however, *Marasmia exigua* (Butler) also caused damage. Their relative proportion was 80:20.

Wet season rice usually is transplanted Jul–Aug and harvested in Nov. But an unusual drought in Aug–Sep caused setbacks. Stray incidences of LF were observed in May on broadcast rice seedlings sown in Apr. Gradually the pest population built up. Percentages of damaged and folded leaves/m^2 of sample plots were recorded May-Oct 1986. The sample was 20 randomly selected plots in each district. Data with rainfall, temperature, and deviations from normal are presented in the table.

Four overlapping LF broods were observed. *Cotesia* sp. and *Temelucha philippinensis* (Ashm.) were the common larval parasites.

It appears the unusual dry conditions combined with other bioecological factors favored the outbreak. After superabundant rain 22 Sep-8 Oct (a record 503 mm rainfall was recorded in 12 d at Chinsurah), the infestation gradually waned. □

Biochemical changes in rice plants infested with mealybug

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We studied the contents of reducing and nonreducing sugars, total phenols, and amino acids in healthy rice plants and those infested with mealybug *Brevennia rehi* Lindinger. Fifty mealybugs were placed on each tiller of 20-d-old IR20 seedlings, and allowed to feed 40 d. Samples were drawn 60 d after treatment from healthy and infested seedlings with three replications.

A 10-g sample of plant material was plunged into boiling 80% ethyl alcohol and extracted for 10 min. The extract was decanted, the tissues ground with a pestle and mortar and reextracted with another aliqout of ethanol, then strained through cheesecloth. Extracts were pooled to make up a desirable volume to use in estimating total and reducing sugars and total phenols and for chromatographic estimation of individual amino acids.

The amino acids were separated unidimensional descending chromatographic technique for qualitative analysis and estimated quantitatively by Demetriades' method. The nitrogen was estimated on dry plants by Humpries' method.

Effect of mealybug infestation on biochemical contents of rice.[a] Coimbatore, India.

Biochemical constituent	Content (mg/g dry weight)		Change (%)
	Healthy	Infested	
Total phenol	3.9	4.0	+ 2.6
Total sugar	16.9	32.6	+ 92.9
Reducing sugar	6.4	12.9	+101.6
Nonreducing sugar	10.5	19.7	+ 87.6
Total N	10.7	6.8	– 36.7
Amino acid (mg/100 g dry weight)			
Histidine	28	34	+ 21.4
Lysine	54	62	+ 14.8
Serine	25	29	+ 16.0
Tyrosine	199	221	+ 11.1
Alanine	–	8	+ 11.3
Glycine	47	60	+ 27.7
Tryptophan	127	142	+ 11.8
Arginine	29	37	+ 27.6
Isoleucine	31	87	+180.6
Proline	52	140	+169.2
Threonine	37	39	+ 5.4
Hydroxyproline	202	297	+ 47.0
Total	838	1156	37.9

[a] Mean of 3 replications.

Feeding injury by mealybugs resulted in a marginal increase in total phenolic content (see table). Total sugar, reducing sugar, nonreducing sugar and total amino acid contents increased phenomenally. Among the amino acids, isoleucine and proline contents increased more. □

Pest Control and Management

WEEDS

Effect of frequent cultivation on *Rottboellia cochinchinensis* density

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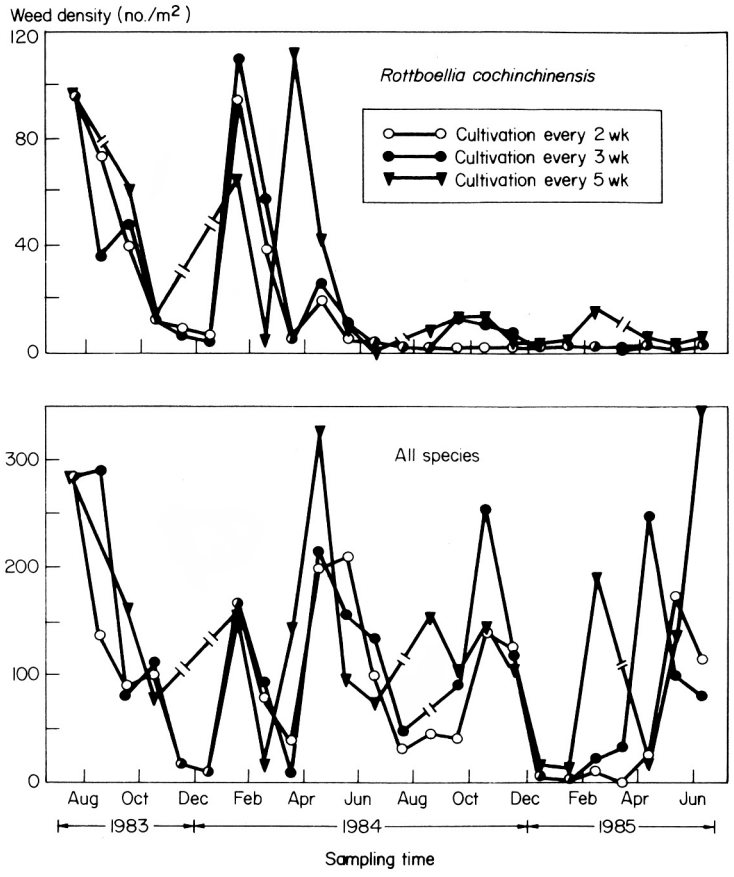
Rottboellia cochinchinensis (Lour.) W.D. Clayton (syn. *R. exaltata)* is a major weed in upland rice, maize, sugarcane, and legumes in the Philippines. We tested the effect of cultivation frequency (every 2, 3, and 5 wk) on *R. cochinchinensis* emergence in a fallow field at IRRI Aug 1983 - Jul 1985. Weeds were counted monthly in two 50- × 50-cm random quadrats per 48-m^2 (6 × 8 m) plot.

Initial weed density was 285 plants/m^2, with *R. cochinchinensis* comprising 30% of the population. After 1 yr, *R. cochinchinensis* population declined substantially (see figure). Reduction was associated with more frequent cultivation. By the end of the second year, *R. cochinchinensis* had been practically eliminated with cultivation every 2-3 wk; only a few plants grew in plots cultivated every 5 wk. This indicates that seeds of this weed either have very short dormancy or no dormancy or are short-lived.

Decline in the *R. cochinchinensis* population was not necessarily accompanied by an overall reduction in



Effect of frequency of cultivation on density of *Rottboellia cochinchinensis* and all weed species. IRRI, Aug 1983-Jul 1985.

total weed density. *Cyperus rotundus* L. populations decreased in plots that were frequently cultivated but increased with less frequent cultivation. Densities of *Eleusine indica* (L.) Gaertn. and *Portulaca oleracea* L. also increased.

Total weed density after 2 yr was not reduced in the plots rototilled every 5 wk. However, *R. cochinchinensis* was replaced by less competitive weeds. □

Complete slide sets of photos printed in Field problems of tropical rice, *revised 1983, are available for purchase at $50 (less developed country price) or $60 (developed country price), including airmail postage and handling, from the Communication and Publications Department, Division R, IRRI, P. O. Box 933, Manila, Philippines. No orders for surface mail handling will be accepted.*

Weed control in irrigated wet and dry seeded rice in medium-textured soils of Northwestern India

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Eight weed control treatments were tested to control weeds in direct seeded rice when sprouted seeds were sown on a puddled field and when dry seeds were sown on an unpuddled bed. The trial was in a split-plot design with three replications during 1983 and 1984 monsoon seasons.

The field was well-drained sandy clay loam soil. Pusa 33, 105-110 d duration and photoperiod insensitive with high yield potential, was the test variety. The crop received 100-22-42 kg NPK/ha. Preemergence herbicides like oxadiazon, pendimethalin, and butachlor were applied 4-5 d after seeding (DAS); propanil was applied 21 DAS. *Echinochloa colona* and *E. crus-galli* were the predominant weed flora.

Effect of herbicide schedule and seeding method on grain yield of direct seeded rice. IARI, New Delhi, India, 1983-84.

Treatment[a]	Grain yield (t/ha)		Weed wt (g/m^2)	
	Dry seeded	Wet seeded	Dry seeded	Wet seeded
Oxadiazon 0.6 pre + propanil 2 post	4.3	4.7	19	20
Oxadiazon 0.6 kg pre	4.1	4.6	18	19
Hand weeding + propanil 2 post	3.8	3.9	36	36
Pendimethalin 1.5 pre + propanil 2 post	2.1	3.0	71	61
Butachlor 1.0 pre + propanil 2 post	1.9	2.2	73	69
Pendimethalin 1.5 pre	1.4	2.5	88	73
Butachlor 1.0 pre	0.9	2.0	101	81
Weedy check	0.5	1.3	125	105
CD for weed control treatment means for the same method of seeding	0.3		6	
CD for method of seeding means for the same level of weed control	0.3		6	

[a]Pre and post = preemergence and postemergence applications. Herbicide measurements are in kg ai/ha.

Among the preemergence herbicides, oxadiazon at 0.6 kg ai/ ha resulted in the best weed kill, with yields of 4.1 t dry seeded rice and 4.6 t wet seeded rice/ha (see table). Combining propanil at 2 kg ai/ha with butachlor or pendimethalin was more effective than when the preemergence herbicides were applied alone. □