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Contents

GENETIC EVALUATION AND UTILIZATION

PEST MANAGEMENT AND CONTROL

SOIL AND CROP MANAGEMENT

ENVIRONMENT AND ITS INFLUENCE

RICE-BASED CROPPING SYSTEMS

ANNOUNCEMENTS

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 guldelines 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 abbreviatlon throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested. Three levels of N were .... *or* Biotypes of the brown planthopper (BPH) differ within Asia. We studied the biotypes of BPH in...
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example: 8 years; 1 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 werc 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

Guidelines

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

Genetic evaluation and utilization

OVERALL PROGRESS

Genetic behavior of an unstable locus for plant height in rice

M. N. Shrivastava and D. V. Seshu, International Rice Research Institute

A spontaneous semidwarf mutant (77.5 cm) was isolated from the bulk population of Kalimoonch 64, a tall (112.0 cm), scented, and photoperiod-sensitive rice variety from Madhya Pradesh, India. In general, the mutant has qualitative and quantitative characters similar to those of its parent except for reduced plant height. But visual observations over several seasons indicated instability of plant height.

Several panicles were strictly selfed through bagging during the 1979 dry season at Los Baños, Philippines. Selfed seeds were planted in wooden boxes containing thoroughly ground and finely sieved soil in the greenhouse. Seedlings were transplanted as single panicle progeny at 30- × 30-cm spacing in a well-puddled field. Frequency of tall revertants was recorded and these were harvested separately. True breeding lines were selfed and planted in individual panicle rows the next season.

Frequency of back mutations varied from 1.04% to 1.22% (Table 1). All 7 individual revertants harvested during the 1979 wet season segregated for plant height during subsequent plantings, indicating a single allele reversion. With only 20 plants/ progeny, ratios could not be worked out but these observations indicate instability of the mutant at gene or possibly chromosome level.

A few additional characteristics, apiculus and husk color, awning, length and breadth of grains, and days to maturity, mutated occasionally. One photoperiod-insensitive early mutant has been isolated. All mutations are under further study.

The F_1 hybrids of the mutant with other semidwarf cultivars such as IR42 and IR38 (carrying Dee-geo-woo-gen gene), Double dwarf 3 (a Calrose mutant from California), and Culture 854 (Baok derivative from India) were all tall, indicating that the dwarfing gene of the mutant is nonallelic with those of the other semidwarfs (Table 2).

The F_1 hybrids of the mutant with IR42 and IR38 showed 30 to 70% sterility but no detectable abnormality in meiosis. The F_2 planted during the 1980 dry season exhibited a unimodal normal distribution, indicating a polygenic inheritance.

Further studies are under way to understand the genetic behavior of the mutant and the phenomenon of instability. ■

Table 1. Frequency of mutation for tall plant stature in selfed progeny of Kalimoonch dwarf mutant at IRRI.

Season	Progeny grown (no.)	Total plants (no.)	Revertants	
			No.	%
1979 dry	–	385	4	1.04
1979 wet	38	570	7	1.22
1980 dry	48	2400	29	1.21

Table 2. Plant height of parents and F_1 hybrids in allelic studies at IRRI.

Cultivar	Height (cm)	Hybrid	Height (cm)
Kalimoonch 64 (tall parent)	112.0	Kalimoonch mutant/IR42	111.0
Kalimoonch dwarf mutant	55.7	Kalimoonch mutant/IR38	115.0
IR42	88.2	Kalimoonch mutant/Culture 854	122.0
IR38	86.3	Kalimoonch mutant/Double dwarf 3	126.8
Culture 854	73.5		
Double dwarf 3	65.0		

IR4422-98-3-6-1, a promising variety for irrigated systems in Bihar, India

S. Saran, R. C. Chaudhary, Kr. J. P. Sinha, H. K. Suri, and S. K. Choudhary, Rajendra Agricultural University, Bihar, Agricultural Research Institute, Mithapur, Patna, India

IR4422-98-3-6-1, from the cross IR2049-134-2/IR2061-125-37, developed at IRRI, was first tested in Bihar in 1977 (IRYN-M) against checks IR8 and IR26. IR4422-98-3-6-1 yielded 5 t/ha against 3.6 t/ha for 1R8 and 4.6 t/ha for IR26.

IR4422-98-3-6-1 was shifted to Uniform Variety Trial 3 for multilocational testing against local check varieties Sita and Jaya during the 1978, 1979, and 1980 wet seasons. It gave consistently better yields than the check varieties at almost all sites (see table) and is now being tested in the minikit test program in farmers' fields.

Semidwarf IR4422-98-3-6-1 takes 135-140 days from seeding to ripening in Bihar and fits local multicropped irrigated systems well. ■

Performance of 1R4422-98-3-6-3 in Uniform Variety Trial 3 at Bihar, India.

Year and variety	Yield[a] (t/ha)				Yield increase (%)
	Patna	Bikramganj	Pusa	Mean	over check
1978					
IR4422-98-3-6-1	6.3	5.4	4.8	5.5	
Sita	5.1	4.3	3.6	4.3	26.7
Jaya	4.5	–	3.8	4.2	31.0
CD at 5%	839	1206	739		
CV	9.36	11.8	12.31		
1979					
1R4422-98-3-6-3	4.4	7.6	2.9	5.0	
Sita	3.6	7.9	3.1	4.8	2.2
Jaya	3.7	7.2	3.2	4.7	5.9
CD at 5%	147	1055	632		
CV	10.44	9.69	12.45		
1980					
IR4422-98-3-6-1	3.6	6.8	4.7	5.0	
Sita	3.2	5.4	3.9	4.2	20.4
Jaya	2.4	6.4	4.6	4.4	13.4
CD at 5%	1064	906	300		
CV	14.14	9.27	14.4		

[a]**Means significant difference

Agronomic characteristics

Screening rice varieties for photoperiod sensitivity

S. Ghosh and S. Saran, Rajendra Agricultural University, Bihar, Agricultural Research Institute, Mithapur, Patna, India

Photoperiod sensitivity is an important consideration for rainfed wetland rices. To identify photoperiod sensitivity, 30 popular and promising rice varieties were sown from 16 May to 16 September at 2-week intervals. Varieties in which days to flowering differed by 5-15 days were classified photoperiod insensitive. Varieties with differences of 16-50 days were classified weakly photoperiod sensitive and those with differences of 51-70 days were classified photoperiod sensitive (Table 1).

Degree of photoperiod sensitivity also was calculated by

$$\frac{X - Y \times 100}{X}$$

where X = flowering duration due to long day effect (16 May sowing) and Y = flowering duration to short day effect (16 August sowing). Photoperiod sensitivities of 15 varieties are shown in Table 2. ■

Table 1. Varietal photoperiod sensitivity at Mithapur, Patna, India.

Insensitive	Weakly sensitive	Sensitive
IET2815	BIET452	BIET613
IET2895	BIET460	BIET653
IET3257	BIET599	BIET820
IET5656	BIET720	BIET821
		C64-117
Rajendra Dhan 201	BIET724	Barobar
BG90-2		Janeria
BIET1084		Kabra
BIET1107		Jalaj
Sita (C)		Bajra
Pankaj (C)		Bhutahi
		Bajal
		Cuttack Basmati
		BR34 (check)
		BR8 (check)

Table 2. Degree of varietal photoperiod sensitivity at Mithapur, Patna, India.

Variety	Flowering duration (days)		Difference (days) (X – Y)	Degree of sensitivity $\frac{X-Y \times 100}{X}$
	Preceded by long day (X)	Preceded by short day (Y)		
BIET613	154	89	65	42.2
BIET653	153	90	63	41.1
BIET820	165	86	79	47.9
BIET821	164	87	77	47.0
C64-117	158	89	69	43.7
Barobar	159	89	70	44.0
Janeria	164	90	74	45.1
Kabra	166	89	77	46.4
Jalaj	160	89	71	44.9
Bajra	161	88	73	45.3
Bhutahi	159	92	67	42.1
Bajal	161	89	72	44.1
Cuttack Basmati	161	91	70	43.5
BR34	153	87	66	43.1
BR8	159	89	70	44.0

Disease resistance

Bacterial blight of rice appears to be indigenous on wild rice species in West Africa

Ivan Buddenhagen, Agronomy and Plant Pathology Departments, University of California, Davis

Bacterial blight (BB) of rice in West Africa was found in 1979 in the Sahel region of central Mali in an experiment station, but not in farmers' fields nor in wild rice populations. Unconfirmed reports of BB in introduced paddy rices in the dry areas of Senegal. Niger, and elsewhere in the West African savanna zone occur from time to time.

In September 1980, BB in Cameroun was confirmed on several Asian semidwarf varieties in an experimental nursery of the large rice project SEMRY I. The project is near Yagoua along the Logone River in the Sahel-Savanna zone at 10–1/2 degrees north latitude. BB was not detected in the wild annual *O. barthii* but it was found in one small farmer's hydromorphic rice plot in the Mandara Mountains. This remote site 10 km SW of Mokolo near the Nigerian border was planted to a dryland variety resembling IRAT13 but neither the varietal name nor the seed source could be determined. So far as I am aware. this is the only known instance of BB in West Africa that is not connected with new Asian semidwarfs and with an irrigated paddy project.

Two areas were surveyed in September 1981 to further investigate the possibility of indigenous BB in wild rice or on farming sites: the Mandara foothills north, east, and southwest of Mokolo and the savanna area between Maroua and SEMRY II, 100 km to the northeast of Maroua.

Some hydromorphic dryland rice *(O. sativa)* mixed with *O. glaberrima* and old African dryland (possibly also some IRAT) cultivars is grown in the Mandara hills. No annual wild rice (*O. barthii*) was seen but the perennial *O. longistaminata* is present. No BB was detected at any of the sites checked, not even in the same farmer's field where BB was found in 1980.

BB was found in many patches of wild *O. barthii* as well as in the less common *O. longistaminata* in the flat savanna NE of Maroua. These areas, near Longi and Bogo, have no native nor introduced rices. They are about 100 km away, without any river connection to the paddy rice project where BB was detected in 1980.

This is evidence that BB is indigenous in the savanna homeland of *O. barthii* and that it is maintaining itself on this annual species and on *O. longistaminata* without any connection to man. It is significant that BB is found only in dry areas similar to those where it has been found in cultivated rice. How widespread the indigenous presence of BB is in West Africa is not known, nor are any details of its epidemiological potential, ecology, off-season survival, or seed transmission. ■

Occurrence of sheath rot in Rajasthan

R. S. Tripathi, Agriculture Research Station, Borkhera, Kota 324001, India

Rice sheath rot caused by *Acrocylindrium oryzae* (revised as *Sarocladium oryzae)* was observed at the Rajasthan research station for the first time during the 1981 wet season. The disease was severe at panicle initiation stage in direct-seeded rainfed trials (UVT 1 and PVT 1) of the All India Coordinated Rice Improvement Project, Hyderabad. Rotting occurred at the upper leaf sheath enclosing young panicles. Oblong lesions on the flag leaf coalesced quickly and covered most of the sheath. The disease caused partial exsertion of the panicles, resulting in grain chaffiness. Powdery growth of the fungus was profuse inside affected leaf sheaths.

Infection in different varieties was calculated by counting infected and healthy panicles per unit area. Infected tillers were more than 50% in highly susceptible varieties and 15-20% in moderately susceptible varieties. Of 73 varieties, 7 showed a clearly susceptible reaction and 14 were moderately susceptible. The varieties and their reaction to sheath rot are:

Highly susceptible: CR141-7639, CRRP 2, IR9204-117-2-3-3-2, RP1422-2-1-2-3, RP1422-2-1-3-4, RP1422-2-2-3-2, RP1422-2-2-3-5, and KP1670-1418-2205-1582.

Moderately susceptible: CR222MW10, OR83-23, BK664, CR215-55-54-1, CR289-1208, RAU3-4-1, RP1674-4038-78-4, RP1899-1689-98, RP1899-1481-78-1, RP1451-1712-4319, RP 1888-4254-1529-126, RP1670-4221-1585-2205-1418-3, Ad 98, and Rewa 353. ■

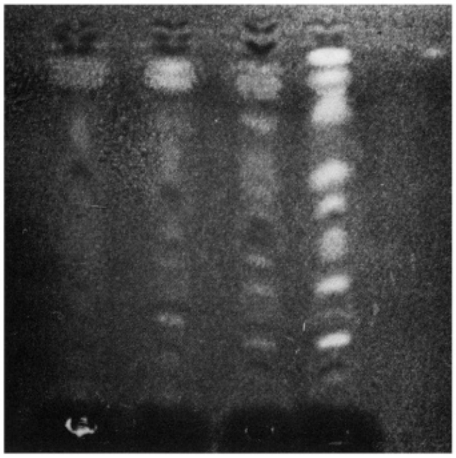
Phytoalexin production in the incompatible reaction of rice to *Pyricularia oryzae*

Pauline M. Bird and James A. Callow, Plant Sciences Department, University of Leeds, Leeds, LS2 9JT, United Kingdom

The synthesis of antifungal compounds of phytoalexins by plants in response to incompatible races or species of fungal parasites is considered an important mechanism of resistance to fungal infection. Diterpenoid phytoalexins (momilactones A and B) have been isolated from blast-infected leaves of normally susceptible rice cultivar Sasashigure after treatment with 2,2-dichloro-3, 3-dimethylcyclopropane carboxylic acid. This fungicide is considered to activate natural resistance mechanisms, including an increased capacity to produce phytoalexins. ■

But until now, a phytoalexin response in the genetically based, cultivar- and race-specific resistance of rice to blast has not been reported. We have found that inoculation with avirulent blast races produced momilactone phytoalexins in genetically resistant cultivars.

After wound inoculation, leaf extracts were subjected to thin-layer chromatography and directly bioassayed by spraying the plate with spores of the green fungus *Cladosporium cucumerinum* (see figure). The white zones correspond to areas of inhibition of *C. cucumerinum,* showing the presence of phytoalexins. Although uninoculated tissue contains low levels of inhibitory compounds, the incompatible reaction clearly results in enhanced phytoalexin production, including the momilactones.



Cladosporium bioassay of leaf extracts of Tetep (T) and IR36 (R) inoculated with *Pyricularia oryzae* (P) or water (W). Momilactone A standard (mA) was included.

Momilactone production in rice with blast disease.

Isolate	Momilactone production	
	Tetep	IR36
2017	– (S)	+ (R)
750778	+ (R)	– (S)

[a]– indicates negligible momilactone production, + indicates momilactone production. R = resistant, S = susceptible.

Two cultivars, Tetep and IR36, were tested with the isolates 2017 and 750778 (see table). Phytoalexin production is correlated with race- and cultivar-specific resistance. (This work was supported by a Ministry of Overseas Development, U. K., grant.) ■

Varietal resistance to kernel smut

S. Srinivasan, Paddy Experiment Station. Aduthurai 612101, Tamil Nadu, India

Kernel smut was first observed in a mild form on the variety Kannagi at Sundaraperumal koil and Swamimalai areas in Thanjavur district during 1975 kuruvai. In 1976, almost all varieties were affected. In Thanjavur delta, disease incidence in the kuruvai crop is heavy when monsoon rains are early. In 1981, incidence was severe.

Screening of 20 short-duration varieties and prerelease cultures assessed disease resistance. Four observations of 25 panicles per variety were made at 3-day intervals from the initial appearance of disease symptoms. The highest disease incidence for the four counts is given in the table. ■

Varietal resistance to kernel smut in Tamil Nadu. India.

Variety	Parentage	Kernel smut (%) (mean of 25 panicles)
ADT31	IR8/Cult 340	10.9
ADT34	IR8/Rodjolele	6.5
TKM9	TKM7/IR8	5.7
ADT36	Triveni/IR20	10.1
ADT33	IR8/Cult 340	6.3
IR50	Nam Sagui 19/IR2071-88//IR2061-214-3-6-2	0.0
Kannayi	IR8/TKM6	9.6
IET4786	CR10-114/CR115	1.8
AD16773	Ratna/ADT33	43.4
AD14018	AUT31/IE3125	3.1
AD14226	ADT30/CO 39	2.6
AD15426	IR30/IR28	0.0
AD14185	Pusa 140/Ratna	13.2
AD16674	ADT31/AD11585	0.0
AD14758	Ratna/AD11585	0.0
AD9246	ADT31/AD198	7.5
AD13887	ADT31/IR36	0.0
AD16586	Tiruveni/IR20//TKM6/IET2222	0.0
Pusa 186-10-4-5	Pusa 140-51///Amir//Sona/improved Sabarmathi	0.0
CO 33	IR8/ADT27	8.4

GENETIC EVALUATION AND UTILIZATION

Insect resistance

An improved method for field screening cultures resistant to brown planthopper

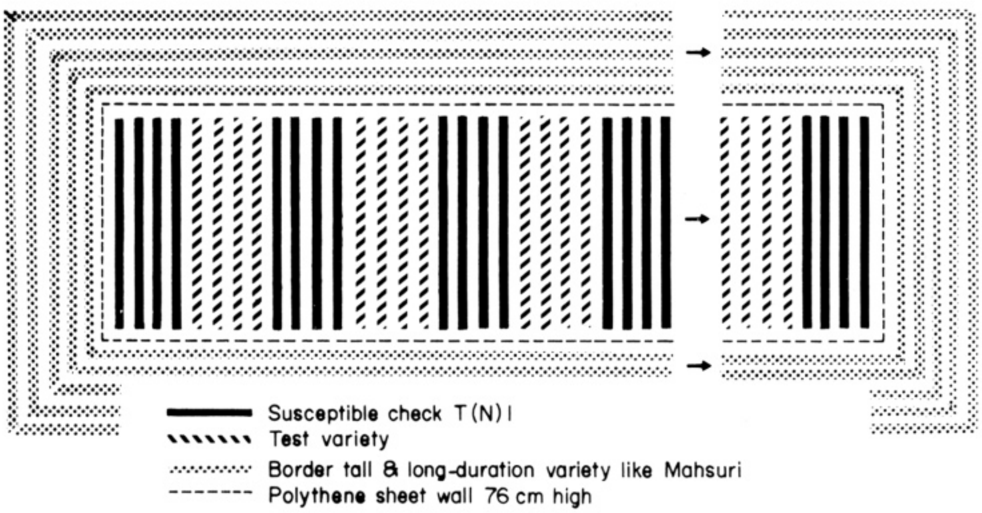
M. B. Kalode. J. S. Bentur, Mangal Sain, U. Prasada Rao, and T. E. Srinivasan, All India Coordinated Rice Improvement Project (AICRIP), Rajendranagar, Hyderabad 500030, Andhra Pradesh, India

To field evaluate at different sites rice cultures resistant to brown planthopper (BPH) *Nilaparvata lugens,* it has been necessary to develop methods to increase the BPH populations because populations are often too low or unevenly distributed. A modification of the method using resurgence-causing insecticides is being successfully utilized at AICRIP (Hyderabad) and other sites in India.

Five border rows of a long-duration variety such as Mahsuri are close planted (10 × 10 cm). Within the border, 4 rows of 10 hills each of test varieties are alternated with 4 rows of a susceptible check (see figure). Beginning 10 days after transplanting (DT), the entire area is sprayed every 10 days with 0.02% methyl parathion or every 15 days with 0.005% decamethrin. Before 30 DT, test varieties are enclosed in a 76-cm-high polythene sheet wall with the top open. Beginning 30 DT, nymphs and adult BPH are released regularly within the enclosure until a sufficient population is reached.

Planting the alternate check in 4 rows, erecting the surrounding polythene sheet wall, and the initial infestation are the improvements over earlier methods. These additions ensure early pest establishment in the screening area, prevent insect movement outside the area, and ensure a high insect buildup.

In screening during 1981 rabi, the BPH population built rapidly from 70 DT and peaked 77 DT. By 83 D, alternating susceptible varieties and some test entries had hopperburn. Insect population was recorded every week; plant damage was recorded when all TN1 plants were killed. With this method, several HPH-resistant cultures identified in the greenhouse were successfully field evaluated in three consecutive seasons. The method is being tested in 1981 kharif at Maruteru and Pantnagar. ■



An improved method for field screening rices against brown planthopper at Hyderabad, India.

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Effects of temperature on rooting ability of rice seedlings

Yi Zhong-cai and Chang Ling-ding, Crop Breeding and Cultivation Research Institute Shanghai Academy of Agricultural Science, Shanghai, China

When temperature is low during early spring transplanting in the Shanghai area, poor rooting ability causes poor recovery of rice seedlings. A test of rooting ability of rice seedlings under five temperature conditions was conducted at Shanghai March-April 1981.

Four *indica* rice varieties, Er Jiu-qing, Yuan Feng-Zao, 776, and Guang Lu-Ai No. 4, were raised in individual nurseries in the greenhouse. One hundred plants per variety were sampled at 32 days seedling age. Their roots were clipped off and cultured in glass bottles filled with water. Ten plants per treatment, with two replications per variety, were cultured at 20, 25, 30, 35, and 40 (±0.5)° C temperatures. After 5 days, root number, root dry weight, and root length were measured (see table).

There was a curvilinear relationship between root number (N) and temperature level (T) for all four test varieties (see figure). The optimum temperature for maximum root number was esti-

Rooting ability of rice seedlings under different temperatures[a] at Shanghai.

Parameter	Variety	20° C	25° C	30° C	35° C	40° C
Root number per plant	Er Jiu-Qing	1.20	1.90	2.85	2.70	0.70
	Yuan Feng-Zao	1.00	2.00	2.05	1.65	0.95
	776	1.65	2.80	2.95	2.80	0.40
	Guang Lu-Ai No. 4	1.55	2.75	2.60	1.50	0.35
Root length (cm) per plant	Er Jiu-Qing	0.65	1.08	1.99	1.75	0.16
	Yuan Feng-Zao	0.31	0.59	0.89	0.71	0.18
	776	0.64	1.59	1.90	1.72	0.07
	Guang Lu-Ai No. 4	0.56	1.33	0.95	0.33	0.06
Root dry weight (mg/plant)	Er Jiu-Qing	0.06	0.12	0.19	0.16	0.04
	Yuan Feng-Zao	0.04	0.09	0.13	0.08	0.04
	776	0.07	0.15	0.23	0.18	0.02
	Guang Lu-Ai No. 4	0.06	0.16	0.09	0.05	0.03

[a] Mean of 2 replications.

mated by

$$T_{opt} = -\frac{b}{2c}$$

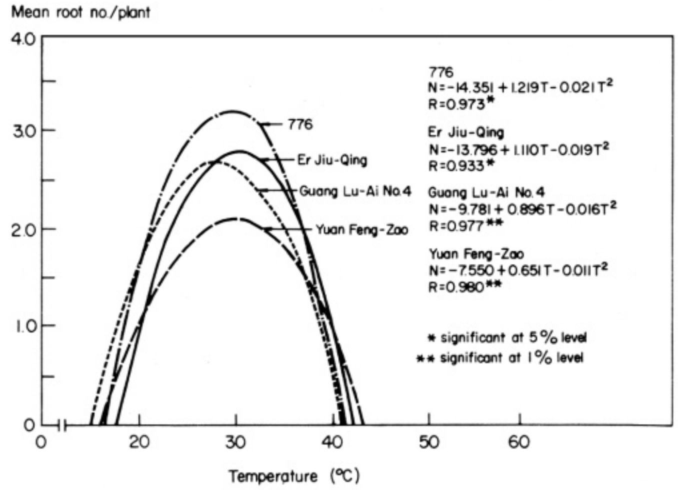
The starting temperature was calculated by

$$T_{start} = T_{opt} - \frac{\sqrt{b^2 - 4ac}}{2c}$$

The coefficients of correlation (r) between root number and temperature level were 0.980** for Yuan Feng-Zao, 0.977** for Guang Lu-Ai No. 4, 0.933* for Er Jiu-Qing, and 0.973* for 776. The optimum temperatures for root number were 29.6° C for Yuan Feng-Zao, 27.7° C for Guang Lu-ai No. 4, 29.9° C for Er Jiu Qing, and 28.8° C for 776.

The T_{opt} for Guang Lu-Ai No. 4, is the lowest for all four varieties, which may indicate its relatively stronger resistance to low temperature. The result also indicates that each rice variety has an optimal temperature level that enhances seedling root number. A lower or higher temperature than this optimum reduces root number.

Root dry weights showed similar trends. The T_{opt} for root dry weight of 4 varieties were 29.9° C for Er Jiu-Qing.



Root number of rice seedlings and temperature at Shanghai.

29.7° C for Yuan Feng-Zao, 29.6° C for 776. and 27.5°C for Guang Lu-ai No. 4. The relationship between root length and temperature was quadratic, the coefficients of correlation (*r*) between root dry weight and temperature were 0.978 lor 776, 0.960 for Yuan Feng-Zao, and 0.902 for Er Jiu-Qing. 'I'he correlation coefficient for Guang Lu-Ai No. 4 was not significant.

The minimum temperature for root number and root dry weight were 17.7° C and 17.9° C (mean 17. 1° C) for Er Jiu-Qing, 15.8° C and 18.3°C (mean 17.l°C) for Yuan Feng-Zao, 16.5°C and 19.0° C (mean 17.8° C) for 776, and 14.9°C and 13.4°C (mean 14.2°C) for Guang Lu-Ai No. 4.

The mean daily optimum temperature during transplanting in the Shanghai area should be above 15° C for Guang Lu-ai No. 4, above 17° C for Yuan Feng-Zao, and above 18° C for Er Jiu-Qing and 776. ■

Effect of sowing date on sterility and vegetation period in western Turkey

M. Sarwar Chaudhary and Açikgöz Nazimi, Agroecology and General Plant Improvement Department, Faculty of Agriculture Aegean University, Bornova, Turkey

To assess the extent of cool temperature injury during anthesis, with special emphasis on sterility, varieties Kashmir Basmati, Krasnodorsky, Calrose, Gritna, and Sarikilçik were sown in single rows of 50 plants each on 8 dates at 10-day intervals from 2 April to 11 June 1979. Plant spacing was 10 × 10 cm in 3 replications. Grains and sterile florets were counted separately.

The longest average vegetative period was 118 days (first sowing) and the shortest was 84 days (last sowing). Sarikilçik showed the shortest vegetative period and Calrose the longest (see table).

Average floret sterility was lowest in the second sowing date crop and highest in the last. Among varieties, Basmati showed the lowest sterility in its fourth sowing date and Krasnodorsky the highest in its seventh sowing date. A significant sowing date-variety interaction on sterility is shown in the table.

Temperature drastically affected sterility. Correlations between sterility and lowest temperature prevailing on the day

Effect of sowing date on days to heading (DH) and sterility of rice in western Turkey.

Sowing date[a]	Sarikilçik		Krasnodorsky		Calrose		Gritna		Kashmir Basmati		Average	
	DH	Sterility (%)1	DH	Sterility (%)	DH	Sterility (%)	DH	Sterility (%)	DH	Sterility (%)	DH	Sterility (%)
1	107	20	107	18	142	23	121	25	112	16	118	20
2	103	14	103	15	130	14	115	17	111	16	112	15
3	94	15	104	17	122	22	108	19	102	14	106	17
4	86	28	94	18	114	11	105	40	119	10	104	22
5	84	21	82	31	110	13	99	19	111	17	97	20
6	82	32	80	39	101	11	96	37	102	18	92	27
7	82	29	75	55	94	13	90	22	94	16	87	27
8	77	35	76	41	89	22	80	36	93	19	84	31
Av	89	24	90	29	113	16	103	27	106	16	100	22.4

LSD: (for sterility % in arcsin transformation) for cultivar: (P: 0.05) = 1.55 for time: (P 0.05) = 1.90.

[a] 2 Apr-11 Jun 1979 at 10-day intervals.

of heading were -0.932 for Sarikilçik, -0.973 for Krasnodorsky, -0.907 for Calrose, -0.944 for Gritna, and -0.835 for Basmati. Correlations between sterility and the lowest temperature to which plants were exposed during the 11 days before heading (generally accepted as the starting point of microsporogenesis) were -0.608 for Sarikilçik, -0.863 for Krasnodorsky, -0.475 for Calrose, -0.630 for Gritna, and -0.012 for Basmati. Negative correlations for sterility-lowest temperature on heading day were higher than those for sterility-lowest temperature exposure during 11 days before heading. Even if there is no cool injury during microsporogenesis, a temperature below critical (15ºC) within 12 hours of heading (on the day or night preceding heading) causes high sterility of florets. This may be due to indehiscence of anthers and failure of pollen grain germination on the stigma.

The response to critical temperature (15°C) varied from variety to variety. Krasnodorsky, Gritna, and Sarikilçik were affected more than Calrose and Basmati. Rice breeding programs in Turkey should concentrate on cool temperature injury during flowering for a second crop production model, which seems possible only with very early cultivars. ■

Cold-tolerant variety VLK Dhan 39 released for Uttar Pradesh hills

V. S. Chauhan, scientist (Breeding), and J. P. Tandon, director, Vivekananda Parvatiya Krishi Anusandhan Shala. Almora-263601, U.P., India

Cold damage is the most serious constraint to rice yields in Northern India at altitudes up to 2200 meters. A highly cold-tolerant variety, VLK Dhan 39, recently was approved by the U.P. State Varietal Release Committee for cultivation in medium-altitude irrigated valleys.

VLK Dhan 39 — a pureline selection from China 1039/IR580-19-2-3-1, was isolated at Khudwani. It performed well in multilocational trials under the All India Coordinated Rice Improvement Programme. In 21 yield evaluation trials and farmers' field demonstrations, it outyielded the local check Thapachini by 31%.

VLK Dhan 39 is early-maturing (115 days) compared to local varieties (130 days). Plants are semi-tall with medium tillering ability and good panicle exsertion. Sheath color of basal leaves is predominantly light purple with a few pure green plants. Florets have purple apiculi and the grains are medium long. It has a fair degree of tolerance for blast and stem borers. Its grain type and cooking quality are acceptable to local consumers.

VLK Dhan 39 gave an average yield of 3.4 t/ha, compared to 2.6 t/ha for Thapacini (see table). ■

Average yields for VLK Dhan 39 in Uttar Pradesh hills, India.[a]

Variety	Yield (t/ha)				
	1976 (2)	1977 (6)	1978 (5)	1979 (7)	Mean
VLK Dhan 39	3.0	4.7	3.7	2.3	3.4
Thapachini	2.2	3.4	2.7	2.1	2.6
Increase over Thapachini (%)		37.8	37.6	10.4	31.4

[a]Values in parentheses indicate the number of sites where yields were averaged.

Low temperature injury in some rice varieties

D. Jaya Raj, R. Vijayakumar, and J. P. Gaddipati, Rice Section, Agricultural Research Institute (ARI), Rajendranagar, Hyderabad, 500030, India.

Unexpected damage in rice variety trials at ARI in early 1981 has been attributed to cold injury. Variety trials were sown the first week of December 1980 and transplanted the first two weeks of January 1981. Seedlings were healthy and green until the beginning of February 1981, when the crop was at maximum tillering. But on 12 February the leaves of some varieties were found to have turned dark yellow to light red (see table).

The damaged varieties were among entries in different trials. The symptoms were uniform in all replications. One parent is common in the parentage of some damaged varieties.

The symptom was uniform in a complete population of a variety, unlike the symptoms expected from disease, pests or nutritional disorder. Other varieties in the trials were green and healthy. Thus, the phenomenon appeared to be a case of cold injury.

The minimum low temperature was 18.1° C on 10 February and 9.6° C on 11 February. This sudden, extreme drop in temperature probably caused cold injury

Varieties showing low temperature damage at Hyderabad.

Variety	Parentage
IR36	IR1561-228//IR24-4/O.N//CR94-13
IR9828-81-2-3	IR2071-559/IR1820-52//IR36
IR13429-91-2-3	IR4432-53-33/PTB33//IR36
RNR31821	W1263/Tella Hamsa
RNR87877	IR34/Tella Hamsa
RNR98205	RP4-14/ RNR29939
RNR99082	IR1514 AE 597/Tella Hamsa
RNR99101	IR1514 AE 597/Tella Hamsa
IET1318	IR139429-196-1
IET6148	Bala/Co 13
1ET6228	IET2936/RP79-11//S_2S_2
IET13969	IET1991/W 13801
BR161-28-25	Chandina/IR425-1-1-3-8-3
CR141-5035	N22/TNI//T90/IR8
CR157-22-1900	Vijayai/PTB 10
PK174-13-1-5	Basmati 370/IR95-1-5-3-2-2-2

in highly sensitive varieties. Weather records for February 1976 show a low minimum temperature of 9.7° C and an average minimum temperature of 13.9° C. But no sudden fall in minimum temperature was recorded which possibly explains why such severe cold injury symptoms had not been observed before. ■

Pest management and control DISEASES

Fungicide control of rice grain infection

K. Govindarajan and S. Kannaiyan, Paddy Experiment Station, Tirur 602025, Tamil Nadu, India

Grain infection caused by seed-borne fungal pathogens *Helminthosporium oryzae, Nigrospora oryzae, Acrocylindrium oryzae,* and *Curvularia* sp. is a serious problem when crop ripening stage coincides with the monsoon. The effect of fungicides on the control of grain infection in IR20 was studied under wet field conditions.

Fungicides were sprayed twice, once at the milky stage and again a week later. Control plots were sprayed with plain water. Infected grains in 5 randomly selected clumps were assessed at harvest. Plots treated with edifenphos and copper oxychloride had the lowest grain infection (see table). ■

Effect of fungicides on grain infection and yield, Tirurkuppam, Tamil Nadu, India.

Fungicide	Application/ha[a]	Grain infection	Grain yield
Copper oxychloride 50% WP	1250 g	15.1	3.40
Edifenphos 50% EC	750 ml	14.6	3.39
Carbendazim 50% WP 500	g	16.7	3.35
Carboxin 75% WP	500 g	16.8	3.29
Mancozeb 75% WP	1250 g	17.1	3.28
Cuman-L 50% EC	1250 ml	17.0	3.27
Captafol 80% WP	750 g	17.0	3.13
Unsprayed control	–	17.3	3.18
C.D.		0.8	ns

[a]Each application.

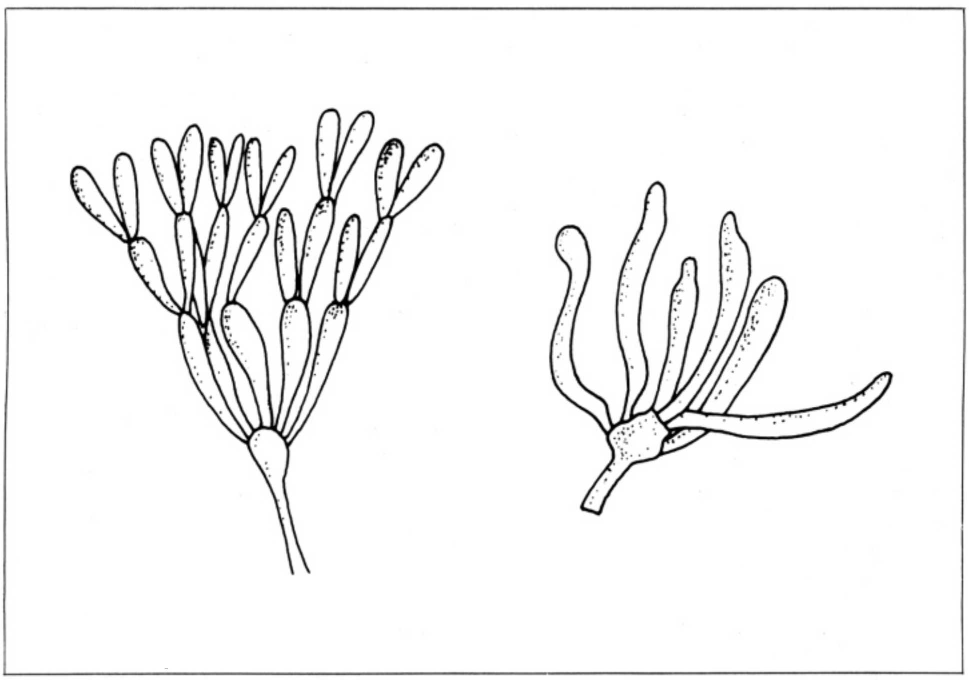
Rotten disease of azolla

Parkpian Arunyanart, Arunee Surin, Wanchai Rochanahasadin, and Somkid Disthaporn, Rice Pathology Branch (RPB), Division of Plant Pathology and Microbiology, Bangkhen, Bangkok, Thailand

Paddy soils in northeast Thailand are more suitable for azolla propagation than soils in other regions. But azolla there has been damaged by an unknown disease.

Disease samples were collected at the RPB during September-November 1981. Two genera of fungi were isolated. One genus showed a whitish colony of small mycelium, the other a cream brown colony of larger mycelium. Both were gown on potato dextrose agar (PDA). The whitish small mycelium was found to be the causal agent of the symptoms of rotten disease on azolla. The fungus belongs to the genus *Myrothecium.* Its general morphology is:

— Hyaline septate mycelium, 2.5-3.8 × 10.3-30 μ, good growth on PDA. Conidiophores macronematous, mononematous, closely packed together to form sporodo-

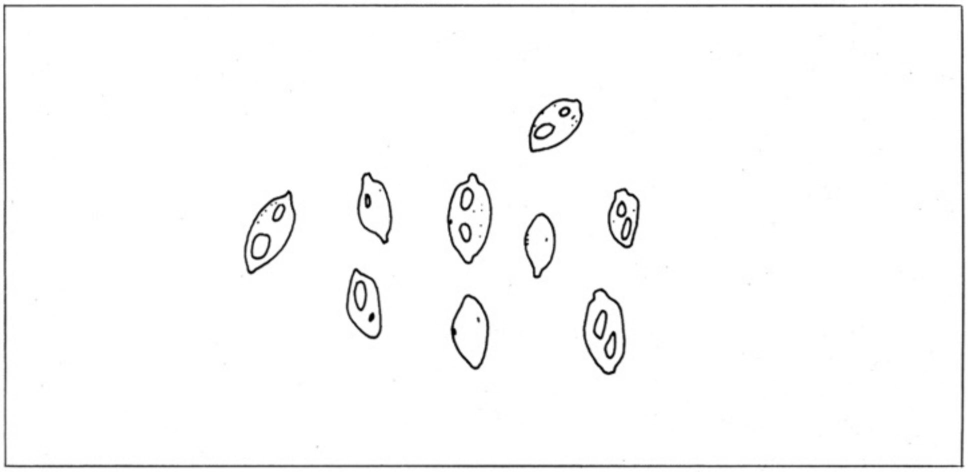


1. Sporodochia of *Myrothecium* fungus causing rotten disease of azolla in Thailand.

chia (see Fig. 1, 2). Branched, with apical branches arranged penicillately, straight or flexuous, colorless or olivaceous, smooth or verruculose.

— Conidiogenous cells monophialidic, discrete, cylindrical, clavate or subulate. Conidia aggregated in dark green or black, slimy masses semi-endogenous or acrogenous, simple, cylindrical with rounded ends, navicular, limoniform or broadly ellipsoidal, often with a projecting truncate base, hyaline to pale olive, smooth or striately marked O-septate.

The conidia found are similar to those of *Myrothecium verrucaria,* which are navicular, limoniform or broadly ellipsoidal, slightly protuberant and truncate at the base, distinctly colored, 6-10 × 2-4.5 μ.



2. Conidia of *Myrothecium* fungus causing rotten disease of azolla in Thailand.

Infected azolla turns brown, then rapidly rots and dies. The disease symptoms are spotted with distinct white fungus mycelium. In favorable conditions, the disease develops and spreads so rapidly that all azolla in a pond 4 × 8 m can be killed in a few days. ■

Pest management and control INSECTS

Mites infesting rice in Visakhapatnam District, Andhra Pradesh, India

A. Venugopalarao, assistant entomologist, Sugarcane Research Station, Anakapalle; A. K. Sanyal, zoologist, Acarology Section, Zoological Survey of India, Calcutta; and T. Ramamohan Rao, assistant research officer, Sugarcane Research Station, Anakapalle, India

Leaves of rice varieties Mypali, Sannabayyahunda, Ramasagaralu, and Phalguna cultivated around Anakapalle were found to have brown streaks (dried tissue) between veins and tears parallel to veins, giving a gale-torn appearance. Two species of mites responsible for the damage were identified by the Zoological Survey of India: *Scheloribates zealundicus,* family Oribatulidae, suborder Cryptostigmata, and *Ololaelaps holaspis,* family Laelaptidae, suborder Mesostigmata.

The oribatid mites are dark brown and round and appear as minute dust particles on a white background. The laelaptid mites are brown and oblong. They feed on the tissues between leaf veins and hide in the hollow places in the fed parts.

The mites were found to be existing on a grass species (under identification) growing on the bunds of rice fields. Their occurrence was mostly due to favorable weather during the early southwest monsoon with intermittent rainy periods. No insecticides had been applied to the crop. ■

Larval parasites of rice leaffolder in southern Sri Lanka

Rohan H. S. Rajapakse and Varuni L. Kulasekare, Agronomy Department, Faculty of Agriculture, Ruhuna University College, Matara, Sri Lanka

A major outbreak of rice leaffolder *Cnaphalocrocis medinalis* (Guenee) was observed in the primary cultivation season April-July 198 l. Characteristic damage included leaf skeletonization, giving a scorched appearance to the borders and shaded areas of the field in the early part of the season.

In a study to identify larval parasites regulating leaffolder populations in southern Sri Lanka, five parasites were found: *Apanteles ruficrus* (Haliday) (Hymenoptera: Braconidae), *Apanteles flavipes* (Cameron) (Hymenoptera: Braconidae), *Microbracon hebetor* Say (Hymenoptera: Braconidae), *Elasmus* spp. (Hymenoptera: Elasmidae), and *Bactromyia franssoni* Bar. (Diptera: Tachinidae). Parasitization of leaffolder larvae was 48% in Kamburupitiya, 53% in Matara, 60% in Hakmana, 38% in Denipitiya, and 70% in Mapalana. Disruption of the leaffolder parasite complex by periodic insecticide spraying to control brown planthoppers and stem borers may have resulted in the outbreak. ■

Major insect pests of rice on hilly tracts of Uttar Pradesh, India

D. K. Garg and J. P. Tandon, Vivekananda Laboratory for Hill Agriculture, ICAR, Almora, Uttar Pradesh, India

Systematic field surveys have been carried out since 1977 to identify the pest complex on Laboratory experimental fields at Hawalbagh (1,250 msl) and cultivator fields at varied elevations and with different agroclimatic conditions. About 40 insects have been identified in rice crops (see table).

The most serious damage is caused by the pink borer *Sesamia inferens* Wlk. Although the pest is active from the beginning of July to the end of September, the infestation peaks at 50-60% in mid-September.

Leaffolder *Cnaphalocrocis medinalis* Guenée maximum intensity occurs from mid-August to early September. A number of species of grasshoppers, such as *Oxya fuscovittata* (Marschall) and *Trigonidium cicindeloides* Rambur, cause damage at all growth stages, including the nursery stage. Other important insect pests identified are the whitebacked planthopper *Sogatella furcifera* (Horv.), pentatomid bugs *Dolycoris indicus* Stål and *Nezara* sp. and gundhi bug *Leptocorisa acuta* (Thumb).

Major insect pests of rice in the hills of Uttar Pradesh, India.

Insect pest	Growth stage	Damage
Heteronychus lioderes	Seedling stage	Root damage (grubs and adults)
Anomala dimidiata var. *barbata; Popillia cupricollis; Holotrichia seticollis;* other species	Seedling to dough	Root damage (grubs); leaf feeding and head damage (adults)
Oxya fuscovittata, Trigonidium cicindeloides, and other species	Seedling emergence to maturity	Leaf feeding (nymphs and adults)
Sesamia inferens	Tillering to dough	Stem tunneling (larvae)
Cnaphalocrocis medinalis	Booting to dough	Feeding on leaf tissue, except epidermis (larvae)
Sogatella furcifera	Flowering to dough	Leaf and stem sucking (nymphs and adults)
Dolycoris indicus and *Nezara* sp.	Heading to dough	Leaf and grain sucking (nymphs and adults)
Leptocorisa acuta	Milky stage	Grain sucking (nymphs and adults)

A number of species of white grub—including *Anomala dimidiata* var. *barbata* Burm., *Popillia cupricollis* Hope, and *Holotrichia seticollis* Moser—were found in dryland rice. *Heteronychus lioderes* was found to cause considerable damage to the nursery stage of irrigated rice in medium altitude areas. Grubs as well as adults were found feeding on rice roots. ■

Chemical control of gall midge

M. B. Kalode, senior entomologist; N. V. Krishnaiah, junior entomologist; and Y. F. Kormaty, technical assistant, All-India Coordinated Rice Improvement Project Rajendranagar, Hyderabad 500030, A.P.

Applying granular insecticides such as carbofuran, mephosfolan, chlorfenvinphos, quinalphos, and phorate and dipping seedling roots in chlorpyriphos and chlorfenvinphos before planting have been the only effective chemical control methods against gall midge *Orseolia oryzae* (Wood Mason), both in the nursery and the main field. This study attempted to develop additional methods of insecticide application.

Twelve wettable powders were evaluated for treating sprouted seeds before sowing. Seedlings 15 and 30 days old were exposed to gall midge adults. Effectiveness was judged on appearance of silver shoots. At 16 g ai./kg seed, Evisect (San 155 90 SP), carbaryl (Sevin 50 WP), cartap hydrochloride (Padan 50 SP), Macbal (50 WP), chlordimeform (Galecron 50 WP), and MIPC (50 WP) caused either poor crop stand or phytotoxicity. Isofenphos completely suppressed gall formation up to 30 days in the nursery and persisted 15 days after transplanting in the greenhouse. Carbofuran showed moderate effectiveness up to 15 days after sowing. Knockbal, fenitrothion, Imidan, and bendiocarb were ineffective.

In another test, seven insecticides were evaluated for soaking sprouted seeds before sowing. lsofenphos wettable powder and emulsifiable concentrate were effective at 0.5% in 3-hour treatments. Chlorpyriphos was effective at 0.5% in 3-hour treatments. Carbofuran, monocrotophos, BMPC, and FMC 35001 were not effective.

In a seedling root dip treatment, 0.02% chlorpyriphos was effective in 12-hour treatments or with 1% urea in 3-hour treatments. In the greenhouse, isofenphos and chlorpyriphos suppressed gall midge development up to 25 days after planting. Further experiments using the two insecticides and superphosphate slurry showed that a 1- to 2-minute dipping period was sufficient for control up to 25 days.

Thirteen granular insecticides were evaluated against different age maggots. Mephosfolan, carbofuran, and isofenphos at 2 kg ai./ha effectively checked silver shoot formation even when applied 7 days after gall midge maggots entered the plant tissues. Mephosfolan at 0.5 and 1.0 kg a.i./ha and carbofuran at 1 kg a.i./ha controlled maggots that had entered 3 days earlier. Chlorfenvinphos, MIPC, phorate, fensulfothion, and AC64475 at 2 kg a.i./ha checked silver shoot formation when applied 3 days after maggot entry. Quinalphos and terbufos killed maggots within one day of entry. Insecticides applied 8 days after maggot entry killed some maggots, but silver shoots formed. ■

Activity of insecticides applied in the root zone to control brown planthopper and green leafhopper

R. P. Basilio and E. A. Heinrichs, The International Rice Research Institute

Carbofuran provides longer residual activity and greater safety to certain predators when applied into the rice root zone than when applied as foliar spray or paddy water broadcast. IRRI entomologists and engineers are collabo-

Effect of insecticides applied in the root zone on brown planthopper and green leafhopper. IRRI insectary, 1980.

Treatment (1.0 kg a.i./ha)	Mortality[a] (%)									
	Brown planthopper					Green leafhopper				
	1 DAT	5 DAT	10 DAT	15 DAT	20 DAT	1 DAT	5 DAT	10 DAT	15 DAT	70 DAT
Carbofuran 12 F	100 a	100 a	86 a	83 a	13 a	100a	100a	94a	83 a	86 a
UC54229 100% Tech.	76 b	48 b	8 b	43 b	1 b	99 a	88 a	71 b	66a	71 ab
UC SF-1 40 F	60 b	66 b	10 b	21 b	3 ab	99 a	95 a	53 b	75 a	64 b
RP32861 25 EC	10 c	9 c	4 b	1 c	1 b	3 b	6 b	8 c	1c	3 c
Control	10 c	6 c	4 b	9 bc	5 ab	1 b	4 b	1 c	10 bc	1 c

[a]In a column, means followed by a common letter are not significantly different at the 5% level. DAT = days after treatment. Mortality readings were taken 48 hours after placing insects on plants.

rating to develop practical root-zone application methods but insecticides that are highly systemic and effective as a root-zone application are few.

Three coded compounds were compared with carbofuran in a greenhouse test to determine their activity when applied in the root-zone (see table). UC54229 and UC SF-1 are carbamates and RP32861 is an oxadiazol. UC SF-1 is micronized carbaryl in an aqueous solution. The insecticides were injected into the soil in porcelain pots with a syringe. Twenty brown planthoppers *(Nilaparvata lugens)* and 20 green leafhopper *(Nephotettix virescens)* female adults were placed on 35-day-old caged TN1 plants at 1, 5, 10, 15, and 20 days after treatment (DAT). Insect mortality was recorded 48 hours after caging the insects.

Only carbofuran provided effective control against the brown planthopper. UC54229 and UC SF-1 were effective against the green leafhopper. In previous tests, UC54229 and UC SF-1 applied as foliar sprays provided no control at 10 DAT. Increase in residual activity when applied in the root zone warrants further testing of UC54229 and UC SF-1 for field control of green leafhoppers and tungro virus. ■

Predators of rice bugs in southern Sri Lanka

R. H. S. Rajapakse and V. I. Kulasekera, Agronomy Department, Faculty of Agriculture, Ruhuna University College, Matara, Sri Lanka

The rice bug *Leptocorisa oratorius* (F.) has been detected feeding on milky grains in large numbers during the major cultivation season yala (April-July) in southern Sri Lanka. A survey of irrigated rice fields in Matara district revealed the occurrence of these predators of early nymphal instars: *Antilochus nigripes* Burm. (Hemiptera:Pyrrhocoridae), *Canthecona robusta* Distant (Hemiptera:Pentatomidae), *Irantha* spp. (Hemiptera: Reduviidae), and *Cicindela sexpunctata* F. (Coleoptera: Cicindelidae).

The predators were identified by the National Museum, Division of Entomology, Sri Lanka. Predator density was very low. Although rice bug density averaged 2-4/hill, only 0.5 (or fewer) predator/hill was found. That may explain the high incidence of rice bugs in the region. ■

Survey of natural enemies of paddy insect pests in Chhatisgarh (Madhya Pradesh), India

S. N. Rawat, surveillance officer, Central Surveillance Station, Bilaspur (M. P.); and M. C. Diwakar, assistant director (surveillance), Directorate of Plant Protection Quarantine & Storage, Faridabad (Haryana)

No precise information on the occurrence of predatory and parasitic fauna on various insect pests of paddy has been available for integrated pest management planning. Therefore, surveys were undertaken on the paddy crop in Chhatisgarh region of Madhya Pradesh for 6 consecutive years, 1975-80 kharif season. Some species identified as parasites and predators of major paddy pests

Parasites and predators of paddy insect pests in Chhatisguh (M.P.), 1975-80.

Natural enemy	Host	Prevalence	Years of Occurrence
Common			
Platygaster oryzae	*Orseolia oryzae*	Moderate	1979-80
Propicroscystus mirificus (Girault)	”	High	1979-80
Polygnotus spp.	”	Trace	1975-80
Proleptacis oryzae	”	Trace	”
Telenomus israeli	”	Trace	”
Neanastatus spp.	”	Trace	”
Cyrtorhinus lividipennis	*Nilaparvata lugens*	High	”
Gonatopus spp.	*Nephotettix* spp.	Moderate	1978-80
	Sogatella furcifera	High	1979-80
	Recilia dorsalis	Trace	1977
Apanteles spp.	*Tryporyza incertulas*	Trace	1975-80
Stenobracon spp.	”	Trace	1975-80
Uncommon			
Apalochrus fasciatus (F)	Host not determined	High	1975-80
Pheidole spp.	”	Moderate	”
Paratrechina longicornis (Latreille)	”	High	”
Dragonflies	”	High	”
Damseiflies	”	High	”

Continued on next page

of the region are listed in the table. Dr. N. C. Pant, director, British Museum, London; and Dr. A. D. Pawar, assistant director (Biological Control), Directorate of Plant Protection Quarantine & Storage, assisted in the identification. ■

Table continued

Natural enemy	Host	Prevalence	Years of occurrence
Aphidius spp.	”	High	”
Selina westermanni (Mots.)	”	High	”
Spiders	”	High	”
Amphipsyche meridiana Ulmer	”	High	1975-76

Leaffolder outbreak in Kohima District, Nagaland, India

V. S. Pangtey and J. N. Sachan, ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema 797106

Rice leaffolder *Cnaphalocis medinalis* Guenee was recorded as a minor pest in 1977 and 1978. But the pest caused heavy damage during the 1979 wet season (Jun-Nov), with infestations peaking in early September. Infestation on IR8 leaves varied from 20% at higher altitudes (1,400 m mean sea level [MSL]) to 36% at lower altitudes (250 m MSL). Infestations seem to be increasing, up to 70% on IR8 and local variety Nagaland Special in 1981. ■

Gall midge incidence at Manipur, India

S. Amu Singh, District Agricultural Officer. Tengnoupal, Chandel, Imphal, Munipur, India

A heavy incidence of gall midge was recorded during 1979-80 kharif in a few pockets of Manipur. To assess the extent of pest incidence, a field survey was conducted in six subdivisions when the crop reached the mid- to late-tillering stage. Fifty hills per variety per loukol (a group of fields) was the survey unit. Observations were recorded from four survey units per subdivision. Varieties planted varied among subdivisions. Percentage of silver shoots was calculated on the basis of actual number of silver shoots and number of tillers per unit.

Gall midge incidence (see table) was highest in Imphal West I and lowest in Imphal West II. The lowest use of plant protection in Imphal West I perhaps accounted for the high incidence of the pest there. In Churachandpur, gall midge incidence was low because the area planted to susceptible high yielding varieties was small. Ratna, IR24, Punshi, and Phouoibi were found to be more susceptible to the insect than local varieties Phourel and Moirangphou (see table). ■

Gall midge infestation in 6 subdivisions of Manipur, India.

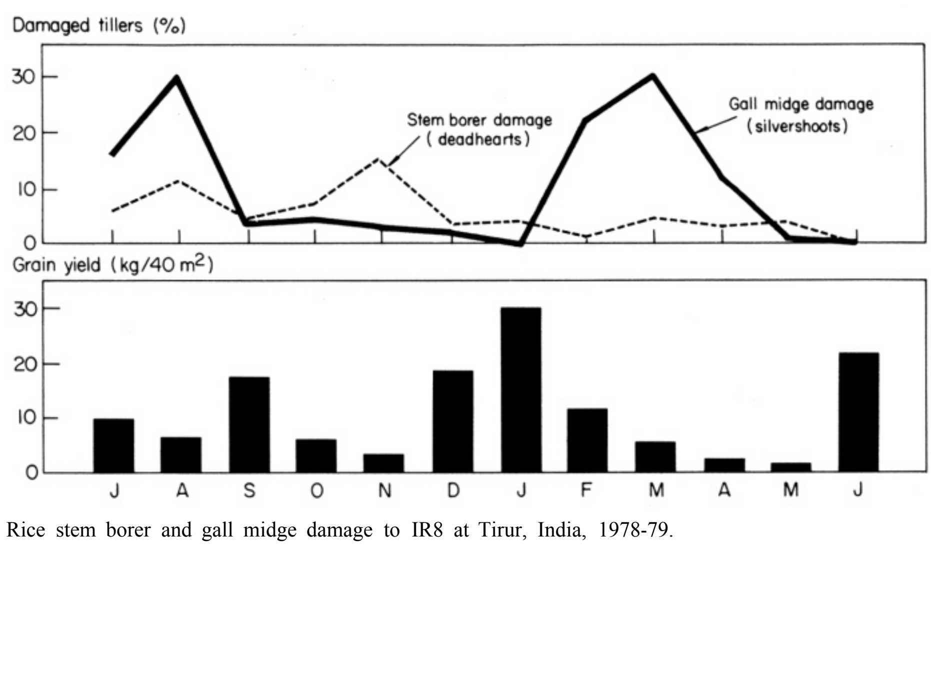
Rice variety	Silver shoots (%)						
	Imphal West 1	Imphal West 11	Imphal East	Thoubal	Bishenour	Chura-chandpur	Mean
Punshi	22.0	12.7	32.4	23.8	15.0	–	21.2
Phouoibi	26.7	14.2	26.0	38.3	16.9	–	22.4
IR24	43.6	10.8	29.3	23.3	19.4	12.7	23.3
Ratna	46.4	–	6.9	23.2	–	24.5	25.2
P.33	42.1	9.8	–	5.6	21.0	–	19.6
Moirangphou	–	17.7	9.6	4.9	3.9	9.5	9.1
Phourel	–	–	6.2	5.1	6.5	11.27	7.2
Mean	36.2	13.0	18.4	17.8	13.8	14.7	18.3
CD (P = 0.05)	3.17	5.25	4.33	6.03	5.11	2.82	

Occurrence of rice stem borers and gall midges at Tirur, Chingleput District, India

R. Saroja, Paddy Experiment Station, Tirur 602025, India

To determine the damage patterns of yellow stem borer and gall midge, two major pests of rice in Chingleput, the susceptible variety IR8 was planted in 40-m^2 plots every month from July 1978 to June 1979. Recommended agronomic practices were adopted. The crop was given no insecticide treatment.

Stem borer and gall midge infestations were assessed at 60 days after transplanting by recording the number



Rice stem borer and gall midge damage to IR8 at Tirur, India, 1978-79.

of deadhearts and silver shoots.

The data on pests and grain yield for each planting were plotted (see figure). These conclusions were drawn:

1. Stem borer occurrence was below the economic threshold (5%) on crops planted in September and from December to June.
2. Gall midge incidence was low on crops planted from September to January and in May and June.
3. The normal times of planting in the three seasons — September in samba, January in navarai, and June in sornavari — are ideal. Crops yielded higher than average, 12.5 kg/40 m^2 (3.1 t/ha). Among the three seasons the highest yield was recorded in navarai.
4. In a season, early or late plantings should be accompanied by timely plant protection measures to avoid yield losses to stem borers and gall midges. ■

Minimum insecticide for rice pest control

K. R. Mohan Rao, G. V. Subbaratnam, N. Hari Prasada Rao, and Khalid Ahmad, Operational Research Project on Integrated Control of Rice Pests (ICORP), Batpala, Andhra Pradesh, India

Monitoring pest populations on rice and adopting economic thresholds have minimized insecticide spraying in the village of Buddam, Andhra Pradesh.

The average number of sprays before starting an ICORP project was 2.1 sprays in the wet season and 2.7 sprays in the dry season. But when sprays were made only when needed, the average number was reduced to as low as zero sprays in the 1977-78 wet season. Spraying was done only once on 9.72 ha and in the remaining 395 ha a good crop was raised without spraying at all. In general, economic loss due to insect pests was avoided during the period of the project (Table 1). And fewer sprays were made without loss in yield.

Field sample plots provide data to initiate control operations. Plots 0.4 ha in size and representative of varieties and dates of planting are selected, and 5 m^2 in each provides the area for counting deadhearts at 15, 30, 55 days after transplanting (DT) and silver shoots at 15 and 35 DT. Counts on 50 hills at random provide the data for other pests.

When the pest density or damage is above an economic threshold (Table 2) in a large number of sample plots, a general survey of farmers' fields is undertaken. Insecticide is applied in fields where an economic threshold has been exceeded.

Other benefits also have been noticed. Incidence of pests in general was low, and the onset of incidence was delayed compared to surrounding areas. Predators of brown planthopper and parasites of gall midge and stem borer contributed increasingly to natural control.

In implementing integrated control, economic thresholds were modified in three cases:

1. In the dry season, stem borer attack develops within 15-20 DT. As the crop at this stage has very few tillers, stem borer attack can result in seedling death and gaps in the field. It is desirable to spray insecticide when the damage reaches 5% deadhearts. Deadheart counts must be taken 15, 30, and 55 DT.
2. Brown planthopper large-scale egg laying occurs during favorable climatic conditions in the preflowering and postflowering stages. Nymph density instead of adult density provides a better basis for control operations. The presence of 25 nymphs/ hill was found to be a useful economic threshold.
3. Since it is difficult to locate the climbing cutworm caterpillars, a better indicator than density is cut panicles. The presence of 5 cut panicles/m^2 should be the threshold for insecticidal spraying. ■

Table 1. Effect of insecticide sprays on rice yield in Bapatla, Andhra Pradesh, India.

Year	Wet season				Dry season			
	ICORP village		Control village		ICORP village		Control village	
	Sprays (no.)	Yield (t/ha)	Sprays (no.)	Yield (t/ha)	Sprays (no.)	Yield (t/ha)	Sprays (no.)	Yield (t/ha)
1974-75[a]	2.1	4.23	2.8	3.57	2.7	3.15	3.2	3.33
1975-76	1.4	3.75	2.1	2.53	0.7	4.50	3.1	4.40
1976-77	0.3	5.00	0.2	3.33	0.3	4.18	2.3	4.19
1977-78	0.0	4.60[b]	0.2	2.65	1.5	3.52	1.6	3.18
		1.77[c]	–	–	–	–	–	–
1978-79	0.1	4.01	0.4	3.65	–	–	–	–
1979-80	0.3	4.20	0.5	4.00	–	–	–	–

[a]Base year. [b]Yield before a cyclone. [c]Yield after a cyclone.

Table 2. Tentative economic thresholds for pest control. Operational Research Project on Integrated Control of Rice Pests, Bapatla, India.

Pest	Threshold
Stem borers	10% deadhearts
Gall midge	5% silvershoots
Green leafhopper) Brown leafhopper)	25 insects/hill
Leaffolder	3 damaged leaves/hill
Cutworms) Rice hispa) Grasshoppers)	1 insect/hill

Effect of volume of insecticide spray on brown planthopper mortality

R. P. Basilio and E. A. Heinrichs, The International Rice Research Institute

Reducing the volume of water in insecticide spray minimizes the cost of farm labor to carry water to the area of application. To determine whether insecticide toxicity is affected by spray volumes, 250, 500, and 1,000 liters insecticide solutions/ha were sprayed on 30- to 35-day-old TN1 potted plants at a rate of 0.75 kg ai/ha using an atomizer run by an air compressor. Beginning one day after treatment (DAT) 20 female adult brown planthoppers were caged on treated plants at 5-day intervals. Insect mortality was recorded 48 hours after caging.

Effect of spray volume (0.75 kg a.i./ha) on mortality of brown planthoppers. IRRI insectary, 1980.

Insecticide and volume (liters/ha)	Mortality[a] (%) 1 DAT	5 DAT	10 DAT	15 DAT	20 DAT
Carbofuran 12 F					
1000	100 a	98 a	90 a	62 a	20 a
500	100 a	99 a	92 a	68 a	27 a
250	94 a	36 b	14 b	9 b	0 b
Perthane 45 EC					
1000	100 a	98 a	41 a	16 ab	2 a
500	98 a	84 a	39 a	30 a	8 a
250	100 a	93 a	39 a	7 b	0 a
Monocrotophos 30 EC					
1000	94 ab	32 a	10 a	7 a	2 a
500	95 a	28 a	7 a	3 a	2 a
250	83 b	26 a	0 a	2 a	0 a
UC54229 100 Tech.					
1000	99 a	100 a	91 a	55 a	25 a
500	100 a	99 a	82 a	42 ab	9 a
250	98 a	82 b	58 b	23 b	5 a

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

Mortality for three volumes of Perthane and monocrotophos spray was similar (see table). However, carbofuran and UC54229 usually were most toxic when applied at 1,000 and 500 liters. ■

Soil and crop management

Effects of phosphorus fertilizer sources in calcareous soil

A. A. Jakhro, Institute of Agriculture, Timbang Menggaris, Kota Belud Sabah, Malaysia

A field experiment on calcareous silty clay soil (pH 7.7, OM 0.4% Ca 23.0 meq/100 g, Mg 13.0 meq/ 100 g, CEC 15 meq/100 g, and Olsen P 4.2 ppm) evaluated two sources of phosphate fertilizer: diammonium phosphate (DAP) and triple superphosphate (TSP). Urea was applied as a nitrogen source with TSP.

Fertilizer treatments were randomized in a complete block design with four replications. Nitrogen and phosphorus levels were 120 kg N/ha and 60 kg P_2O_5/ha. All of the P and half the N were broadcast and incorporated into the soil two days before IR6 seedlings were transplanted. The remaining N was topdressed at the time of panicle initiation.

The number of tillers per hill, plant height, percent plant P concentration at 30 days after transplanting (DT), and grain yield increased signifiantly with the combination of urea and TSP (see table). ■

Effect of sources of phosphate fertilizer on plant height, tiller number, plant phosphorus concentration 30 days after transplanting, and grain yield of rice in calcareous soil in Malaysia.[a]

Source of P fertilizer[b]	Plant ht (cm)	Tillers (no./hill)	P concentration (%)	Grain yield (t/ha)
None (control)	25 c	18 c	0.15 c	3.0 c
DAP	38 b	34 b	0.17 b	4.5 b
TSP	45 a	39 a	0.18 a	5.1 a
CV %	3.61	3.02	1.41	2.97

[a]In a column, means followed by a common letter are not significantly different at the 5% level. [b]Control = 120 kg N/ ha and no P, DAP = diammonium phosphate, TSP = triple superphosphate + urea.

Rice germination and seedling response to oxygen in floodwater

F. T. Turner, associate professor; Cy-Chain Chen, research assistant; and Garry McCauley, associate professor, Texas Agricultural Experiment Station at Beaumont, Rt. 7 Box 999, Beaumont, Texas 77706

Germination and establishment of rice (*Oryza sativa* L.) seedlings are usually less than optimum in water-saturated and flooded soils, apparently because of a deficiency of available oxygen (O_2). This study evaluated the effect of specific O_2 levels on seedling development and identified rice cultivars that may be more tolerant of the low O_2 concentrations associated with water-saturated rice soils.

Gas flowmeters and regulators allow mixing of air and N_2 gas. Six O_2 levels — 21, 10.5, 5.3, 2.0, 1.0, and 0% (99.995% N2 gas) — were bubbled into a transparent plastic box (36 × 28 × 9 cm deep) holding deionized water 7.5 cm deep. Seeds of 4 rice cultivars were suspended on cheesecloth about 3 cm below the water surface. As gas of desired O_2 concentration dispersed into the box, the water circulated slowly. Water circulation plus a thin transparent polyethylene cover helped assure that O_2 concentration within each box was uniform. A YSI Model 53 O_2 meter monitored O_2 levels continuously. Seed boxes were placed in a growth chamber providing light intensity of 400 microeinsteins/m^2 per second, a 12-hour day, and 27° C constant temperature. Length of coleoptile, first leaf, and primary root were measured after 1 week incubation.

Oxygen concentration had little effect on coleoptile emergence, but low O_2 levels enhanced coleoptile elongation. Maximum coleoptile length (20 mm) occurred at 0% O_2. It appears that the rice seed germinated at very low O_2 levels. Root and leaf growth were inhibited at 0% O_2, evidence that low O_2 levels can restrict rice stand establishment.

The critical O_2 concentration for maximum shoot elongation appeared to be about 5%. The critical O_2 concentration for root elongation was less evident. Roots of Labelle and Bellemont seedlings reached maximum length at as low as 5% O_2. Roots of Calrose 76 and M 101 seedlings continued to increase in length at 10.5% and 21% O_2.

To help identify cultivars most tolerant of low O_2 concentrations, growth was measured for 10 cultivars in 10.5 and 1% O_2 (see table). When O_2 decreased from 10.5% to 1%, leaf length differences ranged from −61% (IR8) to −81% (CB744). Root length differences ranged from -35% (Bellemont) to −90% (Starbonnet). Coleoptile length differences ranged from 47% (IR24) to 135% (Labelle). Rice cultivars exhibited tolerance for low O_2 levels in one character, but not in the two others. ■

Length of rice leaf, root, and coleoptile after I week incubation in water saturated with 10.5% and 1% O_2 at Beaumont, Texas.

Cultivar	Difference (%) in length		
	Leaf	Root	Coleoptile
CB744	–81[a]	–63	122
IR8	–61[a]	–60	52
IR24	–78	–77	47[a]
Labelle	–82	–47	135[a]
Mars	–68	–78	93
Peta	–64	–63	62
Bellemont	–82	–35[a]	108
Saturn	–70	–79	74
Starbonnet	–75	–90[a]	93
TN1	–62	–40	67

[a]Extremes for character.

Late planting effects on long-duration semidwarf rices in wetland fields

P. Mukherjee and A. R. Debnath, Rice Research Station, Chinsurah, West Bengal, India

Seedling age and time of planting influence rice productivity to a great extent, particularly in short-duration, photoperiod-insensitive cultivars during the rainy season. This experiment examined the effect of late planting on growth duration and yield performance of long-duration semidwarf rice cultivars in wetland fields (20- to 50-cm water depth) during the 1977 rainy season. Materials were 15 long-duration, semidwarf rice cultivars of diverse genetical backgrounds in 2 seedling age groups, 35 days and 60 days old. The experimental design was randomized complete block with four replications. Plots (net) were 4.8 × 2.6 m with plant spacings of 20 × 15 cm and fertilizer applications of 80-40-40 kg NPK/ha.

Grain yields in both normal and late plantings did not differ significantly (see table). However, grain yields of IR32, IR34, CR1006, and IET3257 increased in the late planting. Growth duration increased in all late planted cultivars. Although growth duration increases appreciably, grain yields of normal and late plantings are comparable in long-duration semidwarf rice cultivars. ■

Grain yield and growth duration of long-duration[a] semidwarf rice cultivars at normal and late planting dates during 1977 rainy season at Chinsurah, West Bengal, India.

Cultivar	Grain yield (t/ha)		Growth duration (days)	
	Normal	Late	Normal	Late
IR32	3.4	3.8	149	171
IR34	3.0	3.5	140	163
CR1006	4.0	4.3	158	180
CR1009	4.1	4.0	153	172
ET3257	3.0	3.4	149	160
ET3235	3.3	3.0	140	160
IET4087	3.1	2.7	142	157
IET2991	3.2	2.8	149	153
Pankaj (m) 107	3.8	3.4	147	161
Pankaj (m) 91	3.5	3.0	152	163
HTA448	2.8	2.6	140	167
HTA108	3.5	3.1	149	167
CNBP153-58-2	2.8	2.6	147	159
CNPB134-34-1-1	2.2	2.0	143	161
Pankaj (control)	4.4	4.3	146	164
LSD (0.05) = 0.4 t/ha	0.5	0.6		

[a] Maturity of 140 days or more. Normal = 35-day-old seedlings, late = 60-day-old seedlings.

Sesbania rosfrafa green manure and rice

G. Rinaudo, B. Dreyfus, and Y. Dommergues, Soil Microbiology, ORSTOM BP 1386, Dakar, Senegal

To study the effect of *Sesbania rostrata,* a tropical legume that colonizes waterlogged soils in the Senegal Valley, as green manure on rice yield, an experiment was set up in microplots (1 m^2 each) during the rainy season. Three treatments were used:

Sesbania rostrata green manure. Plots were sown with *S. rostrata* and kept waterlogged for 45 days (stems inoculated by spraying with a culture of *Rhizobium* strain ORS 551). Irrigation was stopped for 7 days, and the stems of *Seshania* were cut and plowed in. Nineteen days later, plots were fertilized with PK (17.44 g K_2HPO_4/m^2), planted with 2-week-old seedlings of rice cultivar Moroberekan, and waterlogged again.

Mineral nitrogen fertilization. Plots were kept in fallow with the same water management, fertilized with PK and N (23.32 g SO_4 $(NH_4)_2/m^2$), planted, and waterlogged.

Control. Plots were kept in fallow with the same water management, only fertilized with PK, planted, and waterlogged.

Rice was harvested when plants were 135 days old.

In the microplots which had received

Sesbania green manure, yield in dry matter (grain or straw) increased over control (see table). Application of mineral nitrogen was significantly less effective. Nitrogen content of grain and straw was significantly higher in green-manured plots than in plots without green manure.

If extrapolation of the data to the field is valid, we can conclude that the use of *S. rostrata* as green manure permits yields as high as 6 t/ha in a soil with lower than average fertility, such as the one used in this experiment. ■

Effect of *Sesbania rostrata* green manure on the yield and nitrogen content of rice.

Treatment[b]	Av dry yield (g/m^2)		Nitrogen content (%)		Av nitrogen yield
	Grain	Straw	Grain	Straw	(g N/m^2) in grain + straw
PK + green manure	596 a	772 a	1.80 a	0.94 a	18.17 a
PK + N (60 kg/ha)	381 b	484 b	1.27 b	0.49 b	7.21 b
PK (control)	212 c	276 c	1.14 b	0.58 b	4.02 c

[a]Figures followed by same letter do not significantly differ at 1% level. [b]Six microplots per treatment.

Rice crop productivity in alkali soil reclaimed by gypsum or pyrites — a case of eastern Uttar Pradesh

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

Alkaline soils constitute a permanent constraint to rice production in eastern Uttar Pradesh. A series of experiments were initiated in alkali soil (pH 10.4) during the 1976 rainy season and repeated in 1977 and 1978. Plots measured 5 × 4 in a randomized block design with 3 replications. Gypsum was applied at 0, 3, 6, 9, and 12 t/ha. Pyrites were applied at 0, 1.5, 3, 4.5 and 6 t/ha. Pyrites applied were half that of gypsum because the sulfur content (30%) of pyrites is double that of gypsum. In addition, the cost of one ton of pyrites is almost double that of gypsum. Rice husk and sawdust at a maximum dose of 7.5 t/ha also were used.

Medium duration variety IR24 was grown during the first year and Jaya was grown during the second and third years. Transplanting of 5- to 6-week-old seedlings in early to mid-July was at 15-cm plant spacing with 4 to 5 seedlings/ hill. Fertilizer was applied at 120 kg N, 50-60 kg P_2O_5, and 32-40 kg K_2O/ha. Zinc sulfate was applied at 35 to 40 kg/ ha.

Rice husk and sawdust had no effect. Grain yield dramatically increased with increasing doses of gypsum and pyrites (see table). Yield increased from a minimum of 1.0 t/ha in original alkali soil to a maximum of 6.0 t/ha in pyrite-treated and 6.8 t/ha in gypsum-treated plots. Gypsum consistently proved superior to pyrites in enhancing rice yields from alkali soil. Yields in nontreated original alkali soil plots also went up from 1.0 t/ha to 2.0 t/ha suggesting some spontaneous improvement in soil even without any chemical amendments. This might be possible because continued application of fertilizers and zinc sulfate and proper water management aided natural leaching of salts. Yield levels after chemical amelioration suggest that alkali soils are inherently productive and that good rice yields can be obtained with proper soil-water-crop management practices. ■

Effect of gypsum and pyrites on rice yield from alkali soils of Kumarganj (Faizabad), India.

Application rates[a] (t/ha)		Yield (t/ha)								
		1976			1977			1978		
Gypsum	Pyrites	Gypsum	Pyrites	Difference	Gypsum	Pyrites	Difference	Gypsum	Pyrites	Difference
0	0	1.0	1.1	–0.1	1.6	1.6	0	2.0	2.0	0
3	1.5	1.9	1.7	0.2	2.9	2.8	0.1	3.4	3.1	0.3
6	3.0	3.5	2.7	0.8	4.6	4.0	0.6	4.7	4.3	0.4
9	4.5	4.8	4.2	0.6	6.0	5.2	0.8	6.2	5.6	0.6
12		5.3	4.6	0.7	6.4	5.9	0.5	6.8	6.0	0.8
LSD (0.05)		0.4	0.4		0.4	0.3		0.3	0.3	

[a]The soil amendments were applied only once, in 1976.

Influence of presowing soil water and seed iron-coating on iron in soil and yield of dryland rice

A. B. Ingale and K. R. Sonar, Agricultural Chemistry and Soil Science Department, Mahatma Phule Agricultural University, Rahuri 413722, Maharashtra, India

An experiment on a calcareous Vertisol (pH 8.7, organic carbon 0.61%, Olsen-P 8.74 ppm, DTPA extractable Fe 1.38 ppm, Mn 2.64 ppm, and $CaCO_3$ equivalent 8.2%) at Rahuri during the 1980 rainy season examined the influence of water treatment (control and one irrigation daily to about soil saturation) 15 days before sowing and seed coating with an iron compound (control and 2% Fe coating through $FeSO_47H_2O$ and Fe EDTA) on the availability of soil Fe and yield of dryland rice cultivar Karjat 184. Field moisture capacity of 27-35% was maintained from sowing to maturity.

Soil saturation before sowing significantly increased DTPA extractable Fe at 15 days and at sowing, tillering, panicle initiation, and flowering stages of rice growth (see table). This could have been caused by the moderately reduced soil conditions that resulted from soil saturation 15 days before sowing (Eh reduced from + 502 to + 390 mV and pH from 8.70 to 8.15). Coating seed with Fe compounds had no influence on the release of Fe in the soil.

Grain and straw yields were signifi-

Rice yield and release of iron in soil as influenced by presowing soil water treatments and coating seed with iron compounds at Rahuri, India.

Treatment	Rice yield (t/ha)		Release of iron in soil (ppm)						
	Grain	Straw	Water treatment before sowing 1 day	Water treatment before sowing 15 days	Sowing	Tillering	Panicle initiation	Flowering	Harvest
Water treatment									
Control	2.1	2.4	1.64	1.64	2.64	2.91	2.88	2.60	1.71
Soil saturation	2.3	2.7	1.72	3.73	3.77	3.16	3.06	3.08	1.98
Seed coating									
Control	2.1	2.4	–	–	3.18	3.06	2.96	2.79	1.84
$FeSO_4.7H_20$	2.2	2.6	–	–	3.20	2.97	2.85	2.85	1.97
Fe EDTA	2.2	2.6	–	–	3.24	3.01	2.98	2.89	1.71
Water treatment									
F-test	**	**	ns	**	**	**	**	**	ns
S.E. ±	0.21	0.17	0.06	0.04	0.05	0.02	0.02	0.05	0.09
C.D. at 5%	0.63	0.51	–	0.12	0.14	0.07	0.07	0.15	–
Seed coating									
F-test	**	**	–	–	ns	ns	ns	ns	ns
S.E. ±	0.25	0.21	–	–	0.06	0.03	0.03	0.06	0.12
C.D. at 5%	0.75	0.63	–	–	–	–	–	–	–
Interaction									
F-test	**	**	–	–	ns	ns	ns	ns	ns

cantly higher under the presowing soil saturation treatment. This might be due to the increased availability of Fe.

Coating seed with $FeSO_4 \cdot 7H_2O$ and Fe EDTA significantly increased yield, probably because of the increased availability of Fe to rice plants. The interaction between presowing soil water treatment and coating seed with Fe compounds significantly increased yield. ■

Urea application and time of incorporation in Bangladesh paddy

Md. Abdus Sattar, agronomy specialist; and H. Sakai, soil fertility expert, Central Extension Resources Development Institute, Joydebpur, Dacca, Bangladesh

Urea fertilizer usually is incorporated into paddy soil soon after application. But urea is not well absorbed by soil particles in ill-drained paddy fields with deep standing water. A large portion remains in the standing water, even after intensive incorporation practices. The unincorporated urea may be lost through volatilization and denitrification. Because ammonium is easily absorbed by soil particles, incorporation a few days after urea application, after a major portion has been ammonified, may increase the effect of the fertilizer.

A first trial on soil incubation showed that the highest amount of exchangeable ammonium remained in the soil with incorporation 2 to 4 days after urea application (Table 1). In a field trial using 253-m^2 plots in 1981 T. aman season, incorporation 4 days after application maximized paddy yields (Table 2). ■

Table 1. Effect of incorporation lag on recovery of urea[a] nitrogen after 17-day incubation in Bangladesh.

Incorporation (days after application)	Oxidative layer (mm)	Ammonium nitrogen (ppm)
0	6.8	74
2	6.6	103
4	6.5	102
6	6.0	93
9	5.2	76
No incorporation	9.8	70

[a]Rate of 40 kg N/ha, 5 cm standing water, extracted soil layer 5 cm.

Table 2. Effect of time of soil incorporation of applied urea on paddy yield in Bangladesh.[a]

Incorporation (days after application)	Paddy yield (t/ha)
0	5.0
1	5.0
2	5.3
3	6.7
4	6.6
5	6.5

[a]BR 10 variety, 3-split application (40-20-20 kg N/ha).

Effect of insecticide application on nitrogen transformation in flooded soil

K. Sathasivan, S. P. Palaniappan, and P. Balasubramaniyan, Tamil Nadu Rice Research Institute, Aduthurai, India

A soil incubation experiment studied the effects of soil-applied insecticides such as lindane, carbofuran, FMC 35001, and the herbicide butachlor on nitrogen (N) transformations in flooded fields at Coimbatore. The soil was a moderately drained, deep clay loam with a pH of 7.5 and low available N. Pesticides were applied at field dosage. The soil was kept flooded. NH_4-N, NO_3-N, and NO_2-N were determined at different stages of incubation. A completely randomized block design was replicated four times.

Application of lindane and butachlor resulted in lower levels of nitrites and nitrates 2 days after application (see table). Later, the reduction was not significant. A higher accumulation of NH_4-N appeared at early stages but later the NH_4-N was nitrified into NO_2 and NO_3.

Lindane and butachlor seem to be slightly inhibitory to some nitrifying microorganisms, slowing down the nitrification reaction for about 2 days. This effect slowly disappeared and was not felt after 5 days. ■

Effect[a] of pesticide application on N transformation in flooded rice fields at Coimbatore, India.

Treatment	NH_4-N (ppm)				NO_3 + NO_2 N (ppm)			
	2 d	5 d	10 d	20 d	2 d	5 d	10 d	20 d
Control	647	348	124	16	350	622	828	954
Lindane at 1.5 kg ai/ha	756	480	210	18	246	480	785	932
Carbofuran at 0.75 kg ai/ha	656	474	136	21	348	511	862	948
FMC 35001 at 0.75 kg ai/ha	697	498	142	28	282	498	854	954
Butachlor at 1.5 kg ai/ha	723	504	199	19	260	478	780	921
SE	27	38	41	7	23	35	28	20
CD (P = 0.05%)	79	112	–	–	68	104	–	–

[a]At 2, 5, 10, and 20 days after incubation.

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Calcium peroxide as a source of oxygen in flood-prone rice areas

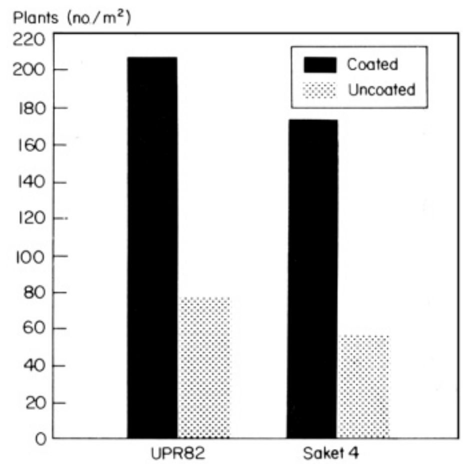
G. L. Sharma, R. C. Gautam, and P. S. Bisht, Agronomy Department, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh, India

A 1979 field experiment studied the effect of calcium peroxide on plant stand of direct-seeded puddled rice varieties Saket 4 and UPR82. Seeds coated with calcium peroxide (60% by weight of seed) were compared with uncoated seeds. Sowing was in 5-10 cm standing water and the water level maintained for the first 15 days, Calcium peroxide significantly increased grain yield of both varieties (see table and figure). ■

Effect of CaO_2 seed coating on grain yield of direct-seeded puddled rice, 1979 wet season, Pantnagar, India.

Treatment	Grain yield[a] (t/ha)
Saket 4 - CaO_2 coating	5.6 a
Saket 4 - no coating	3.7 bc
UPR82 - CaO_2 coating	4.7 ab
UPR82 - no coating	2.2 c

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



Effect of CaO_2 coating on plant stand. Pantnagar, India.

Environment and its influence

Effect of sheath blight infection on respiration and transpiration of rice plants

A. K. Roy, Regional Research Station, Assam Agricultural University, Diphu 782460, Assam, India

The effect of sheath blight infection caused by *Corticium sasakii* (Shirai) Matsumoto [*Thanatephorus cucumeris* (Frank) Donk] on respiration and transpiration of rice plants was observed.

Seventy-two-day-old plants of the rice cultivar Pusa 2-21 were inoculated with a culture of *C. sasakii* grown on sterilized rice grain. Respiration was measured by a Warburg manometer at 30° C. One hundred grams of sheath and leaf tissues in 2-ml citrate buffer was placed in a flask and 0.2 ml 20%. KOH in the center well. The experiment was repeated. One day after inoculation the rate of respiration in the diseased plants decreased (difference in manometric pressure 23.5 mm in diseased tissues against 21.5 mm in healthy tissues).

Sixty-two-day-old plants of the same cultivar grown in pots were carefully uprooted and kept in specimen bottles filled with water. After 2 days, the plants were inoculated as described above. The surface water was sealed by a layer of oil and the plants were kept outdoors under direct sun for 4 hours. Loss of water during transpiration was recorded by noting the difference in weight of the whole assembly in this 4-hour period. The experiment was repeated and observations were taken up to 3 days at 1-day intervals. The average loss of water in the diseased and healthy leaves, respectively, was found to be 0.115 and 0.137 mg/hour per mm^2 after 1 day, 0.107 and 0.160 mg/ hour per mm^2 after 2 days, and 0.110 and 0.120 mg/hour per mm^2 after 3 days, i.e. transpiration in the diseased plants was reduced and the reduction was greater after 2 days than after 1 or 3 days.

Therefore, because of sheath blight infection, respiration in the diseased rice plant increased but transpiration decreased. ■

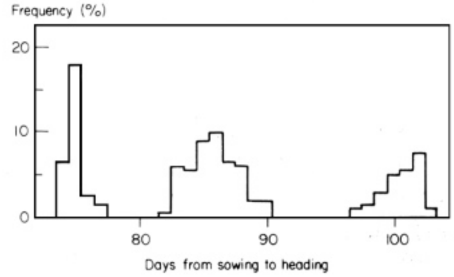
Association between photoperiod sensitivity and basic vegetative growth phase of rice

M. Yokoo, Tohoku Agricultural Experiment Station, Yotsuya, Ohmagari 014-01, and F. Kikuchi, National Institute of Agricultural Sciences, Yatabe, Tsukuba. Ibaraki 305, Japan

Vegetative growth of rice plants can be divided into basic and photoperiod-sensitive, two phases considered to be independently inherited. But experiments with isogenic lines show an association.

A series of alleles at the *Lm* locus, which belongs to the linkage group I, largely controls variation in heading time of cultivated rices. To obtain isogenic lines, individuals heterozygous at the *Lm* locus were selected during 15 generations (from F_1 through BC_4F_{11}) of a cross between Malaysian cultivar Morak Sepilai and Japanese cultivar Fujisaka 5. Fujisaka 5 was used as the recurrent parent through four successive backcrosses. Morak Sepilai transmitted the late-maturing allele Lm^u and Fujisaka 5 the early-maturing allele Lm^e to the hybrid progeny.

The BC_4F_{10} population derived from a single medium-maturing BC_4F_9 plant showed a trimodal distribution for heading time in agreement with the segregation ratio of 1:2:1. This suggests that heading time is controlled by one gene (Fig. 1). Genotypes for three classes of heading time were homozygous early Lm^e / Lm^e, heterozygous medium Lm^e / Lm^u, and homozygous late Lm^u / Lm^u.

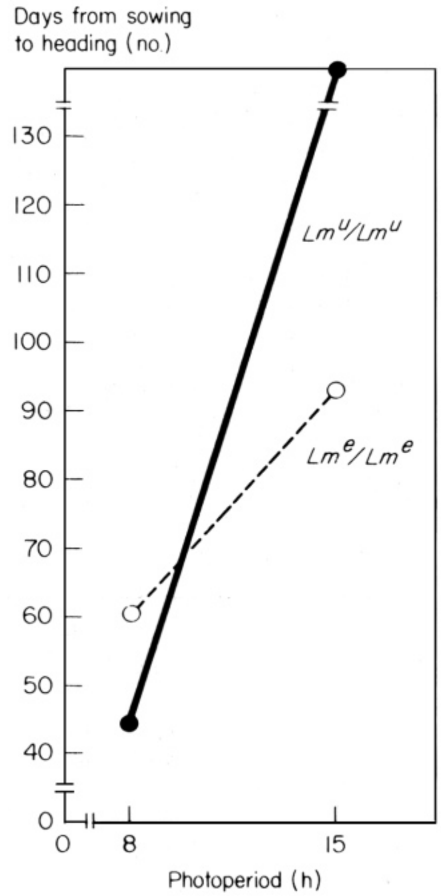


1. Heading time of 238 UC_4F_{10} plants under natural day length conditions, Japan.

Two early and two late homozygous BC_4F_{12} lines were tested for heading time in 8- and I5-hour photoperiod treatments. Plants were placed under natural daylight from 9 am to 5 pm. In the 8-hour-photoperiod treatment, plants were kept in complete darkness for 16 hours. In the 15-hour-photoperiod treatment, plant illumination by fluorescent lamps for an additional 7 hours was followed by 9 hours of darkness. The light intensity was 720 lux on the plant-leaf level.

Under the short-day condition, Lm^u/ Lm^u plants headed 44 days after sowing (DS) and Lm^e/ Lm^e plants headed 60 DS (Fig. 2). The long-day treatment markedly delayed heading in both genotypes. Lm^e/Lm^e plants headed 93 DS. Lm^u/Lm^u plants did not reach heading within 130 days, indicating that Lm^u/Lm^u plants are more sensitive to photoperiod than Lm^e/Lm^e plants.

Assuming that the two phases of vegetative growth period are controlled by different genes, under short-day conditions, Lm^u/Lm^u plants should have the same vegetative growth period as Lm^e/Lm^e plants, since they are nearly isogenic in photoperiod sensitivity. But in this study, short-day treatment accelerated heading of Lm^u/Lm^u plants more than it did that of Lm^e/Lm^e plants. This indicates that the basic vegetative phase is influenced to some extent by photoperiod-sensitive genes. A short basic vegetative phase appears to be associated with photoperiod sensitivity. ■



2. Effect of 2 photoperiod treatments on days to heading of 2 isogenic lines with Lm^e and Lm^u, Japan. Lines that did not head within I30 days were considered nonheading.

Rice seedling growth and metabolism in response to penicillin

A. K. Biswas and S. Mukherji, Plant Physiology Laboratory, Botany Department, University of Calcutta, 35 Ballygunge Circular Road, Calcutta 700019, India

Penicillin promoted the elongation of rice (*Oryza sativa* L. cv. Jaya) seedlings almost linearly, depending upon concentration. The promotion of shoot elongation was stronger (40% over control) than that of root elongation (25% over control). Nucleic acids and protein contents were maintained at higher levels, with a more pronounced effect in embryo than in endosperm (see table). In the embryo, DNA was 88%, RNA was 90%, and protein was 40% more than control at 1,000 ppm. Endosperm DNA and RNA followed the same pattern, measuring about 35% over control at 1,000 ppm. Protein content exceeded that in the control by 30% at 500 ppm. This suggests that the growth-promoting effect of penicillin is mediated through its influence on nucleic and protein synthesis.

Penicillin stimulated the activity of both ribonuclease and a -amylase (see table). The highest activity of RNase was recorded at 500 ppm (5 times control) and that of a -amylase at 1,000 ppm (35% above control).

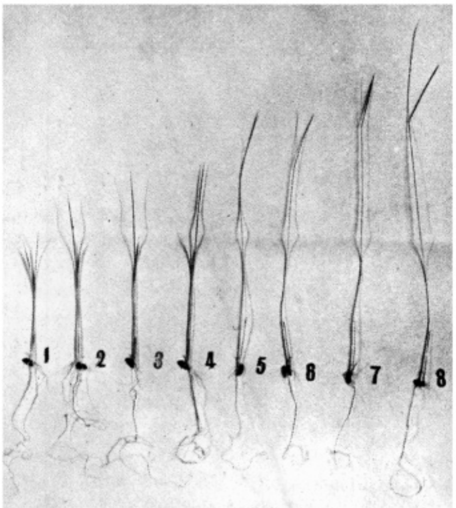
Penicillin in the presence and absence of GA_3 was shown to influence elongation of the second leaf sheath of TN1 rice seedlings (see figure). Sensitivity of

Effect of penicillin on nucleic acid[a] and protein contend[b] and enzyme activity of rice seedlings. Calcutta, India.

Treatment	Embryo of 5-day-old seedlings			Endosperm (3 days after germination)				
	DNA	RNA	Protein	DNA	RNA	Protein	a -amylase[c]	RNase[d]
Control	16	58	3.5	23	91	3.1	3.4	0.40
Penicillin (ppm)								
500	25	101	4.5	33	127	4.0	4.6	1.96
1,000	30	110	4.9	31	122	3.5	4.6	1.30

[a]DNA and RNA are in µg/100 mg fresh wt. [b]Protein is in mg/100 mg fresh wt. [c]As mg maltose released per 10 endosperms and 10 minutes. [d]Absorbancy at 260 nm per 10 endosperms and 30 minutes.

seedlings increased progressively when GA_3 was combined with increasing concentrations of penicillin. The interaction was additive. Penicillin probably stimulated elongation in a manner similar to GA_3. ■



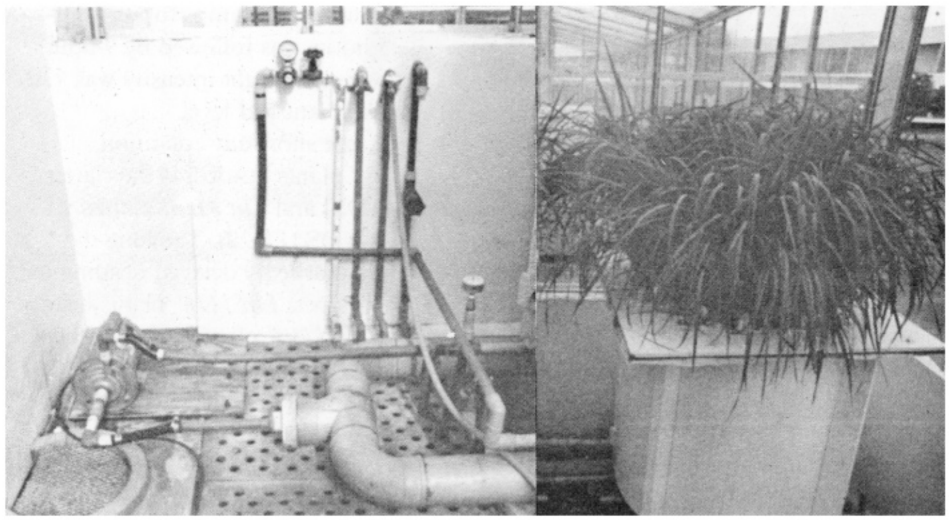
Elongation of second leaf sheath of TN1 rice seedlings. 1 = control (water); 2, 3, 4 = 100, 500, and 1,000 ppm penicillin, respectively; 5 = GA, (10^{-5} M); 6 = GA_3 + 100 ppm penicillin; 7 = GA + 500 ppm penicillin; 8 = GA_3 + 1,000 ppm penicillin.

Aeroponic technique for root system studies of rice *Oryza sativa* L.

J. L. Armenta Soto, P. L. Steponkus, and J. C. O'Toole, International Rice Research Institute

In studies of the relationship of rice root systems to drought resistance at IRRI since 1970, roots have been grown in soil-filled mylar tubes, root boxes, and. in the field. These methods and attendant sampling problems are laborious and time-consuming, and damage to roots can occur during sampling of large populations. The need to study a rice root system with its components intact led to the development of an aeroponic culture system. A nutrient solution is pumped from a reservoir through an atomizing mist nozzle at the base of a cylindrical drum (see figure) about 90 cm in diameter. The nutrient solution mist continuously baths rice roots hanging from the cylinder top. Excess nutrient solution drains back into the reservoir for reuse. The cylinder is covered with a plywood top in which plants are grown in Styrofoam plant holders. Holes 5.0 cm in diameter spaced 7.5 cm centers allow the plants to grow competitively without entangling their roots. Each plant holder is 5.0 cm in diameter with a 2.1 cm center hole. The bottom of each holder is wrapped with plastic screen held securely by a rubber band.

To produce good quality seedlings for use in the aeroponic system, rice seeds were pretreated with 0.2% mercuric chloride to prevent fungus growth and Pregerminated in petri dishes. After two days they were transferred to plastic sieves in a plastic tray containing just enough 50% concentration nutrient solution to cover the germinating seeds. After 11 days, seedlings were transplanted into Styrofoam plant holders inside the phytotron working area. Roots were sprayed with demineralized water to prevent dehydration during transplanting.



General view of the aeroponic device inside a phytotron glasshouse at IRRI.

Immediately after seedlings were transferred to the drum cover, it was set on top of the drum, the aeroponic system switched on, and the seedlings began to receive a mist of standard nutrient solution. The pH was adjusted to 5.0 before the solution was added to the aeroponic reservoir and readjusted daily to avoid nutrient imbalance. The culture solution was renewed weekly from transplanting to sampling.

During the first week after transplanting, only a 50% concentration of the prepared culture solution was used. Beginning from the second week, a full concentration was used. Nitrogen was increased from 40 to 80 ppm the fourth week.

Aeroponic chambers can be operated in a series by extending the air and nutrient solution pressure systems serving the units. ■

Rice-based cropping systems

Effect of tillage level and seed rate on stand establishment and weed growth in mungbean

M. Zahidul Hoque, E. C. Lannao, A. Tanyag, and J. W. Pendleton, Multiple Cropping Department, International Rice Research Institute, Los Baños, Philippines.

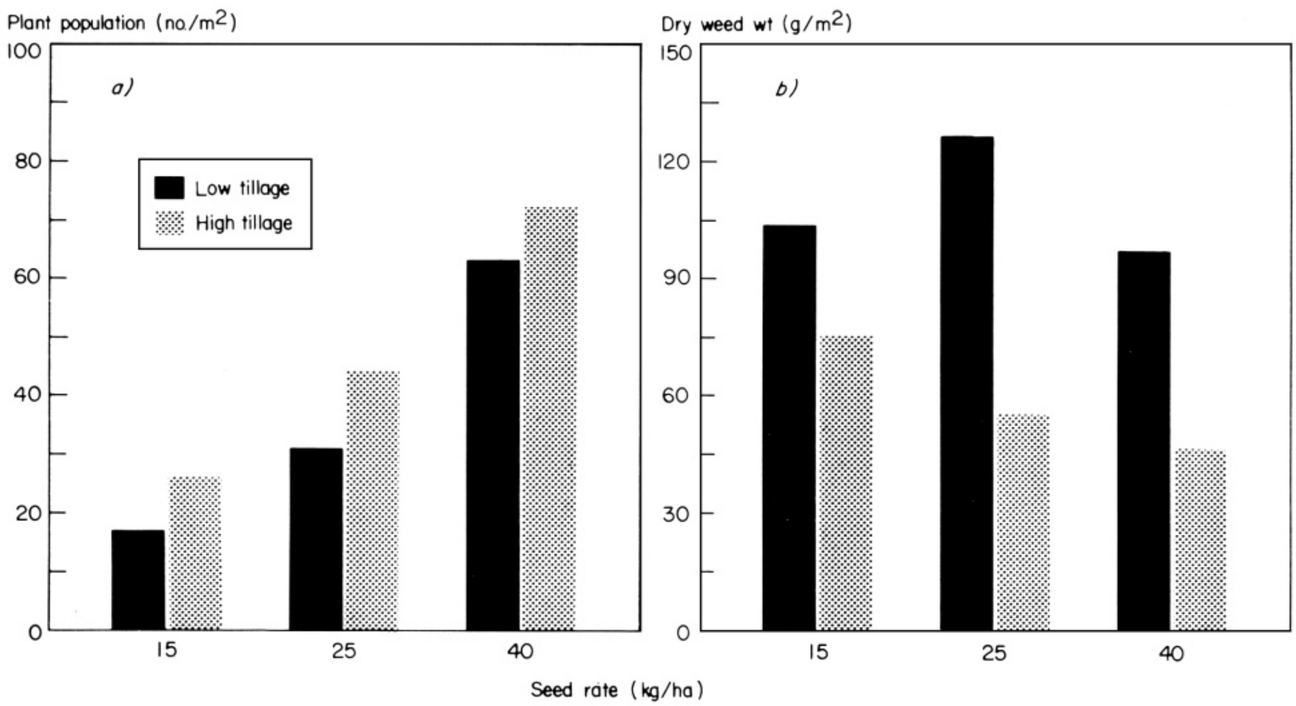
Mungbean is widely grown before and after the monsoon rice crop in the Solana area, Tuguegarao, Cagayan Province, Philippines. Farmers usually use a low seed rate (about 15 kg/ha) and practice minimum tillage for a grain yield of less than I t/ha. Low plant density, weed infestation, and insects are important constraints on yields.

An experiment in a farmer's field at the Solana cropping systems research site of IRRI tested the effects of tillage level and seeding rate on stand establishment and weed infestation in the mungbean crop. A split-plot design was used, with two tillage levels (high: 3 plowings and 3 harrowings, and low: just furrowing) in the main plots and three seeding rates (15, 25, and 40 kg/ha) in the subplots. Treatments were replicated three times.

Seeds were sown continuously in furrows 30 cm apart 10 May 1981. No fertilizer was applied. Plant population and weed infestation (dry weed weight/m^2) data were collected 4 June 1981. Yield samples were not obtained because the crop was waterlogged at the late pod-forming stage by a typhoon on 25 June 1981.

Both the high tillage level and high seed rate consistently increased plant population per unit area (see figure). At 15, 25, and 40 kg seed ha plant populations for the high-tillage treatment were 55, 42, and 14% more than for the low-tillage treatment. The average plant density/m^2 was 47 in high tillage and 37 in low tillage. The seed rate 40 kg/ ha gave a significantly higher plant population/m^2 than did the lower rates. At low tillage, the seed rate 25 kg/ ha gave 84% higher plant populations and the 40 kg/ ha seed rate gave 269% higher plant population than the seed rate of 15 kg/ha. At high tillage, the population was 68% higher with 25 kg seed/ ha and 172% higher with 40 kg seed/ ha.

The effect of seed rate on dry weed weight was not statistically significant. Tillage level had a significant effect on dry weed weight. High tillage reduced weed infestation in the mungbean crop by 46%. Dry weed weight averaged 110 m^2 in the low-tillage treatment and 59 g/m^2 in the high-tillage. There was no significant interaction between tillage level and seed rate on plant population and dry weed weight per unit area. ■



Effect of tillage level and seed rate on plant population and weed growth in mungbean. Solana, Tuguegarao, Philippines, 1981.

Announcements

Dr. K. C. Ling dies at 57

Dr. Keh-Chi Ling, IRRI plant pathologist, died 12 February 1982. Dr. Ling's research on virus diseases of rice in the tropics has helped save the rice crops of millions of farmers.

At IRRI, Dr. Ling studied the vector insects that transmit tungro and grassy stunt, developed methods to screen rice cultivars for virus resistance, and determined relationships among length of time of vector feeding, infection, and expression of disease symptoms.

He identified the wild Indian rice *Oryza nivara* as a source of genetic resistance to grassy stunt virus disease. *O. nivara* genes are incorporated into all grassy stunt-resistant varieties grown today.

Dr. Ling also determined the nonpersistent nature of tungro virus. His research on tungro and its vectors resulted in a practical system for predicting tungro outbreaks in rice-growing areas.

Dr. Clarence Gray receives W. Averell Harriman Distinguished International Service Award

Dr. Clarence C. Gray III has been named winner of the first W. Averell Harriman Distinguished International Service Award for his dedication to helping developing nations grow more food.

Dr. Gray, 63, is deputy director for Agricultural Sciences, The Rockefeller Foundation, and chairman of the IRRI Board of Trustees. He has worked for the past 25 years in programs to increase food production in developing nations.

The award is given by the International Center of the Capital Region, Inc., a nonprofit agency based in Albany, N.Y., USA.

Dr. C. Gray, deputy director for Agricultural Sciences, the Rockefeller Foundation, and chairman, IRRI Board of Trustees.

The International Rice Research Institute
P.O. Box 933, Manila, Philippines

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