# International Rice Research Newsletter

VOLUME 8 NUMBER 3 JUNE 1983


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 editonal process. the editors of the *International Rice Research Newsletter (IRRN)* request that contributors use the following style and guidelines.

**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 and 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 convened to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- When using abbreviations other than for units of measure, spell out in lull the first time of reference, with abbreviations in parenthesis, then use the abbreviation throughout the remaining text. For example: The efficiency of nitrogen (N) use was tested Three levels of N were . . . *or* Biotypes of the brown planthopper (BPH) differ within Asia. We 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 10 or some numbers higher and some numbers lower than 10. For example: six parts, seven tractors; four varieties. *But* There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage: Seventy-five percent of the yield increase is attributed to fertilizer use.

**Guidelines**

- Contributions to the IRRN should generally be based on results of research on rice or on cropping patterns involving rice.
- Appropriate statistical analyses are required for most data.
- Contributions should not exceed two pages of double-spaced, typewritten text. Two figures (graphs, tables, 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 varietles are encouraged.
- Use common — not trade — names for commercial chemicals and, when feasible, equipment.
- Do not include references in IRRN contributions.
- Pest surveys should have quantified data (% infection, degree of severity, etc.).

# Genetic evaluation and utilization

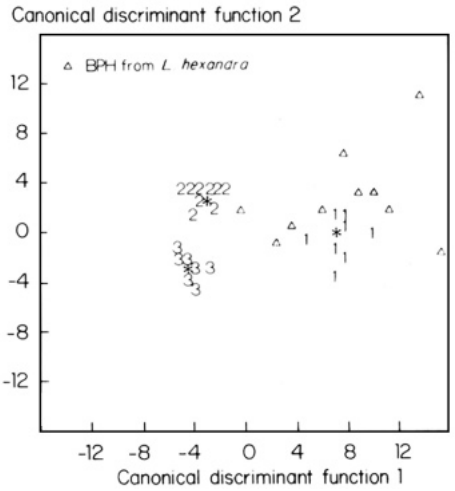
OVERALL PROGRESS

### Morphological variations between brown planthopper biotypes on *Leersia hexandra* and rice in the Philippines

*R. C. Saxena, principal research scientist, International Centre of Insect Physiology and Ecology, and associate entomologist, IRRI; M. V. Velasco and A. A. Barrion, IRRI*

A brown planthopper *Nilaparvata lugens* Stål (BPH) population infesting the weed grass *Leersia hexandra* (Swartz) showed strong host specificity and died if caged on rice plants. Biological characteristics of the grass-infesting BPH population clearly differentiated it from rice-infesting BPH biotype 1, 2, and 3 populations in the Philippines. Morphological and morphometric evaluation of the rostrum, legs, and antennae of both brachypterous and macropterous males and females were made to determine if the grass-infesting BPH is a different biotype.

The scatter plot diagram based on computed discriminant scores of the rostral, leg, and antennal characters of macropterous females of the grass-infesting population and of macropterous females of biotypes 1, 2, and 3 showed distinct segregation (see figure), as was true for other morphs. However, the diffused cluster character of the grass-infesting population indicated it to be a less homogeneous population than either biotype 1, 2, or 3.




Discriminant scores based on rostral, leg, and antennal characters of macropterous females of biotypes of *N. lugens* infesting *Leersia hexandra.* The numbers indicate biotype designation; the asterisk (*) indicates a group centroid. IRRI, 1982.

These findings indicate that the grass-infesting BPH population is distinct from rice-infesting BPH biotypes. Therefore, it is logical to consider it as a primitive, nonvirulent *N.lugens* biotype. □

### Morphological variations among three brown planthopper biotypes in the Philippines

*R. C. Saxena, principal research scientist, International Centre of Insect Physiology and Ecology, and associate entomologist, IRRI; and L. M. Rueda, University of the Philippines at Los Baños, Philippines*

The occurrence and evolution of prolific biotypes of brown planthopper (BPH) *Nilaparvata lugens* (Stål) threatens the stability of resistant rice varieties. These biotypes are identified by observing differential reactions of the host varieties and differential behavioral and physiological responses of the pest. No morphological basis for identifying BPH biotypes has been developed.

Because changes in ecological and physiological traits are frequently followed by subtle changes in morphological characteristics in many organisms, we evaluated morphological and morphometric differences among populations of BPH biotypes 1, 2, and 3 maintained as stock cultures at IRRI. The rostrum, legs, and antennae — body parts that possess receptors for host plant discrimination — were observed.

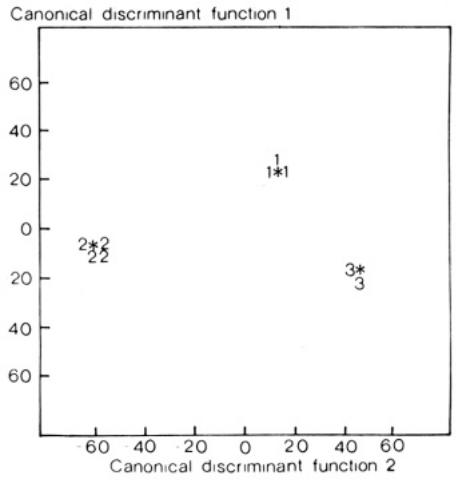
One hundred adults from each biotype population maintained on TN1 (biotype l), Mudgo (biotype 2), and

ASD7 (biotype 3) were prepared for morphological examination as follows: 1) boil in 95% ethanol for about 10 min; 2) macerate in lukewarm 10% NaOH for 10-15 min; 3) wash in 95% ethanol and boil for 15-20 min in chloral-phenol (1:1 part chloral hydrate and phenol crystals); 4) clear in creosote for 10 min; and 5) mount body parts on glass microslides using Hoyer's medium (30 g gum arabic, 50 ml water, 200 g chloral hydrate, 20 ml glycerine). Antennae in glycerol medium were also mounted on slides so they could be moved freely during microscopic examination.

Camera lucida drawings of selected structures were made at 20X objective of a phase contrast microscope. More than 100 morphological characters of the rostrum, including mandibular stylets, legs, and antennae, were measured and evaluated. Characters were examined separately in both sexes and their morphs, i.e., macropterous male, macropterous female, brachypterous male, and brachypterous female.

Multiple discriminant analysis using stepwise selection through Wilk's specification indicated distinct segregation of the three biotypes. The characters of the rostrum, legs, and antennae common to both sexes and their respective morphs contributed to the separation of biotypes. Scatter diagrams, based on computed discriminant scores of the three biotypes, showed a high degree of segregation (see figure). Hoppers classified using leg and antennal characters exhibited a 100% probability of correct morphological identification of the three biotypes.

We are using these criteria to evaluate allopatric populations of BPH biotypes from other geographical areas.




Discriminant scores of three biotypes of N. Iugens based on rostral, leg, and antennal characters of brachypterous females. The numbers indicate biotype designation; the asterisk (*) indicates a group centroid. IRRI, 1980.

GENETIC EVALUATION AND UTILIZATION

# Agronomic characteristics

### Yield response of 10 rices to different nitrogen levels

*Syed Nazeer Peeran and B. V. Anandan, Paddy Experiment Station, Tirur 602025, Chingleput District, Tamil Nadu, India*

TKM9 cultivation is increasing in Tamil Nadu, particularly in the south. During 1981 sornavari (Jun-Jul to Sep-Oct) TKM9, ADT36, CO 41, IET4786, and two prerelease lines, TM3320 and TM3324, were compared for yield performance at different nitrogen application levels.

IR50, IET4786, TM8089, and TM8090 were tested during 1982 navarai (Dec-Jan to Mar-Apr).

Soil at the experimental site had pH 7.6, 0.64% organic carbon, 55 kg available phosphorus/ha, and 368 kg available potassium/ha. Nitrogen was applied at 0, 40, 80, 120, and 160 kg/ha in a strip-plot design with 2 replications.

During sornavari TKM9 yielded higher than other varieties at all nitrogen application levels (Table 1). IR50 yielded highest during navarai (Table 2). Both varieties yielded best at 120 kg N/ha. □

**Table 1. Yield performance of rices grown at 5 nitrogen levels, sornavari 1981, Tirur, India.**

| Nitrogen (kg/ha) | Grain yield (t/ha) | | | | | | |
|---|---|---|---|---|---|---|---|
| | TKM9 | IET4786 | ADT36 | CO 41 | TM3320 | TM3324 | Mean |
| 0 | 4.5 | 3.3 | 3.4 | 3.7 | 3.1 | 3.0 | 3.5 |
| 40 | 5.6 | 3.5 | 4.3 | 4.1 | 3.5 | 3.4 | 4.1 |
| 80 | 6.4 | 5.2 | 5.3 | 4.6 | 4.5 | 4.2 | 5.0 |
| 120 | 7.2 | 5.3 | 5.6 | 5.2 | 5.0 | 4.7 | 5.5 |
| 160 | 6.6 | 5.9 | 6.3 | 5.9 | 5.5 | 4.8 | 5.8 |
| Mean | 6.0 | 4.6 | 5.0 | 4.7 | 4.0 | 4.0 | |

| | CD |
|---|---|
| Varieties | 0.2** |
| N levels | 0.4** |
| Interaction | ns |

**Significant at 1% level. NS = not significant.

**Table 2. Yields of varieties grown at 5 nitrogen levels, navarai 1982, Tirur, India.**

| Nitrogen (kg/ha) | Grain yield (t/ha) | | | | |
|---|---|---|---|---|---|
| | IET4786 | IR50 | TM8089 | TM8090 | Mean |
| 0 | 1.9 | 3.4 | 3.1 | 3.7 | 3.0 |
| 40 | 3.2 | 4.9 | 4.8 | 4.8 | 4.4 |
| 80 | 4.1 | 6.1 | 5.4 | 5.7 | 5.3 |
| 120 | 4.6 | 7.4 | 7.0 | 7.3 | 6.6 |
| 160 | 4.4 | 7.3 | 6.1 | 6.0 | 6.0 |
| Mean | 3.6 | 5.8 | 5.3 | 5.5 | |

| | *CD* |
|---|---|
| Varieties | 0.2** |
| N levels | 0.4** |
| Interaction | |
| Sub at main | 0.3** |
| Main at sub | 0.3** |

**Significant at 1% level.

GENETIC EVALUATION AND UTILIZATION

# Insect resistance

### Screening for leaffolder resistance

*L. Nadarajan and N. Rajappan Nair, Regional Agricultural Research Station, Pattambi, Kerala, India*

Thirty-one rice varieties were screened in fields at Pattambi for leaffolder *Cnaphalocrocis medinalis* Guenée resistance.

Varieties received through international collaborative projects were planted in 5-m rows at 25 × 25 cm spacing. Susceptible variety Jaya was planted in border rows. Susceptible check was TN1. Periodic observations started when TN1 plants showed 40% attacked leaves. When the test varieties were scored, TN1 had 68.8% attacked leaves. Resistance rating by the Standard Evaluation System for Rice was based on the corrected percentage of damage.

GEB24 and PTB33 were highly resistant. TKM6, IR21937-26-2-3, Sri Lankan varieties BG12-1, BG367-3, BG379-2, and Thai variety BKNBR1030-51-1-1-2-1 were also resistant (see table). All other varieties were susceptible or highly susceptible. □

**Resistance of rice varieties to leaffolder, Pattambi, Kerala, India.**

| Score[a] | Variety | Origin |
|---|---|---|
| 1 | GEB24, PTB33 | India |
| 3 | BG12-1, BG367-3, BG379-2 | Sri Lanka |
| | BKNBR1030-51-1-1-2-1 | Thailand |
| | IR21937-26-2-3 | IRRI |
| | TKM6 | India |
| 5 | BR220-1-1 | Bangladesh |
| | Chianung 51-P1-66-1020 | Taiwan, China |
| | 1R21929-12-3-3, ) | |
| | IR21931-47-3-3, ) | IRRI |
| | IR9209-26-2-2-2-3 ) | |
| | Kannagi, T2005 | India |
| 7 | IR13429-170-3, ) | |
| | IR19575-65-2-2-3 ) | IRRI |
| | Kaohsiung Senyw 204 | Taiwan, China |
| | OR100-25, OR55-9, ) | |
| | TNAU9039-14, ) | |
| | TNAU9227-1, ) | India |
| | UPR311-19-2-1, ) | |
| | UPR82-1-7, W1263 ) | |
| 9 | NR59, RNR67580 | India |
| | Surya medal (12923) | Indonesia |
| | X2-0-l., 343-0.1. | Vietnam |
| | TN1 | Taiwan, China |

[a] Standard Evaluation System for Rice.

GENETIC EVALUATION AND UTILIZATION

# Deep water

### Screening rice varieties for deepwater tolerance

*R. Radhakrishnan, Crop Physiology Department, Tamil Nadu Agricultural University, Coimbatore 641 003, India; and B. S. Vergara, plant physiologist, IRRI*

More than 12,000 ha of rice lands in Tamil Nadu are submerged or flooded for up to 4 months, Sep-Jan, during the vegetative phase. Local varieties TNRl and TNR2 yield from 0.8 to 1.0 t/ha.

Twenty-four varieties from the Tamil Nadu Agricultural University germplasm collection were screened at IRRI for various characters that contribute to deepwater tolerance: submergence tolerance, salt tolerance, elongation ability, nodal rooting, and kneeing ability.

*Submergence tolerance.* Ten-day-old seedlings planted in trays were submerged (30 cm) in a water tank along with the check varieties FR13A (resistant) and IR42 (susceptible). Water temperature was maintained at 30°C and light intensity at 400 lux at the tray level. Trays were removed after 7 days and plants were scored 5 days after removal.

Submergence tolerance scores indicated that only TNR1, Dhanya, and Birpak had some degree of tolerance. Submergence tolerance, therefore, does not seem to be a crucial limiting factor for varietal development in deepwater.

*Salt tolerance.* Seedlings were grown in normal culture solution and transplanted to saline soil with E. C. 9 mS/cm. Subsequent irrigation was with normal water. Cultivars were scored for salinity tolerance 4 weeks after transplanting (see table). TNR1, Ponkambi samba, Kattuvanam, Kar paddy, Dulai Baron, Kala or Black Aman, and Ponni showed tolerance equal to that of the check variety Pokkali.

*Elongation ability.* Four-week-old seedlings raised in small plastic pots were submerged in 40-cm water. Water level was increased to 90 cm at a rate of 10 cm/day and maintained for 1 week. Plants were removed and height, number of elongated internodes, and nodal rooting were recorded (see table). Elongation varied from 17 to 65 cm (25 to 129% increase). TNR1 and Ponkambi samba had maximum elongation ability. Chingair and Birpak had more

**Rice varieties tested for various deepwater traits.**

| Variety | Submergence tolerance score [a] | Salt tolerance score [a] | Elongation ability | | | Elongated internodes (no.) | Kneeing ability |
|---|---|---|---|---|---|---|---|
| | | | Final height (cm) | Elongated height (cm) [b] | % of elongation | | |
| TNRl | 5 | 3 | 119 | 64 | 114 | 2 | 1 |
| Ponkambi samba | 9 | 3 | 112 | 63 | 129 | 2 | 7 |
| Kattuvanam | 9 | 3 | 111 | 47 | 73 | 2 | 3 |
| Sarapalli samba | 9 | 5 | 112 | 55 | 95 | 3 | 5 |
| Sirumani Amon | 9 | 9 | 115 | 56 | 95 | 2 | 3 |
| Deepwater type | 9 | 7 | 86 | 17 | 25 | 1 | 3 |
| Donradao | 9 | 7 | 117 | 50 | 75 | 1 | 3 |
| Kar paddy | 9 | 3 | 140 | 63 | 82 | 2 | 5 |
| Dulai Aman | 9 | 9 | 106 | 50 | 89 | 1 | 5 |
| Dulai Baron | 9 | 3 | 92 | 26 | 39 | 1 | 7 |
| Dhanya | 5 | 7 | 115 | 56 | 95 | 3 | 5 |
| Akulu | 9 | 5 | 118 | 52 | 75 | 3[c] | 3 |
| Poongar | 9 | 7 | 84 | 37 | 77 | 3 | 9 |
| Kala or Black Aman | 9 | 3 | 93 | 42 | 82 | 1 | 5 |
| Chingair | 9 | 5 | 133 | 65 | 96 | 3[c] | 5 |
| Lalkanai | 9 | 9 | 134 | 63 | 89 | 3 | 5 |
| Birpak | 7 | 9 | 140 | 63 | 82 | 4[c] | 1 |
| Lakhi | 9 | 9 | 110 | 46 | 72 | 3 | 3 |
| Aeb 368 Rip P type | 9 | 9 | 95 | 31 | 48 | 1 | 9 |
| Perunel | 9 | 7 | 102 | 39 | 62 | 3[c] | 7 |
| White Ottadan | 9 | 9 | 109 | 32 | 42 | 2 | 7 |
| Gutak | 9 | 7 | 77 | 27 | 52 | 2 | 9 |
| Mahsuri | 9 | 7 | 111 | 37 | 50 | 2 | 7 |
| Ponni | 9 | 3 | 71 | 30 | 73 | 1 | 7 |

[a] Standard Evaluation System for Rice Scale. [b] Final height minus height before submergence. [c] Presence of nodal roots.

elongated internodes. Chingair, Birpak, Akulu, and Perunel had profuse nodal roots, which increase plant nutrient uptake.

*Kneeing ability.* Sixty-five-day-old plants were pulled out gently and placed horizontally on the puddled field. Water depth was maintained at 2 cm. Three days later angle of kneeing was scored (see table). TNRl and Birpak had the most pronounced kneeing.

*Photoperiod sensitivity.* Seedlings were raised in plastic pots and subjected to photoperiod treatment for 10, 12, 14, and 16 hours. All the varieties treated with 10 and 12 hours photoperiod flowered. Sarapalli samba, Aeb 368 Rip P, and Gutak flowered at the 14 hour treatment, and were considered photoperiod insensitive. (Aeb 368 Rip P did not flower at 16 hours.) All other varieties were photoperiod sensitive and had relatively long basic vegetative phase. □

GENETIC EVALUATION AND UTILIZATION

# Hybrid rice

### Inheritance of polycaryopsis and breeding of polycaryoptic male-sterile rice

*Hak-Soo Suh, College of Agriculture, Yungnam University, Taegu, Korea (postdoctoral fellow, Plant Breeding Department, IRRI); M. H. Heu, College of Agriculture, Suweon National University, Suweon, Korea; and G. S. Khush, IRRI*

Polycaryoptic rices WX154 (Korea) and Double Rice (Bangladesh), which have more than two ovaries and four stigmas in each floret, were crossed with normal rice varieties 7101 and HR1619-6-2-1, respectively, and with each other. The $F_1$ of the crosses of polycaryoptic and normal rices were normal. Segregation in the $F_2$s agreed with the ratio of three normal to one polycaryoptic. Results indicate that polycaryopsis in WX154 and Double Rice is each controlled by a single recessive gene. The $F_1$ of the cross WX154/Double Rice was normal, and the $F_2$ segregated into nine normal to seven

**Segregation for polycaryopsis in the $F_2$ of the crosses between polycaryoptic WX154 [a] and normal marker line 7101, polycaryoptic Double Rice [b] and normal rice HR1619-6-2-1, and WX154 and Double Rice, IRRI.**

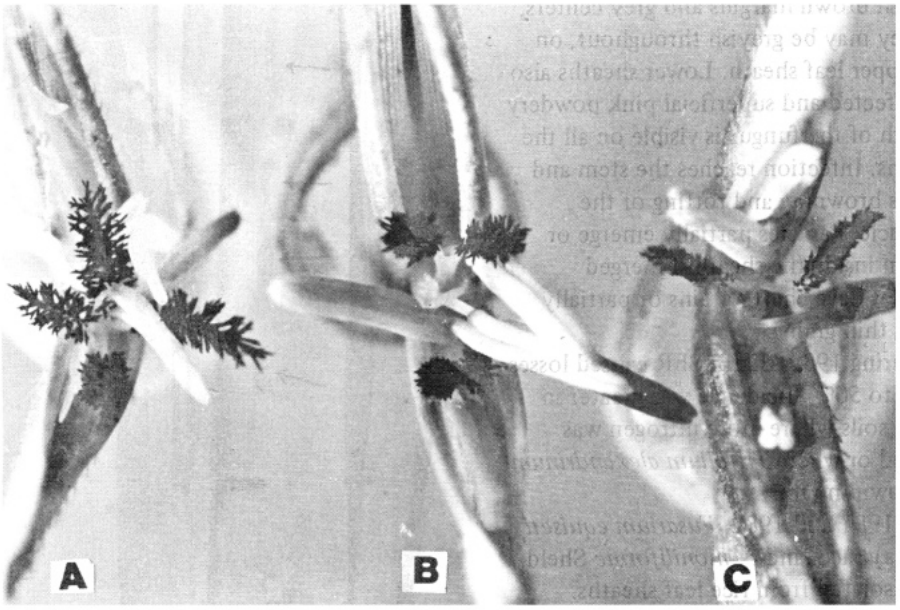
| Cross | $F_1$ | $F_2$ plants (no.) | | | Ratio | $x^2$ | P |
|---|---|---|---|---|---|---|---|
| | | Normal | Poly-caryoptic | Total | | | |
| WX154/7101 | Normal | 232 | 68 | 300 | 3:1 | 0.871 | .25-.50 |
| HR1619-6-2-1/Double Rice | Normal | 139 | 48 | 187 | 3:1 | 0.045 | .50-.90 |
| WX154/Doub1e Rice | Normal | 229 | 158 | 387 | 9:7 | 1.341 | .10-.50 |

[a] From Korea. [b] From Bangladesh.

polycaryoptic, indicating that WX154 and Double Rice have duplicate recessive genes for polycaryopsis (see table).

When the polycaryoptic line YAl , a selection from WXl54/Tongilchal, was crossed with cytoplasmic male-sterile rice V20A, the $F_1$ was sterile. The $F_1$ was backcrossed to YA1. From this $BCF_1$, polycaryoptic male-sterile plants could be selected (see figure), showing that the polycaryoptic line YA1 is a maintainer for cytoplasmic male-sterility, and that polycaryoptic male-sterile plants selected could be maintained by successive backcrosses to YA1.

Polycaryoptic male-sterile rice may have greater seed set because it has four stigmas instead of two. The possibility of using this male-sterile rice for $F_1$ hybrid seed production is being explored. □



Polycaryoptic male-sterile (A), polycaryoptic fertile (B), and normal (C) rice.

GENETIC EVALUATION AND UTILIZATION

# Temperature tolerance

### Effect of abscisic acid on rice seedling resistance to chilling injury

*Pan Rui-chi and Guo que, Plant Physiology Department, South China Normal University, Guangzhou, China*

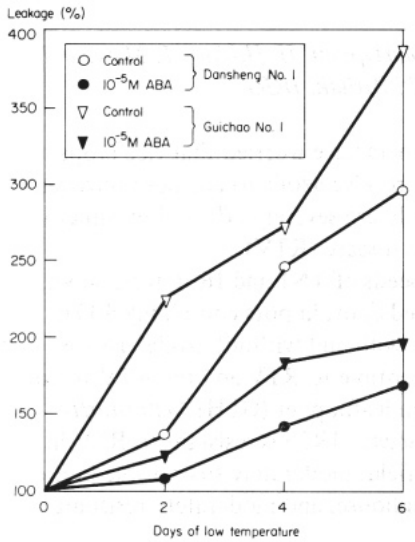
Rice seedlings Dansheng No. 1, Guichao No. 2, and Shanyou No. 2 were studied for the effects of abscisic acid (ABA) on resistance to chilling injury influenced by hormonal regulation.

ABA accumulation varied with varietal resistance to chilling injury. Five days after the low temperature (8-10°C) treatment, seedlings of cold-resistant Dansheng No. 1 showed an ABA increase over cold-sensitive Shanyou No. 2. The longer the low temperature lasted, the more ABA accumulated in leaves of the seedlings (see table).

**Change in ABA content in the leaves of Dansheng No. 1 during low temperature.**

| Days of low temperature | ABA content (ng/g fresh wt) |
|---|---|
| 0 | 0.65 |
| 3 | 13.50 |
| 6 | 20.60 |
| 9 | 58.50 |
| LSD | 0.08 |

Exogenous application of ABA reduced the symptoms of chilling injury such as the leakage of electrolytes from leaves and roots (see figure), leaf discoloration, and reduction of leaf fresh weight. ABA accumulation response should be investigated in further studies. □



Effect of ABA on leakage of electrolytes in chilled rice seedlings.

# Pest management and control DISEASES

### Sheath rot in the Punjab, India

*M. S. Kang and G. S. Rattan, Plant Disease Clinic, Punjab Agricultural University, Ludhiana-141004 Punjab, India*

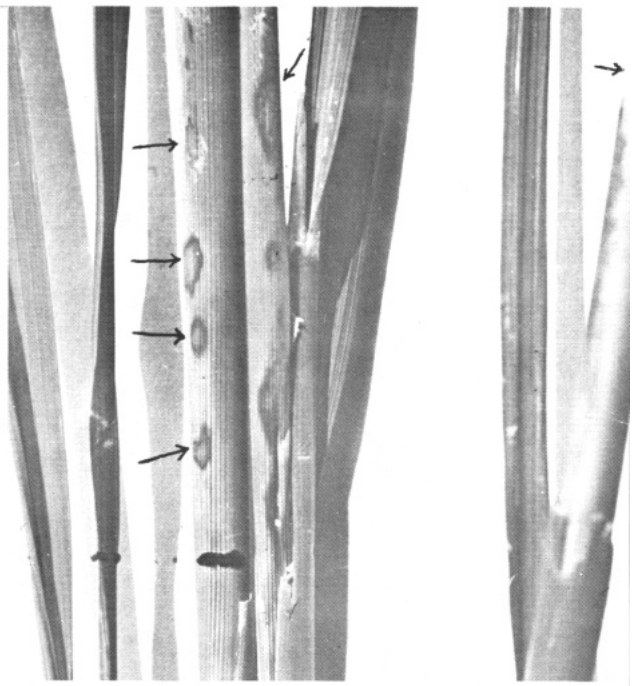
Sheath rot (ShR) caused by *Sarocladium oryzae* (Sawada) Gam. was first reported in India in Hyderabad (A.P.) in 1974 and in Kapurthala (Punjab) in 1980. *Fusarium* has been associated with sheath and panicle rot of rice for the last 3 years, particularly on variety PR106, but was ignored and considered a secondary invader.

*Fusarium* symptoms resemble those produced by *S. oryzae.* They are oblong or irregular spots, 5-20 mm long with

reddish brown margins and grey centers, or they may be greyish throughout, on the upper leaf sheath. Lower sheaths also are affected and superficial pink powdery growth of the fungus is visible on all the sheaths. Infection reaches the stem and causes browning and rotting of the peduncle. Panicles partially emerge or remain inside the sheath. Emerged panicles have chaffy grains or partially filled, thin grains.

During 1982 kharif, ShR caused losses of up to 50%. Incidence was greater in heavy soils where more nitrogen was applied or where *Trifolium alexandrinum* was sown in rabi.

In 1981 and 1982, *Fusarium equiseti* (Corda) Sacc. and *F. monilifome* Sheld. were isolated from rice leaf sheaths. Pathogenicity tests were performed to confirm their association with ShR and panicle sterility. Plants were inoculated by injecting conidial suspensions, or by inserting mycelial bits grown on potato dextrose agar into the boot leaf sheath before panicle emergence. Typical symptoms (see figure) appeared with both methods, lesions developed within 1 week, and the sheath rotted in 3 weeks. Both *Fusarium* species caused disease and produced identical symptoms. □



*Fusarium* sp. symptoms. on sheath after inoculation.

### Effect of azolla on rice tungro virus disease

*K Mariappan, H. Hibino, T. Mew, and M. D. Pathak, IRRI*

Farmers have worried that rice crops that receive azolla to augment nitrogen supply are severely affected by tungro virus disease (RTV).

Seeds of TN1 and IR36 were sown, 5 seeds/pot, in pots containing 400 g soils with and without azolla. TN1 is susceptible to RTV and the RTV vector green leafhopper (GLH) *Nephotettix virescens.* IR36 is resistant to RTV in the field, moderately susceptible in the greenhouse., and moderately resistant to GLH. Ten days after sowing, seedlings were exposed for 24 h to viruliferous GLH that had fed on diseased plants for 4 days. Inoculation was done in cages with 4-5 viruliferous insects per seedling. IR36 and TN1 seedlings raised with and without azolla were exposed separately and together. Uninoculated plants of the same age were kept as control.

The percentages of RTV-infected seedlings were recorded 12 days after inoculation and plant height was measured (Table 1).

Mean values of RTV-infected seedlings between plants raised with and without azolla were almost the same within varieties. TN1 was severely infected and IR36 was moderately infected.

About 500 viruliferous *N. virescens* adults and nymphs were released on pots containing azolla. No insect survived beyond 3 days. The *azolla* did not develop disease symptoms.

A field experiment was conducted in four 5 × 2 plots with wire mesh along the bunds to prevent azolla flow. Azolla *(A. pinnata* and *A. caroliniana)* was incorporated.at 10 kg/plot. Fifteen days later, when fresh growth of azolla was seen, TN1 and IR36 seedlings raised in an insect-proof area were transplanted two plots per variety, one with azolla and the other without. Plant spacing was 20 × 15 cm. Leaf yellowing symptoms similar to RTV were noticed on some TN1 hills 15

**Table 2. Average percentage of RTV-infected seedlings, and seedling height, IRRI.[a]**

| RTV-infected seedlings (%) | | | | Height (cm) of infected seedlings | | | | Height (cm) of uninfected seedlings | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IR36 $A^+$ | IR36 | TN1 $A^+$ | TN1 | IR36 $A^+$ | IR36 | TN1 $A^+$ | TN1 | IR36 $A^+$ | IR36 | TN1 $A^+$ | TN1 |
| – | – | 76.67 | 94.17 | – | – | 22.68 | 20.42 | – | – | 39.83 | 36.44 |
| – | – | 100.00 | 100.00 | – | – | – | – | – | – | – | – |
| 42.50 | – | 75.00 | – | 26.80 | – | 27.14 | – | 42.70 | – | 44.88 | – |
| 50.00 | 45.00 | 90.00 | 88.90 | 29.70 | 27.30 | 25.33 | 30.82 | 43.56 | 34.35 | 44.45 | 38.45 |
| 57.50 | – | 82.50 | – | 29.00 | – | 28.19 | – | 42.00 | – | 32.64 | – |
| – | – | 93.25 | 81.25 | – | – | 27.25 | 24.81 | – | – | 46.33 | 35.67 |
| 33.33 | 47.06 | – | – | 31.69 | 32.64 | – | – | 35.83 | 37.24 | – | – |
| 45.00 | 42.00 | 80.00 | 82.35 | 31.93 | 29.40 | 30.11 | 28.35 | 44.86 | 36.05 | 46.25 | 39.10 |
| 45.67 | 44.69 | 85.35 | 89.33 | 29.82 | 29.78 | 26.78 | 26.10 | 41.79 | 35.88 | 42.39 | 37.42 |

[a] $A^+$ = raised with azolla.

**Table 2. RTV-infected hills at different days after transplanting (DT).**

| Time of observation (DT) | RTV-infected hills (no.) | | | |
|---|---|---|---|---|
| | TN1 | | IR36 | |
| | With azolla | Without azolla | With azolla | Without azolla |
| 15 | 4.6 | 6.2 | 0 | 0 |
| 30 | 65.6 | 63.4 | 0.4 | 1.0 |
| 45 | 83.6 | 84.2 | 2.0 | 1.8 |

days after transplanting (DT). TN1 showed more than 80% infection 45 DT but IR36 remained almost disease free in both treatments (Table 2).

Results obtained in the greenhouse and in the field trial show that azolla application does not cause higher RTV incidence or render the resistant variety susceptible to RTV. □

*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.*

## Biochemical properties of discolored rice grains

*V. S. Duraiswamy and V. Mariappan, Tamil Nadu Agricultural University, Coimbatore, India*

The biochemical properties of discolored rice grains were analyzed and compared with those of healthy white grains (see table). Freshly harvested rice was dehusked and discolored grains were classified as brown, purple, or green. Associated fungi were isolated by blotter technique. Brown and purple grains yielded three species of fungi: *Helminthosporium oryzae, Trichoconis padwickii,* and *Curvularia lunata.* Green grains had *Helminthosporium oryzae.*

Brown grains had higher levels of phenol, reducing and nonreducing sugars, amylose, and gel consistency than white grains. Gelatinization score was lower than for normal grains. Brown grains contained glycine in addition to the eight other amino acids present in white grains.

Purple grains also had high levels of phenol, reducing and nonreducing sugars, and gel consistency. Percent amylose and gelatinization were less than for healthy grains. Alanine, present in white grains, was not detectable, but purple grains, contained glycine. Results for green grains were similar to those for brown grains, but brown grains contained more amylose and had higher gel consistency than other colored grains. □

**Biochemical properties of discolored rice grains.**

| Property | Brown grain | Purple grain | Green grain | White (healthy) |
|---|---|---|---|---|
| Phenolic content (µg/g fresh wt) | 260 | 56 | 65 | 50 |
| Reducing sugar (µg/g fresh wt) | 350 | 430 | 320 | 190 |
| Nonreducing sugar (µg/g fresh wt) | 1000 | 960 | 880 | 820 |
| Percent amylose | 9.4 | 8.0 | 7.6 | 8.8 |
| Amino acids | | | | |
| Isoleucine | + | + | + | + |
| Tryptophan | + | + | + | + |
| Tyrosine | + | + | + | + |
| Alanine | + | – | + | + |
| Aspartic acid | + | + | + | + |
| Glycine | + | + | + | – |
| Arginine | + | + | + | + |
| Histidine | + | + | + | + |
| Cystine | + | + | + | + |
| Gel consistency (mm) | 147 | 123 | 96 | 119 |
| Gelatinization | Intermediate | High or intermediate | High | low |

## Rice grain discoloration

*V. S. Duraiswamy and V. Mariappan, Tamil Nadu Agricultural University, Coimbatore, India*

Rice grain discoloration reduces market value and consumption appeal and often is associated with pathogens. Pathogens that cause grain discoloration and the relationship between discoloration and weather factors were studied in Coimbatore, Tamil Nadu, India.

Seeds collected from mature panicles were dehusked and the discolored grains were classified as green, purple, or brown. Associated fungi were isolated by the blotter technique using 5,000 grains of each calor. White grains (control) yielded no fungi. Green grains (0.8%) yielded *Helminthosporium oryzae.* Among the purple grains, 54.0% yielded *H. oryzae,* 12% yielded *Trichoconis padwickii,* and 5.0% yielded *Curvularia lunata.* Brown grains yielded 65.0, 8.0, and 3.0%, respectively, of these fungi.

Panicles at the various stages of development in the field were inoculated by spraying a spore suspension (40,000 cells/ml) of the 3 species of fungi. Control plants were sprayed with water. The panicles were covered with paper bags im-

**Table 1. Percentage of grains infected by the fungi.**

| | Infected grains (%) | | | |
|---|---|---|---|---|
| | Flower | Milk | Soft dough | Dough |
| Fungus species | | | | |
| *H. oryzae* | 26.5 | 21.5 | 5.9 | 0 |
| *T. padwickii* | 22.4 | 19.5 | 1.9 | 0 |
| *C. lunata* | 23.2 | 20.6 | 1.8 | 0 |
| Control (water spray) | 5.4 | 0 | 0 | 0 |

mediately after spraying and kept covered until maturity.

Percentages of discolored \grains are given in Table 1. All three species of fungi caused discoloration when inoculated at flower, milk, and soft dough stages. *H. oryzae* caused maximum discoloration. Inoculation at flower stage caused more discoloration than at milk stage or soft dough stage. Inoculation at dough stage produced no discoloration.

The influence of weather factors on grain discoloration in commonly grown rice varieties maturing at different months was studied throughout the year (Table 2). Panicles of the crops harvested from October to December had more discolored grains. Low temperature, high humidity, high rainfall, and more rainy days prevailed during these months and appear to cause a higher percent of discoloration. Temperature range at flowering stage seemed to have more influence on the high incidence of grain discoloration.

**Table 2. Grain discoloration in relation to weather factors.**

| Month | Temperature (°C) | | Relative humidity (%) | Rainfall | | Discolored grains (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max | Min | | mm | Rainy days (no.) | CO 39 | Ponni | Bhavarii | IR8 | IR20 | Vaigai | TNl | Kannagi | Benni Bhog[a] | CO 13[b] |
| Jun 1980 | 31.2 | 23.0 | 78 | 30.3 | 6 | 5 | 4 | 9 | 1 | 4 | 2 | 3 | 8 | 14 | 6 |
| Jul | 30.9 | 22.5 | 81 | 25.7 | 3 | 5 | 5 | 9 | 2 | 5 | 3 | 3 | 8 | 14 | 6 |
| Aug | 31.1 | 22.1 | 79 | 15.7 | 2 | 6 | 6 | 9 | 2 | 5 | 3 | 3 | 8 | 14 | 6 |
| Sep | 32.0 | 21.4 | 87 | 67.9 | 3 | 29 | 31 | 39 | 6 | 22 | 29 | 32 | 38 | 29 | 32 |
| Oct | 30.9 | 21.3 | 90 | 217.9 | 8 | 55 | 42 | 56 | 16 | 35 | 62 | 60 | 72 | 72 | 55 |
| Nov | 29.4 | 20.3 | 90 | 176.7 | 8 | 52 | 41 | 54 | 15 | 33 | 61 | 60 | 71 | 71 | 51 |
| Dec | 29.6 | 19.0 | 88 | 6.8 | 1 | 73 | 82 | 80 | 72 | 76 | 72 | 88 | 80 | 83 | 61 |
| Jan 1981 | 30.1 | 18.1 | 87 | 0.2 | 1 | 32 | 33 | 29 | 12 | 30 | 33 | 33 | 30 | 43 | 31 |
| Feb | 32.6 | 17.0 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 0 |
| Mar | 34.3 | 20.8 | 83 | 21.4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Susceptible check for H. oryzae. [b] Local check for blast.

## Accumulation of phenolics in rice varieties due to infection by *Xanthomonas campestris* pv. *oryzae*

*V. Valluvaparidasan and V. Mariappan, Tamil Nadu Agricultural University, Coimbatore, India*

Phenolic compounds play a vital role in the defense mechanism of plants against infectious agents. The participation of phenolic compounds in bacterial leaf blight disease resistance was studied.

Rice varieties ASDS (moderately susceptible), CO 40 (susceptible), TN1 (highly susceptible), and TNAU7 124 (moderately resistant) were sown in pots and fertilized with 80-40-40 kg NPK/ha. Seedlings were clip inoculated with freshly isolated bacterial suspension $10^8$ cells/ml 15 days after seeding. Samples of leaves from the inoculated plants

**Table 1. Effect of *X. oryzae* infection on total phenolics and ortho-dihydroxy phenols in rice varieties [a]**

| Variety | Plant stage[b] | Total content (µg/g leaf tissue) of | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Phenol | | | | | | Ortho-dihydroxy phenol | | | | | |
| | | 7 DI | | 10 DI | | 15 DI | | 7 DI | | 10 DI | | 15 DI | |
| | | H | D | H | D | H | D | H | D | H | D | H | D |
| TNAU7124 | S | 2.67 | 3.30 | 2.51 | 2.84 | 2.51 | 2.62 | 1.65 | 1.87 | 1.91 | 2.25 | 2.42 | 2.31 |
| | T | 2.33 | 2.56 | 2.04 | 2.26 | 1.84 | 2.04 | 0.96 | 1.62 | 1.06 | 1.84 | 1.66 | 1.93 |
| | B | 2.51 | 2.92 | 2.25 | 2.53 | 2.12 | 2.34 | 0.74 | 1.46 | 0.72 | 0.73 | 0.46 | 0.60 |
| ASD5 | S | 2.52 | 2.80 | 2.26 | 2.19 | 2.19 | 2.37 | 1.91 | 2.21 | 2.09 | 1.75 | 2.09 | 2.08 |
| | T | 2.51 | 2.54 | 2.23 | 2.31 | 2.18 | 2.15 | 1.18 | 1.98 | 1.52 | 1.98 | 1.36 | 1.59 |
| | B | 2.64 | 2.66 | 2.47 | 2.45 | 2.34 | 1.84 | 1.87 | 1.45 | 0.72 | 1.04 | 0.56 | 1.43 |
| TN1 | S | 2.53 | 2.61 | 2.52 | 2.95 | 2.03 | 2.28 | 1.65 | 1.32 | 1.54 | 1.78 | 2.45 | 2.09 |
| | T | 2.33 | 1.97 | 2.30 | 1.90 | 2.11 | 2.29 | 1.55 | 1.73 | 1.26 | 1.36 | 1.15 | 1.56 |
| | B | 2.46 | 2.52 | 2.68 | 2.89 | 2.34 | 2.21 | 1.54 | 1.50 | 0.60 | 0.73 | 0.61 | 0.98 |
| CO 40 | S | 2.64 | 2.85 | 2.83 | 2.64 | 2.49 | 2.24 | 1.43 | 1.80 | 2.14 | 2.21 | 2.14 | 2.21 |
| | T | 2.43 | 2.63 | 2.26 | 2.36 | 1.93 | 1.99 | 1.34 | 1.60 | 1.47 | 1.50 | 0.97 | 1.52 |
| | B | 2.29 | 2.32 | 2.34 | 2.46 | 2.10 | 2.24 | 1.50 | 1.54 | 2.04 | 2.06 | 0.98 | 0.61 |

[a] DI = days after inoculation, H = healthy, D = diseased. [b] S = seedling, T = tillering, B = boot leaf.

Conclusion

| | CD | |
|---|---|---|
| Variety | 0.083 | |
| *Stage | 0.072 | $S_1 S_2 S_3$ |
| *Sampling time | 0.072 | $T_1 T_2 T_3$ |
| *Inoculation | 0.059 | $I_2 I_1$ |

were collected 7, 10, and 15 days after inoculation (DI). Leaves from uninoculated seedlings served as control. Ethanol extracts were prepared by following the procedure described in Chandramohan et al 1967. Total phenol in the ethanol extract was estimated using Folin-ciocalteu reagent.

TNAU7124 contained more total phe, no1 than ASD5, CO 40, and TN1 (Table 1). The percentage changes in total phenol in inoculated plants compared with uninoculated plants are presented in Table 2.

Total phenolic content of the four varieties increased. but not uniformly, with inoculation. It decreased with plant age. The interactions between variety and crop stage, variety and sampling time, variety and treatment were highly significant.

Ortho-dihydroxy level increased 7 DI in TNAU7124, ASD5, and CO 40. Tillering and boot leaf stage inoculation of TNAU7124 also caused accumulation of ortho-dihydroxy phenol. During last sampling ortho-dihydroxy phenol decreased except in TN1. Interactions between variety and stage, variety and sampling time, stage and sampling time, variety and treatment, and stage and treatment were significantly superior. □

**Table 2. Percentage changes in total phenolics and ortho-dihydroxy phenol in rice varieties due to *X. oryzae* infection.** [a]

| Variety | Plant stage [b] | Changes (%) in content of | | | | | |
|---|---|---|---|---|---|---|---|
| | | Phenol | | | Ortho-dihydroxy phenol | | |
| | | 7 DI | 10 DI | 15 DI | 7 DI | 10 DI | 15 DI |
| TNAU7124 | S | +23.60 | +13.15 | + 4.38 | +12.12 | +17.80 | – 4.55 |
| | T | + 9.87 | +10.78 | +10.87 | +68.75 | +73.58 | +16.27 |
| | B | +15.54 | +12.61 | +16.26 | +97.30 | + 1.39 | +30.43 |
| ASD5 | S | +11.11 | +23.45 | + 8.22 | +15.71 | –16.27 | – 0.48 |
| | T | + 1.20 | + 3.59 | – 1.38 | +67.80 | +30.26 | +16.91 |
| | B | + 0.76 | – 0.81 | – 21.37 | +22.46 | +44.44 | +16.48 |
| TN1 | S | + 3.16 | +17.06 | +12.32 | –20.00 | +15.48 | +14.69 |
| | T | –15.45 | – 14.78 | + 8.53 | +11.16 | +12.70 | +35.65 |
| | B | + 2.44 | + 7.84 | – 5.56 | – 2.60 | +21.67 | +60.66 |
| CO 40 | S | + 7.96 | – 6.71 | – 10.04 | +25.87 | + 3.27 | + 3.27 |
| | T | + 8.23 | + 4.42 | 1.55 | +19.40 | + 2.04 | +56.70 |
| | B | + 1.31 | + 5.13 | + 6.67 | + 2.67 | + 0.98 | –37.76 |

[a] DI = days after inoculation. [b] S = seedling, T = tillering, B = boot leaf.

# Pest management and control INSECTS

### Fungal pathogens of *Nephotettix virescens* Dist. and *Nilaparvata lugens* Stål

*M. Balasubramanian and V. Mariappan, Tamil Nadu Agricultural University, Coimbatore, India*

The potential benefits of biological insect pest control methods, especially those using bacteria and viruses, are well known. Fungi are now explored as a control method for certain insects, including green leafhopper (GLH) *Nephotettix virescens* and brown planthopper (BPH) *Nilaparvata lugens.*

GLH and BPH were found dead in unsprayed standing rice crops during cold months. Specimens from 26 locations in Tamil Nadu and Kerala States, India, were collected and examined.

Dead insects showed mummification, changes in morphological characters, and outgrowth of fungal tissues, Specimens were washed in three changes of sterile water and plated in sterile agar medium to isolate microorganisms. Nine species of fungi were isolated from GLH and six from BPH. Five species of fungi were common to both insect species (see table).

Pathogenicity tests showed that *Fusarium* sp., isolated from GLH, and *Cephalosporium* sp., isolated from BPH, caused infection and death of both insects 4-7 days after treatment. *Fusarium* sp. caused 72.4 and 48.3% mortality of GLH nymphs and adults and 67.3 and 40.0% mortality of BPH nymphs and adults. *Cephalosporium* sp. caused GLH mortality rate of 70.7 and 37.5% and killed 75.9 and 52.7% BPH nymphs and adults. Spraying fungal suspension containing conidia and mycelia caused higher death rates than spraying the culture filtrate or treating the insects with fungal mass.

**Fungi isolated from *N. virescens* and *N. lugens.***

| Species | Common to both |
|---|---|
| *Aspergillus flavus* | * |
| *Aspergillus niger* | * |
| *Mucor* sp. | * |
| *Phoma* sp. | * |
| *Rhizopus* sp. | * |
| *Penicillium* sp. | |
| *Alternaria tenuis* | |
| *Curvularia* sp. | |
| *Fusarium oxysporium* | |
| *Cephalosporium lecanii* | |

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The two fungal species do not harm rice, cotton, brinjal, tomato, and sorghum. Identification of the *Fusarium* sp. as *Fusarium oxysporium* Schlecht (Booth 1971) was confirmed by Commonwealth Mycological Institute, England. The *Cephalosporium* sp. was identified as *Cephalosporium lecanii* Zimm (Subramaniam 1971). □

### Effect of simulated rainfall on insecticide spray effectiveness

*N. V. Krishnaiah and M. B. Kalode, All India Coordinated Rice Improvement Project, Rajendranagar, Hyderabad 500 030, A.P., India*

During wet season, rainfall causes insecticide sprays to lose effectiveness and spraying often must be repeated. A greenhouse experiment used simulated rainfall and insecticides recommended to control green leafhopper (GLH) and brown planthopper (BPH) to determine the time lapse between insecticide application and rainfall that does not reduce insecticide effectiveness. Carbaryl and monocrotophos (0.05%) were sprayed on 45-day-old TN1 plants with a fine atomizer until runoff.

**Effect of simulated rainfall on effectiveness of insecticide sprays.**

| Insecticide | Time lapse (h) between spray and rainfall | Mortality (%) at days after spraying | | |
|---|---|---|---|---|
| | | GLH | | BPH |
| | | 3d | 8d | 3d |
| Carbaryl (50 WP) | 0.5 | 43 | 17 | 10 |
| | 3 | 40 | 27 | 43 |
| | 24 | 100 | 57 | 87 |
| | No rainfall | 100 | 97 | 100 |
| Monocrotophos (40 EC) | 0.5 | 77 | 70 | 3 |
| | 3 | 83 | 60 | 10 |
| | 24 | 97 | 87 | 30 |
| | No rainfall | 100 | 100 | 80 |
| Untreated control | | 3 | 0 | 0 |

Plants were subjected to about 2 cm simulated rainfall from a sprinkler can fixed 183 cm above the plants 0.5, 3, and 24 h after treatment. Effectiveness was tested by caging GLH adults and BPH nymphs on the plants for 48 h.

Insecticide effectiveness was substantially reduced by rainfall 3 h after spraying (see table). Effect of rainfall after 24 h was small except on monocrotophos used against BPH. □

### Incidence of rice gall midge at Bhubaneswar, Orissa, India

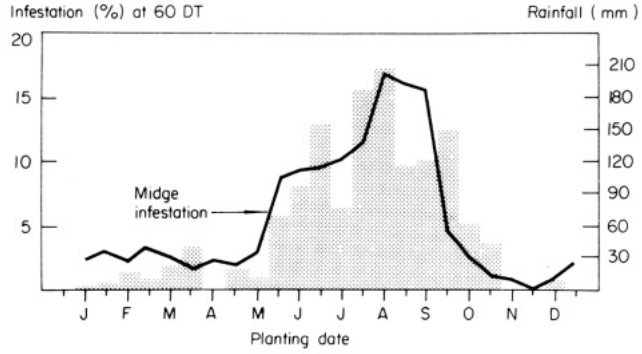
*B. C. Jena, N. C. Patnaik, Orissa University of Agriculture and Technology, Bhubaneswar; and N. Panda, Entomology Department, IRRI*

Rainfall and relative humidity govern the activity of rice gall midge (GM) *Orseolia oryzae* in rice fields and degree of infestation is higher in the wet season than in the dry.

To study the fluctuations of GM attack, susceptible Jaya variety was transplanted in 8-$m^2$ plots at 2-week intervals beginning Jan 1977 and ending Dec 1981. Plantings were replicated 3 times and silvershoot count, total plant population basis, was recorded 60 days after transplanting (DT) in a sample of 240 hills/plot.

GM infestation (see figure) was highest (17%) in Oct, corresponding to Aug planting, which is common among farmers in this rainfed area. Low rainfall months had silvershoot levels below 4%

GM infestation had a positive, significant correlation (n = 72) with the amount of rainfall received during the preceding 15 days ($r$ = 0.446) and 30 days ($r$ = 0.640), indicating the lag effect of rainfall on GM activity. Relative humidity had no lag effect ($r$ = 0.683). □




Gall midge incidence at 60 days after transplanting (DT) in a fortnightly planted Jaya crop.

### Evaluation of some wild *Oryza* species as yellow rice borer hosts

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Yellow rice borer *Scirpophaga incertulas* is regarded as monophagous with exclusive host specificity to rice. African rice *Oryza glaberrima* and 16 wild rice species were compared with established host variety *O. sativa* (cultivar Jaya) to determine other potential hosts (see table).

Newly hatched borer larvae were reared on cut stem pieces until pupation. They were also released on whole plants growing in earthen pots which were observed for damage symptoms and adult emergence.

All larvae placed on *O. perrieri* stem pieces died by the fifth day. Larvae pupated on *O. rufipogon, O. nivara, O. glaberrima,* and *O. latifolia,* as on *O. sativa.* Larvae survived and grew for more than 10 days on the other species but died without pupating.

No visual borer damage appeared for 10 days on 6 species of whole plants and

**Results of rearing newly hatched yellow stem borer larvae on stem pieces and whole plants of wild and cultivated *Oryza* species, Cuttack, India**

| Species | Genome group | Larvae life-span | | |
|---|---|---|---|---|
| | | On stem pieces[a] | On whole plants | |
| | | | Deadhearts produced | Fate of larvae |
| Cultivated rice | | | | |
| *Oryza sativa* Linn. | AA | Pupated | Yes | Moths emerged in 41 days |
| *O. glaberrima* Steud. | AA | Pupated | Yes | Moths emerged in 41 days |
| Wild *Oryza* species | | | | |
| *O. perennis* Moench. | AA | a | Yes | No moth emergence |
| *O. rufipogon* Griff. | AA | Pupated | Yes | Moths emerged in 42 days |
| *O. nivara* Sharma et Shastry | AA | Pupated | Yes | Moths emerged in 41 days |
| *O. barthii* Cheval (=longistaminata) | AA | a | Yes | No moth emergence |
| *O. punctata* Kotschy ex Steud. | BB | a | Yes | No moth emergence |
| *O. eichingeri* Peter | BB | a | No | Larvae not traceable on 10th day |
| *O. officinalis* Wallich | CC | a | No | Larvae not traceable on 10th day |
| *O. collina* Trimen | CC | a | Yes | No moth emergence |
| *O. minuta* Presl. | BBCC | a | No | Larvae not traceable on 10th day |
| *O. alta* Swallen | CCDD | a | Yes | No moth emergence |
| *O. latifolia* Desv. | CCDD | Pupated | Yes | Moths emerged in 42 days |
| *O. grandiglumis* Doell | CCDD | a | Yes | No moth emergence |
| *O. australiensis* Domin | EE | a | Yes | No moth emergence |
| *O. granulata* Nees | GG | a | No | Larvae not traceable on 10th day |
| *O. perrieri* A. Camus | – | b | No | Larvae not traceable on 10th day |
| *O. ridleyi* Hook f. | – | a | No | Larvae not traceable on 10th day |

[a]a= survived for more than 10 days but died without pupation, b = died by 5th day.

dissection showed no larvae. Typical deadhearts appeared in 6-9 days on all other species tested, but moths emerged only from *O. rufipogon, O. nivara, O. latifolia,* and *O. glaberrima* (41-42 days as in *O. sativa*).

Larval development and pupation on stem pieces and larval development to moth emergence on whole plants warrant consideration of *O. glaberrima, O. rufipogon, O. nivara,* and *O. latifolia* as potential yellow rice borer hosts. The first three and *O. sativa* belong to the AA genome group and *O. latifolia* belongs to the CCDD group. □

## Interspecific hybridization between *Nilaparvata lugens* (Stål) and *Nilaparvata bakeri* (Muir) collected from *Leersia hexandra* Swartz

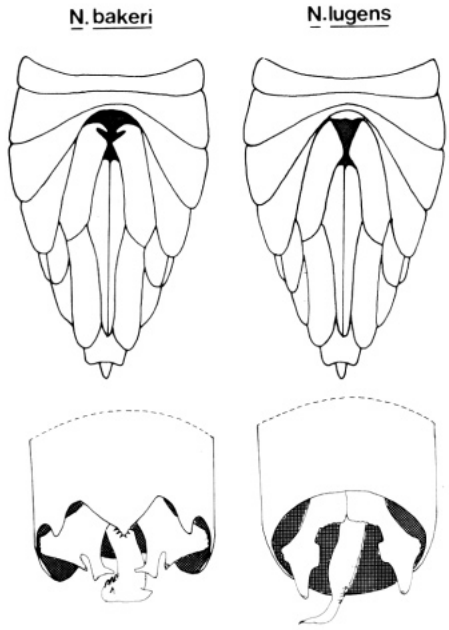
*R. C. Saxena, principal research scientist, International Centre of Insect Physiology and Ecology, and associate entomologist, IRRI; and M. V. Velasco, research aide; and A. A. Barrion, research scholar, IRRI*

A *N. lugens* population was recently observed thriving on a weed grass *L. hexandra* growing in ditches along rice fields on the IRRI experimental farm. Unlike the common rice-infesting brown planthopper (BPH) biotypes, the grass-infesting population does not survive when caged on rice *Oryza sativa* L. plants. Morphological and morphometric evaluation of rostral, leg, and antennal characters of grass-infesting individuals indicated that they are different from BPH biotypes 1, 2, and 3.

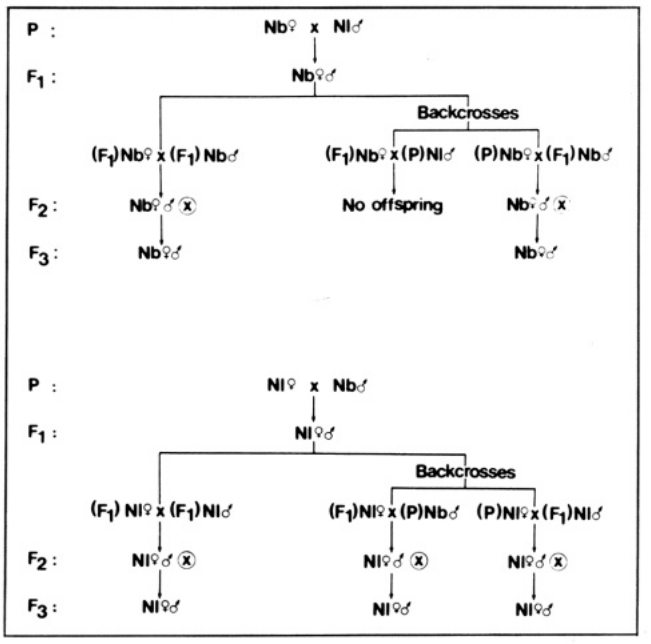
Another closely related planthopper species, *N. bakeri,* also thrives on *Leersia* grass but not on rice. The two species are easily distinguishable by male and female genitalic characters (Fig. 1). The coexistence of the two species on Leersia led us to examine the possibility of interspecific hybridization. Genetic crosses (Fig. 2) were also made to establish the taxonomic status and other biological relationships between the two species. Conspecific crosses of grass-infesting *N. lugens* and *N. bakeri* were the control.

Stock cultures of both species were maintained on potted *L. hexandra* plants in mylar cages. Genetic crosses of the two species were made. Three generations of offspring and backcross progenies yielded the following information:

1. Direct and reciprocal matings of heterogamic parentals resulted in less $F_1$ progenies than those produced by homogamic parentals. Eggs from the heterogamic cross had significantly lower




**1.** Female (top, 20X) and male (bottom, 50X) genitalic characters of *N. bakeri* and *N. lugens* planthoppers, IRRI, 1982.




**2.** Schematic diagram of the genetic crosses between *N. bakeri* (Nb) and *N. lugens* (Nl), IRRI, 1982.

hatchability. Hatchability was 11 and 21% in the direct and reciprocal interspecific crosses, while hatchability in conspecific crosses was 86 and 91%.

2. The genitalic characters of $F_1$ progenies of the interspecific crosses resembled those of their respective immediate female parent. When selfed to produce $F_2$, and backcrossed, a similar genetic transmission mechanism was found. An exception was a backcross involving $(F_1)Nb♀ \times (P)Nl♂$, which failed to produce any offspring. The mechanisms for such maternal inheritance may involve:

a. cytoplasmic inheritance, wherein the characters are determined or controlled by independent cytoplasmic genes;
b. maternal effects, wherein the characters are controlled by nuclear genes, but behave through the effects produced in the maternal cytoplasm; or
c. gynogenesis, wherein the sperm serves only to activate the egg and plays no further part in fertilization nor contributes to the genetic constitution of the embryo.

These observations indicate the existence of some pre- and post-mating barriers between *N. bakeri* and *N. lugens*. Their genetic incompatibility negates possibility of interspecific hybridization occurring in nature. □

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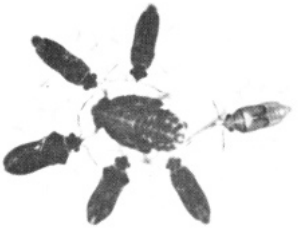
**_Microvelia atrolineata_ Bergroth, a predaceous bug of _Nilaparvata lugens_ (Stål)**

*Gubbaiah, junior entomologist, Regional Research Station, VC Farm, Mandya, Karnataka, India*

Veliid bug *Microvelia atrolineata* was found for the first time in Karnataka during a survey for natural enemies of brown planthopper (BPH) *Nilaparvata lugens* during 1982 wet season. The bugs were feeding on BPH nymphs.

Veliid adults and nymphs were found on the water surface around BPH-infested rice hills. When BPH nymphs dropped onto the water, the veliid bugs paralyzed and fed upon them. As many as six veliid bugs (see figure) attacked a single BPH nymph. There were 10-12 veliid bugs/ 400 $cm^2$ when the crop was at milk stage. Bugs are active and run on the water surface. Population did not fluctuate at different water levels as long as the field remained saturated.

Because veliid bugs feed voraciously on first- and second-instar BPH nymphs, they may contribute to significant pest mortality. □



Veliid bugs attacking a BPH nymph.

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# Pest management and control NEMATODES

**Root-knot nematode damage to rice in West Bengal, India**

*A. K. Pal, district plant protection officer, Balurghat, West Dinajpur, West Bengal, and A. Jayaprakash, assistant nematologist, Central Plant Protection Training Institute, Hyderabad, Andhra Pradesh, India*

Root-knot nematode damaged about 8 10 ha of aus (Mar-Jun) paddy in the drylands of Islampur and Balurghat subdivisions of West Dinajpur. Foliage yellowed, number of tillers and yield were reduced, and plants lost growth vigor.

Plant analysis showed 30 galls and 90 females with or without egg masses/10 g of rice roots. Varieties IET2233, IET1444, and CNM25, grown on seed farms in Islampur and Chopra, were seriously damaged. The nematode also attacked standing crops in farmer fields in Balurghat and Tapan Block.

Nematodes were cultured on TN1. Measurements were:

10 females: length = 395-490 µm, width = 290-350 µm, stylet = 11 µm,

length/greatest width = 1.4.

5 males: length = 1,150-1,248 pm, stylet = 16.5 µm, lengthlgreatest width = 150-175, spicule = 11.5 µm.

20 second-stage juveniles: length = 42040 µm, length/greatest width = 25-27, length/esophagus length = 3.44.0, length/tail length = 6.0-6.5, stylet = 11.5-12 µm.

Measurements and the perineal pattern of females indicated the species is *Meloidogyne graminicola* Golden and Birchfield. The nematode is found in Orissa, Assam, and Tripura States of India; Bangladesh; Thailand; and Louisiana, United States. This is the first record of the nematode in West Bengal. □

**Control of rice root nematode**

*P. Subramanian and B. Velayutham, Nematologv Laboratory, Tiruchi 5, Tamil Nadu, India*

Rice root nematode *Hirschmaniella oryzae* is an important rice pest in India and other countries. Nematode populations are high in flooded, heavy alluvial soils.

Nursery and root-soak pesticide applications were tested for nematode control on IR20 at two locations in Tamil Nadu in 1980-81 (see table). Treatments were replicated thrice in 4-$m^2$ nursery beds and 2 × 1 m plots at 20 × 15 cm spacing.

Root samples were collected at monthly intervals until harvest by randomly uprooting one plant from each plot. Nematodes separated from the roots by the Baermann pan technique were counted. Grain yield, plant height, root length, and root weight were recorded.

Nematode populations ranged from 18 to 270 per 5 g of root examined from different treatments (see table).

Application of carbofuran 3% G at 1 kg ai/ha in the nursery at sowing, followed by phenamiphos or carbosulfone 0.2% root soak, significantly reduced nematode populations and increased grain yield. □

**Effect of pesticides on rice root nematode at 2 locations, Tamil Nadu, India.[a]**

| Nematicide | | Aduthurai | | | | | Sirugamani | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Roots | | | | | Roots | | |
| Seedbed | Seedling root soak | Population (TV) | Plant ht (cm) | Length (cm) | Weight (g) | Grain yield (kg/2 $m^2$) | Population crv) | Plant ht (cm) | Length (cm) | Weight (g) | Grain yield[2] (kg/2 m 1 |
| Carbofuran 3% G 1 kg ai/ha | Carbosulfone 24 EC at 0.2% concn | 6.35 | 94.0 | 30.0 | 27.3 | 0.67 | 7.57 | 77.7 | 32.3 | 28.0 | 0.75 |
| Carbofuran 3% G 1 kg ai/ha | Phenamiphos 40 EC at 0.2% concn | 7.17 | 94.3 | 30.3 | 19.0 | 0.71 | 5.70 | 82.3 | 36.7 | 30.0 | 0.78 |
| Metham sodium 77.5 kg ai/ha | Dimethoate 30 EC at 0.2% | 9.90 | 84.0 | 23.7 | 17.0 | 0.42 | 8.10 | 79.3 | 33.0 | 23.3 | 0.45 |
| Metham sodium 77.5 kg ai/ha | – | 10.20 | 89.7 | 27.7 | 25.3 | 0.41 | 9.87 | 78.3 | 32.0 | 21.7 | 0.47 |
| Untreated check | | 11.63 | 81.7 | 31.3 | 20.0 | 0.41 | 13.20 | 70.7 | 28.7 | 22.0 | 0.39 |
| C. D. | | 1.33 | N.S. | 4.0 | 3.7 | 0.061 | 1.33 | 6.0 | 4.57 | N.S. | 0.06 |

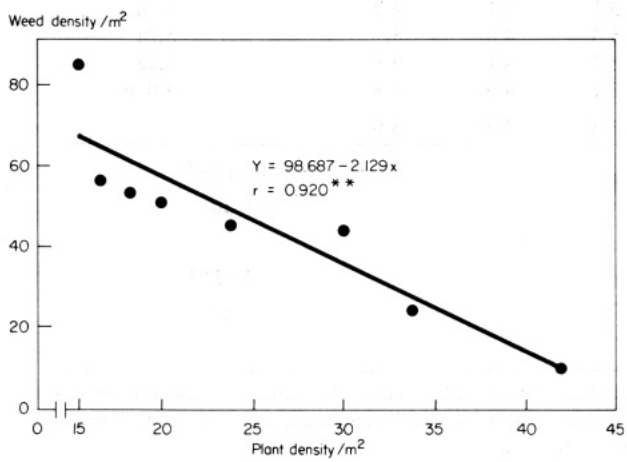
[a]Means for 3 replications. [b]TV = transformed values of $\sqrt{x+0.5}$ where 'x' stands for the nematode population.

# Pest management and control WEEDS

**Effect of planting density and submergence level on weed density in rice fields**

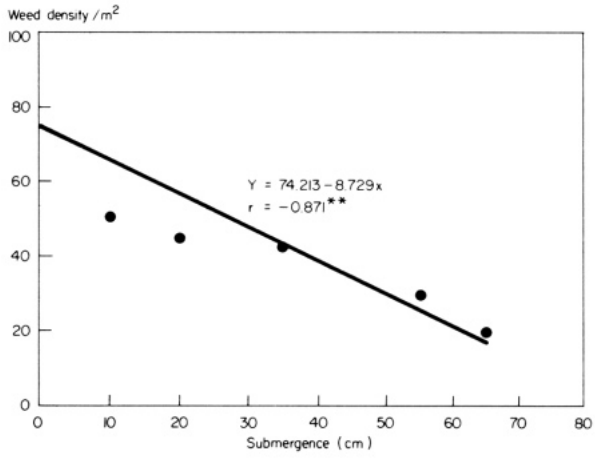
*S. S. Kolhe, P. P. N. Rao, and B. N. Mittra, Agricultural Engineering Department, Indian Institute of Technology, Kharagpur 721302, India*

Effect of planting density and submergence level on weed density was recorded at 70 sites in Nadia District, West Bengal, during the 1981 wet season. Sites were planted with medium-duration improved rice varieties.




**1.** Relationship between planting density and weed density.

Planting density and submergence level were significantly but negatively correlated with and substantially affected weed density. Weed density decreased from 84 to 10 weeds/$m^2$ when planting density was increased from 15 to 42 hills/$m^2$ (Fig. 1). Increasing submergence level from 0.0 to 6.5 cm reduced weed density from 94 to 20 weeds/$m^2$ (Fig. 2). □




**2.** Relationship between submergence and weed density.

Submergence (cm)

*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.*

# Soil and crop management

### Influence of seed rate and timing of fertilizer application on wet seeded rice yield

*Prasert-Songmuang, Nikool Rangsichon, and Wittaya Seetanun, Rice Fertilization Research Branch, Soil Science Division, Bangkok, and Suphan Buri Rice Experiment Station (SBRES), Suphan Buri, Thailand*

Transplanted rice area in the central plain of Thailand is diminishing and wet seeded rice area is increasing, especially in irrigated systems. An experiment to determine optimum seed rate and timing of fertilizer application for wet seeded rice was conducted at SBRES during the 1981 dry season.

Soil at the experimental site was Nakhon Pathom clay, with pH 5.1, 2.97% organic matter, and cation exchange capscity 22 meq/100 g soil. Pregerminated seeds were sown at 62, 94, and 125 kg/ha. Ammonium phosphate (16-20-0) at 219 kg/ha was applied at different times after sowing and 200 kg ammonium sulfate (21% N)/ha was applied at panicle initiation.

Results showed that 62 kg seed/ha was optimum and suggested that chemical fertilizer can be applied up to 30 days after sowing (see table). □

**Effect of seed rate and time of fertilizer application on grain yield of RD7 rice (av of 4 replications). Suphan Buri Rice Experiment Station, 1981 dry season.**

| Time of fertilizer application[a] | Grain yield (t/ha) at seed rate of | | | Mean yield[b] |
|---|---|---|---|---|
| | 62 kg/ha | 94 kg/ha | 125 kg/ha | (t/ha) |
| Incorporated BS | 5.5 | 4.9 | 5.2 | 5.2a |
| 10 DS | 5.5 | 5.1 | 4.9 | 5.2a |
| 20 DS | 5.5 | 4.8 | 5.2 | 5.2a |
| 30 DS | 5.5 | 5.1 | 4.9 | 5.2a |
| 40 DS | 5.1 | 4.6 | 4.8 | 4.8 b |
| Mean | 5.4 | 4.9 | 5.0 | |

| | | F value[c] |
|---|---|---|
| Seed rate (R) | | 8.30* |
| CV (a) | 8.7% | |
| Time of fertilizer application (T) | | 4.02** |
| R × T | | < 1[ns] |
| CV (b) | 5.5% | |

[a]BS = before sowing, DS = days after sowing. [b]Means followed by the same letter are not significantly different among themselves. [c]*Significant at 5% level; **significant at 1% level. ns = nonsignificant. LSD 0.05 for 2 seed rate means = 0.1 t/ha.

### Effect on ratoon rice of cutting height and time of nitrogen application on the main crop

*Md. Abdul Quddus, scientific officer, Division of Rice Cropping Systems, Bangladesh Rice Research Institute; and J. W. Pendleton, Multiple Cropping Department IRRI*

Ratoon rice may increase production where limited rainfall and soil moisture reduce cropping intensity. We studied the effect of main-crop management practices on the performance of ratoon rice at the IRRI farm July 1980 to January 1981.

Nitrogen was applied on breeding line IR9784-2-3-2 as described in Table 1. The main crop was harvested by cutting 5 cm and 15 cm above soil surface and by ani-ani (a method where only the panicles are cut). Plants were cut to 15 cm 7 days after the ani-ani harvest. Two days after harvest 40 kg N/ha was applied to all plots. To encourage tiller growth, fields were flooded with 2-3 cm water 2-3 days after harvest. Water depth was gradually increased to 5-7 cm and maintained at that level until grain ripened.

Nitrogen application at different main-crop plant growth stages did not affect grain yield or other plant characters of the main crop (Table 1). Yield was not influenced by cutting height, but a 5-cm cutting height produced significantly

**Table 1. Grain yield and other plant characters of the main crop of IR9784-2-3-2 as affected by N application. IRRI, 1980 wet season.**

| Treatment (kg N/ha) | | | | | Plant characters[a] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Basal | Panicle initiation | Early milk stage | Late milk stage | 7 days before harvest | Grain yield (t/ha) | Tillers (no./$m^2$) | Panicles (no./hill) | Filled grains (no./panicle) | 100-grain weight (g) |
| 60 | 30 | 0 | 0 | 0 | 3.6 | 425 | 16 | 49 | 2.2 |
| 30 | 30 | 30 | 0 | 0 | 3.5 | 415 | 15 | 46 | 2.2 |
| 30 | 30 | 0 | 30 | 0 | 3.7 | 448 | 16 | 43 | 2.1 |
| 30 | 30 | 0 | 0 | 30 | 3.6 | 439 | 15 | 48 | 2.1 |

[a]Av of 4 replications. Analysis of variance showed no difference between treatments at 5% probability level.

higher percentage of missing hills than harvesting at 15 cm or by ani-ani (Table 2). At 5 cm, panicles per hill or per unit area were less than for other treatments. Difference in grain yields was not statistically significant. Plants cut at 5 cm height had more healthy ratoon tillers, heavier grains, and more even maturity than other treatments. They matured in 74 days versus 65 days for 15 cm and 69 days for ani-ani. □

**Table 2. Grain yield and other plant characters of a ratoon crop of IR9784-2-3-2 as affected by cutting height of main crop. IRRI, July 1980-January 1981.**

| Cutting height (cm) | Plant character[a] | | | | | |
|---|---|---|---|---|---|---|
| | Grain yield (t/ha) | Productive tillers (no./$m^2$) | Panicles (no./hill) | Missing hills (%) | Field duration (days) | 100-grain weight (%) |
| 5 | 0.6a | 237 b | 10 b | 7.0a | 74a | 2.2a |
| 15 | 0.5a | 323a | 13a | 5.2 b | 65 c | 2.1 b |
| ani-ani fb 15 cm | 0.6a | 316a | 13a | 3.8 b | 69 b | 2.2a |

[a]Av of 4 replications. In a column, means followed by a common letter are not significantly different at 5% level. Also an average of all N treatments. fb = followed by.

### Azolla application and rice crop response in Tamil Nadu

*S. Kannaiyan, M. Thangaraju, G. Alagirisami, J. Venkatakishnan, S. Kanagaraj, and G. Oblisami, Agricultural Microbiology Department, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India*

Azolla is a water fern that fixes nitrogen (N) in association with N-fixing blue-green alga *Anabaena azollae.* Four field experiments were conducted during 1981-82 samba (Oct-Feb). IR20 (at Coimbatore), Bhavani (Ahyarnagar), IR20 (Tirurkkuppam), and Ponni (Ambasamudrum) were evaluated using treatments described in the table.

Grain yield for all treatments was higher than for the untreated control. Plots treated with 30 kg N/ha and 30 kg N/ha as azolla at 40 × 10 cm spacing had maximum grain yield followed by plots treated with 60 kg N/ha at 20 × 20 cm spacing at Aliyarnagar center (see table). A similar trend was observed at Ambasamudrum center, but at Tirurkkuppam center plots treated with 60 kg N/ha at 30 x 20 cm spacing had maximum grain yield. At Coimbatore, maximum grain yield was for plots with azolla incorporation as green manure before planting and azolla grown twice as dual crop until heading. Results clearly show the positive influence of azolla inoculation in increasing grain yield. □

**Rice crop response to azolla, Tamil Nadu, 1982.**

| Treatments[a] | Yield (t/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Coimbatore | | Ambasamudrum | | Aliyarnagar | | Tirurkkuppam | |
| | IR20 | % increase | Ponni | % increase | Bhavani | % increase | IR20 | % increase |
| Uninoculated control, 20 × 20 cm | 2.7 | – | 3.2 | – | 1.9 | – | 1.9 | – |
| 60 kg N/ha, 20 × 20 cm | 4.3 | 59 | 3.9 | 21 | 2.9 | 54 | 2.9 | 52 |
| 60 kg N/ha, 40 × 10 cm | 4.1 | 52 | 3.9 | 21 | 2.7 | 43 | 2.7 | 44 |
| 30 kg N/ha by azolla + 30 kg N/ha, 20 × 20 cm | 4.3 | 58 | 3.8 | 18 | 2.7 | 45 | 2.4 | 25 |
| 30 kg N/ha by azolla + 30 kg N/ha, 40 × 10 cm | 4.2 | 53 | 4.0 | 23 | 2.9 | 55 | 2.4 | 29 |
| Azolla GM + azolla DC, 20 × 20 cm | 4.4 | 64 | 3.7 | 14 | 2.6 | 38 | 2.6 | 36 |
| Azolla GM + azolla DC, 40 × 10 cm | 4.1 | 51 | 3.5 | 9 | 2.4 | 27 | 2.4 | 29 |
| Azolla DC, 40 × 10 cm | 4.1 | 50 | 3.4 | 3 | 2.5 | 32 | 2.5 | 35 |
| | C.D. = 497 | | C.D. = 387 | | C.D. = 910 | | C.D. = 210 | |

[a]GM = green manure, DC = dual crop. N was applied as 3 splits. *Azolla pinnata* was inoculated at 300 g/$m^2$ on the 7th day after planting.

**Mineral nitrogen distribution in a paddy soil profile**

*F. R. Pedrazzini, C. N. R. Institute of Soil Chemistry, Via Corridoni, 78, 56100 – Pisa, Italy*

Monthly recordings of $NH_4^+$-N and $NO_3^-$-N were made in soil profiles of four commercial fields during the rice growing season.

Soil samples were collected at the end of Mar 1981 and at monthly intervals from May through Sep at 0-15, 15-30, 30-45, and 45-60 cm depths.

Rice fields, continuously flooded until Aug, were located near Mortara (Pavia, Italy) in the middle of a region where, during 1979, rice production totaled 288,500 t on 54,381 ha.

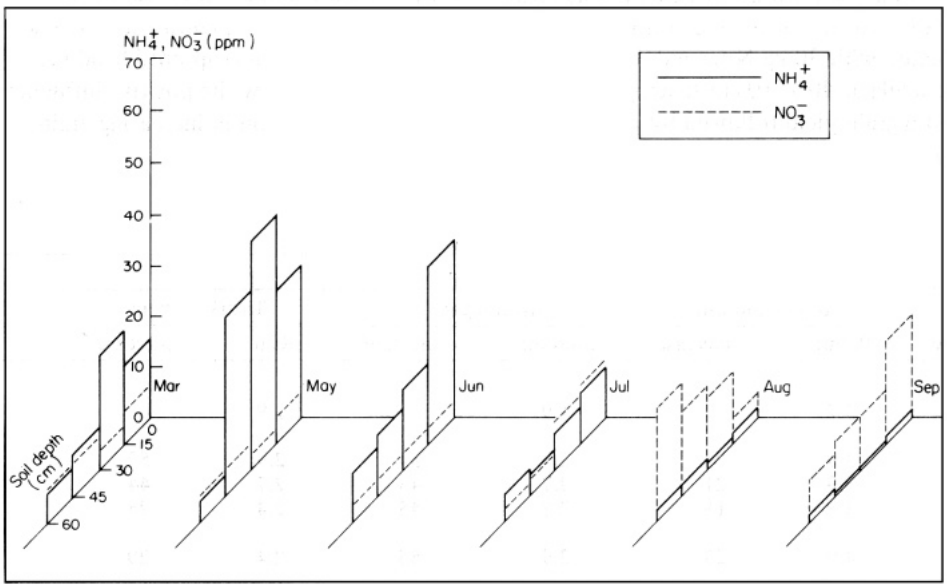
Fields had different soil characteristics, fertilization rates, and management (see table), but they showed a homogeneous rate of mineral nitrogen use. Commercial fields are usually fertilized before flooding and about 1 month after flooding. Fertilizers are scattered on the soil surface.

Ammonium was the dominant form of inorganic nitrogen in the soil during the first half of the rice growing season. Levels were higher on the surface and lower at the 45-60 cm depth (see figure).

**Soil analysis and dates and kind of cultural practices, Mortara, Italy.**

| Field | Soil pH | % sand | % silt | % clay | Cation exchange capacity (meq/100 g) | Organic matter (%) | Flooding date | Seeding date | Basal application[a] (kg/ha) | Topdressing (kg/ha) and date |
|---|---|---|---|---|---|---|---|---|---|---|
| Giarre I | 4.4 | 87.6 | 7.6 | 5.2 | 11.9 | 2.06 | 1 May 81 | 4 Apr 81 | 150 K<br>90 P<br>70 N | 30 N<br>5 Jun 81 |
| Giarre II | 5.7 | 78.1 | 12.3 | 6.7 | 13.4 | 2.2 | 17 Apr 81 | 21 Apr 81 | 60 K<br>40 P<br>50 N | 20 N<br>18 May 81 |
| Mede | 5.8 | 63.0 | 21.4 | 15.4 | 18.7 | 2.4 | 29 Mar 81 | 13 Apr 81 | 40 K<br>46 P<br>49 N | 15 K<br>15 P<br>70 N<br>2 May 81 |
| Campalestro | 5.4 | 77.5 | 13.7 | 8.8 | 17.4 | 1.8 | 13 Apr 81 | 21 Apr 81 | 130 K<br>50 P<br>50 N | 70 N<br>2 May 81 |

[a]For nitrogen fertilization, the following compounds in granular form were used: urea in Giarre I, $CaCN_2$ and $(NH_4)_2SO_4$ in Giarre II and Campalestro, $CaCN_2$, $(NH_4)_2SO_4$, and urea in Mede.




Ammonium and nitrate content in a paddy soil profile during rice culture at Mortara, Italy.

After June, $NH_4^+$–N decreased and $NO_3^-$-N increased, perhaps because of $NH_4^+$-N oxidation in the surface aerobic layer.

During Aug and Sep very low levels of $NH_4^+$-N were detected in the soil and nitrate content increased. This was related to field drainage, and the consequent increase in soil oxygen content which encouraged $NH^+_4$-N oxidation to $NO_3^-$-N.

During Aug, $NO_3^-$-N accumulated in lower soil depths and in Sep higher $NO_3^-$-N content was found in the surface layer, which indicates a possible nitrate reduction in the soil depth. Moreover, relative $NO_3^-$-N abundance in the surface layer at the end of the rice growing season could have led to nitrate leaching during autumn rainfall. □

*The International Rice Research Newsletter (IRRN) invites all scientist 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.*

### Nutrient use efficiency and upland rice yield

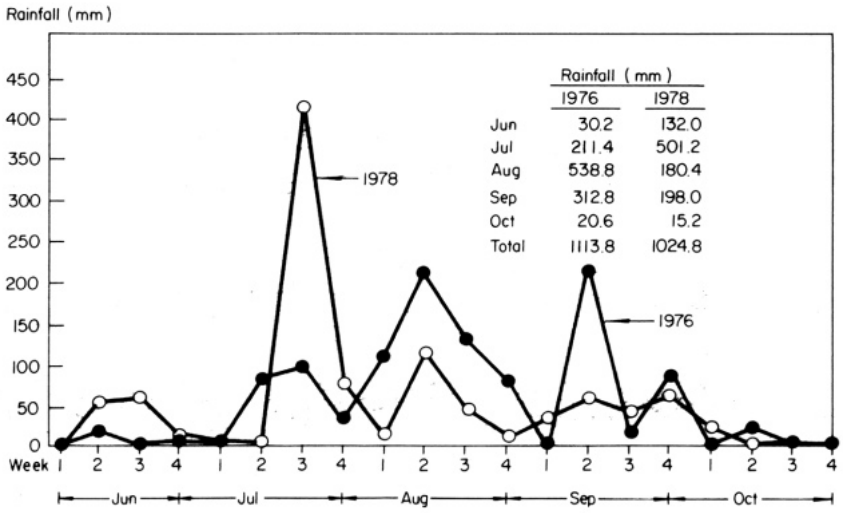
*T. N. Singh, G. Singh, and H. P. Singh, Crop Physiology Department, Narendra Dev University of Agriculture and Technology, Faizabad-224001 (U.P.), India*

Eastern Uttar Pradesh is a major rice growing area which often has drought that makes rice culture risky. Average rainfall is about 1,000 mm, but distribution is erratic.

A field experiment in sandy loam soils to determine varietal response to added nitrogen was conducted in 1976 and repeated in 1978 at Faizabad. Eleven semidwarf and tall rice varieties were grown at 0, 20, 40, 60, and 80 kg N/ha. Phosphorus (13 kg/ha) and potassium (25 kg/ha) were applied at sowing. Nitrogen was applied basally in two equal splits at sowing and tillering. Plots were direct-seeded at 100 kg/ha in rows 20 cm apart after the first rains in July. Figure 1 shows weekly rainfall distribution during the two seasons.

Grain yield in 1976 increased at all nitrogen application levels. IET826 (3.3 t/ha) yielded highest, followed by IET2918 (3.0 t/ha) and FH109 (2.8 t/ha). N22 and Brown Gora yielded 2.5 and 2.4 t/ha. Other variety yields were intermediate.

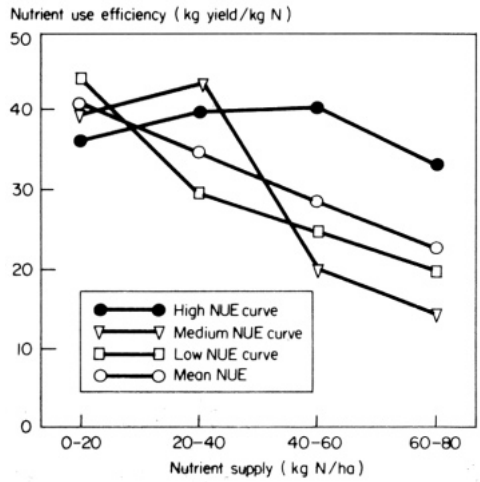
In 1978 IET826 (2.6 t/ha) yielded highest, followed by IET1444 (Rasi) (2.5 t/ha). N22 had the lowest yield – 2.1 t/ha.




**1.** Distribution pattern of rainfall at Faizabad, India, 1976 and 1978.

Nutrient use efficiency (NUE) was calculated for each genotype by dividing the quantity of additional grain yield produced by the nitrogen applied (Fig. 2).

IET826 and IET1444 (Rasi) had a high NUE curve; IET2918, IET2912, Brown Gora, KR-5-142, and Cauvery had a medium NUE curve; and IET3226, FH109, N22, and IET2232 (Narendra 1) had a low curve. □




2. Nutrient use efficiency (NUE) trends of selected upland rice strains, Faizabad, India, 1976 and 1978.

### Growth rate of azolla in Colombia

*W. J. Zimmerman, Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211*

Azolla quickly adapted to simulated in situ conditions when transferred from slow-growing maintenance or storage cultures. Although storage cultures had near-stationary growth rate, the azolla achieved normal growth rate within a week after transfer into simulated environments.

Six of 11 Colombian isolates of *Azolla filiculoides* (provisional designation) were tested at the University of Florida, Gainesville. During the first week after transfer, most isolates doubled fresh weight (FW) in 2 days and dry weight (DW) in less than 72 hours, when grown at moderate light levels (15 klux, 18-hour days) and temperature (26°C day, 22°C night) (Table 1). Doubling increased to 3 days for FW and 4 days for DW the second week after inoculation, probably because of crowding.

Growth rate of the storage culture inoculum, and the conditions of the storage environment affected turnover time and final biomass harvests. In Monteria-3 FW doubling average was 3.20 times and the DW doubling was 3.41 times during the first 7 days of the growth test when the inoculum

**Table 1. Isolate doubling times.**

| Isolate | Doubling time (days) | | | |
|---|---|---|---|---|
| | 1 wk | | 2 wk | |
| | FW | DW | FW | DW |
| Monteria-2 | 2.40 ± 0.44 | 2.26 ± 0.35 | 2.45 ± 0.20 | 2.81 ± 0.30 |
| Monteria-3 | 2.17 ± 0.11 | 2.11 ± 0.08 | 3.36 ± 0.24 | 4.23 ± 0.22 |
| CIAT | 2.00 ± 0.04 | 2.06 ± 0.06 | – | – |
| Amazon-C | 1.92 ± 0.27 | 1.96 ± 0.21 | – | – |
| Amazon-R | 2.01 ± 0.11 | 1.93 ± 0.13 | 3.22 ± 0.54 | 4.24 ± 0.99 |
| Amazon-Y | 1.96 ± 0.21 | 1.88 ± 0.14 | 3.33 ± 0.28 | 3.85 ± 0.46 |

was obtained from an in vitro culture with a high growth rate (trial 1). FW doubling was reduced to 3.06 times and DW 3.25 times when the inoculum was obtained from storage cultures with a minimal growth rate (trial 2). FW doubling fell to 3.14 times and DW to 2.94 times when the inoculum came from storage cultures with near-stationary growth rate, that had been subjected to very low (less than 10 klux) light intensities (trial 3).

Regardless of preinoculation conditions, the growth rate of this isolate (FW measurement) showed an initial lag phase followed by an increase during the first 7 days of the trial. During FW growth rate increase, growth rate determined by DW was decreased correspondingly. At 7 days, the DW and FW growth rates were similar (Table 2).

Another azolla isolate, Amazon-R, was incubated for 24 hours under stress parameters (darkness, 35°C). Subsequent FW diurnal growth rate remained consistently depressed (0.33) for 2 weeks. DW rate decreased 0.56 to 0.38 in 1 week, and to 0.27 in 2 weeks. Nonstressed replications showed a stable FW rate (0.54 to 0.53) and a higher, albeit decreasing, DW rate (0.63-0.49) in the first week. At 2 weeks FW (0.31) and the DW (0.31) growth rates resembled those of the stressed replications. Total doublings were 2.24 FW and 2.67 DW after 7 days for stressed samples, and 3.73 FW and 3.43 DW for nonstressed ones. □

**Table 2. Daily growth rates of Monteria-3.**

| Time lapse | Daily growth rate | | | | | |
|---|---|---|---|---|---|---|
| | Trial 1[a] | | Trial 2[b] | | Trial 3[c] | |
| | FW | DW | FW | DW | FW | DW |
| 1-day | 0.24 ± 0.06 | 0.54 | 0 | 0.39 ± 0.14 | 0 | 0.47 ± 0.24 |
| 2-day | 0.53 ± 0.01 | 0.69 ± 0.08 | 0.07 ± 0.06 | 0.26 ± 0.13 | 0.21 ± 0.07 | 0.43 ± 0.10 |
| 3-day | 0.43 ± 0.02 | 0.58 ± 0.04 | 0.37 ± 0.07 | 0.55 ± 0.10 | 0.40 ± 0.05 | 0.52 ± 0.03 |
| 4-day | – | – | – | – | 0.38 ± 0.06 | 0.51 ± 0.04 |
| 5-day | – | – | – | – | 0.43 ± 0.08 | 0.46 ± 0.07 |
| 6-day | – | – | – | – | 0.46 ± 0.02 | 0.47 ± 0.03 |
| 7-day | 0.46 ± 0.02 | 0.48 ± 0.02 | 0.44 + 0.03 | 0.47 ± 0.02 | 0.44 ± 0.05 | 0.44 ± 0.02 |
| 14day | 0.30 ± 0.02 | 0.24 ± 0.02 | – | – | 0.33 ± 0.02 | 0.29 ± 0.02 |

[a]Trial 1: no difference between storage and growth trial conditions. [b]Trial 2: inoculum not in active growth phase. [c]Trial 3: inoculum not in active growth and stored under < 10 klux.

## Differential tolerance of rices for low-sulfur soils

*C. P. Mamaril, IRRI, and E. O. Momuat and Ch. J. S. Momuat, Maros Research Institute for Food Crops, South Sulawesi, Indonesia*

Forty-three lines or varieties were studied for reaction to low-sulfur soils in irrigated fields during the wet season in South Sulawesi. Soil at the test site was a Typic Tropaquept with H 6 2, 2.66% organic matter, 4.2 µg $SO_4^{2-}$–S/kg, 23 mmol cation exchange capacity/kg, and clay loam texture.

Entries were grown in unreplicated treated and untreated plots. Eighty kg S/ha as ammonium sulfate was applied to the treated plot, and 100 N, 26 P, and 50 K kg/ha were applied to both plots. Each entry was planted in four 3-m-long rows at 20 × 20 cm spacing.

Plant height, tiller number, days to maturity, and grain yield per hill varied by variety. Marked differences were observed in grain yield per hill and days to maturity. Using those parameters, the 43 entries were divided into 4 groups: similar grain yield and days to maturity for both treatments, different grain yield and similar days to maturity, similar grain yield and different days to maturity, and different grain yield and days to maturity (see table). Treated and Untreated plots were considered different when they varied by at least 15% in yield and 7 days in maturity. Results suggest that rices have different reactions to low-S soil in terms of the plant parameters measured.

**Reaction of some rice lines or varieties to low-sulfur soil by grain yield and days to maturity.**

| Line or variety | Grain yield (g/hill) | | Days to maturity | |
|---|---|---|---|---|
| | +S | –S | +S | –S |
| Similar yield, maturity | | | | |
| IR34 | 74.2 | 67.9 | 131 | 135 |
| IR2070-24-1-5-1 | 56.2 | 49.6 | 131 | 135 |
| Pulu bolong | 36.1 | 33.8 | 147 | 149 |
| Ase lelleng | 50.4 | 50.9 | 149 | 149 |
| Mean of 9 lines or varieties | 52.9 | 51.8 | 136 | 138 |
| Similar yield, different maturity | | | | |
| IR20 | 75.7 | 71.1 | 119 | 133 |
| IR.2307-233-3 | 62.1 | 61.1 | 117 | 135 |
| SPR6726-76-2-3 | 50.8 | 51.1 | 115 | 126 |
| Pelita I/1 | 76.7 | 70.7 | 128 | 135 |
| Mean of 9 lines or varieties | 61.0 | 61.8 | 121 | 134 |
| Different yield, similar maturity | | | | |
| IR28 | 60.8 | 34.5 | 112 | 115 |
| IR30 | 73.7 | 40.6 | 112 | 115 |
| IR36 | 63.6 | 51.8 | 112 | 115 |
| Banda | 79.8 | 33.4 | 159 | 161 |
| Mean of 12 lines or varieties | 59.5 | 38.3 | 131 | 133 |
| Different yield, maturity | | | | |
| 1132153-26-3-5-4 | 64.2 | 48.9 | 115 | 131 |
| B2376-9-1 | 80.9 | 61.3 | 115 | 128 |
| B462c-Pn-1-3 | 66.0 | 41.5 | 117 | 126 |
| Syntha | 78.0 | 59.3 | 128 | 140 |
| Mean of 13 lines or varieties | 62.9 | 42.6 | 118 | 132 |

### Efficiency of urea applied to rice by various methods

*Amanullah Bhatti, Habibur Rehman, and Akbar Hussain Gurmani, Agricultural Research Station, Tarnab, Peshawar, Pakistan*

Efficiency of urea applied to rice by different methods was studied at Dera Ismail Khan District, northwest frontier province of Pakistan. The field experiments were conducted for 2 years on soil with 48% clay, 15% $CaCO_3$ low organic matter content (0.5l%), and a pH of 7.9. Urea was applied at 120 kg N/ha at transplanting. A basal dose of 35 kg P/ha was applied as single superphosphate (9% P). IR6 was grown.

Results for grain yield were highly significant (see table). The highest paddy yield (7.3 t/ha) was obtained when urea was incorporated into dry soil before flooding. All fertilizer treatments increased the yields significantly over the control. Wet soil application gave lower yield than dry soil application.

Dry soil urea incorporation also produced the highest straw yield and panicles per square meter, and gave highest net return per hectare and value cost and response ratio. □

**Effect of urea application methods on rice yield.**[a]

| Treatment | Yield (t/ha) | | Increase (t/ha) over no urea | | Value cost ratio (VCR)[b] | Grain nutrient ratio | Panicles (no./$m^2$) | 1,000-grain wt (g) |
|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | | | | |
| No urea | 3.6 | 5.7 | – | – | – | – | 269 | 21.8 |
| Urea broadcast on dry soil before flooding | 6.2 | 11.1 | 2.6 | 5.4 | 6.49 | 21.41 | 496 | 22.8 |
| Urea broadcast on dry soil before last planking | 6.5 | 10.7 | 2.9 | 5.0 | 7.24 | 24.81 | 514 | 22.5 |
| Urea incorporated in dry soil before flooding | 7.3 | 12.8 | 7.7 | 7.1 | 9.51 | 31.08 | 527 | 22.8 |
| Urea added in furrows in dry soil before flooding | 7.0 | 11.3 | 3.4 | 5.6 | 8.54 | 28.16 | 527 | 23.2 |
| Urea broadcast in paddy water before transplanting | 5.3 | 8.5 | 1.7 | 2.8 | 4.32 | 14.25 | 391 | 22.5 |

[a] Av of 2-year results. Results of individual years were significant, but analysis of combined data was not done. [b] Value of rough rice = US$122.5/t; cost of urea fertilizer = US$48.52/120 kg N. Value of straw is not included in the VCR.

### Effect of neem cake on azolla growth and nitrogen fixation

*S. Kannaiyan, M. Thangaraju, and G. Oblisami, Agricultural Microbiology Department, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India*

Azolla is a free-floating nitrogen-fixing fern that plays an important role in the rice soil ecosystem. During January 1982, a field experiment in randomized block design with three replications measured the effect of neem cake on azolla growth and multiplication. Plots were prepared and neem cake at 25, 50, 75, 100, 125, 150, 175, and 200 kg/ha was applied. *Azolla pinnata* (CBE strain) was inoculated at 200 g/$m^2$ and allowed to grow for 20 days. Azolla fresh weight per plot was recorded.

Neem cake significantly increased azolla growth at all application levels (see table). Azolla growth increased with increased neem cake application, and neem reduced *Pyralis* sp. pest infestation considerably. In a pot experiment, azolla was grown with neem cake at 250 to 3,000 ppm levels. Azolla nitrogenase activity and chlorophyll content increased significantly.

**Effect of neem cake on *A. pinnata* growth in the field, Tamil Nadu, India, 1982.**

| Neem cake (kg/ha) | Mean azolla yield (kg/3×2 m plot) | % increase over control | Doubling time (days) |
|---|---|---|---|
| Control | 4.22 | – | 11.02 |
| 25 | 6.91 | 63.74 | 7.92 |
| 50 | 8.22 | 94.78 | 7.20 |
| 75 | 8.28 | 96.20 | 7.18 |
| 100 | 8.37 | 98.34 | 7.18 |
| 125 | 9.26 | 117.43 | 6.78 |
| 150 | 10.91 | 158.53 | 6.30 |
| 175 | 10.25 | 142.89 | 6.46 |
| 200 | 10.81 | 164.70 | 6.36 |

C. D. = 2.142
(C. D: P = 0.01)

*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.*

# Environment and its influence

**Panicle transpiration studies in north-eastern Sri Lanka**

*John Roberts, plant physiologist, and C. H. Batchelor, agricultural hydrologist, Institute of Hydrology, Wallingford, Oxfordshire, UK*

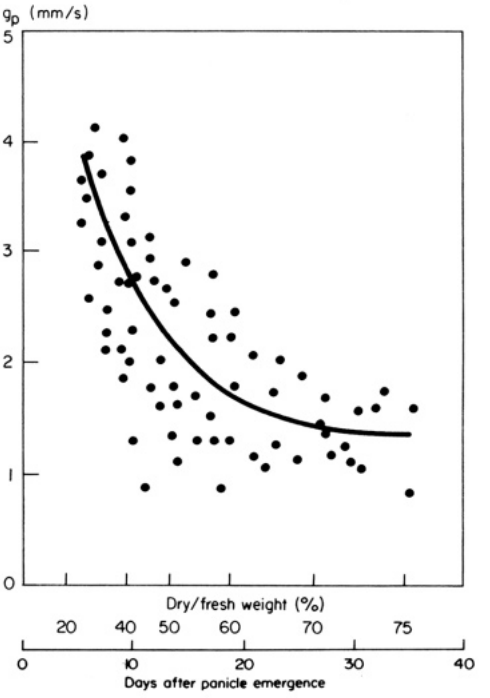
During a study of dry season water use of flooded rice in northeastern Sri Lanka, the contribution of the panicles to canopy transpiration was examined. The studies were made on cultivar BG200/75 growing in the Polonnaruwa region.

In June 1982, when the transpiration of BG200/75 was measured, the mean air temperature during the daytime was 30.2°C and mean vapor pressure deficit was 15 mb. Average daily solar radiation was 18.3 MJ/m$^2$. There was no rainfall except for one short, intense storm.

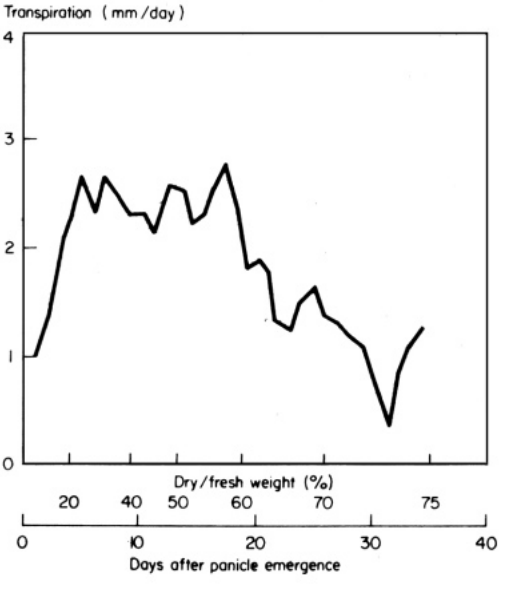
Stomatal conductance of panicles and foliage was determined using diffusion porometers, and aerodynamic conductance was estimated from the rates of water loss from wetted replicas of leaves and panicles. These conductances, along with current environmental variables, were used in the Monteith version of the Penman formula for crop transpiration. In addition, direct measurements of panicle transpiration were made by weighing detached panicles before and after a 10-minute period. Although the technique of weighing detached panicles is said to underestimate transpiration, trends with both methods were similar.

Very little fluctuation in panicle conductance and transpiration was observed during sample days, but a marked decline was associated with panicle ageing (Fig. 1). The highest rates of transpiration from the panicles occurred immediately after emergence. Flowering is from top to bottom of a panicle and takes several days. Transpiration decline in any panicle is probably associated with gradual cessation of flowering and the onset of grain filling. On the crop scale, however, panicle contribution to transpiration does not decline so abruptly because of staggered panicle emergence among tillers. Initial panicle transpiration can be 3 mm/day (Fig. 2). Total crop transpiration at this time can be 9 mm/day, with an additional 2 mm evaporated from irrigation water.

Panicle transpiration is considered a mechanism for maintaining low flower temperature and for reducing sterility. Further work is warranted on conductances and panicle transpiration, in particular immediately after emergence, under a range of soil water conditions. Information should be obtained on the quantities and distribution of stomata within the flower structure in a range of genotypes. In addition the aerodynamic conductance of water vapor away from panicles at different degrees of exposure above the crop should be evaluated. □




**1.** Decrease in panicle diffusive conductance ($g_p$) as panicles age, and the relationship of dry/fresh weight percentages and age.




**2.** Changes in the daily rate of transpiration from panicles as they age.

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P. L. Mohanty and N. P. Sarma. Fertility restorers for cystosterile stocks. IRRN 8:2 (Apr. 1983), 3-4.

In the table on page 3, under the column heading *Maintainers (non-restorers), Kaveri* should read *Cauvery.* □

# Consequences of new technology

### Understanding recommended rice cultural practices as related to farmer adoption

*P. S. Geethakutty and M. K. Sethu Rao, University of Agricultural Sciences, Hebbal, Bangalore 560024, India*

Effective utilization of a new technology demands that users understand the principles behind the technology. This study investigated the relationship between understanding the principles of recommended rice cultural practices and their adoption by farmers.

Rice is the main grain crop of Kerala State, representing more than 35% of the cropped area. In Mavelikara and Karthikappally taluks of Alleppey district, 125 randomly selected rice farmers were the respondents — 60 were contact farmers visited by extension workers on regularly scheduled days and 65 did not have regular extension contacts. A knowledge test related to principles of practices was developed, standardized, and administered to the respondents. Farmers were grouped as having high or low understanding based upon the mean knowledge score. The same procedure was used to rate adoption score, based on the mean adoption score of nine cultivation practices.

Zero order correlations between understanding of principles and culturai adoption were calculated. For both farmer categories the correlation coefficient between understanding the principles and adoption were highly significant (0.860 for contact farmers and 0.888 for noncontact farmers) (Table 1).

A $x^2$ test was also used to establish this relationship. Significant $x^2$ values showed a strong association between understanding and adoption for both groups of farmers (Tables 2 and 3).

The results confirm that when principles of practice are emphasized with strong procedures of the practice, farmers can easily adopt the practice. □

**Table 1. Zero order correlation between understanding principles and adopting practices n = 120 (60 + 60).**

| Farmer group | Correlation coefficient |
|---|---|
| Contact farmers | 0.860** |
| Noncontact farmers | 0.888** |

**Significant at 0.01 level of probability.

**Table 2. Association between understanding principles and adopting practices by the contact farmers (n = 60).**

| Level of understanding | Contact farmers | |
|---|---|---|
| | High adoption | Low adoption |
| High | 25 | 4 |
| Low | 9 | 22 |

$x^2$ = 19.67**, significant at 0.01 level of probability.

**Table 3. Association between understanding principles and adopting practices by the noncontact farmers (n = 65).**

| Level of understanding | Noncontact farmers | |
|---|---|---|
| | High adoption | Low adoption |
| High | 20 | 8 |
| Low | 12 | 25 |

$x^2$ = 21.37**, significant at 0.01 level of probability.

# Announcements

### IRRI scientist recognized

F. N. Ponnamperuma received the 1983 Honorary Fellow Award from the Crop Science Society of the Philippines, and the 1983 American Society of Agronomy Fellows Award.

Ponnamperuma has been with IRRI since 1961 and is head of the Soil Chemistry Department. He is the author of many scientific and review papers and is well known for his review "The Chemistry of Submerged Soils," in *Advances in Agronomy* 1972, which has been identified as one of the most cited articles in that field.

### De Datta receives award

S. K. De Datta, head of the IRRI Agronomy Department, has been presented with the 1983 Achievement Award for Crop Science Research by the Crop Science Society of the Philippines. De Datta came to IRRI as an agronomist in 1964 and is the author of *Principles and practices of rice production* and many scientific articles and reviews. □

### Hooker award

B. Venkateswarlu, senior plant physiologist, All-India Coordinated Rice Improvement Project, Rajendranagar, Hyderabad, has been given the biennial Hooker Award for 1982 in recognition of his contributions in rice physiology. The award is given for outstanding contributions in agriculture, animal sciences, and fisheries in India. □

### International course on seed technology for vegetable crops

The seventh and eighth international courses on seed technology for vegetable crops will be held at the University of the Philippines at Los Baños (UPLB) 13 Jan-18 Apr 1984 and 14 Aug-31 Oct 1984.

The course, sponsored by UPLB and the International Agricultural Centre at Wageningen, the Netherlands, seeks to help meet the demand for well-trained seed technologists, and to train scientists to help increase crop production and to secure supply of viable seeds of high genetic and physical purity. For further information, contact The Directorate, International Training Programme on Seed Technology, P. O. Box 430, College, Laguna 3720, Philippines. □

### Mahadevappa receives model paper award

M. Mahadevappa, professor of seed technology at the University of Agricultural Sciences, Hebbal, Bangalore, India, was given a model paper award for his popular science article *When IR8 spoke in Karnataka* during the 1982 seminar for popular science article writers in Kannada. Mahadevappa has translated several IRRI books into Kannada. □

### Weed Science Symposium

The Department of Agronomy and Horticulture, Universiti Pertanian Malaysia, is organizing a weed science symposium to be held 4-5 October 1983. The major objective is to bring together scientists working on various aspects of weed science to review existing information and discuss problems and advancements in the field. Papers on weed biology, weed control, and herbicides and their effect on the environment are invited. For further information, contact The Secretary, Organizing Committee of Weed Science Symposium, Jabatan Agronomi Dan Kulturakebunan, Universiti Pertanian Malaysia, Serdang, Selangor, Malaysia. □

### Farmer's primer copublished

*A farmer's primer on growing rice,* by B. S. Vergara, IRRI, has been translated and copublished in Marathi. Copies are available from D. S. Ghorpade, College of Agriculture, Kolhapur, M.S., India. □

### New IRRI publications

New IRRI publications available for purchase from the Communication and Publications Department, Division C, IRRI, P. O. Box 933, Manila, Philippines, are:

*Adoption, spread, and production impac of modern rice varieties in Asia*

*Evaluating technology for new farming systems: case studies from Philippine rice farms*

*Research highlights for 1982*

*Weed control in rice* □

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

ISSN 0115–0944