

Sensitivity of acetylcholinesterases of susceptible (S) and MIPC-resistant (R) *N. lugens* strains to carbamate insecticides, Taiwan.

Insecticide	RR <sup>a</sup>	<i>N. lugens</i> strains		
		S	R	Ratio
MIPC	41	0.23	3.62	15.7
MTMC	80	5.86	18.0	3.1
Propoxur	76	0.15	1.10	7.3
Carbofuran	73	0.08	0.33	4.1
Carbaryl	41	0.38	0.92	2.4
Methomyl	33	6.99	29.4	4.2

<sup>a</sup>Resistance ratio = LC<sub>50</sub> of R strain divided by LC<sub>50</sub> of S strain.

less inhibited by several other carbamate insecticides.

A decrease of AChE sensitivity might be the primary cause of MIPC resistance in brown planthopper. A secondary cause is degradation of MIPC mediated by esterases, since a DEF inhibitor of these enzymes enhances the toxicity of MIPC to R strain. Insensitivity of AChE also contributed to brown planthopper resistance to several other carbamates. ■

# Pest management and control WEEDS

## Integrated weed management in dry-land rice

G. C. Tosh, B. S. Reddy, and K. C. Nanda, Orissa University of Agriculture and Technology, Bhubaneswar, Orissa, India

Weeds are a serious problem for direct-sown, short-duration, high-yielding rice-cultivars in Eastern India. This study involved 2 methods of sowing (broadcast and row), 3 seed rates (70, 90, and 110 kg/ha), 4 weed control treatments (nitrofen thiobencarb, propanil, and manual), and unweeded and untreated controls. The experiment was laid out in

a split-plot design with method of sowing and seed rate as the main plots and weed control and unweeded treatment as subplots.

Irrespective of seed rates, sowing in rows recorded higher plant populations, lower dry matter accumulation in weeds, and higher grain yield than broadcast method of sowing (see table). High seed rates recorded higher plant populations, lower dry matter accumulation of weeds, and higher grain yields than low seed rates.

Thiobencarb as a preemergence herbicide was slightly phytotoxic to rice, caus-

ing mortality of some seedlings. Maximum grain yield was obtained with propanil applied as split doses of 1.5 kg a.i./ha each at 15 and 30 days after sowing (DS) or high seed rate sown in rows. Manual weed control by hoeing once 15 DS and hand weeding 30 DS was next in yield. Propanil treatment reduced the dry matter accumulation in weeds from 324.7 g/m<sup>2</sup> to 68.8 g/m<sup>2</sup>. Nutrient loss of 19.3 kg N/ha, 11.6 kg P<sub>2</sub>O<sub>5</sub>/ha, and 68.1 kg K<sub>2</sub>O/ha in the unweeded control was reduced to 3.1 kg N/ha, 2.5 kg P<sub>2</sub>O<sub>5</sub>/ha, and 14.5 kg K<sub>2</sub>O/ha with propanil. ■

Effects of sowing method, seed rate, and weed control treatment in Orissa, India.<sup>a</sup>

Treatment	Plant population (no./m <sup>2</sup> ) 10 DS	Dry matter accumulation of weeds (g/m <sup>2</sup> ) 60 DS	Nutrient uptake by weeds (kg/ha) 60 DS			Grain yield (t/ha)
			N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	
Sowing method						
Broadcasting	107.5	171.0	10.5	6.3	33.7	1.5
Row	143.5	156.8	9.0	5.4	25.9	1.8
Seed rate (kg/ha)						
70	115.6	151.8	9.6	5.6	33.1	1.6
90	128.4	142.6	8.1	4.9	30.8	1.4
110	146.4	104.1	6.1	4.9	23.9	2.0
Weed control method						
Nitrofen@ 1.5 kg a.i./ha 2 DS	150.7	151.5	9.0	5.4	31.9	1.6
Thiobencarb @ 1.5 kg a.i./ha 2 DS	112.0	166.6	10.7	7.0	41.4	1.2
Propanil @ 1.5 kg a.i./ha each 15 and 30 DS	158.0	68.8	3.1	2.5	14.5	2.8
Manual	146.3	76.9	4.6	2.8	16.4	2.1
Unweeded control	155.5	324.7	19.3	11.6	68.1	0.6
CD (0.05) for sowing method	20.6	7.3				0.04
CD (0.05) for seed rate	25.2	9.6				0.05
CD (0.05) for weed control method	11.2	16.4				0.09

<sup>a</sup>DS = days after sowing.

## Effects of herbicides and water management regimes on weeds and grain yields of transplanted rice in India

A. Misra, G. C. Tosh, and K. C. Nanda, Weed Research Scheme, Orissa University of Agriculture & Technology, Bhubaneswar, India

The use of several herbicides under different water management treatments was tried in a replicated field trial at the Agriculture Research Station, Bhubaneswar, during the 1977 and 1978 wet seasons.

Continuous submergence had significantly the lowest weed population and weed weight (see table). Fluchloralin treatment showed promising effects on weed control at all the levels of water