Chemical control of the white grub *Leucopholis coneophora* Burm., a pest of the coconut palm

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Received May 1987; revised January 1988

Grubs of the white grub *Leucopholis coneophora* Burm. feed on the roots of coconut palms and is a severe pest in Kerala and Karnataka States in South India. Four chlorinated hydrocarbon insecticides, HCH, heptachlor, aldrin and chlordane were evaluated for control of the immature stages of the white grub using bioassay techniques. Aldrin and heptachlor were the two most active compounds, weight for weight, against second and third instar grubs, but on a projected cost performance basis HCH and heptachlor emerged as the most promising candidates. Field evaluation of these two insecticides under controlled conditions proved that *L. coneophora* could best be controlled with heptachlor applied at 1.4 kg a.i. ha^{-1} in the month of June or with HCH applied twice at 5 kg a.i. ha^{-1} in June and September.

Keywords: Chemical control; Coconut white grub

The coconut white grub *Leucopholis coneophora* Burm. (Coleoptera: Scarabaeidae: Melolonthinae) is a major pest of the coconut palm in pockets of loamy sand tracts of Kerala and some parts of southern Karnataka. The grubs feed on the coconut roots and those of inter-planted crops. Palms which have been infested continuously for many years show loss of roots, shortening of leaves, yellowing of leaflets and shedding of buttons and immature nuts. Consequently, the yield is greatly reduced.

The results of earlier field experiments for the control of the pest were not conclusive (Nirula and Menon, 1957; Nirula, 1958; Mathen *et al.*, 1964; Johnson and Nair, 1966; Abraham and Kurian, 1970). The uneven distribution of grub populations in the field was the major reason for the inconsistency in the results.

The relative toxicities of four chlorinated hydrocarbon insecticides were assessed in the laboratory against the second and third instar grubs of the pest and the relative efficacy of the two most suitable insecticides was evaluated under controlled field conditions and also during different periods of the year.

Materials and methods

5% dust formulations of the insecticides HCH, heptachlor, aldrin and chlordane in graded doses (Table 1) were applied in a field of sandy loam soil in 1 m^2 plots. The insecticides, applied to randomized plots, were raked into the soil to a depth of 15 cm and replicated thrice.

24 h after application, soil samples from the different plots were collected from a depth of 0–15 cm, using an auger of 7.5 cm diameter. Ten such samples taken from each plot were mixed. Ten 250 ml glass jars were filled with the samples taken from each plot. Pre-soaked groundnut seeds were kept buried in the soil as food for the test grubs. Field-collected grubs of the required age and uniform size were placed singly in each jar. Observations on paralysis and mortality of grubs were recorded at the end of 72 h, paralysed grubs being treated as dead. The experiment was repeated by changing doses till mortality ranges suitable for the assessment of the LC_{50} values of the insecticides were obtained. Percentage kills obtained were corrected using Abbott's formula (1925) and the corrected values were subjected to probit analysis (Finney, 1952).

HCH and heptachlor were further evaluated under field conditions, using cement tubs 1 m across and 1 m deep. The tubs, kept in an open field, were filled with sandy loam soil in March. HCH at 5 kg a.i. ha^{-1} and heptachlor at 1.4 kg a.i. ha^{-1} were applied as 5% dusts and mixed thoroughly with the soil to a depth of 15 cm. For assessing the most suitable time for the application, each insecticide was applied in four treatments varying the time of application. The treatment times tried were in (a) April alone, (b) June alone, (c) April and August and (d) June and September (Table 2). Each treatment was replicated thrice. Untreated checks were also maintained. First instar grubs were collected from the field and kept under observation for three days to eliminate the grubs which might have suffered shock during collection. The normal period of peak occurrence of first instar grubs in the field is from the second half of

Part of PhD thesis submitted to the Kerala Agricultural University, Vellanikkara, Trichur, by the senior author

CPCRI contribution No. 616.

0041-3216/88/040355-03 $03.00

June to the second half of August (Abraham, 1983). Five healthy grubs were placed in each tub five times, at fortnightly intervals, commencing from the second half of June to the second half of August; a total of 25 grubs were thus placed in each tub. They were put in 30 cm-deep holes made in the soil to avoid their coming in direct contact with the insecticide-treated soil at the time of liberation.

The number of grubs reaching the third instar and pupal stage at the end of December and May, respectively, were recorded, these being the usual times by which all the grubs reach such stages in the field.

One month after the last insecticidal application, i.e. in October, each tub was uniformly planted with 25 germinating groundnut seeds; the mortality of the plants served as an index of treatment efficacy since it was correlated with the activity of the grubs surviving during the period.

The data were statistically analysed after applying the angular transformation ($\sin^{-1}\sqrt{x}$) and the results are presented in Table 2.

Results and discussion

The LC_{50} values obtained from the bioassay studies (Table 1) showed that aldrin was the most toxic to second instar grubs, closely followed by heptachlor, but heptachlor was more toxic than aldrin to the third instar grubs. Heptachlor is cheaper; and HCH, whose toxicity appeared to be sufficiently high to adequately control the pest under field conditions, was also more cost-effective than aldrin or chlordane. HCH and heptachlor were therefore selected for further evaluation under field conditions. Data relating to the experiments are presented in Table 2. Heptachlor was superior to HCH in the corresponding schedules of application. However, all the treatments reduced the population of second instar grubs effectively prior to their attaining the third instar or pupal stage.

Among the various schedules of treatments, the double application of heptachlor (June and September) was found to be the best, since there were no surviving grubs and pupae in the treatment and no

Table 1 Laboratory evaluation of the immediate toxicity of chlorinated insecticides to grubs of *L. coneophora*

Insecticide	Range of doses (kg a.i. ha^{-1})	Heterogeneity	LC_{50} (kg a.i. ha^{-1})	Fiducial limits	LC_{90} (kg a.i. ha^{-1})	Cost[a] Rs
Second instar grub						
Aldrin	0.3– 1.8	3.0033	0.73	0.55 1.01	1.31	174
HCH	1.0– 5.0	0.9943	2.37	2.04 2.80	4.83	97
Chlordane	3.0–15.2	0.3943	6.87	6.00 7.44	12.43	1020
Heptachlor	0.3– 1.8	2.1620	0.74	0.21 1.02	1.37	115
Third instar grub						
Aldrin	2.0–10.1	0.2785	4.87	3.29 6.15	8.95	1202
HCH	3.0–15.2	7.1306	7.02	4.71 15.28	14.98	300
Chlordane	4.0–22.8	0.4069	11.53	7.67 13.04	18.74	1509
Heptachlor	1.0– 5.0	0.9502	2.67	1.27 3.13	5.05	408

[a] Cost of commercial formulations of the insecticides as 5% dust at LC_{90} levels

Table 2 Percentage survival of first instar grubs of *Leucopholis coneophora* in insecticide-treated soil when liberated at different intervals after treatment. Percentage mortality of groundnut seedlings placed in the treated soil, one month after the last insecticide application

Treatment			First instar grubs reaching		Mortality of groundnut seedlings (%)
Insecticide	Dose (kg a.i. ha^{-1})	Application time	Third instar stage (%)	Pupal stage (%)	
HCH	5.0	April	70.8	26.6	73.5
HCH	5.0 + 5.0	April/August	21.3	15.2	45.3
HCH	5.0	June	46.6	8.0	49.3
HCH	5.0 + 5.0	June/September	11.8	1.8	6.5
Heptachlor	1.4	April	30.6	9.3	38.7
Heptachlor	1.4 + 1.4	April/August	6.5	0.0	7.7
Heptachlor	1.4	June	10.6	0.0	6.6
Heptachlor	1.4 + 1.4	June/September	0.0	0.0	0.0
Control	none	–	90.7	69.1	100
LSD (P = 0.01)			4.5	4.8	7.9

mortality of sprouted groundnut seeds sown in the treated tubs. Even when insecticide was applied only once in June, the survival of grubs up to the third instar stage was only 10.5% and zero in the pupal stage.

Application of HCH in June and again in September substantially reduced survival of grubs and pupae and mortality of the groundnut plants. This treatment was similar in effect to the application of heptachlor in June. A single application of HCH in April or in June, or two applications once in April and then in August, did not give effective control. The schedule of April and August for the above insecticides was significantly inferior to the schedule of June and September. In a study on the downward movement of HCH and heptachlor by Abraham (1983) it was found that downward movement of heptachlor was very slow and negligible in sandy loam soils of Kerala; HCH moved faster to lower strata of soil. The first instar grubs of *L. coneophora* are more abundant at 15–30 cm depth. This can account for the superior performance of heptachlor to HCH even though both were applied at LC_{90} levels.

It was concluded from the above results that *L. coneophora* can be controlled with a single application of heptachlor at the rate of 1.4 kg a.i. ha^{-1} in the month of June or HCH applied in both June and September, each treatment being made at the rate of 5 kg a.i. ha^{-1} of the toxicant.

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