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JOURNAL OF PLANT PROTECTION RESEARCH Vol. 50, No. 2 (2010)

DOI: 10.2478/v10045-010-0032-2

EFFECT OF BOTANICALS ON INFESTATION INTENSITY OF *ACERIA GUERERRONIS* KEIFER IN COCONUT

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Received: March 17, 2009
Accepted: March 25, 2010

Abstract: The withdrawal of chemical pesticides opens up a new perspective to control pests through botanical extracts. The essential oils derived from various medicinal and aromatic plants proved to have antifungal, antibacterial and insecticidal properties. The present study is directed towards management of a dreaded pest of coconut i.e. eriophyid mite through exploitation of those properties of the plants. The efficacy of a botanical biocide formulated by using seven different aromatic and medicinal herbs against the infestation intensity of eriophyid mite was tested in the experiment at five different coconut farms in different coconut growing states of India. Four application of the formulated product resulted up to 72.17% damage reduction.

Key words: *Aceria guerreronis* Keifer**,** age of nuts, population density, infestation intensity, botanical biocide

INTRODUCTION

Coconut palm an important plantation crop faces many disease and pest problems but since late sixties was attacked by coconut mite, *Aceria guerreronis* (Acari: Eriophyidae) causing large scale losses. This eriophyid mite (*A. guerreronis)* is a microscopic organism that feeds on soft meristematic tissues present under perianth of the coconut and was reported as one of serious pests of coconut in Americas and Africa for the last three decades (Mariau and Julia 1970; Zuluaga and Sanchez 1971; Mariau 1977; Hall and Espiosa 1981). The Eriophyid mite has introduced itself into Tanzania (East Africa), India and Srilanka. In the recent past, the pest spread rapidly to all coconut growing states of India (Muthiah 2007). The economic loss due to coconut mite in India was reported as 34% on an average (Nair *et al.* 2000). The mite takes about 10 days to develop from egg to adult and so thousands of mites build up rapidly beneath perianth of fruit (Howard and Moore 2006) and as reported its populations were significantly affected due to temperature, rain and relative humidity (Sujatha *et al.* 2008). Infestation by eriophyid mite is observed on nuts as triangular patches which later turn brown and corky, nuts become small and malformed, develop deep cracks and subsequently fall off. In short, all these symptoms indicate a diminishing quality and production of coconut thereby causing a fall in economics of this valuable crop.

Indiscriminate use of chemical pesticides through root feeding and spraying possess high range of drift and residual effects, respectively, resulting in worldwide efforts of finding alternative insecticides from plants or plant constituents. The botanicals were reported to be safer and were useful against crop pests by many authors. Botanical biopesticides are eco-friendly pesticides, which are stored in plants as secondary metabolites such as alkaloids, terpenoids, polyacetylenes, unsaturated isobutyl amides and rotenoids (Bhonde and Sharma 2002). Essential oils derived from medicinal and aromatic plants were found to exhibit insecticidal, antifeedant and repellant/attractant activities (Sharma and Malik 2001). Essential oils and their constituents were reported to be a potent source of environmentally safe biocides that could be exploited for commercial application (Amevan *et al.* 1998).

Therefore, the study was carried out on bioefficacy of the formulated botanical biocides prepared from seven different medicinal and aromatic plants for reduction of mite infestation in young coconut plantations in the experimental sites i.e. at five different coconut farms and progressive coconut farmers' fields.

MATERIALS AND METHODS

An experiment was designed to investigate the effects of the herbal formulation against the infestation intensity of eriophyid mite. For this a field trial was conducted under IMMT, Bhubaneswar at five different coconut farms of different coconut growing states of India, namely Karnataka Farm, West Bengal Farm, Orissa Farm, DSP Farm and Phillips Farm replicated five times in a Randomized block design (RBD) during 2007 and 2008. The Random-

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ized block design (RBD) is assumed as a two factor experiment i e., treatments and blocks. It reduces the variance in the data and samples are divided into relatively homogenous subgroups. The farms were selected after an extensive survey of the mite fauna occurring on coconut in these areas. In each farm hundred plants of same age were selected to carry out the experiment. The entire plot was divided into five replications each with 20 plants. In addition to this 20 plants were taken as control plants. The botanical biocide formulated from seven medicinal and aromatic herbs were applied for four times at three months intervals. The four applications were named as Monsoon application, winter application, spring application and summer application according to the season of application. Control plants were treated only with water.

Formulation and application of the botanical biocide

The botanical biocide was prepared from six different aromatic and medicinal herbal sources like Bana tulsi (*Hyptis suaveolense*), Tulsi (*Ocimum sanctum*), Patchouli (*Pogostemon cablin*), Citronella (*Cymbopogon winterianus*), Kalmegh (*Andrographis paniculata*) and Citrus (*Citrus limon*). The plant materials from these herbs were collected and subjected to hydro distillation to extract essential oils. In the present investigation extraction of essential oils from the medicinal and aromatic plants was done in small quantity through hydro distillation using an apparatus called Clevenger hydrodistilllation. After hydro distillation of the aromatic plant parts, the essential oils collected were analyzed by Gas Chromatography (NR/AM/EQ/99 SHIMADZU GC 14B) to record the number of components present in the oil. But for identification of the components present in the oil, GC-MS of the sample was carried out. GC-MS study revealed a number of components but some of the major bioactive components of the medicinal and aromatic plants are given in table 1.

Based on this principle distillation unit of capacity 50 kg was set for unhindered supply of essential oils for biocide preparation. The oils were then mixed in a specific proportion, amended with ethanol extract of Soapnut and diluted four times with ethanol. Similarly the herbal organic manure was prepared by composting the mixture of coir pith, farm yard manure, bana tulsi (*H. suaveolense*) and kalmegh (*A. paniculata)* for 3 months. In experimental sites the liquid formulation @ 25 ml in 250 ml of water per plant was sprayed using a plastic sprayer on inflorescences and young bunches along with the herbal organic manure applied @ 3 kg per plant by preparing rings of 1 feet wide and 1 feet deep leaving three feet around the plant.

Sample collection and observation

To estimate the mite infestation intensity the visual observations were performed based on a surface damage of the nuts from all the plants. The number of mite infested nuts and mite free nuts were counted individually from each bunch of every treated plant. Pre-treatment damage data were taken before application of the formulated botanical biocide. The observations on surface damage were made at every 3 months interval to record the effects of subsequent applications. The last observation on surface damage was recorded as the pre-treatment damage for next treatment. The nuts were divided into four categories according to a visible surface damage, after modifying the method of Moore *et al.* (1989):

– > 75% – severely infested
– 50 to 75 % – moderately infested
– 1 to 50 % – poorly infested
– 0% – no infestation or mite free.

The number of mite infested nuts was calculated by summarizing the severely infested, moderately infested and poorly infested number of nuts. Per cent reduction or the increase in damage was worked out based on the number of infested nuts before and after application. The data were then subjected to analysis of variance after appropriate transformation.

The data were also recorded on the increase or decrease in mite population on nut surface, for this five young nuts were collected randomly from each replication both from treated as well as the untreated plants.

The micronutrients of coconut water and dry matter of copra from treated and untreated nuts collected from trial farms were analyzed in four replicates. The samples were collected, sorted, cleaned up, extracted and finally examined.

RESULTS AND DISCUSSION

The results in table 2 revealed that the pre-treatment damage varied from 58.20 to 99.98%. After imposing treatments, at first post-treatment count, the botanical

Table 1. Major bioactive components of the essential medicinal and aromatic plants

Medicinal and aromatic plants	Major bioactive components	Contribution [%]
H. suaveolens	1. Sabinene 2. Trans caryophyllene 3. 1,8- cineole 4. Eugenol 5. α - terpinolene 6. d1 Limonene 7. E- citral 8. Z- citral 9. 1- phellandrene	17.94 11.71 8.25 8.10 6.43 5.92 4.07 2.79 2.46
O. sanctum	1. Methyl eugenol	75. 07
C. limon	1. D1 limonene 2. E- citral 3. Z- citral 4. Geraniol 5. Nerol	46.93 16.96 13.05 3.81 3.63
A. paniculata	1. Andrographolide	2.50
C. winterianus	1. Citronellol 2. Citronellal 3. α – elemol 4. Geranyl acetate 5. Limonene	29.42 21.22 9.72 5.98 2.53
P. cablin	1. Patchouli alcohol 2. Patchoulene 3. α – Humulene 4. β- caryophyllene	30.70 10.15 4.44 3.14

GC-MS of some sample was carried out at R & D centre, Som Extracts Limited, Ghaziabad

biocide contributed a significant effect to reduce the damage (35.16% damage reduction over pre-treatment damage) in Orissa. This was followed by Phillips farm, DSP farm, West Bengal farm and Karnataka farm, which recorded 22.41, 22.12, 15.15 and 13.53% reduction of damage respectively. After the second count, a range of 12.15 to 38.18% damage reduction was observed. The third count data recorded the maximum reduction in damage over the pretreatment data in Karnataka (72.71%), in the range of 21.33 to 72.71%. With the fourth application of the biocide, although the number of mite free nuts increased, the range of percentage reduction in damage was found to be 17.86 to 31.99%.

Along with the reduction in surface damage the herbal formulation was also found to be effective in reducing the mite population on nuts over control plants in the trial farms (Fig. 1).

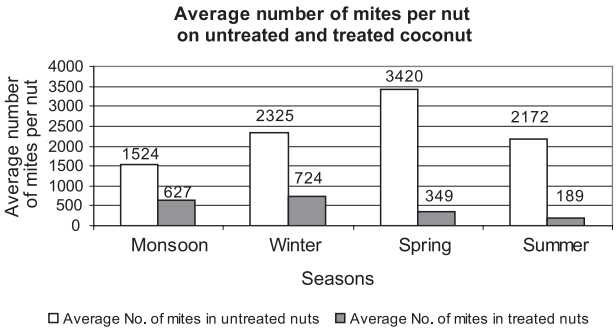

Fig. 1. Reduction of mite population after botanical biocide treatment

The analysis of micronutrients and dry matter from coconut water and copra, respectively, (Table 3, 4) revealed no negative impact of the botanical biocide treatment.

Table 2. Field evaluation of the formulated botanical biocide on *A. guerreronis* infestation intensity

Treatments	Mean % of surface damage of nuts in different trial farms due to eriophyid mite[1]									
	Karnataka farm		DSP farm		Phillips farm		West Bengal farm		Orissa farm	
	% damage	% damage reduction	% damage	% damage reduction	% damage	% damage reduction	% damage	% damage reduction	% damage	% damage reduction
Pre-treatment observation	49.7		63.9		61.3		56.4		90.0	
Aftermonsoon treatment	45.0	21.8	52.4	28.0	50.1	28.2	50.1	22.8	53.6	36.3
Afterwinter treatment	57.3	40.0	38.5	38.1	46.0	20.3	41.5	30.3	47.9	22.8
Afterspring treatment	26.5	59.5	31.9	31.8	36.2	34.7	36.0	27.4	38.6	32.5
Aftersummer treatment	21.7	34.1	28.6	25.0	30.0	32.2	30.0	31.6	31.0	34.4
SE (d)		1.36		0.48		0.54		0.33		0.51
CD (p = 0.05)		2.96		1.04		1.17		0.71		1.11
CD (p = 0.01)		4.14		1.046		1.64		1.00		1.55

[1]mean of five replications; the observations were taken three months after each application; the values are transformed and its significance was tested at 5% and 1% level of significance by CD test; SE – Standard error

Table 3. Micronutrient analysis of coconut water

Samples	Copper [ppm]	Manganese [ppm]	Zinc [ppm]	Cobalt [ppm]	Iron [ppm]	Crude Protein [%]
Treated	27.29	2.08	2.71	17.0	20.1	0.1
Untreated	17.65	1.25	3.15	17.5	17.7	0.1

Mean values of four nuts each from treated and untreated samples

Table 4. Dry matter analysis of copra

Samples	Crude protein [%]	Crude fibre [%]	Ash [%]	Natural fibre element [%]	Organic matter
Treated	5.0	10.0	2.45	49.37	96.8
Untreated	5.76	9.0	1.8	48.2	98.2

Mean values of four nuts each from treated and untreated samples

Thus it could be concluded that the formulated botanical biocide in the form of spraying and soil application was found effective in reducing the infestation intensity as well as population of eriophyid mite, thus could serve as an eco-friendly approach in future pest management strategies, however it needs further research for stable results over environments.

ACKNOWLEDGEMENTS

The authors are thankful to Coconut Development Board, Kochi, Kerala for its financial assistance. Authors are also thankful to Prof. B.K. Mishra, Director, IMMT for his valuable suggestions, active participation and encouragement and for providing necessary infrastructure facilities.

REFERENCES

Amevan Zollo P.H., Biyiti L., Menut C., Lamaty G., Bouchet P. 1998. Aromatic plants of tropical central africa. Part XXXII. Chemical composition and antifungal activity of thirteen essential oils from aromatic plants of Cameroon. Flavor Fragrance J. 13**:** 107–114.

Bhonde S.B., Sharma R.N. 2002. Studies on the biocidal activities of certain essential oils. J. Med. Aromat. Plant Sci. 24 (3): 721–725.

Hall R.A., Espinosa B.A. 1981. The coconut mite, *Eriophyes guerreronis*, with special reference to the problem in Mexico. p. 113–120. In: Proc. of BCPC Conference – Pests and Diseases. 16–19 November 1981, Farnham, UK.

Howard F.W., Moore D. 2006. A Coconut Mite, *Aceria guerreronis* Keifer (Arachnida: Acari: Eriophyidae). http://edis.ifas.ufl.edu

Mariau D. 1977. *A*ceria *(Eriophyes) guerreronis*: an important pest of African and American coconut groves. Oleagineux 32: 101–109.

Mariau D., Julia J.F. 1970. Acariasis caused by *A. guerreronis* (Keifer), pest of the coconut palm. Oleagineux 25: 459–464.

Moore D., Alexander L., Hall R.A. 1989. The coconut mite, *Eriophyes guerreronis* Keifer in St. Lucia: Yield losses and attempts to control it with acaricide, polybutene and Hirsutella fungus. Int. J. Pest Manage. 35 (1): 83–89.

Muthiah C. 2007. Estimation of yield loss caused by eriophyid mite on coconut. Ann. Pl. Protec. Sci. 15 : 484-486.

Nair C.P.R. 2002. Status of eriophyid mite, *Aceria guerreronis* Keifer in India. p. 9–12. In: Proc. of Int. Workshop on Coconut Mite (*Aceria guerreronis*) (L.C.P. Fernando, G.J. de Moraes, I.R. Wickramananda, eds.). 6–8 January 2000, Coconut Research Institute, Lunuvila Sri Lanka.

Sharma S.S., Malik O.P. 2001. Insecticidal, antifeedant and growth inhibitory activities of essential oils of some medicinal plants. J. Med. Aromat. Plant Sci. 22: 373–377.

Sujatha A., Chalapathi Rao N.B.V., Raji Reddy D. 2008. Influence of weather parameters on population build up of coconut eriophyid mite. Ann. Plant Protect. Sci. 16 (1): 203–267.

Zuluaga C.I., Sanchez P.A. 1971. La rona o esoriacion de los frutos del cocotero (*Cocosnucifera* L.) en Colombia. Oleagineux 26**:** 767–770.

POLISH SUMMARY

DZIAŁANIE PRODUKTÓW ROŚLINNYCH NA NASILENIE ZAKAŻENIA PALM KOKOSOWYCH PRZEZ *ACERIA GUERERRONIS* KEIFER

Wycofanie środków chemicznych otwiera nowe perspektywy zwalczania szkodników wyciągami roślinnymi. Udowodniono, że olejki eteryczne pochodzące z różnych roślin leczniczych i aromatycznych mają właściwości przeciwbólowe, przeciwbakteryjne i owadobójcze. Badania były ukierunkowane na opanowanie występowania roztocza (*Aceria guererronis*) pasożytującego na palmach kokosowych, przy wykorzystaniu właściwości wspomnianych roślin. Badano skuteczność sformułowanych biocydów roślinnych, do sformułowania których wykorzystano siedem różnych, aromatycznych i leczniczych roślin. Nasilenie porażenia testowano na pięciu farmach, gdzie uprawiano palmy kokosowe, położonych w różnych stanach Indii. Zastosowanie czterech zabiegów zwalczania przy użyciu opracowanej formulacji produktu spowodowało zmniejszenie porażenia średnio o 72,17%.