Short communication

Ecofriendly management of coconut root grub *Leucopholis coneophora* Burm.

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Abstract

Bio-agents, botanicals and novel insecticides were evaluated against coconut root grub during 2012-14 at College of Agriculture, Padnekkad, Kasaragod, Kerala. Laboratory experiments, field pot experiments and field cage experiments were conducted to identify ecofriendly management measures. Cent per cent mortality of grubs was observed in case of grubs treated with the Novaluron10 EC 0.05%**,** Clothianidin 30 WDG 8.23 x 10^2 g ai ha^{-1} and Azadirachtin 1500 ppm at 5, 10 and 15ml per litre as well as in case of grubs treated with Malathion 50 EC 0.1%. CNSL (Cashew Nut Shell Liquid) 2% and Chlorpyrifos 20 EC 0.02% recorded 80 and 66 per cent mortality respectively. In the pot studies, maximum mortality of 98 per cent was observed in treatments with Azadirachtin 10ml l^{-1} and 15ml l^{-1} followed by Malathion with 97 per cent and Clothianidin with 87 % mortality. In the cage studies, the treatment Azadirachtin 15ml l^{-1} gave highest mortality (97 %) followed by Malathion (87%), Clothianidin (73%), Azadirachtin10ml l^{-1} (70%) and Azadirachtin 5ml l^{-1} (63%). There was no mortality in absolute control. The EPN *Heterorhabditis indica* inflicted no mortality.

Key words: Coconut root grub, Leucopholis *coneophora,* Management, New insecticides, Botanicals, Bioagents.

Coconut production plays an important role in the economy and culture of the state of Kerala. Sandy and sandy loam soils constitute majority of the area under the crop, especially in the coastal regions of Kerala. The root grub, *Leucopholis coneophora* Burmister is an endemic subterranean pest of coconut and other crops in sandy loam soils of peninsular India. It was first reported by Nirula et al. (1952). The grub tunnels into the bole and collar region of the seedlings and severe infestation leads to death of the seedlings. In adult palms, they feed on roots, impairing the translocation of water and nutrients and thus leading to yellowing of fronds and substantial yield loss (Nirula et al., 1952; Abraham & Mohandas, 1988). The pest has an annual life cycle and adult emergence coincides with the onset of monsoon (Abraham & Mohandas, 1988). Presently the grubs are managed by applying soil insecticides belonging to organophosphorus and neonicotinoid groups, with varying results in farmers' fields. In sandy or sandy loam soils with high rainfall, application of pesticides may lead to pollution of groundwater. Moreover, many pesticides which are recommended for root grub management are banned in Kerala especially in Kasaragod. It was under these circumstances that the present research work was undertaken with the objective of developing effective, economically viable and eco-friendly management measures against root grub, *Leucopholis coneophora*.

Evaluations of a bio-agent, botanicals and two novel chemicals were carried out against coconut root grubs, both under laboratory and field conditions. The bio-agent used was the entomopathogenic nematode *Heterorhabditis indica* talc formulation containing 20000 infective juveniles per gram, while the botanicals were neem cake 50kg 40 m^{-2}., cashew nut shell liquid (CNSL) 2% and azadirachtin1500 ppm @ 5ml, 10ml and 15ml l^{-1}.

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Chemical insecticides included Clothianidin 30 WDG 8.23 x 10^2 g ai ha^{-1}, Novaluron 10 EC 0.05%, and Malathion 50 EC @ 0.1%. Chlorpyrifos 20 EC @ 0.02% was used as check. The bio-agents, botanicals and chemicals were compared with each other and with untreated control.

Laboratory evaluation was carried out in a completely randomized design with 11 treatments and 5 replications. The experiment was repeated thrice during September, October and November in 2013.

The assay was conducted in disposable plastic cups of 6.5cm diameter, 8.5cm height and holding 230ml soil. A single third instar grub was transferred to each cup and was provided with a piece of potato as food. The cup was then filled with soil. 25 ml of each treatment was applied on the surface. The cups were frequently watered to maintain the moisture level. The experiment was conducted at ambient conditions. Mortality of the grubs was recorded at five day intervals for 20 days.

Earthern pots of 17 cm diameter and 26 cm height, and holding six litres of soil were used for the experiment. Four numbers of third instar grubs were released in each pot and two potatoes were provided as food. The pots were filled with soil and buried in the ground up to its rim at a depth of 15cm at a spacing of 1m. The pots were irrigated with a rose can to maintain the moisture level near field capacity. 25 ml of each treatment was applied on the soil surface five days after the release of grubs. Mortality of the grubs was observed as previously described. The whole experiment was repeated thrice during September, October and November in 2013.

Plastic net cages of 12cm diameter and 20 cm height with 244 meshes per square inch were prepared. Cages were filled with 2.2 litres of soil and third instar grubs were released at the rate of two grubs per cage. Two pieces of potato were provided in each cage as food. Each cage was then closed with a lid made out of the same material and was hand stitched with nylon twine. The closed cages were completely buried in the field at a depth of 15cm at equal spacing of 15 cm. 25 ml of each treatment was applied on the soil surface five days after the release of grubs. Mortality of the grubs was observed twice at 10 and 20 days after treatment. Moisture levels in the cages were maintained by irrigation as and when required. The whole experiment was repeated thrice during September, October and November, 2013.

Observations on mortality were recorded and per cent larval mortality was calculated by using formula:

Per cent mortality=

$$\frac{\text{Number of dead larvae}}{\text{Total number of larve treated}} \times 100$$

The results of laboratory studies conducted during September, October and November months of 2013 were pooled together to get the most relevant trend. The data are presented in Table 1.

Cent per cent mortality was observed in grubs treated with Novaluron, Clothianidin, Azadirachtin 1500 ppm at all three concentrations evaluated and Malathion consistently in all the three rounds of experiment. The above treatments were on par with CNSL 2% which recorded 80% mortality. Treatment with Chlorpyrifos resulted in a mortality of 66% which was on par with neem cake and cashew nut shell liquid with 67 and 80 per cent mortality respectively. No mortality was observed in control as well as treatment with the entomopathogenic nematode *H. indica*. The results were identical during all the three months.

The results of the field pot studies conducted during September, October and November months of 2013 pooled together are presented in Table 2.

The highest mean mortality of 98% was observed in treatments with Azadirachtin @ 10ml l^{-1} as well as 15ml l^{-1}, followed by Malathion and Clothianidin

Table 1. Effect of different treatments on third instar grubs of *L .coneophora* in the laboratory

Treatments	Mean per cent mortality of root grubs in laboratory assay			
	September	October	November	Mean
T_1- Entomopathogenic nematode *H. indica*	0.00	0.00	0.00	0.00
(0.3 g formulation per cup)	(1.43)	(1.43)	(1.43)	(1.43)
T_2-Cashew nut shell liquid 2%	60.00	100.00	80.00	80.00
	(53.71)	(88.56)	(71.14)	(71.14)
T_3-Neem cake @ 12350 kg ha^{-1}.	60.00	40.00	100.00	66.66
	(53.71)	(36.28)	(88.56)	(59.52)
T_4-Clothianidin 30 WDG 8.23 x 10^2 g ai ha^{-1}	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_5-Novaluron 10 EC 0.05%	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_6-Malathion 50 EC @0.1%	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_7-Chlorpyrifos 20 EC @0.02%.	80.00	80.00	40.00	66.66
	(88.56)	(71.14)	(36.28)	(65.63)
T_8-Azadirachtin 1500 ppm @ 5ml l^{-1}	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_9-Azadirachtin 1500 ppm @ 10ml l^{-1}	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_{10}-Azadirachtin 1500 ppm @ 15ml l^{-1}	100.00	100.00	100.00	100.00
	(88.56)	(88.56)	(88.56)	(88.56)
T_{11}-Absolute control	0.00	0.00	0.00	0.00
	(1.43)	(1.43)	(1.43)	(1.43)
C.D 0.05%	29.94	23.67	23.67	25.76

(Values in parenthesis are transformed values)

Table 2. Effect of different treatments on third instar grubs of *L. coneophora* in field pot studies

Treatments	Mean mortality of root grubs (%)			
	September	October	November	Mean
T_1- Entomopathogenic nematode *H. indica* talc 2.5 g/pot	0.00	0.00	0.00	0.00
	(1.43)	(1.43)	(1.43)	(1.43)
T_2-Cashew nut shell liquid 2%	50.00	85.00	40.00	58.33
	(47.71)	(74.14)	(36.28)	(52.71)
T_3-Neem cake @ 12350kg ha^{-1}.	15.00	45.00	75.00	45.00
	(18.57)	(42.00)	(68.14)	(42.90)
T_4-Clothianidin 30 WDG 8.23 x 10^2 g ai ha^{-1}	80.00	100.00	80.00	86.67
	(68.42)	(88.56)	(68.42)	(75.14)
T_5-Novaluron 10 EC 0.05%	25.00	65.00	45.00	45.00
	(27.28)	(54.00)	(39.28)	(40.18)
T_6-Malathion 50 EC @0.1%	100.00	100.00	90.00	96.67
	(88.56)	(88.56)	(79.54)	(85.66)
T_7-Chlorpyrifos 20 EC @0.02%.	35.00	50.00	25.00	36.67
	(33.28)	(47.71)	(27.28)	(36.09)
T_8-Azadirachtin 1500 ppm @ 5ml l^{-1}	55.00	65.00	65.00	61.67
	(48.00)	(56.71)	(56.71)	(53.80)
T_9-Azadirachtin 1500 ppm @ 10ml l^{-1}	95.00	100.00	100.00	98.33
	(82.54)	(88.56)	88.56	(86.66)
T_{10}-Azadirachtin 1500 ppm @ 15ml l^{-1}	95.00	100.00	100.00	98.33
	(82.54)	(88.56)	88.56	(86.66)
T_{11}-Absolute control	0.00	0.00	0.00	0.00
	(1.43)	(1.43)	(1.43)	(1.43)
C.D 0.05%	21.87	15.81	22.34	20.01

(Values in parenthesis are transformed values)

registering 97 and 87 per cent mortality respectively. All the four treatments were on par with each other and were significantly superior to other treatments. The above treatments were followed by Azadirachtin 5ml l^{-1}, CNSL 2%, neem cake, novaluron and chlorpyriphos with 62, 58, 45 and 37 per cent mortality respectively. No mortality was recorded in case of *H. indica* as well as in control

The mortality also showed variation between the three months, with highest mortality being recorded in October across all treatments except neem cake. As the insects grew they became less susceptible.

The results of the three field cage studies conducted during September, October and November months of 2013 are presented in Table 3.

Azadirachtin15ml/l recorded the highest mean mortality of 97% followed by Malathion (87%), Clothianidin (73%), Azadirachtin 10ml l^{-1} (70%) and Azadirachtin 5ml l^{-1} (63%). All the five were on par with each other and were significantly superior to the remaining treatments. Treatments with CNSL (53%), neem cake and Chlorpyrifos (30%) registered lower mortality of 53,30 and 30 per cent each respectively. Treatment with EPN did not result in any mortality and there was no mortality in absolute control.

The findings of the present study confirm the superiority of azadirachtin over other chemicals as well as botanicals evaluated. Azadirachtin is a terpene which is structurally similar to the moulting hormone ecdysone that can cause insect growth regulatory effect. Azadirachtin is well known for its antifeedant properties also. It has seldom been evaluated as a management measure for subterranean pests. The present findings thus could lead to a viable and ecofriendly option for management of root grubs, especially in Kasaragod, where some classes of synthetic insecticides are banned.

Table 3. Effect of different treatments on third instar grubs of *L. coneophora* in field cage studies

Treatments	Mean mortality of root grubs (%)			
	September	October	November	Mean
T_1- Entomopathogenic nematode *H. indica*1.2 g / cage	0.00 (1.43)	0.00 (1.43)	0.00 (1.43)	0.00 (1.43)
T_2-Cashew nut shell liquid 2%	50.00 (45.00)	90.00 (79.54)	20.00 (18.86)	53.33 (47.33)
T_3-Neem cake @ 12350 kg ha^{-1}.	10.00 (10.14)	10.00 (10.14)	70.00 (62.42)	30.00 (27.57)
T_4-Clothianidin 30 WDG 8.23 x 10^2 g ai ha^{-1}	70.00 (62.42)	100.00 (88.56)	50.00 (45.00)	73.33 (65.33)
T_5-Novaluron 10 EC 0.05%	50.00 (45.00)	20.00 (18.86)	10.00 (10.14)	26.33 (24.66)
T_6-Malathion 50 EC @0.1%	80.00 (71.14)	80.00 (71.14)	100.00 (88.56)	86.67 (76.94)
T_7-Chlorpyrifos 20 EC @0.02%.	30.00 (27.57)	50.00 (45.00)	10.00 (10.14)	30.00 (27.57)
T_8-Azadirachtin 1500 ppm @ 5ml l^{-1}	60.00 (53.71)	60.00 (53.71)	70.00 (62.42)	63.33 (56.61)
T_9-Azadirachtin 1500 ppm @ 10ml l^{-1}.	80.00 (71.14)	50.00 (45.00)	80.00 (71.14)	70.00 (62.42)
T_{10}-Azadirachtin 1500 ppm @ 15ml l^{-1} lit	90.00 (79.54)	100.00 (88.56)	100.00 (88.56)	96.67 (85.66)
T_{11}-Absolute control	0.00 (1.43)	0.00 (1.43)	0.00 (1.43)	0.00 (1.43)
C.D 0.05%	38.54	24.83	29.47	30.94

(The figures in the parenthesis denote are transformed values)

Clothainidin, a nicotinoid molecule as well as Malathion, a popular organophosphorus insecticide, were also found to be effective in managing the root grub larvae in the present studies. This is in conformity with the results of the studies at AINP on white grubs that also found Clothianidin 30 WDG to be effective against white grubs at 2 g kg^{-1} of soyabean seeds (AINP, 2011).

However, Chlorpyriphos, which is considered as ideal against soil borne pests, induced only lower levels of mortality in field pot as well as field cage studies, which calls for further investigations.
H. indica, the only bio control agent evaluated in the present study failed to induce any mortality in any of the three methods employed. Liesch and Williamson (2010) also reported that the nematode failed to control the white grub (*Phyllophaga sp.*) on Christmas tree. In another study using *H. indica* by Sanchez-Saavedra et al. (2012), limited mortality of root grubs was recorded and no infective juveniles emerged from any of the dead adults.

The present study has shown that drenching the soil with Azadirachtin 1500 ppm at the rate of 15 ml/l was effective in the management of coconut root grubs. Clothianidin as well as Malathion 50EC which are relatively safer molecules could also be considered for root grub management where use of insecticides is permitted.

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