Evaluation of acaricidal potential of essential oils of plants against coconut mite

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Essential oils of plants have been identified as potential alternatives for the synthetic chemicals in pest control strategies. As far as the control of acarine pests is concerned, knowledge on effectiveness of plant essential oils is much limited. Results of the current study have confirmed the acaricidal potential of the oils tested against A. *guerreronis*.

Abstract

Toxic effect of the essential oils of *Lavendula angustifolia, Bursera pencillata, Syzygium aromaticum* and *Cyperus rotundus* has been evaluated against the coconut mite *Aceria guerreronis* through bioassay on infested coconuts. The study has established the toxicity of all the four oils on the mite to varying extent. *L. angustifolia* (EC_{50} = 0.09 and EC_{90} = 1.30 mg/nut) recorded highest acute toxicity. This is followed by B.*pencillata* (EC_{50}= 0.12 and EC_{90} = 1.09 mg/nut), *S. aromaticum* (EC_{50} = 0.20 and EC_{90} = 1.22 mg/nut) and *C.rotundus* (EC_{50}=0.28 and EC_{90} =1.56mg/nut) respectively. The investigation further highlighted the potential of these oils for the regulation of the coconut mite and the prospects of essential oils of plants as novel source of acaricides.

Introduction

Mites (Acari) represent one of the interesting and economically important groups of arthropods. This is particularly because of their role as parasites of domestic animals and man, vectors of plant, animal and human diseases and pests of cultivated plants. Among the acarine pests of agricultural crops, the eriophyid mite *Aceria guerreronis,* popularly known as coconut mite has been identified as a major concern in all coconut producing countries of the world[1,2,3,4,5,6]. This pest has been reported for the first time in India during 1998[7] from Kerala and known to incur heavy damage to the crop yield[8,9,10]. Early attempts for control of the mite involved application of synthetic chemical pesticides[3,11]. Investigation on biocontrol possibilities against the mite has identified the fungus *Hirsutella thompsonii* as a potent agent[12]. Later studies focused on the application of *H. thompsonii* for biological control of the pest at different parts of Mexico and India[13,14,15] have reported good results. However, similar attempts carried out at West Africa and St. Lucia were reported to be less encouraging[6,16]. In a review of nonchemical control strategies against coconut mite, Moore (2000) opined that strategic research to be focused on pathogenic fungi against the mite, particularly towards derivation of practically applicable formulations[17]. While analyzing the field situations in India, Mallik *et al.* concluded that adoption of optimal farming practices along with root feeding of azadirachtin would help in managing the economic loss due to coconut mite and also recommended selective propagation

of resistant varieties of coconut as a long term strategy[18]. Hence, it is apparent that the mite continues to maintain its pest status and an efficient regulatory strategy against the problem still remains elusive.

While considering the pest management strategies evolved against acari in general, utilization of essential oils of plants or their components appears to be an emerging area of knowledge during recent times[19,20]. Therefore, attempt has been made in the current study to explore the potential of essential oils of plants as effective toxins against coconut mite.

Materials and Methods

Collecting of coconuts and detection of mites

Young developing nuts, approximately between the age of 4-6 months were collected from infested trees in a private farmland near the premises of Biotechnology Research Centre. The nuts were transported to the laboratory during early hours (8.00 - 9.00 am IST). The presence of mites on the nuts was verified by removing one of the outermost tepals and observing under sterol microscope (Nikon-SMZ) at 20X magnification. The infested nuts containing live mites underneath their observed tepals were chosen for the bioassay.

Essential oils and stock

Essential oils of *Bursera pencillata* (fruit) and *Cyperus rotundus* (rhizome) were hydrodistilled in a clevenger-type apparatus, separated and dehydrated over sodium sulphate and stored at 4°C until use. Whereas oils of *Lavender angustifolia* (floral parts) and *Syzygium aromaticum* (leaf) were purchased from a local commercial supplier. Infested nuts were exposed to various concentrations of the oils.

Laboratory bioassay and experimental design

During the current study, acaricidal activity of the essential oils of 4 plants listed in Table 1 was analyzed. Six replicates were carried out for each concentration along with a control for individual oils. Infested nuts were randomly selected for the above trials. Each experimental nut was sprayed with 3 ml of different concentrations (0.01, 0.025, 0.05, 0.1, 0.25, 0.5 and 1.0 mg/ml) of oil samples dissolved in water with ethanol as emulsifier (2.9 ml water with 0.1 ml ethanol), using a small hand held sprayer, by keeping them in vertical position with perianth facing downwards. This was done to confirm the contact of the oil with the mite. (Actual quantity of oil applied per nut was 0.03, 0.075, 0.15, 0.3, 0.75, 1.5 and 3.0 mg). Control nuts were sprayed with 1 per cent (v/v) ethanol in water. The treated nuts were kept in open air and were maintained at 27±2°C and 70-75% RH throughout the assay period . The mortality was determined as illustrated in following section and data were recorded after 2 hrs of treatment. The experiment was discarded and repeated if the Mean per cent mortality in the control was more than 15 per cent.

Determination of mortality

The assessment of the population density on individual infested nuts was carried out by the method described by Siriwardene *et al.* with modifications[21]. The mites were extracted from the nuts by removing the tepals one by one and washing in 30 ml of detergent solution (Tepol, 1 per cent solution). After washing all the tepals, the nut was also washed in the same sample of detergent solution to dislodge and transfer all the individuals from the nut to the solution, termed as 'mite suspension' hereafter. The 'mite suspension' was agitated for 5s for the mites to get distributed uniformly and make the suspension homogeneous. One ml of the suspension containing mites was spread over 50 cm^2 petriplate as a thin film, which allowed distinguishing between live and dead mites and counting under a stereo microscope. The individuals displaying straight posture, without movement were considered dead and those posing curved posture and slight movement were considered alive. Separate data was maintained on the number of live and dead mites on individual nuts treated with the oils. The total number of live and dead mites per nut was determined by manually counting the live/dead mites in 1 ml of mite suspension multiplied by the amount of detergent solution used to wash one nut (30 ml). The population density of mites on each individual coconut used as sample was varied. In order to overcome the error due to this fact, percentage mortality of the mites for given concentration was calculated. The Mean percentage mortality was estimated by determining the ratio of sum of percentage mortality to that of the number of trials conducted for each concentration. The Mean percentage mortality was further corrected using Abbot's foumula[22].

$$\text{Corrected Mean\% mortality} = \frac{\text{Mean \% Mortality - control}}{\text{100-control}} \times 100$$

control = Mean % mortality of control

Data analysis

The Effective concentration (EC_{50} and EC_{90}) were calculated using computerised profit analysis software (Statsdirect) and χ^2 test was also carried out. This was used to choose the most effective oil.

Result and Discussion

All the four essential oils tested during the current study have exhibited toxic effect on *A. guerreronis* to varied extent. Effective concentration of the essential oils of *L. angustifolia, B. pencillata, S. aromaticum* and *C. rotundus* against coconut mite is presented in Table 1. Investigations on non-chemical control measures against coconut mite are often focused mainly on the fungal pathogen *H. thompsonii*[6,13,14,15,16,17] throughout the coconut belt of the world. Current study has attempted to explore the potential of essential oils of plants for the purpose. Essential oils of plants have been identified as potential alternatives for the synthetic chemicals in pest control strategies[22]. As far as the control of acarine pests is concerned, knowledge on effectiveness of plant essential oils is much limited[19,20]. Results of the current study have confirmed the acaricidal potential of the oils tested against *A. guerreronis*. Among the four oil samples subjected for bioassay, oils of *L. angustifolia* and *B. pencillata* have shown relatively higher levels of toxicity when compared to *S. aromaticum* and *C. rotundus*, as evident through the lower EC_{50} and EC_{90} values exhibited by them. However, toxicity levels exhibited by the other two oil samples were also found encouraging, as the acute toxicity levels of these oils were found comparatively lower. Therefore, the study has established the potential of these oils as effective toxins against the mite, thereby indicating their prospects as acaricides. However investigation on effects of these oils on non-target organisms, especially natural enemies of coconut mites is warranted before recommending these as alternative control measure against the pest.

Table 1. Effective concentration of different essential oils of experimental plants against **A. guerreronis**

Plants	Conc.	Mean % mort.	Ec_{50}(LCL-UCL)	EC_{90} (LCL-UCL)	χ^2 test
L. angustifolia	0.03	11.35	0.09(0.02-0.33)	1.30(0.21-8.53)	117.1**
	0.075	28.33			
	0.15	44.02			
	0.30	66.64			
	0.75	79.99			
	1.50	91.62			
	3.00	100.00			
B. pencillata	0.03	5.68	0.12 (0.04-0.33)	1.09(0.23-5.25)	110.7**
	0.075	29.29			
	0.15	44.16			
	0.30	51.41			
	0.75	71.52			
	1.50	100.0			
	3.00	100.00			
S. aromaticum	0.03	6.28	0.20 (0.14-0.28)	1.22 (0.76-2.01)	16.5*
	0.075	28.67			
	0.15	44.21			
	0.30	63.47			
	0.75	70.62			
	1.50	91.43			
	3.00	100.0			
C.rotundus	0.03	2.66	0.28(0.18-0.42)	1.56(0.86-2.93)	29.1**
	0.075	18.90			
	0.15	36.13			
	0.30	54.79			
	0.75	61.79			
	1.50	83.96			
	3.00	100.0			

**Significant at P<0.01; **Significant at P < 0.0001; LCL : Lower confidence limit; UCL: Upper confidence limit. The concentrations shown in the table are in mg/nut.*

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Kappadam

The spread of Kappadam variety of coconut is more or less confined to a few centres in the Trissur district of Kerala. The palms are tall and stout with strong and short leaf stalks. The leaflets are longer and the nut size is bigger than that of WCT. It has a long pre-bearing period of 9-10 years and the productivity rarely exceeds 40 nuts per palm per year with only 3-4 nuts per bunch.

The nuts are big in size with a copra out-turn of 250-280 g per nut. But the oil content in copra is not as much as in WCT. The experience of farmers is that under good management it is possible to shorten the prebearing period and also to obtain higher yield of nuts. In properly managed gardens the palms have been found to start bearing in 7-8 years and yield more than 50 nuts per palm per year even without irrigation.

Source : Farmer's Assessment of Coconut Varieties in Kerala