

Bioefficacy of Insecticides Against White Grub, *Leucopholis lepidophora* Blanch Infesting Arecanut Palm

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Abstract

The root infesting scarabaeid white grub, *Leucopholis lepidophora* Blanch is a major pest on arecanut in Western ghats area of Karnataka. In an attempt to identify an insecticide with enhanced bioaction against *L. lepidophora*, four insecticides viz., carbosulfan, tefluthrin, chlorpyrifos and phorate (standard insecticide) were screened for their toxicity in the laboratory and in the field. In laboratory bioassay studies, the order of toxicity observed was carbosulfan > tefluthrin > chlorpyrifos > phorate. On relative toxicity, carbosulfan was 4.2 times more toxic as compared to phorate followed by tefluthrin (2.8) and chlorpyrifos (1.9) in the case of II instar grubs. In III instar grubs carbosulfan was 13 times more toxic than phorate whereas, tefluthrin and chlorpyrifos were 12.5 and 2.7 times more toxic than phorate, respectively. A replicated field trial was taken up at arecanut gardens in Sringeri (Karnataka) for two years and the treatments were imposed during post monsoon season (1999 and 2000). Carbosulfan @ 20 g / palm during first and second years effected a mean reduction in grub population to a tune of 80.6 % and 66 % , respectively. Chlorpyrifos @ 8 ml/ palm and carbosulfan @ 10 g / palm caused > 60 % reduction in grub population during both the years of study. The standard insecticide phorate @ 10 g / palm caused a mean reduction of 36.43% and 44% during the respective years.

Keywords: Bioefficacy, insecticides, white grub, *Leucopholis lepidophora*, arecanut

Introduction

The root infesting Scarabaeid white grub, *Leucopholis lepidophora* Blanch (Melolanthinae: Coleoptera) is a pest on arecanut and is widely distributed in Western ghats area of Karnataka (Veeresh *et al.*, 1982). In addition to arecanut it feeds on coconut (Veeresh *et al.*, 1982), sugarcane (Patil and Adusule, 1991), rice (Patil *et al.*, 1986) and groundnut (Adusule and Patil, 1990). The grubs feed on young roots of arecanut palm round the year and continued feeding results in yellowing of leaves, tapering of stem and reduction in number of bunches (Rajamani and Nambiar, 1970).

Effective and long-term control of *L. lepidophora* infesting arecanut was achieved by applying an organophosphate insecticide viz., Phorate 10 G, but currently the farmers complain that the results obtained by this

treatment were highly variable. The reduced efficacy may be due to their continued and indiscriminate use. The reduction in efficacy of organophosphates due to continuous use against scarabaeids was reported by Villani *et al.*, (1988). Hence, it is imperative to search for newer molecules with enhanced bioaction. In the course of present studies, the relative toxicity of certain insecticides to *L. lepidophora* in laboratory and their field efficacy were determined.

Materials and Methods

The test insect (white grubs) was collected from arecanut garden in Sringeri area and maintained in laboratory at $25 \pm 2^\circ$ c. The grubs were held in individual containers filled with soil having moisture to field capacity. Sweet potato bits were provided as food. The grubs were allowed to acclimatize for a week before subjecting to treatment. The diseased/ dead

grubs if any were discarded from the culture.

Four commercial formulations viz., carbosulfan, tefluthrin, Chlorpyrifos and phorate were used in the present studies.

Bioassay

A concentrated stock solution of insecticides was added at the rate of 15 ml to 50 g of autoclaved untreated clay loam soil taken in 100 ml plastic container. The concentrations were calculated considering the quantity of insecticide, $\mu\text{g} / \text{gm}$ of soil (To obtain the ppm level). The grubs of uniform size were taken in container to which the sweet potato was added as food material.

Observations on paralysis and mortality of grubs were recorded 48 h after treatment. Paralyzed grubs were considered as dead. The experiments were repeated by changing the doses till mortality ranges suitable for assessment of LC 50 values of test insecticide were obtained. Per cent mortality was corrected using Abbot (1925) formula and the corrected values were subjected to probit analysis (Finney, 1971) to obtain LC 50 values. The relative toxicity values were calculated by taking the LC 50 values of phorate as an unit for comparison with other insecticides.

Field Trials

Field evaluation of insecticides was taken up at farmer's garden in Gundre village of Sringeri Taluk of Karnataka State. The soil type was clayey loam. The experiment was laid out in randomized block design with three blocks, each block representing a replicate and receiving all the treatments. A trench of two feet wide and two feet deep separated each block. Six palms were maintained for each treatment and a border row was also maintained between treatments in each block. Before the experiment was laid out, the population of grubs in three palm basins / replicate (0.5M²) was ascertained by random sampling. The granular formulations were mixed with river sand

and sprinkled uniformly over the surface. The liquid formulations were mixed in rose can @ 2.5l solution / palm and is spread over the surface uniformly. The grubs in the field were in III instar stage at the time of treatment (Oct 1999 & Oct 2000). Post treatment observations were made at an interval of 30 days after treatment (DAT). Second round of insecticide application was given 45 days after first treatment. The corrected per cent mortality was worked out based on Henderson Tilton (1955) formula.

Results and Discussion

The order of toxicity of insecticides to *L. lepidophora* was determined from the laboratory LC 50 tests as carbosulfan > tefluthrin > chlorpyrifos > phorate. The order of toxicity was independent of instars.

In case of relative toxicity of insecticides to II instar *L. lepidophora* larvae carbosulfan was 4.2 times toxic as compared to phorate followed by tefluthrin (2.87) and chlorpyrifos (1.96) (Table 1).

Similar trend of toxicity was observed with III instar also, but carbosulfan being 13 times toxic to phorate followed by tefluthrin and chlorpyrifos that were 12.5 and 2.7 times toxic to standard insecticide phorate (Table 1).

The performance of carbosulfan and tefluthrin were 13.0 and 12.5 times more toxic to phorate to III instar as compared to II instar where they were 4.2 and 2.8 times more toxic to phorate. In either instar level of grubs the relative toxicity of chlorpyrifos did not vary much. There was a direct correlation between the weight of the larvae and the dose required to obtain the kill.

In the second field trial during the year 2000 the population prior to application of insecticides ranged from 9.66 - 18.66 grubs/3 palm basins (Table 2). Carbosulfan @ 20 g/palm caused > 66% mean reduction in grub population.

Table 1: Relative toxicity of insecticides to *Leucopholis lepidophora* (II and III instar)

Chemical	Instar	Chi square	LC ₅₀ (ppm)	Fudicial limit (ppm)	Upper limit Lower limit	Relative toxicity
Phorate	II	6.797	1.4232	1.0251	1.9858	1.0000
	III	3.876	8.0635	7.3828	8.8019	1.0000
Carbosulfan	II	6.956	0.3358	0.2001	0.5039	4.2382
	III	5.483	0.6191	0.4901	0.7655	13.0245
Tefluthrin	II	6.578	0.4949	0.4192	0.5878	2.8757
	III	5.287	0.6408	0.5662	0.7241	12.5384
Chlorpyrifos	II	2.611	0.7234	0.6385	0.8137	1.9673
	III	12.270	2.8956	1.6929	4.2587	2.7487

Table 2: Efficacy of insecticides in *L. lepidophora* management

Treatment	I year					II year				
	Ist Round		II Round		Mean % mortality	Ist Round		II Round		Mean % mortality
	Pre Count *	% mortality 30 DAT	Pre Count *	% mortality 30 DAT		Pre Count *	% mortality 30 DAT	Pre Count *	% mortality 30 DAT	
Phorate 10 G @ 10 g/ palm	28	30.03 ^b	3.0	42.83 ^{bc}	36.43	15.0	30.50 ^{bc}	4.33	58.91 ^b	44.70
Phorate 10 G @ 20 g/ palm	25	50.53 ^a	1.33	46.30 ^{bc}	48.41	15.66	54.87 ^a	6.0	72.94 ^a	63.90
Chlorpyrifos 5EC @4 ml/palm	32	49.40 ^a	2.33	53.83 ^{bc}	51.61	16.66	39.14 ^b	8.0	65.93 ^{ab}	52.53
Chlorpyrifos 5EC @8 ml/palm	30	61.73 ^a	1.0	63.36 ^{ab}	62.54	13.0	52.03 ^a	9.66	75.69 ^a	63.86
Carbosulfan 6 G @10 g/ palm	42	60.00 ^a	1.66	61.46 ^{ab}	60.69	18.66	55.76 ^a	9.66	64.53 ^{ab}	60.64
Carbosulfan 6 G @20 g/ palm	30	80.40 ^a	0.66	80.93 ^a	80.66	16.33	62.26 ^a	12.66	71.26 ^a	66.76
Neem cake @ 1000 kg/ ha.	26	19.63 ^b	5.0	22.59 ^c	21.11	11.0	25.21 ^c	7.33	43.33 ^c	34.27
Control	25		6.66			9.66		9.00		

* Number of grubs / 3 palm basins; Means followed by same letter in a column are not significantly different at 5% level by Duncan's multiple range test.

Carbosulfan @ 10 g/ palm, chlorpyrifos @ 8 ml/ palm and phorate @ 20 g/ palm caused > 60 % reduction in grub population. The standard insecticide Phorate @ 10 gm / palm caused only 44.7% mortality.

Application of neem cake @ 1000 kg / ha caused a mean reduction of 21 and 34 % in I and II year respectively. The efficacy was significantly lower as compared to other chemical insecticides evaluated including the standard insecticide

Phorate 10 G. These results corroborate with the study conducted by Padmanabhan *et al.*, (1997) who reported that application of neem cake @ 1000kg/ha caused 31.2% mortality of *L. burmestri* infesting arecanut palm.

The increased efficacy of carbosulfan on arecanut white grub, *L. lepidophora* is due to lower water solubility (0.03 ppm) that leads to higher persistent toxicity when applied in the soil (Achik *et al.*, 1989). In addition, the toxicity of carbosulfan is also affected due to its conversion to carbofuran derivative which has a solubility of 700 ppm, as this solubility helps the toxic principle to target the grubs that are present 30 cm beneath the surface. Carbofuran also has a positive correlation between soil organic matter content and the degree of absorption (Jamet and Piedallu, 1975).

Though chlorpyrifos has higher solubility (2 ppm) than carbosulfan it has a tendency to be adsorbed to the soil particle resulting in immobility in soil so as to reach the target site (Wauchope, *et al.*, 1992). This may be the reason attributed for the reduced efficacy of chlorpyrifos against *L. lepidophora* as compared to carbosulfan. More over the principal metabolite of chlorpyrifos TCP adsorbs weakly to the soil particles with a moderate mobility (not effective as carbofuran that is a derivative of carbosulfan) and persistence in soil (USEPA, 1989). The adsorbed chlorpyrifos to the surface soil is subjected to degradation by light, chemical hydrolysis and soil microbes.

Phorate that is currently recommended for managing *L. lepidophora* has low leaching capacity in soils with high clay and organic matter content (Wauchope, *et al.*, 1992), a condition ideally suitable for regions with high water table (U.S.P.H.S. 1995). The insecticide adsorbed to surface soil may be transported via runoff in sediments and water, hence reducing the availability of the toxic principles to reach the target site. This may be the possible reason for

varied results obtained by farmers using phorate to manage arecanut white grubs.

The current recommendation for management of white grub in arecanut gardens is application of phorate 10 G @ 15 g/palm twice a year during May - June and September - October (Nair *et al.*, 1997). Though the emergence and oviposition by adults is during June the maximum population of *L. lepidophora* III instar grubs in the arecanut root zone (15 - 30 cm depth) are found during October. The eggs are laid scattered in the field and mostly in the interspaces. Only the II and III instar move to the palm basins and cause damage to the roots. Hence, considering the physicochemical properties of the chemical insecticides used, it was observed that application of insecticides after the monsoon i.e., during September and October would yield desirable results as against applying during June. This would help the toxic principles to reach the target site without being lost by way of leaching, runoff due to heavy monsoon showers. Hence, carbosulfan and chlorpyrifos are ideal substitute chemicals for phorate in the management of arecanut white grub, *L. lepidophora*.

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