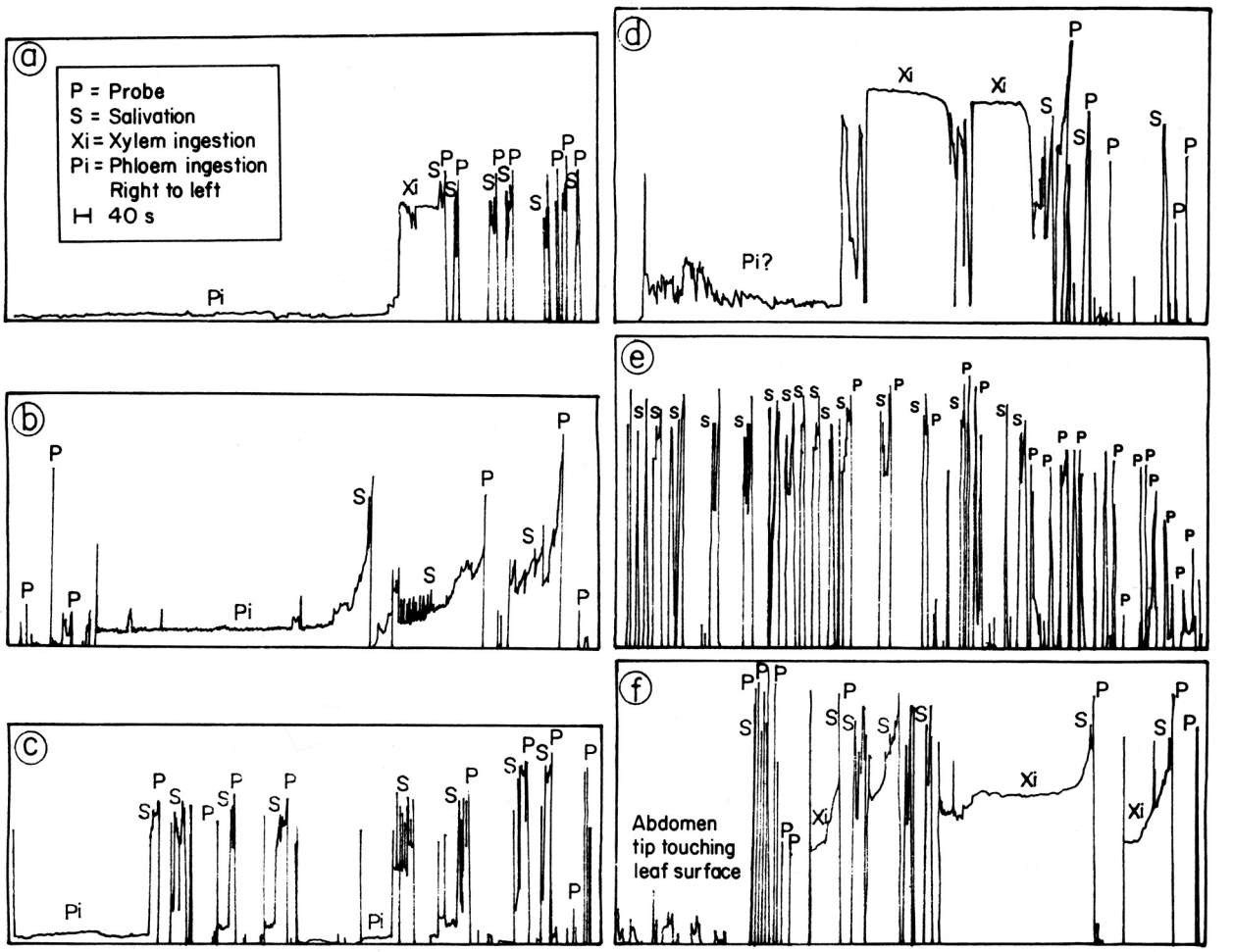
chart recorder. Feeding on the leaf blade of a 30-d-old susceptible TN1 rice plant that had been sprayed with 1 ml of acetone was the control. Feeding activity of GLH females was recorded on TN1 plants sprayed with 1 ml of 1.25, 2.5, 5, or 10% neem oil in acetone, using a quick spray atomizer. For each treatment, 10 different females were tested, using 1 female/plant.

Waveform patterns recorded showed prolonged phloem feeding on control plants (Fig. a). Phloem feeding decreased on plants treated with increasing concentrations of neem oil (Fig. b, c). Decreasing phloem feeding was accompanied by a corresponding increase in the frequency of probing and salivation. On plants sprayed with 5% neem oil, the insect fed from the xylem, and phloem feeding was disrupted (Fig. d). The insect became restless, probed and salivated repeatedly, and fed from xylem on plants treated with 10% neem oil (Fig. e, f).

The change in GLH feeding from phloem to xylem can be attributed to the insect's effort to offset desiccation resulting from its repeated probing, profuse salivation, and restlessness. Increased restlessness on 10% neem oil-treated plants was also evidenced by the slanting posture of the insect and its abdominal tip touching the leaf surface (Fig. f). □

Electronically recorded waveforms during GLH feeding on TN1 rice plants sprayed with a) acetone (control), b) 1.25% neem oil (NO), c) 2.5% NO, d) 5% NO, and e,f) 10% NO.



Chemical control of rice hispa

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The rice hispa *Dicladispa armigera* (Oliv.) did not become a serious rice pest in Pakistan until 1983 wet season, when unusual weather conditions favored low to high infestations on about 2,500 ha in Alipur and Muridkey.

We evaluated four emulsifiable concentrate (EC), six dust, and three granular insecticide formulations for rice hispa control at Muridkey. Spray volume was 400 litres/ha.

Trials were in a completely randomized block design in three replications. Plot size was 84 m^2. Control level was determined by counting live adult rice hispa on 5 randomly selected plants in each plot before and 1, 3, 10, 20, and 30 d after pesticide application.

All EC insecticides were effective, but fenitrothion performed best (see table). Alldusts were effective, but BHC 0.75 kg ai/ha was best. Of the granular insecticides, carbofuran and cartap were effective, but slow acting from 10 through 30 d after application. Diazinon was ineffective. □

Population and % control o f rice hispa at different intervals[a] after pesticide applications, Muridkey, Pakistan.

Insecticide and formulation	Dose (kg ai/ha)	Application method	Av no. of alive hispa adults/5 rice plants at						Percent control of hispa at				
			BA	1 DAA	3 DAA	10 DAA	20 DAA	30 DAA	1 DAA	3 DAA	10 DAA	20 DAA	30 DAA
Diazinon 60 EC	1.125	Spray	89	13 c	l0 e-g	33 c	62 c	91 ab	85	88	63	30	–2
Fenitrothion 20 EC	0.500	Spray	89	9 c	7 f-h	7 f - h	30 d	65 c-e	89	92	92	66	27
Malathion 57 EC	1.425	Spray	88	16 c	15 e	35 c	70 b	85 a-c	81	83	60	20	3
Phosphamidon 50 EC	0.688	Spray	90	7 c	5 f-h	14 d	37 d	75 b-d	92	94	84	59	16
BHC 10 D	0.500	Dust	86	8 c	7 f-h	9 e- f	11 f	14 hi	91	92	89	87	84
BHC 10 D	0.750	Dust 91		2 c	2 h	l i	2 h	4 i	98	98	99	98	96
BHC (10 D) + DDT (10 D) in 1:3 mixture	0.312 +0.937	Dust	83	4 c	4 gh	5 g-i	7 f-h	15 hi	95	95	94	92	81
Carbaryl 10 D	2.500	Dust	91	4 c	3 gh	9 fg	19 e	44 e-g	95	96	90	79	21
Cotton dust [c] (6.3% BHC + 10.4 % DDT + 83.3% sulfur	7.200	Dust	90	8 c	15 e	13 d	21 e	31 f-h	91	83	85	77	66
DDT 10 D	0.750	Dust	86	7 c	6 f-h	6 f-h	l0 fg	18 hi	92	93	93	88	79
Pyridaphenthion 2D	0.800	Dust	92	11 c	12 ef	15 d	21 e	53 d-f	88	87	84	77	42
Carbofuran 3 G	0.750	Broadcast	90	83 ab	29 d	9 fg	7 f-h	22 g-i	8	68	91	92	76
Carbofuran 3 G	1.125	Broadcast	87	73 b	24 d	4 hi	3 gh	5 hi	16	72	95	97	94
Cartap 10 G	1.250	Broadcast	90	79 ab	41 c	8 f-h	7 f-h	27 g-i	12	54	91	92	70
Diazinon 10 G	2.000	Broadcast	87	82 ab	67 b	52 b	37 d	65 c-e	6	23	40	57	24
Control	–	–	90	90 a	93 a	98 a	97 a	101 a	0	–4	–10	–8	13
LSD at 5%				14	7	4	7	24					

[a]BA = before application. DAA = d after application. [b]In a column, averages followed by common letters are significantly similar at 95% level of confidence. [c]Cotton dust is a brand name for BHC + DDT + sulfur mixture formulated by Ittehad Pesticides Ltd., Pakistan.

Pest control and management OTHER PESTS

Control of root-knot nematode in upland rice

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Root-knot nematode *Meloidogyne incognita* is an important upland rice pathogen in Nigeria. Infected plants are stunted and leaves become chlorotic. Roots have fewer root hairs and galls are formed.

Chemical seed treatment was tested for nematode control on variety FARO 11. Rice was grown in plastic pots in autoclaved sandy-loam soil under simulated upland conditions in the screenhouse. Each pot was inoculated with 1,500 *M. incognita* eggs at planting. Roots were washed free of soil at the end of the experiment and scored for galling, and the nematodes in a 200-g soil sample from each pot were counted.

Carbofuran was most effective in protecting the seedlings from root-knot nematode. Seed treated with PCNB and carbofuran had early seedling emergence (see table). PCNB, phenthoate, and EPN provided the best seedling protection against secondary pathogen infection, as indicated by the leaf damage index. All the test chemicals except phenthoate performed better than the control. EPN, however, is suspected to be phytotoxic. □

Chemical seed treatment for control of *M. incognita* in upland rice, Ibadan, Nigeria.[a]

Seed treatment	Rate (ai/ha)	Plant ht (cm) 14 DAS	Seedling vigor[b] 14 DAS	Leaf damage index (14 DAS)	Root galling index[c]	Final nematode count
Disulfoton	1 kg	14.70	7	4	4	1100
PCNB	40 g	19.83	6	2	3	1150
Carbofuran	1 kg	19.13	5	3	1	550
Phenthoate	0.75 kg	13.23	7	2	4	2700
EPN	0.50 kg	8.20	7	2	2	850
Control	–	13.40	7	5	5	2825

[a]Mean of 3 replications. DAS = days after seeding. [b]After the 1980 Standard Evaluation System for Rice. [c]After an international *Meloidogyne* project.

Effect of zinc on stem nematode-infected rice

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We studied the effect of Zn application on stem nematode-infected rice plants. Sixteen pots, each with 8 kg moist Zn-deficient soil (0.6 ppm), were fertilized with 200-66-83 kg NPK. Eight of the pots were fertilized with 50 ppm Zn as $ZnSO_4$. Four germinated seeds of BR3