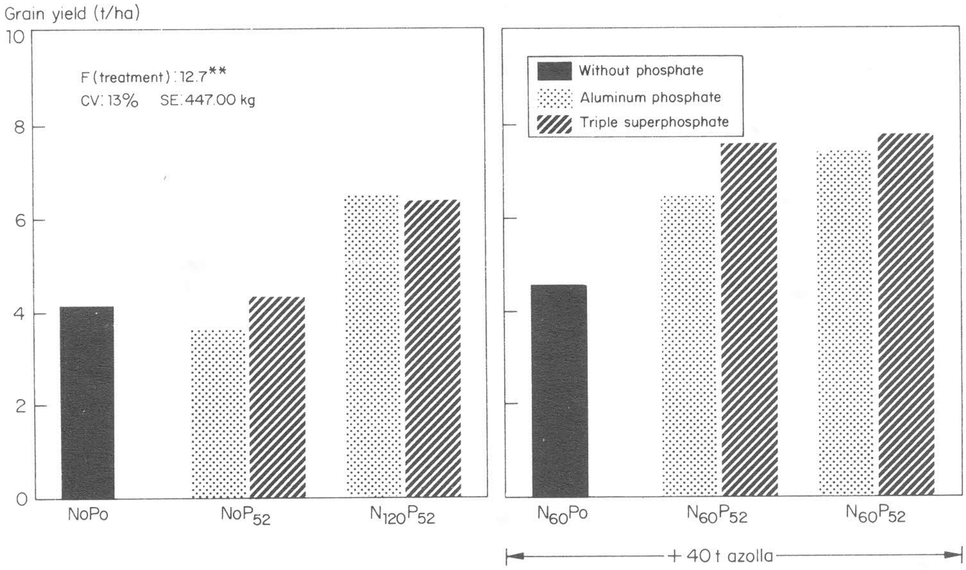
table). The design was a randomized complete block with three replications. Treatments were no N or P, no N plus either of the 2 sources of P at the rate of 52 kg P/ha, 120 kg N (urea) plus either of the 2 sources of P at 52 kg P/ha, and 60 kg N (urea) + 60 kg N (azolla)/ha and O or 52 kg P, applied either split or all at once. Two crops of *Azolla pinnata* var. *imbricata*, of Indian origin (20 t/ha each, equivalent to 30 kg N/ha) were grown successively and incorporated before rice transplanting. The rice variety was Sri Malaysia.

After the third cropping season, rice yield showed no influence from P. After the fourth cropping season, during the 1985 rainy season, no significant difference in yield between the two P sources had occurred (see figure). However, although N and P levels were equivalent with triple superphosphate, yields were higher when azolla was incorporated. Uptake of P from a split application and assimilated by azolla seems better. The response of rice was more pronounced with aluminum phosphate; the split application produced 0.9 t/ha more. By the end of the fourth cropping season, the lack of P had caused an important yield reduction (2.0 and 3.0 t/ha). □




Effects of 2 P sources, applied with and without azolla incorporation, on grain yield of rice variety Sri Malaysia. Fanaye Research Station, Senegal River valley, 1985 rainy season. Basal application of P, except in treatment 6, where P was split-applied.

# Disease management

## Four fungicides for control of grain infection caused by *Helminthosporium oryzae*

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Grain discoloration caused by *Helminthosporium oryzae* Breda de Haan, the causal agent of brown spot (BS), is a major problem in the 35,000 ha irrigated Rio Formoso rice project. A disease outbreak in Feb 1983, during the vegetative phase of the fourth successive planting of lowland rice variety IAC899 in CNPAF experimental fields indicated the possible role of infected plant debris. Despite 3 sprayings with maneb fungicide at 10-d intervals to control leaf infection, the disease retarded plant growth.

We evaluated four marketed spray fungicides for grain infection control in the same fields. The experiment used 8 $m^2$ direct seeded plots in a randomized block design with 8 replications. Fungicides were sprayed at recommended doses 3 times at 7-d intervals, beginning at 50% heading (92 d after seeding). Untreated controls were not maintained because in similar experiments, sprayed plots adjacent to untreated plots exhibited abnormally high disease intensities.

**Effect of fungicide spray on BS control.**[a] **Goiania, Goias, Brazil, 1983.**

| Fungicide | Rate (kg ai/ha) | Flag leaf lesions (no./leaf) | | Diseased grains/panicle (%) | | Unfilled grains/panicle[b] (%) | Grain yield (t/ha) |
|---|---|---|---|---|---|---|---|
| | | 112 DAS | 119 DAS | 108 DAS | 115 DAS | | |
| Ziram 50% EC | 1.5 | 8.91 a | 27.47 a | 27.76 a | 44.58 ab | 41.75 a | 2.05 a |
| Thiophanate-methyl (20%) + chlorothalonil 50% WP | 1.4 | 7.43 b | 22.19 b | 26.56 ab | 45.64 a | 41.16 a | 2.03 a |
| Maneb 80% WP | 1.6 | 8.59 ab | 23.26 ab | 25.71 ab | 39.52 b | 38.70 a | 2.22 a |
| Captafol 48% EC | 0.96 | 9.14 a | 25.91 ab | 23.30 b | 39.34 b | 34.83 a | 2.41 a |
| CV (%) | | 12.0 | 13.5 | 11.8 | 10.2 | 17.2 | 15.2 |

[a]Means of 8 replications. In a column, means followed by a common letter are not significantly different by Tukey test at the 5% level. DAS = days after seeding. [b]Unfilled grain percentage was based on 10 panicles/plot.

Disease intensity on flag leaves and panicles, unfilled grain percentage, and grain yield were measured. Flag leaf lesion counts and percentage of diseased grains/panicle were based on 50 randomly collected tillers/plot.

Treatments differed significantly, but did not reduce flag leaf and grain infection much (see table). Grain infection was negatively correlated with percentage of unfilled grain ($r = -0.84^{**}$) and grain yield ($r = -0.84^{**}$), but differences among the test fungicides were not significant. Blotter test determined that 75% of seeds collected from sprayed fields were associated with *H. oryzae*. That seed lot showed only 39% germination. □

## Distribution and severity of rice seedling diseases in boro seedbeds in Bangladesh

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We surveyed rice seedbed diseases in some northwestern districts during the Nov-Mar boro season. Six diseases—bakanae (Bak), blast (Bl), brown spot (BS), damping-off (DO), root knot (RK), and seedling blight (Sb)—were found in 48 locations. Commonly grown rice were BR1, BR3, BR8, BR9, IR8, Pajam, Purbachi, and some local varieties.

DO was found everywhere, irrespective of variety (see table). RK was the second most common disease; it was not found in alkaline belts of Rajshahi district. Its intensity and severity were highest in sandy soil, especially near riverbanks, even in seedbeds with little standing water, irrespective of varieties sown.

BS was found in seedbeds that suffered from water stress. Bak affected seedlings of Purbachi, Khaily boro (local cultivar), and BR16. Bl was found mainly on Pajam and Iratom seedlings.

**Distribution of seedling diseases as observed in boro seedbeds during January 1987 in northwestern districts of Bangladesh.**

| District | Disease frequency in survey area[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Bak | Bl | BS | DO | RK | Sb | Total |
| Bogra | 6 (18.2) | 0 | 6 (18.2) | 12 (36.4) | 9 (27.2) | 0 | 33 |
| Dinajpur | 0 | 0 | 0 | 2 (50.0) | 2 (50.0) | 0 | 4 |
| Gaibandha | 2 (25.0) | 0 | 2 (25.0) | 2 (25.0) | 2 (25.0) | 0 | 8 |
| Gazipur | 0 | 2 (12.5) | 1 (25.0) | 2 (25.0) | 2 (25.0) | 1 (12.5) | 8 |
| Jamalpur | 1 (12.5) | 0 | 1 (12.5) | 3 (37.5) | 3 (37.5) | 0 | 8 |
| Lalmonirhat | 1 (33.3) | 0 | 0 | 1 (33.3) | 1 (33.3) | 0 | 3 |
| Mymensingh | 2 (11.8) | 3 (17.6) | 3 (17.6) | 6 (35.3) | 3 (17.6) | 0 | 17 |
| Natore | 1 (11.1) | 0 | 3 (33.3) | 3 (33.3) | 2 (22.2) | 0 | 9 |
| Pabna | 0 | 0 | 3 (37.5) | 4 (50.0) | 1 (12.5) | 0 | 8 |
| Rajshahi | 0 | 0 | 2 (33.3) | 2 (33.3) | 1 (16.7) | 1 (16.7) | 6 |
| Rangpur | 2 (14.3) | 1 (7.1) | 1 (7.1) | 5 (35.7) | 5 (35.7) | 0 | 14 |
| Tangail | 0 | 3 (16.7) | 2 (11.1) | 6 (33.3) | 7 (38.9) | 0 | 18 |
| Total | 15 (11.0) | 9 (6.6) | 24 (17.6) | 48 (35.3) | 38 (27.9) | 2 (1.5) | 136 |
| DI | 4 [3-5] | 8 [7-9] | 5 [3-7] | 6 [3-9] | 5 [3-7] | 3 [1-5] | |

[a] Figures in parentheses show percentage of the disease in the district; those within brackets show disease index. DI 1 = lowest disease intensity, 9 = highest disease intensity.

Severity as high as disease index 8 was concentrated in Mymensingh, Tangail, Gazipur, and Rangpur districts. Sb was found in only two locations. More than one disease was observed in the same seedbed in some locations. □

## Managing rice sheath rot (ShR) disease in Kerala, India

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Field trials to evaluate crop nutrition schedules for managing rice ShR disease have shown that sources of N and method of application can influence disease incidence and grain damage.

A field experiment during the first crop season (May-Sep 1985) at the Cropping Systems Research Centre, Karamana, used susceptible variety Jyothi to evaluate crop nutrition schedules for managing ShR.

The fertilizer level used was 70-35-52.5 kg NPK/ha, the recommended rate in disease endemic areas. Sources were farmyard manure (FYM), urea, and ammonium sulfate for N; superphosphate for P; and muriate of potash for K. Except for FYM, all forms of N were applied in three splits, half as basal and half in two equal topdressings. K was applied in two equal splits, basal and as topdressing. All P was applied as basal.

Carboxin (0.1% spray), widely recommended for ShR control, was sprayed with two fertilizer treatments