TESTING OF GARLIC BASED BIO-PESTICIDE ON INSECT PESTS OF COCONUT (*COCUS NUCIFERA* L.)

A REPORT
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Introduction:

In recent days organic farming plays an important role in getting quality food, since people are health conscious and many times asking for organic tender coconut and organic copra. Coconut (*Cocus nucifera* L.) is one of the important plantation crops cultivated across 19.5 lakh ha in India with a production of 14811 lakh nuts with an average of 7608 nuts. In Southern India, every house uses coconut almost every day for one or the other purpose. In addition to use of nuts for food and in temples for spiritual customs and ceremonies, in many parts of the world coconut oil is used as food, bio-fuel and lubricant. While it is one of the important commercial crops in India, it is the most important crop in the world. Keeping this in background the following objectives were framed to upate the pest management practices through suppressing the pests by bio-pesticides (Muralimohan, *et al.,*2008).

In Karnataka ,this palm which is called Kalpavruksh, accounts for more than 18 percent of area in India, is predominantly grown in three agro-systems- hill and mountain (Districts of Hassan, Tumkur, South Chitradurga, Shimoga and Chikmagalur), Coastal (Mangalore, North Karnataka) and plains (Mysore, Mandya, Bangalore rural, Kolar). The menace of coconut black headed hairy caterpillar, *Opisina arenosella* Walker (Lepidoptera: Oecophoridae) cause severe problem by feeding and scarping the lower epidermis of the leaflets. Leaves turn brown and appear scorched. *Opisina arenosella* is widely distributed in regions of India, Sri Lanka, Burma and Bangladesh. This pest affects the growth and yield of coconut palm (Thippeswamy, *et al.,* 2008).

Garlic Biopesticides

Garlic, *Allium sativum* Linn. evolved as a wild plant in Asia thousands of years ago is now cultivated all over the world and is widely used as a spice and as a food. The medicinal properties of garlic were recognized atleast 5000 years ago and it was used

specifically in the treatment of heart diseases by the East-Indians and Egyptians of 1500 BC.

Intact garlic cloves contains about 0.2-0.3% allilin, most of which is converted to allicin when garlic is crushed. When garlic is homogenized in water, the major chemical component is allicin. A methanol or ethanol extract of crushed cloves or powder removes all the allicin. If the solvent is evaporated and solute emulsified in water, the result can be a more potent insecticide, fungicide and bactericide than obtained with water only.

The insecticidal and fungicidal properties are partly due to enzyme inhibition. Isolation and characterization of larvicidal principle of garlic, *A. sativum* have been identified as Diallyl di-sulphide and Diallyl tri-sulphide (Narayanan, 1954). Both natural and synthetic samples of these compounds are fatal at 5 parts per million to *Culex pipiens quinquefasciatus* say. Extracts of garlic have proved effective against *Alternaria* spp, powdery mildew, black spot, *Phytopthora, Fusarium* spp and bacterial pathogen like *Pseudomonas* (Ghosh and Abdurahiman, 1985).

The extracts have proved effective against nematodes, mosquitoes, psyllids, lepidopterans and coleopterans larvae, whitefly, aphids, thrips, mites and stored grain pests. The National Research Centre for Onion and Garlic, Pune, Maharashtra is conducting research on this pesticide.

MATERIAL AND METHODS:

A coconut farm of Tiptur tall 20 years old at Kangovi farm,Kukunahalli village, Dasanapura hobli, Golahalli post, Bangalore Rural was selected for the study. The palm was planted at 30x30 ft row to row and 10x10 ft palm to palm in a row and all the fertilizers as per the recommended dose are being adopted. Irrigation facilities are available and FYM is applied @ 2 baskets per palm per year. The average nut yields of 40, 66, 68 and 42 nuts per palm during the years 2005-06, 2006-07, 2007-08 and 2008-09 were harvested, respectively and on an average @ 48 nuts per palm per year was harvested.

Treatments

1. 5% Azadirachtin- a) 7.5 ml+7.5 ml water
   b) 10.0 ml+ 10.0 ml water
2. GB+ a) 7.5ml+7.5 ml water

b) 10.0 ml+10.0 ml water

3. Monocrotopos (36 EC) a) 7.5ml+7.5 ml water

b) 10.0 ml+10.0 ml water

4. Control: Untreated

Observations:

The whole farm of 4 acres was affected by black headed caterpillar (BHC) severely. Infested coconut palms were randomly selected in the farm. Each treatment was applied to 10 palms. Twenty infested leaflets per palm showing approximately 50 per cent damage were collected at random, from all over the infested fronds (2-3 infested fronds). Random sampling indicated that to-date brown turned fronds had a few larvae and pupae of BHC .Green leaflets with few brown spots had 2^{nd} or 3^{rd} instar larvae generally and leaflets were selected for observations. Simultaneously observations were also recorded in Nittoor and Bellahally.

Each set of 20 infested leaflets were placed in separate polythene bags marked and brought to the laboratory. They were examined under a stereo binocular microscope for different stages of pests, *viz.,* eggs, stages I(1-3 instars),Stage II larvae (4-6 instars) and stage III larvae (7-8 instars) and pupae and its natural enemies. The parasitoid larvae were counted separately and maintained individually in plastic vials (dia.1.5x7.5 cm) for emergence of parasitoids. Due to the practical constraint of separating each instar, they were grouped into stage I (1-3 instars) (<4.0 mm), Stage II larvae (4-6 instars) (4-11 mm) and stage III larvae (7-8 instars) (>11 mm). The root feeding of all the treatments has taken up twice at 20 days intervals. The observations on number of BHC infested fronds per palm, number of larvae and natural enemies per leaflet at 10 days intervals were recorded .The number of surviving black headed caterpillars larvae and pupae were counted before and after each treatment and at 10 days intervals from two randomly selected fronds. All leaflets in the fronds were examined for the surviving larvae and pupae. Natural enemies were also counted. The BHC larvae were counted from Nittoor, Gubbi taluka, Tumkur district and from Bellahally, Nagamangala taluka, Mandya district. They were brought to the laboratory and starved for six hours before implanting onto the

leaflets to be treated from the Kangovi farm, Kukunahalli village, Dasanapura hobli, Golahalli post, Bangalore Rural. Larval mortality was recorded at 0,5,10 and 20 DAT intervals with each treatment replicated 10 times. The data were subjected to the statistical analyses.

Results and Discussion:

The coconut palms in the Kangovi farm were infested with BHC, mite and the rhinoceros beetle. The major pest, however, was the BHC and the treatments were aimed at suppressing BHC infestation. So the palms infested with BHC alone were selected for the study. Coconut palms in the Kangovi farm were severely affected by BHC and observations and examination showed that all stages of the insect pest were found in the farm. Observations during August 3rd and 4th weeks indicated that on an average, 4.10 I and II instars larvae/infested frond in Kangovi farm, 5.24 I and II instars larvae /infested frond in Nittoor and 5.00 I and II instars larvae /infested frond in Bellahally. During first fortnight of September there was very marginal increase in the number of larvae in all the three locations. The numbers of larvae showed a slight decreasing trend in the II fortnight of September. The declining trend continued in October. During IInd fortnight of October, at Kangovi farm, on an average 2.80 larvae of I and II instars /infested frond were recorded. The corresponding numbers in Nittoor and Bellahally were 3.00 and 2.70, respectively. The number of pupae of BHC showed a similar trend. At Kangovi farm, the number of pupae/infested frond varied from 0 to 3 in II fortnight of September and in Nittoor and Bellahally the number of pupae varied from 0 to 2, respectively. No attempt was made to detect the number of eggs of BHC per leaflet at all the three locations. The insect showed development from early instar larvae to late instar larvae and pupae. Larval parasitoids were detected at all the locations. Laboratory observations indicated that the larval parasitization increased from August to October. In Kangovi farm, the per cent larval parasitization varied from 0 to 3, in Nittoor, it varied from 0 to 2.5 and in Bellahally, it varied from 0 to 4.80, respectively. The three parasitoids identified were *Xanthopimpla* species (pupal parasitiod), *Bracon brevicornis* and *Goniozus nephantidis*.

The data of the survey of BHC at three locations is presented in Table 1. The data showed that the BHC infestation was present at all the three locations in addition to their

natural enemies. The data on infested fronds is presented in Table 2. The data showed that GB+ treated palms showed a decreasing trend in the proportion of infested fronds, much earlier than compared to control.

Table 1.Number of larvae, pupae and natural enemies of Black headed hairy caterpillar at three locations*

	Insect life stages**		**Natural enemies****	
Date	**Larvae**	**Pupae**	**Parasitoids**	**Predators**
15.08.2009	06	04	03	04
30.08.2009	10	04	05	00
15.09.2009	08	02	04	01
30.09.2009	12	04	03	05
15.10.2009	10	04	03	04
30.10.2009	08	06	04	06

** Mean number of larvae, pupae, parasitoids *Bracon brevicornis,Goniozus nephantidis*, *Xanthopipmpla* spp. and predators carabid beetle /5 fronds/palm were also found, but not identified.* Figures in table indicate mean values of 3 locations

Table 2. Mean number of infested fronds to the healthy fronds due to damage of the Black headed caterpillar in Kangovi farm

Treatment	Dosage	Dates of observations			
		22.08.2009	**28.08.2009**	**14.09.2009**	**10.10.2009**
5% Azadirachtin	7.5 ml+7.5 ml water	21.00 (70.00%)	11.80(39.33%)	9.00(30.00%)	7.86(26.20%)
5% Azadirachtin	10.0 ml+ 10.0 ml water	17.50(58.33%)	10.56(35.20%)	8.88(29.60%)	6.95(23.16%)
GB+	7.5ml+7.5 ml water	19.00(63.33%)	12.36(41.20%)	10.15(33.83%)	8.05(26.83%)
GB+	10.0 ml+10.0 ml water	17.00(56.66%)	11.00(30.00%)	8.58(21.93%)	4.53(15.10%)
Monocrotopos (36 EC)	7.5ml+7.5 ml water	20.50(68.33%)	13.60(45.33%)	7.69(25.63%)	5.96(19.86%)
Monocrotopos (36 EC)	10.0 ml+10.0 ml water	22.50(75.00%)	13.00(43.33%)	6.45(21.50%)	5.11(17.03%)
Control	-	19.50(65.00%)	22.50(75.00%)	23.50(76.53%)	21.00(75.33%)

*Mean of ten palms/treatment

Various treatments viz., 5% Azadirachtin @ 7.5 ml+7.5 ml water, 5% Azadirachtin @ 10.0 ml+ 10.0 ml water, GB+ @ 7.5 ml+7.5 ml water, GB+@ 10.0 ml+ 10.0 ml water, Monocrotopos (36 EC) @ 7.5 ml+7.5 ml water, Monocrotopos (36 EC) @ 10.0 ml+ 10.0 ml water and Control were evaluated for their efficacy in the management of *O. arenosella* through root feeding (Table 3).

Chemicals were also treated through root feeding to coconut palms. Pre-treatment population counts were on par (3.59 to 7.84 larvae /infested frond) with each other. Ten days after imposing treatment, monocrotophos and Azadirachtin were on par and recorded the least larval count of 1.76 and 3.24 per infested frond compared to 6.41 larvae per infested frond in control. The population counts made on the 20 DAT revealed that Monocrotophos and Azadirachtin continued to be effective in reducing larval count (0.46 and 1.54 larvae/infested frond).

Neem based formulations were found to be effective on the black headed caterpillars. Srinivasa Murthy *et al.* (1994) were the first to evaluate neem based commercial insecticides against *O. arenosella*. The above authors conducted bio-assay for different neem formulations and showed that Neemox at 10 and 20 ml per palm was as effective at 20 days after treatment. Soluneem, in aqueous solution, showed significant reduction in the populations of *O.arenosella* (Shivashankar *et al.,* 2000).

Table 3. Effect of various treatments on larval numbers of Black headed caterpillar, when treated through root feeding

Treatment	Dosage	Number of larvae/infested leaflet		
		Pre-treatment	Post treatment	
			10 DAT	20 DAT
5% Azadirachtin	7.5 ml+7.5 ml water	5.81 (2.60)	3.45 $(1.83)^{ab}$	1.04 $(1.25)^{ab}$
5% Azadirachtin	10.0 ml+ 10.0 ml water	3.79 (2.40)	4.00 $(2.06)^{bc}$	2.10 $(1.79)^{bc}$
GB+	7.5 ml+7.5 ml water	4.44 (2.38)	4.16 $(2.11)^{bc}$	2.52 $(1.93)^{c}$
GB+	10.0 ml+ 10.0 ml water	4.20 (2.27)	3.92 $(2.49)^{c}$	2.07 $(1.83)^{bc}$
Monocrotopos (36 EC)	7.5 ml+7.5 ml water	4.08 (2.30)	5.00 $(2.40)^{bc}$	2.50 $(1.98)^{c}$
Monocrotopos (36 EC)	10.0 ml+ 10.0 ml water	4.88 (2.01)	1.36 $(1.39)^{a}$	0.66 $(0.97)^{a}$
Control	-	5.40 (2.27)	6.14 $(2.54)^{c}$	5.55 $(2.39)^{c}$
F-test		NS	*	*

Means followed by the same letters in column are not statistically significant NS: Non Significant;* Significant (p=0.05); DAT: Days after treatment, 1DAT= no mortality of larvae

The effective concentration of 5% Azadirachtin, GB+, Monocrotophos and control in coconut palms were estimated in the laboratory using bioassays with fourth and fifth instar larvae of *O .arenosella* which were collected from the field. Uniform sized larvae of BHC were selected for the bio assay. The larvae were starved for 6 hrs before implanting on the treated leaflets. The effect of these treatments was studied at 0, 5, 10, 20 days after treatment (Table 4).

On the day of treatment or 0^{th} day of chemical administration to the palms there were no significant differences between treatments with respect to mortality of 5^{th} instar larvae as on 0 DAEP (Days After Exposure Period=5 days of feeding on treated leaflets),when fed on leaflets collected from the field. The per cent larval mortality among treatments were statistically on par with each other. The leaf lets which were treated with GB + (10 ml) showed increasing mortality of larvae from 29.77 % to 69.67%. In monocrotophos (10 ml) and 5% Azadirachtin (10 ml) the corresponding figures were 26.17 to 52.22 % and 25.67 to 100 %,respectively. However the GB+ treated leaflets would support natural enemies of BHC and other major pests on coconut. In contrast Monocrotophos treated leaflets would cause mortality of natural enemies of BHC and other pests, it has high mammalian toxicity and is lethal to eggs of bird especially. So Monocrotophos has been banned in developed countries. When compared to Azadirachtin, GB+ was superior in causing mortality of larvae and is cheaper than Azadirachtin. So, GB+ is recommended for control of BHC on coconut through root feeding @10 ml+10ml water/palm. GB+ is Rs.1500/litre compared to Azadirachtin which is Rs.2000/liter.

Table 4. Efficacy of treatments against fourth and fifth instar larvae of Black headed caterpillar when fed on leaves 10-20 days after treatment to the palms in field

Treatment	Dosage	Larval mortality (%)			
		0 DAT	5 DAT	10 DAT	20 DAT
5% Ozoneem	7.5 ml+7.5 ml water	28.78 (30.99)	63.33 (62.14)^{bc}	57.78 (62.25)^{bc}	46.67 (49.22)^{bcd}
5% Ozoneem	10.0 ml+ 10.0 ml water	26.17 (30.67)	84.44 (81.59)^{ab}	70.00 (74.81)^{ab}	52.22 (23.03)^{e}
GB+	7.5 ml+7.5 ml water	38.34 (34.93)	86.67 (68.86)^{bc}	89.33 (66.14)^{b}	60.11 (57.78)^{b}
GB+	10.0 ml+ 10.0 ml water	26.77 (23.86)	50.01 (50.85)^{d}	63.33 (46.92)^{d}	69.67 (54.78)^{bc}
Monocrotopos (36 EC)	7.5 ml+7.5 ml water	28.67 (19.93)	70.33 (59.71)^{cd}	59.11 (50.85)^{cd}	43.33 (35.22)^{cde}
Monocrotopos (36 EC)	10.0 ml+ 10.0 ml water	25.67 (30.79)	96.00 (83.47)^{a}	93.30 (80.76)^{a}	100 (89.43)^{a}
Control	-	22.00 (26.57)	26.67 (30.99)^{e}	29.23 (33.00)^{e}	31.67 (30.99)^{de}
F- test		NS	*	*	*
S Em ±		4.06	5.36	6.79	7.78
CD (p=0.05)		12.85	13.37	14.88	19.10

Figures in the parentheses are Arcsine √ Percentage transformed values

Means followed by the same letters in column are not statistically significant
NS: Non significant;*: Significant (p=0.05); DAT; Days after treatment
Coconut palms of 4-6 meter height were used for root feeding

ACKNOWLEDGEMENT

The investigator is thankful to The Director of Research, UAS, GKVK, Bangalore**,** VERAEXIM private limited Bangalore, coconut growers of Tiptur tall 20 years old at Kangovi farm,Kukunahalli village, Dasanapura hobli, Golahalli post, Bangalore Rural and Mr.Naga Chaitanya, B for encouragement and help at various stages of this investigation.

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Coconut garden severely affected by Black Headed Caterpillar

A count on life stages of Black Headed caterpillar and Natural Enemies

Root feeding

Response of larvae of Black Headed Caterpillar to treated coconut leaves in the laboratory

Larvae of Black Headed Caterpillar and damage symptoms

Pupae and pupal cases of Black Headed Caterpillar

Adult Black Headed Caterpillar

Damage symptoms of Black Headed Caterpillar