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An assessment of talc formulation of *Hirsutella thompsonii* against coconut eriophyid mite (*Aceria guerreronis* Keifer) in field condition at Karnataka

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Abstract

Currently, several chemicals have been evaluated against the coconut eriophyid mite *Aceria guerreronis* Keifer (Acari: Eriophyidae). But these chemicals are not eco-friendly, have a chance of development of resistance and have a residual effect. Hence, there is a need to assess a safer entomopathogen to manage the coconut mite. Considering this mite pest to cause extensive damage, attempt was made to evaluate the efficacy of *Hirsutella thompsonii* Fisher for the management of eriophyid mite. The four-year pooled data (2014-15 to 2017-18) revealed that spraying of talc formulation of *H. thompsonii* @20 g/palm - 3 sprays during October, January and April was recorded the least mite damaged nuts (58.16%), mite population (10.52 per 4 mm²) and Mean Grade Index-MGI (0.81) has been found effective in reducing the mite population followed by spraying *H. thompsonii* @ 20 g/palm during October + botanical formulation (2% Neem oil - garlic - soap emulsion) during January, April treated palms registered the least damaged nuts of (64.01%), mite population (11.24 per 4 mm²) and MGI (1.18) and Spraying palm oil - sulphur emulsion - 3 sprays/year during October, January and April recorded fewer damaged nuts of (67.89%), mite population (12.95 per 4 mm²) and MGI (1.42) compared to untreated control with higher damaged nuts of (80.49%), mite population (20.50 per 4 mm²) and MGI (2.28). It is concluded that spraying of talc formulation of *H. thompsonii* @ 20 g/palm recorded the least mite damaged nuts, mite population per 4 mm² and mean grade index has been found effective in reducing the mite population in coconut at Arsikere centre, Karnataka.

Keywords: *Aceria guerreronis*, *Hirsutella thompsonii*, Coconut and Karnataka

Introduction

Coconut (*Cocos nucifera*) is commonly known as the 'tree of life' and is planted in over 90 countries, mainly in Asia, Pacific Islands and South America. The total world planted area of coconut is about 12 million ha with the annual estimated potential production of 70 billion nuts. Currently, India, Indonesia and Philippines are the major coconut producers, contributing more than 75% of the total global production (Hoethenkek, 2018) [15]. Coconut eriophyid mite, *Aceria guerreronis* Keifer (Eriophyidae: Acarina) is a potential and invasive pest of coconut causing heavy economic loss to the coconut industry (Nair *et al.*, 2005) [23]. It was first recorded in 1965 in Guerrero state of Mexico (Keifer, 1965) [16]. The first report on occurrence of this exotic mite was made by Sathiamma *et al.* 1998 [28] at Amballur panchayat in Ernakulam district of Kerala during 1998 and followed by parts of Tamil Nadu and Karnataka (Yuvaraja, 2012) [4]. The host range of *A. guerreronis* was recorded from palmyrah palm (*Borassus flabellifer*) in India (Ramaraju and Rabindra, 2001) [27].

Coconut eriophyid mite is a tiny creamy-white, vermiform organism measuring 200-250 microns in length and 20-30 µm in width (Keifer, 1965) [16]. The body is elongated, cylindrical, finely ringed and bears two pairs of legs at the anterior end. Mites attain sexual maturity within a week's time and start laying eggs. An adult mite has lays about 100-150 eggs. The eggs hatch into protonymphs, deutonymphs and finally to adults. The full life-cycle is completed in a period of 7-10 days (Mohanasundaran *et al.*, 1999; Haq, 2001) [21, 14]. In coconut, mites infest the developing young buttons after pollination and form active colonies containing various stages of development, which includes eggs, nymphs and adults inside the floral bracts (tepals) and feed on the soft meristematic portions beneath the perianth.

High reproductive potential and shorter life cycle of the mite result in the enormous multiplication of the colonies. When colony size becomes substantially increased, mite emerges out of the interspaces between the tepals of the developing nut for dispersal. Dispersal of the pest takes place mainly through wind. Honeybees and other pollinators visiting inflorescence of coconut also act as agents for dispersal. Due to feeding the perianth appears initially as whitish triangular patches, as the nuts grow in size, triangular yellow patches become visible, followed by large brownish patches with longitudinal fissures. In case of severe attack the buttons shed, resulting in poor nut setting, intact nuts are deformed, undersized and poorly developed. The farmers of West Bengal call this symptom as "Safeda Dag" (Apurba Bandyopadhyay and Khan, 2003; Yuvaraja, 2012)^[1, 33].

The coconut palm put forth on an average of one inflorescence per month. Thus, throughout the year the mite could locate nuts of suitable age for initiating infestation and population build-up. Peak population was observed during the summer months and a sharp decline in succeeding rainy months representing a negative rapport between mite population and rainfall (Mathew *et al.*, 2000; Nampoothiri *et al.*, 2002; Mallik *et al.*, 2004)^[20, 24, 19]. Studies undertaken in Kerala coast revealed that a period of high temperature with intermittent rains causing high humidity favored higher reproduction and rapid spread of the mite (Nair *et al.*, 2003)^[22]. An observation on the population of the mite within various age groups of the nuts showed that third and fourth bunches harbor maximum mite population.

In Karnataka though pest damage has been reported initially ranging from 18-42%, when severe infestation symptoms were seen on more than 50% of surface area of infested nuts (Mallik *et al.*, 2003)^[18]. Mite damage caused significant reduction in quality of fibers in terms of fiber length and tensile strength. It is revealed that fibers from moderate to severe infested nuts suffered 26-53% reduction in length (Naseema Beevi *et al.*, 2003)^[25]. Observations recorded during subsequent years revealed, an overall reduction in incidence and intensity of pest in areas of its initial occurrence with loss in terms of copra ranging from 8-12% (Rajan *et al.*, 2007)^[26] reported that different grades of mite infested seed nuts could not considerably influence on the growth and vigor of the coconut seedlings in terms of number of leaves, collar girth, seedlings with split leaves as well as on the number of thick roots. They have also recommended that the mite infested seed nuts should be sorted into different lots according to severity of infestation and nursery should be raised separately.

Hirsutella thompsonii Fisher (mitosporic fungi: Hyphomycetes) is a well known fungal pathogen which is commonly associated with the acarines. The mode of penetration of *Hirsutella thompsonii* into the mites is mainly through the legs, which later on forms hyphal bodies in chains in the haemolymph. Hyphae, on which spores are produced, emerge through the mouth as well as genital and anal apertures first and then form all over the body. From the safety point of view, *Hirsutella thompsonii* has been found to be safe to mammals and there is no report of researchers handling this fungus experiencing any ill effects. Hall *et al.* 1980 were the first to study the natural mortality factors of coconut eriophyid mite and to establish the fungus *Hirsutella thompsonii* to be a naturally occurring control agent of *Aceria guerreronis*.

Currently, there are several chemicals have been evaluated against the coconut eriophyid mite *A. guerreronis*. But these chemicals are not eco-friendly, have a chance of

development of resistance and have a residual effect. Hence, there is a need to assess a safer entomopathogen to manage the coconut mite. Considering this mite pest to cause extensive damage, attempt was made to evaluate the efficacy of *Hirsutella thompsonii* Fisher for the management of eriophyid mite. The information on the ecofriendly management of coconut mite involving entomopathogen is very much lacking. Keeping this in view, the present study was carried out with eco-friendly approaches to manage coconut mite.

Methodology

The trial was conducted at Horticulture Research and Extension Centre, Arsikere, Hassan district, Karnataka state during the year of 2014-15, 2015-16, 2016-17 and 2017-18. Randomly, 20 palms in each treatment were replicated it for 4 times, totally eighty palms were selected for the experiment. The pre-treatment observations were recorded before imposing the treatments, tagged the first pollinated bunch as number 1 bunch. That bunch was scored for mite infestation index at 12th month maturity stage. Counted and recorded the total number of nuts and mite infested nuts (shown external symptom), bunch wise from the 1st tagged bunch onwards till the last matured. Single nut has been selected from 4th bunch as sample nut for assessment of mite population. Score the last bunch nut wise for mite severity symptom in a 0 - 4 score. A score of 0-4 scale was developed for recording the extent of mite damage on coconuts (CPCRI, 2014)^[7]. Nuts without mite infestation (healthy-score 0), nuts with less than 25% surface damage (low infestation-score 1), 25-50% nut surface damage (medium infestation-score 2) and 51-75% nut surface damage (high- score -3) and more than 75% surface damage, malformed and puny nuts (severe-score 4).

Recorded Mite Grade index of harvested nuts as per the scale.

% damage on nut surface	Scale	Grade Index	Intensity
Nuts with no mite damage	0	0	Nil
< 25%	1	0.1 - 1.0	Mild
25 - 50%	2	1.1 - 2.0	Moderate
50 - 75%	3	2.1 - 3.0	High
> 75%	4	3.1 - 4.0	Severe

Preparation of 2% Neem oil - garlic- soap emulsion

To prepare 1 litre of mixture 20 ml Neem oil, 20 gram cleaned garlic pearls and 5 gram washing soap are required. Dissolved the washing soap in 500 ml water, added the Neem oil to this solution and mixed it well to form an emulsion. In another 500 ml of water, mixed the well-ground garlic and added this to the soap Neem oil mixture by sieving through a cloth to remove the debris of garlic pearls. This mixture was stirred well and it was used for spraying on the day of preparation itself.

Preparation of palm oil - sulphur- soap emulsion

To prepare 1 litre of mixture 200 ml palm oil, 800 ml of water, 5 gram wet table sulphur (80%) and 12 g soap powder are used. Dissolved the soap and sulphur in water and then added palm oil and mixed thoroughly. This mixture has stirred well and was used for spraying on the day of preparation itself.

Sprayed the nuts in all 6 bunches from top (younger to older) as per the treatment so as to cover the perianth region of the nuts with fine spray solution. Post treatment

observations were also recorded at three, six month's intervals. Simultaneous observations were also made in control plot.

The experiment has been imposed with the following four treatments

T₁: Spraying talc formulation of *H. thompsonii* @ 20 g/palm - 3 sprays during October, January and April

T₂: Spraying *H. thompsonii* @ 20 g /palm during October, followed by Botanical formulation (2% Neem oil - garlic - soap emulsion) during January and April

T₃: Spraying Palm oil - sulphur emulsion - 3 sprays/year during October, January and April.

T₄: Control.

Observations recorded

1. Population from 6 mite colonies from one sample nut of 4th bunch (3 from nut surface and 3 from inner perianth lobes) in an area of 4 mm x 4 mm was counted under microscope and expressed as average mite/ mm².
2. Mite population has been counted by washing method from the same sample nuts drawn with the help of a haemocytometer.
3. Predator count from 6 mite colonies from one sample nut of 3rd and 4th bunch and as average predator number per nut.
4. Incidence: percent of nuts showing eriophyid mite damage on 20 palms was recorded (Nuts with damage symptoms per palm/ Total nuts observed X 100).
5. Incidence of eriophyid mite in new bunches (5 bunches) after spraying
6. Establishment of *H. thompsonii* colonies in sample nuts after spraying.
7. Recorded Grade index of harvested nuts as per the scale

Method of Spraying

As the mite colonies are lodged inside the soft tissues of the developing nuts covered by the perianth, botanical formulation should be applied as fine droplets on the perianth region from top so as to provide its penetration into the perianth lobes through surface tension. Pesticide solution should cover 2 to 6 month old nuts since these bunches harbor the maximum number of mites. There is no need to spray the un pollinated and mature nuts in the palm. Spraying was done by trained person with the help of Gutter sprayer. The spraying was done to all bunches (except the unfertilized flowers spathe) by calculating the volume of solution required for each treatment (Bagde *et al.*, 2014) [3].

Results and Discussion

The trial was conducted at HRES, Arsikere Hassan district, Karnataka for about 4 years. Before application of treatments, it was observed that the population of eriophyid mite ranged between 17.54 to 19.12/4 mm² before initiation of spraying. After three months of spraying, all the treatments showed significant reduction in mite population (14.57 to 15.85/4 mm²) when compared to control (20.25/ 4 mm²). The extent of nut damage in different treatments ranged from 71.20 to 74.13% with a mean grade index of 1.6 to 2.00 before the initiation of the experiment. After three months of spraying, the treatment T₂ *H. thompsonii* treated palms registered the least damaged nuts (67.92%) and mean grade index (1.25) whereas after six months of spraying the treatment T₁ *H. thompsonii* treated palms recorded the least damaged nuts (61.32%) and mean grade index (0.84). (Table 01)

Similarly, in the year of 2015-2016 it was observed that the population of eriophyid mite ranged between 17.57 to 18.34/4 mm² before initiation of spraying. After three months of spraying, all the treatments showed significant reduction in mite population (15.11 to 14.37/4 mm²) when compared to control (19.87/4 mm²). The extent of nut damage in different treatments ranged from 69.31 to 70.92% with a mean grade index of 1.65 to 1.88 before the initiation of the experiment. After three months of spraying, the treatment T₂ *H. thompsonii* treated palms registered the least damaged nuts (65.43%) and mean grade index (1.24) whereas after six months of spraying the treatment T₁ *H. thompsonii* treated palms recorded the least damaged nuts (58.94%) and mean grade index (0.73). (Table 02)

Similarly, in the year of 2016-2017 it was observed that the population of eriophyid mite ranged between 15.24 to 18.12/4 mm² before initiation of spraying. After three months of spraying, all the treatments showed significant reduction in mite population (12.15 to 14.25/4 mm²) when compared to control (20.11/4 mm²). The extent of nut damage in different treatments ranged from 65.21 to 70.59% with a mean grade index of 1.54 to 1.82 before the initiation of the experiment. After three months of spraying, the treatment T₁ *H. thompsonii* treated palms registered the least damaged nuts (62.23%), and mean grade index (1.22) whereas after six months of spraying the treatment T₁ *H. thompsonii* treated palms recorded the least damaged nuts (54.20%) and mean grade index (0.82). (Table 03)

Similarly, in the year of 2017-2018 it was observed that the population of eriophyid mite ranged between 15.27 to 17.44/4 mm² before initiation of spraying. After three months of spraying, all the treatments showed significant reduction in mite population (13.08 to 15.85/4 mm²) when compared to control (18.36/4 mm²). The extent of nut damage in different treatments ranged from 71.55 to 73.55% with a mean grade index of 1.69 to 1.75 before the initiation of the experiment. After three months of spraying, the treatment T₁ *H. thompsonii* treated palms registered the least damaged nuts (64.96%) and mean grade index (1.34) whereas after six months of spraying the treatment T₁ *H. thompsonii* treated palms recorded the least damaged nuts (55.81%) and mean grade index (0.74). (Table 04)

Similarly, in the pooled data of 4 years it was observed that the population of eriophyid mite ranged between 17.20 to 17.91/4 mm² before initiation of spraying. After three months of spraying, all the treatments showed significant reduction in mite population (13. 73 to 15.45/4 mm²) when compared to control (19.74/4 mm²). The extent of nut damage in different treatments ranged from 70.07 to 72.52% with a mean grade index of 1.61 to 1.83 before the initiation of the experiment. After three months of spraying, the treatment T₂ *H. thompsonii* treated palms registered the least damaged nuts (66.02%) and mean grade index (1.29) whereas after six months of spraying the treatment T₁ *H. thompsonii* treated palms recorded the least damaged nuts (58.16%) and mean grade index (0.81). (Table 05)

Among microbial acaropathogens, fungi contribute the predominant pathogens of coconut eriophyid mite. Fungal species associated with eriophyid mite include species of *Sporothrix*, *Poecilomyces*, *Beauveria*, *Metarhizium*, *Verticillium*, *Acremonium*, *Aspergillus*, *Penicillium*, *Fusarium* and *Hirsutella thompsonii* (Kumar *et al.*, 2001) [17] and *Scopulariopsis brevicaulis* (Gopal *et al.*, 2002) [12]. Pathogenicity trials with *Fusarium moniliformae*, Actinomycetes, bacteria and *H. thompsonii* resulted in

34.3%, 10%, 4.5% and 76% mortality, respectively of the mite in treated nuts. *Lecanium* spp. (Chandrika *et al.*, 2010) [5].

The fungal pathogen, *H. thompsonii* has received considerable attention throughout the world as the most effective natural enemy of eriophyid mite of coconut. This fungus has three varieties of which *synnemetosa* has been more often invading *A. guerreronis*. In India the incidence of *H. thompsonii* was recorded from Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Pondicherry, Odisha and Lakshadweep Islands (Chandrika *et al.*, 2010) [5]. *H. thompsonii* is perceived as one of the most potent biological control agents for this pest (Fernando *et al.* 2000) [11] especially because a majority of coconut growers quit using chemical pesticides. Because of the huge demand, a powder formulation (Mycohit) of *H. thompsonii* was developed during 2000 in India to enable its registration and commercialization (Sreerama Kumar *et al.*, 2002) [29]. The control of *Aceria guerreronis* through applications of the *Hirsutella thompsonii* was studied in a coconut plantation in Guerrero, Mexico, in 1982 and 1983. Mortality due to the fungus of 25-75% has been achieved (Espinosa Becerril 1986) [10]. CPCRI has collected potent native isolates of this fungus from diverse locations of India. A total of 42 isolates of *H. thompsonii* were collected and maintained. Pathogenicity tests were carried out with all the 42 isolates of *H. thompsonii*. Pathogenicity was proved positive by establishing Koch's postulates with 9 isolates when carried out in detached nuts harboring mite colonies. Talc-based preparation of *H. thompsonii* (isolate CPCRI 51-II) @ 20g/litre/palm containing 1.6×10^8 cfu with a frequency of three sprayings per year resulted in 63-81% reduction in mite population in the field (CPCRI 2011) [6].

The present findings are in agree with field trial was conducted during October 2011 at Nileswaram, Kasaragod, was continued during 2012 with three rounds of spray by *Hirsutella thompsonii* @ 20 g per palm (1.6×10^8 cfu) during January, May and November. One Mite incidence in the treated palms showed 59 to 65% reduction over the pre treatment period (CPCRI, 2014) [7]. Field application of *Hirsutella thompsonii* in combination with Neem oil/garlic/soap or alternating with botanicals during summer was found superior in suppressing mite population (CPCRI, 2015) [8]. The acaropathogenic fungus, *Hirsutella* isolate (CPHKLA-1) was found effective in the bio-suppression of coconut eriophyid mite (CPCRI, 2016) [9].

The present findings of *H. thompsonii* treated palms

recorded the least damaged nuts (58.16%) and mean grade index (0.81) at Arsikere centre was in conformity with the findings of Sreerama Kumar and Leena 2008 [30], who studied in the field, a newly developed mycelial formulation of *H. thompsonii* applied to coconut bunches brought down the post treatment population of the coconut mite by 85.6-97.1%. Application of the *H. thompsonii* in combination with glycerol resulted in a tolerable mean nut damage grade of 2.0 during the pre-harvest stage, compared with an acute score of 4.0 in control palms. *Hirsutella thompsonii* as biological control agents of *A. guerreronis* on coconut in Sri Lanka (Aratchige, 2009) [2]. Local surveys were carried out in Sri Lanka to assess background levels of *H. thompsonii* from coconut mite populations. Environmental profiling, based primarily in the laboratory, assessed the suitability of each isolate as a biological control agent. Coconut mites infected with *H. thompsonii* were found in each district they have surveyed (Steven Edgington, 2008) [32]. The fungal pathogens namely, *Hirsutella thompsonii*, *Beauveria bassiana*, *Fusarium semitectum* and few opportunistic pathogens namely, *Fusarium moniliforme*, *Cladosporium tenuissimum*, *Aspergillus niger*, *Penicillium* sp. and *Mucor* sp. were collected from eriophyid mite populations in different parts of Karnataka region. Of the total collected nuts, 3.54% were infected by *H. thompsonii*, (Basavaraj Kalmath, 2012) [4]. The fungus *H. thompsonii* is considered to be the most promising potential biological control agent. A survey to find natural enemies of *A. guerreronis* was undertaken in 18 localities, mainly in the Pacific and Indian Ocean areas. Several fungi were found associated with both mite species, only one, *Hirsutella thompsonii*, being pathogenic. It is considered that *H. thompsonii* offers the most potential for biological control (Hall *et al.*, 1980) [13]. The present findings are in line with the works of Sreerama Kumar, 2009 [31] who reported that fungus was capable of bringing down the mite population up to 90%, resulting in considerable reduction in pre-harvest nut damage. In several trials, the fungal treatment was superior to azadirachtin, dicofol, triazophos, and wettable sulphur. *H. thompsonii*, a mite-specific fungus, is the only natural enemy that has been evaluated on a large-scale as a biological control agent for the coconut mite so far. The striking association of *H. thompsonii* with the coconut mite, and the ability of the fungus to establish natural regulation of the pest across all the infested areas in south India, suggested that it would pay to augment the fungus to suppress the pest.

Table 1: Grade index of harvested nuts, mite intensity and mite population per 4 mm² in experimental garden at Arsikere (2014-15)

Tr. No.	Pre treatment observation(Oct. 2014)			Post treatment observation (3 months after spraying) (Jan. 2014)			Post treatment observation (6 months after spraying) (April 2015)		
	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%)#	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **
T ₁	73.35 (58.92)	1.8 (1.34)	18.52 (4.30)	68.44 (55.82)	1.3 (1.14)	14.84 (3.85)	61.32 (51.54)	0.84 (0.92)	11.81 (3.44)
T ₂	71.20 (57.54)	1.6 (1.26)	18.32 (4.28)	67.92 (55.50)	1.25 (1.12)	14.57 (3.82)	65.19 (53.84)	1.12 (1.06)	12.25 (3.50)
T ₃	74.13 (59.43)	2.00 (1.41)	17.54 (4.19)	72.02 (58.06)	1.8 (1.34)	15.85 (3.98)	70.58 (57.15)	1.45 (1.20)	13.77 (3.71)
T ₄	73.66 (59.12)	1.9 (1.38)	19.12 (4.37)	76.41 (60.94)	2.2 (1.48)	20.25 (4.50)	79.44 (63.04)	2.4 (1.55)	19.63 (4.43)
SE m±	0.3	0.04	0.03	0.8	0.03	0.01	1.2	0.08	0.21
CD (p = 0.05)	0.9	0.12	0.09	2.4	0.09	0.03	3.6	0.24	0.63

Values followed by a common letter are not significantly different by LSD (p = 0.05)

** Figures in parenthesis are converted into square root transformation

Figures in parenthesis are arcsine transformed values

Table 2: Grade index of harvested nuts, mite intensity and mite population per 4 mm² in experimental garden at Arsikere (2015-16)

Tr. No.	Pre treatment observation(Oct. 2015)			Post treatment observation (3 months after spraying) (Jan. 2015)			Post treatment observation (6 months after spraying) (April 2016)		
	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **
T ₁	70.33 (56.99)	1.87 (1.37)	18.08 (4.25)	65.43 (53.98)	1.24 (1.11)	14.37 (3.79)	58.94 (50.14)	0.73 (0.85)	11.74 (3.43)
T ₂	69.31 (56.36)	1.65 (1.28)	17.83 (4.22)	67.68 (55.35)	1.44 (1.20)	14.79 (3.85)	63.84 (53.03)	1.18 (1.09)	12.14 (3.48)
T ₃	70.28 (56.96)	1.76 (1.33)	17.57 (4.19)	69.87 (56.71)	1.63 (1.28)	15.11 (3.89)	67.39 (55.17)	1.35 (1.16)	13.25 (3.64)
T ₄	70.92 (57.37)	1.88 (1.37)	18.34 (4.28)	75.48 (60.32)	2.08 (1.44)	19.87 (4.46)	78.75 (62.54)	2.28 (1.51)	20.68 (4.55)
SE m±	0.32	0.27	0.42	0.02	0.02	0.03	0.03	0.08	0.02
CD (p = 0.05)	0.75	0.67	1.20	0.06	0.07	0.08	0.07	0.22	0.06

Values followed by a common letter are not significantly different by LSD ($p = 0.05$)

** Figures in parenthesis are converted into square root transformation

Figures in parenthesis are arcsine transformed values

Table 3: Grade index of harvested nuts, mite intensity and mite population per 4 mm² in experimental garden at Arsikere (2016-17)

Tr. No.	Pre treatment observation (Oct. 2016)			Post treatment observation (3 months after spraying) (Jan 2016)			Post treatment observation (6 months after spraying) (April 2017)		
	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **
T ₁	69.82 (56.67)	1.65 (1.28)	16.51 (4.06)	62.23 (52.07)	1.22 (1.10)	12.15 (3.49)	54.2 (47.41)	0.82 (0.91)	9.75 (3.12)
T ₂	65.21 (53.85)	1.54 (1.24)	15.24 (3.90)	63.11 (52.60)	1.32 (1.15)	13.11 (3.62)	59.18 (50.28)	1.14 (1.07)	10.02 (3.17)
T ₃	70.21 (56.92)	1.71 (1.31)	16.89 (4.11)	67.21 (55.06)	1.59 (1.26)	14.25 (3.77)	63.11 (52.60)	1.41 (1.19)	12.11 (3.48)
T ₄	70.59 (57.15)	1.82 (1.35)	18.12 (4.26)	76.12 (60.74)	2.02 (1.42)	20.11 (4.48)	80.22 (63.59)	2.14 (1.46)	21.31 (4.62)
SE m±	0.41	0.05	0.14	0.04	0.04	0.03	0.06	0.05	0.02
CD (p = 0.05)	1.02	0.14	0.43	0.1	0.12	0.09	0.15	0.12	0.05

Values followed by a common letter are not significantly different by LSD ($p = 0.05$)

** Figures in parenthesis are converted into square root transformation

Figures in parenthesis are arcsine transformed values

Table 4: Grade index of harvested nuts, mite intensity and mite population per 4 mm² in experimental garden at Arsikere (2017-18)

Tr. No.	Pre treatment observation (Oct. 2017)			Post treatment observation (3 months after spraying) (Jan 2017)			Post treatment observation (6 months after spraying) (April 2018)		
	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **
T ₁	73.55 (59.05)	1.75 (1.32)	17.44 (4.18)	64.96 (53.70)	1.34 (1.16)	13.08 (3.62)	55.81 (48.34)	0.74 (0.86)	8.71 (2.95)
T ₂	72.67 (58.48)	1.69 (1.30)	17.13 (4.14)	70.84 (57.32)	1.47 (1.21)	15.14 (3.89)	66.47 (54.62)	1.32 (1.15)	10.44 (3.23)
T ₃	71.56 (57.77)	1.73 (1.32)	16.81 (4.10)	69.65 (56.57)	1.58 (1.26)	15.85 (3.98)	67.28 (55.11)	1.37 (1.17)	12.16 (3.49)
T ₄	71.55 (57.76)	1.71 (1.31)	15.27 (3.91)	76.75 (61.17)	1.95 (1.40)	18.36 (4.28)	82.84 (65.53)	2.18 (1.48)	21.44 (4.63)
SE m±	0.47	0.32	0.61	0.71	0.04	0.07	0.63	0.05	0.08
CD (p = 0.05)	1.41	0.98	1.83	2.14	0.13	0.23	1.87	0.15	0.24

Values followed by a common letter are not significantly different by LSD ($p = 0.05$)

** Figures in parenthesis are converted into square root transformation

Figures in parenthesis are arcsine transformed values

Table 5: Grade index of harvested nuts, mite intensity and mite population per 4 mm² in experimental garden at Arsikere (pooled data of 4 years)

Tr. No.	Pre treatment observation(Oct. pooled)			Post treatment observation (3 months after spraying) (Jan pooled)			Post treatment observation (6 months after spraying) (April pooled)		
	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **	Damaged nuts (%) #	MGI**	mite/4 mm ² **
T ₁	72.52 (58.38)	1.75 (1.32)	17.75 (4.21)	66.02 (54.34)	1.29 (1.14)	13.73 (3.71)	58.16 (49.70)	0.81 (0.90)	10.52 (3.24)
T ₂	70.07 (56.83)	1.61 (1.27)	17.25 (4.15)	67.45 (55.21)	1.32 (1.15)	14.35 (3.79)	64.01 (53.13)	1.18 (1.08)	11.24 (3.35)
T ₃	72.51 (58.38)	1.85 (1.36)	17.20 (4.15)	70.23 (56.93)	1.69 (1.30)	15.45 (3.93)	67.89 (55.48)	1.42 (1.19)	12.95 (3.60)
T ₄	72.37 (58.29)	1.83 (1.35)	17.91 (4.23)	76.42 (60.95)	2.09 (1.45)	19.74 (4.44)	80.49 (63.78)	2.28 (1.51)	20.50 (4.53)
SE m±	0.56	0.28	0.41	0.74	0.04	0.02	0.45	0.08	0.03
CD (p = 0.05)	1.67	0.85	1.22	2.18	0.11	0.07	1.34	0.21	0.10

Values followed by a common letter are not significantly different by LSD ($p = 0.05$)

** Figures in parenthesis are converted into square root transformation

Figures in parenthesis are arcsine transformed values

Conclusion

The 4 years data (2014-15, 2015-16, 2016-17 and 2017-18) revealed that spraying of talc formulation of *H. thompsonii* @20g/palm/litre-3 sprays during October, January and April palms recorded the least mite damaged nuts and mean grade index and has been found effective in reducing the mite population in coconut at Arsikere centre, Karnataka.

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