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Efficacy of selected insecticides against coconut black headed caterpillar, *Opisina arenosella* (Walker) under laboratory and field conditions

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ABSTRACT

The study was aimed at identifying alternative to monocrotophos, the only chemical recommended for root feeding against which the *Opisina arenosella* has shown resistance. This experiment was carried out in laboratory as well as in field conditions. In laboratory condition, among the tested chemicals *viz*., monocrotophos 36% SL, neemazal 1% and emamectin benzoate 5% SG gave one hundred per cent reduction followed by bifenthrin 10% EC (98.35%) and imidocloprid 17.8% SL (98.35%) as compared to untreated control. Field evaluation of selected chemicals indicated that monocrotophos 36% SL and neemazal 1%, gave one hundred per cent reduction followed by emamectin benzoate 5% SG (97.83%) and imidocloprid 17.8% SL (97.04%) as compared to untreated control. Thus besides monocrotophos other chemicals such as neemazal, emamectin benzoate, bifenthrin and imidacloprid also recorded significant mortality of coconut black headed caterpillar. The coconut palm successfully absorbed all these chemicals and can be used for root feeding.

Key words : Coconut black headed caterpillar, *Opisina arenosella,* monocrotophos, root feeding.

INTRODUCTION

The coconut black headed caterpillar, *Opisina arenosella* (Walker) is an important pest of coconut in India. The severity of the pest can be highlighted not by the fact that it can completely devastate a farmer during an outbreak, but also that it can take two years for severely affected trees to realize original yields after the pest is eradicated from the garden (Muralimohan and Srinivasa, 2008). Caterpillars of this species feed on leaflets of coconut palms and initially monocrotophos was administered for managing this menace (Nadarajan and Channabasavanna, 1981). Currently available options for managing populations of this pest resolve mostly around artificial releases of natural enemies and insecticides treatments (Anonymous, 2003). Monocrotophos has been the most frequently used insecticide for the management of coconut black headed caterpillar. Since more than 30 years monocrolophos has been used in managing the pest in Karnataka (Muralimohan *et al*., 2007). Available control measures include mainly topical sprays and systemic application (root administration) of synthetic pesticides, major being the monocrotophos on which the caterpillar has shown resistance (Muralimohan *et al.*, 2007). In spite of several concerted efforts made for the past five decades to control the pest, successful management strategies are still not achieved. Keeping this in view, experiments were planned to identify other chemical which can be administered through root and evaluate their efficiency against black headed caterpillar.

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MATERIALS AND METHODS

Laboratory evaluation of selected insecticides against O. arenosella : To evaluate the selected chemicals against black headed caterpillar under lab condition, ten healthy 8-10 year old palms were selected at College of Agriculture, Shivamogga. All selected healthy palms were treated with 10 chemicals including monocrotophos as check through root feeding technique and untreated palms as control. From each palm, a mature functional root which is brick red in colour and pencil thick was selected. This root was cut slantly at one stroke. Ten ml of chemical with equal quantity of water was filled in a small polythene bag (250 gauge; 7.5 × 5 cm). After ensuring that the cut end was not damaged, it was inserted into the polythene

bag containing the insecticide and the open end of the bag was secured to the root by a thread. Observations were also made on the absorption of chemical upto 48 hours after the treatment. All the selected chemicals were successfully absorbed by the palms within 48 hours. If the chemical remained unabsorbed (in some cases due to root damage) within 48 hours, one more root was selected and fed with the remaining chemical. After seven and 14 days of treatment, leaves were collected from lower fronds of these palms. Two to three leaflets of lower frond from the treated palm was cut into small bits of size five cm and placed in a plastic vial. Twenty third instar larvae of *O. arenosella* were released into the plastic vial in three replications under laboratory condition. One leaflet from an untreated palm was cut into small bits (5 cm length) and released 20 third instar larvae of *O. arenosella* into a plastic vial in three replications which served as an untreated control. Larval mortality was recorded after 24 hours, three and seven days of release. The feed was changed at every two day interval with treated leaves which were stored in refrigerator on first day of collection. *i.e.*, seventh and 14th day after root feeding.

Field evaluation of selected insecticides against O. arenosella : To evaluate the selected newer chemicals under field condition, experiment was carried out at an infested garden in Chikkapattanagere village of Kadur taluk (Chikkamagaluru district) during February 2015. The garden was 15 year old with a height of 8 to 10 m. The garden had high level of infestation with early to medium instar larvae. One day before chemical treatment, pre-treatment assessment of the population of live larvae was done by sampling and examining 20 leaflets from each palm, including the control. All selected ten treatments including monocrotophos as check and untreated palms as control was designed in randomized black with three replications.

Three palms were selected for each treatment, considering each palm as one replicate. From each palm, a mature functional root which is brick red in colour and pencil thick was selected. This root was slantingly cut at one stroke. 10 ml of chemical with equal quantity of water was filled in a small polythene bag (250 gauge; 7.5 × 5 cm). After ensuring that the cut end was not damaged it was inserted into the polythene bag containing the insecticide and the open end of the bag was secured to the root by a thread. Observation was made on the absorption of chemical up to 48 hours after the treatment. If, in any of the tree, the chemical remained unabsorbed, one more root was selected and fed with the chemical. The treatments were imposed on infested palms having early to medium staged larvae. Post treatment observation was taken in three, seven, 14 and 21 days after treatment. Here both laboratory reared F_1 populations were used to compare the mortality. All the collected data were subjected to statistical analysis by ANOVA. When statistical differences were existed within a data set, DMRT was used to separate the means. The details of chemicals and layout of the treatment was given in the Table 1.

RESULTS AND DISCUSSION

Efficacy of insecticides against O. arenosella under laboratory condition after seven days of root feeding : After seven days of root feeding, leaflets were collected from the treated palms and larvae were fed with these leaflets. Observation was made after 24 h, 3 days and seven days later.

24 hours after treated leaflet feeding : The first observation taken after 24 hours of feeding the chemicals treated leaflets to 3rd to 4th instar larvae of *O. arenosella* showed the significant difference among the treatments (Table 1). This indicates that plant roots successfully absorbed all the chemicals tested. Among the different chemical, monocrotophos 36% SL recorded maximum mortality (46.65%), followed by neemazal 1% (45%). In case of bifenthrin 10% EC, emamectin benzoate 5% SG and acephate 75% SP treated leaflets, the mortality count was 40 per cent, 35 per cent and 30 per cent, respectively. The lower larval mortality was observed in acetamaprid 20% SP, fipronil 5% SC and imidacloprid 17.8% SL, and these were on par with each other. No larval mortality was observed 24 hours after feeding on leaflets collected from untreated palms (Table 2).

Three days after treated leaflet feeding : Imidacloprid 17.8% SL (76.65%) and bifenthrin (76.65%) recorded maximum mortality in the larval population of *O. arenosella* and these were on par with each other after 3 days of feeding. Monocrotophos 36% SL (73.35%) was on par with the imidacloprid 17.8% SL (76.65%), bifenthrin 10% EC (76.65%) and neemazal 1% (70%). The chemicals emamectin benzoate 5% SG and acephate 75% SP were

Table 1. Treatment details and layout of the treatment.

Treatment	Common name	Trade name	Label on chemical	Dosage
T_1	Monocrotophos 36% SL	Monocrown	Red	1:1 (10 ml in 10 ml of water)
T_2	Neemazal 1%	Neemal	Green	1:1 (10 ml in 10 ml of water)
T_3	Acephate 75% SP	Tremor	Blue	1:1 (10 gm in 10 ml of water)
T_4	Acetamaprid 20% SP	Nize	Yellow	1:1 (10 gm in 10 ml of water)
T_5	Bifenthrin 10% EC	Spine	Yellow	1:1 (10 ml in 10 ml of water)
T_6	Chlorantraniliprole 18.5% SC	Coragen	Green	1:1 (10 ml in 10 ml of water)
T_7	Emamectin benzoate 5% SG	Missile	Yellow	1:1 (10 gm in 10 ml of water)
T_8	Fipronil 5% SC	Regent	Yellow	1:1 (10 ml in 10 ml of water)
T_9	Imidacloprid 17.8% SL	Confidor	Yellow	1:1 (10 ml in 10 ml of water)
T_{10}	Untreated control			

Table 2. Per cent mortality of *O. arenosella* larvae in lab condition after seven days of root feeding.

Treatments	Per cent mortality of larvae of *O. arenosella* in lab condition		
	24 Hour after feeding	3 Days after feeding	7 Days after feeding
Monocrotophos 36% SL	46.65 (42.70)[a]	73.35 (58.69)[b]	100.00 (90)[a]
Neemazal 1%	45.00 (42.13)[b]	70.00 (56.78)[c]	98.30 (81.86)[b]
Acephate 75% SP	30.00 (33.21)[e]	56.65 (48.44)[d]	95.00 (77.07)[c]
Acetamaprid 20% SP	5.00 (12.92)[g]	18.35 (25.10)[g]	35.00 (36.27)[de]
Bifenthrin 10% EC	40.00 (39.23)[c]	76.65 (60.66)[a]	98.35 (81.86)[b]
Chlorantraniliprole 18.5% SC	10.00 (18.43[f]	25.00 (30)[e]	36.65 (36.86)[d]
Emamectin benzoate 5% SG	35.00 (36.27)[d]	56.65 (48.44)[d]	96.60 (78.46)[c]
Fipronil 5% SC	5.00 (12.92)[g]	20.00 (26.56)[f]	33.35 (35.06)[e]
Imidacloprid 17.8% SL	5.00 (12.92)[g]	76.65 (60.66)[a]	96.65 (78.46)[c]
Control	00.00 (1.43)[h]	11.65 (19.36)[h]	21.65 (27.27)[f]
F test	*	*	*
SEm±	0.11	0.28	0.33
CD at 5%	0.31	0.82	0.98
CV%	4.03	4.98	4.06

Mean denoted by the same letters on each column are not statistically different by (p=0.05) DMRT
Figures in parenthesis are values for arc sin transformed values from the mean; * = Significant at 5%

recorded 56.65% larval mortality and both were on par with each other. Lower mortality was observed in chlorantraniliprole 18.5% SC (25%) followed by fipronil 5% SC (20%), acetamaprid 20% SP (18.35) and these chemicals were on par with each other (Table 2).

Seven days after treated leaflet feeding : Monocrotophos 36% SL recorded 100% larval mortality in *O. arenosella* larvae other chemicals *viz.*, neemazal (98.35%), acephate 75% SP (95%), bifenthrin (98.35%), emamectin benzoate 5% SG (96.6%) and imidacloprid 17.8% SL (96.65%) were also recorded highest mortality in larval population after seven days of feeding and these chemicals were on par with monocrotophos. Lesser mortality was observed in acetamaprid 20% SP (35%) and fipronil 5% SC (33.35%) treated leaflets and these chemicals were on par with each other (Table 2).

Efficacy of insecticides against O. arenosella under laboratory condition after fourteen days of root feeding : After 14 days of root feeding, leaflets were again collected from the treated palms and larvae were fed with these leaflets. Observation was made after 24 h, three days and seven days later.

24 hours after treated leaflet feeding : Significant difference in the mortality of larval population was observed among the treatments. Among the chemicals, monocrotophos 36% SL recorded maximum larval mortality (48.35%) followed by bifenthrin 10% EC (45%). Other chemicals *viz.*, neemazal 1% and imidacloprid 17.8% SL recorded 40 per cent larval mortality and these were on par with each other. Another chemical emamectin benzoate 5% SG was recorded mortality of 36.65 per cent after 24 hours of feeding the chemical treated leaflets. Minimum larval mortality was recorded in acephate 75% SP treated leaflets (20%) and acetamaprid 20% SP, chlorantraniliprole 18.5% SC and fipronil 5% SC (15%) (Table 3).

Three days after treated leaflet feeding : The maximum mortality was noticed in bifenthrin 5% treated leaflets (88.35%) followed by monocrotophos 36% SL (83.35%) and imidacloprid 17.8% SL (76.65%). The chemicals emamectin benzoate 5% SG (71.65%) and neemazal (71.65%) were on par with each other after 3 days of feeding. Minimum mortality was observed in acephate 75% SP (30%), acetamaprid (25%) and chlorantraniliprole 18.5% SC (20%) which were on par with the control. fipronil 5% SC (23.35%) was on par with acetamaprid 20% SP (Table 3).

Seven days after treated leaflet feeding : The maximum larval mortality was noticed in monocrotophos 36% SL, neemazal 1%, bifenthrin 10% EC, emamectin benzoate 5% SG and imidocloprid 17.8% SL showed significant laraval mortality and these all chemicals were on par with each other. Minimum larval mortality was noticed in acephate 75% SP (41.65%) and acetamaprid 20% SP (35%). Least larval mortality was observed in chlorantraniliprole 18.5% SC, (31.65%), which was on par with the control (28.35%) (Table 3).

Efficacy of selected insecticides against O. arenosella under field condition

Pre-treatment population count : The difference in the pretreatment counts of *O. arenosella* exposed to different treatments were statistically non significant. The average number of 16.16 larvae per 20 infested leaflets was noticed (Table 4).

Three Days after treatment : Highest reduction in the larval population of *O. arenosella* was recorded in monocrotophos 36% SL (54.33%). After three days of treatment with neemazal 1%, acephate 75% SP, acetamaprid 20% SP, imidacloprid 17.8% SL and bifenthrin 10% EC reduced the larval population to the extent of, 29.26, 17.47, 14.25, 11.95 and 10.33 per cent, respectively. The chemicals chlorantraniliprole

Table 3. Per cent mortality of *O. arenosella* larvae in lab condition after 14 days of root feeding.

Treatments	Per cent mortality of larvae of *O. arenosella* in lab condition		
	24 Hour after feeding	3 Days after feeding	7 Days after feeding
Monocrotophos 36% SL	48.35 (43.85)[a]	83.35 (65.64)[b]	100 (90.00)[a]
Neemazal 1%	40.00 (39.23)[c]	71.65 (57.41)[d]	100 (90.00)[a]
Acephate 75% SP	20.00 (26.56)[e]	30.00 (33.21)[e]	41.65 (39.81)[c]
Acetamaprid 20% SP	15.00 (22.78)[f]	25.00 (30.00)[f]	35.00 (36.27)[d]
Bifenthrin 10% EC	45.00 (42.13)[b]	88.35 (69.73)[a]	98.35 (81.86)[b]
Chlorantraniliprole 18.5% SC	15.00 (22.78)[f]	20.00 (26.56)[h]	31.65 (33.83)[e]
Emamectin benzoate 5% SG	36.65 (36.86)[d]	71.65 (57.41)[d]	100.00 (90.00)[a]
Fipronil 5% SC	15.00 (22.78)[f]	23.35 (28.65)[g]	30.00 (33.21)[e]
Imidacloprid 17.8% SL	40.00 (39.23)[c]	76.65 (60.66)[c]	98.35 (81.86)[b]
Control	5.00 (12.92)[g]	18.35 (25.10)[i]	28.35 (28.35)[f]
F test	*	*	*
SEm±	0.15	0.28	0.24
CD at 5%	0.44	0.82	0.70
CV%	4.61	4.75	3.08

Mean denoted by the same letters on each column are not statistically different by (p=0.05) DMRT.
Figures in parenthesis are values for arc sin transformed values from the mean; * = Significant at 5%; # = Mean number of larvae from three palms

18.5% SC (6.25%), emamectin benzoate % SG (4.27%) and fipronil (1.8%) were on par with the untreated control (Table 4).

Seven Days after treatment : Among the chemicals tested, neemazal 1% (65.83%) was found to be effective in reducing larval population followed by monocrotophos 36% SL (65.23%), emamectin benzoate 5% SG (57.43%), bifenthrin 10% EC (53.44%) and imidacloprid 17.8% SL (49.26%). Among these chemicals neemazal 1% and emamectin benzoate 5% SG were on par with each other. There was no significant difference between chemicals were observed in reduction of larval population, fipronil 5% SC (14.56%), chlorantraniliprole 18.5% SC (14.56%), acetamaprid 20% SP (24.97%) and acephate 75% SP (30%). These chemicals were on par with the untreated control (10.91%) (Table 4).

14 Days after treatment : Maximum larval mortality was observed in neemazal 1% (97.51% larvae), followed by imidacloprid 17.8% SL (80.60%), emamectin benzoate 5% SG (80.25%), monocrotophos 36% SL (76.18%) and bifenthrin 10% EC (75.59%). Among these chemicals, monocrotophos and emamectin benzoate 5% SG were on par with each other. Least larval mortality was observed in chlorantraniliprole 18.5% SC (12.5%), fipronil 5% SC (20.02%), acetamaprid 20% SP (28.61%) and acephate 75% SP (47.48%). These chemicals were on par with the control (12.7%) (Table 4).

21 Days after treatment : The chemicals monocrotophos 36% SL, neemazal 1%, bifenthrin 10% EC, emamectin benzoate 5% SG and imidacloprid 17.8% SL recorded highest larval mortality on population of *O. arenosella.* All these chemicals are on par with each other. Lower mortality rate were noticed in acephate 75% SP (62.49%), acetamaprid 20% SP (50.05%), chlorantraniliprole 18.5% SC (25%) and fipronil 5% SC (34.53%) and these chemicals were on par with untreated control (18.16%) (Table 4).

The study clearly indicated that, monocrotophos 36 SL (100%), neemazal 1% (100%), emamectin benzoate (100%), bifenthrin10%EC (98.35%) and imidacloprid 17.8 SL (98.35%) recorded had higher mortality of larval population of *O. arenosella* as compared to untreated control (28.35%). These chemicals were successfully absorbed by palms and caused mortality of larvae. Similar trend was observed between lab reared and field collected population with respect to mortality. This is encouraging and may provide a basis for identification for alternate chemical to monocrotophos.

Table 4. Per cent mortality of larval population of *O. arenosella* in field condition through root feeding method.

Treatments	Pre count#	Per cent mortality of larvae of *O. arenosella* in field condition			
		3 DAT	7 DAT	14 DAT	21 DAT
Monocrotophos 36% SL	15.33 (3.92)	54.33 (47.29)^{a}	65.23 (53.72)^{a}	76.12 (60.66)^{c}	100.00 (90.00)^{a}
Neemazal 1%	13.67 (3.70)	29.26 (32.58)^{b}	65.83 (53.70)^{a}	97.51 (80.02)^{a}	100.00 (90.00)^{a}
Acephate 75% SP	13.33 (3.65)	17.47 (24.35)^{c}	30.00 (33.21)^{e}	47.48 (43.28)^{d}	62.49 (51.94)^{c}
Acetamaprid 20% SP	9.33 (3.06)	14.25 (21.97)^{d}	24.97 (29.33)^{f}	28.61 (31.94)^{e}	50.05 (45.00)^{d}
Bifenthrin 10% EC	19.33 (4.40)	10.33 (18.43)^{f}	53.44 (46.71)^{c}	75.59 (60.00)^{c}	100.00 (90.00)^{a}
Chlorantraniliprole 18.5% SC	16.00 (4.00)	6.25 (14.17)^{g}	14.56 (21.97)^{g}	12.50 (20.26)^{g}	25.00 (30.00)^{f}
Emamectin benzoate 5% SG	15.67 (3.96)	4.25 (11.53)^{h}	57.43 (49.02)^{b}	80.25 (63.43)^{b}	97.83 (80.02)^{b}
Fipronil 5% SC	18.33 (4.28)	1.80 (7.71)^{i}	14.56 (21.97)^{g}	20.02 (26.56)^{f}	34.53 (36.66)^{e}
Imidacloprid 17.8% SL	22.33 (4.73)	11.95 (19.36)^{e}	49.26 (44.42)^{d}	80.60 (63.43)^{b}	97.04 (80.02)^{b}
Control	18.33 (4.28)	0.00 (1.43)^{j}	10.91 (18.43)^{h}	12.71 (20.26)^{g}	18.16 (25.10)^{g}
F test	NS	*	*	*	*
SEm±	1.33	0.23	0.57	0.61	0.94
CD at 5%	3.92	0.69	1.69	1.80	2.761
CV%	15.68	17.81	15.69	11.96	15.50

Mean denoted by the same letters on each column are not statistically different by (p=0.05) DMRT.

Figures in parenthesis are values for arc sin transformed values from the mean; NS = Non significant; * = significant at 5%; DAT = Days after treatment; # = Mean number of larvae from three palms

The result was similar with the findings of Rao *et al.* (2004), who evaluated new systemic insecticides (imidacloprid, fipronil, azadirachtin and acephate) as an alternative to monocrotophos (at 10 and 20 ml). Similarly, Patalappa (1988) reported feeding monocrotophos in a plastic tube with a capacity of 30 ml at various dilutions into the roots of infested palms found effective in controlling the larvae of the *O. arenosella*. Literature survey also suggested that the monocrotophos has shown resistance against coconut black headed caterpillar (Muralimohan *et al,* 2007). Muralimohan *et al,* (2013) also reported that gardens which were treated with monocrotophos and azardirachtin 5% remains pest free for a long time and also emphasized that the intervention will be effective if the population is removed much earlier in the generation. Chemicals are the best measures to control this pest but they are effective only on immature stages. If management is targeted based on the stage of the insect, the pest can be eradicated from the gardens within a year. Other management practices like light trap collection of adults, usage of sex pheromone, exploitation of parasitoids in larval and pupal stages are effective in field conditions (Srinivasa and Muralimohan, 2009). These strategies can be included in integrated management practices. However, in this experiment, monocrotophos was the best chemical in both laboratory as well as in field conditions against coconut black headed caterpillar. Other than monocrotophos, bifenthrin 10% EC, imidacloprid 17.8% SL, neemazal 1%, and emamectin benzoate 5% SG were also equally effective.

As the growers are solely depending on monocrotophos for the management of this pest, the present study helped in the identification of alternate chemicals to manage *O. arenosella*.

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