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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 Newsletter (IRRN)* request that contributors use the following guidelines and style:

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

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, or 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 be quantified with data (% infection, degree of severity, etc.).

Genetic evaluation and utilization

OVERALL PROGRESS

Two promising rice cultivars for irrigated systems in Bihar, India

V. N. Sahai, S. Saran, and K. J. P. Singh, Rajendra Agricultural University, Bihar, Agricultural Research Institute, Mithapur, Patna-1, India

Two promising lines from Bangladesh were identified in 1976 at the Agricultural Research Institute, Patna, from the International Rice Yield Nursery. The lines BR51-46-5 and BR51-91-6, are sister selections from the cross IR20/IR5-114-3-1. Both lines have medium growth duration (135-140 days). They are intermediate in height, nonlodging and are suitable for irrigated transplanted areas. BR51-91-6 also performs well under rainfed-lowland fields. Both are moderately resistant to bacterial blight in the field.

The two lines have given consistent yields during the past 4 years (see table), and have been proposed for a minikit test program during 1981 (wet season) kharif in Bihar. ■

Performance of BR51-46-5 and BR51-91-6 at different sites in Bihar during the wet season, 1976 to 1979.

Site	Year	Yield (t/ha)			
		BR51-46-5	BR51-91-6	Jaya	Sita
Patna	1976	5.2	4.9	–	4.2
	1977	6.8	6.0	4.5	5.8
	1978	6.0	6.0	4.5	5.1
	1979	5.4	5.0	3.7	3.6
Pusa	1977	3.8	4.6	3.2	2.4
	1978	4.1	3.3	3.8	3.6
	1979	3.4	3.2	3.2	3.1
Bikramganj	1977	8.7	9.0	7.1	7.8
	1978	4.4	5.4	–	4.3
	1979	6.7	7.5	7.2	7.7

Method for mass-rearing the rice caseworm *Nymphula depunctalis*

J. P. Bandong and J. A. Litsinger, research assistant and entomologist, Entomology Department, International Rice Research Institute

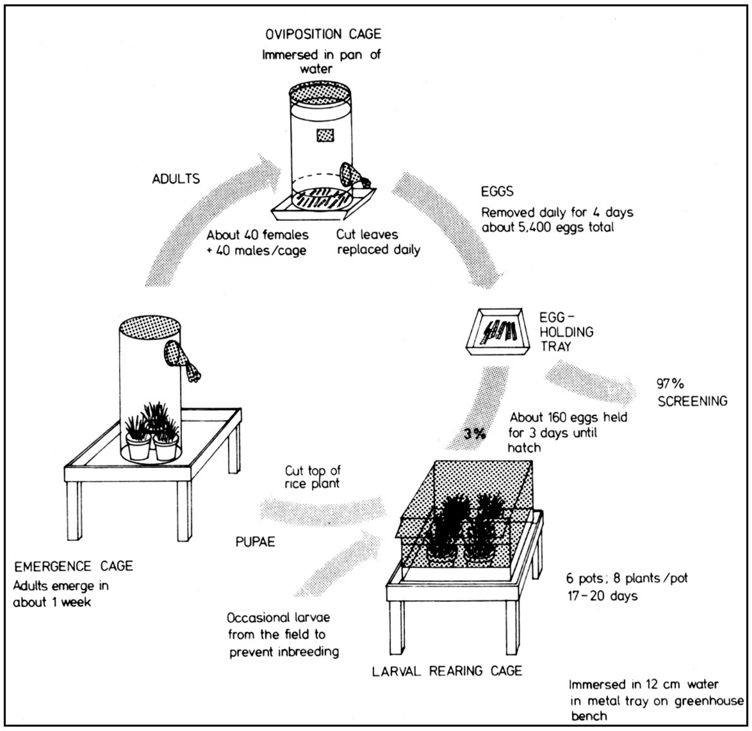
Although the rice caseworm *Nymphula depunctalis* is widely distributed as a pest of rice in Asia, little is known about its ecology and control. The larvae of this pyralid moth possess tracheal gills and require water for survival. Damage is caused by the leaf-feeding larvae, which cut the tips of rice leaves to make tubular cases. Larvae float on the water surface in their cases during the day and at night climb up the rice plant and feed on leaves by scraping the leaf tissue and leaving white skeletonized feeding marks. Fields are infested only during the vegetative stage, from seeding to maximum tillering.

Larval populations are often highly aggregated because water currents passing through paddies cause them to float downstream to lower-lying fields. This aggregative behavior has complicated chemical control trials and little is known about the effectiveness of various insecticides against this pest. Identification of possibly resistant cultivars has been hampered by lack of a rearing method for producing adequate numbers of caseworms for greenhouse screening.

A mass-rearing method was developed to produce caseworms for insecticide and varietal resistance screening programs at IRRI (see figure). The rearing cycle began with the adult. Four oviposition cage designs were tested in a non-airconditioned room offering a range of relative humidities (RH) to determine the optimal requirements for maximum egg production. Egg production was highest in an aerated cage design at 83-87% RH (see table). We used a mylar plastic cylinder cage (25-cm diameter and 54-cm high with mesh top, side windows, and sleeves) immersed in water. The females oviposited on the undersides of cut rice leaves floating on the water. About 30 10-cm-long leaves, cut from 3-week-old IR36 plants, were individually placed on the water leaving about 1-cm distance between them to provide room for females to oviposit.

Forty pairs of moths, placed in the oviposition cage, produced about 5,400 eggs in 4 days. Neither sugar nor other sustenance for the moths increased egg production. The leaves were replaced every day; those with eggs were held in shallow egg-holding trays with the eggs submerged. Eggs hatched in 3 days and the larvae fed on the cut leaves. To maintain the culture, 3% of the eggs (about 160) were introduced into the larval rearing cage to produce the 80 adults.

The larval rearing cage is a wooden frame with mesh sides. It was set in a metal tray containing 12 cm water. Larvae pupated on the leaf sheaths in 17-20 days. At pupation, the pots containing eight plants each, were removed and placed in an adult emergence cage. The tops of the plants were cut so that the emerging moths would rest on the sides of the cage rather than on the plants and thus could readily be collected. The adults emerged in about 1 week. ■



Procedure for mass-rearing the rice caseworm on rice plants in the greenhouse. IRRI, 1979.

Comparison of four oviposition cage designs for maximum caseworm egg production. IRRI, 1979.

Cage design	Eggs/female [a] (no.)	RH (%) [b] inside cage
Nylon mesh (fully aerated)	105 a	83
Mylar plastic cylinder with top and side mesh	136 a	84
Mylar plastic cylinder with top mesh only	133 a	87
Mylar plastic cylinder (enclosed)	67 b	91

[a] Av of 5 replications, 15-18 females and 15-22 males/cage. In a column, means followed by a common letter are not significantly different ($P \leq 0.05$). [b] Recorded at midday; ambient room RH = 76%.

Improvement of tidal swamp rices through induced mutation

M. Mahadevappa, plant scientist, University of Agricultural Sciences, Mandya, India; H. Ikehashi, plant breeder, Central Agricultural Experiment Station, Konosu, Saitama, Japan; H. Noorsyamsi, plant breeder, Central Research Institute for Agriculture, Bandjarmasin, Kalimantan. Indonesia; and W. R. Coffman, plant breeder, International Rice Research Institute

Seeds of 9 rice cultivars from the tidal swamps of South Kalimantan, Indonesia, were treated with ethyleneimine at 2 concentrations (0.2% and 0.4%) for 1 hour and 3 hours to induce earliness and short stature without affecting tolerance of tidal swamp conditions. The correlation of germination of M_1 seeds and spikelet fertility was positive and was helpful in identifying optimal treatments for further experiments. Single panicles selected from M_1 plants from the 2 effective treatments (0.2%, 3 h and 0.4%, 3 h) produced 1,844 M_2 progenies for further screening.

In the M_2, the seedling mutants segregated in a simple Mendelian ratio of 3:1. Screening of the M_2 families under natural long-day conditions in the 1979 dry season facilitated selection of photoperiod-insensitive types from Siyam Halus mutations (IR29386) and of mutants intermediate in plant height but sensitive to photoperiod from Siyam Kuning (IR30446) (see photo).

The early mutants, simultaneously raised in the wet season as M_3 plant progenies, bred true for earliness; they matured about 1 month earlier than the parents, even under short-day conditions. The early and intermediate-statured mutants were also about a

The characteristics of the tidal swamp variety Siyam Kuning (right, foreground) contrast sharply with the erect leaves and short stature of derivatives obtained through treatment with ethyleneimine.

month shorter in growth duration and about 35 cm shorter in plant height, but were unaltered in agronomic or grain characteristics. Those intermediate in plant height, in the background of photoperiod sensitivity, also maintained most of the parent's original characteristics. Tillering was improved while spikelet number per panicle was slightly reduced.

Initial evaluation in the tidal swamps indicated that the mutant derivatives were well adapted. However, when seeded at Bandjarmasin, S. Kalimantan, Indonesia, on 25 March, most of the photoperiod-sensitive mutants were about 1 month later than Siyam Kuning. This was unexpected and will be further investigated in 1981 using several dates of planting.

If ethyleneimine is specific in altering culm length, it should be emphasized as a future tool in the improvement of specifically adapted traditional varieties. ■

Effect of flag leaf on grain yield of transplanted rice

T. Singh, graduate student, Horticulture Department, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, U. P. India, and A. K. Ghosh, head, Agronomy Department, Allahabad Agricultural Institute, Allahabad, 211 007, U. P., India

The flag leaf plays an important role in the assimilation and translocation of assimilates in the rice plant, and thus ultimately influences grain yield. Rice varieties may differ in the degree of the flag-leaf influence on grain yield and the importance of the flag leaf at different stages of panicle development.

A study at Allahabad during the 1975 wet season studied the influence of the flag leaf on grain yield in five rice varieties. The flag leaf was removed at panicle emergence, 7 days after panicle emergence, and 14 days after panicle emergence. The grain yields from those treatments and a treatment with intact flag leaves were compared (see table).

The difference in grain yield among the rice varieties was significant. In all varieties, however, plants with intact flag leaves gave the highest grain yield. Removal of the flag leaf at any stage after panicle emergence caused significant reduction in grain yield. Grain yield reduction was maximum when the flag leaf was removed immediately after panicle emergence. There was a marked improvement in grain yield in all varieties as the process of flag leaf removal was delayed. ■

Effect of flag leaf removal on grain yield of 5 rice varieties. Allahabad, India.

Rice variety	Grain yield [a] (g/55 tillers)			
	0 d	7 d	14 d	Flag leaf not removed
Sona	99.35	112.78	120.78	141.51
RP79-14	110.14	120.23	122.62	129.31
RP79-5	92.44	93.20	108.89	128.01
Ratna	97.99	101.54	107.54	125.11
Jaya	111.76	126.20	130.12	135.75
Mean	102.33	110.83	117.98	131.93
S.Em.	Varieties = 0.31		Treatments = 0.088	
CD (P = 0.01)	” = 0.86		” = 0.28	

[a] Flag leaves were removed 0, 7, and 14 days after panicle emergence.

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. Contributuions are subject to editing and abridgement to meet space limitations. Authors will be identified by name, title and research organizations.

GENETIC EVALUATION AND UTILIZATION

Grain quality

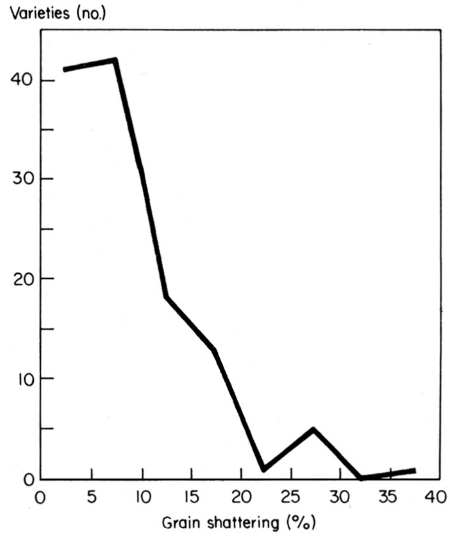
Mode of grain shattering in rice

R. K. Sahu, junior rice breeder; and V. N. Sahu, senior research assistant, Central Rice Research Station, Raipur, Madhya Pradesh, India

Shedding or shattering of grain in rice (*Oryza sativa* L.) during harvesting to threshing sometimes causes major losses (Ramiah and Rao in 1953 reported 5 to 12%). This genetic characteristic of a variety is important to breeders.

To estimate the percentage of shattering in rice, a study was undertaken in 1977 and 1979 kharif of a sample of 121 popular cultivars grown in Madhya Pradesh. A uniform fall method (device from the Philippines) was adopted for each panicle and an average of 15 panicles/variety was used.

The study showed that local paddy No. 20 had no grain shattering and BD 6-1, MTU19, Bangoli-5, CO13, and GS19 had comparatively high percentages (26-29%). The maximum grain-shedding effect (up to 38%) was recorded in HR19.



Mode of grain shattering in rice.

The figure indicates that the majority of the varieties (68.6%) came between the range of 1 to 5 and 6 to 10% grain shattering. These varieties may be useful to the breeding program. ■

GENETIC EVALUATION & UTILIZATION

Insect resistance

A new source of gall midge resistance

R. K. Sahu, V. N. Sahu, P. S. Shrivastava, and B. P. Chaudhary, Central Rice Research Station (CRRS), Raipur, M. P., India

Host plant resistance to the gall midge *Orseolia oryzae* offers distinct advantages to farmers compared to other methods of control, but few resistance donors have been identified: PTB10, PTB18, PTB21 from Kerala, India; Iswarkora from Andhra Pradesh, India; Leuang 152 from Thailand; Siam 29 from Indonesia; and OBS 677 from Sri Lanka.

A new source of resistance to gall midge — Kalimooch 64 — was identified during field evaluation of genetic stock at CRRS during gall midge epidemics in 1972-73, 1975-76, and 1978-79.

The F_1 of Sona/Kalimooch and Jaya/Kalimooch 64 crosses exhibited 100% field resistance during the endemic year 1973. It is assumed that Kalimooch 64 may have a dominant gene for resistance, whereas the resistance from most of the donors reported earlier was recessive. The F_2 segregates escaped the 1974 epidemic; therefore further inheritance studies could not be summarized. However, advanced-generation selections exhibited 100% field resistance to gall midge.

Kalimooch 64 is an indigenous tall variety (142 cm) that is popular among farmers. It has fine grains (1,000-grain wt is 16.8 g) and is aromatic. It matures in 135-140 days and yields about 3.7 t/ha. It is erect and produces 6-8 panicles/hill (each panicle, is about 28 cm long with 205 grains/panicle). Kalimooch 64 is weakly photoperiod sensitive with good tolerance for blast and is resistant to the green leafhopper *Nephotettix virescens.* ■

Role of resistant varieties in depressing brown planthopper populations in the Mekong Delta of Vietnam

Nguyen Van Huynh and Vo Tong Xuan, University of Can Tho, Vietnam

Since 1971, the brown planthopper (BPH) has been the most serious insect pest in the Mekong Delta. BPH-resistant varieties such as TN73-2, IR26, and IR30 partly reduced the BPH damage in the area. Since 1976, BPH biotype 2 which is capable of attacking the biotype 1-resistant varieties has become predominant.

During 1977 and early 1978, BPH attacks with resulting hopperburn and ragged stunt virus were severe in large rice areas. Screening for varieties resistant to biotype 2 began in late 1976, immediately after the biotype was detected. New rice varieties with resistance to biotype 2 — NN3A (IR36) and NN5A (IR2071-179-3) — were released by the end of 1977 after 1.5 years of testing and multiplying on experimental farms. They were planted widely in the areas most severely damaged by the insect.

The BPH populations in those areas remained below the economic threshold. After those two varieties, others resistant to BPH biotype 2 were identified and tested (see table). Since then, the farmers no longer accepted rice varieties susceptible to BPH, except in the deepwater areas where only traditional floating rice varieties can grow.

Today, the BPH is not a constraint to rice production in the Mekong Delta. Resistant varieties are an important component in the integrated control

Gradually improved characteristics of the BPH biotype 2-resistant rice varieties released during 1977–80. University of Can Tho, Mekong Delta, Vietnam.

Variety	Original line	Year of release	Duration (days)	Reaction[a] to BPH biotype 2	Agronomic traits
NN3A	IR2071-625-1-252 (IR36)	1977	110	R	Moderate lodging, dwarf stature
NN5A	IR2071-179-3	1977	115	MR	High percentage of unfilled grains
NN6A	IR2307-247-2-2-3	1979	115	R	Hard straw, more high yielding than NN3A
NN2B	IR2823-399-5-6	1979	125	R	Tolerance for blast, acid sulfate soils; semi-dwarf stature
NN3B	IR2797-115-3	1979	125	R	Tolerance for acid sulfate soils; semidwarf stature
MTL30	IR9129-192-2-3-5	1980	100	R	Very short duration for rotation with soybean

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

program for BPH. Additional control components utilized are the herding of baby ducks, raising of fish, and mass-installation of light traps. To protect the resistant varieties from reinfestation by new biotypes, government authorities prohibit the planting of susceptible varieties in the high-yielding rice areas. ■

Varietal reaction to rice stem borer under different nitrogen levels

R. Saroja and N. Raju, Paddy. Experiment Station, Tirur: 602025, Chingleput District. Tamil Nadu. India

Four prerelease varieties — CRM 10-5747, AD9408, AS 1374, and PL 29 and standard TKM9–were evaluated for their reaction to rice stem borer under 5 levels of nitrogen — 0, 40, 80, 120. and 160 kg/ ha at the Paddy Experiment Station, Tirur, during 1979–80 navarai (December—January to April—May). The trial, comprising two replications, used the split-plot design with varieties as main treatments and nitrogen levels as subtreatments.

Assessment of stem borer infestation was based on deadheart incidence at 60 days after transplanting and whitehead occurrence at harvest. The infestation percentages were determined and the data were analyzed statistically.

The results obtained for variety and N level were statistically significant. AD9408 and CRM 10-5747, were least infested (see table). The other three varieties had significantly higher infestation. Nitrogen level and stem borer incidence were positively correlated. Pest infestation increased with nitrogen level. The no-nitrogen treatment had the least incidence while the treatment with 40 kg N/ ha had moderate infestation. Infestation was high with higher N levels; it was highest with 160 kg N/ha. ■

Varietal reaction to rice stem borer under different N levels, 1979–80 navarai.

N level (kg/ha)	Deadheart and whitehead incidence (%)					Mean infestation % (angles)	CD
	TKM9	CRM 10-5747	AD 9408	AS 1374	PL 29		
0	12.08	9.06	9.06	12.23	14.76	11.44	
40	13.44	12.28	9.84	17.44	16.34	13.87	
80	24.55	10.53	10.76	17.45	22.97	17.25	2.38
120	23.95	12.92	11.54	21.96	24.34	18.94	
160	26.90	15.46	11.16	22.69	23.90	20.02	
Mean infestation % (angles)	20.18	12.04	10.47	18.35	20.46		

CD for main treatment 4.54

CD for interaction N.S.

conclusion:

Varieties: AD 9408, CRM 10-5747, AS 1374, TKM9, PL 29

N levels: 0, 40, 80, 120, 160

Screening rice varieties and breeding lines for thrip resistance in late bora

Md. Anwarul Kabir, and M. S. Alam, Bangladesh Rice Research Institute (BRRI), Dacca, Bangladesh

The rice thrip is now considered a major pest on the late-planted boro rice crop at the BRRI farm, Joydebpur. The main symptoms are leaf rolling from the tip and drying leaf tips. In severe infestations, the plants are stunted and the lower leaves die.

In the field, 390 entries from IRRI were screened for resistance to thrips. Thirty-day-old seedlings were planted on 22 February 1979. Each line was planted in 2 rows in a 5.4-m – long plot, spaced 25 × 15 cm, with 1 seedling/ hill.

Fertilizer was applied at 100-80-80 kg NPK ha. The basal dose was 50-80-60 kg NPK ha. and the rest of the nitrogen was topdressed in 2 equal splits, No protective measures were taken. Scoring at 25 days after planting used this scale:

Thrips grading scale

R	1 =	light infestation (just leaf tip rolling)
MR	3 =	medium light infestation (20 — 30% leaf rolling)
MS	5 =	medium infestation (30 — 50% leaf rolling)
S	7 =	medium heavy infestation (50 — 75%leaf rolling)
HS	9 =	heavy infestation (75 — 100% leaf rolling)

The thrip attack was quite severe. The average damage score was 6. Of 390 varieties or lines. 21 were resistant, 49 moderately resistant, and 316 susceptible to highly susceptible. The resistant lines were also found moderately resistant to rice whorl maggot.

Cultivars found resistant to thrips were: B707C-MR-13-1 (Remadja// IR22/C_4-63G); IET 3817; IET 4506; IR5624-164–2-1 (IR841-85/IR2061// IR2049/IR2031); IR3264–30-2-3, IR7963-30-4-3, and IR7963-87-3-3 (IR3264-13/IR1702-74-3//IR2055-219-1); IR9129-2-2, IR9129-142-2, IR9129-169-3, and IR9129-393-2 (IR28/IR2053-521-1-1//IR2071-625-1); IR9218-2763 (IR36/IR2053-521-3//IR30); BW 78; MRC 505 (BPI-121-3-I/TKM6); IR2058-78-1-3-2-3 (IR1416-13l/IR1364//IR1366/IR1539); CR 1016 (Waikoku/T 90); IR2798-88-3-2 (IR1529-680/IR1913-41//IR1514A-E666; TKM 6; Thirissa; IR4791-80 (IR3342/IR334l); and Kaohsiung Sen Yu 185 (IR1561-152-3/Kaohsiung 2). ■

Rice resistance to whitebacked planthopper

G. N. Mitra and J. S. Bentur, All India Coordinated Rice Improvement Project (AICRIP), Hyderabad India

A mass-screening method identified at AICRIP the cultivar IET6288 as highly resistant to the whitebacked planthopper (WBPH) *Sogatella furcifera* Horvath, a major rice pest in northern and central India. IET-6288 is a progeny of the cross PTB18/PTB2// IR8.

To develop high yielding varieties with multiple resistance, IET6288 was crossed with another high yielding variety, Phalguna, which is resistant to gall midge but susceptible to WBPH. Phalguna is a derivative of the cross IR8/Siam 29. The cross IET6288; Phalguna, designated as RP2149, was screened in the greenhouse. The F_1 plants were resistant to WBPH. The F_2 population had a ratio of 3 resistant to 1 susceptible. To confirm the findings. the F_2 population was screened three times in three separate lots. The same ratio was obtained in all cases (see table). The results show that in this cross, a pair of dominant genes control WHPH resistance. ■

Segregation for resistance to the whitebacked planthopper in the F_2 population of the cross IET6288 (resistant)/Phalguna (susceptible) (RP2149). Hyderabad, India.

Lot	Plants (no.)		X^2	P value
	Resistant	Susceptible	(3:1)	
1	57	19	0.00	0.995–1.00
2	112	34	1.29	0.50 –0.75
3	306	116	1.31	0.25 –0.25
Total	475	169	0.51	0.25 –0.50

Relative susceptibility of rice varieties to gall midge under low rainfall conditions

Prem Chand, S. P. Shaw, and S. C. Prasad Ranchi Agricultural College (RAC), Kanke, Ranchi, India

The rice gall midge *Orseolia oryzae* (Wood-Mason) has become a regular pest of the main-season (Jul-Nov) rice crop in Bihar, particularly in the Chhotanagpur plateau. Rainfall was deficient in 1979 (Fig. 1).

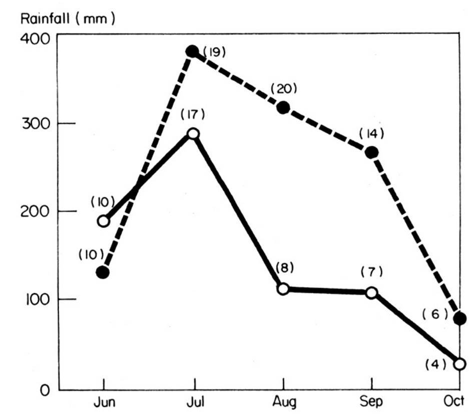
A field study was made of 19 rice cultivars, including two dryland and two rainfed wetland rices. Observations on silver shoot occurrence were recorded (50 hills/variety) in the second week of October — the infestation peak in 1979.

Among the dryland rices RAU40004-105 was most resistant (3.25% silver shoots) (see table). The two cultivars

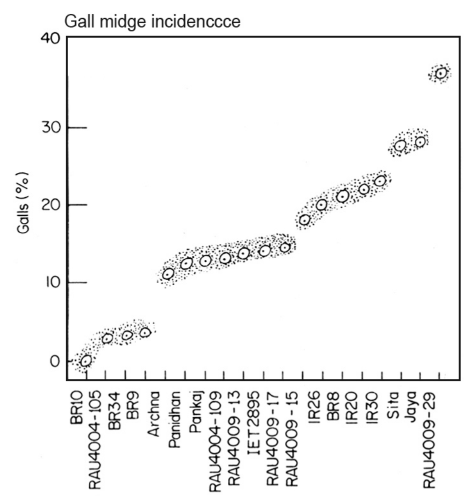
Reaction of transplanted rice cultivars to gall midge in 1979 kharif, Ranchi, India.

Cultivar	Tillers (no./hill)	Silver shoots[a] (%)
BR10	13.1	0.2 a
BR34	14.2	3.1 b
RAU40004-105	6.6	3.3 bc
BR9	11.5	3.5 bcd
Panidhan	13.7	4.7 bcde
Pankaj	14.2	4.8 bcde
Archana	10.4	5.0 bcde
RAU40004-109	8.0	5.4 cde
RAU4009-3	6.8	6.1 def
IET2895	9.7	6.1 def
RAU4009-17	7.8	6.4 def
RAU4009-15	6.4	9.5 fg
IR26	12.6	12.5 g
BR8	11.1	13.4 g
IR20	12.8	14.2 g
IR30	9.0	15.3 g
Sita	13.5	21.5 h
Jaya	12.1	21.8 h
RAU4009-29	6.0	35.8 i

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



1. Rainfall for 1979 and the average for 23 years in Bihar, India. Figures in parentheses are the number of rainy days during the month.



2. Rainfall and gall midge incidence. Ranchi, India.

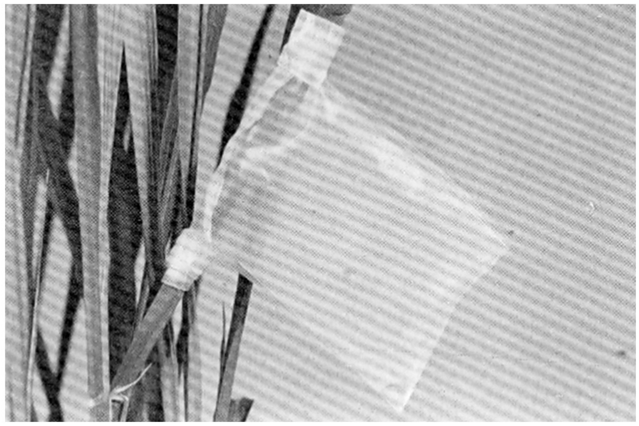
suited to rainfed wetland, RAU4009-3 and RAU4009-17, had 6.1 and 6.4% tiller infestation. Of the wetland cultivars, BRl0 was highly resistant (0.2%) (Fig.2). Maximum damage occurred on RAU4009-29 (35.8%), which also had poor tillering (6 tillers/hill). The susceptible variety Jaya had 21.8% silver shoots; the present resistant variety, IET2895, had 6.1%. ■

Honeydew excretion, feeding activity, and insect weight gain as criteria in determining levels of varietal resistance to the green leafhopper

L. Malabuyoc, research assistant; and E. A. Heinrichs, entomologist, International Rice Research Institute

Studies on the mechanism of rice resistance to the brown planthopper (BPH) have used the quantity of honeydew excretion and insect weight gain to determine levels of varietal resistance. These criteria have provided a better assessment of resistance levels than has the seedling bulk screening method. This study was conducted to determine if those parameters could be used to measure the level of resistance to the green leafhopper (GLH) *Nephotettix virescens.* The susceptible variety TN1 was compared with the resistant IR29.

One-day-old adults were starved for 4 hours, weighed individually, and placed in parafilm sachets on 30-day-old plants (see photo). There were nine replications for each variety; each sachet served as a replication. After 24 hours, the insects were removed and weighed. Honeydew weight was determined by weighing the parafilm sachet with honeydew, then reweighing the sachet after wiping it dry to remove the honeydew.



Each parafilm sachet contained a day-old adult green leafhopper and served as a replication.

The weight of the honeydew excreted on TN1 was only 2.5 times that excreted by hoppers feeding on IR29 (see table). But the weight of assimilated food, which is due primarily to weight gain, provided more accurate information on the levels of resistance of the two varieties. The weight of assimilated food on TN1 was 13 times that on IR29.

As indicated by the amount of honeydew excreted, feeding was also substantial on the resistant IR29, but most of the intake apparently was not assimilated. Measurements of the amount of food ingested and assimilated can be used to detect levels of resistance to GLH. ■

Comparison of ingestion and metabolic utilization of food of the green leafhopper *Nephotettix virescens* feeding on a susceptible and a resistant variety.[a] IRRI, 1979.

Variety	Honey dew wt (mg)	Qty of food ingested[b] (mg)	Wt of as-similated food[c] (mg)	Nutritive value[d]
TN1 (Susceptible)	25.587	26.380 a	0.793 a	0.030
IR29 (Resistant)	10.904	10.966 b	0.062 b	0.006

[a]Mean for 9 insects starved for 4 hours, then fed on 30-day-old plants for 24 hours. In a column, means followed by a different letter are significantly different at the 1% level by DMRT. [b]Qty of food ingested = wt assimilated food + wt of honeydew. [c]Wt of assimilated food = insect wt gain or loss due to feeding + wt loss due to metabolism. [d]Nutritive value = ratio of wt of assimilated food to wt of ingested food.

GENETIC EVALUATION AND UTILIZATION

Deep water

Morphological studies of rice varieties that are tolerant of and susceptible to submergence as seedlings

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Varietal differences in submergence tolerance at the seedling stage have been reported. The morphological differences between submergence tolerant and susceptible rice varieties at seedling stage was the objective of this study.

The seedling height measured in 10-day-old seedlings before complete submergence did not show any significant correlation with submergence tolerance. However, the tolerant varieties were generally taller than the susceptible varieties after complete submergence and recovery.

Although there was no significant correlation between the primary leaf length and survival percentage of plants when submerged in water, the tolerant varieties (all traditional) generally had longer primary leaves than the susceptible varieties (which, except for Leb Mue Nahng 111, were all improved varieties).

Table 1 shows the first and second leaf blades were longer in tolerant

Table 1. Length of the first and second leaf blades of 12 rice varieties 10 days after sowing. IRRI, November 1979.

Variety	Length (mm) 1st leaf blade	2d leaf blade
Tolerant		
FR13A	60	175
Kurkaruppan	81	147[a]
Thavalu (15325)	69	168[a]
Thavalu (15314)	56	183
SML Temerin	62	171[a]
Nam Sagui 19	63	169
Av	65.2	174.5
Susceptible		
Leb Mue Nahng 111	47	174
T442-57	40	144
IR36	32	118
IR8	42	141
RD7	43	139
IR42	41	142
Av	40.8	143.0

[a] Not fully developed leaf.

varieties when compared to the susceptible ones, except Leb Mue Nahng 111. There was a significant correlation between length of the first leaf blade and percentage of survival (r = 0.6715*). The longer leaf blades made it possible for some leaf tips to be above the water level.

Measurement of the overlapping first leaf sheath showed definitely greater overlapping for the tolerant varieties (Table 2).

The role of overlapping leaf sheaths in submergence tolerance was not clear, but one could surmise that overlapping provided a stiffer culm that prevented plant breakage or collapse at the growing point as the water receded. There was a high correlation between overlapping of the first leaf sheath and percentage of survival (r = 0.7261**).

The width-thickness ratio of the culm showed that the culm of tolerant varieties tended to be circular, and that of the susceptible varieties' slender or flat. There was a correlation between width-thickness ratio of seedling culm and percentage of survival (r = -0.6450*).

The shape of the culm probably was

Table 2. Overlapping of the first leaf sheath at 3 cm above the seed of 10-day-old seedlings. IRRI, December 1979.

Variety	Overlapping (microns)
Tolerant	
FR13A	601
Kurkaruppan	639
Thavalu (15325)	608
Thavalu (15314)	505
SML Temerin	594
Nam Sagui 19	460
Av	568
Susceptible	
Leb Mue Nahng 111	430
T442-57	410
IR36	213
RD7	364
IR42	289
Av	353

responsible also for the degree of overlapping of the leaf sheath or vice versa. There was a high correlation (r = -0.7384*) between the length of overlapping and the width-thickness ratio of the culm. The round culms had more overlapping leaf sheaths than the flat culms. ■

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Variation in chlorophyll of rice seedlings under low temperature

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The normal, green color of rice seedling leaves is a desirable characteristic in areas where low temperature prevails early in the growing season. Low temperature during the early growth stages causes yellowing of leaves and stunting. This study evaluates the effect of low temperature on chlorophyll production. It also correlates chlorophyll production with subsequent expression of leaf discoloration.

Seeds of three cultivars — G. S. 10231 (japonica), CNM20 (a mutant of IR8), and IR8 — were sown at different times so the cultivars were exposed to variable diurnal temperatures of 9.3°C/25.2°C—14.90°C/28.8°C. Samples for chlorophyll estimation were taken at 30, 60, and 90 days after sowing (DS), and visual ratings for discoloration were recorded.

Chlorophyll estimation was done by following the method described by Yoshida, Forno, Cock, and Gomez (1976). The chlorophyll absorbance on the leaf tissue extract at 645 and 665 mμ were measured by Spectronic-20. The total chlorophyll content was calculated as the sum of chlorophyll "a" and "b" (mg/g fresh wt).

A high value of total chlorophyll content was noted (Table 1) during high temperatures. Total chlorophyll content was gradually reduced with decreasing temperature (22.3°C—9.1°C). But with the age of plants (90 DS), total chlorophyll increased despite lower temperature.

Expression of leaf color did not show a close relationship with total chlorophyll in all the cultivars. It has been reported that visual differences in greenness in sorghum do not necessarily mean real differences in chlorophyll content. Lines that are alike may or may not contain the same kind and amounts of chlorophyll. A higher chlorophyll a-b ratio was observed at lower temperature (Table 2), suggesting that the production of chlorophyll 'b' suffered more in a cool environment. ■

Individuals, organizations, and media who wish additional details of information presented in IRRN should write directly to the authors.

Table 1. Variations in total chlorophyll content in 3 cultivars under different temperature regimes. West Bengal, India.[a]

Variety	30 DS			60 DS			90 DS		
	Total chlorophyll content (mg/g fresh wt)	Visual rating	Min temp (°C)	Total chlorophyll content (mg/g fresh wt)	Visual rating	Min temp (°C)	Total chlorophyll content (mg/g fresh wt)	Visual rating	Min temp (°C)
CNM20	0.79	1		0.35	7		0.48	7	
G.S. 10231	0.87	1	22.3	0.75	1	17.5	0.49	1	13.7
IR8	0.98	1		1.18	3		0.51	5	
Mean	0.88			0.75			0.49		
CNM20	0.79	1		0.23	7		0.59	7	
G.S. 10231	0.71	1	18.6	0.48	1	14.4	0.68	1	9.5
IR8	0.87	1		0.37	3		0.48	5	
Mean	0.79			0.36			0.58		
CNM20	0.35	3		0.23	7		0.59	7	
G.S. 10231	0.42	1	16.4	0.43	3	12.6	0.66	3	11.2
IR8	0.25	3		0.21	5		0.58	3	
Mean	0.34			0.29			0.61		
CNM20	0.37	7		0.23	7		0.58	3	
G.S. 10231	0.38	3	9.1	0.82	3	12.0	0.84	1	14.7
IR8	0.22	7		0.77	5		0.48	3	
Mean	0.32			0.60			0.63		

[a] DS = days after sowing. Visual rating scale: 1 = least or no yellowing, 3 = slight yellowing, 5 = moderate yellowing, and 7 = severe yellowing.

Table 2. Differences in chlorophyll a–b ratio under different temperature regimes.[a]

Sowing	30 DS			60 DS			90 DS		
	Mean total chlorophyll content (mg/g fresh wt)	ca:cb	Mean min temp (°C)	Mean total Chlorophyll Content (mg/g fresh wt)	ca:cb	Mean min. temp (°C)	Mean total chlorophyll content (mg/g fresh wt)	ca:cb	Mean min. temp (°C)
7 Oct	0.88	0.97	22.3	0.75	0.98	17.5	0.49	1.36	13.7
22 Oct	0.79	0.72	18.6	0.36	1.32	14.4	0.58	1.24	9.5
7 Nov	0.34	1.53	16.4	0.29	1.25	12.6	0.61	1.19	11.2
22 Nov	0.32	1.32	9.1	0.60	1.35	12.0	0.63	1.20	14.7

[a] DS = days after sowing.

Pest management and control DISEASES

Morphological and serological similarities of rice ragged stunt virus samples from China and the Philippines

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The occurrence of rice ragged stunt disease has been reported in China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Taiwan, and Thailand. The disease symptoms are similar in various countries: stunting of plants, appearance of ragged and twisted leaves. formation of vein-swellings, delay in flowering, production of nodal branches, incomplete emergence of panicles, and panicles bearing mostly unfilled grains. The transmission of rice ragged stunt virus (RRSV) by the brown planthopper *Nilaparvata lugens* in a persistent manner is also similar.

An early report [IRRN 4(2):12, 1979] noted that the antiserum of RRSV prepared from materials mailed to Italy from the Philippines reacted positively to diseased materials collected in India, Indonesia, and Thailand when tested by immunoelectron microscopy using the decoration technique.

Recently, diseased materials collected in Guangdong, China [IRRN 4(6): 10, 1979], were examined under an electron microscope and tested by the immunoelectron microscopic techniques of trapping and decoration, and by the enzyme-linked immunosorbent assay (ELISA). The antiserum used was prepared with RRSV from the Philippines. Electron microscopy revealed isometric particles about 50 nm in diameter having spikes, but no other virus-like particles. The RRSV-like particles from China reacted positively with the antiserum of RRSV from the Philippines in both the immunoelectron microscopy and ELISA. We concluded that the rice ragged stunt disease in China is caused by a virus morphologically and serologically similar to that in the Philippines. ■

Report of 1978 Rice Tungro Virus Collaborative Project

K. C. Ling, V. T. John, P. S. Rao, A. Anjaneyulu, M. S. A. Miah, A. Ghosh, S. Koesnang, and Zenaida M. Flores

The life span and tungro transmission of viruliferous *Nephotettix virescens* on seedlings of 10 rice varieties were collaboratively studied at the All India Coordinated Rice Improvement Project (AICRIP), the Central Rice Research Institute (CRRI), Cuttack, India, the IRRI, and Lembaga Penelitian Pertanian (LPP), Indonesia. The objective was to use the varieties as differentials for determining the existence of biotypes of the tungro vector and strains of the tungro virus.

On the basis of life span, the ability of the tungro vector to attack the 10 varieties was similar at the 4 locations. The test varieties were unable to separate the biotypes of the tungro vector in the four locations. The arbitrary classification based on average life span placed Gam Pai 30-12-15, IR34, and Ptb 18 in the resistant group; Latisail and Pankhari 203 in the intermediate group; and Ambemohar 159, Habiganj DW8, IR26, Kataribhog, and TN1 in the susceptible group. However, Ambemohar 159 was in the intermediate group at AICRIP but in the susceptible group at the other locations. Pankhari 203 was susceptible at CRRI, but intermediate at the other locations (see table). Hence, these two varieties could be used to show the slight difference in tungro vector biotypes between AICRIP and CRRI.

On the basis of tungro transmission and seedling infection, the averages support the arbitrary classification of Habiganj DW8, Pankhari 203, and Kataribhog in the group resistant to the tungro virus; Ambemohar 159, Gam Pai 30-12-15, and Ptb 18 in the intermediate group; and IR26, IR34, Latisail, and TN1 in the susceptible group (see table). However, variations occurred among the locations, particularly at AICRIP where none of the varieties could be put in the resistant group. Habiganj DW8 was susceptible at AICRIP but resistant at the other locations. Ptb 18, also susceptible at AICRIP, was resistant or intermediate at the other locations. Hence, the strain of the rice tungro virus at AICRIP might be more virulent. Habiganj DW8 and Ptb 18 could be used to separate the tungro strain at AICRIP (if it remains stable) from strains at other locations. ■

Reactions of 10 rice varieties to tungro-viruliferous *Nephotettix virescens* and to tungro virus on the basis of an arbitrary classification system at 4 locations, 1978.

Variety	Reaction[a] to vector (left letter) and virus (right)				
	AICRIP	CKRI	IRRI	LPP	Mean
TN1	SS	SS	SS	SS	SS
IR26	SI	SS	SS	SS	SS
Ambenmohar 159	IS	SI	SI	SI	SI
Habiganj DW8	SS	SR	SR	SR	SR
Kataribhog	II	SR	SR	SR	SR
Latisail	II	SS	SS	SI	IS
Pankhari 203	II	SI	IR	IR	IR
IR34	II	IS	RS	II	RS
Gam Pai 30-1 2-15	RI	IR	RI	II	RI
Ptb 18	IS	RR	RI	RI	RI

[a]K, I, and S indicate resistant, intevmediate, and susceptible. The underscoring indicates striking difference from others.

Perpetuation of rice tungro virus and its vectors

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The possibility that improved rice cultivars, stubble, wild rices, weeds, and cereal crops can act as reservoir host for rice tungro virus and that wild rices, weeds, and cereal crops are host for the tungro virus *Nephotettix virescens* and *N. nigropictus* was investigated. Both standing crops and stubble of the cultivars Bala, IR8, Krishna, Padma. and TN1 served as better sources of virus inoculum. The cultivars that served as poor inoculum sources were IR20, IR30, Annapurna, IR26, Ratna, CR 138-802-10, and CR 138-994-27.

The susceptible wild rice species were *Oryza australiensis, O. barthii, O. brachyantha, O. eichingeri, O. glaberrima, O. nivara, and O. perennis.* Of these *O. barthii, O. nivara.* and *O. glaberrima* served as better sources of virus inoculum than the others when tested at 15, 30, 35, 60, 75, and 90 days after inoculation (see table).

The resistant wild rice species were *O. alta, O. grandiglumis, O. latifolia, O. malampzhuaensis, O. minuta, O. officinalis, O. perreiri,* and *O. schwenforthiana.* None of the 20 weed species and 6 cereal crops tested was susceptible to tungro virus.

The vector species *N. nigropictus* had a broader spectrum of host range than *N. virescens. N. nigropictus* could reproduce in *O. eichingeri, O. glaberrima, O. malampzhuaensis, O. minuta, O. nivara, O. officinales, O. perennis, O. punctata, O. sativa, Echinochloa colonurn, Ischaemum indicum, Leersia hexandra,* and *Paspalum orbiculare. N. virescens* could reproduce in *O. glaberrima, O. nivara, O. perennis, O. sativa, E. colonum,* and *P. orbiculare.*

Intensive cultivation of semidwarf rice cultivars has made the overlapping of two crops of rice a common practice. Such circumstances might cause greater

Virus recovery from tungro-susceptible *Oryza* spp. Cuttack. India

Oryza spp.	% viruliferous insects					
	Days after inoculation					
	15	30	45	60	75	90
O. australiensis	0.0	6.7	10.0	0.0	0.0	0.0
O. harthii	8.3	10.0	20.0	50.0	35.0	14.3
O. brachyantha	0.0	1.6	0.0	0.0	0.0	0.0
O. eichingeri	0.0	0.0	0.0	13.8	5.2	0.0
O. glaberrima	43.5	61.9	66.7	54.5	79.3	38.9
O. nivara	55.0	33.3	46.1	65.4	39.1	60.0
O. perennis	0.0	6.6	0.0	0.0	0.0	0.0
O. punctata	0.0	11.1	0.0	0.0	0.0	0.0
O. sativa	73.1	68.2	63.3	71.4	47.4	53.3

survival and propagation of tungro virus in the semidwarfs, their stubble, and in wild rice. Some weed hosts such as *E. colonum* might also act as link hosts between two crops, especially in places where a single crop is grown per year.

Although both species of tungro vectors are found together in the paddy ecosystem, they differ in preference for survival and multiplication. It has been found that rice is a preferred host for *N. virescens* over weeds, whereas *N. nigropictus* prefers weeds (e.g. *L. hexandra)* to rice. Thus, in areas where cropping systems overlap, *N. virescens* might be playing a greater role in tungro perpetuation. In single cropping areas, *N. nigropictus* might transmit tungro virus among weeds or wild rices during the off-season. ■

Rice wilted stunt in Taiwan

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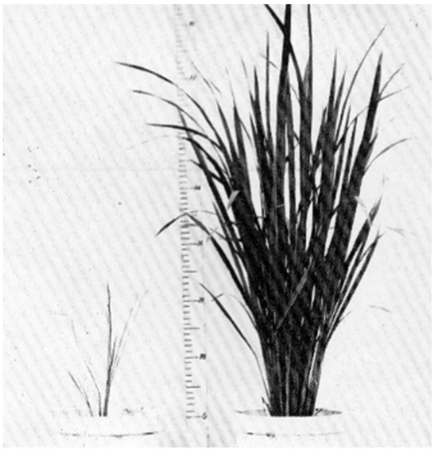
A rice disease characterized by extreme plant stunting, narrow leaves, and, often. premature death of infected plants was first found in paddy fields of Tungshih, central Taiwan in 1977 (see photo). Leaf wilting usually occurred first in the outer, older, leaves, and gradually proceeded to the upper leaves, resulting in plant death at later tillering stages. The disease was transmissible by the brown planthopper *Nilaparvata lugens,* the vector of rice grassy stunt and rice ragged stunt. The frequently lethal symptoms appear to distinguish the disease from grassy stunt and ragged stunt. The disease was named rice wilted stunt and is possibly a new virus disease of rice (see photo).

In greenhouse tests, seedlings of Tainan 5, a japonica, produced rusty yellowish leaves at about 10 days after inoculation. Young leaves twisted and turned pale green. Because the diseased



Rice wilted stunt on Taichung Sen 3. Healthy (right) and infected (left) plants, 60 days after inoculation.

plants seemed weak and usually had fewer tillers than normal, they appear similar to plants infected with rice transitory yellowing virus. Yield losses for Tainan 5 were 95, 78, 73, 65, and 40% when the disease symptoms were first expressed at 21-30, 3 1-40, 41-50, 51-60, and 61-70 days after transplanting. The yield reduction was 97, 82, and 77% for Taichung sen 3, an indica, when the symptoms were first expressed at 21-30, 31-40, and 41-50 days after transplanting. Infection at younger stages of rice growth resulted in complete yield loss.

The brown planthopper transmitted the disease with a latent period of 7 days (range, 3-14 days) at 28-30° C, and infectivity persisted throughout the insects' life. The active transmitters ranged from 22 to 64%. The shortest acquisition access time was 2 hours and the shortest inoculation access time was 30 minutes. Among other Homopteran rice pests so far tested, none transmitted the disease. The disease was not transmitted through rice seeds or by mechanical means. ■

Food web of the rice brown planthopper in the Philippines

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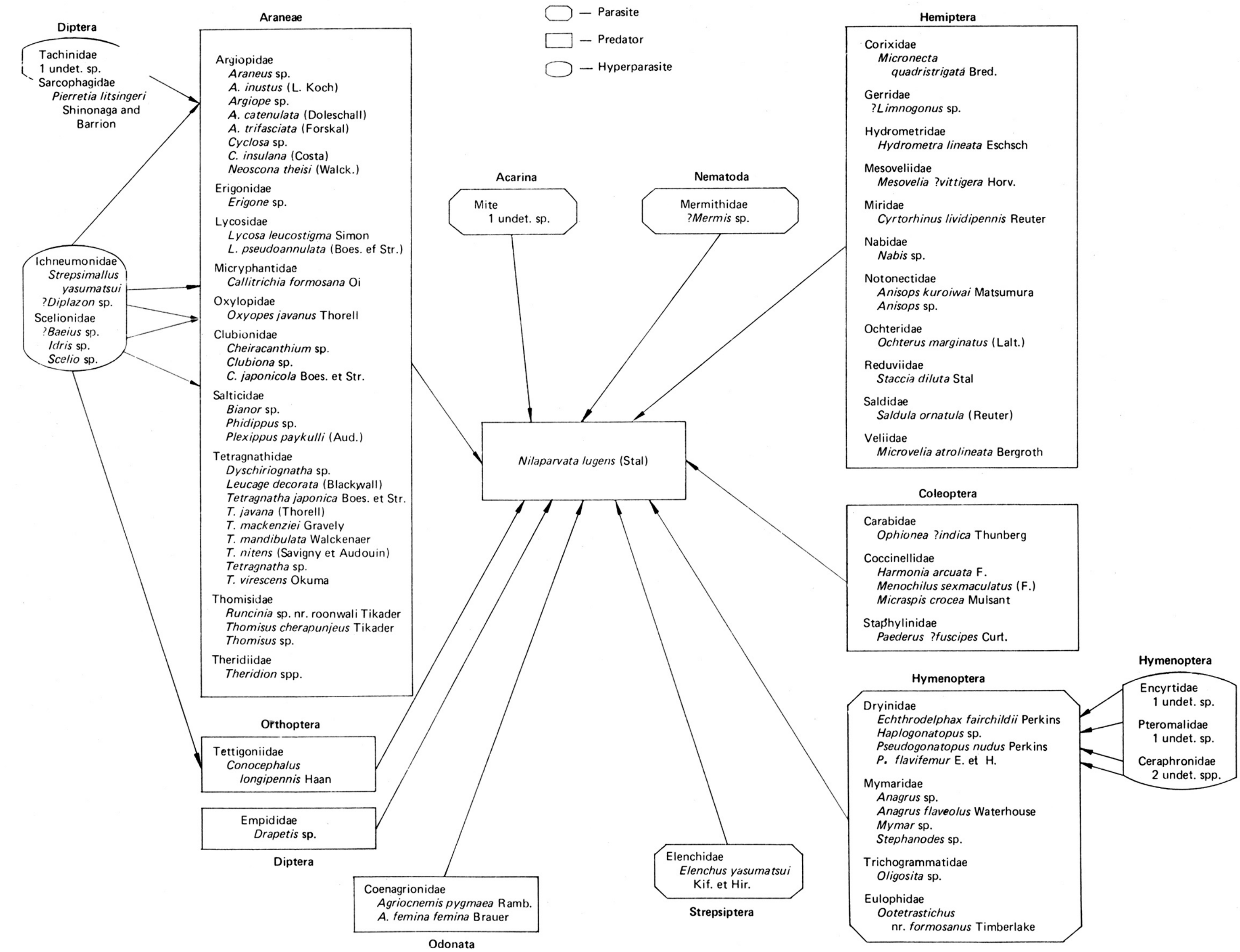
The natural enemy relationships (food web) for the brown planthopper *Nilaparvata lugens* (BPH) were determined to learn more about the biological control possibilities against that pest. Records of predator-parasite relationships representing 74 taxa were determined over a 2-year period (1977-79) from 4 Philippine provinces representing different rice environments: Los Baños, Laguna (irrigated wetland); Tanauan, Batangas (dryland); Oton, Iloilo, and Manaoag, Pangasinan (rainfed wetland). Parasites were reared on BPH, and predator records of field observations or cage studies were obtained. Specimens were sent to taxonomists worldwide for species confirmation. A list of the specialists is available on request.

Five egg parasites belonging to Mymaridae and Trichogrammatidae were recorded (see figure). *Anagrus,* a mymarid species, was the most common. *Gonotocerus,* a mymarid egg parasite of BPH recorded elsewhere in Asia, is host to the green leafhopper *Nephotettix* spp. and was never reared from BPH eggs.



Food web of the rice brown planthopper in the Philippines.

Only one egg predator, the mirid bug *Cyrtorhinus lividipennis* was found.

BPH nymphs and adults are attacked by relatively fewer parasite species than predators. Four species of dryinids, one strepsipteron, one undetermined mite, one nematode, and one eulophid were recorded. The dryinids and the eulophid are both parasitic and predatory in their habits.

Predators make up the majority of natural enemies attacking the BPH nymphs and adults. Spiders are the most numerous natural enemies (48% of the recorded species), and 31 representing 10 families have been found.

Spider species show some preference of rice environment. *Tetragnatha mandibulata* is most common in dryland rice fields. It is followed in number by *Oxyopes javanus, Lycosa leucostigma,* and various argiopids. *Tetragnatha javana* and argiopids predominate in rainfed wetland environments. Irrigated wetland rice fields are inhabited mostly by *Callitrichia formosana* and *L. pseudoannulata* during the vegetative stage and by *Tetragnatha* spp. after maximum tillering.

Theridion preys upon BPH in weedy rice bunds but has never been found in a rice field. Twelve species of true bugs (Heteroptera), five beetles (Carabidae. Coccinellidae, Staphylinidae), two damselflies (Coenagrionidae), a katydid (Tettigoniidae), and a dance fly (Empididae) compose the rest of the predators.

Secondary natural enemies complete the food web. Four hyperparasitic wasps (Ceraphronidae, Encyrtidae, and Pteromalidae) attack all four dryinid species, and a scelionid wasp parasitizes the eggs of *Conocephalus.* Two egg parasites, *Baeius* (Scelionidae) and *Strepsimallus yasumatsui* (Ichneumonidae), were reared from *Oxyopes* and *Clubiona* spider egg masses, respectively. Additional spider egg parasites *Caenopimpla arealis* (Ichneumonidae) from *Oxyopes* and an undetermined sarcophagid fly from

Argiope were reared, Spiders are highly cannibalistic and readily devour one another when other prey is not available. This behavior is a mechanism that regulates their number.

We conclude that rice agroecosystems are rich in species of natural enemies that attack BPH. The apparent lack of hyperparasites in the Philippines is an encouraging indication that natural enemies can be directly manipulated. ■

Yield loss due to leaf scald disease

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Leaf scald disease was initially observed in the 1977 samba season in Tanjore district, Tamil Nadu. During the 1978 thaladi season, the disease was seen in all cultivars raised. In the 1979 thaladi the disease incidence was severe (up to grade 8) in the culture AS2887. Yield losses were assessed. For each disease grade, 100 uniform clumps were harvested and the yield was recorded. The yield loss was worked out in comparison with the yield obtained in 100 healthy clumps of the same variety. The particulars on the percentage loss in the yield is given below.

Disease grade	1	2	3	4	5	6	7	8
% yield loss	–	–	–	–	2.5	7.9	16.1	23.4

Leaf scald disease up to grade 4 caused no yield loss in AS2887; loss was maximum, 23.4%, at disease grade 8. ■

Pest management and control INSECTS

Efficacy of chlorpyrifos (Coroban) 5 & 10 G against two major rice pests in Tamil Nadu

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A field trial on control of leaf roller *Cnaphalocrosis medinalis* and stem borer *Tryporyza incertulas,* major rice pests in Chingleput District, Tamil Nadu, with the rice variety Ponni was conducted by the entomology department at CIP (P) LTD Research Farm during the 1979-80 samba season (Oct-Jan). The study evaluated the efficacy of chlorpyrifos (Coroban) as 5 and 10 G formulated in the chemistry department of the Farm.

Five treatments, each on a 20-m^2 plot, were replicated 4 times. The granules were broadcast into 2.5-cm paddy water 10 days after transplanting (DT). Chlorpyrifos (Coroban 20 EC) at 500 ml/ ha was foliar sprayed twice at 3-week intervals, starting 40 DT to all treatments including the check.

Observations of the cumulative incidence of leaf rollers (leaf damage) and stem borers (deadhearts) were made at 2-week intervals. Grain yields were also recorded.

Chlorpyrifos granules 5 and 10 G were as effective as carbofuran 3 G and quinalphos 5 G against the two pests (see table). All insecticide treatments yielded significantly more than the control. The highest grain yields from plots treated with chlorpyrifos 10 G were significantly greater than yields from plots treated with carbofuran. ■

Relative efficacy of chlorpyrifos 5 and 10 G against rice leaf rollers and yellow stem borers. CIP Research Farm, Tamil Nadu, India. [a]

Insecticide	Leaf roller incidence[b]		Stem borer deadhearts (%)		Yield (t/ha)
	15 DT	30 DT	15 DT	30 DT	
Chlorpyrifos 5 G	2.5 a	1.8 a	3 a	8 b	4.45 ab
Chlorpyrifos 10 G	1.5 a	3.8 b	2 a	5 ab	4.85 a
Quinalphos 5 G	2.5 a	4.0 b	11 b	5 ab	4.40 ab
Carbofuran 3 G	2.8 a	2.8 ab	6 a	3 a	4.15 b
Control	14.0 b	15.3 c	14 b	16 c	2.85 c

[a]Av of 4 replications. In a column, means followed by a common letter are not significantly different at the 5% level. DT = days after transplanting. [b]Number of damaged leaves in 10 randomly selected and marked hills.

Studies on a new insecticide of a novel class of chemical thiocyclam hydrogen oxalate for the control of rice insects

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In China, a large quantity of insecticides are used annually for control of rice insect pests. Most of these insecticides are γ-BHC and methyl parathion. Because of the development of resistance by rice stem borers and other species to these organochlorine and organophosphate chemicals and because of residue hazards to the environment, it has become necessary to search for insecticides of different structures and action.

Results of laboratory and field experiments (1977-79) showed that thiocyclam hydrogen oxalate (Evisect) developed in China from an annelid worm is effective as a spray or root-zone application against striped stem borer, the yellow stem borer, the leaf folder, and rice thrips. Evisect has systemic properties. When used in combination with carbofuran it can control most of the potential insect pests in rice fields.

Another related insecticide, dimehypo (S, S[dimethylamine] trimethylene dithiosulfuric acid ester, is also being evaluated in China. ■

Induction of carbamate resistance in brown planthopper

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Brown planthopper (BPH) adults were collected in April 1977 from a rice paddy at Ping-tung, Taiwan, and brought to the laboratory. They were fed on rice at room temperature with a 16-hour photoperiod. This strain was reared continuously in the laboratory without contact with insecticides until July 1979, when selection with MIPC started. In October 1979 the insects were mixed with field populations from Ping-tung and Mei-nung areas and subjected to a continuous and increasing selection pressure of MIPC (causing about 60% mortality). The LC_{50}, as measured by the spray method, increased from 0.025 mg/ml to 0.673 mg/ml, an induction of carbamate resistance by 27 times in 4 generations of selection.

This is believed to be the first reported case of selection for carbamate resistance in brown planthopper in the laboratory. ■

Sustenance of whitebacked planthopper throughout the year in the Indian Punjab

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Under north Indian conditions, whitebacked planthopper (WBPH) *Sogatella furcifera* (Horv.) populations normally appear in July. If insect rearing begins in July, the high population required for mass screening is obtained only by August and screening for resistance is limited to August-September.

The active period of screening can be prolonged if a high population of WBPH is available through March-April. This means maintaining WBPH in November to January so that sufficient numbers of mating pairs are available by February-March and a high population is available by April.

Earlier attempts to rear WBPH on caged plants indicate the WBPH could not be maintained beyond September. This report describes successful rearing through the year on caged plants under laboratory as well as natural conditions.

Rice plants were grown in pots outdoors from April to November. From December to March, when the climate was not favorable, the rice plants were kept in the laboratory (22°-27°C temperature and 70-80% relative humidity) with an ordinary room heater and Philips Reflectalite fluorescent tubes. The laboratory-grown plants were kept outdoors during the day and taken to the laboratory in the evening.

One-month-old plants were covered with split cages and 50 pairs of newly emerged WBPH adults (less than 24 hours old) were released for oviposition. The insects were removed after 2 days and the plants were observed daily until the emergence of new WBPH adults. The time from adult release to nymphs hatching was called the hatching period and the period between hatching of nymphs and the appearance of adults was the nymphal period. The generation was measured as the time from initial hatching to hatching of nymphs of the next generation (Table 1).

The caged pots were kept outdoors under natural conditions throughout the year. Eleven generations were obtained from August 1978 to September 1979.

During the period December to March, one duplicate set of insect rearing pots was maintained in the laboratory. Four additional generations were obtained during this period (Table 2).

Screening rice genetic stocks for resistance was conducted with this high population of *artificially* reared insects in the screenhouse from mid-March 1979 till late October 1979 when rice seedlings could be raised in the laboratory. This allowed an active screening period of 7-8 months instead of the normal 2. ■

Table 1. Development of caged whitebacked planthoppers held outdoors. Ludhiana, August 1978–September 1979.

Period	Mean temp (°C)	Mean relative humidity (%)	Nymphal period (days)	Hatching period (days)	Generation time (days)
1 Aug–Sep	28.3	72.7	15	10	25
2 Sep–Oct	24.8	63.6	19	12	31
3 Oct–Dec	18.8	63.7	20	20	40
4 Dec–Mar	13.4	71.2	58	33	91
5 Mar–Apr	20.1	65.6	26	7	33
6 Apr–May	28.5	39.4	14	6	20
7 May	28.8	37.8	13	10	23
8 May–Jun	31.2	37.3	15	8	23
9 Jun–Jul	31.7	63.5	17	8	25
10 Jul–Aug	29.9	71.9	15	8	23
11 Aug–Sep	30.7	64.0	16	8	24

Table 2. Development of whitebacked planthoppers in the laboratory. December 1978–March 1979.

Period	Nymphal period (days)	Hatching period (days)	Generation time (days)
1 Dec	11	8	19
2 Dec–Jan	13	8	21
3 Jan–Feb	13	8	21
4 Feb–Mar	12	7	19
5 Mar	13	8	21

Tillage implements for soil incorporation of carbofuran granules in rainfed wetland fields

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Carbofuran as a systemic granular insecticide is readily translocated in rice plants when taken up by the root system. Broadcasting carbofuran granules into the paddy water after transplanting is inefficient because the high water pH causes chemical breakdown and rains wash granules out of the field.

Placing the granules in the plant's root zone by tillage (soil incorporation) is more efficient. But in rainfed wetland environments, the paddy fields dry out during the dry season. When land that has been prepared is flooded, it is difficult to produce a good loose soil structure to facilitate soil incorporation. Furthermore, the delay in land preparation after the onset of rains allows weeds to flourish, hindering tillage in the fallow fields.

We tested five tillage implements used by farmers in the Manaoag Cropping Systems research site, Pangasinan, to determine which of them most effectively incorporated insecticide in the soil, as indicated by whorl maggot and early stem borer control.

Animal drawn implements were used in the normal preparation of four farmers' fields for the single transplanted rainfed crop. The fields were plowed once and harrowed twice before the final harrowing.

The implements used for the final harrowing, during which 1 kg a.i. carbofuran/ha was soil incorporated, were:

1. an 8-hp IRRI-designed power tiller,
2. a wooden paddle wheel rotary harrow (*padulang*),
3. a metal comb harrow (*suyod*),
4. a bamboo flat-frame harrow with teeth composed of short stout nodal branches (*kalmot*),
5. a wooden flat-frame harrow with iron teeth (*kalmot*), and
6. a wooden flat-frame harrow with teeth up for a leveling operation.

All implements except the power tiller were carabao-drawn.

The treatments were compared with a paddy-water broadcast application 5 days after transplanting (DT) and an untreated check. For stem borer and leaf folder control, all plots including the check were protected during the later growth stages with sprays of 1kg a.i. endosulfan/ha at 34, 45, and 55 DT (see table).

For rice bug control, the plots were treated with three sprays of 1 kg a.i. BHC/ha at weekly intervals from the postflowering to the hard dough stage.

All tillage implements provided equally adequate soil incorporation of carbofuran granules to control whorl maggot *Hydrellia sasakii* and stem borer deadhearts caused by *Tryporyza incertulas*. They also resulted in yields significantly higher than those of the paddy water application treatment and the untreated check. ■

Comparison of tillage implements for soil incorporation of carbofuran granules in a single crop of transplanted IR36.[a] Manaoag, Pangasinan, Philippines. 1979.

Tillage implement[b]	Carbofuran (kg a.i./ha)	Whorl maggot grade[c] 30 DT	Stem borer deadhearts (%) 45 DT	Yield (t/ha)
Power tiller	1	1 a	0.5 a	5.4 a
Paddle wheel harrow	1	1 a	0.4 a	5.2 a
Comb tooth harrow	1	1 a	0.3 a	5.3 a
Bamboo box harrow	1	1 a	0.5 a	5.4 a
Wooden box harrow teeth down	1	1 a	0.5 a	5.2 a
Wooden box harrow teeth up	1	1 a	0.4 a	5.3 a
None[d]	1	4 b	2.8 b	4.1 b
	0	8 c	6.2 c	4.2 c

[a]Av of 4 fields/replication. DT = days after transplanting. In a column, means followed by a common letter are not significantly different ($P \leq 0.01$). [b]One pass after granules broadcast. [c]1–9 scale: 1 = 0–1% leaves damaged, 3 = 2–33%damaged leaves, 5 = 34–50%damaged leaves, 7 = > 50% damaged leaves, but no broken leaves, 9 = > 50% damaged leaves with broken leaves. [d]Granules broadcast into the paddy water 5 DT.

Ovicidal activity of insecticides on the rice caseworm *Nymphula depunctalis*

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Eggs of the rice caseworm *Nymphula depunctalis* are laid on the undersides of leaves in contact with the water surface. Because the caseworm is a pest before the rice canopy closes, a significant amount of insecticide applied as a foliar spray reaches the water surface. Granular insecticides broadcast on paddy water would also allow chemical contact with eggs.

We tested the effect of sprayable and granular insecticides as ovicides on the rice caseworm in the field and in an open-air headhouse at IRRI.

In the field trial, 1-day-old eggs on cut leaves were placed on the water surface of plots (2 m^2) with rice plants 15 days after transplanting. Nine insecticides were sprayed at 0.75 kg a.i. /ha in 300 liters water/ha. Eggs were moved to the headhouse 48 hours later and placed in petri dishes with water from the treatments.

In the greenhouse, 9 sprayable insecticides were applied at 400 ppm to petri dishes with water and eggs of 2 ages (1 and 3 days old) on cut leaves. The 1-day-old eggs were exposed to the insecticide for 24 hours, rinsed, and placed in distilled water until they hatched. The 3-day-old eggs (blackhead stage) were also exposed for 24 hours (they hatched on the 4th day).

Eggs of 3 ages (1, 2, and 3 days old) were exposed for 24 hours to 3 granular insecticides in basins of water in the headhouse. The granular insecticides were applied at 0.75 kg a.i./ha

Table 1. Activity of insecticide sprays as ovicides against rice caseworm.[a] IRRI, 1980.

Insecticide [b]	Mortality[c] of eggs exposed for 24 h at		
	1 day old		3 days old
	Field [d]	Headhouse [e]	Headhouse [e]
Azinphos-ethyl40 EC	90 a	–	–
Diazinon 20 EC	78 ab	95 a	20 cd
Triazophos 40 EC	68 abc	94 a	99 a
Malathion 57 EC	44 abc	84 a	99 a
BPMC 50 WP	33 bc	96 a	91 ab
Phosphamidon 50 EC	31 bc	19 b	12 d
Carbaryl 85 WP	26 bc	–	–
Endosulfan 35 EC	29 bc	–	–
MTMC 50 WP	21 c	41 b	99 a
MIPC 50 WP	12 c	91 a	76 b
Carbophenothion 40 EC	–	98 a	41 c
Ethion 40 EC	–	96 a	71 b

[a]100 eggs/replication. In a column, means followed by a common letter are not significantly different at 5% level. [b]400 ppm. EC = emulsifiable concentrate, WP = wettable powder. [c]Mortalities converted using Abbott's formula. [d]Applied at 0.75 kg a.i./ha on water surface. Av, 2 replications. [e]Av, 3 replications.

Table 2. Activity of insecticides, applied as paddy water granules, as ovicides against rice caseworm.[a] IRRI greenhouse, 1980.

Insecticide[b]	Mortality[c] (%) of eggs exposed for 24 h at		
	1 day old	2 days old	3 days old
Carbofuran 3 G	100 a	100 a	97 a
Diazinon 6 G	96 a	99 a	82 b
γ-BHC 6 G	52 b	31 b	85 b

[a]Av, 3 replications (100 eggs/replication). In a column, means followed by a common letter are not significantly different at 5% level. [b]Applied at 0.75 kg a.i./ha (375 ppm). G = granular. [c]Mortalities converted using Abbott's formula.

(375 ppm). All eggs, except those 3 days old, were removed after 24 hours, rinsed, and placed in distilled water until hatching.

In the field trial, which represented a natural situation, mortality was 90% on 1-day-old eggs with azinphos-ethyl after 24 hours of exposure (Table 1). Diazinon, triazophos, and malathion were also highly ovicidal.

The trial with sprayables in the headhouse produced higher mortalities because the insecticide concentration was higher in the water than in the field. All insecticides, except phosphamidon, were highly effective ovicides. Sprayable insecticides differed in ovicidal activity with egg development. Diazinon and carbophenothion were highly effective on 1-day-old eggs; MTMC was more effective on 3-day-old eggs.

All three granular insecticides were highly ovicidal (Table 2). Carbofuran was highly effective regardless of egg age. Diazinon was more active on 1- and 2-day-old eggs, whereas γ-BHC caused the highest mortality to 3-day-old eggs.

The trials included organochlorine, organophosphorus, and carbamate insecticides but no class of insecticides appeared more ovicidal than another.■

Evaluation of foliar insecticides to control rice caseworm *Nymphula depunctalis* in the field

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Few field trials have been attempted for pesticidal control of the rice caseworm *Nymphula depunctalis* because of the tendency of this aquatic insect to be unevenly distributed. The problem was overcome at IRRI by hand-infesting small plots (2 m^2) with known numbers of larvae (4 second-instar larvae/ hill) from a greenhouse colony.

Eleven insecticides were compared as foliar sprays at 0.75 kg a.i./ ha in a volume of 300 liters/ ha at 15 days after transplanting. Each plot was encircled with plastic sheeting to prevent interplot larval movement. After infestation, caseworm larvae were allowed to settle for I day before spraying. The treatments were rated 10 days later by scoring leaf damage — percent tillers with cut leaves — on the basis of the larval feeding habit of cutting off leaf tips.

Because of the behavior of the aquatic larvae, the effects of three sites of application — the plants alone, the paddy water alone, and both plants and water — were also compared. The aquatic larvae float inside their cases on the paddy water during the day and return to the rice plants at night. Farmers often irrigate series of fields along a slope. That causes the lower lying fields to receive water from above. Thus, larvae could move from a higher field into a lower, adjacent field that had recently been sprayed. In such a case only the plants would have insecticide residue.

Table 1. Effect of foliar insecticides in reducing plant damage from rice caseworm larvae.[a] IRRI, 1980.

Insecticide[b]	Tillers with cut leaves (%) at	
	1 day before spraying	10 days after spraying
Azinphos ethyl 40 EC	7.3 a	1.9 a
Triazophos 40 EC	8.4 a	2.3 a
Malathion 57 EC	7.9 a	2.4 a
MIPC 50 WP	9.0 a	2.5 a
Chlorpyrifos 40 EC	9.2 a	2.6 a
Carbaryl 85 WP	8.0 a	2.6 a
Endosulfan 35 EC	8.0 a	2.8 a
BPMC 50 WP	8.8 a	2.8 a
Phosphamidon 50 EC	7.8 a	3.2 a
Diazinon 20 EC	10.5 a	3.4 a
MTMC 50 WP	7.6 a	6.8 b
Untreated	7.8 a	16.6 c

[a]Av of 4 replications. In a column, means followed by a common letter are not significantly different at 5% level. Hand-infested with 10 second-instar larvae/hill the day before spraying. EC = emulsifiable concentrate, WP = wettable powdcr. [b]0.75 kg a.i./ha, 15 days after transplanting.

Fresh larvae from the greenhouse colony (10 second-instar larvae/ mylar tube cage pushed into the mud around a hill of rice, 1 cage/replication) were used in 3 experiments established after the field plots were sprayed:

1. Rice hills and surrounding water directly caged in the field plots (sprayed plants and paddy water),

2. Rice hills removed from the sprayed field plots, placed in pots in the greenhouse, and immersed in fresh water (sprayed plants only), and

3. In the greenhouse, unsprayed potted rice hills immersed in plastic basins of paddy water which had been set in the field before insecticide application (sprayed paddy water only).

The effect of the insecticides in the 3 experiments was measured as larval mortality 48 hours after infestation.

The caseworm was readily controlled by all insecticides tested (Table 1). MTMC was significantly less effective, however, than the 10 other insecticides at 0.75 kg a.i./ha. Lower dosages should be tested in future trials.

Table 2. Effects on caseworm larval mortality of foliar insecticides applied to rice plants, paddy water, or both. IRRI, 1980.

Insecticide[a]	Larval mortality[b] (%) 48 h after spraying of		
	Plants and paddy water[c]	Plants only[c]	Paddy water only[d]
MIPC 50 WP	100 a	100 a	100 a
Diazinon 20 EC	100 a	97 ab	100 a
Azinphos-ethyl 40 EC	100 a	90 ab	100 a
Chlorpyrifos 40 EC	100 a	97 ab	95 ab
BPMC 5OWP	100 a	92 ab	95 ab
Malathion 57 EC	100 a	92 ab	85 ab
Carbaryl 85 WP	100 a	95 ab	75 bc
Endosulfan 35 EC	100 a	68 c	85 ab
Phosphamidon 50 IC	95 a	82 bc	80 bc
MTMC 50 WP	85 a	63 c	55 c
Mean	98	88	88

[a]0.75 kg a.i./ha. WP = wettable powder, EC = emulsifiable concentrate. Applied 15 days after transplanting. [b]Corrected using Abbott's formula. 10 second-instar larvae per replication (one cage). In a column, means followed by a common letter are not significantly different at 5% level. [c]Av, 4 replications. [d]Av, replications.

The supplementary studies on larval mortality support the conclusion that rice caseworm larvae are highly sensitive to insecticides (Table 2). When larvae were exposed to both sprayed plants and paddy water in the field mortality was high (85-l00%) after 48 h. Mortalities were significantly lower with some insecticides (MTMC, endosulfan, phosphamidon) when only the plants were sprayed or only the water was sprayed (MTMC, carbaryl, phosphamidon). Mortality means over all insecticides indicated equal effect from spraying either plants or paddy water. ■

Acid fuchsin technique to stain stylet sheaths of the rice bug *Leptocorisa* spp. feeding on rice grains

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The rice bug *Leptocorisa* spp. as a seed pest has not been evaluated adequately because of a lack of a definitive technique to associate injured rice grains or yield loss with feeding. The rice bug injures grains by feeding 1) on developing (milky stage) grains to cause unfilled grains, 2) during the dough stage to cause "pecky rice" (discoloration of mature grains), and 3) during the dough stage to cause weak point in the kernels. The first injury causes yield loss, the second and third impair grain quality.

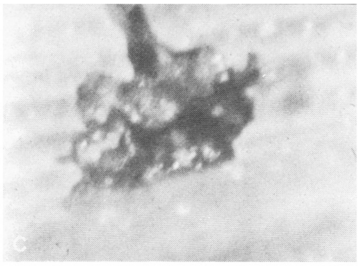
Establishing an economic threshold depends on which kind of injury is important to farmers. A subsistence farmer is concerned primarily with rice bug damage that results in loss of weight (unfilled grains). Grain quality is important because prices for pecky and broken rice are lower. Therefore, subsistence farmers are concerned about control from postflowering to the dough stage. Market-oriented farmers should continue to monitor their fields until the hard-dough stage.

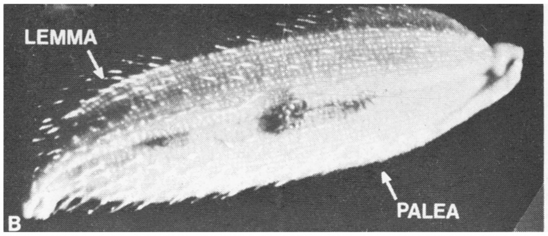
Because all three kinds of grain injury can be caused by factors other than rice bugs, techniques that link a given type of damage directly to rice bug feeding should be developed. Subsequently rice bug numbers in the field can be used in the establishment of economic thresholds. The insecticide check method for measuring yield differences between treated and untreated plots is not definitive because stem borers or leaf folders cannot be ruled out as factors causing yield loss during the grain filling period.

Two techniques commonly used to indicate rice bug injury to grains are: 1) visual inspection of grains for evidence of dark feeding marks on hull:, and kernels, or 2) boiling the grains in a 2% solution of KOH for 5 minutes to clean hulls and kernels. One technique's disadvantage is that fungal organisms can also cause discolored hulls and kernels. KOH cleans surface blemishes caused by fungal organisms; however, there are fungi that can penetrate the kernels.

A stylet sheath staining technique developed by C. C. Bowling, Texas A and M University, working on the rice stink bug *Oebalus pugnax* has been used at IRRI for *Leptocorisa.* When a rice bug feeds on a rice grain, it secretes a proteinaceous stylet sheath. Stylet sheath can be stained with acid fuchsin dye. If an unfilled or discolored grain resulted from rice bug feeding, then a stylet sheath should be evident on the rice hull.

To stain the stylet sheaths, rice panicles are placed in a pan and submerged in a staining solution of 1 part each of phenol, lactic acid, and distilled water, and two parts glycerine, plus enough acid fuchsin to color the solution dark red.





Leptocorisa stylet sheaths (arrows) stained with acid fuchsin dye magnified 40 (a), 90 (b), and 120 (c) times. Note that feeding occurs at the juncture of the lemma and the palea. IRRI, 1980.

After the rice panicles have been immersed in the stain solution (no heating is required) for 30 minutes, they are rinsed in tap water and air-dried. The panicles can be observed immediately, or stored for counting later. The stain solution can be reused.

Leptocorisa produces stylet sheaths that can be seen with the naked eye; however, magnification is advised. Whereas *O. pugnax* penetrates the rice hull with its mouthparts, *Leptocorisa* spp. prefers to feed at the juncture of the palea and lemma (see photo).

To assess rice bug injury, filled and unfilled grains from a random sample of stained rice panicles are removed and counted. The unfilled grains with stylet sheath are assumed to be caused by the rice bug. The filled grains with stylet sheaths are boiled in KOH to determine the number of pecky rice grains in the sample caused by rice bug feeding.

The acid fuchsin staining technique has a practical value in not only determining economic thresholds, but also in evaluating insecticide performance and plant resistance studies. ■

Leptocorisa acuta vs *oratorius:* a clarification of rice bug species

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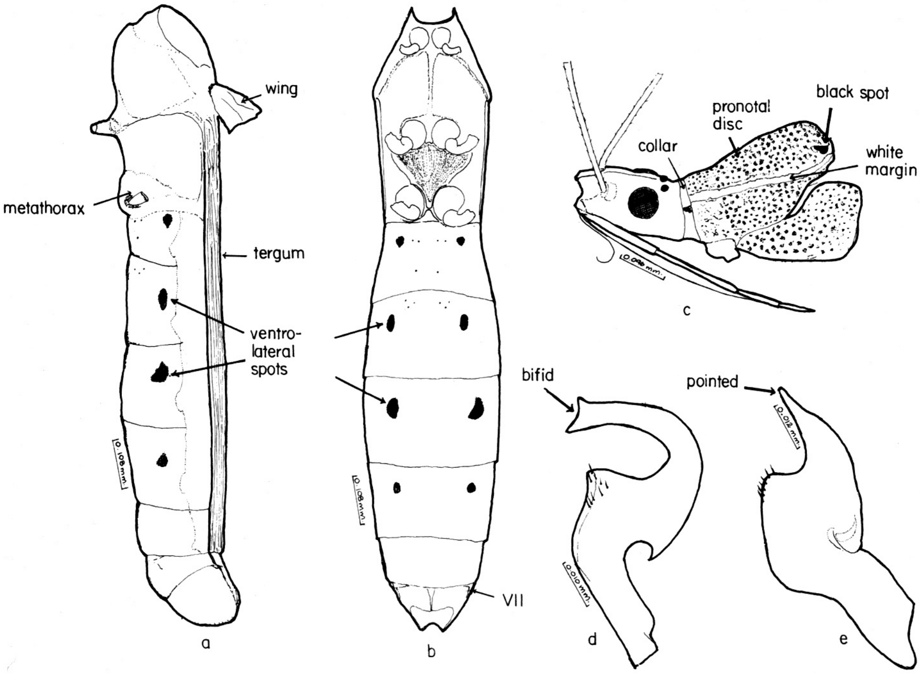
Leptocorisa oratorius (Fabricius) and *L. acuta* (Thunberg) share a common distribution. In Philippine rice fields *L. oratorius* is more abundant than *L. acuta.* The Asian literature mentions *L. acuta* more often than *L. oratorius.* We believe it is difficult for rice entomologists to identify these 2 species.

The distinctive characters that distinguish *L. oratorius* and *L. acuta* are in the table. Also see figure. ■

Characters that distinguish *L. oratorius* from *L. acuta.*

Character	*L. oratorius*	*L. acuta*
1. Body length (mm) male	19.0	13.0
female	18.5	16.3
2. Ventro-lateral spots (abdomen)	Present, usually brown	Absent
3. Pair of dorso-lateral spots on collar	Absent	Present
4. Spot behind compound eye	Present, usually dark brown	Absent
5. Length of pointed paraclypeae (mm)	Long (0.92- 0.96)	Short (0.61 -0.73)
6. Posterior angle of pronotal disc	Bears no black spot	Bears a black spot
7. Color of pronotal disc	Uniformly pale yellowbrown without white margins	Multicolored, with white margins
8. Seventh abdominal tergum of' male	Medially convex	Truncate (straight edged)
9. Seventh abdominal sternum of female	Curved to very slightly convex at center	Curved with a small triangular projection
10. Pygophore	Large, rectangular	Small, rounded
11. Genitalia		
Male		
a. Claspers	Curved and tapered along apices	Bifid at apices
b. Left lateral conjunctival appendage	Elongated and curved at base and apex	Reduced to spine-like
c. Frontal conjunctival appendage	Bears two sclerotized plates	Bears one, only the posterior
d. Ventral thecal appendage	Elongated, constricted at center, curved and pointed at base	Curved to shoe-shaped with broad apex
e. Membranous terminal appendage	Bulbous	Reduced to an apophysis
Female		
a. First gonocoxa	Elongated nearly three times as long as broad, with unequally curved sides	Small, with sinuate outer margins and rounded apices, with evenly curved sides
b. Spermatheca	Thick at miidarea, with a median flange, round and coiled tube	Irregular with a median flange and a long coiled tube



Leptocorisa oratorius (Fabricius) showing the ventro-lateral spots in both sexes, male (a), female (b); *L. acuta* (Thunberg) showing the black spot on the posterior angle of pronotal disc and white line along margins (c); male right claspers of *L. acuta* (d); and *L. oratorius* (e).

A note on the parasite *Haplogonatopus* sp. of brown planthopper nymphs

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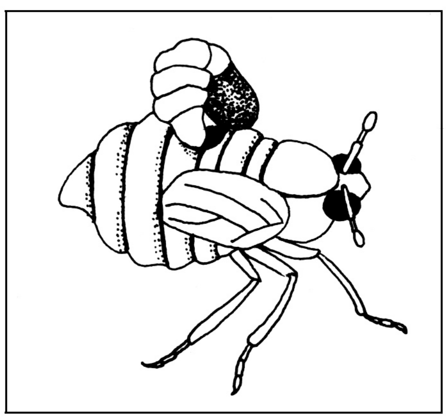
While searching for natural enemies of the brown planthopper (BPH), we found *Haplogonatopus* sp. (Hymenoptera: Dryinidae) parasitizing BPH nymphs for the first time in Andhra Pradesh in September 1977 at the Rice Research Unit, Bapatla, India.

The sac of the parasitic larva appears as a minute, characteristic arch or "∩" form on the second abdominal segment of the BPH nymph (see figure). Parasitized nymphs are less active.

BPH parasitization by *Haplogonatopus* sp. ranged from 1 to 5% (see table). Because these values are low, *Haplogonatopus* sp. cannot be considered an effective natural enemy of BPH unlike the mirid bug *Cyrtorhinus lividipennis* and wolf spider *Pardosa annandalei* (Gravely). However, it can supplement the other parasites' activity. ■



Haplogonatopus sp. larva on BPH nymph.

Parasitism of *Haplogonatopus* sp. larva on BPH nymphs in September 1977. The larvae were collected at weekly intervals from the variety Vasista. Andhra Pradesh, India.

Wk[a]	Parasitized BPH nymphs (no.)	Unparasitized nymphs (no.)	Parasitism (%)
1	3	97	3
2	5	95	5
3	1	99	1
4	5	95	5

[a]Each observation involved 100 BPH nymphs.

Soil and crop management

Timing of fertilizer application for rice in Ubon Ratchathani, Thailand

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A basal incorporation of fertilizers before transplanting is sometimes risky and impractical in rainfed areas. On sandy soils, deep placement may not be effective because of leaching and other causes. Applying fertilizers after transplanting, when the rice plant is well established, may reduce losses.

Initial fertilizer applications at different times after transplanting were compared in a randomized complete block and replicated 4 times at Ubon Ratchathani RES (Ubon loamy sand, pH 4.8, organic matter 0.5%, cation exchange capacity 1.6 meq/ 100 g soil) in the 1979 wet season. A first dose of 125 kg ammonium phosphate (16-20-0)/ha and 31.25 kg potassium chloride (60% K_2O)/ ha was applied with 62.5 kg ammonium sulfate (21% N)/ha at panicle initiation for the fertilizer treatments. The incorporation treatment gave high grain yields (see table). The topdressing treatments gave grain yields comparable to those with basal incorporation. ■

Effects of time of fertilizer application on yield of Niaw Sanpahtawng rice (av of 4 replications). Ubon Ratchathani RES, 1979 wet season.

Time of fertilizer application[a]	Yield (t/ha)[b]
No fertilizer	1.7 c
Incorporated BT	2.4 ab
Topdressed just AT	2.4 ab
Topdressed 7 DT	2.4 ab
Topdressed 14 DT	2.2 b
Topdressed 21 DT	2.2 b
Topdressed 28 DT	2.4 ab
Topdressed 35 DT	2.5 a
CV	8.2%

[a]BT = before transplanting, AT = after transplanting, DT = days after transplanting. [b]Any 2 means followed by the same letter are not significantly different.

Influence of seedling age on rice yield

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During 1979 sornavari and samba seasons, the performance of short- and medium-duration rice varieties was studied in relation to seedling age in sandy loam soils of PES, Tirurkuppam. The previous finding that 25-day-old seedlings are best had to be confirmed with reference to different soil and agro-climatic regions. Short-duration (ADT31 and TKM9) and medium-duration varieties (IR20 and ASDIS) at four seedling ages were tested. Sprouted seeds were treated with diammonium phosphate 3%.

Grain yield of short- and medium-duration varieties at 4 seedling ages during 2 seasons in 1979. PES, Tirurkuppam, Tamil Nadu, India.

Season and variety	Grain yield (t/ha) of seedlings aged				CD
	25 d	30 d	35 d	40 d	(P = 0.05)
Sornavari					
ADT31	3.87	4.05	4.22	4.42	
TKM9	4.16	4.60	5.26	5.70	0.8
Samba					
IR20	3.02	3.24	3.30	3.37	
ASD15	2.82	2.91	2.98	3.02	N.S.

The yield differences between seedling ages were significant for both the short- and medium-duration varieties (see table). In the short-duration group, ADT3 1 recorded yields similar for all seedling ages. The yield trend favored older seedlings. In TKM9, the 40- and 35-day-old seedlings recorded higher yields than the 30- and 25-day-old seedlings. In the medium-duration group, the yield differences among the seedling ages were not significant. Thus, seedlings of short- and medium-duration rice varieties up to 40 days of age can be planted to advantage in sandy loam soils. ■

Seed rate and spacing for the rice crop

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The influence of seed rate in wet nursery and spacing on rice grain yield was studied during 1979 sornavari and samba seasons at PES, Tirurkuppam. Previous studies have shown that increasing or decreasing the seed rate beyond 3 kg/40 m^2 resulted in low yields. The study also aimed to keep the yields high at higher seed rates per unit area by nitrogen (N) placement in the crop (TKM9). The treatments consisted of four seed rates, three times of placement, and two spacings (see table). The N placement in the main field was 75 kg N/ha, given 15, 20, and 25 days after planting in a single dose. Phosphorus and potassium were applied as basal doses as recommended by soil tests.

Results showed that the seed rate of 3 kg/40 m^2 was optimum. The seedlings raised at that rate had optimum physiological growth conducive to higher yields. It was also observed that the grain yield of crops planted at different seed rates was not affected by N applications. The closer spacing of 20 × 10 cm or 50 hills/m^2 gave higher yields, which appeared to be optimum for all short-duration varieties like TKM9 (105 days). ■

Influence of seed rate, nitrogen placement, and plant spacing on grain yields. Tamil Nadu, India.

Treatment[a]	Grain yield (t/ha)	
	1979 sornavari	1979 samba
Seed rates		
1.0 kg/m^2 – Pai nursery	5.87	3.60
1.5 kg/40m^2 – field nursery	6.40	3.61
3.0 kg/40m^2 – field nursery	6.71	3.91
6.0 kg/40m^2 – field nursery	6.02	3.50
CD = (P = 0.05)	0.55	0.24
N placement		
75 kg N/ha 15 DT	6.35	3.61
75 kg N/ha 20 DT	6.18	3.73
75 kg N/ha 25 DT	6.22	3.64
CD = (P = 0.05)	NS	NS
Spacings		
20 x 10	6.44	3.97
20 x 20 cm	6.07	3.34
CD = (P = 0.05)	NS	0.17

[a]DT = days after transplanting.

Growth of azolla with rice and its effect on rice yield

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Azolla is a useful green manure crop. Its nitrogen-fixing activity is due to an endophytic blue-green alga. When azolla is continuously cropped, it can produce molecular nitrogen of as much as 500 kg/ ha annually. In the rice field, azolla growth is fast at the rice crop's early stage, but declines later because of shading by the rice canopy. Widening the distance between rice plant rows will allow the growing of azolla during the whole growth period of wetland rice. This technique was tried experimentally in China.

At IRRI, rice was grown in a 35-m^2 plot in a wide-narrow row spacing.

Wide rows spaced 53 cm alternated with narrow rows 13.6 cm apart. The distance between hills in 1 row was 6.6 cm.

Fresh azolla (*A. pinnata*) amounting to 13-18 kg was inoculated into a plot. A total of 53 kg superphosphate/ ha was applied — half before transplanting and the rest at the time of each azolla inoculation. All plots were supplied with equal amounts of phosphate. Carbofuran (3% a.i.) at 1 g/m^2 was broadcast on the azolla inoculum.

After 15 to 20 days, azolla covered the paddy water surface. The water was drained for 2-3 days to make the azolla adhere to the soil surface. Then the azolla was incorporated into the soil by feet, hand weeder, or rake. A fresh inoculum was applied with superphosphate and insecticide. This allowed azolla to grow 4-6 times during one crop of rice. In the second trial azolla was not grown after rice had headed because the paddy surface was shaded and azolla growth was poor.

To study the effect of azolla incorporation, three treatments — no nitrogen, with chemical nitrogen, and with azolla — were compared (see table). Ammonium sulfate was applied before transplanting and incorporated into the soil. The plots were arranged in a Latin square.

The response of the first rice crop to azolla incorporation was apparent only at late stages of growth. No yield increase from azolla incorporation was observed probably because soil fertility was high. In the second crop rice growth in the early stage was better in azolla-treated plots than in no-nitrogen plots because of the carry-over of nitrogen from the previous azolla crop.

In the third rice crop, some plots were severely affected by boron toxicity. The toxicity was more severe in chemical nitrogen plots — hence yields were lower —than in azolla-treated plots.

In the fourth trial, plot size was 49 m^2 and distance between hills in 1 row was 13 cm. The average for four trials indicated that growing several crops of azolla in wide rows under a rice canopy and incorporating them gave about 1-t grain yield increase over the 0-nitrogen control. ■

Comparison of grain yields of azolla-treated plots and of plots with and without chemical nitrogen. IRRI, 1978-80.

Trial sequence	Cropping duration (from trans-planting to harvest) and variety	Chemical nitrogen applied (kg/ha)	Azolla incorporations (no.) and nitrogen content	Grain yield [a] (t/ha)		
				0 nitrogen	Chemical nitrogen	Azolla
1st	Dec 1978-Apr 1979 121 days IR26	107	6 crops, 105 kg N/ha	6.3 a	8.3 a	6.7 a
2d	May-Aug 1979 124 days IR42	60	4 crops, 70 kg N/ha	3.7 b	4.5 b	5.7 a
3d	Nov 1979-Mar 1980 104 days IR42	100	4 crops, 70 kg N/ha	2.7 b	2.2 b	3.6 a
4th [b]	Feb-Jun 1980 121 days IR42	60	4 crops, 70 kg N/ha	5.2 b	6.2 a	6.2 a

[a] Any two means followed by a common letter are not significantly different from each other at the 5% level. [b] Field is different from the previous ones. One crop of azolla was grown before transplanting. Plant density was half that in the previous trials.

Environment and its influence

Supply of dry matter from stems to grain in rice grown under dryland conditions

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Studies on locally grown cereals show that flowering occurs about halfway through the crop's growth period in maize and wheat but relatively later in rice, with grain development taking up a much smaller proportion of the growth period.

The relatively short grain-filling period in rice suggests either that good grain yields result from an accelerated crop growth rate after flowering, coincident with the development of the grain sink, or that substantial stored dry matter from other plant parts is translocated to the grain during grain filling.

Three varieties, Blue Belle, IR40, and Brazos, which grow well in local dryland conditions, were sampled every 2 weeks for growth analysis.

In all the three varieties, crop growth rate reached a maximum at panicle emergence and decreased soon thereafter. In maize and wheat, crop growth rate reaches a maximum some weeks after anthesis.

Characteristics of 3 rice varieties. Chiredzi, Zimbabwe.

Characteristic	Blue Belle	IR40	Brazos
Sowing to panicle emergence (days)	85	106	95
Sowing to maximum grain dry mass (days)	118	146	132
Difference or grain-filling period (days)	33	40	37
Grain-filling period/total growth period (%)	28.0	27.4	28.0
Maximum dry mass of stems (g/m^2)	937	1029	1042
Dry mass of stems at the time of maximum grain dry mass (g/m^2)	623	578	528
Difference or loss of stem dry mass over grain-filling period (g/m^2)	314	451	514
Dry mass of grain harvested (g/m^2)	696	734	751
Loss of stem dry mass/dry mass of grain harvested (%)	45.1	61.4	68.4

A very large reduction in stem dry matter in the rice varieties after panicle emergence suggests that a very significant proportion of grain yield is derived by translocation of materials from the stems to the grain (see table).

The varieties were similar in proportion of the grain-filling period to the total life of the crop. Between 27% and 28% of the crop duration was used in grain filling in each variety, although maturity ratings ranged from 118 to 146 days. In the relatively short period of 33-40 days, grain yields of nearly 7 t/ha and higher were produced. Those yields were evidently achieved by translocation of stored materials from the stem and elsewhere, supplementing the normal crop growth increment in that period.

The evident loss of dry matter from the stems accounted for 45.1% of the grain dry matter in Blue Belle, 61.4% in IR40, and 68.4% in Brazos. That points to the importance of the stems' storage role in rice. In maize and wheat the loss of stem dry mass during the grain growth period is seldom 10% of the grain yield.

The considerable transfer of materials from the rice stems did not result in any undue weakening — no lodging occurred.

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