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Contents

Guidelines and Style for IRRN Contributors

To Improve communication and to speed the editonal process, the editors of the *International Rice Research Newsletter (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 he convened 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 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, photos) per contribution are permitted to supplement the text. The editor hill 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.).

Agronomic characteristics

Inheritance of plant height in a cross of two cold-tolerant rice varieties

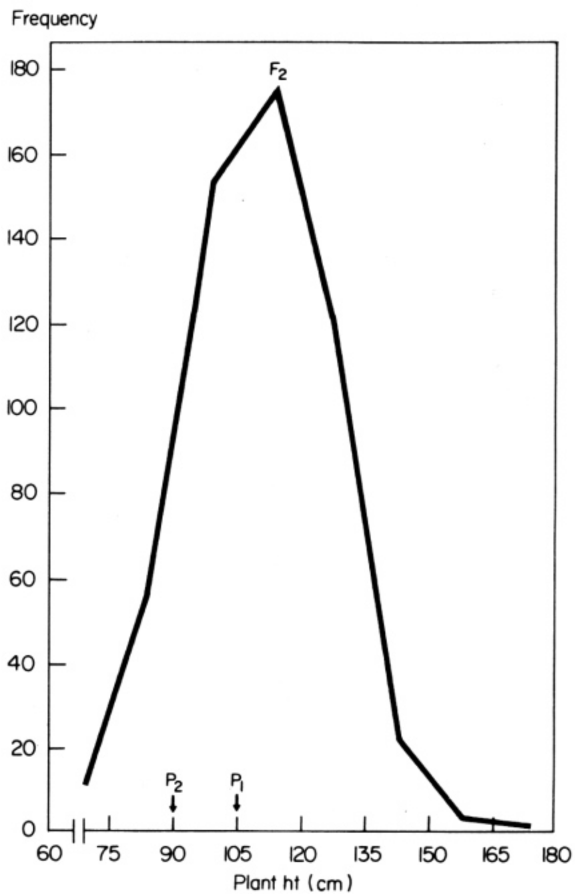
V. S. Chauhan and J. P. Tandon, Vivekananda Laboratory for Hill Agriculture, Almora (UP.) India

Height of the rice plant is an important morphological character that is thought to be monogenically or polygenically controlled. Understanding height inheritance is important to the development of appropriate plant types.

A cross between indica rice VLK39 and japonica rice VL8 has extremely high variability for plant height. Both strains have been released for hill areas and are cold tolerant. VLK39 is a selection from the cross China 1039/IR580. VL8 is a selection from Kaohsiung 22. The F_1 was taller than either parent, thus exhibiting overdominance or complementary effect of plant height genes.

Height of the transplanted F_2 of 543 plants ranged from 60 to 165 cm. Because parent height range was continuous, the segregation could not be classified as monogenic. The frequency distribution was not normal so the segregation. was not polygenic (see figure).

The frequency distribution was negatively skewed and highly leptokurtic with a very steep peak, indicating the possibility of digenic segregation in the expected genotypic frequencies of 1:2 : 2:4:4 : 2:1. However, because environmental fluctuations made it impossible to differentiate between so many phenotypic classes, an attempt was made to fit plant heights into the digenic ratio of 9:7. The F_2 population was grouped into two classes using 105 cm, the height of the taller parent, as the bifurcation point. This split the population into 323:220 plants, which corresponds with



Frequency distribution of plant height of F_2 population of the cross between VLK39 (P_1) and VL8 (P_2).

the 9:7 ratio with a X^2 value of 2.29, nonsignificant at 1% level. Results confirmed the hypothesis that the height variability of the cross results from digenic segregation with complementary gene effects because each parent has one of the dominant genes. Segregates had from early to medium growth duration and there was no obvious association between plant height and growth duration.

The shortest plants in the segregating population were much shorter than the shortest parent and are double recessives, making them of great significance as representatives of a new source of dwarfing obtained by combining two recessive genes. □

Ratoon performance of some short-duration rice cultures

K. Karunakaran, M. B. Jalajakumari, and P. Sreedevi, Regional Agricultural Research Station, Pattambi, Kerala, India

Twenty rice varieties constituting the ninth International Rice Yield Nursery (early) were grown in three replications at Pattambi during the 1981 kharif. Seedlings were transplanted at 15 cm × 10 cm spacing and received 70-35-35 kg NPK/ha. The main crop was harvested to leave 15-cm-tall stubble and entries were assessed for ratoon performance. The ratoon crop was not fertilized or sprayed. It was not irrigated but 625 mm of rain fell over 38 rainy days.

Varietal differences in the ratoon yields were significant. Five IRRI lines —IR9209-48-3-2, IR9761-19-1, IR13427-40-2-3-3, IR13429-109-2-2-1. and IR13429-287-3 – were promising (see table). □

Main crop and ratoon performance of some rice varieties at Pattambi, India.

Variety	Duration (days)		Grain yield (t/ha)	
	Main crop	Ratoon crop	Main crop	Ratoon crop
BAU2-3-43	108	56	3.2	0.1
BKN7033-13-1-1-3-2	108	56	3.8	0.2
BPT1235	110	54	4.4	0.1
BR109-74-2-2-2	119	45	3.7	0.2
BR161-2B-58	117	47	3.5	0.2
Chianung Sen yu 13	113	51	3.6	0.4
IR9209-48-3-2	104	60	4.9	0.3
IR9761-19-1	103	61	4.9	0.3
IR9828-91-2-3	108	56	4.0	0.1
IR13427-40-2-3-3	113	51	4.6	0.5
IR13427-60-1-3-2-2	103	61	4.8	0.2
IR13429-109-2-2-1	108	56	4.6	0.4
IR13429-196-1	108	56	4.9	0.2
IR13429-287-3	113	51	4.8	0.3
MRC603-303	109	55	3.7	0.2
MTU34 19	116	48	3.6	0.0
Taichung Sen Yu 285	113	51	3.6	0.4
TNAU1756	103	61	3.8	0.1
IR36	108	56	4.2	0.2
KAU23332-2	113	51	4.5	0.1
CD (P = 0.05)	–	–	0.55	0.21

Genetic evaluation and utilization

OVERALL PROGRESS

Promising TKM6 rice mutants

S. R. Sree Rangasamy and C. R. Anandakumar, School of Genetics, Tamil Nadu Agricultural University, Coimbatore 641003, India

TKM6 (GEB24/Co 18 hybrid derivative) mutants were isolated after gamma irradiation and treatment with chemical mutagens ethyl methane sulfonate (EMS) and di-ethyl sulfate (dES) either singly or in combination. Several dwarf mutants were isolated from the different treatments in M2 generation. Among them, three dwarf macromutants were identified as promising and grown through M3 and M4 (see table).

The dwarf mutant obtained with a 30 kR gamma ray dose was early maturing and had reduced leaf area, grain size, and total dry matter production, but higher per day production, chlorophyll content, number of grains per panicle, and harvest index. The mutant obtained by combining treatments of 35 kR gamma rays + 30 mM EMS had greater leaf area, chlorophyll content, and per day productivity than the control. The third mutant, obtained with a 35 kR gamma ray dose, yielded higher than the control because of increased leaf area, chlorophyll content, and grains/panicle, and had slender grains. Growth duration, however, was 10 days longer.

The mutants were photosynthetically efficient and the induced dwarfism in these mutants increased yields. They are being tested for direct use and as parents to provide alternative dwarfing sources. □

Performance of TKM6 and its mutants for different traits. [a]

Mutants	Duration (days)	Height (cm)	Productive tillers (no.)	Leaf area (cm^2)	Chlorophyll (mg/g)		Grains per panicle	Length-breadth ratio of grain	Productivity per day (kg/ha)	Total dry matter productivity/plant (g)	Harvest index
					'a'	'b'					
TKM6 control	120	120.0	8	17.89	0.715	0.328	110	3.00	37.50	30.0	30.00
TKM6 30 kR D_1	110	70.0 (–41.6)	7	14.49 (–19.0)	1.009 (+41.0)	0.586 (+78.8)	145 (+31.8)	1.73	45.45 (+21.20)	17.95 (–40.16)	55.71
TKM6 35 + 30	120	116.0 (–5)	11	21.73 (+21.4)	1.043 (+45.8)	0.480 (+46.2)	135 (+22.7)	3.40	58.33 (+55.54)	41.00 (+36.66)	34.15
TKM6 35 kR D_3	130	75.0 (–37.5)	10	19.14 (+ 6.9)	1.006 (+40.5)	0.597 (+82.0)	165 (+50.0)	3.30	61.54 (+64.08)	37.50 (+25.0)	42.67

[a] Figures in parentheses indicate percentage increase or decrease over control.

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Inheritance of blast *Pyricularia oryzae* resistance in rice.

J. A. Flores-Gaxiola, director, Papaloapan Experiment Station, Veracruz, Mexico, and F. L. Nuque, assistant scientist, Plant Pathology Department; J. P. Crill, former head of the Plant Pathology Department; and G. S. Khush, head of the Plant Breeding Department, IRRI

We sought to determine the number of leaf blast resistance genes present in some rice breeding lines and varieties, based on the presence or absence of lesions on F_1 and F_2 populations. The F_1s and segregating populations were inoculated with several races of the pathogen by injection. This study was conducted at IRRI in 1979 and 1980.

Lines derived from Tetep/IR8 (IR1905-81-3-1, IR3259-PP5-160-1, and IR3259-PP8-172-7) were resistant to six blast isolates and the Taiwanese variety Pai-kan-tao was resistant to three (see table). None of the varieties were resistant to an isolate from large lesions on Tetep. IR442-2-58, IR8, Peta, and Nongbaek were susceptible to all seven isolates. Among parents resistant to the same isolate, different genes controlled resistance. Also, for a given parent, different genes controlled resistance to different races.

Apparently, several blast resistance genes are available in a single genotype. Different genes control resistance to a particular race in different genotypes– the genes in Pai-kan-tao that govern resistance to race IH-1 (isolates PO7-10 and 43) and II-1 are different from those in IR81905-81-3-1, IR3259-PP5-160-1, and IR3259-PP8-172-7. No complementary recessive genes for resistance were

Number of genes resistant to specific isolates of the blast fungus, identified in three breeding lines and one variety.

Line, variety	Fungus race	Resistance genes (no.)	Gene interaction
IR1905-81-3-la	IB45	2	Complementary
	ID-15	2	Complementary
	ID-16	1	Dominant
	IH-1(43+PO7-10)[b]	1+1	Dominant
	II-1	1	Dominant
IR3259-PP5-160-1[a]	IB-45	2	Complementary
	ID-15	2	Complementary
	ID-16	1	Dominant
	IH-1(43+PO7-10)[b]	1+1	Dominant
	II-1	1	Dominant
IR3259-PP8-172-7[c]	IB-45	2	Complementary
	ID-15	2	Complementary
	ID-16	2	Complementary
	IH-1 (43+PO7-10)[b]	1+1	Dominant
	II-1	1	Dominant
Pai-kan-tao[d]	IH-1 (43+PO7-10)[b]	2+2	Complementary
	II-1	2	Duplicate

[a] In this line, the genes resistant to the races studied appear to be the same or allelic. [b] Isolates 43 and PO7-10 were differentiated as race IH-1 but distinct genes controlled resistance to each of them. [c] The resistance genes in this line are apparently the same or allelic to those in IR905-81-3-1 and IR3259-PP5-160-1 except for race ID-16. [d] Genes for resistance detected in this variety were nonallelic to the corresponding genes in IR905-81-3-1, IR3259-PP5-160-1, and IR3259-PP8-172-7.

detected in the F_2 of crosses among susceptible parents.

Of the eight resistance genes found in IR1905-81-3-1 and IR3259-PP5-160-1, and nine genes in IR3259-PP8-172-7, the gene conferring resistance to race IH-1 (isolate PO7-10) seems to be linked to the gene resistant to race II-1. The two genes giving resistance to race IB-45 did not segregate independently from the two genes resistant to race ID-15 or from that acting against race IH-1 (isolate 43); the remaining genes showed no linkage. The six resistance genes in Pai-kan-tao segregated independently. □

Resistance of five IR varieties to tungro

E. R. Tiongco, R. C. Cabunagan, and H. Hibino, IRRI

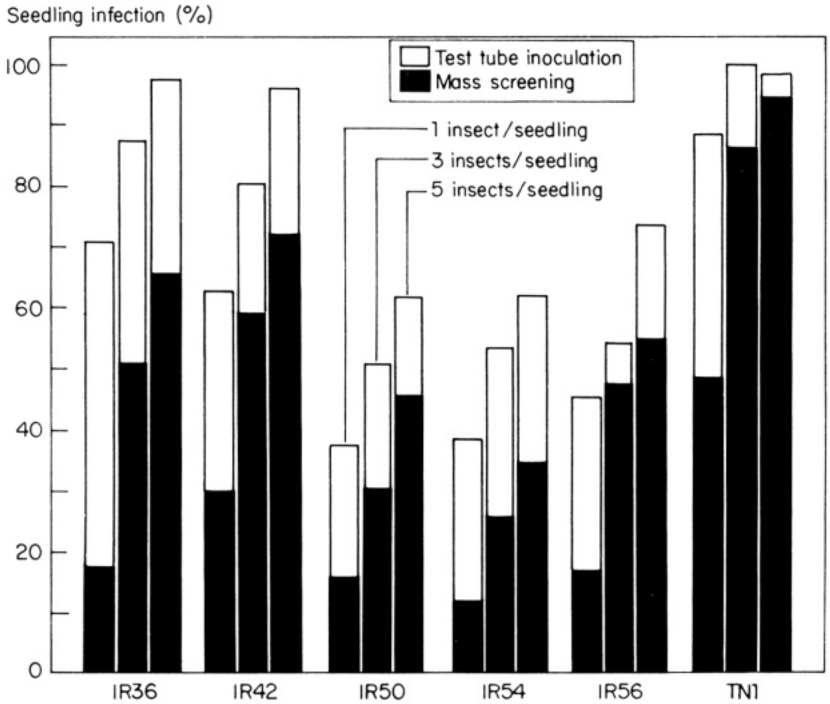
IR36, IR42, IR50, IR54, and IR56 resistance to tungro was determined by mass screening and test tube inoculation methods.

The five IR varieties and TN1 (susceptible check) were inoculated in a cage with 1, 3, and 4 insects/seedling using the tungro mass screening method. Seedling infection increased as insects increased from 1 to 5/seedling (see figure). TN1 always had the highest percentage of infection, regardless of the number of insects per seedling; followed by IR42, IR36, IR56, and IR50. IR54 showed the lowest seedling infection, but infection level was not significantly different from that of IR50 and IR56.

By the reaction scale for tungro, IR36 and IR42 changed their reaction from resistant to susceptible when the number of insects per seedling was increased from 1 to 5. IR50, IR54, and IR56 reaction changed from resistant to intermediate (see table).

Seven-day-old seedlings were each inoculated with 1, 3, and 5 insects, using the test tube inoculation method. Again, percentage of infected seedlings increased with number of insects per seedling (see figure). However, at even 1 insect/seedling, IR36, IR42, and TN1 were susceptible. IR50, IR54, and IR56 had an intermediate reaction (see table). The highest percentage of infection using the test tube inoculation method, regardless of number of insects, may be caused by the insects' forced feeding on the seed ling in confinement.

These results indicate possible unstable tungro resistance in some IR varieties. In the field, degree of resistance decreases with increased disease and insect pressure. This is apparent on varieties with tungro resistance conditioned only by resistance to the vector insect.



Percentage seedling infection of 5 tungro-resistant IR varieties inoculated with different numbers of tungro-viruliferous *N. virescens* per seedling, following the mass screening and test tube methods of inoculation.

Tungro reaction of 5 IR varieties inoculated by 1, 3, or 5 insects per seedling, following the mass screening and test tube methods of inoculation.[a]

Variety	Mass screening			Test tube inoculation		
	1	3	5	1	3	5
IR36	R	I	S	S	S	S
IR42	R	I	S	S	S	S
IR50	R	I	I	I	I	S
IR54	R	R	I	I	I	S
IR56	R	I	I	I	I	S
TN1	I	S	S	S	S	S

[a]Based on the scale for RTV mass screening of resistant (R) = 0-30% seedling infection, intermediate (I) = 31-60% seedling infection, susceptible (S) = 61-100% seedling infection.

Reaction of rice varieties to blast and brown spot diseases at Ponnampet

K. T. Pandurangegowda, N. A. Janardhanagowda, and R. C. Yaraguntaiah, Regional Research Station, V. C. Farm, Mandya, India

An experiment at the Ponnampet Agricultural Research Station, during 1982 kharif identified varieties resistant to blast and brown spot diseases. The National Screening Nursery evaluated 334 entries under nursery and transplanted condition. The nursery followed the uniform b1ast nursery pattern.

Twenty-eight entries had resistance to blast and brown spot (Table 1). Seventy-eight were resistant to leaf blast 83 to neck blast, and 223 to brown spot (Table 2). □

Table 1. Rice with resistance to blast and brown spot diseases, Mandya, India.

Pedigree	
TR20/Co 29	IET 8159
Ratna Mutant	Acham/IR20
IET6080	Ar 10-169 Mutant
Hema/CR57/Vikram/Shakti/ORSTR952	CR151-79/CR1014
CR151/CR1014	Tellahamsa/W12708
IET6288	WGL 16085/Kakatiya
IET6314	Imp. Sona/Pak. Basmati
Cul-240/IR20	IET6314/Co 2
Lalnakanda/IR30	IR32/Swarnadhan
IR8/Co 25	OS4/Palguna
Dorpandy mutant	IR8/IET4141
IET7810	IET4699/Ras 370
IR2061-465-1-5-IR36	IET4699/Bas 370
Hamsraj/Saket 4	IET7748

Table 2. Reaction of rice varieties to blast symptoms and brown spot disease at Mandya, India.

Scale [a]	Entries (no.)		
	Leaf blast	Neck blast	Brown spot
0-3	78	83	223
4-6	213	217	99
7-9	43	34	12

[a] Scale: 0-3 = resistant, 4-6 = moderately susceptible, 7-9 = susceptible.

Audiovisual rice production modules

A 61-module series of audiovisual lessons in rice production may be purchased from IRRI. The modules cover seven topic areas: production management; growth and morphology of rice; production problems and techniques; weeds, diseases, and their control; pests and their control; research design and analysis; and soil relationships. For further information write: IRRI, Communication and Publications Dept., Division R, P.O. Box 933, Manila, Philippines.

IR36, a promising variety for bacterial blight-prone areas of Haryana

S. A. Malik, H. A. U. Regional Research Station, Uchani, Karnal; S. C. Ahuja, H. A. U. Rice Research Station, Kaul, Kurukshetra; and C. V. S. Malik, H. A. U. Directorate of Research, Hissar, India

IR36 is a semidwarf, medium-maturity rice variety with slender grains and bacterial blight (BB) resistance. In 1981, it was recommended by the central variety release committee for commercial cultivation in India. Varietal trials under BB stress were conducted in 1980-82 kharif at Kaul and Karnal stations.

Performance of IR36 under bacterial blight stress in Haryana, India.

Variety	Yield (t/ha) during kharif				Duration (days)	Panicles/ m^2	Length-breadth ratio	BB reaction[a]
	1980 (Kaul)	1981 (Karnal)	1982 (Karnal)	Mean				
IR36	5.6	7.0	5.2	5.9	135	269	2.95	3
Jaya	4.4	7.4	6.2	6.0	148	251	2.32	9
PR106	4.3	6.3	5.1	5.2	149	213	2.60	9
Palman 579	4.5	6.8	5.5	5.6	130	243	2.90	5
CD	0.85	0.56	0.89					
CV(%)	11.12	4.0	11.0					

[a] By 1980 Standard Evaluation System for Rice.

IR36 yielded better than PR106 and Palman 579 checks and was equal to Jaya (see table). IR36 had more panicles per square meter, and higher length-breadth ratio than all three checks. It matured earlier than Jaya, which would allow good performance in wheat - rice rotation. BB infestation in 1981 and 1982 kharif was not as high as in 1980 kharif. □

Reaction of released and prerelease rice varieties to various diseases in Karnataka, India

K. T. Pandurangegowda, S. Kumaraswamy, and R. C. Yaraguntaiah, Plant Pathology Department, Regional Research Station, V. C. Farm, Mandya, India

Blast (B1), brown spot (BS), grain discoloration (GD), and udbatta (UDb) diseases are becoming important in

Reaction of released and prerelease rice varieties to various diseases in Karnataka. India, 1982 kharif.

Variety	Disease score [a]				
	B1 Leaf	B1 Neck	BS	GD	UDb
KMS8	R	R	R	R	S
IET6265	R	M	R	M	R
KMS9	R	R	R	R	R
KMS4	R	R	M	R	R
RP850	R	M	R	R	R
KMS7	R	R	R	R	R
KMP66	R	M	M	R	M

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Karnataka because of their wide distribution during kharif.

Each test variety was surrounded by highly susceptible varieties HR-12 for Bl, Binnibhog for BS, and PTB20 for UDb to expose them to natural infection. Observations were recorded using the Standard Evaluation System for Rice. Bl and BS were rated by lesion type and percent leaf area affected. Blast incidence after flowering was recorded as percent neck infection, and number of discolored grains per panicle was recorded for GD assessment. Percent infected panicles was recorded for UDb.

KMS7, KMS9, KMS5914, KMP10, KMP39, KMP41, and Jaya had resistant reactions to the four diseases (see table). □

TABLE CONTINUED

Variety	Disease score[a]				
	Bl		BS	GD	UDb
	Leaf	Neck			
29509	R	M	M	M	S
KMP101	R	R	M	R	R
Pusa 150	R	R	R	R	M
KMP10	R	R	R	R	R
29781	M	M	R	R	M
HP-1-1	R	R	R	M	M
KMP41	R	R	R	R	R
KMS5914	R	R	R	R	R
KMP39	R	R	R	R	R
ES-18	M	M	M	R	S
Jaya	R	R	R	R	R
IR20	R	R	M	R	R
Rasi	R	M	M	R	M
Mangala	R	R	M	R	M
IR32	M	R	M	R	R

[a] R = resistant (0-3 of the 1980 SES scale), M = moderately susceptible (4-6) and, S = susceptible (7-9).

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Evaluation of promising gall midge-resistant cultivars

P. Samal and B. C. Misra, Central Rice Research Institute, Cuttack 753006, India

Rice gall midge *Orseolia oryzae* (Wood Mason) Mani is a major pest of rice in kharif in many Indian rice growing states. Thirty-eight promising gall midge resistant cultivars developed by breeders were received through the All-India Coordinated Rice Improvement Project, Hyderabad, during 1979 kharif for testing at the Central Rice Research Institute, Orissa. The experiment was laid out in a randomized block design with two replications. Seedlings were spaced at 20 × 15 cm and the plot was fertilized with 60 kg N, 22 kg P, and 25 kg K/ha. Silvershoots were counted at 30 and 50 days after transplanting and average incidence was calculated.

The maximum 32.6% silvershoots was recorded for WGL 26888 (IR22/W12708). Eight cultivars had less than 3% silvershoots, which was significant at the 1% level. They were OR140-9-3 (CR94/RPW6-13), OR158-7-1 (GMR15 18/Pankaj), WGL 26450, WGL 26528, WGL 26536, WGL 26591, WGL 26965, and WGL 27015 (Surekha/Kakatiya). Of these, OR140-9-3, OR158-7-1, and WGL 26450 also had less than 2% silvershoots at Raipur, Rudrur, Bhubaneswar, Mangalore, and Warangal. □

GENETIC EVALUATION AND UTILIZATION

Drought tolerance

Screening wetland rice varieties for drought tolerance

N. K. Mitra, S. Mallik, and S. Biswas, Rice Research Station, Chinsurah 712 102, India

Drought tolerance at vegetative stage is desirable for deepwater rice. Forty varieties (10 recommended, 11 traditional, and 16 improved) including 2 drought-resistant and 1 susceptible check were

Comparative performance[a] of some wetland rice varieties under drought stress.

Entry	Initial stand establishment, 21 DS	Drought tolerance, 45 DS	Recovery, 81 DS	Height (cm), 133 DS	Phenotypic acceptability 133 DS
Recommended varieties					
Pankaj	8.3	9	7.6	31.1	8.3
Mahsuri	7.3	9	8.3	49.3	8.3
Swarna (IET 5656)	9	9	9	22.6	8.3
CR 1009	7.6	9	7.6	49.2	7.6
CR1014	7	9	7.6	61.1	7.6
BIET 821	3.6	3.6	5	88	5
Traditional indica					
OC1393	6.3	7.6	6.3	71.3	7
NC487/77	1.6	1	1.6	93.6	1

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tested to determine drought tolerance.

Seeds of each variety were drilled in rainfed fields on 31 Mar 1983 in 5-m-long rows in 3 replications. Stand establishment, drought damage, drought recovery ability, and phenotypic acceptability were recorded 21, 45, 81, and 133 days after seeding (DS). From 21 to 45 DS the plot received 7 mm precipitation. Maximum air and soil temperature ranged from 31.6 to 41.3ºC and 34.7 to 48.3ºC.

Twenty entries had a drought score of 9 at 45 DS. Eleven entries, including the susceptible check, died during the vegetative period. Pureline selection NC487/77 and hybrid lines CN506-147-2-1 and CN506-147-14-2 (IR30/LMN111//IR1514A-E660) performed better than the resistant check. Jalaplaban, Jaladhi 2, Jaladhi 3, and Janki, all pureline selections, had a high level of drought tolerance (see table). □

TABLE CONTINUED

Entry	Initial stand establishment, 21 DS	Drought tolerance, 45 DS	Recovery, 81 DS	Height (cm), 133 DS	Phenotypic acceptability 133 DS
NC488/78	3.6	6.3	5	71.4	4.3
Achra 108/1	3.6	5	3.6	77.5	3.6
Jalaplaban	2.3	2.3	3	77.8	2.6
FR13A	5.6	7	6.3	63.8	6.3
Jaladhi 1	6.3	6.3	5	75.9	5.6
Jaladhi 2	4.3	3.6	3	83.2	3
Jaladhi 3	3	1.6	3	95.8	2.6
Janki (C64-117)	3	1.6	3	87.5	2.6
Tilokkachari	6.3	6.3	7	74.5	6.3
New varieties					
CN506-147-2-1	3	3	2.3	83.3	2.3
CN506-147-14-2	3	5	3	52.8	2.3
CN683-1	5.6	5	5	80.5	3.6
FPAR 7809	5.6	5	4.3	50.1	5
Resistant check					
Dular	5	3.6	3	102.5	2.6
Salumpikit	8.3	9	8.3	58.7	8.3
Susceptible check					
IR20	9	9	9	28.5	9
Rainfall (mm)	105.9	7.0	116.1		210.5

[a]1980 Standard Evaluation System for Rice. Three replications. DS = days after sowing.

GENETIC EVALUATION AND UTILIZATION

Deep water

Plant height and growth duration at increased water depths

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

Popular semidwarfs were compared with tall varieties in duration and plant height at 55 and 74 cm water depths. Thirty-day-old seedlings were transplanted during the last week of June. Nitrogen was applied in 2 equal splits to supply 40 kg N/ha during tillering stage. Plots were flooded 45 days after planting and water level was maintained for 3 months, until the first week of November.

Semidwarfs generally showed greater increase in plant height (28-36 cm) than intermediate and tall (18-34 cm) varieties. MTUl6, the traditional deepwater variety, increased 16 cm at 55-cm depth, and 40 cm at 75-cm depth. Flowering duration was delayed by 4-13 days for semidwarfs and 0-8 days for intermediate and tall varieties. Semidwarf varieties had weak stems and lodged at the 75-cm water depth. □

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Himalaya 1 and Himalaya 2 — two new semidwarf, cold-tolerant rices for Himachal Pradesh, India

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Fifty percent of the rice area of Himachal Pradesh is at altitudes higher than 900 m. Cold temperatures during flowering reduce rice yields.

Himalaya 1 and Himalaya 2, semidwarf indicas released in 1982, can be successfully cultivated up to 1,550 m altitudes. Himalaya 1, the experimenta1 line HPU734, is a very early maturing selection from IR579 (IR8/Tadukan). It is recommended for low, mid, and high hills. Himalaya 2, the experimental line HPU71, is an early maturing selection from Pusa 33 (Improved sabarmati/Ratna). It is recommended for low and mid hills up to 1,300 m.

Himalaya 1 is high yielding, cold tolerant, and blast resistant. It yields an average 3.9 t/ha — 26, 15, and 3% more than IR579, China 988, or Himdhan (Table 1). It has long, slender, translucent grains with good cooking quality.

Himalaya 2 is high yielding, blast resistant, and early maturing. It yields 3.5 t/ha and has scented, long, bold grains which cook sticky, if used without previous storage. Other varietal characteristics are described in Table 2.

Yield stability data for 20 rices tested in 9 environments at different elevations in 1977 and 1978 show Himalaya 1 had high yield and high stability (regression 1.10 and regression deviation 0.56). Himalaya 2 had average yield and high stability (regression 1.02 and regression deviation 0.09).

In 1980 minikit trials in farmer's fields, both varieties averaged 3.6 t/ha and outyielded local checks by 44%. Highest yields recorded were 7.7 t/ha for Himalaya 1 and 6.3 t/ha for Himalaya 2. □

Table 1. Grain yield of Himalaya 1 and Himalaya 2 in Himachal Pradesh hills, India. [a]

Year	Himalaya 1	IR579	China 988	Himdhan	Himalaya 2	IR579	China 988	Himdhan
				Grain yield (t/ha)				
1976	–	–	–	–	3.9 (4)	3.3 (4)	–	3.5 (4)
1977	4.7 (6)	3.8 (6)	4.0 (6)	4.8 (6)	3.1 (3)	2.8 (3)	3.3 (3)	3.3 (3)
1978	3.9 (11)	3.5 (11)	3.6 (11)	4.2 (11)	3.6 (11)	3.5 (11)	3.6 (11)	4.2 (11)
1979	4.0 (10)	2.2 (10)	3.4 (10)	3.5 (10)	3.3 (10)	2.2 (10)	3.4 (10)	3.5 (10)
1980	3.3 (15)	2.8 (4)	2.6 (6)	2.7 (11)	3.1 (4)	2.8 (4)	–	–
Mean	3.9 (42)	3.1 (31)	3.4 (33)	3.8 (38)	3.5 (32)	2.9 (32)	3.4 (24)	3.6 (28)
				Increase over respective checks (%)				
		26	15	3	–	21	3	–3

[a] Values in parentheses indicate the number of locations for which yields were averaged.

Table 2. Agronomic and quality characteristics of Himalaya 1 and Himalaya 2.

	Himalaya 1	Himalaya 2	IR579	China 988	Himdhan
Plant height (cm)	65	74	68	102	99
Days to maturity	125	130	140	128	130
Panicles (no./m2)	254	226	258	245	207
Spikelets/panicle	111	110	111	79	117
Sterility (76)	12.4	19.3	18.1	15.6	18.0
1,000-grain wt (g)	24.8	25.5	20.6	24.3	25.3
Protein (%)	5.7	7.7	8.0	6.3	7.6
Amylose (%)	24.7	20.3	21.7	21.0	22.9
Alkali digestion value (1-7 scale)	6.2	6.7	6.9	6.3	7.0
Grain shape	Long slender	Long bold	Long slender	Medium bold	Medium bold
Blast, leaf (0-9 scale)	3.0	3.0	4.0	5.0	4.5
Blast, neck (%)	5	5	5	25	10

GENETIC EVALUATION AND UTILIZATION

Tissue culture

Anther culture in rice

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Anther culture techniques can shorten the time required to develop a rice variety and may cost less to use than conventional breeding methods. Tamil Nadu Agricultural University initiated anther culture studies in 1980.

F_1 and F_2 of crosses ASD8/Vaigai, ASD8/Amaravathi, ASD8/Bagavathi, and ASD8/Zhinjan responded to anther culture by producing calluses after 35 to 42 days of incubation in darkness at 24-26ºC (Table 1).

Potato extract medium and N6 medium supplemented with 2 mg 2,4-D/liter were used. Anther response in callus production varied from 2 to 10% and was best in N6 medium. Anther response of ASD8/Bagavathi was best (9.51%). ASD8/Zhinjan had minimum response (2.38%) (Table 1).

Table 1. Anther response of selected Tamil Nadu Agricultural University rices, 1980.

Medium	Cross	Anthers inoculated (no.)	Anther response no.	Anther response %	Av time for response (days)
N6	ASD8/Vaigai (F_1)	540	22	4.07	42
Potato extract	- do -	460	18	3.91	40
N6	ASD8/Amaravathi (F_1)	648	47	7.25	40
Potato extract	- do -	505	25	4.95	42
N6	ASD8/Bagavathi (F_2)	536	51	9.51	35
Potato extract	- do -	485	39	8.04	38
N6	ASD8/Zhinjan (F_1)	443	14	3.16	38
Potato extract	- do -	420	10	2.38	40

When 3 to 4 mm long anther calluses were subcultured in auxin-free regeneration medium, plantlets formed within 15 to 20 days, and were albino or normal. Of the calluses plated from ASD8/Amaravathi, 16% produced green plants, and ASD8/Bagavathi formed 22% green plants. ASD8/Vaigai produced only albinos and ASD8/Zhinjan regenerated only roots (Table 2). □

Table 2. Regeneration of plants from anther calluses of Tamil Nadu Agricultural University rices, 1980.

cross	Anther calluses subcultured (no.)	Green plantlets (%)	Albinos (%)	Roots alone (%)	No differentiation (%)
ASD8/Vaigai (F_1)	40	–	25	48	27
ASD8/Amaravathi (F_1)	72	16	–	64	20
ASD8/Bagavathi (F_2)	90	22	–	49	29
ASD8/Zhinjan (F_1)	24	–	–	68	32

Pest management and control DISEASES

Effect of slow-release nitrogen fertilizers on rice brown spot disease

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Brown spot (BS) *Helminthosporium oryzae* Breda de Haan is becoming a serious disease of high yielding rice varieties in Tamil Nadu. Heavy nitrogen fertilizer application increases BS incidence.

A field trial in kuruvai (Jul-Oct) with the short-duration (105–110 day) variety TKM9 measured the effect of slow-release nitrogen fertilizer on BS incidence. Commercial urea, sulfur-coated urea, and urea supergranule (1-g size) were applied at 29, 58, 87, and 110 kg N/ha in a randomized block design with 3 replications. Urea was applied in two equal split doses: at transplanting and panicle initiation. Sulfur-coated urea was incorporated at transplanting. Urea supergranule was spot applied, one granule for every 4 hills, 15 days after transplanting. Phosphorus and potassium were applied at 50 kg/ha to all plots. Disease incidence was assessed at growth stage 9, using the Standard Evaluation System for Rice.

No application and heavy application of urea caused heavy BS incidence. Application of sulfur-coated urea or urea supergranule appreciably reduced disease incidence (see table). These two fertilizers can be applied at levels from 87 to 110 kg N/ha with good reduction in disease incidence. Sulfur-coated urea performed better than urea supergranule. □

Effect of different forms of urea on BS incidence in rice.

Treatment	Disease intensity[a] at nitrogen levels				
	0	29 kg N/ha	58 kg N/ha	87 kg N/ha	110 kg N/ha
Commercial urea	–	5.1	5.0	4.6	5.0
Sulfur-coated urea	–	4.7	2.4	2.9	1.9
Urea supergranule	–	4.0	4.3	2.7	3.3
No nitrogen	5.6	–	–	–	–

[a]Based on 1980 Standard Evaluation System for Rice. Least significant difference at 5% level = 1.4.

Response of two rice varieties to *Rhynchosporium oryzae* infection.

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Earlier qualitative observations have indicated that in Sierra Leone narrow-leaf rice varieties were less affected by rice leaf scald fungus *Rhynchosporium oryzae* Hashioka & Yokogi than broadleaf varieties. During 1979 and 1980 wet seasons (May-Oct), field experiments compared the response of ROK 16 (broadleaf) and PN623-3 (narrow-leaf) to *R. oryzae* infection either with or without benomyl fungicide. Experiments were at

Table 1. Response of 2 rice varieties to *Rhynchosporium oryzae* infection in Sierra Leone.[a]

Experimental site	Treatment	Leaf area infected (%)	
		ROK16	PN623-3
1979			
Sendugu-NP	Benomyl	0.9	0.8
	Untreated	3.4*	2.8*
Makassa-NP	Benomyl	2.2	2.5
	Untreated	5.2*	4.2*
1980			
Masorie-NP	Benomyl	0.5	1.5
	Untreated	5.9	7.0
Sendugu-NP	Benomyl	0.4	0.3
	Untreated	1.6	1.3
Kenema-EP	Benomyl	0.1	0.1
	Untreated	0.2	0.3

[a]Values are means from the 4 top leaves in 1979 and from the 3 top leaves in 1980. NP = Northern Province, within 8 km from RRS; EP = Eastern Province, 360 km from RRS. ROK16 and PN623-3 have broad-droopy and narrow-erect leaves, respectively. For 1979, *denotes significant difference between benomyl-treated and untreated values; differences between varieties are not significant, $P = 0.05$. For 1980, LSD ($P = 0.05$) are 1.2 (Masorie), 0.7 (Sendugu), 0.1 (Kenema). Untreated plants were artificially inoculated at Masorie.

four RRS upland experimental sites (Table 1).

In 1979 the experiments were conducted separately for each variety in randomized, treated and untreated paired plots replicated six times. Seeds were drilled at 80 kg/ha with 20 cm between rows. In 1980 the experiments were carried out in a randomized complete block design with four replications. Four or five seeds were sown in hills spaced 20 × 15 cm. Plot size was 6 × 2 m, and treated plots received 4 sprayings of benomyl between tillering and dough stages at 0.33 kg ai/ha per spray. About 20 randomly chosen fertile tillers per plot were assessed for infection.

Percentages of the visible area of the leaf lamina infected, from the flag leaf and from three (1979) and two (1980) successive leaves for each tiller selected were averaged for each plot at dough stage in 1979, and at boot and dough stages in 1980. Infection rates between boot and dough stages were calculated for the 1980 experiments.

The varieties did not significantly differ in leaf area infected (Table 1). This observation was also true for the Masorie experiment in 1980 where plots which did not receive benomyl were artificially inoculated with *R. oryzae* conidia at maximum tillering stage. Symptoms from natural inoculum were rarely apparent before maximum tillering. Average leaf area infected in untreated plots was relatively low — between 0.2 and 5.9% for ROK16 and 0.3 and 7% for PN623-3.

Average infection was lowest in the flag leaves and increased progressively on the leaves below. The differences in infection rates were not significant ($P = 0.05$) (Table 2). Benomyl significantly reduced infection and, except for one instance, slowed the infection rate. In plots where enough disease developed to cause loss, average losses for both years were 15.3% for ROK16 and 12.6% for PN623-3. Correlation coefficients (r) between percent leaf area infected and yield for plots were significant ($P = 0.05$) only when r was calculated separately for each variety at each site for a given year. □

Table 2. *Rhynchosporium oryzae* infection rates between boot and dough stages in 2 rice varieties in 1980 in Sierra Leone [a]

Experimental site	Treatment	Infection rate [b]	
		ROK16	PN623-3
Masorie-NP	Benomyl	0.044	0.046
	Untreated	0.043	0.057
Sendugu-NP	Benomyl	0.016	0.003
	Untreated	0.041	0.026
Kenema-EP	Benomyl	0.012	0.029
	Untreated	0.029	0.039

[a] NP = Northern Province, within 8 km from RRS; EP = Eastern Province, 360 km from RRS. ROK16 and PN623-3 have broad-droopy and narrow-erect leaves, respectively. LSD ($P = 0.05$) are 0.043 (Masorie), 0.043 (Sendugu), 0.030 (Kenema). Untreated plants were artificially inoculated at Masorie. [b] After Van der Plank.

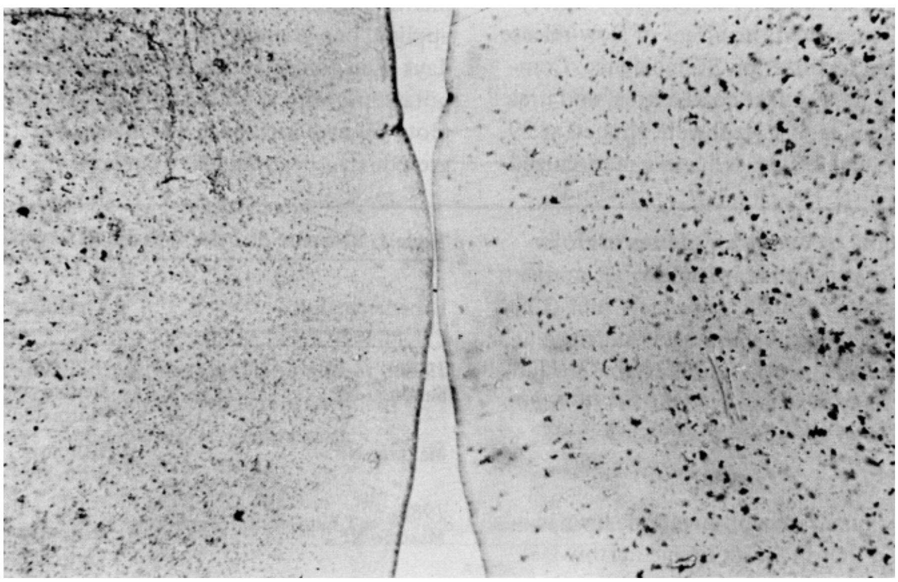
Rice tungro virus complex in tungro-resistant IR varieties

H. Hibino, E. R. Tiongco, and R. C. Cabunagan, IRRI

Tungro disease is associated with a virus complex composed of small bacilliform and isometric virus particles recently described as rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). Diseased plants exhibited severe symptoms when infected with both particles; mild symptoms with RTBV alone; and are almost symptomless with RTSV alone.

The presence of the RTV complex on IR36, IR42, IR50, IR54, and IR56, bred as tungro-resistant varieties, was determined by the latex agglutination test using antisera to RTBV and RTSV, and the virus recovery test using the vector insect *Nephotettix virescens.* Tungro-infected plants were obtained by inoculating 6-day-old seedlings with 1 insect per seedling in test tubes for 24 hours.

The latex agglutination test involved mixing equal volumes of a very small amount of plant sap and a suspension of latex particles (Difco Bacto Latex 0.81) treated with an antiserum. The mixture was then agitated vigorously for 5–10 min. The presence of the virus in the plant sap was indicated by the clumping or agglutination of the latex particles as observed under the light microscope (see figure).



A light micrograph shows clumping of latex particles indicating the presence of virus (right). No clumping (left) indicates absence of virus.

About 57, 42, and 27% of IR42, IR56, and IR36 plants sampled showed RTBV and RTSV. The other sampled plants showed RTBV only. However, all IR50 and IR54 plants sampled reacted to RTBV only. All plants of the susceptible check TN1 reacted to both RTBV and RTSV. No variety reacted to the presence of RTSV only (Table 1).

Attempts to recover the virus from the infected plants were made using *N. virescens.* Recovery was successful from plants infected with RTBV and RTSV. In the recovery tests involving 52 plants infected with RTBV alone, 1,408 seedlings were inoculated with 326 insects that were given 4 days acquisition time on the plants. No positive transmission was obtained regardless of variety (Table 2).

This is the first finding that shows a connection between the presence of RTBV alone in varieties with a high level of resistance to the vector, and with fairly low percentage of tungro infection. Although infected, these plants will not serve as virus source for the spread of the disease. □

Table 1. Presence of RTV complex on 5 IR varieties as detected by the latex agglutination test.

Variety	Reaction to GLH [a]	Reaction to RTV [b]	Plants tested (no.)	Plants (no.) that reacted to the presence of RTBV + RTSV	RTBV	RTSV
IR36	MR	S	15	4	11	0
IR42	MR	S	14	8	6	0
IR50	R	I	13	0	13	0
IR54	R	I	15	0	15	0
IR56	R to MR [c]	S	12	5	7	0
TN1	S	S	13	13	0	0

[a] Data from IRRI Entomology Department. [b]Greenhouse mass-screening results, IRRI Plant Pathology Department: 0 = 30% infection, resistant (R); 31-60%, intermediate (I); 61-l00%, susceptible (S). [c] Reaction varies from resistant (R) to moderately resistant (MR).

Table 2. Virus recovery from plants containing both RTBV and RTSV or RTBV alone using the vector insect *N. virescens.*

Variety	RTBV and RTSV [a]: Plants tested [b] (no.)	Insects tested (no.)	Infective insects (no.)	RTBV alone [c]: Plants tested (no.)	Insects tested (no.)
IR36	4	34	24	11	97
IR4	8	79	66	6	56
IR50	–	–	–	13	55
IR54	–	–	–	15	14
IR5	5	43	27	7	44
TN	113	108	71	–	–

[a] A dash indicates no recovery test conducted because no plant reacted to the presence of the virus. [b] Virus was recovered from all plants tested. [c]No plant or insect tested yielded the virus.

Pest management and control INSECTS

Rice yield loss caused by leaffolder damage at tillering stage

Sellammal Murugesan and S. Chelliah, Tamil Nadu Agricultural University, Coimbatore, India

Yield loss caused by leaffolder infestation at tillering stage was studied in the greenhouse by artificially infesting 55-day-old IR20 plants with 0, 1, 2, or 3 larvae/tiller. Each 30-cm pot had 5 tillers at infestation. The experiment was replicated 6 times.

The number of leaves damaged and total leaves in each infested tiller was recorded when larvae pupated. Percent of leaves damaged was calculated. Grains from individual tillers were collected at maturity, percentage of unfilled grains was calculated, and grain weight was estimated (see table).

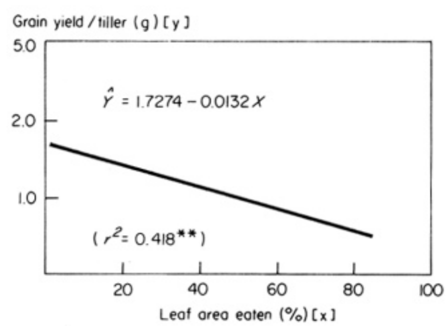
Damage and yield in leaffolder-infested IR20 [a]

Larvae (no.) /tiller	Leaves damaged [b] (%)	Mean yield [b] (g/tiller)	Yield reduction (%)	Unfilled (%)
0		2.1 a		9.6
1	43.6 a	1.1 b	48.8	29.1
2	58.8 b	1.0 b	52.2	26.2
3	70.8 b	0.9 b	56.9	29.0

[a]Mean of 30 tillers. [b]Means followed by common letter are not significantly different at 5% level.

Leaf damage was significantly lower for plants infested with 1 larva/tiller, but the yield did not differ significantly among the treatments. Yield was reduced by 49 to 57% for all treatments and 26 to 29% of grains were unfilled.

The regression of grain yield on the percentage of leaves damaged, and

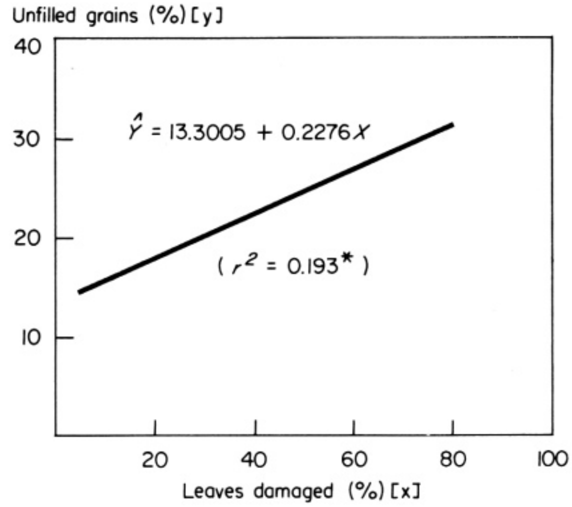


1. Regression of grain yield on percentage of leaves damaged by leaffolder. (n = 120)

percentage of unfilled grains on the percentage of leaves damaged was studied. The regression equation for grain yield on percentage of leaves damaged was $\hat{Y}$= 1.9234 – 0.0149 X, with a highly significant (P = 0.01) r^2 value of 0.409 (Fig. 1). A 10% increase in damaged leaves reduced yield by 0.15 g/tiller.

The regression equation for percentage of unfilled grains on percentage of damaged leaves was $\hat{Y}$= 13.3005 + 0.2276 X, with a significant (P = 0.05) r^2 value of 0.193 (Fig. 2). A 10% increase in the damaged leaves increased the unfilled grains by 2%. □

2. Regression of percentage of unfilled grains on percentage of leaves damaged by leaffolder. (n = 120)



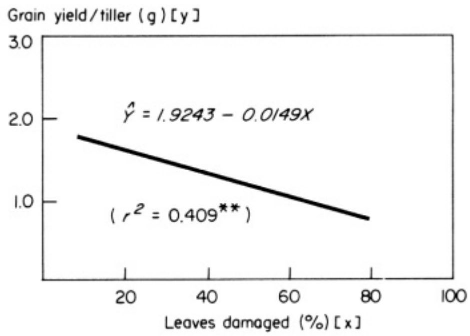
Rice yield losses caused by leaffolder damage to the flag leaf

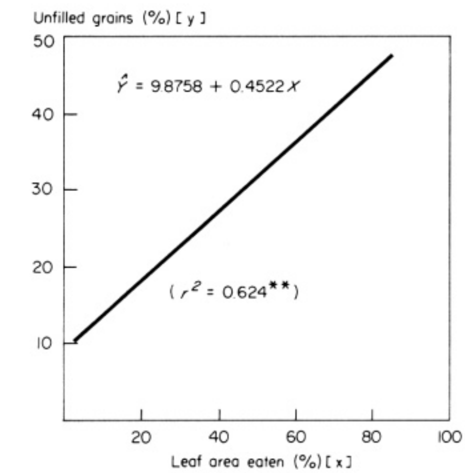
Sellamal Murugesan and S. Chelliah, Tamil Nadu Agricultural University, Coimbatore, India

Rice leaffolder *Cnaphalocrocis medinalis* Guenée is an important rice insect in Tamil Nadu. Infestation is common at maximum tiller or flag leaf stages.

Flag leaves of potted IR20 plants were artificially infested with one 4th-instar larva/tiller. Feeding was confined to the flag leaf. Uninfested plants were the check. Four days after infestation, the larva was removed and damage was recorded as percent of the total area of the leaf. Grains from individual infested tillers were collected at maturity and percent unfilled grains was calculated. Healthy grain weight was recorded and lost grain yield was calculated.

Flag leaf damage ranged from 5 to 85% in different tillers and was categorized as < 25, 26-50, 51-75, and >75%. Leaf area damage up to 50% reduced mean yield per tiller by 47%. When insect damage exceeded 75%, yield was reduced 70% (see table).





1. Regression of grain yield on percentage of flag leaf area damaged by leaffolder. *Top:* 2. Regression of unfilled grains on percentage of flag leaf area damaged by leaffolder.

Effect of flag leaf damage by leaffolder on rice gain yield. [a]

Leaf area damage (%)	Mean yield (g/tiller)	Yield reduction (%)
<25	1.1	47
26-50	1.1	
51-75	1.2	46
>75	0.7	70
Uninfested	2.2	

[a] Mean of 8 replications.

The regression of grain yield on percent of leaf area damaged and percent of unfilled grains on percent of leaf area damaged was studied.

The regression equation of grain yield on the percentage area damaged was $\hat{Y}$ = 1.7274 – 0.0132 X, with a highly significant (P = 0.01) r^2 value of 0.418 (Fig. 1). A 10% increase in leaffolder damage reduced yield by 0.13 g/tiller.

The regression equation of percentage unfilled grains on percent flag leaf damage was $\hat{Y}$= 9.8758 + 0.4522 X, with a highly significant (P = 0.01) r^2 value of 0.624 (Fig. 2). A 10% increase in flag leaf damage increased unfilled grains by 4.5%/tiller. □

Efficacy of insecticides against rice whorl maggot

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Chlorpyriphos 10 G (coroban), carbofuran 3 G (furadan), and monocrotophos 40 EC (Monocil) were tested for control of rice whorl maggot (RWM) *Hydrellia philippina* at the NDUAT Crop Research Station during 1981 kharif. Saket 4 was planted in 5 × 4m plots. Insecticides were applied to 10-day-old nursery seedlings 10 days after transplanting. Insecticide granules were broadcast and monocrotophos was sprayed. RWM infestation was recorded 30 days after transplanting by counting total and damaged leaves on 10 randomly selected plants from each plot. Data were statistically analyzed after angular transformation (see table).

Results showed all treatments to be significantly superior to the control. However, chlorpyriphos 10 G was most effective when applied 10 days after transplanting. Monocrotophos 40 EC achieved similar results whether applied in the nursery or in the field after transplanting. □

Insecticide control of RWM.

Insecticide formulation	Dose (kg ai/ha)	% RWM incidence (av of 3 replications)
10 days after nursery sowing		
Chlorpyriphos 10 G	1.0	14
Carbofuran 3 G	0.5	16
Monocrotophos 40 EC	0.5	17
10 days after transplanting		
Chlorpyriphos 10 G	1.0	5
Carbofuran 3 G	0.5	10
Monocrotophos 40 EC	0.5	16
Control		22
CD at 5%		3.29

Effect of blends of custard-apple oil and neem oil on survival of *Nephotettix virescens* and tungro virus transmission

V. Mariappan and R. C. Saxena, IRRI

Although *N. virescens,* the vector of the rice tungro virus (RTV), is still effectively controlled with insecticides in the tropics, their extensive use may cause insecticide resistance, as has happened in Japan on a closely related species, *N. cincticeps.* Recent studies at IRRI demonstrated that custard-apple *Annona squamosa* and neem *Azadirachta indica* oils significantly reduced *N. virescens* survival and RTV transmission on rice seedlings. Custard-apple oil contains several alkaloids and glycerides of hydroxylated unsaturated acids, and neem reduces insect populations because of several bitters or limonoids. Combinations of the oils were tested to determine if blends would improve pest control activity.

Custard-apple oil and neem oil, emulsified in water individually and as 1:1, 1:2, 1:4 (vol/vol) blends in 1% liquid detergent, were tested at 5, 10, and 20% oil concentrations. Ten-day-old TN1 rice seedlings were sprayed 3 hours before they were exposed to viruliferous *N. virescens.* Control plants were sprayed with a 1% detergent solution. The seedlings were placed in 1.5 × 15 glass test tubes and covered with polyvinyl caps.

Viruliferous insects that had a 4-day acquisition feeding on RTV-infected TN1 plants were released singly into each test tube for inoculation feeding, After 24 hours, the seedlings were transplanted in pots. Individual, fresh, oil-sprayed seed-

Table 1. Survival of *Nephotettix virescens* 1, 2, and 3 days exposure to TN1 rice seedlings sprayed with custard-apple oil (CAO) and neem oil (NO).[a] IRRI, 1983.

Treatment	Oil concn (%)	Insect survival[b] (%) 1 day	2 days	3 days
CAO	5	62 cd	25 cd	5 c
CAO	10	52 d	15 de	0 c
CAO	20	19 efg	2 fg	0 c
NO	5	82 b	50 b	19 b
NO	10	70 bc	34 bc	7 bc
NO	20	52 d	17 de	0 c
CAO + NO (1:l)	5	29 e	7 ef	0 c
CAO + NO (1:l)	10	16 efg	1 fs	0 c
CAO + NO (1:l)	20	7 g	0 g	0 c
CAO + NO (1:2)	5	23 ef	3 fg	0 c
CAO + NO (1:2)	10	16 efg	4 g	0 c
CAO + NO (1:2)	20	7 g	0 g	0 c
CAO + NO (1:4)	5	13 efg	0 g	0 c
CAO + NO (1:4)	10	10 fg	0 g	0 c
CAO + NO (1:4)	20	9 g	0 g	0 c
Control (water + 1% liquid detergent)	0	100 a	100 a	97 a

[a]Average of 5 replications, 320 insects/replication. [b]In a column, means followed by a common letter are not significantly different at the 5% level.

Table 2. Rice tungro virus (RTV) infection in TN1 rice seedlings sprayed with custard-apple oil (CAO) and neem oil (NO) after exposure to viruliferous insects.[a] IRRI, 1983.[a]

Treatment	Oil concn (%)	RTV infection (%) of TN1 seedlings[b] 1 day	2 days	3 days
CAO	5	38 d	16 de	2 d
CAO	10	34 de	12 de	0 d
CAO	20	23 fg	7 ef	0 d
NO	5	67 ab	40 b	15 b
NO	10	56 c	28 c	8 c
NO	20	58 bc	20 cd	0 d
CAO + NO (1:1)	5	25 ef	6 fg	0 d
CAO + NO (1:1)	10	21 fg	0 i	0 d
CAO + NO (1:1)	20	11 i	0 i	0 d
CAO + NO (1:2)	5	21 fg	7 ef	0 d
CAO + NO (1:2)	10	19 fg	3 gh	0 d
CAO + NO (1:2)	20	15 ghi	0 i	0 d
CAO + NO (1:4)	5	17 fgh	3 gh	0 d
CAO + NO (1:4)	10	14 ghi	3 ghi	0 d
CAO + NO (1:4)	20	11 hi	1 hi	0 d
Control (water + 1% liquid detergent)	0	69 a	56 a	36 a

[a]Average of 5 replications, 320 seedlings/replication at the start. [b]In a column, means followed by a common letter are not significantly different at the 5% level.

lings were placed in test tubes containing the surviving viruliferous insects. Successive inoculation feeding of the survivors on treated plants continued until insects died. The experiment used 1,600 insects and 3,352 seedlings in a split-plot design. The first disease symptoms were observed on day 12.

One day of feeding on oil-sprayed seedlings markedly reduced insect survival. All insects survived in the control (Table 1). Insect survival in all treatments with oil blends was significantly lower than in treatments with individual oils.

Two days after feeding, all insects in the control were alive, but insect survival was 0-4% in treatments involving oil blends and 20% custard-apple oil. Three days after feeding, insect survival was 97% in the control, but 0-7% on seedlings sprayed with different concentrations of oil blends or individual oils, except 5% neem oil.

One-day inoculation feeding infected 69% of the control seedlings. Infection of seedlings in treatments involving all concentrations of oil blends and custard-apple oil was only 11–38% (Table 2).

However, neem-oil-treated seedlings had significantly reduced infection only at 10 and 20% concentrations.

After 2 days of inoculation feeding, 56% of the control seedlings were affected, while $\leqslant$7% infection occurred in treatments involving all oil blends and 20% custard-apple oil.

After 3 days of feeding, 36% of the control seedlings were infected, while infection was negligible in all oil treatments except at the lowest neem oil concentration. □

Influence of lunar cycle on light trap catches of rice stem borer

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Effect of lunar cycle on light trap catches of stem borer (SB) *Scirpophaga incertulas* (Walker) was studied at Madurai Agricultural College and Research Institute during four lunar periods between October 1981 and January 1982. A modified Robinson light trap with a 125-w mercury vapor lamp was used. The average number of insects trapped from 2 days before to 2 days after the new moon and full moon was analyzed (see table).

Although some studies report that the lunar cycle influences SB catch, our study indicates a nonsignificant relationship between SB trapped in new moon and full moon periods. The use of a high intensity light source (46 lm/w) may have influenced the results. □

Influence of lunar cycle on light trap catches of rice stem borer.

Moths trapped [a] = (no.)	
New moon	Full moon
291.40 (2.46)	860.80 (2.93)
844.00 (2.93)	396.00 (2.60)
106.00 (2.03)	371.46 (2.57)
10.00 (1.00)	6.40 (0.81)
$F = 0.20^{ns}$	
ns = nonsignificant	

[a] Mean of 5-day catch. Figures in parentheses are transformed values.

Brown planthopper in eastern Uttar Pradesh, India

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Brown planthopper (BPH) *Nilaparvata lugens* Stål infestations were observed at the Crop Research Station, Masodha, NDUAT, Faizabad, and surrounding areas during 1980 kharif. Twenty-four rice varieties were attacked; among them are three important commercial varieties in the region: Saket 4, Sarjoo 52, and Jaya.

Because eastern Uttar Pradesh has a large rice growing area, the appearance of BPH may soon create a serious problem. □

White grub outbreak on rainfed dryland rice in Uttar Pradesh

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White grubs are important pests of rainfed rice in the hill areas of Uttar Pradesh. Severe infestation occurs sporadically and is normally restricted to small areas. Severe outbreaks occurred over large areas during 1981 and more than 50% of the crop was damaged by the pest. In some heavily infested fields, 80% of the crop was damaged.

Anomala dimidiata var. *barbata* Burm. (Rutelinae: Scarabaeidae: Coleoptera), *Holotrichia seticollis* Moser (Melolonthinae: Scarabaeidae: Coleoptera), and *Heteronychus lioderes* Redt. (Dynastinae: Scarabaeidae: Coleoptera) are damage-causing species. *H. lioderes* is found only on rice, but the other species attack almost all other kharif Jun–Oct crops, including millet *(Echinochloa frumentacea),* maize *(Zea mays),* soybean *(Glycine max),* and French bean *(Phaseolus vulgaris).* Dryland rice, which covers the largest area, is the most affected crop.

These white grub species are univoltine. Adult beetles emerge at the onset of monsoon rains, usually in early June. Beetles are metallic green *(A. dimidiata),* dark brown *(H. seticollis),* or black *(H. lioderes). A. dimidiata* and *H. seticollis* beetles feed on leaves of apple, apricot, walnut, poplar, and oak trees and on some wild shrubs. *A. dimidiata* beetles also feed on maize leaves and tassels. *H. lioderes* beetles burrow into the base of the rice plant. Peak activity period is at night. They burrow underground and damage many plants, causing patches of dead plants in the fields. Maximum damage is caused during seedling stage in June and July. Beetles also damage irrigated crops in flooded fields.

Beetles lay eggs a few days after emergence. About one month later grubs begin to cause damage. They feed on roots, rootlets, and roothairs. Attacked plants can easily be pulled from the soil. Grub damage has been observed throughout the crop season, but peaks in August. The most severe infestations were recorded in light, sandy soil.

Sporadic Occurrence of two other species, *Popillia cupricollis* Hope (Rutelinae: Scarabaeidae: Coleoptera) and *Holotrichia Iongipennis* Blanch (Melolonthinae: Scarabaeidae: Coleoptera), has also been reported. *P. cupricollis* grubs cause damage and beetles chew the rice grains at dough stage.

The 1981 outbreak may have been caused by abnormal rainfall during June, when the beetles emerge, and August, when grubs start damaging the crop. A heavy shower in the third week of June after a dry spell seems to have triggered simultaneous emergence of adults, which normally emerge over a long period from June through July. Low rainfall during the next 2 weeks encouraged egg-laying and hatching. Intermittent, low rainfall from last week of July through August favored grubs development. ☐

Occurrence of brown planthopper on *Leersia hexandra* in the Philippines

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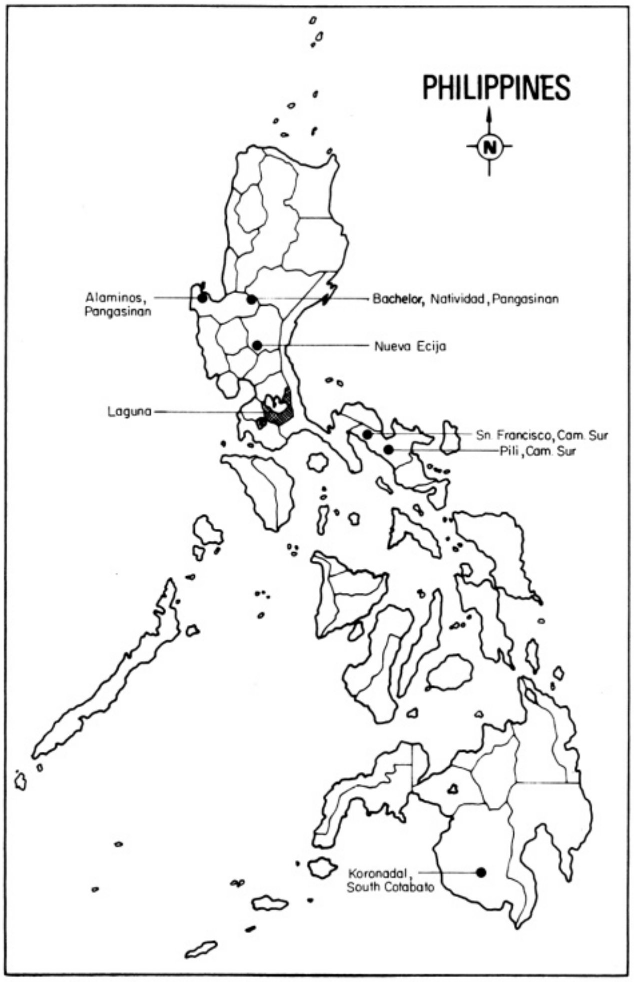
In 1982, a brown planthopper (BPH) population which feeds on the weed *Leersia hexandra* was reported in irrigation canals on the IRRI farm. Studies indicated that this population did not feed on rice. A survey was conducted to determine whether the *L. hexandra* population occurred in other areas in the Philippines. *L. hexandra* populations were found in 5 of 11 provinces surveyed (see table) from north to south (see figure).

Occurrence of BPH in *Leersia hexandra* in Philippine provinces.[a]

Province	Present (+) or undetected (–)
Pangasinan	+
Cagayan	–
Pampanga	–
Tarlac	–
Nueva Ecija	+
Bulacan	–
Laguna	+
Batangas	–
Quezon	–
Camarines Sur	+
South Cotabato	+

[a]Five locations in each province were surveyed.



Locations where Leersia hexandra BPH populations were found.

Leptochloa panicoides Wight, an occasional host of the yellow rice borer *Scirpophaga incertulas* Walker

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Yellow rice borer *Scirpophaga incertulas,* a major rice pest, is monophagous with exclusive host specificity to rice. A set of 52 plant species (25 grasses, 12 sedges, and 15 dicots), which characterize the rice ecosystems of Orissa, were tested with rice (Jaya) for yellow rice borer host potential.

Twenty-five newly hatched first-instar larvae were reared on five stem pieces of each test plant. Stem pieces were replaced every 3 days, surviving larvae were transferred, and larval mortality was recorded. All larvae died within 2 days on 19 grasses, 12 sedges, and 15 dicots, and on 5 more grasses by day 5. The larvae on *Leptochloa panicoides* (Gramineae) continued to survive and grow beyond day 15, but died by day 27. Larvae reared on Jaya pupated on day 29.

L. panicoides plants and rice plants grown in earthen pots were infested with 10 neonate larvae/plant. Larvae caused typical deadheart and whitehead symptoms in 8 and 9 days on *L. panicoides* and in 7 days on Jaya. Third- and fourth-instar borer larvae formed typical leaf cases and migrated from *L. panicoides* to Jaya. Narrow *L. panicoides* stem lumen may be too small to house maturing larvae.

Field surveys in May-June recorded borer egg masses, deadhearts, and whiteheads, but no live larvae on *L. panicoides*. *L. panicoides* should be considered an occasional host for yellow rice borer. It is a common weed in wetland rice fields and along irrigation canals. It flowers during July–August and in March.

Whitebacked planthopper *Sogatella furcifera* Horvath on rice in Kathmandu Valley

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In 1982 the delayed monsoon season caused rice to be transplanted nearly a month late. In Jul-Aug whitebacked planthopper *Sogatella furcifera* Horvath populations reached epidemic levels on more than 3,000 ha in Kathmandu Valley. Damage to late planted rice was most serious. Insect population, calculated by taking 10 standard sweeps in 2 infested areas, is shown in Table 1.

Information on the infested localities in three districts of the Valley is given in Table 2.

Table 1. Number of whitebacked planthoppers per 10 standard sweeps, in 4 replications, Kathmandu Valley, Nepal, 1982.

Date	Locality	Whitebacked planthoppers (no.)			
		1	2	3	4
6 Aug 1982	Sundarijal	13,000	14,4 00	11,200	16,000
19 Aug 1982	Manahara	4,400	3,000	6,000	7,000

Table 2. Area and extent of damage by whitebacked planthopper at different locations in Kathmandu Valley, Nepal, 1982.

District and altitude	Location	Area infested (ha)	Pest status
Kathmandu, 1372-2732 m	Gokarna, Nayapati Sundarijal	1300	Serious[a]
	Sakhu, Pukulachi, Suntole	425	-do-
	Bhadrabas, Mulpani Indrayani	450	-do-
Lalitpur, 457-2831 m	Thaibo, Kitini, Godawari	250	-do-
Bhaktapur, 1372-2166 m	Bageswari, Nagarkot	100	-do-
	Changu Narayan Manahara phat	300	*Medium*[b]

[a]More than 90% infestation (eye estimation). [b]Less than 50% infestation (eye estimation).

BPH outbreak in South Arcot District, Tamil Nadu, India

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A contiguous 243-ha area in Aviyanur, Payithampadi, Kavanur, and Unumdampet along the south bank of Pennai River has been seriously attacked by brown planthopper (BPH). The area has year-around irrigation and is traditionally planted with two short-term rice crops and one medium-duration rice.

Standing crops of IR50, TKM9, IET1722, and Manila planted in Jun-Jul as short-term crops were severely infested in almost all fields. IET1722 had up to 700 BPH/hill, and IR50 had 500-700/hill. Other varieties had about 500/hill. All varieties were hopperburned.

About 2/3 of the BPH population were macropterous females and 1/10 were 3d, 4th, and 5th instar nymphs. Brachypterous insects were few. Substantial numbers of BPH predators such as *Coccinella arcuata, Cyrtorhinus lividipennis,* and ants were observed.

Farmers reported that crops received 173–198 kg N/ha in each rice season. Rice commonly receives three to four applications of quinalphos or BHC. Quinalphos has been reported to be a BPH resurgence-inducing insecticide. Drought with long spells of dry humid weather recently had been broken by late monsoon showers. These factors may have contributed to the BPH infestation. □

The International Rice Research Newsletter and the IRRI Reporter are mailed free to qualified individuals and institutions engaged in rice production and training. For further information write: IRRI, Communication and Publications Dept., Division R, P.O. Box 933, Manila, Philippines.

Efficacy of buprofezin (NNI-750) for brown planthopper (*N. lugens*), green leafhopper (*Nephotettix* sp.), and whitebacked planthopper (*S. furcifera*) control

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Buprofezin (3-isopropyl-5-phenyl-2-tert-butylimino-tetrahydro-1,3,5-thiadizin-4-one) effectively kills brown planthopper (BPH), green leafhopper (GLH), and whitebacked planthopper (WBPH) nymphs at molting when the insects are sprayed directly or feed on treated plants (Table 1).

In greenhouse tests, buprofezin did not effectively control adult BPH, GLH, or WBPH. In field tests, the insecticide affected several generations of BPH and reduced population density to a low level (Table 2). Buprofezin is slow acting, has longer residual effect than conventional insecticides, and is relatively safe to natural enemies. □

Table 1. Effect of buprofezin on 3d-instar BPH, GLH, and WBPH nymphs using Potter's spray tower and foliar spray at 0.075% concentration.[a]

Treatment	Potter's spray						Foliar spray					
	3 DAT			5 DAT			3 DAT			5 DAT		
	BPH	GLH	WBPH	BPH	GLH	WBPH	BPH	GLH	WBPH	BPH	GLH	WBPH
Buprofezin	100 a	99a	100a	100a	99a	100a	l00a	98a	99a	100a	98a	l00a
Control	5 b	8 b	1 b	9 b	10 b	10 b	2 b	0 b	6 b	6 b	2 b	12 b

[a]In a column, means followed by a common letter are not significantly different at the 5% level. DAT = days after treatment.

Table 2. Effect of buprofezin rates on BPH field populations.

Treatment	Means of BPH count after insecticide application[a]									
	1st application				2d application			3d application		
	2 DBFA[b]	5 DAT	10 DAT	15 DAT	5 DAT	10 DAT	15 DAT	5 DAT	10 DAT	15 DAT
Buprofezin										
0.125 kg ai/ha	30.69	11.02 a	11.51 a	10.48 ab	5.80 c	11.66 ab	5.52 d	3.32 b	2.46 b	2.69 bc
0.250 kg ai/ha	26.19	10.36 a	11.21 a	9.49 b	5.15 c	11.94 ab	6.09 c	3.31 b	2.68 b	2.34 c
0.500 kg ai/ha	27.62	10.09 a	11.60 a	10.20 ab	5.00 c	11.76 ab	6.29 c	3.47 b	2.80 b	2.49 bc
BPMC										
0.75 kg ai/ha	25.55	10.99 a	12.09 a	12.06 a	6.50 b	7.86 b	7.09 b	3.28 b	3.05 b	4.72 b
Control	29.40	11.60 a	12.85 a	11.35 ab	16.41 a	18.50 a	15.99 a	13.70 a	13.20 a	14.71 a

[a]In a column, means followed by a common letter are not significantly different at the 5% level. [b]DBFA = days before first application, DAT = days after treatment.

Light trap catches of green leafhoppers by time of day

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Nephotettix spp. are the predominant species of rice leafhoppers and planthoppers in Eastern Uttar Pradesh. Seasonal population fluctuations and hopper species dominance have been recorded regularly since 1976 using light traps installed on the research farm. Traps operate from 1800 to 0600 hours daily. Light trap catches indicate the necessary level of green leafhopper control. We conducted a study to determine the best time of day to trap leafhoppers. Three Mitsuo Yoshimuki light traps with double coiled 210–240 volt tungsten mercury vapor filaments and a 160-watt electric bulb were installed 200 m apart and operated for 3 successive nights at weekly intervals. Insect numbers in each catch were recorded hourly from 1900 to 0600.

Most green leafhoppers were trapped between 1900 to 2100 hours. Catches between 1800 to 1900, and 2100 and 2200 were also high. After 2200, catches decreased toward morning. Of total leafhoppers trapped, 39% were caught between 1900 and 2100 hours, and 64% during the first 4 hours (see table). These data indicate light traps can be used most efficiently between 1900 and 2100 hours.

Catches of rice green leafhopper by hour of day.

Hour	Catch at 3 trapping dates[a] (1981)			Mean catch	% catch
	19 Oct	26 Oct	2 Nov		
1800–1900	97	93	64	84.73	14
1900–2000	146	115	71	110.82	19
2000–2100	130	112	67	103.03	17
2100–2200	104	88	56	82.60	14
2200–2300	96	74	42	70.68	12
2300–2400	67	50	30	48.72	8
2400–0100	47	35	20	33.84	6
0100–0200	39	23	13	24.63	4
0200–0300	22	16	7	15.45	3
0300–0400	11	10	6	9.03	1
0400–0500	10	7	4	7.20	1
0500–0600	7	5	3	5.11	1
Total	776.21	630.17	381.12		
CD at 5% level	17.172	16.757	18.354		
CD at 1% level	23.341	12.777	24.948		

[a]Data were converted to square root ($\sqrt{n+0.5}$), then rounded.

Light trap catches of rice gall midge

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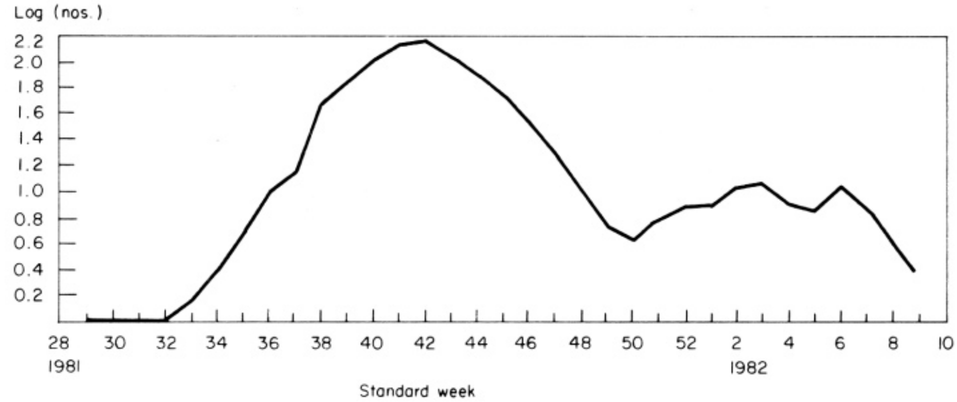
From Jul 1981 to Mar 1982, a bamboo light trap with a 40-watt bulb was operated at the ACRI experimental farm, Madurai, to determine population fluctuations and peak emergence of rice gall midge *Orseolia oryzae* (Wood-Mason). The data will help scientists predict pest occurrence and insecticide applications.

The earliest gall midge capture was in the second week of Aug. Populations gradually increased until mid-Oct, then declined (see figure). Peak occurrence coincided with the maximum tillering phase of the rice crop. □



Adult midges collected in a bamboo light-trap with a 40-watt bulb, Madurai, India, 1981-82.

Insecticide toxicity to natural brown planthopper enemies

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We investigated contact toxicity of some foliar insecticides on brown planthopper predators: the mirid bug *Cyrtorhinus lividipennis* Reuter and spiders, *Lycosa* sp., that inhabit the rice ecosystem

Two 10-day-old TN1 seedlings were planted in clay pots. Plants were sprayed with insecticides 20 days after planting; 24 h later 10 adult mirid bugs (5 males and 5 females) were released per pot and confined in mylar cages. To prevent the predators from starving, three to four BPH nymphs were released in each pot.

Twenty spiderlings were forced to crawl over a chemical solution film in a large petri dish for 2 min then immediately transferred to glass tubes which were covered with muslin. Predator mortality was recorded 24 h after treatment.

Decamethrin and methyl parathion caused 100% *C. lividipennis* mortality, closely followed by cypermethrin, fenvalerate, quinalphos, phosalone, and permethrin (see table). All insecticides tested were highly toxic to spiderlings. Mortality ranged from 74% (FMC35001) to 98% (decamethrin and methyl parathion). □

Toxicity of insecticides to brown planthopper predators.[a]

Insecticide	Corrected mortality[b] (%)	
	C. lividipennis	*Lycosa* sp.
Decamethrin 0.002%	100 a	98 a
Methyl parathion 0.04%	100 a	98 a
Cypermethrin 0.002%	93 a	93 a
Fenvalerate 0.002%	93 a	92 a
Quinalphos 0.04%	93 a	92 a
Phosalone 0.04%	93 a	92 a
Permethrin 0.002%	92 a	90 a
Fenthion 0.04%	85 ab	90 a
Methamidophos 0.04%	76 b	87 ab
Phosphamidon 0.04%	76 b	79 b
FMC35001 0.04%	76 b	74 b

[a] Mean of 3 replications. [b]Analysis based on arcsin/percentage values. Means followed by a common, letter are not significantly different at 5% level.

Pest management and control WEEDS

Sawdust-mulching for controlling weeds in transplanted summer rice

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Weeds are a major constraint to successful summer rice cultivation in Assam. Sawdust mulch 0, 2, and 4 cm thick was tested for weed control on Pusa 33, Mairang, and Ngoba in a split-plot design with 4 replications. On 25 Apr, 25-day-old seedlings were transplanted in 20 × 15 cm spacing on 9-m^2 plots. At land preparation, 80 kg N, 21.5 kg P, and 33 kg K/ha were applied. Weed samples were collected from 1.8-m^2 strips from each plot.

Mulching significantly suppressed weed growth (Table 1). Weed weights

Table 1. Fresh weight of weeds per 1.8 m^2 in rice fields with different sawdust mulching.

Variety	Fresh wt (g) of weeds			
	0	2-cm mulch	4-cm mulch	Mean[a]
Pusa 33	960	700	720	793.3 b
Mairang	2790	1466	853	1703.0 a
Ngoba	1100	1016	866	944.0 b
Mean[a]	1616.7 a	1060.7 b	873.0 c	

[a]Any two means followed by different letters are significantly different at 5% level of probability.

differed in different rice varieties, but interaction between mulching and variety was not significant (Table 2). Less weed weight was associated with Pusa 33, which may be because it produces more tillers and forms a more complete canopy than the two tall varieties. Mulching did not significantly increase yield. The following weed species, in order of frequency, were observed: *Echinochloa colona* (L.) Link, *Ludwigia octuvalvis* (Jacq., Raven), *Cyperus iria* L., *Eclipta prostrata* (L.) *L., Cynodon dactylon* (L.) Pers., *Fimbristylis miliacea* (L.) Vahl, *Eleusine indica* (L.) Gaertn., *Digitaria longiflora* (Retz.) Pers., *Commelina benghalensis* L., *Vernonia cinerea* (L.) Less., *Cyperus pilosus* Vahl, *Dactyloctenium aegyptium* (L.) Beauv., and *Cyperus rotundus* L. □

Table 2. Rice yield in different treatments of sawdust mulching,

Variety	Rice yield (t/ha)			
	0	2-cm mulch	4-cm mulch	Mean
Pusa 33	3.4	4.8	4.6	4.3
Mairang	1.9	2.2	2.1	2.1
Ngoba	3.0	3.4	3.2	3.2
Mean	2.8	3.5	3.3	

Effect of azolla inoculation on weed growth in wetland rice

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Azolla has been reported to suppress weed growth in rice. A field experiment to determine the effect of azolla on growth of *Echinochloa* spp. in flooded rice was conducted in a randomized block design with three replications during 1981-82 samba. Co 43 (TNAU17005) was grown. One week after transplanting, *Azolla pinnata* was inoculated at 100, 150, 200, 250, 300, 350, 400, 450, and 500 g/m^2. A basal amount of 50 kg P/ha and 50 kg K/ha in 3 splits were applied.

Growth of *Echinochloa glabrescens, E. stagnina, E. crus-galli,* and *E. colona* was observed. Weeds were allowed to grow for 40 days, then fields were weeded and weed fresh weight was recorded (see table). Azolla was incorporated 41 days after planting, with 2 more incorporations at 21-day intervals. Grain yield was recorded.

Weed growth was significantly reduced in azolla-inoculated plots, especially in those with higher inoculation levels (see table). The rapid growth and multiplication of azolla limited weed growth and probably altered gas exchange, light penetration, and temperature. □

Effect of azolla inoculation on weed growth in wetland rice.

	Fresh weed weight[a] (kg/7.5-m^2 plot)	% reduction over control	Grain yield (t/ha)
Azolla inoculation (g/m^2)			
100	2.9	47	6.1
150	2.6	51	6.3
200	1.8	67	6.2
250	2.1	62	6.0
300	2.2	60	6.2
350	1.9	66	6.1
400	1.4	74	6.0
450	1.0	81	6.5
500	1.3	76	6.6
30 kg N/ha	5.7	–	6.4
Uninoculated control	5.4	–	3.6
	LSD = 1.2		LSD = 1.3

Significant at 1% level.

[a] *Echinochloa glabrescens, E. colona, E. stagnina, E. crus-galli.*

Pest management and control

NEMATODES

Dissemination of rice root nematode through rice seedlings

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Rice root nematode *Hirschmanniella oryzae* causes up to 25% yield losses in flooded rice. This migratory endoparasite embeds itself in and feeds on root tissue. We studied the movement of root nematode from the nursery to the field by seedlings on farmer fields on the Cauvery Delta in Tamil Nadu.

Random samples of ADT31 rice seedlings and soil from 24 flooded wet season nurseries untreated with pesticides were collected from Cauvery Delta village. Ten 23- to 25-day-old seedlings were pulled from each nursery bed and a core soil sample was taken. Number of nematodes was estimated by Baermann pan technique using 250 g soil and 5 g rice root.

All but one nursery were infested by *H. oryzae.* Population ranged from 6 to 86 (mean 10.74) nematodes/250 g soil and 3 to 148 (mean 30.42) nematodes/5 g of root. Mean (wet) weight of the roots was 1.2 g/seedling and the mean number of nematodes per infested seedling at planting ranged from 0.60 to 29.60 (mean 7.03). These data indicate the importance of using chemicals to control nematodes in the nursery or a root dip before planting rice seedlings. □

Soil and crop management

Effect of crop residue on blue-green algae growth in wetland rice

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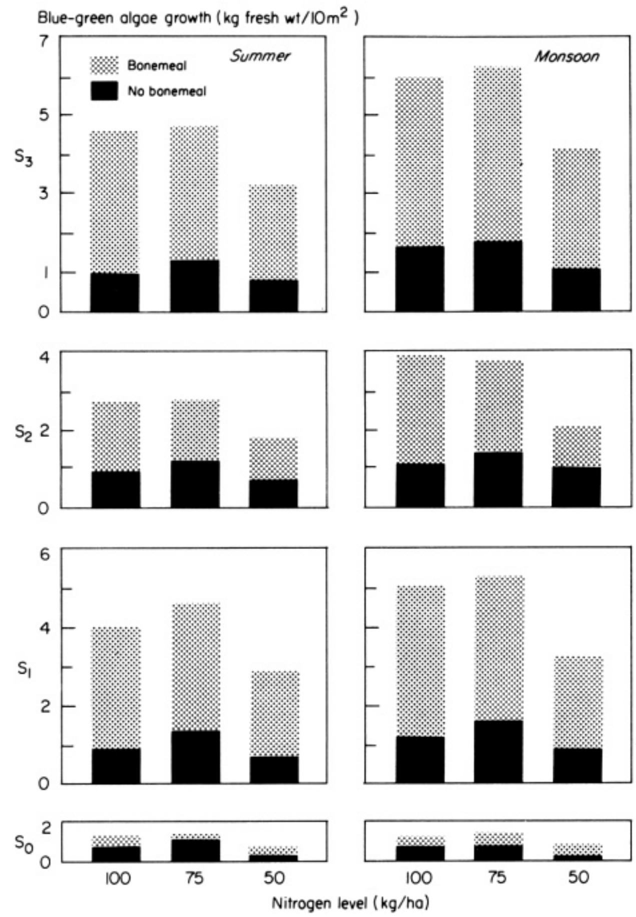
Field experiments determined the effect of crop residue on growth of blue-green algae (BGA) during 1981 summer and monsoon season at Tamil Nadu Agricultural University. Treatments with three replications were randomized in a split-plot design.

Summer treatments were control (S_0), 10 t rice long straw/ha (S_1), 4.6 t 30-cm rice stubbles/ha (S_2), and 10 t composted rice straw/ha (S_3) incorporated with 50, 75, or 100 kg N/ha alone and in combination with bonemeal (22 kg P/ha). The subsequent monsoon rice crop was raised in the same field to study the residual effect of residues and bonemeal. Nitrogen was applied at 50, 75, or 100 kg N/ha alone and in combination with bonemeal (11 kg P/ha).

At rice flowering stage fresh weight of BGA from the topsoil was recorded at four 50 × 50 cm^2 quadrats in each plot and expressed in kg/ 10 m^2.

S_3 recorded the maximum BGA weight in summer. S_1 yield was similar. During the monsoon season, S_3 was superior to S_1 and S_2. This natural BGA buildup was stimulated by crop residues, which provided the raw material for BGA photosynthesis under flooded conditions. Although application of bonemeal significantly improved the growth of BGA in both seasons, BGA grew more during the monsoon season than in summer. Growth was inhibited at 100 kg N/ha (see figure). BGA withstood dehydration during the fallow period between summer and monsoon crops. □



Blue-green algal growth at flowering. Tamil Nadu, India.

Effect of deep placement of nitrogen fertilizer on ratoon rice

Md. Abdul Quddus, scientific officer, Division of Rice Cropping Systems, Bangladesh Rice Research Institute, and J. W. Pendleton, head, Multiple Cropping Department, IRRI

Deep placement of nitrogen fertilizer on rice seems to improve nitrogen utilization efficiency and increase grain yield. We tested the effect of deep placement on ratoon rice yield.

IR9784-52-2-3-2, identified as having relatively good ratooning ability, was grown in 10-liter plastic pots filled with finely ground Maahas clay soil that was mixed thoroughly with 75 mg N, 44 mg P, and 83 mg K per kg soil before potting. Two 12-day-old seedlings raised in trays were transplanted into each pot. Water depth was 2-3 cm for 3 days and then increased to 5-7 cm and maintained at that level until grain ripening. When 90% of the panicle had ripened, plants were harvested by cutting at a 15-cm height above the soil. Four days later, nitrogen as urea was evenly broadcast on the soil surface around each plant or placed 15 cm beneath the soil surface with an injector (see table).

Different N levels and placement methods had a significant effect on grain yield. Nitrogen applied at 15-cm depth produced significantly higher grain yield than broadcast N. The higher grain yield from deep placement was due mainly to increased panicle number and plant vigor (see table). □

Grain yield and other plant characters of a ratoon crop of IR9784-52-2-3-2 as affected by different rates and methods of N placement. IRRI, 1981 dry season (av of 4 replications).[a]

Rate and method of placement	Grain (g/plant)	Panicles (no./plant)	Field grains (no./panicle)	Sterility (%)	100-grain weight (g)	Nodal tillers (%)	Plant height (cm)	Plant vigor[b]	Grain-straw ratio	Growth duration (days)
30 mg N/kg soil broadcast	9.2 b	18 b	32	24	1.89	74.9	69.9	7 a	1.2	58
30 mg N/kg soil deep placement	10.8 c	19 b	34	18	1.85	76.9	69.2	6 a	1.2	58
50 mg N/kg soil broadcast	16.9 b	25 ab	36	21	1.88	80.5	75.6	2 b	1.2	59
50 mg N/kg soil deep placement	25.1 a	34 a	39	13	1.87	65.7	75.2	1 b	1.0	61
Control	7.6 c	16 b	29	19	1.88	63.9	88.8	8 a	1.0	58
F-test on planned comparison										
Control vs others	**	ns	ns		ns	ns	ns	**	ns	ns
Broadcast vs deep placement	**	ns	ns		ns	ns	ns	ns	ns	ns

[a] In a column, means followed by a common letter do not significantly differ at the 5% level. [b] 1 = extra vigorous; 3 = vigorous, 5 = intermediate or normal vigor, 7 = less vigorous than normal, 9 = very weak and small.

Effect of different sources and levels of nitrogen fertilizers on rice grain yield

H. S. Thind, Bhajan Singh, and P. S. Deol, Punjab Agricultural University, Ludhiana 141004, India

A field experiment was conducted on a loamy sand soil (pH 8.3, organic carbon 0.55%, electrical conductivity 0.05 mmho/cm) in Gurdaspur District of Punjab State to determine optimum nitrogen source and fertilizer rate for irrigated rice. Calcium ammonium nitrate, ammonium chloride, and urea were applied at 60, 120, and 180 kg N/ha. Each was applied in 3 equal splits: before puddling, and at 21 and 42 days after transplanting. Farming methods recommended for the area were followed and grain yield was recorded (see table).

Effect of N levels and sources on grain yield of rice variety IR8, Punjab, India.

N (kg/ha)	Rice yield (t/ha) Calcium ammonium nitrate	Ammonium chloride	Urea	Mean
60	4.3	4.7	4.8	4.6
120	6.3	7.0	6.9	6.7
180	6.9	7.8	7.3	7.3
Mean	5.9	6.5	6.3	

No nitrogen = 2.70

CD (5%)
Level or source = 0.28; level × source = 0.46.
Control × treatment = 0.45

Increasing N level significantly increased grain yield. Ammonium chloride produced maximum yield followed by urea and calcium ammonium nitrate. Calcium ammonium nitrate was significantly inferior to ammonium chloride and urea. □

Evaluation of nitrogen availability indices for rice in alluvial soils

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Different methods of testing soil nitrogen levels and their relationship to rice yields in alluvial soils were evaluated in the greenhouse. Five 20-day-old PR106 seedlings grown in a nitrogen-deficient solution culture were transplanted into pots, each with 4.5 kg surface soil (0-15 cm), from 20 Punjab soil sites. Soil pH varied from 7.2 to 10 and electrical conductivity from 0.15 to 2.12 mmho/cm. Treatments of 0 and 100 ppm N as urea

Indices of available nitrogen and their relationship with rice plant parameters.

	O. C. (%)	$KMnO_4$-N	NH_4^+-N	NO_3^--N	$NH^+ + NO_3$-N	NH_4^+-N[a]
	Available nitrogen (kg/ha)					
Range	0.07-0.78	62.7-207.0	5.4-81.5	3.1-75.3	8.5-156.8	9.4-100.4
Mean	0.44	128.5	25.5	34.5	60.0	46.4
	Correlation coefficients (r value)					
Control grain yield	0.473	0.649	0.132	0.228	0.196	0.515
Percent grain yield	–0.027	0.143	0.159	0.193	0.169	0.004
Control grain uptake	0.433	0.581	0.261	0.288	0.313	0.489
Percent grain uptake	–0.250	–0.100	0.317	0.144	0.263	0.127
Control total uptake	0.476	0.643	0.307	0.300	0.346	0.610
Percent total uptake	–0.050	0.132	0.349	0.190	0.304	0.170

[a] After 72 hours of soil incubation at 40°C.

and a basal dose of 11 ppm P and 2 1 ppm K were applied. Grain and straw samples were analyzed for total N.

Soils were tested for available nitrogen by alkaline $KMnO_4$-oxidizable N, organic carbon, 2N KC1 extractable NH_4^+, and NO_3^--N and NH_4^+-N after incubating the soil in a 1 : 1 water suspension at 40°C. Correlation coefficients were calculated for yield and N uptake parameters with nitrogen indices (see table).

Grain yield varied from 3.2 to 19.7 g in control pots, and from 5.3 to 28.3 g in treated pots. Percent grain yield varied from 14.8 to 46.6%, showing 53.4 to 85.2% yield was due to nitrogen application. Total N uptake varied from 9.0 to 44.5 mg/pot and percent N uptake from 11.0 to 48.0%, showing 52.0 to 89.0% uptake was due to applied nitrogen.

$KMnO_4$-oxidizable N and NH_4^+-4 levels after incubation and organic carbon were significantly related to grain yield and N uptake. Grain yield had the highest correlation (0.649) with $KMnO_4$-oxidizable N. NH_4^+-N, NO_3^--N, and $NH_4^+ + NO_3^-$-N did not show significant correlation with grain yield or N uptake. No evaluation methods had a significant relation with percent yield or percent N uptake. □

Management of transplanted rice with seedlings of different ages

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The performance of 25-, 35-, and 45-day-old seedlings was studied at 3 nitrogen levels (0, 60, and 120 kg N/ha) and 15 × 15 and 15 × 10 cm spacing during 1981 wet season. Jaya was planted in the field in a randomized block design in three replications.

Transplanting 25-day-old seedlings produced highest yields, as did increased nitrogen levels. Spacing did not significantly influence yield (Table 1).

Nitrogen level-seedling age interaction (Table 2) indicated that 25-day-old seedlings responded best at 0 and 60 kg N/ha. However, 35-day-old seedlings yielded best at 120 kg N/ha, indicating that yield reductions caused by planting older seedlings may be offset by applying more nitrogen fertilizer.

Table 1. Effect of seedling age, nitrogen level, and spacing on grain yield of Jaya.

Treatment	Grain yield (t/ha)
Seedling age (days)	
25	5.8
35	5.1
45	4.5
N level (kg/ha)	
0	3.9
60	5.4
120	6.2
Spacing (cm)	
15 × 15	5.1
15 × 10	5.3

CONTINUED ON NEXT COLUMN

TABLE CONTINUED

Treatment	Grain yield (t/ha)
Seedling age	
S. Em ±	0.15
CD at 5%	0.31
N levels	
S. Em ±	0.15
CD at 5%	0.31
Spacing	
S. Em ±	0.13
CD at 5%	NS [a]

[a] Not significant.

Table 2. Seedling age – nitrogen inlteraction effect on grain yield.

Nitrogen (kg/ha)	Yield (t/ha) 25 d	35 d	45 d
0	4.6	3.4	3.6
60	6.0	5.4	4.8
120	6.6	6.4	5.5
S. Em ±	0.26		
CD at 5%	0.54		

Azolla and blue-green algae for wetland rice culture

J. Krisnarajan and P. Balasubramaniyan, Tamil Nadu Rice Research Institute, Aduthurai, India

Increasing costs of synthetic nitrogen fertilizer are causing biological nitrogen-fixing systems to become more important. The efficiency of using blue-green algae and azolla to provide all or some nitrogen needs of the rice crop was studied during 1981 kharif. Treatments are indicated in the table.

Results show a significant increase in yield in the treatments where blue-green algae were inoculated at 10 kg crust/ha or when azolla was incorporated (6 t/ha) (see table).

There was no significant difference between the treatments where azolla was incorporated or BGA applied together with 25 kg N/ha as urea and the corresponding treatments without N fertilizer. □

Effect of azolla and blue-green algae on IR20 rice yield.

Treatment	Grain yield (t/ha)
Control	5.2
Azolla incorporated (6 t/ha)	6.2
Azolla inoculated and allowed to grow with rice	5.7
Blue-green algae (10 kg crust/ha)	6.8
25 kg N/ha as urea N + 6 t azolla/ha	6.0
25 kg N/ha as urea N + blue-green algae (10 kg crust/ha)	6.3
CD : P = 0.05	0.60

Nitrogen release patterns of sulfur-coated urea in wetland rice

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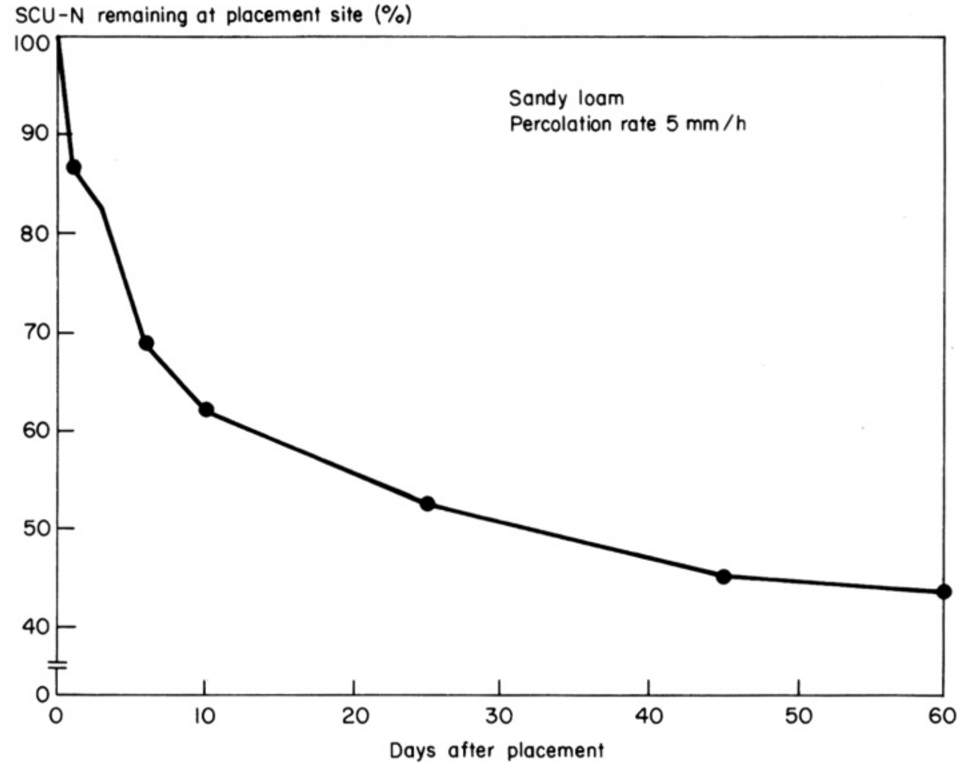
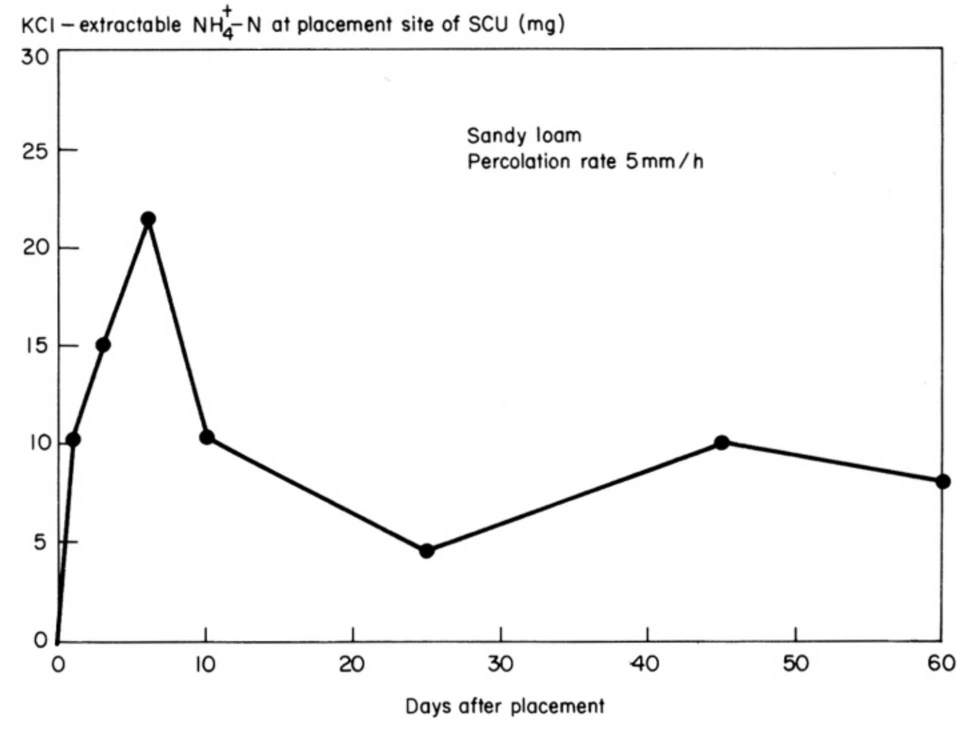
The low agronomic efficiency of applied N fertilizer in wetland rice is of major concern to scientists and farmers in South and Southeast Asia. Nitrogen efficiency can be increased by applying modified urea materials. An example is sulfur-coated urea (SCU), which has been widely tested in wetland rice. International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFFER) trials conducted at the PAU farm have consistently shown that SCU application gives higher rice yields than other modified urea materials.

A field experiment to determine N release patterns of SCU in flooded soils was conducted during 1982 kharif on a sandy loam soil (Typic Ustochrepts: pH 8.5, EC 0.15 mmho/cm, 0.23% organic carbon, 0.04% total N, and 4.54 meq cation exchange capacity/ 100 g). A small nylon screen bag with 460 mg N as SCU (38.6% N) was placed between two layers of wet soil freshly collected from the lower layer of the experimental plots. The bags were placed 10 cm deep in the centers of 4 hills spaced at 15 × 20 cm, 5 days after 45-day-old PR1 06 seedlings were transplanted.

Bags from 4 hills were chosen at random and SCU granules were digested and analyzed for urea N at 1,3,6, 10, 25, 45, and 60 days after placement. The remaining wet soil mass was extracted with 2M KCl-PMA solution and the extract was analyzed for NH_4^+ -N and urea-N. Nontreated soil was also analyzed and results corrected for native soil KCl-extractable NH_4^+-N.

Results showed that SCU granules released urea-N at a fairly even rate up to 60 days after placement. Three days after placement, 83% of urea-N remained in the SCU granules (Fig. 1). Six days after placement 70% urea-N remained. Dissolution rate was about 9% higher than its empirical 7-day dissolution rate of 21%. After 60 days of placement, 44% urea-N still remained.





1. Changes in urea-N remaining at deep placement sites after application of sulfur-coated urea (SCU) in a wetland soil. *Bottom:* **2.** Changes in KC1-extractable NH_4^+-N remaining at deep placement sites after application of sulfur-coated urea (SCU) in a wetland soil.

KCl-extractable NH_4^+-N peaked at 2 1.5 mg N (4.7% of N placed) 6 days after placement. Maximum NH_4^+-N did not exceed 10 mg N for the remaining period (Fig. 2). At 60 days, 45.5% total N (urea-N + NH_4^+; -N) remained, suggesting that SCU granules were protected pools supplying N to the soil solution at an even rate.

Effect of calcium peroxide coating on yield and yield attributes of Jaya

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In flooded soils, where germination and seedling establishment of direct-seeded rice are poor, coating seeds with calcium peroxide may improve germination rate and crop yield. During 1981-82 winter, Jaya was used to study the effect of peroxide coating on yield and yield attributes in puddled and submerged (6-10 cm standing water) plantings. Three levels of calcium peroxide coating – 0, 20, and 40% – were evaluated.

In submerged plots, number of panicles, panicle weight, number of grains per panicle, and panicle length increased significantly with 40% peroxide coating (see table). Except for number of panicles, all yield attributes at 40% peroxide coating were similar in puddled and submerged fields. Yield was highest for 40% coating under submergence, followed by 20% coating. Higher yields in submerged fields were probably due to improved oxygen supply to plants at early growth stage. □

Effect of calcium peroxide seed coating on yield and yield attributes of rice. [a]

Treatment	Panicles/m^2	Panicle weight (g)	Grains/ panicle	Panicle length (cm)	Yield (t/ha)
Puddled					
Noncoated	390 a	2.5 a	75 a	22 a	4.5 a
20% coating	398 bc	3.3 b	90 a	23 a	4.8 a
40% coating	401 c	3.6 bc	93 b	24 bc	4.9 a
Submerged					
Noncoated	394 b	3.0 ab	88 a	22 a	4.5 a
20% coating	401 c	3.0 ab	92 b	23 b	5.3 b
40% coating	410	3.9 c	108 b	25 c	5.5 b

[a] Means followed by the same letter do not differ significantly.

Effect of preplanting submergence and seedling age on wetland rice yield

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Farmers of the Cauvery Delta commonly believe that preparing fields and keeping them continuously submerged for at least a month before planting increases rice yield. This system was tested at TRRI during 1982 kharif.

The field was plowed twice with a tractor-drawn cage wheel 15 days before transplanting, leveled, and kept under continuous preplanting submergence. Yields from this field were compared with those of a similarly prepared field that was tilled on the day of transplanting. Short-duration (105 d) rice variety TKM9 was raised with seedlings of 4 ages in subplots. Treatments were thrice replicated. Plots were harvested individually and yield was recorded at 14% moisture level.

Preplanting submergence gave significantly higher yield irrespective of seedling age (see table). In both fields, 25-day-old seedlings yielded best (see table). As seedling age increased, yield decreased particularly at 40 days of age. □

Effect of preplanting submergence and seedling age on rice grain yield, Aduthurai, India.

Seedling age (d)	Grain yield (t/ha)		
	Preplanting submergence	Control	Mean
25	5.3	4.0	4.7
30	4.8	3.5	4.2
35	4.7	3.5	4.1
40	4.3	2.9	3.6
Mean	4.8	3.5	–
CD (0.05) for submergence	1.08		
CD (0.05) for seedling age	0.43		
Interactions	ns		

Sexual propagation of azolla through the sporocarp

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Azolla usually multiplies by vegetative propagation; however, sexual reproduction, which is essential to the survival of the population during temporary adverse conditions, also occurs. Our experiments indicate the fertilized egg (zygote) undergoes a 2- to 3-month dormancy period.

Fresh and matured megasporocarps and microsporocarps were inoculated in Watanabe's nutrient medium for azolla and incubated under artificial light (3000 lux) with controlled 26 ± 2°C temperature. Sporocarps germinated after 3 months. In the field, sporocarps produced in Mar germinated in Jun when day temperature ranged from 25 to 35°C. Azolla also had a 3-month dormancy period in field nurseries.

Azolla microspores and megaspores do not germinate until they are liberated from the sporangia. Fertilization occurs only in water. The zygote formed after fertilization is deposited on the soil surface where it undergoes dormancy.

We adopted the following procedure to break the dormancy period and induce azolla germination. Fresh azolla with sporocarps were inoculated into potted soil with 1 cm deep water. When water evaporated, azolla deposited on the soil surface dried, leaving zygotes. The top

2.5 cm of soil was removed and dried either in a hot air oven at 60°C for 24 hours or in sunlight for 2 to 3 days, This soil was used as inoculant. Normally, zygotes sprout into small seedlings 10 to 15 days after inoculation and mature sporophytes develop within 20-25 days. The oven-dried zygotes germinated within 10-12 days; sun-dried zygotes germinated in 18-20 days.

The laboratory method allows researchers to raise azolla fronds from dried materials and to transport azolla seed inoculum (dried zygotes), without damaging seed viability. This technique may also solve storage problems, sowing limitations imposed by summer, and help in azolla crossbreeding. □

Effect of summer plowing with different implements on wetland rice yields

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The effect of summer plowing with different implements on wetland rice yield and weed dry matter accumulation was studied during 1980 and 1981. Treatments were no tillage (control), plowing with country plow, tractor-drawn 11-tined cultivator, and tractor-drawn disc plow. Land was tilled in April and rice was transplanted in early July after puddling with a 10-hp power tiller. Soil was a sandy clay loam.

Plots tilled by disc plow had lowest weed population and yielded highest (see table). Weed dry matter accumulation was lowest after disc plowing, amounting to 0.9 t/ha in 1980 and 1.2 t/ha in 1981, followed by values for the cultivator and country plow.

Effect of summer plowing with different implements on rice gain yield and weed dry matter accumulation.

Treatment	Grain yield (t/ha) 1980	Grain yield (t/ha) 1981	Grain yield (t/ha) Mean	Weed dry matter accumulation (t/ha) 1980	Weed dry matter accumulation (t/ha) 1981	Weed dry matter accumulation (t/ha) Mean
Control	2.4	2.0	2.2	2.1	2.7	2.4
Country plow	2.8	2.1	2.4	1.7	2.0	1.8
Cultivator	3.1	2.2	2.6	1.5	1.6	1.5
Disc plow	3.8	2.6	3.2	0.9	1.2	1.1
Mean	3.0	2.2	2.6	1.5	1.9	1.7
CD at 5%	0.1	0.2		0.1	0.04	

Weed flora consisted mostly of *Cyperus rotundus L., Echinochloa crus-galli* (L.) Beauv., *Monochoria hastata* (L.) Solms, *Paspalum scrobiculatum* L., *Panicum* spp., *Hygrophila spinosa* T. Anders., *Oxalis* spp., *Emilia sonchifolia* (L.) DC. ex Wight, *Setaria glauca* (L.) Beauv., *Cynodon dactylon* (L.) Pers., *Sporobolus diander* (Retz.) Beauv., *Chrysopogon* spp., *Caesulia axillaris* Roxb., *Saponaria vaccaria* L., *Spergula arvensis* L., *Jussiaea suffruticosa* L., *Polygonum plebeium* R. Br., and *Ageratum conyzoides* L., in decreasing order of population. □

Response of irrigated dry seeded rice to nitrogen level, interrow spacing, and seeding rate in a semiarid environment

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Semiarid soils are inherently nitrogen deficient, which limits rice yields. Although nitrogen fertilizers are expensive and unavailable in adequate quantities in many developing countries, relatively high rice yields can be obtained by optimizing spacing of rice plants in the field. We studied the interrelationship of nitrogen level, plant population and distribution pattern, and rice yield.

Three field experiments were conducted at the Gezira Research Station (13°30' – 15°5'N and 32°30' – 33°30' E) during 1977-79. Climate is semiarid and most rains (350-400 mm) fall during July and August. Soils are dark cracking Vertisols with 40-65% clay content.

Effect of nitrogen level, interrow spacing, and seeding rates on grain yield and some major yield components of irrigated dry seeded rice IR2053-206-1-36 in a semiarid environment in Sudan Gezira (av of 3 seasons 1977-79).

	Yield (t/ha)	Panicles (no./m^2)	Grains (no./panicle)	1000-grain weight (g)
N (kg/ha)				
60	4.2	343.2	70.8	23.17
120	4.8	386.6	78.3	23.64
180	6.4	411.1	80.1	23.91
Interrow spacing (cm)				
15	5.3	464.9	75.1	23.56
20	5.6	367.0	76.8	23.56
25	5.5	310.1	77.4	23.60
Seeding rate (kg/ha)				
50	5.5	358.7	82.2	23.48
100	4.4	382.8	76.5	23.64
150	5.5	400.5	70.5	23.60
S. E.	0.024	5.43	1.42	0.096

Treatments were 60, 120, and 180 kg N/ha as urea; 15, 20, and 25 cm interrow spacings; and 50, 100, and 150 kg seeds/ha. Treatments were grown in a randomized complete block design with four replications. Land was prepared dry by plowing, disc harrowing, and leveling, then was divided by heavy ridges into 3.8 × 8.0 m plots. Immediately before seeding, 6.2 kg P/ha as superphosphate was incorporated into the soil. Urea was topdressed in equal splits at 10, 45, and 75 days after IR2053-206-1-3-6 rice emerged. Weeds and water were controlled throughout the growing season.

At harvest, 50 panicles were randomly collected from each plot and number of filled grains per panicle and grain weight were recorded. The number of panicles per square meter was determined for five 1-m rows randomly selected from each plot, and the center 3 × 7 m of each plot was harvested to determine grain yield. Data obtained over the three seasons were analyzed.

The results (see table) indicate that grain yield and all major yield components significantly and progressively increased with increased nitrogen application ($P < 0.001$). Interrow 20-cm spacing produced higher grain yield than the other spacings used ($P < 0.001$). However, the close spacing produced more panicles/m^2, but fewer grains per panicle. Similarly, the 150 kg/ha seed rate produced more panicles per square meter but less grains per panicle. The differences in grain yield between the seeding rates were not significant. □

Environment and its influence

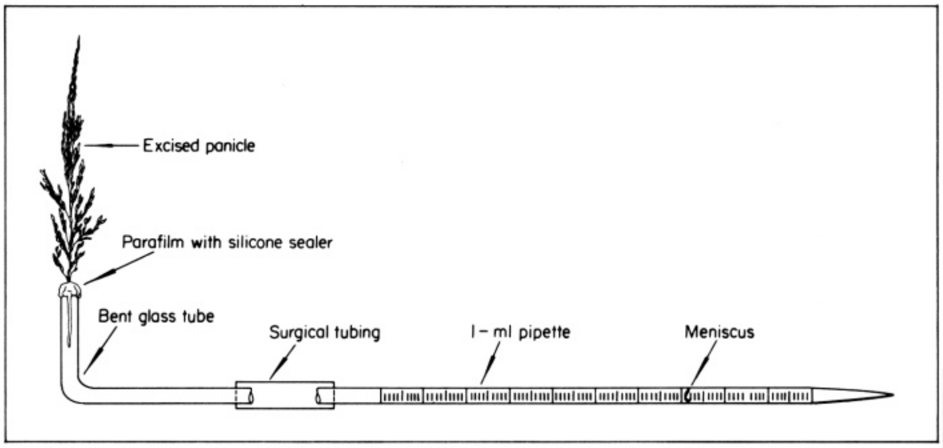
Panicle transpiration measurement with a potometer

O. S. Namuco, Agronomy Department; D. P. Garrity, International Rice Testing Program; and J. C. O'Toole, Agronomy Department, IRRI

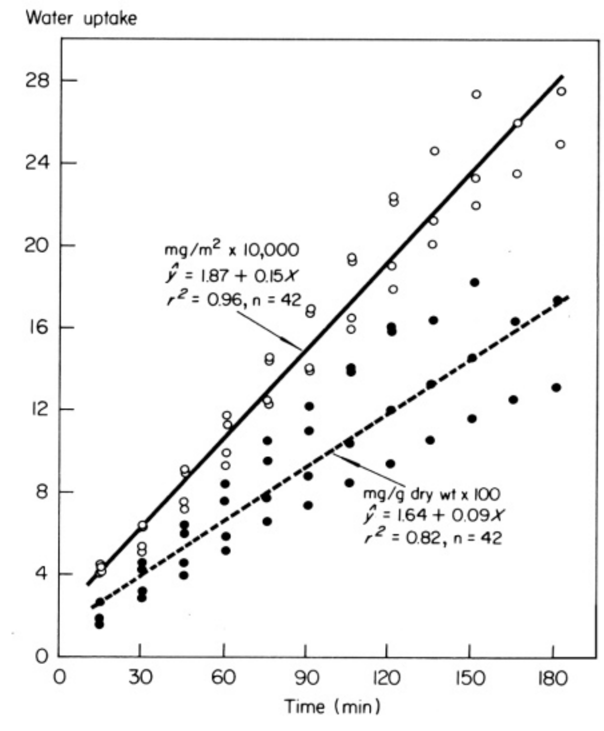
Several studies on rice plant-water relationships have indicated the importance of panicle contribution to total plant water use during the flowering/heading stage.

A simple, inexpensive, rapid method, using a potometer, was used to estimate the transpiration rate of excised panicles. The potometer is portable and can be used in the field or laboratory (Fig. 1). Panicles were excised under water to prevent cavitation of the water column in the xylem by air bubbles. They were sealed into the potometer with parafilm and silicone sealant.

Potometers were placed under a fluorescent-incandescent light bank, which provided about 405 μEm^{-2} sec^{-1} irradiance at the top of the panicle. Air velocity was maintained at 1.9 ms^{-1} and passed uniformly through 4 × 4 cm baffles. Panicle temperature was measured by inserting copper-constantan thermocouples into the spikelets. A shielded-aspirated psychrometer was used to measure water vapor pressure deficit of the air, Water uptake, which should be in equilibrium with transpiration in a steady state system, was determined by changes in the level of meniscus in the pipette measured at 15-minute intervals. To refill the pipette, water was injected through the surgical tubing using a hypodermic needle. The pipette was covered



1. A potometer setup for measurement of panicle transpiration.



2. Water uptake of excised IR36 panicles measured with a potometer. Vapor pressure deficit of the air = 1.652 ± 0.0196 kPa, panicle temperature = 24.21 ± .062ºC.

with aluminum foil to prevent expansion of water caused by heating from the light source. After several water uptake readings, panicle area was measured with an automatic area meter. Transpiration was estimated based on the area of exposed surfaces and on oven-dry weight. Results from both estimates (Fig. 2) showed that the cumulative water uptake or transpiration was linear.

This simple, inexpensive technique should be useful for studying the effects of environmental factors on water use by panicles and for investigations of genotypic variation in panicle water use. □

Rice-based cropping systems

Krishnamany — a new cowpea variew for the summer rice fallow

P. Chandrika, N. Rajappan Nair, T. K Viswanathan, and J. Sreekumari Amma, Reaional Agricultural Research Station, Pakmbi 679 306, Kerala, India

Nearly 80,000 ha in Kerala have potential for increasing pulse production during summer rice fallow. The Government of Kerala is encouraging cowpea production. Harvesting cowpea is expensive because plants must be picked four or five times. A new cowpea variety, Krishnamany, has a very short flowering phase and requires only one or two pickings. It also withstands moisture stress, which is normal during the postrice summer period.

Krishnamany is a black-seeded selection from P. 118/Kolinjipayar. It has short duration (55-60 days), is bushy and nontrading, grows 30-35 cm tall, and produces2-5 branches. Flowers are light violet and medium sized. Pods are about 11 cm long, dark green when immature, and light brown when dry. There are about 10 seeds per pod, which weigh 70 g/l000. The variety is tolerant of yellow mosaic. Recommended seed rate is 20 kg/ha, with 20-30-10 kg NPK/ha. Performance data are in the table. □

Performance of Kdnamany in summer rice fallow in Kerala, India

Variety	Seed yield (kg/ha)						
	Pattambi			Mannuthy	Karamana	Mean	per day
	1980	1981	1982	1982	1982		
Krishnamany	472	719	666	1118	602	715	13.75
Culture 17	465	693	664	1048	513	677	13.02
P. 118	133	323	503	840	250	410	6.95
Kolinji payar	435	478	479	1158	355	581	9.85
Pusa phalguni	402	581	444	790	243	492	8.34
EC 43721	310	576	567	830	306	518	8.78
CD (P = 0.05)	238	137	160	N. S.	160	–	–

Rice — wheat pattern for increased cereal production in alkali soils of eastern Uttar Pradesh

T. N. Singh, Crop Physiology Department, N. D. University of Agriculture and Technology, Faizabad, Uttar Pradesh, India

Although much of eastern Uttar Pradesh is planted to cereals, production is low because of alkaline soils. A rice — wheat cropping pattern was tested in alkali fields at the Kumarganj Crop Research Station from 1976 to 1978.

Soil was 54% sand, 22.3% silt, and 22.1% clay. CEC was 13.4 meq/100 g, ESP 81.6, pH 10.4, EC 2.1 mmho/cm in 1:2 soil:water suspension at 0–15 cm soil depth. Three replications of 5 × 4 m plots in a randomized block design were established and soil was treated with 0, 3, 6, 9, and 12 t gypsum/ha or 0, 1.5, 3, 4.5, and 6 t pyrite/ha before the first transplanting. Less pyrite was applied because it contains 50% more sulfur than gypsum and is almost twice as expensive. Rice husk was applied with gypsum, and sawdust with pyrite at 0, 2.5, 5, and 7.5 t/ha. Dhaincha (*Sesbania aculeuta*) was grown and incorporated as green manure

Cereal grain production from rice — wheat crop sequence in alkali soils at Kumarganj, Faizabad, India

Application rate of soil amendments in 1976 (t/ha)	Yield (t/ha)							
	1976–77		1977–78		1978–79		3-year average	
	Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat
Gypsum								
0	1.0	1.0	1.6	1.1	2.0	1.1	1.5	1.1
3	2.0	2.4	2.9	2.1	3.4	2.1	2.8	2.2
6	3.5	3.4	4.6	3.0	4.7	2.9	4.3	3.1
9	4.8	4.3	6.0	3.7	6.2	3.6	5.7	3.9
12	5.3	4.8	6.4	4.2	6.8	4.2	6.2	4.4
LSD (0.05)	0.4	0.2	0.4	0.3	0.3	0.3	0.5	0.3

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TABLE CONTINUED

Application rate of soil amendments in 1976 (t/ha)	Yield (t/ha) 1976–77 Rice	1976–77 Wheat	1977–78 Rice	1977–78 Wheat	1978–79 Rice	1978–79 Wheat	3-year average Rice	3-year average Wheat
Pyrite								
0	1.1	0.8	1.6	1.1	2.0	1.1	1.6	1.0
1.5	1.7	1.3	2.8	1.6	3.1	1.7	2.5	1.5
3.0	2.7	1.7	4.0	2.1	4.3	2.3	3.6	2.0
4.5	4.2	2.6	5.2	2.6	5.6	2.8	5.0	2.7
6.0	4.6	3.5	5.9	3.1	6.0	3.5	5.5	3.3
LSD (0.05)	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4

in each of the 3 years.

IR24 (1976) and Jaya (1977 and 1978) seedlings were transplanted at 5 to 6 weeks at 15-cm spacing with 4 to 5 seedlings/hill. Nitrogen was applied at 120 kg/ha, with 22–26 kg P, 26–33 kg K, and 35–40 kg $ZnSO_4$/ha.

Wheat varieties HD1982 (1976) and HD1553 (1977 and 1978) were sown at 125 kg/ha in rows spaced 20 cm apart. Fertilization was 100 kg N, 17–28 kg P, 8-26 kg K, and 20 kg $ZnSO_4$/ha. To avoid termite damage, 16 kg BHC/ha was applied. Crops were irrigated when needed.

Rice husk and sawdust application did not affect rice or wheat yields. Yields in 1976 were 1 t rice/ha in untreated plots, 5.3 t in gypsum-treated plots, and 4.6 t in pyrite-treated plots. Wheat yields increased from 1 t/ha to 4.8 and 3.5 t/ha for gypsum- and pyrite-treated plots (see table).

Data showed a substantial residual effect of gypsum or pyrite treatment, and indicated a rice - wheat - green manure cropping pattern does not cause rapid reversion of reclaimed alkali soils.

Comparison of traditional and alternative cropping systems in Cagayan, Philippines

C. J. Andam, science research specialist, Philippine Council for Agriculture and Resources Research Development and E. D. Guzman, research assistant, Cagayan Integrated Agricultural Development project

Three maize-based cropping systems were compared for profitability with the farmer's pattern on the floodplains of Solana, Cagayan, Philippines. Profitability was measured by farm gross margin technique, which is the difference between gross farm income and current total variable costs (TVC) of production. The study was conducted during the 1981-82 dry and wet seasons. Each pattern was tested in a 1,000-m^2 plot with 4 replications.

Mungbean yielded best during wet season because of a uniform rainfall pattern. The second mungbean crop suffered from declining rainfall after Dec. However, wet season crops often are flooded in early Aug when they are at critical growth stages.

Test crops planted in late Apr escaped flooding and heavy rainfall during critical growth stages, but not at harvesting stage.

In the traditional pattern yields of crops established later than mid-May are substantially reduced by heavy rain and flooding, especially on lower fields. Research showed that the physical environment of the area dictates early crop establishment and use of early maturing varieties that resist damaged caused by flooding and drought.

Experimental maize - maize pattern yielded more than the farmer's maize - maize pattern in both seasons and had a higher return above TVC. Patterns with mungbean following or preceding maize, however, were most profitable, regardless of cultural manipulations. Return above TVC for patterns with mungbean ranged from \$582 to \$667.

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

Cost-and-return analysis of traditional and alternative maize-based cropping systems in the river floodplains of Solana, Cagayan, Philippines, 1980–81 cropping season.

Cropping pattern First crop	Cropping pattern Second crop	Yield (t/ha) First crop	Yield (t/ha) Second crop	Gross return [a] (\$)	Total variable cost (\$)	Profit (GR - TVC) (\$)
Maize	Maize [b]	2.0	0.8	408	163	245
Maize	Maize	2.1	1.4	591	194	397
Maize	Mungbean	2.6	1.0	928	346	582
Maize	Maize	1.2	2.4	1008	352	656

[a] Based on current price right after harvest in the research barangay. [b] Farmer's pattern.

Economy of different rice-based cropping patterns for Cauvery Delta

SP. Palaniappan and P. Balasubramaniyan, Tamil Nadu Rice Research Institute, Aduthurai, India

Eight rice-based cropping patterns for the Cauvery Delta were studied for profitability in 1981-82 at Tamil Nadu Rice Research Institute, Aduthurai. Soil at the experimental site was clay loam with low available N, medium available P, and high available K, with pH 7.5. Rice and summer crop yields were assessed individually and the gross margin was calculated for the pattern, by subtracting the cost of cultivation from the gross income for each pattern.

Annual gross margin was $961/ha for rice - rice - cotton + blackgram, $887/ha for rice - rice - cotton, and $786/ha for rice - rice - bhendi (see table). □

Gross margins of different rice-based cropping patterns, Aduthurai, India 1981-82.

Cropping pattern[a]			Gross
Kuruvai (Jul-Oct)	Thaladi (Oct-Feb)	Summer (Feb-Jun)	margin ($/ha)
Rice (TKM 9)	Rice (IR20)	Cotton (MCU 7) + blackgram	887
Rice (TKM 9)	Rice (IR20)	Sorghum + cowpea	527
Rice (TKM 9)	Rice (IR20)	Maize + soybean	473
Rice (TKM 9)	Rice (IR20)	Sunflower + cowpea	302
Rice (TKM 9)	Rice (IR20)	Greengram	482
Rice (TKM 9)	Rice (IR20)	Cotton (MCU 7)	961
Rice (TKM 9)	Rice (IR20)	Bhendi (Co. 1)	786
Rice (CR 1009)	Rice (AD103)	Pearl millet (Co. 6)	159
	CD (P = 0.05)		

[a]Replicated 3 times.

Announcements

IR58, IR60 released in the Philippines

The Philippine Seed Board has named two new IRRI-developed rice varieties, IR58 and IR60, for release in the Philippines.

IR58 is the line IR9752-71-3-2, developed from the progeny of the cross IR28/Kwang Chang Ai//IR36. IR58 matures in 100 days, has high levels of tungro and blast disease resistance, resists brown planthopper biotypes 1 and 2, and has cooking quality similar to that of IR36. It was recommended for cultivation in Luzon and Visayas.

IR60 is the line IR13429-299-2-1-3-1, selected from the progeny of the cross IR4432-53-33/PTB33//IR36. It has been recommended for cultivation in Mindanao because it resists brown planthopper biotypes 1, 2, and 3. IR60 matures in 105 days, It has long slender grains and a high level of blast resistance.

Release of the two varieties brings the number of IR varieties released in the Philippines to 26. The first 11 varieties were named by IRRI. Beginning with IR36, released in 1976, all IR varieties released in the Philippines have been named by the Philippine Seed Board. □

Rice germplasm conservation workshop

A 2-day workshop on the conservation of rice germplasm was co-sponsored by IRRI and International Board for Plant Germplasm Resources 25-26 April. Thirty-five scientists from 21 countries, 9 staff members from 6 other international agricultural research centers and international agencies, and IRRI staff participated in the conference.

Progress in field collection from 1977 to 1982 was reviewed and papers on conservation methodology, the wild *Oryza* species, and seed storage equipment for national centers were presented to assist the germplasm workers. Interinstitutional collaboration between the United States Department of Agriculture, National Institute of Agricultural Sciences, and IRRI was reassessed.

The following areas were identified as priority efforts: urgency in completing the collection of land races, conservation of wild species, systematic evaluation and characterization, seed storage (primarily medium-term), documentation at national centers, manpower development, security of seedstocks under long-term storage, and free germplasm exchange.

Participants from South Asia, Southeast Asia, and Africa drafted a 5-year collection plan and estimated funding requirements. IRRI will continue to coordinate field operations and provide an adviser or field collector. Small-scale collection in Latin America and Oceania will be separately developed.

The scope of the Advisory Committee to the International Rice Germplasm Center at IRRI was also discussed. The Center was recently reorganized to increase security to the rice germplasm bank, and is now a component of IRRI's Global Research Services. □

IRRI-TARC seminar

IRRI and the Tropical Agriculture Research Center of Japan sponsored a seminar on *Collection and utilization of genetic resources in rice with particular reference to disease resistance* 6 Apr 1983, at Tsukuba Science City.

The conference was the third in a series of cooperative meetings to stimulate interest of Japanese scientists in tropical rice and rice-based cropping systems.

Five papers described rice genetic resources at IRRI and in Japan, rice virus diseases in the tropics, blast disease, and bacterial leaf blight disease,

Participants recommended more intensive efforts and closer international collaboration in the collection of rice germplasm. It was also recommended that gene analysis for blast resistance, which has been almost completely limited to japonica varieties, be expanded to include indica varieties. □

Khan receives agricultural engineering award

Amir U. Khan, IRRI agricultural engineer, has been awarded the Adamjee Fecto Gold Medal Award by the Pakistan Society of Agricultural Engineers. The award is presented annually for outstanding contributions to agricultural mechanization and engineering in Pakistan. Khan recently returned to IRRI after working with the IRRI-Pakistan program from 1976 to 1982. □

IRRI scientist recognized

F. N. Ponnamperuma has been elected Fellow of the Soil Science Society of America.

Ponnamperuma is head of the Soil Chemistry Department and has been with IRRI since 1961. □

New IRRI publications

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

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Research highlights for 1982

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