at maximum tillering and flag leaf stage were significantly lower on plants in potash-treated soil than on those grown in soil containing less K, indicating that plants grown in soil with 183 ppm or more K are more BB resistant. Percentage of filled grains was significantly lower in plants grown in soil containing less K than in those with added potash. Although yield was not significantly different between treatments, plants grown in the soil with 349 ppm added K yielded nearly 16% higher than those grown with 100 ppm K. □

Optimum age of rice for brown spot (BS) control by fungicide spray

P. Lakshmanan and N. T. Jagannathan, Tamil Nadu Agricultural University Research Centre, Vellore 632001, Tamil Nadu, India

BS, caused by *Cochliobolus miyabeanus* (Ito and Kuribay) Dickson, is a major rice disease in Tamil Nadu. In North Arcot District, foliar application of various fungicides often does not control the disease.

We sought to determine optimum plant age for fungicide application to control BS in the field. Five treatments were in a randomized block design with four replications (see table). Disease intensity was scored as 0 = no disease, 1 = less than 1% of leaf area affected, 2 = 1-3% affected, 3 = 4-5%, 4 = 6-l0%, 5 = 11-15%, 6 = 16-25%, 7 = 26-50%, 8 = 51-76%, and 9 = 76-100%.

Trials from Aug 1981 to Jan 1982 with Ponni and ADT35 showed that spraying edifenphos at 500 ml/ha at 50 and 65 d after transplanting (DT) effectively reduced disease intensity and significantly increased yield. From Nov 1981 to May 1982, spraying Vaigai and Bhavani 25, 40, and 55 DT also was effective. Spraying TKM9 and ADT31 from Apr to Aug 1982 did not produce significantly different yields although all treatments significantly reduced disease intensity (see table). □

BS intensity and mean yield, Tamil Nadu, India.

Age (DT) at spraying	Aug 1981-Jan 1982				Nov 1981-May 1982				Apr-Aug 1982			
	Ponni		ADT35		Vaigai		Bhavani		TKM9		ADT3 1	
	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)	Intensity (mean)	Mean yield (t/ha)
20, 35	7.0	4.4	3.0	2.7	5.0	8.0	6.0	6.1	2.0	4.8	2.0	2.5
35, 50	4.0	5.0	2.0	2.7	5.0	8.1	5.0	7.4	2.0	4.8	2.0	2.6
50, 65	2.0	5.7	1.0	3.3	4.0	7.9	5.0	7.1	2.0	4.7	2.0	2.5
25, 40, 55	3.0	5.2	1.0	3.1	3.0	9.5	3.0	7.8	1.0	4.8	2.0	2.5
Control	9.0	4.1	3.0	2.6	8.0	5.7	8.0	4.6	2.0	4.7	3.0	2.5
CD (P = 0.05)	2.6	0.3	9.8	0.1	2.4	0.8	0.5	0.9	0.4	NS	0.5	NS

Pest Control and Management
INSECTS

Entomopathogenic microorganisms of rice planthoppers and leafhoppers in China

Li Hongke, Institute of Plant Protection, Hunan Academy of Agricultural Science, Changsa, China

We studied pathogenic microorganisms of rice planthoppers and leafhopper pests in Hunan Province, China. Under optimum temperature and humidity, the pathogens significantly decrease pest populations. The fungal species usually are most abundant in rainy season and at later stages of rice growth. Up to 80% of the hopper population may be infected. At some sites there are high infection levels by entomopathogenic nematode species such as *Amphimermis unka.*

Various species of pathogenic fungi, two nematode species, and one species of bacterium have been identified as infecting hoppers. Several of the fungal species and the bacterium have been isolated on artificial solid media. The nematodes were identified under the microscope.

The following planthoppers and leafhoppers were examined: *Nilaparvata lugens, Sogatella furcifera, Nisia atrovenosa, Laodelphax striatellus, Saccharosydne procerus, Nephotettix cincticeps, Empoasca subrufa, Deltocephalus dorsalis,* and *Macrosteles fascifrons.* The following entomopathogenic fungi were isolated from them: *Entomophthora delphacis, Beauveria bassiana, B. tenella, Metarrhizium anisopliae,* and *Hirsutella saussurei.* Unidentified *Paecilomyces* spp., *Cephanosporium* spp., etc. also have been isolated. Surprisingly, several hoppers were infected with *Nomuraea rileyi,* a common entomopathogen of lepidopteran larvae in the rice ecosystem.

In addition to these entomopathogens, several other species of fungi have been isolated from the insects, e. g. *Penicillium* sp., *Aspergillus* spp., *Fusarium* spp., *Alternaria* spp., and a *Cladosporium* sp. However, their entomopathogenic nature has not yet been determined.

The bacterium was identified as *Serratia marcescens.* Preliminary infection tests both in the laboratory and in field cages show highly promising results. Applying a suspension of conidia of *B. bassiana* on different hopper populations resulted in 60-90% infection 15 d after incubation. □

Efficacy and residues of carbofuran 3G broadcast for yellow stem borer (YSB) control in India

G. S. Dhaliwal, Punjab Agricultural University Rice Research Station, Kapurthala, 144601, Punjab, India

YSB *Scirpophaga incertulas* (Walk.) is a major rice pest in Punjab, India. We evaluated the efficacy of carbofuran 3G 0.75 kg ai/ha in 1, 2, or 3 applications for YSB control on cultivar PR4141. Deadhearts and whiteheads were recorded at 20-d intervals after the first insecticide application.

A 50-g grain sample from a 1.5-kg pooled sample drawn from 3 replications was hydrolyzed by refluxing in 0.25 N HCl, extracted with dichloromethane, and analyzed for insecticide residue by a gas chromatograph. Average carbofuran recovery in fortified samples was 87%.

YSB incidence and carbofuran residues in paddy grain samples, Ferozepur, Punjab, India, 1983.[a]

Carbofuran application	YSB incidence: Deadhearts (%) 50 DT	Deadhearts (%) 70 DT	Whiteheads (%) 90 DT	Whiteheads (%) 110 DT	Yield (t/ha)	Carbofuran residues (ppm) in paddy grains at harvest
30 – –	4.1 ab	8.7 cdef	39.6 cd	55.7 c	0.8 i	–
– 50 –	13.0 bcde	3.5 b	45.9 de	57.6 c	2.5 fgh	–
– – 70	8.3 bcde	10.7 efg	10.8 ab	14.2 ab	4.3 bcdef	–
30, 50 –	3.0 a	2.2 a	40.9 d	56.1 c	3.7 defg	0.036
– 50, 70	15.8 e	2.9 b	6.4 ab	8.8 a	5.8 ab	0.158
30 – 70	3.0 a	9.0 def	3.8 a	7.1 a	5.8 ab	0.100
30, 50, 70	5.1 abc	2.4 b	3.5 a	6.9 a	6.9 a	0.178
Control	17.6 de	24.9 h	78.4 f	82.7 d	0.6 i	–

[a] In a column means followed by a common letter are not significantly different at 5% level.

Although applying carbofuran 30 and 50 d after transplanting (DT) helped control YSB, application at 70 DT was essential to prevent whitehead damage. Maximum yield of 6.9 t/ha was obtained in plots with 3 applications at 30, 50, and 70 DT (see table).

Maximum carbofuran residue (0.178 ppm) was detected in grain samples from plots with 3 carbofuran applications. The lowest residue (0.036 ppm) was in the 30 and 50 DT treatment. In all treatments, carbofuran residue was below the 0.2 ppm tolerance limit. □

Genetic control of isocitrate dehydrogenase (IDH) and malate dehydrogenase (MDH) isozymes in rice brown planthopper (BPH)

R. C. Saxena, principal research scientist, International Centre of Insect Physiology and Ecology, Nairobi, Kenya, and entomologist, IRRI; and C. V. Mujer, research assistant, IRRI

IDH and MDH of BPH are polymorphic, each with at least two electrophoretic variants. We made single-pair crosses of BPH to establish the genetic control of these enzymes.

One hundred pair of BPH biotype 1 were kept in separate test tubes with rice seedlings. The females were all newly emerged. After 3 d, the male parents were collected, frozen, and subjected to starch gel electrophoresis to determine their genotypes. The female parents were transferred individually to mylar cages and collected after 10 d, when they were frozen and subjected to starch gel electrophoresis for genotype identification. Newly emerged progenies from each cross were collected and identified.

Segregation observed and expected in different crosses made to determine the inheritance of IDH and MDH variation in rice BPH.

Cross		Phenotypes			X^2
Isocitrate dehydrogenase		Idh^{100}	$Idh^{93/100}$	Idh^{93}	
Idh^{100} × Idh^{100}	Obs.	97	–	–	
	Exp.	97	–	–	
Idh^{100} × Idh^{93}	Obs.	–	53	–	
	Exp.	–	53		
Idh^{100} × $Idh^{93/100}$	Obs.	37	33	–	0.23[a]
	Exp.	35	35	–	
Malate dehydrogenase		Mdh^{100}	$Mdh^{100/109}$	Mdh^{109}	
Mdh^{100} × Mdh^{100}	Obs.	177	–	–	
	Exp.	177	–	–	
Mdh^{100} × $Mdh^{100/109}$	Obs.	39	58	–	
	Exp.	48	48	–	3.72[a]
$Mdh^{100/109}$ × $Mdh^{100/109}$	Obs.	24	43	20	
	Exp.	22	43	22	0.38[a]

[a] Not significant at the 5% probability level.

The table summarizes the segregation results of the different crosses involving the electrophoretic variants of IDH and MDH. The data are consistent with our