International Rice Research Newsletter

VOLUME 6 NUMBER 3 JUNE 1981

Published by the International Rice Research Institute, P.O. Box 933, Manila, Philippines

Contents

Guidelines and Style for IRRN Contributors

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

Style

- Use the metric system in all papers. Avoid national units of measure (such as cavans. rai. etc.).
- Express all yields in tons per hectare (t/ha) or, with small-scale studies, in grams per pot (g pot) or grams per row (g/ row).
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N/ha; not 60 kg/ha N.
- The US dollar is the standard monetary unit for the IRRN. Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg ha.
- When using abbreviations other than for units 0f measure, spell out the full name the first tme of reference, with abbreviations in parenthesis, then use the abbreviation throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested. Three levels of N were ... or Biotypes of the brown planthopper (BPH) differ within Asia. We studied the biotypes of BPH in ...
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example: 8 years; 3 kg/ha at 2-week intervals; 7%; 4 hours.
- Write out numbers below 10 except in a series containing some numbers 10 or higher and some number lower than 10. For example; six parts; seven tractors; four varieties. But There were 4 plots in India. 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

Guidelines

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

Genetic evaluation and utilization

OVERALL PROGRESS

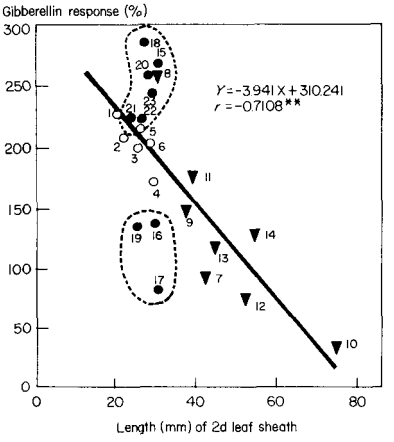
Gibberellin response of japonica-indica hybrids in Korean rice cultivars

Yang Song, Yeongnam Crops Experiment Station, Milyang, Korea; Jiro Harada and Takayuki Tanaka, Hokuriku National Agricultural Experiment Station, Joetsu, Niigata 943-01, Japan

The recent rapid increase in rice yields in Korea is based mainly on the successful release of new japonica-indica hybrid cultivars. These cultivars were bred using IRRI semidwarf lines, whose semidwarf gene comes from Dee-geo-woo-gen and is believed to limit gibberellin (GA) biosynthesis. Hence, these new hybrid cultivars should respond more to applied GA.

To check this effect, we compared the response to GA of the second leaf sheaths of japonica-indica hybrid cultivars with that of some japonicas and indicas. The cultivars used were japonicas: 1) Milseong, 2) Milyang 15, 3) Mankyeong, 4) Koshiji-wase, 5) Nipponbare, 6) Eiko; indicas: 7) Early Tall Peta, 8) Dee-geo-woo-gen, 9) Mao-tsu-tao, 10) Kaladumai, 11) Century Patna 231, 12) Dular, 13) CO 13, 14) Hawara-gepoek; and hybrids: 15) Tongil, 16) Yushin, 17) Milyang 21, 18) Milyang 23, 19) Milyang 30, 20) Milyang 42, 21) Suweon 258,22) Suweon 264,23) Nopung.

The results (see figure) indicated a negative correlation between the length of the second leaf sheaths and the response to GA. Most japonicas had short leaf sheaths and high GA response, whereas indicas, except Dee-geo-woo-gen which possesses a semidwarf gene, had long leaf sheaths and low GA response. The hybrid cultivars had short leaf sheaths but showed different reactions — one gave a very high GA response and the other the lowest response. The first group probably possesses a semidwarf gene of Dee-geo-woo-gen which limits GA biosynthesis; the latter probably possesses some genes that lack the site of action of GA.



Relationship between length of second leaf sheath (LSLS) and response to gibberellin (1 ppm) of japonica, indica, and japonica-indica hybrid rice cultivars. ○ = japonica, ▼ = indica, ● = japonica-indica hybrid. For numbering of cultivars, see text.

Japonica-indica hybrids belonging to the latter group are important as new dwarf gene sources for rice breeding, although the genetic basis for such is unknown. ■

PY1 or Puduvai Ponni — a new rice for late samba

P. Narayanasamy, assistant professor (rice), and S. R. Sree Rangasamy, principal, Farm Science Centre, Pondicherry, India

The northeast monsoon period (Sep-Oct to Dec-Jan) in the Coromandal coastal belt of Pondicherry is characterized by low temperatures (25-30°C), reduced sunlight duration (5.5-8.3 h/day), monsoon cloudiness, and high rainfall (927-1,144 mm in 50-53 rainy days). Pest incidence is heavy during the period. Despite such unfavorable conditions, almost 70% of the cultivable area in the Union Territory of Pondicherry is under monsoon rice because of heavy monsoon showers and excessive moisture.

Among the medium-duration rice var-

ieties released for general cultivation, only Mashuri and IR20 are adaptable.

Mashuri, called Ponni locally, has fine grain, yields 4-4.5 t/ha, and matures in 130 days. But it is highly susceptible to pests. Farmers in the region need a variety with the desirable traits of Mashuri plus high yield potential and pest resistance. With such a variety as the objective, Mashuri and IR8 were crossed and their segregating progenies were studied. A progeny line, P162, was released as PY1 Puduvai Ponni for general cultivation in 1979.

PY1 is a medium-duration variety that grows to 110 cm (Ponni or Mashuri grows to 120 cm). Its tillers are erect and compact, averaging 8 productive ones/hill. PY1 is tolerant of lodging and pests, and matures in 130 days. The color of the ripening spikelet is gold to brown. PY1's density and panicle length are almost identical to those of Ponni. The length-breadth ratio of PY1 grain is 3.0; that of Ponni is 3.2. The 1,000-grain weight of PY1 is 17.2 and that of Ponni is 16.2 g. PY1's yields average 5.4 t/ha (29% higher than that of IR20, and 23% higher than that of Mashuri) (see table). ■

Mean yield of PY1 Puduvai Ponni compared with that of IR20 and Mashuri (Ponni) in the monsoon (Sep-Feb) season in Pondicherry Region, India.

Type of trials	Year	Yield (t/ha)		
		PY1	IR20	Mashuri (Ponni)
Trials at research stations	1977	5.1	3.5	3.5
	1978	4.8	1.9[a]	4.1
	1979	6.5	4.1	5.3
Adaptive trials in farmers' fields	1977	6.0	4.2	4.8
	1978	4.7	4.3	4.3
	1979	5.5	4.8	–
General mean		5.4	4.2	4.4
		Yield difference (%) over IR20		
		+28.6	0	+4.8
		Yield difference (%) over Mashuri		
		+22.8	–4.6	0

[a]Severely affected by brown planthopper and virus; omitted in arriving at general mean.

PY2 or Punithavathi — an early-maturing, fine-grained rice

Thiru P. Narayanasamy, assistant professor (rice), and K. R. Raman, principal, Farm Science Centre, Pondicherry, India

The Union Territory of Pondicherry, India, is an area of intensive rice culture under a rice-based multiple cropping system. Varieties up to 115 days in duration are raised during the dry seasons—January-April *(navarai)* and May-September *(sornavari)*.

Because the duration of the varieties raised is 110-115 days, they cannot be fitted into the rice-based multiple cropping pattern. These varieties postpone planting subsequent crops on time. In addition, the farmers prefer fine-grain rice varieties with high yield potential because the traders and consumers prefer fine varieties.

All the short-duration varieties raised now during *navarai* and *sornavari* have coarse grains (long bold or short bold). Therefore, rice breeding at the Farm Science Centre seeks to develop varieties of less than 100 days duration with fine grain and high yield to profitably fit the rice-based multiple cropping system, where raising crops from January to September depends upon lift irrigation. This led to the identification of the P1275 line, which was released as PY2 (Punithavathi) in February 1980.

PY2 (Punithavathi) is a derivative from the cross between Kannagi (Puza 2-21) and Cult. 2032. It is a medium-dwarf variety like IR20. It grows to 90 cm in height and is resistant to the brown planthopper under field conditions. Tillers are erect, compact, and resistant to lodging. It matures in 95 days under transplanted conditions. The boot leaf is slightly broad, erect, and late in senescence. The grain type is fine (short slender) like TKM6 with the length-breadth ratio of 3.96. Grain weight is 18.5 g/ 1,000 grains and the rice is translucent white. The ripening color of the glume is straw. The spikelet is green tipped. Punithavathi's average yield is 4.75 t/ha — minimum and maximum being 3.38 and 5.37 t/ha, respectively — superior to those of early and short-duration varieties tested (see table). ■

Mean yield level of PY2 or Punithavathi rice variety in the Pondicherry region, India.

Situation	Yield (t/ha) in				Mean
	1978 kharif (sornavari, May-Sep)	I979 rabi (navarai, Jan-Apr)	1979 kharif (sornavari, May-Sep)	1980 rabi (navarai, Jan-Apr)	
Rice Research Station	3.4[a]	4.9	5.4	4.5	4.5
Adaptive trials at farmers' holdings	–	4.7	4.7	4.5	4.1
Demonstration in farmers' holdings	–	–	5.0	4.8	4.9
All India Coordinated Rice Improvement Project trials (IET6972)	–	–	4.9	–	4.9
Lab to Land Program		–	–	4.8	4.8
Mean	3.4	4.8	4.8	4.6	4.8
Local check	1.8 (CO 39)	2.5 (CO 39)	4.2 (ADT31)	–	–

[a]Trial was severely affected by brown planthopper.

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

Genetic diversity of rice varieties in Tamil Nadu

W. Wilfred Manuel, Paddy Experiment Station, Ambasamudram 627401, Tamil Nadu, India

The genetic diversity of rice varieties released in Asia was investigated in 1979 by Hargrove, Coffman, and Cabanilla, IRRI. These authors expressed the view that the cytoplasmic similarity of modern rice varieties, although posing no immediate practical problem, is sufficiently relevant to demand a prompt broadening of the maternal genetic base of modern rices. They recommended the avoidance of the use of maternal derivatives of Cina as females in crosses, the naming of varieties of diverse maternal origin, and the identification and use of alternative sources of dwarfism.

The genetic diversity of rice varieties available in Tamil Nadu was investigated. The state has released 107 varieties; 68 are pure-line selections from traditional cultivars and 39 were developed by hybridization. Twenty-one other high-yielding varieties have been introduced into the state from outside since 1965 (Table 1). Thus 60 varieties developed by hybridization are available. Of that number 17 (28%) released before 1965 are tall varieties with local cultivars as their ultimate female progenitors.

In the varieties available after 1965 (71.7%), 21 have Cina, 8 have DGWG, and the other 14 have local cultivars as ultimate female progenitors (Table 2). All except IR5, NLR 9672, Ponni, White Ponni, and Bhavani carry the same semidwarfing gene from the semidwarf Chinese variety Dee-geo-woo-gen.

After their introduction TN1, IR8, and their derivatives were increasingly used in Tamil Nadu's crossing program. About 50% of the 43 varieties either released or introduced in Tamil Nadu after 1965 have the same maternal parent Cina, and thus have similar cytoplasmic components. The IRRI researchers suggested the use of new sources of semidwarfism such as Ponni Dwarf mutant, D66 (a mutant from Calrose), P3 Dwarf (a spontaneous mutant from Basmati Dehradun), and of alternate sources of maternal parents, which are readily available in the 68 pure lines already released by the State. ■

Table 1. Details on varieties either released or introduced in Tamil Nadu, India, through 1980.

	Varieties (no.)			
	Pure lines	Hybridization		Total
		Until 1965	After 1965	
Varieties developed in Tamil Nadu				
Paddy Experiment Station, Aduthurai	23	5	8	36
Paddy Experiment Station, Ambasamudrarn	11	2	2	15
Paddy Experiment Station, Tirur	6	I	2	9
Paddy Breeding Station, Coimbatore	24	8	10	42
Multi Crop Experiment Sub-station, Palur	2	–	–	2
Deep-Water Rice Research Station, Talainayar	2	–	–	2
Saline & Alkaline Experiment Station, Peravurani	–	1	–	1
Varieties introduced in Tamil Nadu	–	–	21	21
Total	68	17	43	128

Table 2. Ultimate female progenitors of varieties developed through hybridization in Tamil Nadu, India.

Ultimate female progenitor	Until 1965	After 1965	Total
Molagalagulu	1	–	1
ADT 2 (White Serumani)	1	–	1
ADT 3 (Kuruvai)	2	1	3
Norin 6	–	1	1
Norin 8	1	–	1
TKM 7 (Kullakar)	–	1	1
SR 26B (Kalamonk)	1	–	1
CO 3 (Vellaisamba)	1	–	1
CO 4 (Anaikomban)	2	–	2
CO 13 (Arupatham kodai)	1	–	1
PTB 15 (Kavunginpoothala)	–	2	2
Karneji	–	2	2
Manipur 36 (Japan Phon)	–	1	1
T 90 (Machakanta)	–	1	1
Basmati 370	–	2	2
GEB 24 (Kichili Samba)	7	2	9
DGWG (Dee-geo-woo-gen)	–	8	8
Cina	–	21	21
Not known	–	1	1
Total	17	43	60

Isolation of composite rice cultures

W. Wilfred Manuel, L. S. Mani, K. Ganesan, and L. Anavaradham, Paddy Experiment Station, Ambasamudram 627401, Tamil Nadu, India

Because of genotypic differences, cultivars with similar morphology and flowering duration vary in their adaptation and yield potential. When mixed, such types may be suitable for different agroclimatic conditions. A trial to isolate composites with better adaptability was conducted at Ambasamudram during the 1980 kar (Jun-Sep).

The 11 trial varieties were raised in individual nurseries and in 55 combinations. For the combinations, seeds of two varieties were mixed at 1:1. The 66 treatments were transplanted at a 20- × l0-cm spacing at 2 seedlings/hill in randomized blocks with 3 replications. Fertilizer was applied at 100-50-50kg of N-P_2O_5-K_2O/ha.

TM3447, TM2048, TM1927, and TM1898 showed variation in flowering and grain characters, and so were not good combiners. Among the combinations, nine showed uniformity for flowering, pigmentation, and grain characters.

Individual varieties and combinations differed significantly in grain yield but the component varieties vs combinations did not. AS693 yielded highest (7.1 t/ha), followed by AS691 (6.9 t/ha), AS764/2 (6.8 t/ha), and TKM9 (6.8 t/ ha). The best varieties, however, were not always the best combiners. The combination AS687 + AS688 yielded highest (7.8 t/ ha) and was comparable to 17 other combinations (range, 7.5-6.8 t/ha). Among them, six combinations involving AS687, AS688, AS691, and AS693 showed uniformity in flowering duration and grain characters as well as high yield potential (see table).

Grain yield of varieties and combinations, Tamil Nadu, India.

Entry	Yield (t/ha) of varieties	Yield (t/ha) of combinations					
		AS688	AS691	AS693	AS762/1	AS764/2	TKM9
AS687	5.9	7.8	7.2	7.3	7.1	7.0	6.8
AS688	6.3		7.0	6.9	7.3	6.0	7.2
AS691	6.9			6.8	6.5	7.5	7.0
AS693	7.1				6.4	6.6	6.3
AS762/1	6.5					6.7	6.6
AS764/2	6.8						6.3
TKM9	6.8						

C. D. (P = 0.05): varieties, 0.5 t/ha: combinations 1.1 t/ha; varieties vs combinations, ns.

The following two groups of varieties combined favorably among themselves; the best combinations for yield were from the first group.

Group I : AS687, AS688, AS691, AS693

Group II: AS762/1, AS764/2, TKM9

The two groups can be further examined for composites of two or more varieties that are promising for high yield and wide adaptability. ■

GENETIC EVALUATION AND UTILIZATION

Disease resistance

Estimation of yield losses of tolerant and susceptible rice varieties to blast disease in Maharashtra State, India

Thomas F. D'Souza, professor of plant pathology, MPKV, Rahuri (Maharashtra Agricultural University), formerly plant pathologist, AICRIP, Karjat; D. G. Gaikwad, rice pathologist, Lonavla; and V. R. Karandikar, professor of statistics, MPKV, Rahuri, India

An experiment on rice varieties Early Kolpi 70 and Karjat 184 was conducted at the Agricultural Research Station, Lonavla, to estimate yield losses caused by rice blast. Although the yield losses caused by blast (*Pyricularia oryzae*) have been reported at 73%, the information is not precise.

The 4-year experiment was begun in kharif 1972. It was planted in a randomized block design with eight replications, four treatments, and two varieties with and without plant protection. The plants were sprayed with benomyl (1:1000) 5 times at 2-week intervals for the entire period of the crop beginning 20 days after planting. The plot size was 7.68 m^2.

Neck infection developed in 31.20%-76.90% of the EK70 plants over the 4 years of the experiment and only 2.53% 24.33% in K184 plants. The difference in disease infection between the 2 varieties was significant in all 4 years. The pooled analysis revealed the same trend, and indicated that EK70 was more susceptible to blast (52.21% infection) than K184 (14.04% infection).

Benomyl (1:1000) in protected plots significantly reduced the neck infection percentage for 3 years of the experiment. It was not effective in 1972. The pooled analysis of the data confirmed the yearly trend, and the neck infection was 8.8% less in protected plots than in unprotected plots. This difference was significant at the 1% level.

Even though in each year (except 1972) the protected plots had significantly less neck infection, yields were not affected during 1972, 1973, and 1974. During these years, the differences in the yield were not statistically significant (Table 1). But in 1975, protection significantly increased the yield by 0.375 t/ha. In the pooled analysis, the protection treatment was significant. It gave an overall yield increase of 0.181 t/ha. Pooled analysis of data indicated no significant differences in the yield patterns of the two varieties.

Table 2 gives the pooled average yield of each variety in protected and unprotected conditions. The average loss due to blast was 0.3 t/ha for EK70 and 0.2 t/ha for K184. ■

Table 1. Yield of paddy for 2 varieties and in protected and unprotected conditions for 4 years of experimentation, and pooled results, India.

Variety, treatment	Yield (t/ha)				Pooled
	1972	1973	1974	1975	av
Variety					
EK70.	3.8	2.6	2.5	1.7	2.6
K184	4.4	2.2	4.1	2.1	3.2
S.E.^{m}	1.03	0.546	1.961	0.724	4.289
C.D. 5%	3.05	1.61	5.78	2.13	ns
Treatment					
Protected	4.2	2.4	3.4	2.1	2.6
Unprotected	3.9	2.4	3.2	1.7	2.4
S.E.^{m}	1.03	0.546	1.961	0.724	SEd=0.393
C.D. 5%	ns	ns	ns	2.13	t = 4.634

Table 2. Yield losses caused by blast in rices not protected against the disease, India.

Year	Yield (t/ha)					
	EK70			K184		
	Protected	Unprotected	Loss	Protected	Unprotected	Loss
1972	4.1	3.6	0.5	4.4	4.3	0.1
1973	2.7	2.5	0.2	2.1	2.2	–0.1
1974	2.5	2.4	0.1	4.3	3.9	0.4
1975	1.9	1.4	0.5	2.2	1.9	0.3
Av	2.8	2.5	0.3	3.3	3.0	0.2

Varietal reaction to rice tungro disease in deepwater transplanted variety trials at Pusa, Bihar, India

B. N. Singh, senior rice breeder; Y. Prasad, assistant rice pathologist; R. S. Singh, junior scientist (rice pathology); and R. Singh, junior scientist (rice entomology), Rajendra Agricultural University, Pusa, 848125. Bihar, India

Rice tungro virus symptoms were noticed in August 1980 in two varieties, Bhutahi and BR46, in a transplanted deepwater variety trial, UVT-6 (State). The population of green leafhopper *Nephotettix virescens,* the tungro vector, increased and the disease spread fast. Tungro symptoms appeared in many varieties. Infection started with the yellowing of leaves. Later, plants were stunted. The disease was first noticed in the center of the plot; it later spread to other parts.

Reaction of rice varieties to tungro virus.

Score	Entries (no.)	Varieties, lines
1	1	Jaladhi-1
3	6	Janaki (64-117), NC 487/77, CN 603, C 188-1, BIET 820, C 62-10.
5	5	OR 1103, C 185-1, C180-4. C 62-31, C 183-1.
7	11	RAU 21-35-3-5, (BIET 821), RAU 21-82-1-3 (BIET 799), RAU 21-147-1-4 (BIET 807), KLG 70-P, OR 1105, BR 14, CN 540, Pichar, C 181-1, C 186-1, BIET 821.
9	9	RAU 21-168-1-2 (BIET 724). C 62-68, Bhutahi, Bajal. Jalaj. KLG 165-P, KLG 161-7-P, BR 46, OR 1104.

UVT-6 (All-India Coordinated Rice Improvement Program), a transplanted deepwater variety trial in the adjacent plot, also showed the disease symptoms. Both the UVT-6 (State) and UVT-6 (AICRIP) trials had three replications. Scoring was based on the Standard Evaluation System for Rice (1976) and the maximum score was used for varietal reaction (see table). Of 32 entries from 2 trials, only 7 had resistant reactions. The direct-seeded trial in the adjacent field had very little damage.

Janaki (64-117), released in 1980 for cultivation in deepwater areas (up to 150 cm water depth) of North Bihar, is resistant to tungro. So, it replaces BR14 and BR46, the earlier released varieties for similar situations. The nature of the disease was confirmed by rice virologists at the Central Rice Research Institute, Cuttack. ■

Multiple disease resistance breeding materials in Karnataka

S. Sanne Gowda, pathologist, All India Coordinated Rice Improvement Project (AICRIP), University of Agricultural Sciences, Regional Research Station (RRS), V. C. Farm, Mandya; and R. R. Mallikarjunaiah, Jr.. pathologist, Agricultural Research Station, Ponnampet, Coorg, Karnataka, India

The following cultivars were evaluated under field pressure during the 1979 kharif at the RRS, V. C. Farm, and found resistant to discoloration and ephelis, leaf and neck blast, and brown spot fungal diseases. The cultivars represent a relatively wide genetic base and will be good donors in breeding programs.

RP1045-714-3-3 (IET 6884), TR1-15 (IET 7054), RNR 87893 (IET 7063), KAU1674 (IET 7096), CR260-501-294-51 (IET 7144), CR263-889 (IET 7145), RP1153-12-4 (IET 6627), RP1045-23-2-1 (IET 6314), RP1017-1-5-1 (IET 6664), Raminad Str. 3, Usen, IR1721-11-5-3-2-3-1, Milyang 30, IR1544-38-2-2, IR32, BR167-2B-9 (Asha), H 5, IR1905-PP11-29-4-61, lR2588-5-1-2, IR2797-105-2-2-3, IR5853-162-1-2-3, IR8608-82-1-3-1-3, IR10198-662, IR13429-198-2, Rasht 507, 5721. ■

GENETIC EVALUATION AND UTILIZATION

Insect resistance

Studies on varietal resistance and host specificity of rice green leafhoppers

P. R. Kasi Viswanathan and M, B. Kalode, All India Coordinated Rice Improvement Project, Rajendranagar, Hyderabad 500030, Andhra Pradesh, India

Because the green leafhoppers (GLH) *Nephotettix virescens* (Distant) and *Nephotettix nigropictus* (Stal) are important pests of rice, detailed investigations of insect-plant relationships were undertaken.

A high degree of resistance was sought among 108 known pest-resistant entries. In host-plant preference tests, 76 and 72 entries had significantly less damage from *N. virescens* and *N. nigropictus.* In general, *N. nigropictus* caused more damage than *N. virescens* to the same varieties. In various tests, PTB 2, PTB 18, and PTB 7 were highly resistant, and Khama 49/ 8, PTB 21, DS 1, ARC 6049, Khama 49/2, ARC 10243, and Jhinga sail were resistant to both species. The adult longevity test was found to be a good criterion for identifying high levels of resistance in rice varieties.

The high level of resistance of PTB 2, PTB 18, and PTB 7 could be due to the fact that both GLH species showed a low preference for settling and egg-laying on those varieties. Both leafhopper species preferred to settle and oviposit on 30- to 40-day-old plants.

A high level of antibiosis was observed on PTB-2, PTB 18, and PTB 7. Those varieties caused high mortality of first-instar nymphs and newly emerged adults caged on them. There was also low damage to 15-day-old seedlings on which 100 nymphs were caged for 20 days. Plant age did not alter the degree of antibiosis. Insects of both species made more feeding punctures and excreted less honeydew during feeding on resistant varieties. Analysis of the plant tissue demonstrated successful

insertion of insect stylets into the feeding sites and indicate that mechanical barriers were not involved in varietal resistance.

Host range studies involving 56 plant species indicated that *N. virescens* can survive and breed only on rice, while *N. nigropictus* has a host range that includes rice, sugarcane, and five graminaceous weeds. *N. nigropictus* showed greater preference for *Leersia hexandra* than for any other plant including TN1 rice. However, both species could lay eggs even on nonhosts. *N. virescens* made more feeding marks and excreted less honeydew when caged on the host plants suited to *N. nigropictus,* suggesting that narrow host specificity may be due to an imbalance in phagostimulants or the presence of phagodeterrents. These results show that chemosensory, particularly gustatory, stimuli play an important role in host selection in green leafhoppers.

The biochemical causes of resistance to leafhoppers in rice were also investigated. The total phenol content of resistant varieties was relatively higher than that of the susceptible TN1, but it was also high in *L. hexandra.* Thus, individual phenolic compounds may play a role in susceptibility or resistance.

The role of amino acids was not clear because their concentration was low both in resistant rice varieties and in *L. hexandra,* which was the most suitable host for *N. nigropictus.*

Feeding stimulation and inhibition by various chemicals and plant extracts of resistant and susceptible varieties were bioassayed. Sucrose was highly stimulatory and a few amino acids slightly stimulated feeding. Amino acid derivatives, organic acids, and phenolic compounds were strongly deterrent. Similarly, both GLH species had low preference for chloroform and acetone extracts of resistant varieties, but similar extracts from susceptible plants were readily accepted. ■

Varietal resistance of rice to leaf folder

Gavi Gowda, K. R. Jayaram, and B. M. R. Reddy, University of Agricultural Sciences, Regional Research Station, Mudigere, Karnataka, India

A trial was conducted through the upland rice varietal screening program to select varieties suitable for dryland paddy cultivation in the hilly zone of Karnataka in 1980 kharif. Twenty-one entries were included in this trial, replicated three times. During the trial, incidence of the leaf folder *Cnaphalocrocis medinalis* was severe, but some varieties were observed to have lower levels of damage. The damage on different varieties was recorded (see table). ARC25, KMP133, and KMP58 had minimum damage and were also moderately resistant to blast. ■

Extent of damage[a] by leaf folder in different rice varieties. Karnataka, India.

Entry	Leaf damage (%)
Kala keni	69.4
CR222-MW-10	65.5
ARC25	10.6
Black Gora	69.0
Bala	100.0
IR6115-1-1-1	100.0
OR165-85-12	66.9
KMP39	47.2
KMP(A) 57	75.0
OR165-28-14 B	51.2
OR165-18-8	100.0
CRM13-3241	100.0
N22	42.4
MR262	75.0
CR143-2-2	100.0
CR245-1	100.0
KMP58	28.7
IET1444	96.7
KMP133	11.8
KMP134	39.4
Jaya	71.8

[a] Av of 3 replications.

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

GENETIC EVALUATION AND UTILIZATION

Drought resistance

Selection pathways for dryland rice breeding

R. P. Robayo, rice breeder, Instituto Colombiano Agropecuario, Palmira, Colombia; and W. R. Coffma, plant breeder, International Rice Research Institute

Progenies of two rice crosses — IR3135 (IR1539-823-1-4/IR1917-3-17) and IR3189 (IRl721-11-13-20-1-2/C4-63) — were grown and selected under wetland and dryland conditions. The result was three different selection pathways. The pathways (F_2 and F_3) were: 1 = dryland/dryland; 2 = wetland/dryland; and 3 = wetland/wetland lines. F_4 from the two crosses and three pathways were compared under dryland conditions for grain yield and yield components.

The pathways affected neither the grain yield nor the yield components. The two crosses differed significantly in 100-grain weight, tiller number, and plant height, but did not differ significantly in grain yield, panicle number, or panicle length. The variables studied showed no significant interactions.

Statistically nonsignificant mean squares and relatively small variance

components were observed for pathways and crosses × pathways interactions, suggesting that environment had a minimal effect on the comparative yielding ability of the two crosses.

Because only two crosses were studied, these results are not conclusive. But it appears probable that there are no advantages in early generation selection under dryland conditions. Considering the many operational advantages, dryland rice breeders should consider growing all early generation materials under wetland conditions. ■

GENETIC EVALUATION AND UTILIZATION

Adverse soils tolerance

Identification of iron toxicity in Brazil

D. A. Morel and M. O. Machado, Empresa Catarinense de Pesquisa Agropecuaria (EMPASC), Caixa Postal D-20, Florianópolis, Santa Catarina, Brazil

Symptoms similar to those of iron toxicity have been observed in rice-producing regions of Santa Catarina State, Brazil. In 1977, their cause was studied for the first time.

Many brownish spots appeared on the tips of older leaves of affected plants and later spread to the basal parts. The leaves (except the midrib) turned brown and dried. In many areas the brown color turned reddish. The roots were dark brown and were damaged. All the symptoms were observed at the maximum tillering stage.

At the panicle initiation stage and at maturity, samples of roots, culms, and leaves were collected from a rice farmer's field at Camboriú, Itajaí River Valley. Simultaneously plant samples were collected from another plot where no symptoms were observed. The samples were sent to different laboratories for analysis of the contents of nitrogen, phosphorus, potassium, iron, and manganese. One laboratory replicated the sample analysis twice.

The results were compared with those found for various elements by Tanaka and Yoshida in 1970. The iron content of the affected leaves at maturity averaged 846 ppm. Iron toxicity was confirmed as the cause of the symptoms. ■

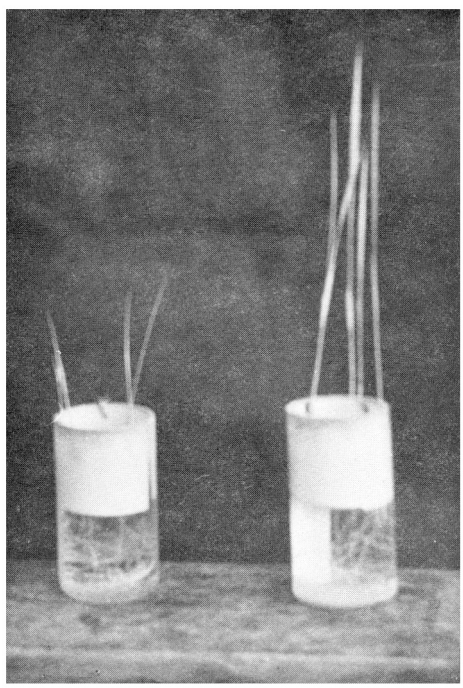
A mass-screening method for salt tolerance of rice varieties at seedling stage

S. K. Datta and S. S. Pradhan, Rice Research Station (RRS), Chinsurah, West Bengal, India

Rice varieties at the seedling stage were screened for salt tolerance in the greenhouse at RRS in Chinsurah.

The experiment was designed to investigate the effects of salinity on seedling growth (up to 21 days) of 100 rice varieties — including the standard variety SR26 B — udder 17.5 mmho/cm of saline water (see figure). The salt solution was prepared by adding sodium chloride to distilled water. Normal and saline water were maintained at a suitable level in sterilized cylindrical, glass jars (9.5 cm × 5.0 cm). Salt solution was estimated by determining electrical conductivity in mmho/cm at 25° C of the solution.

Blotting paper rolls were inserted in the glass jars. Two sets of jars, one for each treatment (normal and saline water), were placed side by side. Five seeds of each variety were made to adhere to the blotting paper by means of their seed hairs so the embryos remained submerged.



Germination and seedling growth of the same variety in saline water (left) and fresh water (right).

Each variety was allowed to germinate in the culture jars. Water, i.e. fresh and saline, was added to the jars and maintained to a depth of 7.0 cm. The salt solution was adjusted to the desired concentration at weekly intervals. The salt tolerance of each variety at seedling stage was determined by length, fresh weight, dry weight, and water content of root and shoot.

A high concentration of saline water delayed germination and depressed seedling growth for all varieties. General effects of salinity were darkening of the green color, withering of leaf tips, followed by yellowing and drying. A high degree of salinity significantly reduced the length of the root and shoot of the rice seedlings. Root growth was more depressed than was shoot growth.

Marked varietal differences in salt tolerance were observed (see table). Hamilton (selected from Nonabokra), a newly recommended variety, showed the best root growth. Root length development in BPI 76 was poor. Hamilton and Dholabokra had significantly higher values for shoot length than the other varieties. The adverse effect of salinity on shoot length was most pronounced in BPI 76.

Fresh weight and dry matter production of root and shoot also were depressed by salinity. Hamilton gave higher values for fresh weight and water content of root and shoot. But Dheral and Marichsail proved better in shoot

Outstanding rices selected from 100 varieties tested for tolerance for high level of salt (17.5 mmho/cm at 25°C) at the seedling stage. RRS, Chinsurah, West Bengal, India.

Variety	Treatment[a]	Root				Shoot			
		Length (cm)	Fresh wt (mg)	Dry wt (mg)	Water content (mg)	Length (cm)	Fresh wt (mg)	Dry wt (mg)	Water content (mg)
Patnai 23	N	16.6	215.0	19.0	196.0	14.4	172.5	27.0	145.5
	S	7.7	85.0	8.5	76.5	4.3	100.0	14.0	86.0
Dheral	N	23.6	103.7	28.3	75.5	25.7	211.3	64.3	147.0
	S	9.0	41.3	13.5	27.7	8.4	129.2	48.0	71.2
TN(I)	N	13.9	212.5	26.3	186.2	9.5	110.0	32.3	78.0
	S	2.2	6.5	3.0	33.4	0.6	12.5	4.3	7.2
IR8	N	15.5	231.7	27.5	203.2	12.5	166.6	40.5	125.1
	S	5.3	42.7	9.3	33.4	1.8	69.2	12.3	46.9
BPI76	N	14.4	135.0	18.5	116.5	7.8	102.5	23.5	79.0
	S	1.6	7.5	2.5	5.0	6.0	11.0	3.5	7.5
Marichsail	N	13.0	147.5	24.3	123.2	17.5	252.5	59.7	192.8
	S	6.7	41.5	12.0	29.5	6.5	121.7	41.0	80.7
Getu	N	15.6	172.5	21.5	151.0	11.9	135.0	23.5	111.5
	S	15.1	95.5	11.0	84.5	8.0	92.5	15.0	77.5
Damoder	N	16.4	93.0	22.0	71.0	16.5	167.5	31.0	136.5
	S	8.3	47.5	12.0	35.3	7.1	90.0	20.0	70.0
Dasal	N	17.8	165.0	30.0	135.0	15.6	160.0	29.0	131.0
	S	7.3	67.5	14.5	53.0	7.1	147.5	18.0	129.0
Dholabokra	N	21.6	217.5	26.5	191.0	22.4	252.5	48.5	204.0
	S	5.6	108.5	15.5	93.0	18.8	145.0	37.0	108.0
Hamilton	N	25.2	220.0	24.0	196.0	22.5	405.0	46.0	359.0
	S	15.9	197.5	13.0	184.5	13.7	215.0	37.5	177.5
SR 26 B	N	15.5	216.5	19.5	197.0	19.1	222.5	47.5	175.0
	S	6.5	100.0	10.0	90.0	6.6	135.0	20.0	115.0

[a] N = normal water, S = saline water.

dry weight, closely followed by Hamilton and Dholabokra. Dholabokra had the maximum value for root dry weight.

Among the high yielding varieties, IR8 performed best. TN1 gave minimum values for most of the characteristics.

Hamilton was highly salt tolerant and BPI 76 was the least. Hamilton performed best on most of the characteristics. Because salinity appears to affect the rice plant most adversely at the seedling stage, this greenhouse technique can be profitably used to select salt-tolerant varieties. ■

GENETIC EVALUATION AND UTILIZATION

Deep water

Genetic control of submergence tolerance in rice

B. Suprihatno, rice breeder, Central Research Institute for Agriculture (CRIA), Ujung Pandang, S. Sulawesi, Indonesia; and W. R. Coffman, professor, Cornell University, Ithaca, New York, USA

The inheritance of submergence tolerance in rice was studied by analyzing the segregation pattern and estimating the genetic parameters of crosses involving the cultivars FR 13A, Kurkaruppan, Thavalu, Gods Heenati, IR36, and B2433b-Kn-10-1-1-1.

Tests for submergence tolerance were conducted under artificial conditions by submerging 10-day-old seedlings for 7 days in 30-cm water. Water temperature was kept constant at 30°C, and light intensity was maintained at 400 lux at the tray level.

Segregation analyses indicated that at least three dominant genes were involved in the control of tolerance for submergence. Two had duplicate gene action, and the third was complementary to either of the first two.

Estimation of the genetic parameters showed that additive and nonadditive gene effects were important in the inheritance of submergence tolerance. Dominance and nonallelic interactions were present in all crosses analyzed, and the nonallelic interactions were mostly of the duplicate type.

Estimates of broad sense heritability were low to moderate, indicating that a large portion of the phenotypic variance was due to nongenetic effects. ■

Response of traditional deepwater rice to nitrogen application

M. R. Khan and B. S. Vergara, International Rice Research Institute

Fertilization is a rare practice in most traditional, deepwater rice fields. Reports indicate positive nitrogen (N) response by some improved, deepwater rice lines in terms of grain yield. But such a response under variable water depths, especially in terms of uptake and utilization, is not well known.

IRRI greenhouse and field experiments indicate that high basal N in deepwater rice produces increased plant length and number of basal tillers. Those attributes are desirable in areas prone to early flooding where rapid elongation of the culm above water level is used to combat flood damage.

High basal tillers are retained in subsequent growth stages under both shallow (25-cm) and medium-deep (75-cm) water levels in a nonelongating type, such as IR42; and in deep (1 30-cm) water level in an elongating type such as Kalar Harsall. The high survival rate of basal tillers ultimately results in increased grain yields due to a higher number of panicles and spikelets per panicle (Table 1). High basal N also stimulates early nodal rooting and nodal tillering — which contributes to grain yields directly or indirectly by absorption of nutrients from floodwater — and additional panicles. This has been substantiated by production of additional nodal tillers and higher grain yields from topdressing with 40 ppm N

Table 1. Yield and yield components of Kalar Harsall at 3 levels of nitrogen under deepwater (130-cm) conditions.

Yield and yield components	Nitrogen level[a] (g/pot)			CV (%)
	2	4	6	
Total grain wt (g)	13 a	25 b	30 c	10.7
Panicles (no.)	14 a	18 ab	23 b	16.6
Spikelets (no./panicle)	51 a	73 b	68 b	12.9
Panicle wt (g)	18 a	32 b	39 c	7.3
Total dry wt (g)	109 a	175 b	213 c	3.2

[a]In a row, means followed by a common letter are not significantly different at 1% level.

in water when the plants were grown with low basal N (Table 2).

For profitable returns, fertilization of deepwater rice fields should be based on initial nutrient status of the soils, rainfall, onset and magnitude of floods, and the nutrient content of floodwaters. A moderate dose of basal N should equip the plant with morphophysiological features that lead to a higher survival rate and hence, increased yields in excess-water stress. ■

Table 2. Effect of topdressing with 40 ppm nitrogen 2 weeks after treatment on Kalar Harsall grown with low nitrogen level in steel drums. IRRI, 1980.

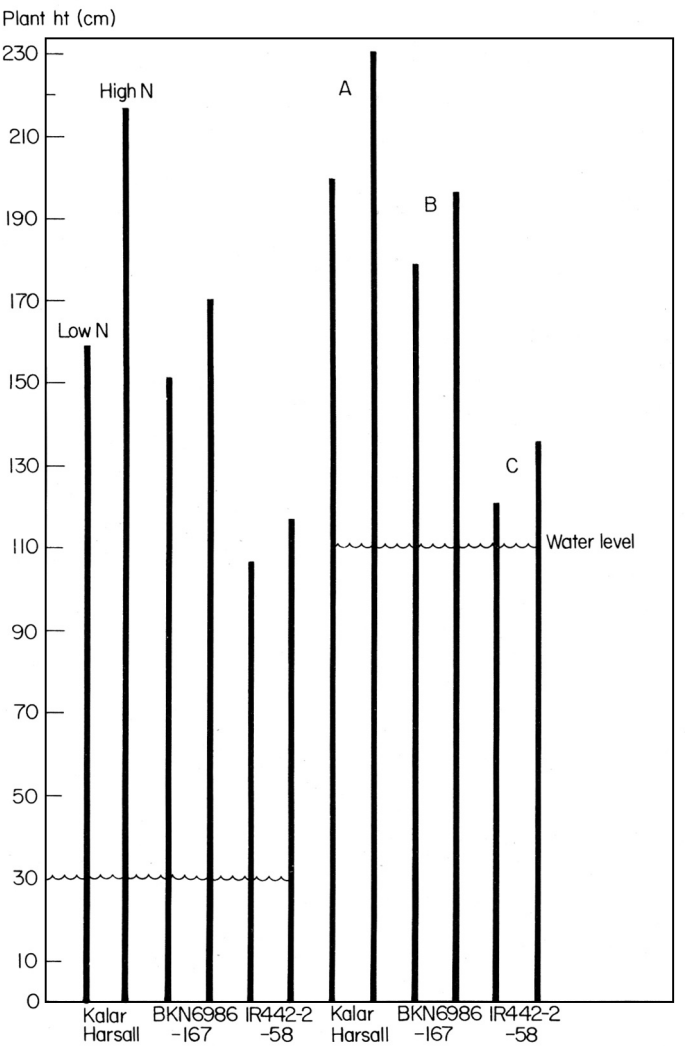
Character	N topdressed (ppm)	
	0	40
Plant ht (cm)	280	325
Basal tillers	14	13
Nodal tillers	0	9
Total tillers	14	22
Nodal root wt (g)	3.5	11.5
Panicle wt (g)	9.6	16.8
Total dry wt (g)	76.9	146.3
Panicle number	12	18
Nitrogen (%) in		
Culm	0.28	0.51
Dead leaf sheath	0.43	0.83
Green leaf	1.28	1.83
Dead leaf	0.33	0.73
Panicle	0.90	1.79

Varietal difference in plant length of some deepwater rices under medium-deepwater and deepwater conditions and at low and high nitrogen levels

M. R. Khan and B. S. Vergara, The International Rice Research Institute

Three distinct types of phenotypic responses in terms of plant length were observed in deepwater rices of diverse origin, grown in low and high nitrogen (N) levels under medium-deep (30 cm) and deep (110 cm) water (see figure).

- Type A - a characteristic response of traditional rices (Kalar Harsall, Leb Mue Nahng 111, Chenab sel. 64-117) that elongate well above the water level at either 30 or 110 cm water depth with high N;
- Type B - characteristic of improved types (RD19, BKN6986-167, and BR223-B-38) with limited elongation ability, which tends to increase in height with high N, but not as much as Type A (the plant parts above water level of this type are optimum);
- Type C - typified by the reaction of IR442-2-58 (including B1050-Mr-18-2 and IR42) with intermediate height and very poor elongation ability, which tends to elongate only to a small degree with high N. The plant parts above water level of this type of response correspond to the optimum range (70-100 cm) under irrigated conditions. At 110-cm water depth, plants with this type of response are barely above water level (10 cm), and higher N cannot help them survive.



Variation in plant height at flowering stage due to low and high N levels at medium-deep (30 cm) and deep (110 cm) water. A = traditional tall (Kalar Harsall), B = improved (BKN6986-167), and C = modern intermediate tall (IR442-2-58).

Type A response is typical of traditional indica varieties at shallow water conditions — application of high basal N has a negative effect because plants

become too tall and prone to lodging. This type is best suited to conditions where the water depth is great and the water rise rate is rapid. However, even under deepwater conditions, the plant parts above the water level are too long and the plants tend to lodge.

Type B is probably the optimum response for deep water. Even at medium-deepwater level, plants with type B reaction perform better because they are shorter than plants with type A. Type C or intermediate height varieties with very limited elongation ability are possible for medium-deep water. Such plants, however, will not give reasonable yields in deeper water, even with the addition of N. ■

GENETIC EVALUATION AND UTILIZATION

Temperature tolerance

Cold-tolerant varieties from China

T. G. Li, and B. S. Vergara, Plant Physiology Department, International Rice Research Institute

Eleven best varieties based on cold tolerance at 4 growth stages have been selected from 1,474 Chinese varieties in the IRRI germplasm bank. The methods used for testing at the different growth stages were described in earlier papers. Early seedling stage was tested at 5ºC, seedling stage at 12ºC, panicle development stage and flowering stage at 15°C.

All entries (see table) are sinica except Hung Chao Lu Yu and Ai Yeh Lu. Ai Yeh Lu has short growth duration and Hung Chao Lu Yu has high protein content (13.1 to 13.6%). The agronomic characteristics of sinica varieties selected do not differ greatly. Fi-Lai-Feng has a long maturity period, but is resistant to bacterial blight. Chu Cheng has the highest 1,000-grain weight.

Most of these donor varieties do not have disease and insect resistance. Crosses with varieties resistant to diseases and insect pests and with good plant type are necessary to improve grain yield and general adaptability. Seeds for national breeding programs are available at IRRI. ■

Varieties cold tolerant at 4 stages.

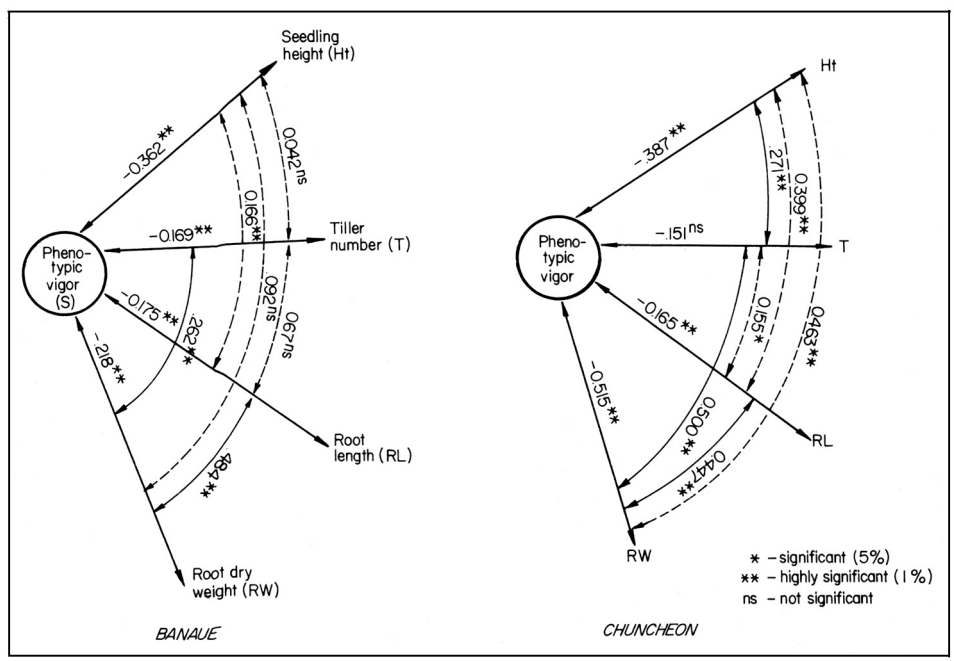
Acc. no.	Variety	Cold tolerance score [a]			
		ES	SS	PD	FS
01178	Chiang Tsenf Tao Ju	1	3	2	1
01179	Hung Chao Lu Yu	1	3	3	2
01254	Y Chang Ju	1	3	3	3
01269	Ta Chang Kong	3	2	2	3
01385	Fang Chi	3	3	2	3
01395	Chu Cheng	3	3	3	3
07288	Fi-Lai-Feng	1	2	3	3
10360	Ai-Yeh Lu (PI 160965)	3	3	2	2
28474	Hsiung-Yo 613	3	2	2	3
36852	Ching-Hsi 15	1	3	2	3
36853	Ching-Hsi 17	1	2	2	3

[a] ES = early seedling stage, SS = seedling stage, PD = panicle development, FS = flowering stage. 1 = good, 9 = poor.

Evaluation of rooting ability of rice in puddled soil in low temperature

C. S. Chung, G. Pateña, S. K. Bardhan Roy, Y. D. Yea, and B. S. Vergara, International Rice Research Institute

In areas where temperature is low during transplanting, recovery of rice varieties after transplanting is poor because of poor rooting ability. To develop a practical and efficient method of screening varieties for good rooting ability, entries in the 1980 International Rice Cold Tolerance Nursery were evaluated 23 days after transplanting at Banaue, Philippines, and 13 days after transplanting at Chuncheon, Korea. There were 245 entries at Banaue and 215 at Chuncheon. High-tillering and vigorous varieties were given a visual



Correlation coefficients among plant characters at Banaue, Philippines, and Chuncheon, Korea.

phenotypic score of 1; short and low-tillering varieties were scored 7.

At Banaue, 2 plants/ entry were sampled to measure the characters under study; 1 plant/entry was sampled at Chuncheon. Correlation between and among the characters measured is shown in the figure. Root dry weight was considered an indicator of good rooting ability in low-temperature conditions.

Scores on phenotypic vigor of plants — scored on a 1-9 scale — were negatively correlated with other characters. A significant correlation between root dry weight and tiller number indicated possible selection of plants that have good rooting ability on the basis of tiller number in low temperatures. This would eliminate the tedious work of carefully pulling the seedlings and washing the soil off the roots. Root length contributed much toward root dry weight, and a positive significant correlation between seedling height and root length revealed an indirect effect of seedling height on root dry weight. Tiller number, however, had no effect on root length at Banaue. In Chuncheon, Korea, phenotypic vigor was significantly correlated with root length and root dry weight, but not with tiller number. Tiller number was significantly correlated with root dry weight, as in Banaue. But unlike in Banaue, the seedling height was significantly correlated with root dry weight — perhaps because the Banaue observation was taken at a later growth stage.

Results in Banaue and Chuncheon indicate that selection for plants with good tillering ability in low-temperature conditions will also select plants with good rooting ability. The early establishment of transplanted seedlings is important in low-temperature areas, which generally have short growing seasons. ■

Use of small pots for testing cold tolerance of crosses at seedling and flowering stages under rapid generation advance

T. G. Li and B. S. Vergara, International Rice Research Institute

The rapid generation advance (RGA) program at IRRI generally uses small plastic square pots (5.5 × 5.5 × 5.0 cm). The practicality of these pots for screening or breeding during RGA was tested. Selection for low temperature tolerance was done at two plant stages: seedling and flowering. Selection at those stages is important in screening donor parents for cold tolerance crossing. The table shows the performance of seven cold tolerance crosses in small pots.

The F_2 seedlings were screened in a cold water tank at 12° C. Thirty percent of the seedlings were found tolerant of low temperature. The susceptible plants were discarded and the tolerant plants were grown under normal water temperatures.

During the flowering stage, the plants were placed in a dark room at 15° C for 3 days, and then taken back to the greenhouse (maximum temperature less than 30° C). The percentage of sterility was taken at harvest time and used as a criterion for selection. Plants with less than 30% sterility were selected.

The use of small square pots for cold tolerance screening at flowering was compared with that of the standard 4-liter pots. A set of 28 varieties were planted in both pots. The results showed a highly significant correlation (r = .7095**) indicating that the small pots can be used in screening for cold tolerance at flowering.

Selection effciency for 7 cold-tolerant crosses grown in small pots during the F_2. IRRI, 1980.

Cross	F_2 seeds (no.) (A)	No. selected after screening		Selection efficiency (%)		
		At seedling stage (B)	At flowering stage (C)	B/A	C/A	C/B
Silewah/IR3880-13	872	I80	27	21	3	15
IR3841-14-2-2-3/IET2815	849	235	73	28	9	31
IET2815/IR6172-6-3	123	41	18	33	2	5
iET2845/CRP6-1899-25/Cul. 854	444	145	53	33	12	37
Taipei NO 309, B922c-Mr-91	114	60	14	53	12	23
Taipei NO 309/IR26	500	272	21	54	4	8
Dumsiah 81/RNR 7303	113	111	0	98	0	0

The study shows that during screening of low-temperature crosses, small pots are best used at the seedling and flowering stages. Their use will reduce the growth duration by 10 to 20 days (to an av of 90 days), plant height by 10 to 20 cm (to an av of 75 cm), and spikelet number by 20 spikelets/plant (to an av of 50). The reduction in spikelet number will not affect the breeding process, and the shorter growth duration will hasten the breeding program. Use of small pots will involve the following steps:

1. Mix fine soil and fertilizer uniformly.
2. Use pregerminated seeds at 2 seeds/pot and thin out weak seedlings.
3. Place pots on pallets with plastic lining.
4. Supply adequate water to prevent the plants from drying.
5. There should be at least 2,000 plants for F_2 crosses. ■

Pest management and control

DISEASES

Preliminary studies on isolation and means of spread of the rice leaf scald fungus in Sierra Leone

M. D. Thomas, senior research officer, Pathology Section, Rice Research Station, Rokupr, Sierra Leone

The incidence of leaf scald disease of rice caused by the fungus *Rhynchosporium oryzae* has increased in the past 4 years in Sierra Leone. Therefore, work was initiated to develop a technique to rapidly inoculate and screen for leaf

scald resistance.

An early step was to identify a suitable culture medium that would enhance growth and abundant sporulation of the fungus. For all isolations, portions of leaf tissue from the advancing margin of scald lesions were treated with 0.5% NaO Cl for 2 minutes then rinsed several times in sterile distilled water. Several attempts were initially unsuccessful in isolating *R. oryzae* from leaves of susceptible rice cultivars with typical scald lesions, using commercial potato dextrose agar (PDA) pH 6 in 9-cm plastic petri dishes on laboratory benches at room temperature (23-25° C). However, sucrose agar (SA) pH 7, and peptone agar (PA) pH 5 were used successfully under the same conditions. On transfer from either SA or PA, the fungus was still not sustained on PDA. In addition to those media, 4 other media were tested. V-8 vegetable juice agar (VA) pH 4.3 was the most successful in maintaining good growth and abundant sporulation of *R. oryzae.*

To determine possible sources of inoculum, *R. oryzae* was isolated from 2 of 25 water droplets that had been sitting on scald lesions for about 2 hours following a rain shower in the morning in several field plots planted with ROK 16. The fungus was isolated from 2 out of 200 1-year-old seeds and 59 out of 100 freshly harvested ones of ROK 16. Fungal colonies on PA also formed from plating out soil collected from rice fields during the growing season and transferred to VA. *R. oryzae* was not detected in the limited number of soil assays conducted.

The preliminary results indicate that the Sierra Leone isolate of *R. oryzae* does not grow well, if at all, on PDA; under Sierra Leone conditions seed, not soil, might be important in spreading the disease; rain splash contributes to short-distance spread of the fungus. More detailed work to verify these observations, as well as quantitative approaches to growth and sporulation in VA and other media and on primary sources of inoculum, is planned. ■

Seed discoloration disease and its chemical control

Parkpian Arunyanart, Arunee Surin, and Somkid Disthaporn, Rice Pathology Branch, Division of Plant Pathology and Microbiology, Agriculture Department, Bangkok, Thailand

Discoloration of rice grain is a minor fungal disease. Until recently, it has been prevalent in all parts of Thailand.

Infected panicles are covered with brown to dark brown lesions. The disease is distinct from blast because no lesions are formed on the neck and nodes. Grains may be infected by various organisms before or after harvest. Infected plants have partially filled discolored grains, which have reduced viability and quality.

Ten fungi were isolated from infected panicles of diseased plants collected from naturally infected fields. Some fungi individually were able to cause seed discoloration. Characteristic symptoms of each on the glumes follow:

1. *Helminthosporium oryzae* caused brown spots with collapsed centers on the surface. In severe cases, the entire glume surface turned brown.
2. *Trichoconis padwickii* caused pale brown to whitish spots with a relatively dark-brown border on the glumes.
3. *Fusarium semitectum* caused purplish brown to reddish brown discoloration.
4. *Cercospora oryzae* caused purplish brown streaks that were longer than those of brown spot on the glume.
5. *Acrocylindrium oryzae* and *Curvularia lunata* caused serious discoloration and empty grains.

When the panicle was inoculated with a mixed inoculum of several fungi, typical symptoms incited by the individual incitants showed together on the same plants.

A two-set field experiment on chemical control of the disease was conducted at the Rice Pathology Branch, Bangkhen, Bangkok, in 1980. The experiment had a randomized, complete block design with three replications. Seven fungicides — copper oxychloride, MBC + mancozeb, mancozeb, edifenphos, Polyoxin Z, Sisthane, and carboxin — were sprayed on susceptible RD9 variety at heading. On one set of plants — for disease prevention — the fungicides were sprayed once directly onto the newly emerged panicle 2 days before artificial inoculation. On the other set — for curative efficacy — the fungicides were sprayed once onto the panicle 7 days after artificial inoculation.

To evaluate the results, 20 panicles were collected randomly from each plot for examination of diseased seeds. The seeds per panicle in each treatment were counted and classified as healthy, dirty, and empty seeds. The data were statistically analyzed.

Table 1. Effectiveness of chemicals in preventing rice seed discoloration.[a] Bangkok, Thailand.

Treatment	Dose (a.i./ha)	Total seeds per panicle	Healthy seeds per panicle	Dirty seeds per panicle	Empty seeds per panicle
Control	0	141.33 a	72.16 ab	60.86 c	8.31 a
Copper oxychloride	0.5 kg	143.00 a	57.61 a	79.18 d	6.21 a
MBC + mancozeb	0.75 kg	119.10 a	75.21 ab	37.93 ab	5.96 a
Mancozeb	0.75 kg	129.41 a	70.33 ab	52.83 bc	6.25 a
Edifenphos	0.5 liter	127.43 a	76.91 abc	45.00 ab	5.52 a
Polyoxin Z	1.5 kg	145.18 a	97.95 c	37.15 a	10.08 a
Sisthane	1 liter	144.56 a	90.61 bc	44.83 ab	9.12 a
Carboxin	1.75 liters	141.53 a	72.46 ab	62.68 c	6.38 a
CV		9.3%	15.08%	15.7%	28.5%

[a] Means followed by the same letter do not differ significantly at the 5% level.

Table 2. Curative efficacy of certain chemicals for rice seed discoloration.[a] Bangkok, Thailand.

Treatment	Dose (a.i./ha)	Total seeds per panicle	Healthy seeds per panicle	Dirty seeds per panicle	Empty seeds per panicle
Control	0	120.81 a	56.45 a	54.26 a	10.10 a
Copper oxychloride	0.5 kg	94.33 a	48.61 a	36.95 a	8.77 a
MBC + mancozeb	0.75 kg	128.18 a	69.71 a	49.13 a	9.34 a
Mancozeb	0.75 kg	94.13 a	51.35 a	34.41 a	8.37 a
Edifenphos	0.5 liter	103.93 a	52.45 a	42.70 a	8.18 a
Polyoxin Z	1.5 kg	95.51 a	54.01 a	34.33 a	7.17 a
Sisthane	1 liter	99.13 a	58.71 a	32.01 a	8.41 a
Carboxin	1.75 liters	106.66 a	69.48 a	25.98 a	11.20 a
CV		15.0%	26.56%	38.0%	48.4%

[a] Means followed by the same letter do not differ significantly at the 5% level.

Plants treated with Polyoxin Z gave the highest number of healthy seeds (97.95) per panicle, followed by Sisthane with 90.61, and edifenphos with 76.91. Plants treated with copper oxychloride had the lowest number of healthy seeds (57.61) per panicle, which was lower than that from the control plot. Copper oxychloride, which caused the highest number of dirty seeds (79.18) per panicle, may be toxic to the panicle (Table 1).

No fungicide showed ability to cure the disease or decrease damage (Table 2). ■

Pest management and control INSECTS

Dimorphopterus similis Slater (Heteroptera: Lygaeidae: Blissinae), a new rice pest from Nigeria

J. C. Ene, Biological Sciences Department, University of Benin, Benin City, Nigeria; and A. Hamid, Biological Sciences Department, University of Sokoto, Sokoto, Nigeria

During a recent survey of rice pests in Sokoto State, Nigeria, a large population of *Dimorphopterus similis* was encountered in rice stubble after harvest. The presence of this species in large numbers (av: 16 adult *D. similis* /hill) and complete failure of crops (yield about 50 kg/ha, or 3% of the 1974 average productivity for Africa) indicate that *D. similis* may become a major rice pest in Nigeria, and elsewhere.

Six species of Blissinae have been reported on rice *Oryza sativa: Blissus richardsoni* Drake from Cuba (Bruner et al 1945), *B. insularis* Barber from St. Croix (Wolcott 1936), *Ischnodemus congoensis* Slater from S. Rhodesia (Slater 1964a); *I. diplachne* Slater and Harrington from S. Rhodesia (now Zimbabwe) (Slater and Harrington 1970); *I. perplexus* Slater and Harrington from Senegal (Slater and Harrington 1970); and *Cavelerius excavatus* (Distant) from India (Fletcher 1921). This report, therefore, brings the number found on rice to seven. It is also the first report of a species of *Dimorphopterus* with economic potential. This is interesting because *Dimorphopterus* is evidently the Old World ecological equivalent of the western hemisphere's *Blissus,* several species of which have economic importance (Hamid and Slater 1979). In view of the above and to facilitate further studies, we have summarized the present knowledge about *D. similis*.

This species originally was described from a single female from South Africa. It was next reported from Senegal and Nigeria. Host plants previously were unknown, although the specimens reported from Nigeria were collected on *Hyparrhenia involucrata* Stapf. (Gramineae). All reports from Africa, including the present one, were from grassland regions.

D. similis is one of 35 species presently included in the genus *Dimorphopterus.* These are distributed mainly in the Ethiopian (16), Oriental (10), and Palearctic (7) regions, but two species also extend into Australia.

The taxonomic status of a number of species of *Dimorphopterus,* including *D. similis,* is not satisfactorily established. This species is closely related to *D. nubicus, D. brachypterus,* and *D. graminum,* all reported from Nigeria. It is desirable to study *D. similis* and its closest taxa to more satisfactorily establish their relationship. ■

Effect of potash levels on the incidence of rice whorl maggot

R. Saroja and N. Raju, Paddy Experiment Station (PES), Tirur, Chingleput District, Tamil Nadu, India

Earlier work on the correlation between potash level and the occurrence of the rice whorl maggot showed that up to 135 kg potassium/ha had no effect on the maggot.

A trial conducted during the 1978-79 samba season (Jul-Aug to Nov-Dec) at PES, Tirur, used higher levels of K than

Effect of potash levels on whorl maggot damage. 1978-79 samba season, Tirur, Tamil Nadu, India.

K (kg/ha)	Damaged tillers[a] (%) 30 DT[b]
0	13.9 a
25	14.8 a
50	14.1 a
75	14.2 a
100	16.6 ab
125	16.3 ab
150	18.1 ab
175	20.8 b
200	24.2 b
CD	5R

[a] Means followed by a common letter are not significantly different at the 5% level. [b] Days after transplanting.

those tested earlier. The trial was laid out with rice variety IR8 and 9 levels of potash: 0, 25, 50, 75, 100, 125, 150, 175, and 200 kg K/ha. Potash was applied basally at the time of planting and no insecticide was used. Whorl maggot infestation was assessed 30 days after transplanting on the basis of percentage of damaged tillers.

The results revealed that whorl maggot damage increased only at the two highest rates of potash (see table). Plants with 175 or 200 kg K/ha had significantly higher whorl maggot damage than those with 0-75 kg K/ha. But the grain yield differences were not statistically significant.

The local fertilizer recommendation is only 50 kg K/ha. Potash application at that level is not expected to increase whorl maggot damage in rice. ■

Control of daphnids in blue-green algae multiplication plots

S. Srinivasan, Paddy Experiment Station, Aduthurai, India

The main problem in field multiplication plots is the damage caused by daphnids that live on the soil surface and form small mud tunnels. Usually, daphnids lie horizontally on the soil surface. When conditions are favorable, the population buildup is so heavy that space becomes unavailable. The daphnids then stick one end of their nests in the soil substrate in a standing water column. If the blue-green algae (BGA) multiplication site is left unprotected, the dense mass of BGA growing on the water surface will vanish within a couple of days because of the severity of damage caused by daphnids.

To develop a suitable control measure, three randomized replicated trials during 1979 kuruvai tested seven granular insecticides in three concentrations (normal, double, triple doses). Because BGA already were established in the field, no BGA seed material was applied to the experimental plots. P_2O_5 in the form of superphosphate was applied uniformly to supply 32 kg/ ha to all plots as a nutrient for algal activity. The granular insecticides were applied as per treatment. Water depth was maintained permanently at 10 cm. On the 10th day, the BGA mass floating on the water surface was collected separately for each treatment. It was spread on a threshing floor and allowed to dry in the sun. The dried algal flakes were collected and weighed.

The results indicated that carbofuran at double dose, and quinalphos, mephosfolan and diazinon at normal doses can be used to control daphnids in BGA multiplication units. ■

Effect of granular insecticides on BGA seed material in multiplication plots. Aduthurai, India.

Insecticide and formulation	Normal rate (kg a.i./ha)	BGA seed material (kg/ 10 m^2)		
		Normal dose	Double dose	Triple dose
Carbofuran 3% G	0.6	6.1	9.0	8.9
Carbaryl 4% G	0.8	5.0	7.3	5.8
B.H.C. 6.5% G	1.3	3.5	5.7	6.7
Quinalphos 5% G	0.6	8.8	9.1	9.0
Mephosfolan 5% G	0.5	8.6	9.1	7.3
Phorate 10% G	1.3	5.0	6.7	8.0
Diazinon 10% G	1.0	8.5	8.9	9.0
Control		0.8	0.9	0.6
C.D. (P= 0.05%)		1.2	1.6	1.1

Insecticides sprayed on brown planthopper eggs

R. P. Basilio, research assistant, and E. A. Heinrichs, entomologist, Entomology Department, International Rice Research Institute

Timing insecticide applications for brown planthopper (BPH) control is difficult because at any one time a field population will be composed of eggs, nymphs, and adults. To reduce insecticide cost an insecticide that has efficacy against all stages is desirable. We tested for ovicidal activity insecticides that showed activity against BPH adults. We report on the ovicidal activity of several coded and commercial insecticides.

Two gravid female BPH in each cage oviposited for 24 hours on 30-day-old TN1 plants. After oviposition, the females were removed and the potted plants sprayed with 6.25 ml of insecticidal solution per pot. Hatched nymphs were counted daily and removed until hatching terminated. Unhatched eggs were counted after the plants were dissected.

Among the 12 insecticides used, 6 had high ovicidal activity: UC 54229, FMC 35001, UC SF-1, UC 27867, carbaryl, and azinphos-ethyl (see table). Propoxur, decamethrin, and NNI-750 had low activity. Diazinon, BHC, and chlorpyrifos had no effect. UC 54229, UC SF-1, and UC 27867 are coded car-

Ovicidal activity of foliar sprayed insecticides on *N. lugens* eggs. IRRI greenhouse, 1980.

Insecticides [a]			Hatched eggs (%)[b]
Common name	Trade name	Formulation	
UC 54229		100% Tech.	0.7 a
FMC 35001	Marshall	20% EC	1.1 a
UC SF-1		40% F	2.7 a
UC 27867		50% WP	2.9 a
Carbaryl	Sevin	85% WP	2.8 a
Azinphos-ethyl	Gusathion A	40% EC	3.9 a
Propoxur	Unden	20% EC	77.6 b
Decamethrin	Decis	2.5% EC	78.1 b
NNI-750		25% WP	80.4 b
Diazinon	Basudin	20% EC	94.0 c
BHC	Lindane	26% WP	96.6 c
Chlorpyrifos	Lorsban	40% EC	96.0 c
Control			97.5 c

[a]Sprayed at the rate of 0.075% concentration (0.75 kg a.i./ha at a spray volume of 1,000 liters/ha). EC= emulsifiable concentrate, WP = wettable powder, Tech. = technical formulation. [b]Av of 4 replications. In a column, means followed by a common letter are not significantly different at the 5% level.

bamate insecticides from Union Carbide, which have been effective against BPH adults in insectary studies at IRRI. FMC 35001, also a carbamate, recently has been registered for use in insect control in several countries. One of its breakdown products is carbofuran, which showed high ovicidal activity in previous IRRI experiments. NNI-750 is a novel insecticide which, according to its manufacturer, Nihon Noyhaku, is an insect growth regulator. It is reported to have shown BPH ovicidal activity in company tests. ■

Rice ear-cutting caterpillar, an injurious pest at panicle stage

R. K. Papel, A. K. Khatri, and B. S. Choudhary, Entomology Department, J. N. Krishi Vishwa Vidyalaya, Jabalpur, India

The rice ear-cutting caterpillar *Mythimna separata* (Walk.) has become a regular rice pest, particularly at the panicle stage of the crop. The second and third generations of the pest are responsible for economic losses of grain yield in early-maturing and medium duration varieties, respectively.

The peak activity is from the last week of September to the second week of October, depending on the planting time of the crop. Observations on the pest's biology under natural conditions on caged plants of a popular variety, Kranti, were made in kharif, during September-October 1980 at Jabalpur.

In the field, the eggs generally were laid on the bottom of semidried leaves, and not near the tip, in a line under the fold of leaves where they were protected from parasitization. The egg period varied from 5 to 7 days. Immediately after hatching, the larvae first fed on dried leaf tissues; later they fed on the green leaves. Early instars (up to 4th instar) also fed on the palea and lemma of the grain as well as on anthers of the flowers. Advanced-stage larvae (4th to 6th instars) cut and nibbled the grains and spikelets. The larval period varied from 22 to 27 days. The pupae were either naked between the tillers or in earthen cocoons in the soil near the base of the plant. The pupal period was 8-11 days. The whole life cycle from egg to adult emergence was completed in 33-45 days. ■

Sugarcane pyrilla attacking rice, and its biological control in India

A. D. Pawar, assistant director (Biolological Control), Directorate of Plant Protection. Quarantine and Storage, N. H. IV, Faridabad, Haryana l21001, India

Sugarcane pyrilla or leafhopper *Pyrilla perpusilla* (Walker) (Homoptera: Fulgoroidea:Lophopidae) is a serious pest of sugarcane in northern India, and is potentially dangerous to wheat, oats, maize, bajra (pearl millet), rice, and sorghum, particularly the hybrid varieties. Sugarcane is a primary host of *P. perpusilla.*

During August-October 1978-79, a heavy incidence of sugarcane pyrilla was observed on rice in Karnal and Sonepat districts of Haryana during surveys of the pest and its natural enemies. The infested rice fields were near heavily infested sugarcane fields. Adults, nymphs, and egg masses of pyrilla were found on the rice. The pyrilla population averaged 15.5 individuals (eggs + nymphs + adults/leaf). Interestingly, the adults and nymphs of pyrilla in rice and sugarcane fields were parasitized by the larvae of the ectoparasite *Epipyrops melanoleuca* Fletcher, and the eggs were parasitized by the egg parasite *Tetrastichus pyrilae* Crawford. Parasitization of nymphs and adults averaged 20-60% and that of eggs 75-95%. The parasites probably effectively controlled pyrilla on rice in late September 1978 and in 1979; no insecticides were applied.

A pyrilla attack was similarly heavy in rice fields adjacent to sugarcane fields in Gurdaspur district, Punjab, in August-September 1980. The pyrilla also appeared to be effectively controlled by *E. melanoleuca* and *T. pyrillar.* The two parasites keep pyrilla under control in sugarcane in Bihar, Uttar Pradesh, Haryana, Punjab, and parts of Rajasthan. The eggs and live cocoons of *E. melanoleuca* can be released in pyrilla-infested fields at 40,000-50,000 eggs/ ha and 4,000-5,000 cocoons; ha when the pyrilla population averages 3.5 individuals (eggs + nymphs + adults)/ leaf (the threshold level in sugarcane). ■

Egg parasitoids of rice pests in Malawi, East Africa

H. R. Feijen, Universidade Eduardo Mondlane CP 257, Maputo, Mozambique; and G. G. M. Schulten, Royal Tropical Institute Department of Agricultural Research, Amsterdam, Netherlands

During ecological investigations on rice pests in Malawi from 1971 to 1975 many parasitoids were reared from eggs collected in the fields (see table).

Trichogramma kalkae was the most important parasitoid of the stem borer *Diopsis macrophthalma,* one of the most common rice pests in Africa. It parasitized an average of 41% of the *Diopsis* eggs. *T. pinneyi* parasitized an average of 16% of *D. macrophthalma* eggs. An unidentified Sciomyzid fly was an important alternative host of *T. pinneyi* Two other parasitoids (but of little importance) were *Trichogrammatoidea simmondsi* and a *Paracentrobia* species. (An extensive paper on the mentioned *Trichogramma* species is in press.)

Of the lepidopterous borers *Chilo djffusilineus* was parasitized mainly by *Telenomus ulliyetti* (27%) and *Trichogramma mwanzai* (7%), a recently described species.

Eggs of the pink borer *Chilo partellus* were parasitized by *T. japonicum* (33%) and *Trichogrammatoidea simmondsi* (17%). From eggs of *Thopeutis* spp. were reared *T. japonicum* (42%), *Telenomus tolli* (21%), and *T. uliyetti* (7%). Unidentified lepidopterous eggs were parasitized by another *Paracentrobia* sp. and by *Lathromeromya cercopicida.*

Experiments showed *T. kalkae* and *T. pinneyi* to be highly susceptible to pesticides such as diazinon, dimethoate, endosulfan, malathion, and phospha-

Egg parasitoids and their hosts.

Egg parasitoid	Host										
	Diopsis macroph-thalma	*Diopsis apicalis* complex	*Sepedon angularis*	Sciomyzid sp.	*Chilo diffusi-lineus*	*Chilo partellus*	*Thopeutis* sp.	Lepidop-teran sp.	Hemip-teran sp.	Chrysopid sp.	*Epicauta velata*
Trichogrammatidae											
Trichogramma kalkae	+	+[a]	+[a]								
Trichogramma pinneyi	+		+	+	+						
Trichogramma mwanzai					+						
Trichogramma japonicum						+	+				
Trichogrammatoidea simmondsi	+		+	+		+					
Paracenrrobia sp.	+			+				+		+	
Lathromeromya cercopicida								+			
Scelionidae											
Telenomus ullyetti					+		+		+		+
Telenomus tolli							+		+		+
Telenomus sp.									+		
Mymaridae											
Anagrus sp.										+	

[a]Only in the laboratory.

midon. Knockdown was 100% within 3 hours on residues of these pesticides after recommended application rates. Concentrations down to 10% of the normal gave a total knockdown within 24 hours. The fungicide Hinosan showed no direct toxicity. In nurseries sprayed with phosphamidon the parasitization of *Diopsis* eggs dropped from 60% to lower than 1%, while the number of *Diopsis* eggs hardly decreased. ■

Field control of rice caseworm with foliar insecticides

J. P. Bandong and J. A. Litsinger, Entomology Department, International Rice Research Institute

The rice caseworm *Nymphula depunctalis* is a significant pest of flooded rice in Asia, Africa, and South America, but little published information on its control with insecticides exists. In a trial at IRRI, 11 insecticides were tested as foliar spray (0.75 kg a.i./ ha) 14 days after transplanting (DT) IR40 rice to plots (2 m^2) that had been hand-infested with greenhouse-reared 2d-instar larvae (4 larvae/ hill) on the previous day. Each plot was surrounded with levees and plastic sheeting to prevent interplot larval movement.

Caseworm larvae are aquatic; they possess tracheal gills, and live within rice leaves folded into cases secured with silk. During the day, they float on water; at night, they climb plants to cut off leaves to make new cases or feed on severed leaves on the water surface. Cut leaves are symptomatic of caseworm feeding. As the larvae mature they skeletonize the leaf tissue of standing plants, causing the damaged leaves to turn white.

Comparison of 11 foliar insecticides for control of rice caseworm based on plant damage and larval mortality.[a] IRRI, 1980.

Insecticide[b]	formulation[c]	Plant damage[c,d]		Larval mortality[f] (%)		
		Tillers with cut leaves (%) 5 DS	Leaf scraping[e] grade 10 DS (1-9)	Plants and paddy water sprayed[d]	Only plants sprayed[d]	Only paddy water sprayed[g]
MlPC	50% WP	4.5 a	1.3 a	100 a	100 a	100 a
Triazophos	40%, EC	4.6 a	1.1 a	100 a	100 a	100 a
Chlorpyrifos	40% EC	4.4 a	1.3 a	100 a	98 ab	95 ab
Azinphos-ethyl	40% EC	4.2 a	1.2 a	100 a	90 ab	100 a
BPMC	50%) EC	5.1 a	1.5 a	100 a	93 ab	95 ab
Malathion	57% EC	4.2 a	1.3 a	100 a	93 ab	85 ab
Diazinon	20% EC	7.5 ab	1.2 a	100 a	98 ab	100 a
Carbaryl	85% WP	5.8 a	1.3 a	100 a	95 ab	75 bc
Phosphamidon	50% EC	5.3 a	1.3 a	95 a	83 bc	80 bc
Endosulfan	35% EC	5.1 a	1.3 a	100 a	68 c	85 ab
MTMC	50% WP	12.6 b	1.9 b	85 a	63 c	55 c
Check		23.2 c	4.2 c	5 b	0 d	0 d

[a]In a column, means followed by a common letter are not significantly different ($P < 0.05$). [b]0.75 kg a.i./ha 14 days after transplanting. [c]WP = wcttable powder, EC = emulsifiable concentrate, DS= days after spraying. A tiller was acored as damaged if at least one leaf was cut off. [d]Av of 4 replications. [e]1-9 scale based on % leaf area scraped: 1 = none, 3 = 1-10, 5 = 11-25, 7 = 26-50, 9 = 51-100. [f]48 hours after spraying. [g]Av of 2 replications.

Damage to plants was scored as percentage of tillers with cut leaves and percentage of leaf tissue removed (scraped).

Within the plots, additional information was taken to compare the effect of spraying plants or paddy water separately. In the former, a hill of rice was removed from each plot immediately after spraying and moved to the greenhouse in a plot submerged in insecticide-free water. In the latter, a hill of rice was removed from each plot immediately after spraying and replaced with an insecticide-free potted hill of rice of the same age from the greenhouse. A mylar

plastic tube cage was placed over the potted plants and pushed into the soil. A third hill of rice, which represented sprayed plants and paddy water, was likewise caged in each plot after spraying. Ten second-instar larvae were introduced into each cage and mortality was determined 48 hours later by opening the larval cases.

The results showed that caseworm larvae were controlled readily with insecticides applied at 0.75 kg a.i./ha (see table). All chemicals tested significantly reduced plant damage and caused high larval mortality compared with the untreated check. MIPC and triazophos were the most toxic and MTMC the least toxic of the chemicals tested. Most insecticides were highly effective when applied to either plants or paddy water. However, when only plants were sprayed, MTMC and endosulfan killed significantly fewer larvae than most of the other insecticides. When only the paddy water was sprayed, MTMC appeared to be the least effective.

The results indicate that the rice caseworm can be controlled effectively with one insecticide application after transplanting because this insect is a pest only during the tillering stage. Future trials should test insecticides at lower dosages. ■

Rice grasshopper outbreak in West Bengal, India

P. B. Chatterjee and A. Debgoswami, Rice Research Station, Chinsurah 712 102, West Bengal, India

The rice grasshopper *Hieroglyphus banian* (Fabricius) is a minor insect pest of wetland rice. Unclean cultivation and weed growth in and around rice fields usually favor its occurrence.

In October 1980 the grasshopper attacked about 3,000 ha of wetland rice in Midnapore, West Bengal. It appears that the well-distributed rainfall in the months preceding the infestation promoted the growth of weeds, which are alternate hosts of the grasshopper. After the initial proliferation, the insect migrated to rice.

During the attack the rice was mainly in the boot-leaf and flowering stages. The varieties that suffered most were Kakhuria, Bombai Mugi, Bhutia, Nona, and Sundarsail — all tall, photoperiod-sensitive indica varieties that mature in about 160 days. However, the rice variety Jaya was also attacked.

Grasshopper damaging the boot leaf and emerging panicle in West Bengal, India.

The insect fed on the foliage, flag leaves, and the leaf sheaths on the upper part of the rice plant. As a result the emerging inflorescence was exposed (see photo) and became sterile. ■

Gryon nixoni Masner (Hymenoptera: Scelionidae): a new egg parasite of *Leptocorisa oratorius* in the Philippines

A. T. Barrion, and P. C. Pantua, research assistants; and J. A. Litsinger, entomologist, Entomology Department, International Rice Research Institute

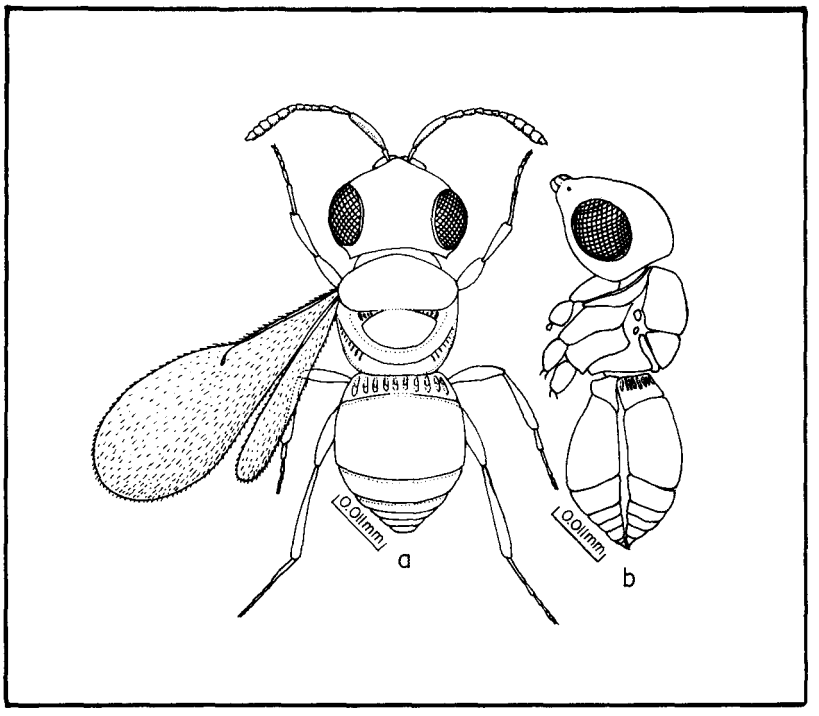
Two egg parasites of the rice bug *Leptocorisa oratorius* (= *L. acuta* in the reports of Uichanco 1921, 1949; Otanes and Sison 1941) have been recorded in the Philippines: 1) *Ooencyrtus malayensis* Ferriere (Encyrtidae) and 2) *Telenomus comperei* Crawford (Scelionidae). In a 1978-79 field trial at IRRI to compare the natural enemy abundance in weekly and biannual cropping patterns without insecticide, an egg parasite of *L. oratorius* was found new to the Philippines.

The study used rice cultivars IR36 and IR1917 from October 1978 to January 1979. Potted mature plants laden with 1-day-old eggs of *L. oratorius* from a greenhouse colony were placed in the field at weekly intervals from flowering to hard dough stages of the field crop.

Parasitization of rice bug eggs by *Gryon nixoni* Masner obtained by exposing potted plants laden with *Leptocorisa oratorius* eggs in a portion of a weekly-cropped area planted the same week as biannual fields of IR36 and IR1917 without insecticide. IRRI. 1978-79.

Cropping system	Cultivar	Eggs exposed (no.)	Parasitized eggs (no.)	Parasitization (%)
Weekly	IR36	589	173	29
Biannual	IR36	288	52	18
Weekly	IR1917	147	23	16
Biannual	IR1917	213	9	4

Gryon nixoni Masner, female, dorsal view with right (fore and hind) wings removed (a) and side view (b).



After 4 days' exposure in the field, the eggs were incubated in the laboratory in small, sealed, glass vials with moisture provided in a wad of cotton.

Parasitization was probably higher in the continuously cropped fields (16 and 29%) than in the biannually cropped fields (4 and 18%) (see table).

The scelionid parasite, identified by the senior author as *Gryon nixoni* Masner (= *Hadronotus flavipes* Ashmead and *leptocorisae* Nixon), is also recorded in India, Indonesia, Malaysia, and Papua New Guinea. The adult is 1.25 mm long and black except for hyaline wings, yellow-brown legs, reddish to dark brown antennae, coxae, and tarsal segment V, and with a pale yellow stigmal vein (see figure). ■

Pest management and control WEEDS

Plant height as a varietal characteristic in reducing weed competition in rice

Nizam Uddin Ahmed, senior scientific officer; and M. Zahidul Hoque, head, Rice Cropping Systems Division, Bangladesh Rice Research Institute (BRRI), Joydebpur, Dacca, Bangladesh

The extent of weed infestation in rice fields is influenced by factors such as degree of land preparation, water management, fertilizer application, seeding method, and plant density.

Taller plant types generally are considered more efficient than shorter plant types in suppressing weed growth because they grow rapidly and shade the weeds. To determine the extent of yield reduction caused by weeds in rice varieties of different plant heights, experiments were conducted in 1979 transplanted aman and 1979-80 boro seasons at the main station of BRRI. The experiments were in a randomized complete block design with three replications.

In the t. aman season, the highest yield was obtained from BR4, followed by Nizersail and BR6, in both unweeded and weed-free conditions (see table). The relative yield performance of the three varieties was not influenced by weed infestation. However, the yield reduction from weeds increased with decrease in plant height. The yield reduction from weeds was 0.25 t/ha in the tallest variety Nizersail and 0.46 t, ha in BR4 with intermediate plant height. These reductions were not significant. But in the shortest variety BR6, the yield reduction of 0.68 t/ha was significant.

In the boro season (see table), the trend was similar. The highest and significant yield reduction (0.95 t/ha) from weeds was in the shortest variety, Chandina. The yield reduction decreased with increasing plant height.

The relative yields of different rice varieties may not be changed by weed competition. The potential yields are reduced by weeds, more in the shorter, high yielding varieties than in the relatively taller local varieties. This finding indicates more benefits from weeding in high yielding varieties than in the local varieties. ■

Yield reduction caused by weeds in rice cultivars of different heights, in 2 seasons at BRRI, Dacca, Bangladesh. [a]

Variety	Plant ht (cm)	Grain yield (t/ha)		Yield reduction (%)
		Unweeded check	Weed-free	
		1979 t. aman season		
Nizersail	154	2.96 a	3.21 a	7.19
BR4	I20	3.19 a	3.65 a	12.60
BR6	97.5	2.03 a	2.71 b	25.09
		1979-80 boro season		
Habiganj Boro VI	106.5	1.94 a	2.36 a	17.80
BR9	98	2.40 a	3.06 a	21.57
Chandina	62.4	2.54 a	3.49 b	27.22

[a] Av of 3 replications. In a row, means followed by a common letter do not differ significantly at the 5% level.

Soil and crop management

A quick method of evaluating straw decomposition in flooded soil

Taufiqul Aziz and I. Watanabe, Soil Microbiology Department, International Rice Research Institute

Rice straw has an important role in maintaining soil fertility. When incorporated into the soil, rice straw stimulates microbial activity. Its role in increasing soil fertility is dependent on the rate of its decomposition in the field. This work was undertaken to study the rate of rice straw decomposition in the field.

Air-dried rice straw was cut into 2- to 3-cm pieces. One gram was put into 5- × 7-cm bag made of nylon net with a 0.7-mm opening. The bags were placed in 10-cm depth of soil in the rice field at IRRI in September, and then were taken out at 20, 40, 60, and 80 days after incubation. The straw from each bag was gently rinsed once in distilled water and the dry weight, ash, and total N% were measured to study the decomposition pattern (see table). Organic matter was determined by ignition loss.

Dry weight and the organic matter of straw per bag decreased rapidly up to 40 days, and then decomposition slowed down. There was a 46% reduction in dry weight and 60% in organic matter of straw per bag during the 40-day period. The ash content of straw/bag remained more or less the same throughout the period. The total N% of straw increased rapidly up to 60 days (see table). ■

Changes in rice straw during its decomposition in the soil. [a]

	0	Day 20	Day 40	Day 60	Day 80
Wt of straw per bag (g)	1.00	0.69 ± 0.04	0.54 ± 0.036	0.50 ± 0.05	0.39 ± 0.05
Ash per bag (g)	0.18	0.22 ± 0.03	0.21 ± 0.037	0.22 ± 0.036	0.19 ± 0.05
Organic matter per bag (g)	0.82	0.46 ± 0.018	0.33 ± 0.019	0.28 ± 0.027	0.21 ± 0.012
Decrease in organic matter/bag (g)		0.36	0.49	0.55	0.61
Total N (%)	0.47	0.60 ± 0.04	0.83 ± 0.058	1.03 ± 0.07	1.12 ± 0.13
Increase in N %		0.13	0.36	0.56	0.65

[a] Mean and standard deviation (5 replications).

A simple method for middle-term preservation of azolla germplasm

Bai Ke-zhi, Nilda S. Beria, and I. Watanabe, Soil Microbiology Department, International Rice Research Institute

Thirty-two strains of azolla including all species except *A. nilotica* and *A. microphylla* have been collected at IRRI. Proper maintenance of this germplasm is a problem. A method was developed to preserve the germplasm for 100 days or more without reinoculation.

The healthy fronds of azolla, grown in the greenhouse or in the field, are washed with tap water. About 100 shoot tips (each with several young leaves) are cut from the fronds and enclosed in small nylon bags. The shoot tips are treated with 2% sodium hypochlorite and 0.1% Polysorbate solution to eliminate algae and other pests epiphytic on the shoot tips. After 2-3 minutes in the solution, the shoot tips are washed several times with sterilized distilled water. About 10 shoot tips are placed in 50-ml Erlenmeyer flasks with cotton plugs, each containing 20 ml sterilized nitrogen-free nutrient medium (Holst medium). The inoculations are cultivated in 25°/21°C (12 hours day, 12 hours night) under 12 klux light intensity and 75% relative humidity. Normal fronds are formed from the shoot tips in 2-3 weeks. These clones, which are free from epiphytic algae and other pests, are transferred to 15° / 15°C (12 hours day/ 12 hours night) under about 1 klux fluorescent light for preservation.

Healthy fronds are repropagated from the preserved clones. Preserved material transferred to suitable growth conditions after 100 days are a normal green and retain nitrogen-fixing activity.

An *Anabaena-azollae-free* clone of *A. pinnata* (Tancheng strain) obtained from the Botany Institute of the Chinese Academy of Sciences was also preserved and has remained viable. ■

Effect of presowing moisture regimes and farmyard manure on the forms of iron and manganese in soils and on yield of rice

C. B. Gore and K. R. Sonar, Agricultural Chemistry and Soil Science Department, Mahatma Phule Agricultural University, Rahuri 413 722, Maharashtra, India

A greenhouse experiment on calcareous (pH 8.4, organic carbon 0.5%, and $CaCO_3$ 7.2%) and noncalcareous (pH 8.2, organic carbon 0.62%, and $CaCO_3$ 1.0%) Vertisols (Vertic Ustropepts) during the 1980 summer studied the effect of adding farmyard manure (0 and 0.75%) and of moisture regimes (dry, saturated, and 3-cm submergence) 15 days before sowing, on the forms of iron (Fe) and manganese (Mn) in soils and on the yield of rice cultivar Tuljapur 1.

Exchangeable Fe and Mn in both soils increased with an increase in pre-

Effect of presowing moisture regimes and farmyard manure addition on forms of iron and manganese in soils 8 and 15 d after moisture treatment and on rice yield. Maharashtra, India. [a]

Treatment [b]	Iron content (ppm)				Manganese content (ppm)				Rice yield (g/pot, 6 plants)	
	NH_4OAc, pH 4.8		NH_4OAc, pH 3.0		Exch. Mn NH_4OAc, pH 7		Reducible Mn NH_4OAc, pH 7 + 0.2% hydroquinone		Grain	Straw
	8d	15 d	8d	15 d	8d	15 d	8d	15 d		
Cal, FYM, Dry	2.5	2.5	4.1	4.1	1.0	1.0	290	290	7.65	36.80
Cal, FYM, Sat	5.7	7.5	7.4	19.6	7.0	10.5	277	270	12.25	47.60
Cal, FYM, Subm	7.0	9.2	24.7	36.5	9.5	15.0	266	252	19.47	56.00
Cal, no FYM, Dry	2.5	2.5	4.1	4.1	1.0	1.0	290	290	3.85	33.30
Cal, no FYM, Sat	3.7	6.0	7.9	13.6	3.2	7.7	282	277	8.93	44.60
Cal, no FYM, Subm	6.2	8.0	21.4	25.2	4.7	12.1	277	257	16.42	50.60
Noncal, FYM, Dry	4.0	4.0	5.9	5.9	1.8	1.8	312	312	8.15	38.20
Noncal, FY M, Sat	6.2	10.2	19.3	21.2	9.5	14.5	297	287	15.00	47.40
Noncal, FYM, Subm	7.2	10.3	46.9	52.0	13.0	19.0	287	277	20.90	59.40
Noncal, no FYM, Dry	4.0	4.0	5.9	5.9	1.8	1.8	312	312	7.12	37.40
Noncal, no FYM, Sat	5.0	8.7	17.9	17.9	5.0	10.5	303	285	9.60	41.00
Noncal, no FYM, Subm	7.0	9.5	26.7	36.0	8.1	15.5	292	280	15.85	48.90

[a] Mean of 2 replications. [b] Cal= calcareous, FYM = farmyard manure, Sat = saturated, Subm = submerged.

sowing moisture from dry to submergence, and with the duration of moisture treatment (see table). Soil saturation and submergence 15 days before sowing resulted in a greater release of exchangeable Fe and Mn, which might be due to reduced conditions (Eh reduced from 530 to 260 mV in calcareous soil and from 510 to 256 mV in noncalcareous soil) and decrease in pH (from 8.2 to 7.6 in calcareous soil and from 8.1 to 7.8 in noncalcareous soil). Noncalcareous soil recorded higher exchangeable Fe and Mn than calcareous soil. The addition of farmyard manure resulted in higher content of exchangeable Fe and Mn. The highest exchangeable Fe and Mn were observed under the presowing soil submergence treatment with farmyard manure.

Easily reducible Mn, however, showed a reverse trend. It rapidly decreased as a result of presowing moisture regimes with the addition of farmyard manure, which was accompanied by an increase in exchangeable Mn.

An increase in rice grain and straw yield was observed. It probably was due to an increase in the supply of Fe and Mn in the soil as a result of soil water treatments 15 days before sowing. The highest grain and straw yield was obtained in noncalcareous soil under presowing submergence treatment with addition of farmyard manure. ■

Population of the weed *Marsilia quarfrifoliata* in plots with azolla

S. Srinivasan, Paddy Experiment Station (PES), Aduthurai, India

Irrigation water is usually released from Mattur reservoir in June in Thanjavur district. The first short-duration crop in the double-crop wetland system is planted in June-July. In the single-cropped wetland area, long-duration varieties are planted in September-October, 2-3 months after water is released. Submergence of those fields during that period encourages some wetland weeds such as *Marsilia quartrifoliata, Panicum repens, P. colonum, Cyperus rotundus, Pistia striotus,* and *Echinocloa colona. M. quartrifoliata* spreads quickly and manual labor to remove it from the field before planting costs US$41-103/ha.

At PES, fields where azolla was growing differed in *Marsilia* weed population from fields with no azolla. Weed population was assessed in 10 randomly selected areas, 10 m^2 each, in which azolla grew densely and in which azolla was absent. The weights follow:

Plots	Mean fresh weed wt (kg/10 m^2)
With dense azolla growth	0.52
Control (no azolla)	26.31

Trials on seed requirements showed that a minimum of 1 t seed material/ha was needed for the samba fields. Azolla can be grown without phosphorus application if the old water is drained from the field once a week and fresh water is maintained at 5-10 cm.

Thus a thick layer of azolla can ward off *M. quartrifoliata* while saving 25 kg N/ha, as previously reported. ■

Azolla manuring rectifies zinc deficiency

S. Srinivasan, Paddy Experiment Station, Aduthurai, India

Zinc deficiency is a problem in the second crop (thaladi) immediately following the first crop (kuruvai) in double-cropped wetlands in Thanjavur district of Tamil Nadu.

A trial with three replications during the 1979-80 thaladi season studied the maximum level of azolla (*A. pinnata*) application that gave a significant additional yield in the variety ADT31. The number of leaves and the intensity of leaf area affected by zinc deficiency were assessed 4 times — 20th, 25th, 30th, and 35th day after transplanting (DT) — as the zinc deficiency was observed in a severe form in the early stages of crop growth. The mean of the maximum

Data on zinc deficiency symptoms.[a] Aduthurai, India.

Treatment	% of leaves affected		Intensity of leaf area affected (%)	
	AV	TV	AV	TV
Control	67.3	55.1	31.2	34.0
Azolla 10 t/ha	42.0	40.4	12.3	20.5
" 20 "	17.5	24.7	5.9	14.1
" 30 "	8.7	17.2	2.0	8.1
" 40 "	3.1	10.1	0.7	4.8
" 50 "	0.5	4.1	0.5	4.1
" 60 "	0.5	4.1	0.5	4.1
" 70 "	0.5	4.1	0.5	4.1
" 80 "	0.5	4.1	0.5	4.1
" 90 "	0.5	4.1	0.5	4.1
" 100 "	0.5	4.1	0.5	4.1
C.D. (P= 0.05%)		6.3		4.7

[a]AV = actual value of zinc deficiency worked out in percentage; TV = transformed value (angular value) of the percentage of zinc deficiency. Intensity of leaf areas affected = the area of the leaf covered by zinc deficiency symptoms.

deficiency symptom on the 25th DT for each treatment was recorded (see table).

Significant reduction in zinc deficiency was observed with azolla application from 10 t/ha onward compared to the untreated control. The deficiency symptom was negligible at 40 t azolla/ ha and the crop was completely free from it at 50 t/ha and above. ■

Comparison of supergranules, sulfur-coated and ordinary urea in transplanted Jaya rice

Pyare Lal, G. L. Sharma, R. C. Gautam, and P. S. Bisht, Agronomv Department, G. B. Pant University of Agriculture & Technology, Pantnagar 2631345 India

A field experiment compared the effectiveness of urea supergranules, sulfur-coated urea (SCU), and ordinary urea at low to moderate levels of nitrogen application (see table). At 30 kg N/ ha, the supergranules proved significantly superior to the best split of ordinary urea but statistically at par with SCU. At higher levels of nitrogen application (60 and 90 kg N/ha), supergranules and SCU were not superior to the best split, but were definitely superior to single basal incorporation. ■

Effects of urea supergranules, sulfur-coated urea (SCU), and ordinary urea on transplanted Jaya rice, Pantnagar, India, 1980 rainy season.[a]

Nitrogen rate (kgN/ha)	Source and method of application[b]	Grain yield (t/ha)
0	No nitrogen	2.5
30	Urea, best split	3.6
30	SCU, broadcast and incorporated, basal	4.1
30	Supergranules of urea, placed[a] 10-12 cm deep	4.3
60	Urea, best split	5.2
60	Urea, broadcast and incorporated, basal	4.2
60	SCU, broadcast and incorporated, basal	5.1
60	Supergranules of urea, placed 10-12 cm deep	5.3
90	Urea, best split	5.8
90	Urea, broadcast and incorporated, basal	4.3
90	SCU, broadcast and incorporated, basal	5.7
90	Supergranules of urea, placed 10-12 cm deep	5.7
	S.Em. ±	220
	C.D. (5%)	640
	C.V.(%)	9

[a]Nursery sowing: June. [b]Placement was in the center of 4 hills.

Environment and its influence

A simple screening technique to identify rice genotypes with low photorespiration

C. Gangadharan and S. K. Nayak, Central Rice Research Institute (CRRI), Cuttack 753006, India

C_3 and C_4 plants are known to differ sharply in their response to physical factors such as light, temperature, and oxygen concentration. Physical conditions largely govern the efficiency of the physiological and biochemical parameters that control the growth processes. Adverse physical stresses such as high temperature, light intensity, or oxygen concentration enhance photorespiration and impose a premium on net photosynthetic efficiency for productivity in C_3 plants.

Gangadharan and Kleinhofs have used those stress parameters in a screening technique to isolate barley and wheat genotypes that are more efficient in net photosynthesis. Only the two stress parameters oxygen and light are now used for rice.

A plexiglass chamber, 1.5 × 0.6 × 0.6 m was placed on a zinc tray filled with water, with outlet and inlet. A measured quantity of oxygen was let in daily for about 10 minutes through a flowmeter at 2 liters/ minute from an oxygen cylinder after the chamber was filled with atmospheric air so that the enriched air had an oxygen concentration of 25-26%. A mercury light continuously lighted the chamber at night to give a light intensity of 25-26 klux. A thermometer held through the ceiling of the chamber recorded temperature. Earthen pots, 10 cm in diameter, with 10 seedlings (aged 15-20 days) each, were kept on the tray in water. Four pots of maize seedlings were also distributed as checks for screening.

The seedlings turned pale and chlorotic after about 10 days and withered completely within 4 weeks. Some plants survived comparatively longer than others under high oxygen concentration. Data on seedling survival and photosynthetic rates after flowering and 3 days after oxygen enrichment in the chamber are in the table. Two runs were made on sets showing survival.

The preliminary observations clearly established variations in the rice genotypes' ability to withstand higher oxygen concentration under continuous light. These observations are relevant in that higher levels of oxygen inhibit the activity of the carboxylating enzyme (RuDP-carboxylase) and enhance RuDP oxygenase activity. Obviously photorespiration was enhanced under high oxygen levels. Genotypes with low oxygenase activity even at high oxygen level

Seedling survival and photosynthetic rate of different genotypes. Central Rice Research Institute, Cuttack, India.

Genotype	Survival rate[a] (no. seedlings/pot) Run I/Run II	Photosynthetic rate at flowering (mg CO_2/dm^2 per h)	Photosynthetic rate at 3 days after O_2 enrichment (mg CO_2/dm^2 per h)
IET 4087	3/4	28.67	8.36
4105	–	12.01	4.19
5631	–	15.66	5.27
3852	–	14.44	5.62
5882	4/3	29.30	8.25
5887	–	21.14	7.15
5890	–	18.28	6.10
5897	–	16.30	4.19
6145	3/3	27.14	9.12
6205	–	17.21	6.15
6207	5/4	25.42	8.37
6208	–	17.25	4.15
6209	3/4	24.24	7.92
6212	–	14.16	4.12
6271	–	18.47	5.13
6658	4/4	27.12	8.67
5606	3/3	34.83	9.15
2812	–	13.28	4.19
Jagannath	4/5	23.71	7.67
Pankaj	3/4	18.17	4.89
Intan	–	13.60	4.14
RPW4-14	–	21.39	7.12
Vijaya	5/4	29.58	8.36
T141	5/5	26.22	8.65
CR 1014	–	15.23	7.18
IR8	4/5	25.16	8.91

[a] – = nil survival. Total number of seedlings/pot = 10.

survived better because their photorespiration rate was lower and their net photosynthetic efficiency was greater.

This technique helps in rapidly identifying promising rice cultivars that are efficient in photosynthesis. It is easier to use and less cumbersome than the low carbon dioxide concentration techniques normally used to identify photosynthetically efficient plants. Large-scale screening is tried at CRRI and results are being confirmed. ■

Morphological evidence of *air passages* between culms and roots in rice

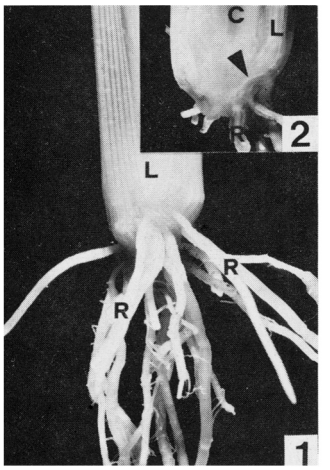
S. Y. Zee, Botany Department, University of Hong Kong, Hong Kong

The mechanism of oxygen transport from shoot to root in the rice plant has been assumed to be associated with the passive diffusion of air through air passages in the tissue. If this view is correct, then it is important that such an air passage, which would allow the free transport of air from the top of the plant to the roots, be demonstrated.

Numerous studies have shown that lysigenous spaces and aerenchyma intercellular spaces are present in the cortical tissues of the rice plant culm. Similar lysigenous and aerenchymatous spaces are also present in the roots. The literature shows that these lysigenous and aerenchymatous spaces may be responsible for the passive transport of air in the plant. But what is not certain is whether the lysigenous and aerenchymatous spaces in the culm are connected in any way with the lysigenous and aerenchymatous spaces of the root.

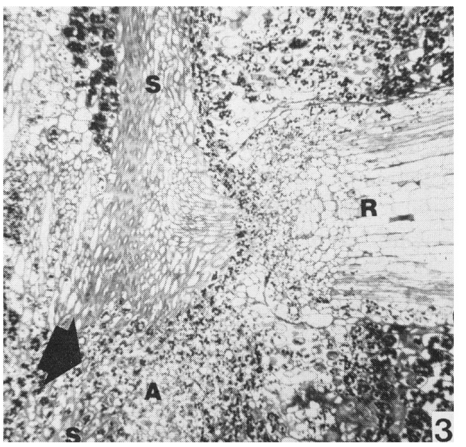
A longitudinal section cut through the junction point between the culm and the root (Fig. 1) shows that between the cortex and the central vascular tissues of the culm there is a band of sclerenchymatous tissue, about 0.1 mm thick (Fig. 2). This thick layer of sclerenchymatous tissue could act as a barrier, if not totally stop, the passive flow of air between shoot and root.

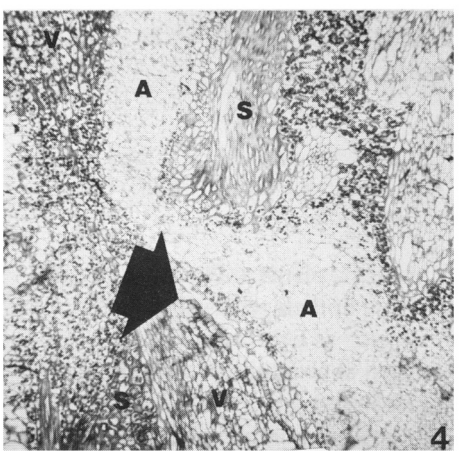
To see if this layer of sclerenchymatous tissue would act as a barrier to the



1. The outer appearance of the rice plant (variety IR36) at the junction point between the root (R) and the culm. L = leaf sheath.

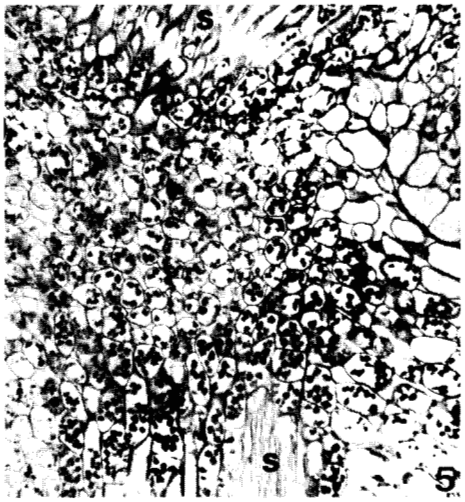
2. A longitudinal view of the rice plant at the junction point between the culm (C) and the root (R). Arrow indicates the position of the layer of the sclerenchymatous tissue.

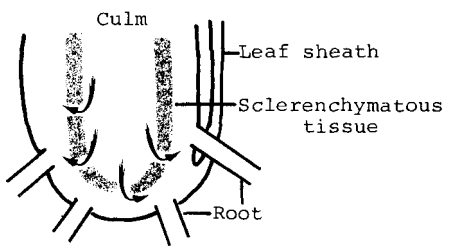




3. Longitudinal section through the junction point between the culm and the root (R). Note that the continuity of the layer of the sclerenchymatous tissue (S) has been interrupted (arrow) by the aerenchymatous tissue (A). ×100.

4. Another view of the region similar to that shown in Figure 3. Note that in addition to the aerenchymatous tissue (A), the vascular tissue (V) also passes through the interrupted region (arrow). S = sclerenchymatous tissue. × 100.





5. A higher magnification view of the interrupted region in the sclerenchymatous tissue (S). X 250.

6. Diagram showing the Passage of air (arrows) through the interrupted regions of the sclerenchymatous tissue at the junction point between culm and roots.

free flow of air, the junction points between the culm and the root were examined with the use of serial glycol methacrylate sections. The sections show that the layer of sclerenchymatous tissue is not continuous, but is interrupted at places by aerenchymatous cells (Fig. 3, 4. and 5) with large intercellular spaces. Within these intercellular spaces or "air passages," air coming from the shoot could easily diffuse as depicted diagrammatically in Figure 6.

Thus, morphologically, there are continuous "air passages" from the culm to the root in the rice plant. ■

Leaf rolling and unrolling behavior in relation to soil moisture tension and climatic factors

A. R. Gomosta, senior scientific officer; F. A. Begum, scientific officer; and M. Z. Hoque, head, Plant Physiology Division, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Rolling and unrolling of rice leaves are common symptoms of drought. The leaves remain open in the morning, roll severely at noon, then unroll in the afternoon. This behavior in relation to soil moisture stress and climatic factors was investigated under field and greenhouse conditions.

Nine pure line rice varieties belonging to the aus group (local early varieties grown as dryland broadcast paddy) were grown under dryland conditions in the field in March 1979 for 30 days with proper irrigation, then the water supply was stopped to expose them to high soil moisture tension (SMT). The SMT was measured by gypsum blocks at 8-10 cm and 12-15 cm soil depths. The degree of leaf rolling and water saturation deficit (WSD) and SMT were recorded when the varietal differences in terms of leaf rolling became distinct at noon.

All the varieties had no to slight symptoms of leaf rolling in the morning and in the afternoon. But at noon, they differed significantly in degree of leaf rolling even though the SMT during morning, noon, and afternoon was similar (see table). It appeared that the

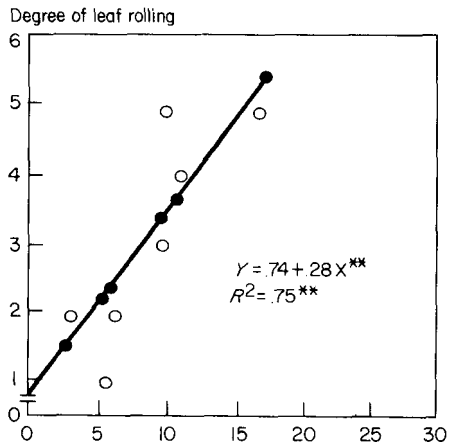
Soil moisture tension at 3 different times measured by gypsum blocks installed at two soil depths, Bangladesh.

Soil depth (cm)	Gypsum block no.	Soil moisture tension (bars) at 0830 h	1230 h	1730 h
8-10	1	–6	–6	–6
	2	–2	–2	–3
	3	–2	–2	–2
	4	–1	–1	–1
	5	–3	–3	–3
12-15	1	–1.5	–1.8	–1.8
	2	–0.8	–0.8	–0.8
	3	–1.5	–1.5	–1.5
	4	–0.3	–0.3	–0.3
	5	–1.0	–1.0	–1.0

degree of the plant's internal moisture stress determined the rolling and unrolling of rice leaves in the field. The WSD percentage of rice leaves was considered the index of the plant's internal moisture stress, and was positively associated with degree of leaf rolling (see figure).

During the time of observation, the air temperature was 25°C in the morning and 35°C at noon and in the afternoon. Relative humidity was 98% in the morning, 53% at noon, and 43% in the afternoon. Solar radiation was 0.37 cal/ cm^2 per minute in the morning, 1.00 cal/cm^2 per minute at noon and 0.25 cal/cm^2 per minute in the afternoon. The observations indicate that the amount of available solar radiation is perhaps the most important factor determining the WSD of rice leaves and, consequently, the degree of leaf rolling.

To quantify the contribution of solar radiation, temperature, and relative



Relationship between degree of leaf rolling and water saturation deficit (%). Leaf rolling scale: 1 = none or slight symptom, 5 = severely rolled.

humidity to WSD of rice leaves, the diurnal change of WSD of the three upper leaves of BR8 was determined under high SMT in the greenhouse from 0600 to 1800 hours at 2-hour intervals. The solar radiation, temperature, and relative humidity were also recorded. The relationship between average WSD of the three upper leaves and the three climatic components is shown by the following equation:

$Y = 4.437 + 8.324\ X_1{}^{**} + 0.087 X_2{}^{ns} + 0.018\ X_3{}^{ns}$:

where Y is WSD, X_1 is solar radiation, X_2 is air temperature, and X_3 is relative humidity. The value of R^2 was 0.97. The equation indicates that available solar radiation significantly determined the change of WSD in this experiment. The percentage contribution of solar radiation, temperature, and relative humidity

to WSD was 71.6, 17.6, and 10.9.

The results explain rolling and unrolling of rice leaves at high SMT. Rice leaves roll severely at noon because of high internal moisture stress caused by bright sunshine. In the morning and in the afternoon they remain open because of lower WSD caused by lower solar radiation. ■

Rice-based cropping systems

Success with old rice seedlings

Pyare Lal, R. C. Gautam, and P. S. Bisht, Agronomy Department, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145, India

In parts of North India, temperature is low during ripening of rice and young seedlings transplanted late yield low. The transplanting begins and continues at different ages depending upon the farmers' resources (irrigation, labor, machinery, etc.). An experiment was conducted to assess the yield variation that results from transplanting seedlings at different ages and to explore the possibility of averting yield reduction through the use of seedlings from sparsely seeded puddled nurseries (25 and 50 g seed/m^2 vs the 100-g/m^2 recommended practice). The rice variety was Jaya. A randomized block design with 3 replications was used. The nursery was sown on 9 June 1976, seedlings were transplanted at 25, 35, 45, and 55 days old at 20- × 15-cm spacing. Seedlings were uprooted with the Khurpi so that there was minimum injury to the seedlings, particularly the old ones. Care was also exercised to ensure that all the shoots of the old seedlings were included when transplanted at 2 seedlings/hill. Thus, 2, 3, 4.5, and 5.5 shoots/hill were transplanted at 25, 35, 45, and 55 days age, respectively. Nitrogen fertilizer was applied to the nursery at 100, 125, 150, and I75 kg N/ha for the different ages. In the main field, the crop was fertilized with 120 kg N/ha.

The yield reductions caused by transplanting old seedlings were small and nonsignificant (Table I). The yield was 11% lower in 55- day-old seedlings than in 25-day-old. Ripening occurred during 16-27 October (Table 2) and the crop was exposed to a mean maximum air temperature of 31.5°-32.2°C and to a minimum temperature of 17.3°-15.2°C (cold), respectively. Aged seedlings (45 and 55 days) experienced more cool weather than the young seedlings (25 and 35 days). Using well-grown seedlings from sparse nurseries (25 g seed/,m^2) was 7.3% more advantageous than using seedlings from dense nurseries (100 g seed/m^2). Thus, reasonably high yields can be obtained from 55-day-old seedlings, with slight reduction in yield, provided the seedlings are well managed and uprooted with the least injury and 5-6 well-developed shoots are transplanted in each hill. ■

Table 1. Grain yield of rice variety Jaya as influenced by seedling age and seeding rate in nursery, 1976.

Seedling age (days)	Grain yield (t/ ha) at seeding rate of 25 g/m^2	50 g/m^2	100 g/m^2	Mean
25	8.00	8.25	7.82	8.02
35	7.67	7.74	7.87	7.76
45	7.68	7.54	6.99	7.40
55	7.34	7.26	6.85	7.15
Mean	7.67	7.70	7.38	

Treatment	S.Em. 1	C.D. 5%
Seedling age	181	Nonsignificant
Seed rate	157	Nonsignificant
Interaction	315	Nonsignificant
C.V. %	7.2	

Table 2. Date of maturity of rice variety Jaya as influenced by seedling age and seeding rate in nursery, 1976.

Seedling age (days)	Date of maturity when Jaya was seeded at 25 g/m^2	50g/m^2	l00 g/m^2
25	16Oct	16 Oct	18 Oct
35	21 Oct	22 Oct	23 Oct
45	22 Oct	24Oct	26 Oct
55	24Oct	26 Oct	27 Oct

Survey of farmers' rainfed and irrigated cropping patterns in Bangladesh

M. Zahidul Hoque (present address: Multiple Cropping Department, IRRI), cropping systems specialist; Rais-Uddin Akanda, scientific officer, Bangladesh Rice Research Institute (BRRI); and M. Zakaria, asst. director, Directorate of Agriculture (Extension and Management)

A survey of the cropping patterns followed by farmers in Bangladesh was conducted by BRRI and the Directorate of Agriculture (Extension and Management), Government of the Peoples' Republic of Bangladesh, to prepare inventories of the existing cropping patterns under rainfed and irrigated conditions. A questionnaire was sent to the Extension Officer/ Agriculture Officer of each *thana* (5th-level administrative unit) of the country. A total of 186 thana responded to the survey.

In the rainfed areas, the cropping intensity was 100-300%. The most common cropping pattern reported by 100 thana was jute - transplanted aman rice (t. aman) - rabi crops (winter crops: oilseeds, potato, wheat, tobacco). The next most common pattern reported by 87 thana was aus rice (mainly a direct-seeded crop) - t. aman rice - rabi crops (wheat, *panicum* sp., oilseeds, pulses, spices). Among the double-cropping patterns reported were jute - rabi crops (63 thana), jute - t. aman rice (30 thana), and aus rice - t. aman rice (18 thana). Single cropping of aus rice, t. aman rice, B. aman (deepwater) rice, potato, oilseeds, vegetables, and spices was also reported for the rainfed areas.

The survey revealed that in the irrigated areas, farmers practiced single, double, and triple cropping. Aus rice - t. aman rice - rabi crops (wheat, potato, oilseeds, winter vegetables, tobacco, etc.) was the most common cropping pattern (178 thana), followed by the aus rice - t. aman rice - boro rice pattern (108

thana). Among the double-cropping patterns, boro rice - t. aman rice and aus rice - t. aman rice were the most common patterns, each reported by 10% of the sample thana. The next most common patterns were aus rice - boro rice and aus rice - rabi crops. Single cropping of rice (mostly boro), wheat, tobacco, vegetables, and spices, was also reported for the irrigated areas. Jute crop was confined to the rainfed areas.

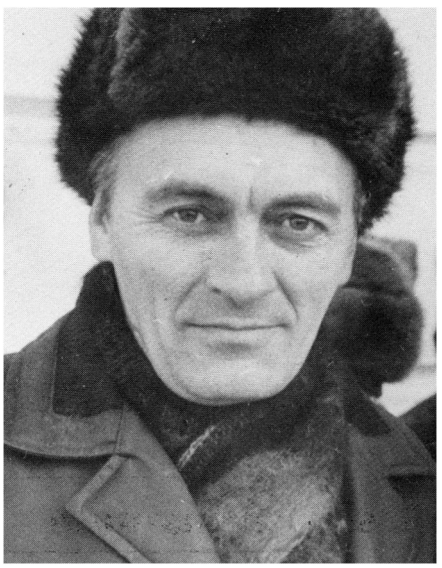
Single cropping patterns were reported by about 40% thana under rainfed conditions and 18% under irrigated conditions. Also more thana practiced double-cropping patterns in the rainfed conditions (44%) than in the irrigated (28%). On the other hand, more thana (78%) reported triple-cropping patterns under irrigated conditions than under the rainfed (60%).

These results indicate that the opportunity exists for crop intensification in Bangladesh. ■

Announcements

Honors for E. P. Alyoshin

The USSR's Order of People's Friendship was awarded to Dr. E. P. Alyoshin in February 1981. Dr. Alyoshin is a corresponding member of the USSR Agricultural Academy and director of the All-Union Rice Research Institute. The award, made through an edict from the USSR Supreme Soviet Presidium, acknowledged Dr. Alyoshin's role in the scientific support of the production of 1 million tons of rice in the Krasnodar territory in 1980. ■



E. P. Alyoshin, recipient of the USSR's Order of People's Friendship.

ICAR award to Dr. R. C. Chaudhary

The Indian Council of Agricultural Research awarded the *Kheti Purashkar* to Dr. R. C. Chaudhary, chief scientist, rice, Bihar. The award is given for popular scientific publications in agriculture, which convey to readers the significance of recent scientific advances to improve biological productivity. It carries a cash prize and a citation. Dr. Chaudhary's award acknowledged the release and promotion of the rice variety Prasad in India. Prasad is a reselection from the introduced IRRI line IR1561-216-6. Dr. Chaudhary is presently a senior postdoctoral fellow in the IRRI plant breeding department. ■

Sterling Wortman dies at 58

Dr. Sterling Wortman died of cancer 26 May 1981 in Greenwich, Connecticut, USA. He was 58 years old. Wortman was the founder of the International Agricultural Development Service (IADS) and served as its president from 1975 to 1979.

Dr. Wortman joined the Rockefeller Foundation in 1950 as a maize breeder in the foundation's Mexican agricultural program. In 1955 he went to the Pineapple Research Institute in Hawaii.

When the International Rice Research Institute was launched in 1960, he rejoined the Rockefeller Foundation and, on assignment, served IRRI until 1964 as assistant director and associate director. He then became director of the Pineapple Research Institute. In 1966 he was appointed director of agricultural sciences for the Rockefeller Foundation. He became vice president of the foundation in 1970.

When IADS was founded in 1975 he served as both president of IADS and vice president of the Rockefeller Foundation. ■

International training on Seed Technology for Vegetable Crops

The fourth International Course on Seed Technology for Vegetable Crops will be held 1 September - 17 November 1982 (closing date for applications: 1 April 1982). The course, organized by the University of the Philippines at Los Baños (UPLB) in cooperation with the International Agricultural Centre at Wageningen, the Netherlands, will be held at UPLB.

The course is primarily for individuals whose agricultural education background is equivalent to a BS and whose work involves the development of vegetable seed. It will concentrate on vegetable crops grown in the Asian and Pacific region. Brochures, including application forms, will be sent to various institutes and entities in the region.

For more information, write to: Project Directorate, International Programme on Seed Technology, P. O. Box 430, College, Laguna 3720, Philippines. ■

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

ISSN 0115–0944