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Study on absorption of pesticides formulation into coconut palm and their feasibility against coconut eriophyid mite using syringe method of pesticides application

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Abstract
The present investigation to study on absorption of pesticides formulation into coconut palm using syringe method of pesticides application showed that acaro-insecticides *viz.,* spiromesifen 22.9% SC, abamectin 1.9% EC, fipronil 5% SG and buprofezin 25% SC found to have very low solubility threshold and were not effective in complete absorption by coconut fronds. Though the acaro-insecticides having acaricidal activity may not be used against coconut eriophyid mite, *Aceria guerreronis.* Further studies can be conducted under desire solubility level of different chemical formulations and their absorption in to the coconut palm for the management of *A. guerreronis* using syringe method.

Keywords: Coconut, coconut eriophyid mite, pesticides, syringe method

Introduction

Coconut (*Cocos nucifera* Linn.), is a member of the family Arecaceae. This palm is known for their versatility ranging from food to cosmetics. It forms a regular part of diet in the tropical and subtropical countries. Coconut is distinct from other fruits containing a large quantity of nutritious water in endosperm. Matured coconut can be used as seed nuts and processed for oil from dried nut called 'copra'. It is also used as charcoal from the hard shell and coir from the fibrous husk. The kernel contains protein, fat, carbohydrate, fibre, ash, calcium, phosphorus, iron, and traces of beta-carotene (Anon., 1976) [1]. The versatile palm popularly known as the 'Kalpavriksha' the tree which provides all the necessities of life. Due to multiplicative abiotic and biotic factors, the range of productivity and production is low in India. Being a perennial, coconut palm harbours hundreds of insects and other arthropods round the year. An important introduced pest of coconut palm is *Aceria guerreronis* Keifer, commonly called "coconut eriophyid mite" which was first observed on coconut in the state of Guerrero, Mexico in 1960 (Keifer, 1965) [7]. Until the pest was known only in Africa and America (Howard and Rodrigeuz, 1990 [4]; Julia and Mariau, 1979) [6] but at the end of the 1990s it was reported for the first time from Sri Lanka and southern India (Fernando *et al.*, 2002) [2] causing considerable damage to coconut in these countries. The coconut eriophyid mites feed and breed beneath the perianths (floral bracts) of coconut fruits causing damage to the epidermal meristematic tissues. The severity of its damage on nuts may results in deep fissures in the fruit pericarp, distortion of the fruit, reduction in fruit size and weight, and a decline in copra yield (Julia and Mariau, 1979) [6]. Higher damages of this mites lead to premature nut drop or extreme reduction in the size of nuts and such nuts are difficult to de-husk. Yield losses attributable to *A. guerreronis* damages range from 10 to 70 per cent (Moore *et al.*, 1989) [9]. Reduction in nut size leading to 25 per cent loss in the yield of copra has also been recorded (Gopal and Gupta, 2001) [3]. Considering the importance of coconut as a plantation crop and the potentiality of the mite which cause heavy damage. Several acaricides have been tried against *A. guerreronis* with different methods of application *viz.*, spray application, root feeding method and trunk injection method with varied level of suppression of this pest. The present study is placed for newer acaricides and new method of application.

Materials and Methods

Tested pesticides

To study the syringe method of pesticides administration in coconut palm, four acaro-insecticides *viz.,* spiromesifen 22.9% SC, abamectin 1.9% EC, fipronil 5% SG and buprofezin 25% SC were selected. Initially the solubility potential of the formulations was studied using dilution analysis and the rate of formation of sediments. Further, the formulations at different dilutions were injected to coconut palms using syringe method to understand the rate of absorption and the detailed methods are described below.

Study on solubility of acaro-insecticides formulations

Acaro-insecticides *viz.,* spiromesifen 22.9% SC, abamectin 1.9% EC, fipronil 5% SG and buprofezin 25% SC were subjected to solubility analysis. The solubility study was carried out at Biochemistry laboratory, College of Agriculture, V. C. farm, Mandya, University of Agricultural Sciences, Bengaluru, Karnataka during the month of July-August 2017. Each formulation was serially diluted several times to get different dilutions. All these diluted insecticides were kept for sedimentation for 12 hours in glass tubes and observed for solubility. The details of different dilutions of acaro-insecticides are given in Table 1.

Table 1: List of acaro-insecticides dilutions used for the solubility studies

S. No.	Acaro-insecticides	Dilution (%)
1	Spiromesifen 22.9% SC	0.001, 0.01, 0.05, 0.1, 0.5, 5
2	Abamectin 1.9% EC	0.02, 0.05, 0.2, 0.5, 5
3	Buprofezin 25% SC	0.0005, 0.005, 0.05, 0.5, 5
4	Fipronil 5% SG	0.001%, 0.01, 0.05, 0.1, 0.5, 5

Image processing and analysis of degree of sedimentation in acaro-insecticides formulations

The procedure for image processing and quantification of sediments formed in the dilution study of different acaro-insecticides formulations were followed as for image processing and quantification of sediments formed in the dilution study of different acaro-insecticides, the open source java-based image processing tool "ImageJ", released by the National Institute of Health (NIH), was used. The high-resolution digital images were imported in to the works space of "Image J" and converted the image type to 8-bit grey scale. The image properties were fine tuned to minimise the all back-ground noise. After noise reduction the free hand straight line drawing tool was selected. Using the drawing tool, the diameter of sediment button was measured and exported to coma-separated-value (CSV). The values were used to understand sedimentation limit (Figure 1).

Study site of pesticide administration into coconut palm

The study site is situated at College of Agriculture, V. C. farm, Mandya, University of Agricultural Sciences, Bengaluru, Karnataka, India. The existing 20 years old coconut palms were used for studying absorption of different acaro-insecticides using syringe method during the month July-August-2017.

Syringe method of administration of diluted pesticide formulation in the coconut fronds

The fronds of the coconut palm were selected for administrating pesticides into palm by syringe method as described here under. The different dilution of pesticides studied for solubility as were administered to the coconut frond using syringe method. The materials used in the syringe method of insecticides administration were fabricated drill bit (0.3 cm diameter), hand drill bit (0.3 cm diameter), disposable syringes (10 ml), bee wax, polythene covers, ladder and test insecticides. At the study site, the selected coconut palms were administered with different dilutions of insecticides. The middle fronds of the palms were selected for the study. Upper side at base of the frond was selected for administering insecticides. Hand drill with 0.3 cm of diameter or fabricated drill bit (0.3 cm diameter) was used to make a hole at 45-degree angle to a depth of 1.5 cm on the base of the coconut frond. The syringe (10 ml) loaded with 5 ml of insecticide solution was placed into the hole the apical point of syringe was sealed with wax to avoid leakage. Each dilution of different insecticides was injected in equal quantity (5 ml, n=1) on different coconut palms between 9 to 11 am. Furthermore, the lowest concentration under the solubility limit of above acaro-insecticides were replicated three times along with water injection as control in equal quantity (10 ml, n=3) on fronds.

Absorption rates of acaro-insecticides

The acaro-insecticides at different dilutions studied for solubility were tested for absorption by the coconut palms at the study site. The observations on absorptions were recorded of the quantity of injected dilutions absorbed by the coconut frond after 24 and 48 hours of administration of pesticides.

Result and Discussion

The results on solubility and absorption of different dilutions of acaro-insecticides using syringe method in coconut palms are presented here under following subsections;

Study on solubility of different acaro-insecticides formulations

The results of different acaro-insecticides formulation tested for the solubility are presented in Table 2. The formulation, spiromesifen 22.9% SC diluted to 0.001, 0.01, 0.05, 0.1, 0.5 and 5% and were taken in series of glass tubes and kept undisturbed for 12 hours. After this brief storage period, partial sediments were observed in dilution at 0.01% and above and no visible sediments were found at 0.001% and below (Table 2, Fig. 1; first row). Further, on comparison of a solubility potential of technical grade spiromesifen (0.00013 mg/ml; Macbean, 2008) [8], it was observed that the dilutions at 0.001%, the calculated concentration of active ingredient was above the reported solubility threshold of active ingredient. Though the observation pertaining to the calculated concentration of active ingredient in diluted formulation and the reported solubility threshold of active ingredient are paradoxical, one of the possible reasons could be the variations in the strength of active ingredient in the chemical formulation besides the role of other substances that enhance the solubility. However, spiromesifen 22.9% SC at dilutions, 0.01% and above the sediments were observed, and it could be due to the presence of excess of active ingredient above the solubility threshold concentration and other non-active-ingredient components. Acaro-insecticide, abamectin 1.9% EC was diluted to 0.02, 0.05, 0.2, 0.5 and 5% and partial sedimentation was recorded in dilution at 0.05% and above. No visible sediments were found at 0.02% and below (Table 2, Fig. 1; second row). On comparison with the solubility potential of technical grade abamectin (0.0078 mg/ml; Wislocki, 1989) [3], it was found that the dilutions at 0.02%, the actual concentration of active ingredient was below the solubility threshold concentration. However, abamectin 1.9% EC at 0.05% and above dilutions, the sediments were observed and this could be due to the presence of excess of active ingredient above the solubility threshold concentration and other non-active-ingredient components. The chemical formulation, buprofezin 25% SC diluted to 0.0005, 0.005, 0.05, 0.5 and 5%. The partial sediments were found to be observed in dilution at 0.005% and above and no visible sediments were recorded at 0.0005% and below (Table 2, Fig. 1; third row). The comparison of a solubility potential of technical grade buprofezin (0.0009 mg/ml; Tomlin, 2004), it was recorded that the dilution at 0.0005%, the calculated concentration of active ingredient in the diluted formulation was found above the solubility threshold concentration. However, buprofezin 25% SC at 0.005% and above dilutions, the sediments were observed and this could be due to the presence of excess of active ingredient above the solubility threshold concentration and other non-active-ingredient components. The formulation, fipronil 5% SC was diluted to 0.001, 0.01, 0.05, 0.5, 0.1 and 5% and partial sedimentation was observed in dilution at 0.01% and above. No visible sediments were recorded at 0.001% and below (Table 2, Fig. 1; fourth row). On comparison with the solubility potential of technical grade fipronil (0.0019 mg/ml; Macbean, 2008) [8], it was found that the dilutions at 0.001%, the actual concentration of active ingredient was below the solubility threshold concentration. However, fipronil 5% SC at 0.01% and above dilutions, sediments were observed and it could be attributed to the solubility of active ingredient and non-active-ingredient components in the formulation.

Absorption of acaro-insecticides at different dilutions in coconut palm using syringe method

The acaro-insecticides tested for the solubility were administrated to the coconut palms using syringe method at study site and the results on absorptions was recorded based on quantity of solution absorbed by fronds at 24 and 48 hours after imposing injection are presented in Table 3 and 4. Among different dilutions evaluated for the potential for being absorbed by the coconut palm at study site, it was interesting to note that, no formulation at any of the tested dilution was absorbed completely. The partial absorption was observed in lower concentration of a few formulation *viz.,* buprofezin 25% SC (0.0005 and 0.005%), spiromesifen 22.9% SC (0.001 and 0.01%), abamectin 1.9% EC (0.02 and 0.05%), fipronil 5% SC (0.001 and 0.01%). However, some of the formulations at higher concentration, remained unabsorbed and they were; buprofezin 25% SC (0.05, 0.5 and 5%), spiromesifen 22.9% SC (0.05, 0.1, 0.5, 5 and 10%), abamectin 1.9% EC (0.2, 0.5 and 5%) and fipronil 5% SC (0.05, 0.1, 0.5 and 5%) (Table 3). Further, the lowest concentrations of above formulations replicated on fronds and it was observed that partial absorption was recorded by fronds after 24 and 48 hours of injection in formulations *viz.*, fipronil 5% SC (2.83 ml), spiromesifen 22.9% SC (3.17 ml), abamectin 1.9% EC (3.50 ml) and buprofezin 25% SC (3.67 ml) compared to water injection (10.00 ml) (Table 4).

The partial absorption and non-absorption of acaro-insecticides formulation at different dilutions in coconut palms could be attributed to the abiotic factors *viz.,* water soluble potential of active ingredients, water soluble potential of non-active ingredients components, other environmental variables like humidity, temperature, rainfall etc. and biotic factors *viz.*, the anatomic point of injection site on the coconut palm, age of the coconut palm. When the polarity of non-active ingredients of the insecticide formulation is hydrophobic a complex and stable emulsion is formed upon diluting with water. Though these emulsions are stable at lower concentration, at higher concentration the non-active ingredients of the emulsion forms fine aggregates and a suspension is often formed. A suspension naturally will have fine insoluble particulate matter and such matters are tend to sediment on long duration static storage and form a thin film on the bottom of the cavity. The above discussed properties of non-active ingredients composition of formulation are expected to strongly hinder the absorption of diluted formulations by the coconut palm. However, Huang *et al.* (2016) reported that abamectin, when administered to trunk of sweet olive trees (*Osmanthus fragrans)* using a no-pressure injection system to control of the nettle caterpillar, *Latoia lepida* (Lepidoptera: Limacodidae) resulted in, abamectin was completely absorbed in 14 days with lower mortality of *L. lepida.* The present investigation showed partial absorption of abamectin over 48 hours of imposing treatment. It could be the difference between the tree anatomy. Moreover, in the present investigation the acaro-insecticides *viz.*, spiromesifen 22.9% SC, abamectin 1.9% EC, fipronil 5% SC and buprofezin 25% SC were tested first time using syringe method in coconut palms and none of the formulations were found to have desired property of being absorbed by following syringe method. In the dilution and solubility analyses, some formulations were found to have insoluble non-active-ingredient at higher concentration level and a few others formed stable emulsion on diluting with water. Presence of insoluble sediments in chemical formulations is expected to interfere with the absorption of active ingredient through the xylem vascular tissues. Therefore, among the formulations evaluated, no one was suitable for injection using syringe method. Hence, no observation on mite population was recorded.

Conclusion

The acaro-insecticides *viz.*, spiromesifen 22.9% SC, abamectin 1.9% EC, fipronil 5% SG and buprofezin 25% SC tested in the present studies were found to have very low solubility threshold and were not effective in complete absorption by coconut fronds. Though the acaro-insecticides having acaricidal activity may not be used against *A. guerreronis.* However, the present investigation of using pesticides formulation for solubility and absorption is of importance specially in pest management. The studies have shown that the slight change in the concentration resulting in either sedimentation or non-absorption. In the present scenario most farmers use higher concentration or dosages either for spray or any other means of applications. Such applications may not be resulting in proper absorption into the plant system. Future perspective in this aspect can be brought before using the pesticide formulation to be absorbed by the plant system by various means of injection into the plants. Therefore, further studies on these aspects need to give importance for the research studies and pest management and Further investigation can be conducted under desire solubility level of different pesticides formulations for the management of *A. guerreronis* using syringe method.

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Table 2: Different dilution of acaro-insecticides studied and observed solubility

S. No.	Acaro-insecticides	Dilution (%)	Solubility	Calculated concentration of active ingredient (mg/ml)	Solubility potential of active ingredient in water (mg/ml) (Reference value)
1	Spiromesifen 22.9% SC	0.001	Complete	0.00229	0.00013 (Macbean, 2008) [8]
		0.01	Partial	0.0229	
		0.05	Partial	0.1145	
		0.1	Partial	0.229	
		0.5	Partial	1.145	
		5.0	Partial	11.45	
2	Abamectin 1.9% EC	0.02	Complete	0.0038	0.0078 (Wislocki, 1989) [13]
		0.05	Partial	0.0095	
		0.2	Partial	0.038	
		0.5	Partial	0.095	
		5.0	Partial	0.95	
3	Buprofezin 25% SC	0.0005	Complete	0.00125	0.0009 (Tomlin, 2004),
		0.005	Partial	0.0125	
		0.05	Partial	0.125	
		0.5	Partial	1.25	
		5.0	Partial	12.5	
4	Fipronil 5% SG	0.001		0.0005	0.0019 (Macbean, 2008) [8]
		0.01	Complete	0.005	
		0.05	Partial	0.025	
		0.1	Partial	0.05	
		0.5	Partial	0.25	
		5.0	Partial Partial	2.5	

Note: (Complete = no visible sedimentation observed, Partial = visible sedimentation observed). The calculated concentration in the corresponding dilution was found more than that of the solubility threshold concentration that needs further analysis to quantify the actual active ingredient in the formulation.

Table 3: Degree of absorption of acaro-insecticides at different dilutions in coconut fronds using syringe method

S. No.	Acaro-insecticides	Dilution (%)	Absorption out of 5 ml injected volume	
			after 24 hours	after 48 hours
1	Spiromesifen 22.9% SC	0.001	3.0	3.0
		0.01	2.0	2.0
		0.05	0.0	0.0
		0.1	0.0	0.0
		0.5	0.0	0.0
		5.0	0.0	0.0
2	Abamectin 1.9% EC	0.02	2.0	2.0
		0.05	1.0	1.0
		0.2	0.0	0.0
		0.5	0.0	0.0
		5.0	0.0	0.0
3	Fipronil 5% SG	0.001	2.5	2.5
		0.01	1.0	1.0
		0.05	0.0	0.0
		0.5	0.0	0.0
		0.1	0.0	0.0
		5.0	0.0	0.0
4	Buprofezin 25% SC	0.0005	2.5	2.5
		0.005	2.0	2.0
		0.05	0.0	0.0
		0.5	0.0	0.0
		5.0	0.0	0.0
5	Water	5 ml	5.0	5.0

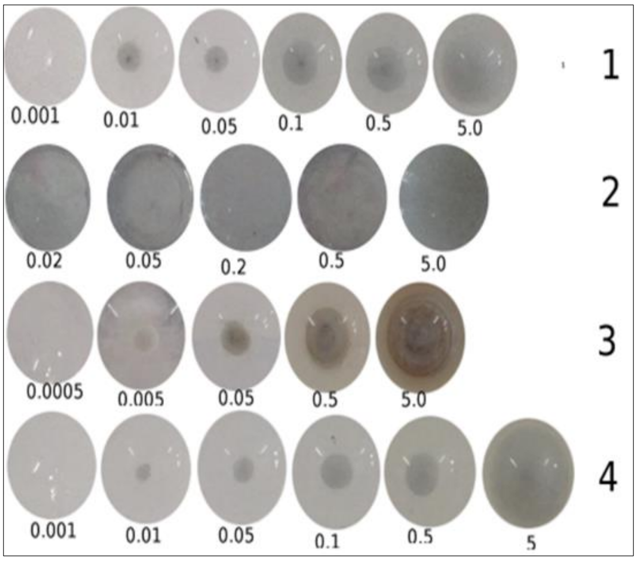

Fig 1: Sedimentation button formation on the bottom of glass tubes with different dilutions (%) of insecticides studied (First row- Spiromesifen 22.9% SC, Second row- Abamectin 1.9% EC, Third row- Buprofezin 25% SC and Forth row- Fipronil 5% SC)

Table 4: Degree of absorption of different acaro-insecticides at lowest concentration in coconut fronds

S. No.	Acaro-insecticides	Dilution (%)	Absorption out of 10 ml injected volume (Mean ± S.D.)	
			after 24 hours	after 4 hours
1	Spiromesifen 22.9% SC	0.001	3.17 ± 0.76	3.17 ± 0.76
2	Abamectin 1.9% EC	0.02	3.50 ± 0.50	3.50 ± 0.50
3	Buprofezin 25% SC	0.0005	3.67 ± 0.76	3.67 ± 0.76
4	Fipronil 5% SC	0.001	2.83 ± 1.04	2.83 ± 1.04
5	Water	-	7.50 ± 0.50	10.00 ± 0.00

(S.D.: Standard deviation)

References

1. Anonymous. The Wealth of India. A dictionary of Indian raw materials, Council of scientific and industrial research, New Delhi, India, 1976, 10.
2. Fernando LCP, Wickramananda IR, Artchige NS, Maraes GJ. Studies of coconut mite *Aceria guerreronis* in Sri Lanka. Proc. Int. Workshop on coconut mite Aceria guerreronis. Coconut Research Institute, Sri Lanka. 2002; 1-12.
3. Gopal M, Gupta A. *Hirsutella thompsonii* the where withal to counter coconut eriophyid mite Scourge. Curr. Sci. 2001; 80(7):831-836.
4. Howard FW, Rodrigeuz EA. Tightness of the perianth of coconut in relation to infestation by coconut mites. Florida Entomol. 1990; 74:358-361.
5. Huang J, Zhang J, Yan L, Jun L, Xiao HS. Evaluation of the effectiveness of insecticide trunk injections for control of *Latoia lepida* (Cramer) in the sweet olive tree Osmanthus fragrans. Peer J. 2016, 2480.
6. Julia JF, Mariau D. New research on the coconut mite *Eriophyes guerreronis* (K.) in the Ivory coast. Oleagineux. 1979; 34:181-189.
7. Keifer HH. Eriophyid studies B-14. California. Department of Agriculture Bureau of Entomology, 1965, 20.
8. Macbean C. The Pesticide Manual, 15th ed., Ver. 5.1, Fipronil (120068-37-3), Alton, UK; British Crop Protection Council, 2008.
9. Moore D, Alexander L, Halls RA. The coconut mite, *Eriophyes guerreronis* Keifer in St. Lucia: yield losses and attempts to control it with acaricide, polybutene and *Hirsutell fundus*. Trop. Pest Manag. 1989; 35(1):83- 89.
10. Shivashankar T. New Syringe Method of insecticide administration technique to control coconut black headed caterpillar (*Opisina arenosella* Walker). Mysore J Agric. Sci. 1999; 30(4):301-305.
11. Shivashankar T, Annadurai RS, Srinivas M, Preethi G, Sharada TB, Paramashivappa, *et al*. Control of coconut black headed caterpillar (*Opisina arenosella* Walker) by systemic application of Soluneem- A new water-soluble neem insecticide formulation. Curr. Sci. 2000; 78(2):176-179.
12. Tomlin CDS. In: The Pesticide Manual, 13th ed., Version 3.1.Surrey UK, British Crop Protection Council. Buprofezin (69327-76-0), 2004.
13. Wislocki PG. Environmental aspects of abamectin use in crop protection. Springer, Verlag, New York, 1989.