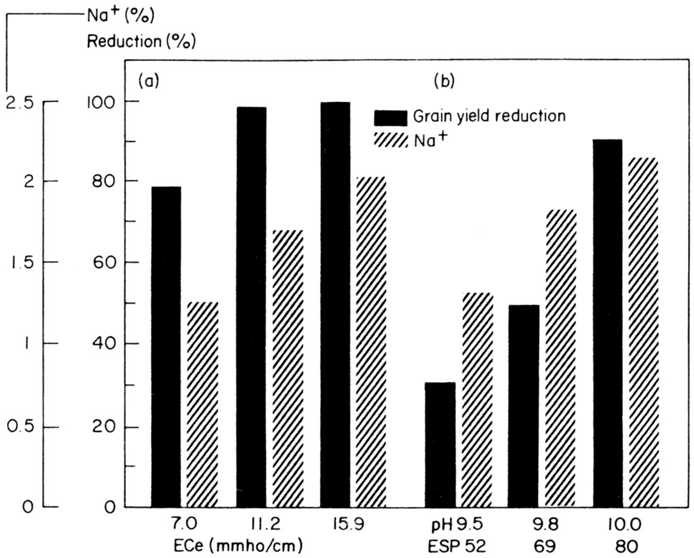
[a] Numbers in parentheses indicate test locations.

Genetic Evaluation and Utilization
ADVERSE SOILS TOLERANCE

Salinity and sodicity tolerance in rice

A. Qadar, Division of Genetics and Plant Physiology, Central Soil Salinity Research Institute, Karnal 132001, Haryana, India

In a study of salinity and sodicity tolerance in rice, 40-d-old M1-48 seedlings Were transplanted in pots in Soils with EC 2.8, 7.0, 11.2, or 15.9 dS/m and pH 8.2, 9.5, 9.8, or 10.0. Exchangeable sodium

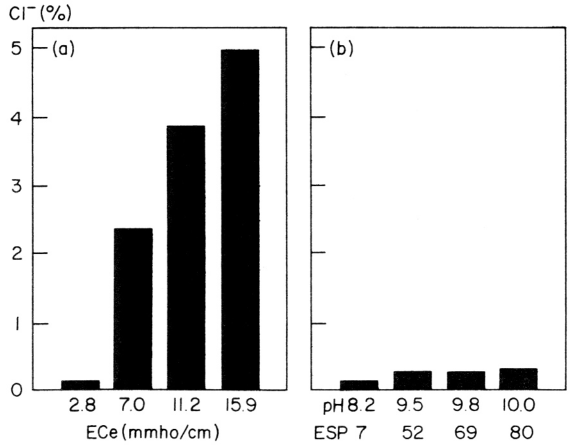


1. Effect of salinity (a) and sodicity (b) on percent reduction of gram yield and Na^+ content of mature shoots of M1-48.

percentage (ESP) for the sodic soils was 7, 52, 69, and 80, respectively. Increasing salinity and sodicity levels reduced grain yield. By comparing reduction of yields at same Na contents in the shoot, we determined that salinity was more harmful than sodicity.

Analyses of mature rice shoots for Na^+ and Cl^- content showed that plants grown in sodic conditions have relatively higher Na^+ content at each sodicity level than at respective salinity conditions (Fig. 1).

Cl^- concentration was very high in shoots of plants grown in saline conditions (Fig. 2), and much higher at each salinity level than Na^+. For example, at EC 15.9 dS/m, Cl^- was 2.5 times higher than Na^+. Plants grown under sodic conditions had low Cl^- content, although there was a slight increase with an increase in sodicity stress. It is inferred that high sensitivity of M1-48 to salinity is due to Cl^- metabolism rather than to that of Na^+. □



2. Effect of salinity (a) and sodicity (b) on mature shoot Cl^- content of M1-48.

Genetic Evaluation and Utilization

DROUGHT TOLERANCE

VL Dhan 206, a new upland rice variety

V. S. Chauhan, J. P. Tandon, J. C. Bhatt, and H. C. Joshi, Vivekananda Laboratory for Hill Agriculture, Almora 263601, India

VL Dhan 206 is a 165- to 170-d variety released by the Uttar Pradesh State Varietal Release Committee in 1983 for upland areas. It is a pureline selection from local Bamni. VL Dhan 206 is medium tall and medium tillering, with light green foliage and good panicle exsertion. Panicles are semicompact with good spikelet fertility. Grains are medium-sized with light yellow husks and straw-colored apiculus. Kernels are white, translucent, and nonglutinous. The rice has medium amylose content and cooks dry. It is tolerant of blast and stem borer and has good seedling cold tolerance.

VL Dhan 206 yielded 24% more than check variety Majhera 3 in trials and 25% more in farmer field demonstrations (see table). □

Yield of VL Dhan 206 in multilocational trials, Almora, India.[a]

Variety	Yield (t/ha) 1970-79 (17)	1980 (4)	1981 (6)	1982 (2)	Mean
VL Dhan 206	1.6	2.8	1.8	1.4	1.9
Majhera 3	1.2	2.5	1.4	1.2	1.5

[a] Number of trial sites is in parentheses.

Pest Control and Management

DISEASES

Saket-4 resistance to tungro virus (RTV)

B. P. Yadav, Plant Pathology Department, Rajendra Agricultural University, Bihar, Pusa, Samastipur 848125; and M. D. Mishra, Division of Mycology and Plant Pathology, Indian Agricultural Institute, New Delhi 110012, India

We evaluated Saket-4, IR8, and TN1 for RTV resistance. Varieties were planted together in 2.5- × 2-m plots in 4 replications in 1981 and 1982. Twenty-five plants in the center of each plot were

Table 1. The number of days needed for symptom development on rice plants inoculated with RTV at 30, 45 or 60 days after sowing (DAS), Bihar, India.

Symptom	Days needed for symptom development[a] TN1 30 DAS	TN1 45 DAS	TN1 60 DAS	IR8 30 DAS	IR8 45 DAS	IR8 60 DAS
Interveinal chlorosis	7	7	12	7	7	12
Orange-yellow color	8	8	14	8	8	14
Yellowing	10	10	20	10	10	20
Leaf tilting	10	11	25	10	11	30
Leaf rolling	13	14	28	14	26	–
Incomplete leaf emergence	15	15	–	17	20	–
Delayed panicle initiation	8	6	4	6	4	2

[a] No symptoms developed in Saket-4.

caged with 2 viruliferous green leafhoppers (GLH) *Nephotettix virescens* Distant), Hyderabad ecotype, per tiller for 18-h inoculation feeding at 30, 45, and 60 d after sowing (DAS).

Inoculated plots were surrounded by 1.5-m-high nylon screen to restrict vector movement. Infected plants were marked to estimate spread of infection in the field.

TN1 and IR8 cages with GLH were 100% RTV-infected at all inoculation stages. Symptom expression was delayed by 5-20 d in plots inoculated at different growth stages (Table 1). At 30 DAS, 59% of TN1 plants and 15% of IR8 plants were infected. Sixty-day inoculation gave 2% infection in TN1 and 1% in IR8 (Table 2). Saket-4 did not have external RTV symptoms. Recovery tests in glasshouse and field conditions from 25 Saket-4 plants caged with GLH showed negative transmission, thus confirming its RTV resistance. □

Table 2. Percent RTV-infected plants, Bihar, India.

Cultivar	Infected plants (%) at indicated DAS		
	30 DAS	45 DAS	60 DAS
TN1	59	19	2
IR8	15	4	1
Saket-4	0	0	0

New methods to detect seedborne *Trichoconiella padwickii*

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Stack burn disease of rice caused by *Trichoconiella padwickii* (Ganguly) Jain is an important seedborne disease. Some ways of detecting the fungus are the standard blotter method, modified blotter method at pH 4, potato dextrose agar, deep freeze method, and guiacol agar method. We have developed a new, macroscopic method of detecting *T. padwickii* on rice seeds and a new modified blotter method.

In the macroscopic method, rice seeds were boiled in distilled water under 15 psi for 20 min. The extract was filtered through cheese cloth to fill 1 litre. Agar was added to the extract and sterilized for 15 min. The proportion of rice extract and agar was adjusted to 40:4, 40:20, 80:4, and 80:20. The numbers 40 and 80 indicate the weight (g) of seed used to get the extract; 4 and 20 indicate the weight of agar in 1,000 ml of extract. An antibiotic, Ambistryn-S (0.5 g), was added after sterilization. Twenty ml of this medium was poured into each petri plate. Ten rice seeds were sown equidistantly in each petri plate. The plates were incubated in laboratory conditions (diffused light, 25 ± 2°C); near ultraviolet light (NUV)/darkness (12h/12h) cycles at 22 ± 1°C; or in complete darkness (22 ± 1°C). *T. padwickii* colonies were counted 10 d later.

In the modified blotter method, blotter discs were immersed in rice extract obtained by boiling 40 g rice seed in 1 litre of distilled water. The seeds were placed on the blotter in petri plates and the plates were incubated under 12 h/12 h cycles of NUV and darkness at 22 ± 1°C. In the next 24 h, the plates were incubated at -20°C, then were subjected to NUV/darkness cycles for 5 more days.

Rice extract agar medium developed in our laboratory induced maximum expression (48%) of seedborne *T. padwickii* and thus was superior to all other methods (see table). The blotter immersed in rice extract also influenced good expression (41%) of the fungus on seeds.

Percentage of incidence of *T. padwickii* by different seed health testing methods.

Seed health testing method	Incidence [a] (%) in given sample number				Mean (%)
	1	2	3	4	
Standard blotter method	8	10	24	42	21 d
Modified blotter method at pH 4	12	16	38	44	27 c
Potato dextrose agar	18	14	6	36	19 d
Guiacol agar	40	22	52	46	40 b
Blotter immersed in paddy extract	25	30	42	68	41 b
Deep freeze method	23	24	39	43	32 c
Paddy extract agar (40:20)	27	40	76	51	48 a

[a] Treatment means followed by the same letter are not significantly different by Duncan's multiple range test (P=0.05) after are sine transformation.

The rice extract agar medium around *T. padwickii*- infected seeds turned pink on the 4th d when incubated under laboratory conditions and NUV/darkness cycles. Neither the mycelia nor the spores were colored.

Most high yielding rice varieties are susceptible to stack burn disease. The association of the fungus with the seed favors early seedling infection. In routine seed health testing, a macroscopic method for identifying *T. padwickii* is important because it is simple, reliable, and quick. □

Antagonistic effect of dhaincha on survival of *Rhizoctonia solani* f. sp. *sasakii*

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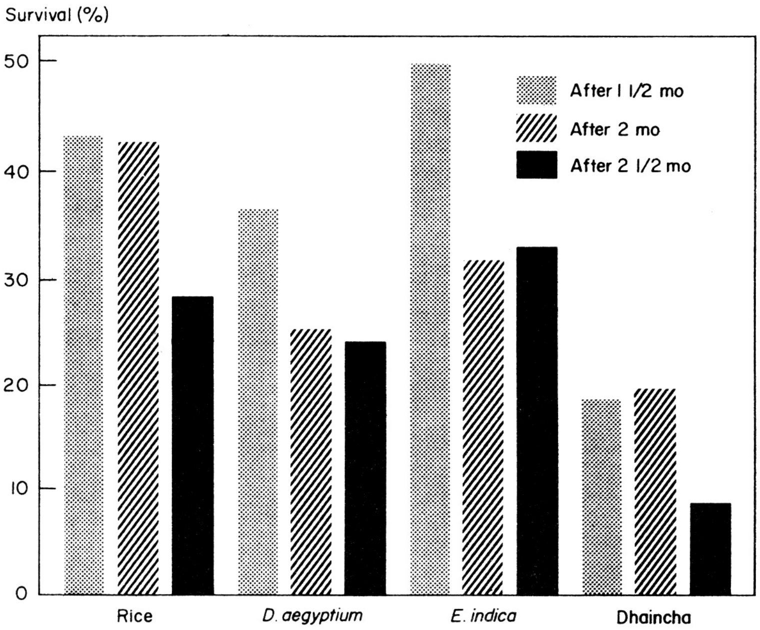
Survival of sclerotia of *R. solani* Kühn f. sp. *sasakii Exner,* the sheath blight fungus of rice, was found to vary with vegetation adjacent to rice, and particularly when near dhaincha *Sesbania aculeata* Fawcett and Rendle, a green manure plant. We studied the effect of the common monocotyledonous weeds *Eleusine indica* (L.) Gaertn. and *Dactyloctenium aegyptium* (L.) Beauv. on *R. solani* incidence.

Plantlets of the weeds and seedlings of Pusa 2-2 1 were transplanted on 17 Aug 1982 in 25-cm-diam clay pots containing rice field soil. Eighteen days later, sclerotia of the fungus grown on sterilized rice grains were mixed with soil, bundled in nylon net, and buried about 5 cm deep in the root zone. Sclerotia survival was recorded at 1 1/2, 2, and 2 1/2 mo after burial. After the specified burial period, sclerotia were retrieved from the bundles, sterilized in mercuric chloride, and put in petri dishes previously layered with potato dextrose agar fortified with streptomycin sulfate for recording germination.

The figure shows that although survival rate of the sclerotia did not vary markedly in the root zones of rice and weeds, it declined significantly in the root zone of dhaincha. In all the cases, survival rate was less after 2 1/2 mo than after 1 1/2 mo. It appears that the environment of dhaincha root reduces survival of the sclerotia of *R. solani.* However, dhaincha leaves became severely infected when artificially inoculated with the fungus. □



Percent survival of *R. solani* sclerotia in the root zone of different plants at different periods.

Influence of bacterial leaf streak (BLS) on bacterial blight (BB) of rice

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BB (caused by *Xanthomonas campestris* pv. *oryzae)* and BLS (caused by *X. campestris* pv. *oryzicola)* are the most important bacterial diseases of rice in India. In the rainy months of Jul-Sep, both diseases affect rice over a substantial area. Rainy weather favors disease dissemination and infection. The bacterial ooze from the leaves under high humidity is spread by wind-driven rains and by leaf contact.

We studied the interaction of the diseases on leaves of AC360, a cultivar highly susceptible to both diseases.

Leaves were inoculated with BLS by rubbing, then 2 d later were inoculated with BB by clipping. Disease development was assessed 5-7 d later. The progressive end of the BB lesion failed to develop water-soaking and it progressed slowly with orange discoloration, indicating almost a masking effect of BLS on BB development.

When leaves were first inoculated with BB and inoculated with BLS 4 d later, disease assessment at 3 d showed BLS lesions developed more slowly than when leaves were inoculated first with BLS. Lesions turned brown and produced less bacterial ooze than did the rapidly elongating water-soaked lesions with abundant bacterial ooze that developed far from the BB lesion and also on leaves with only BLS infection. In screening rices for resistance to BB and BLS, caution needs to be exercised in rating their reaction if the plants are infected with both pathogens. □

Purification and serology of rice tungro spherical virus (RTSV)

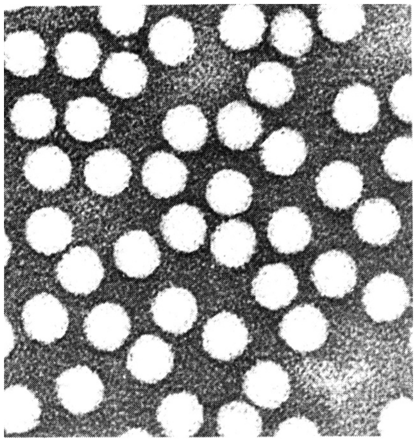
H. Hibino and P. Q. Cabauatan, Plant Pathology Department, IRRI

We used the procedure followed for rice waika virus (RWV) in Japan to purify RTSV. RTSV-infected TNl plants (without roots) were homogenized in 0.01 M ethylenediamnetetraacetic acid (EDTA), pH 8.0. The sap was clarified by heating at 40°C for 1 h and the virus was precipitated with 7% polyethylene glycol 6,000,0.2 M sodium chloride, and 1% triton X-100.

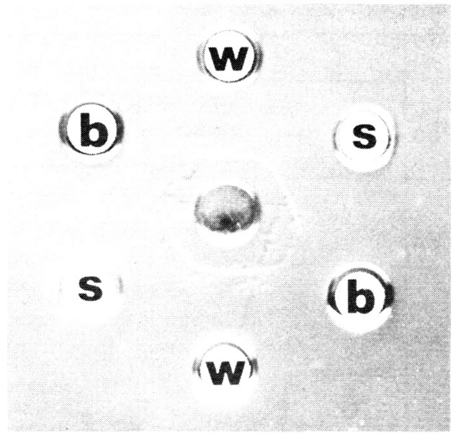
The resuspended virus was treated with 20% carbon tetrachloride and subjected to different centrifugation (40,000 rpm for 40 min, then 10,000 rpm for 10 min, at 4° C in a Beckman RT-65 rotor). Supernatant was layered on 10-50% linear sucrose density gradient (prepared in 0.01 M phosphate buffer [PB] , pH 7.4), and centrifuged at 25,000 rpm for 180 min at 4°C in a Beckman SW 27 rotor.

The light scattering band (virus zone, about 3 cm from the meniscus) was collected, diluted with 0.01 M EDTA (pH 8.0), and centrifuged at 40,000 rpm for 40 min. The virus was resuspended in 0.01 M PB (pH 7.4) and centrifuged at 10,000 rpm for 10 min. The resulting supernatant contained isometric particles about 30 nm in diameter very similar to RWV (Fig. 1). Purified preparations had maximum ultraviolet (UV)-light absorption at 259-260 nm and minimum at 239-240 nm. The UV absorption ratio at 260 nm and 280 nm (A 260/280) for purified virus ranged from 1.52 to 1.74.

Rabbits were immunized against RTSV by 4 intramuscular and 1 intraveinal injections at 2-wk intervals with purified virus (A_{260} adjusted to 1.0 mixed with equal volume of Freund's complete adjuvant). An antiserum with a titer of 1:640 in ring interface precipitin and 1:160 in double gel diffusion (Ouchterlony) tests was obtained. An Ouchterlony test was used to compare RTSV and RWV antisera. A single band formed between homologous and heterologous combinations and the reaction bands fused (Fig. 2). Hence, RTSV is not only morphologically similar but also serologically identical to RWV. □



1. Electron micrograph of purified RTSV negatively stained with 2% phosphotungstic acid (200,000X), IRRI.



2. Ouchterlony test showing serological relation between RTSV and RWV: the center well contains purified RTSV and outer wells contain antiserum to RWV (W), antiserum to RTSV (S), and phosphate buffer (b), IRRI.

An alternative host for *Ustilaginoidea virens* (Cke.) Tak.

S. A. Shetty and H. S. Shetty, Applied Botany Department, University of Mysore 570006, India

Rice false smut, also known as pseudosmut or green smut, caused by *Ustilaginoidea virens* (Cke.) Tak. was first reported by Cooke (1878) from Tinnevelly in Tamil Nadu, India. The disease cycle of the pathogen is still obscure.

During an extensive survey of false smut incidence in Dakshina Kannada District in 1983 kharif, we found that *Digitaria marginata* L., a common rice weed, also was infected with false smut in 85% of the fields surveyed.

We conducted a cross-inoculation test to determine the infectivity to rice panicles of smut spores occurring on *D. marginata.* Smut balls (pseudomorphs) were collected from infected *D. marginata* and a spore suspension (about 10^4 spores/ml) was prepared in sterile distilled water. The suspension was inoculated on individual Basmati spikelets. The inoculated panicles were covered with polyethylene bags for 15 d and observed for smut ball development.

Ten days after inoculation, yellowish smut balls began to emerge from the glumes. About half of the inoculated florets developed into smut balls.

We found *D. marginata* around the field was infected with false smut before panicle-bearing rice tillers matured. It is possible that when rice flowers open, the smut spores from infected *D. marginata* become airborne and infect them. Either chlamydospores from hibernating pseudomorphs or ascospores from germinated sclerotia may act as primary inoculum for infecting *D. marginata.* From *D. murginata* the smut spores cross-infect rice. □

Rice yellow dwarf in Tamil Nadu, India

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Yellow dwarf infected a large area of rice in Pudukkottai District of Tamil Nadu in Aug 1984. Of 1,000 ha surveyed, more than 200 ha in rice at different growth stages was affected. In each infected field, 1 m^2 was randomly selected, total and infected hills were counted, and percent disease was calculated. ADT36, TKM9, IR20, and IR50 were susceptible see table). Maximum infection was 40% on IR20. Co 33 had 7% infection. Green leafhopper *Nephotettix virescens* population was high. Although some disease had been noticed in previous years, this was the first widespread occurrence. □

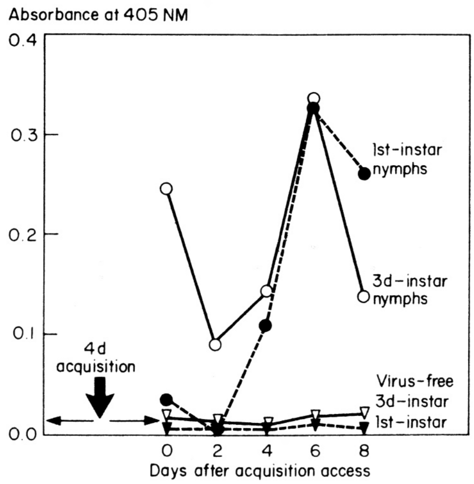
Incidence of yellow dwarf in rice varieties, Tamil Nadu, India.

Village surveyed	Variety	Infection (%)
Satharam	ADT36	12.6
Kamathipuram	ADT36	24.1
Arimalam	ADT36	10.0
Kamarajapuram	ADT36	18.8
Mirattunilai	ADT36	16.6
	ADT36	12.5
Mirattunilai	IR20	39.6
	IR20	21.8
	IR20	14.2
	IR20	23.1
	IR20	19.8
Meenakshipuram	TKM9	15.9
Mirattunilai	IR50	10.0
Kalyanapuram	Co 33	1.5

Development of rice ragged stunt virus (RSV) in the vector brown planthopper (BPH)

A. Parejarearn and H. Hibino, IRRI

We studied RSV development in BPH. Virus-free BPH 1st and 3d-instar nymphs were allowed to feed separately on RSV-infected plants for 4 d and then held on healthy TN1 seedlings. Insects were collected every 2 d and homogenized with 0.2 M phosphate buffered-saline (pH 6.5) containing 0.05% Tween plus 2% polyvinylpyrolidone at 0.05 ml/insect and 0.1 ml/insect for 1st and 3d instars. Extracts were tested for RSV antigen in ELISA using polystyrene microtitre plates (immulon). The relative content



Relative content of RSV antigen in BPH on various days after 4-d acquisition feeding.

of RSV antigen was indicated as absorbance at 405 nm.

A significant amount of RSV was detected in extracts soon after feeding on RSV-infected plants stopped. Two days later, however, RSV was not detected in 1st-instar nymphs and was at low level in 3d-instar nymphs (see figure). RSV content increased gradually up to 6 d and then declined.

Results showed that RSV acquired by BPH retains antigenicity for 2 d and begins to multiply about 6 d after acquisition feeding begins. □

Distribution of rice ragged stunt virus (RSV) in infected TN1 plants

A. Parejarearn, research fellow, and H. Hibino, virologist, Plant Pathology Department, IRRI

We evaluated distribution of RSV-infected TN1 plants. Thirty-day-old TNl plants infected with RSV at seedling stage were removed from pots. The roots were thoroughly cleaned, and the plants were divided into roots, leaf sheaths, and leaf blades. The parts of each plant were homogenized in mass with 4 times a phosphate-buffered saline solution (pH 7.4) containing 0.05% Tween 20. A relative amount of RSV antigen was determined through enzyme-linked immunosorbent assay (ELISA) using a polystyrene micro-titre plate (Linbro) coated with 2.5 μg/ml of immunoglobulin against RSV. The enzyme-immunoglobulin conjugate was diluted 300 times. The virus amount was indicated as absorbance at 405 nm in a Micro-ELISA reader. In another test, the leaves and sheaths were numbered based on the tiller number and leaf position from older to younger, and were separately tested in ELISA following the same procedure.

Virus antigen was detected in roots, sheaths, and leaves, but there was more in sheaths than in roots and leaves (Table 1). Regardless of tiller number, the second and third sheaths had higher mean absorbance value than other plant parts (Table 2). RSV was also detected in the youngest leaf and sheath, which did not have visible disease symptoms. However, no RSV was detected in the oldest leaves of some samples. □

Table 1. Relative amount of RSV in roots, sheath, and leaf blade of TNl plants 1 mo after inoculation, revealed as absorbance at 405 nm in ELISA. [a]

Sample	Trial	Absorbance		
		Root	Sheath	Leaf
Infected	I [b]	0.40 ± 0.13 [c]	0.49 ± 0.14	0.45 ± 0.07
	II [d]	0.65 ± 0.26	0.73 ± 0.60	0.45 ± 0.07
Healthy		0.07 ± 0.03	0.015 ± 0.01	0.03 ± 0.01

[a]Extract at 1/5 dilution was tested directly in ELISA. [b]Mean absorbance value from 4 individual infected plants. [c]Sandard deviation at 5% level. [d]Mean absorbance value from 9 individual infected plants.

Table 2. Distribution of RSV in infected TN1 plants 1 mo after inoculation, revealed as absorbance at 405 nm in ELISA. [a]

Sample	Samples (no.)	Absorbance	
		Range	Mean [b]
First tiller			
Root	9	0.35 - 1.29	0.65 ± 0.27
Sheath 1	9	0.13 - 1.30	0.65 ± 0.34
Sheath 2	9	0.12 - 1.19	0.76 ± 0.36
Sheath 3	8	0.52 - 1.10	0.78 ± 0.24
Sheath 4	7	0.50 - 1.05	0.73 ± 0.18
Sheath 5	3	0.30 - 0.91	0.62 ± 0.25
Leaf 1	8	0.08 - 0.52	0.32 ± 0.16
Leaf 2	8	0.15 - 0.97	0.41 ± 0.25
Leaf 3	8	0.31 - 1.14	0.56 ± 0.29
Leaf 4	6	0.17 - 0.88	0.51 ± 0.21
Leaf 5	3	0.38 - 0.72	0.59 ± 0.15
Youngest leaf sheath	3	0.35 - 1.42	0.71 ± 0.50
Second tiller			
Sheath 1	7	0.40 - 0.88	0.63 ± 0.19
Sheath 2	7	0.34 - 1.47	0.63 ± 0.43
Sheath 3	5	0.32 - 0.91	0.62 ± 0.21
Sheath 4	3	0.39 - 0.50	0.43 ± 0.05
Leaf 1	7	0.06 - 0.75	0.37 ± 0.23
Leaf 2	7	0.14 - 0.48	0.34 ± 0.11
Leaf 3	5	0.32 - 0.83	0.52 ± 0.16
Leaf 4	3	0.33 - 0.45	0.40 ± 0.05

[a] Extract at 1/5 dilution was tested directly in ELISA. [b] Standard deviation at 5% level. Mean absorbance of healthy plant root = 0.075 ± 0.25, sheath = 0.015 ± .005, and leaf = 0.026 ± .009.

Pest Control and Management

INSECTS

Seedling root dip treatments to control gall midge (GM)

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We sought to develop a simple, economic method for GM *Orseolia oryzae* (Wood-Mason) control. In 1982 kharif we evaluated 8 chlorpyrifos 0.02% treatments for GM control (see table). Unprotected Jaya seedlings (5.3% silvershoots were recorded in the nursery) were planted in a replicated trial in 5- × 5-m plots at 20- × 15-cm spacing. For the seedling root treatment, rock phosphate at 60 kg P/ha was mixed with wet clay at 3:1 and water was added to make a thick slurry. Chlorpyrifos 20 EC was mixed with the slurry at 0.02% concentration. Seedling roots were uniformly coated with the chlorpyrifos-treated slurry and planted. At planting, the field was puddled with very little standing water.

Because seedlings were GM infested at planting, all treatments had GM incidence even at 15 d after transplanting (DT). However, incidence increased significantly only in the untreated control up to 45 DT. Beyond 60 DT there was no significant difference in GM infestation between treatments, largely because GM-infested seedlings were planted. Preinfestation treatment is essential. As an alternative to chlorpyrifos seedling root dip for 12 or 3 h, chlorpyrifos-treated carbono phosphate treatments gave good results (see table). Carbono phosphate is commonly used in rice and coconut soils at Goa in kharif. □

Effect of seedling root dip treatments on GM damage and rice grain yield, Goa, India, 1982.[a]

Treatment	Silvershoots (%)				Productive tillers/hill (no.)	Grain yield (t/ha)	Gross profit[b] ($/ha)	Cost of insecticide application[c] ($/ha)	Net gain[d] ($/ha)	Gain from insecticide[e] ($/ha)	Benefit: cost[f]
	15 DT	30 DT	45 DT	60 DT							
SRD with chlorpyrifos 0.02% for 12 h	3.8 a	2.5 ab	11.4 ab	19.3a	6.4 a	3.4 a	438	6	432	210	36.0
SRD with chlorpyrifos 0.02% in 1% urea solution for 3 h	6.9 a	1.9 a	8.9 a	25.5 a	5.9 a	2.4 b	319	7	312	90	13.9
SRT with chlorpyrifos 0.02% treated CPS for											
1 min	5.7 a	8.0 c	19.7 c	26.1 a	6.1 a	2.2 b	285	6	279	57	10.5
5 min	3.3 a	7.1 c	18.4 bc	30.1 a	5.5 a	2.1 b	272	6	266	44	8.3
10 min	7.1 a	5.1 bc	15.8 ab	34.0 a	55 a	2.3 b	296	6	290	68	12.3
20 min	5.3 a	7.5 c	16.8 bc	26.2 a	5.4 a	2.4 b	319	6	313	91	16.2
30 min	3.5 a	5.5 bc	16.6 bc	26.8 a	5.0 a	2.3 b	300	6	294	72	13.0
Untreated control	5.6 a	20.2 d	32.6 d	27.9 a	4.8 a	1.7 b	222	0	222	–	–

[a] Mean of 3 replications. In a column, means followed by a common letter are not significantly different at 5% level. SRD = seedling root dip, SRT = seedling root treatment, CPS = carbono phosphate slurry, DT = days after transplanting. [b] Yield in kg/ha at 14% moisture × \$0.13. [c] \$1.31 for labor + cost of insecticide including the cost of urea. [d] Gross profit – cost of insecticide application. [e] Net gain of treatment – net gain of control. [f] (Gross profit of treatment – gross profit of control) ÷ cost of insecticide application.

Tyrophagus palmarum (Oudemans) mite in rice seedlings and leaf sheaths

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The mite *T. palmarum* (Oudemans) (Acaridae:Astigmata) was recorded to infest rice in China. In India, the first recorded mite infestation was observed in rice seedlings and leaf sheaths of Ratna in a 1977 rabi nursery at CRRI. Mite infestations were surveyed in rice nurseries and fields in 1979 and 1982-84. The mite infested seedlings and leaf sheaths of Ratna, Karuna, CR1009, CR1014, Jaya, Vijaya, Pusa 2-21, Kalinga-I, Supriya, and Jagannath (see table). It was identified at the United States Department of Agriculture Systematic Entomology Department.

Adults and nymphs feed on growing leaves of seedlings, causing a bleached appearance followed by wilting, shriveling, and drying. These symptoms were confirmed by inoculating adult mites on 10-d-old Ratna seedlings and observing mite development under controlled conditions. Inoculating 10 or 100 mites/100 seedlings produced similar symptoms after 15 d. Mite populations varied from 2 to 34 mites/seedling (see table) on 25-d-old seedlings from 1983 dry and wet season nurseries. Mites were counted using a stereoscopic binocular microscope.

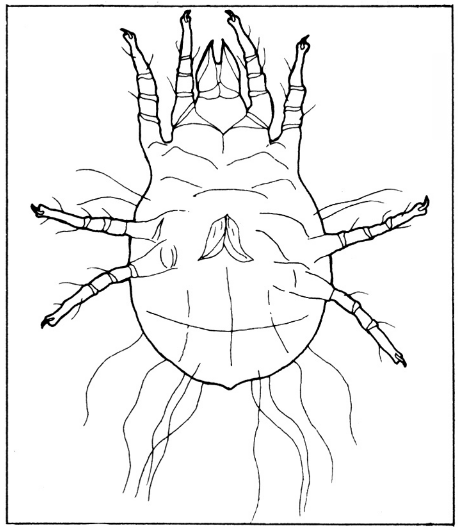
T. palmarum has more hairs than most rice-infesting mites. The post-abdominal region has five pair of hairs as long as or longer than the mite's legs. Two pair of hair grow on each side of the anterior abdominal region between the 2d and 3d pair of legs (see figure). The mite is transparent but takes on the color of feeding materials. It is fast moving and can be seen as a small moving dot on seedlings.

We attempted mass rearing of *T. palmarum* on different diets of fungi grown on several artificial media. It multiplied vigorously on *Fusarium moniliforme, Alternaria padwickii,* and *Curvularia* sp. On 10 different media, the mites grew best on 4% oatmeal agar (OMA). Egg-to-egg life cycle took 10-12 d on *F. moniliforme* grown on 4% OMA. Mites produced about 247 eggs, of which 210 hatched. About 167 adults emerged from the hatched larvae. Females reproduced parthenogenetically. There was no male population in the culture. □

***T. palmarum* populations in seedlings and leaf sheaths in 1983 dry and wet season nurseries, Cuttack, India.**

Variety	Populations (adults, juveniles, and eggs) 10 seedlings[a]
Ratna	34 b
Karuna	30 ab
CR1009	28 ab
CR1014	18 ab
Jaya	25 ab
Vijaya	19 ab
Pusa 2-21	2 a
Kalinga-I	16 ab
Supriya	15 ab
Jagannath	19 ab

[a]Av of 10 replications. Means followed by a common letter are not significantly different at the 5% level by Duncan's multiple range test.



T. palparum mite, Cuttack, India.

Parasitization of yellow stem borer (YSB) *Scirpophaga incertulas* eggs

H. S. Kim and E. A. Heinrichs, IRRI

We surveyed the IRRI farm to determine the extent of parasitization of YSB egg masses. Egg masses were randomly collected at weekly intervals from Jul to Aug 1984 from rice fields, 15-20 d after transplanting, and brought to the laboratory for collection of emerging parasites.

Three species of hymenopterous parasitoids — *Tetrastichus schoenobii, Telenomus rowani,* and *Trichogramma japonicum* — were reared from 455 egg masses (Table 1). *T. schoenobii* was the most abundant among the species, parasitizing 95% of the eggs. *T. schoenobii* may be the most efficient because two to four (av of three) host eggs are needed to complete the larval period. *T. japonicum* was so small that one to four (av of two) parasites developed from one host egg. Thus, in calculating percent parasitism by *T. schoenobii,* the number of emerged parasites is multiplied by 3. For *T. japonicum,* the number of emerged parasites is divided by 2 (see footnote to Table 1). Female parasites were five times as abundant as males.

Multiparasitization occurs in YSB egg masses (Table 2). Eighty-eight percent of the egg masses were parasitized by one or a combination of parasite species. The highest parasitization (35%) was by a combination of *T. rowani* and *T. japonicum.* □

Table 1. Percent parasitization of YSB egg masses and the sex ratio of the parasitoids, IRRI, Jul-Aug 1984.

Parasite	Egg masses (no.)	Eggs parasitized[a] (%)	Parasites (no./egg mass)		Stem borer larvae (no./egg mass)		Sex ratio (male:female)
			Emerged	Unemerged	Hatched	Unhatched	
T. schoenobii	46	94.7	18.7	2.0	1.5	2.0	5:1:1
T. rowani	15	45.3	20.8	10.3	18.4	19.1	5:3:1
T. japonicum	6	8.1	10.0	3.0	63.8	9.9	4:7:1

[a]Calculated as: *T. schoenobi* = $\frac{(C \times 3) + (D \times 3)}{(A + D) + (C \times 3) + (D \times 3)} \times 100$

T. rowani = $\frac{C+D}{A+B+C+D} \times 100$

T. japonicum = $\frac{C/2 + D}{A + B + (C/2) + D} \times 100$

Where A = no. of hatched stem borer larvae,
B = no. of unhatched stem borer larvae,
C = no. of emerged parasites, and
D = no. of unemerged parasites.

Table 2. Multiparasitization of YSB egg masses (n = 485) by 3 parasites, IRRI, Jul-Aug 1984.

Parasite combination	Parasitization of egg masses (%)
T. rowani + *T. schoenobii* + *T. japonicum*	9.8
T. rowani + *T. japonicum*	34.6
T. rowani + *T. schoenobii*	17.7
T. schoenobii + *T. japonicum*	11.5
T. schoenobji	9.5
T. rowani	3.2
T. japonicum	1.2
Total	87.5

A simple technique of rearing yellow stem borer (YSB) *Scirpophaga incertulas* (Walker)

F. G. Medrano and E. A. Heinrichs, IRRI

Insecticide evaluation and host plant resistance studies using YSB have been limited by an inadequate insect supply during certain months. Previous workers made unsatisfactory mass rearing attempts by placing larvae on 40- to 45-d-old rice plants or cut stem pieces of flowering plants, or feeding them artificial diets.

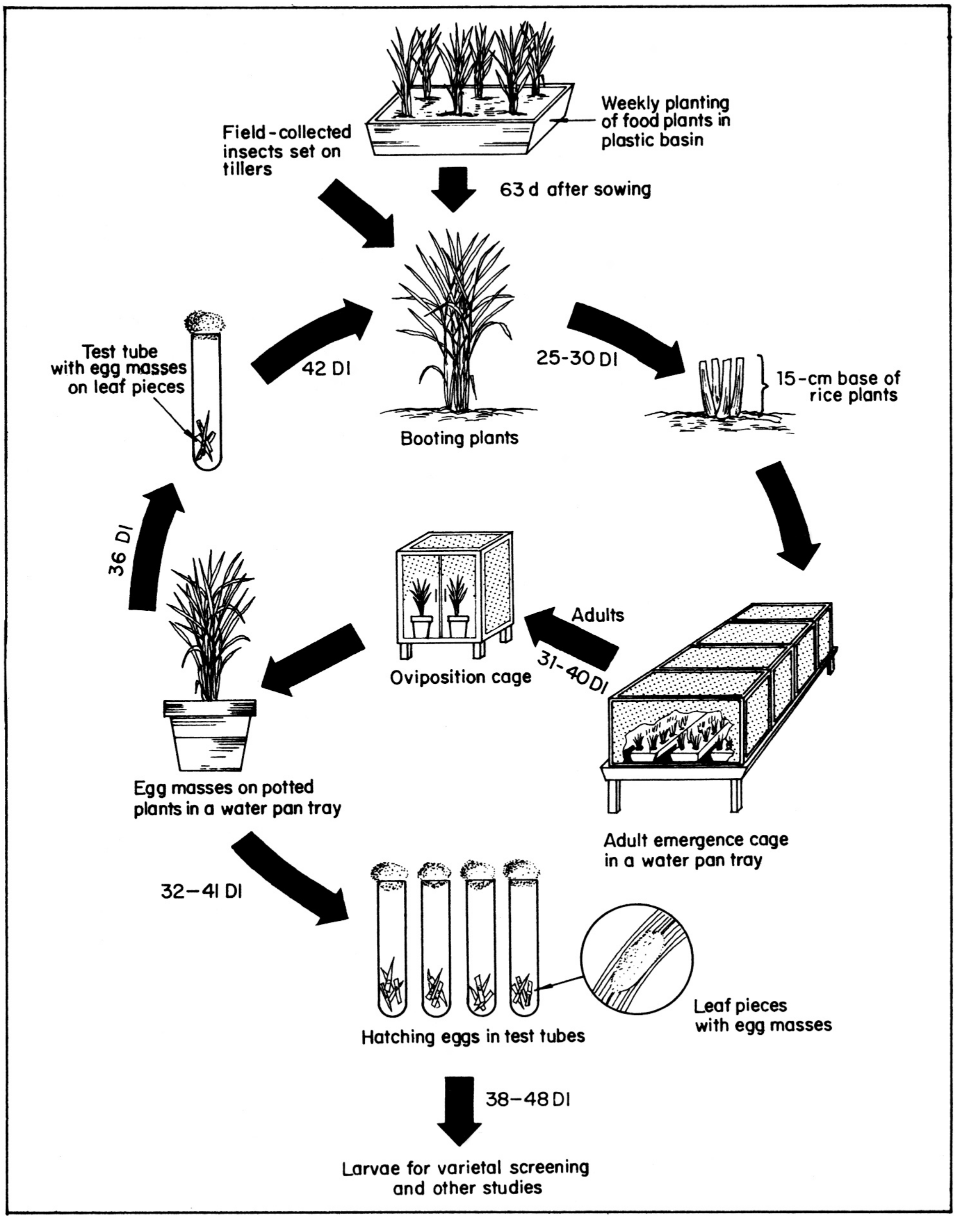
We developed a simple mass rearing technique using healthy booting stage rice plants. IR62 is used as a food plant because it is early maturing, high tillering, and YSB susceptible, but is resistant to several other insects and diseases that may infest a greenhouse culture.

The figure illustrates the YSB rearing procedure. Six hills of 14-d-old IR62 seedlings are transplanted weekly in a 34- × 25- × 11-cm plastic basin containing rice soil. At booting stage, about 63 d after sowing, tillers with bulging leaf sheaths are infested with 2 larvae/tiller. A 2.5-cm slit is cut along the midportion of the bulging leaf sheath. The incision is opened by spreading the cut edges to about 1 cm, which exposes a small section of the growing panicle. The slit is held open and YSB larvae are placed on the exposed panicle with a camel hair brush. When the edges of the slit close, the insects are trapped inside the boot. There should be no smoking during this procedure because newly hatched YSB larvae are highy sensitive to tobacco smoke.

Infested plants are placed in a 1.5- × 5.5- × 0.15-m water pan tray inside a large screen room. The water provides moisture for the plants and prevents ants from feeding on the insects. When the larvae have pupated at 25-30 d after infestation (DI) the plants are cut to 15-cm height and transferred to an adult emergence cage in another water pan tray. When adults emerge at 31-40 DI they are transferred to an oviposition cage containing 40- to 45-d-old potted TNl plants. The YSB lay eggs on TNl 1-2 d after emergence.

Potted plants with egg masses are collected daily (32-41 DI) and placed in a water pan tray. To maintain the culture, the leaves of the TN1 plants with egg masses laid at 36 DI are cut into small pieces 4 d after oviposition. The leaf pieces are placed in test tubes or ball jars with moist cotton at the bottom. The eggs hatch at 42 DI. Larvae are then placed on booting plants and the cycle is repeated.

To provide larvae for experiments, cut leaves with egg masses at 32-35 DI and 37-41 DI are placed in test tubes. The hatching larvae are for varietal screening for resistance or for basic studies of resistance mechanisms.



Steps in rearing YSB for resistance studies. DI = d after infestation.

With these procedures, about 80% of all infested tillers produce an adult moth.

Each week at IRRI, we infest 10 plastic containers, each with 6 hills of 63-d-old plants, to maintain the insect culture and to infest 1 concrete bed (2.5 × 26 m) of about 1,500 30-d-old test plants for screening cultivars for resistance. □

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

R. C. Joshi, E. Medina, and E. A. Heinrichs, IRRI

From Oct to Mar 1984, larvae of *M. patnalis* Bradley (Lepidoptera:Pyralidae), identified by A. T. Barrion of IRRI, were observed folding and damaging rice leaves on the IRRI experiment farm. This leaffolder species is widely distributed in Southeast Asia. However, it has escaped the attention of rice entomologists because the larva and adult, larval behavioral habits, and plant damage symptoms closely resemble those of the more commonly known leaffolder, *Cnaphalocrocis medinalis.*

We studied the life cycle of *M. patnalis* in the greenhouse at 26-34°C and 70-80%

relative humidity. Gravid female moths collected from the field were the source of insects. Females laid eggs singly or in groups of 2-9 on upper and lower rice leaf surfaces, but mostly on the upper leaves touching the margins of the main veins. Groups of two eggs were most common. Sometimes, eggs were laid on leaf sheaths. Incubation took 4 d (see table). The first-instar larvae fed in groups. They scraped the leaf surface and preferred young seedlings. The second-instar larvae folded leaves and fed within the fold. Feeding was always on parenchyma cells (between veins). No feeding was observed on bundle sheath and sclerenchyma cells. The larvae passed through 6 instars in 23 d.

Pupation occurred within a silken cocoon, most commonly between two adjacent leaves tied together with silk. Pupation also occurred at the basal part of the inner tillers and lasted 9 d.

Adult emergence was most frequent from 2200 to 2400 h. Ma1e:female was 2:1 (n=80). Females laid about 120 eggs. Total development period and percent survival at different stages of development are in the table. □

Life cycle of the rice leaffolder *Marasmia patnalis* reared on TN1, IRRI greenhouse, 1984.

Character	Duration [a] (d)		Survival (%)
	Av	Range	
Egg	4	4-5	92
Larva	23	21-25	88
Prepupa	1	1-2	[b]
Pupa	9	7-11	74
Total development period	37	33-43	
Adult longevity			
Male	3	4-3	
Female	5	6-7	

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

Effect of sequential release of resistant rices on brown planthopper (BPH) biotype development in the Solomon Islands

Dant T. Ho, entomologist, Solrice, P. O. Box 5, Honiara, Solomon Islands

New BPH *Nilaparvata lugens* Stål biotypes on some varieties may develop in six to nine generations in laboratory tests. In the Solomon Islands, planting varieties with different resistance genes for the last 10 yr produced a highly virulent BPH population,

IRRI resistant varieties were introduced in 1974. IR26, IR28, IR30, IR1628, and GPL 2S were planted from 1974 to 1977, until BPH biotype 2 developed (Table 1). IR36 and IR42 were planted in 1978, but were phased out because of susceptibility to leafroller *Susumia exigua* and root rot. Mala was then planted until 1981.

Field screening in 1980 indicated that BPH biotype 2 was dominant. In mid-1984, BG379-5 suffered heavy hopperburn and was replaced by resistant MTU5249, which is still planted. In 1984 seedling screening, BPH biotype 3 was identified (Table 2). ASD7 and BG379-5 were susceptible, but Ptb 33 was only slightly damaged.

As BPH biotypes have changed, fewer varieties of the International Rice Brown Planthopper Nursery (IRBPHN) of the International Rice Testing Program have maintained BPH resistance in the Solomon Islands. Only 12% of the 1984 IRBPHN were moderately to highly resistant to our present BPH population, compared with 39% in 1980.

Table 1. Effects of sequential release of resistant rice varieties on BPH biotype development in the Solomon Islands, 1974-84.

Year	Variety	Resistance gene	Virulence [a]	Remarks
1974	IR26	*Bph 1*	Biotype 2	Susceptible
1975	IR1628	Unknown	–	Susceptible to sclerotinia root rot
1976	IR28, IR30, GPL 2S	*Bph 1*	Biotype 2	–
1977	BG94-1	Unknown	–	Susceptible to leafroller
1978	IR36	– *bph 2*	–	IR36 and IR42 were used in only 2 croppings and were very susceptible to leafroller
	IR42	– *bph 2*		
	Mala	Unknown		
1979	IR42, Mala		–	–
1980	Mala	–	Biotype 2 [b]	Hopperburned in late 1980, but tolerant of high *N. lugens* population
Early 1982	BG379-5	Unknown	–	Hopperburned in March 1984
1984	BG379-5	–		–
	IR9852-22-3	Unknown (with IR36 as parent)	Biotype 3	–

[a] *N. lugens* virulence at the end of the resistance life. [b] As ASD7, resistant in 1980.

Table 2. Results of seedling bulk test for BPH resistance in November 1984 [a], Solomon Islands.

Variety	Score [b]	Remarks
TN1	9	Susceptible check
Mudgo	9	*Bph 1*
ASD7	9	*bph 2*
Ptb 33	3.6	*Bph 3*
Babawee	7	*bph 4*
MTU5249	1.6	Parentage: MTU4569/ARC6650 currently resistant commercial variety
BG379-5	9	Parentage: BG96-3*2/Ptb33, commercial variety from 1982 to March 1984
ARC6650	1.6	Parent of MTU5 249
BG367-2	.3	Parentage: BG280-1*2/Ptb 33, most resistant variety in 1984 IRBPHN

[a] Av of 3 replications. Screening made in seedboxes using *N. lugens* from commercial fields. Seedlings were infested with nymphs and adults 9 d after germination. [b] Scored according to 0-9 scale of the *Standard evaluation system for rice.*

The quick breakdown in resistant varieties was caused by several factors: 1) intensive staggered cropping within a small (1,000 ha) area; 2) destruction of natural enemies *Cyrtorhinus* sp., spiders, and egg parasites of BPH because of heavy insecticide use to control BPH, leafroller, and armyworm; and 3) failure to control BPH or BPH resurgence because of ineffective coverage of aerial insecticide sprays, especially at late crop stages.

To combat these problems, increasing emphasis is placed on pest control through integrated pest management and a substantial reduction in the use of highly toxic, broad-spectrum insecticides. We also are changing from continuous cropping to planting two crops per year with a fallow period. New resistant varieties are being introduced. ☐

Chemical control of rice gall midge (GM) and leaffolder (LF)

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We evaluated the effectiveness of chlorpyrifos seedling root dip and granular carbofuran application for controlling GM *Orseolia oryzae* (Wood-Mason) and LF *Cnaphalocrocis medinalis* Guenee in 1981-83 kharif.

Ten days after sowing the nursery, carbofuran 3% granules were applied: 40 kg/ha in 1981 and 20 kg/ha in 1983. The nursery was unprotected in 1982.

At transplanting, we compared 12-h and 3-h seedling root dips in chlorpyrifos 0.02% in a 1% urea solution. In 1983, we also evaluated a root treatment with chlorpyrifos 0.02%-treated carbono phosphate slurry. The amount of carbono phosphate needed for P fertilizer for the main field area (at 300 kg/ha, equal to 60 kg P/ha) was mixed 3:1 with wet clay and water was added to make a thick slurry. Chlorpyrifos 20 EC was mixed in the slurry at 0.02% concentration. The roots of seedlings were uniformly coated with the slurry and planted after 5-10 min. At planting, the field was puddled and had little standing water.

Carbofuran 3% granules at 20 kg/ha were applied to all chlorpyrifos-treated plots 20 d after transplanting (DT). Water was impounded for 3 d after granular application. The trial was in a randomized block design in 4 replications with an untreated control. Jaya was planted in 10- × 5-m plots at 20- × 15-cm spacing. Soil was a sandy loam.

GM damage was recorded at 45 and 60 DT and LF damage at 75 DT. All treated plots were GM free in 1981 and 1983. In 1982, damage until 45 DT was low, but beyond 60 DT, there was no significant difference between treated and untreated plots (Table 1). This was primarily because the unprotected seedlings from the nursery had 5.4% GM infestation.

LF was effectively controlled in all treated plots (Table 1), which had more productive tillers and significantly higher yield than the untreated control (Table 2). ☐

Table 1. Chemical control of GM and LF at Goa, India, 1981-83.[a]

Treatments[b]	Silvershoot (%) 45 DT	Silvershoot (%) 60 DT	LF damage (%)	Productive tillers/hill (no.)
		1981		
A	0.0 a	0.0 a	0.5 a	8.9 a
B	0.0 a	0.0 a	1.0 a	7.3 b
Control	16.0 b	35.7 b	7.7 b	4.7 c
		1982		
A	6.0 a	34.7 b	3.6 a	7.1 a
B	4.7 a	21.7 a	3.9 a	6.5 a
Control	36.7 b	28.1 a	33.1 b	4.9 b
		1983		
A	0.0 a	0.0 a	0.0 a	7.3 a
B	0.0 a	0.0 a	0.0 a	7.3 a
C	0.0 a	0.0 a	0.0 a	7.1 a
Control	10.8 b	18.0 b	15.9 b	6.7 a

[a]In a column in a particular year, means followed by a common letter are not significantly different at the 5% level. [b]A = NP + RD with chlorpyrifos 0.02% for 12 h fb 20 kg carbofuran 3% gr 20 DT. B = NP + RD with chlorpyrifos 0.02% for 3 h in 1% urea solution fb 20 kg carbofuran 3% 20 DT. C = NP + RT with chlorpyrifos 0.02% treated CP slurry for 5-10 min fb 20 kg carbofuran 3% gr on 20 DT. NP = nursery protection with carbofuran 3% gr @ 40 kg and 20 kg/ha, respectively during 1981 and 1983. RD = root dip, RT = root treatment, fb = followed by, CP = carbono phosphate, gr = granule, DT = days after transplanting.

Table 2. Yields and economics of insect control in chemical control trials at Goa, India, 1981-1983.[a]

Treatment[b]	Yield[c] (t/ha)	Gross profit[d] ($/ha)	Cost of insecticide application[e] ($/ha)	Net gain[f] ($/ha)	Gain from insecticides[g] ($/ha)	Benefit:cost[h]
			1981			
A	4.7 a	611	43	568	217	6.1
B	4.4 a	572	44	528	177	5.0
Control	2.7 b	351	0	351	–	–
			1982			
A	3.4 a	442	37	405	249	7.7
B	3.3 a	429	38	391	235	7.2
Control	1.2 b	156	0	156	–	–
			1983			
A	3.5 a	455	40	415	90	3.3
B	3.6 a	468	41	427	102	3.5
C	3.5 a	455	40	415	90	3.3
Control	2.5 b	325	0	325	–	–

[a]At conversion rate of US$1 = Rs 13.02. [b]See Table 1 for treatment details. [c]In a column in a particular year, means followed by a common letter are not significantly different at the 5% level. [d]Grain yield in kg/ha at 14% moisture × 0.13. [e]$1.96 for labor + cost of insecticide including the cost of urea. [f]Gross profit – cost of insecticide application. [g]Net gain of treatment - net gain of control. [h](Gross profit of treatment – gross profit of control) + cost of insecticide application.

Rearing pink stem borer *Sesamia inferens* on the southwestern corn borer diet

C. R. Vega, Hong Su Ma, and E. A. Heinrichs, IRRI

For 2 yr, we have successfully reared dark-headed stem borer *Chilo polychrysus,* armyworm *Mythimna separata,* cutworm *Spodoptera mauritia,* and pink stem borer on the southwestern corn borer diet. We studied the effect of that diet and a rice stem diet on the growth and development of the pink stem borer.

Rearing on rice stems. Seedlings of susceptible Rexoro were transplanted in 30-cm-diam clay pots. Fifty days after transplanting tillers were cut at the base. Stems were cut into 10-cm pieces and placed in 50 vials, each 11 cm long. To prevent the stem pieces from drying, a film of water was maintained at the base of each vial.

Pink stem borer moths emerging from field-collected pupae were allowed to oviposit on Rexoro plants inside cages. Egg masses were kept in a rearing room maintained at 28-30 °C and 70-80% relative humidity (RH), and allowed to hatch. Each stem piece in the vial was infested with two newly hatched pink borer larvae. Twice weekly the stem pieces were replaced with fresh ones. Individual weights of last-instar larvae and pupae were recorded. Emerging adults were allowed to oviposit on Rexoro plants and the incubation period of eggs was recorded.

Rearing on the southwestern corn borer diet. Field-collected pupae were caged and emerging moths were allowed to oviposit on Rexoro plants. Egg masses were incubated at 28-30 °C and 70-80% RH.

One litre of the custom southwestern corn borer diet (Bio-Mix #9763) was prepared using the following ingredients and steps:

Pack A	g/litre
Agar	17.2
Pack B - dry mix	
Wheat germ, toasted	21.1
Sucrose	25.0
Casein, vitamin-free	25.0
Salt mix Wesson	7.0
Linseed oil	0.2
Cholesterol	0.1
Corn cob grits (autoclaved)	37.0
Methylparaben	1.5
Sorbic acid	0.5
Pack C - vitamins	
Vanderzant vitamin mix	5.3
Ascorbic acid	2.1

1. Bring 545 ml of distilled water to a rolling boil.
2. Add 17.2 g of agar and stir until most of the agar has dissolved.
3. Pour water-agar mixture into the blender.
4. Add 118 g of pack B to the mixture and mix for 3 min at high speed.
5. Pour 366 ml of chilled distilled water into the blender and mix for 1 min.
6. Add 7.4 g of vitamins (pack C) and mix for 1 min.
7. Pour into rearing cups. If bacterial contamination is a problem, add with the vitamins 4 ml of 10% formaldehyde or 125 mg of aureomycin or both.

When the mixture cooled and the sides of the cup were dry, each cup was infested with two newly hatched pink stem borer larvae. Fifty cups were maintained for observation. Insect survival and growth duration of larvae and pupae were noted for each cup and individual weights were taken of last-instar larvae and pupae. The resulting moths were allowed to oviposit on rice plants and incubation periods of the eggs taken.

Table 1. Duration of egg, larval, and pupal stages and length of life of adult pink stem borer reared on rice stems or southwestern corn borer diet.

Insect stage	Duration (d)			
	Rice stem		Artificial diet	
	Av	Range	Av	Range
Egg	7.6 ± 1.0	6-9	6.5 ± 1.1	5-8
Larva	28.9 ± 3.8	22-35	22.1 ± 5.9	18-33
Pupa	8.4 ± 1.1	7-10	10.6 ± 1.1	9-13
Adult	4.9 ± 0.9	3-6	3.3 ± 0.5	3-4

Table 2. Weights of last-instar larvae and pupae of pink stem borer when reared on rice stems or the southwestern corn borer diet.

Insect stage	Weight (mg)			
	Rice stem		Artificial diet	
	Av	Range	Av	Range
Larva	170.0 ± 46.5	112.1 - 279.6	217.3 ± 46.9	133.0 - 296.0
Pupa				
Female	164.7 ± 22.2	130.3 - 206.5	209.9 ± 38.8	163.6 - 278.0
Male	123.1 ± 20.6	92.0 - 183.9	148.2 ± 48.2	118.6 - 168.6

Larval development was more rapid on the southwestern corn borer diet. The larval stage took 22 d versus 29 d for the rice stem diet (Table 1). The length of the egg and pupal stages were similar on the two food sources. Weights of last-instar larvae and pupae were distinctly higher on the southwestern corn borer diet, indicating that it is a better food source than rice stems (Table 2).☐

Yellow stem borer (YSB) survival as affected by growth stage of early and medium-duration rices

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

Previous studies have shown that IR46 is more resistant to the YSB *Scirpophaga incertulas* at panicle initiation than at other growth stages. To determine the effect of growth stage on YSB survival from larva to adult, medium-duration IR46 was compared with early-maturing IR60. Survival was studied at early tillering, maximum tillering, panicle initiation, booting, and flowering.

Three seedlings were transplanted per clay pot on a staggered schedule so plants of the five ages could be simultaneously infested with insects. Each pot was a replication and treatments were replicated 10 times. Before larval infestation, tillers were thinned to 12/pot and 10 first-instar larvae were placed one on each. Two tillers were uninfested. Plants were placed in a 20- × 100-cm mylar film cage. YSB adults were collected and counted when they emerged. Percentage survival was determined:

$$\frac{\text{No. of adults}}{\text{No. of larvae used to infest the plant}} \times 100$$

Survival on IR46 was lowest at early tillering and panicle initiation, and highest at booting (see table). Survival was intermediate at maximum tillering and flowering. Survival on IR60 was lowest at maximum tillering and panicle initiation and equally high at early tillering, booting, and flowering. Results indicate that the high level of resistance at IR46 panicle initiation is at least partially due to low larval survival. The reason for the different responses of the two varieties to YSB was not determined. □

Survival of 1st-instar YSB larva to the adult stage on medium-duration IR46 and early-maturing IR60 at different plant growth stages, IRRI.

Variety	Growth duration (d)	Survival[a] (%) Early tillering	Maximum tillering	Panicle initiation	Booting	Flowering
IR46	130	44 c	66 b	35 c	85 a	60 b
IR60	110	73 a	43 c	55 b	73 a	70 a

[a] In a row, means followed by a common letter are not significantly different at the 5% level by Duncan's multiple range test.

Effect of slow-release N fertilizers on stem borer (SB) and sheath rot (ShR) incidence and on rice grain yield

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We studied the effect of slow release N fertilizers on SB and ShR incidence and grain yield of IR20 in 1983-84.

SB and ShR incidence was significantly lower with neem cake-coated urea at both N levels (see table). Differences in grain yield were not statistically significant. Heavy rain (500 mm during flowering and maturity stages) reduced grain yield. □

Effect of slow-release N fertilizers on SB and ShR incidence and rice grain yield,[a] Tirunelveli, India.

N source	75 kg N/ha SB (% white heads)	75 kg N/ha ShR-infected tillers (%)	75 kg N/ha Grain yield (t/ha)	100 kg N/ha SB (% white-heads)	100 kg N/ha ShR-infected tillers (%)	100 kg N/ha Grain yield (t/ha)
Prilled urea	23 c	41 b	1.2 a	21 b	50 c	1.2 a
Neem cake-coated urea at 20%	6 a	31 a	1.5 a	5 a	33 a	1.5 a
Coaltar-coated urea at 1%	14 b	38 b	1.4 a	17 b	40 b	1.5 a
Urea superganules	16 b	40 b	1.3 a	17 b	42 b	1.3 a

[a] In a column means followed by a common letter are not significantly different at 5% level.

Preventing tungro (RTV) by applying insecticides to control green leafhopper (GLH) in Bangladesh

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We tested two insecticide treatments for control of GLH *Nephotettix virescens* and RTV. Carbofuran 3G at 3 kg ai/ha was incorporated in the seedbed before planting seeds, or diazinon 60 EC at 0.6 litre ai/ha was sprayed on seedlings 10 and 20 d after sowing.

In the seedbed, 21-d-old seedlings were inoculated with RTV viruliferous GLH for 4 d. The seedlings were transplanted in 14 treatment plots, each with

RTV infection on TN1 plants treated with carbofuran and diazinon at different growth stages, Joydebpur, Bangladesh.[a]

Seedbed treatment	Treatment in transplanted plot: Land preparation	Max tillering	Panicle initiation	Hills[b] (no.) showing RTV symptoms: %	Severity[c]
None[d]	–	–	–	30.3 bc	4.3 abc
None	–	–	–	50.8 d	6.3 c
C	–	–	–	27.8 bc	4.3 abc
C	C	–	–	14.0 a	3.0 a
C	C	C	–	15.0 a	3.7 ab
C	C	C	C	8.7 a	3.0 a
None[d]	C	C	C	10.0 a	3.7 ab
None	C	C	C	19.9 abc	3.0 a
D-60	–	–	–	58.6 d	5.7 bc
D-60	D-10	–	–	53.9 bc	5.7 bc
D-60	D-10	D-10	–	31.3 bc	3.7 bc
D-60	D-10	D-10	D-10	53.2 bc	4.3 abc
None[d]	D-10	D-10	D-10	12.0 ab	3.7 ab
None	D-10	D-10	D-10	26.6 abc	3.7 ab

[a] A dash (–) means no insecticide was applied. C = carbofuran, D-60 = diazinon 60 EC, D-10 = diazinon 10G. [b] Means of 3 replications. Means followed by a common letter are not significantly different at 5% level by Duncan's multiple range test. [c] Rated by the 1976 *Standard evaluation system for rice.* [d] Not inoculated with RTV.

3 replications (see table). In the transplanted field, either carbofuran 3G at 0.681 kg ai/ha or diazinon 10G at 1.7 kg ai/ha was incorporated at final land preparation, and broadcast at maximum tillering and panicle initiation. RTV infection was visually recorded at 70 d after transplanting.

Disease score (percentage and severity) was significantly lower in carbofuran-treated plots than in diazinon. treated ones. It was lowest when carbofuran was applied in the seedbed and in transplanted plots up to panicle initiation. □

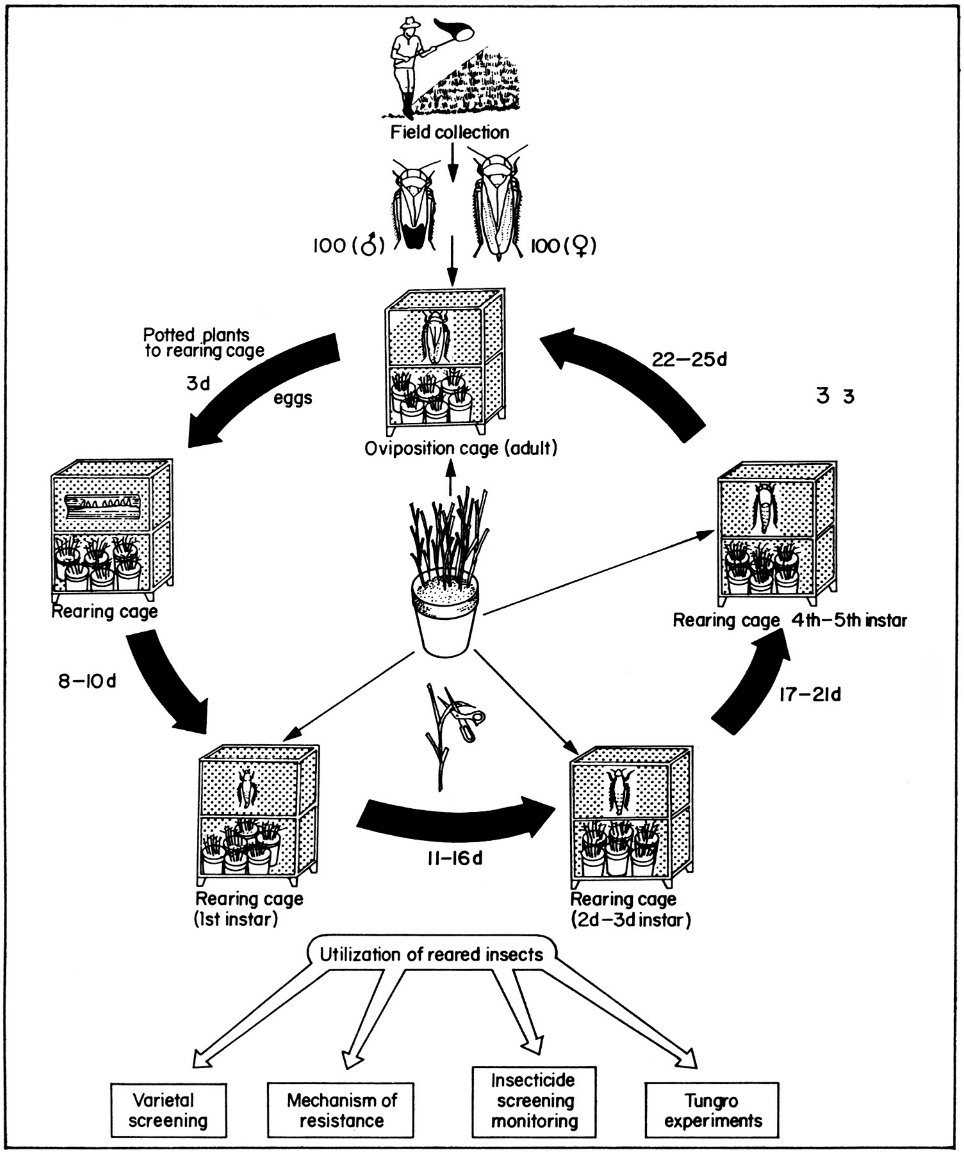
Mass rearing of *Nephotettix malayanus*

H. S. Kim, E. A. Heinrichs, and H. R. Rapusas, IRRI

Mass rearing techniques for the green leafhoppers *N. virescens, N. nigropictus,* and *N. cincticeps* have been successfully developed. However, no mass rearing technique has been developed for *N. malayanus.* Tests to select a host plant for *N. malayanus* rearing identified the weed *Leersia hexandra* as the most favorable. We developed a rearing procedure using *L. hexandra* (see fire).

L. hexandra cuttings were prepared by cutting 15-cm side shoots and transplanting them in pots at 10 cuttingslpot. Plants were fertilized with ammonium sulfate at 7 d after transplanting (DT). At 10 DT, 6 pots were placed in the oviposition cage. To start the culture, 100 field-collected females and 100 males were placed in the oviposition cage with the *L. hexandra* plants.

The 6 pots infested with eggs were transferred into the rearing cage and replaced with 6 new potted *L. hexandra* plants at 3 d-intervals. Eggs in the leaf sheaths of *L. hexandra* hatched in 8-10 d. Nymphs reached the 2d and 3d instar in 11-16 d, 4th and 5th in 17-21 d, and adulthood in 22-25 d. Fresh *L. hexandra* plants were placed in the cage each week. About 2,000-3,000 *N. malayanus* individuals can be produced in each generation with 1 oviposition cage and 1 rearing cage. Insects are maintained in the rearing cage until they are needed for varietal screening, insecticide screening, studies on resistance mechanisms and tungro virus infection, or to maintain the culture by transferring adults to the oviposition cage. □



N. malayanus rearing procedure and use of reared insects, IRRI.

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.

Seasonal population of rice leafhoppers and planthoppers at Varanasi, India

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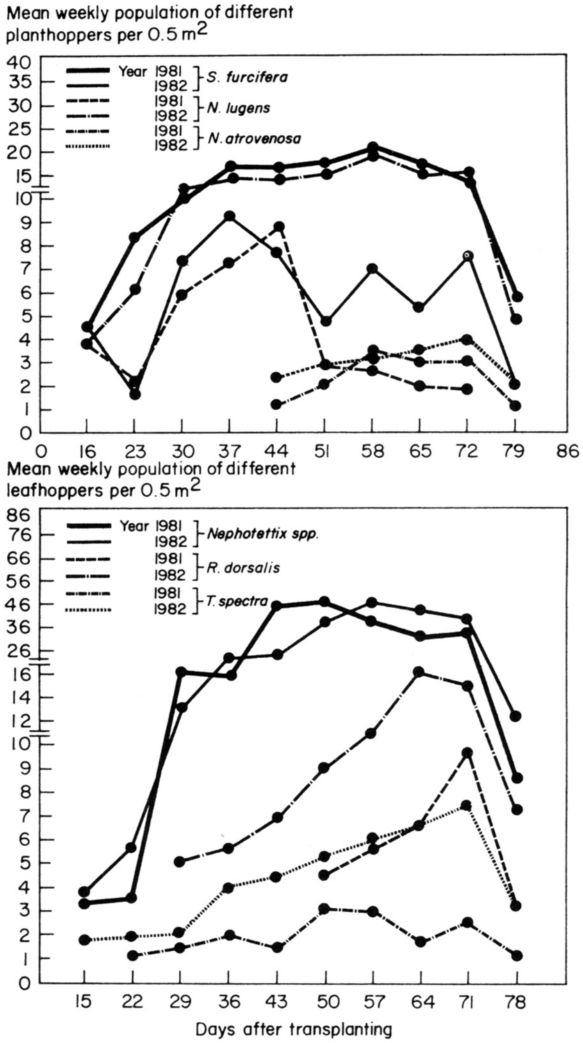
Leafhoppers and planthoppers are the most dominant insect pests in kharif. The most important of these are *Nephotettix virescens, N. nigropictus, Nilaparvata lugens, Sogatella furcifera, Recilia dorsalis, Tettigella spectra,* and *Nisia atrovenosa.* We recorded seasonal population density changes of these hoppers to determine how to develop management programs for their control.

Thirty rices were grown in a randomized block design with three replications at the BHU research farm in 1981 and 1982. Hopper infestation in 0.5-m^2 plots was recorded from 15 d after transplanting (DT) to 70 DT.

The figure shows that *Nephotettix* spp., *N. lugens,* and *S. furcifera* populations developed earliest in both years. *T. spectra* also appeared early in 1982 and at 22 DT in 1981. *R. dorsalis* and *N. atrovenosa* occurred first at 50 and 44 DT in 1981 and at 29 and 44 DT in 1982.

There was no relationship between peak population density and crop age. Peak populations developed early in 1981: *S. furcifera* at 37 DT, *N. lugens* at 44 DT, and *Nephotettix* spp. and *T. spectra* at 50 DT. Peak populations of *N. atrovenosa* and *R. dorsalis* were at 58 and 71 DT. In 1982, peak populations occurred later (see figure).☐



Mean population density of leafhoppers and planthoppers at Agricultural Research Farm, B. H. U. Varanasi, 1981 and 1982 kharif.

Pest Control and Management
WEEDS

Yield improvement and economic return of herbicide application in broadcast rice

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On the Guadalcanal Plains, Solomon Islands, where rice has been grown intensively with heavy mechanization and short turnaround, weeds are a problem and herbicide use is vital to rice production. To estimate the effect of herbicide application (propanil, 360 g ai/litre) on weed population and rice yield, we conducted a trial in a previously weedy rice field. Major grass species were *Echinochloa colona* and *E. crus-galli.* There were very few broadleaf weeds in the experimental plot. Major broadleaf weeds on the rice farm were *Sphenoclea zeylanica* and *Monochoria vaginalis.*

Five propanil treatments were applied — 2, 3, 4, 5, or 6 litres/ha (0.76, 1.08, 1.44, 1.80, or 2.16 kg ai/ha) — using a knapsack sprayer. Each treatment was replicated 4 times in randomized complete blocks. A 5- × 10-m plot was one replication. To avoid disturbing seedling growth, herbicide was applied from a timber placed across the plot. Ten 1-m swaths were sprayed along the length of the plot.

IR9852-22-3 was seeded on prepared, flooded fields at 120 kg/ha. The field was drained 7 d after seeding (DS). Propanil was applied at 15 DS. Four days after herbicide application, the field was reflooded. N was applied as urea at 30, 40, and 40 kg N/ha at 30, 50, and 75 DS, respectively. Weed population was recorded at harvest on four 1-m^2 quadrats. Yield was recorded from the whole plot.

As propanil dose increased, weed density declined. Rice yield doubled at the lowest herbicide dose and more than tripled at higher doses. In untreated plots, yield loss was 74% (Table 1).

Table 2 shows the effect of weeds on yield components. Yield reduction was highly related to the decrease in panicles/ unit area. In heavily infested plots (treatments 1 and 2), rice density was reduced by 1/3 to 1/2 as compared to density with good control (treatment 6), indicating that yield loss was due not only to competition between weeds and rice for soil nutrients and light but also to death of rice seedlings at early growth stages. At about 70 DS, weeds became taller than rice plants, reducing photosynthesis at preflowering and grain formation. Spikelets/panicle and percentage empty spikelets were significantly reduced in untreated and low-dose plots. Weight of 1,000 grains was not affected by weed infestation. Broadleaf weeds did not affect crop growth because seedling establishment was good and homogeneous. ☐

Table 1. Herbicide application and economic return for irrigated, broadcast rice, Solomon Islands. [a]

Treatment	Dosage (kg ai/ha) of propanil	Weeds/m^2 (no.)	Yield (t/ha)	Yield loss (%)	Gain [b] (US$/ha)
1	0	505 d	1.1 d	74	–
2	0.76	207 c	2.1 c	52	210
3	1.08	64 b	3.6 b	18	550
4	1.44	22 ab	4.2 ab	6	670
5	1.80	10 ab	3.9 ab	11	615
6	2.16	1 a	4.4 a	–	723

[a]Separation of means by Duncan's multiple range test at the 5% level. [b]Gain was estimated by comparing with yield of the untreated plots, using current prices on paddy ($225/t) and propanil (Stam F34 e.c.) ($2.90/litre).

Table 2. Yield and yield components of broadcast rice at different weed densities, [a] **Solomon Islands.**

Treatment	Panicles/m^2	Grains/panicle (no.)	% empty grain	1000-grain wt (g)	Yield (t/ha)
1	160 c	50 b	22 a	29 a	1.1 d
2	207 bc	55 b	27 b	30 a	2.1 c
3	293 ab	60 ab	25 ab	30 a	3.6 b
4	331 ab	77 a	23 a	30 a	4.2 ab
5	273 b	74 a	24 ab	28 a	3.9 b
6	376 a	71 a	24 ab	29 a	4.4 a

[a] Means of four 50-m^2 plots served as 4 replications. Yield components were obtained from 5 plants in each replication, Means followed by a common letter are not significantly different at 5% level by Duncan's multiple range test.

Efficiency of herbicide carriers for lowland rice weed control

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We studied the efficiency of herbicide carriers for weed control in the All India Coordinated Research Programme on Weed Control in 1984 wet season at TNAU. An emulsifiable concentrate (EC) formulation of thiobencarb at 1.5 kg/ha was mixed with easily available carriers: farmyard manure (2, 4, or 6 kg/ha), rice bran and husk (2, 4, or 6 kg/ha), soil (12.5, 25, or 50 kg/ha), sand (50 kg/ha), or wat er (750 litres ha) and applied 5 d after transplanting (DT) with 3 to 5 cm standing water in the field. The mixtures were compared with a control preemergence sprinkle application of oxadiazon EC (0.48 or 0.72 kg/ha) and an unweeded control,

In the control plots, weed density/m^2 at 30 and 50 DT was 50 and 196 for *Echinochloa crus-galli* (L.) Beauv., 22 and 32 for *Paspalum* sp., 18 and 126 for *Cyperus difformis* (L.), 6 and 18 for *Marsilea quadrifolia* L., and 28 and 8 for *Monochoria vaginalis* L. Thiobencarb with different carriers at all rates effectively controlled annual grasses and sedges, but not *Paspalum* sp.

Treatments reduced weed dry matter

Efficiency of herbicide carriers for weed control on rice, Coimbatore, India.

Treatment: Carrier and quantity per ha	Treatment: Preemergence herbicide and dose (kg/ha)	Weed wt[a] (g/m^2) 30 DT	Weed wt[a] (g/m^2) 50 DT	Productive tillers (no./5 plants)	Grain yield (t/ha)
Farmyard manure	Thiobencarb				
2 kg	1.5	48	124	57	5.2
4 kg	1.5	46	112	63	5.6
6 kg	1.5	22	153	61	5.5
Rice bran and husk					
2 kg	1.5	31	93	53	5.3
4 kg	1.5	15	123	58	5.8
6 kg	1.5	41	119	59	5.7
Soil					
12.5 kg	1.5	43	147	57	5.3
25 kg	1.5	66	108	57	5.8
50 kg	1.5	24	84	60	5.0
Sand, 50 kg	1.5	34	132	54	5.8
Water, 500 litres	1.5	26	166	59	5.4
EC formulation direct spraying	Oxadiazon				
4 litres	0.48	36	178	58	4.7
6 litres	0.72	28	120	64	5.9
No herbicide or weeding	–	84	300	49	3.2
CD		6	8	1	0.5

[a] DT = days after transplanting.

and increased productive tillers and IR50 grain yield (see table). There was little difference between carriers. Preemergence oxadiazon EC reduced early rice growth but effectively controlled grasses, sedges, and aquatic weeds such as *Marsilea quadrifolia* and *Monochoria vaginalis.* It gave 4.7-5.9 t grain yield/ha compared with 3.7 t/ha for the unweeded plot. Mixing an EC formulation of preemergence herbicide with carriers, or direct sprinkling, is simple and economical. □

Rice field weeds of Mwea Irrigation Scheme, Kenya

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The Mwea Irrigation Scheme is the largest rice growing area in Kenya. It is near Mount Kenya, about 100 km north of Nairobi. We identified the rice field weeds and examined their distribution.

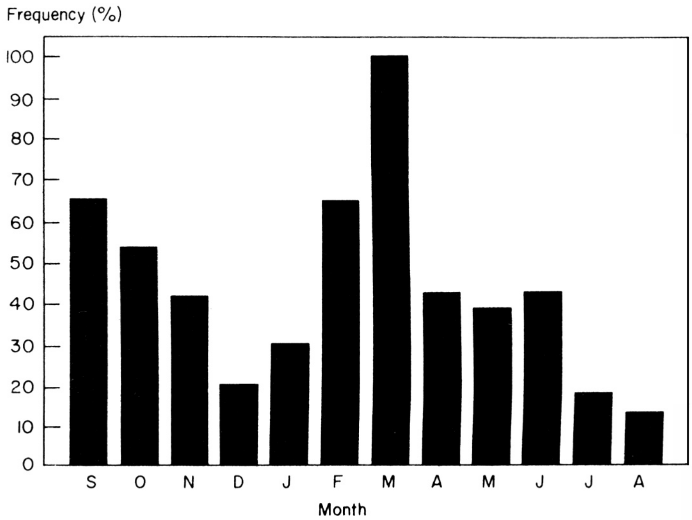
Twenty-nine weeds were identified (see table). According to Sculthorpe's life-form categories, 22 were emergent, 3 floating-leaved, 2 submersed, and 2 free-floating. The major habitats of the weeds were within the rice crop, on the levees of major canals, and inside feeder canals and drains.

Weed distribution was studied in 1980-81 and percentage frequency was scored in 1000 1-m^2 quadrats. The figure shows the distribution has bimodal peaks in Sep and Mar. The general decline in weed population between Sep and Dec might be attributed to weeding at the initial stages and drainage as the rice crop matures. The increase between Jan and Mar is due to reflooding and the subsequent reemergence of obligately aquatic weeds. Puddling and rototilling reduce weeds in Aug, when fields are prepared for the next season. The weeds could not be totally eradicated in Dec when dryland conditions were prevalent because of the persistence of some weeds and nonuniform field preparation. □

Weeds of Mwea Irrigation Scheme, Kenya.[a]

Weed species	Lifeform	Habitat
Alternanthera sessilis (L.) DC.	E	XO ●
Ammannia auriculata Willd.	E	XO
A. baccifera L.	E	X ●
A. prieuriana Guill & Perr.	E	XO ●
Aponogeton absynicum Hochst. ex A. Rich	FL	X ●
Ceratophyllum demersum L.	S	X ■ θ●
Commelina benghalensis L.	E	XO ▲θ●
Cyperus difformis L.	E	XO θ●
C. immensus C. B. Clarke	E	XO θ●
C. latifolius Poir	E	XO θ●
Diplachne caudata K. Schum.	E	XO θ●
Echinochloa colona (L.) Link	E	XO θ●
Leersia hexandra Sw.	E	XO ▲θ●
Lemna minor L.	FF	X ●
Ludwigia octovalvis (Jacq.) Raven	E	XO ●
L. prostrata Roxb.	E	XO ●
L. stolonifera (Guill. & Perr.) Raven	E	XO ▲θ●
Mariscus assimilis (Steud.) Podlech	E	XO θ●
Marsilea macrocarpa Presl.	FL	XO ▲θ●
Najas graminea Del.	S	XI ■ θ●
Nymphaea caerulea Savign	FL	X θ●
Ricciocarpus natans (L.) Corda	FF	X
Scirpus confussus N. E. Brown	E	XO θ●
Sesbania sesban (L.) Merr	E	XO θ●
Sphaeranthus bullatus Mattf.	E	XO ●
S. cyathuloides O. Hoffm.	E	XO ●
S. suaveolens (Forsk.) DC.	E	XO ▲θ●
Typha angustifolia L.	E	XO ■ θ●
T. latifolia L.	E	XO ■ θ●

[a]E = emergent, FL = floating-leaved, S = submersed, FF = free-floating, X = inside rice crop, O = on levees of major canals, ■ = inside major canals, ▲ = inside major canals but floating, θ = inside feeder canal, ● = inside drains.



Distribution of weeds at Mwea Irrigation Scheme, Kenya, 1980-81 growing season.

Pest Control and Management
OTHER PESTS

Reaction of some upland rices to root-knot nematodes in rubber plantation fields

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In 1984, upland rice lines that were grown and selected for intercropping in a pararubber crop at Kok-Primeng Rubber Experiment Station were seriously damaged by the root-knot nematode *Meloidogyne* spp. Infested plants had root galling, yellowed leaves and leaf sheaths, stunting, and low tillering. Based on the number of root galls, some lines had resistance to the nematode (see table). □

Field reaction of upland rice lines to root-knot nematode infestation at Kok-Primeng Rubber Experiment Station, Narathiwat, Thailand.

Cross	Selection no.	Infestation[a] (%)	Reaction[b]
SPR72103-67-2/IR208-78	SPRLR77205-3-2-1-4	37	MR
SPT7220-13-13-1/RD5	BKNLR77003-PSL-65021	81	S
RD11/IR28	SPRLR5010-149-1-1	92	S
RDl/IR28	SSPRLR75001-60-1-2	81	S
RD7/IET2845/IR4215-4-3-1-1	SPRLR223-53-2-2	87	S
IR36/RD25	BKNGB80076-5-08	25	R
IR36/RD25	BKNGB80076-6-030	31	MR
IR36/RD25	BKNGB80076-12-072	44	MR
IR36/RD25	BKNGB80076-15-050	25	R
IR36/RD25	BKNGB80076-17-091	31	MR
IR36/RD25	BKNGB80076-12-072	25	R

[a] Av of 4 replications. [b] R = 0-25% root galls, MR = 26-50%, MS = 51-75%, and S = 76-100%.

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,

Soil and Crop Management

Organic matter as a P source for azolla

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Azolla culture with lowland rice is drawing farmer interest in northeastern India. P is essential for rapid azolla growth, and P deficiency gives azolla a red-brown color. For best azolla growth, 8.8 kg P/ha must be applied, which is more than the total fertllizer applied by farmers in Assam. We studied organic matter supplements to provide P for azolla.

Cow dung and poultry litter, applied to equal 9 kg P/ha at 1- or 2-mo intervals were compared to 0 and 9 kg P applied at 1-mo intervals.

Results (see table) showed that azolla growth increased from Mar to May, then declined from Jun to Aug. In May, the interaction of application intervals and organic matter sources was significant. Azolla grew better with 2-mo applications of cow dung and poultry litter.

Results indicated that when organic matter is used as a P source it should be applied well ahead of azolla inoculation so soil microorganisms can break it down and make it available as an azolla nutrient. Applying 9 kg P/ha as single superphosphate significantly increased azolla production. □

Azolla biomass production as affected by P application and 2 application intervals of cow dung and poultry litter, Assam, India.

Organic matter source	Application intervals (mo)	P as SSP[a] (kg/ha)	Azolla biomass production (t/ha) Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
No organic matter	–	–	6.0	6.7	15.5	21.2	23.7	14.9	14.4	13.2
No organic matter	–	9	7.6	8.5	19.5	28.0	33.5	18.0	17.5	17.3
Cow dung	1	–	6.0	7.5	17.6	27.1	28.5	16.9	15.0	17.5
Cow dung	1	9	6.9	8.4	22.7	29.2	31.0	21.7	17.2	19.7
Poultry litter	1	–	5.6	8.1	16.6	23.7	24.0	18.4	17.2	20.7
Poultry litter	1	9	6.5	7.2	21.2	28.2	25.7	19.9	17.9	19.9
No organic matter	–	–	6.2	7.2	15.9	20.9	23.0	16.8	16.7	15.5
No organic matter	–	9	7.4	7.2	20.9	29.5	28.2	19.0	17.0	15.7
Cow dung	2	–	5.7	6.1	18.6	23.7	32.5	16.9	15.7	14.9
Cow dung	2	9	5.1	9.5	23.3	32.1	36.2	20.8	19.8	18.9
Poultrylitter	2	–	4.7	8.2	16.6	27.6	29.0	17.9	14.2	14.2
Poultrylitter	2	9	7.0	8.7	22.1	30.1	39.5	20.8	19.1	17.4
Mean	–	–	6.2	7.8	19.2	26.8	29.2	18.5	16.8	17.1
	SEm (P)		0.3	0.3	0.7	0.8	0.5	0.7	0.6	0.8
	CD (0.05)		0.8	ns	2.1	2.5	4.4	2.1	1.6	ns
	SEm (F × C)		0.4	0.6	1.3	1.5	2.6	1.3	1.0	1.5
	CD (0.05)		ns	ns	ns	ns	7.7	ns	ns	ns

[a] Single super phosphate.

Nitrogen requirement and spacing for late-transplanted, photoperiod-sensitive, tall indica rice

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In parts of Bihar, early Jul floods wash out lowland rice. Farmers retransplant in Aug with old seedlings of tall, photoperiod-sensitive indicas. Sometimes, labor shortages also delay transplanting. We sought to identify a suitable rate and time of N application and spacing for Janaki, a new photoperiod-sensitive variety suitable for poorly drained lowlands. A field trial was conducted at RAU Research Farm in 1981 kharif.

The experiment was in a split-plot design with three replications. Janaki was planted in four spacings and with six times and rates of N application (see table). Spacings were in the main plot and N treatments in subplots. The soil was a silt loam with pH 8.5, 0.23% organic carbon, 17 kg available P/ha, 86 kg available K/ha, and EC 0.44 mmho/cm at 25°C.

Sixty-day-old Janaki seedlings were transplanted 8 Aug 1981. N was applied as urea. PK at 8.6 and 8.3 kg/ha as a single superphosphate and muriate of potash were applied at puddling. The crop was harvested 7 Dec 1981 from a net plot size of 6.25 m^2 and grain yield was adjusted to 14% moisture.

N rate and timing significantly affected grain yield (see table). Maximum grain yield was obtained with 40 kg N/ha applied basally. It was 11 and 9% higher than yield with the same N applied in equal splits at transplanting and panicle initiation, or at transplanting and tillering. Higher yield was due mainly to more panicles/m^2.

At 20 kg N/ha, basal N application increased yield 10% over the same dose applied at panicle initiation. Poor yield due to late N application may be associated with lower tiller productivity. These results indicate that time of N application was most critical for the late-transplanted crop.

Although the grain yield was statistically similar at different spacings, 20- × 15-cm spacing appeared to be best, and increased yield 12% over that with 20- × 20-cm spacing. Panicles/m^2 increased with closer spacing, while panicle weight and percent spikelet fertility decreased. Panicle length and 1,000-grain weight were unaffected by spacing. □

Grain yield and yieldcontributing characters as affected by different spacing and fertilizer treatments, Pusa, India.

Treatment	Grain yield (t/ha)	Panicles/m^2	Panicle length (cm)	Panicle weight (g)
Spacing (cm)				
20 × 20	1.7	119	18	2.5
20 × 15	1.9	149	18	2.2
15 × 15	1.9	171	18	2.1
20 × 10	2.0	177	17	2.0
Time and rate (kg/ha) of N application				
Control	1.6	143	18	2.0
20 as basal	1.9	159	18	2.4
20 at panicle initiation (PI)	1.7	149	17	2.1
40 as basal	2.2	171	18	2.3
20 as basal + 20 at PI	2.0	157	17	2.2
20 as basal + 20 at tillering	2.0	145	18	2.6
CD 5% for				
Spacing	ns	20	ns	0.2
Rate and time of N application	0.2	16	0.7	0.2

Effect of different levels of N, P, and azolla on rice

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We studied the effect of different levels of N, P, and azolla (*Azolla pinnata* R. Br.) on rice in 1983 kharif. Soil was a sandy clay with pH 6.7, 285.50 kg available N/ha, 26.92 kg available P/ha, and 340.90 kg available K/ha. The experiment was in a split-plot design with nine main plot and three subplot treatments in three replications. Main plot treatments were 0, 50, and 100 kg N/ha as urea and 0, 11, and 22 kg P/ha as single superphosphate. Subplot treatments were no azolla and azolla intercropped or dual-cropped with rice.

In the intercropped plots, 3t azolla/ha was inoculated 1 d after transplanting (DT) rice, grew with rice, and was incorporated twice after transplanting. In dual-cropped plots, 3 t azolla/ha was inoculated at 20 d before transplanting, allowed to grow as a monocrop and an intercrop, and incorporated twice each, before and after transplanting. N was applied in equal splits at transplanting and 30 DT, P was applied basally, and 42 kg K/ha as muriate of potash was applied basally to all plots. Jaya was transplanted at 20- × 10-cm spacing on 18 Jul and harvested 19 Nov 1983.

Applying N and azolla improved rice growth and increased straw yield (Table 1). Grain yield was adversely affected at higher N levels and in dual azolla

Table 1. Effect of different levels of N, P, and azolla on yield and yield parameters of rice, Bangalore, India, 1983 kharif. [a]

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Grain to straw ratio	Weight of single panicle (g)	Grain weight per panicle (g)
N (kg/ha)					
0	5.3	5.5	1.0	1.7	1.4
50	5.0	6.7	0.8	1.6	1.3
100	4.7	7.5	0.7	1.5	1.2
CD P: 0.05	ns	0.6	0.1	ns	ns
P (kg/ha)					
0	5.0	6.6	0.8	1.6	1.3
11	5.0	6.4	0.8	1.5	1.3
22	5.0	6.8	0.8	1.6	1.3
CD P: 0.05	ns	ns	ns	ns	ns
No azolla	5.1	5.8	0.9	1.7	1.4
Intercrop	5.2	6.3	0.9	1.7	1.4
Dual crop	4.7	7.6	0.6	1.3	1.0
CD P: 0.05	0.3	0.4	0.1	0.2	0.1
CD P: 0.01	0.4	0.5	0.1	0.2	0.2

[a] ns = not significant.

cropping because of reduced panicle weight and grain weight/panicle, caused by poor grain filling. This may have been due to overcrowding and mutual shading of plants during the 40 d from transplanting to panicle initiation.

Grain yield was highest (5.8 t/ha) in dual azolla cropping without fertilizer N, followed by that with 50 kg N/ha (Table 2). Results indicated that only a small amount of added N is needed to obtain higher grain yield, and a poorly timed excessive N supply may adversely affect the grain yield where soils have good N and P status. Applying P did not significantly affect grain yield.□

Table 2. Effect of N and azolla interaction on rice grain yield, Bangalore, India.

N level (kg/ha)	Rice grain yield (t/ha)		
	No azolla	Intercropping	Dual cropping
0	4.9	5.8	5.1
50	5.5	5.0	4.7
100	5.0	4.8	4.2
CD P: 0.05	0.6[a]	0.7[b]	

[a]Between 2 azolla means at the same level of N. [b]Between 2 N means at the same or different levels of azolla.

Effect of N sources and levels on deep water rice

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We studied the effect of N source and level on deep water rice yield at Thot Not in 1983 wet season. Soil was a Sulfaquept with pH 4.5,0.178% N, 0.067% P_2O_5, 0.067% SO_4^{--}, 2.88 meq Al^{3+}/100 g, and 0.56 meq H^+/l00 g. Water depth reached 120 cm in mid-Oct.

The experiment was in a split-plot design with 18-m^2 subplots and 3 replications. Thirty-five-day-old Nang Tay Dum (local floating variety) and RD19 (modern variety) were transplanted at 25- × 30-cm spacing in the main plots. Prilled urea (PU), sulfur-coated urea (SCU), or urea supergranules (USG) were applied at 14.5, 29, or 43.5 kg N/ha and compared to a no-N control. Basal P at 18 kg/ha was applied to all plots.

PU and SCU were broadcast and incorporated 10 d after transplanting (DT) and USG was placed 10 cm deep between 4 hills at 7 DT.

Yield increased with increased N application (see table). At 43.5 kg N/ha, USG performed better than SCU or PU. At 14.5 kg N/ha, yields were similar for all N sources. SCU generally performed poorly because of the acid sulfate soil.

Varietal performance and interaction between varieties and N management did not significantly differ. Although RD19 has improved plant type, a high percentage of unfilled grains, few grains/panicle, and gall midge damage caused it to yield the same as Nang Tay Dum. Drought at early growth reduced yield of both varieties. □

Yield of Nang Tay Dum and RD19 at different N sources[a] and levels, Hau Giang, Vietnam, 1983.

Variety	Yield (t/ha)										
	0 N	14.5 kg N/ha			29 kg N/ha			43.5 kg N/ha			Mean
		PU	SCU	USG	PU	SCU	USG	PU	SCU	USG	
RD19	1.2	1.2	1.1	1.3	1.4	1.3	1.7	1.5	1.6	1.9	1.4
Nang Tay Dum	1.0	1.1	1.2	1.3	1.3	1.4	1.7	1.7	1.6	2.1	1.4

Varieties : ns — CV (%) 21.96
Nitrogen : LSD 5%: 0.23 — CV (%) 13.88
Variety × nitrogen : ns — CV (%) 13.88

[a]PU = prilled urea, SCU = sulfur-coated urea, USG = urea supergranules.

N release from sesbania green manure and effect of time of application of N fertilizer on lowland rice

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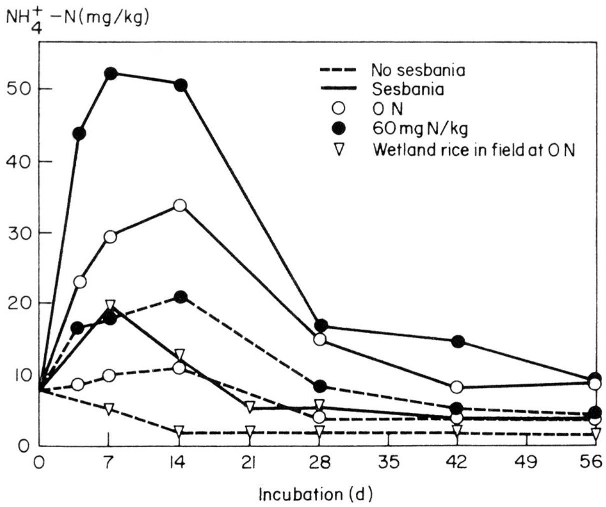
Interest is increasing in the use of organic and green manures for rice culture. At the PAU farm, we showed that N release from sesbania (*Sesbania aculeata*) incorporated in irrigated rice depended on the number of days it was buried before transplanting. Incorporation 1 d before transplanting released 60-120 kg N/ha,

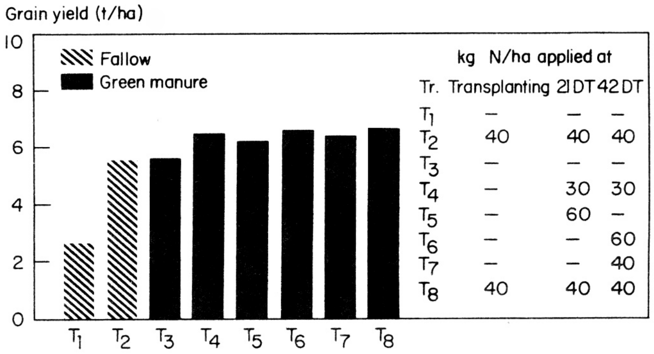


1. Effect of sesbania on KCl-extractable NH_4^+ –N in a flooded soil under laboratory and field conditions, Ludhiana, India.

depending upon the amount incorporated in the soil. We studied N release from sesbania green manure and its effect on timing fertilizer N application.

Soil of the experiment was loamy sand (Typic Ustochrept) with 5 mm percolation/h. It had pH 8.4, EC 0.15 mmho/cm, 0.34% organic carbon, 0.06% N, and 8 μg/g KCl-extractable NH_4^+-N. Finely chopped 2-mo-old fresh sesbania was mixed 20% by volume with soil with and without fertilizer N. The soil samples were submerged and incubated at 30 ± 1°C. Three samples from each treatment were taken at 4, 7, 14, 28, 42, and 56 d of incubation and extracted with 2 N KCl to determine NH_4^+-N content (Fig. 1).

In a field experiment, 2-mo-old sesbania, equivalent to 22 t green matter/ha and 120 kg N/ha, was incorporated 1 d before transplanting rice on 10 Jul 1984. All but the no-green-manure plots received the same amount of sesbania. At last puddling, 26-30 kg PK/ha was applied to all plots. Urea N at 40-120 kg/ha was applied in different combinations at transplanting or 21 or 42 d after transplanting (DT). The crop was harvested at maturity and grain yield was determined at 14% moisture content.



2. Effect of sesbania green manure on time of N application in rice, Ludhiana, India.

The kinetics of KCl-extractable NH_4^+-N indicated that sesbania began releasing N soon after incorporation. At 4 d of incubation, 44 and 23 mg NH_4^+-N/kg was received in soil with sesbania, with and without applied N. Peak NH_4^+-N was within 7 to 14 d of sesbania incorporation and release remained steady through 56 d.

Data indicated that incorporating sesbania alone gave yield as high as applying 120 kg N/ha as urea (Fig. 2). Furthermore, with sesbania, applying 40-60 kg fertilizer N/ha at 42 DT gave yields at par with treatments where N was applied at transplanting or 21 DT. Sesbania-N was sufficient for rice at early growth stages. Topdressing 40 kg N/ha at 42 DT was necessary in lowland rice with incorporated sesbania. □

Effect of seeding rate and N levels on yield of direct-seeded rice

N. M. Chau, P. T. Hoang, B. K. Singh, and N. V. Luat, Cuu Long Delta Rice Research Institute, Vietnam

We evaluated IR21717-42-1 performance at different seeding rates and N levels on a Ustifluvent soil with pH 5.7 at Chau Thanh District, An Giang Province. N was applied at 40, 70, 100, or 130 kg/ha in main plots and seeding rates were 200, 250, 300, 350, or 400 kg seed/ha in subplots. The experiment was in three replications. After land preparation, excess water was drained away and 13 kg P/ha as superphosphate was broadcast. Pregerminated seed was broadcast on uniformly puddled soil on 15 May 1983. N was applied, one-half at 20 d after sowing (DS) and in equal splits at 30 and 45 DS. Rice was harvested 18 Aug and yield was estimated from an 18-m^2 area.

Grain yield as influenced by seed rate and N level, An Giang Province, Vietnam.

Seeding rate (kg/ha)	Grain yield (t/ha)				
	40 kg N/ha	70 kg N/ha	100 kg N/ha	130 kg N/ha	Mean
200	3.9	4.7	4.8	5.0	4.6
250	3.9	4.7	4.7	5.0	4.6
300	4.0	4.4	4.8	4.7	4.5
350	4.0	4.3	4.5	4.2	4.4
400	3.8	4.3	4.3	4.1	4.1
Mean	3.9	4.5	4.6	4.6	

	CD at 5%	CV (%)
Main effects		
Seed rate (S)	0.2	6.7
N level (N)	0.4	10.0
Interaction effects		
Seed rate at a constant N level	0.3	
N at a constant S level	0.5	

Interaction between seeding rate and N level was significant. It was not possible to increase yield by increasing seeding rate beyond 200 kg/ha (see table). Data indicate that seeding rate might be reduced below 200 kg/ha without affecting yield. □

Comparison of chemical indices for available K for rice in alluvial soils of Punjab

M. P. S. Gill and G. Dev, Soils Department, Punjab Agricultural University, Ludhiana, India

We compared different soil tests for available K in 20 soils and their relationship to rice yield and K uptake in the greenhouse. Soils had pH 8.7 ± 0.4, electrical conductivity 0.52 ± 0.26 mmho/cm, 0.44 ± 0.18% organic C, 57.4 ± 17.6 ppm $KMnO_4$-N, and 2.2 ± 1.1 ppm Olsen-P. Five 20-d-old PR106 seedlings grown in a K deficient solution were transplanted into pots each with 4.5 kg soil.

Treatments were 0 and 21 ppm K as KCl. A basal dose of 50 ppm N and 11 ppm P was applied to all pots and 50 ppm

N was added 3 wk after transplanting. The crop was harvested at maturity and grain and straw yields recorded. The grain and straw samples were digested in a diacid (HNO_3 + $HClO_4$ in 4:1 ratio) mixture and analyzed for K. Percent yield or K uptake was calculated:

$$\text{Percent yield or K uptake} = \frac{\text{yield or K uptake without K treatment}}{\text{yield or K uptake with applied K}} \times 100$$

Available K in soil was extracted using IN neutral ammonium acetate (1:5 soil: solution, 5 min shaking); 0.5 M sodium bicarbonate of pH 8.5 (1:20 soil: solution, 30 min shaking); Morgan's reagent 3% acetic acid + 10% sodium acetate of pH 4.8 (1:5 soil:solution, 5 min shaking); 1% citric acid (1: 10 soil:solution, 4 h shaking); Troug's reagent 0.002 N H_2SO_4 + 0.3% $(NH_4)_2SO_4$ with pH 3.0 (1:200 soil:solution, 30 min shaking); and boiling nitric acid (boiling 2.5 g soil in 25 ml IN HNO_3 for 10 min and 4 washings, each with 15 ml of 0.1N cold HNO_3 to make volume to 100 ml). Simple correlation coefficients were calculated for yield and K-uptake parameters with K indices (see table).

Determining available K by different indices and their relation to rice plant parameters, Ludhiana, India.[a]

	NH_4OAC	$NaHCO_3$	Morgan	Citric acid	Troug	Nitric acid
			Available K (ppm)			
Range	26.3-179.9	50.0-270.1	62.5-325.0	29.9-195.1	9.8-220.1	533.0-2397.8
Mean	83.0 (±43.8)	127.7 (±64.5)	170.0 (±88.2)	101.0 (±53.0)	101.0 (±73.6)	1485.0 (±498.0)
			Correlation coefficient (r-value)			
Control grain yield	0.300	0.580**	0.438	0.398	0.335	0.340
Control dry matter yield	0.168	0.461*	0.300	0.263	0.163	0.198
Control grain K uptake	0.292	0.525*	0.437	0.374	0.345	0.331
Control dry matter K uptake	0.305	0.572**	0.444*	0.405	0.315	0.345
Percent grain yield	–0.234	0.085	0.044	–0.126	–0.205	0.080
Percent dry matter yield	–0.397	0.055	–0.100	–0.282	–0.330	0.092
Percent grain K uptake	–0.208	–0.032	–0.028	–0.156	–0.111	–0.023
Percent dry matter K uptake	–0.25 4	0.07	–0.605	–0.208	–0.235	0.150

[a]Significant at 5% (*) or 1% (**) levels; dry matter = grain + straw.

Grain yield varied from 8.5 to 44.5 g/pot in the control and 14.4 to 57.4 g/pot in treated pots. Total dry matter (grain + straw) yield varied from 25.4 to 102.1 g/pot and 38.8 to 107.5 g/pot in control and K-treated pots. Total K uptake by grain and straw ranged from 150 to 1,182 mg/pot in control and 280 to 1,373 mg/pot in K-treated pots. Grain yield varied from 59 to 98% and K uptake from 47 to 96%. Only in 6 soils was the response in yield or K uptake due to applied K above 20%. Results indicate that 2 to 41% of the yield obtained and 4 to 53% of K uptake could be attributed to applied K.

The correlation between control grain yield and control K uptake with K extracted by 0.5 M $NaHCO_3$ was highly significant (r = 0.580** and 0.572**). Other methods related poorly with plant parameters. The prediction value (r^2) for the highest correlation of r = 0.580 was 33.6%. Probably the low response to applied K in these soils resulted in low predictability for the indices. When different indices of K availability were related, we found that K extracted by 0.5 M $NaHCO_3$ was highly and significantly correlated with NH_4OAC extractable K (r = 0.788**), suggesting that the former extractant can be satisfactorily used to estimate available K in the soils while also determining available P (0.5 M $NaHCO_3$ is an accepted method for estimating available P in these soils) in a single extraction. Soils with less than 72 ppm $NaHCO_3$-K are low in available K.☐

Effect of N level on aged rice seedlings

S. Ramasamy, P. Sennaiyan, and V. Sivasubramanian, Tamil Nadu Rice Research Institute (TNRRI), Aduthurai, India

We studied tillering capacity, grain yield, and duration of IR20 at two seedling ages and different N levels in a randomized block design at TNRRI in 1983–84 winter.

Single 40- or 60-d-old seedlings were transplanted at 0 N, 100 kg N (50+25+25), 150 kg N (100+25+25), or 200 kg N (150+25+25)/ha as basal plus 2 topdressings. Plots received 50 kg P and potash/ha basally.

Effect of seedling age and N level on IR20 duration, yield characters, and grain yield, Aduthurai, India.

Treatment (kg N/ha)	Field duration (d)	Tillers/ hill	Productive tillers/hill	Dry matter (t/ha)	Grain yield	
					kg/ha daily	t/ha
			40-d seedlings			
0 N	103	5.8	5.3	7	26	2.7
50+25+25	110	8.5	8.1	16	37	4.1
100+25+25	111	9.4	8.9	17	39	4.4
150+25+25	111	9.8	8.1	19	41	4.5
			60-d seedlings			
0 N	99	6.3	5.9	6	21	2.0
50+25+25	107	8.8	7.6	13	32	3.4
100+25+25	111	9.5	8.4	14	35	3.9
150+25+25	114	9.2	8.2	15	36	4.2
LSD (0.05)						
Treatments	1.5	1.2	1.2	2	3	0.3
Seedling age	ns	ns	ns	1	1	0.2
N	1.0	0.9	0.8	1	2	0.2

Primary tillers of 60-d-seedlings produced panicles in 21 d after transplanting, irrespective of N level, but there were only 2-3 tillers/hill.

Increasing N increased dry matter production, grain yield, and tillering at both seedling ages (see table).

At 200 kg N/ha, 60-d seedlings yielded grain on par with that at 150 kg N in 40-d seedlings. At 100+25+25 kg N, 60-d seedlings yielded on par with 40d seedlings at 50+25+25 kg N. Daily production increased with N application at a declining rate.

Main field duration of older seedlings was affected by N level, but there was no significant difference in field duration between seedling ages at higher N levels, The 40-d seedlings yielded better with less N. □

Impact of different soil moisture status on transplanted aman varieties

M. J. Islam, K. A. Haq, M. S. Rahman, and M. B. Rahman, Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur, Bangladesh

We studied the effect of soil moisture status on rice yield in 1983 transplanted aman at BRRI. Soil moisture status was monitored in farmer fields from panicle initiation to crop maturity and 112 5-m^2 crop-cuts were collected from fields with different moisture status. Varietal reaction and grain yield, adjusted to 14% moisture content, were recorded,

With continuous standing water, BR11 yielded highest, 6.2 t/ha, which was 210% higher than yield with visible desiccation.

Yield of transplanted aman cultivars at different soil moisture levels, Gazipur, Bangladesh.[a]

Soil moisture status	Average yield[b] (t/ha)								
	BR11 14	BR10 3	BR4 8	Pajam 30	Nizersail 23	Chandra sail 16	Chini-gura9	Kaligira 6	Binni 3
5-6 cm standing water	6.2 (210)	–	–	4.1 (128)	–	–	2.8 (47)	–	–
Saturated	–	–	–	–	–	–	–	–	–
Moist but not saturated	4.9 (145)	– –	3.6 (33)	3.5 (94)	–	–	–	–	–
Hair-like cracks	3.9 (95)	4.6 (31)	–	2.8 (56)	2.4 (50)	2.9 (61)	2.6 (36)	1.9 (28)	–
Visible cracks	–	–	3.0 (11)	2.6 (44)	2.2 (38)	2.3 (28)	–	–	–
Visible desiccation	2.0	3.5	2.7	1.8	1.6	1.8	1.9	1.5	1.2
Av	3.9	3.9	3.2	2.8	1.8	2.2	2.3	1.7	1.2

[a]Figures under each variety name indicate the number of samples. Values in parentheses in each column indicate percent yield increase over the yield with visible desiccation.

BR10 and BR11 yielded an average 3.9 t/ha (see table). BR10 and BR11 were more sensitive to water stress than Pajam.

Of the local varieties, Chinigura yielded highest with an average 2.3 t/ha. □

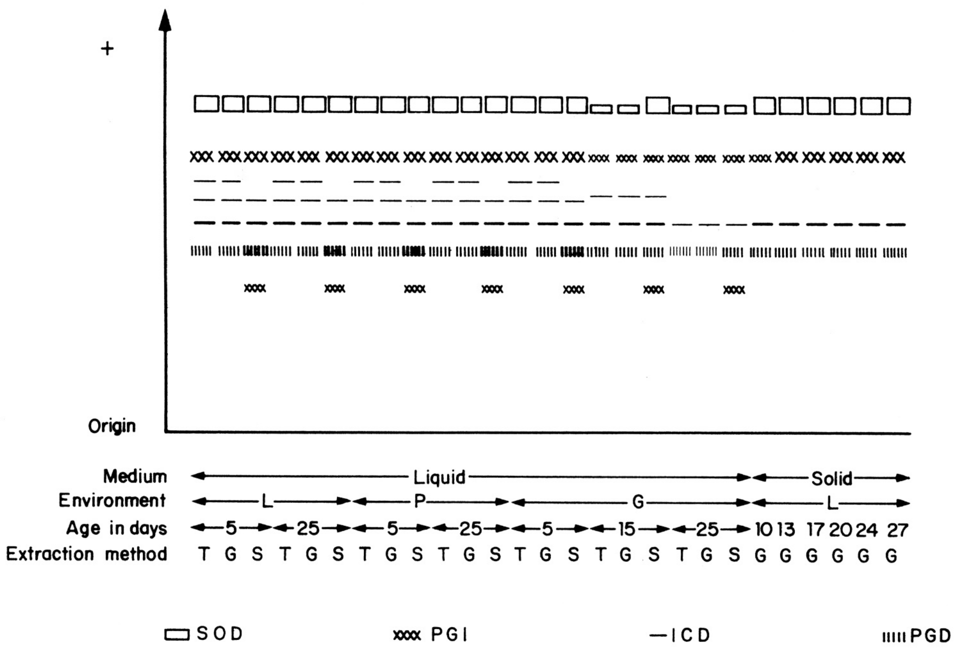
Isozymes, possible markers for blue-green algae (BGA) identification

J. C. Glaszmann, Ingenieur de Recherches, IRAT, visiting associate scientist, and P. A. Roger, Maitre de Recherches, ORSTOM, and visiting scientist, IRRI

To evaluate the potential of electrophoretically detectable isozymes for identifying BGA strains, especially in soil inoculation experiments, we worked to develop a sample preparation method that maximizes zymograms consistency.

The technique is horizontal starch gel electrophoresis using 14% starch in a tris (0.034 M) histidine (0.018 M) gel buffer with pH 8.0 and a tris (0.400 M) citrate (0.105 M) electrode buffer with pH 8.0. Zymograms were revealed by standard specific histochemical staining.

In a preliminary survey, 4 of 18 enzymes were observed in most of the tested strains (20 species in 9 genera) at different growth stages. They were phos-



1. Synthetic diagram of zymograms of various extracts of Anabaena PCC 7120. L = laboratory, P = phytotron, G = greenhouse, T = thawing, G = thawing + manual grinding, S = thawing + sonication.

phoglucose isomerase (PGI), isocitrate dehydrogenase (ICD), phosphogluconate dehydrogenase (PGD), and superoxide dismutase (SOD).

We compared zymograms of 63 extracts of an *Anabaena* strain (PCC 7120) for these 4 enzymes: 54 of them were obtained from liquid cultures on BG 11 medium without N. They were

1. grown in 3 environments:
a) *laboratory:* 25 ± 2°C, continuous lighting provided by cold white neon tubes, light intensity about 600 lux;
b) *phytotron:* 28 ± 1°C, continuous lighting provided by neon tubes and incandescent bulbs, light intensity about 5 klux; c) *greenhouse:* 25-38°C, maximum light intensity around 90 klux.
2. harvested 5, 10, 15, 20, 25, and 30 d after inoculation.
3. extracted after deep freezing using three methods: a) simple thawing,
b) manual grinding using a glass rod,
c) sonication for 5 min, with the culture in an ice bath.

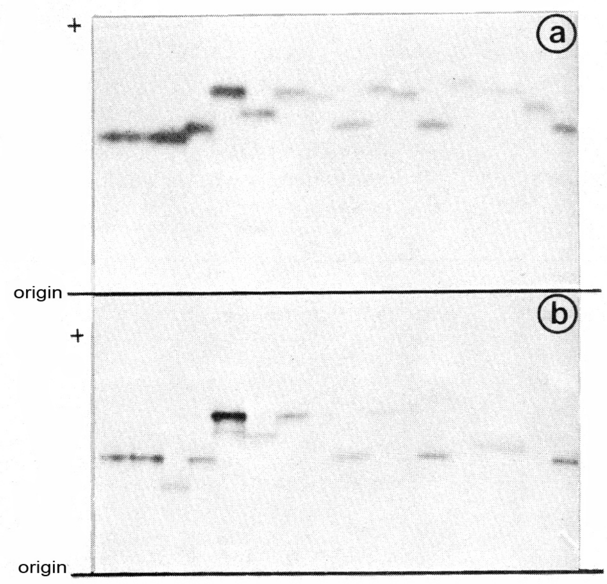
The other 9 extracts were obtained from cultures on solid medium (BG 11 medium without N, 1% bacto agar) grown in the laboratory under continuous lighting (600 lux). Individual colonies were harvested at 10, 13, 15, 17, 20, 22, 24, 27, and 30 d after plating and extracted by manual grinding in cold distilled water.

We observed the following (Fig. 1):

- For a given extraction procedure, there was no difference between laboratory and phytotron grown samples whatever their age. In greenhouse grown samples, the intensity of the bands decreased with the age of the material and a qualitative inconsistency was observed for ICD.
- Manual grinding increased the intensity of the bands as compared with a simple thawing of deep frozen samples. Sonication had a similar effect, but induced development of a new PGI band and the disappearance of an ICD band.
- In material produced on solid medium, a same single band was observed for each of the four enzymes, at all colony ages. This band was the only one common to all the zymograms of the samples grown in liquid medium.

Manual grinding of individual colonies grown on solid medium appears to minimize possible artifacts by selecting bands that consistently appear with the other procedures of extraction and in material grown under different conditions. A major additional advantage is that petii dishes inoculated with suspension dilutions of soil for routine BGA counts can be used directly for isozyme characterization.

This method was tested with nine other *Anabaena* species and nine different genera. In all cases, a single major band was observed for each of the PGI, PGD, and SOD enzymes. Some strains, however, did not produce an ICD band. Varisation among strains was large (Fig. 2), which indicates good potential for strain identification. □



2. Zymograms of PGI (a) and PGD (b) from various BGA strains.

Evapotranspiration and water use of rice in central India

A. S. R. A. S. Sastri, B. L. Chandrakar, and B. R. Chandrawanshi, Zonal Agricultural Research Station (ZARS), J. N. Agricultural University, Raipur 492012, India

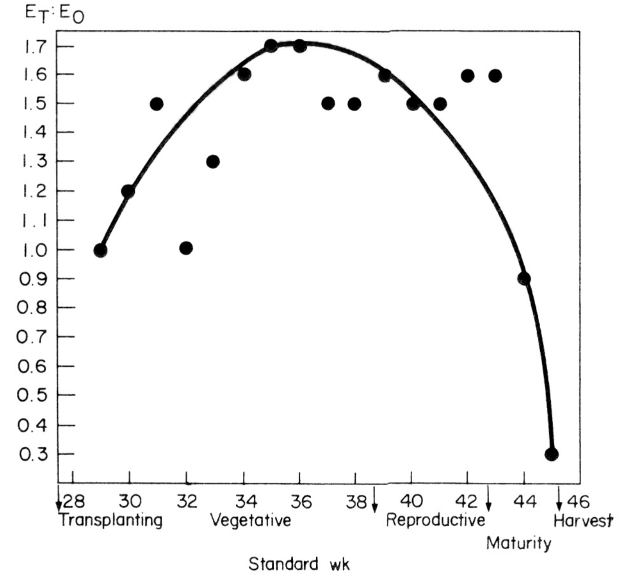
We studied evapotranspiration and water use of Samridhi rice, a 125-d variety, from 1979 to 1983 at ZARS, Raipur (21°16' N, 81°36' E). Rice was planted in 40- × 40-m plots with 2 volumetric lysimeters in the center of each field. Soil was a sandy loam. Twenty-five- to 30-d-old seedlings were transplanted about 20 Jul. NPK was applied at 80-40-40 kg/ha.

Lysimetric evapotranspiration (E_T), open-pan evaporation (E_O), grain yield, and water use efficiency of rice over 5 yr in Raipur, India.

Year	E_T (mm)	E_O (mm)	E_T:E_O	Grain yield (t/ha)	Water use efficiency (kg/ha per mm of E_T)
1979	570	418	1.36	2.6	4.6
1980	705	396	1.78	3.8	5.4
1981	788	458	1.72	3.6	4.6
1982	695	428	1.62	3.2	4.7
1983	473	382	1.24	3.9	8.3
Av	645	416	1.55	3.4	5.3

From transplanting to harvest (about 100 d) lysimetric evapotranspiration E_T) averaged 645 mm versus 416 mm open pan evaporation (E_O) (see table). Rerage E_T:E_O (crop coefficient K) was 1.55, varying from 1.78 in 1980 to 1.24 in 1983. Average grain yield was 3.4 t/ha. Water use efficiency (kg/ha per mm of E_T) averaged 5.3.

To better understand water use during the growing season, the E_T:E_O values for each week were calculated for 5 yr and averaged (see figure). During peak vegetative growth, rice at Raipur required 1.7 times E_O for % losses. E_T:E_O decreases rapidly at maturity. □



Water use pattern of rice (var. R-2384) crop over 5 yr in Raipur, India.

Rice-Based Cropping Systems

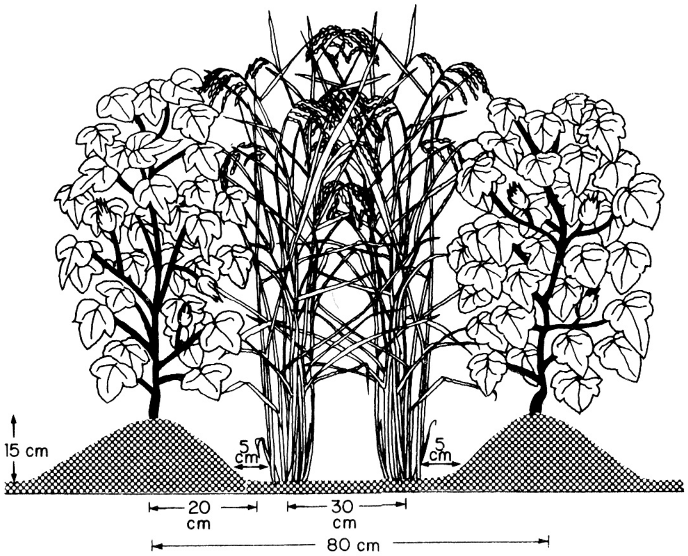
Intercropping rice and cotton

V. K. Khaddar and N. Ray, Project for Management of Salt-Affected Soil, College of Agriculture, Indore, Madhya Pradesh 452001, India

To reduce the risk of farming under erratic monsoon conditions, we evaluated rice + cotton intercropping in black-cotton soil at the Agriculture College Farm at Indore (see figure). Cotton was planted on ridges and rice in furrows to suit the moisture needs of each.

Ridges were 15 cm high and 40 cm across at the base. Seeds of Barwaha cotton, which tolerates standing water, were sown 3 Jul 1983 and drought-resistant, salt-tolerant CSR-4 rice was transplanted 27 Jul 1983. At transplanting, there was no standing water and furrows were not puddled, but the soil was soft from a recent rain. Rice was transplanted at 30-cm spacing to allow more light to reach the crop. Within 80 cm, there were 2 rows of rice and 1 row of cotton (see figure). Furrow irrigation was applied as needed.

Rice was harvested the 1st week of Nov when cotton had begun to shed leaves, which facilitates sowing a rabi crop such as barley in the furrows. Rice + cotton intercropping gave per hectare yields of 1.5 t cotton, 2.5 t rice grain, and 3.9 t rice straw. We are conducting further studies to identify optimum plant spacings for both crops. □



Rice + cotton intercropping.

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.

Announcements

Chelliah is named director of Tamil Nadu Rice Research Institute

S. Chelliah, former IRRI senior research fellow in entomology, has been named director of the Tamil Nadu Rice Research Institute of Tamil Nadu Agricultural University (TNAU). Chelliah was formerly head of the TNAU Entomology Department. ☐

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