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Guidelines and Style for IRRN Contributors

Articles for publication in the *International Rice Research Newsletter* (IRRN) should observe the following gudelines and style.

Guidelines

- Contributions should not exceed two pages of double-spaced typewritten text. Two figures (graphs, tables, or photos) may accompany each article. The editor will return articles that exceed space limitations.
- Contributions should be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses should be done.
- Announcements of the release of new rice varieties are encouraged.
- Pest survey data should be quantified. Give infection percentage, degree of severity, etc.

Style

- For measurements, use the International System. Avoid national units of measure (cavan, rai, etc.).
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha, 2 h/d.
- Express yield data in tonnes per hectare (t/ha). With small-scale studies, use grams per pot (g/pot) or g/row.
- Express time, money, and common measures in number, even when the amount is less than 10. For example: 8 min, $2, 3 kg/ ha, 2-wk intervals.
- Write out numbers below 10 except in a series containing 10 or higher numbers. For example: six parts, seven tractors, four varieties. *But* There were 4 plots in India, 8 in Thailand, and 12 in Indonesia.
- Write out numbers that start sentences. For example: Sixty insects were put in each cage. Seventy-five percent of the yield increase is attributed to fertilizer.
- Place the name or denotation of chemicals or other measured materials near the unit of measure. For example: 60 kg N/ha, not 60 kg/ha N; 200 kg seed/ha, not 200 kg/ha seed.
- Use common names — not trade names — for chemicals.
- The US$ is the standard monetary unit in the IRRN. Data in other currencies should be converted to US$.
- When using acronyms, spell each out at first mention and put the specific acronym in parentheses. After that, use the acronym throughout the paper. For example: The brown planthopper (BPH) is a well-known insect pest of rice. Three BPH biotypes have been observed in Asia.
- Abbreviate names of months to three letters: Jun, Apr, Sep.
- Define in the footnote or legend any nonstandard abbreviations or symbols used in a table or figure.
- Do not cite references or include a bibliography.

Genetic Evaluation and Utilization

OVERALL PROGRESS

IRAT170: a high-yielding, medium-duration upland rice for Nigeria

S.O. Fagade, P. G. Pillai, and J. K. Kehinde, National Cereals Research Institute, Ibadan, Nigeria

We tested a number of breeding lines and varieties in 1983 upland rice zonal trials. IRAT170 was identified as a high-yielding variety with medium maturity and good plant type. It was evaluated with other selected entries in the advanced yield nurseries of the Coordinated Rice Evaluation Trials (CRET) in 1984 and 1985. In 1984 CRET, IRAT170 outyielded the commonly cultivated popular variety FARO 11 in four of the five locations. In 1985, IRAT170 was superior to FARO 11 in all four locations (see table). Grain yield of IRAT170 was 37% higher than that of FARO 11.

IRAT170, a cross of IRAT13 and Palawan, was introduced from the Ivory Coast. It is medium tall (120 cm) with medium maturity (125 d). It has straight compact tillers and is resistant to lodging. Panicles are also compact with good spikelet fertility. Grains are long bold (B type) with nonglutinous endosperm. Cooking quality is better (amylose content 23.0%) than that of FARO 11 (amylose content 19.0%). It is also superior to FARO 11 in pest and disease resistance.

IRAT170 has been recommended for release for upland humid areas of Nigeria. □

Yield performance of IRAT170 in multilocational trials, Nigeria, 1984-85.

Location	Grain yield (t/ha)						Increase over check (%)
	1984		1985		Mean		
	IRAT170	FARO 11	IRAT170	FARO 11	IRAT170	FARO 11	
Moor Plantation	3.6	3.4	5.6	3.7	4.6	3.6	28
IITA, Ibadan	1.4	0.6	0.6	0.1	1.0	0.4	150
Ikenne	2.6	2.1	2.6	1.9	2.6	2.0	30
Amakama	2.1	2.2	2.4	1.8	2.3	2.0	15
Onne	2.7	1.7	–	–	2.7	1.7	59
Mean	2.4	2.0	2.8	1.9	2.6	1.9	37

Development of a rice composite for Nigeria

S.O. Fagade, National Cereals Research Institute, Badeggi, Nigeria

Six rice varieties with similar agronomic characteristics but different reactions to diseases, lodging, and drought were selected and diallel-crossed in 1977. The varieties were commonly cultivated FARO 11, drought-tolerant E425 and 0S4, FARO 25 with moderate resistance to brown spot, and high-yielding IRAT1069m-1-2 and IR1154-243-1. The F_1 and F_2 populations were phenotypically similar to the parents except for variations in height and tolerance for drought and diseases. The F_2 crosses tested in 1978 were grouped into five classes (Table 1). These groups, with FARO 11 and a physical mixture of the six parent varieties as checks, were tested for 3 yr.

FAROX299, involving crosses of IRAT1069m-1-2 with other varieties, was shorter than FARO 11 and other crosses. It also showed higher

Table 1. Performance of composites in station trials, Moor Plantation, Ibadan, Nigeria, 1978.

Group	Designation	Cross	Average height (m)	Days to maturity	Panicles/ m^2	Drought score	Blast score	Grain yield (t/ha)
a	FAROX298	Crosses of FARO 11	111	120	132	3	4	1.90
b	FAROX299	Crosses of IRAT1069m-1-2 with other varieties [excluding (a)]	105	119	144	2	2	2.12
c	FAROX300	Crosses of E425 and others excluding (a) and (b)	112	120	122	3	4	2.00
d	FAROX301	Crosses of OS4 and others excluding (a), (b), and (c)	109	120	132	3	4	1.90
e	FAROX302	Crosses of FARO 25 and others excluding (a), (b), (c), and (d)	108	123	132	3	4	2.00
f	FARO 11 (check)	–	111	120	132	4	3	2.00
g	Mixture (check)	Physical mixture of all parents in equal proportions	113	120	122	5	3	2.00
LSD	–	–	ns	ns	ns	–	–	ns
CV%	–	–	8.6	–	14.8	–	–	16.4

phenotypic acceptance and resistance to drought. During 1982 season, when total rainfall for the last 40 d of crop growth was 60 mm, FAROX299 produced the highest grain yield.

In 1984, the composite outyielded FARO 11 at three sites of a multilocation trial and produced as much yield as FARO 11 in one location (Table 2). At Onne, a high-rainfall area, FAROX299 showed resistance to sheath blight and leaf scald.

Table 2. Performance of FAROX299 in multilocation trials in Nigeria, 1984.

Variety	Grain yield[a] (t/ha)					
	1	2	3	4	5	Mean
FAROX299	3.08	1.10	2.30	1.00	1.97	1.88
FARO 11 (check)	3.42	0.65	2.17	2.23	1.76	2.04
ITA117 (check)	2.35	0.25	1.58	1.48	1.74	1.48

[a]Location 1 = NCRI, Ibadan; 2 = IITA, Ibadan; 3 = Ikenne; 4 = Amakama, and 5 = Onne (IITA).

In 1986, the composite was recommended by the Nationally Coordinated Research Project for release as a commercial variety for Nigeria. ☐

Paicos 1, a promising new rice for Manipur

A.J. Singh, Imphal 795001, Manipur, India

Paicos 1 is a promising semidwarf rice from a cross between local Phouren and RP8-9. It has wide adaptability to irrigated, rainfed lowland, and transplanted conditions. It is photoperiod insensitive, matures in 135-140 d, and has high yield potential and stability. It outyielded popular rice varieties Punshi and Jaya (Table 1). The grains are long, slender, and translucent with local consumer preference similar to that for Punshi.

Field trials during Jul-Aug and Nov-Dec 1981-84 showed high resistance to leaf and nodal blast and false smut (Table 2). ☐

Table 1. Performance of Paicos 1 in Imphal District. Manipur, India, 1981-85.

Variety	Av yield (t/ha)	Duration (d)	Panicles/ m^2	Milling %	Length: width	Kerne1 elongation (mm)	Cooking quality
Paicos 1	6.2	138	290	68	3.44	1.98	Good
Punshi	5.9	135	291	65	3.10	1.83	Good
Jaya	5.8	138	290	70	2.86	1.76	Fair
CD at 5%	0.2						
CV%	9.0						

Table 2. Field reaction of Paicos 1 to blast and false smut. Manipur, India, 1981-85.

Variety	Reaction[a]			Rating[a]
	Leaf blast	Nodal blast	False smut	
Paicos 1	0-1	0-1	0-1	R
Punshi	2-3	2-3	2-3	S
Jaya	2-3	2-3	2-3	S

[a]Scored on the *Standard evaluation system rice* scale. R = resistant, S = susceptible.

Pant Dhan 6, a new variety for the hills of Uttar Pradesh

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The hilly region of Uttar Pradesh (about 46,485 km^2) has diverse soil, topography, and rainfall. High-yielding varieties capable of performing well at lower and medium altitudes (up to 1,676 m) have been lacking.

Pant Dhan 6, a high-yielding variety recently released for this area, was evolved by the pedigree method following hybridization of IR8608-298-3-1 and IR10179-23 at IRRI. As IR19728-9-3-2, it was introduced in India through the 198 1 International Rice Observational Nursery. and grown at Pantnagar during the wet season.

Pant Dhan 6 is an early maturing (113-120 d in the hills), semidwarf variety suitable for transplanting at lower and medium altitudes. During 3 or testing, Pant Dhan 6 performed better than K39, Majhera 3, Thapachini, and other local checks (Table 1). In the hill regions of Uttar Pradesh, it yielded 65% higher than standard variety K39 and 67% higher than local check Thapachini. It has medium slender grains.

Pant Dhan 6 has shown resistance to leaf blast and brown leaf spot and moderate resistance to neck blast and leaf scald, the most common diseases in the hills. It has shown resistance to stem borer and moderate susceptibility to leaffolders (Table 2). □

Table 1. Grain yield and days to flowering of Pant Dhan 6 in Uniform Variety Trials at Hawalbagh, Almora (U.P.), India, 1983-85.

Variety	Yield (t/ha)				Days to 50% flowering			
	1983	1984	1985	Mean	1983	1984	1985	Mean
Pant Dhan 6	2.9[a]	4.2[a]	5.2[a]	4.1	91	81	92	88
K39	1.4	2.1	4.0	2.5	79	73	83	78
Thapachini (local check)	2.0	3.5	3.6	2.4	98	107	102	102
CD at 0.05	1162	1164	824					
CV (%)	22.5	24.5	11.6					

[a]Significantly superior to K39 and Thapachini.

Table 2. Reaction of 3 varieties to diseases and insects at Hawalbagh, Almora, India, 1983 kharif.

Variety	Reaction[a]					
	Disease				Insect	
	Neck blast	Leaf scald	Sheath rot	Brown leaf spot	Stem borer	Leaffolder
Pant Dhan 6	5	5	7	3	3	7
K39	9	5	5	3	7	7
Thapachini (local check)	5	7	7	4	5	7

[a]*Standard evaluation system for rice* 0-9 scale.

Swarnaprabha, a physiologically efficient variety

Ch. Narasingarao and K.S. Murty, Central Rice Research Institute, Cuttack, India

Ptb 43 or Swarnaprabha, an early high-yielding variety from the cross Bhavani/Triveni was released in Kerala State in Feb 1985. The new variety is suitable for all three growing seasons.

Swarnaprabha and 11 other promising early rice cultivars of similar duration (Ratna as check) were field tested in 2 dry (Dec-Apr 1985 and 1986) and 1 wet (Jun-Nov 1985) season trials at 15- × l0-cm spacing. Sixty kg N as urea was applied in 3 equal splits: at seeding, 20 d after seeding, and booting.

Agronomic characteristics of Swarnaprabha and check variety Ratna at Cuttack, India.

Character	1985 wet season		1985 dry season		1986 dry season	
	Swarnaprabha	Ratna	Swarnaprabha	Ratna	Swarnaprabha	Ratna
Duration (d)	117	122	130	135	130	135
Height (cm)	113	86	107	82	112	86
Panicles/m^2	313	370	387	478	389	430
Spikelets/m^2 × 10^3	27.4	22.1	28.5	25.1	33.9	30.2
Grains/m^2 × 10^3	21.1	15.8	23.1	18.9	26.8	24.5
1,000-grain weight (g)	24.5	21.7	23.7	19.8	25.2	21.8
Total dry matter (g/m^2)	1012	786	1218	967	1159	999
Grain yield (g/m^2)	465	325	499	409	644	531
Harvest index	46	41	41	42	56	53
Solar energy utilization (Eu %)	1.11	0.91	1.00	0.75	0.94	0.75
Crop growth rate (panicle initiation to flowering, g/m^2 per d)	19.9	12.2	23.1	12.0	19.2	18.8
Crop growth rate (flowering to harvest, g/m^2 per d)	10.7	9.9	18.3	18.0	12.5	6.5
Sink capacity (g/m^2)	671	480	678	497	855	659
Postflowering dry matter (g/m^2)	363	248	493	449	400	215

Duration was 120 d in the wet season and 130 d in the dry (see table). Productive panicles/ m^2 were about 390 in the dry season and 310 in the wet. It has medium bold grains (1,000-grain weight = 24.0 g) and white kernels. Height is 110 cm, with leaf area index about 3.5, harvest index 0.46, and solar energy utilization 1.11% in the wet and 0.94% in the dry seasons.

Swarnaprabha had the highest dry matter and grain yield in one wet and two dry seasons. Crop growth rate during reproductive and ripening stages, sink capacity, and postflowering dry matter accumulation were high, resulting in high spikelet and grain numbers/m^2. Yields were over 4.5 and 5.5 t/ha in the wet and dry seasons.

Yield difference between seasons was marginal, showing its stability. □

Two upland rice varieties recommended for release in Nigeria

S. O. Fagade, P. G. Pillai, and J. K. Kehinde, National Cereals Research Institute, Ibadan, Nigeria

To identify high-yielding and short-duration varieties for upland environments, five entries selected from local testing at Ibadan were evaluated in multilocational trials during the 1984 and 1985 wet seasons. IRAT133 and IRAT144 were the best performers (see table). They also had the highest yields in 1983 Ibadan trials. The Third National Conference of the Nationally Coordinated Research Project on Rice (Apr 1986) has recommended that they be released for cultivation.

IRAT133 and IRAT144 are crosses of IRAT13 and IRAT10, introduced from Ivory Coast. They have short duration and disease and drought resistance. IRAT133 is short, IRAT144 is medium and has the better plant type. □

Performance of IRAT133 and IRAT144 in upland environments in Nigeria.

Variety	Height (cm)	Days to flowering	Yield[a] (t/ha)	Increase (%) over check
IRAT144	127	75	3.0	43
IRAT133	116	72	2.9	38
ITA257 (check)	118	72	2.1	–

[a]Av of 1984 and 1985 multilocational trials.

Two high-yielding varieties for southern Andhra Pradesh wet season

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NLR27999 and NLR9672-96 are semidwarf varieties with higher yield potentials than NLR9672 and NLR9674. Both have grain dormancy after harvest and yield as high as 6.5 t/ha in the wet season. Both yield well, even with 60-d-old seedlings. NLR27999 is suitable for late planting, up to the end of Oct.

NLR9672-96 is a secondary selection from NLR9672, derived from Bulk H-9/ Millek kuening. NLR27999 is a cross derivative of RP3 1-49-2/ BCPl. Bulk H-9 and BCPl are tall, Molagolukulu-grain type. Millek kuening and RP31-49-2 are resistant to blast (Bl).

Grains of NLR27999 and NLR9672-96 are short and bold with dirty brown glumes, similar to that of traditional Molagolukulu. Grain shedding at maturity is less than in NLR9672. Threshability is good. Milled rice is white and translucent.

NLR9672-96 matures in 150-160 d and NLR27999 in 160-170 d. Both are weakly photoperiod sensitive and are

Table 1. Agronomic traits of NLR27999 and NLR9672-96 and pest and disease reactions. Andhra Pradesh, India.

Character	NLR27999	NLR9672-96	NLR9672	NLR9674
Duration (d)	160-170	150-160	150-160	160-1 70
Plant type	Semidwarf, compact tillering, nonlodging, light green foliage with erect flag leaf	Semidwarf, compact tillering, nonlodging, light green foliage with droopy flag leaf	Semidwarf, compact tillering, nonlodging, light green foliage with droopy flag leaf	Semidwarf, compact tillering, nonlodging, light green foliage with erect flag leaf
Plant height (cm)	113	119	100	104
Tillering ability	Moderate	Moderate	Moderate	Moderate
Panicles/m^2	289	282	248	269
Grains/panicle	291	301	339	326
1000-grain weight (g)	21.8	21.5	23.5	22.5
Dormancy	Present	Present	Present	Present
Reaction to				
Blast	Moderately resistant	Moderately resistant	Susceptible	Susceptible
Bacterial blight	Moderately resistant	Moderately resistant	Moderately resistant	Susceptible
Brown plant-hopper	Resistant	Resistant	Resistant	Resistant
Gall midge	Susceptible	Susceptible	Susceptible	Susceptible

moderately resistant to B1 and bacterial blight and resistant to brown planthopper.

Both varieties are nonlodging under recommended N levels. NLR9672-96 has a droopy flag leaf; NLR27999 shows an erect and medium flag leaf. They have good tillering ability, with more panicles/m^2 and more grains/panicle than NLR9672 and NLR9674. The 1,000-grain weight does not vary (Table 1).

In replicated wet season trials in 1981-84, NLR9672-96 and NLR27999 consistently gave mean grain yields of 5.5 and 5.3 t/ha, compared to 4.4 and 4.1 t/ha for NLR9672 and NLR9674 (Table 2).

Table 2. Performance of NLR9672-96 and NLR27999 at Nellore, India, 1981-84.

Variety	Grain yield (t/ha)					Increase over check (%)	Grain yield[a] (t/ha)			Increase over check (%)	Grain yieldn[b]
	1981	1982	1983	1984	Mean		1983	1984	Mean		1984
NLR27999	4.3	5.6	–	6.5	5.5	27.3	6.2	5.1	5.7	9.8	5.3
NLR9672-96	–	–	3.8	6.5	5.2	23.1	–	5.6	5.6	7.1	5.4
NLR9672	3.7	4.8	3.4	–	4.0	–	5.5	4.8	5.2	–	4.3
NLR9674	3.8	5.5	2.6	4.0	4.0	–	–	4.6	4.6	–	–
CD	0.23	0.25	0.19	0.35			–	0.38			
CV (%)	4.0	3.24	15.01	1.24			–	16.08			

[a]Multilocation trials (mean of 5 locations). [b]Minikit farmers' field trials.

In 1983 multilocation trials in 5 locations, NLR27999 yielded 13% more than NLR9672. In 1984 multilocation trials, NLR27999 yielded 6% more and NLR9672-96 17% more than NLR9672.

In farmers' fields minikit trials with NLR9672 as check, average yields of NLR27999 and NLR9672-96 were 23% and 25% higher than that of NLR9672. □

Genetic Evaluation and Utilization

AGRONOMIC CHARACTERISTICS

Ratooning ability of 20 F_3 rice crosses

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With rice ratooning becoming a popular cropping system in some areas, breeding for ratooning ability is gaining importance. We did a preliminary study of 8 parents and 20 crosses in the 1984 wet season. Hybrids were represented by the F_3 generation.

Planting was for a minimum population of 102 and a maximum of 3,213 hills/entry (see table). Ratoonability was measured on an individual hill basis.

The main crop was harvested leaving a stubble height of not more than 10 cm; the stubbles were allowed to sprout with only residual moisture. Ratoon growth was measured the third week after main crop cutting. Only hills with at least one fresh, normal-appearing tiller were rated as having regrowth ability.

Ratoonability varied from almost none in Mangala (17%) and Karikagga

Ratooning ability of F_3 populations of various crosses. 1984 wet season, Karnataka, India.

Culture[a]	Sprout (%)	Hills (no.)	Parent used for comparison	Value[b]
Jaya/Mahsuri (D)	100	255	Jaya	+ 2.06*
Jaya/Mahsuri (D)			Mahsuri	+ 0.42 ns
Jaya/Sonamahsuri	99	102	Jaya	+ 0.96 ns
Mahsuri	99	306	–	–
Jaya	98	597	–	–
Mahsuri/Doddi (M)	97	816	Mahsuri	– 2.11*
Jaya/Mahsuri (M)	97	1326	Jaya	– 0.67 ns
Jaya/Mahsuri (M)			Mahsuri	– 2.04*
Purple puttu	97	204	–	–
Mahsuri/IR36	95	3315	Mahsuri	– 3.62**
			IR36	+ 11.87**
Mahsuri/Prakash	95	204	Mahsuri	– 3.71**
Jaya/Mahsuri (T)	95	255	Jaya	– 1.68 ns
			Mahsuri	– 3.07**
Jaya/Type 3 (D)	94	255	Jaya	– 2.82**
Jaya/IR36	94	3213	Jaya	– 3.45**
			IR36	+ 11.49**
Pusa 150/IM1 (T)	93	255	IM1	+ 0.97 ns
Intan mutant 3	93	1224	–	–
Intan mutant 1	91	1011	–	–
Intan mutant 2	91	1011	–	–
Pusa 150/IM1 (M)	90	1836	IM1	– 0.88 ns
IET7031/Mangala	89	867	Mangala	+ 22.52**
Jaya/Type 3 (M)	88	609	Jaya	6.09**
Jaya/Type 3 (T)	87	255	Jaya	– 6.32**
Janaki/Mangala	82	153	Mangala	+ 12.90**
Karikagga/Telhamsa	74	255	Karikagga	+ 20.22**
Pusa 150/Telhamsa	73	510	–	–
Mahsuri/Doddi (T)	65	255	Mahsuri	– 20.6**
IR36	65	102	–	–
Pushpa	43	510	–	–
Mangala	17	255	–	–
Karikagga	4	577	–	–

[a]D = dwarf, M = medium, T = tall. [b]** = significant at 1% * = significant at 5%, ns = not significant.

(4%) to high in Mahsuri (99%) (see table). IR36 and Pushpa showed moderate ratoonability.

Based on F_3 data, heterozygous genotypes had higher average ratooning ability (90%) than the pureline parents (64%). This suggests dominant and heterotic expression of the genes governing inheritance of ratooning ability. Mutants of parents with good ratoonability generally maintained this character, but Intan mutants did not. This indicates recessive genes governing this character. Further study involving hybrids of parents having total absence of ratoonability, such as Karikagga, and profuse and uniform ratoonability, such as Intan, Mingolo, Intan mutants, and Mahsuri, would be worthwhile. □

Relationship of filled grain percentage to yield

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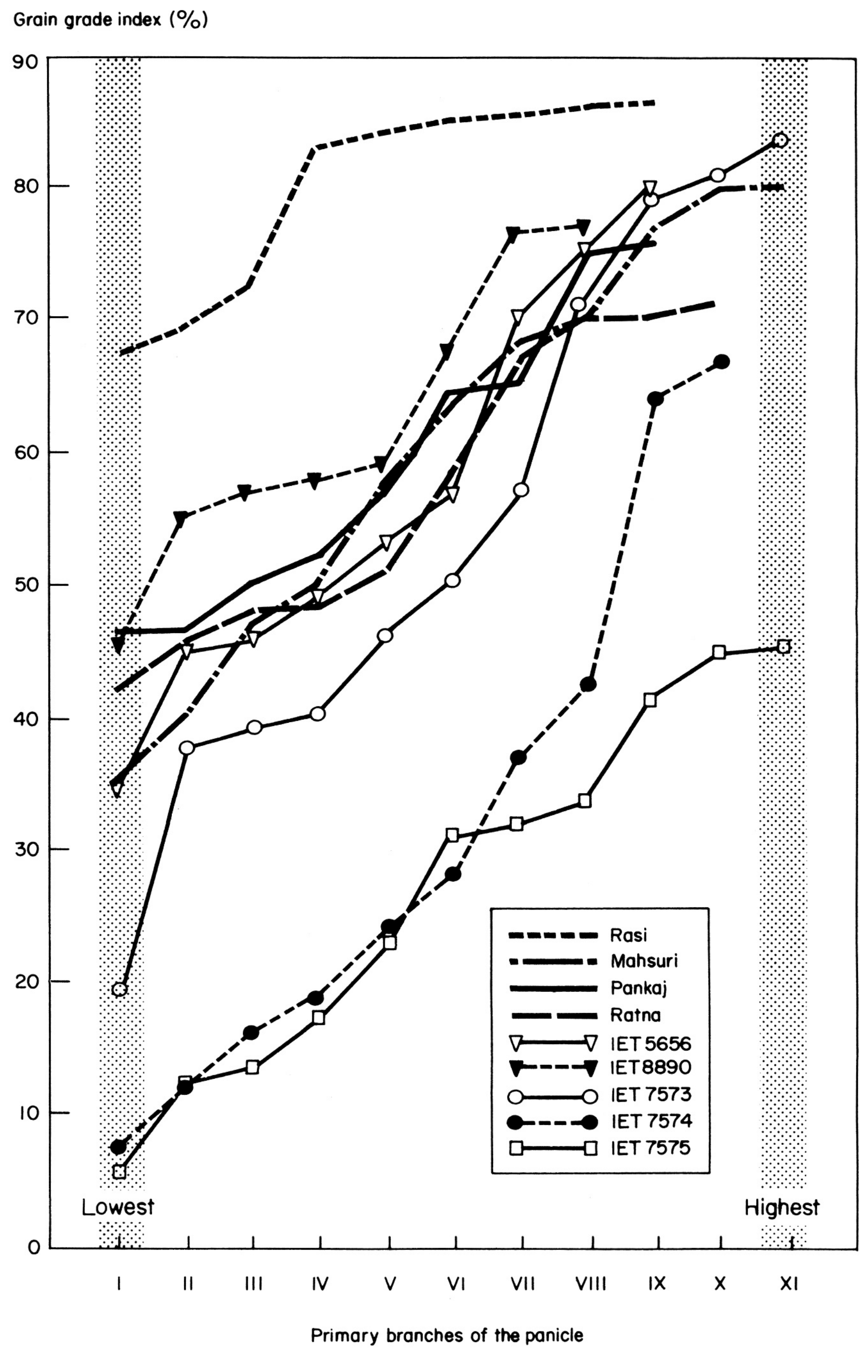
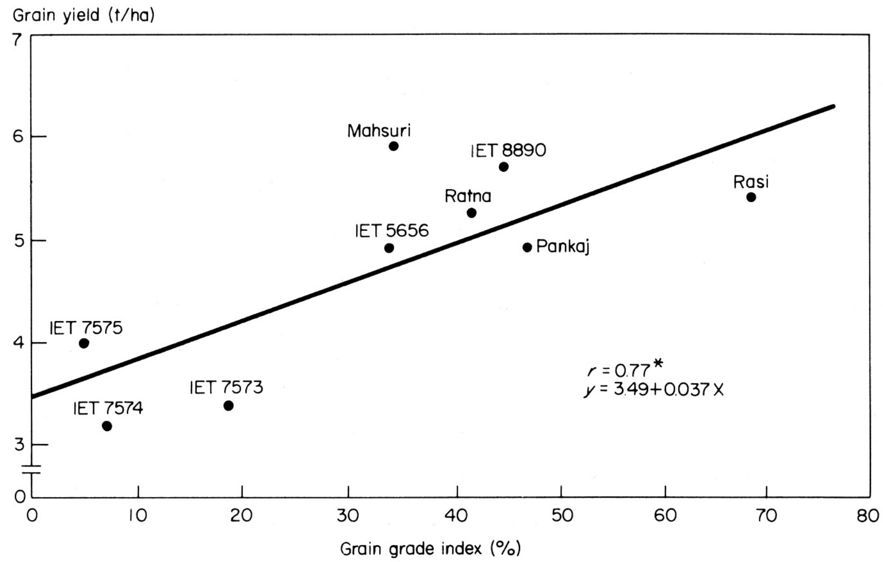
Nonsynchronous flowering results in differential grain filling. Although panicles have good size and number of spikelets, low yields indicate the need for selecting for a higher percentage of fully filled grains. We studied filled grain patterns in panicles of short- (Rasi, Ratna, and IET8890), medium- (IET7573, 1ET7574, and IET7575), and long-duration (IET5656, Mahsuri, and Pankaj) varieties.

At harvest, the percentage of filled grains at 1.18 specific gravity was measured for each primary branch. Grain grade was high at the top and low at the bottom, irrespective of variety duration (Fig. 1). Yields correlated positively with grain grade of the lowest branch of the panicle (Fig. 2). Based on the percentage of filled grain on the lowest branch of the panicle, yield potential could be identified as poor (less than 10%), average (20-30%), moderate (30-40%), and high (>50%). □



1. Grain grades on primary branches of panicle. Andhra Pradesh, India.



2. Relationship between grain grade of the 1st primary branch (bottom) and yield. Andhra Pradesh, India.

Main and ratoon rice crop performance in mangrove swamps

M. P. Jones, WARDA Regional Mangrove Swamp Rice Research Station, Rokupr, Sierra Leone

In some of the tidal mangrove swamps of Sierra Leone and Guinea, very low yields are obtained from second crop transplanted rice because farmers prefer long-duration photoperiod-sensitive varieties. The first crop matures in late Dec or early Jan. The second crop transplanted in Jan is subject to high levels of salt in the soil or to flooding at late growth stages.

We evaluated ratoon cropping as a way to increase production at Rokupr during 1982-83.

In the ratoon study, 16 varieties produced grain (see table). The Pa Foday Yoreh 260 ratoon yield was 64.4% of the first crop yield. Other varieties that performed fairly well were ROK10, Pa Merr 108A, Pa Fant 213, IR4594-4-1-15, Pa Bathurst 32A, improved Mashuri, CP4, and BR51-49-6. Some varieties with low tolerance for salinity, such as ROK10, did fairly well because the ratoon crop matured before high soil salinity developed.

In the second crop study, only Pokkali was harvested, with 246 kg/ ha grain yield. This highly salt-tolerant variety matured earlier than the other varieties, before the development of very high salt levels. The varieties which flowered late Apr to early May had empty spikelets. Average electrical conductivity during this period ranged from 15 to 18 mmho/cm for floodwater and 11 to 13 mmho/cm for topsoil.

Ratoon growth averaged 90 d. Photoperiod-sensitive Pa Merr 108A produced a ratoon crop in 94 d. This means that long-duration photoperiod-sensitive varieties harvested in Dec will produce a second ratoon crop in mid-March, much earlier than the normal second crop and well before the development of very high soil salinity. With the ratoon crop, land preparation, raising of seedlings, and transplanting are eliminated. □

Performance of 16 rice varieties grown as main and ratoon crops in mangrove swamps in Rokupr, Sierra Leone.

Variety	Salt tolerance ratio	Grain yield[a] (t/ha) Main crop	Grain yield[a] (t/ha) Ratoon crop	Growth duration (d) Main crop	Growth duration (d) Ratoon crop
	High tolerance				
Pa Foday Yoreh 260	0.69	2.7 ab	1.7 a	194	90
Pa Merr 108A	0.68	2.1 bc	0.9 c	197	94
Pa Fant 213	0.60	1.9 cd	0.9 c	197	99
IR4595-4-1-15	0.56	0.1 g	0.6 d	167	104
Pa Bathurst 32A	0.59	2.1 bc	0.6 d	180	98
Pokkali	0.75	0.7 fg	0.2 i	141	107
	Moderate tolerance				
Improved Mashuri	0.52	0.8 f	0.5 de	174	92
CP4	0.49	2.7 ab	0.5 def	197	94
ROK5	0.54	2.7 ab	0.4 fgh	147	80
BD2	0.52	2.8 a	0.4 fgh	147	98
	Low tolerance				
ROK10	0.39	2.6 ab	1.1 ab	197	95
BR51-49-6	0.38	1.2 ef	0.5 efg	164	81
BG90-2	0.31	0.9 ef	0.3 fgh	164	91
BG11-11	0.37	0.8 ef	0.3 hi	163	94
Djabon	0.33	1.4 de	0.3 hi	168	96
Bali Grodak	0.32	1.3 ef	0.3 hi	160	86
SE = 0.16					
CV (%)		16.8	12.7		

[a]In a column, values followed by identical letters are not significantly different from each other at the 5% level.

Effect of time of lodging on rice productivity

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In Bihar, rain between the last week of Sep and the first week of Oct helps boost rice productivity. But, when this rain is accompanied by gusty wind, crops lodge. In 1985, rain during the second week of Oct was accompanied by high wind velocity. We assessed the loss in yield among cultivars of different maturity groups.

Maximum yield loss was 55% in IET7251 — the crop lodged 1 wk before flowering — followed by Sugandha, which lodged at booting (see table). Among the semidwarfs, maximum yield loss was in Radha that lodged 1 wk before flowering, followed by Pankaj that lodged either at flowering or at booting. Minimum yield loss was in Sujata that lodged 10 d after flowering. □

Effect of time of lodging on rice yields.

Variety	Duration (d)	Growth stage at lodging	Yield (t/ha)		Loss[a] (%)
			Lodged	No lodging	
Dwarf (high yielding varieties)					
Pankaj	155-160	Booting	3.5	6.5	46.8 e
Pankaj	155-160	Flowering	3.5	6.7	47.4 e
Radha	155-155	1 wk before flowering	3.1	6.2	49.9 f
Radha	150-155	1 wk after flowering	4.7	6.1	23.6 b
Sujata (BG90-2)	135-140	At flowering	3.5	5.4	35.7 c
Sujata (BG90-2)	135-140	10 d after flowering	4.4	5.2	18.2 a
Sita	135-140	1 wk after flowering	3.2	5.4	41.0 d
Sita	135-140	2 wk after flowering	3.2	5.4	41.6 d
Tall plant type					
Sugandha	Photoperiod sensitive	Booting	1.5	3.3	54.3 g
ET7251	155-160	1 wk before flowering	2.2	4.8	55.1 g

[a] Values followed by identical letters are not significantly different from each other at the 5% level.

Seed dormancy in some short-duration rices

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We assessed seed dormancy in 11 traditional rice varieties and 14 promising short-duration (90-110 d) breeding lines grown during aus (Mar-Sep), when preharvest seed sprouting in the field often follows monsoon rains. Seeds collected 30 d after flowering, coinciding with peak monsoon months, were dried to 13-14% moisture content. Germination at harvest and length and intensity of dormancy were measured. Dormancy intensity was determined by the time necessary to break dormancy with 50 °C heat treatment for 4 d. Dormancy length was days to attain 80% germination under ambient conditions.

Dormancy was 15-44 d in the traditional varieties and 27-54 d in the breeding lines. Many traditional varieties had strong seed dormancy; all the breeding lines except CR289-1208 (IET7255) were weakly dormant (see table). China aus attained 100% germination after heat treatment and had very weak dormancy. □

Seed dormancy of 25 shortduration rices. Chinsurah, India.

	Germination (%) after 4 d heat treatment at 50° C	Dormancy	
		Intensity[a]	Period (d)
Traditional			
Bhutmuri	24	MD	30
Harimandir	nil	SD	40
Orissa aus	2	SD	40
Begunbichi	2	SD	42
Soni	78	WD	43
Panke	nil	SD	32
N22	2	SD	35
Baumal	32	MD	31
Joli	nil	SD	44
Juma	98	WD	41
China aus	100	WD	15
Breeding lines			
HPU741	74	WD	42
IR9708-51-1-2	72	WD	35
IR9729-67-3	88	WD	40
CR289-1208 (IET7255)	55	MD	54
Suweon	100	WD	28
BKNLR75091-CNT-B3 RST40-2-2	100	WD	37
IR8608-189-2-2-1-3	95	WD	30
Pusa 312	100	WD	38
OR165-93-15	78	WD	44
RP2086-74-6-1	100	WD	27
UPLRi7	90	WD	27
IR13204-24-16	90	WD	34
NSRP-1 Early	95	WD	30
RAU4045-10	85	WD	33

[a] WD = weakly dormant, MD = moderately dormant, SD = strongly dormant.

Leaf chlorophyll content of submerged rice seedlings

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We assessed leaf chlorophyll content of seedlings of six rice varieties (B-9c-Md-3-3, CN540, CR126-42-1, FR13A, Mohon, and OC1393) grown in pots under submerged and nonsubmerged conditions.

Seedlings were raised in 25-cm-diam earthen pots at 50 seeds/pot with 8 replications. At 10 d after seeding (DAS), 4 pots/variety were submerged in 50-cm water for IO d, then treated normally to 35 DAS. Leaf chlorophyll content was estimated at 10, 12, 16, 20, 24, and 35 DAS.

Leaf chlorophyll content decreased with increasing age of seedlings (see table). Chlorophyll content in submerged seedlings was similar to that in nonsubmerged seed1ings up to 6 d after submersion, then dropped drastically. After submersion ended, chlorophyll content continued to decrease for 4 d before recovery started.

B-9c-Md-3-3 had the highest chlorophyll content after submergence. CN540 seedlings had the highest chlorophyll content at 10 DAS, but content decreased faster with aging. Three varieties died. □

Chlorophyll content of leaves of submerged and nonsubmerged rice seedlings. West Bengal, India.

Variety	Chlorophyll content (mg/g fresh wt) of seedlings at given days after seeding										
	Nonsubmerged						Submerged			Recovery	
	10	12	16	20	24	35	12	16	20	24	35
B-9c-Md-3-3	2.16	2.14	1.92	1.87	1.84	1.73	2.84	1.43	1.58	0.46	2.27
CN540	5.12	1.73	2.64	1.98	2.13	2.13	2.68	1.92	0.46	0.77	–
CR126-42-1	3.50	2.55	1.95	1.73	1.56	1.43	3.80	1.54	1.30	0.62	–
FR13A	2.91	3.01	1.20	1.22	1.70	1.70	2.65	1.92	0.73	0.17	2.39
Mohon	3.21	3.73	2.37	2.19	1.67	0.94	5.03	2.10	0.64	0.57	–
OC1393	4.32	3.88	2.86	2.16	2.04	1.70	4.28	1.81	0.71	1.10	2.27
Mean	3.54	2.84	2.06	1.86	1.82	1.61	3.55	1.79	0.91	0.62	2.31

Genetic Evaluation and Utilization

GRAIN QUALITY

Grain quality of new varieties PR 108 and PR 109 in Punjab, India

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Two new rice varieties were released in Punjab in 1986. PR108 is resistant to sheath blight and whitebacked planthopper (WBPH), PR109 is resistant to bacterial blight and WBPH. PR108 and PR109 are as high yielding as PR103 and PR106 and Jaya under disease- and insect-free conditions (see table).

Total rice recovery and head rice recovery of PR108 and PRI09 equaled those of PR103, PR106, and PR4141 and head rice recovery was higher than Jaya's.

The new varieties have long, slender white grains. PR108 has high and PR 109 has intermediate amylose content. Cooking quality compares favorably with that of PR106, PR4141, PR103, and Jaya. PR108 and PR109 have slightly higher protein content than other varieties.

With their good milling quality, desirable appearance, good cooking and eating quality, and good protein value, the new varieties are likely to be as acceptable to consumers and millers as PR106, which commands a premium price. □

Grain quality characteristics of rice varieties.[a] Kapurthala, India.

Variety	Yield (t/ha)	Total rice recovery (%)	Head rice recovery (%)	1,000-grain wt (g)		Length: breadth ratio	Cooking time (min)	Kernel elongation ratio	Volume expansion ratio	Amylose (%/dry basis)	Protein (%) at 14% moisture
				Paddy	Milled rice						
PR108	7.1	74.0	63.1	23.3	17.3	3.2	19	1.8	4.2	26.2	8.0
PR109	6.9	73.0	63.0	24.5	18.8	3.2	26	1.7	4.8	24.7	8.7
PR103	6.6	73.3	63.3	25.0	18.9	3.0	19	1.6	3.7	16.0	7.9
PR106	6.5	73.5	63.2	22.8	16.9	3.3	18	1.8	3.9	25.4	7.8
Jaya	7.1	75.2	56.6	27.3	21.6	2.5	22	1.7	4.2	26.3	7.8
PR4141	5.8	74.2	61.3	21.9	16.5	3.0	23	1.7	4.6	23.1	7.9

[a]Av of 3 replications.

Relationship of agroclimatic parameters to high density grain production

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Production of high density (HD) grains differs with crop duration, season, and N levels. We found that HD grain index (% of fully filled grain at 1.18 specific gravity divided by spikelets per panicle) is influenced positively by crop duration and season and negatively by N level.

Long-duration varieties IET5656, Mahsuri, CR 1009, and Pankaj had higher HD grain indexes than the short- and medium-duration varieties

(Table 1). A similar trend was found when these varieties were tested under the different climatic conditions of the All India Coordinated Rice Physiology program.

Short- and medium-duration varieties performed better in the dry season (65% HD grains) than in the wet season (45-55%).

HD grains had a negative relationship with higher N levels in the field (Table 2). However, higher N levels resulted in higher production of tillers, panicles, and spikelets, and higher leaf area index and total dry matter. Those overall increased yields were attributed to other yield components. □

Table 1. Grain grade index of early, medium, and late varieties by season. Andhra Pradesh, India, 1984.

Variety	Grain grade index (%) Wet season	Dry season
Early		
Rasi	50	62
Ratna	45	60
Sita	52	59
Medium		
Jaya	55	64
Prakash	58	65
Late		
IET5 656	71	77
Mahsuri	70	75
CR1009	65	70
Pankaj	75	80
Angular transformation		
CD 5% =	2.33	2.00
CD 1% =	3.21	2.75
CV (%) =	2.64	2.01

Table 2. Influence of N level on grain grade index and yield components of 3 varieties. Andhra Pradesh, India.

N level (kg/ha)	Tillers/m^2	Panicles/m^2	Leaf area index	Total dry matter (g/m^2)	Spikelets/ m^2	Grain index (%)	Grain yield (t/ha)
Ratna							
0	546	526	3.4	1,415	34,350	60	5.8
50	603	573	5.0	1,464	38,800	57	6.4
100	605	590	5.1	1,582	43,120	56	6.8
150	609	569	6.0	1,586	52,950	56	6.8
200	620	585	5.9	1,590	54,530	46	6.9
Experimental mean	596.6	568.6	5.08	1,526.33	44,750	55.00	6.54
CD 5%	6.4	5.5	0.54	17.66	2,290	3.45	0.62
CD 1%	9.3	8.0	0.79	25.68	3,210	5.38	ns
CV (%)	0.6	0.5	5.67	0.61	3.32	3.33	5.00
Prakash							
0	550	543	8.3	1,516	31,400	56	6.1
50	563	551	8.8	1,662	34,990	59	6.3
100	589	581	7.6	1,685	38,060	48	6.8
150	635	624	7.6	2,896	38,270	42	6.1
200	688	674	10.2	3,007	39,100	40	6.9
Experimental mean	605.0	594.6	8.5	2,153.20	36,364	49.00	6.6
CD 5%	6.4	7.74	0.21	23.81	1,504	5.38	0.4
CD 1%	9.4	11.3	0.31	34.63	2,109	7.83	0.6
CV (%)	0.6	0.69	1.34	0.59	2.69	5.83	3.2
Phalguna							
0	409	401	4.3	1,462	24,500	56	5.7
50	435	412	6.7	1,602	22,240	58	6.8
100	468	433	6.8	1,679	23,910	54	7.0
150	479	473	6.4	1,694	23,230	53	7.1
200	490	475	6.2	1,696	35,380	50	7.3
Experimental mean	456	439	6.1	1,627	25,852	54	6.8
CD 5%	11	7	0.5	23.2	1,683	4	0.5
CD 1%	16	10	0.8	34	2,359	ns	0.8
CV (%)	1	1	4.6	1.8	4	4	4.2

Genetic Evaluation and Utilization
DISEASE RESISTANCE

Reaction of IR lines to tungro virus (RTV)

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We screened 51 breeding lines against RTV, using artificial inoculation in the glasshouse. The seedlings (15 d after seeding) were exposed to green leafhoppers (GLH) that had acquisition access feeding on RTV-infected TNl plants for 4 d, at 2 insects/ seedling. The insects were allowed 2 d inoculation access feeding. RTV infection was scored 15 d after inoculation, following the *Standard evaluation system for rice* (Table 1).

Ten seedlings of each culture scoring 0-3 were tested for serological reaction to RTBV and RTSV by latex agglutination method (serum supplied by H. Hibino, IRRI). Reactions of all 10 seedlings in each culture were similar (Table 2).

Breeding lines IR32429-148-1-3-3, IR35366-90-3-2-1-2, IR37865-29-3-1-3, and IR39357-91-3-2-3 are being evaluated and used for breeding resistant varieties. □

Table 1. RTV infection in IRRI rice cultures.

Selection	RTV %[a]	Grade
IR42	18	4
IR24632-34-2	60	7
IR25588-7-3-1	75	8
IR25840-83-3-2	50	7
IR28128-45-3-3-2	38	6
IR29658-43-3-2-1	46	7
IR29670-15-2-3	25	5
IR29692-99-3-2-1	18	4
IR29725-109-1-2-1	13	4
IR31802-48-2-2-2	31	6
IR31851-96-2-3-2-1	58	7
IR31868-64-2-3-3-3	30	5
IR32307-107-3-2-2	67	8
IR32429-47-3-2-2	44	7
IR32429-68-3-3-3	50	7
IR32429-122-3-1-2	50	1
IR32429-148-1-3-3	0	0

Continued on page 15.

Table 1 continued.

Selection	RTV %[a]	Grade
IR32843-92-2-2-3	40	6
IR32851-87-2-3-1	56	7
IR34631-79-2-2-3	46	7
IR35293-125-3-2-3	15	4
IR35366-28-3-1-2-2	54	7
IR35366-90-3-2-1-2	0	0
IR35546-17-3-1-3	36	6
IR35546-33-2-2-3	33	6
IR37865-29-3-1-3	10	3
IR39357-91-3-2-3	10	3
IR39357-133-3-2-2-3	60	7
IR39379-99-2-3-3-2	69	4
IR39385-20-1-2-1-1	25	5
IR39385-124-3-3-2-3	18	4
IR41985-111-3-2-2	80	8
IR42015-83-3-2-2	38	6
IR39379-190-2-2-3-1	17	4
IR39422-18-1-2-2	75	8
IR25604-99-1-3-2-2	18	4
IR39422-19-3-3-3-3	60	7
IR39423-124-3-3-1	46	7
IR25587-133-3-2-2-2	54	7
IR28150-84-3-3-2	21	5
IR28222-9-2-2-2-2	46	7
IR28224-3-2-3-2	72	8
IR28228-28-1-3-3-2	29	5
IR28228-119-2-3-1-1	18	4
IR29723-143-3-2-1	53	7
IR31836-46-1-3-1	62	8
IR32453-93-3-3-1-3	40	6
IR32720-138-2-1-1-2	70	8
IR34583-22-1-2	62	8
IR39326-9-2-2-3	62	8
IR39334-31-2-2-2	42	7
ADT36 (susceptible check)	90	9
ADT31 (susceptible check)	80	8
TN1 (susceptible check)	90	9
TKM9 (susceptible check)	100	9
IET7492 (resistant check)	8	3

[a]One hundred seedlings/culture inoculated.

Table 2. Serological reaction of RTV-resistant cultures.[a]

Selection	Reaction[b] to	
	RTBV	RTSV
IR32429-148-1-3-3	–	–
IR35366-90-3-2-1-2	–	–
IR37865-29-3-1-3	–	–
IR39357-91-3-2-3	+	–
IR50 (resistant check)	+	–
ET7492 (local resistant check)	–	+
TKM9 (susceptible check)	++	++
ADT36 (susceptible check)	+	+++

[a]Ten seedlings/culture tested. [b] – = no infection, + = low infection, ++ = medium infection, +++ = high infection.

Field screening for blast (Bl) resistance

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Bl caused by *Pyricularia oryzae* is a major disease affecting commonly grown varieties IR50 and TKM9 during Dec-Feb throughout Chingleput District, Tamil Nadu. A severe outbreak occurred during 1985-86.

To identify a resistant, high-yielding rice culture for this season, we evaluated 93 rice accessions under nursery conditions when disease pressure was high. Seeds were sown in 1.2- × 3.0-m plots. Diammonium phosphate (DAP), applied at 180 g/plot 10 d after sowing, induced severe incidence of Bl. Disease scoring was done at 30 d after sowing according to the *Standard evaluation system for rice.*

Among the cultures or varieties tested, 38 showed resistant reactions of 1-3, 21 had 5, others showed 7-9 (see table). Most of the highly susceptible cultures had IR50 as one parent. ☐

Reaction of rice accessions to Bl at Tirur, India.

Culture or variety	Parentage	Disease score[a]
BG367-3	BG280-1-2/Ptb 33	1
TM10265	ADT31/IR8	1
TM4865	AC76/IR8	1
DPI 1091/5	IR20/Kannagi	1
IR20	IR262/TKM 6	1
IR52		1
IR54		1
IR62		1
TNAU843136	CO 37/IR8	1
TNAU831549	TNAU1756/Bhavani	1
TNAU831358	CO 37/Pankhari 203	1
TNAU831411	IET2508/TNAU1756	1
TNAU831399	IET6262/CO 37	1
TNAU831434	IET6262/TNAU1756	1
TM8089	Selection from TKM9	3
ADT36	Triveni/IR20	3
TM1304	TKM 9 Mutant (10 kr)	3
TM1305	TKM 9 Mutant (10 kr)	3
TM1313	TKM 9 Mutant (10 kr)	3
TM1314	TKM 9 Mutant (10 kr)	3
CO 34	TN1/CO 29	3
AS25370	ASD1/IRON 207	3
AS28883	TKM9/IR36	3
IR36	IR1561//1R24-4/ *O. nivara* ///CR94-13	3
IR56		3
IR60		3
TNAU80030	IR30/Babawee// IR2703-1-252	3
TNAU80042	R. Heenathi/ R3403-267[2]	3
TNAU801804	CO 41/CO 39	3
TNAU831540	Pankhari 203/IR36	3
TNAU831521	PY2/IR36	3
TNAU831345	CO 37/IR34	3
TNAU831351	CO 37/SLO 16	3
TNAU843062	IET4141/CO 43	3
TNAU843032	CO 41/CO 43	3
TNAU843028	PYl/CO 43	3
TNAU83134	IET2508/TKM9	3
TNAU840337	TKM9/W. Ponni	3
TM4660	ADT3 1/CH46	5
AS13744	ADT3 l/Ratna// ASD8/IR8	5
TM1307	TKM9 Mutant (10 kr)	5
TNAU801790	CO 41/CO 39	5
TKMl	Pisini pureline selection	5
TNAU83077	CO 73/IR50	5
TNAU83054	IR50/TKM9	5
TNAU8306911	IR50/Kannagi	5
TNAU83069/2	IR50/Kannagi	5
TNAU801803	CO 4l/CO 39	5
TNAU83104	CO 41/CO 39	5
TNAU83108	TKM9/TNAU658	5
TNAU831520	PY2/IR36	5
TNAU842955	TKM9/W. Ponni	5
TNAU843232	IET6262/CO 37	5
TNAU831541	TNAU1756/Bhavani	5
TNAU2151	IR28/Kannagi	5
TNAU2099	GEB24/IR30	5
TNAU2057	CO 37/IR26	5
TNAU840335	TKM9/W. Ponni	5
TNAU840336	TKM9/W. Ponni	5
TM2011	C22/TKM6//IR50	7
TM2017	C22/TKM6//IR50	7
TM2021	C22/TKM6//IR50	7
TM2022	TKM9/TKM1//ADT36	7
TM2025	TKM9/TKM1//ADT36	7
TM2026	TKM9/TKM1//ADT36	7
TM9400	IR8/Kalinga// IR34/CH1039	7
CO 33	IR8/ADT27	7
TNAU801793	CO 41/CO 39	7
TKM5	Manakattai PLS	7
TKM6	GEB24/CO 18	7
TKM7	Kullakar PLS 1	7
TKM8	TKM6/TN1	7
IR8	Peta/DGWG	7
TNAU80058	IR2061-456-1-55/IR36	7
TNAU2209	CO 33/CO 13	7
TNAU801824	CO 41/CRM13-3241	7
TM1324	TKM 9 Mutant (20 kr)	9
TM1325	TKM 9 Mutant (20 kr)	9
TM1326	TKM 9 Mutant (20 kr)	9
TKM9	TKM7/IR8	9
IR50		9
TM4966	TKM8/ADT9//CR141-192/IR26	9
Kannagi	IR8/TKM6	9
TKM4	Yerra Sona PLS	9
CO 18	Vellaikar PLS	9
TNAU840193	9426/6/IR50	9
TNAU840198	9426/6/IR50	9
TNAU842805	94-26/6/IR50	9
TNAU831146	20060/2/IR50	9
TNAU2006	CO 13/IR50	9
TNAU831154	CO41/IR50	9
TNAU831126	TNAU2426/2/IR50	9
TNAU840230	CO 41/IR50	9

[a] *Standard evaluation system for rice.*

Screening for resistance to tungro (RTV)

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We evaluated 35 promising rice cultures for RTV resistance in the field. The trials were laid out in the 1983 dry season and the 1984 wet and dry seasons at Madurai and Cumbum Valley, where RTV incidence was high.

Test entries were sown in two 4-m rows at 20- × 15-cm spacing, surrounded by susceptible TNl on 4 sides. The field received 100-50-50 kg NPK/ ha. RTV incidence was recorded 60 d after planting.

TNAU831520 and TNAU831521 were free of RTV; IET7492, IET7955, and ACM9 scored 2 (see table).

Seedlings of these 5 cultures and of IR50 (resistant check) and TNl (susceptible check) were artificially inoculated with RTV at 10 d after seeding, using viruliferous green leafhoppers *Nephotettix virescens* at 2 insects/ seedling, 25 seedlings/variety. After 48 h feeding, seedlings were transplanted to pots. RTV incidence was recorded 25 d after inoculation. TNAU831520, TNAU831521, IET7492,1ET9755, and IR50 were free from infection; ACM9 scored 4 and TN1, 9.□

Reaction of promising rice cultures or varieties to RTV. Tamil Nadu, India.

Culture or variety	Parentage	RTV infection grade	Culture or variety	Parentage	RTV infection grade
ACM1	CO 13/IR26	5	TNAU831170	CO 41/IR50	4
ACM2	Kannagi/IR28	6	TNAU831175	CO 41/IR50	4
ACM3	BhavanilCO 36	5	TNAU831218	IR50/CHO 1039	5
ACM4	Bhavani/BC11-6-3	4	TNAU831358	CO 37/Pankhari 203	6
AMC5 (MDU2)	CO 25/IR8	5	TNAU831370	TNAU13613/ Pankhari 203	6
ACM6	IR22/CO 30	4			
ACM7	Jaya/CO 18	4	TNAU831407	IET6262/Vaigai (CO 37)	4
ACM8	IR8/W1263	4			
ACM9	IR2153-14-1-6-2/ IR28//IR2070-625-1	2	TNAU831418	IET6262/TNAU1756	7
			IET6262	Pankaj/Vijaya	5
ACM10	IR19746-28-2-2*	5	IET7153	T141/T141 mutant	5
TNAU831520	PY2/IR26	0	IET7327	Vijaya/CR94-1512-6	6
TNAU831521	PY2/IR36	0	IET7328	VijayalCR94-1512-6	5
TNAU831125	TNAU94266/IR50	3	IET7492	CNM539	2
TNAU831126	TNAU94266/IR50	4	IET7563	Rasi/ADT21	3
TNAU831134	TNAU94266/IR50	3	IET7955	RP1883-19-2-2-1	2
TNAU831139	TNAU20060^2/IR50	4	IR20	IR262/TKM6	5
TNAU831145	TNAU20060^2/IR50	3	Ponni	TG65/ME80	4
TNAU831146	TNAU20060^2/IR50	4	ADT31	IRS/Cul. 340	6
TNAU831154	CO 41/IR50	6	Vaigai (CO 37)	TNl/CO 29	5
TNAU831167	CO 41/IR50	4	TN1	DGWG/Tsai-Yuan-chai	7
TNAU831168	CO 41/IR50	5			

Breakdown of varietal resistance to bacterial blight (BB) at Pantnagar, India

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BB caused by *Xanthomonas campestris* pv. *oryzae* has become endemic in the plains and foothills of the Himalayas in northwestern Uttar Pradesh. Genetic resistance among popular varieties of the region has been a reliable control. But resistance conferred by the traditional *Xa* 4 gene has broken down. Most high yielding varieties developed so far with this gene now are susceptible to BB in the foothills. The stable donors used have been DV85 (*xa 5* × *Xa 7*), BJ1 and IET4141 (*xa 5*), and UPRB30 and UPRB31 (genes not identified). However, these donors became very susceptible to the local BB isolate during wet season 1986, which indicates the possibility of a breakdown of the *xa 5* gene.

We clip-inoculated 43 rice varieties at maximum tillering and scored reaction, by the *Standard evaluation system for rice,* to a local isolate of BB.

It appears that the BB situation at Pantnagar (29 °N latitude, 79° 30’ E

Reaction of *O. sativa* varieties and a strain of wild species *O. barthii* to BB at Pantnagar, 1982-86.

Variety	Gene for resistance	BB reaction (0-9)[a]				
		1982	1983	1984	1985	1986
Oryza sativa						
TKM 6	*Xa* 4	3	3	9	7	7
Govind	*Xa* 4	3	5	9	7	7
Prasad	*Xa* 4	5	5	9	7	7
IR20	*Xa* 4	3	5	9	7	7
IR22	*Xa* 4	5	7	7	7	7
BJ 1	*xa* 5	3	3	3	3	7
IET4141	*xa* 5	3	3	3	5	7
DV 85	*xa* 5 + *Xa* 7	3	3	3	1	7
Pant Dhan 4	Not known	5	5	9	7	7
UPRB 30	Not known	3	3	3	3	7
UPRB 31	Not known	3	3	3	3	7
TN1	No gene	9	9	9	9	9
Oryza barthii	Not known	–	–	–	0	0

[a] Scored by SES.

longitude, 243.84 m altitude) is changing (see table). The need to explore new sources of resistance and their use in the breeding program is urgent. We are evaluating entire germplasm and breeding lines. A strain of the related wild species *Oryza barthii* is maintaining its resistance and can be exploited for resistance breeding. □

Genetic Evaluation and Utilization
INSECT RESISTANCE

Growth duration and hispa susceptibility

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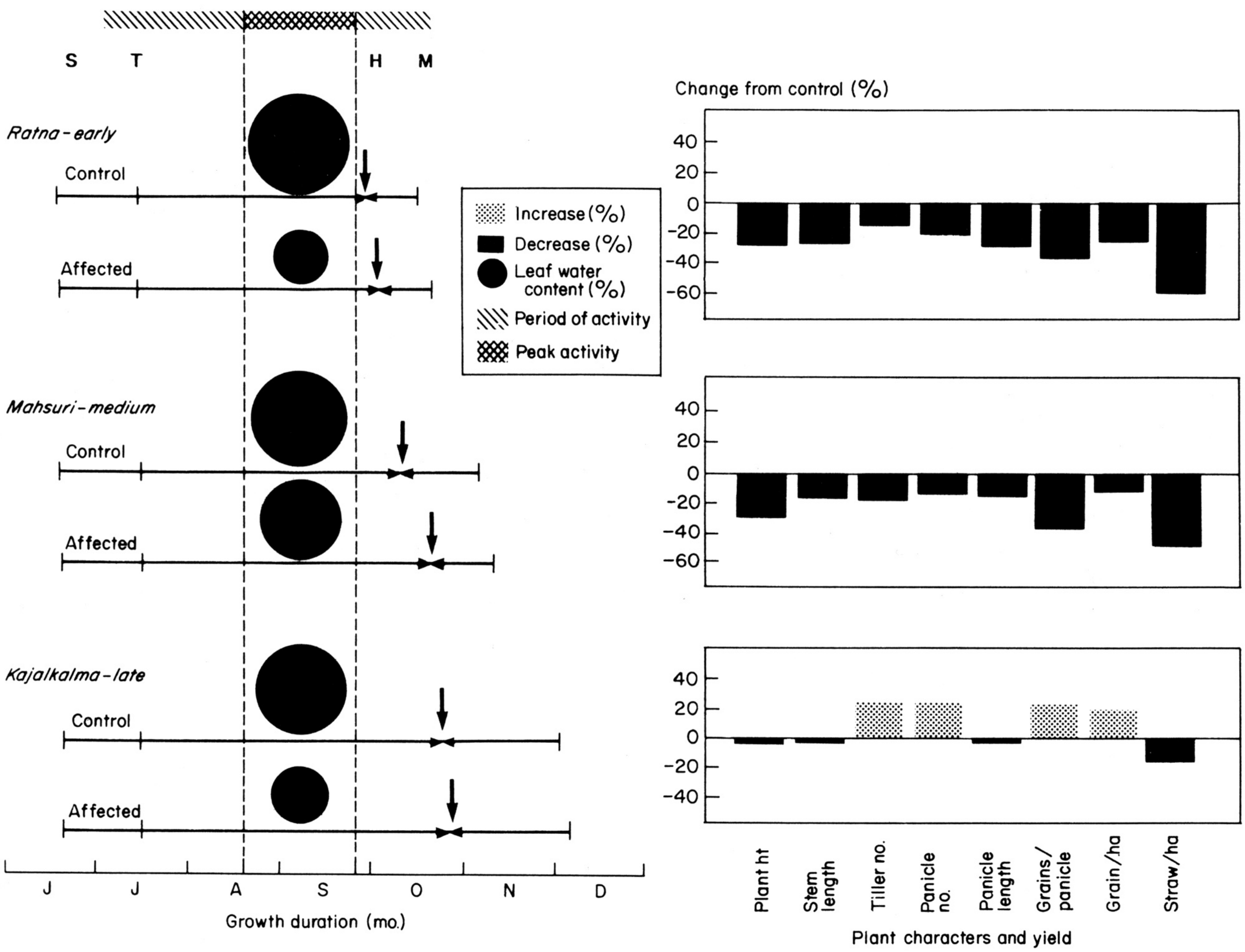
We evaluated the effect of hispa *Dicladispa armigera* infestation on growth and yield of rices with different durations: Ratna (early), Mahsuri (medium), and Kajalkalma (late).

Plots were 50 × 20 m with 20- × 15-cm plant spacings. Test plots were fertilized at 40-20-20 kg NPK/ ha. Recommended agronomic practices were adopted. Thionil insecticide as foliar spray was applied as needed to the control plots.

Percentage of leaf water content was calculated on the basis of fresh weight of leaves at the peak period of infestation (see figure).

Feeding by hispa grubs and adults caused leaves to turn whitish, membranous, and dry. Infestation was 20% on Mahsuri, 36% on Ratna, and 40% on Kajalkalma. Leaf water content of infested plants decreased for each variety (see figure).

The early and medium varieties had significantly lower growth, yield attributes, and yield than the late variety. In general, hispa infestation



Hispa activity and its effect on leaf water content, growth, and yield of 3 rice types. Pandua, West Bengal, India, 1985. S = seeding, T = transplanting, H = heading, M = maturity, delayed heading. The prolonged growth period after hispa infestation significantly improved seed setting in late variety Kajalkalma, but reduced seed setting in Ratna (early) and Mahsuri (medium). In Kajalkalma, early depression of vegetative growth in hispa-infested plots favored effective tiller formation. The delay in heading favored assimilation and accumulation of reserves, promoting reproductive development and grain yield. □

Whitebacked planthopper (WBPH) damage in Pakistan

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In 1986, WBPH severely damaged rice in Sind and Baluchistan. Crop loss was 70% at some locations. We evaluated 2 varieties in the National Uniform Rice Yield Trial at Usta Muhammad, Nasirabad, Baluchistan. Damage ratings ranged from 5 to 9 (0 = healthy, 9 = dead). Basmati 370 scored a damage rating of 5 (see table). □

Reaction of rice cultivars to WBPH in Baluchistan, Pakistan, 1986.

Cultivar	Damage rating (0 to 9 scale)
BAS 370	5
DR37	6
DR39	6
DR41	6
DR82	6
DM16-5-1	6
IR6-93	6
K17-BLK-4-1 IR2053	7
IR6-104	7
DR36	7
DR42	8
DR83	8
IR6	8
BAS385	8
DR38	8
KS282	9
DR40	9
DR43	9
Lateefy	9

Field evaluation of rice culture resistance to leaffolder (LF) and sheath rot (ShR)

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To select high-yielding cultivars with resistance to LF *Cnaphalocrocis medinalis* Guente and to ShR caused by *Sarocladium oryzae* (Saw.) Gem., 64 rice accessions were screened in the field during 1985-86 samba season at Tirur. Seedlings were transplanted, at 25 d after sowing, in 3 rows of 10-m length with 20- × 10-cm spacing. Susceptible check CO 43 was planted after every 10 test entries and on all the 4 sides of the trial field. Plots were fertilized with 125-50-50 kg NPK/ha. All the P and K and 50 kg N were applied basally; the remaining N was topdressed in equal splits at 20, 40, and 60 d after transplanting. No plant protection measures were given. LF damage incidence was assessed at growth stage 6 and ShR incidence at growth stage 8, using the *Standard evaluation system for rice.*

LF damage ranged from 5.3 to 95.5% and ShR incidence from 0.8 to 81.1%. Of the 64 entries screened, 13 were resistant, 14 intermediate and 37 susceptible to both LF and ShR (see table).

LF infestation and ShR incidence correlated positively. A culture or variety resistant to LF was also resistant to ShR. □

Reaction of rices to leaffolder and sheath rot. Samba 1985-86, Rice Research Station, Tirur, India.

Entry	Damage rating	
	Leaffolder	Sheath rot
DPI 1091/5	1	1
White Ponni	1	3
TNAU 80030	1	3
TNAU 80042	3	3
TM 4300	3	3
TM 8381	3	3
AU 42/1	3	3
P 837	3	3
ACM 1	3	3
AD 85002	3	3
TM 10232	3	3
TKM 1	3	3
Ponni	3	3
TNAU 654012	5	3
TNAU 831175	5	3
TM 1143	3	5
TM 10137	3	5
Paiyur 1	3	5
BG 367-3	3	5
TM 10265	3	5
IET 7303	5	5
IR 20	5	5
TM 8300	5	5
AD 85004	5	5
IR 42	5	5
TM 1087	5	5
IET 5656	5	5

Reaction of rice varieties to thrips

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An unusual dry spell, low rainfall, and high temperature during wet season 1986 caused heavy thrips *Baliothrips biformis* damage in the nursery as well as in the transplanted crop at Ambasamudram. Pest damage was most severe in Aug with 35 °C temperatures that were highly conducive to thrips multiplication.

We scored the reaction to thrips of 81 rice varieties being raised in the preliminary variety trial. The trial in a simple lattice design was replicated twice with spacing 15 cm between rows and 10 cm between plants. Cross plot size was 4 m^2. The crop was at heading.

Reaction to thrips was scored on leaf damage by the *Standard evaluation system for rice* scale 1-9.

Only AS13744, RAU4071-57-13, and RP2430-103-56-51 scored 1. Nom scored 9, but 47 scored 3, 25 scored 5 and 6 scored 7. Popular varieties BG367-4, ASD16, and IR64 scored 5. □

Reaction of rice culture seedlings to thrips

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We studied the resistance to thrips *Stenchaetothrips biformis* (Bagnall) of four gall midge (GM)-resistant cultures, two GM-susceptible cultures, six cultures with multiple resistance to stem borer, GM, and green leafhopper, and five popular varieties in the nursery during 1986 kharif. Seedlings were screened at 20 d after sowing by the hand sweep method.

GM-susceptible Sona was resistant to thrips; GM-resistant ET8649 was susceptible (see table). Multiple pest-resistant BG367-3 and TM10137 were susceptible to thrips, multiple resistant TM4506 was resistant. CO 43 had the lowest thrips incidence. ☐

Average number of thrips in the field, Madurai, India.

Culture	Thrips (no.)/ hand sweep
GM-resistant cultures [a]	
KT6012 (IR8/W1263)	24
ET6315 (Sona/Manoharsali)	23
IET8649	39
IET8655	21
GM-susceptible cultures [a]	
Sona	13
IR20 (IR262/TKM6)	24
CD (P = 0.05)	14
Cultures with multiple insect resistance [b]	
BG367-3 (BG280-1-2/Ptb 33)	116
TM10137 (IR26/CR106-190)	92
TM10237 (ADT32/TKM9//IR34)	32
TM4966 (TKM8/ADT9// CR141-192/IR26)	41
TM4506 (Sigadis/CR138-941)	27
TM4300 (IR262/Bhavani)	40
Popular rice varieties [b]	
PY3	67
TKM9 (Triveni/CO 39)	44
IR50 (1R2153-14-1-6-2/1R28//IR36)	55
White Ponni (Mutant of Ponni)	42
CO 43 (Dasal/IR20)	39
CD (P = 0.05)	23

[a]Mean of 4 replications. [b]Mean of 3 replications.

Resistance to thrips of traditional rice cultivars

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Severe thrips *Stenchaetothrips biformis* (Bagnall) infestation in Jul 1986 killed most high-yielding varieties and breeding lines in the nursery (10-15 d after sowing [DAS]). However, several traditional cultivars resisted thrips damage.

We evaluated 400 traditional and 250 high-yielding rice cultivars for thrips resistance in the field. Pregerminated seed was sown in 3 rows 1 m long in moist soil at 1 seed/cm. Resistant Ptb 33 and susceptible TN1 checks were sown at random. At 7 DAS, the water level was raised. At 15 DAS, when TN1 seedlings were completely wilted, damage was rated on the *Standard evaluation system for rice* 0-9 scale.

All high-yielding cultivars were susceptible to thrips; 39 traditional cultivars were resistant (see table).

Thrips resistance in traditional rice cultivars.

Cultivar	Origin
Sirumani	Chingleput, Tamil Nadu
Arunjothi	Chingleput, Tamil Nadu
Thattan Samba	Chingleput. Tamil Nadu
Pitchavari	Chingleput. Tamil Nadu
Balavani Samba	Madurai, TN
Sirumanian	Madurai, TN
Uppu milahi	Ramanthapuram, TN
Varagu milahi	Ramanthapuram, TN
Ariyan	Ramanthapuram, TN
Vellai kattai	Ramanthapuram, TN
Red Sirumani	Jhanjavur, TN
Molagolukulu	Jhanjavur, TN
Sadai Thillai	Jhanjavur, TN
Palkachakka	Jhanjavur, TN
Senthilnayagam	Tirunelveli, TN
Mapili Samba	Tuunelveli, TN
Thattai Vellai	Tuunelveli, TN
Valavasa Muntan	Tirunelveli, TN
Veedhi Vadangan	Tirunelveli, TN
Kalmanavari	Tirunelveli, TN
Koola Valai	Tirunelveli, TN
Garudan Samba	South Arcot, TN
Kottamalli Samba	South Arcot, TN
Katta Samba	Trichy, TN
Perumbalam Samba	Trichy, TN
Pattarai Samba	Palur, TN
Annapetta	Malabar, Kerala
Cheera	Malabar, Kerala
Chengaramani	Malabar, Kerala
Chevukuttadan	Malabar, Kerala
Kuruthu Kumblown	Malabar, Kerala
Kuthi Kondappan	Malabar, Kerala
Kuttadan	Malabar, Kerala
Mundan	Malabar, Kerala
Mundathan	Malabar, Kerala
Moolai Mangalation	Godavari, Andhra Pradesh
Karthigai Samba	Godavari, Andhra Pradesh
Kaki R. Akkulu	Nellore, Andhra Radesh
Bobbili ganti	Vizakapattinam. Andhra Pradesh

Hill rice resistance to leafhoppers and planthoppers in Tamil Nadu

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Traditional rice cultures are grown Aug-Jan under rainfed conditions in the hilly regions of Gudalur, Nilgiris District, Tamil Nadu, at an altitude of 1,342 m, annual rainfall 2,000 mm. Farmers prefer traditional pest-free cultivars that can be raised unprotected.

Seeds of 10 traditional hill rices collected from farmers' fields in Gudalur were evaluated for resistance to leafhoppers and planthoppers in the greenhouse, using the standard seedbox screening technique. Ptb 33 and TNI were the resistant and susceptible checks. Separate seedboxes were used for each insect species × cultivar, with five replications. At 7 d after seeding, seedlings were infested with 8 to 10 second-instar nymphs per seedling for brown planthopper (BPH) and whitebacked planthopper (WBPH), and 5 second-instar nymphs per seedling for green leafhopper (GLH). Damage was scored according to the *Standard evaluation system for rice* 0-9 scale when 95% of TNI plants were killed.

All 10 traditional cultivars (Chethuvali, Karuvali, Kodagan, Kothandam, Mangalapuram, Maranel, Thodavalan, Valan Channel, Vali, and Velumbala) were highly resistant to BPH, WBPH, and GLH. ☐

Resistance to rice whorl maggot (RWM) and leaffolder (LF) in the north-central plateau of Orissa, India

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We studied the reaction of 22 medium-duration (101-125 d) and 24 medium-late-duration (126-140 d) rice cultivars to RWM and LF in the 1986 wet season. Plant populations were 450/cultivar at 15 × 10 cm spacing. RWM leaf count was recorded at 30 d after transplanting (DT) and LF incidence at 50 DT on random samples of 10 plants.

No entry was free of RWM and LF infestation (see table). Most exhibited moderate resistance. ☐

Reaction of rice cultivars to RWM and LF in Orissa, India.

Entry	Cross	Leaf infestation (%) RWM 30 DT	LF 50 DT
	Medium duration (101-125 d)		
OR131-5-8	Kumar/CR57-49	19.3	16.0
OR131-8-5	Kumar/CR57-49	16.0	18.7
OR135-3-4	OR10-26/CR57-49	17.3	16.0
OR158-7-1	IR8/Siam 29//Parijat	26.7	20.0
OR194-1	Adt 27/IR8//Parijat	13.3	13.3
OR367-B-1	IR7687 (Mahsuri/IR30)	17.3	8.0
OR372-B-13	IR9093 (73-1196-12/1R30// IR2071-625-1)	34.7	34.7
OR375-SP-36	IR10904 (IR30/ARC5929)	13.3	16.0
OR378-1	IR11201 (IR2070-414-3-9-6/ Mahsuri)	12.0	26.7
OR409-5	IR30/Suphala	20.0	9.3
OR4 10-7	IR28/Suphala//OR78-19	10.7	16.0
OR495-7	Annapurna/IET1444	37.3	24.0
OR556-37	Parijat/Annapurna	8.0	37.3
ORS26-2016-10-1	Obs 677/IR207l//RPb-13/W1263	10.7	5.3
Annapurna	Ptb 10/TN1	5.3	18.7
Daya	Kumar/CR57-49	6.7	17.3
IR36	IR8/Tadukan//TKM 6/TN1/// IR24/ *O. nivara*	5.3	16.0
Keshari	Kumar/Jagannath	16.0	36.0
Pusa 2-21	IR8/TKM6	13.3	13.3
Sarathi	OR10-135/W1263	8.0	29.3
Nayagarh-Kanhei	Local check	5.3	12.0
Sri Rama-Kashipur	Local check	8.0	9.3
	Medium-late duration (126-140 d)		
OR42-10	BAM-6/IR8	6.7	18.7
OR290-4-4	Jagannath/Dular	12.0	22.7
OR297-10-1	Rajeswari/T14l//IET1444	12.0	26.7
OR310-2-2	Hema/CR57//RPb-l3/Sakti///ORS952	8.0	21.3
OR297-10-2	Rajeswari/T141//IETl444	12.0	14.7
OR364-B-3	IR7137 (73-1095/IR2070-747-6)	16.0	14.7
OR364-SP-19	IR7137 (73-1095/IR2070-747-6)	2.7	16.0
OR367-SP-42	IR7687 (Mahsuri/IR30)	10.7	17.3
OR369-IB-10	IR8422 (BG 34-8/IR2070-414-3-9-6)	5.3	24.0
OR370-B-4	IR8703 (IR32/Mahsuri)	22.7	16.0
OR371-SP-12	IR8918 (Obs 677/IR2070-423-2-57)	17.3	16.0
OR372-B-11	IR9093 (73-1196-12/IR30// IR2071-625-1)	9.3	20.0
OR372-B-20	IR9093 (73-1196-12/1R30// IR2071-625-1)	6.7	21.3
OR373-IB-4-1	IR9264 (Mahsuri/IR2061-213-2-16// IR2061-213-2-16)	8.0	12.0
OR380-B-12	IR11602 (Ratna/IR2071-625-1-252)	2.7	12.0
OR405-4	Dular (Dwarf)/T1145//Dular (Dwarf)	6.7	22.7
OR409-31	IR30/Suphala	9.3	10.7
ORS26-2008-4	Obs 677/IR2071//RPb-l3/W1263	16.0	16.0
ORS26-2014-4	Obs 677/IR2071//RPb-l3/W1263	10.7	28.0
Jajati	Rajeswari/T141	18.7	20.0
Pratap	KumarlCR57-49	9.3	24.0
Kaincha	Local check	8.0	8.0
Sarubhojani	Local check	6.7	14.7
Suryakanti	Local check	4.0	13.3

Rice mite *Oligonychus oryzae* (Hirst) incidence on IR elite lines

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Thirteen IR elite lines and 6 rice varieties were transplanted in 3 rows of 2 m each in the screenhouse. A severe incidence of rice mite 50 d after planting caused leaf yellowing. Mite populations were recorded in 1-cm^2 area/leaf on 10 leaves taken at random from 10 hills/elite line.

IR35546-52-3-3-2 had fewer mites, followed by IR29723-143-3-2-1, IR5, IR25587-133-3-2-2-2, IR50, and IR64 (see table). Mite populations were high on ADT36 and TN1. ☐

Rice mite *O. oryzae* populations on IR elite lines at Coimbatore, India.

Variety or breeding line	Mites[a] (no.)/10 cm^2
IR35546-52-3-3-2	17.5 a
IR29723-143-3-2-1	32.0 b
IR5	33.0 b
IR25587-133-3-2-2-2	38.0 bc
IR50	38.5 bcd
IR64	38.5 bcd
IR25588-7-3-1	44.5 cde
IR29723-88-2-3-3	45.0 cde
IR32808-54-3-1-39	47.0 cdef
IR28222-9-2-2-2-2	48.0 defg
IR29692-65-2-3-3	49.5 efgh
IR32429-47-3-2-2	52.0 efgh
IR31802-48-2-2-2	52.5 efgh
IR331868-64-2-3-3-3	53.0 efgh
IR62	56.0 fgh
IR29725-109-1-2-1	56.0 fgh
IR28150-84-3-3-2	57.0 gh
TN1	59.0 h
ADT36	67.0 i

[a]Mean of 2 replications. Means followed by a common letter are not significantly different at 0.05% level by DMRT.

Wild rice resistance to brown planthopper (BPH)

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We screened 30 wild rice accessions originating in South and Southeast Asia and South America and received from IRRI for resistance to BPH in the greenhouse, using the standard seedbox screening technique. Ptb 33 and TN1 were used as resistant and susceptible checks.

To break dormancy, seeds were kept at 50°C for 5 d. The lemma and palea were removed by hand and 20 seeds/ accession were sown in 15-cm-long rows in wooden seedboxes.

At 7 d after sowing, the seedlings were thinned to 15/row, infested with 8 to 10 first-instar nymphs/seedling, and covered with mylar film cages. Damage rating was done when 95% of the susceptible check plants were killed.

All 30 wild rice accessions were resistant (see table). Wild rices *O. latifolia, O. officinalis,* and *O. punctata* also were found to be resistant to BPH biotypes 1, 2, and 3 at IRRI. □

BPH resistance in wild rices. Coimbatore, India, Greenhouse, 1986.

Species	IRRI acc. no.[a]	Origin
O. latifolia	100165	Guatemala
O. latifolia	100167	Costa Rica
O. latifolia	100168	Costa Rica
O. latifolia	100169	Costa Rica
O. latifolia	100171	Guatemala
O. latifolia	100172	Guatemala
O. latifolia	100895	USA
O. latifolia	100914	Mexico
O. latijolia	100956	India
O. latifolia	100959	Mexico
O. latifolia	100962	Guatemala
O. latifolia	100963	Guatemala
O. latifolia	100964	Guatemala
O. latifolia	100965	Costa Rica
O. latifolia	100966	Panama
O. latifolia	101392	Guatemala
O. officinalis	100179	Japan
O. officinalis	100878	Thailand
O. officinalis	100896	Thailand
O. offcinalis	100948	India
O. officinalis	101074	Philippines
O. officinalis	101121	Philippines
O. officinalis	101135	Philippines
O. officinalis	101155	Malaysia
O. officinalis	101166	Philippines
O. australiensis	101144	Australia
O. australiensis	101397	USA
O. punctata	101409	Ghana
O. longistaminata	101200	Nigeria
O. alta	101395	USA
Ptb 33 (resistant check)		India
TN1 (susceptible check)		China

[a] All except the susceptible check had a damage rating of 1 by the *Standard evaluation system for rice* scale of 0-9.

Genetic Evaluation and Utilization
ADVERSE SOILS TOLERANCE

Varieties tolerant of coastal acid saline soils

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Salt-tolerant rice varieties do not perform satisfactorily when salinity is associated with soil acidity. We screened 108 varieties suitable for coastal acid saline soils (pH 3.2, ECe 2.6-4.5 dS/m) at Nirdeshkhali.

RD15 from Thailand gave the highest grain yield (see table). Local variety SR26-B, IR44, IR8067-41-1E-P1, BW100 from Sri Lanka, B2149b-Pn-26-1-1 from Indonesia, and ITA230 from Nigeria appear highly promising. □

Rice varieties' tolerance for coastal acid saline soils at Nirdeshkhali, India.

Variety	Origin	Yield[a] (t/ha)
BG35-2	Sri Lanka	1.9
BWl00	Sri Lanka	2.3
B2149b-Pn-26-1-1	Indonesia	2.3
B58b-Mr-105-2	Indonesia	1.5
IR28222-9-2-2-2-2	IRRI	1.6
IR44	IRRI	2.5
ITA230	Nigeria	2.0
Mahsuri	Malaysia	1.8
SR26-B (local check)	India	2.5
IR8067-41-IE-PI	IRRI	2.2
RD15	Thailand	3.1
1R26 (check)	IRRI	0.5
CD (5%)		0.7

[a] Mean of 3 replications.

Effect of saline irrigation water on yield

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We studied the effect of saline irrigation water on grain yield of 27 rice varieties in a randomized block design with 3 replications in 1984 kharif. Soil was clayey with pH 8.4 and EC (1:1) 1.5 dS/m. Seedlings were transplanted at 40 d. Treatments were 1 dS/m, 4 dS/m, and 6 dS/m irrigation water. Each plot received 80 kg N/ha as urea, 18 kg P/ ha as single superphosphate, and 25 kg K/ha as muriate of potash, and was irrigated to 6 cm 19 times. Rainfall was 502 mm.

At salinity level of 4 dS/ m, only BPT11563 showed a 50% yield reduction (see table). At 6 dS/ m, CSR6, CSRS, RP4-14, and CSR2 had yield reductions ranging from 31.6 to 39.1%; BPT3402, MTU8089, CSR 1, Phalguna, MTU2400, WGL44752, BPT3301, BPTl1503, and MTU2077 had moderate yield reductions ranging from 40.3 to 49.6%; other varieties showed more than 50% yield reduction. □

Effect of saline irrigation water on yield at Bapatla, India.

Variety	Yield (t/ha)			Reduction (%)
	1 dS/m	4 dS/m	6 dS/m	at 6 dS/m
Phalguna	5.9	4.9	3.4	43.5
RP4-14	3.5	2.5	2.1	38.9
MTU2077	6.2	4.9	3.1	49.6
MTU2400	4.2	3.2	2.3	45.0
MTU6637	3.1	2.1	1.4	53.3
MTU8089	5.4	3.9	3.2	41.2
BPT3291	3.6	2.5	1.7	52.7
BPT3301	4.3	2.9	2.2	48.6
BPT3402	5.6	4.4	3.4	40.3
BPT5899	5.4	3.3	2.1	61.5
BPT8233	4.3	3.7	2.0	52.5
BPT8250	3.4	1.9	1.5	55.3
BPT8424	3.5	2.8	1.6	52.9
BPT9921	4.7	3.5	2.3	52.1
BPT9938	3.4	2.1	1.6	51.6
BPT9942	5.4	3.4	2.6	52.2
BPT11503	4.9	3.3	2.5	49.2
BPT11563	4.5	2.2	1.8	59.4
BPT11660	5.0	4.1	2.4	52.9
CSRl	3.3	2.2	2.0	41.2
CSR2	3.6	2.5	2.2	39.1
CSR5	3.3	2.5	2.1	37.3
CSR6	5.1	4.4	3.5	31.6
WGL44644	3.0	2.1	1.4	55.1
WGL44752	3.4	2.8	1.9	45.1
WGL44753	3.7	2.7	1.7	54.3
WGL44759	3.7	2.3	1.6	56.3

CD for varieties = 0.21
CD for EC levels = 0.07
CD for EC levels × varieties = 0.36

Genetic Evaluation and Utilization
DEEP WATER

A promising rice culture for shallow waterlogged conditions

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We evaluated medium-duration rice cultures suitable for shallow waterlogged conditions (50 cm) in artificially inundated fields 1984-85 and 1985-86. Water depth was maintained at 50 cm from vegetative stage to maturity.

Of eight entries, 1ET5656 (Sona/RPW6-13) withstood submergence best (see table). IET5656 has 146 d duration and medium height (1 25 cm), and is nonlodging. Grain is medium bold with white rice.

Yields of rice cultures under waterlogging. Tamil Nadu, India, 1984-85 and 1985-86.

Culture	Mean grain yield (t/ha)	Duration (d)
IET5656	4.2	146
Co 42	3.8	147
CR 1009	3.6	155
Ponni	3.5	141
White Ponni	3.4	140
Pankaj	3.5	144
NLR9672	3.2	150
TNR1 (local check)	2.7	153

Genetic Evaluation and Utilization
DROUGHT TOLERANCE

Seedling tolerance for dehydrating wind

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We evaluated the reaction of 105 varieties to an unusual heavy, dehydrating wind during Jun-Oct 1986.

The 105 varieties from different sources were sown 2 rows each in

Rice varieties or cultures showing resistance to wind. Tamil Nadu, India.

Score	Varieties or cultures
1 10% of population with leaf tops dry	ASD1, ASD7, ASD8, ASD9, TPS1, IR28178-45-4, AS25839, CR1030, DPI831, NaagSamba, Arivikiruvai, Karuthavellai, Manjal Saradi, Thattaravellai, Vellarakkan, and TNAU80030
3 25% of population with leaf tops dry	Co 33, Co 41, IR64, TKM9, AD9246, AD85001, AS688, PL 29, ADT35, ASD5, ASD11, ASD15, IR44, IR46, IR52, IR54, IR62, Ponni, AS28883, CR1014, 1ET6711, IR2193-26-3-5-2, TM4506, TPl974, Kochisamba, Kattisamba, Panamarasamba, Samba, Tanjore Samba, Yanaisamba, Muntakka, KutrichaRasali, Saradi, Ponraiyan, Kallanthattaravellai, Thulanadan, Valsaraimundan, GEB24, Co 19, and PTBl5
5 40% of population with leaf tops dry	ASD16, ADT30, ADT31, ADT33, ADT36, IET1444, IET4786, IR36, IR58, IR60, Arupatham Kuruvai, AD7486, TM8089, IR20, IR34, 1R48, Paiyur-1, W. Ponni, Bhavani, AD9408, AS2887, AS24976, BR10, BS19, C22, CR1009, IET5233, IET7301, IET7590, Channavellai, Co 40, BCPl, BPT1235, and TNAU89994
7 50% of population with leaf tops dry	IR50, PY3, Thiriveni, Co 42, Co 43, Co 44, IR5, IR8, IR42, AD14185-1, AS781/1, AS6860/1, AS6860/2, AS23972 and AS24711

raised beds 40 m long × 75 cm wide. Each variety was raised in two rows made by pressing wood. The wet nursery was irrigated with well water.

The Tirunelveli District had a severe drought due to failure of the southwest monsoon. The dry spell was associated with a heavy wind, blowing at times for more than a week. The seedlings started drying from the tip downward. Initially the margin dried up; gradually 1/3 to 2/3 of the surface of the upper portion of the lamina turned yellow and dried up.

The seedlings were scored on percentage of plants with dried leaves (see table).

Irrespective of plant stature, 16 varieties had 10% drying. Among the remaining, 40 had 25%,34 had 40%, 15 had 50%.

Most of the local varieties had less than 25% drying. □

Genetic Evaluation and Utilization

HYBRID RICE

Hybrid rice research in Bihar, India

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We studied the characteristics of cytoplasmic-genetic male sterile (CMS) lines V20A, Z97A, V41A, and P203A, their maintainer (B) lines, and restorer (R) lines IR50 and IR54. The maintainer lines were 2-5 cm taller than the CMS lines, which is conducive to setting more crossed seed. Effective tiller numbers were recorded in V20A (20), Z97A (18), V41A (20), and P203A (16). In maintainer lines, tiller numbers were 17 in V20B, 13 in Z97B, 14 in V41B, and 13 in P203B.

CMS lines had better and longer tillering than maintainer and restorer lines, but poorer panicle exsertion and more delayed flowering. Flowering in CMS lines (10-15 d) continued longer than in B and R lines (7-10 d). In CMS lines, stigma exsertion varied from 25 to 55%; in B and R lines, it ranged from 11 to 44%. There was no obvious flowering peak in CMS lines, but B and R lines had obvious peaks. Duration of floret opening to closing was longer in CMS lines than in B and R lines.

UPRB8 and UPRB31 were analyzed as alternate sources of sterile cytoplasm. One CMS line has an alternate source of cytoplasm developed from UPRB31/IR46.

In 74 crosses made using elite cultivars with 3 CMS lines (WA type), 23 restorers, 22 partial restorers, and 16 maintainers were identified (see table).

Heterosis, heterobeltiosis, and standard heterosis for 7 agronomic traits were measured in 20 hybrids. Heterobeltiosis and standard heterosis were positive for early vegetative vigor, tillers/plant, panicle length, spikelets/panicle, and test weight, but were negative for days to heading and plant height.

V20A/ IR50, V20A/ IR36, V20A/ IR28, Z97A/ IR50, Z97A/ IR36, Z97A/ IR28, Z97A/ IR2307-247-2-2-3, and Z97A/IR13420-6-7-3-1 were tested in dry season field trials and V20A/IET5656, Z97A/IET5656, V20A/IR50, and V20A/IR54 were tested in wet season trials. All 12 hybrids showed positive and significant heterosis, heterobeltiosis, and standard heterosis for yield. Heterosis ranged from 44.5 to 81.3% over the midparent, 8.4 to 45.0% over the better parent, and 24.0 to 72.5% over the standard check. Maximum heterosis (81.3% over the midparent) was in Z97A/IR2307-247-2-2-3. Highest heterobeltiosis was in V20A/IR50 (41.9%) and highest standard heterosis in Z97A/IET5656 (72.5%). Most of the hybrids had more than 20% heterosis over the better parent and best commercial varieties.

No apparent improvement in grain quality characters was found in restorers, partial restorers, and maintainers.

Best isolation distance for seed production of hybrid and CMS lines was 40 m. Maximum increase in percentage seed set was with 30 ppm gibberellic acid. Clipping leaves above the panicles of CMS lines increased seed set. The best planting combination was 1 row of restorer line at 10- × 10-cm spacing and 6 rows of CMS (A) line at 20- × 15-cm spacing. The best combination for CMS seed production was 4 rows of A line at 10- × 10-cm spacing and 2 rows of B line at 15- × 10-cm spacing. □

Restorers and maintainers identified in 74 crosses of elite cultivars. Bihar, India.

Good restorers	
BIET360	FR43B
IET3279	IET7278
IET5656	PR103
IR46	UPR238-42-2-31
Archana	RAU4090-1
IR50	IR17494-32-1-1-3-2
IR54	Sein Ta-Lay
IET7256	BIET569
IR36	BIET944
Kiran	Br 8
MRC603-303	Pankaj
Partial restorers	
Panidhan 1	IET6063
UPR82	IET2881
Jaya	IET6985
T136	IR1967-263-3-2-2-1
IET6148	IET6988
IET3273	IET3116
IET7280	IET4141
ET5995	Janki
BIET45 C	IET5741
Rasi	Br 46
CR44-35	Multani
Maintainers	
MW10	IET3626
Bhavani	Ratna
IR34	UPR73-23
IET6711	Mahsuri
BG90-2	P203B
IET3257	BR52-87-1
Cauvery	BIET724
IET7616	
IET4099	

Minimum isolation distance for hybrid rice production

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In studies to determine the minimum isolation distance for maintaining male sterile lines and for producing genetically pure hybrid rice seed, Zhen Shan 97A, a cytoplasmic-genic male sterile (CMS) line, was used as the female parent and Zhen Shan 97B as the pollinator. Zhen Shan 97B seedlings were transplanted at 40 d after seeding (DAS) on 19 and 26 Jul 1986 in a 5- × 5-m block. Zhen Shan 97A was transplanted in 50-m-long single rows in directions related to normal prevailing winds during anthesis. Plant-to-plant distance was 50 cm. Seed set was recorded by distance from pollinator. Percentage seed set was computed as the ratio of seeds/plant to florets/plant.

Seed set on CMS plants near the pollinator was high, but dropped drastically as distance from pollinator increased. No seed set occurred beyond 22 m in any direction (see table). The maximum coverage occurred when average wind velocity was 4 km/h, mean temperature was 27.5 °C, and relative humidity was 74% during Sep 1986.

These results suggest that rice pollen can disperse up to about 22 m under those particular weather conditions. However, because pollen dispersal depends upon such factors as pollination vigor, wind direction, wind velocity, relative humidity, temperature, and hours of sunshine, confirmation over years and locations is needed to establish isolation distances for maintaining male sterile lines and for producing hybrid seed. □

Seed set on cytoplamic male sterile rice plants. Ludhiana, India.

Distance (m) from pollinator	Percent seed set of plants at given direction from pollinator						
1	1.73	2.07	2.28	2.01	1.90	2.81	1.80
5	0.79	0.57	0.63	0.68	0.51	0.89	0.35
10	0.31	0.00	0.38	0.35	0.42	0.34	0.00
14	0.10	0.18	0.19	0.00	0.39	0.00	0.11
15	0.13	0.00	0.16	0.00	0.18	0.14	–
16	0.11	0.12	0.00	0.31	0.35	0.18	–
17	–	–	0.11	0.16	0.29	0.12	–
18	–	–	0.14	0.15	0.34	–	–
19	–	–	0.00	–	0.00	–	–
20	–	–	0.00	–	0.18	–	–
21	–	–	0.00	–	0.11	–	–
22	–	–	0.12	–	–	–	–
50	–	–	–	–	–	–	–

Genetic Evaluation and Utilization
TISSUE CULTURE

Tissue culture propagation of cytosterile stocks

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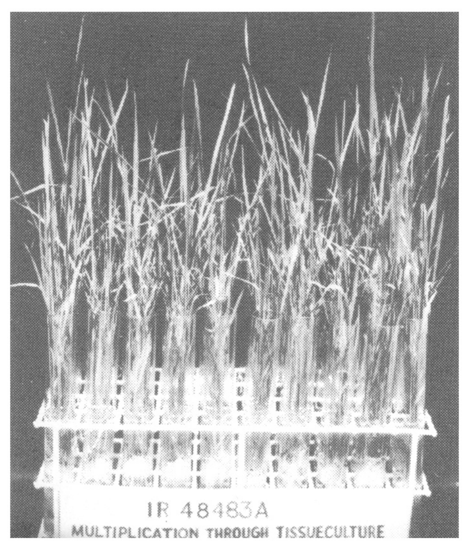
Somatic embryogenesis through formation of myriad supernumerary and adventitious embryoids in callus cultures is an attractive approach for mass propagation of the cytosterile stocks used in hybrid rice production. Cytosterile stocks (A lines) are maintained by pollination with fertile isonuclear maintainers (B lines).

For large-scale multiplication, A and B lines normally are grown in alternating rows in isolation. We have successfully used tissue culture techniques to mass-produce four cytosterile lines possessing WA cytoplasm: V20A, Madhu A, IR48483A, and IR46830A.

Callus was initiated from dehusked sterilized seeds by culturing on N_6 medium supplemented with 2 mg 2,4-dichlorophenoxy acetic acid (2,4-D) per liter. Each seed embryo yielded a 400-500 mg callus mass within 3-4 wk.

The 4-wk-old embryo-derived calluses were transferred to MS regeneration medium containing auxin (naphthalene acetic acid [NAA], 0.75 mg/ liter), cytokinins (kinetin, 0.25 mg/ liter), and benzyladenine (BA) (0.75 mg/liter) in the proportion 3:1:3. Very high frequency plantlet regeneration was obtained within 3 wk; 200-250 plantlets could be regenerated from the callus derived from a single seed (see figure).



Plantlets obtained from somatic callus cultured from a single seed.

With another passage in culture, the callus derived from a single seed can give rise to a tenfold increase in mass, and 2,000-3,000 regenerated plantlets can be expected from a single seed.

We also cultured another source of explant — young immature panicles (inflorescence) of the cytosterile stocks — on MS, N_6, and H_e media supplemented with various growth regulators. Callus could be induced after 2 wk of culture from the surface of the spikelets, but the callus appeared to be mostly nonembryogenic.

For practical application of micropropagation techniques to mass production of special breeding stocks, such as cytosteriles and the elite hybrids, three factors should be considered: the time required for *in vitro* multiplication, the purity of the genotype in cultured and regenerated plants, and the capacity of regenerants to withstand the transfer from tube to soil. In our experience, within 8-9 wk the multiplication rate of stock as plantlets is 1:200. Rooting for better anchoring capacity and hardening the regenerated plants for transfer from tube to soil may need another 2 wk. Seedlings of transplantable size can be obtained in 11-12 wk.

We examined the regenerated plants for variants induced in callus culture (somaclonal variation). The regenerants did not exhibit any variation in sterility or other morphological traits. However, our observations were limited to cultured plants obtained directly from embryo calluses without subculturing.

Callus proliferation through several passages of subculture, the level of 2,4-D in the induction medium, and the concentration of BA in the regeneration medium may induce variation in callus cultures. The purity of the genotype maintained in tissue culture multiplication efforts needs critical examination. □

Phenotypic patterns in somaclones from plants regenerated from somatic cell culture of IR lines

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Families of plants regenerated from somatic cell culture of IR36, IR50, IR52, and IR54 were evaluated in the second generation (Sc_2). Four groups were classified by phenotypic patterns and somaclone relationships to donor parents (Table 1): 1) no segregation within the family, similar to parent type (SPT) (82.9%); 2) no segregation (uniform) within the family but dissimilar to parent type (DPT) (1.7%); 3) limited segregation involving one or two characters (simple segregation); and 4) more than two characters segregating simultaneously.

We found no significant differences in character between the SPTs and donor variety, but DPTs and the donor variety significantly differed in days from sowing to flowering, plant type, shape and color of leaves, length of flag leaf, plant height, effective tillers, length of panicles, seed numbers/panicle, and seed shape (Table 2). However, each DPT population was still uniform within the family. The coefficient of variation of all characters was less in the DPTs than in the donor variety, showing that the DPTs were homozygous. □

Table 1. Phenotypic patterns of the Sc_2 generation in somaclones of indica rice. [a] **Guangzhou, China.**

Sc_2 lines derived from	Sc_2 (no.) in given phenotypic pattern: No segregation		With segregation		Total (no.)
	Similar to donor parent	Dissimilar to donor parent	Simple segregation	Complex segregation	
IR36	99 (77.9)	5 (3.9)	7 (5.5)	16 (12.6)	127
IR50	2 (50.0)	0	1 (25)	1 (25)	4
IR52	2 (25.0)	0	0	6 (75.0)	8
IR54 [b]	136 (90.6)	0	11 (7.4)	3 (2.0)	150
Total	239 (82.9)	5 (4.7)	19 (6.3)	26 (9.1)	289

[a] Values in parentheses are percentages. [b] Maturity of IR54 too late to evaluate characters, classified according to days from seeding to flowering.

Table 2. Agronomic characteristics of nonsegregating somaclones and donor variety. [a] **Guangzhou, China.**

Variety and somaclones [b]		Seeding to harvest (d)	Blade color [c]	Plant height (cm)	Panicle length (cm)	Effective panicles (no.)	Seeds/panicle (no.)	Seed setting (%)
IR36		118	L	71.1 ± 3.7	19.5 ± 2.4	18.0 ± 4.2	98.7 ± 22.1	81.6 ± 10.3
SPT	S1	118	L	68.4 ± 2.0	20.5 ± 2.1	14.1 ± 2.0*	128.1 ± 21.4**	80.3 ± 8.8
	S2	115	L	71.4 ± 3.2	20.9 ± 2.4*	15.1 ± 3.0*	116.8 ± 12.5**	82.4 ± 5.7
	S3	115	L	72.6 ± 4.2	19.6 ± 1.1	10.1 ± 2.7**	96.5 ± 15.8	79.9 ± 14.5
	S4	118	L	70.8 ± 4.6	22.6 ± 2.3*	15.7 ± 3.5	87.6 ± 4.8*	71.9 ± 8.8**
DPT	D1	96	D	59.4 ± 3.7**	20.4 ± 1.1	15.6 ± 3.2	78.5 ± 6.3***	86.4 ± 6.3*
	D2	96	D	52.8 ± 2.9**	16.1 ± 1.4**	15.1 ± 3.0*	68.8 ± 8.1**	78.8 ± 8.9
	D3	96	D	61.9 ± 3.7**	18.7 ± 2.5	11.0 ± 2.9**	76.9 ± 5.7**	83.1 ± 8.0
	D4	99	D	58.8 ± 3.1**	16.9 ± 1.7**	14.2 ± 2.9*	55.9 ± 6.4**	74.3 ± 10.8*
	D5	98	D	59.9 ± 2.0**	17.8 ± 1.4**	10.6 ± 3.7**	66.8 ± 5.5**	83.8 ± 7.9

[a] *Significantly different from the donor parent variety at 0.05 level. **Significantly different from the donor parent variety at 0.01 level. [b] SPT = similar to donor parent variety, DPT = dissimilar to donor parent variety. [c] L = light color, D = dark color.

Regeneration of anther-derived callus

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We tested four differentiation media for numbers of regenerates with green and multiple shoots from anther-derived callus. Nine indica varieties and five F_2 crosses of deep water rice were used.

Single calli cultured from each variety were inoculated with three to five replications of the differentiation media. Gamborg's basic medium with 4% sucrose and different kinds and concentrations of growth regulators was used to regenerate anther-derived callus.

D2 and D3 were best for green plant regeneration (Table 1). However, D3 with adenine sulfate (AD) in addition to other growth regulators produced more multiple shoots. Adding naphthalene acetic acid (NAA) or benzylamino purine (BA) increased the number of green shoots. Degeneration of callus or dead tissue formation occurred in all media tested.

D3 was further tested with callus cultured from five F_2 crosses of deep water rice. Although it gave rise to albino shoots, the production of multiple shoots per callus was confirmed (Table 2). Single plants from the multiple shoots were grown into individual plants. The results indicate a varietal difference in regeneration ability and green shoot production. No single medium seems to be best for a wide range of genotypes. ☐

Table 2. Regeneration from anther-derived callus of 5 F_2 crosses of deep water rice in a specific medium.[a] Gazipur, Bangladesh.

Variety	D3					
	g	a	r	mg	ma	d
IR43141 (BR525-2-1/ IR19672-155-2-11-3)	–	–	1	6	–	–
IR43126 (BR314-B-4-6/ DWCT 156-1-B-B)	1	–	1	3	–	–
IR43131 (BR311-B-5-4/ IR13429-299-2-1-3)	1	4	–	1	4	–
IR43615 (IR10110-23-1// BR222-B-249/RD19)	–	–	–	–	–	1
	–	–	–	–	–	1
IR43841 (BR223-B-55-H2-B-RD19/BR576-331-1// IR11288-B-B-118-1)	–	–	–	–	–	1
Total	2	4	2	10	4	2

[a] D3 = Gamborg's (B5) + 4% sucrose + 0.5 BA + 5.0 AD + 1.0 K + 0.5 IAA. g = single green shoot, a = single albino shoot, r = root, mg = multiple green shoots callus, ma = multiple albino shoot, d = dead tissue, – = slight or no callus growth.

Table 1. Regeneration from anther-derived callus in 4 regeneration media.[a] Gazipur, Bangladesh.

Variety	D0						D1						D2						D3					
	g	a	r	mg	ma	d	g	a	r	mg	ma	d	g	a	r	mg	ma	d	g	a	r	mg	ma	d
BR9-HR7	–	–	1	–	–	1	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	1
CNM-20	–	–	–	–	–	1	–	1	1	–	3	2	–	–	–	–	–	1	–	–	–	–	–	1
BR601-3-3-4-2-2	–	–	1	–	–	5	–	2	1	–	4	3	–	–	1	–	–	3	–	–	1	–	–	4
IR29692-65-2-3	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
BR562-23-1	–	–	1	–	–	1	–	1	1	–	4	2	–	–	–	–	–	1	–	–	1	–	–	1
IR13240-108-2-2-3	–	–	–	–	–	1	–	–	–	–	–	1	–	1	–	–	–	1	1	1	–	1	20	–
Delta	–	–	2	–	–	2	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
Cul 25315	–	–	–	–	–	1	–	–	–	–	–	1	3	2	1	3	2	–	1	–	1	4	–	–
Calrose	1	–	2	1	1	1	–1	p	2	–	11	1	–	1p	2	–	–	2	–	–	–	–	–	2
Total	1	0	7	1	1	14	0	5	6	–	22	13	3	4	4	3	2	9	2	1	3	5	20	10

[a] D0 = Gamborg's (BS) + 4% sucrose, D1 = Gamborg's (B5) + 4% sucrose + 0.5 K + 1.0 IAA, D2 = Gamborg's (B5) + 4% sucrose + 0.25 NAA + 1.0 K + 0.25 IAA, and D3 = Gamborg's (B5) + 4% sucrose + 0.5 BAP + 5.0 AD + 1.0 K + 0.5 IAA. g = single green shoot, a = single albino shoot, p = purple) shoot, r = root, mg = multiple green shoot, ma = multiple albino shoot, d = dead tissue, – = only slight growth or no growth of callus.

Multiple reciprocal translocation from somatic cell culture in IR54

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We found a multiple chromosome reciprocal translocation (MRT), involving five nonhomologous chromosomes, from somatic cell culture of IR54. Young panicles were cultured in MS medium (sucrose 6%) with 1 mg 2,4-D and 1 mg kinetin/liter. The callus was subcultured for one passage and transferred to MS medium (sucrose 3%) with 2 mg NAA and 2 mg kinetin/liter for regeneration.

One MRT plant was found in the regenerated plants. It was shorter than IR54 and its anther did not split during flowering. The pollen grains were almost empty and not stained by I-KI. No seeds were set under selfing; some seeds were set under crossing.

Chromosome behavior in meiosis of pollen mother cells (PMC) was abnormal. Bivalents at diakinesis numbered 6 to 12. Only 5.7% of the cells had 12II at diakinesis. Various multivalent configurations were observed at diakinesis, such as tetravalents (10II + 1IV or 8II + 21V or 6II + 31V), hexavalents (9II + 1VI or 7II + 1IV + 1VI or 6II + 2VI), octavalents (8II + 1VIII or 6II + 1IV + 1VIII), and tenvalents (7II + 1X) (see table). The tenvalents were present either as a ring or as a chain (see

Chromosome conjugation at diakinesis. Guangzhou, China.

Chromosome conjugation	1211	10II + 1IV	9II + 1VI	8II + 1VIII	8II + 2IV	7II + 1IV + 1VI	7II[a] + 1X	6II + 3IV	6II + 1IV + 1VIII	6II + 2VI	Total
Frequency	25	15	29	36	27	61	223	10	9	5	438
%	5.70	2.96	6.62	8.21	6.16	13.9	50.91	2.28	2.05	1.14	

[a] Ring-shaped tenvalent (711 + S) = 107,48%. Chain-shaped tenvalent (7II + 1 10) = 116, 52%.

figure). The maximum number of chromosomes in the ring-shaped configuration was tenvalent.

Ring-shaped chromosome configurations at diakinesis and sterile pollen grains and seeds are the major characters of reciprocal translocation heterozygotes. The tenvalent ring showed that the reciprocal translocations involved 5 nonhomologous chromosome pairs. □

7II + 1 (10) (top) at diakinesis and 5II + 1IV + 1X (bottom) at metaphase I. Guangzhou, China.

Pest Control and Management

DISEASES

Influence of *Trichoconiella padwickii* on seed germination and seedling growth in rice

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Trichoconiella padwickii is a common rice seed fungus, particularly when harvesting is at high atmospheric humidity. The effect of the fungus on seed germination and shoot length, and the symptoms produced were studied using the soil inoculation technique. A 1% inoculum was incorporated in the first 10 cm of soil. Sterilized seeds of Cauvery, Benibhog, Jaya, IR20, and Mahsuri were planted.

All five varieties showed significant reductions in seed germination and shoot length (see table). The maximum reduction in seed germination and shoot length was in Mahsuri. □

Influence of *T. padwickii* on seed germination and shoot length. Bihar, India.

Variety	Seed germination (%)			Shoot length		
	Control	*T. padwickii* inoculated	Reduction	Control (m)	*T. padwickii* inoculated (cm)	Reduction (%)
Mahsuri	80	46	57.5	5.6	3.9	69.6
Cauvery	81	46	56.8	4.9	3.3	67.3
Jaya	84	44	52.4	5.7	3.4	59.6
IR20	79	41	51.9	5.4	3.1	57.4
Benibhog	78	42	53.8	5.2	2.8	53.8
CD 5%		1.4			0.3	
CV (%)		2.3			1.9	

Across-season survival of *Xanthomonas campestris* pv. *oryzicola,* causal agent of bacterial leaf streak (BLS)

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BLS is caused by *Xanthomonas campestris* pv. *oryzicola.* We studied its survival cycle in India.

During the Jun-Nov season, Assam Rice Collection entries at AICRIP farm were severely affected by BLS. Seeds of 12 severely affected cultivars were harvested, sun-dried, and stored at room temperature. Part of this seed was sown in the following Dec-Apr season and observed for disease development. None of the 12 cultivars showed BLS symptoms. In the following Jun-Nov season, part of the old BLS-infected seed and freshly harvested BLS-free seed were planted in isolated fields to avoid external contamination.

BLS appeared in the infested seed only, not in the newly harvested disease-free Dec-Apr season seed. This confirms seed transmission of BLS from one summer season to the next.

It also indicates the inability of the disease to be established during the cool dry weather winter season. The disease cycle is broken if summer seed is sown in the winter season, but not if it is kept for the following summer season. □

Status of false smut (FS) of rice in eastern Uttar Pradesh, India

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FS caused by *Claviceps oryzae-sativa* Hashioka [*Ustilaginoidea virens* (Cke) Tak.] has become a very important disease of wet season rice in eastern Uttar Pradesh. We have studied FS incidence and factors related to its incidence since 1975.

Considerable variability in FS severity has been noted in different varieties from year to year and from locality to locality in the same season. Varieties flowering early generally escape infection. Meteorological factors relationships to FS incidence indicate that relatively lower temperatures (around 20°C) and high humidity (above 90%), coupled with well-distributed moderate rainfall during flowering, favored the disease. Late sowing usually resulted in higher FS infection. The disease was more severe at higher fertility levels (100-50-50 kg NPK/ha) than at lower fertility levels (50-25-25 kg NPK/ha).

The percentage of smutted grains/panicle varied considerably in different varieties, but there was little variation in the size of smut balls. There appears to be a direct correlation between percentage of infected tillers and percentage of smutted grains/panicle. FS infection reduces grains/panicle and 1,000-grain weight, compounding yield reductions. It increases the number of partially filled and unfilled grains, leading to high chaffiness. The seeds near smutted grains have lower germination than seeds from healthy panicles.

Eastern Uttar Pradesh had a FS epidemic 1984-85 to 1985-86. FS incidence ranged from 10 to 30% in affected rice plots. Cultivars showing high disease intensity were TN1, IR8, Jaya, IR24, Ratna, Prasad, Sona, Bala, Sarjoo 49, Sarjoo 52, Mahsoori, Sita, Saket 4, Narendra 1, Narendra 2, and Cauvery. In years of low FS incidence, these varieties were free of symptoms. Field evaluation for varietal resistance gave ambiguous results.

Newer cropping technology, including planting high N-responsive varieties, enhancing the moisture supply, and including late sown wheat in the crop rotation, aggravated the disease in farmers' fields. In years of severe incidence, FS losses equaled losses to bacterial blight and sheath rot. □

Antifungal effects of plant extracts on *Drechslera oryzae* in rice

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We screened 31 plant extracts belonging to 22 families for their antifungal effects on *Drechslera oryzae,* using the paper disk method (inhibition zone technique).

A 25-g sample of each plant material was washed, chopped, ground with a mortar and pestle in 50 ml of distilled water, and filtered through cotton wool. The filtrate was autoclaved for 20 min at 15 lb pressure. Sterile filter paper disks (10 mm) were soaked in the sterile plant extract, control disks were soaked in sterile water. *D. oryzae* spore suspension (10^6 spores/ml) was mixed with warm potato dextrose agar and poured into sterile plates. Two treated disks were placed in each plate and maintained at laboratory temperature (28 ± 1°C). Each treatment was replicated three times. Radius of inhibition zone was recorded at 48 h (see table).

The maximum *D. oryzae* inhibition zone was observed with leaf extract of *Mentha piperita,* followed by *Piper nigrum* seed extract and *Allium sativum* extract. □

Effects of some plant extracts on *Drechslera oryzae* in rice. Tamil Nadu, India.

Plant extract	Radius of inhibition zone	
	mm	Transformed value
Mentha piperita	22.33	4.77
Piper nigrum	22.00	4.74
Allium sativum	21.00	4.63
Eupatorium cannabinum	20.66	4.59
Acorus calamus	20.66	4.59
Azadirachta indica bark	18.66	4.37
Tecoma stans	18.33	4.33
Zingiber officinale	15.66	3.97
Piper betle	15.33	3.97
Canna indica	13.66	3.76
Catharanthus roseus	12.33	3.58
Azadirachta indica leaf	9.66	3.18
Eucalyptus citrodora	9.00	3.07
Allium cepa	8.66	3.02
Azadirachta indica seed	7.66	2.85
Casuarina equisetifolia	5.33	2.40
Pennisetum purpureum	3.33	1.95
Leucaena leucocephala	1.33	1.34
Polyalthia longifolia	1.00	1.22
Datura metel	0.66	1.05
Ruellia tuberosa	0.33	0.87
Brassica juncea	0.00	0.70
Tribulus terrestris	0.00	0.70
Musa paradisiaca	0.00	0.70
Amorphophallus campanulatus	0.00	0.70
Bougainvillea glabra	0.00	0.70
Carica papaya	0.00	0.70
Cosmos bipinnatus	0.00	0.70
Passiflora edulis	0.00	0.70
Pseuderanthemum atropurpureum	0.00	0.70
Parthenium hysterophorus	0.00	0.70
Control	0.00	0.70
Mean		0.08
CD (P = 0.01)		0.23

Loss in rice seed weight due to *Trichoconiella padwickii*

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T. padwickii infects rice seeds at maturity, causing pink or purple to light brown discoloration on the glumes. Infected seed samples of varieties Cauvery and Mahsuri were graded on severity of discoloration:

0 — apparently healthy, free from specks and discoloration
1 — 1-2 minute pinhead-like pink specks on the surface of the seed coat
3 — 2-5 specks approximately 0.5-1.0 mm size

5 — several spots or blotches 2-3 mm size covering 11-25% of the seed

7 — spots or blotches 3-4 mm size covering 25-50% of the seed, with a few chaffy seeds

9 — pink spots or blotches 5.0-7.0 mm covering 50-75% or more of the seed, glumes tending to be more chaffy

Effect of *T. padwickii* infection on rice seed weight.

Grade	Cauvery Weight (g)	Cauvery Reduction (g)	Cauvery Loss (%)	Mahsuri Weight (g)	Mahsuri Reduction (g)	Mahsuri Loss (%)
0	27.80	Base	Base	29.50	Base	Base
1	26.30	1.50	5.4	27.95	1.55	5.2
3	25.65	2.15	7.7	27.35	2.15	7.3
5	24.44	3.36	12.1	25.86	3.64	12.4
7	22.50	5.30	19.1	21.21	8.29	28.1
9	19.58	6.22	22.4	18.87	10.63	36.0

Reduction and percentage loss in weight were calculated, taking the 1,000-grain weight of 0 scale seeds as the base. As the severity of infection increased, seed weight decreased (see table). Weight loss ranged from 5.03 to 36.02% and was more pronounced in Mahsuri. □

Phytoalexin inducer chemicals for control of blast (Bl) in West Bengal

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B1 incited by *Pyricularia oryzae* Cav., endemic in the northeastern hill states of India is particularly serious under upland conditions. Phytoalexin inducers, found to be effective in treating seed against brown spot, were examined for their effectiveness in B1 control.

We tested 20 chemicals in upland field trials in randomized block design, in 1984 and 1985 summer seasons using Pusa 2-21 and in 1984-85 winter season using Ratna. Rice grains soaked for 24 h in dilute (mostly 10^{-4} M) aqueous solution of test chemicals or water were direct seeded into 1- × 0.45-m plots or sown in seedbeds and transplanted into 1-m^2 plots and treated with 120 kg urea/ ha or 50 kg superphosphate/ ha. At Lembucherra, B1 symptoms were noticed at 47 d in 1984 and at 27 d in 1985. Assessment for computation of disease index on the basis of number of leaf lesions in a plant and relative size of leaf lesion was made at 8 d and 22 d after symptoms appeared, following the *Standard evaluation system for rice.*

Ten of the 20 chemicals tested in 2 trials at Lembucherra provided substantial protection, reducing symptoms by 72-89% in one or both trials (Table 1). Seven others reduced symptoms by 60-68%. Treated plants had fewer lesions; all 10 treatments in 1984 reduced mean lesion size by 60-73%.

At Pandua, symptoms appeared after 88 d. Assessment 10 d later recorded 85-89% control in 3 treatments and 60-71% control in another three (Table 2). Lesion expansion was inhibited; proportionately fewer lesions of large size and many more of small size could be seen.

Many of the phytoalexin inducer

Table 1. Effect of chemicals in wet seed treatment to control Bl infection. Lembucherra, Tripura, India.[a]

Chemical[b]	1984 8 d Mean disease index/plant	1984 22 d Disease score[c]	1984 22 d Mean lesion length[d] (cm)	1985 8 d Mean disease index/plant	1985 22 d Disease score[c]
Control (water)	14.6	8	1.12	22.4	9
Ferric chloride	3.4 (76.7)	4	0.36	4.8 (78.7)	2
Barium chloride	4.0 (72.6)	5	0.34	18.9 (15.4)	7
Cupric chloride				5.6 (75.0)	2
Cadmium chloride	4.0 (72.6)	4	0.38	9.0 (59.8)	3
Nickel nitrate	2.6 (81.4)	4	0.31	15.0 (32.8)	7
Lithium sulfate				8.7 (61.2)	3
Cysteine	1.8 (87.7)	3	0.28	8.7 (61.2)	3
Sodium selenite	1.6 (89.1)	4	0.29	14.0 (37.4)	5
Thioglycollic acid	5.8 (60.3)	5	0.29	13.1 (41.1)	5
Cycloheximide	1.6 (89.1)	3	0.32	6.2 (72.2)	2
P-chloromercuribenzoate	4.0 (72.6)	5	0.3		
Sodium malonate				5.7 (74.6)	2
Sodium iodoacetate				7.1 (68.1)	2
Sodium molybdate				7.6 (66.2)	2
Sodium fluoride				8.4 (62.3)	3
Sodium azide				9.5 (57.8)	3
DL - norvaline				7.7 (65.7)	3
DL - methionine				9.3 (58.5)	3
DL - phenylalanine				8.3 (62.8)	3
Indole acetic acid				10.1 (54.9)	5
LSD (P = 0.01)	0.8			2.2	

[a]Data are averages of observations from 30 plants. Values in parentheses indicate percentage reduction from control. [b]Chemicals used mostly at 10^{-4} M, except the amino acids at 10^{-2} M, lithium sulfate and cysteine at 10^{-3} M, sodium selenite at 10^{-5} M, and cycloheximide at 10^{-6} M. [c]By the *Standard Evaluation System for Rice* 0-9 scale. [d]Mean of all lesions on 20 leaves, 2 each (3d and 4th position) from 10 plants.

chemicals tested can provide seed protection from Bl over a fairly long period. That protection had little relationship to their direct fungitoxic effects. Although the protection varied from one experiment to another, cupric chloride, ferric chloride, cycloheximide, p-chloromercuri-benzoate, and sodium malonate provided good control under different cropping conditions and in different seasons. The compounds seem to act by activating a host defense in susceptible varieties that helps to restrict the number of infections and to limit lesion size, thus preventing the heavy inoculum buildup essential for severe Bl infection. □

Table 2. Effect of chemicals used for wet seed treatment on Bl symptoms. Pandua, West Bengal, India.[a]

Chemical[b]	Lesions/ tiller (no.)	Proportion of lesions of different size groups[c]				Mean disease index per tiller[d]
		L	M	S	VS	
Control (water)	30.8	57	10	10	23	20.5
Cupric chloride	4.8	36	17	15	32	2.2 (89.3)
Barium chloride	22.8	53	12	12	23	14.6 (28.8)
Mercuric chloride	17.5	53	19	8	20	11.5 (43.9)
Lithium sulfate	15.4	34	17	15	34	10.2 (50.3)
Cysteine	13.7	42	16	15	27	7.7 (62.4)
Thioglycollic acid	16.8	47	15	14	24	10.1 (50.7)
Sodium selenite	18.3	34	11	34	21	8.1 (60.5)
Sodium malonate	10.8	40	16	14	30	5.9 (71.1)
Cycloheximide	6.2	36	14	14	36	3.1 (84.9)
p-chloromercuribenzoate	5.3	32	13	10	45	2.8 (86.4)
LSD (P = 0.01)						7.7

[a] Data represent average of observations from 30 tillers (one each from 30 plants). [b]Chemicals were used at 10^{-4} M, except lithium sulfate and cysteine at 10^{-3} M, sodium selenite at 10^{-5} M, and cycloheximide at 10^{-6} M. [c]Lesion size: L = large, M = medium, S = small, VS = very small. [d]Values in parentheses indicate percentage reduction from control.

Effect of additional nitrogen on incidence of the kresek phase of bacterial blight (BB)

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BB severity increases with N level. But the effect of added N on initial BB stages is not known. We conducted a pot experiment to measure the effect of N on kresek.

Highly susceptible AC360 seedlings were transplanted at 25 d into porcelain pots filled with 6 kg dry field soil, and grown initially with 60 kg N/ha. At tillering, when tillers started showing kresek symptoms, half the pots were supplied additional N at 120 kg/ ha. Each treatment was replicated seven times.

At flowering, no significant difference in kresek incidence was found (see table). But at tillering, plants receiving additional N showed high vigor and produced more kresek-free tillers. □

Incidence of kresek in plants supplied additional nitrogen. CRRI, India.

Treatment	Total tillers (no.)	Kresek tillers (no.)	Panicle-bearing tillers (no.)
60 kg N/ha (initial)	13.3	3.7	5.7
120 kg N/ha (additional)	25.6	3.4	15.3
CD 5%	1.9	ns[a]	2.7
1%	2.7		3.8

[a]Not significant.

Blast (Bl) outbreak in northeastern Haryana, India

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B1 caused by *Pyricularia oryzae* is the most important disease of scented rices in northeastern Haryana. In 1986 kharif, Bl affected scented rices Pak, Basmati, T-3, and Basmati 370 grown on nearly 80,000 ha. Basmati occupying nearly 80% of the area was damaged most.

We surveyed 60 fields at the dough to maturity stage. Average neck Bl incidence was 20-40% in Ambala, 30-70% in Karnal, and 30-80s in Kurukshetra. Incidence was highest under water stress and in late transplanted fields. □

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Pest Control and Management

INSECTS

First recorded incidence of rice bugs in Manipur, India

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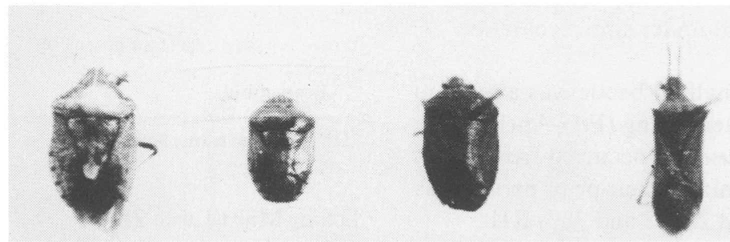
Surveys of insects in the major rice growing districts of Imphal, Thoubal, and Bishnupur covered 24 villages of Manipur Sep-Nov 1986. Four species of bugs were recorded for the first time during the milk stage of rice. Three belong to family Pentatomidae, and one to Coreidae (see figure). These bugs caused chaffy grains and discoloration, depending on time of appearance and intensity.



Four rice bugs found in Manipur, India, 1986. 1) *Dolycoris indicus* Stal: mild, active in Apr-Oct. 2) *Menida histrio* (Fabr.): mild, active in Jun-Oct. 3) *Scotinophara coarctata* (Fabr.): mild, active in Jul-Sep. 4) *Cletus signatus* (Walk.): severe, active in Apr-Oct. Nos. 1-3 are Pentamidae, 4 is Coreidae.

The stink bug *Cletus signatus* was a major pest, with 10-40% infestation. In severe cases, 2-3 bugs/ 10 panicles caused heavy rice yield losses. Other bug species were of minor importance, with 3 to 6% infestation. □

Predators of brown planthopper *Nilaparvata lugens* Stål (BPH) in ricefields of the Mekong Delta, Vietnam

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Predators of BPH in the Mekong Delta were sampled visually.

The predator complex and its populations were counted on the bunds of ricefields in sample areas of 1 m^2 with 3 replications at 7-d intervals.

Some species that had high populations were *Lycosa pseudoannulata, Tetragnatha nitens, T. javana, T. virescens, Paederus fuscipes, Clubiona japonicola, Ophionea indica, Zelotes* sp., Callitrichia formosana (Table 1). The remainder of the complex were sparse.

Wolf spider *Lycosa pseudoannulata,* four jawed spider *Tetragnatha* sp., staphylinid beetle *Paederus fuscipes,* and carabid beetle *Ophionea indica* are four important predators of rice BPH found in the Mekong Delta.

Table 1. Predator complex of BPH in winter-spring and summer-autumn, Hau Giang, Vietnam, 1985.

Family	Species	Abundance
Salticidae	*Bianor*	++
	Plexippus paykulli	+
	Phidippus sp.	+
Sparassidae	*Heteropoda* sp.	+
	Clubiona japonicola	++
	Clubiona sp.	+
Lycosidae	*Lycosa pseudoannulata*	+++
Oxyopidae	*Oxyopes* sp.	+
Tetrwthidae	*Tetragnatha japonica*	++
	T. javana	+++
	T. mandibulata	++
	T. nitens	+++
	T. virescens	+++
Micryplantidae	*Callitrichia formosana*	++
Staphylinidae	*Paederus fuscipes*	+++
Carabidae	*Ophionea indica*	++
Coccinellidae	*Verania discolor*	++
	Coccinella repanda	+
Miridae	*Cyrtorhinus lividipennis*	++
Veliidae	*Microvelia* sp.	++
Agrocnemidae	*Agrocnemis* sp.	++

++++ = highly abundant, +++ = abundant, ++ = less abundant, + = scarce.

Their population dynamics were observed during four seasons 1982-84. The study used rice varieties IR36, IR46, IR48, Triveni, Utri Rajapan, and TN1 in a randomized block design with three replications. Twentyday-old seedlings were transplanted at 20- × 20-cm spacing, fertilized with 100 kg N + 60 kg P_2O_5 + 30 kg K_2O/ha, and hand weeded. Predator populations were recorded at 5-d intervals on 1 m^2 per plot.

Wolf spider occurred throughout the crop cycle. The peak period was at tillering 35-50 d after transplanting, in Jan in winter season rice and in Jul in summer season rice, when the temperature was 23-25 °C and relative humidity (RH) 89-94%.

Four jawed spiders appeared 1-70 d after transplanting (DT) with the peak period 25-40 under similar climatic conditions.

The staphylinid beetle was abundant during winter-spring (Feb-Apr). *Paederus fuscipes* occurred from 40 DT to ripening. Their peak period was 60-80 DT at 28°C and 78% RH.

The carabid beetle appeared 35-75 DT in winter-spring and erratically in summer-autumn, with the peak at 40 DT in Mar (Table 2).

Predatory capacity was studied by releasing 10 third-instar nymphs of BPH and bean aphid with an adult predator in 10- × 25-cm glass jars with 4 replications. *L. pseudoannulata* had the highest capacity on BPH; *O. indica* had the highest on bean aphid.☐

Table 2. Population dynamics and predatory capacity of BPH predators. Hau Giang, Vietnam.

Item [a]	*Lycosa pseudoannulata*	*Tetragnatha* sp.	*Paederus fuscipes*	*Ophionea indica*
Time of occurrence (DT)	1-100	1-70	40-100	35-75
Peak period (DT)	35-50	25-40	60-80	40
Population of adults/m^2				
Highest	8.4	5.6	23.4	0.4
Average	3.4	1.1	11.0	0.1
Predatory capacity (nymphs/d) on				
BPH	8.5	6.1	5.8	5.2
Bean aphid	7.3	7.4	8.4	9.5

[a] DT = d after transplanting.

Juvenoid-induced shortening of overwintering in stem borer (SB) *Sesamia inferens*

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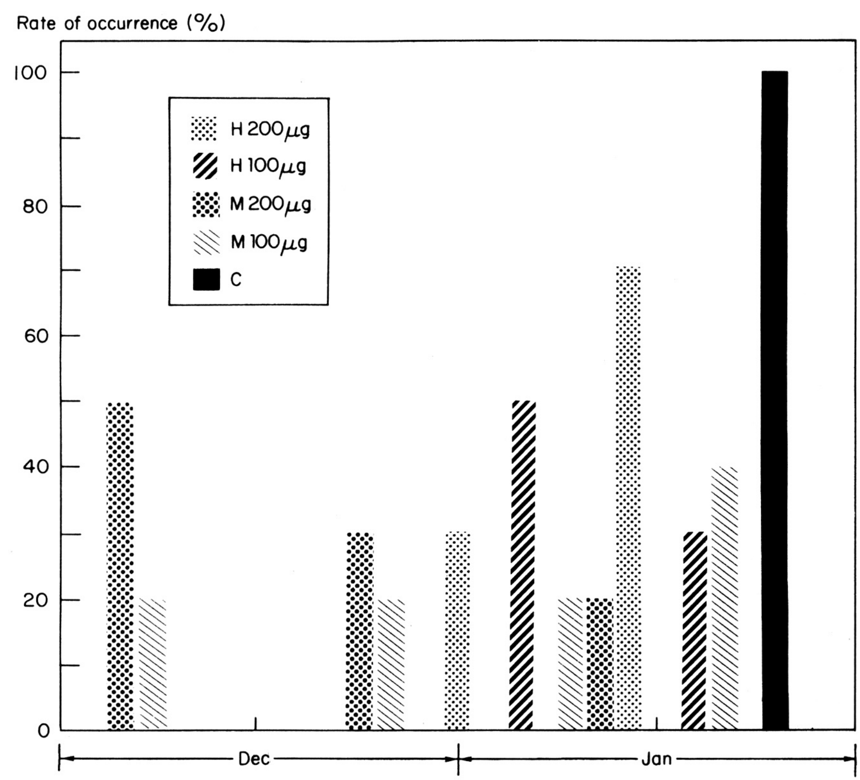
We collected overwintering larvae of pink SB *S. inferens* (Walker) in the first week of Dec by incising the tillers of rice stubbles uprooted from ricefields having more or less physiologically well-synchronized populations. Each larva was placed inside a small glass tube (5 cm long and 0.5 cm bore) with moist cotton plugging both ends. The tubes were wrapped in black paper. The larvae were reared in a chamber with temperature 23 ± 1°C, light-dark cycle 11-13 h, and relative humidity 70-80%.

Juvenoids hydroprene (Zoecon, ZR-0512) and methoprene (Zoecon, ZR-0515) in acetone dilution were applied topically. Each larva received 1 μl solution; 1 μl acetone/ individual served as check. Some check larvae were left in the stubble in the open to compare overwintering duration. The duration of larvae inside and outside was the same.

Check moths (normal adults) emerged in the second half of Jan. In the treated populations, adultoid larvae having one or two pairs of wing pads, juvenile labrum, mandible and maxillo-labial-hyphopharyngeal complex, antennae incompletely segmented, larval maxillae often incompletely differentiated into proboscis, developed much earlier (see figure). This indicates that juvenoids may have a role in early termination of the overwinter dormancy.☐



Occurrence of different forms of overwintering *S. inferens* larvae treated with juvenoids hydroprene (H) and methoprene (M). West Bengal, India. C = control.

Seed treatment with calcium peroxide to control green leafhopper (GLH) and brown planthopper (BPH)

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Direct seeding with pregerminated rice seedlings is becoming popular in the Philippines because of high labor costs for transplanting. Calcium peroxide has been used as a coating material to prevent poor germination of rice seeds broadcast directly in flooded fields. In a test of germination of IR36 seed at IRRI, at a 1:1 ratio of calcium peroxide and seeds, 66% germinated.

We evaluated seven insecticides in the laboratory. IR22 seeds presoaked 24 h were coated with each chemical at 0.5 kg ai/50 kg seeds and afterwards with calcium peroxide at 1:1 by weight. The seeds were sown in 25-cm-diam clay pots with 5 cm standing water. Ten newly emerged GLH and BPH adults were placed inside each mylar film cage at 10 d after sowing (DAS) and then every 5 d to 30 DAS. Mortality was recorded 48 h after infestation.

Isofenphos and carbosulfan showed good results (Table 1).

In a second test, we evaluated isofenphos and carbosulfan at 0.5 kg ai/50 kg seeds with and without calcium peroxide. There was no significant difference in mortality of BPH and GLH.

In a field test, isofenphos and carbosulfan with calcium peroxide were evaluated at 5 rates: 0.4, 0.5, 0.6, 0.8, and 1.0 kg ai/ 50 kg seeds. Seeds were sown in 30-m2 plots with 5 cm standing water. At 11 DAS, then every 5 d to 41 DAS, 20 GLH and 20 BPH adults were caged together on each plot.

Significantly higher BPH and GLH mortalities were obtained on seedlings from seeds treated with insecticide + calcium peroxide, even at 0.4 kg ai/50 kg seeds, up to 28 d after treatment than on seedlings with calcium peroxide alone. Carbosulfan was slightly better (Table 2). □

Table 1. Laboratory evaluation of 7 insecticides and calcium peroxide (cal-per) as seed treatment for BPH and GLH control. IRRI, 1983.

Chemical [a]	Mortality (%) at indicated days after treatment [b]		
	12	22	32
		BPH	
Isofenphos + cal-per	90.0 a	90.0 a	82.5 a
Carbosulfan + cal-per	85.0 a	97.5 a	65.0 a
Chlorpyrifos + cal-per	7.5 b	2.5 b	7.5 b
Acephate + cal-per	7.5 b	5.0 b	7.5 b
Fenthion + cal-per	2.5 b	0.0 b	0.0 b
Carbofuran + cal-per	0.0 b	12.5 b	0.0 b
Prothofos + cal-per	0.0 b	10.0 b	5.0 b
Cal-per alone	0.0 b	5.0 b	2.5 b
		GLH	
Isofenphos + cal-per	77.5 a	65.0 b	80.0 a
Carbosulfan + cal-per	75.0 a	85.0 a	57.5 a
Acephate + cal-per	50.0 b	12.5 c	7.5 b
Carbofuran + cal-per	12.5 c	12.5 c	7.5 b
Prothofos + cal-per	0.0 d	12.5 c	0.0 b
Chlorpyrifos + cal-per	0.0 d	10.0 c	7.5 b
Fenthion + cal-per	0.0 d	7.5 c	0.0 b
Cal-per alone	0.0 d	10.0 c	0.5 b

[a] Applied at 0.50 kg ai/50 kg seed. Cal-per : seed ratio was 1:1 by weight. [b] In a column within a species, means followed by a common letter are not significantly different at 5% level by DMRT. Av of 4 replications, 10 adults/replication.

Table 2. Field evaluation of seeds soaked in 2 insecticides plus calcium peroxide (cal-per) against BPH and GLH. IRRI, 1984.[a]

Insecticide	Rate (kg ai/50 kg dry seed)	Adult female mortality[b] (%)			
		13	23	33	43
			BPH		
Carbosulfan + cal-per	0.4	60 a	73 a	28 a	16 ab
Carbosulfan + cal-per	0.6	64 a	75 a	30 a	15 ab
Carbosulfan + cal-per	1.0	60 a	75 a	43 a	23 a
Isofenphos + cal-per	0.4	54 a	65 a	30 a	16 ab
Isofenphos + cal-per	0.6	54 a	60 a	33 a	19 ab
Isofenphos + cal-per	1.0	46 a	68 a	50 a	18 ab
Cal-per alone	–	15 b	15 b	23 a	6 b
			GLH		
Carbosulfan + cal-per	0.4	56 a	63 a	48 ab	21 a
Carbosulfan + cal-per	0.6	46 ab	61 a	58 a	25 a
Carbosulfan + cal-per	1.0	56 a	69 a	43 ab	28 a
Isofenphos + cal-per	0.4	41 ab	58 a	38 b	23 a
Isofenphos + cal-per	0.6	46 ab	54 a	33 b	18 ab
Isofenphos + cal-per	1.0	40 ab	64 a	50 ab	25 a
Cal-per alone	–	24 b	13 b	23 b	9 b

[a] IR22 was direct seeded 11 Jan 1984. Av of 4 replications, 20 adults/replication. [b] Recorded 48 h after caging at 13, 23, 33, and 43 d after treatment. In a column within each species, means followed by a common letter are not significantly different at 5% level by DMRT.

Rice whorl maggot (RWM) damage produces unfilled grains

A.T. Barrion and J.A. Litsinger, Entomology Department, IRRI

RWM *Hydrellia philippina* Ferino is an important vegetative stage rice pest in wetlands. The female fly normally lays eggs singly on leaf surfaces of seedlings in standing water.

We observed RWM oviposit on booting stage rice. Neonate larvae moved down and settled inside the bulging base of the leaf sheath to avoid desiccation and predation. Larvae that were able to enter the boot fed on the lemma and palea to cause white, partly wrinkled, and unfilled spikelets.

We caged IR1917-3-17 rice plants at the booting stage in the greenhouse and infested them with varying numbers of RWM flies. The flies were allowed to oviposit on the leaves for 3-4 d. Unfilled grains were counted after all panicles had become fully exserted.

The number of unfilled grains increased with fly density (see table), RWM damage is indistinguishable from that caused by high temperature or drought. □

Unfilled IR1917-3-17 grains at different RWM densities. IRRI greenhouse, Oct-Nov 1986. [a]

RWM (no. adult pairs/plant)	Unfilled grains (no./plant)
0 (control)	la
1	4 a
5	7 ab
10	10 b
20	19 c

[a]Av of 4 replications with one plant/cage. In a column, means followed by a common letter are not significantly different at 5% level by DMRT.

The rice whitebacked planthopper (WBPH) in Karnataka

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In recent years, low populations of WBPH *Sogatella furcifera* Horv. were noticed in association with the brown planthopper (BPH) in most rice growing areas. WBPH had been considered a minor pest of rice in Karnataka. The population was active during tillering, declining at heading. Later BPH populations multiplied enormously, causing hopperburn.

During 1986 kharif, WBPH was recorded in small patches in Visveswaraya Canal Tract of Mandya on variety Mandya Vijaya 50 d after transplanting. Each hill had an average of 15-20 2nd-instar nymphs. Initially the crop exhibited yellowish leaf margins, which later turned reddish, in circular patches in the middle of the field.

High N fertilization (1 30 kg/ ha) with frequent heavy rain in Sep-Oct might have favored WBPH buildup. Low numbers of predatory bugs *Cyrtorhinus lividipennis* and *Microvelia atrolineata* were found in association with WBPH. WBPH populations (3-5/hill) also were found on IR20, IET7575, Jaya, and Madhu. This is the first time WBPH occurrence was reported in Karnataka. □

Effect of vegetable oil on rice leaffolder (LF) feeding behavior

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We evaluated the antifeeding effect of neem *Azadirachta indica,* mahua *Bassia latifolia,* maravetty *Hydrocarpus wightiana,* and pinnai *Calophyllum inophyllum* oils on rice LF *Cnaphalocrocis medinalis* larvae. The oils were applied as 5% formulations in water containing 1% Teepol.

Forty-day-old TN1 rice plants were sprayed with emulsified oils in a completely randomized block design replicated 5 times; 1% Teepol was the control. Three hours after spraying, five second-instar larvae were released on each plant and covered with a mylar cage. Percent leaf damage was measured 5 d after release of larvae.

Damage was significantly less with all oil treatments (see table). Neem oil and maravetty oil effectively inhibited larval feeding; leaf damage was only 5.5-6.0% against 52.6% for control. □

Inhibition of LF larvae feeding by vegetable oils. Coimbatore, India.

Treatment	Leaf damage (%)
Neem oil (5%)	5.6 a
Mahua oil (5%)	19.8 b
Maravetty oil (5%)	6.0 a
Pinnai oil (5%)	20.8 b
Control (Teepol 1%)	52.6 c

[a] Means of 5 replications each. Mean followed by a common letter are not significantly different at 5% level.

A larval parasite of swarming Caterpillar and common cutworm in the Philippines

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Many natural enemies regulate highly localized populations of the swarming caterpillar *Spodoptera mauritia acronyctoides* Guenée and the common cutworm *Spodoptera litura* (Fabricius). A tachinid *Peribaea orbata* (Wiedemann) [Diptera: Tachinidae] was the most common parasite reared from larvae collected from three habitats — rice, sugarcane, and grassy areas — in Laguna,. Batangas, and Cagayan Provinces.

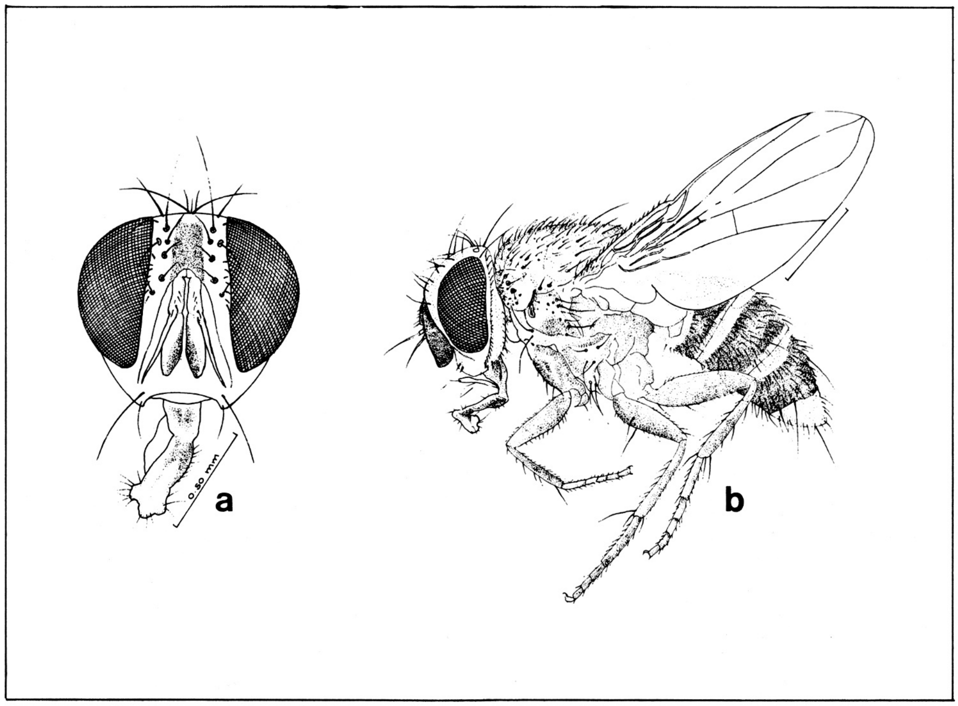
Larvae were held in 45- × 45- × 20-mm disposable plastic dishes and provided with fresh leaves. To avoid fungal or bacterial infection, the larvae were treated with 1% benzalkonium chloride (mixed with alkyldimethylbenzylammonium chloride) solution.

Parasitized 4th- to 5th-instar larvae ceased to feed and were sluggish until the parasite maggots emerged from their bodies. Two to eight maggots emerged from each larval host. The creamy white parasite maggots pupated beside the host cadavers; adult flies emerged after 7-8 d in the laboratory.

The fly *P. orbata* (see figure) is a small (4 mm long), black tachinid belonging to the tribe Siphonini. The tribe is characterized by minute prealar setae, very small size, head not sexually dimorphic, males and females with broad frons, two pairs of proclinate orbital setae, and strong outer vertical setae and thorax with strong subequal prostigmatic setae diverging from each other (particularly in *Peribaea*).

Parasitization was higher (6-19%) in unweeded sugarcane and ricefields containing *Rottboellia* and *Amaranthus* than in weeded fields (2%), suggesting that *P. orbata* is more effective at higher plant densities.

P. orbata is synonymous with *Actia monticola* Malloch and *A. rotondipennis* Malloch in the Philippines but previously had not been associated with any host. □



The tachinid fly *P. orbata* a) Head in frontal view, b) adult. Scale = 1 mm.

Rice insects and diseases in Goa, India

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No systematic survey of rice pests had been conducted in the Union Territory (UT) of Goa, Daman, and Diu. We monitored 6 locations in the north, 10 in the central, and 5 in the south at 3-wk intervals from mid-Jun to mid-Sep 1984. UT, 0.38 million ha in size, lies on the western coast of India. Rice, the main field crop, is on 54,000 ha, or 33.4% of the net area sown. The climate is warm humid tropical with temperatures around 17°C and 3 m annual rainfall.

Rice is cultivated primarily as a rainfed single crop. Irrigated rice is common only near springs, canals, and stream banks. Only 6% of area sown is cultivated more than once per year. Rice is a second crop Nov-Feb on only about 3,000 ha with assured irrigation.

Rice - groundnut, rice - pulses, and rice - vegetables are other common cropping patterns. About 80% of total area under rice is planted to high yielding varieties Vikram, IET6080, Govinda, Jaya, Jothi, and Annapurna.

Rice pests and their intensity in Goa, India, 1984.

	Intensity (%)
Insects	
Hieroglyphus spp.	23
Cnaphalocrocis medinalis	15
Nephotettix virescens	10
Hydrellia spp.	7
Nymphula depunctalis	7
Orseolia oryzae	6
Leptocorisa acuta	5
Nephotettix nigropictus	5
Stenchaetothrips biformis	4
Dicladispa armigera	4
Pelopidas mathias	2
Leptispa pygmoea	1
Sogatella furcifera	1
Scirpophaga incertulas	0.5
Nilaparvata lugens	0.4
Brevennia rehi	0.2
Pathogens	
Xanthomonas oryzae	15
Cochliobolus miyabeanus	6
Pyricularia oryzae	3
Rhynchosporium oryzae	1
Thanatephorus cucumeris	1
Xanthomonas translucens f. sp. *oryzicola*	1
Acrocylindrium oryzae	1
Ustilaginoidea virens	1

Pest levels and rice crop damage were recorded from 2 fixed plots at each survey site, 100 m back of each side of the road, using the *Standard evaluation system for rice* 0-9 scale. Average damage intensity was computed for each insect and disease found.

Eight diseases and 16 insects were found (see table). The survey indicated a shift in importance in insects, from *Scirpophaga incertulas* to *Hieroglyphus banian* and *Cnaphalocrocis medinalis.* The major disease problem was *Xanthomonas oryzae. Cochliobolus miyabeanus* was more important than *Pyricularia oryzae.* □

Plant host range of the rice bug (RB)

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RB *Leptocorisa oratorius* (Fabricius) comprises 80% of the *Leptocorisa* RB collections from wetland and dryland rice in the Philippines. *L. acuta* (Thunberg) and *L. palawanensis* Ahmad also are found in significant numbers.

Only plants in the milk or dough stage are nutritionally acceptable to *L. oratorius.* It survives by being long-lived (adults can live over 3 mo) and dispersive, seeking late maturing rice or alternative grassy weed hosts. We studied RB survival on rice and some commonly reported weed hosts.

Neonate nymphs were placed on ripening-stage rice and eight common weeds. All nymphs died on *Eleusine indica* (L.) Gaertn., *Paspalum conjugatum* Berg., and *Dactyloctenium aegyptium* (L.) Beauv (see table).

Oryza sativa L. was the most suitable host, with the most favorable growth index, greatest fecundity, and highest number of stylet sheaths. *Echinochloa* species, led by *E. colona* (L.) Link, were acceptable hosts, but with significantly lower growth indices, fecundity, and number of stylet sheaths. Nymphal development ranged from 21 d with rice to 36 d with *Paspalum scrobiculatum* L.

Paspalidium flavidum (Retz.) A. Camus and *P. scrobiculatum* can be considered marginal hosts. □

Growth and development of *L. oratorius* on rice and common ricefield grassy weeds. IRRI greenhouse, 1986.[a]

Plant[b]	Growth index[c]	Insect dry weight (mg)	Fecundity (eggs/female)	Stylet sheaths (no./panicle)
Oryza sativa	1.9 a	18 a	65 a	1.3 a
Echinochloa colona	1.1 b	14 ab	51 b	1.2 ab
E. glabrescens Monro ex Hook f.	0.9 c	12 b	41 bc	1.2 ab
E. crus-galli ssp. *hispidula* (Retz.) Honda	0.9 c	12 b	45 c	1.2 ab
Paspalidium flavidum	0.4 d	8 b	21 d	0.7 b
Paspalum scrobiculatum	0.2 e	3 c	5 e	0.5 c

[a]Av of 4 replications, 10 rice bugs/5 panicles. In a column, means followed by a common letter are not significantly different at 5% level by DMRT. [b]Nymphs failed to develop on *Eleusine indica, Paspalum conjugatum,* and *Dacryloctenium aegyptium.* [c]Growth index = survival (%)/developmental period (d).

Effect of three neem products on brown planthopper (BPH) oviposition

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We evaluated the effect of three neem products on BPH oviposition. Neem oil at 1% and 2% were prepared in water containing 1% Teepol. Neem seed kernel extract at 5% was prepared from 50 g of powdered neem seed kernel soaked in 1 liter water for 12 h, filtered, and Teepol 1% added to the filtrate. Neem cake at 5% was prepared from 50 g neem cake soaked in 1 liter water for 12 h, filtered, and Teepol 1% added to the filtrate.

Ten gravid BPH females were caged for 12 h on 40-d-old plants. Eggs were counted visually under a stereoscopic microscope. Treatments with all three neem products significantly reduced BPH oviposition (see table). Eggs/treated plant ranged from 12 to 44, compared to 143 eggs/control plant. □

Effect of three neem products on BPH oviposition. Tamil Nadu, India.

Treatment	Eggs/plant[a]
Neem oil (1%)	19
Neem oil (2%)	12
Neem seed kernel extract	38
Neem cake extract	44
Control	143

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

Pest Control and Management

WEEDS

Agronomic and economic evaluation of herbicides in transplanted rice

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In 1984, we studied the effect of five granular and two liquid herbicides and hand weeding on weed control in transplanted rice in a randomized block design with four replications. Jaya seedlings at 21 d were transplanted on 24 Jun.

Weed infestation was high. Dry weight in nonweeded control was 397 g/m^2 (see table). *Echinochloa colona* (L.) and *E. crus-galli* (L.) predominated (85% total dry weight). Other weeds were *Cyperus iria* (L.), *C. difformis* (L.), *Scirpus grossus* (L.), and *Fimbristylis miliacea* (L.). Broadleaf weeds were negligible.

Thiobencarb at 1.5 kg ai/ ha controlled weeds effectively (biomass was reduced by 42%), resulting in yield (5.4 t/ha) significantly higher than that of the nonweeded control (3.1 t/ha). Thiobencarb with one hand weeding yielded 5.8 t/ha, two hand weedings yielded 6.2 t/ha, and the weed-free check, 6.0 t/ha. Next were 1 kg 2, 4-D EE/ha and 1.5 kg butachlor granules/ha.

Butachlor EN and Anilofos EC were not effective, probably because rain followed treatment. In cost-benefit ratio, 2 hand weedings gave an extra return of $291; thiobencarb, $234; and thiobencarb with one hand weeding, $250, over the nonweeded control. Two hand weedings at the prevailing labor wage ($0.84/d) was cheaper than the most promising herbicides, but labor availability is a limitation. ☐

Effect of herbicides on weed control in transplanted rice. Pantnagar, India, 1984.

Treatment	Concentration[a] (%)	Dose (k/ha)	Yield (t/ha)	Weed dry weight at harvest (g/m^2)
Hand weeding twice	–	–	6.2	0
Weed-free check	–	–	6.0	0
Thiobencarb + one weeding			5.8	42
Thiobencarb	10 G	1.5	5.4	164
Thiobencarb	10 G	1.0	4.2	229
2,4-D EE	4G	1.0	4.7	150
2,4-D EE	4G	0.8	3.9	211
Butachlor	5G	1.5	4.6	266
Butachlor	5G	1.0	3.7	282
Pendimethalin	5G	1.5	4.1	265
Pendimethalin	5G	1.0	3.6	254
Oxyfluorfen	0.35 G	0.15	4.1	242
Oxyfluorfen	0.35 G	0.1	3.2	287
Anilofos[b]	30 EC	0.4	3.7	263
Anilofos[b]	30 EC	0.3	2.5	298
Butachlor[b]	50 EN	1.5	3.1	295
Butachlor[b]	50 EN	1.0	3.1	260
Nonweeded control	–	–	3.1	397
LSD 5%			2.0	

[a] G = granule, EC = emulsifiable concentrate, EN = emulsion. [b] Rain followed spraying.

Weed species occurring in rice seedling nurseries in Guimba, Nueva Ecija, Philippines

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We surveyed the weeds in farmers' rice seedling nurseries in Barangay Bantug, Guimba, Nueva Ecija, Philippines, in the 1985 wet and 1986 dry seasons.

In the wet season, 17 species belonging to 13 genera and 7 families were recorded in 17 seedling nurseries; grasses and sedges accounted for 70.6% of the species (see table). In the dry season, nine species belonging to six genera and two families (five species of Poaceae, and four of Cyperaceae) were recorded in three seedling nurseries.

The most commonly occurring species in both seasons were *Echinochloa glabrescens, Paspalum distichum, Fimbristylis miliacea, Scirpus supinus, Echinochloa oryzoides,* and *Cyperus difformis.*

Weeds not controlled in the nursery compete with the rice seedlings, resulting in weak seedlings. The weeds pulled with the rice seedlings also are transplanted. The grassy weeds, in particular, are highly competitive during crop growth. ☐

Weed species recorded in rice seedling nurseries in Guirnba, Nueva Ecija, Philippines, 1985-86 wet and dry seasons.

Weed species	Family	Wet season, 1985 (17)[a]	Dry season, 1986 (3)[a]
Cynodon dactylon (L.) Pers.	Poaceae	+	–
Cyperus difformis L.	Cyperaceae	+	+
Cyperus iria L.	Cyperaceae	+	–
Cyperus rotundus L.	Cyperaceae	+	+
Echinochloa colona (L.) Link	Poaceae	+	+
Echinochloa glabrescens Munro ex Hook. f.	Poaceae	+	+
Echinochloa oryzoides (Ard.) Fritsch.	Poaceae	+	+
Eclipta prostrata (L.) L.	Asteraceae	+	–
Fimbristylis miliacea (L.) Vahl	Cyperaceae	+	+
Ischaemum rugosum Salisb.	Poaceae	+	+
Lindernia antipoda (L.) Alston	Scrophulariaceae	+	–
Ludwigia octovalvis (Jacq.) Raven	Onagraceae	+	–
Monochoria vaginalis (Burm. f.) Presl	Pontederiaceae	+	–
Panicum repens L.	Poaceae	+	–
Paspalurn distichum L.	Poaceae	+	+
Phyla nodiflora (L.) Greene	Verbenaceae	+	–
Scirpus supinus L.	Cyperaceae	+	+

[a] Number of nurseries surveyed indicated in parentheses; + = present, – = absent.

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

Irrigation Water Management

Water management for rice in coastal saline soils

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Growth, yield attributes, and yield of rice under different levels of submergence in coastal saline soils, India. [a]

Submergence level	Plant ht (m)	Tillers/ hill	Effective tillers (%)	Sterility (%)	1000-grain wt (g)	Straw yield (t/ha)	Grain yield (t/ha)
Rainfed	94.0	13.3	61.3	29.1	24.8	5.2	4.5
2.5 cm	96.8	15.8	87.1	27.5	26.0	7.7	5.6
5.0 cm	97.0	13.4	71.6	26.4	25.3	8.3	4.8
7.5 cm	97.6	14.3	79.8	27.4	25.2	8.1	4.7
10.0 cm	98.7	12.9	88.9	22.2	26.1	7.1	5.4
12.5 cm	98.1	12.5	82.7	19.0	25.5	6.3	5.1
CD at 0.05	4.2	0.9	15.2	2.8	0.7	0.79	0.58

[a] Pooled data, 2-yr trials.

Experiments on wet season rice studied different water regimes: rainfed and submergence at 2.5, 5.0, 7.5, 10.0, and 12.5 cm continuous water to maturation. Submergence was maintained by irrigation or by draining the plots manually. Jaya rice was grown with 150-60-60 kg NPK/ha in a randomized block design.

Analysis of growth and yield-attributing characters and straw and grain yields indicate a direct relationship to water depth (see table). The rainfed crop manifested adverse effects. Tillers/ hill declined with increased water depth; percentage effective tillers increased only up to 10.0 cm water. Percentage grain sterility decreased with increased submergence. Variation in panicle length did not vary significantly; grain test weight was statistically higher with submergence than in the rainfed crop.

Grain yields were higher with 2.5 cm and 10.0 cm submergence levels. Higher and lower water levels lowered yields. Straw yields were highest from 2.5 to 10.0 cm water depths.

ECe (3.93-5.05 dS/m) and pH (7.3-7.65) did not vary with water regime, although ECe values were lower at all stages of crop growth with increased submergence. □

Soil and climate-based irrigation schedules for rice

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Effect of irrigation regime on yield (IR50) at Coimbatore, India.

Treatment	Kharif		Summer	
	Total water applied (mm)	Yield (t/ha)	Total water applied (mm)	Yield (t/ha)
1.5 $\sum_{1}^{7}$ (ET + HC)	1256	5.0	1439	5.2
1.0 $\sum_{1}^{7}$ (ET + HC)	960	4.9	1028	5.1
0.5 $\sum_{1}^{7}$ (ET + HC)	665	4.1	618	4.3
7 cm/wk	986	5.0	1040	5.1
5 cm/wk	780	4.7	800	4.9
CD 5%	–	0.4	–	0.2

Field experiments in 1985 kharif and 1986 summer studied irrigation schedules based on soil and climate. Crop evapotranspiration (ET) was calculated using pan evaporation reading; percolation loss was estimated based on soil hydraulic conductivity. The cumulative water loss by ET and percolation for a week was replaced with irrigation water at 0.5, 1.0, and 1.5 times the loss and compared with 5 and 7 cm water applied per week.

Irrigation equivalent to the loss of water by ET and percolation was sufficient to obtain maximum yield (see table). More water did not improve yield. Irrigating to half the water lost used the least amount of water but reduced yield considerably. Applying 5 cm water/wk also was sufficient for yield. □

Soil and Crop Management

Vertical distribution of soil solution NH_4^+ – N and grain yield of lowland rice with integrated N management

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In an INSFFER experiment on Jaya in lowland silty clay loam soil (pH 7.2, organic C 1.2%), grain yield was highest with 120 kg N/ha applied in integrated inorganic-organic approach (60 kg N/ ha through urea supergranules + 60 kg N/ha through *Azolla*) (see table). That better yield through an integrated approach is attributed to more N supplied to the soil solution NH_4^+–N pool (see figure). Soil solution samples were taken anaerobically from piezometers installed at 10 and 20 cm depth of wet soil. □

Grain yield of Jaya under integrated nitrogen management, Pantnagar, wet season, 1984-85.

Treatment[a]	N rate (kg/ha)	Grain yield (t/ha)
Check	0	3.4
USG	58	5.8
USG + fresh straw (29 + 29)	58	4.8
PU + *Azolla* (58 + 29)	87	6.7
PU + fresh straw (58 + 29)	87	6.2
USG + *Azolla* (58 + 29)	87	7.0
USG +fresh straw (58 + 29)	87	5.3
PU	120	7.3
USG + *Azolla*[b] (60 + 60)	120	8.0
CD (5%)		1.2

[a] PU = prilled urea best split, USG = urea supergranules placed at 10-12 cm depth at 7 d after transplanting (DT), *Azolla* was incorporated. [b] 50% *Azolla* was incorporated and 50% inoculated at 7 DT.

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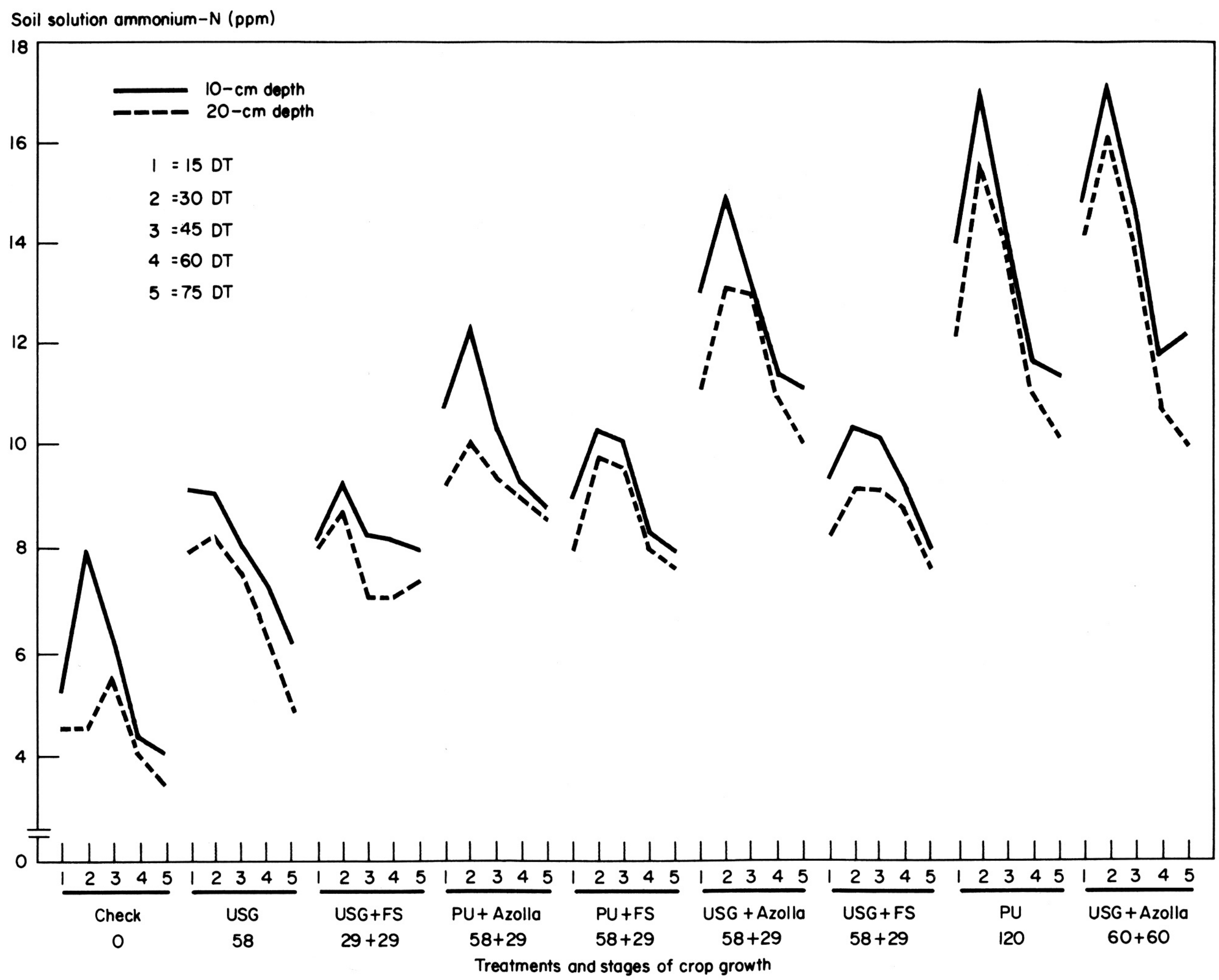

Vertical distribution of soil solution ammonium-N under various N rates with integrated N management. FS = fresh straw.

Wheat straw management for rice on a coarse-textured soil

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In the Punjab, rice - wheat is a common crop rotation. With combine harvesting, wheat residues are left in the field and either burned or incorporated before transplanting rice. We studied the effect of residue management on rice yield.

In 1985, straw from the wheat crop (about 7 t/ha) was removed from the field, incorporated, or burned. These treatments were compared with applying 12 t farmyard manure (FYM)/ha.

The experiment was laid out in a randomized complete block design with four replications. Soil was a nonsaline Tulewal loamy sand, Ustipsamment with pH 8.2, EC 0.22 mmho/cm, CEC 7.9 meq/ 100 g soil, and 0.20% organic C. Rice variety PR106 was fertilized with 120 kg N and 26 kg P/ ha.

Incorporation of about 7 t wheat straw/ ha wheat straw and applying 12 t FYM/ ha had similar effects on yield and yield attributes of rice and on soil fertility parameters (see table). When wheat straw was removed, tillers/plant, N uptake, and organic C content of the soil were affected adversely. Burning the straw increased tiller density and grain yield over nonincorporation. It had no significant effect on organic C content and nutrients availability. □

Effect of wheat straw management and farmyard manure on yield, yield parameters, and nutrient uptake by rice and soil characteristics. Ludhiana, India, 1986.

Treatment	Rice yield (t/ha)		Nutrient uptake (kg/ha)			Plant height (cm)	Tillers/ Plant	1,000-grain wt (g)	Soil organic C (%)	Available nutrients in the soil (kg/ha)		
	Grain	Straw	N	P	K					N[a]	P[b]	K[c]
Wheat straw removed	5.9	7.9	94	22	137	92	9.1	21.6	0.21	82	8.6	60
Wheat straw burned	6.5	7.8	99	23	135	94	10.3	20.6	0.22	76	8.4	73
Wheat straw incorporated	6.2	8.5	105	23	139	96	10.5	21.6	0.25	78	11.0	75
Farmyard manure	6.2	8.6	113	22	156	95	10.3	22.1	0.24	105	11.6	74
LSD (P = 0.05)	0.4	ns	9	ns	5	ns	1.2	ns	0.03	18	ns	ns

[a] Hot $KMnO_4$ extractable. [b]Olsen's P. [c]Ammonium acetate extractable.

Rice hulls as organic fertilizer on transplanted rice

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The use of rice hulls as organic fertilizer on transplanted rice was evaluated during two wet (WS) and two dry seasons (DS), 1983-84. Rice hull was incorporated either just before the first plowing or before final harrowing at 0.5 and 1 t/ ha. The 0.5 t/ha substituted for 1 bag 14-14-14 fertilizer and the 1 t/ha for 2 bags based on a recommended fertilizer rate of 90-28-28 kg NPK/ ha, equivalent to 2.75 bags urea and 4 bags 14-14-14. The 14-14-14 was basal; urea was topdressed before panicle initiation (60 d after transplanting). Rice variety IR54 was used.

Yields with rice hulls were similar to yields with 90-28-28 kg NPK/ha (Table 1).

Table 1. Performance of IR54 with rice hull (RH) as fertilizer.[a] CLSU, Nueva Ecija, Philippines.

Treatment	Plant height at maturity (cm)	Panicles (no./m^2)	Yield (t/ha)
Unfertilized	95	399	4.1
90-28-28 kg NPK/ha	98	428	5.6
0.5 t RH/ha	98	412	6.1
1 t RH/ha	101	432	5.8

[a]Av of 3 replications within 4 seasons (2 WS, 2 DS).

Table 2. Costs and returns from RH as fertilizer.

Item	90-30-30 kg NPK/ha	1 t RH/ha	0.5 t RH/ha	Unfertilized
Gross income ($)	1042.22	1114.81	1049.67	786.64
Cash expenses ($)				
Labor	251.19	265.56	259.07	203.34
Material inputs	221.44	193.67	210.33	102.67
Overhead ($)	171.82	170.35	171.61	153.52
Total expenses ($)	644.45	629.58	641.02	459.52
Net income ($)	397.77	513.14	442.15	309.12
Rate of return (%)	62	81	69	67

The highest cost of production and lowest rate of return were with 90-30-30 kg NPK/ ha (Table 2). Rice hulls at 1 t/ha as replacement for 2 bags 14-14-14 gave the highest net income and rate of return. □

Seedling emergence in upland rice

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Two weeks after seeding, most varieties seeded at below field capacity (35% soil moisture 7 d after soil reached field capacity) had higher seedling emergence than those seeded at field capacity (46% soil moisture). Seedling emergence was seriously affected when seeding was at lower moisture level — 16% soil moisture 14 d after the soil reached field capacity. But even at this moisture level, most modern varieties emerged better than traditional upland varieties (see table).

Shoot length was far better at 35% soil moisture than at 46%. Even at 16% soil moisture, shoot length was better than at field capacity. Root length was better in most modern varieties at both reduced moisture levels than at field capacity. In most traditional varieties, root length was similar at all moisture levels. □

Seedling emergence and growth at different moisture levels of direct seeded upland rices.[a] Bangladesh Rice Research Institute, Dhaka, Bangladesh.

Variety	Seedling emergence[b] (%)			Shoot length[c] (cm)			Root length[c] (cm)		
	FC	7 DAF	14 DAF	FC	7 DAF	14 DAF	FC	7 DAF	14 DAF
				Modern					
BR1	80	85	57	14	22	13	4	6	3
BR2	56	54	39	15	24	22	4	4	6
BR3	82	72	60	11	24	16	5	6	5
BR6	86	91	52	10	22	16	4	4	5
BR7	50	72	56	12	24	16	5	5	5
BR8	62	68	26	12	25	19	6	5	4
BR9	90	84	65	14	26	15	4	6	5
IR20	63	81	44	12	18	13	5	4	4
				Traditional					
Hashikalmi	100	100	25	15	25	20	4	7	4
Dharial	72	78	30	12	26	18	4	5	4
Kataktara	84	94	36	11	26	18	5	5	5
Marichbati	76	74	32	11	25	19	6	5	4
Panbira	66	89	32	11	20	14	4	4	4
Pankhiraj	75	80	51	13	22	16	5	5	5
Surjamukhi	85	80	29	15	24	18	5	6	5

[a] FC = field capacity (46% moisture), 7 DAF = 7 d after the soil reached field capacity (35 % moisture), and 14 DAF = 14 d after the soil reached field capacity (16% moisture). [b] Av of 3 replications. [c] Av of 3 replications, 10 seedlings each.

Effect of phosphorus on lowland rice yield

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We studied the effect of the timing of phosphate application on rice variety Sita (130-135 d duration) in 3 wet season trials in a randomized block design with 8 treatments and 4 replications. Soil was a dark grey heavy clay with poor drainage, medium fertility (0.74% organic C, 0.07% total N, 22 kg available P/ha, 185 kg available K/ha), and CEC 32.2 meq/100 g.

Applying P basally yielded best (see table).

Effect of P application timing on panicles/m^2 and yield.[a] Patna, India.

Treatment[b] (kg P/ha)	Panicles/m^2	Grain yield (t/ha)
No P (control)	312 f	3.95 e
26 as basal	374 a	4.61 a
26 at 10 DT	359 ab	4.45 abc
26 at 20 DT	357 ab	4.56 ab
26 at 30 DT	353 c	4.19 bcd
26 at 40 DT	331 d	4.20 bcd
26 at 50 DT	326 de	4.06 cd
26 at 60 DT	321 de	4.07 cd

[a] In a column, means followed by a common letter are not significantly different at 5% level. [b] DT = days after transplanting.

It appears that early application of P enhanced early tillers and that these tillers were more productive. □

Effects of green leaf manure on soil fertility and rice yield

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Nitrogenous fertilizers are essential for higher rice yields. However, it is well known that the yield potential of a field decreases with continuous fertilizer applications. Maintaining soil fertility is considered to be linked to increased microbial biomass and microbial activity.

Soil enzymes, particularly dehydrogenases, are derived primarily from soil microorganisms. The level of soil enzymes may be an indicator of general microbial populations and activities.

We compared the effects of various green leaf manures and a nitrogenous fertilizer (urea) on rice yield and on soil fertility status.

The test soil was clay loam with a pH of 7.0, CEC 36 meq/100 g, 0.75% organic C, 0.13% total N, 70 kg available P/ha, and 92 kg exchangeable K/ha.

Fresh leaves of glyricidia *Glyricidia maculata,* neem *Azadirachta indica,* and pungam *Pongamia glabra,* and urea were applied at 100 kg N/ha and trampled. IR20 seedlings were transplanted immediately. Soil samples were collected 75 d after transplanting and dehydrogenase activity assessed.

Green leaf manures and urea were equally effective in increasing yield (see table). But only green leaf manures increased soil microbial activity, indicating higher soil fertility status. □

Comparative efficacy of green leaf manure and urea in increasing yield of rice and soil microbial activity, Aduthurai, India.

Treatment	Grain yield (t/ha)	Microbial activity (dehydrogenase activity in units; 1 unit = optical density of 0.001 at 546 mm)
Glyricidia	4.31 ± 0.13	100.0 ± 24.5
Neem	4.87 ± 0.53	82.5 ± 20.6
Pungam	4.59 ± 0.18	62.5 ± 9.6
Urea	4.81 ± 0.19	22.5 ± 5.0
Control (no N)	2.28 ± 0.11	17.5 ± 5.0

N, P, and K uptake of rice on coastal saline soils

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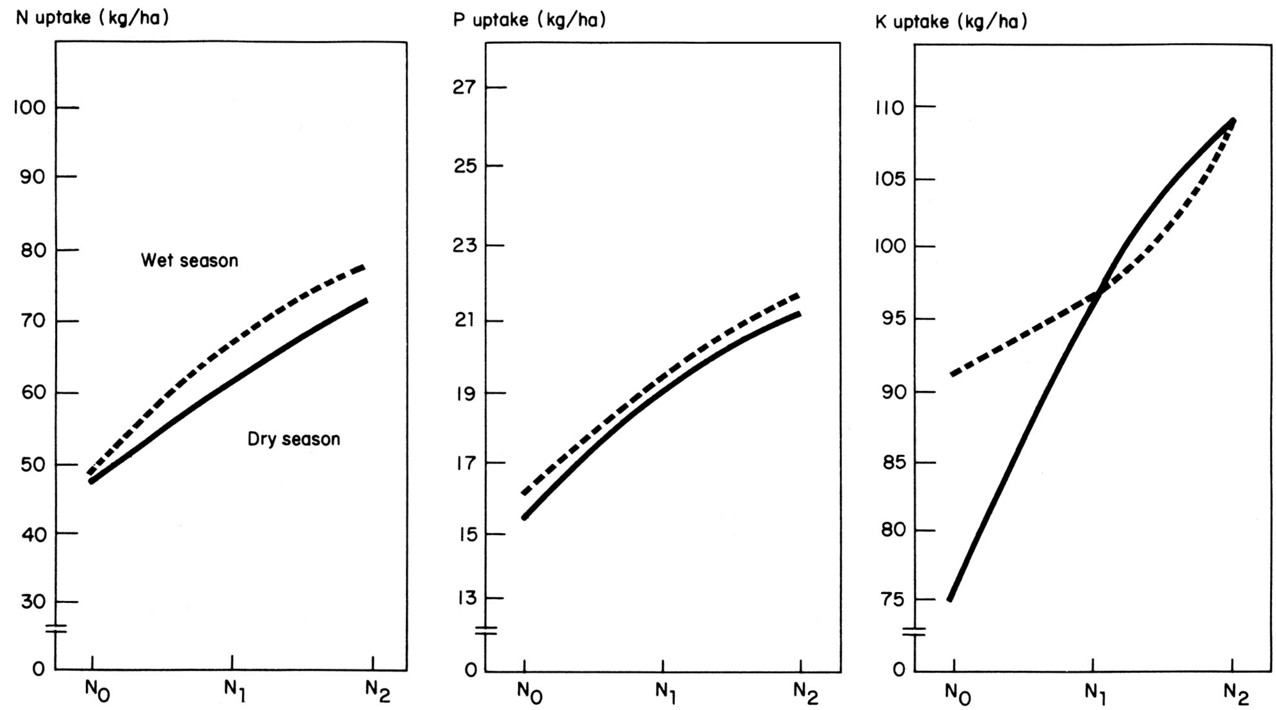
We studied N, P, and K uptake in CSR4 rice on coastal saline soil. Three levels of N (0, 50, 100 kg/ha), P (0, 25, 50 kg/ ha), and K (0, 25, 50 kg/ ha) were tried in 3^3 factorial design. Initial ECe was 3.0-12.0 dS/m, pH 7.1, available N 295 kg, P 23.5 kg, and K 490 kg/ ha.

P and K response and NPK interaction did not significantly affect grain yield. N effect on yield was highly significant at all levels in all the seasons, yielding 3.0, 3.9, and 4.3 t/ha in wet season and 2.8, 3.5, and 3.8 t/ha in dry season.

Uptake of N increased with increased application levels in both seasons; the increase was higher in wet season than in dry (see figure). Although the yield effects of P and K were insignificant, the uptake of those nutrients was positive and increasing, especially with high levels of N.

Lower assimilation of these nutrients, especially N, in dry season than in the wet season might be due to soil salinity.☐



Uptake of N, P, and K at different N levels. CSSRI, India.

Effect of N and *Azospirillum* on rice N uptake

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We conducted a pot experiment in Entisols of Indo-Gangetic alluvium (pH 7.2, 0.043% total soil N, 5.0 ppm Olsen P, 103 ppm 1 N NH_4 OA_c K) with 4 N levels (0, 15, 30, and 45 ppm) and *Azospirillum* (*A. brasilense*) inoculation on Saket 4. Earthen pots lined with polyethylene sheets were filled with 10 kg soil and basal dressing of 13.0 ppm P and 25.0 ppm K through single superphosphate and muriate of potash. Ammonium sulfate was the N source.

Roots of 22-d-old seedlings were dipped in carrier-based inoculant slurry and seedlings transplanted at 5/pot. Yield was recorded, grain analyzed for N content, and uptakes calculated.

N increased grain yield, grain N content, and N uptake. The highest values were associated with 45 ppm N (see table). Each N increment increased the parameters. N fixation and production of growth-promoting substances by *Azospirillum* might have contributed to improved root mass, thereby increasing grain yields and N uptake. ☐

Effect of applied N and *Azospirillum* on rice N uptake.

Treatment	Grain yield (g/pot)	Grain N (%)	N uptake (mg/pot)
Control (no N)	16.2	1.60	259.2
15 ppm N	21.5	1.66	356.9
30 ppm N	26.2	1.78	466.3
45 ppm N	30.0	1.87	561.0
A. brasilense	18.2	1.64	298.4
LSD (5%)	2.2	0.01	4.4

Effect of treating single superphosphate with cowdung

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We studied the effect of cowdung-treated single superphosphate (SSP) on panicles/m^2 and grain yield of rice variety Sita (135 d duration) in a 3-yr wet season field trial. Soil was dark gray, neutral heavy clay (pH 7.1) with poor drainage, medium fertility (0.75% organic C, 0.07% total N, 22 kg available P/ha, 185 kg available K/ha), and CEC 32.1 meq/ 100 g. P fertilizer was mixed with fresh cowdung in a 1:3 ratio 10-12 h before application. Six levels of P in addition to the P content of cowdung were used in a randomized block design with five replications.

Yields from treated plots were significantly higher than from control plots, indicative of nutrient deficiency in the soil (see table). P as SSP mixed with cowdung as a basal dose yielded significantly higher. P increased yields even when applied as late as at maximum tillering.

Both SSP alone and with cowdung applied basally and at maximum tillering increased panicles/m^2, except for SSP alone at tillering. □

Effect of cowdung-treated single superphosphate (SSP) on yield of grain and panicles of rice.[a] Bihar, India, 1983-85.

Treatment[b]	Mean grain yield (t/ha)	Mean panicles/ m^2
Control (no P)	2.94 c	252 b
17.2 kg P as SSP, basal	3.43 b	270 a
17.2 kg P as SSP, 20 DT	3.35 b	249 b
17.2 kg Pas SSP + cowdung (1:3), basal	3.93 a	277 a
17.2 kg P as SSP + cowdung (1:3), 20 DT	3.60 ab	274 a

[a] In a column, means followed by a common letter are not significantly different at 5% level. [b] DT = days after transplanting.

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Sources and methods of N application for irrigated wetland rice

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We studied sources and methods of N application for irrigated wetland rice on a sandy loam soil with pH 7.0, organic matter 0.9%, total N 0.07%, and CEC 12.2 meq/ 100 g. The test variety was GR-11.

Prilled urea (PU) local best split and standard best split, sulfur-coated urea (SCU), urea supergranules (USG), and Massoorie-phosphorus-coated urea (MPCU) at 58, 87, and 116 kg N/ ha were compared. (MPCU is an indigenous material supplied by Madras Fertilizer Limited.)

In the local best split application, PU (46% N) was applied in 4 equal splits: basal, at maximum tillering, panicle initiation, and booting stage. In standard best split application, PU was applied 2/3 basal and 1/3 topdressed 5 to 7 d before panicle initiation, incorporated with no standing water. SCU (36% N) was incorporated 6 d after transplanting (DT). USG (46% N) was placed in the center of every 4 hills at 10-12 cm soil depth 6 DT. MPCU (32% N) was basally applied and incorporated before transplanting.

Treatment significantly affected panicles/m^2 (see table). At 87 kg N/ha, USG gave significantly more panicles than SCU.

USG at 58 kg N/ ha yielded significantly higher than MPCU and urea best split. SCU at 87 and 116 kg N/ ha produced significantly higher yields than all treatments except USG. □

Grain yield and panicles/m^2 with different N sources and application methods, Nawagam, India.

Treatment (kg N/ha)	Form and application method	Grain yield (t/ha)	Panicles/m^2 (no.)
0	No N	2.16	163
58	PU best split (local)	3.31	203
58	PU standard best split	2.68	210
58	SCU broadcast and incorporated	3.69	280
58	USG placed 10-12 cm deep	4.34	308
58	MPCU broadcast and incorporated	2.91	236
87	PU best split (local)	3.56	249
87	PU standard best split	3.34	247
87	SCU broadcast and incorporated	4.88	289
87	USG placed 10-12 cm deep	4.44	341
87	MPCU broadcast and incorporated	3.70	294
116	PU best split (local)	3.95	277
116	PU standard best split	3.31	273
116	SCU broadcast and incorporated	4.96	296
116	USG placed 10-12 cm deep	4.52	303
116	MPCU broadcast and incorporated	3.90	280
	CD (0.05)	0.76	41

Performance of *Azospirillum* biofertilizer in irrigated and rainfed upland rice

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We studied the field performance of a local isolate of *Azospirillum lipoferum* under irrigated and rainfed upland conditions.

The irrigated experiment was laid out with IR50 rice in a red sandy loam soil (pH 7.6, EC 0.35 mmho, 265 kg N, 12.2 kg P, 276 kg K/ha). Different levels of fertilizer N with and without *Azospirillum* biofertilizer were compared.

Sixty kg seed/ ha were uniformly coated with 1 kg *Azospirillum* inoculant which contained approximately 10^8 cells/g of peat soil carrier, following the recommended seed treatment method. After sprouting, the soaked seeds were sown in the nursery bed and 2 kg *Azospirillum* biofertilizer mixed with 25 kg powdered farmyard manure (FYM) was broadcast. In the main field, 2 kg *Azospirillum* biofertilizer mixed with 25 kg of powdered FYM/ha was broadcast before transplanting. The roots of 25-d-old rice seedlings were dipped in a water-slurry of 1 kg *Azospirillum* for 20 min before transplanting in 16-m^2 plots in a randomized block design with 3 replications. Tillers and dry weight were recorded 60 d after transplanting, and grain and straw yields at harvest.

Tillering was enhanced by increased fertilizer N (Table 1) and *Azospirillum* biofertilizer significantly increased tiller numbers and plant dry weight at all fertilizer levels. Maximum increase in plant dry weight was with 50% fertilizer N.

Azospirillum biofertilizer treatment markedly increased the grain and straw yields at all N levels (Table 2). Grain yield response to *Azospirillum* biofertilizer was more pronounced at lower levels of fertilizer N (0 and 50%). Significant increases in tiller numbers, plant dry weight, and grain yield also were obtained at 100% N level with *Azospirillum* treatment, indicating that the higher level of fertilizer N (75 kg N/ ha) did not inhibit activity of the *Azospirillum* strain. The mean grain yield at 50% N fertilizer level with *Azospirillum* treatment equaled yield with 100% N fertilizer alone.

Table 1. Effect of *Azospirillum* biofertilizer on tillering and dry weight of irrigated IR50 at Madurai, India.[a]

Fertilizer level	Tillers/plant (no.)		Dry wt (g/plant)	
	No *Azospirillum*	*Azospirillum* inoculant at 6 kg/ha	No *Azospirillum*	*Azospirillum* inoculant
No N	12.0	15.0	10.3	11.8
50% N	14.7	16.1	11.0	13.9
15% N	15.3	19.0	13.2	14.9
100% N	11.3	20.1	14.5	15.5
CD (P = 0.05%)	1.6	1.6	0.03	0.03

[a] Means of 9 observations.

Table 2. Influence of *Azospirillum* biofertilizer on grain and straw yields of irrigated and rainfed upland rice. Madurai, India.

Fertilizer level	Grain yield (t/ha)		Increase (%)	Straw yield (t/ha)		Increase (%)
	Untreated	*Azospirillum* inoculated		Untreated	*Azospirillum* inoculated	
			Irrigated (IR50)			
No N	2.1	3.2	47.1	5.6	5.8	3.6
50% N	3.3	4.1	24.5	6.6	7.7	20.6
15% N	3.2	4.4	17.6	7.1	8.3	16.1
100% N	4.2	5.2	22.7	8.7	9.8	2.6
CD (P = 0.05)	0.2	0.2		0.156	0.156	
			Rainfed upland (PMK. 1)			
No N	2.0	2.2	15.4	2.5	3.4	43.4
50% N	2.3	2.9	25.9	3.6	4.6	21.4
75% N	2.4	2.9	18.0	4.0	4.8	20.4
100% N	2.9	3.1	6.0	4.9	5.8	18.8
CD (P = 0.05%)	0.04	0.04		0.1	0.1	

The rainfed upland experiment was in a rainfed bunded field at Paramakudi. With rice starch solution as adhesive, seeds of PMK. 1 were coated with *Azospirillum* biofertilizer at 1 kg peat-based inoculant/75 kg seeds per ha. In addition, 2 kg biofertilizerl/ha was mixed with 15 kg dry powdered FYM and broadcast in the main field before direct seeding. Three levels of fertilizer N in the form of urea were applied.

Maximum increase in grain yield due to *Azospirillum* biofertilizer treatment was with the 50% N level (20 kg N/ ha) (Table 2). Grain yield at this level equaled that with full fertilizer N, *Azospirillum* biofertilizer enhanced straw yield at all N levels; the maximum increase was at zero-N level. ☐

Effect of combining chemical N and *Sesbania aculeata* in upland rice

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The lateritic sandy-loam upland soils of Bhubaneswar are low in organic matter (0.43 to 0.5% C), base status (CEC 3.8-4.1 meq/100 g soil), pH (5.1 to 5.4), and available P (14 kg/ ha, Bray's) and high in Fe and Al. But farmers rarely use farmyard manure or compost because the manures are diverted to produce rice in low and medium lands. Moreover, farmers hesitate to grow a green manure crop in lieu of a kharif crop.

During 1985-86 kharif, upland rice Subhadra was sown at 100 kg/ ha in 15- × 10-cm rows with and without *Sesbania aculeata* broadcast at 40 kg seed/ ha with 4 N levels. Half the N was applied at sowing, half at tillering. All treatments received a basal 13 kg P and 25 kg K/ha.

At 20 d after germination, sesbania plants were killed by spraying 0.9% propanil. The leaves and the stems created a temporary mulch that automatically disintegrated and mixed with the soil within a week. No manual mixing was necessary and there was no sign of injury to the rice crop.

The legume increased rice germination by 21% under the crust and affected the lateritic upland situation. Twenty-day-old sesbania bearing 7 to 17 nodules/plant contributed 4.3-6.3 t green manure/ha.

Grain yield increased significantly (see table). The yield with sesbania alone equaled yield with 40 kg N/ha. □

Effects of nitrogen and sesbania on number of nodules, green matter from sesbania, plant population, and rice yield. Orissa, India.

N level (kg/ha)	Sesbania nodules/ plant[a] (no.)	Sesbania green matter incorporated (t/ha)[a]	Rice plants/m²		Grain yield (t/ha)	
			Without sesbania	With sesbania	Without sesbania	With sesbania
0	6.8	4.3	274	326	1.1	1.4
20	12.8	4.8	277	241	1.2	1.5
30	13.2	5.6	218	345	1.3	1.5
40	15.6	5.8	252	313	1.5	1.8
50	17.0	6.3	280	359	1.6	2.1
Mean	13.10	5.4	260	316	1.3	1.6
CD (0.05)					0.2	

[a]Treatments had received 50% N at time of data collection.

Split application of slow-release urea

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We studied the comparative efficiency and time of application of slow-release urea materials such as neem cake-coated urea (NCCU, 20% neem cake powder), coal tar-coated urea (CTCU, 1% coal tar), urea supergranule (USG, 1-g size), and prilled urea (PU) in 2 soil types.

ADT36 (110 d, Jun-Sep 1984) and IR20 (135 d, Sep 1984-Feb 1985) were tested in the clayey loam soils of Aduthurai (silty clay to clay, Vertisol, clay 40% low in N) where 2 rice crops are usually grown. IR20 (medium duration, Jul-Dec 1984) was tested in the sandy loam soils of Pattukottai (sandy loam, Alfisol, clay 12.0% low in N). The recommended NPK of 75.0-37.5-37.5 kg/ha for the 110-d variety and 100-50-50 kg/ha for the 135-d variety were applied.

USG gave significantly higher yields than PU in both soil types (see table). Yields with NCCU and CTCU only equaled that with PU. Split application of slow-release urea gave higher yields than single basal in both soils. □

Effect of split application of slow-release urea on yield. India, 1984-85.

Treatment	Yield (t/ha)		
	Clay soil		Sandy loam soil
	Crop 1	Crop 2	
Source			
NCCU	4.6	4.6	4.6
CTCU	4.8	4.7	4.7
USG	5.0	4.7	5.0
PU	4.4	4.5	4.7
LSD (P = 0.05)	0.3	ns	0.2
Time of application			
Single basal (slow-release urea)	4.5	4.6	4.5
Single basal (50% slow-release + 50% PU)	4.5	4.5	4.5
Split application[a] (slow-release urea)	5.0	4.7	4.9
Split application[a] (basal PU + topdressed slow-release urea)	4.9	4.7	4.9
Split application[a] (basal slow-release + topdressed PU)	4.6	4.8	4.9
LSD (P = 0.05)	0.3	ns	0.2

[a]Split application = 50% N before planting, 50% N at maximum tillering.

Effect of soil moisture regime and straw incorporation on root growth and yield of rice

R. Singh, G. C. Aggarwal and N. T. Singh, Soils Department, Punjab Agricultural University, Ludhiana 141004, India

We conducted a lysimeter experiment with rice variety PR106 on a calcareous sandy loam soil (Typic Ustochrept). Air-dried soil was passed through a 2-mm sieve and used to fill iron barrels 1 m high with 50-cm internal diameter. The treatments, replicated 3 times, were combinations of 3 levels of straw incorporation (no straw, 1% straw, and 2% straw) and 3 soil moisture regimes (field capacity, saturation, and submergence). Straw was chopped into 2- to 4-cm pieces and mixed into the top 15 cm of soil. The soil moisture treatments were imposed after 3 wk of continuous submergence following transplanting. To attain field capacity, 4-6 cm water was applied 24 h after infiltration of water previously applied. Saturation was 0-1.5 cm ponded water; submergence was 4-6 cm ponded water. Fertilizer was applied at 150 kg N and 13 kg P/ha.

Depth of roots was determined at

maturity by excavating and washing the soil in the 0-5, 5-10, and 10-25 cm layers. Roots were rewashed and dried at 60°C. Rooting density was expressed as weight of dry roots per unit volume of soil. Root weight index was total root weight per cm^2 soil surface in the entire (0-25 cm) root zone.

Soil moisture regime significantly affected root distribution (see table). Root weight index increased with water supply. Incorporation of straw significantly decreased the root weight index and rooting density in all three layers. However, in the surface (0-5 cm) layer, the fraction of total roots increased from 34% under no straw to 38% when 2% straw was incorporated, showing that higher soil reduction increased the fraction of the total roots in the surface layer.

Effect of soil moisture regime and straw incorporation on root growth and yield of rice. Ludhiana, India.

Treatment	Rooting density $\mu g/cm^3$) at indicated depth			Root weight index (mg/cm^2)	Yield (g/pot)
	0-5 cm deep	5-10 cm deep	10-25 cm deep		
Moisture regime					
Field capacity	482	415	157	7.3	107
Saturation	661	502	287	10.1	206
Submergence	995	567	377	13.5	234
Straw treatment					
No straw	891	728	329	13.0	235
1% straw	702	479	287	10.2	169
2% straw	538	277	203	7.1	143
CD (0.05)					
Moisture regime or straw	174	117	172	3.0	19

Incorporation of straw also decreased the rice grain yield significantly. The grain yield was linearly related to the root weight index (R^2 = 0.93). The reduction in root growth and grain yield was probably due to the accumulation of toxic substances in the root zone, under highly reduced conditions provided by the decomposition of added straw. This also appears to be the likely reason for significantly higher grain yield under submergence than under saturation, since the toxic substances will be better leached under continued submergence than under saturation. □

Influence of moisture regime on IR50

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An experiment was conducted on water needs of IR50 during summer and kharif 1985. Four irrigation treatments were evaluated: continuous submergence (5 cm), 5-cm depth to saturation, saturation up to and after heading and 5-cm water during heading (panicle initiation to flowering), and saturation at 25% depletion of available soil moisture (DASM). The experiment was in a randomized block design with eight replications.

IR50 yield and water use efficiency.

Treatment	1985 dry season (summer)			1985 wet season (kharif)		
	Total water applied (mm)	Grain yield (t/ha)	Water use efficiency	Total water applied (mm)	Grain yield (t/ha)	Water use efficiency
Continuous submergence (5 cm)	1850	6.2	3.34	1399	6.4	4.55
Saturation to 5 cm	986	6.6	6.67	1141	6.6	5.75
Saturation up to and after heading and 5 cm during heading	1205	6.4	5.29	1055	6.2	5.88
Saturation at 25% DASM	620	5.7	9.18	685	5.5	8.06
CD at 5%		0.5			1.0	

During the dry season, irrigation to saturation to 5-cm depth consumed 47% of the water required by continuous submergence (see table). This trend continued in the wet season, with a saving of 18% of the irrigation water. Irrigation to saturation at 25% DASM consumed the least irrigation water (620 mm in summer and 685 mm in wet season) and yield was reduced by only 11% (on the average) for a higher water use efficiency. □

P and K requirements of upland rice in eastern Uttar Pradesh

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We studied the effect of P and K on yield and yield components of rainfed upland rice variety IET7613 (85 d maturity) during 1985 at Faizabad. Soil was sandy loam with 22.5% field capacity and 4.6% wilting point of the 0-15 cm soil profile. Bulk density was 1.42 g/cm^3. Total rainfall during the crop season was 920 mm with monthly distributions of 92 mm (Jun), 374 mm (Jul), 140 mm (Aug), 197 mm (Sep), and 117 mm (Oct). The rice crop faced 3 dry spells: 6 d during the first 14 d of Jul, 7 d during mid-Aug, and 11 d during the first 14 d of Sep.

Rice was directly sown on 30 Jun in rows spaced 20 cm. Sixty kg N/ha was topdressed in 3 splits: 24 kg N/ha at 15 d after germination (DG), 18 kg at 40 DG, and 18 kg at 55 DG.

Two levels of P as superphosphate and one level of K as muriate of potash were basally applied in a randomized block design with 3 replications (see table). A foliar spray of $ZnSO_4$ was also applied. The soil had 12.5 kg available P and 122 kg available K/ha.

Effect of P and K on yield of rainfed upland rice at Faizabad, U. P., India.

NPK (kg/ha)	Days to 50% heading	Panicles/m^2	Grains ($\times 10^3/m^2$)	Sterility (%)	1,000-grain wt (g)	Harvest index (%)	Yield (t/ha)
60-0-0	71.0	260.0	14.1	18.3	25.9	52.8	2.8
60-13-0	69.0	276.6	14.3	18.1	26.1	55.2	3.0
60-19.5-0	69.0	308.3	15.4	15.8	26.8	56.5	3.7
60-0-25	69.0	281.6	14.4	17.9	26.1	50.1	3.0
60-13-25	68.0	301.6	15.7	14.8	26.1	53.3	3.1
60-19.5-25	67.0	330.0	15.8	14.5	27.2	56.2	3.8
CD .05	1.2	25.2	0.7	ns	0.7	ns	0.1

ns = not significant.

Both P and K greatly increased yield. However, P was more beneficial. The highest yield was obtained with 19.5 kg P and 25 kg K/ha. □

Rice-Based Cropping Systems

Rice-based crop sequences for the Andaman Islands

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Monocrop rice is commonly grown Jun-Dec in the Andaman Islands, with most fields fallow during the Jan-Apr dry season. Different crops were evaluated in the 1984-85 and 1985-86 crop years following harvest of single or double rice crops. The soil of the test site is a clay loam. Short-duration IET4106 rice was grown May-Aug as first crop, followed by IR36 in Sep-Dec as a second crop. Rice received 90-60-40 kg NPK/ha and yielded 4.2-4.7 t/ha in the first crop and 1.9-2.6 t/ha in the second crop. Severe pest problems lowered IR36 yields.

Average grain yields of dry season crops and net return, 1984-86, Port Blair, India.

Crop sequence	Yield (t/ha)			Net return[a]
	Crop 1	Crop 2	Crop 3	($/ha)
Rice - fallow	4.6	–	–	348.75
Rice - sorghum	4.6	2.6	–	597.50
Rice - maize	4.7	3.4	–	733.33
Rice - sesamum	4.4	0.5	–	534.83
Rice - black gram	4.6	1.3	–	737.75
Rice - rice - sorghum	4.2	1.9	1.9	438.33
Rice - rice - maize	4.2	2.3	2.1	518.42
Rice - rice - sesamum	4.3	2.3	0.5	516.08
Rice - rice - black gram	4.4	2.6	1.1	714.17
Rice - rice - green gram	4.5	2.4	0.5	455.42

[a] Based on 1984-86 local market rates.

Dry season crops were sown in Jan and harvested in Mar-Apr. Fertilizer applications were 60-40-30 kg NPK/ha for maize or sorghum, 40-30-30 for sesamum, and 20-40-25 for black gram or green gram.

Pulses, oilseeds, and cereals performed well on residual soil moisture during the rice fallows (see table). This indicates that intensive cropping is feasible in the Andamans; cropping intensity could be increased by 200-300%. □

Fertilizer required for irrigated wheat in rice - wheat cropping pattern, Chhattisgarh, Madhya Pradesh

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The fertilizer requirement of wheat following rice was tested.

Medium-duration rice variety Kranti was used as test crop in kharif (wet season). Initial soil fertility is presented in Table 1. Rice received 80-23-25 kg NPK/ha and yielded 3.5-3.8 t/ha.

After rice harvest, wheat variety

Table 1. Soil fertility of experimental plots. Madhya Pradesh, India, 1981-83.

Character	1981-82	1982-83
pH	7.1	7.2
Organic C	0.6	0.5
Available N (kg/ha)	200	180
Available P (kg/ha)	15	14
Available K (kg/ha)	354	333

Sonalika (HD 1553) was sown on 30 Nov 1981 and Kalyan Sona (HD1593) on 11 Dec 1982 in 5- × 2-m plots in a randomized block design replicated 3 times. Seed rate was 100 kg/ha.

In both years, panicle length, spikelet number, number of spikelets per panicle, and test weight of wheat were significantly related to fertilizer level (Table 2).

Grain and straw yields responded significantly to fertilizer application during both years. The highest yields of grain and straw were at 120-27-50 kg NPK/ha. □

Table 2. Effect of fertilizer on yield and yield-attributing characters of wheat following rice. Madhya Pradesh, India, 1981-83.

Treatment (kg/ha)			1981-82 (Sonalika HD1553)					1982-83 (K. Sona HD1593)				
N	P	K	Grain yield (t/ha)	Length of panicles (cm)	Spikelets (no./panicle)	Spikelets /panicle	1000-grain wt (g)	Grain yield (t/ha)	Length of panicles (cm)	Spikelets (no./panicle)	Spikelets /panicle	1000-grain wt (g)
0	0	0	1.1	6.9	13.1	36.4	33.2	0.7	7.9	13.2	31.7	32.0
40	0	0	1.6	7.8	14.5	44.6	35.2	1.3	8.4	14.6	42.2	35.0
80	0	0	1.9	8.1	15.5	45.4	33.6	1.9	9.3	16.0	51.0	34.8
120	0	0	2.5	8.5	16.4	55.2	35.1	2.3	9.7	17.2	55.2	34.6
40	9	0	1.6	7.7	14.8	44.6	34.4	1.5	8.7	15.0	43.6	33.8
80	18	0	1.9	8.4	15.7	48.0	35.6	1.8	9.3	15.8	47.1	35.6
120	27	0	2.8	8.4	17.9	52.4	35.9	2.4	9.9	16.5	51.3	36.5
40	9	17	1.5	7.3	14.4	39.9	34.9	1.2	8.5	14.9	39.4	34.5
80	18	33	1.9	7.6	15.6	50.9	36.6	2.0	9.4	15.8	50.2	36.4
120	27	50	3.1	8.3	15.4	51.1	36.1	2.4	9.3	15.7	49.5	35.2
	LSD (0.05)		0.4	0.6	1.4	6.3	1.2	0.5	0.7	1.2	7.5	2.0

Effect of zinc and phosphorus on rice - wheat yields in semireclaimed alkali soil

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Most alkali soils of the Indo-Gangetic plains are rich in available P but deficient in available Zn. When soils are reclaimed, P availability decreases because of leaching, formation of calcium phosphates, and crop uptakes. At the same time, continuous Zn application results in a high buildup of available Zn in the soils. This disproportionate availability of Zn and P may affect crop growth and plant chemical composition.

A long-term field experiment in a split-plot design with four replications studied the effect of applied Zn on yields in loamy alkali soil. The soil was treated with gypsum (14 t/ha) and cropped in a rice (Jaya) - wheat (HD2009) sequence. After the fourth rice crop, 18 kg/ha was added to one-half of each plot.

Zn significantly increased wheat yield (see table). P application had no effect, even in the sixth year of reclamation. Rice responded significantly to Zn and P applied together after the fourth year. P or Zn alone gave significantly lower yields than P and Zn together. Zn and P significantly increased nutrient uptake by both crops.

The optimum fertilizer for a rice - wheat sequence was 2 kg Zn/ha. Higher applications increased DTPA-extractable Zn up to 23.88 mg/kg and had a residual effect on succeeding crops with no deleterious effect on yields. However, 18 kg Zn/ha significantly reduced available Fe. Application of 18 kg P/ha significantly reduced DTPA-extractable Zn by about 20% but increased P availability.

These results suggest that P application to wheat can be deferred to the sixth year of reclamation, but 18 kg P/ha and 2 kg Zn/ha are essential for rice after the fourth year. □

Effect of Zn and P fertilizer on grain yields of rice and wheat and on DTPA-extractable Zn at harvest of the 6th rice crop in reclaimed alkali soil. Karnal, India.

Zinc added (kg/ha)	Grain yield[a] (t/ha)								DTPA - Zn (mg/kg) at 6th rice	
	Rice						Wheat			
	1st WP	4th WP	5th		6th		6th		WP	P
			WP	P	WP	P	WP	P		
0	5.06	4.99	5.16	5.37	4.87	5.19	2.56	2.60	0.52	0.56
2	6.01	5.98	5.14	6.12	5.14	6.42	3.33	3.38	3.20	3.14
4	6.04	6.19	5.53	6.15	5.31	6.37	3.38	3.42	5.10	4.92
9	6.00	6.11	5.42	6.24	5.34	6.76	3.29	3.46	9.52	9.36
18	6.00	6.18	5.46	6.08	5.27	6.85	3.08	3.21	15.84	13.72
27	5.97	6.08	5.47	6.24	5.30	6.69	3.05	3.29	23.88	19.05
Mean	5.85	5.92	5.41	6.03	5.21	6.38	3.12	3.23	9.63	8.46
LSD (0.05)										
Zn	0.62	0.26	0.39		0.68		0.38		2.07	
P	–	–	0.22		0.37		ns		0.82	
Zn × P	–	–	ns		ns		ns		2.01	

[a] WP = without phosphorus, P = with phosphorus.

A pigeonpea + rice intercropping system for rainfed uplands

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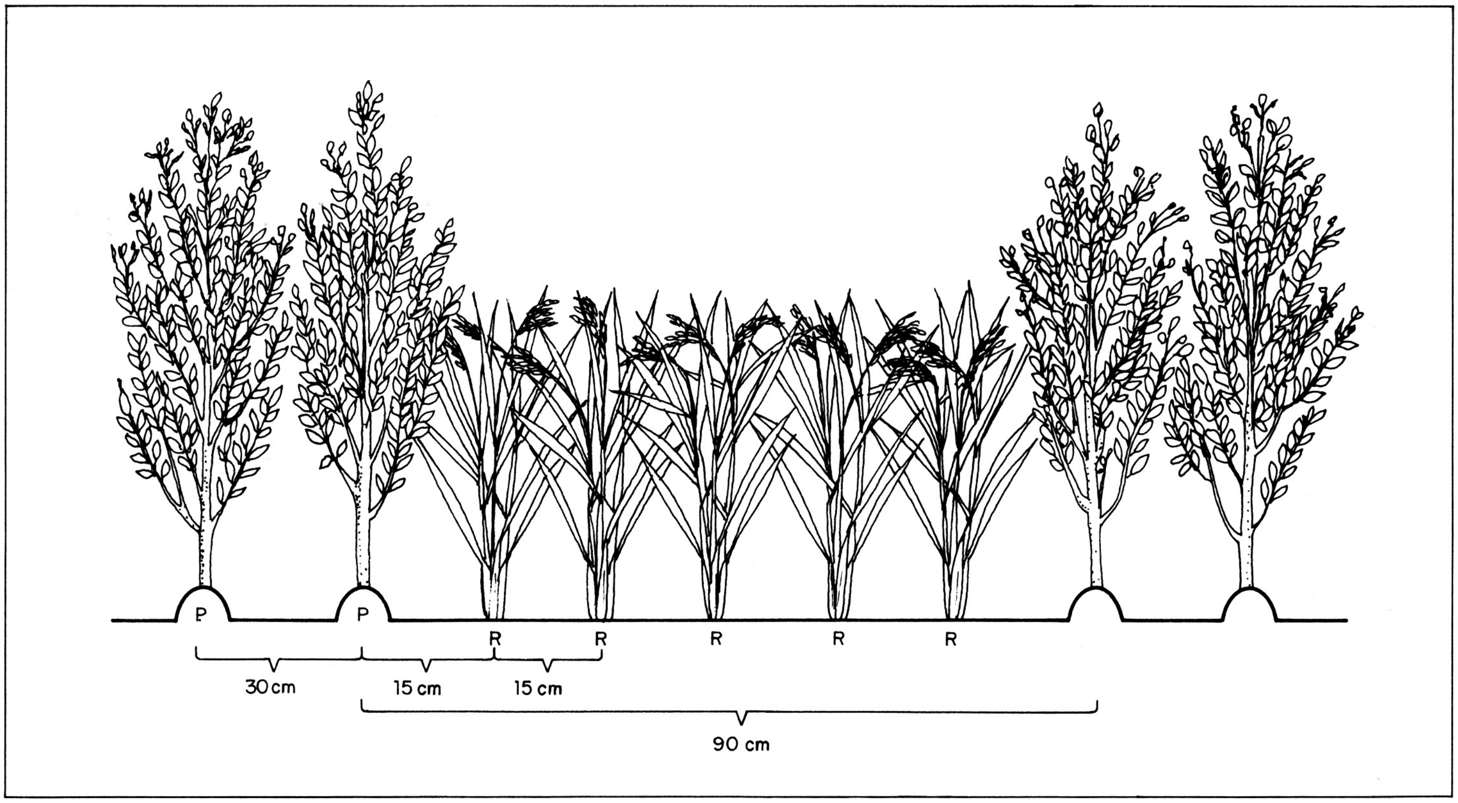
A replicated trial during 1984 and 1985 wet seasons tested the feasibility of pigeonpea + rice intercropping. Soil was laterite and sandy loam with pH 5.3, 0.04% total N, 18 kg available P/ ha, 150 kg available K/ ha, and CEC 3.8 meq/100 g.

Pigeonpea cultivar R-60 (180 d) was grown in paired rows with 30 cm spacing. In the 90-cm spacing between 2 paired rows, 5 rows of rice cultivar Subhadra (90 d) were grown with 15 cm row-to-row spacing (see figure). The pigeonpea plant population was kept constant. Rice plant population varied because of less plot area in the intercrop. Pigeonpea received 20-18-17 kg NPK and rice received 60-18-17/ha.

Yields of pigeonpea only were 0.58-2 t/ha; of rice only, 1.74-2.58 t/ha. Intercrop pigeonpea yields were 0.52-1.7 t/ha; intercrop rice, 1.20-1.36 t/ha. The land equivalent ratio varied from 1.32 to 1.69. The intercrop yielded more than 50% of the pure rice crop yield and lost only l0-15% of the pure pigeonpea yield. This could make pigeonpea + rice feasible for rainfed uplands. □



Pigeonpea (P) + rice (R) intercropping system. Orissa, India.

Influence of zero-tillage on rice stem borer (SB) larval diapause in a rice - wheat cropping pattern

C. Inayatullah, A. Rahman, and A. Majid, National Agricultural Research Centre, Islamabad, and L. Khan, Entomology Department, University of Agriculture, Faisalabad, Pakistan

Larvae of yellow SB *Scirpophaga incertulus* (Wlk.) and white SB *S. innotata* (Wlk.) overwinter in rice stubble; the adults emerge in Mar-Apr. Destruction of rice stubble after harvest and delaying planting to 20 May are recommended to control rice borers.

Rice - wheat is a common cropping pattern. The feasibility of directly drilled (zero-tillage) wheat in rice stubble was studied as a possible low-cost farm technology.

Wheat was drilled by tractor in 0.5-ha plots at 6 locations in Sheikupura and Sialkot Districts during 1985-86. The check was wheat planted using conventional cultural practices (five cultivations).

A random sample of 500 rice tillers from the following rice crops was collected the first week of Feb. In direct-drilled wheat plots, the number of SB-infested tillers (12%) was significantly higher (P = 0.05) than in control plots (3%). In the direct-drilled wheat plots, there were 1-2 (mean 1.2) live larvae/tiller, compared with 0-1 (mean 0.4) live larva/ tiller in check plots.

The increased carryover of larvae with zero-tillage wheat could be a factor limiting the next year's rice crop, if nurseries are planted before 20 May. Zero-tillage wheat is safe to grow because *Scirpophaga* do not feed on wheat. *Sesamia inferens* (Wlk.) and *S. uniformis* (Dudgn.) have been reported to attack rice and wheat in small numbers, but they could not be detected during this study.☐

Rice-based cropping systems under irrigation in North India

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Rice is becoming a more important crop during the Jun-Oct monsoon season in irrigated areas of North India because of its higher yield potential and better market price. It has even replaced maize in areas where soils are coarse textured with high permeability. We evaluated rice-based cropping systems for those areas.

A 1983-86 field trial included 9 crops fitted into 7 crop rotations: four 1-yr and three 2-yr. Soil was well-drained (saturated hydraulic conductivity **1** cm/h) sandy loam (Fluvent) with neutral soil reaction and medium soil fertility.

Rice-equivalent yields and net returns from rice-based cropping systems evaluated in North India, 1983-86.

Rotation	Rice-equivalent grain yield (t/ha per yr)	Net return ($/ha per yr)	Benefit-cost ratio
Rice - wheat [a]	9.9	500.00	1.22
Rice - linseed - black gram [a]	8.3	423.00	0.98
Rice - toria - wheat - black gram [a]	12.3	491.30	0.7 7
Rice - linseed - maize (fodder) [a]	10.8	532.50	1.28
Rice - sugarcane + wheat - potato - green gram [b]	13.1	413.90	0.5 3
Rice - toria - sugarcane - wheat - black gram [b]	10.2	416.70	0.80
Rice - wheat - sugarcane - potato - black gram [b]	15.4	524.20	0.5 9
CD (5%)	1.0	50.90	–

[a] One-year crop rotation. [b] Two-year crop rotation.

A 2-yr rotation of rice - wheat - sugarcane - potato - black gram gave the highest rice-equivalent grain yield; rice - linseed - black gram gave the lowest (see table). Rice - wheat, the most popular crop rotation of the area, was next to last in grain production. The best 1-yr crop rotation was rice - toria - wheat - black gram.

Rice - linseed - maize (fodder) gave the highest net returns, equal to rice - wheat, rice - toria - wheat - black gram, and rice - wheat - sugarcane - potato - black gram. The highest benefit-cost ratio was with rice - linseed - maize (fodder), followed by that with rice - wheat. ☐

ERRATA

D.K. Kundu, F.N. Ponnamperuma, and H.U. Neue. An improved method of representative sampling from aerobic soil solutions. 11 (6) (Dec 1986), 35-36.

The corrected article is reprinted below.

An improved method of sampling representative solutions from aerobic soils

D.K. Kundu, F.N. Ponnamperuma, and H. U. Neue, Soil Chemistry Department, IRRI

Analysis of a solution collected in situ from aerobic soil can be used for characterizing the soil chemical environment of upland rice. However, it is difficult to obtain samples from aerobic soils with moisture contents near field capacity (FC). The displacement method for well-packed FC moist soil columns has not been tested for validity under normal pot culture conditions. We evaluated samples collected by the conventional displacement method from three FC moist potted soils with different hydraulic conductivities.

Twelve kilograms each of air-dried (>2 mm sized) Luisiana clay, Maahas clay, and Pila loam soils were placed in 16-liter porcelain pots fitted at the bottom with drainage (coarse sintered glass) tubes. The soils were brought to FC moisture using tensiometers.

To collect soil solutions, 0.5% KSCN as displacing liquid was poured on the soil surfaces. The displaced solutions were drained into measuring cylinders. We tested the collected solutions for SCN-ion at regular intervals. Drops of acidic $FeCl_3$ solution were used as the indicator (a blood red-colored complex is formed).

From the fast-draining Luisiana clay and Pila loam soils, we could collect only 20-30 ml of soil solution. Beyond this volume, the leachate was diluted by the displacing liquid. In slow-draining Maahas clay, no displacent appeared in the first 200 ml. About 175 ml of soil solution is needed for a complete analysis; the displacement method was not appropriate for soils with fast drainage properties.

In a second experiment, we compared soil solution collected by the displacement method with equilibrated saturation extracts of three soils. Equilibrium was ensured by recycling the saturation extracts three times. Saturating an FC moist soil, then immediately draining it does not give equilibrium extract. Allowing FC moist soils to remain saturated for a long time (beyond 8 h in many cases) might cause soil reduction.

We used three soils set up as in the first experiment, replicated six times. Demineralized water, in volumes required to bring the FC moist soils to saturation, was poured on the soil surface. The first 125-ml leachates were collected as the displaced solutions, and the rest as saturation extract.

The extracts were then recycled through soils three times, first allowing them to remain in contact with soil for about 30 min by keeping the drain tube closed. The final (fourth) extract was collected as the equilibrated saturation extract. To prevent further oxidation, the soil solutions were collected in flasks prefilled with N_2 gas.

We measured solution pH and Eh in an electrometric cell under N_2 environment. The recycled saturation extracts were representative of soil solutions; the displaced solutions were seriously diluted and altered by the displacing liquid (demineralized water, pH 5.38) (see table).

During subsequent experiments, we observed that it is necessary to recycle the saturation extract three times in fast-draining soils; recycling once or twice seldom ensured equilibrium. □

Comparison of pH and Eh values[a] of solutions from FC moist soils collected by 2 different methods.

Soil	Soil pH (1:1)	pH: Displaced solution	pH: Recycled saturation extract	Eh (V): Displaced solution	Eh (V): Recycled saturation extract
Luisiana clay	4.1	4.6 a	4.5 b	0.31 b	0.32 a
UK-1 clay loam	6.6	5.9 b	6.5 a	0.29 a	0.26 b
Pila loam	1.5	6.9 b	7.3 a	0.21 a	0.23 b

a Mean of 6 replications. In a row, treatment means of a given parameter having a common letter are not significantly different by DMRT at 5% level.

R.D. Daquioag, P.O. Cabauatan, and H. Hibino. Balimau Putih. Cultivar tolerant of rice tungro-associated viruses. 11 (6) (Dec 1986), 8.

Please replace the printed table with the corrected copy given here.

Reaction of Balimau Putih and TNl in RTBV and RTSV by test tube inoculation of RTBV and RTSV at 5 insects[a] per seedling. IRRI, 1986.

Variety	Plants (no.) infected with[b]: RTBV+ RTSV	RTBV	RTSV	Healthy plants (no.)	Infection (%)	Height reduction (%): RTBV+ RTSV	RTBV	Yield reduction (%): RTBV+ RTSV	RTBV
TN1	87	31	0	8	93.6	41.6	21.3	90.0	50.0
Balimau Putih	46	68	3	5	95.9	11.4	5.0	18.4	7.6

[a] Green leafhopper *Nephorettix virescens* were given 4 d access to TN1 plants infected with both RTBV and RTSV. [b] Total of 4 trials. Detected by ELISA.

Announcements

Spanish translation released

The Spanish edition of *A methodology for on-farm cropping systems research* by H.G. Zandstra, E.C. Price, J.A. Litsinger, and R.A. Morris has been released. The International Development Research Centre of Canada translated and published the edition in cooperation with IRRI. IDRC has distributed copies of the book to all Latin American agricultural libraries on the IRRI mailing list. Copies also may be ordered from IRRI, P.O. Box 933, Manila, Philippines. Price is US$5 LDC and US$16.70 HDC.

Book on nitrogen in flooded soils published

Recent findings from basic studies on N transformation processes and technology development are summarized and updated in *Nitrogen economy offlooded rice soils,* published July 1986 by Martinus Nijhoff Publishers, The Netherlands. IRRI Agronomist S.K. De Datta was co-editor with W.H. Patrick, Jr.

Rice commonly utilizes less than 40% of applied fertilizer; current studies focus on minimizing N losses and maximizing N use efficiency.

Nitrogen economy offlooded rice soils (ISBN 90-247-3361-8) can be ordered from Kluwar Academic Publishers Group, P.O. Box 322, 3300 AH Dordrecht, The Netherlands, at US $60.50.

Oryza, a quarterly rice research journal

Oryza is inviting the world's rice research workers to submit reports of their research. A publication of the Association of Rice Research Workers (ARRW), Cuttack, India, *Oryza* (ISSN 0474-7615) carries original work and critical reviews in English on all aspects of rice research. Papers in *Oryza* are abstracted in many abstracting journals.

Although contributors to *Oryza* usually are required to hold membership in ARRW, the editor-in-chief can waive the requirement for authors who face difficulties making payment toward membership.

Oryza guidelines follow:

- Full-length papers, short communications, or critical reviews should be typed double-spaced.
- Manuscript copy should include 1) title, 2) name and address of each author, 3) abstract, 4) introduction, materials and methods, results, and discussion, 5) acknowledgments (if any), 6) references, 7) tables, 8) figures and legends.
- Tables and figures should be self-explanatory and should include appropriate measures of variability.
- Routine testing of varieties, chemicals, etc., are *not* published.
- Send original typed manuscript and one copy with two copies of all illustrative materials to Editor-in-Chief, ORYZA, Association of Rice Research Workers, Cuttack 753006, India.
- Reprints (25) will be supplied authors who are members of ARRW. □

New IRRI publications

Helpful insects, spiders, and pathogens — friends of the rice farmer

IRRN index for 1986

Upland rice: a global perspective

Progress in rainfed lowland rice □

Rice IPM Newsletter

In July 1987, IRRI will begin publication of the quarterly Rice IPM Newsletter for researchers, extension workers, and policy makers interested in integrated pest management (IPM) for rice. Its purposes are to provide a central source of information on the key theories and practices of rice IPM and to promote the exchange of information. The newsletter will include current issues in rice IPM, examples of IPM systems, requests for research collaboration, reviews of IPM publications, extension notes and information, and announcements of meetings, workshops, and training programs.

Please note that research papers will not be accepted. Current research notes should continue to be directed to the *International Rice Research Newsletter.*

Send requests for subscriptions and items to be published to: *The Rice IPM Newsletter*, Kevin D. Gallagher, Dept. of Entomology, IRRI, PO Box 933, Manila, Philippines.

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