The Bioscan 9(1): 341-346, 2014 (Supplement on Plant Pathology)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

STUDIES ON EFFICACY OF NEEM BIO-PESTICIDES AGAINST ERIOPHYID MITE (*ACERIA GUERRERONIS* KEIFER.)

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KEYWORDS
Neem bio-pesticide
Eriophyid mite
Aceria guerreronis K.

Received on :
05.01.2014

Accepted on :
10.03.2014

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ABSTRACT
The present study investigated efficiency of neem bio-pesticides *viz*. neem garlic extract and neemazal on coconut mite (*Aceria guerreronis* Keifer.). The first application of treatments indicated that the treatment [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 23.43 and 38.07 per cent reduction in mites over control after seven and fourteen days after application of treatments during 2006- 07 and 2007- 08, respectively. For the same period of time the second application of treatments resulted that the [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 54.34 and 59.26 per cent reduction in mites over control after seven and fourteen days after application of treatments, respectively. The treatment T5 [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 59.88 and 60.19 per cent reduction in mites over control after seven and fourteen days after third application of treatments, respectively. Finally as considers overall experimental data its revealed that treatment which comprises spraying and root feeding of Neemazal 5 % (T5) found most effective followed by treatment T4 [Neemazal 1% (Spray) + Neemazal 5% (Root feeding)], T8 [Neemazal 5% (Spray)] and T3 [Neemazal 1% (Spray) + Neemazal 1% (Root feeding)] in management of eriophyid mite population.

INTRODUCTION

Coconut is grown in more than 93 countries on a total area of 12.5 million ha producing 5562 million nuts annually. India, Indonesia, Philipines and Srilanka are the four major producers contributing about 78 per cent of total world's production (Anonymous, 2004; Mathew, 2004).

In India, eriophyid mite (*Aceria guerreronis* K.) was first reported in 1998 in Ambalour panchayat, Ernakulum district of Kerala (Sathiamma *et al*., 1998; Haq, 1999) and Sri Lanka (Fernando *et al*., 2002), at the end of the 1990´s. The feeding of mite causes scarring of growing nuts resulting in nut malformation and reduced copra yield (Moore *et al*., 1989 Ramaraju *et al*., 2002; Ranjith, 2003). Heavy damage, result in the loss of quality and quantity of coconut (Ramaraju *et al*., 2000; Negloh *et al*., 2011; Lekeshmanaswamy and Prathipa, 2014). Recently a new mite *Aceria amrini* n. sp. was collected from *Tamarix aphylla* (Tamaraceae), from India (Joshi *et al*., 2013).

In the recent past, the pest has spread rapidly to all coconut growing stages of India (Gopal and Gupta, 2001; Vidyasagar, 2000; Reddy and Naik, 2000; Muthiah, 2007). Since it is difficult to spray the chemicals in taller trees, root feeding of water per tree is suggested (Ramaraju *et al*., 2002). Fernando *et al*. (2002) reported that spraying of neem oil in combination with garlic (2%) mixture and Neemazal (1%) recorded 60 per cent reduction of eriophyid mite population. Ramarethinam *et al*. (2000) suggested that the usage of nimbecidine in combination with one or more entomopathogenic fungi like *Hirsutella thompsonii*, *Verticillium lecanii* (Zimmeran) *vieges* and *Paecilomyces* sp. in 200 litres of water was found better for mite control in coconut. The spraying of TNAU neem oil or TNAU-Agro biocide and TNAU neem oil at monthly intervals recorded satisfactory control of the eriophyid mite (Kannaiyan *et al.,* 2000; Ramaraju *et al.,* 1999 and 2000).

The biocide, neem oil and garlic (2%) mixture was found to be effective in reducing the mite population and nut damage (Nair *et al*., 2003; Saradamma *et al.,* 2000). Spaying of Azadirachtin, NSKE , Econeem and neem oil or root feeding with the same chemical can be recommened as one of the steps of IPM for the ecofriendly management of coconut eriophyid mite (Saradamma *et al.,* 2000; Muralidharan *et al.,* 2001; Kannaiyan *et al.,* 2002; Thirumali *et al*. 2003; Sujata *et al*., 2005; Girisha, 2005). Pushpa and Nandihalli (2010) studied bioefficacy of botanicals in the management of *A. guerreronis* indicated that among the different botanicals NSKE 5 per cent was found effective in reducing mite and egg population.

The pest is recently observed in the state of Maharashtra and in the Konkan region in particular. Number of control measures mostly involving aerial application and root feeding

with chemical pesticides are banned due to hazardous residue noticed. No information is available on extent of incidence and management practices. In view of this the investigation was proposed to undertake over all studies on eriophyid mite. There is practical difficulty in insecticidal spray to reach the height of coconut trees. The information on performance of sprayers and effect of combination of neem products and application methods are very scanty. Considering the importance of coconut as a plantation crop in this country and the potential of this mite pest to cause extensive damage, attempt was made to evaluate efficacy of certain botanical insecticides for the management of eriophyid mite with special attention to those underneath the perianth.

MATERIALS AND METHODS

Field experiment was conducted during two years (2006-2007 and 2007-2008) at 'Asond' coconut orchard of the Central Experimental Station (C. E. S.), Wakawali of Dr. Balasaheb Sawant Konkan Krishi Vidyapeth, Dapoli, State. Maharashtra, India. It is situated at 17°40' to 17°45' North Latitude and 75°16' to 75°19' East Longitude and at elevation of 250m above Mean Sea Level. The area is with red lateritic soil and warm and humid climate. The work carried out over the coconut variety 'Pratap' which was planted on 30th June, 1991.

The experiment was carried out in Randomized Block Design (RBD) with nine treatments (Table 1). All the treatments were replicated three times simultaneously considering single tree as a unit.

Method of application of bio-pesticide

Table 1: Treatment details

T1	Neem garlic extract 2% (Spray) + Neemazal 1% (Root feeding)
T2	Neem garlic extract 2% (Spray) + Neemazal 5% (Root feeding)
T3	Neemazal 1% (Spray) + Neemazal 1% (Root feeding)
T4	Neemazal 1% (Spray) + Neemazal 5% (Root feeding)
T5	Neemazal 5% (Spray) + Neemazal 5% (Root feeding)
T6	Neem garlic extracts 2% (spray)
T7	Neemazal 1% (Spray)
T8	Neemazal 5% (Spray)
T9	Untreated control (No any application)

Table 2: Schedule of root feeding and spraying

Number of application	Month of year
1st application	October – November
2nd application	January – February
3rd application	March – April

Table 3: Dose of bio-pesticides used for treatment

Mode of application	Dose of biopestide
Spraying	Neemazal 5% = 5 ml Neemazal (50000 ppm commercial product) / liter of water Neemazal 1% = 4 ml Neemazal (10000 ppm commercial product) / liter of water
Root feeding	Neemazal 1% = 10 ml Neemazal + 10 mL water Neemazal 5% = 7.5 mL Neemazal + 7.5 mL water

Method of Spraying

Spraying was done by trained person with the help of hand sprayer. The spraying was done to all bunches (except the unfertilized flowers spathe) by calculating the volume of solution required for each treatment (Pushpa, 2006).

Method of Root feeding

The predetermined quantity of bio-pesticides was mixed in the known quantity of water and applied by root feeding. The live roots were searched by digging the pit near coconut trunk 2-3 feet apart. The pencil sized thick and sweet potato colored root was selected. The precaution was taken to avoid injury or any sort of damage to selected root. Such root was given slanting cut with the help of sharp knife .The cut was given in one stroke so that it should not blurt. The bio-pesticides mixed in water were taken in polythene bag of 15×10cm size. Then the cut section of the root was dipped in the solution. The root was placed in such a way to have access of total quantity of solution to be absorbed. Then the bag was tied to root with help of cotton thread (Fig. 1, 2, 3 and 4). It was observed for 24 hrs for complete absorption of solution by the root. After 24 hrs if the solution not absorbed by the root then the root was replaced by another root and the process was repeated till the solution was successfully taken by the root. The application of bio-pesticides through root feeding and spraying was done for three times in year (Table 2). In case of Neemazal 1% and Neemazal 5%, the commercial products available in market were used (Table 3) while Neem garlic extract was prepared locally as described below.

Preparation of Neem garlic extract

To prepare 2% Neem-garlic extract 200 g cleaned raw garlic was measured and mixed in 300mL water and made in to a paste in the grinder and kept in separate flask. Then 50 g washing soap was measured and the washing soap solution was prepared by adding 500 ml luck warm water and kept in another flask, similarly 200mL Neem oil was kept ready in another flask. Then a container was taken in which the solution was sieved through a fine cloth to remove the debris. The garlic extract was added with 500 ml washing soap solution and 200 ml neem oil. All these ingredients were stirred and mixed homogenously with help of mixer. The solution was diluted by adding 9 liters of water and mixed well to use as spray solution.

Method of recording observation

The efficacy of bio-pesticides was judged on the basis of the number of mites present in 4 mm^2 area under perianth before and after application of bio-pesticides (Pushpa, 2006).

Mite count

For counting mites from infested nuts, approximately middle of nut bunch was selected from spathe. The selected nut was removed from the bunch. The perianth of the nut was removed properly without disturbing the surface of nut below the perianth. Then patch of surface from perianth circumference was removed with help of sharp knife. This cut patch was taken on the stage of binocular microscope to observe the presence of mite or to count the number of eggs in known space of 4 mm^2. This area was accessed by using 2×2 mm window prepared to card sheet.

Table 4: Efficacy of bio-pesticide against mite *A. guerreronis* during first application

Sr. no.	Treatment	Pre count	Average number of mite per 4 mm² area											
			1st Year 2006-07				2nd Year 2007-08				Mean of Two year			
			7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC
1	T1	47.22	41.07	17.84	38.00	27.07	30.00	28.57	29.22	31.15	36.78	20.01	33.61	28.91
2	T2	51.66	42.77	14.44	42.33	18.76	28.33	32.54	26.66	37.18	36.50	20.65	34.50	27.03
3	T3	43.78	39.60	20.78	34.11	34.54	31.33	25.40	29.44	30.63	35.77	22.23	31.78	32.78
4	T4	48.22	41.08	17.82	35.77	31.35	30.33	27.78	28.44	33.00	36.28	21.13	32.11	32.08
5	T5	51.00	43.55	12.88	33.66	35.40	26.89	35.98	24.89	41.36	35.22	23.43	29.28	38.07
6	T6	44.89	41.88	16.22	38.44	26.23	35.33	15.88	33.78	20.44	38.61	16.05	36.11	23.63
7	T7	47.33	43.78	12.42	41.00	21.32	32.55	22.50	30.77	27.48	38.17	17.02	35.89	24.09
8	T8	48.11	43.11	13.76	39.00	25.15	31.89	24.07	30.33	28.52	37.50	18.47	34.66	26.69
9	T9	48.55	49.99	-	52.11	-	42.00	-	42.44	-	46.00	-	47.28	-
SE+		NS	1.02		1.30		0.46		0.44		0.64		0.63	
CD at 5%			3.06		3.90		1.39		1.33		1.92		1.88	

Note: UTC = Untreated control; DAT = Days after treatment

Table 5: Efficacy of bio-pesticide against mite *A. guerreronis* during second application

Sr no.	Treatment	Pre count	Average number of mite per 4 mm² area											
			1St Year 2006-07				2nd Year 2007-08				Mean of Two year			
			7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC
1	T1	32.88	29.00	44.89	24.11	53.61	25.44	37.21	23.44	41.85	27.22	41.60	23.78	48.55
2	T2	37.33	32.44	38.35	28.11	45.95	23.55	41.91	22.44	44.35	28.00	39.92	25.27	45.32
3	T3	30.00	25.11	52.28	22.4	56.80	25.89	36.16	23.89	40.78	25.50	45.29	23.17	49.87
4	T4	28.44	23.11	56.12	20.78	60.09	25.22	37.83	23.55	41.62	24.16	48.16	22.16	52.04
5	T5	27.33	21.00	60.10	17.44	66.41	21.55	46.85	20.22	49.77	21.28	54.34	18.83	59.26
6	T6	34.44	30.00	43.05	25.00	52.05	31.11	23.31	29.22	27.43	30.56	34.45	27.11	41.34
7	T7	35.88	31.00	41.16	26.22	49.54	28.44	29.87	27.44	31.88	29.72	36.23	26.83	41.95
8	T8	33.66	27.89	47.02	23.44	54.86	27.67	31.79	26.44	34.38	27.78	40.39	24.94	46.04
9	T9	53.22	52.66	-	52.11	-	40.55	-	40.33	-	46.61	-	46.22	-
SE+		NS	0.89		0.83		0.63		0.57		0.42		0.49	
CD at 5%			2.67		2.48		1.88		1.71		1.27		1.48	

Note: UTC = Untreated control; DAT = Days after treatment

Table 6: Efficacy of bio-pesticide against mite *A. guerreronis* during third application

Sr.	Treatment	Pre count	Average number of mite per 4 mm^2 area											
			1st Year 2006-07				2nd Year 2007-08				Mean of Two year			
			7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC	7 DAT	Per cent reduction over UTC	14 DAT	Per cent reduction over UTC
1	T1	35.44	21.11	58.50	19.78	58.77	24.89	38.02	23.33	40.66	23.00	49.51	21.55	50.64
2	T2	33.78	24.11	52.57	20.66	56.96	23.89	40.59	22.88	41.82	24.00	47.32	21.77	50.13
3	T3	33.00	19.22	62.20	17.44	63.68	23.89	40.56	22.33	43.22	21.55	52.69	19.88	54.46
4	T4	29.77	17.33	65.93	15.11	68.53	23.11	42.64	22.78	42.10	20.22	55.61	18.94	56.61
5	T5	24.55	14.66	71.23	12.55	73.81	21.89	45.52	22.22	43.44	18.28	59.88	17.38	60.19
6	T6	35.66	22.55	55.61	21.22	55.79	28.55	29.02	27.11	31.08	25.55	43.91	24.16	44.66
7	T7	30.67	22.11	56.59	20.22	57.80	29.00	27.94	27.00	31.41	25.55	43.91	23.61	45.92
8	T8	26.33	20.11	60.54	18.55	61.27	27.11	32.59	24.66	37.33	23.61	48.17	21.60	50.52
9	T9	49.74	50.88	- 48.00	-	40.22	-	39.33	-	45.55	-	43.66	-	
SE+		NS	0.70	0.58		0.44		0.54		0.39		1.57		
CD at 5%			2.09	1.75		1.33		1.62		1.15		4.70		

Note: UTC= Untreated control; DAT= Days after treatment

The window card sheet was used to access the number of mites under binocular microscope. The window sheet was kept on the piece of cut surface as described above and number of mites present in that 4 mm^2 window was counted through binocular microscope (Pushpa, 2006). The mite count was recorded a day before application of treatment as a pre count and there after 7 and 14 days after the application of treatment.

Statistical analysis

The population reduction over control was worked out. Later the observations subjected to simple RCBD (ANOVAs) during statistical analysis Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Efficacy based on presence of mites

Mite count observed in the year 2006-07 and 2007-08 after first application

The data on the mite count was statistically non-significant which indicates that the eriophyid mite infestation was uniform throughout the experimental coconut trees.

The pooled mean of two years (2006- 07 and 2007- 08) presented in Table 10 of first application of treatments indicated that the treatment T5 [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 23.43 and 38.07 per cent reduction in mites over control after seven and fourteen days after application of treatments, respectively. This was followed by treatment T3 [Neemazal 1% (Spray) + Neemazal 1% (Root feeding)] with 22.23 and 32.78 per cent reduction in mites after seven and fourteen days after application of treatments, respectively (Table 4).

Mite count observed in the year 2006-07 and 2007-08 after second application

According to the collective mean of two years presented in of second application of treatments indicated that the treatment T2 [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 54.34 and 59.26 per cent reduction in mites over control after seven and fourteen days after application of treatments, respectively. This was followed by treatment T4 [Neemazal 1% (Spray) + Neemazal 5% (Root feeding)] with 48.16 and 52.04 per cent reducing in mites after seven and fourteen days after application of treatments, respectively (Table 5).

Mite count observed in the year 2006-07 and 2007-08 after third application

The pooled mean of third application in two years (2006-07 and 2007-08) presented in Table 6. It found that the treatment T5 [Neemazal 5% (Spray) + Neemazal 5% (Root feeding)] was found most effective in reducing the mite count with 59.88 and 60.19 per cent reduction in nmites over control after seven and fourteen days after third application of treatments, respectively. This was followed by treatment T4 [Neemazal 1% (Spray) + Neemazal 5% (Root feeding)] and T3 [Neemazal 1% (Spray) + Neemazal 1% (Root feeding)] with 55.61, 52.69 and 56.61 %, reduction in mites after seven and fourteen days after application of treatments, respectively.

Finally as considers overall experimental data its revealed that

Figure 1: Selection of root for root feeding

Figure 2: Slanting cut given to selected root

Figure 3: Dipping of root in the insecticidal solution

Figure 4: Tieing of bag to the root

treatment which comprises spraying and root feeding of Neemazal 5 % (T5) found most effective followed by treatment T4 [Neemazal 1% (Spray) + Neemazal 5% (Root feeding)], T8 [Neemazal 5% (Spray)] and T3 [Neemazal 1% (Spray) + Neemazal 1% (Root feeding)] in management of eriophyid mite population. The present findings are in confirmatory with Girisha (2005), Pushpa (2006), Pushpa and Nandihalli (2008) and Pushpa and Nandihalli (2010) who found that neem pesticides found effective in controlling mite population. Also Fernando *et al*. (2002) and Ramaraju (2000) reported that spraying of neem oil in combination with garlic 2 per cent mixture and Neemazal (1%) recorded 60 per cent reduction of eriophyid mite population. Similarly Reddy and Naik (2000) reported that spraying of all fruit bunches at the crown with neem oil mixed with garlic extract and soap solution (20mL neem oil + 20 g garlic emulsion + 5 g soap in 1 lit. water) twice at monthly interval for effective control of pest. The neem oil was proven to be effective treatment by recording significantly lowest mite population (Nandihalli, 2009; Begum and Ramesh Babu, 2013). Botanicals such as neem oil, garlic, fish oil, rosin soap etc. are preferred, through less effective, due to their ecofriendliness. Proper management of the palms helps to contain the pest and reduce economic loss (Napoothiri *et al*., 2002). Rao *et al*., (2004) also reported effectiveness of botanical against eriophyid mite.

The use of botanical insecticides either solely or in combination in integrated pest management systems is increasingly becoming important. Neem bio-pesticides are best suited for use in organic food production in industrialized countries but can play a much greater role in developing countries as a new class of eco-friendly products for controlling pests.

Conventional insecticides have inherent toxicities that cause danger to the health of the applicators, consumers and the environment. In case of systematic pesticides various chances of presence of considerable residue levels in kernel and water. Pessimistic effects on human health led to a reappearance in interest in botanical insecticides because of their minimal costs and fewer ecological side effects.

However, in current state botanical insecticides plays only a minor role in IPM and crop protection. Moreover, some of these botanical extracts could find a place in IPM strategies. With increasing concern over the coconut mite management researchers should look after the multi-location field trials for conforming efficacy of neem bio-pesticides on mites and investigation on the resistance development among mite

population.

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