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# Contents

# Guidelines and Style for IRRN Contributors

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

**Style**

- Use the metric system in all papers. Avoid national units of measure (such as cavans, rai. etc ).
- Express all yields in tons per hectare (t/ha) or. with small-scale studies in grams per pot (g/pot) or grams per row (g/row)
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure, for example: 60 kg N/ha: not 60 kg ha/N.
- The US dollar is the standard monetary unit for the *IRRN.* Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example 20 kg ha.
- When using abbreviations other than for units of measure, spel1 out the full name the first time of reference, with abbreviation 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: 8years; 3 kg ha at 2-week intervals; 7%; 4 hours.
- Write out numbers below 10 except in a series containing some numbers 10 or higher and some numbers lower than 10. For example, six parts: seven tractors: four varieties. *But* There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.

**Guidelines**

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

# Genetic evaluation and utilization

OVERALL PROGRESS

## Outcrossing potential of a cytosterile stock of rice

*N. P. Sarma, P. K. Mohanty, and P. J. Jachuck, Central Rice Research Institute, Cuttack-753006, India*

Successful development and production of hybrid rice in the People's Republic of China (PROC) have encouraged rice breeders to explore hybrid technology in the tropics. For the approach to be viable, economic seed production is imperative. Cost of hybrid seed depends on natural cross-pollination and seed set potential of cytosterile (C-ms) stocks used for seed increase of male steriles (ms) or for seed production. We evaluated outcrossing potential of V 20A C-ms under open pollination during 1981 and 1982 dry seasons.

V 20B (pollinator) seedlings were planted in a 12- × 20-m isolated plot at 15- × 20-cm spacing in 1982 dry season. (The 1981 plot was smaller.) Three seedlings, aged 1, 2, and 3 weeks, were transplanted to each hill to provide male sterile plants a substantial pollen load for 2-3 weeks. V 20A C-ms seedlings replaced pollinator plants in every 7th hill, providing 1 cytosterile plant for 1.44-$m^2$ planted area, or a 1:48 to pollinator plants.

Extent of outcrossing on ms plants located between pollinator plants was estimated by counting the seeds set on the panicles of all the ms plants. Data are presented as percentage of seed set (see table). Seed set varied with individual plants. However, the two dry seasons differed little in mean percentage of seed set on ms plants (22.6% in 1981 and 26.3% in 1982). Close examination of C-ms panicles showed about one-third of the basal region florets did not set seed because this portion of the panicle lacked exsertion and because the flag leaf was physically hindered.

Seed set data were reanalyzed to estimate seed set potential through open pollination alone by subtracting number of florets in the boot leaf sheath. This analysis estimated seed set to be 29.3% and 31.1 % for the two seasons, an encouraging statistic. Perhaps using gibberellic acid spray at panicle initiation could give a 5% increase in natural seed set. Supplemental pollination, flag leaf clipping, and synchronized flowering, as used in hybrid seed production plots in PROC, may enhance the C-ms seed set potential on open pollination.

**Percentage seed set on V 20A cytosterile plants through open pollination using V 20B pollnator, Cuttack, India.**

| Year | Cyto-sterile plants (no.) | Mean seed set (%) | Mean seed set ('%) on exserted panicle |
|---|---|---|---|
| 1981 | 36 | 22.68 | 29.33 |
| 1982 | 95 | 26.31 | 31.14 |

## Performance of new BW rice varieties under farmer-managed conditions

*A. H. G. Mithrasena, research officer, Field trial division, Regional Agric. Research Station, Bombuwela, Sri Lanku*

BW rice varieties developed at the Bombuwela research station for problem areas in Low Country wet zones were tested during April-July 1981.

BW272-6B was tested in bog and half-bog soils where farmers usually grow Herath Banda, a low yielding local variety. BW267-3 was evaluated where severe iron toxicity is prevalent. BW266-7 was studied where gall midge damages crops.

Farmers were given seed but they determined land preparation and management techniques, including fertilizer and agrochemical application.

In selected fields, 375-$m^2$ plots were marked. Harvesting was by crop-cutting survey, supervised by field trial researchers. Three 18-$m^2$ plots were harvested from within the larger plots.

**BW variety yields in selected Low Country Wet Zone locations, Bombuwela, Sri Lanka.**

| Variety | District | Locations (no.) | Av yield (t/ha) |
|---|---|---|---|
| BW272-6B | Kalutara<br>Galle | 23 | 2.12 |
| BW267-3 | Kalutara<br>Galle<br>Gampaha<br>Matara<br>Rathnapura<br>Colombo | 37 | 3.13 |
| BW266-7 | Rathnapura | 03 | 2.65 |

All varieties proved successful when used with low inputs in the Low Country wet zone (see table). BW272-6B yielded 2.12 t/ha, nearly twice the Herath Banda yield of 1.44 t/ha. It was well adapted to bog and half-bog soils.

BW267-3 was highly adapted to iron-toxic soils and yielded well. BW266-7 was resistant to gall midge from seedling stage to maximum tillering and produced well.

## A natural rice mutant from IR22

*A. K. Mitra, senior lecturer, Gramsevak Training Centre, Chinsurah; and D. K. Mukherji, jt. director of agriculture (research), West Bengal, Calcutta-700 001, India*

Natural or spontaneous mutants in rice occur infrequently and are usually lethal. A mutant has been isolated from an IR22 multiplication plot at the Rice Research Station, Chinsurah, West Bengal, India. Leaves have no auricle, ligule, or junctura.

The mutant was protected from pollen contamination and seeds obtained were grown the following season to test previous observations. Reciprocal crosses were made between IR22 and the mutant. $F_1$ plants were scored for auricle, ligule, and junctura characteristics 4 weeks after sowing. The progeny exhibited all three leaf characteristics, indicating dominance. $F_2$ populations showed segregation patterns conforming to monogenic control of the characteristics (see table).

**Distribution frequencies of $F_2$ population.**

| Auricle, ligule and junctura: Present | Auricle, ligule and junctura: Absent | $X^2$ value |
|---|---|---|
| 610 | 214 | 0.364<br>$p = 0.70 - 0.50$ |

The mutant's leaves grow at an acute angle. Studies are in progress to determine if this leaf arrangement captures more solar radiation and allows higher nutrient uptake rates.

## An early dwarf mutant of Tilakchandan

*J. S. Nanda, S. C. Mani, Harpal Singh, J. P. Singh and C. V. Singh, Plant Breeding Department, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Nainital U.P., India*

Tilakchandan is a popular rice variety in northwestern Uttar Pradesh. It has excellent cooking qualities and mild aroma. It is a traditional tall, photoperiod-sensitive, late-maturing variety (150-155 days). Use is decreasing because the variety is not efficient in rice-wheat rotation, which is common in the region.

In 1972 a breeding program was initiated to develop dwarf and early mutants. Dehusked seeds were soaked in distilled water for 6 hours, then treated with freshly prepared EMS aqueous solution in 3 concentrations (0.2%, 0.4% and 0.6%). They were held at room temperature for 6 hours, with intermittent shaking.

Treated seeds were washed in running tap water for 1 hour, then sown on blotting paper at room temperature. Seedlings were moved to a field nursery 7 days after sowing, and transplanted (10 × 20 cm spacing) in the main field 25 days after sowing.

The first three panicles and bulks were separately carried to the M2 generation. Panicle to row planting and, thereafter, single plant progenies were carried from M3 to M6. Productive mutants were isolated, purified, multiplied, and evaluated in multilocation trials.

The selected mutant matured earliest. Qualities were similar to those of Tilak chandan (Table I). Kernel length and elongation rate were higher than for Tilakchandan. Alkali value and water uptake were slightly lower. Mutant yield was lower because panicles had fewer grains (Table 2). The mutant is dwarf and flowers early. It can be used in hybridization programs. Seed is available to interested breeders.

**Table 1. Morphological and grain characteristics of Tilakchandan and its mutant, West Bengal, India**

| Characteristic | Tilakchandan | Mutant |
|---|---|---|
| Height (cm) | 125 | 85 |
| 50% flowering (days) | 122 | 82 |
| Av no. of tillers/hill | 18 | 18 |
| Position of flag leaf | Erect | Erect |
| Plant type | Tall | Dwarf |
| Panicle length (cm) | 25.8 | 23.6 |
| Grains per panicle | 169.8 | 101.4 |
| Awned or awnless | Awned | Awned |
| 1,000-grain weight | 16.7 | 13.6 |
| Kernel length (mm) | 5.0 | 5.6 |
| Kernel width (mm) | 2.0 | 2.0 |
| Length-breadth ratio | 2.5 | 2.8 |
| Rice color | White | White |
| Abdominal white | Absent | Absent |
| Hulling (%) | 76.0 | 75.0 |
| Milling (%) | 72.0 | 70.5 |
| Alkali value | 4.1 | 2.5 |
| Kernel elongation | 2.1 | 2.3 |
| Volume expansion | 5.8 | 5.1 |
| Water uptake (at boiling temp) | 600 | 520 |
| Cooking quality | Good | Good |

**Table 2. Yield performance of Tilakchandan and its mutant in scented variety trials, 1979 and 1980 kharif, West Bengal, India.[a]**

| Variety | Yield (kg/ha) Pantnagar 1979 | Pantnagar 1980 | Nagina 1979 | Nagina 1980 | Bulandshahr 1979 | Bulandshahr 1980 | Days to 50% flowering |
|---|---|---|---|---|---|---|---|
| Tilakchandan (mutant) | 1210 | 2350 | 2227[b] | 1250 | 5020* | 2917 | 82 |
| Tilakchandan (normal) | 3298* | 3856* | 1662 | 2472* | 2945 | 3558 | 122 |
| C.D. (5%) | 1195 | 684 | 904 | 1183 | 872 | 821 | – |
| C.V. | 29.01 | 10.20 | 23.65 | 17.55 | 10.12 | 18.21 | – |

[a]*Significantly higher at 5% level of significance. [b]Crop suffered from drought.

## Thermosensitivlty of rice seeds grown by farmers

*L. P. Kauraw and N. K. Chakrabarti, Central Rice Research Institute (CRRI), Cuttack-753 006, India*

Treating rice seeds with hot water is recommended to control externally and internally borne pathogens like fungi, bacteria, and nematodes. Treatment use is limited because of the differential sensitivity of seeds to hot water. It is necessary to determine the thermosensitivity of seed of different rice varieties before subjecting them to hot water treatment. This study was made to ascertain rice sensitivity to hot water treatment at recommended temperatures (52 or 54°C).

Seeds of 13 improved semidwarf rice varieties — IR8 (Peta/DgWg), Vani (IR8/CR1014), Jagannath (TI41 mutant), Kalinga-1 (Dungharsali/IR8), Ratna (TKM6/IR8), Pankaj (Tonkai Raton/Peta), Parijat (TKM6/TN1), Indira (Tainan 3 mutant), CR 158-5008-52-212, CR10-4181-10, CR9242, local Athgadi, BJ 1 — and the improved tall variety TI41 were collected from farmers in the CRRI Operational Research Project Area at Kandarpur in Cuttack, Orissa.

Twenty-five grams seed of each variety were placed in separate cloth bags, soaked in room temperature water for 8 hours, and then separately treated in a Kilburn hot water bath at 52 or 54°C for 10, 20, and 30 minutes. They were then dipped in water at room temperature. Untreated controls were maintained for each variety and treatment. Germination of 400 seeds was tested by the blotter method.

Germination was reduced for all varieties when seeds were placed in 54°C water for 30 minutes. Seeds of Ratna, Indira, BJ 1, CR10-4181-10, and Vani were insensitive to treatment at 52°C for 30 minutes. Athgadi, Kalinga-1, T141, and Pankaj were insensitive to 52 and 54° C temperatures when exposed for 10 minutes only, but germination was reduced when the seeds were exposed for 20 or 30 minutes. Jagannath, IR8, CR9242, CR158-5008-52-212, and Parijat were very sensitive to hot water. Germination declined as exposure time and temperature increased (see table).

**Percentage of seed germination of rice varieties treated with hot water at 52 and 54°C for 10, 20, and 30 minutes in Cuttack, India.**

| Variety | Temperature (°C) | Germination (%) | | | |
|---|---|---|---|---|---|
| | | Control | 10 min | 20 min | 30 min |
| IR8 | 52 | 59.00 | 46.50 | 34.50 | 21.75 |
| | 54 | 59.25 | 40.50 | 26.25 | 18.00 |
| Vani | 52 | 29.00 | 29.75 | 25.50 | 26.75 |
| | 54 | 41.00 | 40.00 | 35.00 | 25.50 |
| Jagannath | 52 | 51.25 | 40.00 | 23.60 | 14.00 |
| | 54 | 54.00 | 35.00 | 21.50 | 8.50 |
| CR9242 | 52 | 45.25 | 35.00 | 24.25 | 20.50 |
| | 54 | 48.00 | 40.00 | 28.75 | 23.25 |
| Kalinga-1 | 52 | 58.50 | 60.00 | 45.75 | 35.00 |
| | 54 | 61.75 | 59.00 | 44.50 | 32.25 |
| CR158-5008-52-212 | 52 | 53.75 | 38.75 | 29.75 | 29.25 |
| | 54 | 49.50 | 38.50 | 29.00 | 24.00 |
| T141 | 52 | 57.50 | 60.00 | 40.00 | 41.50 |
| | 54 | 60.50 | 58.25 | 38.50 | 30.75 |
| Ratna | 52 | 74.50 | 71.00 | 68.50 | 68.75 |
| | 54 | 77.25 | 77.50 | 69.00 | 42.25 |
| Athgadi | 52 | 69.25 | 66.25 | 58.00 | 39.00 |
| | 54 | 70.00 | 67.00 | 53.00 | 29.75 |
| Pankaj | 52 | 72.50 | 69.25 | 55.00 | 57.75 |
| | 54 | 71.75 | 66.00 | 48.50 | 26.50 |
| BJ 1 | 52 | 50.00 | 52.50 | 48.00 | 45.00 |
| | 54 | 55.75 | 54.00 | 46.50 | 41.00 |
| CR10-4181-10 | 52 | 46.00 | 44.00 | 47.00 | 44.75 |
| | 54 | 48.15 | 44.50 | 32.25 | 27.00 |
| Indira | 52 | 79.00 | 74.00 | 76.25 | 77.25 |
| | 54 | 81.50 | 74.00 | 45.75 | 35.00 |
| Parijat | 52 | 66.75 | 54.00 | 42.25 | 31.00 |
| | 54 | 72.50 | 58.25 | 44.00 | 33.50 |

GENETIC EVALUATION AND UTILIZATION

# Agronomic characteristics

## Yield, plant characteristics, and quality of some rice varieties in the Amazon Valley

*G. C. Shukla, rice agronomist, Instituto de Pesquisas (IRI), Caixa Postal 258, 66000 Belém, Pará, Brazil*

Five to ten million hectares in the lower Amazon basin of Brazil are swampy for most of the year. Little land is reclaimed for planting. At São Raimundo, land was diked and a fully mechanized project established. Seeding and fertilizer and pesticide application are done aerially. Crops are harvested by combines. Electric pumps facilitate irrigation and drainage.

Soils are acidic and have high exchangeable iron and aluminum content. In a preliminary seed multiplication trial superior varieties were selected. Using these varieties, a replicated yield trial was conducted in 1981 to isolate high yielding varieties with good grain quality. Rough rice yields at 14% moisture and plant ancillary characteristics are in Table 1. Milling yields and grain quality are in Table 2.

Varieties had significant yield differences. Variety J-229 is the present com-

Table 1. Yield and plant ancillary characteristics from varietal yield trial experiments, São Raimundo, Brazil, 1981.[a]

| Entry | Variety | Yield (t/ha) | Plant ht (cm) | Effective tillers/plant | Lodging (%) | Days to flowering | Days to maturity |
|---|---|---|---|---|---|---|---|
| J-32 | IR22 | 6.78 | 108 | 19 | 1 | 103 | 138 |
| J-40 | IR24 | 7.91 | 98 | 20 | 1 | 93 | 126 |
| J-179 | IR36 | 7.63 | 86 | 27 | 3 | 85 | 116 |
| J-229 | P738-97-3-1 | 7.56 | 100 | 20 | 1 | 103 | 136 |
| J-233 | Juma 58 | 6.71 | 118 | 18 | 1 | 111 | 145 |
| J-266 | IR11248-52-2-3-3 | 6.59 | 113 | 27 | 7 | 95 | 126 |
| J-301 | IET6503 | 6.16 | 104 | 25 | 3 | 85 | 118 |
| J-305 | IAC899-55-6-4-6 | 7.84 | 116 | 21 | 1 | 94 | 128 |
| J-310 | P1291 | 9.00 | 123 | 18 | 1 | 104 | 136 |
| J-311 (Phil.) | BR51-46-1-C-1 | 7.25 | 118 | 20 | 5 | 98 | 130 |
| J-311 (S.P.) | BR51-46-1-C-1 | 7.50 | 122 | 18 | 1 | 101 | 134 |
| J-314 | IR665-23-3-1 | 7.61 | 106 | 19 | 1 | 98 | 131 |
| J-319 | IET5518 (CR35-2740) | 6.79 | 103 | 21 | 1 | 84 | 115 |
| J-323 | IR9129-7-1 | 6.38 | 86 | 23 | 1 | 77 | 110 |
| J-324 | IR9129-102-2 | 6.55 | 96 | 24 | 1 | 82 | 114 |
| J-325 | IR9168-13-1 | 8.00 | 107 | 23 | 1 | 85 | 116 |
| J-327 | UPR70 | 5.08 | 90 | 22 | 1 | 82 | 113 |
| LSD (0.05) | | 0.90 | | | | | |
| CV (%) | | 8.90 | | | | | |

[a] Germplasm for J-311 (Phil.) was received from the Philippines and J-311 (S.P.) from the Instituto Agronômico de Campinas, Brazil.

mercial variety. It was compared with J-310, J-311 (S.P.), J-311 (Phil.), J-314, J-325, J-40, J-179, and J-305. Variety J-310 yielded best but had high opacity and broken grain percentage. J-311 (S.P.), which was resistant to leaf blast, needs further testing in large plots. Most J-311 (Phil.) plants lodged. J-314, J-179, and J-324 had a low percentage of whole grains and a high percentage of opacity. J-40 was susceptible to leaf blast and neck blast. J-305 had medium (5.87 mm) grain length. Variety J-266, which gave good results in 1980, yielded low and lodged severely. It had medium grain length.

Table 2. Grain quality and milling yields of different varieties, São Raimundo, Brazil, 1981.

| Entry | Milling yield (%) | Whole grains (%) | Opacity (%) | Grain length (mm) | Grain width (mm) | L/W[a] ratio |
|---|---|---|---|---|---|---|
| J-32 | 71.28 | 61.92 | 11 | 6.82 | 2.44 | 2.80 |
| J-40 | 69.44 | 49.44 | 13 | 6.76 | 2.04 | 3.31 |
| J-179 | 72.56 | 35.44 | 28 | 6.43 | 1.87 | 3.44 |
| J-229 | 67.52 | 46.50 | 14 | 6.55 | 2.12 | 3.09 |
| J-233 | 67.20 | 44.16 | 32 | 6.72 | 2.25 | 2.99 |
| J-266 | 71.52 | 52.90 | 14 | 5.88 | 2.11 | 2.79 |
| J-301 | 70.08 | 46.32 | 13 | 6.49 | 1.77 | 3.66 |
| J-305 | 69.92 | 54.32 | 12 | 5.87 | 2.00 | 2.94 |
| J-310 | 72.72 | 53.04 | 33 | 7.17 | 2.11 | 3.40 |
| J-311 (Phil.) | 72.88 | 60.80 | 20 | 6.60 | 2.19 | 3.01 |
| J-311 (S.P.) | 70.80 | 53.60 | 23 | 6.50 | 2.28 | 2.85 |
| J-314 | 69.68 | 39.10 | 35 | 7.16 | 2.00 | 3.58 |
| J-319 | 72.56 | 57.84 | 17 | 7.14 | 2.08 | 3.43 |
| J-323 | 72.24 | 58.64 | 12 | 6.40 | 2.02 | 3.39 |
| J-324 | 70.72 | 44.48 | 18 | 6.59 | 2.05 | 3.21 |
| J-325 | 71.28 | 35.20 | 38 | 7.32 | 2.13 | 3.44 |
| J-327 | 66.16 | 55.84 | 33 | 6.87 | 2.01 | 3.42 |

[a] Length-width.

GENETIC EVALUATION AND UTILIZATION

# Grain quality

## Rice panicle type for high grain yields in low temperature areas

*B. S. Vergara, J. H. Lee, G. Pateña, J. D. Yea, and R. M. Visperas, IRRI*

High rice yields result from large numbers of spikelets per unit area. Number of spikelets depends on panicles per unit area and spikelets per panicle.

In modern varieties planted in the tropics, increased yield is generally produced by increasing panicle number (panicle number type). In traditional indica varieties with limited panicle number at flowering, yield is multiplied by increasing panicle weight or spikelets per panicle (panicle weight type).

Table 1. 1981 IRCTN entries by grain yield, panicle number per hill, and spikelets per panicle. Chuncheon, Korea, 1981.

| Grain yield (t/ha) | Spikelets/ panicle | Entries (no.) with given panicles/hill 4-6 | 7-9 | 10-12 | 13-15 | 16-18 |
|---|---|---|---|---|---|---|
| >6 | <130 | 0 | 0 | 10 | 8 | 2 |
| | >130 | 1 | 5 | 10 | 1 | 0 |
| <6 | <130 | 1 | 27 | 32 | 9 | 0 |
| | >130 | 4 | 29 | 21 | 4 | 0 |

In low temperature areas. some farmers prefer panicle weight type rice because panicles are harvested individually. The 1981 International Rice Cold Tolerance Nursery (IRCTN) planted in Korea was analyzed to determine if high yields result from high panicle number or large spikelet number per panicle.

High yields resulted from high panicle number (10-12/hill) (Table 1). However, both panicle weight and panicle number types can produce large yields. Suweon 306 and IR9129-169-3-2-3-3 yielded high because they had many panicles per hill (Table 2). TI668 and Barkat, from mountain regions, produced large yields from big panicles. lR9224-K1, an IRRI line reselected in Kashmir, India, has high panicle and spikelet numbers and yielded the highest.

**Table 2. Grain yield, number of panicles per hill, and number of spikelets per panicle of high yielding lRCTN entries. Chuncheon, Korea, 1981.**

| Entry | Yield (t/ha) | Panicle number | Total spikelets | Fertility (%) | Flowering date |
|---|---|---|---|---|---|
| T1668 | 7.16 | 6.0 | 196 | 91 | 1 Aug |
| Barkat | 6.18 | 8.2 | 150 | 89 | 28 Jul |
| IR15924-265-3 | 8.94 | 8.2 | 135 | 84 | 18 Aug |
| IR9224-K1 | 9.49 | 13.0 | 140 | 95 | 31 Jul |
| AC3828 | 8.63 | 13.0 | 127 | 94 | 5 Aug |
| C11561-1 | 8.05 | 13.4 | 112 | 95 | 11 Aug |
| IR9129-169-3-2-3-3 | 6.18 | 17.0 | 124 | 84 | 7 Aug |
| Suweon 306 | 6.86 | 18.4 | 115 | 76 | 18 Aug |

GENETIC EVALUATION AND UTILIZATION

# Disease resistance

## Testing for sheath blight resistance in rice

*N. Shobha Rani and K. Satyanaravyna, All India Coordinated Rice Improvement Project (AICRIP), Rajendranagar, Hyderabad 30, India*

Rice sheath blight (ShB), caused by *Rhizoctonia solani* Kuhn [*Thanetophorus cucumeris* (Frank) Donk.], occurs during wet season in parts of Kerala, Andhra Pradesh (A. P.), and West Bengal. In 1979 a severe outbreak occurred on BPT1235 and MTU6024 in West Godavari district, A. P.

Chemical control is the only way to arrest ShB. Resistant short-statured rice varieties need to be developed.

A program to breed high yielding varieties with ShB resistance was initiated at AICRIP, Hyderabad, during 1979 kharif. Fifty-eight entries were field tested. Plants were inoculated by typhabit method at maximum tillering. Thirty-seven varieties were moderately resistant; scores ranged from 3.0 to 5.0. During I980 kharif moderately resistant entries were retested in two 3.75-m rows flanked by the susceptible check variety Taichung Native 1. High humidity (RH 95%) created by overhead sprinklers induced maximum disease. Only 11 varieties showed resistant reaction (score 1.0 to 3.0) in high humidity (see table). OS4 and IR42 were scored as resistant, confirming 1979 results. IET4699 was resistant, Guyana sel. 60-283 and Pankaj were moderately resistant.

Eight thousand $F_4$ plants from three crosses — RP1821 (OS4/ RPW6-I7), RP1819 (Pankaj/RP1821), and RP1822 (Pankaj/ lET5656) — were field tested under favorable conditions. RP1821 crosses were most promising — 189 plants scored highly resistant (0.0 and 1.0). Among those, 76 lines were uniform. They are being tested in a replicated yield trial at AICRIP headquarters during the 1982 dry season and at Maruteru, West Godavari, reported to be a ShB hot spot, to reconfirm disease reaction.

**Donor screening nursery results at AICRIP, 1980 kharif.**

| Entries with score [a] of | | | | | |
|---|---|---|---|---|---|
| 0 | 1 | 3 | 5 | 7 | 9 |
| | ET4699 | IR2071-588-4 | | IET6774 | TN1 |
| | | Guyana Sel. 60-283 | | RP193-1 | Ram Tulsi |
| | | ET5891 | T141 | ARC15762 | |
| | | ET6770 | Ta-poo-cho-z | IR2071-588-5 | |
| | | Pankaj | IET6234 | La ka | |
| | | IR42 | IR1103-15-8 | | |
| | | OS4 | Nang Payah | | |
| | | ET6235 | Ramadja | Phourel | |
| | | IET6272 | IET7043 | Morangedo | |
| | | Saibham | IET7109 | Phekaudu | |
| | | | Athebu | Morang Chaeran | |
| | | | Mamte | Bag Murali | |
| | | | Suduwee | | |

[a] 1980 Standard Evaluation System for Rice scale of 0-9: 0 = no incidence, 9 = lesions reaching top of tillers; severe infection on all leaves and some plants killed.

## Tetep: a potential source of resistance to rice dwarf in Nepal

*B. P. Upadhyay, assistant plant pathologist, National Rice Improvement Project, Parnipur, Nepal; and D. B. Lapis, associate professor of Plant Pathology, University of the Philippines at Los Baños, Philippines (presently, senior research fellow, Plant Pathology Department, IRRI)*

In 1977 rice dwarf virus (RD) was discovered in Taichung 176 and KT32-2 (a locally bred line) at Khumaltar Station in Kathmandu Valley, Nepal. *Nephotettix nigropictus,* the predominant green leafhopper species in the valley, transmits the virus. To identify potential sources of RD resistance, a preliminary screening of rice cultivars was made in the greenhouse at Khumaltar during July-September 1981. We sought to identify a single variety resistant to RD and blast (Bl), the most serious diseases in the region, to simplify breeding for resistance to both diseases.

Results indicate Tetep and lines derived from Tetep — IR 1905-8-3-1, IR1416-128-5-8 — are resistant. Tetep lines IR1544-340-6-1 and IR1905-PPII-29-4-61 were moderately resistant (disease incidence was 10-12%).

Tetep seems to be resistant to RD as well as to B1 (see table).

**Rice dwarf and blast resistance[a] of Tetep and Tetep-derived cultivars at Khumaltar, Nepal, 1977-81.**

| Cultivar | Rice dwarf: Diseased seedlings[b] (%) | Rice dwarf: Degree of resistance | Rice blast: Disease score[c] | Rice blast: Degree of resistance |
|---|---|---|---|---|
| Tetep | 0 | HR | 0-4 | MR |
| IR1905-8-3-1 | 0 | HR | 0-2 | HR |
| IR1416-128-5-8 | 0 | HR | 0-1 | HR |
| IR1544-340-6-1 | 20 | R | 0-1 | HR |
| IR1905-PPII-29-4-61 | 10 | R | 0-1 | HR |

[a] HR = highly resistant, R = resistant, MR = moderately resistant. [b] Av of 3 replications. [c] 1980 Standard Evaluation System for Rice scale 0-9: 0 = no incidence, 9 = 51-100%, Range is for years 1977-81.

## Sources of resistance to leaf scald disease

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Leaf scald disease (LSc), caused by *Rhynchosporium oryzae,* commonly occurs in northeast India. Natural disease pressure during wet season is high and offers an excellent opportunity to screen germplasm in the field.

Since 1980, when a varietal screening program was initiated, 741 rice cultivars have been tested for LSc resistance. Few varieties have shown resistance. Of 589 cultivars evaluated in 1980, 24 were resistant. Others were moderately resistant to susceptible (see table). During 1981, 152 cultivars were tested — only 2 were resistant.

Cultivars were field-tested in upland nurseries with high nitrogen (100-60-0) fertilization. Seeds were sown in 2-m rows at 20-cm intervals. They were surrounded by the local susceptible variety, Mirikrak, which has a susceptible to highly susceptible reaction.

**Sources of resistance to rice leaf scald, Shillong, India, 1980-81.**

| Variety | Score[a]: Upper Shillong (1800 m, 245 entries) 1980 | Score[a]: Barapani (950 m, 152 entries) 1981 | Score[a]: Nayabunglow (800 m, 344 entries) 1980 |
|---|---|---|---|
| Paro white | – | 1 | 1 |
| Pokhareli masino | 1 | 1 | 1 |
| Ciat ICA-5 | – | 3 | 1 |
| Colombia-I (73120) | – | – | 1 |
| Colombia-II | – | – | 1 |
| Aus 173 | 1 | – | – |
| Carreon | 1 | – | – |
| Leng Kwang | 1 | – | – |
| PL20 (BG11-11 SEL) | 1 | – | – |
| Sail boro 56-2 | 1 | – | – |
| VL8 | 1 | – | – |
| Baekgogna | 1 | – | – |
| Heug Do | 1 | – | – |
| Heug Jo | 1 | – | – |
| Heug Jo Do | 1 | – | – |
| Ishikari | 1 | – | – |
| Kita-Kogane (Yukara/Joiku No. 230) | 1 | – | – |
| Nan-ei (Tomoe-Nishiki/Norin No. 20) | 1 | – | – |
| Tomoyutaka | 1 | – | – |
| Yu-Nami | 1 | – | – |
| IR9224-K 1 | 1 | – | – |
| K333 (Shin-Ei/Rikuto Norin) | 1 | – | – |
| Shin-ei (Tomoe-Nishiki/Norin No. 20) | 1 | – | – |
| *Checks* | | | |
| Mirikrak (local) | 5 | 7 | 9 |
| IR36 | – | 7 | 7 |
| IR8 | 7 | – | 5 |
| China 1039 | 7 | – | – |

[a] By the 1980 Standard Evaluation System for Rice scale 1-9: 1 = less than 1% (apical lesions), 9 = 51-100% (apical and marginal lesions).

## Field reaction of two newly released rice varieties to leaf blast and gall midge in Manipur

*S. Amu Singh, district agricultural officer, Tengnoupal, Chandel, Manipur, India*

In 1979, Punshi and Phouoibi, new rice varieties developed at the State Rice Research Station, Wangbal, were released in Manipur. Since release, they have almost replaced IR24, and are in about 75% of the areas planted to high yielding varieties (Punshi, 50% and Phouoibi, 25%).

Punshi, formerly KD6-18-7, is a cross between local Phouren (female parent) and IR661-1-140-3-2. It is well adapted to irrigated, rainfed lowland, and transplanted conditions and has moderate drought resistance. It is weakly photoperiod sensitive and matures in 138 days. It has outyielded IR24 by 10-l5% at 80-40-30 kg NPK/ ha.

Phouoibi, formerly KD6-2-1, has similar parentage, adaptability, and resistance. It matures in 135 days, and has outyielded IR24 by 8-12% at 80-40-30 kg NPK/ ha.

Before their release, Punshi and Phouoibi were reported to be moderately resistant to blast and gall midge, currently the most destructive local rice disease and insect pest. However, field observations and surveys conducted during July-August 1979 have hinted at high susceptibility to blast and gall

**Reaction of Punshi and Phouoibi to leaf blast and gall midge in Manipur, India, 1979.**[a]

| Subdivision | Punshi SS (%) | Punshi Blast score | Phouoibi SS (%) | Phouoibi Blast score | IR24 (check) SS (%) | IR24 (check) Blast score | Phouren (check) SS (%) | Phouren (check) Blast score |
|---|---|---|---|---|---|---|---|---|
| Imphal West I | 22.04 | 2-3 | 26.78 | 1-4 | 43.58 | 1-3 | 9.60 | 0-1 |
| Imphal West II | 12.71 | 5-6 | 14.19 | 3-4 | 10.80 | 3-5 | 3.92 | 0-3 |
| Imphal East | 32.44 | 3-4 | 26.05 | 1-4 | 29.32 | 2-4 | 6.19 | 1-2 |
| Thoubal | 23.85 | 4-5 | 38.33 | 3-6 | 23.26 | 2-6 | 5.07 | 0-1 |
| Bishenpur | 14.98 | 3-6 | 16.89 | 3-5 | 9.36 | 2-4 | 6.46 | 0-2 |

[a]SS = silvershoot. Blast score is by the 1980 Standard Evaluation System for Rice.

midge (see table). Further field observations later confirmed their susceptibilities.

In addition, Punshi is occasionally infected, from nursery to late tillering stage, with leaf scald caused by *Rhynchosporium oryzae.* Standard Evaluation System for Rice (1980) scores range from 3 to 5.

## Bacterial blight resistance in donor varieties having other desirable traits

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To isolate a multiple donor variety for bacterial blight (BB), stem rot (SR), brown planthopper (BPH), stem borer (SB), and blast (Bl) for use in the breeding program, 30 desirable varieties were tested for reactions to BB. The experiment was conducted under artificial epiphytotic conditions at Haryana Agricultural University, May-October 1981.

Two 5-m-long rows of each variety were artificially inoculated at maximum tillering. Inoculation was done by cutting 5 cm of the upper leaf portion with a sickle dipped in a single-isolate inoculum. The inoculum was prepared by soaking small pieces of naturally infected leaves in water for 20 minutes.

Disease reactions were compared 15 days after inoculation. The standard IRTP evaluation (scale 1-9) was used. Disease intensity had reached 9 in susceptible varieties.

BJ 1 and DV 85 showed resistance and appeared to be a suitable donor for BB. Dasal, FR 43B, Mahsuri, IET 4141, Chuigak-45, TKM6, LZN, UPRB 30 and 31, and CB 1 were moderately resistant. Three varieties had intermediate resistance. All others tested were susceptible to BB (see table). These studies showed varieties TKM6 and BJ 1 are resistant to BB. They also have desirable grain character and plant type.

**Reaction of various donor varieties to bacterial blight at Karnal, India.**[a]

| Variety | Donor for | Other desirable trait(s) | Reaction to BB[b] |
|---|---|---|---|
| CH 1039 | High altitude | – | 5 |
| Patnai 23 | Salt resistance | Resistant (R) to B1, BS, SB | 9 |
| Dasal | Salt resistance | – | 3 |
| Getu | Salt resistance | Tolerant (T) of salinity | 5 |
| SR 26 B | Salt resistance | – | 7 |
| Basmati-370 | Salt tolerance, SR resistance | R to Bl | 7 |
| Jhona 349 | Alkali tolerance | – | 9 |
| FR 43B | Flood resistance | – | 3 |
| FR 13A | Flood resistance | R to SR | 7 |
| Mahsuri | Lowland | – | 3 |
| Jagannath | Lowland | – | 7 |
| Lalnakanda 41 | Upland, drought tolerance | – | 9 |
| MTU 17 | Upland, drought tolerance | – | 9 |
| Kataribhog | RTV | – | 9 |
| Latisail | RTV | – | 9 |
| ARC 6650 | BLS resistance | R to BPH, WBPH, RTV | 7 |
| IET4141 | BB resistance | – | 3 |
| Chuigak-45 | BB resistance | – | 3 |
| DV 85 | BB resistance | – | 1 |
| TKM6 | BB and SB resistance | R to Bl, RTV, GLH, BPH, SSB, SR | 3 |
| BJ 1 | BB resistance | R to Bl, BLS, SB | 1 |
| LZN | BB resistance | R to Bl | 3 |
| UPRB 30 | BB resistance | – | 3 |
| UPRB 31 | BB resistance | R to Bl | 3 |
| IR8 | Bl resistance | – | 7 |
| Carreon | Bl resistance | R to BLS | 7 |
| Tadukan | Bl resistance | R to BLS | 5 |
| CB 1 | SB resistance | – | 3 |
| Siam 29 | GM resistance | R to B1, BLS | 9 |
| CR94-721-3 | GM | – | 7 |

[a]Bl = blast, BB = bacterial blight, BLS = bacterial leaf streak, BPH = brown planthopper, BS =brown spot, GLH = green leafhopper, GM = gall midge, SB = stem borer, SR = stem rot, SSB = striped stem borer, RTV = rice tungro virus, – = not tested. [b]On a scale of 1-9: 1 = resistant, 9 = susceptible.

## Seedling age and incidence of rice dwarf

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Rice dwarf (RD), the only rice virus disease presently reported in Nepal, is transmitted by the green leafhopper *Nephotettix nigropictus.* RD also occurs in Japan, Korea, and Taiwan.

A greenhouse experiment, conducted at Khumaltar Agriculture Station, Kathmandu, Nepal, in July 1981, examined the effect of rice seedling age on disease incidence. Seedlings aged 25 and 45 days were separately inoculated with virus. Results indicated RD incidence was higher in 25-day-old seedlings (see table). On average, 69% of seedlings became infected when inoculated at 25 days. Only 26.8% of seedlings were infected when inoculated at 45 days. NR6-5-16-18B$_1$ and NR6-5-46-48 showed higher percentage of infected seedlings when inoculated at 45 days. IR3707-117-2 was disease-free at both ages.

This study suggests rice seedlings build resistance to RD as age increases. Age specificity of disease incidence shown by some cultivars (see table) indicates resistance to this virus may depend on crop growth stage. CH45 showed 100% infection in both inoculation stages. It can be used as a good susceptibility check for RD varietal screening in Nepal.

**Effect of seedling age on rice dwarf incidence at Khumaltar, Nepal, July 1981.**

| Cultivar | 25-day-old seedlings | | 45-day-old seedlings | |
|---|---|---|---|---|
| | Inoculated (no.) | Infected (%) | Inoculated (no.) | Infected (%) |
| IET2938 | 10 | 20 | 9 | 11 |
| IR2061-628-1 | 9 | 56 | 10 | 10 |
| Chandina | 8 | 100 | 10 | 70 |
| BG94-1 | 7 | 57 | 10 | 40 |
| CH45 | 10 | 100 | 10 | 100 |
| NR6-5-46-45 | 10 | 100 | 10 | 90 |
| IR2070-414-3 | 10 | 70 | 10 | 10 |
| IR2071-124-6-5 | 10 | 80 | 10 | 0 |
| IR2071-586-5-6 | 10 | 70 | 10 | 40 |
| BR4 | 8 | 50 | 9 | 0 |
| BR51-91-6 | 10 | 80 | 10 | 10 |
| IR2797-125 | 10 | 33 | 8 | 0 |
| NR6-5-16-18B$_1$ | 10 | 50 | 10 | 70 |
| IET4183 | 6 | 50 | 10 | 10 |
| IR3707-117-2 | 10 | 0 | 10 | 0 |
| IR3941-25-1 | 9 | 89 | 10 | 0 |
| IET1444 | 8 | 75 | 10 | 40 |
| Se 322-G-19 | 10 | 100 | 10 | 20 |
| IR2061-522-6-9 | 8 | 88 | 10 | 10 |
| NR6-5-46-48 | 10 | 30 | 8 | 50 |
| NR6-7-83-46 | 10 | 100 | 10 | 40 |
| BG374-2 | 9 | 89 | 10 | 10 |
| BC374-1 | 10 | 100 | 10 | 20 |
| IET4094 | 11 | 91 | 10 | 20 |
| IR22 | 10 | 40 | 9 | 0 |
| Mean | | 69 | | 27 |

GENETIC EVALUATION AND UTILIZATION

# Insect resistance

## Reactions of some Korean rice varieties to brown planthopper biotype 2

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Susceptibility of rice varieties with or without *Bph 1* gene for resistance to brown planthopper biotypes 1 and 2 was studied in the greenhouse.

Resistant Korean cultivars and susceptible varieties were screened at different days after infestation (DI) using the seedling bulk test. Pungsanbyeo (without resistance gene), Baekunchalbyeo (*Bph 1*), and Milyang 63 (*bph 2*) were

**Table 1. Reactions of selected rice varieties to BPH biotypes 1 and 2 at seedling stage at different days after infestation. Korea, 1981.**

| Variety | Resistance gene | Damage rating[a] at given days after infestation | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Biotype 1 | | | | Biotype 2 | | | |
| | | 9 | 11 | 13 | 15 | 9 | 11 | 13 | 15 |
| Pungsanbyeo | None | MR | MR | M | M | R | R | MR | M |
| Iri 358 | ” | MS | S | S | S | R | MR | MS | MS |
| Milyang 23 | ” | MR | MR | MS | MS | R | MR | M | M |
| Suweon 307 | ” | S | S | S | S | MR | MR | MS | S |
| Baekunchalbyeo | *Bph 1* | R | R | R | R | M | S | S | S |
| Milyang 58 | ” | R | R | R | R | MS | S | S | S |
| Milyang 60 | ” | R | R | R | R | M | MS | S | S |
| Hangangchalbyeo | ” | R | R | R | R | MR | MS | S | S |
| Milyang 61 | ” | R | R | R | R | MR | MS | S | S |
| Milyang 57 | ” | R | R | R | R | M | M | MS | S |
| Suweon 309 | ” | R | R | R | R | MR | M | MS | S |
| Milyang 55 | ” | R | R | R | R | R | MR | MS | S |
| Milyang 56 | ” | R | R | R | R | R | MR | MS | S |
| Iri 352 | ” | R | R | R | R | MR | MR | MS | S |
| Nampungbyeo | ” | R | R | R | R | R | MR | M | M |
| Cheongcheongbyeo | ” | R | R | R | R | R | MR | M | S |
| Iri 357 | ” | R | R | R | R | R | MR | M | M |
| Milyang 30 | ” | R | R | R | R | R | MR | M | M |
| Milyang 63 | *bph 2* | R | R | R | R | R | R | R | MR |

[a]Based on seedling bulk test: R = resistant, S = susceptible, MR = moderately resistant, MS = moderately susceptible.

standard checks.

Pungsanbyeo, Iri 358, Suweon 307, and Milyang 23, all without *Bph 1,* were moderately resistant to biotype 2 at 11 DI. Baekunchalbyeo, Hangangchalbyeo, and Milyang 57, with *Bph 1,* were moderately susceptible or susceptible to biotype 2 (Table 1).

In another experiment, 50 2d- or 3d-instar BPH nymphs were caged in circular plastic tubes (5 × 30 cm) on individual plants of each variety 25 days after seeding. There were four replications for each variety. Pungsanbyeo was moderately susceptible to biotype 1 at 4 DI, susceptible at 10 DI, and was killed within the next 5 days. It was moderately resistant to biotype 2 at 4 DI and moderately susceptible at 10 DI. Baekunchalbyeo with *Bph 1* was readily killed and considered extremely susceptible to biotype 2. Milyang 63 with *bph 2* had resistance to biotypes 1 and 2 (Table 2).

Varieties without resistance genes were more susceptible to biotype 1 than to biotype 2. Capacity of the two biotypes to attack different rice varieties differs.

**Table 2. Damage reactions of different rice varieties to BPH biotypes 1 and 2. Korea, 1982.**

| Biotype | Variety | Resistance | Damage rating[a] | |
|---|---|---|---|---|
| | | | 4 DI | 10 DI |
| 1 | Pungsanbyeo | None | M | S |
| | Baekunchalbyeo | *Bph* 1 | R | MR |
| | Milyang 63 | *bph* 2 | MR | MR |
| 2 | Pungsanbyeo | None | MR | MS |
| | Baekunchalbyeo | *Bph* 1 | S | S |
| | Milyang 63 | *bph* 2 | R | R |

[a]DI = days after infestation, R = resistant, S = susceptible, MR = moderately resistant, MS = moderately susceptible.

## Differences between seedling bulk and population buildup tests of varietal resistance to whitebacked planthopper

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For the seedling bulk test, 10 varieties were sown in 15-cm-long rows in plastic boxes (10 × 10 × 50 cm) in the greenhouse. One-week-old seedlings, 20 per variety, were infested with 6-8 whitebacked planthopper (*Sogatella furcifera* H.) nymphs each. Plant reactions were graded 7, 10, 13, 15, and 23 days after infestation (DAI), according to the Standard Evaluation System for Rice.

For the population buildup test, the same 10 varieties were transplanted in wagner pots (20 × 15 cm) in the field on 27 May and 5 pairs of planthoppers/pot were caged on 6 July. Insects were counted 20, 30, 40, and 60 days after infestation.

Results between the seedling bulk test and the population buildup test were different. In the seedling bulk test, 5 varieties were moderately resistant or resistant 7 days after infestation (Table 1). All were susceptible or moderately susceptible at 23 DAI. In the population buildup test, all varieties except Nampungbyeo had high insect buildups (Table 2).

Final rating by the seedling bulk test should be made after there is no further increase in damage.

**Table 1. Variety reaction to whitebacked planthopper as measured by the seedling bulk test in Korea.**

| Variety | Reaction[a] at indicated days after infestation | | | | |
|---|---|---|---|---|---|
| | 7 d | 10 d | 13 d | 15 d | 23 d |
| Nampungbyeo | MR | I | I | MS | MS |
| Jinjubyeo | MR | I | MS | S | S |
| Suweon 295 | S | S | S | S | S |
| Milyang 30 | S | S | S | S | S |
| Suweon 305 | S | S | S | S | S |
| Suweon 301 | MR | MR | I | I | S |
| Mityang 23 | MR | I | MS | MS | S |
| Baekunchalbyeo | R | MR | MR | MR | MS |
| Suweon 299 | I | MS | MS | S | S |
| Suweon 298 | I | MS | MS | S | S |

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

**Table 2. Population buildup of whitebacked planthopper on rice plants infested at 40 days after transplanting in pots in Korea.**

| Variety | Population (no.) at indicated days after infestation | | | | | | | | Damage[a] |
|---|---|---|---|---|---|---|---|---|---|
| | 20 d | | 30 d | | 40 d | | 60 d | | |
| | Nymph | Adult | Nymph | Adult | Nymph | Adult | Nymph | Adult | |
| Nampungbyeo | 152 | 0 | 23 | 190 | 0 | 43 | 0 | 18 | 3 |
| Jinjubyeo | 148 | 0 | 15 | 118 | 86 | 64 | 19 | 30 | 2 |
| Suweon 295 | 154 | 0 | 12 | 114 | 220 | 104 | 67 | 37 | 5 |
| Milyang 30 | 64 | 0 | 17 | 148 | 234 | 68 | 76 | 19 | 8 |
| Suweon 305 | 108 | 0 | 21 | 57 | 266 | 100 | 214 | 82 | 4 |
| Suweon 301 | 120 | 0 | 38 | 146 | 270 | 321 | 47 | 102 | 7 |
| Milyang 23 | 94 | 0 | 12 | 114 | 286 | 61 | 158 | 21 | 5 |
| Baekunchalbyeo | 120 | 0 | 16 | 118 | 710 | 212 | 358 | 40 | 9 |
| Suweon 299 | 98 | 0 | 13 | 154 | 760 | 100 | 52 | 60 | 8 |
| Suweon 298 | 122 | 0 | 36 | 108 | 930 | 111 | 380 | 117 | 9 |

[a]0 = no damage, 9 = hopperburned.

# Deep water

## Character association and path coefficient analysis of deepwater rices

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Correlation and path coefficient analysis are important tools in determining the contribution of cultivar characters to yield and its components. Correlation coefficient reveals the association between two characters. Path analysis partitions correlation coefficients into direct and indirect effects and indicates the relative significance to yield for each component character.

Fifteen floating rices — local selections GT53, GT60, GT61, GT64, GT76, GT92, GT93, GT103, GT105, DW48, DW6172A, DW6255, GMS12, GMS13, and standard variety Jalmagna — were sown April 1979, before the onset of monsoons. Plots were 5 × 2 m in a randomized block design with 3 replications. Uncontrolled flooding started on 27 June, reached 280 cm 21 August, remained constant for about a week, and then gradually declined at 1-2 cm/ day.

The number of days to 50% flowering varied from 172 to 180; that to maturity was 196 to 2 15 days. Plant length varied from 290 cm for GT105 to 390 cm for Jalmagna.

Characters among the varieties studied differed significantly. Genotypic correlations were generally higher than phenotypic correlations. Only plant height showed a significant positive correlation with yield at both genotypic and phenotypic levels (Table 1). Other characters were not significantly associated with yield or with each other, except days to flowering and days to maturity.

Path analysis showed direct positive effects of plant height and days to maturity on yield (Table 2). Other attributes had negative direct effects. But days to flowering showed maximum indirect effects, followed by panicle bearing tillers/ plant through days to flowering and number of aquatic tillers/ plant through days to flowering.

Plant height and days to maturity were the principal characters responsible for yield in these deepwater rices, but the positive residual indicates that other characters might also contribute.

**Table 1. Correlation coefficients between 6 characters of deepwater rice, Uttar Pradesh, India.[a]**

| Character[b] | Plant height | Panicle bearing tillers/ plant | Aquatic tillers plant | Days to flowering | Days to maturity |
|---|---|---|---|---|---|
| Yield/plot | | | | | |
| G | 0.91** | –0.49 | –0.34 | 0.14 | 0.04 |
| Ph | 0.51* | –0.27 | –0.14 | 0.12 | 0.01 |
| Plant height | | | | | |
| G | | –0.44 | –0.16 | –0.10 | –0.12 |
| Ph | | –0.30 | –0.13 | –0.10 | –0.10 |
| Panicle bearing tillers/plant | | | | | |
| G | | | –0.05 | 0.13 | 0.19 |
| Ph | | | –0.08 | 0.07 | 0.12 |
| Aquatic tillers/plant | | | | | |
| G | | | | –0.22 | –0.21 |
| Ph | | | | –0.17 | –0.19 |
| Days to flowering | | | | | |
| G | | | | | 1.00** |
| Ph | | | | | 0.94** |

[a]**P = 0.01, *P = 0.05. [b]G =genotypic, Ph = phenotypic.

**Table 2. Path coefficient analysis of deepwater rice characters**

| Character | Plant height | Panicle bearing tillers | Aquatic tillers/ plant | Days to flowering | Days to maturity | Correlation with yield |
|---|---|---|---|---|---|---|
| Plant height | 0.76[a] | 0.16 | 0.06 | 0.23 | –0.30 | 0.91 |
| Panicle bearing tillers | –0.33 | –0.36[a] | 0.02 | –0.30 | 0.48 | –0.49 |
| Aquatic tillers/plant | –0.12 | 0.02 | –0.35[a] | 0.51 | –0.52 | –0.34 |
| Days to flowering | –0.07 | –0.04 | 0.08 | –2.33[a] | 2.50 | 0.14 |
| Days to maturity | –0.09 | –0.07 | –0.07 | –2.33 | 2.50[a] | 0.06 |
| Residual | | | 0.38 | | | |

[a]Direct effect.

## Screening for ufra resistance in deepwater rice

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Ufra disease of rice, caused by the nematode *Ditylenchus angustus,* causes serious deepwater rice crop losses in Bangladesh and several South Asian countries. Control methods exist but are not widely accepted. The following method of screening rice varieties for ufra was evolved in an experimental deepwater tank but could be adapted for field testing.

*Layout and seedling establishment*

1. Divide the tank into 1-m$^3$ plots and make a 15- to 20-cm-high plastered mud levee around each plot. There should be 1 m between plots.
2. Sow rice seeds in line, with 15 cm between lines. Use one row for each variety. After germination thin to 20 seedlings/line.

*Inoculation method*

1. Take several ufra-infested plants and tease them longitudinally. Cut into small pieces and soak in water overnight. Examine the extraction under a microscope and estimate *D. angustus* population per plant. Prepare an inoculum to ensure each seedling in the test receives 100 nematodes. Infested plants should be teased as before, cut into small pieces, and spread evenly over the plot in shallow standing water.

*Postinoculation management*

1. After inoculation, raise water level to the uppermost seedling node. Maintain this level for the first few weeks.
2. Once seedlings start to elongate, flood the tank to maintain water level at the uppermost node. This is necessary for 34 months after inoculation.

*Observation and sampling*

1. Inspect plants regularly for chlorotic discoloration of the leaf base, just below the collar. This discoloration is characteristic of ufra during vegetative phase and may be visible 3-4 weeks after inoculation. It more often is visible after 6-7 weeks, but 3-4 months is recommended to allow full development of chlorosis and spread of nematodes. At 3-4 months randomly sample at least 5 plants from each line.

**Rice variety classification.**

| Plant condition | Nematodes/tiller (av no.) | Infestation (%) | Reaction[a] |
|---|---|---|---|
| No disease symptom | None | Nil | HR |
| No disease symptom | 1-100 | 1-20 | R |
| Disease symptom visible | 1-100 | 1-20 | R |
| Disease symptom visible | 101-300 | 21-60 | I |
| Disease symptom visible | 300+ | 61-100 | S |

[a]HR = highly resistant. R = resistant, I = intermediate, S = susceptible.

*Laboratory processing of plant samples*

1. Dissect the individual plant to innermost tender leaf, cut into pieces about 5 mm long, place in a bijou bottle (or other small vial), add 2 ml tap water, loosely cover, and leave overnight.
2. Shake the container to thoroughly mix suspension. Examine 1 ml under a stereomicroscope, using a 1-ml Peters mounting slide to count nematodes. A few nematodes should be examined by compound microscope (100×–400×) to ascertain the proportion of *D. angustus* in the sample.
3. Calculate total number of nematodes per tiller, average number of nematodes per tiller, and percentage of infestation of each variety or breeding line.

*Scoring rice varieties*

Classify the test varieties into the categories in the table.

*Precautions*

Some varieties may not show a consistent relation between the average number of nematodes per tiller and the observed percentage of infestation. Such varieties should be left as unclassified and considered for retesting.

GENETIC EVALUATION AND UTILIZATION

# Temperature tolerance

## Selection for rice cold tolerance using grain yields versus phenotypic acceptability

*G. S. Chung, M. H. Heu, B. S. Vergara, J. D. Yea, G. Pateña, and R. M. Visperas, IRRI*

In the rice cold tolerance nursery, selection is based on leaf color, panicle exsertion, growth duration, fertility, and phenotypic acceptability (PA). However, the ultimate measure of performance is grain yield and field performance. An observational yield trial for low temperature areas was started in 1980 at Chuncheon Experiment Station, Korea, to study PA and compare yields. One hundred entries were planted in 1980 and in 1981.

Many entries yielded high (see table) but some yielded low because of high sterility, caused partly by delayed heading.

Several lines of IR crosses yielded high indicating the improvement rice breeders have made on old varieties. In most crosses, Kn-lb-361 was important. IR9202 (IR2053-521-1-1/K116//Kn-1b-361) was promising. IR2053 was early and had good grain quality. K116, from India, and Kn-1b-361, from Indonesia, are cold tolerant.

Cold tolerance at panicle initiation and flowering stage must be improved for Chianan 2, Chianung 242, K-84, and Khonorollo. They are high yielding under moderate temperatures but showed low percentage of fertility in

**Results of the 1980-81 observational yield trial for low temperature areas, Chuncheon, Korea.**

| Designation | Yield (t/ha) | PA |
|---|---|---|
| *1980* | | |
| China 988 | 6.81 | 5 |
| IR7167-33-2-3-3-1-3 | 6.45 | 3 |
| IR9202-5-2-2 | 6.60 | 5 |
| IR9202-6-1-1-2-2 | 6.51 | 3 |
| IR9202-10-2-1-1-3 | 6.85 | 5 |
| IR9202-10-2-1-5-1 | 6.30 | 5 |
| IR15636-8-3 | 7.30 | 5 |
| IR15889-32-1 | 7.89 | 7 |
| Shoa-Nan-Tsan | 6.45 | 5 |
| SR3044-78-3 | 7.30 | 3 |
| SR4079-4-2 | 6.30 | 9 |
| Cheoulwon 21 (check) | 5.51 | 5 |
| *1981* | | |
| SR5204-91-4-1 | 6.92 | 3 |
| IR15924-265-3 | 6.69 | 6 |
| IR9202-33-4-2-1 | 6.41 | 5 |
| IR7167-33-2-3-3-1-3-1 | 6.40 | 3 |
| IR20897-B-45 | 6.28 | 3 |
| Suweon 235 (check) | 3.77 | 3 |

Korea.

Most high yield varieties had a 3 to 5 PA score. PA is a poor measure of performance or yield ability. Many entries had poor PA but yielded high.

Low PA and grain yield correlation resulted because short stature is more desirable in Korea, where high nitrogen levels are used. In 1981 PA was not correlated with visual plant characters — days to heading, panicle number per hill, and spikelets per panicle. It was correlated with plant height ($r$ = 0.59**), which is not correlated with grain yield.

PA is a location-specific measurement. PA scoring in the observational yield trial should be discontinued to increase efficiency and allow more entries to be tested.

# Pest management and control DISEASES

## Improved method for obtaining viable counts of *Xanthomonas oryzae*

*R. W. H. Parry and J. A. Callow, Plant Sciences Department, University of Leeds, LS2 9JT, UK; and E. R. Morris, Unilever Research, Colworth Laboratory, Sharnbrook, Bedford, MK44 ILQ, UK*

Recovering colonies from single *Xanthomonas oryzae* cells is difficult. Recent experiments show improved recovery results if *X. oryzae* is poured into a weak agar medium. Colonies in poured preparations are counted more easily because they spread more slowly than those from bacterial suspension on the surface of agar medium.

After 48 hours incubation at 28° C, up to 400 colonies can be resolved on a 9-cm petri dish. These remain suitable for counting for at least 60 hours. The poured method is faster than surface spreading, and contamination is reduced.

Spread and poured cultures from a decimal dilution series of *X. oryzae* PXO 71 were prepared on three commonly used media (Table 1). Preliminary experiments showed 0.4% wt/vol agar to be the most suitable concentration for viable counting.

Spread cultures were prepared by dispensing 0.1 $cm^3$ of bacterial suspension onto the surface of lightly dried medium and spreading with a sterile glass rod. Poured cultures were prepared by placing 0.1 $cm^3$ of suspension into a sterile petri dish, and adding 10-20 $cm^3$ of medium, held molten at 38-40° C. The dish was swirled to ensure even inoculum distribution.

Uniform colonies developed in the poured media. They were counted after 60 hours. Spread cultures were counted after 84 hours because growth was uneven and some colonies appeared later and grew more slowly than others (Table 2).

Live counts were higher for poured than spread preparations for all media. Goto's medium supported growth better than WF-P or Dye's medium. Dye's medium was unsuitable. Growth dependence on inoculum density was overcome only when samples were poured into weak Goto's medium. This, together with the high viable counts obtained (more than 50% total count) and the high degree of reproducibility between replications, suggests pour-plating in Goto's medium containing 0.4% agar is the best way of obtaining viable *X. oryzae* counts.

The method has been used successfully for quantitative recovery of several strains of *X. oryzae* from infected rice plants, and should be useful in genetic procedures requiring isolated mutant recovery.

**Table 1. Components of three media for growth of *X. oryzae.***

| Component | Qty (g/liter) | | |
|---|---|---|---|
| | Dye's | WF-P | Goto's |
| $(NH_4)_2HPO_4$ | 1.00 | – | – |
| $K_2HPO_4$ | 2.00 | – | – |
| KCl | 2.00 | – | – |
| $Na_2HPO_4 \cdot 12H_2O$ | – | 2.00 | – |
| $Ca(NO_3)_2 \cdot 4H_2O$ | – | 0.50 | – |
| $FeSO_4 \cdot 7H_2O$ | – | 0.50[a] | – |
| $MgSO_4 \cdot 7H_2O$ | 0.20 | – | – |
| Na-glutamate | – | – | 1.00 |
| Yeast extract | 1.00 | – | – |
| Peptone | – | 5.00 | 10.00 |
| sucrose | 10.00 | 20.00 | 10.00 |
| Agar[b] | | | |
| Spread medium | 17.00 | 17.00 | 17.00 |
| Poured medium | 4.00 | 4.00 | 4.00 |

[a]According to S. H. Ou, "Rice diseases," p. 59. [b]Oxoid No. 3.

**Table 2. Colonies of *X. oryzae* per 9-cm petri dish.[a]**

| Dilution | Colonies[b] (no./9-cm petri dish) | | | | | |
|---|---|---|---|---|---|---|
| | Dye's | | WF-P | | Goto's | |
| | Pour | Spread | Pour | Spread | Pour | Spread |
| 1 | c | c | c | c | c | c |
| $10^{-1}$ | c | 0 | c | c | c | c |
| $10^{-2}$ | c | 0 | c | c | c | c |
| $10^{-3}$ | c | 0 | c | c | c | c |
| $10^{-4}$ | c | 0 | c | c | c | c |
| $10^{-5}$ | 1500[c] | 0 | 2000[c] | 1500[c] | 2000[c] | 1500[c] |
| $10^{-6}$ | 107.3 ± 11.1 | 0 | 212.7 ± 15.7 | 31.3 ± 16.8 | 223.0 ± 5.3 | 100.3 ± 20.0 |
| $10^{-7}$ | 3.0 ± 0.6 | 0 | 14.7 ± 2.4 | 0 | 21.7 ± 2.2 | 3.0 ± 1.5 |
| $10^{-8}$ | 0 | 0 | 1.3 ± 0.3 | 0 | 2.3 ± 0.9 | 0 |

[a]Means of triplicates ± standard errors are shown. Total bacterial count (viable and nonviable) estimated using counting chamber at 4.4 x $10^9/cm^3$ original suspension. [b]c = confluent growth. [c]Approximate count.

## Occurrence of white tip disease in deepwater rice in Bangladesh

*M. L. Rahman, scientific officer, and Isobel McGeachie, nematologist, ODA/ BRRI Deepwater Rice Project, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh*

Rice white tip disease, caused by the nematode *Aphelenchoides besseyi* Christie 1942, was reported near Dacca in 1955 but its distribution in other deepwater rice areas and the extent of crop and yield damage in Bangladesh are unknown. In 1981 white tip was found in the Manikganj, Narshingdi, and Chandina deepwater rice areas. Samples were taken at booting stage and examined for nematodes. About 60% of the rice fields in Manikganj were infested. New symptoms induced by this nematode and its influence on some plant characters including yield components were recorded.

Chlorotic discoloration on the leaf base just below the collar at 2- to 3-leaf stage of the seedling and splash patterned chlorosis or chlorotic stripes on the innermost leaf with a whitish tip at the elongating stage of the crop were disease symptoms. The flag leaf of the infected plant was shortened, twisted, crinkled, and often distorted or split longitudinally. The panicle emerged partially or completely and had whitish spikelets on the tip or throughout.

In a preliminary survey, the local deepwater rice variety Rajboalia was highly susceptible to white tip nematode. It was examined to assess nematode population in rice grains and influence on panicle length, panicle weight, and some yield components. Ten panicles with white tip symptoms and 10 healthy panicles were sampled from each of 10 different fields. Panicle length and weight were measured. Filled and sterile grains were counted, then grains were threshed and bulked separately. One thousand grains from each bulk sample were weighed and nematode population in 100 grains was estimated by soaking split grains overnight and examining and counting nematodes under a microscope.

**Population density of white tip nematode in rice grains and its influence on panicle length, panicle weight, and yield components in deepwater rice variety Rajboalia, Bangladesh, 1981.**

| Character | Healthy plant | Diseased plant | Mean difference [a] |
|---|---|---|---|
| Nematode population/100 grains | 112 | 650 | 538** |
| Panicle weight (g) | 5.7 | 1.9 | 3.7** |
| Panicle length (cm) | 30.0 | 23.0 | 7.0** |
| Filled grains/panicle | 173 | 47 | 126** |
| Sterile grains/panicle (%) | 21.8 | 77.2 | 55.4** |
| 1,000-grain weght (g) | 18.1 | 5.5 | 12.6** |

[a] **All differences are statistically significant ($t$-test) $p = 0.01$.

Panicles from plants with white tip symptoms were significantly shorter, weighed less, had fewer filled grains and lower 1,000-grain weight. There were significantly more nematodes per 100 grains (see table).

## In vitro toxicity of some fermented oil cake extracts to *Rhizoctonia solani* and *Sclerotium oryzae*

*V. Damodar Naidu and V. T. John, All India Coordinated Rice Improvement Project, Hyderabad 500 030, India*

Applying some nonedible oil cakes is thought to increase some soil antagonist populations. We studied the effect of oil cakes commonly used by Indian farmers on in vitro inhibition of *Rhizoctonia solani* and *Sclerotium oryzae,* which cause rice sheath blight and stem rot.

Two hundred grams each of kusum *Schleichera trijuga;* mohuwa *Bassia latifolia;* neem *Melia azadirachtae;* and sal *Schorea robusta* were placed in plastic mug and fermented for 25 days in irrigation water. Contents were then filtered and the supernatant was centrifuged. The resultant solution was adjusted to 200 ml stock solution by flash evaporation. The stock solution was added to potato dextrose agar (PDA) media in different concentrations (see table) and autoclaved. Nutrient concentration (potato decoction and glucose) for all

**Growth inhibition of *R. soloni* and *S. oryzae* in fermented oil cake extracts, Hyderabad, India.**

| Oil cake | Concentration | | *R. solani* colony diameter (cm) | PI [a] | *S. oryzae* colony diameter (cm) | PI [a] |
|---|---|---|---|---|---|---|
| | Medium | Extract | | | | |
| Kusum | 180 | 20 | 3.8 | 57.7 | 1.4 | 72.7 |
| | 160 | 40 | 1.3 | 85.6 | 1.0 | 83.6 |
| | 140 | 60 | 0.8 | 91.1 | 0 | 100.0 |
| | 120 | 80 | 0 | 100.0 | 0 | 100.0 |
| Mohuwa | 180 | 20 | 4.6 | 48.9 | 1.1 | 80.0 |
| | 160 | 40 | 4.6 | 48.9 | 0.7 | 87.2 |
| | 140 | 60 | 4.3 | 53.3 | 0 | 100.0 |
| | 120 | 80 | 4.1 | 54.4 | 0 | 100.0 |
| Neem | 180 | 20 | 4.5 | 50.0 | 0 | 100.0 |
| | 160 | 40 | 2.8 | 69.0 | 0 | 100.0 |
| | 140 | 60 | 2.0 | 77.8 | 0 | 100.0 |
| | 120 | 80 | 0.8 | 100.0 | 0 | 100.0 |
| Sal | 180 | 20 | 3.4 | 62.2 | 3.9 | 29.1 |
| | 160 | 40 | 2.5 | 73.3 | 3.7 | 32.7 |
| | 140 | 60 | 0 | 100.0 | 3.1 | 45.5 |
| | 120 | 80 | 0 | 100.0 | 2.0 | 63.6 |
| Control | Potato dextrose agar | | 9.0 | – | 5.5 | – |
| | C.D. for colony diameter | | 0.31 | C.D. for colony diameter | 0.19 | |
| | C.V. | | 7.76% | C.V. | 10.35% | |

[a] Percentage of growth inhibition (PI) over check.

treatments was constant. Poison-food technique was used to study growth inhibition of the two pathogens.

The media was plated into petri dishes and dried for 24 hours. Plates were inoculated with *R. solani* and *S. oryzae* growth disks. PDA plates without any extract were used as control. Colony diameter was measured 3 days after inoculation.

Results (see table) showed the pathogens were inhibited at all oil cake extract concentrations. *R. solani* growth inhibition was greater in sal cake extract followed by that in kusum, neem, and mohuwa extracts. *S. oryzae* growth was completely inhibited at all neem cake extract concentrations.

## Occurrence of brown spot in rice in relation to nutritional soil status

*L. P. Kauraw and R. N. Samantaray, Central Rice Research Institute, Cuttack-753 006, Orissa, India*

Brown spot, caused by *Cochliobolus miyabeanus* (Ito and Kuribayashi) Drechsler ex Datsur, severely damaged Mahsuri variety during the 1978 dry season in the Operational Research Project Village of Kandarpur in Cuttack, Orissa.

Fields of Mahsuri in five villages — Athanga, Kandarpur, Fakirpara, Sidheswarpur, and Deopur — were tested for disease severity. A nine-point scale was used to score disease damage. Observations were made at maximum tillering and 1 month before harvest. More than 14 spots per leaf were counted. In Athanga, rice leaves had type C lesions or small spots. In other villages disease intensity was not so severe. Severity varied with soil nutritional status (see table). Percentages of organic carbon, nitrogen, and potash, and cation exchange capacity (CEC) of the soil were very low in Athanga. Seed was sown late and there was an irrigation water shortage.

In the other villages, disease incidence was low. Percentages of organic carbon and nitrogen in the soil were medium. Potash and CEC levels in the soil were low. Planting was done on time and there was irrigation water.

Disease incidence was lowest in Deopur. Soil pH was acidic, organic carbon medium, and total nitrogen slightly higher than in other fields.

The present study indicates brown spot occurrences are most severe in soils with high pH, low organic carbon percentage, low nitrogen and potash levels, low CEC and under dry conditions which cause low plant nutrient availability.

**Occurrence of brown spot on rice variety Mahsuri at different soil fertility levels and sites, Orissa, India.**

| Site | pH | Organic carbon (%) | Total N (%) | Olsen P (ppm) | CEC (meq/100 g soil) | Exchangeable cations (meq/100 g soil) | | | Fe (ppm) | Mn (ppm) | Disease intensity[a] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | K | Ca | Mg | | | Maximum tillering stage | 1 mo before harvest |
| Athanga | 6.3 | 0.44 | 0.040 | 7 | 7.60 | 0.051 | 4.55 | 1.233 | 9 | 20 | 8.92 | 9.00 |
| Kandarpur | 6.1 | 0.58 | 0.040 | 6 | 7.10 | 0.051 | 4.00 | 1.183 | 16 | 32 | 3.40 | 3.72 |
| Fakirpara | 6.6 | 0.56 | 0.048 | 9 | 10.40 | 0.102 | 7.45 | 1.850 | 12 | 20 | 3.68 | 4.20 |
| Sidheswarpur | 5.6 | 0.50 | 0.029 | 10 | 9.70 | 0.051 | 5.20 | 2.733 | 13 | 48 | 4.76 | 5.16 |
| Deopur | 5.5 | 0.70 | 0.063 | 6 | 12.00 | 0.193 | 4.30 | 1.523 | 11 | 30 | 1.96 | 2.68 |

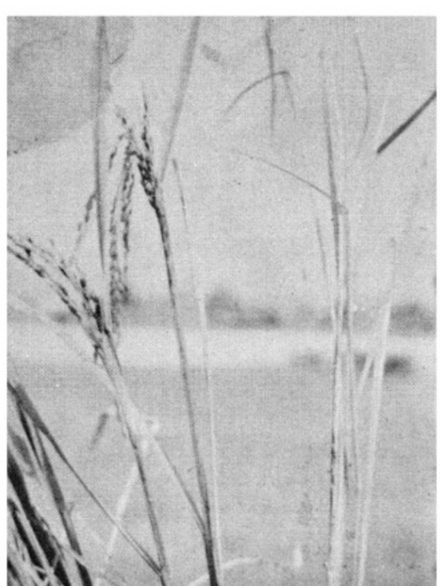
[a]1980 Standard Evaluation System for Rice scale of 1-9: 1 = less than 1% incidence, 9 = 76-100%.

## *Echinochloa colona,* an alternate host of *Sarocladium oryzae* causing sheath rot of rice

*M. M. Rahman, A. K. M. Shajahan, and S. A. Miah, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh*

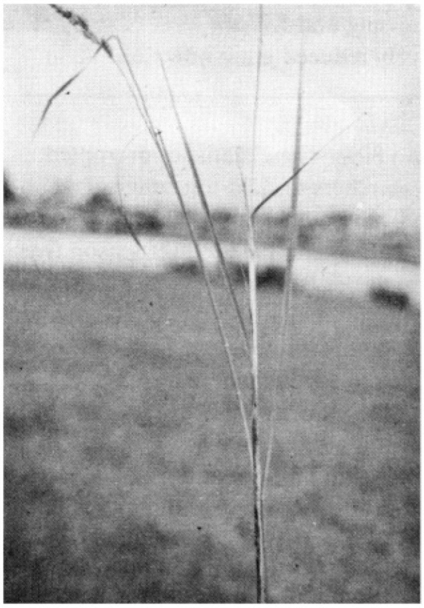
Sheath rot caused by *Sarocladium oryzae* (Saw) Gem. is a major disease in Bangladesh. It was first observed in 1973.

During the 1980 boro season (spring rice, harvested in April), rice field weed *Echinochloa colona* (L) Link was found growing near an infected hill of variety BR3, a variety moderately susceptible to sheath rot. Infected BR3 tillers and the culm of the weed were close to each other. The leaf sheaths of the weed were infected. Symptoms were similar to rice sheath rot except that lesions were lighter brown and had while-ish mycelia and fungus spores (Fig. 1 and 2).



**1.** Typical symptoms of rice (left) and *E. colona* (right) infected with *S. oryzae.*

lnfected rice hills and weed plants were collected to isolate the causal organism(s). Growth characters and morphology of the fungal colony isolated from the weed were similar to those of the colony isolated from the rice. Fungi from rice and weed were identified as *S. oryzae.* Isolated organisms were cross-inoculated in potted BR3 and *E. colona* plants. In 15-20 days BR3 and *E. colona* produced symptoms similar to those observed in the field.



**2.** Close-up of typical *S. oryzae* symptoms on sheaths of *E. colona.*

Although the fungus is known to be seedborne, how the infection initiates from the infected seeds is unknown. Perhaps *E. colona* is the alternate host of *S. oryzae.* It may be responsible for spreading inocula to healthy rice plants during panicle initiation to boot stages, when the plants are thought to be infected.

This is the first report of an alternate host of *S. oryzae.* We suggest *E. colona* be destroyed around levees, fields, and areas adjacent to rice production to avoid the disease. The weed not only hosts *S. oryzae* but also other disease organisms, including rice tungro virus.

## Seed treatment as prophylaxis against root-knot nematode in rice

*S. C. Sahu and Y. S. Rao, Central Rice Research Institute, Cuttack-6, Orissa, India*

We tested the efficacy of treating rice seed (variety Ratna) with common fungicides to deter root invasion and endoparasite development of rice root-knot nematode *Meloidogyne graminicola.* Seeds were treated with a 3:1000 fungicide solution applied at 3 g/kg seed before planting them in pots. Soil was inoculated with second-stage infective nematode larvae (60 larvae/g soil). Seedlings were examined for root-knot and endoparasitic stages of the nematode 30 days after germination. Treatments were replicated four times.

Ceresan dry, a mercurial seed dressing fungicide recommended for control of rice blast, Helminthosporiose, and foot rot was most effective (see table). Seed treatment was effective against fungal diseases and nematodes.

**Effect of fungicidal seed treatment on rice nematode control, Orissa, India.**

| Fungicide | Chemical name | No. of female larvae/plant root system |
|---|---|---|
| Blitox-50 | Copper oxychloride | 20.25 |
| Captafol | N-[(1,1,2,2-tetrachloroethyl) sulfenyl-cis-4-cyclohexane-1,2-dicarboximide] | 25.20 |
| Ziram | Zn-dimethyl dithiocarbamate | 23.30 |
| Coppesan 45.5 wp | Copper oxychloride | 29.15 |
| Mancozeb | Zn-ethylene-bis + manganous ethylene-bis dithiocarbamate | 26.30 |
| Carbendazim | 2-(methoxy-carbamoyl) benzimidazole | 25.95 |
| Ceresan dry | Ethyl mercury chloride | 12.95 |
| Control | | 26.55 |
| C.D. (0.01) | | 10.20 |

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

## Efficacy of fungicides for the control of brown spot

*S. K. Sharma and Sushil K. Maheshwari, Plant Pathology Laboratory, Botany Department, Agra College, Agra-282002, India*

Rice brown spot caused by *Helminthosporium oryzae* Breda de Haan (*Cochliobolus miyabeanus* Ito et Kurib) is a serious disease in Uttar Pradesh and other Indian rice-growing states. Because primary infection is from seed and secondary infection from airborne inoculum, researchers theorized that a seed treatment followed by foliar fungicidal application might effectively control the disease.

Five seed dressing and seven foliar fungicides (Tables 1 and 2) were tested for ability to control brown spot. Field tests using a split-plot design and three replications were conducted during the 1977-78 wet season. Jhona 349 was the susceptible variety. Seeds were treated with fungicides before sowing. Foliage was sprayed 25, 40, 55, and 70 days after transplanting.

Grain infection was lowest when seeds were dressed with thiram and mancozeb.

**Table 1. Relative efficacy of seed dressing fungicides on grain infection and paddy yield.**

| Fungicide (2.5 g/kg) | Grain infection (%) | Grain yield (t/ha) |
|---|---|---|
| Mancozeb | 5.82 | 3.0 |
| Thiram | 4.47 | 2.6 |
| Blitox | 7.21 | 2.2 |
| Ceresan | 9.23 | 2.1 |
| Tillex | 8.45 | 2.0 |
| Control | 12.11 | 1.5 |
| C.D. (5%) | 1.30 | 1.40 |

**Table 2. Effect of fungicidal foliar spray on grain infection and paddy yield.**

| Fungicide | Dose (%) | Grain infection (%) | Grain yield (t/ha) |
|---|---|---|---|
| Mancozeb | 0.30 | 4.62 | 3.0 |
| Kitazin 48% | 0.10 | 5.78 | 2.7 |
| Blitox | 0.25 | 5.10 | 2.4 |
| Blue copper | 0.30 | 7.17 | 2.3 |
| Zineb | 0.30 | 6.12 | 2.2 |
| Dithane-C-10 | 0.30 | 5.89 | 2.3 |
| Captafol | 0.30 | 8.02 | 2.1 |
| Control | | 14.62 | 1.9 |
| C.D. (5%) | | 3.30 | 4.16 |

Maximum yields of 3.0 and 2.6 t/ha were recorded for these treatments. Mancozeb and Kitazin 48%, used in foliar application, were most useful (Table 2).

Mancozeb was effective used as seed dressing or foliar spray. Thiram as seed dressing and Kitazin 48% as spray effectively reduced grain infection.

## Efficacy of certain fungitoxicants against rice stem rot

*S. K. Sharma, Plant Pathology Laboratory, Botany Department, Agra College, Agra-282002, India (present address: AARO, Government Agriculture Research Center Hanumangarh Town)*

Stem rot, caused by *Sclerotium oryzae* Catt. (*Leptosphaeria salvinii* Catt), is one of the most common rice diseases in Uttar Pradesh and in other Indian rice-growing areas. Farm workers have estimated grain weight losses ranging from 5 to 80%. These statistics prompted researchers to field-test fungicidal control methods for the disease.

During the 1978-79 wet season five fungicides (see table) were tested on susceptible variety Jhona 349 for their ability to control stem rot. Fields were sprayed 30, 50, and 70 days after transplanting. Spray was directed to plant clumps at water level.

Kitazin 17% and dichlozoline were most effective in controlling the disease. Other effective fungicides, in descending order, were thiabendazole, Kausamine, and edifenphos.

**Efficacy of fungicides against stem rot disease and improved paddy grain yield, Agra College, India.**

| Fungicide | Dose | Disease control[a] (%) | Increased grain yield over control (kg/ha) |
|---|---|---|---|
| Kitazin 17% G | 1 kg/ha | 78.8 | 55.8 |
| Dichlozoline | 1 kg/ha | 70.6 | 51.2 |
| Thiabendazole | 0.15% | 61.7 | 40.2 |
| Kausamine | 0.10% | 45.5 | 30.5 |
| Edifenphos | 0.1% | 31.6 | 22.6 |

[a]Disease incidence in control was 40.2%.

$$\% \text{ disease} = \frac{\% \text{ disease in control} - \text{control}}{\text{control}} \times 100.$$

# Pest management and control INSECTS

## Boot leaf and spikelet damage in rice by whorl maggot *Hydrellia philippIna* Ferino

*Mangal Sain, J. S. Bentur, and M. B. Kalode, All India Coordinated Rice Improvement Project (AICRIP), Rajendranagar, Hyderabad 500 030, India*

Rice whorl maggots *Hydrellia* spp. (Diptera: Ephydridae) damage leaves during tillering stage. Flag leaf and occasional damage to developing grains are recorded, but no information on damage in late crop growth is available. During 1980 rabi widespread boot leaf and spikelet damage was noted on the AICRIP farm in Hyderabad. When

Dissected panicles from boot stage showing whorl maggot *Hydrellia philippina* damage to spikelet (left) A closer view of a shriveled spikelet and the maggot is on right.

**Whorl maggot damage at different crop growth stages, AICRP, 1979-80.**[a]

| Treatment | Early leaf damage (%): 1979 rabi, 40 DT | Early leaf damage (%): 1979 kharif, 20 DT | Early leaf damage (%): 1980 rabi, 30 DT | Late damage (1980 rabi): Tillers with boot leaf damage (%) 80 DT | Late damage (1980 rabi): Damaged spikelets/ affected panicle in boot (no.) 80 DT | Late damage (1980 rabi): Damage panicle) (%) 93 DT |
|---|---|---|---|---|---|---|
| No protection | 15.9 | 8.3 | 26.0 | 4.4 | 6.8 | 5.8 |
| Sprayed[b] on 15 and 55 DT | 15.5 | 8.9 | 21.9 | 2.9 | 8.1 | 5.7 |
| Sprayed[b] every 10 days | 8.9 | 1.9 | 25.3 | 1.6 | 4.5 | 3.3 |

[a]DT = days after transplanting. [b]Quinalphos @ 0.5 kg a.i./ha.

booting stage tillers were dissected, maggots were observed to be feeding on spikelets (see figure). After emergence the affected panicles showed damage (shriveled spikelets) caused by the pest.

Whorl maggot damage to Jaya variety, under different protection treatments, during three consecutive seasons is presented in the table. Damaged leaves in the vegetative stage (20 to 40 days after transplanting (DT) ranged from 8.3-26% in unprotected treatments. During 1980 rabi, 1.6-4.4% tillers with boot leaf damage were observed at 80 DT in different treatments. In affected boots 4.5-8.1% spikelets per panicle were injured. Damage in emerged panicles at 93 DT ranged from 3.3 to 5.8%. Insecticidal treatments at 10-day intervals reduced late damage symptoms more than other treatments.

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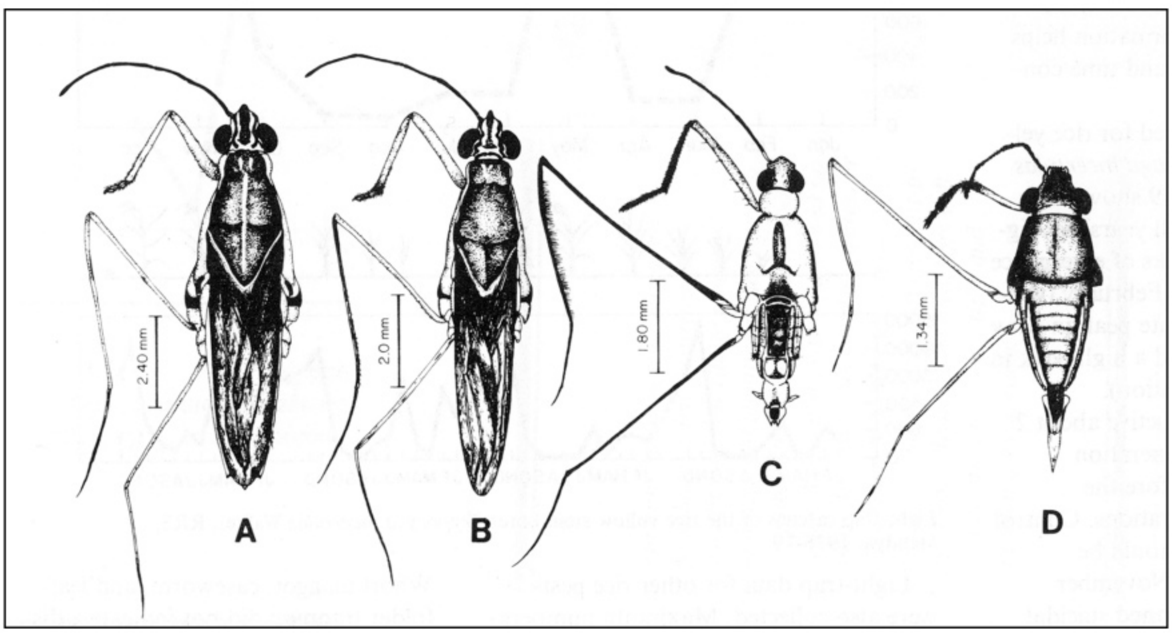
## Water striders: new predators of rice leafhoppers and planthoppers in the Phillippines

*Alberto T. Barrion, research assistant, and James A. Litsinger, entomologist, Entomology, Department, IRRI*

A 1981 survey of the rice field aquatic habitat on the IRRI farm revealed four species of water striders (Hemiptera: Gerridae) (see figure and table). Field and laboratory observations showed these water striders preyed on leafhoppers (*Nephotettix virescens, N. nigropictus, Cofana spectra, Recilia dorsalis,* and *Exitianus indicus*) and planthoppers (*Nilaparvata lugens, Sogatella, furcifera, Sogatodes pusanus,* and *Harmalia* sp.) that fell on the water.




Adult water striders *Limnogonus fossarum* (A, female), *L. nitidus* (B, female), *Rheumatogonus* sp. (C, male), and *Rhagadotarsus* sp. (D, female).

**Characters of rice field-inhabiting gerrids, IRRI 1981.**

| Character | *Limnogonus* *Fossarum* (F.) | *Limnogonus* *Nitidus* (Mayr) | *Rheumatogonus* sp. | *Rhagadotarsus* sp. |
|---|---|---|---|---|
| Total body length (mm) | | | | |
| Male | 8.88 | 8.16 | 5.66 | No male insect collected |
| Female | 10.88 | 9.0 | 7.33 | 4.83 |
| Body appearance | Long and slender | Long and slender | Slightly shorter and thinner | Short to slightly oval |
| Length of middle and hind femora compared to body length | Shorter | Shorter | Longer | Shorter |
| Inner margin of eyes | | Concave | Concave | Convex |
| Posterior lobe of pronotum | With yellow longitudinal band | Without band | Without band | Without band |
| Posterior 2/3 of middle tibia | Without thick hairs | Without thick hairs | With thick hairs | Without thick hairs |
| Shape of posterior end of abdomen | Bluntly pointed | Bluntly pointed | Blunt to slightly pointed | Pointed or spinelike |

Water striders are fast moving. They are not usually seen in rice fields because they sense any water disturbance and are quick to flee. Water striders require constant water supply and are numerous in paddies irrigated from rivers or reservoirs.

Species of the genus *Limnogonus* are most numerous on the IRRI farm, which is irrigated from reservoirs year-round.

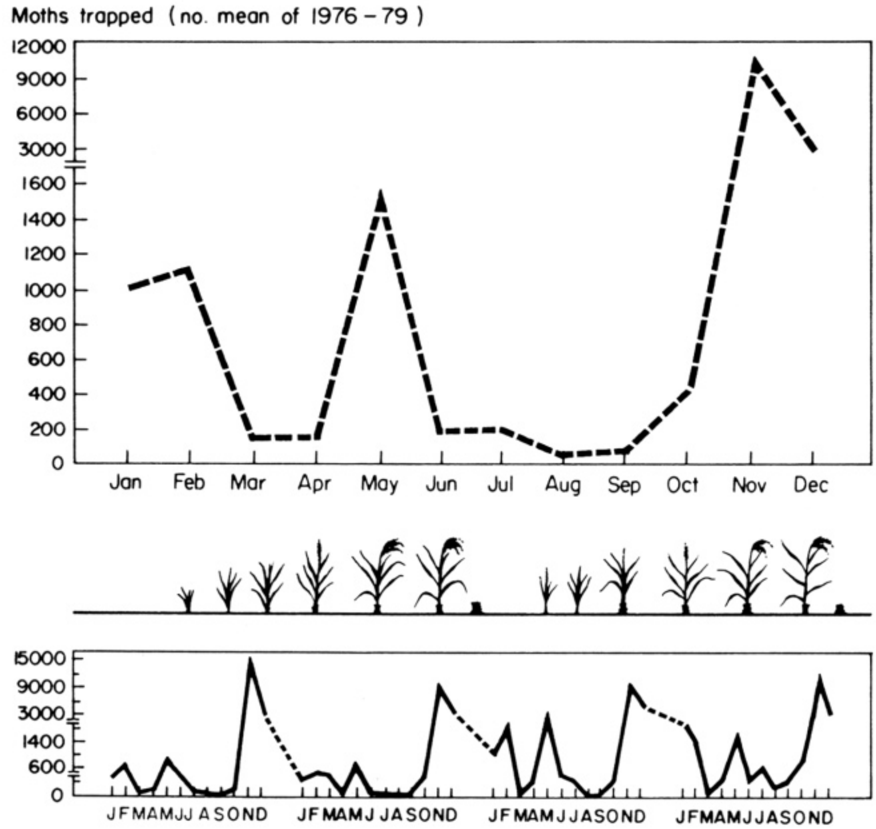
## Light-trap catches of rice yellow stem borer

*T. M. Manjunath, University of Agricultural Sciences Regional Research Station (RRS), V. C. Farm, Mandya 571 405, Karnataka. India*

Light-trap catches at RRS, V. C. Farm, Mandya, indicate that seasonal appearance and population fluctuations of some important rice pests follow an annual pattern. This information helps forecast pest occurrence and time control measures.

Light-trap data collected for rice yellow stem borer *Scirpophaga incertulas* Walker from 1976 to 1979 show moth emergence is similar in all years (see figure). There are three peaks of emergence each year: a low peak in February (winter generation), a moderate peak in May (summer generation), and a high peak in November (kharif generation).

The pest is most destructive about 2 weeks after the winter generation emerges and a month before the summer and kharif generations. Control measures, if necessary, should be initiated then. May and November appearances might be termed suicidal emergence, as there is little standing rice to support progenies of large populations.




Light-trap catches of the rice yellow stem borer *Tryporyza incertulas* Walker, RRS, Mandya, 1976-79.

Light-trap data for other rice pests were also collected. Maximum numbers of leafhoppers, planthoppers (including brown planthopper), and gall midge were trapped in May and November. Whorl maggot, caseworm, and leaffolder trapping did not indicate a distinct trend. Maximum catch of most important rice pests in this area was in November.

## Bionomics of the rice water weevil *Lissorhoptrus brevirostris* (SFFR.) in Cuba

*Rafael M. Carbonnel, Rice Experimental Station "Sur del Jibaro," Sancti-Spiritus, Cuba*

The rice water weevil, first reported in 1950, is a principal insect pest of rice in Cuba. Adults also feed on 34 alternate host plants, but complete development from egg to adult occurs on graminaceous species.

The life cycle from oviposition to emergence of adult is 50 days at a mean temperature of 26.2° C. In controlled conditions, adults live an average of 714 days.

In direct field counts adults appeared in mid-March. Highest population densities of adults, larvae, and pupae occurred between May and October, when average temperatures were 20° - 27.5° C and rainfall was higher than 100 mm. Population densities of adults, larvae, and pupae are highly correlated with mean temperature ($r$ = 0.93, 0.99, and 0.81, respectively). Light-trap data confirmed that adults appeared between May and October. Two peaks, in June and September, are considered two generations. The correlation between adult populations and mean temperatures in the Sancti-Spiritus rice zone was 0.80.

Although adults feed on rice leaves, injury is not economically important because, even at the highest populations, they do not remove more than 1.4% of the foliar area. Larvae cause much greater damage, destroying up to 83% of root tissue and causing 54% yield loss.

In plots where different damage intensities of larvae were simulated (15% to 60% root tissue), yield reductions obtained were 37.3% to 61.1%.

Insecticide-treated plots yielded 8.75 t/ha, untreated check plots 3.41 t/ha.

### Effect of spacing on leaffolder *Cnaphalocrocis medinalis* Guenée infestation in rice

*G. S. Thangamuthu, agronomist, and Chellammal Murugesan, entomologist, All India Coordinated Rice Improvement Project (AICRIP); and S. Subramanian, professor of agronomy, Tamil Nadu Agricultural University (TNAU), Coimbatore-3, India*

We studied the effect of spacing on leaffolder *Cnaphalocrocis medinalis* Guenée infestation in rice during January-March 1982. Variety TNAU 17005 was field tested at Paddy Breeding Station, Coimbatore, India.

Four spacings were evaluated in six replications. Nitrogen fertilizer was applied as urea supergranules at 75 kg N/ha, P and K each were applied at 40 kg/ha. Differential leaffolder infestation was recorded 55 days after transplanting. Total leaves and total leaves infested by larvae were counted on 10 randomly selected hills in each plot (see table).

**Effect of spacing on leaff older *Cnaphalocrocis medinalis* Guenée infestation in rice, Coimbatore, India.**

| Spacing (cm) | Infestation (%) |
|---|---|
| 10 × 15 | 36 |
| 15 × 20 | 26 |
| 22.5 × 20 | 7 |
| 30 × 20 | 12 |

Mean infestation in the plots ranged from 7 to 36%. Plants with close spacing (10 × 15 cm) recorded significantly higher infestation than plants spaced 22.5 × 20 cm and 30 × 20 cm.

# Pest management and control WEEDS

### Efficiency of some herbicides and hand weeding for transplanted rice weed control

*S. K. Mukhopadhyay and B. T. Mandal, College of Agriculture (Palli Siksha Sadana), Visva-Bharati University, West Bengal, India*

Field experiments during the 1980 wet season at Palli Siksha Sadana, Visva-Bharati University, Sriniketan, tested new herbicides and herbicide combinations for their ability to suppress weeds in transplanted rice. *Echinochloa colonum, Echinochloa crus-galli* (grasses), and *Ludwigia parviflora* (broadleaf) were predominant weeds in the field.

Oxyfluorfen EC effectively controlled grasses, broadleaf weeds, and sedges when applied at 0.096, 0.120, and 0.144 kg ai/ha 4 days after transplanting (DT) (see table). However, rice plants yellowed after application, and although they recovered after 2-3 weeks, crop yields were reduced.

Fluchloralin EC (0.720 ai/ha, applied 2 days before transplanting [DBV]) followed by bentazon (0.960 kg ai/ha 25 DT) produced highest grain and straw yield. Hand weeding or rotary weeding 25 and 45 DT produced similar results.

Incorporating fluchloralin EC (0.960 kg ai/ha) at puddling, 2 DBT, produced the next best yield. When no weeding was done, 39% grain yield loss was observed, compared to the best treatment.

**Effect of herbicides and hand weeding on weed weight and rice yield, West Bengal, India.**[a]

| Herbicide, weeding | Application | | Weed dry wt ($g/m^2$) 50 DT | Grain yield (t/ha) |
|---|---|---|---|---|
| | kg ai/ha | Time | | |
| Oxyfluorfen EC | 0.096 | 4 DT | 12.6 | 2.7 |
| Oxyfluorfen EC | 0.120 | 4 DT | 12.5 | 2.6 |
| Oxyfluorfen EC | 0.144 | 4 DT | 11.8 | 2.9 |
| Fluchloralin EC | 0.720 | 2 DBT | 12.9 | 3.3 |
| Fluchloralin EC | 0.960 | 2 DBT | 6.0 | 4.0 |
| Bentazon AS | 0.960 | 25 DT | 23.9 | 3.1 |
| Bentazon AS | 1.440 | 25 DT | 20.5 | 3.1 |
| Fluchloralin G – 2,4-D IPE | 0.500 | | 12.8 | 3.6 |
| Fluchloralin G – 2,4-D EE | 0.500 | | | |
| | 0.625 | 2 DT | 12.6 | 3.6 |
| Fluchloralin EC fb bentazon AS | 0.720 | 2 DBT | | |
| | 0.960 | 25 DT | 5.8 | 4.1 |
| Fluchloralin G fb bentazon AS | 0.675 | 2 DBT | | |
| | 0.960 | 25 DT | 3.0 | 4.1 |
| Hand weeding | | 25 & 45 DT | 5.1 | 4.1 |
| Rotary weeding | | 25 & 45 DT | 5.2 | 4.0 |
| Unweeded control | | | 48.6 | 2.5 |
| SEm ± | | | 2.7 | 0.6 |
| C.D. at 5% | | | 8.4 | 1.8 |
| CV | | | 6% | 3% |

[a]DT = days after transplanting, DBT = days before transplanting, G = granular, EC = emulsifiable concentrate, AS = aqueous solution, fb = followed by.

### Chemical weed control in dryland rice

*T. N. Singh, Gulab Singh, and H. P. Singh, Crop Physiology Department, N. D. University of Agriculture and Technology, Faizabad (U. P.), India*

In 1976-78 three chemical herbicides were evaluated for control of common weeds in dryland rice fields of eastern Uttar Pradesh. Two concentrations of active ingredient of each herbicide were compared with hand weeding and no weeding. Test plots were 5 × 2.5 m. The experimental layout was a randomized block design with treatments replicated 4 times.

Variety Narendra (IET2232) was sown at 100 kg seed/ha in rows 20 cm apart using a wheelhoe. Nutrients were applied at 60-30-30 kg NPK/ha. Half

**Effect of chemical herbicide on yield of dryland rice at Faizabad.**

| Treatment | Grain yield (t/ha) | |
|---|---|---|
| | 1976 | 1978 |
| Control (no weeding) | 0.6 | 0.6 |
| Propanil (1.5 kg/ha) | 1.7 | 1.8 |
| Propanil (3.0 kg/ha) | 2.1 | 2.2 |
| MCPA (0.4 kg/ha) | 1.6 | 1.6 |
| MCPA (0.8 kg/ha) | 1.8 | 2.0 |
| 2,4-D (0.5 kg/ha) | 1.5 | 1.7 |
| 2,4-D (1.0 kg/ha) | 2.0 | 2.1 |
| Hand weeding (2 times) | 2.3 | 3.0 |
| C.D. (5%) | 1.7 | 2.0 |

the N and all the P and K were applied at sowing; half the N was topdressed at tillering.

Major weed species 4 weeks after sowing were *Panicum colonum, Cyperus rotundus, Paspalum* sp., *Phyllanthus niruri, Edipta erecta, Cynodon dactylon, Ammannia baccifera,* and *Bonnaya* sp. Herbicides were sprayed by foot-operated Maruti sprayer 4-5 weeks after sowing. In 1977, the crop did not mature because of severe drought. In 1976 and 1978, yields were higher with chemical control but highest with hand weeding (see table).

## Yield losses to delayed weeding in direct-seeded, rainfed dryland rice

*S. P. Singh, scientist S-1 (Agronomy), and J. P. Tandon, director, Vivekananda Laboratory, for Hill Agriculture, Almora, U. P., India*

Rainfed dryland rice in the hills of Uttar Pradesh is direct-seeded in winter fallow fields in March-April. Germination depends on soil moisture conserved from winter rains. Monsoon rains start in late June and the crop is harvested at the end of the rainy season, about 170 days to maturity. Hand weeding is the only weed control method.

To identify the critical time and number of weedings, nine treatments with three replications were tested in a randomized block design.

Grain yield without weed control was significantly lower than in the weed-free check (see table). Yield decreased with weeding delay, to a maximum loss when weeding was delayed to 100 days. Weeding at 40 days significantly reduced grain yield and additional weedings did not improve yields significantly until 4 weedings. Straw yield, weed dry weight. and weed control efficiency showed similar trends.

**Effect of hand weeding treatment on weed dry weight, control efficiency, grain yield, and straw yield in direct-seeded rainfed dryland rice, Almora, UP., India.**

| Treatment[a] | Grain yield (t/ha) | Straw yield (t/ha) | Weed dry weight (t/ha) | Weed control efficiency (%) |
|---|---|---|---|---|
| No weeding | 0.2 | 0.6 | 2.9 | – |
| One hand weeding 40 DE | 1.4 | 2.4 | 1.4 | 53 |
| One hand weeding 60 DE | 0.9 | 1.7 | 1.7 | 42 |
| One hand weeding 80 DE | 0.6 | 1.7 | 1.8 | 38 |
| One hand weeding 100 DE | 0.3 | 0.8 | 2.2 | 26 |
| Two hand weedings 40 and 60 DE | 1.4 | 2.7 | 1.2 | 60 |
| Three hand weedings 40, 60, and 80 DE | 1.6 | 3.8 | 1.1 | 63 |
| Four weedings 40, 60, 80, and 100 DE | 2.2 | 4.1 | 0.7 | 76 |
| Five hand weedings 20, 40, 60, 80, and 100 DE | 2.5 | 4.2 | 0.4 | 88 |
| C.D. (5%) | 0.50 | 2.00 | 0.66 | |

[a]DE = days after emergence.

# Soil and crop management

## Effect of early drainage on yields

*Chao Cheng-nan, Chiayi Agricultural Experiment Station, TARI, Chiayi, Taiwan*

To facilitate mechanical harvesting, paddy fields are drained early — at the ripening stage — but that causes an increase in imperfectly ripened grains and a decrease in yield. If drainage is postponed, the paddy field could be too soft at harvest for the operation of a combine harvester. The effects of 5 different drainage times were measured at 5-day intervals from 10 days after heading to harvest. Preliminary results showed that the later the drainage, the greater the yield (see table).

**Effect of different drainage times on yield and yield components of mechanically harvested paddy in Taiwan.[a]**

| Drainage time (DH)[b] | Yield (g/plant) | Panicle wt (g) | Spikelets per panicle (no.) | Fertility rate (%) | Wt of 1,000 grains (g) | Imperfectly ripened grains (%) |
|---|---|---|---|---|---|---|
| 10 | 12.10 bc | 1.71 d | 111.2 a | 76.4 b | 20.8 c | 43.8 a |
| 15 | 11.98 bc | 1.96 cd | 108.0 a | 77.0 b | 24.1 b | 24.4 b |
| 20 | 13.93 b | 2.22 bc | 105.4 a | 83.7 ab | 25.4 b | 19.8 b |
| 25 | 16.68 a | 2.63 ab | 116.8 a | 84.0 ab | 27.5 a | 14.8 b |
| 30 | 18.75 a | 2.83 a | 117.7 a | 91.8 a | 27.0 a | 13.3 b |

[a]Any 2 means with a common letter are not significantly different at the 5% level. [b]DH = days after heading.

## Transplanting made easy — broadcasting of seedlings

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

Transplanting costs equal about 15% of total rice production cost. Transplantings delayed by labor shortages result in lowered yield caused by low temperature limitation in subtropical India. A low-cost, low-labor transplanting method must be developed.

**Grain yield[a] of variety Jaya as influenced by different methods of transplanting, Pantnagar, India, 1981.**

| Treatment | Grain yield (t/ha) |
|---|---|
| Row transplanting using 20- × 20-cm spacing on saturated soil surface | 6.00 |
| Random transplanting on saturated soil surface | 5.62 |
| Broadcast transplanting on saturated surface | 5.96 |
| Row transplanting using 20- × 20-cm spacing in about 5 cm water | 5.90 |
| Random transplanting in about 5 cm water | 5.49 |
| Broadcast transplanting in about 5 cm water | 5.70 |
| *F* test | ns |
| S.Em.± | 0.23 |
| C.V.(%) | 7.0 |

[a]At 14% moisture.

Researchers compared seedling broadcast transplanting and standard row transplanting procedures. A randomized block design with four replications was used. The nursery was sown on 2 June 1981. Transplanting was 2 July.

Grain yields for the two methods were not significantly different (see table). Seedling broadcast was as effective as row transplanting. Broadcast transplanting took 60% of the time for regular transplanting. Rice was shallow transplanted, less root damage occurred, and plant population was increased at little extra cost.

Broadcasting has some limitations, however. Maintaining plant populations is difficult when modderate to heavy rains occur after transplanting. Deep water (10 cm or more) makes the technique impossible.

Work is in progress to refine the technology and to define the economics in different situations.

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# Rice-based cropping systems

## Management of fertilizer phosphorus in a rice-wheat rotation

*H. S. Gill and O. P. Meelu, Soils Department, Punjab Agricultural University, Ludhiana 141004, India*

Two field experiments in 1977-80 measured the response of rice to fertilizer phosphorus (P) and evaluated direct, residual, and cumulative effects of recommended P (26 kg P/ha) in a rice-wheat rotation at Punjab Agricultural University Farm. The Fatehpur loamy sand soil is nonsaline (E. C. 0.12 mmho/cm) and alkaline (pH 8.5), and has low organic carbon (0.228%), available nitrogen (90 kg/ ha), and available P (7 kg/ ha), and medium available potassium (146 kg/ ha).

Rice did not respond to graded levels of P (0, 9, 18 and 26 kg/ ha) applied across treatments with 12 t farmyard manure/ ha, 40 and 80 kg N/ ha split applied, and 120 kg N/ ha alone (Table 1). However, rice did respond to farmyard manure, nitrogen and the combinations.

In a second experiment in the same field, rice did not respond to direct applications of fertilizer P (Table 2). But wheat responded significantly and consistently. Yields with the application of 26 kg P/ha to either or both crops in the rotation are similar. Direct, residual, and cumulative effects resulted from differential P fertilization.

Direct application of recommended P to wheat achieved the highest yield. Wheat yield was 50% lower when P was applied only to rice in the rotation. There was no cumulative effect from P application to both crops.

**Table 1. Effect of phosphorus on yield of unhusked rice in Ludhiana, India.**

| Main treatment[a] | | Yield (t/ha) at P levels of | | | | Mean |
|---|---|---|---|---|---|---|
| FYM (t/ha) | N (kg/ha) | 0 | 9 kg/ha | 18 kg/ha | 26 kg/ha | (t/ha) |
| 0 | 0 | 3.02 | – | – | – | – |
| 12 | 0 | 3.66 | – | – | – | – |
| 12 | 40 | 5.22 | 5.13 | 5.35 | 5.09 | 5.20 |
| 12 | 80 | 6.75 | 6.98 | 6.90 | 7.02 | 6.91 |
| 0 | 120 | 6.96 | 6.84 | 6.85 | 6.78 | 6.86 |
| Mean | | 6.31 | 6.32 | 6.37 | 6.30 | 6.32 |
| LSD (0.05) | | | | | | .60 |
| P levels: NS | | | | | | |

[a] FYM = farmyard manure, N = nitrogen.

**Table 2. Effect of differential application of recommended dose of P (26 kg P/ha) on grain yield of rice and wheat.[a]**

| P treatment (kg/ha) | | Yield (t/ha) | | Total yield |
|---|---|---|---|---|
| Rice | Wheat | Rice | Wheat | (rice +wheat) |
| 0 | 26 | 6.6 | 4.1 | 10.7 |
| 26 | 0 | 6.4 | 2.4 | 8.8 |
| 26 | 26 | 6.5 | 4.2 | 10.7 |
| Control | | 3.1 | 1.2 | 4.3 |
| LSD (0.05) | | 0.39 | 0.28 | 0.60 |

[a]Av of 3 years (1977-78 to 1979-80).

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# Announcements

## Seed technology course

The Sixth International Course on Seed Technology for Vegetable Crops will be 11 August-26 October 1983 in Los Baños, Philippines. It is organized by the University of the Philippines at Los Baños and the International Agricultural Centre at Wageningen, The Netherlands.

The course is for individuals with a BS, or equivalent, in agriculture who work in vegetable seed development. Emphasis will be on vegetable crops grown in Asia and the Pacific region. Closing date for application is 1 April 1983.

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

## IRRI 1981 insecticide evaluation studies available

The 1981 Insecticide Evaluation Report contains 118 tables reporting results of studies using more than 60 coded and commercially available insecticides. It reports on field and greenhouse tests for control of brown planthopper, whitebacked planthopper, green leafhopper, striped stem borer, yellow stem borer, rice bug, whorl maggot, and armyworm.

Results of tests to determine the effect of insecticides on natural enemies and the efficacy of botanical insecticides are included. Application and slow-release formulations are discussed.

Results of chemical control in integrated pest management trials and from field trials on upland crops (mungbean, soybean, cowpea, peanut, maize, sorghum) at cropping systems program sites are presented.

The 142-page report is available without charge from the Entomology Department, IRRI, P.O. Box 933, Manila, Philippines. The 1978, 1979, and 1980 reports are also available.

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