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Bioefficacy of Spiromesifen (Oberon®) 240 SC against Coconut Eriophyid Mite *Aceria guerreronis* Keifer and Determination of Residues

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Abstract: Bio efficacy of spiromesifen (Oberon®) 240 SC was tested against coconut eriophyid mite, *Aceria guerreronis* Keifer in comparison with recommended insecticide, triazophos 40 EC. Spiromesifen was applied as spot application (crown spraying) at 1, 2, 3, 4 mL L^{-1} and triazophos at 5 mL L^{-1} per tree. Observations recorded at 7, 15 and 30 days after spraying showed that spiromesifen at the rate of 4 mL L^{-1} was significantly superior than triazophos and control, while spiromesifen at the rate of 3 mL L^{-1} and triazophos at the rate of 5 mL L^{-1} were equally effective in reducing the mite population. The residue levels in coconut water and kernel samples collected on 0, 1, 3, 5, 10, 15, 30, 45 and 60 days after third spray were found to be below detectable level.

Key words: Spiromesifen, triazophos, eriophyid mite, *Aceria guerreronis*, coconut, residues

Introduction

In Tamil Nadu, India, severe outbreak of a nut infesting eriophyid mite *Aceria guerreronis* Keifer (Eriophyidae: Acari) feeding on tender nuts of coconut (*Cocos nucifera*) resulted in heavy damage and loss in yield and quality of nuts (Ramaraju *et al*., 1999). At present, the infestation is widespread in India and reported from Karnataka, Andhra Pradesh, West Bengal, Gujarat, Andaman and Nicobar Islands and Lakshadweep Islands (Haq, 1999). Commonly used insecticides have lost their efficacy because of continuous and discriminate use. Hence, there is a need to go for newer molecules to avoid the risk of resurgence and pest resistance. Spiromesifen is the latest insecticidal innovation from Bayer crop Science. The product belongs to a new chemical class named spirocyclic phenyl substituted tetronic acids and offers unique mode of action classified as lipid biosynthesis inhibitors. It is a new insecticide/miticide for foliar application against white fly, mite and psyllids. Spiromesifen (Oberon®) showed excellent efficacy against *Bemisia tabaci and Trialeurodes vaporariorum* in laboratory and greenhouse trials (Nauen *et al*., 2002). In the present study, the efficacy of spiromesifen (Oberon®) 240 SC was tested against coconut eriophyid mite *A. guerreronis* by crown application.

Materials and Methods

Field Experiment

A field experiment was conducted in farmer's holdings at Coimbatore, T.Nadu, during March, 2003, with 8-10 year old coconut trees. Six treatments were included to evaluate the efficacy of the new chemical, spiromesifen 240 SC. The treatments consisted of spiromesifen at 1, 2, 3, 4 mL L^{-1}, triazophos at 5 mL L^{-1} and an untreated check. The variety used was west coast tall and eight trees constituted one replication. Spot application (spraying) of treatments was done by using a rocker sprayer. Pre treatment and post treatment counts on mite population were made from three month

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old buttons (single button/tree) at 7, 15 and 30 Days After Spraying (DAS). The mite population was assessed in an area of 4 sq mm on the innermost three bracts and nut surface covered by the perianth (Ramaraju *et al*., 2000) using a binocular stereo zoom microscope. Three rounds of treatments were given at 45 days interval.

Determination of Residues

Sampling

Samples of 75% matured coconut were collected on 0, 1, 3, 5, 10, 15, 30, 45 and 60 days after third spray. A representative sample of 100 mL coconut water and 50 g coconut kernel were placed in a wide mouthed sampling container containing 100 mL acetone. The bottles were sealed with Teflon lined cap and stored in deep freezer until extraction of residues.

Extraction

Fifty gram coconut kernel sample and 100 mL of coconut water sample was extracted with 100 mL acetone. The kernel sample was blended in a warring blender for 3 min and filtered through Buchner funnel with mild suction and condensed.

Liquid-liquid Clean up

The extract was taken in a 250 mL separating funnel. Then 25 mL ethyl acetate/cyclohexane (1:1, v/v) and 25 mL saturated sodium chloride was added to kernel and water sample homogenates and the samples were shaken vigorously for 1 min. The phases were allowed to separate for 30 to 60 min. The partitioning process was repeated twice with additional 25 mL portions of ethyl acetate. The organic phase layer was filtered through Whatman No. 1 filter paper overlaid with anhydrous sodium sulphate (10 g). The filtrate so obtained was concentrated to watery residue (near dryness) using a rotary flash vacuum evaporator at 40°C. Ethyl acetate 1.5 mL was added and residues were dissolved completely. Approximately 1.5 g of mixture of sodium sulphate/sodium chloride (1/1 W/W) were added and flask was swirled. Then, cyclohexane (1.5 mL) was added to obtain a total volume of 3 mL and flask was swirled vigorously.

Column Clean up

Glass chromatographic column with 50 cm length and 1.5 cm diameter was used in the column clean up. The drip tip of the glass column was plugged with cotton wool and packed air tight using a mixture of Silica gel: Celite: Florisil: Charcoal 4:4:1:1 v/v/v/v. Layers of sodium sulphate were packed at top and bottom. The column was pre washed with 25 mL of hexane initially and eluted with ethyl acetate/cyclohexane (1:1 v/v). The collected elutant was condensed to near dryness and reconstituted by acetone for final determination.

Final Determination

The residues of spiromesifen 240 SC were estimated by using a Chemito model 2685 HT gas liquid chromatography fitted with a Ni^{63} electron capture detector with the following operating parameters.

Column	: 5% SE 30 on Anakrom Q		
Temperature (°C)	: Column	Injector	Detector
	220	240	300
Flow rate (mL min^{-1})	: 60	Retention time	: 3.50 min

The final quantification was made using the formula

$$\text{Residues in ppm} \frac{Hs}{Hstd} \times \frac{Wstd}{Ws} \times \frac{Vs}{Asj}$$

Where:

H_S - Height of the sample
Hstd - Height of the standard
Wstd - Weight of the standard in ng
Ws - Weight of the sample in g
Vs - Volume of the sample in mL (final extract)
Asj - Aliquot of the sample injected in µL

Recovery Studies

The mean recovery of spiromesifen spiked at 1 and 2 µg g^{-1} in kernel was 88% and at 0.5 and 1 µg g^{-1} in coconut water was 80.93% . The sensitivity of the instrument was 0.1 ng and the determinability was 0.004 µg g^{-1} for kernel and 0.002 µg g^{-1} for water considering the final volume of the extract as 2 mL.

Results and Discussion

The pre treatment mite population ranged from 75.75 to 84.75 number per 4 sq. mm (Table 1). The spot application of spiromesifen 240 SC at the rate of 4, 3, 2 and 1 mL L^{-1} and triazophos 40 EC at the rate of 5 mL L^{-1} recorded 17.89 to 33.36% reduction of mite population when sampled on 7 days after first round of treatment. Spiromesifen at the rate of 3 mL L^{-1} and triazophos at the rate of 5 mL L^{-1} were on par in their effect after 15 (39.71 and 39.65%) and 30 days after spraying (DAS) (43.47 and 42.39%). After the second spray, mite population reduction was much better than the first round and per cent reduction over control ranged from 13.53 to 39.10, 22.87 to 72.35 and 42.58 to 76.54 after 7, 15 and 30 days of treatment, respectively (Table 2). Spiromesifen applied at the rate of 4 and 3 mL L^{-1} recorded 72.35 and 56.44% reduction in mite population after 15 DAS, respectively and were on par with the standard check which gave 57.82% reduction. At 30 DAS, spiromesifen at the highest dose resulted in significantly higher percent reduction compared to all other treatments. After third spray, spiromesifen applied at lower doses i.e., 1 and 2 mL L^{-1} showed 67.51 and 68.94% reduction of mite population at 15 DAS, respectively, whereas the higher doses, i.e., 3 and 4 mL L^{-1}

Table 1: Efficacy of spiromesifen 240 SC against coconut mite, *A. guerreronis* - I spray

		Percent reduction in mite population over control**			
Treatments	Pre count* No.	7 DAS	15 DAS	30 DAS	Mean
Spiromesifen 4 mL L^{-1}	75.75	31.49	53.44	18.17	34.37
	(8.71)[a]	(31.25)[ab]	(46.85)[b]	(21.94)[a]	
Spiromesifen 3 mL L^{-1}	84.75	28.83	39.71	43.47	37.34
	(9.14)[a]	(30.59)[ab]	(38.66)[ab]	(40.06)[b]	
Spiromesifen 2 mL L^{-1}	77.63	25.34	40.24	28.79	31.45
	(8.75)[a]	(28.69)[ab]	(38.67)[ab]	(31.05)[ab]	
Spiromesifen 1 mL L^{-1}	83.00	17.89	24.81	27.35	23.35
	(9.08)[a]	(20.78)[a]	(27.48)[a]	(29.61)[ab]	
Triazophos 5 mL L^{-1}	84.63	33.36	39.65	42.39	38.46
	(8.89)[a]	(34.99)[b]	(38.12)[ab]	(39.28)[b]	
Untreated check	77.75	-	-	-	-
	(8.75)[a]				
Mean	80.59	27.38	39.57	32.03	-
	(8.89)	(29.26)	(37.96)	(32.38)	

No. Number of mite per 4 sq. mm; DAS- Days after spraying, Figures in parenthesis are $\sqrt{x + 0.5}$ */arc sin **transformed values, In a column, means followed by a common letter are not significantly different by DMRT (p = 0.05)

Table 2: Efficacy of spiromesifen 240 SC against coconut mite, *A. guerreronis* - II spray

Treatments	Pre count*No.	Percent reduction in mite population over control ** 7 DAS	15 DAS	30 DAS	Mean
Spiromesifen 4 mL L^{-1}	78.00 (8.77)^{ab}	34.70 (33.56)^{ab}	72.35 (60.09)^{b}	76.54 (61.86)^{c}	61.20
Spiromesifen 3 mL L^{-1}	86.5 (9.26)^{ab}	28.80 (30.87)^{ab}	56.44 (48.78)^{b}	57.76 (50.30)^{abc}	47.66
Spiromesifen 2 mL L^{-1}	82.75 (9.03)^{ab}	13.53 (19.62)^{a}	34.38 (35.03)^{a}	42.58 (40.42)^{a}	30.16
Spiromesifen 1 mL L^{-1}	93.63 (9.66)^{b}	28.89 (30.35)^{ab}	22.87 (27.51)^{a}	47.99 (43.72)^{ab}	33.25
Triazophos 5 mL L^{-1}	62.25 (7.82)^{a}	39.10 (37.32)^{b}	57.82 (49.84)^{b}	70.02 (51.40)^{bc}	55.65
Untreated check	71.13 (8.37)^{ab}	-	-	-	-
Mean	79.04 (8.82)	28.99 (30.35)	48.77 (44.25)	58.98 (50.74)	-

No. Number of mite per 4 sq. mm; DAS- Days after Spraying, Figures in parenthesis are $\sqrt{x+0.5}$ */arc sin **transformed values, In a column, means followed by a common letter are not significantly different by DMRT (p = 0.05)

Table 3: Efficacy of spiromesifen 240 SC against coconut mite, *A. guerreronis* - III spray

Treatment	Pre count *No.	Percent reduction in mite population over control** 7 DAS	15 DAS	30 DAS	Mean
Spiromesifen 4 mL L^{-1}	49.25 (6.53)^{a}	82.62 (66.45)^{b}	87.96 (70.96)^{b}	89.67 (71.48)^{c}	86.75
Spiromesifen 3 mL L^{-1}	64.00 (7.50)^{a}	77.99 (62.52)^{b}	79.26 (63.74)^{b}	79.64 (63.93)^{b}	78.96
Spiromesifen 2 mL L^{-1}	69.00 (7.54)^{a}	65.43 (54.20)^{a}	68.94 (56.50)^{a}	65.58 (54.65)^{a}	66.65
Spiromesifen 1 mL L^{-1}	79.13 (8.43)^{a}	59.12 (50.33)^{a}	67.51 (55.35)^{a}	59.01 (50.28)^{a}	61.88
Triazophos 5 mL L^{-1}	35.75 (5.89)^{a}	76.34 (61.64)^{b}	81.66 (64.93)^{b}	79.03 (62.97)^{b}	79.01
Untreated check	73.25 (7.93)^{a}	-	-	-	-
Mean	61.73 (7.30)	72.30 (59.03)	77.07 (62.29)	74.04 (60.25)	-

No. Number of mite per 4 sq. mm; DAS- Days After Spraying, Figures in parenthesis are $\sqrt{x+0.5}$ */arc sin **transformed values, In a column, means followed by a common letter are not significantly different by DMRT (p = 0.05)

recorded significantly higher population reduction of 79.26 and 87.96%, respectively (Table 3). At 30 DAS, spiromesifen at the rate of 3 mL L^{-1} and triazophos at the rate of 5 mL L^{-1} treatment were on par with each other in their effect. The mean per cent reduction in mite population after third spray was 86.75, 78.96, 66.65, 61.88 and 79.01 respectively, when applied with spiromesifen at the rate of 4, 3, 2 and 1 and triazophos at the rate of 5 mL L^{-1}. The relative efficacy was in the order of spiromesifen 240 at 4 > 3 mL L^{-1} ≤ triazophos 40 EC 5 mL L^{-1} > spiromesifen 2 ≤ 1 mL L^{-1}.

It was observed that reduction in mite population was more significant up to 15 DAS and increased thereafter in few treatments during first and third round of spraying. But a gradual reduction in mite population was recorded up to 30 DAS after second spray. This may be due to overlapping generation of mites, egg hatchability and delivery of chemicals which either directly or indirectly contributes favourably for the multiplication of mites inside the perianth. Once the residual effect of sprayed chemical ceases, the mite population tend to increase with the multiplication of unaffected mites inside the perianth (Ramaraju *et al*., 2000).

Spiromesifen was also found highly active against tetranychid mite eggs, all juvenile and quiescent stages and female adults by contact (Nauen *et al*., 2005). Kavitha *et al*. (2006) reported higher efficacy of spiromesifen 240 SC at the rate of 120 g a.i. ha^{-1} against chilli mite, *Polyphagotarsonemus latus*.

Table 4: Dissipation pattern of spiromesifen 240 SC in coconut

	Water sample (Residues in ppm)				Kernel sample (Residues in μg g^{-1})			
	Doses (mL L^{-1})				Doses (mL L^{-1})			
DAS	1	2	3	4	1	2	3	4
0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
60	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL- Below Detectable Level

A good efficacy of spiromesifen was reported against nymphal stages of B-type *B. tabaci* feeding on melons and collard (Liu, 2004). Earlier workers have also reported that spot application of triazophos satisfactorily controlled the mite population. Spot application of triazophos 5 mL L^{-1} was found effective in reducing the mite population up to 70%, 30 days after two rounds of spraying (Karuppuchamy *et al*., 2001). Spraying of 4 mL of triazophos 40 EC once in 30 days as topical application was suggested for mite control (Ramaraju *et al*., 1999). In contrast, a low cumulative mite population reduction of 49.1% after five rounds of triazophos (0.2%) treatment was reported by Prakash (2002).

The residues of spiromesifen in coconut kernel and water were determined from the samples collected from treated field and the results revealed that residues of spiromesifen applied at 1, 2, 3 and 4 mL L^{-1} were at Below Detectable Level (BDL) in both the matrices, up to 60 days (Table 4). Similarly, the residues of spiromesifen applied at 96 g a.i. ha^{-1} on chilli fruits reached BDL on 7 DAS and the half life was 2.29-3.84 days (Kuttalam *et al*., 2004). Also, Kuttalam *et al*. (2000) reported that no detectable amount of residues were found in coconut water and kernel when sprayed with monocrotophos (1.5 and 3 mL L^{-1}), triazophos (5 and 10 mL L^{-1}), dicofol (2.5 and 5 mL L^{-1}) and methyl demeton (4 and 8 mL L^{-1}), up to 60 days after application. No detectable amount of residues was found in coconut water and kernel when triazaphos was administered through root at 10, 15, 20 and 40 mL per palm (Narasimha Rao, 2000).

The results of the present study clearly revealed that spiromesifen is an excellent chemical in controlling eriophyid mite without any adverse effect on the consumption utility of coconut water and kernel because of its quicker dissipation and short lived residues and will be an excellent tool in resistance management programmes.

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