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Contents

Style for IRRN Contributors

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

- 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/how).
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N/ha; not 60 kg/ha N.
- The US dollar is the standard monetary unit for the *IRRN.* Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- 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.
- Type all contributions double-spaced. ■

GENETIC EVALUATION AND UTILIZATION

Germplasm conservation

Observations on local rice germplasm in Liberia

S. S. Virmani, visiting scientist, Plant Breeding Department, International Rice Research Institute (formerly rice breeder, International Institute of Tropical Agriculture [IITA], Central Agricultural Experiment Station [CAES], Suakoko, Bong County, Republic of Liberia)

In 1977, 469 local rice varieties (mostly dryland), including 60 varieties of the African cultigen *Oryza glaberrima,* were collected by the Ministry of Agriculture, in collaboration with the Genetic Resources Unit of the IITA. These rices were maintained and evaluated at the CAES, Suakoko, in 1978–79.

The following observations were made on the materials:

1. Various agronomic characteristics that can be used in breeding programs such as height, tillering, growth duration, photoperiod sensitivity, and grain size and shape had high genetic variability. In the 1978 wet season, 209 single plants were selected for breeding in the progeny of those materials evaluated under dryland conditions.

2. The local varieties showed genetic variability. Variants and off-type plants were found among progeny of 74% of the single-panicle rows and 34% of the bulk rows. The variants included: dwarf to semidwarf plants among talls; photoperiod-insensitive (flowering) among photoperiod-sensitive (non-flowering) during the dry season under wetland conditions; purple culm bases among green culm bases; and typical to intermediate *glaberimma* types among *O. sativa,* and vice versa. These observations indicate that outcrossing as well as mechanical mixtures may occur in farmers' varietal populations. The presence of intermediate types of *O. sativa-O. glaberrima* indicates that *O. glaberrima* may provide such mechanisms.

Some dryland rice farmers reported that *O. glaberrima* plants continued to occur in their rice fields, despite attempts to rogue them.

Further studies are required to clearly identify the nature of genetic segregation and the role of *O. glaberrima* in providing an outcrossing mechanism in local dryland rice varieties. ■

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Varietal resistance to rice diseases and insects in Liberia

S. S. Virmani, visiting scientist, Plant Breeding Department, International Rice Research Institute (formerly rice breeder, International Institute of Tropical Agriculture [IITA], Central Agricultural Experiment Station, Suakoko, Bong County, Liberia)

Liberia is in the tropical forest zone of high rainfall in West Africa and the country's ecological conditions are favorable for many rice diseases and insects. In conditions of subsistence farming (shifting cultivation), the pests' severity is not usually apparent, but under permanent or intensive rice farming, the pests become obvious.

Rice diseases identified in Liberia include blast *Pyricularia oryzae,* leaf scald *Rhynchosporium oryzae,* brown spot *Helminthosporium oryzae,* sheath rot *Acrocylindrium oryzae,* sheath blight *Corticium sasakii,* sheath blotch *Pyrenochaeta oryzae,* glume discoloration (caused by various fungi), false smut *Ustilaginoidea virens,* udbatta *Ephelis oryzae,* and pale yellow mottle virus. The most serious are blast, leaf scald, sheath rot, sheath blotch, glume discoloration, and brown spot. Pale yellow mottle virus may be serious in the future.

Rice insect pests identified in Liberia include caseworm *Nymphula depunctalis* (in wetland fields only); Diopsis *Diopsis thoracica;* stem borers *Maliarpha separatella, Chilo zacconius,* and *Sesamia calamistis;* whorl maggot *Hydrellia prosternalis;* leaf-feeding beetle *Epilachna* sp; grain-sucking insects *Stenocoris* sp., *Aspavia* sp., and *Leptocolyza* sp.; and for stored grains, the common rice weevil *Sitophilus oryzae.* Observations on their incidence in various parts of Liberia indicate that the following can be serious in some situations: caseworm, stem borer, Diopsis, and grain-sucking insects.

The following varieties, which could be used in future breeding programs, have been identified as resistant to some of the important pests: IR1416-131-5 and LAC 23 to blast; Tetep, IR4547-6-1-1, IR2035-290-2-1-1, and IAC1500 to leaf scald; Suakoko 8, IR2058-435-3-1, IR2071-105-2, IR2071-586-5-6, 1R4422-6-2, and B462b-Pn-31-1 to brown spot; Brengut, BW78, BKN6323, and ROK 2 to caseworm; IR5, Suakoko 8, Gissi 27, LAC23, OS6, M55,63-83, IR1754-F5B-23, and IRAT 13 to the common rice weevil. ■

Yield losses caused by sheath rot

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

A study was made of the yield losses caused by sheath rot damage on crops raised during the normal kharif in Thanjavur district, Tamil Nadu, where the disease has a maximum incidence of 65%.

In 1979 kharif, 100 diseased panicles were collected from the first tillers of hills in uniformly fertilized bulk plots of 10 rice cultivars. The grain yields from the panicles with different grades of sheath rot infection were recorded; the yield losses are shown in the table.

Yield losses caused by sheath rot disease, Tamil Nadu, India.

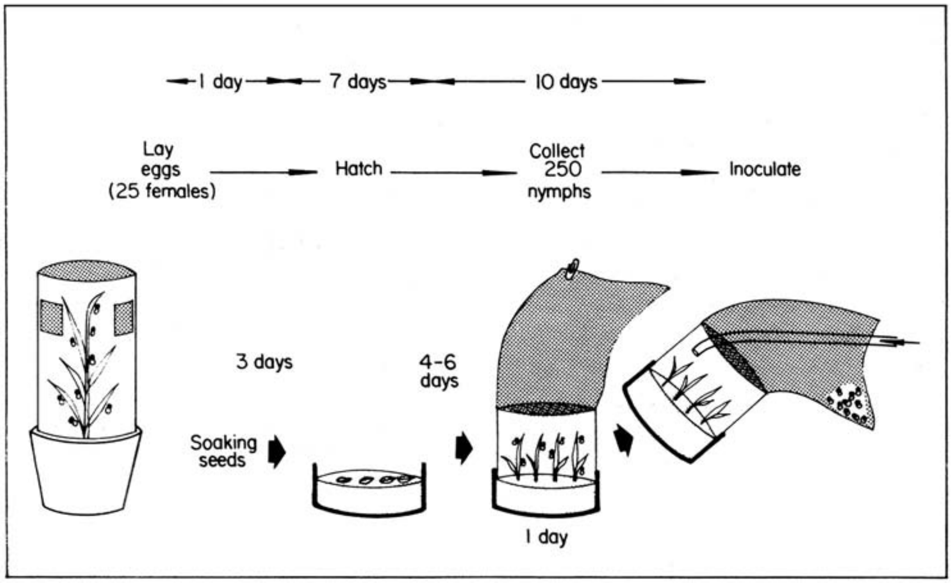
Variety	Grade 1 yield (g/sample)	Yield loss (%) at disease grade			
		3	5	7	9
ADT31	265.9	+0.5	13.2	48.1	81.6
IET2881	263.9	2.6	21.5	58.5	81.2
Pusa 4-1-11-1	202.2	+0.5	17.3	63.9	85.2
AD6380	272.1	8.1	40.4	65.0	89.5
AD5620	236.4	6.8	21.3	63.4	81.8
AD54-1	255.3	7.9	31.1	58.6	86.6
AS3827	271.8	4.2	20.9	55.7	83.6
CRM10-5747	228.3	3.5	21.2	61.5	85.2
Bhavani	308.9	2.7	16.1	58.0	80.8
IR20	262.0	1.4	35.7	65.3	89.8

At disease grade 3, no yield loss was observed in ADT31 and Pusa 4-1-1 1-1; in AD5620, IR20, AD54-1, and AD6380 the loss was 7–8%. ■

A greenhouse screening technique for ragged stunt resistance

H. Hibino, M. Roechan, H. Warsidi, and M. Muchsin, Indonesia-Japan Joint Food Crop Research Program, Central Research Institute for Agriculture (CRIA), Bogor, Indonesia, and Pests and Disease Division, CRIA, Bogor

Ragged stunt virus disease is transmitted by the brown planthopper (BPH) in a persistent manner. Climatic factors that affect the BPH population may also affect disease resistance scores in field screening. The disease symptoms are often unclear until the plant's heading stage in the field. Therefore, scientists need screening techniques that both eliminate the effect of climatic factors and allow detection of disease symptoms at the seedling stage.



Procedures for inoculating plants by means of viruliferous insects for ragged stunt screening. CRIA, Indonesia.

In a project to develop such a screening technique for ragged stunt resistance, BPH originally collected at the Muara Experimental Farm, CRIA, were reared in a screen cage for 4 years. Ragged stunt virus, originally isolated from a diseased rice plant collected at Pandeglang, Java, in 1976, was maintained on the rice variety TNI or Pelita I-1.

Twenty-five BPH females were allowed to lay eggs for 1 day on an infected plant covered with a plastic cylindrical cage. The eggs began to hatch 7 days after being laid. The nymphs were kept on the plant for acquisition access and virus incubation. Seventeen days after egg laying, about 250 nymphs collected with an aspirator connected to a water stream sucker were used to inoculate 50 seedlings of each variety at the first- or second-leaf stage in a glass dish covered with a plastic cylinder. A screen sack with a small hole at one corner was on one side of each cylinder. After 1 day of inoculation, a pipe connected to a compressor was inserted into the hole. The nymphs were forced by air stream through the pipe to the corner of the screen sack and the plastic cylinder with the nymphs was transferred to a glass dish with fresh seedlings of the other variety. Each group of nymphs was transferred to fresh seedlings several times and then killed (see figure).

The inoculated seedlings were grown in a greenhouse. The number of infected plants and their symptoms were recorded 1 month after inoculation. Five seedlings showing typical symptoms were selected and transplanted in a concrete tub. After heading, late symptoms were recorded.

An average of about 500 (range, 400–700) nymphs were obtained frome 25 females/day of egg laying. If the nymph population was much greater than 500/plant, the plant often died before it could be used for inoculation. The use of five diseased plants/week for egg laying gave about 2,500 viruliferous nymphs/week. If 250 insects were used to inoculate one variety and they were transferred four times/week, then 10 varieties/day or 40 varieties/week could be inoculated.

The following weekly schedule is suggested.

Friday – Allow 25 female BPH to lay eggs on a diseased plant.

Saturday – Kill all female insects.

Monday – Collect nymphs and divide them into groups of 250 each.

Monday-Friday – Inoculate daily by transfer.

Friday – Kill the nymphs. ■

Differential host reactions to blast

D. V. Seshu, plant breeder, and H. E. Kauffman, plant pathologist, International Rice Research Institute

Cooperative screening of the International Rice Blast Nursery (IRBN) from 1975 to 1979 by rice scientists in different countries has led to the identification of several good resistant donor varieties, both traditional and improved, and differential host reactions to the blast pathogen at different locations. Most of the resistant semidwarf breeding lines were selections from crosses involving the tall donors Tetep, Carreon, Tadukan, Dawn, Sigadis, and Pankhari 203, either singly or in combinations. Those lines (some samples are IR1905-PP11-29-4-61, IR3259-8-172-5, IR4547-2-1-2, IR9852-18-1) showed resistance at more than 75% of 50 test sites in Asia, Africa, and Latin America.

Key locations for identifying differential reactions were identified, based on the level of disease pressure and consistency of varietal reactions over time – Parwanipur, Nepal; Lampegon, Indonesia; and Bumbong Lima, Malaysia. The information from these locations combined with reactions at other specified locations indicated 8 major groups and 15 varieties distinctive in host-response patterns. The varieties could serve as useful differentials in future research on blast disease (see table). B40, Fanny, and Kung-shan-wu-shan-ken can serve as susceptible checks at all or most locations. Tetep and Carreon exhibited resistance reactions at almost all locations. ■

Blast differentials based on International Rice Blast Nursery (IRBN) results, 1975–79.

Group	Cultivar	Reaction [a]						
		Major groups			Within group distinction			
		Parwanipur, Nepal	Lampegon, Indonesia	Bumbong Lima, Malaysia	IRRI, Philippines	Bac Ha, Vietnam	Cali, Colombia	Peradeniya, Sri Lanka
1	242/105	R	R	S				
2	IR1529-680-3	R	S	R	S		S	
	IR2071-176-2	R	S	R	R		R	
3	B25	R	S	S	R	R	R	
	CI 8985	R	S	S	S	S	S	
	BG94-1	R	S	S	R	R	S	
	CO25	R	S	S	S	R	R	
4	B46	S	R	R		S		
	Zenith	S	R	R		MR		
5	Chokoto	S	R	S				R
	CI 5 309	S	R	S				S
6	B5O	S	S	R		R		
	T23	S	S	R		S		
7	Tetep	R	R	R				
8	Fanny	S	S	S				

[a] R = resistant, S = susceptible, MR = moderately resistant.

Insect resistance

Extent of recuperation from attack of *Dicladispa armigera* after insecticidal control in some rice varieties

K. Budhraja, R. R. Rawat, and O.P. Singh, Entomology Department, J. N. Agricultural University, Jabalpur, M. P., India

Four rice varieties — Anupama, Chatri, Nungi, and Ratna — were moderately to heavily infested with *Dicladispa armigera* (Oliv.) in farmers' fields at Gohalpur, Jabalpur, Madhya Pradesh, in the 1978–79 rainy season. Before treatment, Anupama had 238, Chatri had 110, Nungi had 48, and Ratna had 197 beetles/l0 hills. The varieties were sprayed 3 times with quinalphos at 0.04% at 10-day intervals and their recovery from damage was studied. After treatment the beetle population per 10 hills averaged 1.2 on Anupama, 5.1 on Chatri, 1.0 on Nungi, and 1.0 on Ratna. The parameters used were adult population, percentage of damaged leaves, percentage of damaged leaf area, height of tillers, number of panicles per hill, length of panicles, number of grains per panicle, and grain yield (see table). They were compared on the basis of averages in 10 treated and 10 untreated plots of each variety. Differences between treated and untreated plots for each parameter were significant.

Yields in treated and untreated plots averaged 1.95 and 0.87 t/ha, respectively, for Anupama, 2.02 and 1.5 t/ha for Chatri, 1.8 and 1.2 t/ha for Nungi, and 5.0 and 0.7 t/ha for Ratna. The differences in recuperation appear to have been caused by differences in pest severity and in varietal resistance. ■

Effect of insecticidal treatments on adult populations of *Dicladispa armigera*, yield characteristics, and yields of rice, Jabalpur, M.P., India.

Factor	Increase (or decrease) (%)			
	Anupama	Chatri	Nungi	Ratna
Number of adults per 10 hills	(97.56)	(91.83)	(95.19)	(97.97)
Percentage damaged leaves	(49.86)	(54.70)	(62.12)	(74.32)
Percentage damaged leaf area	(77.61)	(73.58)	(94.75)	(81.29)
Tiller ht (cm)	9.31	15.00	10.35	12.74
Number of panicles per hill	106.81	94.00	51.11	325.00
Panicle length (cm)	20.87	20.55	15.58	18.35
Number of grains per panicle	27.99	80.38	90.19	84.42
Grain yield	125.	37.38	41.60	594.44

Reaction of rice cultivars to gall midge

V. B. Sankpal and R. B. Dumbre, Entomology Department, Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri District, Maharashtra, India

Twenty rice cultivars from the Central Rice Research Institute, Cuttack, Orissa, were screened for their reaction to gall midge under natural field infestation in an endemic area in Sawantwadi, Ratnagiri, Maharashtra, in 1977 and 1978 kharif. The experiment was in a randomized block design with three replications. The seedlings were transplanted at a 20- × 15-cm spacing. Silver shoots were counted at peak pest incidence in both years. The cultivars were graded as resistant (0–5% infestation), moderately resistant (5.1–10%), and susceptible (10.1–22%).

Twelve cultivars were highly resistant; the rest were susceptible. CR94-72-1 was almost immune to gall midge (0%) infestation, both years). CR94-721-3, CR94-1512-1, and CR200-37 showed less than 1% infestation. CR94-721-3 yielded significantly higher (2.2 t/ha) than most other cultivars. ■

Genetics of whitebacked planthopper resistance

T. Sai Krishna, reader in Botany, A.V. College, Hyderabad, A.P., India; and D.V. Seshu, plant breeder, International Rice Research Institute

Several rice varieties were identified as resistant or moderately resistant to whitebacked planthopper (WBPH) *Sogatella furcifera* (Horvath) in greenhouse screening tests at the All India Coordinated Rice Improvement Project (AICRIP) headquarters, Hyderabad. The nature of inheritance of resistance of five of those varieties was studied in crosses with TN1, a susceptible variety. Results based on F_1, F_2, and F_3 progeny indicate that a single dominant gene governs the resistance in varieties PTB33, ARC14636, and ARC14766, and that a single recessive gene governs resistance to WBPH in ARC6650 and ARC14394. All five resistant varieties involved in the study were also found resistant to the brown planthopper at Hyderabad. ■

CORRECTIONS:

IRRN 4:4 (August 1979)

Page 10. In Sam L. Page and John Bridge, Root and soil parasitic nematodes of deepwater rice areas in Bangladesh, line 10 in column 2 should read "at BRRI." Line 3 in column 3 should read "(which causes the most spectacular damage to deepwater rice)."

Page 11. In P. G. Cox, Synergy *between benomyl and carbofuran in the control of ufra,* "at 2 kg/m^2 ." in line 6 of text in column 2 should read "2 $kg/25m^2$."

Drought resistance

Dryland rice selections for drought-prone areas of West Bengal, India

N. C. Basu Raychaudhuri, Rice Research Station, Bankuta, India

Drought is the most serious problem for rainfed dryland rice areas of West Bengal, India's leading rice-growing state. New semidwarf varieties have made little impact because they cannot tolerate moisture stress.

Rice areas in the 2 worst affected districts, Bankura and Purulia, are about 380,000 and 230,000 ha. A single crop of rainfed rice is the main livelihood of the farmers; dryland rice accounts for more than 60% of the rice lands. Among the main causes of low yields are short and uneven rainfall distribution, undulating land, and poor soil moisture retention.

Work on dryland rice improvement was undertaken at Bankura and Purulia. A number of field screening tests using cultivars obtained through the International Rice Testing Program (IRTP) were followed by yield potential tests. For 2 years (1 976 and 1977), more than 200 dryland rice cultivars from different countries were tested in duplicate sets in the two districts on a typical coarse sandy loam soil with poor moisture retention.

Visual scoring of drought resistance and recovery and effects of drought on growth and yield components were periodically recorded according to the IRRI Standard Evaluation System for Rice.

More than 50% of the entries, mostly tall traditional types, were tolerant of drought. After rigorous screening, 24 early-maturing (105 days) and 24 medium-maturing types (106 – 125 days) were selected and tested for yield potential. The most promising (see table) have been further tested in adaptive trials and minikit plots in different locations. and results are encouraging. ■

Promising dryland cultivars for the drought-prone areas of West Bengal, India.

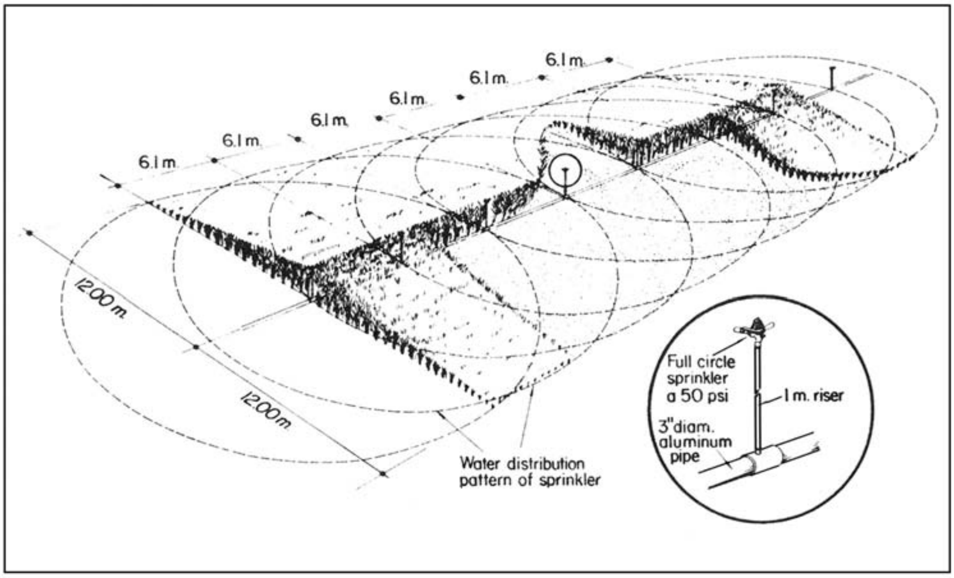
Designation	Origin	Maturity (days)	Plant ht (cm)	Grain yield (t/ha)	Drought reaction[a]
B9c-Md-3	Indonesia	99	96	4.1	3
IR2061-522-6-9	IRRI	104	114	3.7	3
IET1444	India	103	92	3.6	3
CR141-192	India	100	105	3.5	1
CR125-17	India	89	88	3.5	3
Se. 302-G	Senegal	90	82	3.5	3
CR 143-2-2	India	102	95	3.4	3
DV110	Bangladesh	105	136	3.4	3
RC7046	India	102	132	3.3	3
Panke	India	101	142	3.3	1
ARC7060	India	89	146	3.3	1
Se. 322 B19	Senegal	89	80	3.2	1
FH109	India	103	99	3.2	3
Brown Gora	India	93	132	3.2	1
CTG1516	Bangladesh	100	140	2.9	1

[a]At reproductive stage. 1 = none to slight effect of stress, 3 = moderate effect of stress (leaf tip drying up to 3/4 length of leaves).

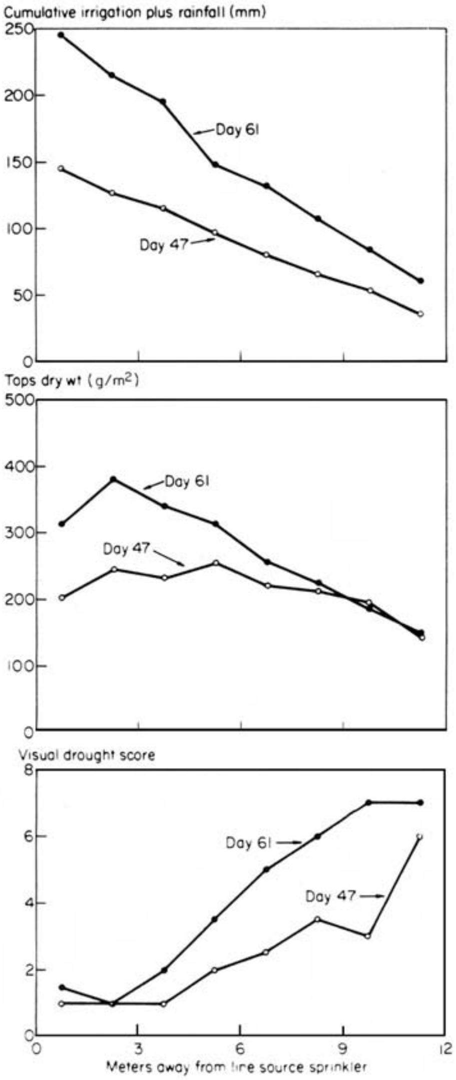
The line source sprinkler: a new research tool for drought screening

J. C. O'Toole and D. W. Puckridge, Agronomy Department, International Rice Research Institute

A new research technique, the line source sprinkler, was evaluated at IRRI for use in drought resistance screening in the 1979 dry season. Figure 1 illustrates the field installation, which consists of full-circle sprinklers spaced at intervals of 6.1 m (20-ft pipe section). The system produces a linear decrease in the amount of water applied with distance away from the line (Fig. 2). Also shown in Figure 2 are some crop responses to varying amounts of applied irrigation water.



1. Schematic of the field layout of sprinklers in the source sprinkler technique.



2. Linear decrease in water applied and corresponding crop response, i.e. dry weight of tops and visual drought score after 47 and 61 days.

Although space restrictions prohibit the illustration of all the variables measured, we found a high correlation of such responses as dry matter accumulation, leaf area index, plant height, leaf water potential, drought resistance score, yield, and yield components with the water applied. That finding illustrates the technique's usefulness in research where water is a primary variable. The line source sprinkler may be used at a particular growth stage such as the very sensitive flowering stage. We plan to use it to develop a drought screening method that will be sensitive to yield and percentage sterility.

The line source sprinkler technique was developed by Dr. R. J. Hanks and associates at Utah State University, USA. It should be particularly useful in climates where a distinct dry season allows its use without rainfall. If properly used, the technique would shorten to one or two dry seasons the many years of multilocational testing, which are costly and involve the problem of interpreting the complex effects of natural droughts. Interested rice scientists may contact the authors for further details. ■

GENETIC EVALUATION AND UTILIZATION

Adverse soils tolerance

Zinc deficiency – a new problem for irrigated rice in Bangladesh

Anirnesh C. Roy and A. K. M. Shahjahan, Bangladesh Rice Research Institute (BRRZ), Joydebpur, Dacca, Bangladesh

The introduction of modern rice varieties has intensified rice cultivation in Bangladesh, particularly in areas with dry-season irrigation. Newer BRRI varieties adapted to various locations and seasons have changed the total cropping patterns substantially in irrigated rice lands. Additional irrigation facilities and projects have further intensified rice production. But the intensive wetland rice cultivation has also brought about new soil problems.

Because of several field reports on the poor performance of the modern varieties in some irrigated areas of Bangladesh, we conducted a preliminary survey to identify the actual field problems of rice cultivation in major rice-growing areas of Bangladesh in the 1978–79 aus, aman, and boro seasons. In some irrigated lands, particularly in the alkaline zone, we observed a new nutritional problem associated with continuous wetland conditions.

In large areas of alkaline soils in the Ganges-Kobadak Project in northwestern Bangladesh with year-round irrigation, rice plants were characterized by stunted growth, poor root development, and in severe cases, rusty brown spots on the leaves. Similar symptoms were also observed in Faridpur, Kishoreganj, Chittagong, Barisal, Comilla, and Dacca districts. Suspecting zinc deficiency, we collected soil and plant samples for laboratory analysis. The results confirmed our field observations (see table).

Soil and plant analyses data on some selected samples with suspected zinc deficiency. Bangladesh Rice Research Institute.

Location	District	Soil characteristics			Plant zinc (ppm)	Variety
		pH	Organic matter (%)	0.05N HCl [a] extract-able zinc (ppm)		
DND project	Dacca	7.40	n.a.	0.48	21.1	IR8
CIP	Comilla	7.40	1.72	0.52	12.5	IR8
Gournadi	Barisal	6.85	2.29	0.83	n.a.	local
BRRI station	Rajshahi	8.00	1.05	0.00	18.6	IRTN line
Kanaipur	Faridpur	7.70	1.76	0.08	n.a.	IR8
Mohanandapur	Faridpur	7.80	1.64	0.07	12.5	IR8
Kaijuri	Faridpur	7.90	2.07	0.10	14.5	IR8
Sajekupa	Jessore	7.40	2.10	0.28	15.7	IR8, BR1
Amla	Kushtia	7.40	2.48	0.13	9.6	BR3, BR1
Sandwip	Chittagong	7.95	1.50	0.95	19.6	IR8
Jhenaida	Jessore	7.18	2.27	0.14	28.0	IR8, BR3
Maria	Kishoreganj	6.90	2.00	2.08	18.8	IR8
Gangail	Kishoreganj	7.20	1.81	2.48	19.7	BR3, IR8
Santhia	Pabna	7.85	2.25	0.10	20.1	BR4
BAU	Mymensingh	7.40	1.98	1.46	15.9	IR8

[a]Extractable soil zinc was estimated by the Katyal and Ponnamperuma method. n.a. = not analyzed.

Application of zinc salts effectively minimized the problem at some locations where it was severe. We suspect that zinc deficiency threatens higher yields in intensive rice cropping areas with alkaline and saline soils.

The cheapest way to handle the problem where available soil zinc is above the critical level is to dry the soil between two rice crops. In soils with low zinc, zinc sulfate or zinc oxide should be applied along with the normally applied fertilizers. Such requirement would mean additional input costs for many Bangladesh farmers. ■

Coastal saline soils in the Philippines as potential rice lands

Bernardo Quidez, Luis Bernardo, and F. N. Ponnamperuma, research assistants and principal soil chemist, respectively, International Rice Research Institute

To ascertain the potential of Philippine coastal saline soils as rice lands, the performance of a total of 26 salt-tolerant rices was studied in 24 replicated experiments at 14 sites in farmers' fields from 1977 to 1979. The soils at the sites were characterized chemically and hydrologically, and the salt dynamics was monitored. The plants were scored visually for salt injury.

The soils ranged from 4.4 to 7.8 in pH, from 1.3 to 15.4% in organic matter content, and from moderate to high in nutrient status. Of the high-pH soils, seven were zinc deficient and two were boron toxic. The two strongly acid soils were iron toxic. Intrusion of seawater, saline creek water, or saline groundwater affected all 14 sites, especially in the dry season; deep flooding in the wet season occurred at 4 sites. The salt concentration increased during the dry season and decreased in the wet. EC values ranged from 1 to 15 mmho/cm during the year.

The performance of the rices varied with salt concentration, water availability in the dry season, and flood damage in the wet season. On slightly saline soils not subject to drought or deep flooding. the salt-tolerant pest-resistant semidwarfs IR42, IR2071-105-4, IR2307-247-2, IR4619-48-3, IR4630-22-2, IR9884-3-3, and IR9884-54-3 yielded more than 4 t/ha.

There is promise that yields on current saline rice fields can be increased and that coastal soils where salinity and flooding are not severe can be made into productive rice lands without costly inputs. ■

GENETIC EVALUATION AND UTILIZATION

Deep water

Design of a deepwater tank for ufra research

P. G. Cox, plant pathologist, Bangladesh Rice Research Institute (BRRI)/Overseas Development Agency (ODA) Deepwater Rice Pest Management Project, BRRI, Joydebpur, Dacca, Bangladesh

In previous varietal screening in Bangladesh against ufra disease of deepwater rice (caused by stem nematode *Ditylenchus angustus* Filipjev), leaf sheaths were inoculated with nematodes to achieve adequate infestation. This procedure may not be appropriate because it does not help detect sources of resistance on the basis of difference in the surface properties of the rice plant, e.g. how smooth or how tightly wrapped the leafsheaths are. These properties could be particularly important under natural conditions because they enable the nematodes to move from the water, through which they spread and reach the young tissues on which they feed. Therefore a special deepwater tank (see figure) was constructed at BRRI to simulate natural infestation under controlled conditions on a large scale.

The main experimental tank (20- × 20-m area, 2 m deep), whose walls are made of earth, is supplied with water from a tubewell. The water level can be maintained at 0.5 m, in spite of irregular rainfall, by inserting a constant level device in the drain conduit. It is important that water leaving the tank complex contain no live nematodes that might infest farmers' fields or nearby experimental sites. The water is led through a series of sedimentation chambers arranged in a row along one wall of the tank. The concrete-lined

A deepwater tank for ufra research, Bangladesh Rice Rescarch Institute. (Note the sedimentention chambers along the far wall of the tank, and the use of polythene cages and miniature deepwater tanks to partition the main tank.

chambers are twice as deep as the main tank and always contain water. They are connected by "T" pieces that direct the water flow from the top of one chamber to the bottom of the next. If significant numbers of the nematodes survive successive sedimentation, they can be killed by adding formaldehyde to the chambers. Water leaving the last sedimentation chamber is directed into an open drain with an independent water supply, which may be used to dilute any chemical treatment.

In 1979, a successful infestation was achieved in a plot (8 × 8 m) by incorporating 1.5 infested panicles/m^2 with the surface soil at sowing in early April; the subsequent rice crop was almost totally lost because of ufra.

Miniature deepwater tanks (IRRN 4:3), which provide total exclusion, or polythene cages, which prevent the mass movement of nematodes between adjacent plots, may be used to segregate individual plots from water in the main tank. The main tank can also be used to study other methods of ufra control such as transplanting. ■

GENETIC EVALUATION AND UTILIZATION

Cold tolerance

Effect of low temperature on boro rice in West Bengal

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The dry season (boro) rice crop on the Gangetic Plains of West Bengal is subject to low-temperature stress, which inhibits normal plant growth and delays maturity (av min day/night temperature is 25.2/9.2°C – 28.8/14.9°C). The possibility of minimizing the effect of cold by using tolerant varieties and modified agronomic practices was investigated at the Chinsurah RRS.

The more important results are summarized:

- When seeds are sown on 12 November, 26 November, and 10 December (the traditional sowing time), seedling height gradually decreases, regardless of variety, as temperature falls (av min 17.4–9.7°C). But seedlings sown in mid-November have the proper height and higher dry-matter content at 45 days after sowing. That facilitates transplanting.
- Low temperature delays seedling leaf emergence by as long as 30 days. As seedlings grow older, the effect of low temperature disappears; regardless of variety and sowing time, the 4-leaf stage occurs at 45 days after sowing.
- Seedlings sown in mid-November (25.5/9.6°C – 29.0/14.4°C) have higher ultimate plant height and number of fertile tillers than seedlings sown in early December.
- The crop sown in early December has a shorter growth duration than that sown earlier. Early flowering causes high spikelet sterility. Seed fertility is higher under a diurnal temperature range of 31.5/20.1°C – 33.5/22.4°C during panicle initiation to flowering, which occurs in the second week of March, regardless of variety or sowing date.
- Mid-November sowing gives higher yields for all the varieties. Yields of crops sown on 26 November and 10 December were 22 and 30% lower, respectively.
- Among several high yielding varieties tested, CR126-42-1 showed the best general adaptability for boro. ■

Pest management and control DISEASES

Influence of insecticide sprays on brown planthopper resurgence

S. Chelliah, entomologist, Tamil Nadu Agricultural University (TNAU), Coimbatore 641003, India, and E. A. Heinrichs, entomologist, International Rice Research Institute

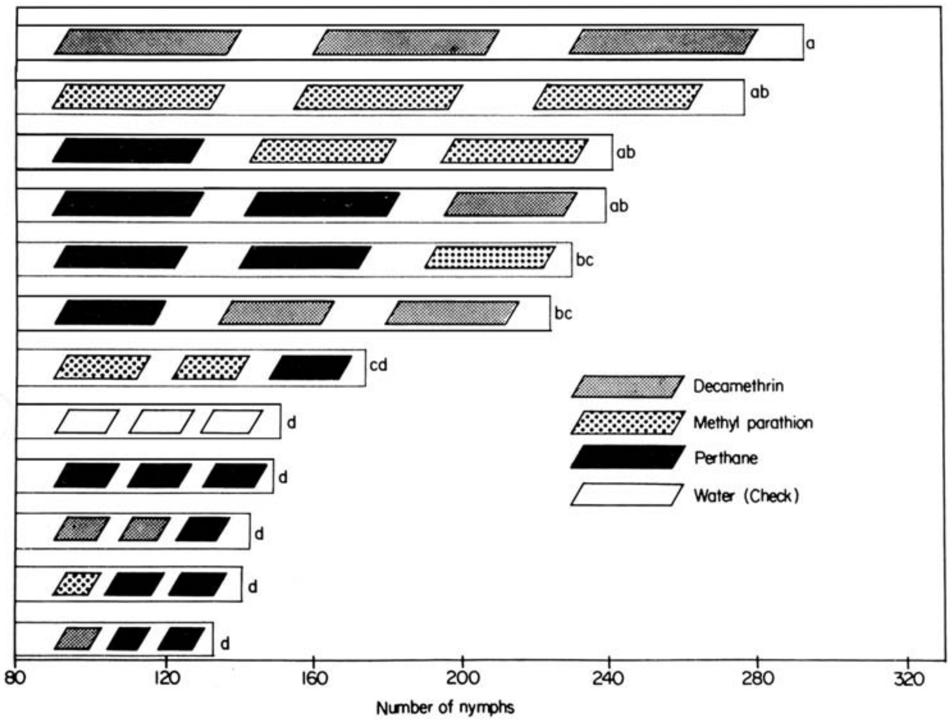
An lRRl experiment was conducted to determine the effect of the last insecticide in a series of three spray applications in inducing BPH resurgence.

Ten-day-old TN1 seedlings were planted at 2 seedlings/pot in clay pots 12 cm in diameter. The potted plants were kept insect free. Sprays were prepared in water from commercial formulations of emulsifiable concentrates at 0.04% concentration (except decamethrin, for which 0.002% was used). The quantity of spray fluid required per plot – at 500 liters/ha – was based on field recommendations.

Ten days after planting, the first insecticide was sprayed. The potted plants were placed on an electrically operated revolving table and the insecticide was sprayed with an atomizer. The plants were sprayed either three times with the same insecticide or one or two times with one insecticide followed by another insecticide. The plants in each pot were covered with cylindrical mylar film cages and were maintained in an insectary with a regulated temperature of 27 ± 1 °C, relative humidity of 60–80%, and photoperiod of 12 hours/day.

Fifteen days after the 3d spraying, 2 gravid BPH females/pot were released and confined with the sprayed plants for 7 days. Sufficient populations of test insects of the same age were maintained on TN1 plants to daily replace dead insects. After 7 days, the insects were removed and their reproductive rate was assessed indirectly by counting the emerging nymphs from plants that received different insecticides. The counted nymphs were removed every day, and counting went on until all eggs hatched.

The number of nymphs hatching was the criterion for evaluation of the resurgence potential of the insecticides. The number of nymphs differed significantly among treatments (see figure). The highest number emerged from plants sprayed 3 times with decamethrin. The last insecticide sprayed generally had a decisive role in inducing or preventing BPH resurgence. In treatments where plants were sprayed twice with Perthane and then by decamethrin or methyl parathion the level of BPH resurgence was equal to that where plants were sprayed three times with methyl parathion. When Perthane was sprayed last, the number of BPH nymphs did not increase, regardless of the insecticides used in previous sprayings. This implied that even if resurgence-causing insecticide had inadvertently been used, the population buildup could be controlled by use of an insecticide that would negate the resurgence effect. ■



The influence of insecticide used in spray sequence on brown planthopper reproductive rate. Tamil Nadu Agricultural University and IRRI.

A new bacterial disease of rice

R. C. Chaudhury and S. M. Ghufran, Rajendra Agricultural University, Bihar Agricultural Research Institute, Mithapur, Patna 800001, India

Most plants in a 2-ha plot of the variety Pankaj were observed to be drying during a routine field visit to the Institute farm in 1979 kharif. The crop was in the maximum-tillering stage. The growth of the infected plants was somewhat stunted. From a distance the disease appeared to be the kresek stage of bacterial blight. But a closer examination showed black and rotting basal internodes and enclosing leaf sheaths. The gummy, rotted portion emitted a foul odor. Core portions of tillers dried first; sometimes the central leaf dried much earlier than the other leaves and the symptoms resembled those of stem borer damage. The dried leaves were erect and straw color. Only a few tillers in most infected hills remained healthy. Roots were normal but dried tillers could easily be pulled out.

T. W. Mew, IRRI pathologist, on a September 1979 visit to the institute, suggested that the disease might be caused by *Erwinia* sp. S. Devadath from the Central Rice Research Institute, Cuttack, examined the crop on 31 October and suggested that the disease might be bacterial foot rot caused by *Erwinia chrysanthemi,* which was reported by Goto in Japan in 1979. This may be the first report of the disease in India. The disease is being further investigated. ■

A new record of rice transitory yellowing virus in northern Thailand

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Yellowing symptoms of rice plants similar to those of rice transitory yellowing disease (RTYV) occurred on wet-season rice at the late growth stage in August-September 1979 in Chiengrai and Chiengmai, northern Thailand. At locations where disease symptoms were observed, 18 to 32% of the hills were infested.

Electromicroscopic observations of dip preparations and ultrathin sections of diseased plants revealed that bullet-shaped virus particles (90 × 120 nm in dip preparations, 90 × 180 nm in ultrathin sections) were similar to those found in diseased leaves infected with RTYV in Taiwan and Okinawa, Japan. In ultrathin sections, the virus particles were observed in phloem cells of diseased plants. *Nephotettix nigropictus* and *N. cincticeps* transmitted the virus effectively and in a persistent manner. The virus incubation period in the insects was about 2 weeks; the viruliferous insects often remained infective during their entire life span.

The virus belonging to the rhabdovirus group was identified as rice transitory yellowing virus. This is the first report of the occurrence of this disease in the tropics. ■

Further studies on the potential of rice stubble for spreading tungro in West Bengal, India

B. Tarafder and S. Mukhopadhyay, Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani, Nadia, West Bengal, India

A previous study on the potential of rice stubble in spreading tungro in West Bengal confirmed that infected stubbles of TNl plants can act as a virus source and maintain the virus for 75 days, The same procedure was used to test the infected stubbles of high yielding and local varieties for efficiency in transmitting virus.

Of the nine high yielding varieties (Ratna, Pankaj, Cauvery, IET1441, IR579, IET2295, IET2914, Jaya, and IR8) and 11 local varieties (Laghu, Kathamuk, Rajmalati, Kalamkathi, Lakhansail, Sachimohan, Jhulur, Dhushri, Dudhshar, Ashanlaya, and Madhumalati) tested (see table), Ratna and IR8 retained the virus in the stubbles for only 30 days; Pankaj, IR579, and Jaya for 60 days; and IET2914 for 90 days. The stubbles of Cauvery, IET1441, and IET2295 carried no virus.

Of the local varieties tested, Kalamkathi and Dudhshar carried the virus in the stubbles for only 30 days; the stubbles of Laghu, Rajmalati, Lakhansail, Sachimohan, Ashanlaya, and Madhumalati retained the virus for 60 days; and those of Kathamuk and Dhushri for 90 days (see table). The research was funded by the Indian Council of Agricultural Research, New Delhi. ■

Transmission of rice tungro virus from stubbles of different rice varieties 30, 60, 90, and 120 days after harvest. West Bengal, India, 1978.

Variety	Transmission (%) in seedlings			
	30 days	60 days	90 days	120 days
Ratna	10	0	0	0
Pankaj	10	5	0	0
Cauvery	0	0	0	0
IET1441	0	0	0	0
IR579	20	10	0	0
IET2295	0	0	0	0
IET2914	30	20	10	0
Jaya	20	10	0	0
IR8	10	0	0	0
Laghu	20	10	0	0
Kathamuk	20	10	0	0
Rajmalati	20	5	0	0
Kalamkathi	10	0	0	0
Lakhansail	20	10	0	0
Sachimohan	20	10	0	0
Jhulur	10	0	0	0
Dhushri	20	10	0	0
Dudhshar	10	0	0	0
Ashanlaya	20	10	0	0
Madhumalati	20	10	0	0

Effect of transplanting date and seedling age at transplanting on spread of tungro

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Experiments were conducted at the plant virus experimental field to determine the effect of transplanting date and of seedling age at transplanting on the spread of tungro virus disease in a rice crop during 1978 kharif. The Indian Council of Agricultural Research, New Delhi, funded the research.

In the first experiment 25-day-old TN1 seedlings were transplanted at 5-day intervals in 3-m^2 replicated plots provided with uniform inoculum for tungro virus (1 infected plant/plot). The number of plants with tungro symptoms was recorded at 3- to 6-day intervals until the end of September.

Transplanting date had pronounced effects on the spread of tungro (see table). The spread of the disease increased when the transplanting date gradually shifted from mid-July to the first week of August, when spread became maximum. With subsequent shifts of

Effect of transplanting date and age at transplanting of TN1 seedlings on the spread of rice tungro virus (RTV) disease during 1978 kharif (Jul-Nov) and the corresponding vector population in the field, West Bengal, India.

Date of observation	LH[a] (no.)		RTV infection (%)	LH (no.)		RTV infection (%)	LH (no.)		RTV infection (%)	LH (no.)		RTV infection (%)	LH (no.)		RTV infection (%)	LH (no.)		RTV infection (%)
	A	N		A	N		A	N		A	N		A	N		A	N	
	Effect of transplanting date of 25-day-old TN1 seedlings																	
	16 Jul			21 Jul			26 Jul			1 Aug			6 Aug			11 Aug		
28 Jul	0	0	–	0	0	–	0	0	–									
2 Aug	1	0	–	1	0	–	2	0	–	0	0	–						
7 Aug	0	2	–	4	2	–	3	9	–	3	10	–	3	5	–			
12 Aug	1	1	–	1	37	–	3	70	–	2	38	–	3	82	–	4	11	–
17 Aug	1	0	–	0	15	–	0	20	–	0	40	–	0	43	–	2	3	–

(Continued on next page)

Effect of transplanting date . . . . cont'd.

Date of observation	LH[a] (no.) A	LH[a] (no.) N	RTV infection (%)	LH (no.) A	LH (no.) N	RTV infection (%)	LH (no.) A	LH (no.) N	RTV infection (%)	LH (no.) A	LH (no.) N	RTV infection (%)	LH (no.) A	LH (no.) N	RTV infection (%)	LH (no.) A	LH (no.) N	RTV infection (%)
Effect of transplanting date of 25day-old TN1 seedlings																		
	16 Jul			*21 Jul*			*26 Jul*			*1 Aug*			*6 Aug*			*11 Aug*		
22 Aug	0	0	2.77	1	2	–	1	3	–	1	14	–	2	29	–	2	35	–
27 Aug	1	0	2.77	2	23	5.55	2	28	5.55	7	39	2.77	4	47	2.77	4	18	–
4 Sep	1	1	5.55	10	14	5.55	15	33	9.72	16	31	9.72	8	42	5.55	11	43	–
11 Sep	0	4	5.55	6	6	9.72	3	2	15.27	10	8	20.83	21	13	8.33	22	16	2.77
16 Sep	2	0	5.55	7	0	9.72	11	12	15.27	20	12	20.83	24	12	8.33	21	15	2.77
19 Sep	2	0	5.55	4	4	9.72	10	4	15.27	13	5	41.66	30	15	11.11	42	28	4.16
23 Sep	0	0	5.55	1	2	9.72	15	12	15.27	25	18	41.66	33	43	11.11	56	46	4.16
25 Sep	2	0	5.55	24	1	9.72	24	25	15.27	64	35	41.66	56	46	11.11	44	66	4.16
Effect of seedling age at transplanting																		
	55 days old			*50 days old*			*45 days old*			*40 days old*			*3.5 days old*					
12Aug	0	0	–	5	0	–	6	0	–	2	0	–	0	0	–			
17Aug	7	16	–	6	13	–	3	15	–	1	10	–	1	4	–			
19Aug	3	18	–	4	41	–	6	63	–	16	55	–	0	22	–			
21Aug	2	10	–	3	20	–	2	16	–	2	25	–	2	23	–			
26 Aug	2	16	4.16	6	15	5.55	3	22	–	3	14	–	2	13	–			
2 Sep	1	10	6.94	5	37	9.72	4	40	6.94	5	14	6.94	5	13	5.55			
4 Sep	7	39	6.94	9	35	9.72	4	40	6.94	5	14	6.94	5	13	5.55			
11 Sep	4	5	6.94	9	35	9.72	13	40	13.88	6	36	6.94	6	25	5.55			
16 Sep	15	16	6.94	23	18	9.72	24	8	20.83	16	6	34.72	16	6	12.50			
19Sep	21	10	6.94	11	11	9.72	14	8	20.83	15	0	41.66	11	7	12.50			
23 Sep	5	4	6.94	35	11	9.72	60	30	20.83	16	4	41.66	29	14	12.50			
25 Sep	34	31	6.94	26	45	9.72	32	38	20.83	26	20	41.66	44	72	12.50			

[a] LH = leafhoppers; A = adults; N = nymphs.

transplanting time toward mid-August, however, the spread gradually decreased.

In the second experiment, TN1 seedlings —35, 40, 45, 50, and 55 days old — were transplanted on 1 August 1978 in 3-m^2 replicated plots. The number of plants with tungro symptoms was recorded at 2- to 5-day intervals until the end of September.

Age at transplanting had marked effects on tungro spread during kharif (see table). Disease spread was maximum in seedlings transplanted at 40 days old. The extent of infection was lower in seedlings transplanted earlier or later. ■

Pest management and control INSECTS

Rice gall midge outbreaks in Thailand

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The rice gall midge *Orseolia oryzae* has long been a major pest of rainfed rice in Thailand. Annual infestations in northern, northeastern, and eastern Thailand are heavy. In recent years, severe outbreaks have also occurred on irrigated dry-season rice in the central plain. Gall midge distribution has now extended to the southern peninsula.

Table 1. Occurrenceof the rice gall midge at various locations in Thailand, 6–18 September 1979 (wet season).

Location	Damaged tillers (%)	Rice variety affected
Lam-Ngob, Trad	11.7	No. 28 (local variety)
Ban Ta Kak, Trad	19.4	RD1
Bau, Chantaburi	12.3	Paung-Ngen
Ban Don Chik, Ubonratchatani	26.5	Niew-San-Pa-Tong
Ban Pa Rauk, Chiengrai	40.1	Niew-San-Pa-Tong

Areas where gall midge is endemic were surveyed in the 1979 wet season. Heavily infested areas were observed at the insects' population peak in September. Healthy tillers and galls were recorded on 100–200 randomly selected hills at each site. Unemerged galls were also randomly collected and dissected to determine parasitism incidence.

Gall midge infestation was highest (40% damaged tillers) on Niew-San-Pa-Tong rice at Ban Pa Rauk, Chiengrai province, northern Thailand (Table 1). At Ubonratchatani in the northeast, 26.5% tillers were damaged — much more than in the previous 2 years. But a shortage of rain in that area in October greatly reduced the overwintering gall midge population.

In Trad province, eastern Thailand, the population increased, especially on rice variety RD1. Although the percentage of galls on RD1 was relatively low, the plants were heavily stunted and yields were greatly reduced. Gall midge survival in the area was probably high because of low parasitization by *Platygaster* spp. (Table 2). For the first time, a gall midge outbreak was reported in Chantaburi. About 175 ha of local rice varieties in Bau district were heavily infested.

The abundance of wild host plants favors the survival of overwintering populations in the northern and eastern areas. ■

Table 2. Survival of the rice gall midge at various locations in Thailand, 1979 wet season.

Location	Galls observed (no.)	Survival (%)	Mortality (%) caused by			
			P. oryzae	*P. folsteri*	*N. gracillius*	Unknown
Lam-Ngob, Trad	103	80.6	0	0	18.4	1.0
Ban Ta Kak, Trad	117	70.9	0	0	24.8	4.3
Bau, Chantaburi	123	48.0	17.1	0.8	30.0	4.1
Ban Don Chik, Ubonratchatani	126	22.2	3.2	0	68.3	6.3
Ban Pa Rauk, Chiengrai	1 37	46.8	36.5	10.2	2.9	3.6

Gall midge occurrence in Uttar Pradesh, India

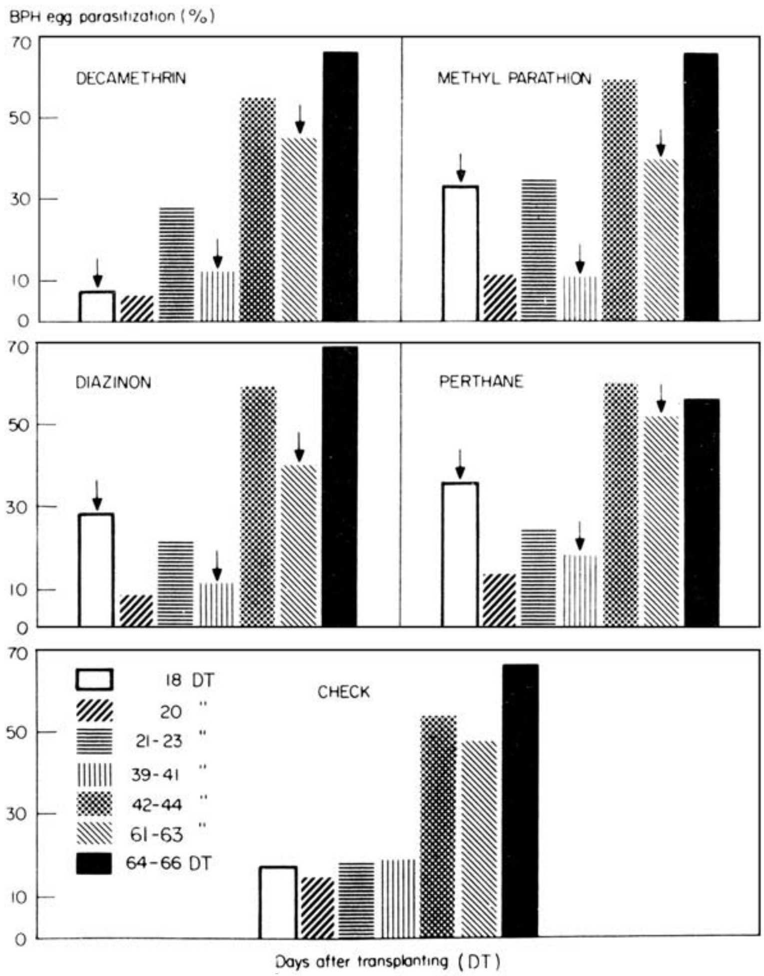
S. M. A. Rizvi, entomologist, and H. M. Singh, research assistant, Rice Research Station, N. D. University of Agriculture and Technology, Faizabad, Uttar Pradesh, India

Gall midge in serious proportions was observed in more than 2,000 ha in Faizabad district of U.P. in kharif 1978. The pest was observed only once earlier — in kharif 1971 — in the state. Most of the area infested in 1978 was contiguous; in some pockets the incidence was as high as 65%. The late-planted crop of Saket 4, Jaya, and IR8 were affected most. At the Masodha Rice Research Station, IET2232, IR24, Reshmi, NP5136, FH1, FH109, Satna, Belar, Ranga, FRG2, and FRG19 were also found severely affected by the pest. The incidence was observed from late August to mid-October. ■

Parasitization of BPH eggs in rice treated with foliar insecticide

S. Chelliah, entomologist, Tamil Nadu Agricultural University, Coimbatore 641003, India; and E. A. Heinrichs, entomologist, International Rice Research Institute

Sprays of the insecticides decamethrin, methyl parathion, and diazinon have caused resurgence of brown planthopper (BPH) in IRRI fields; Perthane spray has not. Laboratory studies indicated that those insecticides stimulate BPH reproduction, but their role in causing field resurgence by suppressing natural enemies has not been determined. Thus, a study was conducted to determine the effect of the insecticides on BPH egg parasitization, using the technique of Otake.



Percentage of parasitization of brown planthopper (BPH) eggs on rice sprayed with foliar insecticides. Arrows indicate days after transplanting (18, 39, 61 DT) when the insecticides were sprayed. IRRI, 1979 dry season.

Taichung Native 1 (TNl) seedlings were planted in clay pots (15 cm diam) at the rate of 4 seedlings/pot. When the plants were 30 to 40 days old, 20 gravid BPH were released into cylindrical mylar film cages covering each pot.
Twenty-four hours later, the hoppers

were removed and the potted plants with hopper eggs were randomly placed in field experimental plots growing IR22 at the rate of 3 pots/plot. Each plot measured about 30 m^2. Insecticides were sprayed on the field plots at 18, 39, and 61 days after transplanting (DT). Potted plants with eggs were exposed to field parasitization after the 1st spraying at 20 and 21–23DT, after the 2d spraying at 42–44 DT, and after the 3d spraying at 64–66 DT. The plants with BPH eggs were exposed to parasitization for two days and brought back to the greenhouse.

From each pot, three tillers, together with roots, were removed. The roots were washed and the plants transferred to 20-cm-long, 2.5-cm-wide glass tubes with 2.5 cm water at the bottom to soak the roots. The tube was plugged with cotton wool.

The number of nymphs hatching from each set of tillers was assessed daily, and the nymphs were removed. Most nymphs hatched 7 to 10 days after oviposition. Two species of egg parasites — *Anagrus* sp. and *Oligosita* sp. — emerged later. The parasites moved upward in the tubes and were trapped in the cotton wool. When all parasites had emerged they were counted with the aid of a stereoscopic microscope. The two species could easily be distinguished by morphological differences. The tillers were later dissected under a stereoscopic microscope and the parasitized and the healthy, unhatched eggs laid in each group of plants and the percentage of parasitization by the two parasite species were assessed. That gave a relative picture of the activity of egg parasites in field plots treated with insecticides.

Anagrus sp. was more abundant than *Oligosita* sp. Parasitism by *Anagrus* sp. reached 65% from 64 to 66 DT; parasitism by *Oligosita* sp. was 23%. Parasitization of eggs in field plots treated with decamethrin at 18 DT was reduced significantly. Two days after spraying, parasitization in all the insecticide treatments was generally reduced but the level increased between 21 and 23 DT. Despite 2 more spray applications at 39 and 61 DT the percentage of parasitism generally increased in all treatments. As indicated in the figure, parasitism was high (50–70%) in all insecticide treatments and in the untreated check. The results of this experiment indicate that BPH resurgence in rice treated with decamethrin, methyl parathion, and diazinon apparently is not caused by an adverse effect on the BPH egg parasites *Anagrus* and *Oligosita* sp. ■

Evaluation of lethal concentration of different insecticides against the brown planthopper

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Twelve insecticides at different concentrations were tested for LD_{50} (lethal concentration required to kill 50% of test insects) values against brown planthopper adults (Table 1). Thirty-day-old potted plants of TN1 were sprayed until runoff stage with an atomizer. The plants were then kept under natural climatic conditions for 24 hours. Then insects were released on them. Mortality was determined after 24 hours. Diazinon was used as the standard for comparison.

Phosphamidon was three times as toxic as diazinon; monocrotophos and carbofuran were more than twice as toxic. Chlorpyrifos, quinalphos, carbaryl, and endrin were 1.4–1.9 times as toxic as diazinon. ■

Relative toxicity values of some insecticides against brown planthopper adults.[a] CRRI. India.

Insecticide	LD_{50}[b]	Relative toxicity
Diazinon	0.0105	1.0
Carbofuran	0.0052	2.0
Chlorpyrifos	0.0055	1.9
Carbaryl	0.0073	1.4
Quinalphos	0.0072	1.5
Lindane	0.024	0.4
Mephosfolan	0.0676	0.2
Phosphamidon	0.0034	3.1
Endosulfan	0.0305	0.3
Monocrotophos	0.00404	2.6
Endrin	0.0077	1.4
Chlorfenvinphos	0.0128	0.8

[a]Max temp = 32.3°C. mean max temp = 29.0°C. Min temp = 14.2°C mean min temp = 17.4°C. Mean RH = 69%. [b]Lethal concentration required to kill 50% of the insects.

Insecticide evaluation for whorl maggot control

M. B. Arceo, research assistant, and E. A. Heinrichs, entomologist, Entomology Department, International Rice Research Institute

Several insecticides were applied as granules and as foliar sprays to identify those most effective in controlling the whorl maggot *Hydrellia sasakii.* The insecticides tested and the methods and rates of application are listed in the table.

Foliar spraying was done twice — 3 and 15 days after transplanting (DT) — with a knapsack sprayer at 300 liters of water/ha per application. Cypermethrin was sprayed with an ultra-low volume (ULV) applicator at 2 liters/ha.

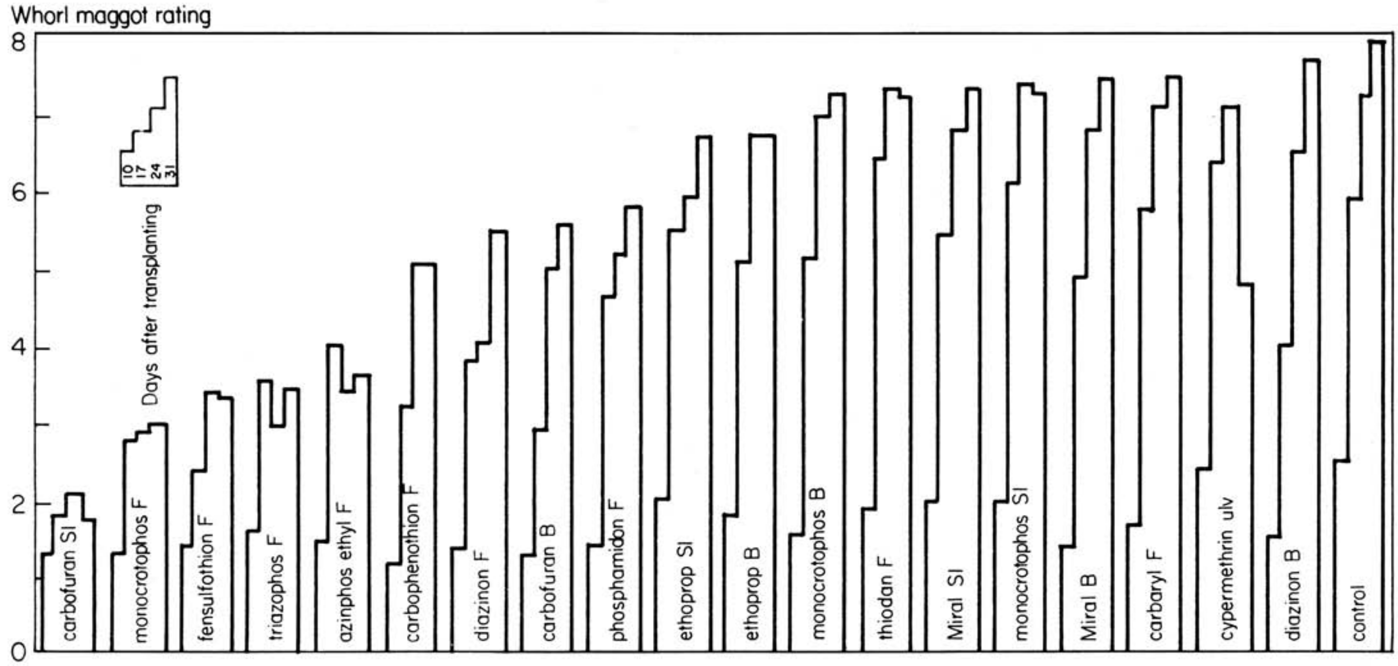
Soil incorporation was done 1 day, before transplanting; the paddy water broadcast was done at 3 DT.

Whorl maggot damage was assessed weekly, from 10 to 31 DT on a scale of 1–9. The results (see figure) indicate that carbofuran soil incorporation was

Insecticides, application methods, and rates for whorl maggot control, IRRI.

Insecticide (common name)	Application method[a]	Rate (kg a.i./ha)
Carbaryl	F	0.75
Phosphamidon	F	0.75
Endosulfan	F	0.75
Azinphos ethyl	F	0.75
Diazinon	F	0.75
Triazophos	F	0.75
Monocrotophos	F	0.75
Fensulfothion	F	0.75
Cypermethrin	ULV spray	0.02
Carbophenothion	F	0.75
Carbofuran	SI	0.75
Miral	SI	0.75
Ethoprop	SI	0.75
Monocrotophos	SI	0.75
Carbofuran	F	1.00
Miral	B	1.00
Ethoprop	B	1.00
Monocrotophos	B	1.00
Diazinon	B	0.75
Control	–	–

[a]F = foliar spray, ULV = ultra-low volume, SI = soil incorporation, B = broadcast.



Whorl maggot rating taken weekly on plots of IR36 treated with different insecticides. IRRI, 1979 dry season. 1 = 0-1 leaf damaged/hill; 3 = 2 or more but less than 1/3 of leaves damaged; 5 = 1/3 to 1/2 of leaves damaged; 7 = more than 1/2 of leaves damaged with no leaf breaking; 9 = more than 1/2 of leaves damaged with some leaves broken.

the most effective treatment for whorl maggot control. Control was also satisfactory on plots sprayed twice with monocrotophos, fensulfothion, triazophos, or azinphos ethyl.

Carbofuran as a paddy water broadcast treatment initially gave good control, but its residual activity was shorter than when it was incorporated into the soil. ■

Residues of carbofuran in soil, rice grain and straw as affected by rates and number of applications

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Insecticides with greater persistence leave more toxic residues on treated crops and become a health hazard for men and cattle. Carbofuran is effective against many major rice pests, but its residues status in the grain, straw, and soil after paddy harvest is not known.

Carbofuran granules at 1 .0 kg a.i./ha were broadcast 1 to 3 times at different stages of crop growth in nonreplicated micro field plots planted with Jaya spaced 20 x 20 cm. The treatments were 1 application at 15,40, or 70 days after transplanting (DT), 1 application at 15 and 40 DT, 1 application at 70 DT, and an untreated check (see table).

At or after harvest, samples of soil, grain, and straw from 12 random plants and 100 g of grain randomly drawn from each treatment were collected and were analyzed by the gas chromatographic technique. The residues in grain of treated plots ranged from 0.034 to 0.056 ppm; residues in the straw ranged from 0.039 to 0.112 ppm. The soil contained higher residues – 0.261 to 0.672 ppm. The residue tolerances established for carbofuran in the USA were 1 .0 ppm for rice straw and 0.2 ppm for rice grain. The carbofuran residues in this study were within those prescribed tolerance limits. ■

Carbofuran residues in rice grain, straw, and soil of the variety Jaya, summer, 1977.

Treatment	Total dosage (kg a.i./ha)	Time lag (days) between last treatment and		Residues (ppm) of carbofuran		
		Harvest	Residue analysis	Grain	Straw	soil
1 application Furadan 3G at 15 DT	1.0	98	122	0.034	0.051	0.261
2 applications Furadan 3G at 15 and 40 DT	2.0	78	102	0.044	0.051	0.288
3 applications Furadan 3G at 15, 40, and 70 DT	3.0	48	72	0.056	0.112	0.345
1 application Furadan 3G at 40 DT	1.0	78	102	0.041	0.048	0.315
1 application Furadan 3G at 70 DT	1.0	48	72	0.038	0.039	0.672
Control	–	–	–	0.002	0.007	0.034

[a]DT = days after transplanting.

Pest management and control RODENTS

Squirrels as rodent pests of rice in Bangladesh

Shamsul Alam, M. Aminul Haque, and M. Azizul Haque, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Rats are important rice pests, especially in deepwater rice areas of Bangladesh, but there has been no record of squirrels as rice pests. During a tour of southwestern Bangladesh in July 1979, we not only received reports of squirrel damage, but also observed a group of squirrels damaging the dryland aus rice crop in the Ganges-Kobadak project area, Kushtia district. The five-striped Indian squirrel Funabulus pennati Wroughton eats grain the way rats do. It is important in three districts of Bangladesh – Kushtia, Jessore, and Khulna – bordering West Bengal, India. It has not been found in other Bangladesh districts except for one reference from Sylhet.

Other squirrel species, including the five-striped Indian squirrel, are serious pests of vegetables, fruits, and nuts. ■

Irrigation and water management

A simple microlysimeter to measure transpiration and evapotranspiration in wetland rice fields

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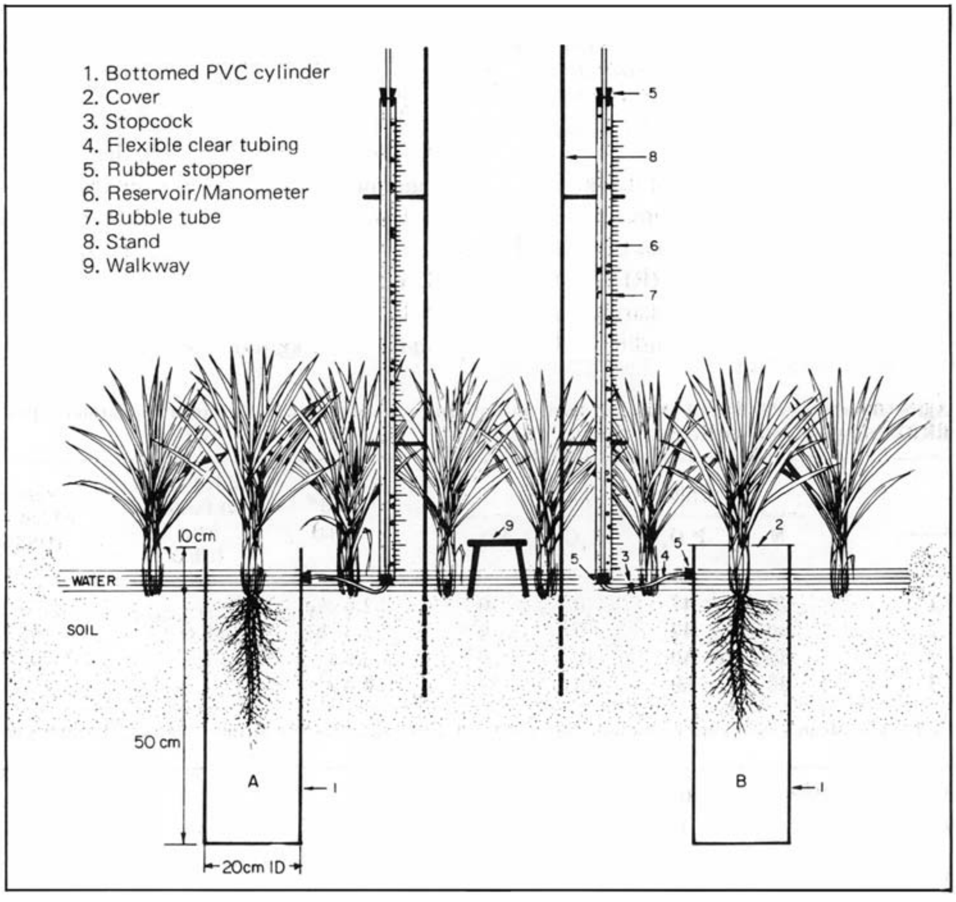
The measurement of water loss as transpiration and evapotranspiration (ET) for each hour or each day in the field is difficult because, the available methods are either expensive or inaccurate. A simple microlysimeter for use in irrigated wetland rice fields was designed and tested. It consists of a polyvinylchloride (PVC) cylinder, sealed at the lower end and connected to a water reservoir-cum-manometer with flexible tubing (see figure). Water in the microlysimeter was maintained at a constant level equivalent to the height of flooded water in the surrounding field with the Mariotte system. Measurement of the water loss from the reservoir-manometer represents the transpiration or evapotranspiration during a time interval.

The microlysimeters were calibrated in the laboratory, then installed in plots in a puddled field. The soil was excavated and the cylinders were installed 50 cm deep, leaving 10 cm of the cylinder's top portion above the soil surface (see figure). The cylinders were so installed that the rice hill in each lysimeter became an integral part of the 20- x 20-cm field planting pattern. Transpiration was measured by carefully covering the PVC cylinders with perspex sheets and checking the evaporation from the water surface in the cylinders. The trial was replicated four times.



Cross section of installed microly simeters for measuring evapotranspiration (A) and transpiration (B) in wetland rice.

To verify the reliability and accuracy of the microlysimeter results, 40- x 40-cm tanks, each holding 4 hills, were installed along with these units in 1978–79.

Three rice varieties – IR20, IR36, and Dular – were grown in both types of units. ET data were collected from the 2 units from 15 days after planting until flowering. There was good agreement of data obtained from each type of unit. When graphed, the distribution of data points along a 1:1 line indicated that both microlysimeters are reliable and accurate for ET measurement in wetland rice fields.

The table shows an example of ET rates for the 3 cultivars and pan evaporation and solar radiation values on 3 clear days at about the maximum tillering stage in the 1978 dry and wet seasons.

Simple to fabricate and maintain the microlysimeters can be made locally and handled easily. The microlysimeter principle might also be applied to ecological studies of water use by non-crop aquatic and semi-aquatic species. ■

Evapotranspiration rate at maximum tillering growth stage on 1 clear day for 3 cultivars of rice grown at IRRI in the 1978 dry and wet seasons.

Date	Season	Evapotranspiration (mm/day)			Av pan evaporation	Solar radiation
		IR36	IR20	Dular	(mm/day)	(cal/cm^2 per day)
13 Apr	Dry	10.0	9.0	8.2	8.8	663
25 Sep	Wet	5.7	4.3	7.8	4.8	571
19 Dec	Wet	4.2	4.3	6.2	4.2	476

Soil and crop management

Role of balanced fertilizers in increasing farmers' rice yields and profits

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To examine the potential of using recommended levels of balanced fertilizers, an experiment was conducted in a farmer's field at the BRRI cropping systems research site at Laskarchala in 1979 aus. The variety Chandina (BR1) was used; the crop was transplanted, with supplemental irrigation. The experiment was in a randomized complete block design with four replications.

Treatments consisted of 4 levels of fertilizer application: the farmer's level (26-47-0 kg N-P_2O_5-K_2O/ha), the recommended level for N + the farmers' level of P_2O_5, (80-47-0 kg N-P_2O_5-K_2O/ha), the recommended level for N-P_2O_5-K_2O (80-60-40 kg/ha), and the recommended level for N-P_2O_5-K_2O plus sulfur as SO_4 (80-60-40-34 kg/ha).

The yield was highest from the recommended level for NPK plus sulfur (4.3 t/ha), but it did not differ significantly from the treatment without sulfur (3.9 t/ha) (see table).

Replacing the farmer's level of N only with the recommended level significantly increased grain yield (3.3 t/ha vs 2.6 t/ha). Economic analysis of the extra costs and returns over the farmer's level indicated that investing an extra US$16.57–31.53/ha could bring an extra net return of US$129.00–372.28/ha ■

Agroeconomic evaluation of extra nitrogen, phosphorus, potassium, and sulfur over the farmer's level of management in the 1979 aus at the Laskarchala BRRI Cropping Systems Research Site.

Treatment	Fertilizer rate (kg/ha) N	P_2O_5	K_2O	SO_4	Yield[a] (t/ha)	Added yield over farmer's level (t/ha)	Value of added yield (US$/ha)	Cost of added inputs (US$/ha)	Added profit over farmer's level (US$/ha)	Benefit-cost ratio
1[b]	26	47	0	0	2.6 c	–	–	–	–	–
2	80	47	0	0	3.3 b	0.6	145.58	16.57	129.01	7.7
3[c]	80	60	40	0	3.9 a	1.3	308.51	26.63	281.88	10.5
4	80	60	40	34	4.3 a	1.7	403.80	31.53	372.28	11.8

[a] CV = 6%. Mean yields with a common letter did not differ significantly at the 1% level. [b] Farmer's level. [c] Recommended level.

Varietal reaction of rice to age of seedlings transplanted in alkali soil

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An experiment conducted on an alkali soil (pH 8.2, ESP: 15.47%, and EC: 0.48 mmho/cm at 25°C) in 1977–78 kharif studied the effects of transplanting seedlings of different ages. The split-plot design had varieties in the main plot and seedling age in the subplot. Fertilizer was applied at 120 kg N/ha (60 kg basal, 30 kg 20 days after transplanting [DT], and 30 kg at 40 DT irrespective of growth stage), 60 kg P_2O_5/ha, and 80 kg K_2O/ha as basal. Three healthy seedlings were transplanted in each hill.

The table shows that the period required for establishment was not greatly influenced by the age of seedlings at transplanting. However, seedlings older than 25 days were established 1 or 2 days earlier. The time from panicle emergence to maturity generally was shorter in the short-duration variety Bala than in the medium-duration Ratna and the long-duration Sona. But in all three varieties, the time was shorter in seedlings

Effect of seedling age at transplanting on establishment, maturity, grain yield, and straw-grain ratio of 3 rice varieties, 1977-78 kharif, Allahabad, India.[a]

Age of seedlings (days)	Establishment (DT)	Time between PE & maturity (days)			Maturity (days)			Grain yield (t/ha)			Straw-grain ratio		
	BRS	B	R	S	B	R	S	B	R	S	B	R	S
25	666	35	48	50	109	128	130	2.7	2.6	2.4	1.18	1.26	1.19
35	555	30	45	35	117	130	132	2.0	2.8	2.8	1.31	1.30	1.42
45	555	28	40	37	120	133	135	2.0	1.9	2.1	1.26	1.26	1.37
55	544	22	30	31	131	135	141	0.8	0.8	1.3	1.21	1.19	1.21

[a]DT = days after transplanting. B = Bala. R = Ratna. S = Sona. PE = panicle emergence. Grain yield: highly significant for seedling-age treatment. LSD for seedling-age treatments: 0.381. LSD for variety treatments: 0.258.

that were older at planting. In contrast, seedlings that were transplanted at an older age matured later. That could account for the greater setback at different growth stages of older seedlings. Relatively older seedlings of Ratna and Sona gave the highest grain yields when transplanted at 35 days but gave lower yields when transplanted later. The straw-grain ratio, which was highest in 35-day-old seedlings, decreased in older seedlings, which grew and developed poorly.

It may be concluded that rice seedlings should be transplanted in alkali soils between the ages of 25 and 35 days. If transplanted earlier, the seedlings may die; if transplanted later, they will yield poorly. The finding could be due to the higher concentration of soluble salts that results in the higher mortality of seedlings planted when between 21 and 25 days old. Thus, the older seedlings do better in saline alkali soils. ■

Potassium chloride pretreatment on rice seeds

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A field trial was conducted to determine the efficiency and response of rice seedlings to nutrients available in the soil. The variety ADT31 was used in a two-replication split-plot design.

The main plot treatments were M1 -- green leaf manure at 5 t/ha; M2 -- M1 + superphosphate at 250 kg/ha; M3 -- M2 + blue-green algae at 25 kg/ha; M4 -- nitrogen placed at 75 kg N/ha; and M5 -- control (no manure).

The subplot treatments were S1 -- control; S2 -- potassium chloride 1% (seed soaking); S3 -- manganese sulfate 8% (seed soaking); S4 -- ferrous sulfate 8% (seed soaking); S5 -- diammonium phosphate 4% (sprouted seed treatment); and S6 -- zinc sulfate 4% (sprouted seed treatment).

Grain yield of fertilized rice plants and pretreated rice seeds, Tamil Nadu, India.

Main plot	Yield (t/ha)	Increase (%) over control	Subplot	Yield (t/ha)	Increase (%) over control
M1	3.6	116	S1	3.1	100
M2	3.7	120	S2	4.2	135
M3	3.5	114	S3	3.8	121
M4	4.2	134	S4	3.6	115
M5			S5	3.3	106
			S6	3.7	119
‘F’ test					
SE	122.0			45.1	
LSD	0.480			0.131	

Among the main plot treatments, M4 gave a 34% higher yield than the control (see table).

Among the subplot treatments, S2 was significantly superior treatments and gave the highest grain yield, 35.0% over the control. ■

Rice-based cropping systems

Performance of improved agricultural practices for dryland rice production in Sierra Leone

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Trials were conducted for the past 3 years on rice in farmers’ fields under dryland ecology at sites across Sierra Leone to determine:

1. If permanent cultivation can replace the bush fallow-rice system of traditional cultivation.
2. If improved cultivation methods can increase the yields of traditional rice varieties.
3. The benefit-cost ratio due to fertilizer application.

Upland farmers in this part of Africa every year clear the bush from a new site and abandon that site after one rice crop or a crop of groundnut, cassava, or both, and return to the same site 8–10 years later. The fallow period has been reduced to 4–5 years in some parts of Sierra Leone.

In the first rice crop grown after bush fallow around Rokupr, the average rice yield with the application of 60–80 kg N/ha was 1.9–2.0 t/ha. The rice yield in the second and third year after bush fallow could be maintained at a similar level through the application of adequate amounts of fertilizers (Table 1). It is therefore not true that upland rice should not be grown in successive years on the same site.

The trials in farmers' fields to study the effect of improved practices included fertilizer application and line sowing. The results demonstrated that farmers' production with local varieties can be improved considerably through improved cultivation practices (Table 2).

The fertilizer response data collected from on-farm trials showed that investment on fertilizer was highly remunerative. Allowing for the risk of crop failures due to natural calamities and other costs in fertilizer application, a net profit of $2 or more every $1 investment can be considered remunerative (Table 3).

The results show that in the bush fallow-rice system, the application of either nitrogen or potassium, or both, gives high net returns in almost all districts. ■

Table 1. Average yield of rice (ROK 3) in uplands under different cropping systems. Rokupr, Sierra Leone, 1976 wet season.

Cropping system (no. of rice crops after bush fallow)[a]	Trials (no.)	Yield (t/ha) Without fertilizer	With fertilizer 60 kg N/ha	With fertilizer 80 kg N/ha
1st	5	1.26	1.93	2.04
2d	4	0.77	1.87	2.05
3d	4	0.82	1.61	1.82

[a]One rice crop was grown per year.

Table 2. Effect of improved and traditional cultivation practices on the yield of a local rice variety. Rokupr, Sierra Leone, 1978 wet season.

District	Trials (no)	Av yield (t/ha) Improved practices	Av yield (t/ha) Traditional practices	Yield increase (%) due to improved practices
Kambia	5	1.82	0.90	101
Tonkolili	5	1.04	0.57	77
Bo	5	1.61	0.85	88
Moyamba	10	1.56	1.02	51
Kailahun	5	1.30	0.61	114
Kono	5	1.24	0.84	47

Table 3. Net returns on investment on fertilizer application to upland rice. Rokupr, Sierra Leone, 1978 wet season.[a]

District	Net return ($/$1 investment) 60 kg N/ha	30 kg K/ha	60 kg N and 30 kg K/ha	60 kg N, 30 kg P, and 30 kg K/ha
Kambia	7.23	4.86	5.91	2.64
Bombali	3.63	7.94	4.90	5.38
Tonkolili	2.70	3.16	3.07	3.50
Kaoinadugu	3.30	7.80	0.78	0.71
Bo	1.87	5.39	1.05	1.07
Moyamba	7.00	20.35	8.81	5.09
Kailahun	4.41	26.92	6.37	3.01

[a] Price of 1 kg N = $0.49, 1 kg P_2O_5 = $0.70, 1 kg K_2O = $0.25, and 1 kg rice grain = $0.22.

Growth and yield of *Tilapia nilotica* fish and rice in irrigated paddies

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An experiment to determine the effect of two population densities (25,000 and 37,500) of *Tilapia nilotica* on the growth and yield of the fish as well as on rice yield was conducted in farmers' fields at the BRRI Cropping Systems Research site at Salna in 1979 aus (Apr–Aug). The rice variety Chandina was transplanted with and without fish. Two trenches, each 1 m wide and 50 cm deep, were maintained across the middle of the paddies with fish. Well-prepared levees were maintained around the paddies. Fish were released into the field 5 days after transplanting (DT). Water depth was maintained at 5–10 cm until 25 DT and at 10–15 cm for the remainder of the period.

The paddies without fish were kept flooded at a depth of 5–10 cm. Fertilizer was applied at 50 kg N/ha and 43 kg P_2O_5/ha. At 30 DT the water depth was reduced to about 2–4 cm, and nitrogen was topdressed.

The rice crop and the fish were harvested at 106 DT. The fish whose initial population was 25,000 increased 215% in number per hectare; each fish increased in size by 5 cm (see table). The

The influence of 2 population densities of fish on the number, size, and weight of fish and on rice yields. BRRI, 1979.

Population	Fish population (no./ha) Initial	At harvest	Increase	Fish size (cm) Initial	At harvest	Increase	Fish wt (kg/ha) Initial	At harvest	Increase	Rice yield (t/ha) With fish	Without fish
1	25,000	53,771	28,771	4.5	9.5	5.0	114	442	328	2.8	2.8
2	37,500	78,457	40,957	4.5	8.5	4.0	149	273	124	2.6	2.6
Mean	31,250	66,114	34,864	4.5	9.0	4.5	132	358	226	2.7	2.7

fish whose initial population was 37,500 increased in number by 209%; in size, each fish increased by 4cm. Fish weight increased considerably during the cropping duration. A higher population reduced the ultimate size of each individual fish and the total fish yield per hectare. But fish culture had no appreciable effect on the rice yield. ■

Suitable cultivars for intensive rice-based cropping systems in Bangladesh

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The Rice Cropping Systems Division initiated research to evaluate and modify the essentially rice-based cropping systems of the BRRI project area. The cultivation of nonrice crops should be incorporated into the existing rice cropping systems to improve the potential cropping patterns for rainfed and irrigated areas. Unfortunately, suitable cultivars for many nonrice crops were not available from local sources. BRRI has no mandate to develop varieties other than those of rice, so the division undertook a varietal screening program with active participation of relevant national and international organizations.

From 1974 to 1978, varieties of corn, sorghum, pearl millet, peanut, soybean, cowpea, and chickpea were evaluated at the BRRI experimental farms and in selected farmers' fields of the BRRI project area. Several promising varieties were identified (see table) and are now used in various single and double cropping systems in the area. ■

Promising cultivars for intensive rice-based multiple cropping systems. BRRI, Bangladesh.

crops	Best performing cultivars	Potentially acceptable cultivars
Field corn	Thai Comp., No. I DMR BC_3(S) C1, Early DMR Comp. 2	Thai Comp., No. I (S) C_2, Early DMR Comp. I
Sweet corn	Thai Comp. supersweet DMR #1	College sweet synthetic
Sorghum	IS2940, Cosor 2	CS108, Cosor 3, CS100
Pearl millet	ICRISAT-7141NEP-13-5007-2 (OP)	ICRISAT-7142NEP-13-5613-1 (OP)
Peanut	Kidang, SK-38	CES101, P23, EG. Bunchy
Soybean	Davis, Williams (dry season) Bossier, Hardee, Seemes (wet season)	Clark 63, TK5 Williams, Davis
Chickpea	ICRISAT No. 4951, 2784	2836, 4961, 4465
Cowpea	All season	TVU354, TVU201, RDC-6-12W

Evaluation of mung bean cultivars under monoculture and intercropping systems

Md. Nazrul Islam Miah, research fellow; and Virgilio R. Carañgal, network coordinator, Cropping Systems Program, Multiple Cropping Department, International Rice Research Institute

The pulse crop mung bean *Vigna radiata* is grown mostly as monoculture but is also intercropped with corn and sugarcane or grown under plantation crops such as coconut or rubber. Mung bean is also relayed in wetland rice in most of Southeast Asia. Evaluation of mung bean varieties for varied conditions is imperative because of yield fluctuations due to seasonal and environmental situations. An important question is whether breeders should evaluate varieties in monoculture or in intercropping systems for maximum testing efficiency.

Ten mung bean varieties were evaluated in monoculture and intercropped with corn in dry- and wet-season trials in 1978–79 at the new upland area of the IRRI experimental farm. Recommended cultural management practices, such as fertilization, weeding, irrigation, and

Yield comparison (kg/ha) of mung bean varieties and their relative ranking for monoculture and when intercropped with corn. IRRI, 1978–79 dry season and 1979 wet season. [a]

Mung bean variety	1978–79 dry season				1979 wet season			
	Monoculture yield (kg/ha)	Rank	Intercrop yield (kg/ha)	Rank	Monoculture yield (kg/ha)	Rank	Intercrop yield (kg/ha)	Rank
EG-MG-174-3	850 a	1	203	2	873 abc	5	465 abc	6
CES 55	638 ab	2	213	1	779 bc	8	377 c	8
S8 (Green)	619 b	3	160	5	671 c	10	363 c	9
M350	601 b	4	135	7	1055 a	2	525 abc	4
CES-IT-2	589 b	5	178	3	1061 a	1	667 a	1
CES-14	561 b	6	137	6	821 abc	7	387 bc	7
CES-U-1	534 b	7	168	4	694 c	9	315 c	10
MG-50-10A (Y)	490 b	8	115	10	1024 ab	3	478 abc	5
CES-1D-21	475 b	9	127	9	877 abc	4	611 a	2
CES-IF-5	449 b	10	129	8	871 abc	6	598 ab	3
Mean	580		157 ns		873		478	
CV (%)	23		42		18		21	

[a] ns = not significant. In a column means followed by the same letter do not differ significantly at the 5% level.

spraying of fungicide and insecticide were used.

The varieties that yielded high in monoculture also yielded high when intercropped with corn in both seasons (see table). When the varieties were ranked on the basis of yield performance in the tests, among the five top yielders in monoculture in the dry season were EG-MG-174-3, CES 55, S8 (Green), M350, and CES-1T-2. When intercropped with corn, the top yielders were CES 55, EG-MG-174-3, CES-1T-2, CES-U-1, and S8 (Green). The test varieties performed differently in the wet season. The five top yielders for monoculture were CES-1T-2, M350, MG-50-10A (Y), CES-1D-21, and EG-MG-174-3. In intercropping, the top yielders were CES-1T-2, CES-1D-21, CES-1F-5, M350, and MG-50-10A (Y).

In the dry season, correlations of mung bean yields and rank orders for monocrops vs corn association gave positive and significant *r* values ($r = 0.75^{*}$ for yield, and $r = 0.80^{**}$ for rank order). Varieties also exhibited similar relationships in the wet-season planting ($r = 0.74^{*}$ for yield, and $r = 0.88^{**}$ for rank order). Correlations of mung bean yields and rank orders for monocrops vs intercrops over two seasons were also found significant at the 1% level of significance ($r=0.88^{**}$ for yield, and $r = 0.82^{**}$ for rank order). Although seasons influence the yield and cultivar ranking, promising mung bean varieties can be screened in monoculture and recommendations for other associated systems can be made. ■

Reducing turnaround time and cost of production by zero and minimum tillage in intensive rice cropping systems

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A longer turnaround time has been one of the most important constraints to intensive rice cropping patterns, particularly those involving modern rice varieties, in Bangladesh. Farmers usually keep a turnaround time of 2–3 weeks between rice crops. The later part of the period is often used for land preparation. Four tillage treatments were used in an experiment undertaken in 1979 aus in a farmer's field at the BRRI Cropping Systems Research site at Salna to determine the effect of zero and minimum tillage and reduced turnaround time on the yield of aus (Chandina) rice following a crop of boro (Pajam) rice. Both crops were irrigated. In the experimental aus crop, the farmer applied fertilizer at 56 kg N/ha, 28 kg P_2O_5/ha, and 28 kg K_2O/ha. Forty-eight percent of the nitrogen and all P_2O_5 and K_2O were applied basally; the rest of the nitrogen was applied in two topdressings. The treatments were replicated twice and received uniform water management, weeding, pest control, and other operations.

A 1-day turnaround period was needed for the zero tillage treatment; a 4-day period for the minimum tillage treatment. High-intensity tillage was applied within 3-day turnaround time. The farmer plowed 7 times and laddered 4 times during a 15-day turnaround period. There was no significant difference in grain yield due to tillage practice.

However, land preparation for minimum tillage cost $14.02/ha; that for high-intensity tillage within 3 days, $60.93/ha; and that for the farmer's level of tillage, $71.61/ha. The zero tillage practice in the irrigated rice paddies reduced the turnaround time to 1 day without reducing grain yields, thus enabling the farmers to grow more intensive cropping patterns. Expensive land preparation could be totally avoided in the irrigated areas by adopting the zero-tillage technique. ■

Machinery development and testing

Power and cost requirements for field operations in rice cultivation

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The human and animal power requirements for various field operations were monitored during cultivation of the 1979 aus rice crop at the BRRI cropping systems research site, Salna, Dacca district. Detailed records were maintained on the actual human- and animal-hour requirements by using a stopwatch for the various operations of 12 farmers who grew aus rice (4 used traditional varieties, 8 grew modern ones). The costs of human and paired-animal-hours were computed at the rate of $0.08 and $0.17/hour, respectively.

The table shows that 969 human-hours/ha costing $80.87/ha, and 167 paired-animal-hours/ha costing $27.87/ha were used for all field operations. Weeding accounted for the highest human-hours (37%), followed by transplanting (19%), harvesting (18%), and plowing (15%). Animal power was used only in plowing (89%) and laddering (11%). When modern varieties were used, the total human- and paired-animal-hours per hectare were 822 and 254, at a corresponding total cost of $68.47 and $42.40. Plowing required the maximum human-hours (29%), followed by harvesting, weeding, and transplanting. Plowing also used 93% animal power. Interestingly, the total per-hectare power costs for the traditional and modern varieties were almost the same. The study showed that plowing, transplanting weeding, and harvesting were the major field operations requiring 89% of the total power requirements of both traditional and modern varieties. ■

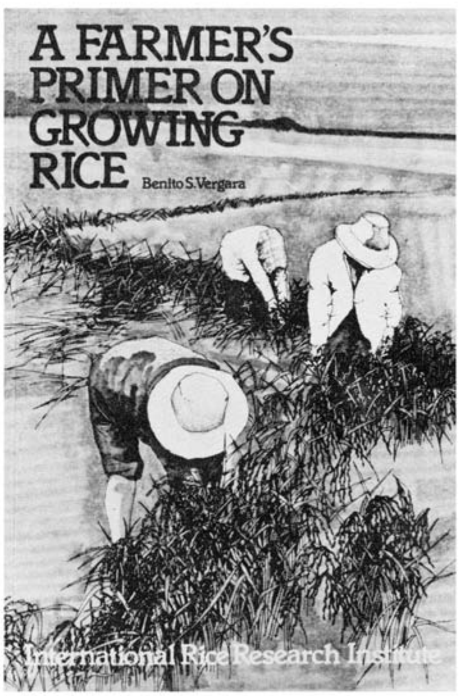
Average human-hours, animal-hours, and costs required for various field operations in the cultivation of traditional and modern varieties of aus rice. 1979 aus season, Salna village, Dacca district, Bangladesh.[a]

Operation	Traditional variety (4 samples)				Modern variety (8 samples)			
	Human-h/ha	Cost of human power ($/ha)	Paired-animal-h/ha	Cost of animal power ($/ha)	Human-h/ha	Cost of human power ($/ha)	Paired-animal-h/ha	Cost of animal power ($/ha)
Plowing	149 (15)	12.40	149 (89)	24.87	237 (29)	19.73	237 (93)	39.53
Laddering	18 (2)	1.53	18 (11)	3.00	17 (2)	1.40	17 (7)	2.87
Trimming levees	43 (5)1	3.60	–	–	12 (1)	1.00		
Applying fertilizer	10 (1)	0.87	–	–	7 (1)	0.60		
Applying manure	00	0.00	–	–	18 (2)	1.53		
Uprooting seedlings	24 (3)	2.00	–	–	13 (2)	1.07		
Transplanting	186 (19)	15.53	–	–	131 (16)	10.93		
Weeding	361 (37)	30.07	–	–	161 (20)	13.40		
Applying pesticide	00	0.00	–	–	29 (3)	2.40		
Harvesting	178 (18)	14.27	–	–	197 (24)	16.40		
Total	969	80.87	167	27.87	822	68.45	254	42.40

[a] Numbers in parentheses indicate the percentage of total for the column.

Announcements

IRRI will provide illustrations for translations of *A farmer's primer on growing rice*



Recommendations given to farmers in the past have often failed to answer questions such as why a farmer incubates seed, why he applies fertilizer, or how and when fertilizer should be incorporated. *A farmer's primer on growing rice* was designed to help the progressive farmer or rice specialist understand and explain why and how the improved rice varieties and technology increase production.

Several national rice improvement programs have requested IRRI's cooperation in the translation and local printing of *A farmer's primer.*

Therefore, IRRI will provide black-and-white prints of all illustrations and artwork in the book (with English text blocked out) to rice agencies interested in publishing local-language editions. The cost is US$16 (actual reproduction cost plus airmail postage and 1 English edition).

Dr. Benito S. Vergara, IRRI plant physiologist, authored the 221-page handbook during a sabbatic leave at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), Los Baños, Philippines.

Individuals or organizations in developing nations may purchase A *farmer's primer* at US$2.00/copy (post-paid, surface mail) or at $4.30/copy (postpaid, air mail) (₱15.10 or ₱25.50 in the Philippines). Those in highly developed nations may order the book at $5.20/copy (surface mail) or $7.30 (air mail).

Interested organizations may write to: Office of Information Services (OIS), IRRI, P.O. Box 933. Manila, Philippines. ■

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