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Contents

Guidelines and Style for IRRN Contributors

To improve communication and to speed the editorial process, the editors of the *International Rice Research Newletter (IRRN)* request that contributors use the following style and guidelines:

Style

- Use the metric system in all papers. Avoid national units of measure (such as cavans, rai, etc.).
- Express all yields in tons per hectare (t/ha) or with small-scale studies in grams per pot (g/pot) or grams per row (g/row)
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N ha; not 60 kg/ ha N.
- The US dollar is the standard monetary unit for the *IRRN.* Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- When using abbreviations other than for units of measure, spell out in full the first time of reference, with abbreviations in parenthesis, then use the abbreviation throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested. Three levels of N were . . . or Biotypes of the brown planthopper (BPH) differ within Asia. We studied the biotypes of BPH in ...
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example: 8 years; 3 kg/ha at 2-week intervals; 7%; 4 hours.
- Write out numbers below 10 except in a series containing 10 or some numbers higher and some numbers lower than 10. For example: six parts; seven tractors; four varieties. *But* There were 4 plots in India, 8 plots in Thailand. and I2 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

Guidelines

- Contributions to the IRRN should generally be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses are required for most data.
- Contributions should not exceed two pages of double-spaced, typewritten text. Two figures (graphs, tables. photos) per contribution are permitted to supplement the text. The editor will return articles that exceed space limitations.
- Results of routine screening of rice cultivars are discouraged. Exceptions will be made only if screening reveals previously unreported information (for example, a new source of genetic resistance to rice pests).
- Announcements of the release of new rice varieties are encouraged.
- Use common - not trade - names for commercial chemicals and, when feasible, equipment.
- Do not include references in IRRN contributions.
- Pest surveys should have quantified data (% infection. degree of severity, etc.).

Genetic evaluation and utilization

OVERALL PROGRESS

Stigma receptivity of some cytoplasmic male-sterile lines of rice

S. S. Virmani, IRRI, and Zhong-He Tan, Sichuan Academy of Agricultural Sciences, China

Success of hybrid .rice breeding programs depends on the extent of natural outcrossing on male-sterile (ms) lines. Individual ms plants of cultivated rice show 20-92% outcrossing. In hybrid rice seed production plots in China, outcrossing on ms lines varies from 15 to 45%, depending on ms line, extent of synchronization in flowering of ms line and pollen parent, and environmental condition. The maximum rate of natural outcrossing on a ms line used in hybrid seed production is 74%. Duration of stigma receptivity is an important floral trait that influences outcrossing.

Duration of stigma receptivity of three cytoplasmic ms lines was estimated at IRRI during 1981 wet season. V41A, Zhen Shan 97A, Yar-Ai-Zhao A were compared with a fertile maintainer line V41B. Seven panicles that had exserted 50% of their total length were selected for each line. Florets that had bloomed were removed. Only those expected to bloom the following day were retained. These florets were clipped and anthers were removed with a vacuum emasculator. Emasculated panicles were immediately covered with glassine bag. One panicle per line was pollinated every day for 7 days using IR9852-39-2 pollen. Percentage seed set on pollinated panicles was recorded 3 weeks after pollination.

Seed set data (see table) show that stigmata of the cytosterile and maintainer lines remained receptive for 6-7 days. The high seed set on panicles of Zhan Shan 97A, Yar-Ai-Zhao A, and V41B, pollinated after 6 days of emasculation, may be due to experimental error. If these data are ignored, effective stigma receptivity (resulting in 40-50% seed set) of ms V41A was 2 days longer than that of maintainer V41B. Effective stigma receptivity of cytosterile Zhan Shan 97A was 2 days shorter than that of the 2 other cytosteriles. Selection of cytosterile lines with longer stigma receptivity duration should help increase yield in hybrid rice seed production.

Duration of stigma receptivity of male sterile lines, IRRI, 1981 wet season.

Line	Seed set (%) on panicles pollinated after						
	1d	2d	3d	4d	5d	6d	7d
V41A	79.5	77.1	84.8	76.9	51.3	12.00	4.8
Zhan Shan 97A	51.1	30.3	50.0	2.7	8.7	50.00[a]	0.00
Yar-Ai-Zhao A	90.0	78.8	68.2	66.7	41.1	61.8[a]	0.00
V41B	70.0	59.1	48.3	17.2	15.1	37.5[a]	5.3

[a]High seed set may have been caused by experimental error.

A pseudograin on a cytoplasmic male-sterile rice line

R. C. Chaudhary, Rajendra Agricultural University Agricultural Research Institute, Mithapur, Patna, India; and S. S. Virmani, G. S. Khush, and B. O. Juliano, IRRI

Wu 10A, a Chinese cytoplasmic male-sterile line, was found to be sterile when grown in the IRRI phytotron (day-night temperature regimes 26°/18° C, 29°/21° C, 35°/27° C; natural day light, and relative humidity 90%). However, panicles remained green and droopy and had spongy spikelets filled with liquid. In some spikelets filling caused the husk to crack. When dried only a papery kernel, which was called a pseudograin, remained (see figure). Pseudograin frequency was about 70%.

Rice pseudograin on cytoplasmic male-sterile Line Wu 10A.

Mean level of sugars and amino acids of Wu 10A pseudograins.

Property	Mean
Caryopsis dry wt (mg)	0.89
Soluble sugars (µg glucose/grain)	219
Soluble sugars (% glucose dry basis)	24.5
Free amino acids (µg leucine/grain)	54
Free amino acids (% leucine dry basis)	6.0

Pseudograins could not be germinated in the seed germinator or by in vitro culture. Biochemical analysis of freeze-dried pseudograins showed high levels of soluble sugars and free amino acids (see table) comparable to those of a 1-day-old fertile grain. Normal embryo weighs 0.3 mg and a fertile caryopsis 21 mg. Pseudograin weight was less than 1 mg. Whether or not this is a case of parthenocarpy (a type of apomixis) remains to be established.

The International Rice Research Newsletter (IRRN) invites all scientists to contibute 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 abridgement to meet space limitations. Authors will be identified by name, title, and research organization.

Gamma ray-induced semidwarf mutants in Basmati 370

S. S. Malik, Haryana Agricultural University, Regional Research Station, Uchani, Karnal, India

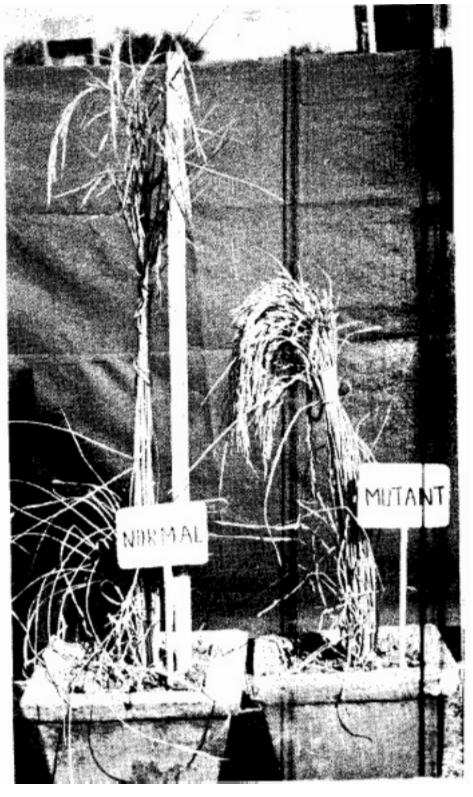
Local, tall, superfine-grained, and scented indica variety Basmati 370 was exposed to 20, 30, and 40 Kr of gamma rays from a ^{60}Co source. Several chlorophyll and other morphological mutants were isolated in the M_2 and M_3 generations.

A highly productive semidwarf mutant, Basmati A54. was recovered from 20 Kr gamma ray-treated material in the M_2 generation. It showed high uniformity in the M_3 generation (see figure).

This mutant matures 28 days earlier and has agronomic and quality characters superior to those of the original Basmati 370 (see table).

Semidwarf mutant BMS 1 was isolated from the same treatment. It had thin plants, profuse tillering (15-20 tillers/ plant), and reduced panicle and grain size. Its lemma and palea were fully opened and grains were not fully covered with husk. Anthers were small and 35 to 40% pollen sterility was observed in the M_3 generation. This mutant showed alternate branching from every node of the stem. Leaves were erect and dark green.

These two mutants can be used directly or indirectly to replace tall variety Basmati 370, which has a low yield potential.



Basmati 370 and mutant Basmati A54 recovered in the M_3 generation after exposure to 20 Kr gamma rays at Karnal, India.

Some agronomic and quality characters of Basmati 370 and its mutant Basmati A54 at Karnal, India.

Line	Plant ht (cm)	Maturity (days)	Tillers/ plant (no.)	Grains/ panicle (no.)	1,000-grain wt (g)	Grain yield/ plant (g)	Grain			Scent
							Length (mm)	Breadth (mm)	L:B	
Basmati 370	125	148	7.50	125	20.10	9.31	6.75	1.80	3.75	Yes
Basmati A54 (mutant)	85	120	12.50	130	23.80	14.72	7.45	1.85	4.02	No
C.D. at 5%	7.35	2.42	2.12	ns	1.12	3.45	0.23	ns		

GENETIC EVALUATION AND UTILIZATION

Agronomic characteristics

Ratooning ability of some photoperiod-sensitive rices

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

Ten photoperiod-sensitive deepwater and wetland rice varieties and variety IR36 were field-tested at Chinsurah to determine ratooning ability.

Pregerminated seeds were sown 14 November 1981 and transplanted 10 January 1982. Each variety was harvested the end of May. Plants were cut to 8 cm and 12 cm. Ratooning ability was scored 15 days after cutting. Plants with new tillers were considered to have ratooning ability.

Differences in ratooning ability were significant at the 1% level. Photoperiod-sensitive varieties, except Kumargorie. scored higher than IR36, highest ratooning variety was SR26B (97%), followed by NC1263 (94%), Achra 108/1 (93%), NC 365 (93%), Tillakachari (91%), and Bhasamanik (91%) (see table). Cutting height did not significantly affect ratooning ability.

Ratooning ability of some rice varieties, Chinsurah, India.

Variety	Percent of hills with ratoons		
	8 cm	12 cm	Mean
SR26B	97	97	97
NC1263	92	96	94
NC365	94	92	93
Achra 108/l	97	88	93
Tillakachari	96	85	91
Bhasamanik	94	87	91
Bansmoti aman	88	89	89
Latisail	76	85	81
FR13A	86	76	81
Kumargore	71	52	62
IR36	61	61	61
Mean	87	83	
C.D. at 5%	27	28	
Pooled variety MS with 10 df	587.25**[a]		
Pooled cutting height MS with 1 df	200.0*		
Pooled variety cutting height MS with 10 df	45.67		
Pooled error MS with 21 df	35.64		

[a]Two asterisks indicate significance at 1% level.

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Rice grassy stunt disease in Kerala, India

P. Santhakumari, G. Mathai, and L. Rema Devi, Rice Research Station (RRS), Moncompu, Kerala, India

Rice grassy stunt (GSV) is transmitted by brown planthopper (BPH). A GSV epidemic occurred in the Kuttanad tract of Kerala during punja (December-March) 1972-73.

GSV incidence in Kerala remained low until 1980 when incidence severely damaged the Kuttanad rice crop immediately following a BPH attack. In 1981 punja GSV was observed in varieties grown for the screening trial at RRS. Moncompu. Infected plants were pale green, had erect leaves with excessive tillering and stunting, and failed to flower.

The disease was severe in varieties Aswathy, Sabari, Suriya, Sathya, Supriya, IR22, Kannaki, Jaya, TN1, ADT31, IR2058-78-1-3, and IRBN43, 48, 122, 484, and 511.

No GSV was observed on IR20, TKM9, TKM6, TKM5, Jyothy, Rohini, Triveni, Bharathy, MO 5, IR26, and IRBN46, 47, 51, 53, 54, 188, 190, 450, and 486.

Incidence of kernel smut in wetland rice varieties

V. S. Thri Murry and A. K. Singh, regional research station, J. N. Agricultural University Research Farm, Sarkanda Bilaspur 495001, India

Seeds of 31 varieties were examined for kernel smut infection. Sample seed lots were taken by gathering handfuls of seed and mixing. Lots of 50 g each were examined for black pustules or streaks bursting through the glumes.

Only Bd 8 showed greater than 1% infection (see table). Six varieties showed no infection.

Rice varieties showing different percentages of kernel smut.

Variety	Smutted grains (%)
Bd 8	1.9
HR 12	0.8
JR 15-552, Madhuri, Ratna, Phalguna, R115-2597, JR 16-15-1-1	0.5-0.6
Kranti, Pragati, Bd 47, RP 9-4 R115-355, Bangoli 6, R 8-2535, R 22-252, JRM 3-1-6	0.2-0.4
R 35-2752, Bd 2, Jaya, R 2384, Bapatla 1235, Surekha, Bangoli 5, CRM 13-3241	0.04-0.1
Pankaj, Mahsuri, Jagriti, Garima, Pate1 85, Safri 17	0.0

New blast-resistant cultures from India

M. Ramachandran, P. Vivekanandan, K. Govindarajan, and R. Saroja, Paddy Experiment Station, Tirurkuppam, Tamil Nadu, India

TKM9, a high yielding, early-maturing cosmopolitan red rice released January 1978, is popular in Tamil Nadu. During navarai 1979-80 (December-January to March-April) TKM9 showed 60-70% blast incidence. From this crop, 10 single plants exhibiting field resistance to blast (0 to 5%) were isolated and studied. In 1980-81 preliminary yield trials, three of these selections showed promising yield and blast resistance.

In comparative yield trials during navarai 1981-82 they yielded better and showed less blast incidence than TKM9 (see table). These cultures are being tested in multilocation trials. The best variety will be released for wider cultivation when yield potential and blast resistance are confirmed.

Performance of blast-resistant lines at Paddy Experiment Station, Tirurkuppam, India.

Culture	Parentage	Growth duration (days)	Grain yield (t/ha)	% yield increase over TKM9	Blast (%)
TM8089	TKM9 selection	120	3.8	112	5.0
TM8090	TKM9 selection	117	3.7	109	10.5
TM8091	TKM9 selection	120	4.1	121	4.5
TKM9	TKM7/IR8	117	3.4	100	21.5
	CD (P = 0.05)		0.5		

Bacterial stalk rot, new rice disease in Bangladesh

M. A. Hossain, N. R. Sharma, and S. A. Miah, Division of Plant Pathology, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Banghdesh

Bacterial stalk rot or foot rot of rice caused by *Erwinia chrysanthemi* pv. *chrysanthemi* Burkholder, McFadden, and Dimock was observed in Bangladesh for the first time 27 April 1982 at the BRRI Joydebpur farm on breeding line BR161-2B-23 transplanted in an irrigated field. Of 300 varieties or lines in the field, 27 were heavily infected.

Bacterium from ooze extracted from a severely infected tiller was isolated in PSA (peptone-sucrose-agar) medium. Different dilutions of the ooze were used for pure culture isolation. The single colony isolate was multiplied on King's medium B. Pathogenicity was tested by inoculating test plants twice. The BR161-2B-23 isolate was tested on Taichung Native 1 (TNl) plants at boot stage, reisolated from the inoculated TNl, and retested on the same variety at early tillering to midtillering stages. In both tests, plants showed the same symptoms as the field sample.

Leaf sheaths of infected plants were brown and water soaked. Leaves were brownish yellow and drooped from rotted dark brown leaf sheaths. Basal internode tissue rotted and had a foul smell. Dark brown color on the sheath just beneath the leaf juncture or ligule is the initial symptom. The disease spread to closed young leaves, culms (nodes and internodes), and the crown. Roots became rotten and dark brown to blackish and had a foul smell. Rotten young leaves and culms smelled the same.

Artificial inoculation of the bacterial suspension (10^8 to 10^{10} cells/ ml water) by injecting TN1 plants at tillering stage, maximum tillering stage, and boot stage produced initial symptoms (water-soaked lesions around inoculation points) in 16 hours. When the plants were at maximum tillering to boot stage the youngest leaves started to wilt after 48 hours. Within 3-4 days lesion length sometimes extended through 60-80% of the sheath. At early tillering the dark brown lesion was restricted to the point of inoculation on the outer sheath, but even the youngest closed leaves and culms (nodes and internodes) became infected. Within a week, the leaves of inoculated plants turned brown and plants wilted and died.

The causal organism, *E. chrysanthemi* pv. *chrysanthemi,* was confirmed by per forming physiological diagnostic tests such as anaerobic growth, gas formation from D-glucose, growth in 5% NaCl, no blue pigment on yeast extract-dextrose calcium carbonate (YDC) medium, and brown pigment formation on PSA.

GENETIC EVALUATION AND UTILIZATION

Insect resistance

The Malayan black bug *Scotinophara coarctata* (F.) [Hemiptera: Pentatomidae]: a new rice pest in the Philippines

A. T. Barrion, research assistant, and O. Mochida and J. A. Litsinger, entomologists, Entomology Department, IRRI; and N. dela Cruz, extension specialist, Ministry of Agriculture, Puerto Princesa, Palawan, Philippines

Four species of *Scotinophara* black bugs have been recorded in the Philippines — *S. cinerea* Le Guill. (Hasegawa, 1971) (*S. cinerea* is now synonymous with *S. coarctata*), *S. scotti* Horvath (Miyamoto, Japan, pers. comm.), *S. ochracea* (Dist.), and *S. lurida* (Burm.) (Wongsiri, 1975) — but none have been reported as rice pests.

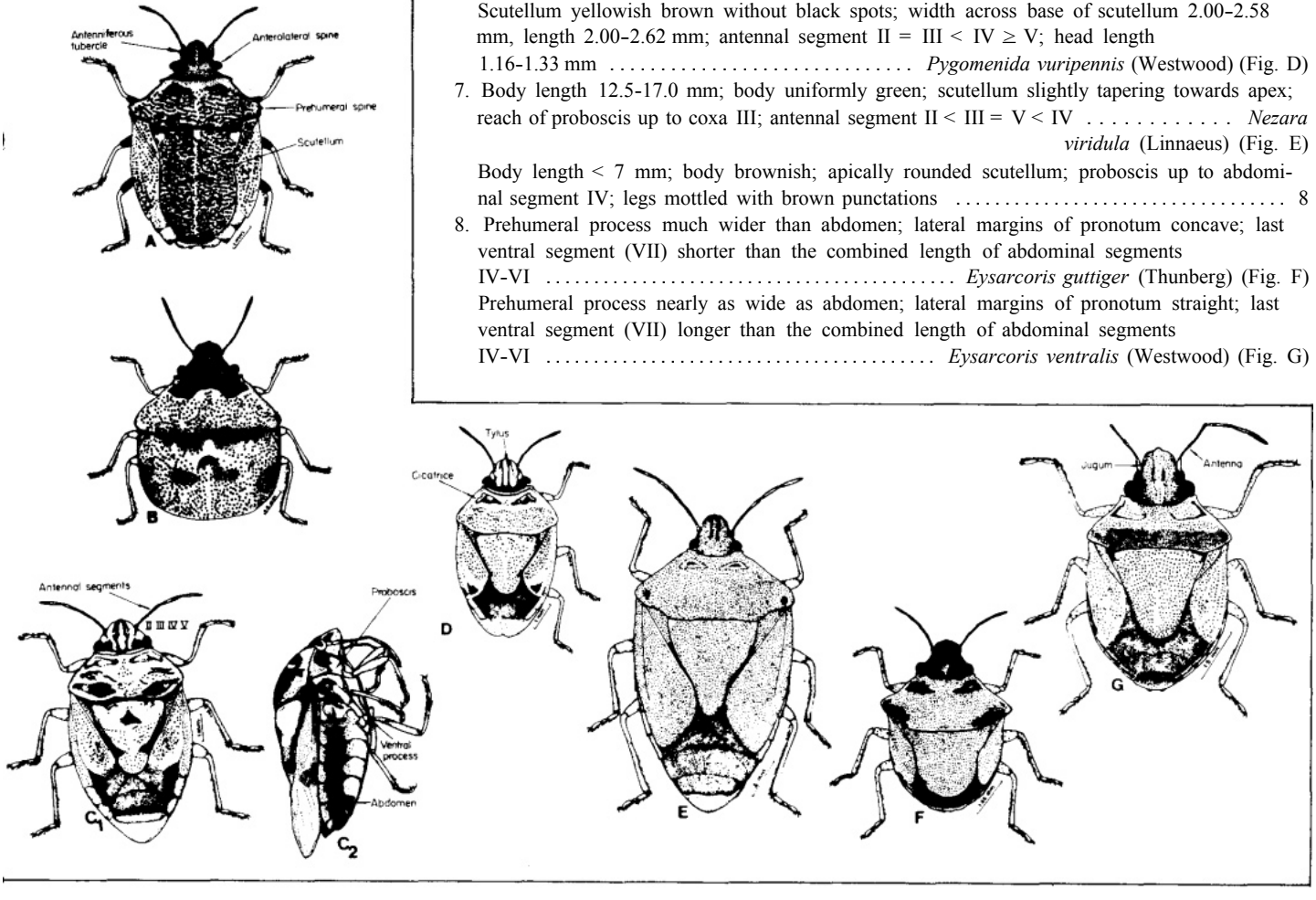
In February 1982, a new pest, the Malayan black bug *S. coarctata* (F.) (confirmed by Miyamoto) was found Bonobono, Batarasa, South Palawan. major outbreak followed during March-June, and spread toward central and

northern Palawan, covering 4,500 ha. Estimated populations averaged 79-188 adults/m^2 (>400/m^2 in one field in Nara) and chemical control cost the provincial government US$20,000.

The adult bug is 7-9 mm long, has a black head, collar, and cicatrices; yellowish brown antennae; reddish to dark brown thorax with yellow tinge; pale to dark brown abdomen; and reddish brown legs with yellowish tibiae and tarsi.

A female lays 40-60 eggs and guards them until they hatch. Each egg measures 1 mm long, is greenish when laid, and turns pinkish as it matures. The nymph is brown with yellowish green abdomen and 2-3 black scent glands. Pentatomid species from rice fields in Palawan can be identified using the following key (see figure):

1. Prehumeral spine prominent; body coloration dark brown to black 2
   Prehumeral spine partially developed to entirely absent, body coloration not as above 4
2. Tip of anterolateral spine projected backward; head across eyes nearly twice as wide as long; width across prehumeral process 4-4.5 mm; antennal segment I as long as II and III combined ..... *S. courctata* (Fabricius) (Fig. A)
   Tip of anterolateral spine projected forward 3
3. Width across prehumeral process 5.5-6.0 mm; head width across eyes about 1/4 wider than long; antennal segment I shorter than II, segments III and IV nearly equal, and segment V about 1/3 longer than IV; tip of anterolateral spine extended beyond anterior angle of pronotum ..... *S. lurida* (Burmeister)
   Width across prehumeral process 5.0 mm; head width across eyes more than 1/3 wider than long; antennal segments I and II nearly equal, segments III and IV nearly equal, segment V = II + III; tip of anterolateral spine not extended beyond anterior angle of pronotum ..... *S. ochracea* (Distant)
4. Body about 2.0-2.5 mm long; body strongly convex and ovoid; broadly rounded scutellum nearly as wide and long as abdomen; proboscis extended up to abdominal segment IV ..... near genus *Seponia* (Fig. B)
   Body 5.3-17 mm long; scutellum shorter and smaller than abdomen; reach of proboscis rarely up to abdominal segment IV 5
5. Abdominal segment III with a long ventral spine-like process pointed forward reaching coxa II 6
   Abdominal segment III without a long ventral process 7
6. Scutellum with black spots, 1 central and a pair each along lateral and basal margins; width across base of scutellum 2.66–3.00 mm, length 2.50-2.90 mm; antennal segment II ≤ III < IV > V; head length 1.33-1.40 mm ..... *Pygomenida bengalensis* (Westwood) (Fig. C)
   Scutellum yellowish brown without black spots; width across base of scutellum 2.00–2.58 mm, length 2.00–2.62 mm; antennal segment II = III < IV ≥ V; head length 1.16-1.33 mm ..... *Pygomenida vuripennis* (Westwood) (Fig. D)
7. Body length 12.5-17.0 mm; body uniformly green; scutellum slightly tapering towards apex; reach of proboscis up to coxa III; antennal segment II < III = V < IV ..... *Nezara viridula* (Linnaeus) (Fig. E)
   Body length < 7 mm; body brownish; apically rounded scutellum; proboscis up to abdominal segment IV; legs mottled with brown punctations 8
8. Prehumeral process much wider than abdomen; lateral margins of pronotum concave; last ventral segment (VII) shorter than the combined length of abdominal segments IV-VI ..... *Eysarcoris guttiger* (Thunberg) (Fig. F)
   Prehumeral process nearly as wide as abdomen; lateral margins of pronotum straight; last ventral segment (VII) longer than the combined length of abdominal segments IV-VI ..... *Eysarcoris ventralis* (Westwood) (Fig. G)



Rice-inhabiting bugs collected from Palawan: A = *S. coarctata* (Fabricius); B = nr. *Seponia;* C = *P. bengalensis* (Westwood), dorsal view (C_1) and side view (C_2); D = *P. varipennis* (Westwood); E = *N. viridula* (Linnaeus); F = *E. guttiger* (Thunberg); and G = *E. ventralis* (Westwood).

Deep water

Performance of some semidwarf varieties at increased water depth

S. S. N. D. B. Prasad, Agricultural Research Station, Pulla, A. P. Agricultural University, India

Semidwarf varieties PLA1100, Prakash (RP4-14), MTU4407, and BPT1235 were compared with six tall varieties in a replicated trial for suitability for increased water depth (75 cm) at the Agricultural Research Station, Pulla (A.P.), India, during 1981 kharif.

PLA1100 at the posttillering stage tolerates shallow (50 cm) stagnant water. The three other semidwarfs are popular varieties under cultivation in the area but had not been tested in deepwater areas. CN540, CN643, BIET724, and Jalaj are taken from uniform variety trial 6 (All India Coordinated Trial, 1981 kharif).

Seeds were sown the last week of May and transplanted the last week of June. Nitrogen (40 kg/ ha) was applied in 2 splits during the tillering stage. Water depth was increased to 75 cm 45 days after planting and maintained for 3 months. No entry was submerged at flooding.

Grain yields of PLA1100, Mahsuri, CN540, and CN643 were similar. PLA1100 had greater internode elongation than all other varieties in the trial. Increased plant height resulted in weak stems and partial lodging. Nondormant seeds germinated during the test. The panicles of Prakash, MTU4407, and BPT1235 were partially exserted, had high spikelet sterility, and yielded low. Jalaj and PLA2 are tall and have longer growth duration. CN540, CN643, and BIET724 are suited to the water depth maintained during the trial (see table).

Semidwarfs with some elongation ability, such as PLA1100, can perform as well as or better than tall deepwater rices in 75-cm-deep water.

Grain yield and character of rice varieties in deepwater test, 1981 kharif, Pulla, A.P., India.

Designation	Source	Grain yield (t/ha)	Days to flower	Panicles (no./m^2)	Plant ht (cm)		
					75 cm water	Normal	Increase over normal
Mahsuri	Tai 65/2 Mayang Fbos 80	2.6	122	284	167	144	23
CN540	IR262/Khao Nahng Nuey 11	2.5	127	237	173	155	18
CN643	IR262/Khao Nahng Nuey 11	2.4	129	246	175	141	34
BIET724	IR8/BR34	2.0	121	244	177	157	20
Jalaj	IRS/BR14	1.7	135	244	210	180	30
PLA2	GEB 24/Kavingun poothala	1.4	167	264	233	200	33
Prakash (RP4-14)	IR8/T90	1.1	112	206	115	100	15
MTU4407	Vijaya/Mahsuri	0.2	110	212	104	86	18
BPT1235	Sabarmati/WGL12708	0.06	95	182	99	86	13
PLA1100	Mahsuri/Vijaya	2.5	152	209	138	110	28

TCA177, a promising deepwater rice

B. N. Singh and Laljinath Singh, Plant Breeding Department, Rajendra Agricultural University, Bihar Pusa (Samastipur) 848125, India

TCA177, a pure line selection from Desaria rices was successfully grown where water level rises to 200 cm or higher. It was selected from deepwater varieties grown in North Bihar.

During 1981 kharif, when water level rose to 173 cm in a regional deepwater experimental trial comprising 16 entries and 3 replications at Pusa, TCA177 had good elongation ability and percent survival in a 14-m^2 plot. Jaladhi-1, BR223-B-38, SPR7233-1-24-2-2-2-3, BKN6986-147-2 (RD19), BKN6986-108-3, and Janaki died.

TCA 177 has short bold grains, purple stigma and apiculum, straw-colored husk, and red kernels. It can be sown pure or mix-cropped with moong *(Phaseolus mungo)* in February-March in deepwater areas. It tolerates drought during early seedling growth, and has good initial vigor.

TCA177 also resists rice tungro virus and bacterial blight (pathotype II of deepwater areas), which are major problems. It is a late aman photoperiod-sensitive type and yields around 3t/ha. It is being multiplied for testing under the minikit program.

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Pest management and control DISEASES

Effect of meteorological factors on symptomatology and acquisition of rice tungro virus by *Nephotettix virescens*

G. Mohana Rao, research scholar and A. Anjaneyulu, virologist, Division of Plant Pathology, Central Rice Research Institute, Cuttack-753 006, India

The effect of meteorological factors on symptomatology and acquisition of rice tungro virus by *Nephotettix virescens* in rice cultivars Taichung Native 1 (TN1), Jaya, and IR20 was studied for 2 years in monthly periodical plantings in the nethouse.

TN1 showed the most Severe symptoms. During monsoon season (July-October) the older leaves exhibited bright orange discoloration. Summer (March-June) and winter (November-February) symptoms were not so severe. Infected plants did not recover from the infection and were stunted.

Jaya exhibited severe symptoms during early stages, but infected plants recovered and produced new green foliage within a month. Recovered foliage showed no chlorosis during summer and monsoon, but exhibited slight chlorosis during winter. IR20 infection was most Severe during winter, and symptoms resembled those of Taichung Native 1. Infected plants showed no leaf discoloration during other seasons, but they were stunted.

The average percentages of stunting were 50.5 (summer), 40.4 (monsoon), and 48.6 (winter) in TN1; 37.0, 37.2, and 54.3 in Jaya; and 19.8, 12.6, and 29.2 in IR20. In IR20 the percentage of stunting was negatively correlated with maximum and minimum temperatures, relative humidity, and rainfall and positively correlated with hours of sunshine (see table). In Jaya, stunting was negatively correlated with maximum and minimum temperatures. There were no significant correlations for TN1. During the period of study temperature varied from 27.0 to 37.1°C (maximum) and 12.0 to 26.4° C (minimum). Relative humidity varied from 60 to 87%, rainfall from 0.0 to 15.5 mm/day, and sunshine from 3.4 to 9.9 hours.

Incubation period in the host varied slightly between the cultivars but significantly between seasons. The mean incubation period was 5.7, 5.8, and 11.4 days during summer, monsoon, and winter in TN1; 5.9, 5.8, and 11.4 in Jaya; and 7.8, 7.0, and 12.5 in IR20. In all cultivars incubation period was negatively correlated with maximum and minimum temperatures, relative humidity, and rainfall and positively correlated with hours of sunshine.

N. virescens carried more virus from TN 1 and Jaya than from IR20, as evidenced by the number of viruliferous leafhoppers. Weather did not affect virus acquisition from TN1. In Jaya and particularly in IR20, the vector acquired more virus in winter than in other seasons. The average percentages of viruliferous leafhoppers were 57.7, 50.7, and 57.1 during summer, monsoon, and winter in TN1; 57.3, 58.9, and 68.7 in Jaya; and 0.9, 2.1, and 14.2 in 1R20. In IR20, the percentage of viruliferous leafhoppers was negatively correlated with maximum and minimum temperatures, relative humidity, and rainfall and positively correlated with hours of sunshine. There were no significant correlations in TN1 and Jaya.

Relationship[a] between weather and percentage of stunting, incubation period, and viruliferous *N. virescens,* Cuttack, India.

	Correlation coefficients								
	% stunting			Incubation period			% viruliferous leafhoppers		
	TN1	Jaya	IR20	TN1	Jaya	IR20	TN1	Jaya	IR20
Maximum temperature	0.106	–0.563**	–0.434*	–0.731**	–0.695**	–0.644**	–0.205	–0.299	–0.702**
Minimum temperature	–0.128	–0.658**	–0.771**	–0.893**	–0.879**	–0.854**	–0.260	–0.263	–0.856**
Relative humidity	–0.228	–0.219	–0.757**	–0.572**	–0.595**	–0.626**	0.022	–0.200	–0.483*
Rainfall	–0.259	–0.245	–0.718**	–0.509*	–0.516**	–0.535**	–0.149	–0.094	–0.431*
Sunshine hours	0.296	0.224	0.696**	0.491*	0.503*	0.515*	0.111	0.017	0.437*

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

Insecticide control of rice tungro virus disease

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Rice tungro virus is transmitted by leafhopper vectors *Nephotettix virescens* and *N. nigropictus.* The disease can be reduced by controlling vectors with insecticides. Six emulsifiable concentrate insecticides — cypermethrin, FMC 35001, phosphamidon, demeton-o-methyl sulphoxide, ofunack, and dichlorvos — and one wettable powder, acephate, were field tested for control of tungro and its vectors.

Cypermethrin (0.05% concentration) and the other insecticides (0.1% concentration) were applied by foliar spray to Taichung Native 1 (susceptible) and Ratna (tolerant) at 10-day intervals, beginning 10 days after transplanting (DT) and ending 50 DT. The experiment used a randomized block design with three replications. Seed was sown 10 August and transplanted 10 September to coincide with natural *Nepho-*

tettix occurrence. Three diseased Jaya tillers were planted in the middle of each plot at 10 DT to serve as initial virus inoculum source.

All insecticide-treated plots showed reduced disease incidence and vector populations. Cypermethrin reduced disease incidence and increased grain yields most effectively (see table). No adults or nymphs were found in cypermethrin-treated plots. Acephate, FMC 35001, phosphamidon, and demeton-o-methyl sulphoxide were also effective when sprayed on Ratna.

A strong negative correlation between disease incidence and grain yield (–0.614** for Taichung Native 1 and –0.508** for Ratna) indicated that tungro virus disease was the primary cause of reduced yield in the insecticide-treated plots. The positive correlation between disease incidence and leafhopper population (r = 0.893** for Taichung Native 1, and 0.971** for Ratna) shows the disease is spread primarily by *N. virescens.*

Disease incidence, gain yield, and leafhopper population of insecticide-treated Taichung Native 1 (T) and Ratna (R),[a] Cuttack, India.

Treatment	Disease incidence (%)		Grain yield (t/ha)		Leafhoppers (no./20 hills)[b]			
					Adults		Nymphs	
	T	R	T	R	T	R	T	R
Cypermethrin	3.0 a	0.3 a	5.3 a	6.6 a	0.0 a	0.0 a	0.0 a	0.0 a
FMC 35001	50.8 c	3.4 b	1.4 c	5.0 b	33.7 c	13.7 b	0.7 a	1.3 ab
Phosphamidon	56.7 d	6.1 c	1.1 de	4.4 bcd	38.7 cd	14.7 b	1.3 ab	1.0 ab
Demeton-o-methyl sulphoxide	58.1 d	4.5 bc	1.2 cd	4.5 bc	40.0 cd	16.0 bc	6.0 bc	0.0 a
Ofunack	71.5 e	12.5 d	0.9 ef	4.0 cd	42.3 d	18.7 c	8.7 c	0.7 ab
Dichlorvos	73.1 e	11.2 d	0.9 f	3.6 d	46.0 d	23.0 d	33.3 d	2.7 ab
Acephate	31.2 b	2.8 b	1.8 b	5.0 b	22.7 b	15.3 bc	0.7 a	0.7 ab
Control	100.0 f	51.5 e	0.3 g	2.7 e	68.7 e	41.3 e	48.7 e	12.0 c

[a]Values followed by a common letter do not differ significantly by Duncan's multiple range test (P = 0.05). [b]Av values of 3 replications.

Effect of pruning on rice bacterial blight

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At the Ranchi Agricultural College Farm, a brown gora crop with excessive vegetative growth, caused by residual nitrogenous manure, was pruned 50%, 50 days after sowing, to avoid lodging.

Within 2 weeks the pruned crop was severely affected by bacterial blight. Pruned plants had an infection rate of 7 by the Standard Evaluation System for Rice. Adjacent unpruned brown gora had disease severity 3.

Cutting leaves with unsterilized sickles disseminated the pathogen from naturally infected leaves by causing penetration through pruning injury.

Scald susceptibility of cultivars grown at different nitrogen levels

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Incidence of leaf scald caused by *Rhynchosporium oryzae* Hashioka & Yokogi (= *Gerlachia oryzae* [Hashioka & Yokogi] W. Gams), perfect stage *Monographella albescens* (Thum.) in 25 rice cultivars receiving 50, 100, 150, and 200 kg N/ha was recorded at CRRI farm October-November 1981. IR28 and Pankaj were leaf scald resistant at all nitrogen levels. Eight cultivars were moderately resistant, eight were moderately susceptible, and seven were susceptible (see table). Susceptibility to leaf scald increased with nitrogen levels. No cultivar was susceptible up to 100 kg N/ha During the second and third weeks of October, when disease development was maximum, mean minimum temperature was 22.5° C and mean relative humidity was 77%.

Scald susceptibility of 25 rice cultivars grown at different nitrogen levels at CRRI. Cuttack. India.

Cultivar	Disease score[a] (0-9) at given nitrogen level			
	50 kg/ha	100 kg/ha	150 kg/ha	200 kg/ha
		Resistant		
IR28	0	0	0	0
Pankaj	1	1	1	1
		Moderately resistant		
CR294-548-1	0	1	1	3
CR318-549, Jagannath	0	1	3	3
RTN68, IR8	0	3	3	3
CR316-639-1, IR36	1	3	3	3
CR188-10	3	3	3	3
		Moderately susceptible		
CR318-548-7, CR319-644-2	1	3	3	5
CR316-639-2, PR106, Ramkrishna	1	3	5	5
PR107	3	3	5	5
CR318-461, BG90-2	3	5	5	5
		Susceptible		
CR294-548-3	1	1	7	7
CR294-548-2, CR315-621	1	3	7	7
CR294-28-1	1	5	7	7
IR2071-178-3, IET4141	3	5	7	7
Jaya	5	5	7	7

[a]1 = resistant, 3 = moderately resistant, 5 = moderately susceptible, 7 = susceptible.

Greenhouse evaluation of granular, wettable powder, and flowable insecticide formulations for tungro prevention

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Some insecticides appear to prevent tungro infection in addition to killing the green leafhopper vector *Nephotettix virescens.* Greenhouse trials evaluated three insecticide formulations (see table). Three replications of 20 35-day-old Taichung Native 1 plants planted in 50- × 50- × 10-cm galvanized trays were tested. Granular insecticides (2 kg ai/ ha) were broadcast on the soil surface. Wettable powder and flowable insecticides (0.1% concentration) were sprayed on plants. At 1 and 5 days after treatment (DAT) each plant was inoculated with 2 viruliferous *N. virescens.* An equal number of untreated plants were inoculated as a check. Insect mortality was recorded 48 hours after caging, and infected plants were counted 20 days after inoculation. Virus infection prevention was calculated:

$$\% \text{ prevention} = \frac{\% \text{ infected plants in control} - \% \text{ infected plants in treatment}}{\% \text{ infected plants in control}} \times 100$$

Of granular insecticides tested, carbofuran prevented virus infection at 1 DAT. At 5 DAT it was 89% successful. MIPC, bendiocarb, and BPMC also effectively prevented the virus. All 4 insecticides caused 100% vector mortality.

Although disulfoton, mephosfolan, and phorate also gave 100% vector mortality, they did not prevent tungro virus infection. The remaining granular insecticides were ineffective in either preventing virus infection or killing the vector.

Acephate (wettable powder [WP]) and carbofuran (foliar) prevented tungro infection 100% at 1 DAT. At 5 DAT, they prevented it 89%. Bendiocarb (WP), carbaryl (WP), and MIPC (WP) also effectively prevented the virus infection. These 5 insecticides caused 100% vector mortality. DDT (WP) and BHC (WP) neither killed the vector nor prevented virus infection.

Results indicate that insecticides that control the vector do not necessarily prevent virus infection. The reasons are obscure, suggesting that insecticides that prevented infection should be tested in the field.

Effect of granular, wettable powder, and flowable insecticides on rice tungro virus infection and *N. virescens* mortality,[a] Cuttack, India.

Insecticide		Prevention of infection (%)		Insect mortality[b] (%)	
Common name	Trade name	1 DAT	5 DAT	1 DAT	5 DAT
Carbofuran	Furadan 3 G	100 a	89 a	100 a	100 a
MIPC	MIPC 4 G	92 b	81 b	100 a	100 a
Bendiocarb	Garvox 5 G	85 b	59 c	100 a	100 a
BPMC	BPMC 4 G	84 b	61 c	100 a	100 a
Thiocyclam hydrogen oxalate	San 155 5 G	55 c	30 d	71 b	38 b
Disulfoton	Solvirex 5 G	34 cd	8 fg	100 a	100 a
Mephosfolan	Cytrolane 5 G	22 de	6 g	100 a	100 a
BHC	Hilbeech 6 G	12 ef	10 f	24 c	10 c
Diazinon	Diazinon 6 G	8 ef	3 h	69 b	33 b
Quinalphos	Ekalux 5 G	5 fg	3 h	32 c	20 c
Lindane	Lindane 5 G	0 g	9 fg	26 c	17 c
Phorate-1	Phorate 10 G	0 g	0 i	100 a	100 a
Phorate-2	Thimet 10 G	0 g	14 e	100 a	100 a
Acephate	Orthene 75 WP	100 a	89 a	100 a	100 a
Carbofuran	Furadan 40 F	100 a	89 a	100 a	100 a
Bendiocarb	Ficam 80 WP	85 b	84 a	100 a	100 a
Carbaryl	Sevin 50 WP	85 b	84 a	100 a	100 a
MIPC	MIPC 50 WP	85 b	84 a	100 a	100 a
DDT	Hildit 50 WP	35 c	0 b	79 b	13 b
BHC	BHC 50 WP	20 d	0 b	40 c	2 c

[a]DAT = days after treatment. Values followed by the same letter do not differ significantly at $P = 0.05$ by Duncan's multiple range test. [b]Adjusted values by Abbott's formula.

Greenhouse evaluation of emulsifiable concentrate insecticides against tungro virus infection

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Twenty-seven emulsifiable concentrate insecticides (see table) were tested in three trials in the nethouse to determine their ability to prevent tungro virus infection.

Insecticides (0.1% concentration) were sprayed on 35-day-old Taichung Native 1 plants raised in 50 × 40 × 10 cm galvanized trays. Each insecticide treatment had 3 replications of 20 plants each. Each treated plant was inoculated with 2 viruliferous *Nephotettix virescens* vectors at 1 and 5 days after treatment (DAT). An equal number of untreated plants were inoculated as control. Insect mortality was recorded 48 hours after caging, and infected plants were counted 20 days after inoculation. Prevention of virus infection was calculated:

$$\% \text{ prevention} = \frac{\% \text{ infected plants in control} - \% \text{ infected plants in treatment}}{\% \text{ infected plants in control}} \times 100$$

Effect of emulsifiable concentrate (EC) insecticides on tungro virus infection and *N. virescens* mortality,[a] Cuttack, India.

Insecticide		Prevention of infection (%)		Insect mortality[b] (%)	
Common name	Trade name	1 DAT	5 DAT	1 DAT	5 DAT
		Trial 1			
Cypermethrin	Ripcord 10 EC	100 a	100 a	100 a	100 a
DDT	Hildit 25 EC	64 b	32 c	100 a	64 b
Fenitrothion-1	Accothion 50 EC	61 bc	27 c	100 a	70 b
Vamidothion	Vamidothion 30 EC	60 bc	60 b	100 a	100 a
Malathion	Cythion 50 EC	50 c	6 de	100 a	58 b
Phosalone	Zolone 35 EC	37 d	0 e	100 a	100 a
Fenitrothion-2	Folithion 50 EC	19 e	15 cd	72 b	12 c
Methyl parathion	Metacid 50 EC	18 e	20 cd	39 c	7 c
Dichlorvos	Nuvan 100 EC	16 e	12 cd	100 a	100 a
Endosulfan	Hildan 35 EC	1 f	0 e	5 d	3 c
		Trial 2			
FMC 35001	Marshall 25 EC	92 a	77 a	100 a	100 a
Ofunack	Ofunack 40 EC	85 a	46 b	100 a	100 a
Monocrotophos	Nuvacron 40 EC	15 b	11 c	97 a	26 b
Dimethoate	Rogor 35 EC	15 b	42 b	65 b	38 b
Formothion	Anthio 25 EC	10 b	6 cd	77 b	11 c
Diazinon	Bazanon 20 EC	9 b	10 cd	80 b	20 bc
Chlorpyriphos	Dursban 20 EC	0 c	0 d	6 c	0 d
		Trial 3			
Phosphamidon	Dimecron 40 EC	88 a	61 a	100 a	100 a
Demeton-O-methyl	Metasystox 25 EC	82 a	58 a	100 a	100 a
BPMC	Sulphoxide BPMC 50 EC	62 b	48 ab	88 b	81 b
Quinalphos	Ekalux 25 EC	42 c	22 bc	100 a	53 c
Fenitrothion	Folithion 50 EC	25 d	15 cde	65 c	53 c
Thiometon	Ekatin 25 EC	24 d	7 de	90 a	53 c
Methyl parathion	Paratox 50 EC	17 de	20 bcd	28 d	5 f
Phenthoate-1	Elsan 50 EC	17 de	5 e	89 b	14 e
Carbaryl	Sevimol 40 EC	15 de	8 cde	94 ab	29 d
Phenthoate-2	Phendal50 EC	11 e	6 de	100 a	100 a

[a] DAT = days after treatment. Values followed by the same letter do not differ significantly at P = 0.05 by DMRT. [b] Adjusted values by Abbott's formula

Of 10 insecticides tested in trial 1, cypermethrin prevented virus infection at 1 and 5 DAT. Vamidothion provided 60% prevention at 1 and 5 DAT. DDT, fenitrothion-l, and malathion gave some protection at 1 DAT, but little at 5 DAT. Cypermethrin, vamidothion, phosalone, and dichlorvos caused 100% vector mortality at 1 and 5 DAT. DDT, fenitrothion-1, and malathion caused 100% mortality at 1 DAT.

In trial 2, FMC 35001 effectively prevented infection and caused vector mortality. Ofunack was next best. The remaining insecticides neither prevented virus infection nor controlled the vector.

In trial 3 phosphamidon and demeton-O-methyl prevented infection and caused 100% *N. virescens* mortality. Phenthoate-2 controlled the vector at 1 and 5 DAT, but did not prevent infection.

Results indicate that some insecticides that controlled the vector did not prevent virus infection. Phosalone, dichlor vos, and phenthoate-2 killed the vector, but did not prevent infection. This phenomenon needs to be investigated. Cypermethrin, vamidothion, FMC 35001, ofunack, phosphamidon, and demeton-O-methyl prevented virus infection and controlled the vector effectively.

Antagonistic effects of soil microorganisms on rice sheath blight pathogen

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The effects of microorganisms associated with rice sheath blight pathogen on the latter's survival on dryland and wetland culture were investigated.

A Trichoderma sp. colonizing the sclerotial bodies of *Thanatephorus cucumeris* in a dryland rice field was isolated and tested for antagonistic activity against the pathogen. On potato dextrose agar (PDA), an inhibition zone was formed between *Trichoderma* and *T. cucumeris*. Pathogen growth stopped after contact with *Trichoderma*. *Trichoderma* continued growing and eventually covered the whole plate.

Microscopic examination showed that *Trichoderma* frequently coiled around aerial hyphae of *T. cucumeris* on the agar surface. No coiling around subsurface hyphae was observed. Scientists observed that: 1) many short branches were produced by the main hyphae of *Trichoderma* and that each branch coiled tightly around the pathogen's hyphae, 2) the main hyphae coiled around the pathogen's hyphae, and the coils formed at a narrower angle with few coils per unit length of hypha, 3) the *Trichoderma* hyphae grew parallel to *T. cucumeris* hyphae and at intervals produced short branches that coiled around the pathogen's hypha. Further examina-

tion showed cytoplasm vacuolation, and coagulation followed by hyphae bursting.

Bacteria with different colony types were isolated from sheath blight sclerotia and tested in petri dishes to study their antagonistic activities against *T. cucumeris*. Many isolates were antagonistic. Some inhibited mycelial growth and caused browning of hyphal tips. Microscopic examination showed that necrosis of hyphae occurred. Hyphae remained intact but nonviable, and protoplasm was agglutinated and pigmented.

Isolate 17 prevented lesion development when sprayed on detached rice flag leaves before, after, and simultaneously with inoculation of the pathogen. Sclerotial bodies soaked in a suspension of bacterial isolate 17 for 2 weeks were not viable. Bodies treated with isolate 24 showed an abrupt germination decline (63.3% to 26.7%) at 0 and 2-week sampling periods. Twenty percent of the sclerotia soaked in isolate 24 for 6 weeks were viable.

Effect of antagonistic bacteria on incidence and severity of sheath blight in the IRRI greenhouse.[a]

Treatment	Incidence[b] (%)	Severity (lesion length, cm)
Isolate 17 + pathogen	30	0.61
Isolate 24 + pathogen	75	1.27
Pathogen alone	100	2.00

[a]Bacterial suspension (1×10^6 cells/ml) was sprayed at the basal portion 1 day before inoculation. [b]Incidence based on number of tillers infected divided by total number of tillers: 3 hills/replication; 3 replications/treatment.

Preliminary greenhouse test results showed isolate 17 sprayed at the basal portion of the rice plants 1 day before inoculation was superior to isolate 24 for reducing sheath blight incidence and inhibiting lesion development (see table).

Host range of rice gall dwarf virus

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A new rice virus disease that causes stunting, dark green leaf discoloration, and presence of galls along the leaf blades and leaf sheaths was identified as rice gall dwarf virus (RGDV) in Thailand in 1979.

Second- and third-instar nymphs of rice green leafhopper *Nephotettix nigropictus* that had fed on infected rice plants for 2 to 3 days were reared on healthy TN1 seedlings for 10 to 14 days, then *N. nigropictus* was used to inoculate 11 plant species grown in pots: maize *Zea mays,* sorghum *Sorghum nervosum.* timothy grass *Phleum pratense,* orchard grass *Dactylis glomerata,* Italian rye-grass *Lolium multiflorum,* Japanese grass *Alopecurus aequalis* var. *amurensis,* wild rice *Oryza rufipogon,* barley *Hordeum distichum.* wheat *Triticum aestivum,* rye *Secale cereale.* and oat *Avena satilla.* At the second leaf stage seedling were inoculated by placing 2 viruliferous insects on each plant for 2 to 3 days.

Virus symptoms developed 15 to 30 days after inoculation. Inoculated plants were examined by electron microscope using a negative stain preparation, then were back-inoculated to healthy rice seedlings. Barley, wheat, rye, oat, Italian ryegrass, Japanese grass, and wild rice showed typical symptoms. Polyhedral particles 65 nm in diameter were observed in the negatively stained preparation. Rice plants exhibited symptoms after back-inoculation.

Maize, sorghum, timothy grass, and orchard grass did not show symptoms. No particles were observed under the electron microscope, nor did symptoms appear after back-inoculation.

Weed host of *Rhizoctonia solani* Kuhn, a rice sheath blight pathogen

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During July 1982 *Echinochloa colona,* a common rice field weed, was severely infected with *R. solani* in some fields in the Cooch Behar district of West Bengal and the Goalpara district of Assam.

Both areas are in high-rainfall zones (more than 300 cm/year). The infected weed was growing in rice fields with 20-25 cm standing water, and on the boundary ridges of the fields. Soil pH was between 5.5 and 6.5. Rice plants were moderately affected by the disease.

R. solani isolates from this weed species have been found to infect artificially inoculated rice.

Decline in number and viability of sclerotia of rice stem rot fungus in soil

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Sclerotia of *Sclerotium oryzae* Catt., the causal pathogen of rice stem rot disease, were produced on a sterile rice-rice hull mixture and used to artificially infest soil from a wet fallow field.

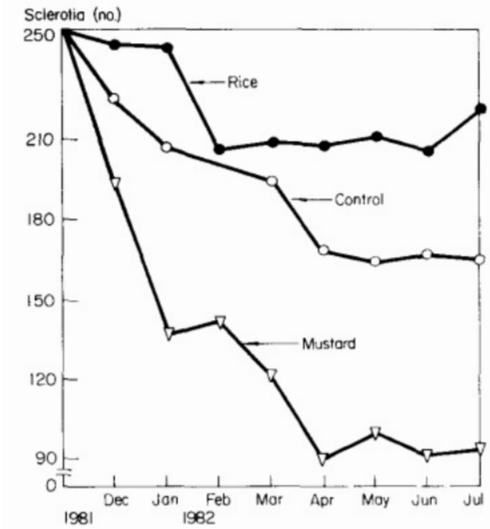
Seventy-nine mg of sclerotia were weighed and mixed thoroughly into 3 kg of sandy loam soil in pots by sprinkling the sclerotia on the soil surface and thoroughly mixing the soil using a hand-operated rototiller. Propagules (sclerotia) were introduced at the rate of about 5 sclerotia/g of soil, which corresponds to a moderate infestation level. There

were three replications using two amendments. Chopped and dried rice and mustard *Brassica campestris* var. *Sarson* straws were added to equal 2% of the soil. Pots were located in normal field conditions and watered occasionally to supplement rainfall and provide average annual precipitation.

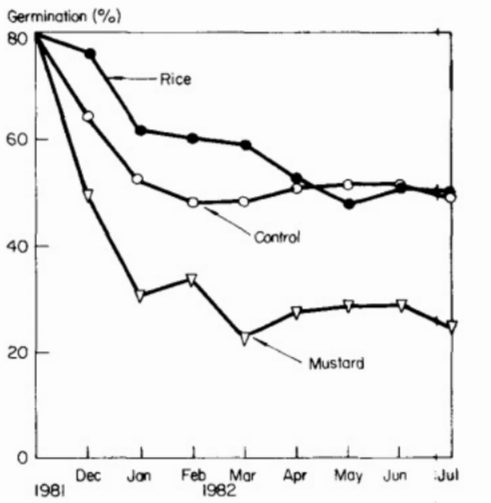
Soil columns were sampled at the end of the month using a standard soil-core sampler 2 cm in diameter and 18 cm deep. At each sample date, five soil cores were collected from each treatment, bulked in a paper bag, and air-dried in the laboratory. Five 50-g subsamples were taken from each bag and sclerotia were recovered by washing over 20- and 100-mesh screens. Sclerotia from each treatment were counted under a dissecting microscope and viability was tested by growing them on water agar supplemented with streptomycin sulfate and penicillin at 3,000 ppm each under constant fluorescent light at 25+2° C.

Presence of organic matter reduced sclerotia survival — percent viability of sclerotia was less although total number of sclerotia had increased or remained constant over time. Burying sclerotia for 8 months in the presence of mustard reduced their number by 76% (Fig. 1) and viability by 75% (Fig. 2). Number and viability also declined in treatments without amendment, but after a few months germination ability stabilized at about 50%. Rice straw amendment decreased number and viability in the beginning, but sclerotia increased at the end of the burial period (Fig. 1).

Rice residue seems to be a major factor in increasing the *S. oryzae* inoculum level in field soil. However, application of mustard organic matter will substantially reduce the inoculum level in the field.



1. Effect of organic amendments on decline of sclerotia number.



2. Effect of organic amendments on germination of sclerotia.

Pest management and control INSECTS

Rice yield losses to gall midge in North Thailand

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Rice gall midge *Orseolia oryzae* (Wood-Mason) is one of the most economically important insect pests of rainfed wetland rice in Thailand. Granular insecticides are the only effective means of control, but they are expensive and require multiple applications to obtain satisfactory results. Gall midge infestations vary in Thailand and insecticide application should be based on the use of an economic threshold.

Experiments in farmers' fields at Ban Parauk, Cheingrai, assessed yield losses caused by gall midge. A conventional

Gall midge infestation, yield components, and yield losses of 4 rice varieties at Ban Parauk, Cheingrai, Thailand. 1979-81. [a]

Variety	Insecticide treatment [b]	Infested tillers (%) 55-65 DT	Tillers (no./hill)	Panicles (no./hill)	Yield (t/ha)	Yield loss (%)
		1979				
RD1	Treated	1.0	11.4	5.5	2.3	–
RD1	Untreated	21.5	12.0	4.4	1.9	19
Niew-San-Pahtawng	Treated	2.2	10.7	4.6	2.7	–
Niew-San-Pahtawng	Untreated	26.5	10.9	4.4	2.5	8
Dawk-Ma-Li 105	Treated	0.4	10.1	5.7	2.0	–
Dawk-Ma-Li 105	Untreated	19.2	10.7	4.9	1.8	10
Leaung-Laung	Treated	1.8	7.1	4.5	2.9	–
Leaung-Laung	Untreated	25.0	11.5	3.1	1.9	33
		1980				
RD1	Treated	6.3	9.7	6.0	1.8	–
RD1	Untreated	71.5	13.7	3.2	0.9	52
Niew-San-Pahtawng	Treated	1.4	8.1	6.0	2.5	–
Niew-San-Pahtawng	Untreated	68.9	11.1	3.8	1.5	42
Dawk-Ma-Li 105	Treated	1.4	9.6	6.0	1.9	–
Dawk-Ma-Li 105	Untreated	73.7	11.8	3.5	0.9	49
Leaung-Laung	Treated	0.6	8.1	5.7	2.5	–
Leaung-Laung	Untreated	61.1	12.2	3.6	1.2	50
		1981				
RD1	Treated	9.8	11.8	8.9	3.1	–
RD1	Untreated	28.7	13.8	8.8	2.5	17

CONTINUED ON OPPOSITE PAGE

experiment, using plots with and without insecticide, was used 1979-81 on four susceptible rice varieties — RD1, Leaung-Laung, Dawk-Ma-Li 105, and Niew-San-Pahtawng — in a strip plot design with three replications. In treated plots carbofuran (1 kg ai/ ha) was incorporated into the soil before planting and broadcast on paddy water 20 and 40 days after transplanting.

The second assessment method observed individual hills. Leaung-Laung was transplanted in a 0.08-ha field in 1981. Gall midge-infested tillers (silvershoots) and total tillers were counted from 10 randomly selected rows/plot, 50 hills/row, 500 hills/ plot. Yield per hill was recorded. A wide range (0, 1-5,6-10, 11-15, 16-20, 21-30, 31-50, and 51-70%) of infestation levels which could be correlated with yield were obtained with this method.

Results from the conventional insecticide plot method showed potential yields varied annually, possibly because of weather factors (see table). Relating rice yield to gall midge infestations was unsuccessful because it would require many years to get a wide range of gall midge infestation levels. High gall midge infestation (average of 69% infested tillers) occurred in 1980. Yield reduction in all varieties ranged from 42 to 50%. Less damage (22-23%) occurred in 1979 and 1981. Yield loss variation was greater at lower levels of infestation. In most cases Niew-San-Pahtawng and Dawk-Ma-Li 105 showed lowest losses. Gall midge infestation induced rice tillering, and there were more tillers in untreated plots than in treated ones but panicle number was small.

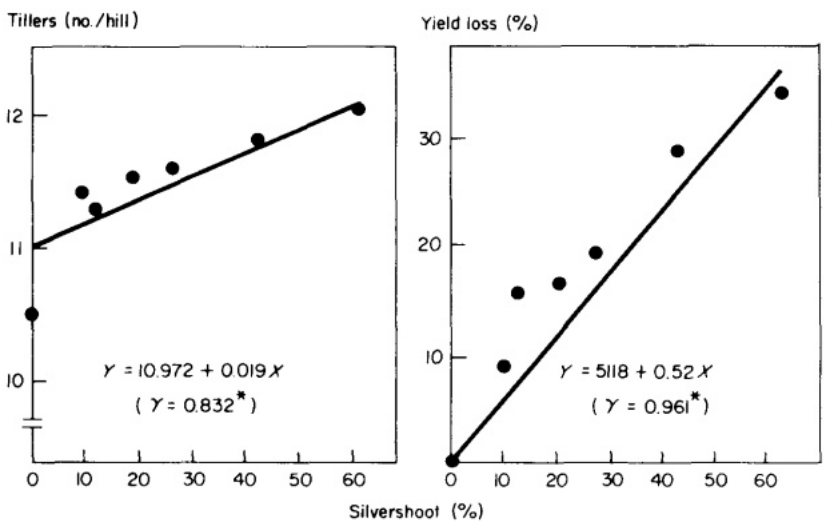
Results from the single hill experiment demonstrated that tiller number increased gradually with increasing gall midge infestation (see figure). The general yield loss equation was $Y = 5.118 + 0.52\ X$ (when Y = % yield loss and X = % silvershoots). When this equation was used to determine average yield loss for the four rice varieties, the results closely agreed with those of the conventional method.

Data showed average potential rice yield was 2.64 t/ha. Using the yield loss equation, yield reduction at 20% gall midge infestation is 15.6% or 411 kg/ ha, costing $57.5 (when 1 t rice = $140) in lost production. Two applications of carbofuran cost $57.2 (1 kg of carbofuran = $0.86). Therefore, treating infestation levels above 20% will give a return benefit to cover the cost of control. Because annual gall midge infestation of rice at Ban Parauk, Cheingrai, is more than 20%, insecticide application is economic..

TABLE CONTINUED

Variety	Insecticide treatment[b]	Infested tillers (%) 55-65 DT	Tillers (no./hill)	Panicles (no./hill)	Yield (t/ha)	Yield loss (%)
Niew-San-Pahtawng	Treated	1.6	8.5	6.8	3.6	–
Niew-San-Pahtawng	Untreated	16.2	9.3	5.5	2.8	22
Dawk-Ma-Li 105	Treated	3.7	10.8	8.1	3.2	–
Dawk-Ma-Li 105	Untreated	21.9	12.3	7.6	2.9	10
Leaung-Laung	Treated	3.7	8.8	7.1	3.1	–
Leaune-Laung	Untreated	20.2	9.9	6.7	2.1	13

[a]Av of 3 replications. Insect damage and yield components were measured from 30 random hills. DT = days after transplanting. [b]1 kg ai carbofuran/ha was incorporated into the soil before transplanting, and broadcast 20 and 40 DT, except in 1979 trial when only 2 broadcast applications (20 and 40 DT) were made.



Relationships between percent gall midge infestation and number of tillers and yield loss in Leaung-Laung rice variety at Ban Parauk, Cheingrai, 1981.

Leersia hexandra as weed host for the brown planthopper

F. C. Medrano and E. A. Heinrichs, Entomology Department, IRRI

The brown planthopper (BPH) *Nilaparvata lugens* that normally develops on *Leersia hexandra* weed has been found at two sites on the IRRI farm. Incubation period and egg hatchability were tested in 10 replications.

Five gravid females were enclosed in each 6- × 30-cm mylar cage and allowed to oviposit for 24 hours on *Leersia* plants. The insects were removed and nymphs that hatched were counted and removed daily. When hatching terminated, plants were dissected and unhatched eggs counted.

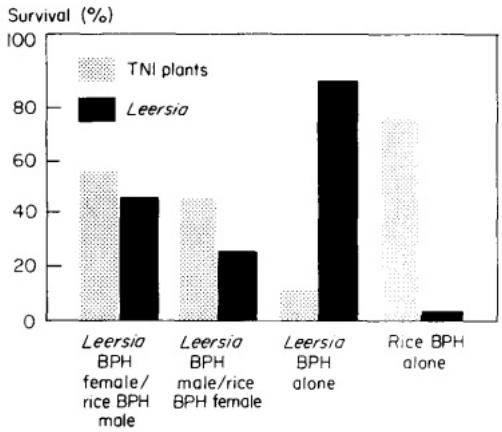
BPH longevity and fecundity were also studied. Pairs of newly emerged adults were placed on potted *Leersia* in a mylar cage. Insects that died were counted and removed daily. Living insects were transferred every 3 to 4 days to fresh host plants. Plants from which adults were removed were dissected and eggs were counted.

Incubation period was 7.8 days, egg

hatchability 81%. Males lived 27 days and females 33 days, and fecundity was 513 eggs. Data are equivalent to BPH biotype 1 data from TN1 plants.

Leersia-reared BPH fed little on rice plants, as indicated by low amounts of excreta, and did not survive on TN1 and several resistant varieties. Rice-plant-reared BPH populations, tested in the greenhouse, did not live on *Leersia,* but could contribute to the rice-feeding BPH gene pool through intermating.

A crossing experiment was conducted to determine if Leersia-reared and rice-plant-reared BPH mate and to assess the virulence of the offspring. Individual fifth-instar nymphs of *Leersia*-reared BPH were placed in test tubes containing *Leersia* cuttings and greenhouse rice-reared BPH were placed in test tubes containing TN1 seedlings. Using adults that emerged simultaneously, crosses of



Survival of progeny from crosses between *Leersia* brown planthopper (BPH) and rice-reared BPH at 15 days after being placed on *Leersia* and TN1 plants.

Leersia BPH and rice-reared BPH were caged on *Leersia* and TN1 plants planted together in a clay pot. When eggs hatched, 10 newly emerged nymphs were caged on separate potted Leersia and TN1 plants. Some F_1 progenies survived (see figure) and produced F_2 progenies on *Leersia* and TN1 plants. If intermating also occurs under field conditions, the wild *Leersia* BPH population can contribute to BPH field infestation.

The flea beetle as a rice pest in Assam, India

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The flea beetle *Chaetonema basalis* Baly. was studied on rice plants during transplanting and tillering stages in ahu (March-July) and sali (July-December) 1980-81 in Assam, India. Mild infestations were reported in Barpeta Agricultural Subdivision, Kamrup, Assam, but there was no significant economic damage.

Adults are small, round, black, shining beetles about 1.5 to 2 mm long. They are found on leaves and jump when disturbed. They feed by scraping the green matter from leaves, leaving short straight lines on the leaf surface that are parallel to leaf veins. Damage resembles that caused by the rice hispa *Dicladispa armigera.* Later, ends of affected leaves turn brown and wither. Heavily infested fields look scorched. In severely infested fields 25-40 beetles/ hill can be found.

A rabi oilseed survey has shown that the pest also attacks mustard pods during winter.

Rice thrips in Mymensingh, Bangladesh

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Rice thrips *thrips oryzae* Williams have become a major problem at the INA experimental farm, Mymensingh, and in adjacent areas. During 1982 aus season (summer rice) all varieties on the farm (high yielding and local) were severely damaged. In some cases infestation was 100%.

Infestation occurs in seedling and early growth stages. Thrips nymphs and adults suck sap from the leaves. In heavy infestation plants may dry.

Thrips increase might have been caused by the long winter and summer drought and by the destruction of natural enemies through heavy insecticide application. Infestation decreased with the onset of rainy season.

Status of the brown planthopper in Thailand

Weerawooth Katanyuku1(present address: Entomology Department, IRRI), Raywat Pattarasuthi, Narong Chantaraprapha, Pinit Nilpanit, Thamnoon Bhudhasamai, Suwat Rauy-aree, and Chinatana Tayathum, Entomology and Zoology Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

Brown planthopper (BPH) *Nilaparvata lugens* (StåI) is one of the most destructive rice pests in central Thailand. In 1981, 36,000 ha were severely damaged. In a survey of pest status April-June 1981, BPH populations and natural enemies were estimated by direct counting (50 hills/field) and sweep net (50 sweeps/field) at 42 sites in 9 provinces, BPH eggs and egg parasites were sampled by dissecting 10 random hills at each location. BPH was in 95% of samples. Density was 204 adults and nymphs/ 50 hills and 6.5/ 50 sweeps (see table). Rice ragged stunt disease (RSV) was in 43% of sites, averaging 5% infected hills. Natural enemies — damselflies, wolf spider *Lycosa pseudoannulata,* long-jawed orb weaver *Tetragnatha* spp, and coccinellid beetle *Micrapis discolor* — were abundant. Mirid bug *Cyrtorhinus lividipennis* population was

Population densities of brown planthopper (BPH) and its predators, and ragged stunt disease (RSV) incidence in central Thailand, April-June 1981.

Species	Sampling method	No.[a]	Occurrence in sampling areas (%)
BPH *Nilaparvata lugens*	Direct count	204.3	95.2
	Sweep net	6.5	75.7
BPH eggs	Stem dissection	61.4	78.8
Damselflies	Sweep net	23.2	100.0
Lycosa pseudoannulata	Direct count	7.8	97.6
	Sweep net	2.1	37.8
Tetragnatha spp.	Sweep net	14.8	83.8
Micrapis discolor	Sweep net	11.6	78.4
Cyrtorhinus lividipennis	Sweep net	4.8	40.5
RSV	Direct count	5.2(%)[b]	42.9

[a]Number/50 hills or 50 sweeps except eggs, which were taken from 10 hills. [b]% infected hills of 50 hills.

low, 4.8/50 sweeps at 41% of the sites. There were 61.4 BPH eggs/ 10 hills in dissected stems, but an average 61% of eggs were parasitized, mostly by *Anagrus* sp. and *Oligosita* sp.

Sixty-six percent of fields sampled had transplanted rice. The remainder had direct, wet-seeded. RD1, RD7, and RDl1 predominated. High rates of nitrogenous fertilizers, ranging from 24 to 89 kg N/ha (av 46 kg N/ha) were applied. Most farmers used a 16-20-0 fertilizer formulation. Two or three insecticide applications per growing season were made to 94% fields sampled. Carbofuran, monocrotophos, and carbaryl were the most common insecticides. Application rates were lower than recommended dosages — 10-20 g or ml/ 20 liters water for spray formulation, and 0.5 kg ai/ ha for granular formulation.

Results indicated outbreaks of BPH and RSV are probably caused by cultivation practices. Farmers grow susceptible high tillering varieties, apply high fertilizer rates, and practice double or continuous cropping. Insecticides may not be critical to insect outbreaks. Damage by BPH and RSV will increase because of high insect density and disease reservoirs unless farmers adopt new insect-resistant varieties and modern pest management practices.

Predatory potential of the wolf spider *Lycosa pseudoannulata* on rice brown planthopper

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Several species of spiders in rice ecosystems prey on and effectively regulate rice leafhoppers and planthoppers. The wolf spider *Lycosa pseudoannulata* is the predominant species in irrigated wetland rice at Coimbatore, India. To determine the predatory potential of wolf spider on brown planthopper (BPH) *Nilaparvata lugens,* glasshouse studies were made at Paddy Breeding Station, Coimbatore.

In the first experiment, 20 5th-instar BPH nymphs were placed on potted rice plants as food for each spider. In the second experiment, 20 adult BPH (10 brachypterous and 10 macropterous forms) were used. Fourth-instar spiders were used in both experiments and all the spiders molted at least once during the 15-day experimental period. Ten replications (hills) were maintained in each experiment.

The number of BPH eaten or killed by each spider was recorded daily. A constant population of live BPH in the same stage was maintained. The same spiders were used throughout the experiment.

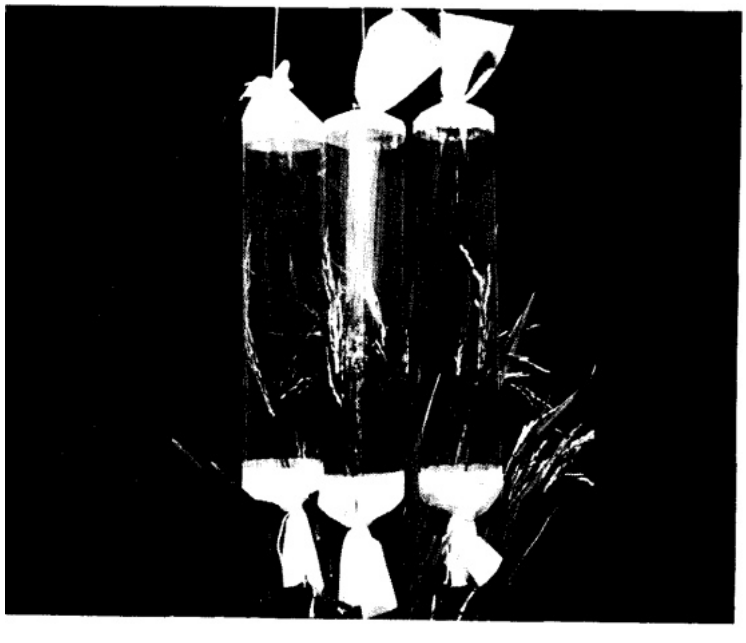
Each spider consumed an average of 6 5th-instar BPH nymphs/day. When brachypterous and macropterous adults at 1:1 were provided as food, each spider consumed 7 adults/day. Spiders did not prefer one form to the other.

Life history of rice bug *Leptocorisa oratorius* (F.)

I. T. Domingo, E. A. Heinrichs, and F. C. Medrano, Entomology Department, IRRI

The life history of the rice bug *Leptocorisa oratorius* (F.) was studied in the greenhouse at 27.4° C (range 20.5-34.3° C) and relative humidity of 81% (range 63.0-93.8%).

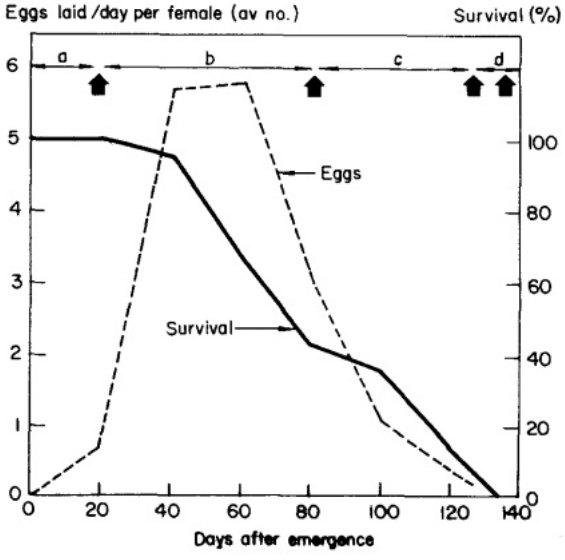
Newly laid eggs from an adult colony maintained on potted plants were clipped from leaves and placed on moist filter paper in a petri dish for incubation. Emerging nymphs were transferred in pairs to milk-stage panicles of potted



1. Mylar film cage measures 7.5 cm in diameter, 30 cm long. Nylon mesh sleeves at the ends are 13 cm long.

plants enclosed in mylar film cages (Fig. 1).

The bugs laid eggs in single or double rows on the leaves and sometimes singly on the panicles of the potted plants. Eggs hatched in 7.5 days (range of 6-9) and nymphs passed through 5 instars with an average nymphal period of 20.5 days (range 19-22). Preoviposition and egg laying periods were 18.0 days (range 9-25) and 57.0 days (range 6-108). Average life span was 80.0 days (26-134). Each female laid an average of 284.5 eggs (range 0-569) during 108 days of egg laying (Fig. 2). Gravid females laid eggs on leaves of potted plants at late booting rather than at milk stage.



2. Fecundity and longevity of rice bugs. IRRI, 1982. a = preoviposition period, b = peak, b + c = egg-laying period, a to d = longevity.

Propicroscytus mirificus (Girault) [Hymenoptera: Pteromalidae] correct name for the larval parasite of rice gall midge

Alberto T. Barrion, research assistant, and James A. Litsinger, entomologist, Entomology Department, IRRI

Obtusiclava oryzae Subba Rao is the most important larval parasite of rice gall midge *Orseolia oryzae* (Wood-Mason) in India, Indonesia, and Thailand. It is also the type-species of the genus *Obtusiclava* Subba Rao, 1973 [ref: Subba Rao, B.R. 1973. Descriptions of a new species and genus of *Pteromalidae* (Hymenoptera) parasitic on *Pachydiplosis oryzae* (Wood-Mason) (Diptera: Cecidomyiidae). Bull. Ent. Res. 62:627-29]. In 1978, after examining Girault's types in Queensland Museum, Australia, Boucek discovered that the *Obtusiclava* is the same genus as *Propicroscytus Szelenyi,* 1941. Furthermore, *Propicroscytus mirificus* (Girault) has a new junior synonym in *O. oryzae* Subba Rao [ref: Boucek, Z. et al 1978. A preliminary review of *Pteromalidae* (Hymenoptera) of India and adjacent countries. Oriental Ins. 12(4):433-67]. Henceforth, the genus *Propicroscytus* Szelenyi, 1941, having been described earlier, has priority over *Obtusiclava* Subba Rao, 1973. Therefore, the correct name for *O. oryzae* Subba Rao is *Propicroscytus mirificus* (Girault).

Soil and crop management

Increasing nitrogen use efficiency in transplanted rice by blending urea with margosa seed cake powder

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Margosa (*Azadirachta indica*) seeds contain an alkaloid called *nimbidin* that inhibits soil nitrification. Margosa cake is cheap and locally available at several places in India. Used in combination with urea, it can increase nitrogen use efficiency in rice. However, when powdered country-pressed deoiled margosa cake is mixed with urea (15-30% wt/ wt) the two do not adhere.

Effect of urea blended with margosa cake powder (MCP) on transplanted Jaya during 1980 kharif, Pantnagar, India

N rate (kg/ha)	N application method	Grain yield[a] (t/ha)	Yield response (kg grain/ kg N)
0	No nitrogen	3.2	–
50	Urea mixed with 15% MCP, basal incorporated	5.3	42
50	Urea mixed with 30% MCP, basal incorporated	4.6	28
50	Urea coated with 15% MCP with coal tar and kerosene oil, basa1 incorporated	5.3	42
50	Urea coated with 30% MCP with coal tar and kerosene oil, basal incorporated	5.0	36
50	Urea coated with coal tar and kerosene oil, basal incorporated	5.1	38
50	Urea basal incorporated	4.7	30
50	Urea band-placed at about 5 cm depth	4.8	32
50	Urea best split	5.1	38
100	Urea best split	6.6	34
	S.Em ±	0.24	
	C.D. at 5%	0.70	
	C.V. (%)	9.9	

[a] At 14% moisture.

In recent years, coal tar and kerosene oil at 1:2 have been blended with urea and margosa cake for better adherence. The combination has helped inhibit nitrification and reduce nitrogen loss through NO_3 leaching and denitrification. It is used as a basal application to save the cost of topdressing, and can be used in split applications where topdressing is difficult because of waterlogging.

A randomized block design with 4 replications was used during the 1980 rainy season to evaluate margosa-urea application of suboptimum nitrogen levels (50 kg N/ ha) in fields. Soil was silty clay loam, pH 7.8, 1.38% organic carbon, with 50 kg available P/ha and 162 available K/ha. A treatment of near optimum nitrogen (100 kg N/ha) was included for comparison. The nursery was sown 6 June and the crop harvested 23 October.

Urea blended with 15% margosa powder alone, or with coal tar and kerosene oil, yielded 5.3 t/ha — comparable to yield with urea best split (5.1 t/ha) — and gave the highest grain yield response (42 kg grain/kg N) (see table). Urea coated with coal tar and kerosene oil was equally effective. Margosa cake showed no advantage over split-applied urea in areas where topdressing can be practiced.

Margosa application may hold promise for fields where water cannot be drained to allow topdressing. In such situations, fertilizer is applied as a single basal application. Urea blended with margosa gave 0.6 t/ha extra grain yield over single application, saving about 20% nitrogen at little extra cost (US$4-5) in fields where topdressing could not be used because of poor drainage.

Germination of seed from parent crop varieties irrigated with saline and nonsaline water

S. K. Datta, and S. K. De, Rice Research Station, Chinsurah, West Bengal, India

Seven photoperiod-sensitive winter rice varieties were grown during wet season in nonsaline (control) and saline irrigated plots at the Salt Paddy Research Sub-station, Gosaba, West Bengal. The soils are silty clay loam.

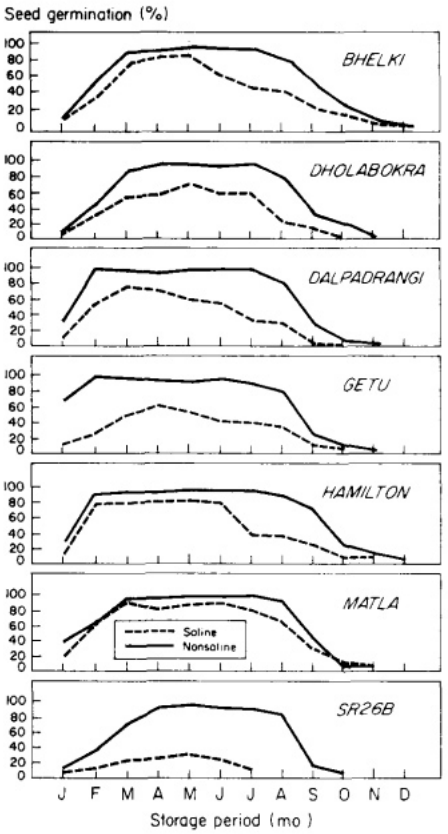
Nonsaline plots were irrigated with fresh water (pH 6.5-7.6, EC 0.8-1.1 mmho/cm) from a rainfed tank. Saline plots were irrigated with saline water (pH 5.8-6.0, EC 8.0-12.8 mmho/cm) from the Vidya River, which is directly connected with the Bay of Bengal. Irrigation water salinity was recorded at 15-day intervals throughout the growing season.

Seeds harvested in November-December were thoroughly dried, cleaned, and stored in cloth bags. Seed viability was monitored for 12 months.

Seeds collected from both saline and nonsaline plots showed varying dormancies. In general, seeds from saline irrigated plots were poorer in viability retention (see figure). Germination one month after harvest was remarkably lower in salt-affected seeds than in the control, irrespective of variety, indicating the inhibitory effect of salinity on the crop. Viability of salt-affected seeds was highest in April and May, then gradually diminished.

Math variety was an exception. Its viability gradually increased until July. Hamilton showed similar viability. Seeds of the five other varieties from saline irrigated plots rapidly lost viability after 4 months. Seeds from nonsaline plots retained over 90% germination capacity for more than 7 months.

A considerable number of seeds of the five other varieties were abnormal, with grain sterility and low grain-filling. Grain size was also reduced.



Monthly changes in germination of seeds of 7 rice varieties in saline and nonsaline irrigated plots. West Bengal, India.

Spacing and plant population for transplanted rice in alkali soil of eastern Uttar Pradesh

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Soil alkalinity is a major constraint to transplanted rice production in eastern Uttar Pradesh. Patchy plant growth, thin plant population, restricted tiller production, and decreased grain formation cause low yield in alkali (sodic) soils.

An experiment in July 1976 determined optimum plant density and population for increased rice production in alkali soils. Plants were tested in 3 replications at 10-, 15-, and 20-cm spacing and rates of 2, 3, 4, and 5 seedlings/hill.

Because natural soil pH was 10.3, gypsum at 6 and 12 t/ha was applied to different subplots with 3 replications 1 week before transplanting to test soil potential under partially and well-reclaimed conditions. An additional 120 kg N/ha, 50 kg P_2O_5/ha, and 40 kg $ZnSO_4$/ha were applied to all plots.

The experiment was repeated in the same plots using medium-duration variety Jaya transplanted during July 1977 and 1978.

In partially reclaimed soil, narrow spacing yields were highest, with yields increasing as plant populations per hill increased (see table). Maximum yields of 2.1, 5.5, and 5.3 t/ha during 1976, 1977, and 1978 were at 10-cm spacing and 5 seedling/hill.

In well-reclaimed soil neither 10-cm nor 20-cm spacings yielded higher. During 1976 highest yield was at 15-cm spacing and 5 seedlings/ hill. Although general yield levels increased with plant populations and with soil improvement, the difference in yield between the 2 best treatments (4 and 5 seedlings/ hill) narrowed to become statistically equal. Maximum grain yields of 6.5 and 6.6 t/ ha during 1977 and 1978 were at 15-cm spacing and 4 seedlings/hill.

Effect of spacing and plant population (2, 3,4, and 5 seedlings/hill) on rice yield in partially and we11-reclaimed alkali soils of Kumarganj (Faizabad), India.

Spacing (cm)	Gypsum[a] (t/ha)	Yield (t/ha) 2	3	4	5
			Pusa 2-21 (1976)		
10	6	1.2	1.5	1.6	2.1
	12	1.2	1.6	1.8	2.2
15	6	1.0	1.3	1.7	2.1
	12	1.6	2.1	3.1	3.8
20	6	0.8	1.1	1.4	1.7
	12	1.5	1.9	2.2	2.7
LSD (0.05)		0.3			
			Java (1977)		
10	6	4.3	4.7	5.1	5.5
	12	5.5	6.0	5.3	4.8
15	6	3.8	4.2	4.7	5.2
	12	5.1	5.5	6.5	6.3
20	6	3.5	3.9	4.3	4.6
	12	5.0	5.3	5.9	6.2
LSD (0.05)		0.5			
			Jaya (1978)		
10	6	4.1	4.5	5.0	5.3
	12	5.3	5.6	5.4	4.8
15	6	3.6	4.0	4.5	4.9
	12	5.2	5.8	6.6	6.4
20	6	3.5	3.7	4.1	4.5
	12	4.9	5.3	5.7	6.1
LSD (0.05)		0.4			

[a] Gypsum was applied only once, in 1976.

Optimum spacing and nitrogen for medium-duration rice

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A 1982 experiment during samba (July-August to November-December) at PES, Tirur, showed that Ponni and IR20 yields increased at 20 × 20 cm rice plant spacing, regardless of the level of nitrogen applied (see table).

Effect of nitrogen levels and spacings on rice yield, Tirur, India, 1982 samba.

Nitrogen (kg/ha)	Ponni yield (t/ha) 20 × 10 cm	20 × 20 cm	IR20 yield (t/ha) 20 × 10 cm	20 × 20 cm
0	3.4	3.9	3.3	3.7
10	4.0	4.4	3.7	4.1
20	4.2	4.9	4.2	4.6
30	4.6	5.1	4.6	5.0
Mean	4.1	4.6	4.0	4.4
	CD		CD	
Nitrogen level	0.3**		0.2**	
Spacing	0.3**		0.2**	

Environment and its influence

Variations and associations in rice physiological growth parameters

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Grain productivity can be improved by using component breeding, which assumes productivity is associated with growth parameters and their heritability. Direct and indirect gene action related to productivity and growth traits should be known. This study hypothesizes level of improvement can be predicted by calculating the genetic coefficient of variation using heritability estimates.

Jaya, Kranti, JR 16–15-2, JR25-13-8, Madhuri, Garima, Ratna, Anupama, JR15-55-2, and IR36 were grown in a randomized block design with three replications at JNKVV Research Farm during July 1978-79. Growth parameters were evaluated every 2 weeks.

Physiological growth parameters among varieties varied significantly. Means of individual characteristics and the general mean also differed (Table 1). Coefficient of variation for genotype (gcv) ranged from 1.05 relative growth rate (RGR) to 25.99 leaf area ratio (LAR). Coefficient of variation for phenotype (pcv) ranged from 15.02 net assimilation rate (NAR) to 50.43 RGR. The gcv was equally higher in leaf area index (LAI) and crop growth rate (CGR), indicating the level of possible improvement.

Heritability values for all characteristics exhibited wide variations: range of 21.1 to 89.6. Heritability estimates were high for RGR followed by seed yield and leaf parameter (leaf weight ratio [LWR], LAR, and LAI). NAR and specific leaf area (SLA) had lower heritability values, reflecting environmental influence. Maximum genetic improvement was recorded for LAI and LAR

Positive, significant associations of LAI were recorded with leaf area dura-

Table 1. Estimates of variations in physiological parameters,[a] Jabalpur, India, 1978-79.

	LAI	LAR	LWR	SLA	RGR	CGR	NAR	Seed yield (t/ha)
Mean	3.38	63.17	.268	229.1	.046	31.63	10.58	4.75
Minimum	1.81	16.91	.15	105.6	.016	13.67	7.63	3.08
Maximum	4.38	82.35	.35	330.9	.083	50.27	12.36	5.74
Phenotypic variance	1.03	359.52	.004	3766.4	.00054	107.06	2.54	7.99
Genotypic variance	0.77	269.65	.003	858.0	.00048	63.00	0.54	6.53
Environmental variance	0.26	89.87	.001	2908.4	.00056	44.06	3.08	1.46
pcv	30.05	30.02	24.88	26.79	50.43	32.69	15.02	18.81
gcv	25.96	25.99	21.66	23.54	1.05	25.09	6.92	16.99
h^2B (%)	74.6	75.0	75.7	22.7	89.6	58.0	21.1	81.6
G.A.	8.22	29.29	0.104	28.70	0.043	12.36	0.69	15.03
G.A. as % of mean	243.28	46.37	38.81	12.53	93.24	39.07	6.54	31.62

[a] LAI = leaf area index, LAR = leaf area ratio, LWR = leaf weight ratio, SLA = specific leaf area, RGR = relative growth rate, CGR = crop growth rate, NAR = net assimilation rate, pcv = coefficient of variation for phenotype, gcv = coefficient of variation for genotype.

tion (LAD), LWR, seed yield, and SLA; of LAR with LAD, SLA, and seed yield; of LAD with LWR, seed yield, and RGR; and of SLA with seed yield. RGR correlated positively and significantly with CGR, but negatively and nonsignificantly with seed yield (Table 2).

This study indicates LAI and RGR are the only characters that significantly influence economic productivity of rice cultivars.

Table 2. Multiple correlation of physiological parameters, [a] Jabalpur, India, 1978-79.

Parameter	LAR 2	LAD 3	LWR 4	SLA 5	RGR 6	CGR 7	Yield 8
1 LAI	.881**	.892**	.855**	.329*	.080	–.116	.453**
2 LAR		.798**	.755**	.623**	.0838	.166	.558**
3 LAD			.794**	.258	.313*	–.140	.388*
4 LWR				.013	.144	.105	.453**
5 SLA					–.085	.155	.418**
6 RGR						.491**	.411*
7 CGR							.082

[a] LAI = leaf area index, LAR = leaf area ratio, LAD = leaf area duration, LWR = leaf weight ratio, SLA = specific leaf area, RGR = relative growth rate, CGR = crop growth rate.

Emergence of calcium peroxide-coated rice seed at different water depths

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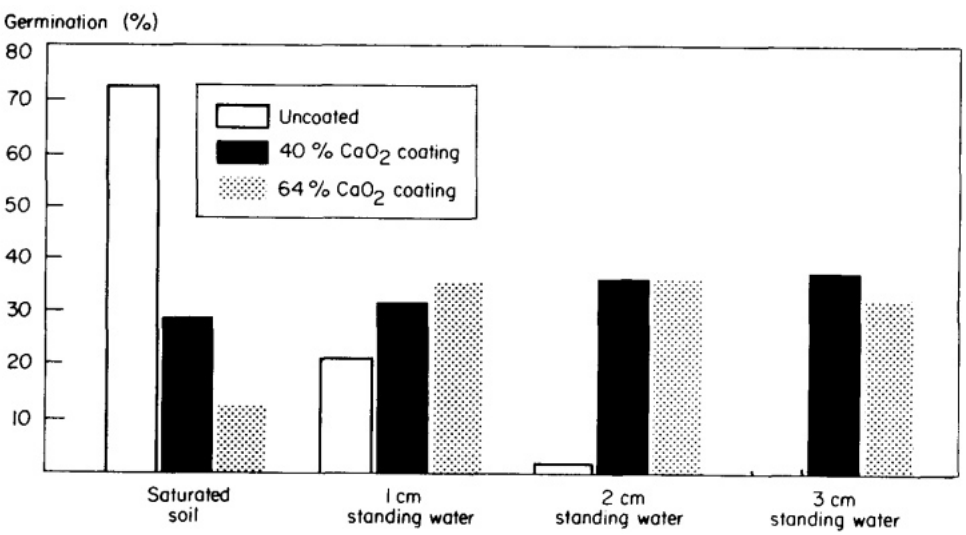
The effect of submergence depth on germination of calcium peroxide-coated seed was studied in pot culture. Plastic containers 24 cm deep and 20 cm in diameter were filled with 6 kg soil, ground to pass through 2-mm pores. Pusa 37 seeds, uncoated and coated with 40% and 64% by weight of calcium peroxide, were seeded uniformly at 100 seeds/pot. Soil was maintained either 1) in saturated condition, 2) with 1 cm standing water, 3) with 2 cm standing water, or 4) with 3 cm standing water. Each treatment had three replications.

In saturated soil, calcium peroxide coating adversely affected seed germination (see figure). Of seeds with 64% calcium peroxide coating, only 12% germinated. Germination of uncoated seeds was 72%.

In standing water, germination and seedling emergence of calcium peroxide-coated seeds increased. In 1 cm standing water, more seeds germinated with 64% coating than with 40% coating. In 2 cm standing water, the 2 coating levels were equally effective. In 3 cm standing water, fewer seeds germinated with 64% coating. As depth of standing water increased, germination and seedling emergence of uncoated rice seeds decreased. All germinated seeds emerged.



Effect of calcium peroxide coating on germination and seedling emergence in rice. IARI, New Delhi, India.

Rice-based cropping systems

Economics of rainfed upland rice-based cropping systems in the northwestern Himalayas

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About 70% of 150,000-ha rice area in the Kumaon and Garhwal hills of Uttar Pradesh is in dryland rice. The most popular dryland 2-year rotation is rice (March-September) - wheat (October-May) - finger millet *Eleusine coracana* L. (June-October) - fallow (November-March). In this sequence, a 150% cropping intensity is obtained. Cropping intensity potential can be increased to 200% by direct seeding early-maturing rice varieties in June.

A 4-year fixed-plot field study at Vivekananda Parvatiya Krishi Anusandhan Shala (VPKAS) Experimental Farm, Hawalbagh (Almora), explored ways of increasing cropping system intensity. The local rotation was compared with five improved crop sequences, four of which used early-maturing experimental rice varieties.

Grain yield, costs, and returns 1977-78 to 1980-81 for dryland cropping systems in Uttar Pradesh, India.[a]

Cropping pattern	Rainy season yield (t/ha)	Winter yield (t/ha)	Total variable cost ($/ha)	Net return ($+/ha)	Benefit-cost ratio
Rice - wheat	2.1	2.7	467	333	1.7
Rice - lentil	1.7	1.8	423	464	2.1
Rice - chickpea	1.9	2.2	457	711	2.6
Rice - pea	1.9	1.5	439	386	1.9
Spring rice -rapeseed	2.4	0.8	435	210	1.5
Spring rice - wheat	1.5	2.8	344	202	1.6
Finger millet - fallow	2.7				

[a]Cultivars used were VL206 (spring rice), experimental strains (June rice), VL421 (wheat), T36 (lentil), VL86 (chickpea), VL1 (pea), T9 (rapeseed), and VL101 (finger millet).

Average grain yield of June-seeded experimental varieties equaled that of spring-seeded rice. June seeding made 2 annual rice crops possible. Rapeseed (*Brassica campestris* L. var. *toria*), included in the spring sequence, produced a reasonably good yield (0.8 t/ha).

Highest average annual net return and benefit-cost ratios were recorded using a June-seeded rice - chickpea rotation followed by rice - lentil, rice - field pea, and rice - wheat sequences (see table). Results show that changing from traditional dryland rice rotations to more intensive cropping sequences using early-maturing varieties suitable for June seeding is profitable. Planting legumes in rabi season helps economize fertilizer use.

Improved cropping sequences provide a 2-week gap between harvest and seeding. Socioeconomic surveys indicate there is substantial underutilized human and bullock power in the hill villages to provide additional power requirements needed for more intensive crop rotations.

Number of tillers, nitrogen concentration, and grain yield of kharif rice crops as influenced by dubari crops and nitrogen level

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Rice is the major kharif crop in Sind Province, Pakistan. Several rabi season dubari crops are cultivated after rice. Crop patterns are rice - gram, rice - lucerne, rice - fallow, and rice - wheat.

A study was conducted to determine the effects of dubari crops on number of tillers, percent nitrogen concentration, grain yield, and nitrogen response of the kharif crop. In the first-year study, gram - rice, lucerne - rice, fallow - rice, and wheat - rice were examined in a complete block design with four replications. Plot size was 5 m × 10 m. No plot received nitrogen but all received 30 kg P_2O_5/ha. IR8 rice seedlings were transplanted.

In the second-year study 0, 30, 60, 90, 120, and 150 kg N/ha were tested in a randomized complete block design with 4 replications. Half of the nitrogen and 30 kg P_2O_5/ha were broadcast and incorporated into the soil. Remaining nitrogen was topdressed 30 days after transplanting (DT).

Number of tillers and percent nitrogen concentration at 30 DT, and grain yield (t/ha) of the rice crop increased progressively and significantly after gram and lucerne (see table). However, the rice crops did not differ significantly in those characteristics.

Effect of dubari crops on number of tillers and nitrogen concentration at 30 days after trans planting, and on grain yield of kharif rice;[a] Sind, Pakistan.

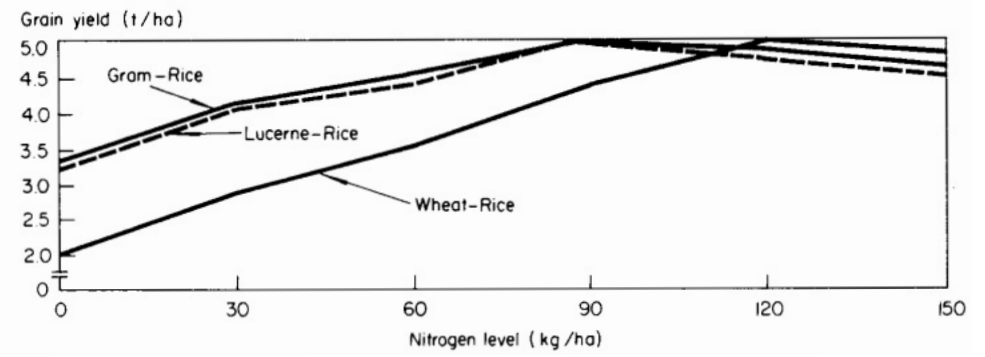
Crop pattern	Tillers (no./hill)	N concentration (%)	Grain yield (t/ha)
Gram - rice	55 a	2.5 a	3.6 a
Lucerne - rice	52 ab	2.5 ab	3.5 ab
Fallow - rice	45 c	2.3 c	2.5 c
Wheat - rice	35 d	1.8 d	1.9 d

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

Yield after gram and lucerne increased with nitrogen levels up to 90 kg/ha, but decreased beyond that level (see figure). After wheat, yield increased with nitrogen levels up to 120 kg/ha, then declined. Maximum yields of rice

grown after gram, lucerne, and wheat did not differ but a significant difference in nitrogen requirement was observed. However, kharif rice crop required 30 kg N/ ha less when grown after gram and lucerne than after wheat.

Results suggest that biological nitrogen fixation by dubari crops after kharif rice benefits growth and grain yield of the next rice crop.



Effect of nitrogen fertilizer on grain yield of kharif rice grown after dubari crops.

Announcements

Activities of the IRRI Japan Library Office

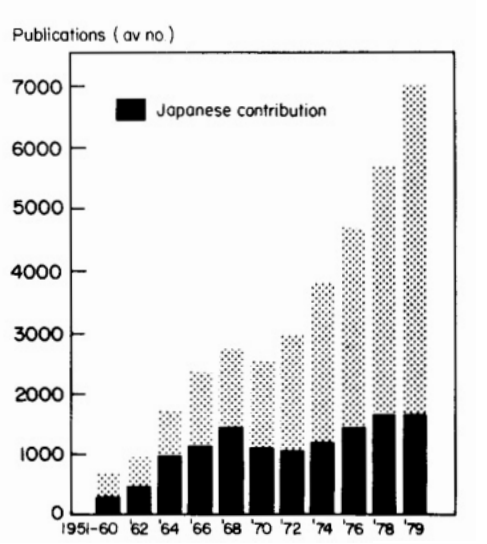
Kazuico Morooka and Yuko Sasajima, IRRI Japan Office, c/o National Institute of Agricultural Sciences, Yatabe, Tsukuba, Ibaraki 305 Japan

Japanese scientists contributed about one-fourth of the world literature on rice that was cataloged in the 1979 International Bibliography of Rice Research (IBRR), published by the IRRI Library (see figure). About 80% of these materials are in Japanese, which reduces their impact on international agriculture. In anticipation of this shortcoming the IRRI Tokyo Office (now the Japan Office) at the National Institute of Agricultural Sciences was concurrently established with IRRI.

The Japan Office screens, collects, indexes, and translates published and unpublished Japanese materials about rice research. Translating complete books on rice in cooperation with Japanese authors and researchers and writing English annotations of other works are an important function of the office.

More than 67,942 Japanese references were included in the IBRR between 1951 and 1979. All publications cited in the IBRR are available at the IRRI library and copies of IBRR have been distributed to the libraries of major universities and institutes associated with rice research throughout the world.

Since 1961 the Japan Office has translated 900 books and articles from Japanese to English. Translations are available at the IRRI library, the translation center of the John Crerar Library in Chicago, Illinois, USA, and the Japan Office. Lists of translations are in IBRR supplements published since 1964.



Ratio of the number of publications written by Japanese scientists to the world rice literature.

New IRRI publications

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

A global experiment in agricultural development

An adventure in applied science: a history of the International Rice Research Insritute

A methodology for on-farm cropping systems research

Fundamentals of rice crop science

Landless workers and rice farmers: peasant subclasses under agrarian reform in two Philippine villages

Major weeds of rice in South and Southeast Asia

Manual for testing insecticides on rice

Proceedings of the 1981 International Deepwater Rice Workshop

Research highlights for 1981

Rice research strategies for the future

Tne role of anthropologists and other social scientists in interdisciplinary teams developing improved food production technology

The International Rice Research Institute
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