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Contents

Guidelines and Style for IRRN Contributors

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

Style

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

Guidelines

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

Genetic evaluation and utilization

OVERALL PROGRESS

Occurrence of rare elements in rice plants

R. Perumal, Tamil Nadu Rice Research Institute, Aduthurai, India

Mass spectra (Ms-702 mass spectrograph) of the flag leaves of some rice varieties revealed the presence of the rare elements Cr, As, Br, Sr, Ag, Ba, and Pb as well as that of essential elements. We estimated the amount of such rare elements (see table). □

Estimated levels of rare elements in rice plants, Aduthurai, India

Element	Quantity (ppm) of element[a]			
	Ponni	Co 25	IR50	IR26
Cr51	53	52	54	54
As75	2	2	1	2
Br79	3	3	3	3
Sr88	12	14	14	15
Ag107	1	1	1	2
Ba138	1066	1017	1270	1437
Pb208	5	5	5	8

[a] The values presented are on ash weight basis relative to silicon, used as an internal standard. Percent silicon is about 18%. The estimate of the volatile element As is approximate because of probable loss during ashing.

CN505-5-32-9, a photoperiod-sensitive semidwarf for rainfed lowlands

S. Mallik and S. Biswas, Rice Research Station (RRS), Chinsurah 712102, India

CN505-5-32-9, a promising lowland rice, is from the cross IR26/SML 40-10-4. Selection from F_2 was made at the RRS, Chinsurah, as part of the rainfed lowland breeding program. Different generations were evaluated for drought tolerance at early vegetative stage, waterlogging (50 cm deepwater), and pest resistance. Considering local yield trials in 1979, 1980, and 1981, in which CN505-5-32-9 averaged 5 t/ha, it was nominated for the 1982 kharif All India Coordinated Rice Improvement Project deepwater trials and was evaluated at Tripura (West

Table 1. Yield performance of CN505-5-32-9 at different sites in India.

Site	Yield (t/ha)		Experimental mean (t/ha)	CD (0.05) (kg)	Max water depth[a] (cm)
	CN505-5-32-9	Tilakkachari (check)			
Arundhu tinagar (Tripura)	6.4	4.1	3.9	992	NA
Chinsurah (West Bengal)	5.8	4.3	4.1	654	40
Sindri (Bihar)	3.4	1.3	1.1	826	50
Pulla (Andhra Pradesh)	3.3	1.9	2.3	508	70
Patna (Bihar)	3.1	2.8	2.0	781	NA
Mean	4.4	2.9	2.7		

[a] NA = not available.

Table 2. Height and duration of CN505-5-32-9 under different sowing and land situations at RRS Chinsurah (22.9°N, 88.4°E).

Sowing date	Culture	Land situation	Max water depth (cm)	Height (cm)	Days to flower
19 Mar 1982	Transplanted	Lowland	30	112	232
19 Mar	Transplanted	Medium land	5	102	235
30 Mar	Direct seeded	Lowland	40	135	215
31 Mar	Direct seeded	Upland	0	110	225
29 Apr	Transplanted	Lowland	45	113	190
2 Jun	Direct seeded	Lowland	70	138	160

Bengal), Bihar, and Andhra Pradesh. Mean grain yield over 5 locations was 4.4 t/ha and was more than that of check variety Tilakkachari (2.9 t/ha). At Arundhutinagar, it yielded around 6 t/ha. The water level varied from 40 to 70 cm in the test locations (Table 1).

CN505-5-32-9 is photoperiod sensitive and flowers the first week of Nov when day length is 11 h 50 min. It has stiff culms and moderate elongation capacity, and is 110 cm tall when grown in shallow water, but can elongate to 138 cm in deep water (Table 2).

CN505-5-32-9 produces 250 panicles/m^2 and long bold, white grains. The 1,000-grain weight is 24.8 g. It is resistant to bacterial leaf blight and brown spot. □

GENETIC EVALUATION AND UTILIZATION

Agronomic characteristics

Pant Dhan 4, a medium-maturing rice variety for irrigated lands

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Pant Dhan 4, a medium-maturing, dwarf (93 cm) rice variety was released recently in U. P. for cultivation in irrigated fields. It was developed in Sri Lanka from the cross IR262/Remadja and tested in the International Rice Observational Nursery as BG90-2 in 1974. The plants have good tillering capacity, mature in 126-132 d, and have high yield potential. Grains are long, slender, and translucent, with good cooking quality. It is moderately resistant to bacterial leaf blight and will be a good substitute for Jaya, which has become susceptible.

Pant Dhan 4 was tested in station trials from 1976 to 1980 and in state variety trials from 1979 to 1982 (see table). □

Performance of Pant Dhan 4 in state variety trials in Uttar Pradesh, India.

Trial centers	Grain yield (t/ha)		CD at 5%	CV in 5%	Days to maturity	
	Pant Dhan 4	Jaya			Pant Dhan 4	Jaya
			1981 kharif			
Azamgarh	4.6	4.6	0.1	1.8	134	131
Bareilly	7.0	6.7	0.2	2.1	133	141
Haldwani	7.2	5.4	1.2	12.4	139	143
Hardoi	4.1	4.3	0.2	4.3	124	135
Mathura	5.1	4.8	0.3	4.5	123	130
Meerut	2.0	1.7	0.3	12.6	140	141
Jhansi	2.1	2.5	0.6	16.1	123	127
Barabanki	3.2	3.6	0.4	7.9	122	129
Etawah	3.1	4.3	1.0	20.6	122	126
Varanasi	3.1	3.5	1.5	12.0	110	126
Average	4.2	4.2	–	–	126	133
			1982 kharif			
Azamgarh	3.8	4.5	0.09	1.73	131	133
Bareilly	5.9	5.6	0.07	0.75	132	139
Haldwani	5.8	5.5	0.9	9.8	152	154
Hardoi	4.8	4.7	0.3	5.3	130	138
Mathura	4.3	4.6	0.2	3.2	115	128
Meerut	6.3	4.5	1.0	10.8	139	139
Jhansi	5.6	4.7	N.S.	22.2	129	137
Barabanki	–	–	–	–	–	–
Etawah	–	–	–	–	–	–
Varanasi	–	–	–	–	–	–
Average	5.2	4.9	–	–	132	138

Variation of ripening periods among rice genotypes

J. P. Saini and J. P. Tandon, Vivekananda Parvatiya Krishi Anusandhan Shala, Indian Council of Agricultural Research, Almora, Uttar Pradesh, India

Most of the photosynthates accumulated as grain yield are formed from anthesis to senescence. Little information is available on the extent of variation in this duration. We sought to define ripening period for rice genotypes with a wide range of maturity duration. The entries were from different rice growing regions and included some local hill collections. Entries were transplanted in irrigated fields on 15 Jul 1981 and 1982 at Almora, at 1,600 m above sea level. Of an initial 100 entries, 9 were dropped because they did not

Vegetative and grain ripening periods in days for different rice types, Almora, India.

Duration	Genotypes (no.)	Duration (d)			
		Preanthesis		Postanthesis	
		Mean	Range	Mean	Range
Short	20	80	65-87	37	20-43
Medium	45	96	88-105	36	30-44
Medium-long	22	100	106-114	40	33-48
Long	4	120	115-125	37	28-45

flower normally. Data were recorded for primary tillers when anthesis began and when 75% of the florets showed glume senescence.

Entries flowered between the third week of Aug and the first week of Oct. Preanthesis phase ranged from 65 to 125 d (see table). Average period from anthesis to glume senescence (ripening period) varied from 28 to 48 d. Ripening period was not related to length of pre-anthesis period (r=-0.10), and the different maturity groups had similar ranges.

Short-duration cultures flowered the last 2 wk of Aug when average temperatures were relatively higher (23.0°C). Long-duration entries flowered the first week of Oct when average temperatures were lower (17.5°C). The similar range of durations among genotypes of the two groups indicates that the observed variation was not caused by temperature differences and is in fact a varietal character.

Genotypes with short ripening duration (around 30 d) were Daegaldo and Heug-Jodo (early); Jodo, Mujudo, and Deog-Jeog-Jodo (medium); Kaoshang 27, IR9202-23-2, IAC25, China 988, and Thapuli (medium-long); and C21 and China 4 (long). Long ripening period (around 40 d) was recorded for L 100-A, Nancee, K333, and Kitakogan (early); JC99, IR80-102, Khonorullo, Barmi, and Eiko (medium); Chinan 2, Tapuno, Norin 18, VL 8, and Taichung 176 (medium-long); and Kalimpong (late). □

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Reaction of several rice varieties to rice tungro virus (RTV) complex

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The presence of RTV complex in non-IR varieties with different reactions to tungro infection and to its vector, green leafhopper (GLH) *Nephotettix virescens,* was determined by latex test using antisera to rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). Eleven-day-old seedlings were mass-inoculated with an average of five tungro-viruliferous insects per seedling. Only plants that exhibited tungro-like symptoms were included in this test.

We also studied the effect of an increased number of viruliferous insects per seedling on RTV complex infection in five resistant varieties: Gam Pai 30-12-15, Pankhari 203, Habiganj DW8, Utri Rajapan, and ARC1 1554. In a screen cage, the seedlings were mass-inoculated with 25 viruliferous GLH/seedling for 3 h with TNl as the virus source. Healthy TN1 seedlings with one insect per seedling in test tubes were inoculated simultaneously with viruliferous insects taken from this colony. All inoculated plants were evaluated using the latex test.

Results indicated that RTBV and RTSV were generally present in varieties with susceptible and intermediate reactions to

Table 1. Presence of RTBV and RTSV as detected by the latex test in non-IR varieties mass-inoculated by an average of 5 insects/seedling, IRRI.

Variety	Reaction to		Plants tested	Plants (no.) that reacted to the presence of			Plants (no.) with no
	GLH[a]	RTV[b]	(no.)	RTBV+RTSV	RTBV	RTSV	reaction
Gam Pai 30-12-15	R	R	21	0	16	0	5
ARC11554	R	R	11	1	9	0	1
Pankhari 203	MR	R	20	1	16	0	3
Habiganj DW8	MS	R	12	1	11	0	0
Utri Rajapan	MS	R	19	11	8	0	0
Bremli	S	I	22	22	0	0	0
KU115	S	I	19	19	0	0	0
R21	S	I	25	25	0	0	0
Tosidongi	S	I	12	10	2	0	0
Liao-Feng 4	S	I	16	5	11	0	0
Naylamp	MR	S	18	12	6	0	0
ARC5929	S	S	8	8	0	0	0
63-83	S	S	20	19	0	0	1
AUS 100	–	S	18	18	0	0	0
Kuatik Putih	MR	S	24	24	0	0	0
TN1 (check)	S	S	24	21	3	0	0

[a] Data from IRRI Entomology Department. [b] Greenhouse mass screening results, IRRI Plant Pathology Department: 0-30% infection = resistant (R), 31-40% = intermediate (I), 60-100% = susceptible (S).

Table 2. Presence of RTBV and RTSV as detected by latex test in resistant non-IR varieties mass-inoculated by an average of 25 insects/seedling, IRRI.

Variety	Plants tested	Plants (no.) that reacted to the presence of			Plants (no.) with no
	(no.)	RTBV+RTSV	RTBV	RTSV	reaction
Gam Pai 30-12-15	21	1	8	0	12
Pankhari 203	21	0	8	0	13
Habiganj DW8	35	0	19	0	16
Utri Rajapan	32	6	12	1	13
ARC11554	41	0	14	0	27
TN1[a] (check)	19	16	2	0	1

[a] Inoculated in test tube at one insect per seedling.

the disease, except for Liao-Feng 4. RTBV alone usually was observed on resistant varieties, except Utri Rajapan (Table 1). Even when the viruliferous insects were increased, infected plants of tungro-resistant varieties usually contained RTBV alone, with the exception of Utri Rajapan (Table 2). Infected resistant varieties developed milder symptoms and were not a virus source for the spread of RTV. □

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Screening for resistance to rice hispa

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Rice hispa *Dicladispa armigera* (Oliv.) is a sporadic insect pest of transplanted rice. Adult beetles cause parallel white streaks on the leaf. The grubs are leaf miners and cause leaf tissue to wither. In 1983 kharif an unusual outbreak of rice hispa occurred in Ranchi.

To screen for resistance to rice hispa, we planted 64 cultivars of diverse origin in 2 replications in 1.6- × 5-m plots at 20- × 15-cm spacing. Percent leaves damaged was recorded from 25 randomly selected plants from each plot. Leaf damage ranged from 15.6 to 97%. OR165-94-1 (15.6% damage) and KAU1945 (18.6% damage) were moderately resistant (see table). □

Resistance of rice to rice hispa, Bihar, India.

Score [a]	Damage (%)	Variety
0	No damage	–
1	1-10	–
3	11-20	OR165-94-1, KAU1945
5	21-35	MTU6637, CR341-5-10, NRL326-3, UPR81-44, NDR312, OR79-21, OR158-7-1, RP52-2.
7	36-50	RP1848-01-3-2-1, RP1846-219-3-1, BK670, HPU804, RP1575-636-6-1, Rewa 353, RP1442-4-3-1-2, RP1575-243-719-681
9	50-100	NDU127, OR131-5-8, KAU23332-2, FH448, CO 33-83, CN834-1-7-1-2, RP1895-2-1, IR36, UPR254-24-1-1, AS19789, KD5-2-8, NDU83, OR196-2, RP1788-43-2-1-6-2, NDU80, NDR301, RP1888-1441-56-4456, BIET236, UPR79-104, BAU4090-1, Ratna, RP1699-175-112-1, BR1235, RP1831-25-2-2, UPR103-44-2, RP1388-494-145, SKL-6, UPR96-40-2, UPR79-161, Rasi, HKR1, CR268-400-5, HKR78-31, RP1570-44-1, UPR79-123, RGL-2624, RP1699-26-1-1, RAU4056-53-5, NSRP11, RP1699-174-97-1, RP1699-183-133-1, RP1831-20-4-5, RP1898-6, Pusa 245-1-17-1, NDR302, KR10-47.

[a] 0-9 scale: 0 = resistant, 9 = susceptible.

Screening rice varieties for resistance to whitebacked planthopper

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Whitebacked planthopper (WBPH) *Sogatella furcifera* is a serious rice pest in Indonesia. We screened 206 breeding lines for WBPH resistance at the BORIF greenhouse in 1982-83 wet seasons.

A seedbox screening test was used and lines were scored by the Standard Evaluation System for Rice (see table). The 33

Performance of 9 lines with resistance to whitebacked planthopper, Bogor, Indonesia.[a]

Line	Score [b]	Eggs laid [c] (no.)	Insects (no.) on the plant [d]		
			1 DI	2 DI	3 DI
B3728d-pn-39-3-2	3	11.2 a	8.3 d	10.0 b	8.5 b
B5198b-84-Mr-3	3	13.8 a	7.3 cd	2.0 a	2.5 a
B3825e-Kn-45-2-3	3	11.2 a	7.0 bcd	3.3 a	3.0 a
B3894-17c-Sm-54-2	3	10.8 a	7.3 bcd	4.8 a	4.3 ab
B4032d-Mr-1-3-1	3	13.0 a	3.5 ab	4.8 a	2.5 a
IR5657-33-2-2-3	3	24.8 b	5.0 abcd	3.8 a	5.3 b
IR13240-102-2-Mr-6	3	12.6 a	6.8 abcd	4.0 a	2.3 a
IR5853-198-1-Mr-3-2	3	10.0 a	3.8 abc	4.5 a	1.5 a
IR5853-198-1-Mr-3-3	3	10.6 a	3.8 abc	4.8 a	3.8 a
TN1 (susceptible check)	9	38.6 c	11.8 a	12.0 b	13.5 c
Colombo (resistant check)	3	–	–	–	–
Rathu Heenathi (resistant check)	3	11.2 a	3.25	3.0 a	1.0 a

[a] Means in a column followed by the same letter are not significantly different at the 0.05 level. [b] Scoring by Standard Evaluation System for Rice: 0 = highly resistant, 9 = susceptible. [c] Av of 5 replications. [d] Av of 4 replications. DI = days after infestation.

lines that showed resistance in the first test were screened again. For the 9 that still showed resistance, insect preference and the number of eggs laid on leaves of each rice line were recorded. Resistant Colombo and Rathu Heenati and susceptible TN1 were used as controls.

Lines with high resistance scores had fewer eggs and fewer insects than susceptible TN1. IR5853-198-1-Mr-3-2 had fewest eggs and insects. □

Reaction of rice varieties to gall midge in Tamil Nadu

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Gall midge (GM) *Orseolia oryzae* (Wood-Mason) is a destructive pest of rice in Tamil Nadu, particularly Madurai, Tanjore, and Trichi districts. Sep infestations cause 25 to 30% yield loss.

From Aug to Dec 1981, 46 prerelease and released varieties from the All India Coordinated Rice Improvement Project, Hyderabad, were field-screened at Thaniamangalam, Madurai. Each variety was grown in a single 3-m-long row in 3 replications. GM infestation was encouraged by growing TN1 on borders, cutting tillers, keeping water in the plots to attract flies, and lighting plots at night. Total number of hills infested were recorded (see table). Six varieties were not infested (see table).□

Field screening of rice varieties for gall midge resistance, Madurai, Tamil Nadu, 1981.[a]

Variety	Hills infested[b] (%)		Variety	Hills infested[b] (%)	
IET6056	45.8	a	IET7329	16.4	bcdefghij
IR20	41.7	ab	Eswarakora	15.2	bcdefghij
Chitraikar	36.3	abc	W1263	14.1	bcdefghij
TN1	35.0	abcd	IET17327	14.0	bcdefghij
Vaigai	34.3	abcde	PTB10	13.3	cdefghij
Karuna	31.3	abcdef	IET6101	13.3	cdefghij
IET6579	31.0	abcdef	IET7012	12.5	cdefghij
Chandrikar	29.7	abcdefg	IET7236	9.1	cdefghij
IET7328	28.8	abcdefgh	IET7013	8.1	cdefghij
IET7174	28.8	abcdefgh	IET6109	6.9	efghij
IET6296	28.2	abcdefghi	IET6 266	6.6	efghij
Bhavani	26.5	abcdefghij	IET6 727	4.9	fghij
Jaya	25.8	abcdefghij	IET7014	4.6	fghij
IET6730	25.2	abcdefghij	IET6293	2.7	ghij
Puduvai Ponni	24.8	abcdefghij	IET6286	1.3	hij
IR8	23.6	abcdefghij	IET7015	0.6	ij
Kakatiya	23.1	abcdefghij	Vikram	0.6	ij
IET6080	22.1	abcdefghij	IET7010	0.0	j
PTB2l	21.8	abcdefghij	Phalguna	0.0	j
MDU- 1	19.7	abcdefghij	IET7016	0.0	j
Kuruvai	17.4	bcdefghij	IET6290	0.0	j
IET6757	17.1	bcdefghij	IET7009	0.0	j
IET7026	16.5	bcdefghij	IET7008	0.0	j
CV (%) = 81.27			*F* value = 2.56** at 1% level.		

[a]Av of 3 replications. [b]Means followed by a common letter are not significantly different at 1% level.

GENETIC EVALUATION AND UTILIZATION

Hybrid rice

Isolation of maintainers and restorers for Chinese male-sterile lines

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Following successful development of cytoplasmic genetic male-sterile lines in China, heterosis breeding of rice became a commercial reality. We sought to identify effective, stable restorers for the Chinese cytoplasmic genetic male-sterile lines Zhen Shan 97A, Er Jiu Nan 1A, and V20A. We evaluated many crosses, in-

Table 1. List of complete restorers, partial restorers, and maintainers identified at Delhi and Aduthurai, India, for Chinese cytoplasmic genetic male-sterile lines, 1982.

Male-sterile line	Complete restorers (R)	Partial restorers (PR)	Maintainers (M)
	Delhi (kharif)		
Zhen Shan 97A	Pusa 245-51-1	TKM6	Pusa 3 12
	Pusa 212	ADT33	Pusa 150-21-1
	IR26	IR9782-111-2-1-2	ITA225
	IR36	Pak Bas 177	ITA 119
	IR9761-19-1	Gharbharan	ITA118
	IR19793-25-2-2-2	Ratna	ITA141
	IET4141	Saket 4	ITA117
	Mijingem		ITA175
			ITA 116
			AC5725
			Bas 370
			Type 3
			Karnal Local

Continued on next page

cluding traditional tall and improved dwarf varieties and elite breeding lines at Delhi in kharif and at Aduthurai in kuruvai and summer. Percent spikelet fertility of F_1 hybrids was used as fertility index. Lines that restored 80% or more spikelet fertility were classified as complete restorers, those restoring between 79% and 10% were partial restorers, and those with less than 10% were called maintainers (see table).

Results of crosses of the three male-sterile lines with pollinators indicate that they have a similar cytoplasmic background. The study suggested that environment may influence the level of fertility restoration. For instance, ADT33, which was classified as a complete restorer to V20A during kuruvai at Aduthurai, was only a partial restorer to Zhen Shan 97A and V20A during kharif at Delhi. Similarly, NDC50, which was a complete restorer to V20A at Delhi, was a partial restorer to Er Jiu Nan 1A during summer at Aduthurai. However, most restorers or maintainers performed consistently. IR26, Pusa 37-3, and Pusa 245-51-1 were among the most effective and stable restorers and showed good hybrid vigor. □

Table continued.

Male-sterile line	Complete restorers (R)	Partial restorers (PR)	Maintainers (M)
	Delhi (kharif)		
V20A	Pusa 518-1 Pusa 245-51-1 Pusa 37-3 Pusa 212 IR19793-25-2-2-2 IR50 IR9761-19-1 IR52 IR36 IR26 NDC28 NDC50 IET4141 Mijingem	Pusa 167-120-3-2 Pusa 293-42-1 Pusa 499-6-3 Pusa 152-1 Pusa 150-82-1-2-3 Pusa 371-2-8-2 IR9782-111-2-1-2 IR30 IR43 ADT33 BJ1 TKM6 Pak Bas 177 Gharbharan Ratna Saket 4	Pusa 147-2 Pusa 33-18-1 Pusa 312 ITA118 ITA141 ITA117 ITA175 ITA116 ITA225 ITA162 ITA183 UPRM500 PAU29 AC5725 Bas 370 Nagina 22 Type 3 Karnal Local Imp. Sabarmati BPi-Ri-6 CH1039 dwarf mutant
	Aduthurai, 1982 summer		
Zhen Shan 97A	Pusa 269 ADT35 ASD15 J141 ITA 164	IR13256 Kapoor Chini NDC88 PR106 Jaya	Culture 340 Pusa 312 PAU29 CH1039 dwarf mutant Peta
Er Jiu Nan 1A	UPI-Ri-3 Mijingem D241 C171-120 CR156-50-21-207 IET4141 Pusa 512-1 Pusa 269 Pusa 145 Pusa 5164-1 Pusa 29342-1 IR9671-19-1 IR5853-68 IR89974-4-2 IR26 IR36 IR50 IR52	Pusa 371-5-2 Pusa 150-82 ADT35 NDC50 Pak Bas 177 Gharbharan DGWG	Pusa 368-1 CH41 Co 33 TKM8 Seratus Malam MTU3419 ITA 116 ITA225 ITA173 PAU29 BPi-Ri-6 IR32
V20A	IR50 ASD15 ADT35	Pusa 152-1	Pusa 312 CR1014 UPRM500
	Aduthurai, 1982 kuruvai		
Zhen Shan 97A	RSII Pusa 269 ASD11	IR20 Ponni Pusa 150 Pusa 506-1-1-1	CH1039 dwarf mutant
Er Jiu Nan 1A	UPI-Ri-3		IARI 10560 Seratus Malam Co 33 Bas 370
V20A	IR9828-91-2-3 Ponni ADT33 ASD15 Mahsuri Boothy	Pusa 150	

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.

Adverse soils tolerance

Screening for salinity tolerance by rapid generation advance

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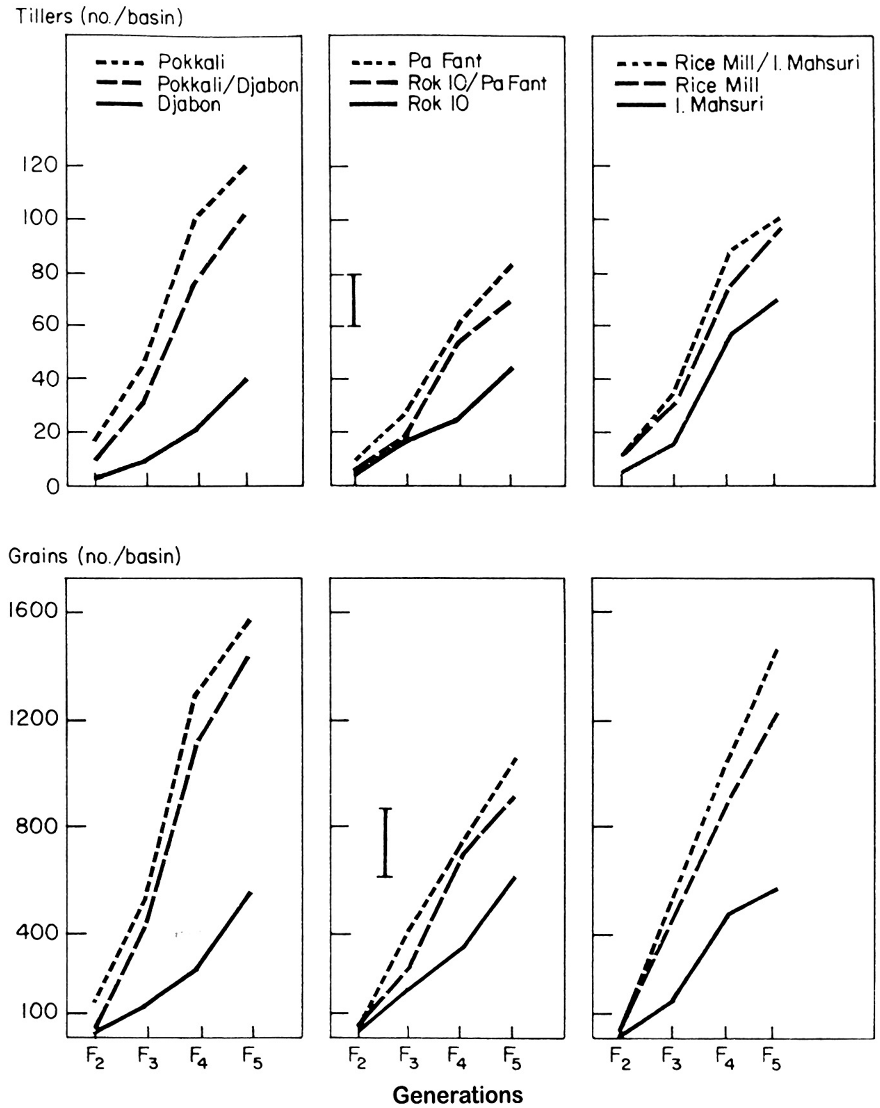
Considerable intravarietal variation in levels of salinity tolerance of rice varieties has been reported. We sought to improve salt tolerance by selecting within crosses and parents and comparing progress over five generations.

One hundred eighty seeds of each variety or cross (see figure) were closely spaced in plastic basins 25 cm in diam × 20 cm deep, filled with mangrove soil. Four weeks after sowing, the plants were subjected to 60 mM NaCl concentration for 2 wk by submerging the basins in salt solution. After exposure to salt, the plants were induced to flower by shortening the day length to 8 h for 2 wk. Surviving plants (tillers) were grown to maturity. Seeds of each variety or cross were harvested and bulked for use in the next generation. The cycle was repeated for three more generations (F_3-F_5).

F_6 seeds of each cross were grown in three 5-m rows at 25- × 25-cm spacing in a saline mangrove swamp. Forty kg N/ha was applied as urea by injection. Selection of suitable genotypes was primarily by tiller number/plant.

Results indicated that successive generations could be grown continuously and only plants that are highly or moderately tolerant of salt will survive to go to the next generation (see figure). Highly sensitive individuals died after exposure to 60 mM NaCl solutions for 2 wk. Mean salt tolerance of all the varieties or crosses increased with each generation, but the degree of tolerance was significantly different ($F = 7.1$, $P<0.01$ for tiller number, and $F = 6.5$, $P<0.01$ for number of filled grains).



Varietal response to selection for salinity tolerance during rapid generation advance. Vertical bar represents the LSD ($P < 0.05$) between any two points. Correlation coefficient = ($r = 0.86$ $dF = 34$ $P < 0.001$) between tiller number and total grain number.

Field performance of F_6 plants from the screenhouse test. Readings were taken on selected plants only.

Cross	Selected plants (no.)	Mean tillers (no.)	Range of tillers (no./plant)
Pokkali/Djabon	7	18.4	13-26
Pa Fant 213/Rok 10	9	20.6	14-32
Improved Mahsuri/Rice Mill	35	15.8	11-27

Selection for other characters like plant height and tiller number per plant was not possible during rapid generation advance because of the narrow range within which varieties were distributed. Selection for suitable morphological characters is only possible in the saline swamp in subsequent generations (F_6-F_7), where selection should be easier because only nearly fixed lines would be available. The range of various characters of F_6 plants (see table) grown in the field showed that the variability was not lost over several generations of selfing in the rapid generation process. Rapid generation speeded the cycle without affecting individual plant potential for other morphological characters. □

Evaluation of some elite rice cultures for intercropping on Oxisols in coconut gardens

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Most coconut gardens in Kerala are planted on sloping terrain on Oxisols. Because 85% of the gardens are rainfed, coconut and long-duration perennial intercrops such as banana, cassava, and pineapple suffer severe moisture stress from Dec to May. Planting short-duration crops like upland rice during the monsoon (Jun-Nov) may reduce competition between coconut and intercrops for soil moisture. Upland rice cultivation in the rainfed coconut gardens could be lucrative, with suitable varieties and management practices.

Seven rice cultivars from the Central Rice Research Institute and one local cultivar (see table) were grown in a randomized block design in a coconut garden with 40-year-old palms spaced 8 × 8 m at Kottamparamba (11° 15'N, 75° 52' E, altitude 80 m above sea level) 1980 monsoon. Plot size was 4 × 2 m. Farmyard manure at 5,000 kg/ha, lime at 250, N at 40, P at 20, and K at 20 were applied. NPK was applied in equal splits 15 and 30 d after sowing, both applications in combination with hand weeding. Bunds were opened to minimize standing water. Appropriate insect controls were used. Rice was harvested in Sep.

CR143-2-2, MW10, AUS61, and CtG 1516 yielded more than 4 t/ha (see table), twice that of the local check. Although the data are for 1 year only, the study indicates the wide scope for adopting suitable rice varieties for intercropping in coconut-based cropping systems. □

Yield data of upland rice intercropped with coconut. 1980 kharif.[a]

Variety	Yield (t/ha)	Panicles (no./m^2)	Grains/ panicle (no.)	1,000-grain wt (g)	Sterility (%)	Harvest index	Duration (d)
CR143-2-2	4.5	205	79	27	22	0.98	103
MW10	4.5	212	79	27	12	0.97	103
CR16 2-2	3.4	196	73	24	12	1.28	96
AUS61	4.2	114	184	20	15	0.59	109
BG35-2	3.7	181	63	31	43	0.62	109
CtG1516	4.2	186	94	24	9	0.94	96
ARC7001	3.7	204	61	26	27	0.69	96
Local check	2.1	218	37	29	25	0.55	99
LSD (0.05)	967.5	NS	18.8	1.9	1.9	15.14	0.05

[a] Sowing date = 6 Sep 1980. Spacing = 20 × 10 cm. Plot size (harvested) = 3.4 × 1.6 m. Soil pH was 5.5 (0-30 cm depth). Rainfall in Jun, Jul, Aug, and Sep 1980 was 1369, 1325, 611, and 115 mm. Normal rainfall is 944, 1117, 599, and 262 mm.

Performance of rice varieties in sodic soils

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We assessed tolerance levels of varieties P2-21, Jaya, IR8, and CSR1 to highly sodic soils at Gudda Research Farm and to semireclaimed sodic soils at Karnal in 1982 kharif. Soil at Gudda was a sandy loam with pH 10.5, 92% exchangeable sodium, exchangeable Ca + Mg 0.4 meq/100 g, 0.23% organic carbon, and cation exchange capacity 9.0 meq/100 g. Soil at Karnal was a sandy loam, with pH 8.7, 10% exchangeable sodium, exchangeable Ca + Mg 7.50 meq/100 g, 1.30% $CaCO_3$,

Relative performance of rice varieties in sodic and semireclaimed sodic soil.

Variety	Grain yield (t/ha)	Height (m)	Productive tillers/ hill	Panicle length (m)	pH after rice harvest[a] 0-15 cm	pH after rice harvest[a] 15-30 cm	% reduction of grain yield
				Semireclaimed sodic soil[a] in Karnal			
Jaya	7.2	92.7	9.6	21.3	8.5	8.8	–
IR8	7.5	98.8	9.8	21.1	8.5	8.7	–
P2-21	6.4	87.6	9.6	20.3	8.6	8.8	–
CSRl	4.5	136.6	9.5	19.4	8.5	8.7	–
CD (P = 0.05)	0.4	3.6	NS	1.5			
				Sodic soil at Gudda			
Jaya	0.8	56.4	7.5	15.4	10.2	10.3	89
IR8	0.7	57.2	7.6	15.5	10.2	10.2	90
P2-21	0.8	64.5	7.4	15.6	10.1	10.3	87
CSRl	1.7	90.4	10.4	15.6	10.1	10.2	66
CD (P = 0.05)	0.04	4.8	1.3	NS	–	–	–

[a] Initial pH (0-15 cm) was 8.7 for semireclaimed sodic soil and 10.5 for sodic soil.

and cation exchange capacity 10.0 meq/ 100 g.

Rice was transplanted 14 Jul. Soils had adequate available P and K, but all varieties received 150 kg N/ha as urea in 3 equal splits (at transplanting and at 25 and 50 d after transplanting) and 25 kg $ZnSO_4$/ha at transplanting. The experiment had four replications.

In Karnal, P2-21 was harvested 1 Oct, Jaya and IR8 were harvested 26 Oct, and CSRl was harvested 11 Nov. Sodic soil at Gudda delayed maturity and the same varieties were harvested on 14 Oct and 10 and 18 Nov.

Yields of Jaya and IR8 were similar at Karnal, and were significantly more than that of P2-21, which yielded significantly more than CSRl (see table). On sodic soil, however, Jaya, IR8, and P2-21 yielded similarly and were significantly inferior to CSR1.

All varieties yielded much less in sodic soils than in semireclaimed sodic soil. The mean pH of the sodic soil decreased from 10.5 to 10.2 because of rice cultivation. □

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Yield characters for cold-tolerant rice

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We studied yield-related characters for cold-tolerant rice at the VLHA, 1,300 m above sea level. Each of 380 entries included in the third International Rice Cold Tolerance Nursery was transplanted at 20-cm spacing in nonreplicated plots in three 3-m-long rows.

Some cultures suffered severe post-anthesis cold damage, and only 225 entries were observed for yield. Plant height, tillers/plant, panicles/plant, grains/panicle, % fertile spikelets/panicle, 1,000-grain weight, grain and straw yield, and harvest index were recorded and evaluated by correlation and path analyses.

Yield/plant was significantly and positively correlated with number of tillers (0.36), number of panicles (0.39), straw yield (0.25), and harvest index (0.69). Straw yield was significantly and positively correlated with plant height (0.29), number of tillers (0.30), and grains/panicle (0.20). Grains/panicle and % fertility had positive and significant correlation (0.37). Number of panicles was positively and significantly correlated (0.24) with harvest index, but negatively and significantly correlated with grains/panicle (–0.31), % fertility (–0.31), and 1,000-grain weight (–0.27). Number of tillers was negatively and significantly correlated with grains/panicle (–0.20), % spikelet fertility (–0.28), and 1,000-grain weight (–0.23). The association of plant height and straw was negative and significant (–0.24), as was plant height and number of panicles (–0.23).

Path analysis showed that panicles/plant had maximum direct and indirect effect on grain yield. Grains/panicle, spikelet fertility, and 1,000 grain weight also had direct effects on yield, but those were counterbalanced by a negative indirect effect of panicles/plant.

Results indicate that breeding to develop high yielding, cold-tolerant rices should emphasize number of panicle-bearing tillers/plant, high grains/panicle, good spikelet fertility, and high harvest index. □

Varietal tolerance for low temperature and influence of planting dates and nitrogen fertilization

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From 1979-81 dry seasons, 463 entries from the International Rice Cold Tolerance Nursery were screened for vegetative stage tolerance for 16-20°C temperatures. Seeds were sown 14 Oct and transplanted 15 Nov. Seedlings of each line were planted 2/hill in a 5-m-long plot with 4 rows spaced at 25 × 25 cm. NPK was applied at 120-40-40 kg/ha, with N applied in 3 equal splits.

Ten promising entries were selected (Table 1) for further field evaluation on the basis of plant height, growth duration, tiller number, leaf color, panicle emergence, flowering uniformity, spikelet sterility, phenotypic acceptability, grain size, and grain yield.

The 1982 performance of the entries was evaluated at three planting dates and

Table 1. Agronomic characters of 10 outstanding entries selected from 463 entries in the International Rice Cold Tolerance Nursery; 1979-81 dry season (Nov-Mar)[a] Badeggi, Nigeria.

Entry	Yield (t/ha)	Maturity (d)	Plant ht (cm)	Spikelet fertility	Panicle exsertion	Phenotypic acceptability
RPKN-2	4.4	115	118	X	X	X
B2012C-KN-15-1-3-2-3	5.6	121	122	X	X	X
KULU	4.8	121	119	X	X	X
KN-361-BKK-27-1	4.4	115	118	X	X	X
IR9202-36-3-2	6.0	139	100	X	X	X
B737F-KN-10-3-1-2	5.6	118	120	X	X	X
lR9202-25-1-3	7.2	120	108		X	X
IR8965-K1	6.0	122	77	X	X	X
IR9224-Kl	6.0	106	94		X	X
IR9202-22-3-2	6.8	139	99	X	X	X

[a] x = promising entries.

nitrogen levels (Table 2). P and K were applied basally at 40 kg/ha. Twenty-day-old seedlings of each variety were planted in 3- × 3-m plots at 30- × 7.5-cm spacing in a randomized complete block design in 3 replications.

Planting date significantly affected yield (Table 2). Jul seeding produced a normal crop, Sep seeding experienced cold stress at production phase, and Nov seeding experienced cold stress at vegetative phase. KN-361 -BKK-27- 1, IR9202-25-3-3, IR9202-22-3-2, and IR9224-K1 were cold tolerant at vegetative and reproductive phases, but low tillering caused low yields. They were, however, judged to be promising parents for the cold tolerance breeding program. RPKN-2 and KULU were cold tolerant at vegetative phase but susceptible at reproductive phase. B2012C-KN-1-3-2-2, BG90-2, TOS 103, IR9202-36-3-2, B737F-KN-10-3-1-2, and IR8965-K1 were susceptible at both growth stages.

Response to N was highest for the Nov seeding and least for the Sep seeding (Table 2). Adding N for Sep plantings caused high sterility and depressed yield for KN-361-BKK-27-1, B2012C-KN-15-1-3-2-3, B737F-KN-10-3-1-2, IR9202-22-3-2, IR9224-K1, IR8965-K1, and TOS103, but improved yield significantly for RPKN-2 in both plantings.

The test on RPKN-2, B2012C-KN-15-1-3-2-3, KULU, and KN-36 1-BKK-27-1, the highest yielders, is being repeated in cold tolerance multilocational trials and on-farm minikit trials. □

Table 2. Effect of planting date and nitrogen application on performance of 12 entries in the advanced cold tolerance yield nursery, 1982 Badeggi, Nigeria.

Entry	Grain yield[a] (t/ha)			N response[b] (t/ha)	
	P_1	P_2	P_3	P_2	P_3
RPKN-2	4.2 bcde	4.1 f	5.4 d	1.0**	1.1**
B2012C-KN-15-1-3-2-3	5.5 de	4.3 f	4.8 cd	–0.4	2.7**
KULU	3.3 abcd	2.1 ab	4.5 cd	1.2**	0.4
BG 90-2[c]	6.4 e	3.9 ef	4.4 cd	1.2**	0.3
TOS 103[c]	4.7 cde	2.9 bcd	4.0 cd	–0.6	1.9**
KN-361-BKK-27-1	3.8 abcd	4.4 f	3.8 bcd	–0.7*	1.8**
IR9202-36-3-2-2	3.7 abcd	2.8 bc	3.5 abc	1.4**	0.1
B737F-KN-10-3-1-2	6.5 e	3.7 def	3.4 abc	–0.3	0.6*
IR9202-25-1-3	1.8 ab	2.8 bc	3.2 abc	0.3	1.9**
IR9202-22-3-2	2.1 ab	3.2 cde	2.1 ab	–1.9**	0.0
IR8965-K1	2.6 abc	2.3 abc	2.0 a	–0.1	0.7*
IR9224-K1	1.4 a	1.7 a	1.7 a	–0.4	1.3**
Mean	3.8	3.2	3.6		

[a] P_1 P_2 P_3 = Jul, Sep, and Nov plantings. Minimum temp (°C) during 5 months of crop growth were 23, 23, 23, 23, 19 for July; 23, 23, 19, 16, 12 for Sep; and 18, 16, 17, 20, 22 for Nov. In a column, means followed by a common letter are not significantly different at the 5% level. [b] Difference of mean of 80 and 120 kg N/ha, and no N; * and ** = significant at 5% and 1% levels. P_2 = Sep seeding, P_3 = Nov seeding. [c] Popular wet season varieties.

GENETIC EVALUATION AND UTILIZATION

Tissue culture

Embryo grafting of rice varieties

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We used an embryo grafting technique – the embryo of one rice variety is transferred to the blank endosperm of another variety – to study the DNA:RNA interaction of grafted plants on plant characters, especially F_1 spikelet sterility.

Under a stereoscope, the embryo from a healthy, dehulled, surface-sterilized kernel was removed aseptically using forceps and a fine needle, and transferred to the embryo groove of another kernel from a different variety. During transfer, the endosperm was dipped either in sterile deionized water (SDW) or in a starch suspension prepared by crushing the endosperm of the recipient variety with SDW.

Success of embryo grafting combinations.

Varietal combination		Embryos (no.)		Mortality (%) of grafted seedlings in pot
Embryo donor	Endosperm	Total grafted	Mature[a]	
BR1	BR4	80	0	
BR4	BR1	80	0	
BR1	BR7	80	3	60
BR7	BR1	80	0	
BR4	BR9	80	10	50
BR9	BR4	80	6	45
BR1	BR9	72	0	
BR9	BR1	72	0	
BR3	BR7	60	2	50
BR7	BR3	60	3	60
BR9	Dharial	60	3	60
Dharial	BR9	60	0	
BR4	Kasra	60	0	
Kasra	BR4	60	0	
BR4	Madhumala	60	0	
Madhumala	BR4	60	0	
BR9	Kasra	60	0	
Kasra	BR9	60	0	
BR4	*S. coarctata*	40	0	
S. coarctata	BR4	40	0	
BR9	*S. coarctata*	40	0	
S. coarctata	BR9	40	0	

[a] Those at 1-4 mo after harvest.

After transfer, separate grafted kernels were placed on each of the following sterile substrates to germinate and grow: moist filter paper, moist sand, a perforated moist filter paper platform in a test tube, and a petri dish or test tube containing water agar (DIFCO) at concentrations of 2.0, 1.5, 1.0, 0.75, and 0.5%. In the water agar, grafted kernels were planted with the embryo end facing the cap or lid. Kernels were incubated at 26 + 2°C for 3 wk. Drops of SDW were added when necessary. For growth comparison, intact kernels of the two varieties and their detached embryos were also placed in the media with the grafted kernels. To determine the best embryo age for successful grafting, embryos aged 4, 7, 10, and 14 d after anthesis were transferred to the mature endosperm of different varieties. Experiments were in four replications.

Grafting was confirmed when the endosperm was exhausted and squeezed into a thin membrane. After 2 wk, the embryo and the endosperm were completely bound together. Grafted plants were transferred to sterile pots with nutrient solutions and covered with polyethylene sheets.

Results show that grafting was successful for BR4 and BR9 combinations (see table). The best substrate for grafted plant establishment was the 0.75% water agar medium. Grafting was successful only with embryos of more than 10 days after anthesis. Plants from grafted embryos and plants grown from normal seed were phenotypically similar in plant height, tiller number, and grain type. However, maturity date of grafted plants was 10-15 d later. □

Callus induction and plant regeneration from embryo tissues of rice

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We successfully induced calli and regenerated whole plantlets by culturing embryo-tissue of cultivar Palman 579, indicating that embryo culture might be used to propagate rice cultivars.

About 160 embryo tissues were cultured for callus induction; 80% began to grow as a separate friable mass of calli. Embryos were isolated from dehusked seeds, washed with distilled water, sterilized in 0.1% $HgCl_2$ solution for 10 min, and washed 6 times in sterile distilled water. Embryos were cultured on Murashige and Skoog's medium (MS) (1962) supplemented by different concentrations of 2,4-D (1, 2, and 4 mg/liter). pH of the medium was adjusted to 5.8 and cultures were incubated at 26 ± 2°C with a 16 h/8 light/dark photoperiod. The MS medium was supplemented with 3% sucrose + 2,4-D (2 mg/liter) + coconut water (15% vol/vol) + casein hydrolysate (500 mg/liter).

After 34 subcultures, callus pieces were transferred to the differentiating medium containing MS + 1% sucrose + IAA (2 mg/liter) + coconut water (15 vol/vol) + casein hydrolysate (500 mg/liter). When small shoot buds emerged on the surface of the callus tissues, 20% of the calli were separated into plantlets. Albino plants were occasionally found in the callus tissues.

Eighteen plantlets lived. They were transferred to MS basal medium with half the concentration of growth substances and then to a hormone-free basal medium to establish a vigorous root system. When plantlets grew 10-15 cm tall they were acclimatized in a growth chamber before transfer to the field. Albino plantlets died.

Meiotic analysis of the regenerated plants indicated a normal haploid chromosome number (n = 12). □

Pest management and control DISEASES

Control of black rot disease of azolla

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Black rot disease caused by *Rhizoctonia solani* Kuhn is a serious disease of azolla. The pathogen first affects the middle portion of the azolla frond, then spreads gradually to the branches. Fronds rot and turn black in patches. We evaluated various fungicides for control of *R. solani* in in vitro laboratory tests. Carbendazim (2 – methoxy – carbamoyl benzimidazole) effectively inhibited *R. solani.* In a later study, carbendazim was tested for *R. solani* control in 5-litre mud pots. Four litres of water, 5 ppm superphosphate, and 20 ppm carbofuran were added. Carbendazim levels of 10, 20, 30, 40, and 50 ppm were added to the pots. Azolla was inoculated at 15 g/pot. Azolla fresh weight was recorded 10 d later (see table).

When azolla was grown in mud pots, disease incidence substantially reduced azolla growth (see table). As carbendazim was increased, azolla growth also increased. Carbendazim at 50 ppm concentration gave maximum azolla growth.

Costs of using carbendazim are small (see table). A disease incidence is severe only in nursery plots where azolla growth is abundant. Using the fungicides in nurseries may save azolla for field inoculation. □

Control of black rot disease of azolla, Tamil Nadu, India.

Carbendazim (ppm)	Mean azolla (g/pot)	% increase over control	Cost of carbendazim ($/ha)
Control	8.33	–	–
10	16.67	100.12	0.19
20	19.00	128.09	0.38
30	19.17	130.13	0.57
40	19.83	138.06	0.75
50	20.67	148.14	0.94

CD: 1.0975

Effect of sheath rot on some yield components

B. A. Estrada, assistant scientist; C. Q. Torres, research assistant; and J. M. Bonman, associate plant pathologist, Plant Pathology Department, IRRI

We studied the effect of sheath rot (ShR) on some yield components in an irrigated field of four plots planted to IR442-2-58 that was severely infected with *Sarocladium oryzae* Gams and Hawks.

Fifty plants per plot were randomly selected and evaluated for disease incidence Individual tillers of each plant were rated using a 3-infection level scale (see figure). Healthy panicles made up 20.8% of the sample, 19.8% were in category 1, 13.5% in category 2, and 45.9% in category 3.

For further evaluation, 200 panicles from each disease severity category were harvested. Number of spikelets/panicle, percent filled spikelets/panicle, weight of filled grains/panicle, and 1,000-grain weight were recorded.

Percent filled spikelets/panicle was the yield component most affected by the disease, with only 2.7% recorded at scale 3 (see table). Number of spikelets/panicle and 1,000-grain weight were also significantly less for severely diseased panicles than for healthy ones. ShR significantly reduced yield per panicle and yield loss increased with increased severity.

Based on the measurements for yield/panicle within each disease severity category, and on the frequency of each category in the plots, the total yield loss associated with the disease was 52.8%. □

Severity rating scale (0 = healthy, normal panicle exsertion, no discoloration or very few grains discolored; 1 = small brown lesions covering about 1/10 of leaf sheath, panicle exsertion apparently normal, few grains discolored; 2 = larger lesions which tend to coalesce and may cover less than half the leaf sheath, about 65% or more panicle exsertion, moderate grain discoloration; 3 = lesions have coalesced and may cover entire leaf sheath, no exsertion to slight exsertion of about 30% straight upward panicle, severe discoloration with whitish fungal growth).

Yield components of panicles with various sheath rot severity ratings.

Severity rating	1,000-grain wt (g)	Spikelets/ panicle	Filled spikelets (%)	Relative yield (%)
0	24.9 a	164.2 a	95.0 a	100
1	24.3 a	178.5 a	90.7 a	88.3
2	22.3 b	171.4 a	59.8 b	62.4
3	14.8 c	144.5 b	2.7 c	1.2

[a]Healthy and diseased panicles of IR442 selected in the field. Means in columns followed by different letters are significantly different at the 5% level.

Effect of herbicides on neck blast infection and rice yield

N. I. Singh, junior pathologist, All India Coordinated Rice Improvement Project, Wangbal, Manipur, India

Herbicides have been known to increase susceptibility of various plants to fungal and viral diseases. We studied the effect of herbicides commonly used in rice production on severity of neck blast (NBl) caused by *Pyricularia oryzae,* weed population, and rice yield in the field during

Effect of herbicides on NBI infection, weed population, and yield, Wangbal, Manipur, India.[a]

Herbicide treatment	Application rate (kg ai/ha)	Weeds/m^2	Infection (%)	Yield (t/ha)
2,4-D	1.00	80	26.20 (30.64)	2.21
Fluchloralin	0.80	88	24.33 (29.46)	2.23
Pendimethalin	1.50	94	26.12 (30.67)	2.21
Oxyfluorfen	0.10	75	41.20 (39.90)	1.92
Thiobencarb	1.00	42	50.50 (45.09)	1.80
Butachlor	1.50	63	33.70 (35.47)	2.11
Untreated and nonweeded control		141	20.06 (26.60)	2.97
Weed-free check		0	16.95 (24.32)	3.60
CD (5%)			7.99	0.97

[a]Mean of three replications. Angular transformed values are in the parentheses.

1982 kharif. The experiment was in a randomized complete block design with three replications. Punshi was the test variety.

Six granular herbicides were broadcast 5 days after transplanting. Untreated and nonweeded plots were the control. Weeds/m^2 were counted at harvest and disease intensity was scored using the 1980 Standard Evaluation System for Rice. Thiobencarb controlled weeds best, followed by butachlor. However. heavy NBl infection was observed in thiobencarb-treated plots, which resulted in the lowest yield (see table). Increased NBl infection may have been caused by changes in the metabolic processes of the rice plants. □

Effect of fungicides on neck blast infection and rice yield

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Neck blast (NB1) of rice caused by *Pyricularia oryzae* Cav. is a serious problem in Manipur. We studied the relative efficacy of six fungicides for NB1 control in wet fields in 1982.

Fungicides carbendazim, benomyl, ziram, captafol, mancozeb, and edifenphos were sprayed at tillering, leaf . booting, and just after flowering. Control plots were sprayed with sterile water. Percent infected panicles was calculated at maturity. Edifenphos-treated plots had no infection and yielded most, followed by those treated with ziram (see table). □

Effect of fungicides on NBl and yield, mean of three replications, Wangbal, Manipur, India.

Fungicide	Application rate (kg or liters/ha)	Infection (%)	Yield (t/ha)
Carbendazim	0.5	12.1	2.35
Benomyl	0.5	4.3	2.67
Ziram	2.5	3.6	2.91
Captafol	2.0	23.5	2.05
Mancozeb	2.5	21.1	2.10
Edifenphos	1.0	0	3.50
Control		27.2	1.95

Association of two types of virus particles in an isolate of rice tungro disease

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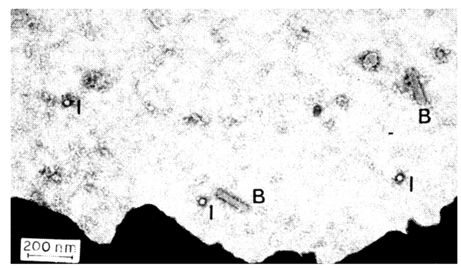
Late planted Jaya exhibited 90 to 100% tungro disease incidence in Orissa during 1982 kharif. Disease identity was established by transmission tests of the vector *Nephotettix virescens.* We studied tungro-infested plants under an electron microscope at the CNRA.

Dip preparations in 1% neutral phosphotungstic acid (PTA), made from sap of different parts of infected leaves, were observed under an EM 300 Philips electron microscope. Isometric virus particles about 28 nm in diam and bacilliform virus particles measuring about 33 nm in diam and 175 nm long were observed (see figure). In different samples, bacilliform virus particles and isometric virus particles were in ratios 1:10 and 1:11. Observations indicated that both isometric and bacilliform virus particles are associated with severe tungro symptoms in the Cuttack isolate, which also is true for isolates from several other South and Southeast Asian countries.



Electron micrograph showing tungro isometric (I) and tungro bacilliform (B) virus in dip preparations from leaf sap infected with rice tungro disease from Cuttack, India. Virus particles were negatively stained with 1% neutral PTA (magnification 54000 X).

Observations using negative coloration of samples, made from crude sap of infected leaves in PTA, indicate a lower percentage of bacilliform particles than of isometric particles. However, our electron microscope observations of purified virus preparations indicated that negative staining with PTA does not allow a correct estimate of the two types of virus particles, perhaps because PTA preparations damage bacilliform particles. □

Pest management and control INSECTS

Some common predators of rice insect pests in Assam, India

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Assam is a tropical rain forest area with green vegetation throughout the year. Rainfall is 1,400-1,800 mm, humidity averages 85-95%, and temperature is 20-30°C during the monsoon (Jun-Sep), which is the main rice growing season. Monsoon conditions favor rice cultivation, pest multiplication, and the proliferation of their natural enemies. Predators, particularly arthropods, are abundant and play a significant role in controlling major insect pests of rice.

From 1980 to 1982, we evaluated monsoon rice to determine the role of natural enemies (see table). The Commonwealth Institute of Entomology, London, and the Systematics Section of the Entomology Division, Indian Agricultural Research Institute, New Delhi, identified the specimens. ☐

Common predators of rice insect pests recorded 1980-82 in Assam, India.

Predators	Prey	Prevalence or intensity
I. Araneae (spiders)		
Tetragnathidae *Tegragnatha mandibulata*	Nymphs and adults of *Cofana spectra, C. yasumatsui, Nephotettix virescens. N. nigropictus,* and *Sogatella furcifera*	High
Oxyopidae *Oxyopes javanus* Thorell	-do-	High
Araneidae *Neoscona theisi* (Walckenaer)	-do-	Moderate
Araneus sp.	-do-	-do-
Lycosidae *Pardosa* sp.	-do-	Low
II. Odonata (dragonflies)		
Libellulidae *Orthetrum sabina* (Dowry)	Adults of *Scirpophaga incertulas. Nymphula depunctalis* and *N. fluctuosalis*	High
Crocothemis servilia (Dowry)	-do-	-do-
Pantala flavescens (Fabricius)	-do-	Moderate
Diplacodes nebulosa (Fabricius)	-do-	-do-
III. Odonata (damselflies)		
Coenagrionidae *Ischnura delicata* Dis	Nymphs and adults of *Nephotettix virescens, N. nigropictus. Cofana spectra,* and *Sogatella furcifera.*	High
Ischnura rofostigma Selys	-do-	-do-
Agriocnemis pygmaea Rambur	-do-	Moderate
Ceriagrion coromandelianum (Fabricius)	-do-	Low
IV. Orthoptera (meadow grasshopper)		
Tettigoniidae *Conocephalus longipennis* (de Haan)	Nymphs and adults of *Nephotettix* sp. and *Recilia dorsalis*	Moderate
V. Hemiptera (predaceous bugs)		
Pentatomidae *cicrona caerulea* Linnaeus	Larvae of *Naranga diffusa, Mythimna separata, Spodoptera mauritia,* and *S. litura.*	Moderate
Andrallus spinidens Fabricius	-do-	Low
Pygomenida benghalensis (Westwood) *Menida histrio* F.)	Adults of *Dicladispa armigera*	Moderate
Reduviidae *Coranus* sp.	Larvae of *Naranga* sp. and *Spodoptera* sp.	Moderate
VI. Diptera (rubber fly)		
Asilidae *Promachus* sp.	Nymphs and adults of *Oxya fuscovitatta*	Moderate
VII. Coleoptera (beetles)		
Cicindelidae *Cicindela sexpunctata* Fabricius	Nymphs and adults of *Leptocorisa acuta* and *L. oratoria*	Moderate
Carabidae *Casnoidae indica* Thumberg	Nymphs of planthoppers and leafhoppers	-do-
Coccinellidae *Micraspis discolor* Fabricius	Nymphs and adults of *Cofana* sp. *Nephotettix* sp. and *Sogatella furcifera*	High
Harmonia octomaculata Fabricius	-do-	Low
VIII. Hymenoptera (wasps)		
Sphecidae *Psenulus* sp. nr. *Aogatophagus* P.	Nymphs and adults of leafhoppers	Low

A simple technique for locating feeding sites of green leafhopper in rice plants

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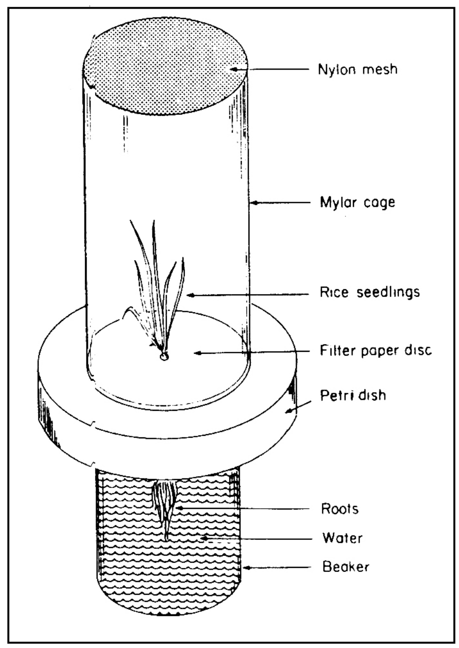
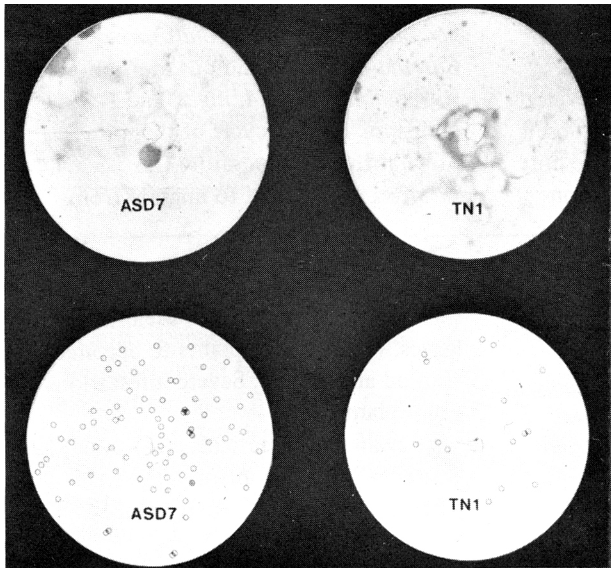
The feeding behavior of the green leafhopper (GLH) *Nephotettix virescens* (Distant) on susceptible and resistant rice varieties is not yet clearly understood. Although GLH is regarded as a phloem feeder on susceptible rice varieties and a xylem feeder on resistant varieties, the existing semiquantitative biochemical methodologies for locating GLH feeding sites are complicated. We tested a simple technique for monitoring GLH feeding using a dye that is selectively translocated in xylem vessels.

GLH-susceptible TN1 and resistant ASD7 were grown separately in clay pots in a greenhouse. When seedlings were 10 d old, they were carefully removed from the pots and roots were washed thoroughly to remove soil particles. Roots were then immersed in an aqueous solution of 0.2% Safranine O (Kansai Reagent Corp.,



1. Assembly for collecting GLH honeydew, IRRI 1983.

Hirakata, Japan) for about 6 h, until the dye colored all the xylem vessels red. Seedlings were removed and the excess dye was washed off. Two to three seedlings of each variety were placed in separate 250-ml glass beakers with enough water to immerse the roots. Each beaker was covered with a medially perforated 12-cm-diam plastic petri dish through which the seedling shoots emerged (Fig. 1). A 9-cm-diam Whatman filter paper disc was placed on the petri dish around the base of each seedling, which was enclosed in a cylindrical mylar cage 15 cm high and 9 cm in diam. Ten newly emerged GLH females were introduced into each cage and allowed to feed on seedlings for 24 h. A set of untreated seedlings was infested similarly as a control. The honeydew excreted by GLH females dropped on the filter paper discs and was absorbed. Red honeydew spots on filter paper discs indicated xylem feeding. When filter paper discs from control seedlings were treated with a 0.1% ninhydrin-acetone solution, bluish amino acid spots indicated phloem feeding.



2. Filter paper discs on which GLH honeydew was collected when the insect fed on resistant ASD7 and susceptible TN1 rice varieties. Bluish amino acid spots on ninhydrin-treated filter paper discs, (top) indicate more phloem feeding on TN1, while the encircled red spots on filter paper discs (bottom) indicate more xylem feeding on safranine-treated ASD7 plants, IRRI 1983.

On susceptible TN1, GLH was primarily a phloem feeder, although occasionally it also sucked small quantities of xylem sap (Fig. 2). On resistant ASD7, red honeydew spots indicated the insect switched to xylem feeding. However, the insect also did some phloem feeding, because there were traces of amino acids in the honeydew.

We are evaluating the efficacy of this technique for determining the feeding habits of other rice leafhoppers and planthoppers. □

Occurrence of grain mite *Tarsonemus* sp. in stored rice

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A tarsonemid mite, *Tarsonemus* sp. (Tarsonemidae), was found in stored rice grains (see table). After one month of storage in gunny bags, 1,000 randomly collected grain samples of each cultivar were planted 10/plate in moist 6-cm-diam petri plates after tearing the lemma and palea of each grain. They were incubated at room temperature (26±3ºC) for 8 d. Then adult and juvenile populations of mites were counted, using a stage microscope.

Mite populations ranged from 0 to 19.56/grain and varied by cultivar. Ratna had the most mites and Kalinga I and CR1009 were not infested. White tip nematode *Aphelenchoides besseyi* and fungi such as *Alternaria padwickii* and *Fusarium moniliforme* were found in grains which contained the mite populations.

In another experiment, under natural storage conditions (27 ± 6ºC and 86 ± 8% RH) the tarsonemid mite lived for 180-360 d in gunny bags, 180-315 d in ghumma (burnt earthen storage containers), and 135-360 d in doli (woven bamboo structure plastered with cow

Population and survival of *Tarsonemus* sp. in stored rice, Cuttack, India

Rice cultivar	No. of mites/grain[a] (adults + juveniles)	Germination[b] (%)		Survival[c] (days)		
		Unsterilized grains	Sterilized grains	S_1	S_2	S_3
Ratna	19.6	86.2	87.0	360	315	360
Jaya	16.3	85.7	82.7	360	315	315
Shakti	12.0	81.0	85.2	270	225	225
CR146-225	9.0	83.2	81.2	225	225	180
CR113-84-2	6.7	84.7	87.2	225	180	180
CR126-27-25	6.1	86.0	86.7	225	180	180
CRM13-3241	4.0	88.7	87.0	225	180	225
JBS508-13-14	3.7	84.7	83.7	225	180	225
CR1014	1.6	81.0	83.2	180	180	180
Kalinga I	0.0	86.5	88.7	–	–	–
CR1009	0.0	84.7	86.0	–	–	–
CD to compare germination percentage of sterilized and nonsterilized grains		at 5% = 3.94, 1% = 5.12				

[a] Mean population in 1,000 grains. [b] Mean germination tested after 45 d of storage. [c] Samples stored under natural storage conditions in CRRI godown. [d] S_1 = gunny bags, S_2 = ghumma, S_3 = doli.

dung). Survival again varied with cultivar (see table),

We found that mite eggs on Ratna grains were viable even after 6 yr in a refrigerator (8 ± 2°C), and could develop into adults on moist petri plates exposed to room temperature. We reared the mite in controlled conditions on media containing different fungal diets. Mites multiplied vigorously on diets of *Alternaria padwickii, Fusarium moniliforme,* and *Curvularia* sp., but did not multiply on *Aspergillus flavus, A. niger,* and *Penicillium* spp. The life cycle of the mite is 6-7 d at room temperature (26 ± 3°C).

Mites were found to migrate from seeds to seedlings when seeds were sown in small pots. Percent grain germination of mite-infested grains was not adversely affected, but seedlings infested with a large mite population did not live more than 20 d after germination. Detailed studies on biology, bionomics, and etiology of this mite are in progress. □

Chemical control of the rice white leafhopper *Cofana spectra* (Distant)

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White leafhopper *Cofana (Tettigella)* spectra is considered a minor pest of rice, but is becoming more widespread each year in Tamil Nadu. Nymphs and adults suck the sap from the leaf sheaths and leaves, which causes plants to become stunted and yellow. Severe infestations cause plant death.

We evaluated insecticides (see table) for white leafhopper control in the field using a randomized complete block design with four replications. TNAU15776/3 was planted at 20- × 15-cm spacing in 20-m^2 plots. Leafhopper populations for different treatments were recorded each week by counting insects on 20 randomly selected plants from each plot (see table).

Application of 1.25 kg ai carbofuran granules per hectare at 30 and 60 days after transplanting gave best control (see table). □

Effect of insecticide treatments on *C. spectra,* Coimbatore, India.

Treatment[a]	*C. spectra* population/20 hills[b]								
	58 DT	65 DT	72 DT	79 DT	86 DT	93 DT	100 DT	107 DT	Mean
Untreated check	9.8 c	9.5 d	13.3 d	12.3 d	10.5 c	11.5 c	10.5 c	10.5 d	18.6 e
Carbofuran granule at 1.25 kg ai/ha, 5 DT	7.0 a	5.8 ab	6.5 c	6.8 bc	6.3 b	4.3 a	4.3 ab	4.0 ab	5.5 c
Carbofuran granule at 1.25 kg ai/ha 30 DT, fb quinalphos spray 0.5 kg ai/ha 50 DT	9.3 bc	8.0 cd	5.8 bc	4.8 ab	5.8 b	4.8 ab	3.5 a	5.3 bc	5.8 cd
Carbofuran granule at 1.25 kg ai/ha 60 DT, fb monocrotophos spray 0.5 kg ai/ha 80 DT	6.8 a	6.3 bc	6.3 c	7.0 c	4.3 ab	4.3 a	5.3 ab	4.3 ab	5.5 ab
Carbofuran granule 1.25 kg ai/ha 5 and 30 DT, fb quinalphos spray 0.5 kg ai/ha 50 DT	7.0 a	6.3 bc	7.5 c	6.5 bc	6.3 b	6.5 b	5.8 b	6.8 c	6.5 d
Carbofuran granule 1.25 kg ai/ha 5 and 60 DT, fb monocrotophos spray 0.5 kg ai/ha 90 DT	8.0 bc	7.8 bcd	5.8 bc	6.0 bc	6.3 b	4.0 a	4.0 ab	3.5 ab	5.6 c
Carbofuran granule 1.25 kg ai/ha 30 and 60 DT	7.3 ab	5.3 a	3.0 a	3.8 a	2.5 a	3.0 a	3.3 a	2.5 a	3.8 a
Carbofuran granule at 1.25 kg ai/ha, fb quinalphos spray 0.5 kg ai/ha 50 DT and monocrotophos spray 0.5 kg ai/ha 80 DT	6.0 a	6.0 bc	4.0 ab	4.5 ab	4.3 ab	4.5 ab	4.8 ab	3.3 ab	4.6 b

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

Rice thrips outbreak in the Visweswarayya Canal (VC) tract

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Late rains delayed the release of irrigation water from the Krishnaraja Sagar reservoir catchment area in 1983 and drought and dry weather apparently favored the fast multiplication of rice thrips *Stenchaetothrips biformis* (Bagnall) during the wet season. Thrips severely damaged high yielding rice cultivars planted in the VC tract in Sep.

In a hill, 60 to 70% of the leaves were infested and up to 22 nymphs and 5 adults (av 5 and 1.5) per leaf were recorded. Infestation was most severe 10 to 15 d after transplanting and lasted as long as 40 to 45 d.

Application of carbofuran 3G at 0.5 kg ai/ha or foliar application of monocrotophos 40 EC or phosphamidon 100 EC at 0.05% gave good control. After a moderate rainfall during the infestation, the thrips population was reduced. □

Brown planthopper biotypes in India

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The differential response of rice varieties to the brown planthopper (BPH) in international screening tests indicated that the BPH population on the Indian subcontinent is not the same as natural populations in other Asian countries. Further studies were conducted to compare the response of rice varieties to BPH populations from southern India and BPH populations maintained at IRRI in the Philippines.

Adult BPH were collected from fields at TNAU, Coimbatore; Tamil Nadu Rice Research Institute, Aduthurai; Agricultural College, Madurai; and Krishi Vigyan Kendra, Pondicherry, to study the biotype variation. Populations were cultured separately on TN1 plants. Pregerminated seeds of rice varieties ARC6650, ARC10-550, ASD7, ASD11, Babawee, 1ET5741, IET6315, Mudgo, Rathu Heenati, Sinna Sivappu, T7, V. P. Samba, and the susceptible check TN1 were sown in standard seedboxes. Ten days after sowing, seedlings were infested with second- and third-instar nymphs and seedboxes were covered with fiberglass mesh cages. Damage was scored using the 0-9 Standard Evaluation System for Rice scale when 90% of the TN1 seedlings died.

Reaction[a] of rice accessions to BPH populations collected from different regions.

Accession	Gene for resistance	Damage rating[b]			
		Population from Tamil Nadu and Pondicherry	Population in the Philippines		
			Biotype 1	Biotype 2	Biotype 3
Mudgo	*Bph* 1	9 d	1	9	1
ASD7	*bph* 2	9 d	1	3	9
Rathu Heenati	*Bph* 3	3 c	1	3	1
Babawee	*bph* 4	3 c	1	3	1
Sinna Sivappu	Not known	1 a	1	3	1
ARC6650	Not known	1 a	1	3	1
ARC10550	Not known	1 a	9	9	9
ASDll	Not known	3 c	9	9	9
IET5741	Not known	3 c	9	9	9
1ET6315	Not known	2 b	9	9	9
T7	Not known	3 c	9	9	9
V. P. Samba	Not known	3 c	9	9	9
TN1	No resistance	9 d	9	9	9

[a]Based on the 1980 Standard Evaluation System for Rice 0-9 scale. [b]Mean of three replications. Means followed by a common letter are not significantly different at 5% level.

Known differential varieties and selected rice accessions reacted similarly to BPH from Tamil Nadu and Pondicherry, but Mudgo and ASD7 rices, carrying *Bph 1* and *bph 2* resistance genes, were susceptible to BPH populations from Tamil Nadu and Pondicherry, while Rathu Heenati *(Bph 3)* and Babawee *(bph 4)* were resistant (see table). ARC6650, ARC10550, IET5741, IET6315, T7, ASDl1, Sinna Sivappu, and V. P. Samba showed consistently resistant reactions to BPH from Tamil Nadu and Pondicherry. ARC6650, Rathu Heenati, Babawee, and Sinna Sivappu are resistant to BPH biotype 1, biotype 2, and biotype 3 in the Philippines but 1ET5741, IET6315, T7, ASDl1, and V. P. Samba are highly susceptible.

Thus the *Bph 1* and *bph 2* genes did not confer resistance to the Tamil Nadu and Pondicherry BPH populations; however, *Bph 3* and *bph 4* genes conferred resistance to BPH populations occurring in the Philippines and in South India. ARC6650 and Sinna Sivappu also possessed a high level of resistance to the Philippine and the south Indian BPH populations. Those differential varietal reactions indicate that the BPH population in Tamil Nadu and Pondicherry is different from the Southeast Asian population. ☐

Occurrence of *Porthesia xanthorrhoea* Koller on summer rice

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The hairy caterpillar *Porthesia xanthorrhoea* Koller was first recorded at Raipur on summer rice in Apr 1983. Estimated moth population was 189/ha, with 1:1 sex ratio. Moths were active until Jun. Because no plant damage, except for egg masses on middorsal leaf surfaces, was apparent in the field, laboratory studies were initiated to determine feeding behavior and life cycle.

Oval egg masses measuring 1.2 cm are covered with pale brownish yellow hair, and appear similar to those of *Scirpophaga incertulas* Wlk. An average of 65 larvae hatched from each egg mass after a 6-d incubation.

Newly hatched caterpillars fed on tender leaf sheaths and on cut stems. About 23% first-instar and 43% seventh-instar larvae died in the laboratory. Disease caused seventh-instar death. Preoviposition was 2 d, oviposition was 1-2 d, and total life cycle was 47 d.

In the laboratory, larvae were fed whole stems, cut stem pieces, or preflowering, milky, and dough stage spikelets, or a combination of those. Larvae did not feed on entire stems or milk and dough stage spikelets. But they readily fed on cut stems by tunneling up to 2 to 6 mm. They also fed on preflowering spikelets. They fed on tender leaves (leaving only the midrib) and sometimes on mature leaves. The newly hatched larvae, up to the third instar, fed gregariously on cut stems and central leaf margin, while sixth- and seventh-instar caterpillars devoured the entire top portion of stems.

Larvae fed on the stylet, stigma of the ovary, and anther lobes, but not on the filament. The palea of preflowering spikelets were cut from the middle but the lemma was not eaten. Up to 50% of the top and 37% of the middle of preflowering spikelets were eaten and only 3.2% of preflowering spikelets were eaten from the lateral side. An average 62% of preflowering spikelets were entirely eaten and 38% were partly eaten. The larvae fed on an average 24.8 spikelets/d during various instars. During the sixth to eighth instar as many as 257 preflowering spikelets were eaten, which indicates the magnitude of grain loss. □

Controlling armyworm with synthetic pyrethroids and conventional insecticides

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For the first time, a severe outbreak of rice armyworm *Spodoptera mauritia* Boisd. occurred in IR20 nurseries in Oct 1983 at the Agricultural College Farm, Madurai. An average 400 to 420 third- and fourth-instar larvae per square meter was recorded. We evaluated three synthetic pyrethroids and four conventional insecticides for control. Insecticides were applied with a knapsack sprayer on 15-d-old nurseries in the evening. Treatments were in three replications. Living and dead larvae in a 1-m^2 area were counted 24 h after spraying and percent mortality was calculated (see table).

Evaluation of three synthetic pyrethroids and four conventional insecticides for control of rice armyworm larvae, Madurai, India.

Insecticide	Application rate (g ai/ha)	Larval mortality (%)[a]
FMC54800	12.5	100 a
FMC54800	25	100 a
FMC54800	50	100 a
FMC65318	15	100 a
FMC65318	30	100 a
FMC65318	45	100 a
Cypermethrin (Ripcord 10 EC)	50	100 a
Chlorpyriphos (Coroban 20 EC)	200	100 a
Endosulfan (Endocel 35 EC)	350	91.6 b
Phosalone (Zolone 35 EC)	350	84.9 c
Heptachlor 20 EC	500	84.1 c
Check		

[a] Calculated 24h after insecticide treatment. Means followed by a common letter are not significantly different at 5% level.

FMC54800, FMC65318, cypermethrin, and chlorpyriphos were the most effective chemicals. □

Effect of insecticide application on rice growth

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Brown planthopper (BPH) *Nilaparvata lugens* (Stål) is the most serious rice pest in many Asian countries. We studied plant growth and biochemical changes in rice plants after foliar insecticide application.

Two 10-day-old TN1 seedlings were transplanted in 12-cm clay pots and sprayed with insecticides 20, 30, and 40 d after planting under pest-free conditions. There were 12 treatments (see table) and 3 replications. Control plants were sprayed with water. Fifteen days after the last spraying, the number of tillers and leaves and plant height in each treatment were recorded. Nutrient changes caused by insecticide application were determined by sampling 20 cm of leaf sheath and stem above the soil. Samples were dried and analyzed for total N, P, K, Ca, and Mg.

Foliar application of fenthion, methyl parathion, permethrin, and deltamethrin increased tillering (see table), as did application of quinalphos, fenvalerate, cypermethrin, phosphamidon, and carbosulfan. BPMC and methamidophos did not affect tillering. Plant height was not affected by insecticide application; neither was nutrient content. Results suggest that lush growth after insecticide application might attract immigrating BPH□

Effect of foliar application of insecticide on TN1 plant growth, Aduthurai, India.[a]

Treatment[b]	Mean numbers		Plant ht (cm)
	Tillers	Leaves	
Fenthion	8.0 a	29.0 a	72.7 a
Methyl parathion	10.0 a	30.7 a	75.7 a
Quinalphos	7.7 b	26.3 b	75.0 a
Phosphamidon	7.3 bc	25.7 bc	75.0 a
Carbosulfan	7.3 bc	24.7 c	73.7 a
BPMC	7.0 c	23.7 cd	72.3 a
Methamidophos	7.0 c	22.3 d	70.3 a
Fenvalerate	7.7 b	25.7 b	73.3 a
Permethrin	9.0 a	24.7 c	71.7 a
Cypermethrin	8.0 b	28.3 ab	74.7 a
Deltamethrin	9.0 a	29.0 a	76.0 a
Untreated check	6.7 c	20.3 b	72.3 a

[a] Data are means of three replications. Means followed by a common letter are not significantly different at 5% level. [b] The first seven are insecticides applied at 0.04%. The next four are pyrethroids applied at 0.002%.

Plant hosts of rice caseworm

J. P. Bandong, research assistant, and J. A. Litsinger, entomologist, Entomology Department, IRRI

Twelve rice field weeds were compared to rice as hosts of rice caseworm *Nymphula depunctalis* (see table). Rice caseworm eggs from a greenhouse colony were placed in cages around potted vegetative-stage plants immersed in water. Developing larvae were forced to feed on one plant species in this no-choice trial.

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.

Results showed that the rice caseworm is highly polyphagous and could survive rice-free periods on alternative hosts. Low larval survival on rice was caused by the small volume of water used in each potted plant in the experiment. Despite this deficiency, the rice caseworm survived on 8 of 12 weed species tested. *Paspalum conjugatum* was equal to rice in survival and developmental time. *Echinochloa colona, E. glabrescens,* and *Cynodon dactylon* were poorer hosts than rice. Rice caseworm survived poorly on *Paspalum paspalodes* (= *distichum*), *Leptochloa chinensis, Dactyloctenium aegyptium,* and *Eleusine indica.* There was no survival on the sedges *Cyperus difformis, C. iria,* and *Fimbristylis miliacea* (= *littoralis).* ☐

Eight grasses and four sedges compared with rice as suitable plant hosts to the rice caseworm.[a] IRRI. 1980.

Plant	Survival from egg to pupa (%)	Development time from egg to pupa (no. days)	Eggs laid by first-generation moths reared on plant host (no./female)
Poaceae (Gramineae)			
Oryza sativa	52 a	17.2 a	171
Paspalum conjugatum	38 ab	20.0 a	177
Echinochloa colona	28 b	18.4 a	179
Echinochloa glabrescens	25 b	19.4 a	153
Cynondon dactylon	25 b	18.6 a	200
Paspatalum paspalodes	7 c	19.5 a	194
Leptochloa chinensis	5 c	20.0 a	163
Dactyloctenium aegyptium	11 c	29.1 ab	72
Eleusine indica	8 c	23.8 ab	0
Cyperaceae			
Cyperus rotundus	1 c	35.0 b	–
Cyperus difformis	0 c	–	–
Cyperus iria	0 c	–	–
Fimbristylis miliacea	0 c	–	–

[a] Five replications/plant species, 20 eggs/replication. In a column, means followed by a common letter are not significantly different (P = 0.05).

Pest management and control WEEDS

Effect of time of application and residual effect of herbicides in direct seeded flooded and rainfed bunded rice

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Weed control experiments were conducted for four seasons at TNAU to evaluate performance of 1.0 kg butachlor /ha, 1 kg thiobencarb/ha, and 0.75 kg pendimethalin/ha individually at 8 and 12 days after seeding (DS) and in combination with 2.0 kg propanil/ha at 16 DS. Grain yield from Bhavani (see table) indicated that thiobencarb + propanil performed better than individual herbicides under flooding in both seasons. In monsoon season they produced higher yield only for rainfed bunded rice. The 8th-day application of pendimethalin produced better yields than other herbicides for rainfed bunded rice in summer.

In residual effect studies after rice harvest, herbicides had no adverse effect on germination and dry matter production of cotton, finger millet, blackgram, and sesamum. ☐

Effect of time of application of herbicides on grain yield of direct seeded rice, Coimbatore, India.

Time of application[a]	Herbicide dose (kg ai/ha)	Yield (t/ha) Monsoon mean Flooded	Yield (t/ha) Monsoon mean Rainfed bunded	Yield (t/ha) Summer mean Flooded	Yield (t/ha) Summer mean Rainfed bunded
8 DS					
Butachlor	1.0	3.8	3.8	4.3	2.1
Thiobencarb	1.0	4.0	3.9	4.7	2.1
Pendimethalin	0.75	4.0	4.0	4.5	2.7
12 DS					
Butachlor	1.0	4.1	3.1	4.9	1.8
Thiobencarb	1.0	4.5	2.9	5.0	1.8
Pendimethalin	0.75	4.2	3.4	4.7	2.2
16 DS					
Butachlor	1.0	5.1	3.4	5.3	1.6
+ propanil	2.0				
Thiobencarb	1.0	5.2	3.6	5.4	1.8
+ propanil	2.0				
Pendimethalin	0.75	4.9	3.5	5.2	2.0
+ propanil	2.0				
Hand weeding at 20 DS		3.3	1.2	4.0	0.7
Hand weeding at 20 and 40 DS		4.9	3.7	4.7	1.8
Unweeded control		2.0	0.5	2.8	0.2
CD for time of application at rice systems		670	–	383	–
CD for rice systems at time of application		682	–	426	–

[a] DS = days after seeding.

Crop-weed competition in direct seeded flooded and rainfed bunded rice

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Field experiments with direct-seeded Bhavani at TNAU in monsoon and summer seasons showed that *Echinochloa crus-galli* was the predominant grass weed in flooded rice and *Echinochloa colona* in rainfed rice. The weeds competed with rice at all stages. *Cyperus difformis* was the predominant sedge, and caused severe competition with the early flooded crop. *Cyperus iria* was the dominant weed in rainfed rice. *Eclipta alba* was a dominant dicot weed under both conditions. In flooded rice, *Ammannia baccifera* and *Marsilea quadrifolia* were dominant.

Effect of weed treatments on grain yield of direct seeded rice, Coimbatore, India.

Treatment	Yield (t/ha)			
	Monsoons		Summer	
	Flooded	Rainfed	Flooded	Rainfed
Unweeded control	1.6	0.5	2.1	0.0
Weed free up to				
10 d	1.7	1.0	2.1	0.2
20 d	2.4	1.4	3.5	0.4
30 d	3.5	2.7	4.2	0.6
40 d	4.0	3.3	4.3	0.9
50 d	4.4	3.5	4.3	1.5
60 d	4.2	3.6	4.5	1.7
70 d	4.3	3.7	4.5	1.9
80 d	4.2	4.0	4.4	2.2
90 d	4.2	4.1	4.2	2.2
CD for weed-free control at rice systems			424	
CD for rice system at weed-free control			503	

Based on grain yield (see table), a weed-free period of 50 d in monsoon and 30 d in summer improved flooded rice yield. To get high yields in rainfed rice, 60 d was needed in monsoon and 70 d in summer. □

Pest management and control OTHER PESTS

Breeding, movement, and populations of mice in Thailand

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Mark and release trapping was used to study the movement and population of mice *Mus cervicolor* and *M. caroli* in a rice field in Chainat Province, about 180 km north of Bangkok, where rice was cultivated only in rainy season (Jun-Sep). Mice were trapped from 4 plots for 5 nights each month. Plots were about 500 m apart. From Jan to Jun, when no rice is grown, mouse traps were in a 7 × 7 grid placed at 10-m intervals, 49 traps to each plot. From Jul to Dec 1980 a trap-line along the dikes was used because fields were flooded.

Most mice caught (533 or 87.8%) were *M. cervicolor* (see table). Seventy-seven (12.2%) *M. caroli* were trapped. Maximum catches were in Mar, Apr, and May. The longest midpoint of movement (radius of greatest distance) was 29.4 m. Home range as based on 127, 35, and 19 recaptures in Mar, Apr, and May respectively, was 421.2 m^2. Breeding activity, determined by number of pregnant females trapped, occurred in late Jan and early Feb, Jul, Sep, and Oct. □

Variation of temperature, relative humidity, rainfall, habitat, breeding activity, number of mice trapped, midpoint of movement, and size of home range for *M. cervicolor* and *M. caroli.*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max temp ºC	35	36.4	38.6	38	34.1	33.6	33	33.2	22.9	32.2	30.1	32.6
Min temp ºC	9.6	11.0	15.4	16	34.4	22.5	22	21.6	21.3	20.8	18.7	10.0
RH (%)	67	81	79	77	78	79	83	80	81	78	81	69
Rainfall (mm)	0	47.7	23.8	72.7	2.9	1.5	5.9	2.9	7.4	1.8	8.3	0
Habitat [a]	1	2	3	3	4	5	6	7	8	9	10	1
Breeding activity	0	70%	0	0	0	0	33.33%	0	100%	75	0	0
M. cervicolor trapped	0	4	294	152	73	5	16	11	3	5	0	0
M. caroli trapped	0	1	32	13	4	1	15	5	2	4	0	0
Midpoint of movement (m)	0	0	12.36	13.82	8.29	0	29.45	10	20	0	0	0
Home range (m^2)	0	0	347.07	421.25	263.16	0	0	0	0	0	0	0

[a] 1 = after harvest, 2 = burn straw, 3 = dried, 4 = plow, 5 = broadcasting, 6 = age of rice 1 mo, 7-9 = age of rice 2, 3, 4 mo, 10 = milk stage to harvesting.

Soil and crop management

Effect of nitrogen levels and application time on direct-sown rice

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Direct sown Kranti (1981) and Ratna (1982) were tested for response to 20, 40, 60, or 80 kg N/ha applied at sowing, interculture by country plow, tillering, or panicle initiation at Sarkanda Farm, Bilaspur. Soil was a sandy loam with 180-87-436 kg available NPK/ha in 198 1 and 100-65-622 kg available NPK/ha in 1982.

Drought limited response to fertilizer in 1981, but different N application levels significantly affected number of tillers/ plant, panicle length, and filled spikelets for Kranti. N application did not significantly affect those characters for Ratna. Application of 80 kg N/ha increased yield significantly over that of other treatments, which yielded similarly (see table).

Applications of N at sowing, interculture, or as four splits (sowing, interculture, tillering, and panicle initiation) produced similar results. Application of N in equal splits at sowing and interculture, interculture and tillering, and ½ at interculture and equal splits at tillering and panicle initiation produced similarly and yielded significantly more tillers than other treatments (see table). Grain yield was significantly more when N was applied at interculture, tillering, and panicle initiation.

Yields tended to be low because incidence of gall midge, bacterial blight, and sheath rot was high. □

Effect of nitrogen levels and application time on yield-contributing characters and rice yield, Bilaspur, India.

Treatment	Kranti, 1981				Ratna, 1982			
	Effective tillers (no./plant)	Panicle length (cm)	Filled spikelets (no./panicle)	Grain yield (t/ha)	Effective tillers (no./plant)	Panicle length (cm)	Filled spikelets (no./panicle)	Grain yield (t/ha)
Nitrogen (kg/ha)								
20	2.3	20	14	3.1	2.2	20	22	2.2
40	2.6	21	13	3.2	2.4	21	17	2.4
60	2.7	20	10	3.2	2.4	20	22	2.4
80	2.8	21	9	3.4	2.7	22	17	2.8
CD (0.05)	0.2	1	2	ns	ns	ns	ns	0.3
Application time								
At sowing	2.4	20	11	2.9	2.2	21	16	2.0
At interculture	2.5	20	11	3.2	2.4	21	23	2.5
Equal splits at sowing and interculture	2.8	20	10	3.2	2.5	20	17	2.4
Equal splits at interculture and tillering	2.7	20	12	3.3	2.4	21	24	2.5
½ N at interculture, ¼ at tillering, and ¼ at panicle initiation	2.7	21	12	3.5	2.5	21	20	2.8
Equal splits at sowing, interculture, tillering, and panicle initiation	2.4	21	12	3.2	2.3	21	16	2.6
CD (0.05)	0.3	ns	ns	ns	ns	1	5	0.3

[a] ns = nonsignificant.

Paddy and air-breathing-fish culture: effects of supplemental feed on the growth and yield of rice and fish

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We studied the effects of supplemental feed on growth and yield of mixed cultures of two air-breathing catfishes Singhi *(Hereropnaustes fossilis)* and Magur *(Clarias batrachus)* and scented rice variety Randhunipagal at ORP in aman season.

The experiment consisted of these treatments: 1) control (rice plots without fish), 2) rice plot with fish, and 3) rice plot with fish and artificial feed.

Equal numbers of Magur and Singhi fingerlings were stocked at 1 fish/m^2 in early Oct. Before stocking. they were treated with a 100 ppm solution of formalin for 30 s. Each morning, fish in treatment 3 were fed a low-cost 1:2 mixture of fishmeal and rice bran mixed with cow dung at 5% total body weight. Fish were harvested by draining the plots in mid-Nov.

Plots were 24 × 6 m with a shallow 75- × 40-cm perimeter canal. A trapezoidal protective dike bounded the canal.

Rice was sown on 10 Jul (midmonsoon). Seedlings were transplanted in wet soil in early Aug after plots were thoroughly puddled. Rice was harvested in early Dec.

Growth and development of rice and fish with and without supplemental feed at the Operational Research Project, Pandua, West Bengal, India.

Character	Without fish	With fish	
	Control	Without feed	With feed
Randhunipagal			
Plant height (cm)	136	134	127
Effective tillers/plant	14	10	11
Panicle length (cm)	21	21	21
Grains/panicle	106	106	121
Grain sterility (%)	11	10	10
Singhi and Magur			
Survival (%)	–	75	72
Increase in length (mm)	–	6	25
Increase in weight (g)	–	17	41

Releasing air-breathing fingerlings in the paddy field.

Soil was a clay loam with pH from 5.9 to 6.2. Farmyard manure at 9 t/ha was applied to all plots. Two plants spaced 20 × 20 cm were transplanted in each hill. Normal cultivation methods were practiced and water level was maintained at 8-10 cm.

Ten plants for analysis were randomly selected from each treatment and uprooted at harvest. Growth and yield data for 10 randomly selected fishes from each of treatments 2 and 3 also were recorded at harvest (see table, figure).

Rice grown with the air-breathing fish yielded more than the control, and the plots with supplemental feed produced more (see table). Plots with supplemental feed also yielded the heaviest and longest fish. Straw yield was lower in treatments 2 and 3 because of reduced plant height. ☐

Effect of sowing date on growth and performance of six rice varieties in western Turkey

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We studied the effect of different sowing dates on duration and yield of rice varieties and the efficacy of rice as a 2d crop after wheat or barley. Six rice varieties were sown on 7 dates at 10-d intervals from 2 Apr to 1 Jun in 1980 and 1981 in Izmir. Seedlings were transplanted at 4- or 5-leaf stage at 10- × 30-cm spacing in 3 replications.

The highest average grain yield (8.2 t/ha) was from the second sowing, and the lowest (5.4 t/ha) was from the last sowing (see table). Calrose gave the highest average yield (9.1 t/ha) and Labelle yielded lowest (5.1 t/ha). The first seeding had the longest average duration (134 d) and the 6th seeding had the shortest (95 d). Labelle had the longest duration (121 d) and Krasnodorsky was earliest (98 d). There was a significant sowing date × variety effect on yield and duration (see table).

We concluded that in western Turkey,

- early seeding produces higher grain yield,
- short-grained Calrose and high quality varieties Kashmir Basmati and Labelle will grow and yield well if seeded in Apr,
- second crop transplanted rice (after 15 Jun) is possible after wheat or barley,
- delayed sowing generally decreases yield, and
- late sowing reduces grain yield more for short-duration varieties (Krasnodorsky and Maratelli) than for medium-duration varieties (Gritna). ☐

Effect of sowing date on days to heading (DH) and yield (Y) of six rices in western Turkey.

Sowing date[a]	Kashmir Basmati		Calrose		Gritna		Krasnodorsky		Labelle		Maratelli		Av	
	Y (t/ha)	DH	Y (t/ha)	DH	Y (t/ha)	DH	Y (t/ha)	DH	Y (t/ha)	DH	Y (t/ha)	DH	Y (t/ha)	DH
1	8.7	138	11.4	147	6.0	127	6.3	122	6.4	141	5.8	126	7.4	134
2	9.1	128	13.0	137	6.2	116	7.2	110	6.2	130	7.4	113	8.2	122
3	7.3	120	8.7	127	5.8	109	5.8	102	5.2	126	6.7	105	6.6	115
4	7.5	113	8.6	119	5.3	101	5.4	95	5.0	121	6.2	98	6.3	108
5	8.0	105	8.6	111	5.9	94	5.4	86	4.9	113	6.2	92	6.5	100
6	6.5	98	7.5	102	5.3	91	4.5	84	4.3	107	4.8	88	5.5	95
7	6.2	101	6.0	97	6.0	100	5.0	87	3.9	107	5.2	86	5.4	96
Av	7.6	115	9.1	120	5.8	106	5.7	98	5.1	121	6.0	101		

LSD: (5%) Yield: Variety: 1.7 Sowing date: 1.7
DH : ‘’ : 4.3 ‘’ : 4.5

[a] 2 Apr to 1 Jun at 10-d intervals.

Effect of phosphorus fertilizer on phosphorus transformation in rice soils

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We studied the transformation of added P in rice soils in a pot experiment using different P fertilizers. Black soil (8 kg available P/ha, 12.5 ppm Al-P, 3 ppm Fe-P, 103 ppm Ca-P) and alluvial soil (1 0 kg available P/ha, 21 ppm Al-P, 32 ppm Fe-P, 19 ppm Ca-P were used. IR20 was the test variety. Ninety kg P/ha was applied in various forms (see table). Soil was sampled at tillering, panicle initiation, and harvest, and subjected to P fractionation using the Chang and Jackson procedure.

For black soil, Ca-P transformation was highest at all stages followed by that of Al-P and Fe-P. Fe-P transformation was dominant in alluvial soil, followed by that of Ca-P and Al-P (see table). In black soil, Al-P increased with growth stage. The other fractions increased up to panicle initiation. In alluvial soil, all the three P fractions increased to panicle initiation, then decreased to harvest. In diammonium phosphate-treated pots, Al-P was highest followed by that in pots with single superphosphate and monoammonium phosphate. In rock phosphate-treated pots, Fe-P and Ca-P were maximum (see table). ☐

Effect of phosphorus fertilizers on phosphorus transformation in rice soils. Adutlhurai, India.

Fertilizer	Black soil			Alluvial soil		
	T	PI	H	T	PI	H
		Aluminum-P				
Diammonium phosphate	39	74	100	34	41	30
Monoammonium phosphate	43	58	64	35	45	43
Single superphosphate	40	45	101	28	45	45
Rock phosphate	33	65	50	34	43	41
Control	25	62	56	26	46	25
Mean	36	71	74	31	44	37
		Iron-P				
Diammonium phosphate	20	20	18	108	116	125
Monoammonium phosphate	30	20	45	88	125	125
Single superphosphate	20	45	15	100	114	100
Rock phosphate	20	60	15	100	161	116
Control	11	40	9	81	136	93
Mean	20	37	18	96	130	112
		Calcium-P				
Diammonium phosphate	188	250	218	98	93	88
Monoammonium phosphate	184	234	218	93	108	90
Single superphosphate	218	250	188	108	110	113
Rock phosphate	254	188	218	108	175	80
Control	182	232	160	90	120	71
Mean	205	231	200	99	121	88

		Al-P			*Fe-P*			*Ca-P*	
	F	SE	CD.	F	SE	CD.	F	SE	CD.
Source of fertilizer	**	0.67	1.37	**	0.86	1.76	**	1.00	2.05
Soil	**	0.43	0.88	**	0.55	1.12	**	0.63	1.23
Stages	**	0.52	1.06	**	0.67	1.37	**	0.77	1.57
Sources and soils	**	0.95	1.94	**	1.50	3.07	**	1.41	2.88
Sources × stage	**	1.17	2.39	**	1.22	2.50	**	1.72	3.52
Stages × soil	**	0.74	1.51	**	0.95	1.94	**	1.09	2.23

[a] T = tillering, PI = panicle initiation, H = harvest.

Response of rice cultivars to phosphorus

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Application of P as well as N has become necessary to maximize rice yields. Rice varieties differ in their ability to utilize soil and fertilizer P. We studied in 1983 the response of lowland rabi (Dec to Apr) rice to applied P on a soil with 14.7 kg available P/ha. Soil was clayey with pH 7.75, E.C. 0.62 dS/m, 0.77% organic carbon, and 390.2 kg available K/ha. The experiment was in a split-plot design with 6 rice varieties (IR50, BPT1235, MTU6783, MTU6910, MTU8922, and

Grain and straw yields of 6 rice varieties treated with 5 levels of P at Marutem, India.

Variety	Grain yield (t/ha)						Straw yield (t/ha)						Duration (d)
	0 P	17.5 kg P	26.2 kg P	35.0 kg P	43.7 kg P	Mean	0 P	17.5 kg P	26.2 kgP	35.0 kg P	43.7 kg P	Mean	
IR50	5.2	5.2	5.2	5.6	5.2	5.3	4.3	4.4	4.4	4.8	4.6	4.5	104
BPT1235	4.1	4.8	4.9	4.6	4.7	4.6	4.8	5.1	5.2	5.3	5.3	5.1	117
MTU6783	4.4	4.6	4.6	5.0	5.0	4.7	4.4	4.5	4.7	4.8	4.1	4.6	109
MTU6910	3.8	3.4	4.1	3.9	4.6	3.9	4.8	5.6	5.8	5.7	5.6	5.5	126
MTU8922	4.4	4.7	5.1	4.8	5.1	4.8	3.8	4.0	3.8	4.2	4.4	4.1	114
MTU2099	4.7	4.7	4.9	5.2	4.8	4.9	4.0	3.7	3.6	4.0	4.3	3.9	122

	F test	SEM	CD	F test	SEM	CD
P levels	S*	-	0.14	S*	-	0.07
Varieties	S*	-	0.18	S*	-	0.13
Interactions						
P level X Variety	S*	-	0.37	S*	-	0.26
Variety X P level	S*	-	0.39	S*	-	0.28
CV%		-	5.24		-	3.97

S* : Significant at 0.05 level.

MTU2009) and 5 levels of P (0, 17.5. 26.2, 35.0, and 43.7 kg/ha) applied basally as superphosphate. Before last puddling, 26.8 kg Kg/ha was applied basally and 120 kg N/ha was applied in equal splits: basal, topdressing 25 d after planting, and before panicle initiation.

Grain and straw yields were statistically analyzed (see table). All treatments with added P gave higher grain yield than the control. Highest mean grain yield (5.3 t/ha) was from IR50, which was significantly superior to all other varieties (see table).

Mean grain yield for different P levels was significant only to 26.2 kg P/ha. MTU6910 yielded more straw than all other varieties (see table). Varieties which recorded higher grain yield recorded low straw yield.

IR50 was best for rabi and application of 26.2 kg P/ha appeared to produce maximum yield for most rabi varieties. □

Optimum seeding rate and nitrogen level for rice grown in semidry conditions

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In Tamil Nadu almost 200,000 ha of semidry land is planted to rice. We sought to identify optimum seeding rate and nitrogen level for rice grown in semidry land in field trials at ACRI in 1978-79 and 1979-80.

Five seeding rates — 60, 80, 100, 120, and 140 kg seed/ha — and 4 nitrogen levels — 0, 40, 80, and 120 kg N/ha — were evaluated in a split-plot design with 3 replications. Soil was sandy with pH 7.6, medium levels of available N and P, and low K.

Dry seed of MDU1, a 135-d variety recommended by Tamil Nadu Agricultural University for semidry conditions, was sown in lines and N was applied in 2 equal splits: at maximum tillering (25 d after transplanting) and at panicle initiation. The crop was grown under controlled water conditions until tillering, then irrigated like lowland rice. Butachlor 5% granules were applied at 1.5 kg ai/ha 5 d after sowing to control weeds.

Data on grain yield and other components are in the table. Seeding rate did not significantly influence grain yield in 1978-79. In 1979-80 sowing, 100 kg seed/ha produced the highest yield — 1.8 t/ha. There was no significant difference between 80 kg and 100 kg seed/ha, however.

Nitrogen level increased grain yield significantly at the no-N vs N application level, but there was no significant difference between applications of 40, 80, and 120 kg. The most economic dose was 40 kg N/ha. □

Effect of seeding rate and nitrogen level on grain yield and yield components, Tamil Nadu, 1978-1980.

Treatment	1978-79				1979-80			
	Productive tillers (no.)	Grains/panicle	1,000-grain wt (g)	Yield (t/ha)	Productive tillers (no.)	Grains/panicle	1,000-grain wt (g)	Yield (t/ha)
Seeding rate (kg/ha)								
60	5.5	64.4	21.2	0.7	6.3	66.4	21.2	1.2
80	5.8	63.8	21.3	1.0	6.6	69.0	21.8	1.6
100	5.5	58.7	21.2	0.9	6.3	59.5	20.8	1.8
120	4.9	52.5	20.8	0.6	5.3	51.4	20.4	1.0
140	5.3	56.2	20.9	0.7	5.7	55.2	21.2	1.1
Nitrogen level (kg/ha)								
0	4.1	53.9	20.8	0.6	4.4	58.3	20.8	0.8
40	6.4	58.7	20.8	0.8	7.1	59.2	20.8	1.5
80	5.6	61.8	21.2	0.9	6.3	62.3	21.5	1.6
120	5.4	62.3	21.4	0.9	6.2	61.4	21.6	1.5
SE								
Seeding rate	0.4	7.5	0.83	1.4	0.41	5.6	0.23	173
Nitrogen level	0.2	4.8	0.2		0.32	3.5	0.12	0.1
CD (0.05)								
Seeding rate	ns	ns	ns	ns	ns	ns	ns	0.4
Nitrogen level	0.5	ns	ns	0.2	0.65	ns	0.24	0.3

Effect of calcium peroxide-coated rice seeds on germination and seedling growth under submerged conditions

C. Kundu and S. Biswas, Rice Research Station, Chinsurah, Hooghly, India

Rice is direct seeded in rainfed lowlands in much of Asia and South Asia. Sudden heavy rain often submerges the seeded fields, and greatly affects germination and seedling emergence.

We studied the effect of coating rice seeds with calcium peroxide on germination and seedling establishment under submerged conditions. NC492 and Jaladhi 2 seeds were coated with 20% and 40% calcium peroxide by weight. Five seeds were sown in each 6-cm-diam plastic pot and 20 pots comprised each of 5 replications in a randomized block design. Another experiment used 10.5-cm-diam petri plates in the laboratory. In each plate, 100 seeds were placed on filter paper and 2 ml of distilled water was added. Each set was in three replications.

The pots were submerged, leaving seeds 10 cm below water level for 5 d in controlled tanks. Then the water level was reduced to 2 cm and maintained for 15 d, after which data were recorded.

Results of the pot experiment showed that 40% coating significantly increased the percentage germination for both cultivars (Table 1).

Results of the petri plate test indicated germination and seedling growth of both cultivars was reduced at both calcium peroxide concentrations (Table 2) perhaps because an alkaline medium developed from the solution of calcium peroxide in water. Further study is in progress. □

Table 1. Effect of calcium peroxide coating on germination of two rice cultivars under submerged conditions, Chinsurah, India.[a]

Treatment	Germination[b] (%)	Mean shoot length (cm)	Mean root length (cm)
	NC492		
CaO_2 coated (40%)	86.6**	25.0	14.8
CaO_2 coated (20%)	70.0**	23.3	14.1
Uncoated (dry)	16.6	24.2	12.8
Uncoated (sprouted)	35.0	23.9	13.0
	Jaladhi 2		
CaO_2 coated (40%)	73.3**	22.1	16.8
CaO_2 coated (20%)	68.3 *	20.9	14.0
Uncoated (dry)	56.6	16.6	12.7
Uncoated (sprouted)	60.6	18.4	13.4

[a] Data were recorded 20 d after sowing. [b] *Significant at P = 0.05, **significant at P = 0.01.

Table 2. Effect of calcium peroxide coating on germination of two rice cultivars in petri plates in the laboratory, Chinsurah, India.[a]

Treatment	Germination (%)	Mean shoot length (cm)	Mean root length (cm)
	NC492		
CaO_2 coated (40%)	62.0	7.2	3.5
CaO_2 coated (20%)	69.0	11.2	6.5
Uncoated	100.0	14.6	11.5
	Juladhi 2		
CaO_2 coated (40%)	59.0	6.2	5.0
CaO_2 coated (20%)	76.0	7.5	5.2
Uncoated	98.0	13.2	14.5

[a] Data were recorded after 10 d.

Effect of seedling age at transplanting and fertilizer levels on grain yield

B. H. Shahani, research officer, Agronomy, A. B. Khan, director, Agricultural Research Station (ARS), Dera Ismail (D.I.) Khan; and M. A. Khan, lecturer in Agronomy, Faculty of Agriculture, Gomal University, D. I. Khan, N. W. F. P., Pakistan

We tested the performance of IR6 at different transplanting ages and 10 fertilizer levels at ARS and the Government Seed Farm Rakh Manghan in D. I. Khan in 1982. The experiment was in a split-plot design with three replications. Seedling ages were evaluated in main plots and fertility levels in subplots.

N. P. and K were broadcast and incorporated into dry soil before transplanting. A composite soil sample (0-25 cm) was analyzed (Table 1).

Grain yields for seedlings transplanted at different ages did not significantly differ (Table 2). Yield increased significantly as fertilizer levels were increased. The highest grain yield of 6.4 t/ha was obtained with 138-26-0 kg NPK/ha (Table 2). □

Table 1. Physicochemical properties of soils at two experimental sites in India.

Location	pH (1:5)	Ecx10[6] (1:5)	P (ppm)	K (ppm)	OM (%)	Texture
Agricultural Research Station	8.1	950	3	145	0.62	Clayey
Government Seed Farm Rakh Manghan	8.0	1200	2	124	0.72	Clayey

Table 2. Effect of seedling age and different fertilizer levels on rice (IR6) grain yield. D. I. Khan, NWFP, Pakistan, 1982.

Fertilizer applied (kg/ha)			Grain yield[a] (t/ha) of seedlings transplanted at			Av grain yield[b] (t/ha)
N	P	K	30 d	45 d	60 d	
0	0	0	3.4	3.6	2.9	3.3 f
46	0	0	4.5	4.8	4.5	4.6 e
92	0	0	5.4	5.4	5.4	5.4 bcd
138	0	0	6.3	6.3	5.9	6.7 ab
46	26	0	4.7	4.9	4.8	4.8 de
92	26	0	6.1	5.7	5.7	5.8 abc
138	26	0	6.9	6.4	6.0	6.4 a
46	26	50	4.5	5.3	4.9	4.9 cde
92	26	50	5.9	6.0	5.7	5.9 ab
I38	26	50	5.8	6.2	6.2	6.1 ab
Average			5.3	5.5	5.2	

[a] Av of 2 locations. [b] Means followed by a similar letter are not significantly different at 5% level.

Effect of urea on the N_2 -fixing algal flora in lowland rice at ripening stage

P. A. Roger, visiting scientist, ORSTOM, France; R. Remulla, research assistant, and I. Watanabe, soil microbiologist, IRRI

An inhibitory effect of nitrogcn fertilizers, especially urea, on N_2-fixing algal flora in lowland rice fields has frequently been observed during the first stages of rice growth. Because increasing rice canopy reduces the amount of light reaching the floodwater, light often limits algal growth at the end of the rice cycle, especially in rainy season. Information on the late-stage effect of N fertilizers on N_2-fixing algal flora is scarce.

In the azolla demonstration plots at IRRI, rice is transplanted in wide double-row spacing that allows light to reach the water surface throughout the rice cycle. We used the no-N and 100-kg-urea demonstration plots to study the effect of N fertilizer on N_2-fixing blue-green algae (BGA) at grain ripening stage of rice. In the urea plots, N fertilizer was split-applied: ½ before transplanting, ¼ at tillering (14 days after transplanting), and ¼ at panicle initiation.

The algal biomass in the urea plots comprised mainly filamentous green algae (*Spirogyra* sp.. *Mougeotia* sp.) in clumps 10-12 cm in diameter. No-N plots had very large colonies of *Nostoc* sp., 3-8 cm in diameter, and a few small clumps of filamentous green algae.

Composite soil core samples were taken from the plots and the N_2-fixing algal flora was studied by plating suspension-dilutions of soil on Gorham solid medium (1% agar) without N. The medium is selective for N_2-fixing BGA, but permits the growth of some non-N_2-fixing BGA for 2 weeks after inoculation, after which they become discolored but can still be counted. The plates were incubated at 25-30°C under continuous fluorescent light (5001x) for 3 weeks.

Colony-forming units of N_2-fixing BGA. [a]

Species	Colony-forming units (no.)					
	No nitrogen			100 kg N/ha		
	10^{-5}	10^{-4}	10^{-3}	10^{-5}	10^{-4}	10^{-3}
Nostoc	3	31	322	0	9	69
Anabaena	1	2	4	0	1	0
Calothrix	0	2	23	0	0	0
Fischerella	0	1	7	0	0	0
Oscillatoria [b]	7	–	–	13	198	–
Total	4	36	356	0	10	69
Nb of N_2-fixing BGA per cm		3.7×10^5			7.9×10^4	

[a] Each value is the mean of 6 counts (triplicate platings of duplicate samples). [b] Nonfixing in aerobiosis - bleached colonies.

Results (see table) showed that urea had a statistically significant Inhibiting effect on N_2-fixing BGA. There were five times more colonies in no-N than in urea plots. The N_2-fixing algal flora, dominated by Nostoc sp., was more diversified in the no-N plots (4 genera) than in N plots (1 genus). *Oscillatoria,* a non-N_2-fixing BGA, was more abundant in N plots.

Results reported in the literatule on the effects of N fertilizers on N_2-fixing microorganisms are controversial, especially those concerning the later stages of rice growth. Our information indicates a clear inhibition of N_2-fixing BGA by urea late in the rice cycle. □

Effect of bushening and nitrogen application on gall midge and rice yield

Prem Chand and R. S. Singh, Birsa Agricultural University (BAU), Kanke, Ranchi 834006, India

Bushening is a shallow-plowing operation with a wooden plow 4-6 wk after broadcast seeding, when there is sufficient water in the field. It loosens, but does not invert soil. The tillage operation improves soil aeration, destroys weeds by incorporating them in the puddle, and redistributes rice seedlings to provide for uniform stand. Bushening is widely used by farmers in Kanki.

We studied the effect of bushening on gall midge (*Orseolia oryzae*) incidence at the BAU farm in 1987 kharit. Treatments were no bushening (M1), bushening 30 days after seeding (DS) (M2), bushening 35 DS (M3), and transplanting 30-d-old seedlings (M4). Eighty kg N/ha was applied before bushening (N1) or after (N2). Variety Archna was seeded on 6 Jul.

Table 1. Effect of bushening and N application on percent silvershoots, Kanke, India.

Treatment	Silvershoot (%)
M1	11 b
M2	16 b
M3	4 a
M4	12 b
SEm (M)	1.78
CD 5%	6.14
N1	8 a
N2	13 b
SEm (N)	1.44
CD 5%	4.68

Table 2. Effect of bushening and N application on grain yield. K anke, India.

Treatment		Yield (t/ha)	
		N1	N2
M1		1.5	1.4
M2		1.5	1.5
M3		1.5	1.2
M4		1.3	1.1
Mean		1.4	1.3
CD 5%	N	0.006	
	M×N	0.027	

M3 had the lowest percent silvershoots (Table 1), and N1 nitrogen application gave best results (Table 2). M1 + N1, M2 + N1, and M3 + N1 gave similar yields. □

Optimum seedling age for transplanting short-duration rice

T. S. Theetharappan and S. P. Palaniappan, Agronomy Department, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India

Field experiments in 1978-79 used short-duration rice variety IET1444 (Rasi) to determine the optimum age at which to transplant seedlings and to test plant spacing. Three seedling ages (25, 40, 55 d) and three spacings (10 × 10, 15 × 10, 20 × 10 cm) were tested in the main plots. Two nitrogen levels (100 and 150 kg/ha) and 2 nursery methods were in the subplots.

Plant height, productive tillers/hill, and panicle length were not adversely affected by transplanting up to 40-d-old seedlings. With 55-d-old seedlings, those characters were significantly affected. Spacing of 20 × 10 cm was best (see table), regardless of seedling age. Semidry nursery and 150 kg N/ha produced better growth and yield. Grain yield of 25- and 40-d-old seedlings differed insignificantly. □

Growth and yield of IET1444 at different transplanting ages.

Treatment	Plant ht (cm)	Productive tillers (no./hill)	Panicle length (cm)	Filled spikelets (no.)	Grain yield (t/ha)	Daily production (kg/ha)
Seedling age						
25 d	73	8	8	73	5.1	57
40 d	78	8	17	74	5.0	59
55 d	72	6	16	63	3.9	49
Spacing						
10 × 10 cm	74	7	17	68	4.7	55.2
15 × 10 cm	74	7	17	71	4.7	55.9
20 × 10 cm	75	8	17	71	4.6	54.4
Nitrogen level						
100 kg/ha	73	7	17	69	4.5	53.2
150 kg/ha	76	8	17	71	4.8	57.2
Nursery method						
Wet	73	7	17	67	4.6	53.7
Semidry	75	7	17	72	4.8	56.5
CD at 5%						
Seedling age	2.7	0.3	0.4	3.0	0.45	5.2
Spacing	2.7	0.3	ns	ns	ns	ns
Nitrogen level	1.4	0.2	ns	2.0	0.11	1.4
Nursery method	1.4	ns	0.3	2.0	0.11	1.4

Efficiency of Mussoorie rock phosphate in a rice - wheat rotation

J. S. Brar and Bhajan Singh, Soils Department, Punjab Agricultural University (PAU), Ludhiana, India

Although ground rock phosphate has been a useful additive for acid soils, its performance in neutral and alkalihe soils has not been described.

We evaluated the performance of Mussoorie rock phosphate (MRP) in a long-term rice - wheat rotation on a neutral Typic Haplustalf at PAU farm, beginning in 1976 kharif. MRP has 10.2% P, of which only 0.9% is citrate soluble. Soil was a loam with pH 7.4, electrical conductivity 0.20 mmho/cm, 0.40% organic carbon, 4 ppm Olsen's extractable P, and 75 ppm available K.

A basal dose of 120 kg N/ha as urea and 50 kg K/ha as muriate of potash was applied (see table). To increase the efficiency of MRP, pyrite (FeS) five times that of MRP was added in all MRP treatments. Treatments were in a randomized block design with three replications.

For rice, P and K were applied at transplanting. N was applied in equal splits at transplanting and 3 and 6 wk after transplanting. For wheat, P, K, and 1/2 N were drilled at sowing, and the remaining N was applied before the first irrigation. Grain yield was recorded each year and the effect of P treatment on rice and wheat yield is in the table.

Rice yields after P treatments were slightly more than control yields, but the differences were not significant. The application of superphosphate to wheat at 26.2 kg P/ha increased yields significantly over the control. MRP treatments did not yield as well as superphosphate treatments. This was due to a decrease in soil pH from 7.4 to 5.7 under 52.4 kg P from MRP and a decrease from 7.4 to 6.3 under 39.3 from MRP during the aerobic conditions of wheat cultivation. □

Effect of phosphorus treatments on rice and wheat grain yields, Ludhiana, India.

Treatment	Av of six crops	
	Unhusked rice (t/ha)	Wheat (t/ha)
P_0	6.3	2.1
$P_{26.2}$ (SP)[a]	6.6	2.5
$P_{26.2}$ (MRP)[b]	6.4	2.1
$P_{26.2}$ (¼ SP + ¾ MRP)	6.5	2.2
$P_{13.1}$ (SP)	6.5	2.4
$P_{13.1}$ (MRP)	6.5	2.2
$P_{13.1}$ (¼ SP + ¾ MRP)	6.5	2.3
$P_{52.4}$ (MRP)	6.4	1.2
$P_{52.4}$ (¼ SP + ¾ MRP)	6.5	1.7
CD at 5%	ns	0.37

[a] $P_{26.2}$ SP = 26.2 kg P/ha from single superphosphate. [b] $P_{26.2}$ MRP = 26.2 kg P/ha from MRP.

Environment and its influence

Flight duration of the brown planthopper

L. J. Rosenberg and J. I. Magor, Tropical Development and Research Institute, College House, Wrights Lane, London W8 SSJ, UK

Brown planthopper (BPH) annually migrates to the summer rice growing areas of China, Japan, and Korea. These migrations are windborne and move in the same direction and at the same speed as the wind. We used weather maps to determine the duration of flight of BPH caught on ships on the East China Sea in Jun and Jul 1973 and 1981. The BPH data were collected by Japanese scientists Iijima and Oya.

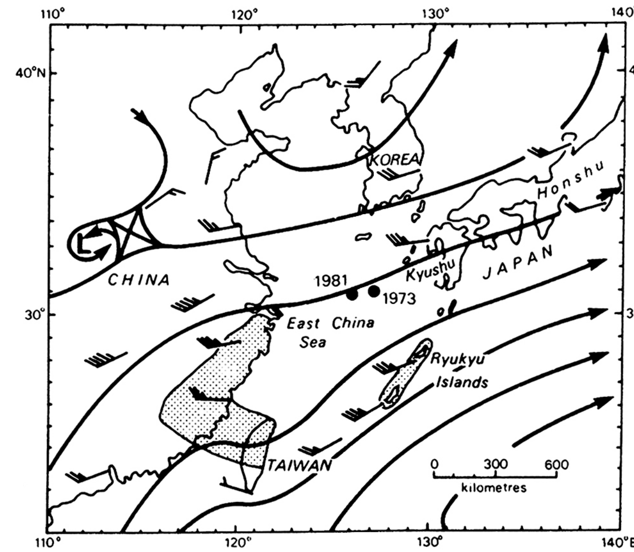
Trajectories were drawn upwind from the ships from the time of insect capture until a potential source of macropterous BPH was reached. BPH have been caught at heights of up to 1.5 km. and as wind speed and direction change with height, trajectories were drawn in the 10-m and 1.5-km wind fields.

During the study, the centers of a series of depressions passed north of Japan from west to east. Strong southwesterly winds at the surface and 1.5 km occurred in the warm sectors of the depressions and were present when BPH were caught (Fig. 1). South of Japan, air flowing toward the depressions was influenced by the clockwise flow out of the North Pacific Subtropical Anticyclone and southerly or southeasterly winds were common over the Ryukyu Islands and occasionally blew in China and parts of Japan (Fig. 2).

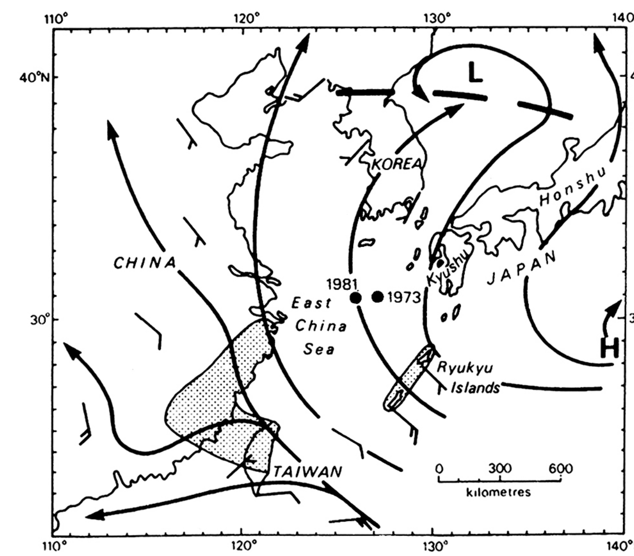
The change in wind direction as the depressions passed affected the location of sources. Trajectories at 10 m or 1.5 km or both linked all 33 captured samples to potential sources — usually in mainland or Taiwan, China (Fig. 1), but twice, the 10-m trajectory ended in the Ryukyu Islands (Fig. 2). Simulated flights between those locations and the ships lasted between 9 and 30 h. Trajectories were extended beyond the ships and all but two reached South Korea or Japan, 18 in 30 h or less.

These flight duration estimates are similar to those obtained in the laboratory for BPH from the tropics, suggesting that long distance migration also occurs in the tropics.

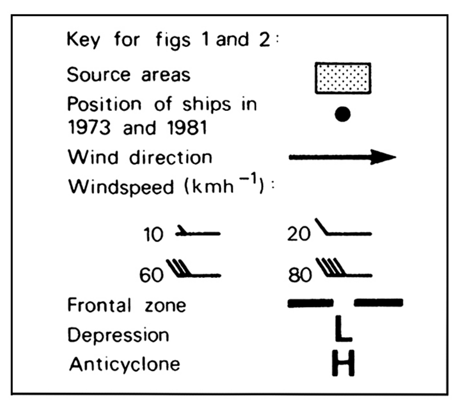
Full details of this study have been published in Ecological Entomology 8(3):341-350 (1983). □



1. Source area southwest of ship. 1.5 km wind field at 0000 GMT (0800-0900 local time) on 27 Jun 1981.



2. Source area southeast of ship. 10 m wind field at 0000 GMT (0800-0900 local time) on 1 Jul 1973.



Rice-based cropping systems

Irrigated sunflower in rice fallows of Konkan

B. P. Patil, Konkan Krishi Vidyapeeth, Dapoli 415712, Maharashtra, India

In Konkan, a humid area with heavy rainfall, rice is the main crop in the monsoon season (Jun-Sep). After rice is harvested, most fields remain fallow. As more irrigation projects are constructed, potential for cropping in the rice fallow increases.

We evaluated sunflower after rice and sought to determine the appropriate level of N application on three sunflower varieties (EC68413, EC68414, and EC69874). N levels were 40, 60, and 80 kg N/ha. Treatments were in three replications. Experiments began in Nov 1973, 1974, and 1975 after rice harvest. Fields were on irrigated laterite soils, which had high N and K and medium P content. Sunflower was sown at 60- × 30-cm spacing at 10 kg seed/ha. Plants were thinned to 1/hill. P at 11 kg/ha was applied basally at sowing. N was applied in equal splits at sowing and 1 mo later. The crop was irrigated every 10-12 d and received 8 irrigations.

Results from 3 yr showed that EC68414 yielded significantly more than the other varieties. Nitrogen levels did not produce significantly different yields, but the interaction between N and varieties was significant (see table). □

Effect of nitrogen levels 40, 60, 80 kg/ha, on mean yield of sunflower varieties planted after rice, Konkan, India.

Year	Yield (t/ha)									CD at 5%
	EC68413			EC68414			EC69874			
	40	60	80	40	60	80	40	60	80	
1973-74	1.8	2.0	2.1	1.8	2.1	2.1	1.2	1.7	1.8	NS
1974-75	1.4	1.5	1.3	1.6	2.1	2.2	1.7	1.2	1.0	NS
1975-76	1.3	1.5	1.5	1.5	1.4	1.3	1.4	1.4	1.7	NS
Pooled mean		1.7			1.9			1.4		0.18

Interaction CD at 5% 0.3

Announcements

Yoshida dies

Dr. Shouichi Yoshda, principal scientist and head of the IRRI Plant Physiology Department, died 23 Jan 1984 in Tokyo, Japan, after an extended illness. He was 53.

Yoshida earned his BS degree in agricultural chemistry in 1954 and the D Agr in soil science and plant nutrition in 1964, both from the University of Hokkaido. He joined the IRRI staff in 1966. Yoshida's primary research interests were in mineral nutrition, crop physiology, and environmental influence on the rice crop.

He made significant contributions to rice science with his work on high temperature-induced spikelet fertility, zinc deficiency research that led to the recognition of zinc as the third most important nutrient for rice, and physiological studies on the potential productivity of rice in the tropics and in temperate areas.

During his professional career Yoshida authored or coauthored more than 70 scientific and technical publications. He wrote the widely used *Laboratory manual for physiological studies of rice.* His *Fundamentals of rice crop science,* a 1981 IRRI book, is being translated into Chinese, Spanish, and Vietnamese. □

Grain processing losses bibliography

The Tropical Development and Research Institute (TDRI) has published the *Grain processing losses bibliography, supplement 1 to G117,* covering combine harvesting, threshing, hulling, milling, and grinding, and excluding storage. For further information contact TDRI, 127 Clerkenwell Road, London, EC 1R 5 DB UK. □

Miah receives gold medal

S. A. Miah, head of the Plant Pathology Department of the Bangladesh Rice Research Institute, was awarded a presidential gold medal by the Government of Bangladesh for his contribution to rice research and development. Miah was a senior research fellow at IRRI in 1977-78. □

Mabbayad, Pablico, and Moody win best paper prize

M. O. Mabbayad, P. P. Pablico, and K. Moody of the IRRI Agronomy Department received the best paper prize at the Asian-Pacific Weed Science Society conference recently held in the Philippines. The paper, titled *The effect of time and method of land preparation on weed populations in rice,* characterized weed flora and their effect on rice yield with different planting dates, soil preparation, and moisture regimes.

Mabbayad and Pablico are IRRI research assistants and Moody is an agronomist. □

Effective management of agricultural research

Effective management of agricultural research is a 6-week training course in Ireland for senior agricultural research officials from developing countries. The 27 Aug-5 Oct 1984 course is designed to help participants direct successful agricultural research and development in their own countries, and ensure more effective use of total resources.

The course is sponsored by the Agricultural Research Institute of Ireland and DEVCO, the Irish State Agencies Development Cooperation Organization. For further information write: Program Coordinator, Effective Management of Agricultural Research, DEVCO, Kildress House, Pembroke Row, Dublin 2, Ireland. □

Khush receives Philippine plant breeding award

G. S. Khush, plant breeder and head of the IRRI Plant Breeding Department, has been awarded a certificate of appreciation by the Philippine Bureau of Plant Industry for his "immense assistance to and continued support for the Rice Varietal Improvement Program of the Philippines, thereby making now possible the rapid multiplication and distribution of improved high yielding varieties in the rice areas of the country." □

Swaminathan receives honorary doctorate

M. S. Swaminathan, IRRI director general, was awarded the degree of Doctor of Science (honoris causa) by the University of Delhi for his work in agricultural research and development. □

New IRRI publications

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

- *Potential productivity of field crops under different environments*
- *Upland rice research: an international bibliography, 1965-1982*
- *International bibliography of rice research, cumulative indexes, 1976-1980*
- *International workshop on research priorities in tidal swamp rice*
- *International directory of rice workers*
- *IRRI alumni book, 1962-80*
- *Farmer's primer on growing rice,* Cebuano and French translations. □

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