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Contents

Guidelines and Style for IRRN Contributors

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

Style

- Use the metric system in all papers. Avoid national units of measure (such as cavans. rai, etc.).
- Express all yields in tons per hectare (t/ha) or, with small-scale studies, in grams per pot (g/pot) or grams per row (g/row).
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N/ha: not 60 kg/ha N.
- The US dollar is the standard monetary unit for the IRRN. Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- When using abbreviations other than for units of measure, spell out the full name the first time of reference, with abbreviatlons in parenthesis, then use the abbreviation throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested. Three levels of N were .... or Biotypes of the brown planthopper (BPH) differ within Asia. We studied the biotypes of BPH in ....
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example; 8 years; 3 kg/ha at 2-week intervals; 7%; 4 hours.
- Write out numbers below 10 except in a series containing some numbers 10 or higher and some numbers lower than 10. For example: six parts; seven tractors; four varieties. But There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

Guidelines

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

Agronomic characteristics

Local indica rice varieties with desirable floral traits influencing outcrossing

H. C. Sarkar, plant breeder, and N. M. Miah, principal plant breeder, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dhaka, Bangladesh

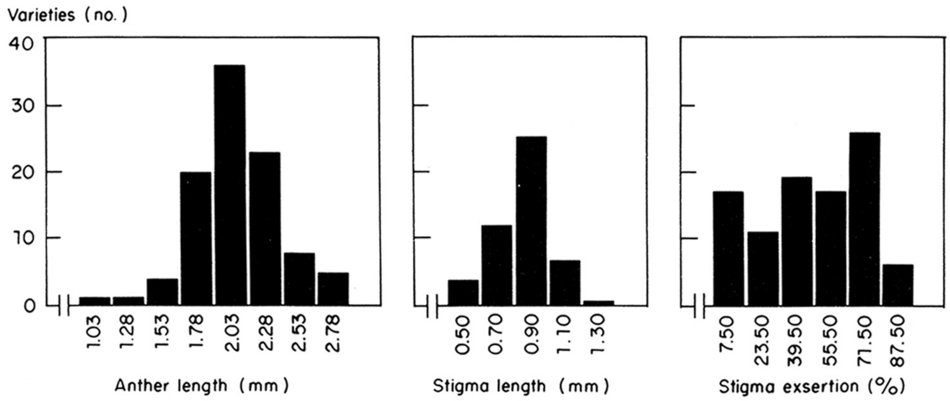
We sought to identify local indica rice varieties with desirable floral traits influencing outcrossing at BRRI main station, Joydebpur, during the 1982 transplanted aman season (Jul-Dec). Ninety-eight local varieties were grown in 5.4- × 2-m plots at 25- × 15-cm spacing using one seedling/hill. No fertilizer was applied.

Anther size (length), stigma size (length), and stigma exsertion (%) were recorded for each entry. Anther length varied from 0.97 to 2.80 mm ($\bar{X}$ = 2.08 ± 0.03); stigma length from 0.42 to 1.34 mm ($\bar{X}$ = 0.85 ± 0.02); and stigma exsertion from 0 to 90% ($\bar{X}$ = 46.24 ± 2.58).

Ten entries had larger anthers (≥22.00 mm) and stigmata (≥ 1.00 mm) with good exsertion (≥ 50%) (see table). The distribution of varieties by anther length, stigma length, and stigma exsertion is shown in the figure. □

Varieties with larger anthers (≥ 2.00 mm long) and stigmata (≥ 1.00 mm long) with good exsertion (≥ 50%).

Variety	Anther length (mm)	Stigma length (mm)	Stigma exsertion (%)
Ashwini	2.04	1.04	50
Kalagura	2.28	1.00	70
Lal Khama	2.08	1.04	60
Kumri	2.10	1.04	60
Loatung	2.10	1.06	75
Dhalai ropa	2.30	1.00	75
Holud jaron	2.14	1.00	70
Rajbhog	2.10	1.34	70
Kanpasha	2.18	1.14	80
Laida	2.48	1.08	75



Frequency distribution of varieties by anther length, stigma length, and stigma exsertion.

Rice seed viability under two storage conditions

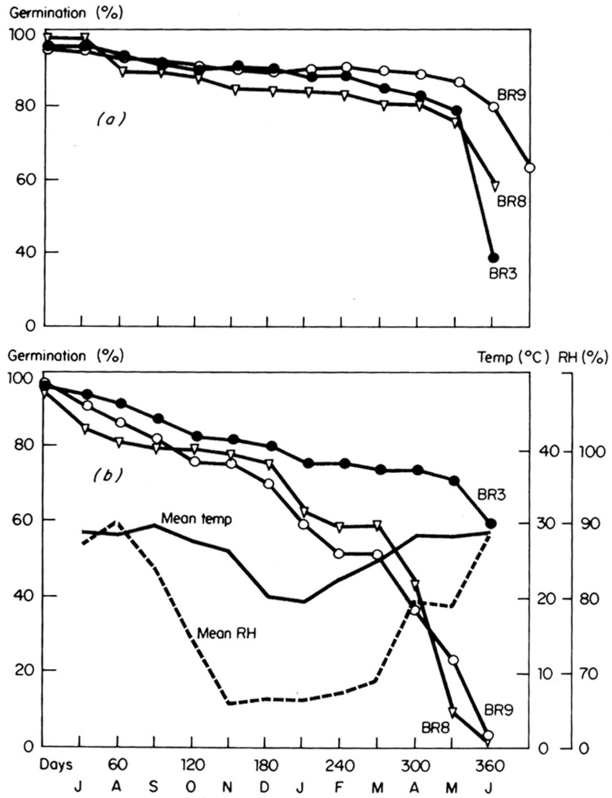
Md. Zahurul Haque and Mahmuda Haroon, Plant Physiology Division. Bangladesh Rice Research Institute (BRRI), Joydebpur, Dhaka, Bangladesh

BR8 and BR9, two high yielding varieties (HYVs) recently released by BRRI for boro and aus seasons, yield better than other HYVs, but field workers reported that germination percentage, particularly that of BR9, was poor. Rapidloss of seed viability was suspected to be a genetic trait.

We studied the seed viability range of BR8 and BR9, with BR3 as check. Boro-harvested seeds were sun-dried to 12% moisture (wet basis) and stored in metal baby food containers and in gunny bags in a laboratory room, Seed viability was checked at monthly intervals by germinating the seeds in water culture at 32°C in the germinator. using 100 seeds and 3 replications.

Seed viability remained high until 352 days from harvest when seeds were stored in metal containers. BR9 germination percentage was highest (see figure). BR8 and BR9 seeds stored in gunny bags lost viability much more rapidly than BR3. A similar trend in seed viability loss was recorded in aus-harvested BR3, BR8, and BR9 seed, except that viability range was shorter for boro-harvested seeds.

It appears that BR8 and BR9 seeds are more susceptible to exposure to the atmosphere (gunny bag storage) although their genetic potential for seed viability range is higher than that of BR3, as indicated by storage in a closed metal container. It is suggested that the seeds of these varieties be carefully stored and handled to minimize exposure to high humidity associated with high temperatures. □



Germination percentage of boro-harvested rice seeds stored in closed metal containers (a) and in gunny bags (b), and mean temperature and mean relative humidity (RH) of storeroom.

Inheritance of leaf sheath color in rice

P. G. Eruotor, Plant Science Department, Ahmadu Bello University, Zaria, Nigeria

We studied the inheritance of purple leaf-sheath coloration using the parents Taichung Native 1 (TN1) with a green leaf sheath, and Dular with a purple leaf sheath, F_1 and F_2 populations of the cross TNl/Dular, and backcrosses of F_1/TN1 and F_1/Dular.

The distributions of parents, F_1, F_2, and backcross progenies are shown in Table 1. Color varied from deep purple to green. Plants were grouped as colored (purple) and green as shown in Table 2.

The purple leaf sheath was dominant in F_1 and the difference between the two was monogenic. F_2 data also indicated that the purple leaf sheath is dominant and is conditioned by a single gene. The backcross plants of F_1/TN1 confirmed the finding, indicating that a pair of alleles condition segregation in crosses between parents with purple leaf sheaths (Tables 1 and 2). □

Table 1. Distribution of parents, F_1, F_2, and backcross progenies.

Parent or progeny	Plants (no.) in each class				Total plants (no.)
	Purple	Intermediate dark purple	Light purple	Green	
TN1				60	60
Dular	58				58
F_1	3	19			22
F_2	22	128	98	99	347
BC(F_1/TN1)	5	27		23	55
BC(F_1/Dular)	15	5			20

Table 2. Segregation in F_2 progeny of TNl/Dular, backcross progeny of F_1/TN1 and F_1/Dular for leaf sheath color.

Cross	Plants (no.)			Expected ratio	X^2	*P* value
	Colored [a]	Green	Total			
TN1/Dular	248	99	347	3:1	2.12	0.20-0.10
F_1/TN1	32	23	55	1:1	1.16	0.30-0.20
F_1/Dular	20	0	20	No seg.		

[a] Colored represents all classes of purple, purple intermediate, dark purple, and light purple.

ERRATUM

T. N. Singh, Gulab Singh, and H. P. Singh. Chemical weed control in dryland rice. IRRN 7 (5) (Oct 1982), 21-22. In the table on page 22, the last row should read:

CD (5%) 0.17 0.20

GENETIC EVALUATION AND UTILIZATION

Disease resistance

A promising donor for blast resistance

V. P. S. Dev and K. Karunakaran, Regional Agricultural Research Station, Pattambi, Kerala, India

Leaf blast is one of the most important rice diseases in Kerala, and Pattambi is a hot spot for the disease. While screening prerelease cultures for disease resistance, we found that KAU1907, a short-duration, white-kerneled, medium-tall culture from the cross Bhavani/Triveni scored 1 in a trial where the national check variety Vani scored 6, using the 0-9 scale. Tests in three subsequent trials confirmed this highly resistant reaction of the culture (see table). This finding is significant because KAU1907 has wide adaptability to important seasons and cropping situations in Kerala, including rainfed uplands. □

Reaction of KAU1907 to leaf blast at Pattambi, India.

Variety	Disease score (0-9 scale)			
	1981-82		1982-83	
	Trial 1	Trial 2	Trial 1	Trial 2
Triveni	5	5	9	7
Kannagi	9	3	7	3
Vani	6	1	1	1
KAU1907	1	0	0	0

Antibiotic activity of rice agglutinin

S. K. Addy, Plant Pathology Department, Assam Agricultural University, Jorhat-785 013 India; and R. N. Goodman and A. L. Karr, Plant Pathology Department, University of Missouri, Columbia, Missouri 65211, USA

Agglutination or immobilization of plant pathogenic bacteria in several hosts, including rice, has been reported. We isolated a small molecular weight protein from rice seeds and leaves that showed agglutination and antibiotic activity. The rice agglutination factor (RAF) was isolated from cultivars TN1 and BJ1. Agglutination was determined by the agglutination drop test. Antibiotic activity was measured, using the cylinder-plate method, against a virulent strain of *Xanthomonas campestris* pv. *oryzae* (H470) and an avirulent acapsular strain of *Erwinia amylovora* (E8) (see table).

The RAF derived from BJ1 had higher antibiotic activity than that from TN1. The RAF from BJ1 seeds also was higher than that from TN1. It is likely that the RAF plays a role in the disease resistance capability of certain cultivars not only by its agglutinating activity but also by antibiotic activity. □

Antibiotic activity and agglutination titers of the rice agglutinin factor (RAF) derived from the seeds and leaves of some rice cultivars.[a]

Source	Av diam of inhibition zones (mm) against		Agglutination titers against	
	X. c. pv. *oryzae*	*E. amylovora* (E8)	*X. c.* pv. *oryzae* (H470)	*E. amylovora* (E8)
TN1 seed	8	10	1:64	1:64
TN1 leaf	10	0	n.t.	n.t.
BJ1 seed	10	8	1:256	1:128
RJ1 leaf	16	7	n.t.	n.t.

[a] n.t. = not tested.

Varietal resistance to leaf blast and sheath blight at Pattambi, India

V. P. S. Dev and C. A. Mary, Regional Agricultural Research Station (RARS), Pattambi 679 306, Kerala, India

Leaf blast (Bl) and sheath blight (ShB) are two major rice diseases in Kerala. During 1981-82 kharif, 388 cultivars of National Screening Nursery I were tested for Bl and ShB resistance at RARS, Pattambi. which is a hot spot location for both diseases. Screening for Bl used UBN pattern and was under upland situations with Pusa 2-21 as the susceptible check. ShB screening was under transplanted conditions with Jyothy as susceptible

Rice cultures with multiple resistance to leaf blast and sheath blight at RARS, Pattambi, Kerala, India.

Entry	Cross	Reaction to	
		Leaf blast	Sheath blight
TNAU17005	Dasal/IR20	R	MR
RNR74822	Sona/Monoharsali	R	R
R245-30-41	OBS677/IR2078-436-3-5	R	R
HPU2205	ASll/IR1820-17-1	R	R
HPU2206	-do-	R	R
HPU2203	AS11/IR1820-210-2-//CH1039	R	R
IET6080	-do-	R	MR
RP1015-12-10-3-1-1	Sona/Monoharsali	MR	MR
R161-3179	Kali monch 64/Sona	MR	MR
KMP8	-do-	MR	MR
KMP41	-do-	MR	MR
RNR82249	Tella hamsa/Rasi	MR	MR
RP1015-45-117-1	Sona/Monoharsali	MR	MR
RP1015-38-85-1	-do-	MR	MR

check. Each test entry was planted in two 2-m rows, spaced at 20- × 15-cm. Plants were inoculated at tillering stage with the ShB pathogen multiplied on rice stem pieces. Disease reactions were judged by the Standard Evaluation System for Rice scale.

Disease pressure was high (location severity index [LSI] = 7.22) for B1 and moderate (LSI = 4.60) for ShB.

CR280-5, JR49, and MGL 14 were highly resistant to ShB and 139 entries showed resistant or moderately resistant reactions. RNR788 11, WGL 26420, and RGL 1746 were highly resistant to B1 and 39 entries had resistant to moderately resistant reactions. Although all the six lines with highly resistant reactions to on disease were susceptible to the other disease, 14 entries resistant to both diseases were identified (see table). □

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Japonica cultivars are more susceptible to brown planthopper biotype 1 than Tongil hybrids

H. G. Goh, J. O. Lee, Y. H. Kim, and C. G. Kim, entomologists, Institute of Agricultural Sciences, Office of Rural Development, Suweon, Korea

Susceptibility of Tongil lines (japonica/ indica) with no genes for resistance to brown planthopper (BPH) was studied using a seedling bulk test. Four japonica and 4 Tongil lines that are recommended to farmers in Korea were alternately planted in 15-cm-long rows in plastic boxes with 2 replications. Cultivar reaction to BPH biotype 1 was recorded at 7, 9, 11, and 13 days after infestation (DI) using the 1980 Standard Evaluation System for Rice.

Seedling reactions of selected rice cultivars to brown planthopper biotype 1.

Rice type	Variety	Damage rating[a] at given days after infestation 7d	9d	11 d	13 d
Tongil (japonica/ indica)	Milyang 23	R	R	MR	M
	Seogwangbyeo	R	R	MR	MS
	Pungsanbyeo	R	R	MR	MS
Japonica	Jinjubyeo	MR	M	S	S
	Dongjinbyeo	M	MS	S	S
	Samnambyeo	M	MS	S	S
	Sangpungbyeo	M	MS	S	S
	Cheongcheongbyeo (R check)	R	R	R	R

[a]Based on seedling bulk test: R = resistant, MR = moderately resistant, M = moderate, MS = moderately susceptible, S = susceptible.

Japonica varieties Jinjubyeo, Dongjinbyeo, Samnambyeo, and Sangpungbyeo were susceptible to BPH at 11 DI. Tongil lines Milyang 23, Seogwangbyeo, and Pungsanbyeo were moderately resistant to BPH at 11 DI (see table). Among rice cultivars with no BPH resistance genes, japonica cultivars at seedling stage were much more susceptible to BPH than Tongil lines. □

GENETIC EVALUATION AND UTILIZATION

Adverse soils tolerance

Rice tolerance for coastal salinity

T. S. Sinha, junior plant breeder, and A. K. Bandyopadhyay, senior scientist and officer in charge, Central Soil Salinity Research Institute (CSSRI), Canning, West Bengal, India

Rice varieties were screened in rainfed fields for coastal soil salinity tolerance during kharif (Jun-Nov) 1980, 1981, and 1982 at CSSRI. Trials were in a randomized block design with three replications. Soil pH was 7.0 and soil salinity (ECe) ranged from 6.3 to 11.5 in 1980, 6.3 to 8.3 in 1981, and 9.4 to 16.9 mmho/cm in 1982 at different crop growth stages. One-hundred and sixty-three varieties or lines were compared to local checks CSRl and Nonasail (Sel), using the 1980 Standard Evaluation System for Rice scale. Plant survival at maturity also was recorded (see table).

In 1980 Nonasail (Sel) scored best at all stages. The lines IR4432-28-5 and IR2863-35-3-3 also were promising. In 1981 10 varieties or lines scored better than the resistant check at vegetative stage. Among them, IR9884-54-3 and M152 were the most tolerant. Although IR42 had 100% survival, it had poorer growth than IR36. Lines that performed as well as the local check CSRl were IR4432-28-5, Nonasail (Sel), IR10198-66-2, and IR2307-247-2-2-3. IR4432-28-5, Nonasail (Sel), IR10198-66-2, and CSRl exhibited more tolerance at ripening stage than at vegetative stage. IR9852-19-2 and IR13426-19-2 had better tolerance at ripening stage.

Salinity was highest in 1982 and most varieties had high mortality and poor growth. However, M152, M242, PNL 28-23, and Nonasail (Sel) had 50% survival and performed best. Tests showed that there are three levels of salt tolerance: tolerance at all growth stages, tolerance at vegetative stage, and tolerance at ripening stage. Nonasail (Sel), CSR6, CSRl, M152 in that order, had tolerance at all growth stages. IR4432-28-5 and IR13426-19-2 performed well and IR9884-54-3 appeared suitable for medium saline soils. □

Field scores and survival of some promising varieties or lines in screening for tolerance for coastal salinity.

Variety or line	Plant survival at maturity (%)				Tolerance score[a]							
					Vegetative				Maturity			
	1980	1981	1982	Av	1980	1981	1982	Av	1980	1981	1982	Av
IR36	56	99	16	57	8	4	8	7	6	6	9	7
IR42	48	100	12	53	8	6	8	7	7	5	8	7
IR4432-28-5	79	98	21	66	6	4	8	6	5	4	8	6
IR9852-19-2	57	98	30	61	8	6	6	6	7	4	8	6
IR9884-54-3	73	99	19	64	7	4	7	6	6	4	8	6
IR9975-5-1	62	69	11	47	7	6	7	7	6	6	8	7
M152	34	91	74	66	8	4	3	5	7	4	4	5
M242	37	63	64	55	8	4	5	6	7	5	6	6
Nonasail (Sel)	92	87	61	80	4	4	4	4	4	4	6	4
PNL 11-2	60	9	24	31	7	4	7	6	6	7	6	6
PNL 28-23	70	61	53	61	6	6	8	6	7	6	8	7
IR10198-66-2	70	93	15	59	7	4	8	6	7	4	8	6
IR10206-29-2	59	84	22	55	8	6	8	7	7	5	8	7
IR13426-19-2	58	83	–	71	7	5	–	6	7	4	–	5
IR2307-247-2-2-3	55	99	19	58	8	4	8	6	6	5	8	6
IR2863-35-3-3	79	96	5	60	6	6	9	7	5	5	9	6
Pokkali	7	60	4	24	8	9	9	8	6	7	8	7
M-1-48	59	2	–	30	8	9	–	9	9	9	–	9
CSRl		97	37	67	–	4	6	5	–	3	5	4

[a]1980 Standard Evaluation System for Rice scale of 1-9: 1 = growth and tillering nearly normal; 9 = almost all plants dead or dying.

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:

- *Consequences of small farm mechanization*
- *Investigaciones en arroz en los años 1980: resumen de los informes de la conferencia internacional de investigaciones en arroz del afio 1982*
- *Map series of Bangladesh: rice area planted by season, rice area planted by culture type, farm size distribution, and base map.*

GENETIC EVALUATION AND UTILIZATION

Deep water

Performance of some promising varieties in floating-rice areas of Cuu Long Delta

Nguyen Van Luat, B. K. Singh, Nguyen Minh Chau, Tran Van Hoa, and Le Van Thanh, Cuu Long Delta Rice Research Institute, Omon, Hau Giang, Vietnam

Deepwater rice is grown on about 0.5 million ha on the Cuu Long (Mekong) Delta. Most is grown in An Giang, Dong Thap, Kien Giang, Hau Giang, and Long An Provinces. There is little information on agronomic characteristics and yield of popular local varieties.

We compared local varieties Nang Tay Dum, Nang Tay Lon, Nang Chet Cut, Ba Bong, Sa Mo Chum, Cu La, and introduced varieties Leb Mue Nahng 111, BKNFR76031-1-13-1, BKNFR76047-4-3-1, and RD19 at An Giang and Hau Giang (see table).

In Jun 1982 1-month-old seedlings were transplanted in 25- × 25-cm spacing at 1 seedling/hill. Maximum water depth

Grain yield and plant characters of some photoperiod–sensitive rices in floating-rice areas of Cuu Long (Mekong) Delta, S. R. Vietnam, 1982.

Variety	Date of heading	Height (cm)	Panicles (no./m^2)	Field grains/ panicle	Unfilled grains %	1000-grain weight (g)	Yield[a] (t/ha)
				An Giang			
Local							
Ba Bong	07 Dec	260	89	146	12.3	32.2	3.0 def
Cu La	20 Nov	247	108	151	16.3	23.9	3.3 cd
Nang Chet Cut	17 Nov	250	92	151	18.2	24.8	2.9 ef
Nang Tay Dum	23 Nov	254	89	195	18.4	22.8	3.6 a
Nang Tay Lon	23 Nov	255	83	133	15.9	29.7	3.6 ab
Sa Mo Chum	25 Nov	237	103	165	14.3	22.5	3.4 abc
Introduced[b]							
BKNFR76031-1-13-1	23 Nov	228	92	82	30.9	34.4	2.5 g
BKNFR76047-4-3-1	01 Dec	210	69	98	27.9	28.7	2.2 g
Leb Mue Nahng 111	22 Nov	255	88	116	22.7	31.8	3.0 def
RD19	05 Dec	208	117	62	25.3	30.7	3.1 cde
				Hau Giang			
Local							
Ba Bong	01 Dec	212	69	121	18.0	33.3	3.7 a
Cu La	19 Nov	231	88	84	30.7	24.3	2.5 b
Nang Chet Cut	15 Nov	248	75	99	20.0	24.6	2.6 b
Nang Tay Dum	30 Nov	244	65	158	20.5	23.3	2.7 b
Nang Tay Lon	20 Nov	258	71	102	20.2	28.3	2.5 b
Introduced[b]							
BKNFR76031-1-13-1	21 Nov	245	76	96	24.1	34.9	2.5 b
Leb Mue Nahng 111	20 Nov	256	62	103	23.9	32.0	2.4 b
Pin Gaew 56	15 Dec	298	84	127	19.2	30.8	3.4 a

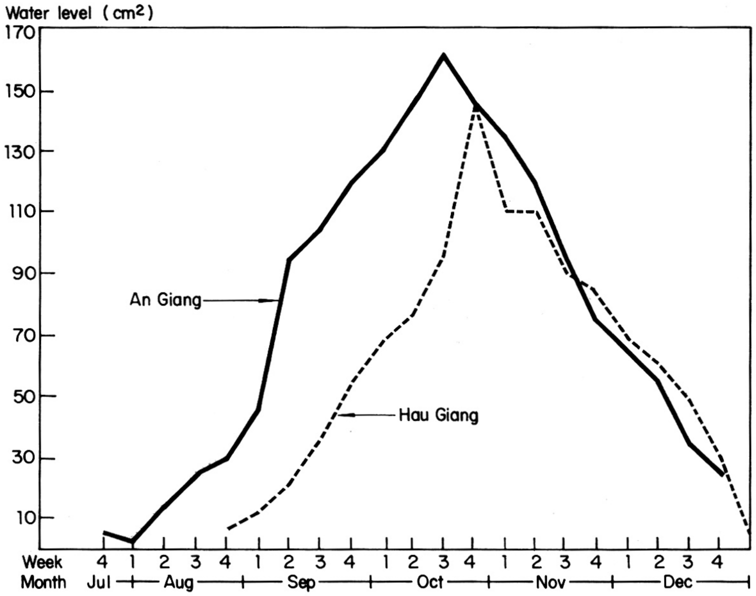
[a]Means followed by a common letter are not significantly different at 5% level. [b]From Thailand.

was 161 cm at An Giang and 146 cm at Hau Giang in late Oct (see figure).

At An Giang, Nang Tay Dum yielded highest (3.6 t/ha) and was significantly superior to Nang Tay Lon and Sa Mo Chum. It also had the highest number of filled panicles. Nang Tay Lon had highest grain weight and Sa Mo Chum had more panicles/m². Ba Bong was superior at Hau Giang. Soil type may have caused differences in varietal performance in the two locations. Hau Giang has slightly acid sulfate soil and An Giang has normal alluvial soil.

Introduced varieties had a higher percentage of unfilled grains than local varieties, except Pin Gaew 56, which had a large number of filled grains/panicle and high grain weight (see table).

BKNFR76031-1-1-13-1, BKNFR76047-4-3-1, and RD19 had less adaptability in An Giang, a typical floating rice area, because they have lower elongation ability and can be damaged by deep flooding.



Weekly fluctuation in floodwater depth in the experimental plots in An Giang and Hau Giang Provinces of Cuu Long Delta, S. R. Vietnam, 1982.

Leb Mue Nahng 111 and Pin Gaew 56 had elongation ability similar to that of local varieties. Ba Bong and Pin Gaew 56 were late maturing and had longer plants and good kneeing ability, making them suitable for deep water.

Elongation rate of some deepwater rices of Bihar, India

R. Thakur, senior rice breeder, and R. K. Singh, assistant research officer, Plant Breeding and Genetics Department, Rajendra Agricultural University, B. A. C. Sabour, Bhagalpur, India

Deepwater rices are characterized by rapid elongation of stem, sheath, and leaf blade when water rises. If water rises gradually, they keep their leaves above the surface. Elongation rate of many local deepwater cultivars grown in Bihar has not been established. We recorded daily elongation of local varieties Janaki (64–117), BR14, Pichar, Barogar, Desaria, Malida, and 62-68.

Forty-day-old potted seedlings were submerged in a 1-m-deep water tank. Water level was adjusted daily, and height was measured on 4 consecutive days.

Daily elongation rate varied. Maximum daily elongation was 26 cm for Desaria, 25 cm for Barogar, 18 cm for Pichar, 13 cm for Janaki (64–117), 12 cm for BR14 and for 62–68, and 7 cm for Malida. The time of greatest elongation also varied. Desaria, Barogar, and 62-68 had greatest elongation on day 1; Pichar, Malida, and BR14 on day 4; and Janaki (64–117) on day 3 (see table).

Barogar and Desaria, both floating rices, elongated fastest, and had greatest day 1 elongation, which is desirable.

Average daily elongation of local deepwater rice in Bihar, India.

Variety	Av daily elongation (cm)							
	Day 1		Day 2		Day 3		Day 4	
	Av	Range	Av	Range	Av	Range	Av	Range
Janaki (64-117)	2	0.2–5.4	5	0.7–6.5	5	1.0–12.7	3	0.5–10.8
Pichar	4	1.2–8.2	2	0.3–3.8	4	0.5–13.3	14	1.5–18.0
Barogar	16	8.0–25.0	8	4.0–17.0	8	2.0–17.0	8	2.0–17.2
Desaria	9	2.0–14.0	6	1.4–10.4	14	5.1–26.1	5	1.0–13.0
Malida	1	0.2–3.5	3	1.6–5.0	3	1.0–4.5	6	3.0–7.0
62-68	7	4.5–10.0	8	5.5–12.0	4	1.0–6.2	2	0.5–6.1
BR14	7	0.5–7.0	5	0.5–10.0	4	0.5–10.3	9	5.0–11.7

GENETIC EVALUATION AND UTILIZATION

Drought resistance

Rasi, a drought-tolerant variety

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During 1979 dry season (Mar-Jul) AICRIP coordinated two trials with 17 entries, each grown in randomized block design with 3 replications at RAU, Pusa campus (25.59°N, 85.40°E, and 51.81 m above sea level). Recommended cultural techniques were used to raise a good crop. Unfortunately the trial could not be irrigated for 15 days (starting middle of May) during the vegetative growth stage, 33 days after transplanting. Leaf firing was visible after a week of water stress. Total precipitation until harvest was 800 mm, including 637 mm in July. Only Rasi (IET1444) did not have leaf firing drought symptoms. Leaf firing intensity varied from 15 to 50% of the leaf blade for other varieties. Rasi yields under drought conditions were promising (see table). □

Rasi yield performance under drought stress, Samastipur, India, 1979.

Variety	Days to 50% flowering	Grain yield (t/ha)
Rasi (IET1444)	99	3.7
Ratna	108	1.5
Pusa 2-21	108	1.9
Saket-4 (CR44-35)	102	3.1
CD (5%)	–	0.65
CV %	–	23.20

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

HPU741, a promising early, cold-tolerant rice variety

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HPU741, a cold-tolerant rice variety selected for earliness and uniform maturity, and designated as IR3941-45-Plp2B from the cross CR126-42-5/ IR2061-213, is suitable for cultivation in low, mid, and high hills of Himachal Pradesh up to 1,550 m altitudes.

In transplanted experiments conducted throughout Himachal Pradesh from 1977 to 1982, HPU741 yield averaged 3.7 t/ha – 19.4% more than IR579, 5.7% more than China 988, and 8.8% more than Himdhan (Table 1).

In rainfed upland experiments from 1980 to 1982, it averaged 2.8 t/ha, 27.3% more than China 988 and 16.7% more than Himdhan (Table 1). Table 2 shows that tests in rainfed uplands experienced severe to moderate drought stress from flowering to maturity.

Yield stability parameters for 20 rices tested in the elite varieties trials in

Table 1. Grain yield of HPU741 in Himachal Pradesh, India.[a]

Year	Grain yield (t/ha)			
	HPU741	China 988 (check)	Himdhan (check)	IR579 (check)
Transplanted experiments				
1977	3.9 (5)	3.5 (5)	3.6 (5)	–
1978	3.7 (7)	3.6 (7)	4.0 (7)	3.5 (7)
1979	3.8 (6)	3.3 (6)	3.3 (6)	2.5 (6)
1980	3.7 (16)	3.0 (11)	3.0 (16)	3.0 (8)
1981	3.8 (14)	3.9 (9)	3.7 (14)	3.5 (7)
1982	3.4 (9)	3.8 (5)	3.3 (9)	2.6 (5)
Mean	3.1 (57)	3.5 (43)	3.4 (57)	3.1 (33)
Increase over respective checks (%)	–	5.7	8.8	19.4
Rainfed upland experiments				
1980	2.3 (3)	2.1 (3)	2.4 (3)	
1981	3.4 (4)	2.8 (4)	3.8 (4)	
1982	2.6 (8)	1.9 (8)	1.7 (8)	
Mean	2.8 (15)	2.2 (15)	2.4 (15)	
Increase over respective checks (%)	–	27.3	16.7	

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

Table 2. Rainfall pattern during flowering to maturity period of direct-seeded rice in rainfed uplands, Palampur, H. P. India, 1980-82.[a]

1980	Rainfall (mm)	1981	Rainfall (mm)	1982	Rainfall (mm)
1-12 Sep	124.1 (10)	1-2 Sep	45.7 (1)	1-6 Sep	– (6)
13-23 Sep	– (11)	3-14 Sep	– (12)	7-14 Sep	33.4 (4)
24-25 Sep	21.0 (2)	15-21 Sep	125.3 (4)	15-21 Sep	– (7)
26 Sep to 7 Oct	– (12)	20-23 Sep	– (4)	22 Sep	7.6 (1)
8 Oct	8.2 (1)	24-29 Sep	39.6 (4)	23 Sep to 7 Oct	– (15)
9-15 Oct	– (7)	30 Sep to 15 Oct	– (16)	8-9 Oct	10.2 (2)
				10-15 Oct	– (6)

[a]Figures in parentheses indicate the number of rainy/dry days.

Table 3. Agronomic and quality characteristics of HPU741.

	HPU741	IR579 (check)	China 988 (check)	Himdhan (check)
Cross	CR126-42-5/IR2061-213	IR8/Tadukan	–	R575/T(N)1
Plant height (cm)	72	68	102	99
Days to maturity	124	138	128	130
Panicles (no./m²)	220	258	245	207
Spikelets (no./panicle)	99	111	79	117
Spikelet sterility (%)	12.1	18.1	15.6	18.0
1,000-grain wt (g)	25.9	20.6	24.3	25.3
Protein (%)	6.3	8.0	6.3	7.6
Amylose (%)	17.5	21.7	21.0	22.9
Alkali digestion value (1-7 score)	5.5	6.9	6.3	7.0
Length-breadth ratio	3.0	3.6	2.6	2.2
Leaf blast (1-9 score)	2.0	4.0	5.0	4.5
Neck blast (%)	10	5	25	10

1977 and 1978 in 9 environments indicated that HPU741 had high yield (3.4 t/ha) and high stability (regression 1.02 and deviation from regression 0.38).

In 15 minikit trials in farmers' fields during 1980, it averaged 2.9 t/ha and outyielded local checks by 26.6%. The highest yield recorded was 6.9 t/ha on a progressive farmer's field.

HPU741 has low spikelet sterility, high grain weight, long slender grains, and resists leaf blast (Table 3). □

Pest management and control DISEASES

Rice grain discoloration in Assam, India

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Rice grain discoloration (also known as *dirty rice* or *pecky rice* in some countries) has increased sharply in Assam, particularly on the high yielding sali crop (Jul/ Aug-Nov/Dec) grown under moderate fertilization. Grain discoloration reduces germination, causes coleoptile or radicle decay, or both, results in chaffy grain, and reduces yield. Surveys of stored grain samples in Assam show that 22 fungi are associated with about 93% of the spotted grain (see table). Bacteria and two nematodes (neither *Ditylenchus angustus* nor *Aphelenchoides besseyi*) have been isolated from the remaining discolored grain

Curvularia lunata, the most common fungus, was associated with 37% of the discolored grain; *Fusarium* spp., 13%; and *Chaetomium* spp., 6%. Occasionally, more than one fungus was isolated from a single discolored grain. Discolored grain varied from 7% in TTB2-6-1-1 to 18% in Ngoba (av, 12%). Germination of discolored grain was reduced 45% in Ngoba and 85% in IET4140 and TTB 4/7 (av, 63%). Weight loss varied from 20% in Mahsuri to 45% in IR8 (av, 26%).

Fungi associated with rice grain discoloration in Assam, India, and % of discolored grain.

Fungus	Discolored grain (%)
Aspergillus sp.	7
Curvularia geniculata (Tr. & Earle) Boedijn	6
C. lunata (Walker) Boedijn	37
C. veruciformis Agarwal & Sahni	1
Cephalosporium sp.	<1
Chaetomium globosum Kunze & Schm.	4
Chaetomium sp.	2
Drechslera oryzae (Breda de Haan) Subram. & Jain	4
Fusarium chlamydosporum Wr. & Rg.	2
F. moniliforme Sheld.	7
Fusarium sp.	4
Mucor sp.	1
Nigrospora sp.	<1
Pyricularia oryzae Cav.	3
Phyllosticta glumarum (Ell. & Tr.) Miyake	1
Rhizopus oryzae Went & Gerlings	<1
Trichoconiella padwickii (Ganguly) Jain	2
Torula sp.	<1
Verticillium intertexturn Isaac	3

In pathogenicity tests using spore and mycelial suspensions of 3 species of *Curvularia, Cephalosporium* sp., *F. chlamydosporum, Fusarium* sp., and *V. intertextum,* about 50% of the grains were infected when the inocula were placed outside the glumes. Up to 90% were infected when the glumes were forced open and the inocula were placed inside. □

Influence of time of rice ragged stunt virus infection on deepwater rice yield

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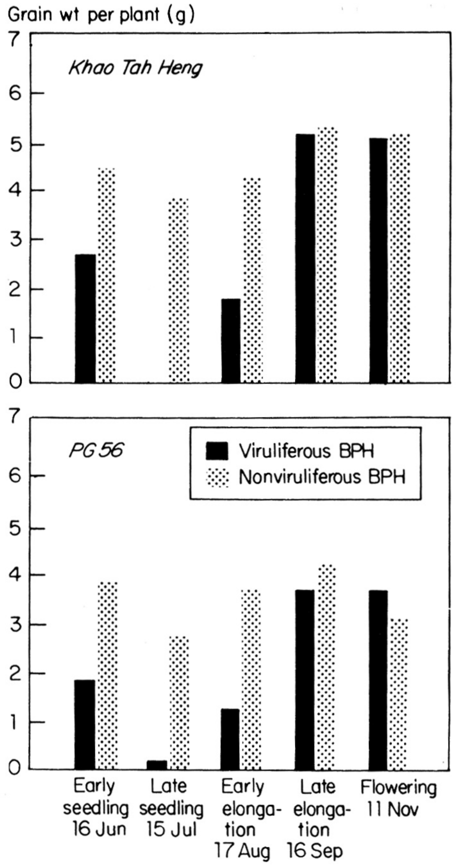
Two deepwater rice varieties susceptible to rice ragged stunt virus (RRSV), KTH123 (early), and PC56 (late), were grown in pots and inoculated with viruliferous brown planthopper (BPH) at five growth stages to test the hypothesis that in deepwater rice most field transmission happens before flooding. There were 3 plants/pot and 3 replications/treatment. A second set of plants treated in the same way was exposed to an equal number of nonviruliferous BPH to eliminate the effect of feeding on yield and plant growth. Plants were sown on 17 May and kept in a normal screenhouse for the first two inoculations. On 16 Jul the pots were transferred to screened metal tanks and the water level was raised to elongate the plants. The last three inoculations were carried out in the metal tanks. Virus symptoms were recorded during the plant development and grain yield and yield components were measured at maturity.

Grain yield was zero or negligible in both varieties following inoculation in the late seedling stage (60 days after seeding [DS]) and was reduced by about 50% with inoculation in the early seedling and early elongation stages (see figure). RRSV symptoms developed in many plants inoculated at those three growth stages. After mid-elongation stage, inoculation did not significantly lower yields although a few disease symptoms did develop. Yield reduction was caused by absence of panicles or fewer and smaller ones. The disease also reduced plant length. The effect of feeding of 20 hoppers/plant for 24 hours in the late seedling stage is shown in the figure.

Results indicate that major virus transmission takes place early in the season before deep flooding and resistance screening can be done at seedling stage. It may be possible to limit the disease by controlling vector populations before flooding.



Effect of time of inoculation with RRSV on the grain yield of deepwater rice, Bangkhen, Thailand, 1982.

Pest management and control INSECTS

Outbreak of rice ear-cutting caterpillar *Mythimna separata* (Walker) in Manipur, India

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A serious outbreak of rice ear-cutting caterpillar *Mythimna separata* occurred in the Imphal Valley of Manipur during late Oct 1982 after unusually heavy Feb to Sep rainfall that caused repeated flooding. Oct was comparatively dry. Caterpillar outbreaks were severe in flood-prone areas, particularly in East and Thoubal Blocks of the valley. Many larval-pupal parasites were observed.

Recently introduced varieties Punshi and Phouibi, planted to 50% and 25% of the cultivated area, were seriously damaged. In the East Block 75% of the grain was damaged in some fields. Degree of infestation was recorded based on number of larvae and pupae/hill on 4 rice varieties grown in a 1-ha plot in Khumbong (West - II Block). Caterpillar infestation rose with the number of green, unproductive tillers (Table 1). The caterpillar population was greatest on RCM-3 followed by that in Punshi, IR24, Moirangphou. Jaya, Mashuri, CH988, CH1039, Phouren, and Kumbi. Many other local varieties grown in small pockets had little or no damage.

Malathion and BHC dust were recommended to control the pest. Spray formulations of insecticides, however, also were used by some farmers. When pesti-

Table 1. Incidence of rice ear-cutting Caterpillar on 4 varieties of paddy. [a]

Variety	Tillers (no./hill)			Insects (no./hill)		
	Total	Productive	Unproductive	Total	Larvae	Pupae
RCM3 (Moirangphou/Jaya)	19.5 a	13.5 a	7.3 a	10.9 a	6.2 a	5.2 a
Punshi (IR661-1-140-3-2/ Phouren)	14.5 b	10.7 b	4.3 b	3.0 b	2.0 b	1.5 b
IR24 (IR8/IR127-2-2)	14.0 b	11.4 b	3.1 c	2.2 b	2.2 b	0.5 b
Moirangphou (local)	11.5 c	11.0 b	1.0 d	0.5 c	0.5 c	0.5 b
SE	1.03	0.80	0.31	0.92	0.51	0.50
CD (<0.05)	2.05	1.64	0.63	1.90	1.00	1.02

[a] The figures are n + 0.5 transformation of the original values. In a column means followed by a common letter are not significantly different at the 5% level.

cide was not available, some farmers spot-sprayed with kerosene, petroleum, and diesel oils. Kerosene sprays were reported to have performed better than pesticides. We compared the efficacy of insecticide dusts and kerosene in laboratory tests (Table 2).

One-gram insecticide dust formulation was spread evenly in a 21-cm petri dish and final-instar larvae were released. One millimeter of kerosene was placed in a petri dish of the same size. A 1:4:40 mixture of kerosene, common salt, and water caused larval mortality equal to that with quinalphos (5%) and methyl-parathion (2%) dusts. ☐

Table 2. Comparative efficacy of kerosene and insecticide dusts against rice ear-cutting caterpillar.

Treatment[a]	Mortality[b] of last-instar larvae at indicated time after treatment (%)		
	15 min	30 min	60 min
BHC 10D	17 c	80 b	97 ab
Carbaryl 5D	20 c	27 c	73 c
Malathion 5D	23 c	77 b	100 a
Quinalphos 5D	77 a	100 a	100 a
Methyl parathion 2D	80 a	100 a	100 a
Kerosene + common salt + water (1:4:40)	83 a	100 a	100 a
Kerosene + water (1:40)	63 b	83 b	90 bc
Common salt + water (1:4)	0 d	3 d	10 d
Water	0 d	0 d	0 d

[a]D = percent dust formulation. [b]In a column, means followed by a common letter are not significantly different at the 5% level.

Insecticide resistance in brown planthoppers of Malaysia

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Recent toxicological studies on insecticidal effects of some carbamates commonly used to control brown planthopper (BPH) *Nilaparvata lugens* in Malaysia suggest that insecticide resistance may be developing.

In 1982 BPH were collected from fields of MR1, a local susceptible variety, in Tanjong Karang. They were cultured in the greenhouse on MR1 for 10 to 15 generations. One-day-old BPH adult females from this culture were treated, using a microapplicator, with various concentrations of MTMC diluted with acetone. Before treatment, the insects were anesthetized with CO_2. Treated insects were allowed to recover in a petri dish before being released onto 2-week-old MR1 rice plants in mylar film cages. Mortality was recorded after 24h.

Toxicological studies in 1977 used BPH collected from fields of Mat Chandu, a local susceptible variety in Bumbong Lima. BPH were reared on TNl in the greenhouse for 20-25 generations before the studies were carried out. The same test procedure was used, except that the treated hoppers were released onto 2-week-old TN1 rice plants.

Data from both studies were analyzed by a probit analysis computer program from Imperial College, Silwood Park, which performs independent single analysis and joint analysis with parallel data. If the data do not contradict the hypothesis of parallelism, the program compares effectiveness in terms of relative potencies.

Data show that BPH populations in Malaysia have become more resistant to MTMC between 1977 and 1982. During those years, a relative potency increase of 19.42 has developed, perhaps caused by the increased use of MTMC dust for BPH control. ☐

Cytogenetic variations between *Nilaparvata bakeri* (Muir) and *Nilaparvata lugens* (Stål) planthoppers

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Populations of planthopper species *N. bakeri* and *N. lugens* recently were found coexisting on a weed grass *Leersia hexandra* (L.) Swartz, which grows abundantly in ditches along rice fields at the IRRI experimental farm, Los Baños. The planthoppers can be distinguished by genitalia. The grass-infesting *N. lugens* is a distinct deviant of the rice-infesting *N. lugens* brown planthopper and is suspected to be another biotype.

Hybridization studies were conducted to determine the genetic proximity between *N. bakeri* and *N. lugens.* Genetic crosses showed minimal compatibility and proved that natural hybridization is impossible. Cytogenetic investigations were made to elucidate specific relationships and observed phenotypic segregations of progenies in reciprocal heterogamic crosses.

Using the technique for preparation of brown planthopper chromosomes, actively dividing testicular cells of newly

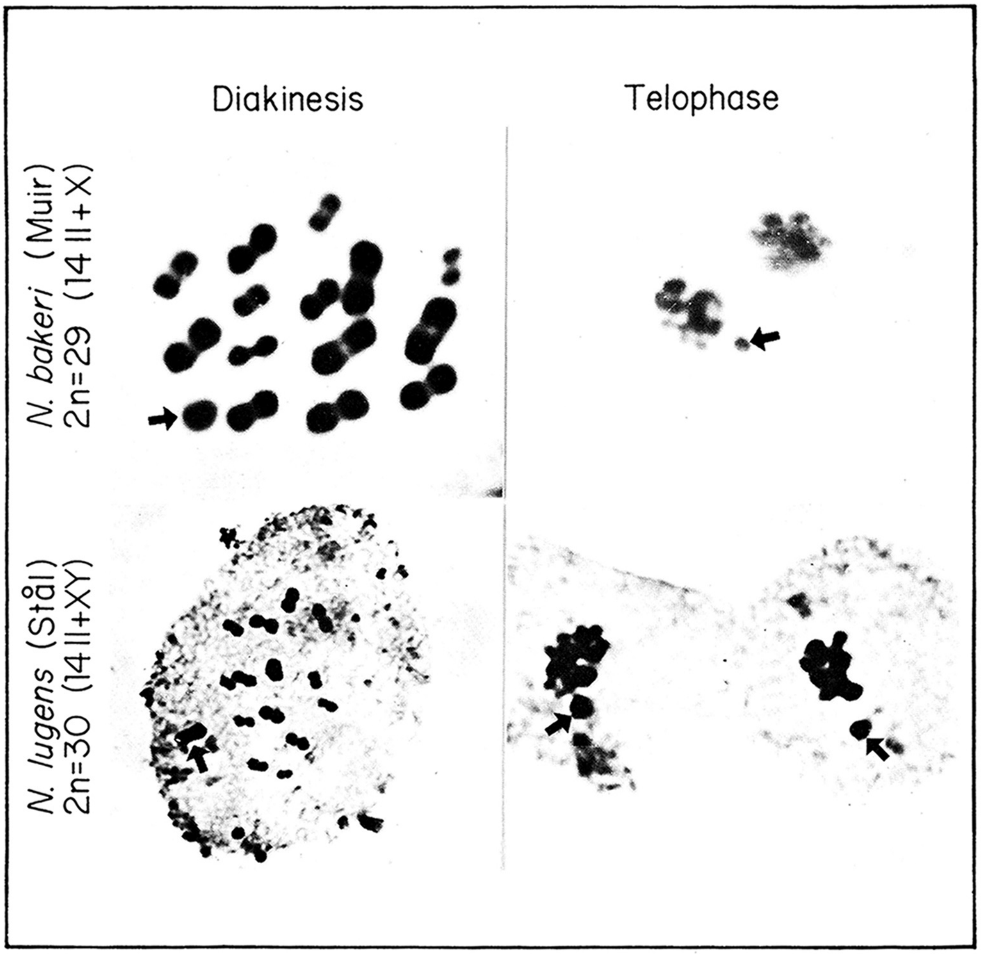
Variations in diploid chromosomal complement and sex-determining mechanisms of *N. bakeri* and *N. lugens*.

Species	Variations		
	Chromosome number (2n)	Sex-determining mechanism	Complete genome and prospective gametes
N. bakeri	Female: 30	XX	14 II + XX → 14 I + X ova
	Male: 29	XO	14 II + XO → 14 I + X sperms; → 14 I + O sperms
N. lugens	Female: 30	XX	14 II + XX → 14 I + X ova
	Male: 30	XY	14 II + XY → 14 I + X sperms; → 14 I + Y sperms

emerged *N. bakeri* and *N. lugens* brachypters were examined. The following variations in karyotypic features were detected:

1. Although females yield only one type of ova and males produce two types of sperm in both species, variations exist in the diploid chromosomal complement and the sex-determining mechanism (see table and figure).
2. In both species, chromosomes in gonial meiosis do not have distinct centromeres because they have diffused kinetochores. The constrictions vital for chromosomal movements and segregations during the meiotic stages are located along the length of the chromosomes. However, *N. bakeri* has relatively longer chromosomes: the shortest and the longest *N. bakeri* chromosomes are nearly 4 times longer than those of *N. lugens.* The nucleolar organizer of *N. bakeri* is its longest (143.50 mm) chromosome. In *N. lugens* it is 20.75 mm long.

These cytogenetic deviations impose pre- and post-mating barriers to effective hybridization between *N. bakeri* and *N. lugens,* and are additional taxonomic indices for differentiating the two species. ☐



Autosomes and sex chromosomes of planthopper species from Leersia hexandra (L.) Swartz. Sex chromosomes are indicated by arrows.

Incidence of brown planthopper *Nilaparvata lugens* Stål on IR50 at graded levels of fertilization at Aduthurai

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IR50 was recently introduced in Tamil Nadu. We studied the response of this variety under graded levels of fertilization and BPH damage in a randomized block design with eight treatments and three replications. BPH population was recorded 80 d after transplanting (see table).

BPH population increased with fertilizer levels. Maximum BPH/hill was 106 when 150 kg N/ha was applied. The BPH population was lowest (5/hill) when no fertilizer was applied. P and K did not significantly influence BPH population.

Incidence of BPH under graded levels of fertilization, Aduthurai, India.

Fertilization[a]			BPH	Yield
N	P	K	(no./hill)	(t/ha)
0	0	0	5	4.1
50	0	0	50	4.7
100	0	0	53	5.5
150	0	0	106	4.6
50	11	21	28	4.7
100	22	42	54	5.4
150	33	62	84	5.0
0	22	42	5	5.0
CD			47.8	1.0

[a]Fertilization: 50% N = basal application, 25% N = topdressing at tillering, 25% N = topdressing at panicle initiation; P and K = basal applications.

At 100 kg N/ha with or without P and K, yield was 5.5 t/ha although the BPH population was above the economic threshold level. ☐

Effect of carbofuran and nitrogen on leaffolder incidence

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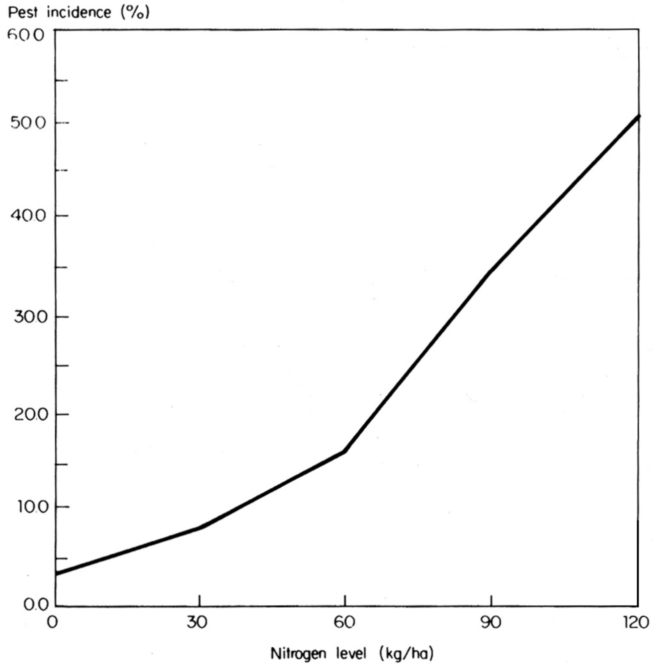
The effects of combined application of carbofuran and nitrogen on leaffolder *Cnaphalocrocis medinalis* (G.) incidence was studied at Tamil Nadu RRI Sep 1982-Jan 83. The field trial was in a split-plot design with three replications. Thirty-day-old IR20 seedlings were planted in 20-m^2 plots at 20- × 10-cm spacing. Carbofuran was incorporated at 0.5 and 0.75 kg ai/ha with a basal application of nitrogen as urea at planting. Carbofuran was topdressed at 0.5, 0.75, and 1.0 kg ai/ha with the first topdressing of urea 15 days after transplanting (15 DT). N levels 0, 30, 60, 90, and 120 kg/ha were applied

Effect of carbofuran application on leaffolder incidence, Aduthurai, India, 1982-83.

Treatment	Leaffolder damage (%)
Control	27.1
0.5 kg carbofuran ai/ha incorporated at planting	24.5
0.5 kg carbofuran ai/ha topdressed at 15 DT	21.1
0.75 kg carbofuran ai/ha incorporated at planting	26.4
0.75 kg carbofuran ai/ha topdressed at 15 DT	19.7
1.0 kg carbofuran ai/ha topdressed at 15 DT	17.6
CD	NS



Effect of nitrogen level on leaffolder incidence.

to subplots in 3 splits – 50% basal, 25% at active tillering, and 25% at panicle initiation. Leaffolder incidence on 10 hills/ plot was recorded at 60 DT by counting the total and damaged leaves and calculating the percentage.

Method of carbofuran application did not significantly influence leaffolder incidence. However, topdressing of carbofuran at 15 DT caused a slight decrease in the pest incidence (see table). Increased levels of nitrogen application caused a corresponding increase in pest population (see figure). Carbofuran-nitrogen interaction was not significant. □

A new predaceous beetle of whitebacked planthopper in India

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Whitebacked planthopper (WBPH) *Sogatella furcifera* (Horvath) is a potentially destructive rice pest during kharif in Madhya Pradesh. Populations are suppressed by several enemies including mirid bug *Cyrthorhinus lividipennis.* Staphylinid beetle *Paederus fuscipes* Curtis (Staphy1inidae:Coleoptera) is a predator of brown planthopper (BPH) in Malaysia, Japan, Taiwan, and Thailand. Two species of this beetle, *P. fuscipes* and *P. melampus* Er., feed on BPH in India.

Large populations (25-30 beetles/ hill) of staphylinid beetle *P. fuscipes* were found in fields in Apr 1981, feeding on WBPH nymphs. In confinement the beetles also preferred nymphs. This is the first record of *P. fuscipes* in M. P., India. □

Attraction of rice gall midge *Orseolia oryzae* to light sources

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Gall midge *Orseolia oryzae* (Wood-Mason) is a major rice pest in India and in Tamil Nadu State. Infestations occur from Aug to Feb with maximum populations between Sep and Nov. Gall midge attraction to different light sources and light traps was studied at the Agricultural College and Research Institute, Madurai. A bamboo trap with a 40W incandescent bulb, a bamboo trap with a 250W infrared lamp, and a Robinson type trap with a 125W mercury vapor lamp were set up in a triangle over the field. The trap posttions were randomly interchanged each day after morning counts. Total weekly gall midge catches were combined over 4 weeks and compared.

The bamboo trap with 250W infrared light source attracted the most insects, followed by the 40W incandescent light

Attraction of rice gall midge *Orseolia oryzae* **to different light sources, Madurai, India, 1981.**

Week ending	40W incandescent lamp	250W infrared lamp	125W HPL mercury vapor lamp
19 Sep 81	149 (2.17)	360 (2.56)	69 (1.84)
26 Sep 81	120 (2.08)	258 (2.41)	35 (1.54)
3 Oct 81	140 (2.15)	274 (2.44)	67 (1.83)
10 Oct 81	155 (2.19)	255 (2.41)	52 (1.72)
Total	(8.59)	(9.82)	(6.93)
Mean	(2.15)	(2.46)	(1.73)

[a] Figures in parentheses are transformed values.

trap and the Robinson trap (see table). The Robinson trap may have trapped fewer midges because the high-intensity light attracted many kinds of insects, including large ones, which made it difficult for fragile, smaller gall midges to reach the trap. It also may be that the photokinetic response of gall midge is greater toward the infrared range. □

Brown planthopper biotypes in Korea

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Brown planthopper (BPH) populations come to Korea on prevailing low-pressure winds from southern China during the crop growing season. We studied the distribution of migrating BPH biotypes in Korea. Seventy-eight BPH females were collected from the southwest coast of the Korean peninsula 23-27 Aug 1982. They were individually reared for two to three generations on susceptible rice variety Milyang 23 in the greenhouse.

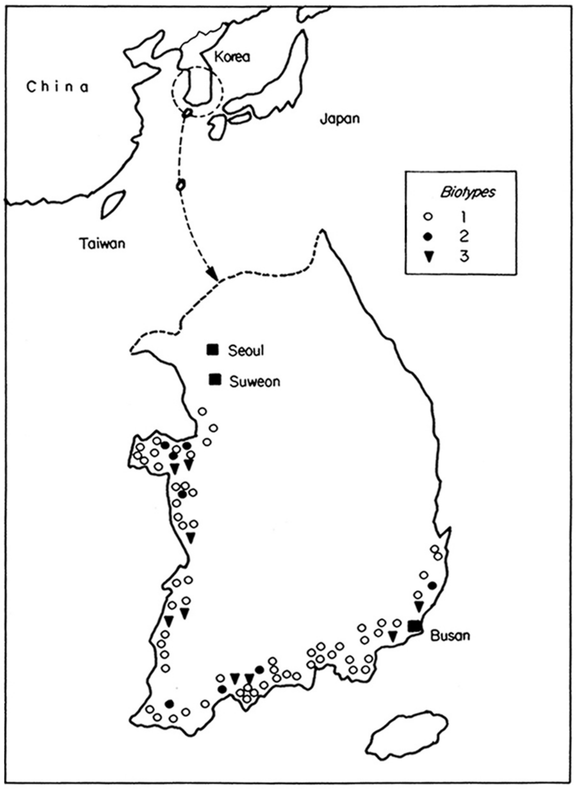
Differential varieties were Milyang 23 with no resistance gene, Cheongcheongbyeo with *Bph 1* resistance gene, and Milyang 63 with *bph* 2 resistance gene (see table).

BPH biotypes from each local collection were differentiated using the seedling bulk testing method. Results showed 61 local collections were BPH biotype 1, 8 were biotype 2, and 9 were biotype 3 (see figure). □

Reaction of different rice varieties to BPH biotypes and local collections in Korea in 1982.

Variety	Resistance gene	Damage rating[a]					
		Biotype			Local collections from		
		1	2	3	Ashan	Hongseong	Boseong
Milyang 23	None	S	S	S	S	S	S
Cheongcheongbyeo	*Bph 1*	R	S	R	R	S	R
Milyang 63	*bph* 2	R	R	S	R	R	S

Based on seedling bulk test. R = resistant, S = susceptible.



Distribution of brown planthopper biotypes in Korea.

A simple technique for rearing rice thrips in the glasshouse

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Identification of varietal resistance to rice thrips *Stenchaetothrips (Baliothrips) biformis* (Bagnell) requires a mass screening technique that can be used in the glasshouse. We tested techniques for mass rearing rice thrips.

Rice seedlings heavily infested with thrips were uprooted from the field and planted in groups of 5 in shallow 15- × 27- × 6-cm plastic planting flats in the glasshouse. Each group of infested seedlings was surrounded by 4 groups of 1-week-old Bg 34-8 uninfested seedlings. Distance between seedling groups was 3-5 cm.

Thrips moved from the infested seedlings to the uninfested ones and reproduced. The colony was maintained by uprooting newly infested seedlings and planting new seedlings. A colony was successfully maintained for more than 4 months (about 6 generations) and each flat of infested seedlings could be used to infest 3 to 5 trays of uninfested seedlings. It took about 30 minutes to plant one flat of seedlings. □

Neem *(Azadirachta indica* A. Juss) products for control of rice stem borers

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The insect antifeedant properties of neem (*Azadirachta indica* A. Juss) oil seed are well known. In addition to phagodeterrence, insect growth-disrupting properties have also been attributed to several neem derivatives. Cake made from neem seeds after oil extraction has been reported to be an excellent insect repellent, organic manure. and an effective nitrification inhibitor.

To verify these attributes of neem products, field trials conducted at Mbita Point Field Station of ICIPE in western Kenya used neem oil, neem cake, and blended urea-neem cake. Urea-neem cake is a mixture of 1,000 g urea fertilizer (46% N) to 250 g neem cake. Neem cake and urea-neem cake were incorporated in the subsoil at land preparation before transplanting at similar neem cake rates. Neem oil was sprayed on rice plants 1, 30, and 55 days after transplanting (DT). It was mixed with water and sprayed at 6, 15, and 30% emulsified concentration (EC), the equivalent of 10, 25, and 50 liters/ha, respectively. Sindano, a traditional rice variety, was grown without additional fertilizer.

During the trial, the predominant insect species were the white borer *Maliarpha separatella* and the pink borer *Sesamia calamistis. M. separatella* caused a large proportion of unfilled grains. *S. calamistis* caused whiteheads at plant maturity. The stalk-eyed fly *Diopsis thoracica* and *D. apicalis* infested rice at early vegetative phase and caused deadhearts.

Neem oil at high concentrations was better protection than neem cake or urea-neem cake at early vegetative stage. Plots treated with urea-neem cake had more deadhearts than those treated with neem cake, which showed that N induced

Effect of neem products on stem borer infestation and rice yield in western Kenya.[a]

Treatment	Rate/ha	Insect infestation[b]			Yield components	
		Deadhearts (%)	Whiteheads (no./1000 tillers)	Stem infestation (%)	Harvest index[c]	Weight of filled grains per hill (g)
Neem oil	10 liters	3.1 cd	.3 b	60 ab	42.1 a	31.9 ab
	25 –	2.0 de	.6 b	53 ab	42.8 ab	31.5 ab
	50 –	0.0 f	.8 b	51 ab	42.8 ab	38.8 b
Neem cake (NC)	10 kg	1.9 e	.5 b	49 b	42.8 ab	27.7 ab
	25 –	1.4 e	.5 b	49 b	43.5 b	44.2 bc
	50 –	2.8 d	.2 b	37 c	43.8 b	52.5 c
Urea-neem cake	50 – (10 kg NC + 40 kg urea)	4.4 b	.3 b	37 c	44.4 bc	35.3 b
Blended urea-neem cake mixture	125 – (25-+100-)	3.5 c	1.1 ab	43 b	44.8 c	52.5 c
	250 – (50-+200-)	2.6 d	.7 b	37 c	44.7 c	62.4 d
Untreated	0	8.5 a	4.5 a	69 a	41.5 a	21.6 a

[a]Mean of 3 replications of 12-m^2 plots each. Means in a column followed by common letter are not significantly different at the 5% level. [b]Deadhearts: percent tillers with deadhearts at 60 DT, caused mainly by *Diopsis* spp. Whiteheads: number of whiteheads in 1,000 tillers at harvest; stem infestation: percent stem infested by *M. separatella.*

[c]Harvest index = $\frac{\text{dry grain weight}}{\text{dry grain and straw weight}} \times 100$

Diopsis infestation and attenuated the systemic effect of neem cake (see table).

At harvest, percentage stem infestation of *M. separatella* was significantly lower in plots treated with neem cake and urea-neem cake than in untreated and neem-oil-treated plots. However, there was no significant difference in the number of whiteheads. Neem oil does not affect *M. separatella* infestation, probably because it has low persistence under sunshine and high temperature.

Crops treated with neem cake and urea-neem cake had higher grain and straw weights than plots treated with low concentrations of neem oil and untreated plots. Results showed that combining neem cake and nitrogen fertilizer produces significantly higher yields. When rice stems were dissected at harvest, high larval mortality and delayed *M. separatella* development were observed in plots where neem cake or urea-neem cake was applied. The systemic effect of neem cake might be related to *M. separatella* mortality and low stem infestation.

Parasitization of gall midge maggots in exposed and suppressed galls

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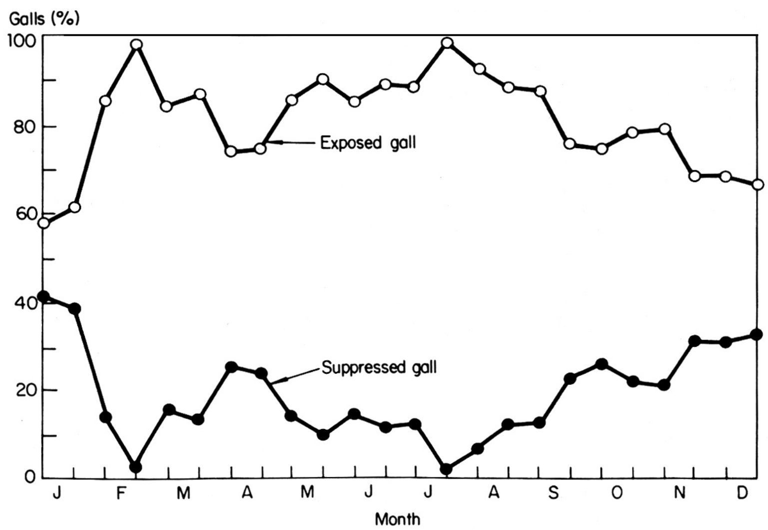
Rice gall midge *Orseolia oryzae* infestation causes galls, often called silvershoots. Infested plants compensate by producing excessive tillers that give the rice plant a bushy look. These tillers are unproductive and galls forming within them do not protrude through the leaf whorl, but harbor maggots parasitized by *Platygaster oryzae* (Cameron), an egg-larval parasite.

Rice workers scoring for varietal

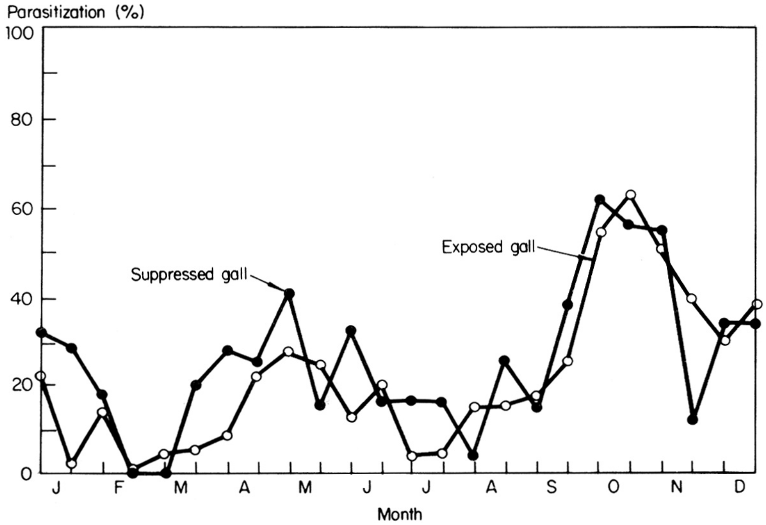


1. Exposed and suppressed galls in Jaya, Bhubaneswar, India.

resistance or susceptibility to gall midge or recording midge infestation and parasitization in the field often do not record infestation and parasitization of suppressed galls.

To estimate the proportion of exposed and suppressed galls in the infested hills, 20 random hills of Jaya in the vegetative stage were dissected every 2 weeks for 3 years and 7,541 galls were tested to determine the parasitization percentage in exposed versus suppressed galls.

There was a 4:1 ratio of exposed to suppressed galls (Fig. 1). Farasitization in the suppressed galls was higher during early Apr, May, and Jun, late Jan and Mar, and in Jul (Fig. 2). ☐



2. Parasitization of galls by *Platygaster oryzae.*

Thaia subrufa (Homoptera:Cicadellidae) occurrence in Karnataka, India

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Thaia leafhoppers are becoming serious pests of cereals, especially rice. *Thaia oryzivora* Ghauri and *T. subrufa* (Motschulsky) cause substantial damage to rice in several Asian countries.

In Feb 1978, *T. subrufa* adults and nymphs were found in large numbers on leaf blades of rice seedlings in summer crop nurseries in Mudigere. Infestation persisted, even on transplanted rice plants, in Mar-Apr 1978 and caused hopperburn symptoms in some plots. Panicle size in affected plots was considerably reduced. Leafhopper populations were so high that 150 to 200 adults were collected in each sweep of a 25-cm diameter insect net. The ratio of males to females ranged from 1:1.20 to 1:2.06 in different months.

Adults and nymphs usually sucked on the leaf undersurface, causing white specks on the upper surface, which often ran into zigzag lines. The specks later turned brown and gave the plants a burnt appearance. When enclosed on rice plants in the laboratory, a single adult damaged a 1-cm^2 area a day. Preliminary biological observations show that the nymphal period lasts 23-25 days and has 5 instars, and that adults live 33-45 days.

Pest activity in the rice fields has been monitored since 1978. Although found throughout the year, the pest bred actively Oct-May and severely damaged the summer crop. Light trap catches of adults are shown in the table. The pest was also seen on several grass weeds and on finger millet *Eleusine coracana* Gaertn.

Light trap catches of Thaia subrufa in Karnataka, India.

Month	Leafhoppers (no.)[a]	
	1981	1982
Jan	577	205
Feb	635	145
Mar	287	59
Apr	175	231
May	92	168
Jun	4	2
Jul	0	2
Aug	–	–
Sep	0	–
Oct	16	3
Nov	164	193
Dec	246	99

[a] – = no observation.

Dimethoate, methyl parathion, and quinalphos at 0.05% spray effectively controlled the pest. Leafhopper populations also declined after a heavy rain. ☐

Effect of nitrogen and plant density on rice stem borer infestation in Western Kenya

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A survey of rice ecosystems in Kenya showed that rice farmers grow rice in low-fertility swamps at high plant density (about 1 million hills/ha at 10- × 10-cm spacing) because they believe higher plant populations will produce higher yields.

We studied the effect of plant density and fertility on insect infestation in field trials at Mbita Point, in western Kenya, under swampy lowland conditions. Sindano, a traditional rice variety, was grown on black cotton soil (saline phase, gleyic solonetz) composed of 40% sand, 14% silt, and 46% clay. Rice was planted at 10- × 20- and 20- × 20-cm spacing for populations of 500,000 and 250,000 hills/ha. Nitrogen was applied at 0,60, and 120 kg/ha at land preparation with 30 kg P and 50 kg K/ha. The predominant rice insect was stem borer. No disease was observed.

Results showed that stem borer damage was the same for crops at different plant densities, except at 120 kg N/ha. Deadhearts were caused by *Diopsis* spp. and whiteheads by *Sesamia calamistis.*

Infestation by combined *S. calamistis* and *Maliarpha separatella* did not differ among treatments (see table), but percentage of empty grains was significantly related to the level of stem infestation by *M. separatella.* Although stem infestation was similar among treatments, the percentage of empty grains was significantly higher at higher N levels.

Yield was relatively low because of low soil fertility. Analysis of number of productive tillers per unit area indicates that the high density crop produced many panicles/m^2 but few grains/panicle. Yield did not increase with plant population, and seed costs and labor costs for transplanting were higher. High density planting was not economically viable. □

Effect of fertility and plant density on stem borer infestation and rice yield in Western Kenya.[a]

	500,000 hills/ha			250,000 hills/ha		
	0 kg N/ha	60 kg N/ha	120 kg N/ha	0 kg N/ha	60 kg N/ha	120 kg N/ha
Hills with deadhearts[b] (%)	2.8 a	3.5 ab	8.5 b	5.3 ab	6.2 ab	15.4 c
Hills with whiteheads[c] (%)	1.9 a	4.0 ab	7.0 b	4.8 ab	9.2 bc	15.2 c
Stem infestation[c] (%)	70.0 a	72.0 a	74.0 a	73.0 a	81.0 a	83.0 a
Empty grains (%)	2.6 a	2.7 ab	4.9 c	2.4 a	2.8 b	4.1 c
Panicles/m^2	352 b	392 c	477 d	242 ab	201 a	330 b
Grains/panicle	108 a	107 a	111 a	313 b	315 b	359 b
Yield (t/ha)	1.9 a	1.9 ab	1.9 b	1.9 b	2.0 c	2.0 d

[a]Means in a row followed by a common letter are not significantly different at the 5% level. [b]Deadhearts and whiteheads were counted 60 and 120 days after transplanting, respectively. [c]Recorded at harvest.

Stem borers in various rice ecosystems in Kenya

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We surveyed incidence of stem borers, a serious rice pest in some Kenyan ecosystems. Rice is grown on small farms and in irrigated lowlands, rainfed uplands, and swamplands.

Lowland irrigated rice is the most important ecosystem, being a monoculture in areas of several thousand hectares. Upland rainfed rice is grown in small areas and rotated with maize or sorghum during the long rainy season. Swampy lowland rice is grown on marginal swampland in western Kenya where water can be 30 cm deep and tall varieties are planted.

Lepidopterous borers present are *Chilo partellus, Sesamia calamistis,* and *Maliarpha separatella.* The first two species are major pests of sorghum and maize and *M. separatella* is specific to rice. Dipterous borers are *Diopsis thoracica* and *D. apicalis.*

The survey included the western, central, and coastal provinces. At each location rice stalks at various growth stages were dissected. Infestation was recorded as percentages of hills and tillers infested. Species composition and average number of larvae, pupae, and pupal cases recovered per hill were recorded (see table).

Stem borer incidence in various rice ecosystems in Kenya.

Rice ecosystem	Year	Hills infested (%)	Tillers infested (%)	Stem borers/hill (no.)[a] C	D	M	S	Species composition (%) C	D	M	S
Lowland irrigated (2 locations)	1981	95	41	0	0	4.5	.2	0	0	90	10
	1982	72	10	0	.3	.3	0	0	52	48	0
Mean		83	25.5	0	.15	2.4	.1	0	26	69	5
Upland rainfed (6 locations)	1981	62	14	.1	.01	.1	0	50	6	44	0
	1982	16	8	.5	.05	.15	.1	12	32	44	12
Mean		39	11.0	.3	.03	.12	.05	31	19	44	6
Swampy lowland (3 locations)	1982	53	5	0	.9	0	0	0	100	0	0
Flooded swamp (1 location)	1981	56	12	0	0	.8	0	0	0	100	0

[a]C = *Chilo partellus,* D = *Diopsis* spp.; M = *Maliarpha separatella,* S = *Sesamia calamistis.*

Stem borer infestation generally was higher in lowland irrigated rice, with *M. separatella* predominating. *M. separatella* also infested flooded swamp rice, where other stem borers were absent. It damaged the crop at all growth stages and caused a large proportion of unfilled grains. *Diopsis* occurred more frequently in lowlands where water is available, but was not found in flooded swamps. It infested rice only at early vegetative phase and caused characteristic deadhearts. Upland rainfed rice was infested more by sorghum and maize pests — *C. partellus* and *S. calamistis* — than lowland rice.

Different stem borer species and damage levels in various rice ecosystems require different control methods. Yield obtained from ecosystems other than lowland irrigated rice is low, making chemical control uneconomical. For upland rice, however, yield-improving practices such as crop rotation or intercropping with a leguminous crop tends to reduce stem borer population while increasing soil fertility. □

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

Gall midge damage at rice panicle stage

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Gall midge damage to rice panicles and spikelets was first recorded at Raipur, Madhya Pradesh, during 1974 and 1978 kharif. In 1982 kharif, panicles and spikelets of 153 late transplanted tall and semidwarf popular varieties were seriously damaged by gall midge. We began varietal screening to isolate a source of gall midge resistance and to identify damage symptoms.

Two rows of 18 hills of each variety screened were transplanted 23 Aug 1982. Hills with panicle infestation, infested panicles, infested spikelets, and healthy panicles were recorded (Table 1). About 37% of hills, 21% of panicles, and 0.4% of spikelets were infested.

Of varieties screened for resistance, only Madhuri, Phalguna, and Surekha did not have gall midge-infested panicles or spikelets in all three plantings (Table 2). However, Madhuri was highly susceptible to gall midge at tillering stage. All hills of local tall varieties Safri 17, Basmati 370, Khao Dawk Mali, and Rati were infested.

Panicles and spikelets of varieties resistant to gall midge at vegetative stage showed varying degrees of susceptibility (Table 2).

We described the damage symptoms. The flag-leaf sheath is distorted, twisted, and crinkled with blunt or curved tips, atrophied or without leaf blade, and tissue paper thin. The penultimate leaf suppresses the flag leaf sheath and falsely represents the flag leaf. It tightly entangles the flag leaf, inhibits panicle exsertion, and prevents spikelet fertilization to varying degrees. Levels of sterility in susceptible Bd 200 varied from 53% to 62%. □

Table 1. Gall midge damage to panicles and spikelets in staggered plantings, 1982 khanif, Raipur, India.

Sowing date	Varieties planted (no.)	Hills (no.)	Panicles (no.)	Infestation (%)		
				Hill	Panicle	Spikelet
22 Jun	146	2,971	14,845	34	16	0.6
12 Jul	153	5,436	29,686	37	17	0.3
5 Aug	81	1,862	7,690	41	29	0.3
Mean				37	21	0.4

Table 2. Gall midge damage to panicles and spikelets of midge-resistant varieties.

Variety	Infestation (%)		
	Hill	Panicle	Spikelet
R2384 (R68-1/Jaya)	1.0	1.0	0.0
R35-2752 (IR22/W1263)	7.0	1.0	0.0
R35-2750 (IR22/W1263)	6.0	1.0	0.0
Siam 29	21.0	12.0	1.0
Bangoli-5 (RPW6-17)	19.0	9.0	1.0
Mean	11.0	5.0	0.3

Pest management and control WEEDS

Tolerance of rice weeds for natural floodwater submergence

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We studied the effect of natural floodwater on growth of dryland and wetland rice weeds.

During early Sep 1982, much of the AAI farm was flooded by river water. After floodwater receded, weed growth on dryland and wetland rice fields was observed. Ten random samples of each weed species on the farm were observed and growth stage, plant height, and nature of submergence were recorded.

In dryland rice fields, which had 60 cm floodwater for 3 days, 13 weed

Table 1. Effect of submergence in 60cm floodwater depth for 3 days on dryland rice weeds.

Weed species	Growth stage	Plant height (cm)	Nature of submergence	Remarks
Broadleaf weeds				
Alternanthera sessilis (L.) R. Br. ex. Roth	Flowering	21	Submerged	Unaffected
Biophytum sensitivum (L.) Dc.	Vegetative	5	- do -	- do -
B. sensitivum (L.) Dc.	Flowering	8	- do -	- do -
Cleome viscosa L.	Fruiting	95	Partially submerged	Complete defoliation and death of the plant
Convolvulus arvensis L.	Vegetative	16	Submerged	Unaffected
Eclipta prostrata (L.) L.	Flowering	26	- do -	- do -
Lindernia Ciliata (Colsm.) Penn.	Vegetative	6	- do -	- do -
Lindernia crustacea (L.) F. Muell.	Vegetative	6	- do -	- do -
Oldenlandia corymbosa L.	Vegetative	12	- do -	- do -
Phyllanthus niruri L.	Fruiting	51	- do -	- do -
Phyllanthus urinaria L.	Fruiting	75	Partially submerged	- do -

CONTINUED ON NEXT PAGE

species were unaffected by submergence. *Cleome viscosa* L. was defoliated and died although it was only partially submerged (Table 1).

In wetland fields with 90 cm floodwater for 4 days, 6 species were unaffected. *Eclipta prostrata* (L.) L. at vegetative stage was defoliated, except for the terminal leaf. It later recovered from flooding. Submergence at flowering stage did not damage it (Table 2). □

TABLE CONTINUED

Weed species	Growth stage	Plant height (cm)	Nature of submergence	Remarks
Grasses				
Cynodon dactylon (L.) Pers.	Vegetative	10	Submerged	- do -
Echinochloa colona (L.) Link	Flowering	28	- do -	- do -
Panicum trypheron Schult.	Flowering	35	- do -	- do -
Sedge				
Cyperus rotundus L.	Flowering	18	- do -	- do -

Table 2. Effect of complete submergence in 90-cm floodwater depth for 4 days on wetland rice weeds.

Weed species	Growth stage	Plant height (cm)	Remarks
Broadleaf weeds			
Altemanthera sessilis (L.) R. Br. ex. Roth	Flowering	19	Unaffected
Ammannia baccifera L.	Vegetative	18	- do -
Caesulia axillaris Roxb.	Vegetative	25	- do -
Eclipta prostrata (L.) L.	Vegetative	20	Defoliation of all leaves except terminal leaf
E. prostrata (L.) L.	Flowering	29	Unaffected
Grasses			
Echinochloa colona (L.) Link	Flowering	65	- do -
Echinochloa crus-galli (L.) Beauv. var. *breviseta* (Doell) Nelr.	Flowering	80	- do -
Echinochloa crus-galli (L.) Beauv. var. *crus-galli*	Vegetative	57	- do -
Sedge			
Cyperus iria L.	Vegetative	45	- do -

Pest management and control NEMATODES

Nematode pests associated with deep water rice in Bangladesh

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Ufra disease caused by *Ditylenchus angustus* (Butler, 1913) *Filipjev,* 1936. Experiments at Matlab Bazar, Comilla, in 1980 and 1981 showed that delayed sowing or, even better, transplanting of deepwater (floating) rice reduced ufra disease incidence and produced higher yields than when standard practice was followed. In 1982, treatment with the nematicide carbofuran was tried with delayed planting. Transplanting in late Apr successfully established the crop and also reduced ufra disease incidence. Applying 1.5 kg carbofuran ai/ha further reduced the disease (see table). Larger scale testing of the technique is planned for 1983.

Disease resurgence has been monitored since its setback by the 1979 drought. In most of the known ufra areas, disease incidence has stabilized. In some areas, however, disease severity has lessened, which may be related to the adoption of deepwater rice - boro - deepwater rice cultivation.

Of 600 entries screened for ufra resistance in the deepwater tank, 85 were found highly resistant. In a pot screening test of 101 of the IRDWON II and III breeding series, 6 entries had no visible infestation and 6 had less than 10% infestation. Forty-seven entries from the 1981 screening were field tested, but disease incidence was too low for satisfactory results. Ten 1981 entries have been highly resistant in all tests.

Root-knot disease caused by *Meloidogyne graminicola (Golden & Birchfield, 1965)* Dry season populations of *M. graminicola* declined sharply 1 month after the deepwater rice harvest. Crop losses caused by rice root-knot nematode were studied in pots and in the field. Populations of 2,000 nematodes/plant caused severe stunting of root and shoot development in pots and reduced yield more than 60%. Field populations of 1,000 nematodes/kg soil caused poor plant growth and yields.

Carbofuran 3 kg ai/ha incorporated at sowing significantly reduced infestation, but did not significantly increase yields at Rajbari, Joydebpur.

Forty-one entries were screened in a preliminary pot test. Although no entries resisted infection, 5 had low infection, as judged by gall counts and microscopic examination of root tissues.

Yield and ufra disease incidence of deepwater rice under different planting and nematicide treatments.

Treatment	Yield (t/ha)	Ufra disease (incidence (%)
Broadcast seed	0.24	77.2
Broadcast seed with carbofuran	0.44	58.3
Transplanted	0.59	52.9
Transplanted with carbofuran	0.94	36.7

White tip disease caused by Aphelenchoides besseyi Christie, 1942. Deepwater rice areas were widely surveyed for white tip disease symptoms. Only one new area of infestation — Dubail, Tangail — was recorded.

The Gazaria beel at Manikganj, where the disease was a problem in 1981 was comprehensively surveyed. More than 56% of the fields were infested. In most, 5 to 10% of the rice stems showed disease symptoms. Disease incidence at flowering stage of Rajboalia was not reflected in the number of infected panicles at harvest. Nevertheless, the disease affected all yield components. □

Soil and crop management

Efficiency of different urea fertilizers in lowland rice

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Applied fertilizer nitrogen (N) efficiency in lowland rice is low. We evaluated the effect of water regime and urea fertilizers on rice dry matter yield and N uptake in the greenhouse using a completely randomized design in three replications. The soil was sandy loam (Typic Ustochrepts) with pH 8.5, EC 0.15 mmho/cm, 0.23% organic carbon, 0.04% total N, and 4.54 meq CEC/ 100 g. The N levels were 0 and 115 mg/kg. The urea materials were 3 splits of prilled urea (PUS), urea in mudball (MBU), urea supergranules (USG), sulfur-coated urea (SCU), neem cake-coated urea (NCU), and lac-coated urea (LCU). A no-nitrogen check also was planted. The water regimes consisted of continuous soil submergence with and without drainage. Drainage was maintained at a percolation rate of 5 mm/h by using pinch corks at drainage outlets.

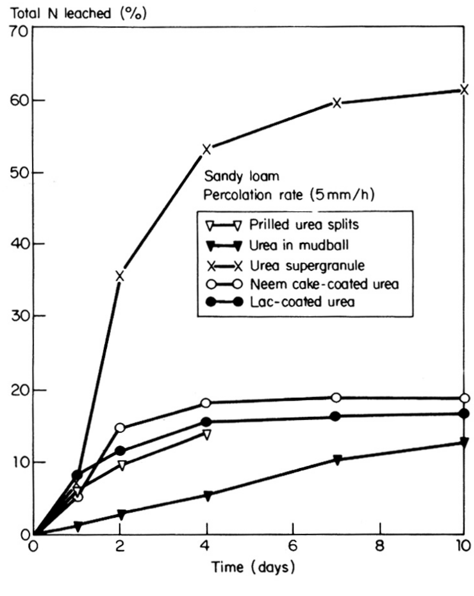
Soil samples of 8 kg each at the 15-cm depth were air-dried, ground, and treated with 26 mg P/kg and 50 mg K/kg applied as single superphosphate and muriate of potash respectively. The soil was placed in 10-liter pots, flooded, puddled, and where appropriate, treated with 115 mg N/kg. Urea materials, except PUS, were either deep-placed 5-7 cm or broadcast and incorporated 5-7 cm deep. Four 27-day-old PR106 seedlings were planted in each pot. The pots were flooded to maintain 5 cm of standing water and, where appropriate, drainage was imposed. Plants were harvested 60 d after transplanting and dry matter yields were recorded. N uptake was computed using dry matter data and Kjeldahl N in the rice plants.

Without drainage, dry matter yields and N uptake were significantly depressed

Effect of drainage and urea materials on dry matter yields and N uptake of rice plants. [a]

Urea material	Without drainage: Dry matter (g/pot)	Without drainage: N uptake (mg/pot)	With drainage: Dry matter (g/pot)	With drainage: N uptake (mg/pot)
Check	9.8 a	118 a	17.2 a	262 a
Prilled urea 3 splits	37.2 c	850 cd	36.3 c	625 b
Urea in mudball	36.4 c	897 d	32.8 bc	603 b
Urea supergranule	40.3 c	910 d	21.2 a	366 a
Sulfur-coated urea	29.3 b	691 b	32.9 bc	695 b
Neem cake-coated urea	28.5 b	721 bc	29.5 b	650 b
Lac-coated urea	29.5 b	705 b	29.6 b	577 b
Interaction [b]	DU**	DU**	DU**	DU**

[a] CV for dry matter = 9.9%; CV for N uptake = 12.7%. In a column, means followed by the same letter are not significantly different at the 5% level. [b] **P = 0.01, D = drainage treatment, U = urea material.



Cumulative leaching losses of total N (urea + NH_4^+ -N) from a lowland rice soil.

in the check, NCU, SCU, and LCU compared to MBU, PUS, and USG (see table).

With drainage, dry matter yield and N uptake with SCU equaled that with PUS and MBU. LCU and NCU also showed a similar trend. Dry matter yield and N uptake were significantly depressed with USG, and equaled the dry matter yield and N uptake of the check. Dry matter yield and N uptake of the check were twice what they were with no drainage.

With drainage, the low dry matter yield and N uptake with USG was caused by cumulative leaching losses of total N (urea + NH_4^+ -N) (see figure). Nitrogen leaching losses were 62.1% for USG, 19.1% for NCU, 16.9% for LCU, 14.3% for PUS, and 13.0% for MBU. No leaching losses of urea or NH_4^+-N were recorded for SCU.

Effect of micronutrients and farmyard manure on yield and micronutrient content of rice

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A field experiment to determine the effect of micronutrients and farmyard manure (FYM) was conducted on a sodic soil with sand + silt 85.4%, clay 14.6%, $CaCO_3$ 2.45%, pH 10.6, exchangeable sodium percentage 92, CEC 10.0 meq/ 100 g, gypsum requirement 25 t/ha; and DTPA extractable Fe, Mn, and Zn 3.5, 4.2, and 0.45 ppm, respectively, at Gudha experimental farm of CSSRI.

The experiment was in a split-plot design with 4 replications of 5 micronutrient treatments: T1, control, no micronutrient; T2, 20 ppm Fe; T3, 20 ppm Mn; T4, 5 ppm Zn; and T5, 20 ppm Fe + 20 ppm Mn + 5 ppm Zn and 0 and 10 t FYM/ha. FYM contained 0.85% N, 0.35% P, 0.78% K, 0.35% Ca, 0.24% Mg, 0.22% S, 52 ppm Zn, 125 ppm Mn, 10 ppm Cu, and 320 ppm Fe. Fifty percent of the gypsum requirement was broadcast and mixed and all plots received 150 kg N/ha as urea. Micronutrient sources were $FeSO_4 \cdot 7H_2O$, $MnSO_4 \cdot H_2O$, and $ZnSO_4$ $7H_2O$. Plot size was $40 m^2$. Micronutrients, FYM, and 75 kg N/ha were broadcast and disced into the soil. Plots were irrigated and 30-day-old Jaya rice seedlings were transplanted 15 Jul 1979. The remaining 75 kg N was topdressed in 2 equal splits at 3 and 6 weeks of crop growth. Leaf samples of 30-day-old plants (3d and 4th leaves from the. top) were collected and plant samples were taken at harvest 1 Nov 1979.

Zn application significantly enhanced the grain and straw yield (see table). Fe and Mn did not affect yield but the highest yield was recorded when these elements were applied with Zn.

Crop growth was poor in plots without Zn and symptoms of moderate Zn deficiency were noticed at early growth stage (25-30 days). FYM significantly enhanced the yield, irrespective of the micronutrient treatment, possibly because of the increased availability of Zn caused by its application. Zn concentration in 30-day-old leaves was less than the critical 10 ppm value in plots where it was not applied because available soil Zn was less than the critical 0.55 ppm level. Application of Fe, Mn, and Zn enhanced their respective concentration in the crop. FYM also effectively increased micronutrient concentration in the crop.

Effect of micronutrients and FYM on rice yield and micronutrient concentration.

Treatment	FYM rate (t/ha)	Yield (t/ha)		Micronutrient concn (ppm)						
				Zn			Fe		Mn	
		Grain	Straw	Leaves	Grain	Straw	Grain	Straw	Grain	Straw
Control	0	5.0	8.0	8.5	8.1	10.5	45	335	40	285
	10	5.3	8.3	9.6	9.9	12.8	55	375	48	340
Fe (20 ppm)	0	5.0	8.0	8.4	8.0	10.4	52	360	46	295
	10	5.4	8.4	9.8	10.0	13.1	68	415	52	365
Mn (20 ppm)	0	5.2	8.2	8.6	8.5	10.6	46	340	51	315
	10	5.6	8.7	11.2	11.8	18.2	55	380	58	425
Zn (5 ppm)	0	5.6	8.7	15.5	12.9	25.4	45	340	42	280
	10	6.0	9.1	20.6	15.8	30.5	56	380	48	345
Fe+Mn+Zn	0	6.0	9.1	15.4	12.8	26.8	50	365	55	325
	10	6.0	9.3	21.8	15.1	31.8	68	425	62	480
CD (0.05) for comparing										
FYM level means		0.22	0.35	1.2	0.9	0.7	8	20	6	18
Micronutrient means		0.33	0.44	1.0	0.8	1.6	5	14	3	10

Comparison of photoperiod-sensitive ratooned rice and normal sown aman rice

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Ratooned and normal sown aman rice varieties were compared. Photoperiod-sensitive rice varieties SR26B, FR13A, Tillakkachari and Achra 108/1 were sown on 14 Nov 1981 and harvested May 1982. Ratooned tillers grew in the fields. A sim-

Comparison of photoperiod-sensitive ratooned and normal sown aman rice, Chinsurah, India, 1981-82.

Variety	Aman sown rice				Ratooned rice			
	Plant ht (cm)	Panicle length (cm)	Tillers (no.)	Yield (t/ha)	Plant ht (cm)	Panicle length (cm)	Tillers (no.)	Yield (t/ha)
SR26B	146	22	7	3.7	158	24	11	2.5
FR13A	113	22	8	3.8	146	25	11	3.0
Tillakkachari	142	24	9	3.8	170	26	13	5.0
Achra l08/l	132	25	7	3.9	170	27	11	4.8
Mean	133	23	8	3.7	161	26	12	3.8

ilar set of varieties was sown 17 Jul 1982 and their performance was compared to that of the ratooned crop.

Plant height, panicle length, and tiller number were higher for ratoons than for normal sown man rice. Ratooned Tillak-kachari and Achra 108/1 yielded more than the aman sowing of the same varieties (see table). The mean yield of ratooned rice varieties equaled that of normal sown rice, indicating the suitability of ratoon cultivation in lowland areas where flood or sudden water stagnation hampers the freshly planted rice crop during the wet season. □

Fungi-caused rotten disease of azolla

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In 1981, the fungus *Myrothecium* sp. was discovered to cause rotten disease of azolla. In 1982 azolla propagation in northeast Thailand was increased and an outbreak of rotten disease occurred. Damage was more severe than in 1981 and symptoms were different from those caused by Myrothecium sp. Disease samples were collected from a farmer's propagation pond in Sakolnakorn Province in Nov-Dec 1982. Six genera of fungi were isolated: *Myrothecium* sp., *Rhizoctonia* sp., *Sclerotium* sp., Fusarium sp., and two unidentified fungi. One unidentified genus had a yellow colony of mycelium, the other a black colony. All were grown on potato dextrose agar.

Healthy azolla was individually inoculated with the six isolated fungi and grown in a 38-cm-diameter pot. Each treatment and a distilled water sprayed control was replicated four times. Disease development was recorded.

Rhizoctonia sp. damaged azolla most, causing infected ferns to rot 5-7 days after inoculation. *Myrothecium* sp. caused rotting 10-15 days after inoculation (see table). *Sclerotium* sp. caused small brown lesions on the leaves 7 days after inoculation, but did not cause rotting. *Fusarium* sp. and the two unidentified fungi did not cause the disease. □

Comparison of disease symptom development on *Azolla pinnata* after inoculation by selected fungi.

Fungus	Symptom development, (days after inoculation)			Azolla death (days after inoculation)	Azolla rotting (days after inoculation)	Disease appearance
	Leaf	Stem	Root			
Rhizoctonia sp.	2	2	2	3–4	5–7	Infected fern turned pale-brown in color, then brown to dark brown.
Myrothecium sp.	2	2	3	3–5	10–15	Infected fern turned grey-green in color, then grey-brown to dark brown.
Sclerotium sp.	7	–	–	–	–	Infected fern showed only small brown lesion on leaf.
Fusarium sp.	–	–	–	–	–	No symptom
Unidentified (yellow colony)	–	–	–	–	–	No symptom
Unidentified (black colony)	–	–	–	–	–	No symptom
Distilled water (control)	–	–	–	–	–	No symptom

Effects of plant population and urea supergranule deep placement on rice yield

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We studied the effect of plant population and deep placement of urea supergranules (USG) on rice yield at Coimbatore in 1980 wet season and 1981 dry season (Jan-May). The soil was clay loam with pH 7.8, 0.38% carbon, and CEC 26.8 meq/100 g.

The trial was laid out in a randomized block design with four planting treatments in five replications. Plot size was .0 × 4.0 m. Heavy tillering rice Co 43 from the cross Dhasal/IR20 was planted at 2 seedlings/hill. The table gives treatment details and number of panicles, panicle weight, and grain yield.

Results indicated that 20 × 15 cm spacing (33 plants/m^2), or half the population of conventional spacing, gave significantly higher grain yield in both seasons. Yield with 22 plants/m^2 equaled that of 33 plants/m^2 during wet season. However, yield with 33 plants/m^2 was significantly higher than with 22 plants/m^2 during dry season (see table).

The number of panicles/m^2 was significantly higher in a conventional plant-

Effect of plant spacing and USG placement on rice panicles and grain yield of Co 43.[a]

Spacing (cm)	Hills (no./m^2)	USG (no./4 hills)	Panicles/m^2		Panicle wt (g)		Grain yield (t/ha)	
			WS	DS	WS	DS	WS	DS
15 × 10	66	1	489	476	1.90	1.85	4.9	6.1
15 × 20	33	2	315	586	2.68	2.44	5.2	6.6
22.5 × 20	22	3	233	495	2.85	2.22	5.2	6.3
30 × 20	16	4	225	470	2.39	2.24	5.1	6.2
CD (0.05)	–	–	39	30	0.27	0.48	0.2	0.2

[a]Urea supergranule (USG) at 75 kg N/ha was deep placed. WS = wet season, DS = dry season.

ing with 66 hills/m ^{2} in wet season, but was higher at 15- × 20-cm spacing in dry season.

Panicle weights from treatments of 33 and 22 hills were comparable in both seasons. Panicle weight for 66 hills was the lowest.

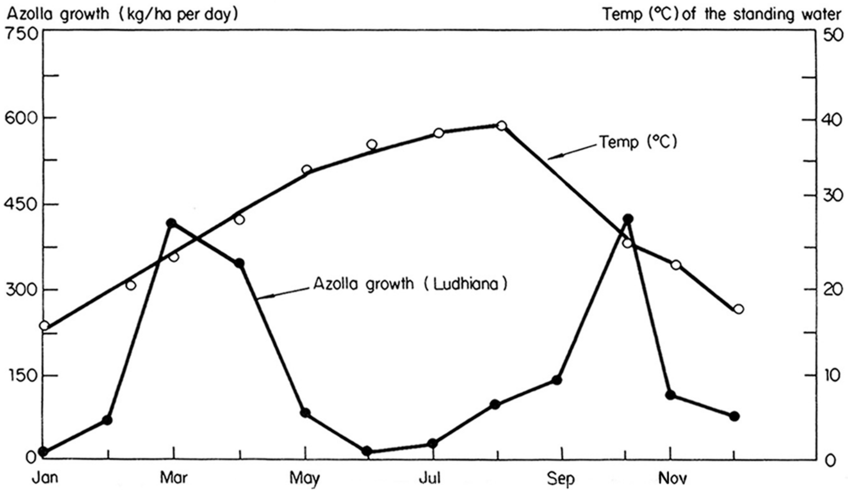
Deep placement utilizes more labor at conventional spacing. Using the modified 15 × 20 cm spacing reduced the number of planting sites 50%, and therefore reduced seed and planting costs 50%. These savings will compensate for the extra labor needed for USG deep placement. □

Multiplication of azolla in alkaline soils of Punjab

Viraj Beri, O. P. Meelu, and Baldev Raj, Soils Department, Punjab Agricultural University (PAU), Ludhiana, India

Azolla may be a substitute for nitrogen fertilizer in wetland rice, but its multiplication and growth are determined by soils and environmental factors. We studied azolla growth patterns in a subtropical alkaline soil at the PAU farm in Ludhiana.

Six concrete tanks (2 × 2.2 m) were filled to 15 cm with a sandy loam soil with pH 8.4. A 15–20 cm water level above the soil was maintained. Tanks were inoculated with 250 g of a local azolla species in Jun 1979. Superphosphate at 1.75 kg P/ha per week was applied to each tank. The temperature of the top 0-2 cm of water in the tank was recorded daily at 1500 hours. Azolla growth and N fixation were monitored every 2 weeks throughout the year.



Growth rate of azolla in tanks as affected by temperature.

Azolla harvested in Mar, Apr, and Oct weighed 10-13 t fresh matter/ha per month and contained 30 kg N/ha. Fresh matter and total N varied from 0.3 to 4.2 t and 0.8–10.7 kg N/ha per month for other months. Azolla produced 55 t/ha per year, which contained about 139 kg N.

Azolla grew slowly from Jun to Sep, which is the rice season, because of high ambient temperatures (see figure). High standing water temperatures (34–39 °C) from May to Sep and low temperatures (16–21 °C) from Dec to Feb reduced azolla growth. Azolla species with high temperature tolerance need to be tested. □

Rock phosphate-pyrite mixture: a good substitute for single superphosphate

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Use of inexpensive, readily available fertilizers without sacrificing yield is top priority. From kharif 1979 to 1981 we compared yields from neutral and alkaline rice fields fertilized with a basal application of a single superphosphate with those of fields treated with a 1:5 rock phosphate-pyrite mixture. Both treatments received 26.4 kg P/ha.

Direct and residual effect of rock phosphate-pyrite mixture on grain yield (av of 3 seasons).[a]

Treatment	Yield (t/ha) (av 3 seasons)		P uptake in rough rice (kg/ha)		% recovery in rough rice		Olsen's P (kg/ha) after 3 seasons (RRS, Mandya -NS)	Residual effect on grain yield (P treated plot-control) t/ha (RRS, Mandya -NS)
	Mandya (NS)	Siruguppa (HS)	NS	HS	NS	HS		
Control (no P)	4.1	3.6	11.5	7.6	–	–	8.7	–
Single superphosphate at 26.4 kg P/ha	4.9	4.7	15.2	11.8	11.4	15.2	9.4	0.8
Rock phosphate – pyrite mixture (1:5) at 26.4 kg P/ha	5.2	4.9	17.9	13.2	22.7	21.7	12.0	1.1
F Test	*	**						*
CD (0.05)	0.67	0.81						0.48
CV (%)	12.1	10.3						14.6

[a]NS = neutral soil, HS = high pH soil.

Trials were conducted at the Regional Research Station at Mandya on a sandy loam Alfisol (pH 6.9, Olsen's P 8.5 kg/ha, and CEC 16.8 meq/100 g) and at the Agricultural Research Station at Siruguppa on a silty clay Vertisol (pH 8.6, Olsen's P 6.2 kg/ha, and CEC 24.2 meq/100 g). Recommended agronomic procedures were used for the transplanted crops, and Prakash (IET2254) was grown

The Mussoorie rock phosphate used

contained 7.3% P, of which 20.3% was citric acid soluble. The pyrite contained 9.2% sulfur and 11.6% iron. Application was based on total P of the rock phosphate. Three equal splits of 100 kg N/ha were applied at planting, tillering, and panicle initiation and 50 kg K/ha was applied as muriate of potash at planting.

Soil samples were collected after three seasons and analyzed to determine residual effects of the treatment (see table). Data indicated that the rock phosphate-pyrite mixture could be a good substitute for single superphosphate in neutral and high pH soils. The rock phosphate treatment exhibited better residual response under neutral soil conditions, as reflected by a 14.6% yield increase (see table). It cost 1/3 less per hectare to apply rock phosphate than to apply a single superphosphate. □

Effect of straw management on soil nitrogen in a rice — wheat rotation

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Farmers are using more combine-type harvesting machines and therefore are burning more rice and wheat straw in Punjab. Burning crop residues in the field may change soil nutrients, especially the C, N, P, S ratio, and other physicochemical and biological soil properties. The effect of straw management on soil N in a rice - wheat rotation was studied in a farmer's field in Kasabad, Ludhiana. Soil was sandy loam with pH 8.3 and E.C. 0.45 mmho/cm.

After wheat was combine-harvested in May 1980, the field was divided into three plots for straw removal, incorporation, and burning. Each plot was divided into 24 plots for 3 replications of 8 fertilizer treatments — 0, 50, 100, and 150 kg N/ha as urea with and without 22 kg P/ha as single superphosphate. The experiment was repeated after the 1980 rice harvest, the 1980-81 wheat harvest, and the 1981 rice harvest. Soil was sampled (0-15 cm depth) after harvest and analyzed for available N, total N, organic N, and organic carbon.

Fertilizer treatments did not significantly affect soil N. Therefore the data for the straw management practices were pooled (see table).

Straw incorporation significantly increased organic carbon, total N, hexosamine N, and amino acid N. Burning or removing the straw after each crop harvest increased nonhydrolyzable N in the soil. Burning straw lowered total N by 11%, hydrolyzable N 31%, hexosamine N 88%, and amino acid N 60%. $KMnO_4$-N and hydrolyzable NH_4^+-N, hexosamine N, and amino acid N levels were significantly higher where straw was incorporated.

Available N level was low, and decreased with cropping. Where straw was continuously incorporated, total N increased by about 20% after 4 crops. It decreased by about 10% where straw was burned. Amino acid N increased in straw-incorporation plots. Hexosamine N and amino acid N decreased after rice but increased after wheat. □

Organic carbon and soil nitrogen as affected by various straw management practices, Punjab, India.

Soil N form	Initial level	1980 after rice			1980-81 after wheat			1981 after rice			1981-82 after wheat			CD (5.0%)
		Straw incorporation	Straw removal	Straw burning	Straw incorporation	Straw removal	Straw burning	Straw incorporation	Straw removal	Straw burning	Straw incorporation	Straw removal	Straw burning	
Organic carbon (%)	0.54	0.52	0.52	0.48	0.55	0.55	0.54	0.61	0.57	0.54	0.62	0.56	0.53	0.02
$KMnO_4$-N (µg/g)	84	55	53	64	50	48	46	58	48	46	55	50	46	5.3
Total N (µg/g)	486	503	486	455	516	481	464	569	498	450	582	486	435	17.4
Hydrolyzable-N (µg/g)	311	298	301	219	311	276	219	332	280	214	336	289	214	13.5
Nonhydrolyzable-N (µg/g)	195	204	183	234	205	205	249	236	218	236	246	267	221	28.4
Hydrolyzable NH_4^+-N (µg/g)	112	124	105	106	121	107	107	117	105	115	105	98	103	6.4
Hexosamine-N (µg/g)	42	33	20	16	53	23	9	47	19	4	55	22	5	4.5
Amino acid-N (µg/g)	112	121	109	39	138	117	44	145	131	51	152	133	45	5.6

Performance of modified urea fertilizer on a sandy loam soil

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Urea is the commonly used nitrogen fertilizer in India. Nitrogen losses through ammonia volatilization are often high. Use of controlled-release N fertilizers and urea supergranules has been advocated to increase N-use efficiency in rice.

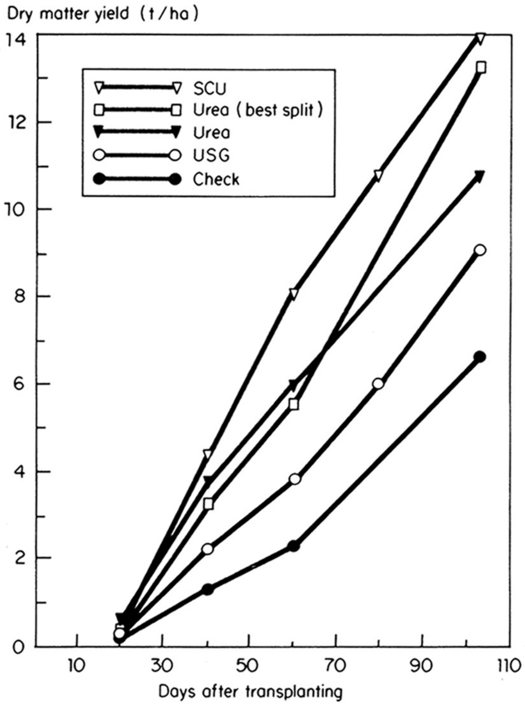
The efficiency of modified urea materials was compared to that of split applications of prilled urea at the PAU farm in Ludhiana. Soil was a Fatehpur sandy loam (Typic Ustipsamment) with pH 8.4, 0.35% organic carbon. 62 kg available N/ha with a percolation rate of 7 mm/h, and CEC 5.3 meq/100 g soil. Prilled urea, sulfur-coated urea (SCU), urea supergranules (USG), lac-coated urea (LCU), and neem-cake-treated urea (NCU) were tested. All modified urea materials were applied in a single dose at transplanting. Prilled urea was applied either all at transplanting or in 3 equal splits: at transplanting, 21, and 42 days after transplanting. USG was point-placed 10 cm deep between 4 plants in alternate rows. All urea was applied at 120 kg N/ha. A basal dose of 13 kg P and 25 kg

Effect of different urea materials on rice yield.

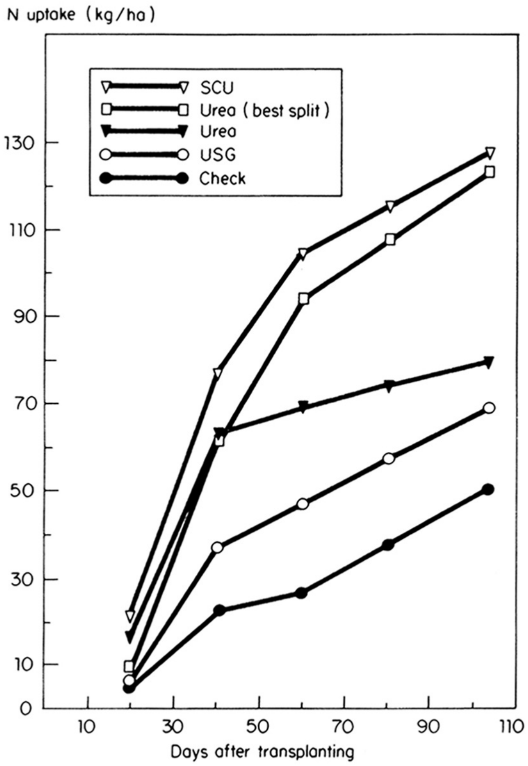
N source	Grain yield (t/ha)				
	1978	1979	1980	1981	Mean
Control	3.65	2.43	3.39	1.95	2.85
Urea 3 split	5.90	5.95	5.21	5.53	5.65
SCU	6.51	6.32	6.00	6.61	6.36
USG	5.64	3.55	4.06	2.99	4.06
Lac-coated urea	5.93	5.10	–	4.99	5.33
Neem-cake-coated urea	5.77	4.41	5.09	4.54	4.96
Urea all at transplanting	5.27	4.39	4.90	–	4.85
CD .05	–	0.66	0.85	0.31	–

K/ha was applied at last puddling.

Results (see table) showed that SCU, followed by split application of prilled urea, produced significantly superior grain yields. A similar trend was reflected in progressive dry matter accumulation and total N-uptake (Fig. 1, 2). USG gave the lowest biomass accumulation and N uptake. The rapid percolation rate and 10 cm placement may have caused USG to leach beyond the rice rooting zone. SCU, because of controlled release, yielded higher than prilled urea. □



1. Dry matter accumulation by rice as affected by different N sources applied at 120 kg N/ha.



2. Rice uptake of N from different sources applied at 120 kg N/ha.

Effect of organic residues on pulling force of rice seedlings

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High yielding rice varieties are the most important kharif (wet season) cereal crop in Punjab. Transplanted rice nurseries are grown on small flat beds. Seeds are broadcast after the seedbed is thoroughly wetted and puddled. Seedlings are difficult to pull from flat beds and often are broken. We studied soil amendments to reduce pulling force.

Replicated experiments were conducted in 2- × 2-m plots in sandy loam at Ludhiana and in silt loam at Gurdaspur. The Ludhiana experiments were conducted for 2 years. Studies at Gurdaspur were for 1 year. Treatments are described in the table. Pulling force was measured on 40-day-old seedlings and expressed as pulling force index (PFI), a nondimensional parameter.

Results showed that the pulling force was significantly higher in puddled seedbeds than in raised seedbeds, irrespective of soil type. PFI in raised seedbeds was 30 in sandy loam and 84 in silt loam. It increased to 70 and 175 in puddled seedbeds.

Pulling force was significantly affected by organic residue treatments. Highest PFI values (70 and 175) were recorded in the controls. PFI was de-

Effect of different organic residues on PFI of rice nurseries in sandy loam and silt loam, Punjab, Indian.[a]

Treatment[b]	PFI	
	Sandy loam	Silt loam
Raised bed (control)	30 d	84 d
Puddled (control)	70 a	175 a
15 t FYM/ha, puddled	56 b	123 c
30 t FYM/ha, puddled	50 b	120 c
4 t rice husk/ha, puddled	57 b	135 b
8 t rice husk/ha, puddled	39 c	122 c

[a]In a column, figures with similar letters do not differ significantly. [b]FYM = farmyard manure.

creased when organic residues were added, but results of different organic residue treatments, except 8 t rice husk/ha, did not differ significantly. Adding rice husk reduced PFI to almost half that of the sandy loam control. In silt loam. adding 4 t rice husk/ha was not as effective as adding farmyard manure and 8 t rice husk/ha.

Results indicate that applying farmyard manure or rice husk to nursery beds helped reduce seedling pulling force. However, seedbeds with rice husk and other low nitrogenous residues may need additional nitrogen. □

Effect of rice hulls applied to rice fields

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Rice hull at 20 t/ha was spread over a rice field about 1 week before planting, and the field was plowed, manured, and puddled. The operations significantly improved rice growth and yield and the soil texture, compared to the control (see table).

Data show that rice hulls have no allelopathic effect on rice, although rice straw has some such effect before decay. The increase in silica content in both plant and soil suggests that tolerance for blast disease can be improved.

Effect of 20 t rice hull on rice growth and yield, Taiwan, 1980 winter. [a]

Attribute	Rice hull applied	Control
Grain yield (t/ha)	8.2	7.2
Panicles (no./m^2)	399	377
Single panicle wt (g)	2.6	2.2
Test wt (g/1000 grains)	26	24
Leaf silica content (%)	14	5
Soil redox potential (mv)	–169	–150
Exchangeable K in soil (ppm)	64	42
Silica in soil (ppm)	212	112
Organic matter in soil (%)	2.2	2.0

[a] Variety = Tainung 65.

Nitrogen fertilization in transplanted rice

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In the 1981 monsoon season we evaluated the efficiency of urea, sulfur-coated urea (SCU), urea supergranules (USG), and lac-coated urea (LCU) at 0, 29, 58, 87, and 116 kg N/ha on flooded transplanted rice in a randomized complete block design with 3 replications. Soil in the field was a silty clay loam Alfisol with pH 5.8, 0.73% organic carbon, 628.19 kg available N/ha, 10.8 kg available P/ha, and 144.78 kg available K/ha. Cation exchange capacity was 17.2 meq/100 g. At puddling, all plots received 18 kg P as single superphosphate (16% P_2O_5) and 33 kg P/ha as muriate of potash (60% K_2O).

Grain yield increased significantly and consistently as nitrogen level increased up to 87 kg N/ha. USG produced significantly higher grain yield than three equal splits of ordinary urea (at transplanting, maximum tillering, and panicle initiation) and other nitrogen sources. SCU was not a better nitrogen source for flooded rice in acidic soil.

Nitrogen use was 1.8 times more efficient than the best split application when applied as USG. Split application of urea had lowest efficiency at all but at 116 kg N/ha (see table). □

Effect of N levels and sources on rice yield and N use efficiency at Palampur, India.

N level (kg/ha)	N source [a]	Grain yield (t/ha)	N use efficiency (kg grain/ kg N)
0 (control)	None	2.2	–
29	Urea	3.6	45.5
	SCU	3.8	55.1
	USG	4.6	82.3
	LCU	3.7	49.8
58	Urea	4.6	40.6
	SCU	4.8	43.6
	USG	5.4	53.8
	LCU	5.2	51.1
87	Urea	5.4	36.4
	SCU	5.5	37.8
	USG	6.0	42.9
	LCU	5.6	38.4
116	Urea	5.5	28.3
	SCU	5.2	25.8
	USG	5.9	31.4
	LCU	5.5	27.7

	SEm ±	CD 5%
For N levels	0.28	0.81
For sources	0.28	0.81
For interaction	0.56	1.62

[a] SCU = sulfur-coated urea, USG = urea supergranules, LCU = lac-coated urea.

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

Effect of source and timings of nitrogen fertilizer application on rice grain yield in heavy sodic soil

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Fertilizer requirements and efficiency in sodic soil differ from those in normal soil. We studied the efficiency of different N fertilizers applied at different growth stages on the yield of high yielding, salt-tolerant dwarf variety CSR4 during 2 consecutive years in virgin sodic soil at the Barwaha experiment station (W. Nimar district, Madhya Pradesh).

No soil amendment was applied in the replicated field experiment. In both years 150 kg N in different forms, 33 kg K/ha were applied to all plots (Table 1). Fifty percent N was applied basally by broadcasting and incorporation on puddled soil with standing water before transplanting, and 50% was topdressed in one or two applications.

Soil samples were collected from the submerged field at 4 places in each 4- × 6-m plot. Electrical conductivity (EC) and pH were measured after drying, grinding, and sieving. Cation exchange capacity (CEC) and exchangeable sodium

Table 1. Effect of sources and timing[a] of application of N fertilizer on rice grain yield.

Nitrogen source	Grain yield (t/ha) 1981 T_1	T_2	T_3	Source means	1982 T_1	T_2	T_3	Source means
$(NH_4)_2SO_4$(AS)	4.8	4.3	4.4	4.7	4.7	4.7	4.6	4.7
KNO_3 + urea	3.4	3.9	4.9	4.1	4.4	4.6	4.8	4.6
Calcium ammonium nitrate (CAN)	4.1	3.0	4.3	3.8	2.7	2.5	2.5	2.6
Ammonium sulfate nitrate (ASN)	4.0	4.2	4.1	4.1	3.1	2.5	3.5	3.4
$(NH_4)_2SO_4 + KNO_3$	4.1	4.2	4.5	4.3	4.0	4.1	4.3	4.1
$(NH_4)_2SO_4$ + CAN	4.7	3.8	4.7	4.4	4.4	3.9	4.4	4.2
Timing of application means	4.2	4.0	4.5		3.8	3.8	4.0	

CD for forms of fertilizer (P–0.05) = 0.56 . . . . 0.32
CD for timing of application (P–0.05) = 0.39 . . . . –
CD for combination (forms × timing) = 0.97 . . . . .0.55

[a] T_1 = ½ N basal + ½ N at tillering, T_2 = ½ N basal + ¼ at tillering + ¼ at floral initiation, T_3 = ½ N basal + ¼ at tillering + ¼ at flag leaf emergence.

Table 2. pH values and their differences as affected by fertilizer forms and times of application.[a]

Treatment[b]	1981 I	H	D	Mean reduction (formwise)	1982 I	H	D	Mean reduction (formwise)
$(NH_4)_2SO_4$(AS)								
T_1	9.8	8.9	0.9		9.7	8.9	0.8	
T_2	9.8	8.9	0.9	0.86	9.6	8.6	1.0	0.90
T_3	9.7	8.6	0.8		9.4	8.5	0.9	
KNO_3 + urea								
T_1	9.8	8.8	1.0		9.4	8.4	1.0	
T_2	9.7	8.7	1.0	0.96	9.4	8.5	0.9	1.00
T_3	9.8	8.4	0.9		9.6	8.5	1.1	
Calcium ammonium nitrate (CAN)								
T_1[c]	9.6	9.1	0.5		9.3	8.7	0.6	
T_2	9.5	9.1	0.4	0.53	9.7	9.1	0.6	0.63
T_3	9.8	9.1	0.7		9.7	0.0	0.7	
Ammonium sulfate nitrate (ASN)								
T_1	9.7	8.9	0.8		9.5	8.7	0.8	
T_2	9.8	8.9	0.9	0.86	9.6	8.8	0.8	0.80
T_3	9.8	8.9	0.9		9.6	8.8	0.8	
$(NH_4)_2SO_4 + KNO_3$								
T_1	9.9	8.9	1.0		9.7	8.6	1.1	
T_2	9.8	8.9	0.9	0.93	9.6	8.5	1.1	1.00
T_3	9.7	8.8	0.9		9.5	8.7	0.8	
$(NH_4)_2SO_4$ + CAN								
T_1	9.9	9.1	0.8		9.6	9.0	0.6	
T_2	9.7	9.0	0.7	0.73	9.5	8.8	0.7	0.73
T_3	9.8	9.0	0.8		9.6	8.7	0.9	

F_1 F_4 F_0 F_3 F_5 > F_2 CD at 5% – 0.33

[a] I = initial, H = harvest, D = I – H. [b] For T_1, T_2, T_3, see Table 1 footnote. [c] Due to '0' value in one replication, the data had to be transformed for analysis of variance. Hence the significant differences are indicated by notations.

percentage (ESP) were determined in dry soil. Average EC was 3.18 mmho/cm, pH 9.7, CEC 44 meq/100 g, and ESP40. No winter crop was planted after rice and the same soil treatments were repeated next season with the same rice variety. Average EC was 2.23 mmho/cm, pH 9.2, and ESP 34.

Ammonium sulfate produced maximum grain yields and calcium ammonium nitrate gave the lowest (Table 1), perhaps because soil pH decreased less in this treatment during the later crop growth stages (Table 2). Except for KNO_3 + urea, which yielded better in 1982 than in 1981, the performance of the other fertilizers was the same for both years.

Applying nitrogen as 1/2 basal, 1/4 at tillering, and 1/4 at flag leaf emergence stage yielded best. Lowest yield was obtained when fertilizer application was 1/2 basal, 1/4 at tillering, and 1/4 at flower initiation. KNO_3 + urea gave maximum grain yield in both years when applied 1/2 basal, 1/4 at tillering, and 1/4 at flag leaf emergence.

Soil pH at harvest decreased with all fertilizer treatments but increased during transplanting the following year after the field was fallow during winter. The interaction between fertilizers and stages of application significantly influenced the decrease in pH values in 1981. □

Effect of some agronomic practices on upland rice yield and weed infestation under bush fallow continuous rice cultivation

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This study began in 1981 on upland Plinthic Acrisols at Suakoko where a thick secondary bush had been cleared in the 1979 dry season and rice was grown in the 1980 wet season. The trial was repeated in 1982 at the same site. The study evaluated line and broadcast planting, split N, K, and basal P fertilizer, weeding (twice), insect pest control (3 equal split doses of carbofuran granules at 1.2 kg ai/ha), and water conservation by bunding. Treatments were designed to develop a complete package (CP = line sowing, fertilizer, weed and pest control, and bunding) and an intermediate package (IP = CP minus bunding). The traditional method consisted of broadcast seeding, no fertilizer or insect control, one hand weeding, and no bunding. There were eight randomized, replicated treatments with the local rice cultivar. LAC23.

The results (see table) show that traditional management produced lowest yields in both years. In 1981 there was no significant difference in grain yield among CP, IP, IP minus pest control, and IP minus line sowing. In 1982, however, both CP and IP had significantly higher grain yields than the latter two treatments.

Regardless of treatment, weed infestation increased from 1981 to 1982. Grass weeds dominated, and grass and broadleaf weed infestation increased while sedges decreased. There were more weeds in IP minus weeding followed by the traditional method and IP minus line sowing.

In the second rice crop, grain yield with the traditional method (0.5 t/ha) could be doubled by adopting a package consisting of line sowing, fertilizer application, and weeding in areas where the population of destructive insect pests has not reached the economic threshold level.

In the third rice crop, grain yield with the traditional method (0.3 t/ha) could be tripled by line sowing, fertilizer application, weeding, and insect control. About 20% yield reduction can be expected if insecticide is not applied. However, armyworm *Spodoptera exempta,* which may invade upland rice fields after bush fallow, must be controlled by insecticide.

To maintain soil productivity and grain yields in consecutive rice crops after bush fallow, it is necessary to include crop rotation with legumes and other arable crops in the above package of agronomic practices. □

Effect of various agronomic practices on grain yield and number of weeds in upland continuous rice cultivation at Suakoko, Liberia (high rainfall zone).

Agronomic practice	Grain yield (t/ha)		Yield reduction (%) compared to IP		Weeds (no./m^2) at harvest							
					Grass		Sedges		Broadleaf		Total	
	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982	1981	1982
Complete package (CP)	1.3 a	1.0 a	–	0.9	100	152	2	0	56	75	158	227
Intermediate package (IP = CP – bunding)	1.2 a	1.1 a	–	–	116	166	2	0	44	60	162	226
IP – fertilizer	0.6 b	0.5 c	49	50	108	150	2	0	61	54	171	204
IP – weeding	0.6 b	0.6 c	48	47	220	315	10	1	101	104	331	419
IP – line sowing	1.3 a	0.9 b	–	14	126	210	6	0	72	74	204	284
IP – insect control	1.3 a	0.8 b	–	20	114	154	3	1	43	75	160	230
Traditional method (control)	0.5 c	0.3 d	56	68	206	293	9	3	59	78	274	374
Traditional method + bunding	0.6 bc	0.4 d	52	66	192	244	18	1	46	92	256	337
CV (%)	5.8	10.4										
LSD (0.05)	0.08	0.11										

Rice response to zinc at various salinity and alkalinity levels

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A pot experiment studied rice response to Zn application in Rohi sandy loam soil (Typic Ustifluvent, pH 7.4, no calcium carbonate, 0.5 ppm DTPA extractable Zn) treated with NaCl and $NaHCO_3$ to give initial electrical conductivities (EC) of 5, 10, and 20 mmho/cm at 25°C and exchangeable sodium percentages (ESP) of 10, 20, 40, and 60. Original and treated soils received 0 and 10 mg Zn/kg soil as $ZnSO_4$. A basal dose of 120 mg N, 13 mg P, and 30 mg K/kg soil from $CO(NH_2)_2$, KH_2PO_4, and KC1 was applied to all pots. Five 30-day-old PR106 rice seedlings were transplanted in pots containing 10 kg soil and submerged in deionized water throughout the experiment.

Zn application increased dry matter yield (140% over the control) and the Zn content of rice straw (see table). As salt and alkali levels in soil increased, rice dry matter yield and Zn content significantly decreased. Adding Zn increased dry matter yield and Zn content of rice at all EC and ESP levels, but the effect was more pronounced in soils treated with salt than with alkali. Rice seedlings could not grow at EC of 20 mmho/cm and ESP of 60. Although adding Zn alleviated Zn deficiency, it did not offset the ill effects of high salinity and alkalinity levels on plant growth. □

Effect of Zn on dry matter yield and Zn content of rice straw. [a]

Treatment [b]	Dry matter yield (g/10 kg soil)	Zn content (ppm)
EC 5	12.4	12.5
EC 5 + Zn	23.0	33.5
EC 10	0.5	12.1
EC 10 + Zn	4.2	29.2
ESP 10	10.6	12.2
ESP 10 + Zn	19.7	26.4
ESP 20	9.0	10.6
ESP 20 + Zn	15.8	20.6
ESP 40	5.5	9.7
ESP 40 + Zn	7.6	17.5
Original Soil	17.9	13.5
Original soil + Zn	42.9	41.4
CD at 5%	2.1	1.3

[a] 85-day-old. [b] EC = electrical conductivity in mmho/cm at 25°C. ESP = exchangeable sodium percentage.

Effect of nitrogen level on grain yield of rice under bush fallow continuous rice cultivation in high rainfall

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Upland soils in Liberia are generally low in nitrogen (N) and phosphorus (P). We evaluated the yield response of some upland rice varieties to applied N under bush fallow continuous rice cropping systems in the high-rainfall forest zone.

Trials were conducted first in 1980 on Acrisol soils at Suakoko after thick bush was cleared during the 1979 dry season. Nitrogen levels were tested in main plot trials and replicated varietal tests were in subplots. Trials at the same site were conducted in the 1981 and 1982 wet seasons. In 1980 and 1981, N as urea was applied in two split doses. In 1982 it was applied in three splits. In each trial 18 kg P/ha was applied at seeding and 33 kg K/ha as muriate of potash was applied at time of N application in split doses.

In 1980, after the bush was cleared, all 5 varieties yielded more than 1.0 t/ha without fertilizer N. With application of 20 to 40 kg N/ha, 2 to 3 t grain yields/ha could be harvested. Some varieties lodged at 40 kg N/ha. Yield increased with level of N applied.

Grain yields in 198 1, regardless of N levels or varieties, were lower than in 1980, but grain yields increased with N levels.

Similarly, third-year grain yields at all N levels and varieties were lower than in the first and second years (see table).

Local rice variety LAC23, which was grown in all 3 years, was used to estimate the yield response surface as follows:

$$1980: \hat{Y} = 1648.0 + 48.87x - 0.33x^2$$
$$1981: \hat{Y} = 798.7 + 17.01x - 0.10x^2$$
$$1982: \hat{Y} = 715.9 + 15.96x - 0.005x^2$$

(where $\hat{Y}$= grain yield in kg/ha, and x = N level in kg/ha).

The equations indicated that the yield response to applied N in LAC23 was almost linear. However, the estimated yield increase (kg/kg N) decreased with increasing N levels as follows:

Year	N levels (kg/ha)	Yield increase (kg/kg N)
1980	20	42
	40	36
1981	20	15
	40	13
	60	11
1982	30	16
	60	16
	60	16

Yield response of rice varieties to nitrogen under bush fallow continuous rice cultivation in high rainfall area of Liberia.

Variety	Days to 50% flowering	Grain yield (t/ha) in various nitrogen levels (kg/ha) and years						Mean
		0	20	30	40	60	90	
				1980				
LAC23	95	1.6	2.5	–	3.1	–	–	2.4
4418	93	1.0	2.8	–	3.6	–	–	2.5
MRC172-9	86	1.1	3.1	–	3.3	–	–	2.5
IR2035-108-2	94	1.1	2.5	–	3.0	–	–	2.2
ROK3	88	1.5	1.8	–	2.4	–	–	1.9
Mean		1.3	2.5	–	3.1			
LSD (0.05) N × V			0.2					
				1981				
LAC23	95	0.8	1.1	–	1.3	1.5	–	1.2
4418	93	1.0	1.3	–	1.4	1.7	–	1.3
C22	99	0.7	0.9	–	1.4	1.7	–	1.2
IRAT132	92	0.7	0.8	–	1.0	1.3	–	1.0
Mean		0.8	1.0	–	1.3	1.5		
LSD (0.05) N × V			0.14					
				1982				
LAC23	104	0.7	–	1.2	–	1.7	2.1	1.4
SEL IRAT 194/1/2	86	0.7	–	1.0	–	1.5	1.9	1.3
LS(1)-19-1-1	107	0.5	–	0.9	–	1.5	1.9	1.2
TOX502–2SLR-LS2-5B	97	0.5	–	0.8	–	1.2	1.9	1.1
Mean		0.6	–	1.0	–	1.5	2.0	
LSD (0.05) N			0.12					
LSD (0.05) V			0.16					

Yield data indicate that for the first rice crop after bush fallow 20–40 kg N/ha may be needed to harvest more than 2.0 t rice/ha. However, 1.0 t rice/ha could be harvested without added N. For the second and third rice crops, more than 40 kg N/ha may be needed to harvest 1.5 to 2.0 t rice/ha.

The economics of applied N in upland bush fallow continuous rice cropping systems have yet to be defined. N application alone will not maintain grain yields. Decreasing organic matter content, exchangeable cations, CEC, and soil pH may cause low yields in succeeding rice crops.

Nitrogen management for transplanted rice in rainfed lowlands

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A major cause of low transplanted lowland rice yields in India is low fertilizer inputs, especially nitrogen fertilizer. Uncontrolled water supplies in lowland areas cause erratic fertilizer response. We sought to develop appropriate technology for N fertilizer application for transplanted rice grown on rainfed lowlands.

The experiment was conducted at the Rice Research Station, Malan, during the 1980 wet season. Soil was loamy with pH of 5.85; medium levels of organic carbon, available N, and P; and high available N, and P; and high available K. Three–week-old Himdhan seedlings were transplanted at 15– × 15–cm spacing. At puddling time, before transplanting, 40 kg each of P_2O_5 and K_2O/ha were applied.

Applying 60 kg N/ha significantly in–

creased grain yield compared to the no-nitrogen check. Response to nitrogen applied under various treatments ranged from 6 to 40 kg grain/kg N (see table). highest grain yield was recorded when urea supergranules were deep-placed in the root zone. Neem cake and lac-coated urea produced equal grain yields that were lower than those with supergranules. When nitrogen was applied as equal splits of urea at planting and panicle initiation, grain yield was much lower than that in the other treatments. Farmyard manure-coated urea did not perform well. Urea applied at planting produced lowest grain yields.

The experiment showed the benefits of applying nitrogen to lowland rice and the effectiveness of urea supergranule deep placement. □

Grain yield, nitrogen response, and some agronomic characters as influenced by different nitrogen treatments in transplanted rice under rainfed lowland conditions, Malan, India.

N source	Time and rate (kg/ha) of N application			Efficiency of nitrogen (kg grain/kg N)	Grain yield (t/ha)	Panicles (no./m^2)	Panicle weight (g)
	Planting	Panicle initiation	Total				
Control	0	0	0	–	1.1	210	1.93
Urea	60	0	60	6	1.4	261	1.95
Urea	30	30	60	24	2.5	289	2.13
Urea (neem cake coated)	60	0	60	33	3.1	405	2.14
Urea (farmyard manure coated)	60	0	60	23	2.5	245	1.98
Urea supergranule	60	0	60	40	3.5	429	2.12
Granulated compost	60	0	60	22	2.4	241	1.96
Urea (lac-coated)	60	0	60	33	3.1	423	2.11
CD 5%					0.1	27	0.09

Cropping systems

Fertilizer nitrogen management in wheat - summer mung - rice crop rotation

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Rice - wheat is the most common crop rotation followed by farmers in the Punjab because it produces high yields. As the rice - wheat area has increased, pulse production has declined. Pulse production can be increased by planting a wheat - summer mung - rice rotation using G-65 mung, which matures in 60 days.

We studied a wheat - summer mung - rice rotation in 1979-80 rabi with the objective of increasing pulse production and using mung straw as green manure to provide nitrogen to rice.

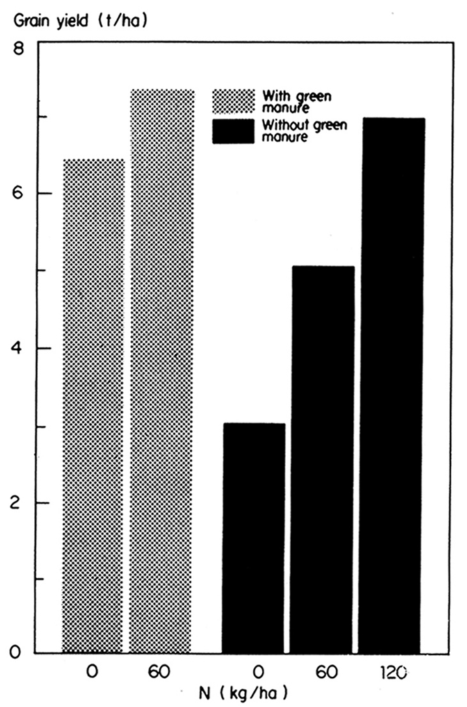
The crops were grown at the PAU farm in loamy sand soil, with pH 8.2 and 0.17% O.C. Immediately after wheat was harvested in mid-Apr, the field was irrigated and mung G-65 at 20 kg/ha was sown between the wheat rows. The mung crop depended on residual fertility after the wheat crop, which received 120 kg N, 26 kg P, and 25 kg K/ha. The mung crop matured the 4th week of Jun, which coincided with the beginning of the monsoon when farmers generally do not have enough covered space to keep the produce before it is dried and threshed. The pods were manually picked and mung straw was incorporated 1 day before rice was transplanted.

Grain and straw yield of mung and mung straw nitrogen content, Ludhiana, India.

Item	1980	1981	1982	Mean
Grain yield of mung (t/ha)	0.84	0.85	0.89	0.86
Fresh weight of mung straw (t/ha)	7.6	7.6	7.5	7.6
Dry weight of mung straw (t/ha)	4.6	4.6	4.5	4.6
N content of mung straw (%)	2.16	2.21	2.26	2.21
N added through straw (kg/ha)	99.4	101.7	101.7	100.9

Average mung yield was 0.86 t/ha. Mung straw weighed 7.6 t fresh weight/ha and 4.6 t dry weight/ha, which added 101 kg N/ha to the soil (see table).

The figure shows that green manuring with mung straw 1 day before rice transplanting produced higher rice yields than using 60 kg N/ha where mung straw was removed. Mung straw and 60 kg N/ha produced rice yields equal to those with 120 kg N/ha in treatments where mung straw was removed. □



Effect of summer mung straw green manure on rice yield, 1980-82.

Announcements

Dr. James C. Moomaw dies

Dr. James C. Moomaw, 55, head of the IRRI Agronomy Department 1961-67, died 23 July after a long illness. Moomaw left Los Baños in 1967 to become project leader for the Sri Lanka-IRRI-Ford Foundation Rice Project. He later worked with the International Institute of Tropical Agriculture, became director of the Asian Vegetable Research and Development Center in Taiwan, China, and served as executive director of the Near East Foundation.

Moomaw received his BA from Carleton College, MS from the University of Idaho, and Ph D from Washington State University. He was well known for his work with the Rockefeller Foundation, the World Bank, the Food and Agriculture Organization of the United Nations, IADS, and the United Nations Development Programme.

Moomaw is survived by his wife Carolyn and four sons. □

Pesticide application journal

The International Centre for the Application of Pesticides (ICAP), a unit of the Cranfield Institute of Technology in England, was established in 1982 to provide a research information service for government agencies, industry, and others concerned with improvement and development of aerial and ground pesticide application systems for crops including rice. The Centre publishes a quarterly journal, *AIM,* which includes news and abstracts of published articles and welcomes questions and reports about pesticide application.

The ICAP address is Cranfield Institute of Technology, Cranfield, Bedford MK43 OAL, England. □

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