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Eco-friendly management of rugose spiraling whiteflies *Aleurodicus rugioperculatus* Martin infesting coconut in zone-10

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Abstract
This study was carried out at Agriculture and horticulture Research Station Ullala, Mangalore for Zone-10 of Karnataka, India during 2022 to 2023. The experiment was conducted to evaluated Eco-friendly Management of Rugose spiraling whiteflies *Aleurodicus rugioperculatus* Martin infesting coconut in zone -10, among all the treatment, Thiamethoxam 25WG (foliar spray) at 0.25 g/l recorded the lowest pest grade up to 15th days after spray. And next best treatment was Azadirachtin 10,000 ppm (foliar spray) at 1.75 ml/l which caused significant highest mortality of the pest. Biopesticides were failed to establish during this study it may be due to weather parameters, it requires congenial weather for its growth.

Keywords: Rugose spiraling whitefly, coconut, *Aleurodicus rugioperculatus*, eco-friendly management

Introduction
Coconut (*Cocos nucifera* L.) is one of the most priceless gifts of nature to mankind. It is cultivated for its multiple purposes mainly for its nutritional, medicinal and cosmetic value (Ahuja *et al*. 2014) [1] and various additional products of coconut are tender coconut water, copra, coconut oil and coir pith. The coconut palm is known as "Kalpavriksha" because every component of it is employed in some capacity in the everyday lives of people in locations where coconuts are grown. The coconut palm is exaggerated by a number of diseases and insect pests, some of which are noxious while others reduce its strength resulting in economic loss. In the recent time, coconut crop in India have experienced many latest invasive pests, predominantly whiteflies. Invasion of rugose spiraling whitefly (RSW), *Aleurodicus rugioperculatus* Martin has been earliest reported from India in Tamil Nadu (Sundararaj and Selvaraj, 2017) [11], Andhra Pradesh (Chalapathirao *et al*. 2020) [4] which caused significant damage and still it continues to be major threat**.**
RSW is an invasive pest that is indigenous to 22 nations in Central and South America. Its epidemic was recently reported from the southern Indian peninsula, namely from the states of Tamil Nadu, Karnataka, Kerala, and Andhra Pradesh (Sundararaj and Selvaraj, 2017) [11]. Although invasive pests target a variety of host plants, they most prefer palms (coconut, oil palm), woody ornamentals and fruit crops (i.e. banana) compare to other crops. Due to sucking nature which stresses the host plant by depriving it of water and nutrients and secreting honeydew, and also encourages the formation of sooty mould on the leaves which decreases photosynthesis rate (Taravati and Mannion, 2015). As the pest was lately reported in India, there are no effective chemical pesticides and biopesticides to manage rugose spiraling whitefly in coconut.
Biological control is alternative to the indiscriminate use of synthetic pesticides through naturally occurring insect predators, parasitoids and Entomopathogens which are economically feasible, ecologically compatible and environmentally friendly. In recent years, there is more scope in utilizing the potential of the insectivore insects in biological control. In general, Biopesticides are less toxic than conventional pesticides, therefore they considered as safer for human health, and some of the biopesticides used in pest control are *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii.* They can be used as alternatives to the synthetic pesticides as they are environmentally friendly and also, their use does not lead to resistance build-up in target pests. Biopesticides or biological pesticides based on plants or pathogenic microorganisms and specific to the target pest offer an ecologically sound and effective solution to pest problems (Gupta and Dikshit, 2010) [5].

Moreover, such biopesticides are considered as safe to a large extent for humans and their environment (Kalra *et al*., 2007; Jarwar *et al*., 2014) [7, 6]. Therefore, current focus has been on the use of potential Biopesticides to manage the pest populations below the threshold levels.

Material and Methods

To evaluate the field efficacy of an insecticide molecules and different biopesticides against whitefly, an experiment was conducted at Agriculture and horticulture Research Station Ullala, Mangalore during 2022-23. The treatments were imposed immediately after reaching the required pest load. The coconut palms were planted 3-8 years ago and which were replicated thrice in Randomized Block Design (RBD). The crop was cultivated with, the recommended package of practices except for the plant protection measures against the whitefly. The different treatments as mentioned in Table 1 were imposed and observations recorded are described here under.

Table 1: Treatments Details

Treatments No	Treatment details	Dosage
T_1	Azadirachtin 1 EC (10,000 ppm)	2 ml/L
T_2	*Beauveria bassiana*	5 g/L
T_3	*Metarhizium anisopliae*	5 g/L
T_4	*Lecanicillium lecanii*	5 g/L
T_5	Pongamia oil (foliar spray)	5 ml/l
T_6	Thiamethoxam 25WG	0.25 ml/L
T_7	control	-

Observation: Pest intensity

Three palms were selected from the orchard and from each palm bottom three matured fronds were selected and from the selected fronds, five leaflets were selected and the observations on pest intensity was made by using 0-3 scale (Srinivasan *et al*., 2016) [10] at a day before imposing treatment, 1st, 7th and 15th days after imposing treatments.

Table 2: Details of infestation index under field condition (Srinivasan *et al*., 2016) [10]

No. of egg spirals	Grade	Category	Infestation index
No egg spirals and sooty mold encrustation noticed.	0	Nil	0.0
Fewer than 10 egg spirals per leaflet; presence of sooty mold encrustation in 5-6 lower most fronds.	1	Low	0.01 to 1.0
10 to 20 egg spirals per leaflet; presence of sooty mold encrustations in 10-12 fronds.	2	Medium	1.01 to 2.0
More than 20 egg spirals per leaflet; presence of sooty mold encrustations in more than 12 fronds.	3	High	2.01 to 3.0

The infestation index was worked out by adopting formula as suggested by Srinivasan *et al*. (2016) [10]

$$\text{Infestation index} = \frac{(\text{No. of palms under scale } 0\times0) + (\text{No. of palms under scale } 1\times1) + (\text{No. of palms under scale } 2\times2) + (\text{No. of palms under scale } 3\times3)}{\text{Total No. of palms observed}}$$

Table 3: Efficacy of different insecticidal molecules and biopesticides against whitefly in coconut

Tr. No.	Treatment details	Dosage	Mean No. of egg spirals per palm				
			1 DBT*	1 DAT	7 DAT	15 DAT	ROC at 15 DAT
1	Azadirachtin 10000 ppm (foliar spray)	1.75 ml/l	21.93 (4.74)	17.26 (4.21)^{b}	9.12 (3.10)^{b}	7.29 (2.79)^{b}	67.6
2	*Beauveria bassiana* (foliar spray)	5g/L	21.84 (4.62)	19.51 (4.47)^{b}	17.24 (4.21)^{cde}	16.10 (4.07)^{def}	28.44
3	*Metarhizium anisopliae* (foliar spray)	5g/L	20.89 (4.64	20.14 (4.54)^{b}	19.15 (4.43)^{de}	17.25 (4.21)^{def}	23.33
4	*Lecanicillium lecanii* (foliar spray)	5g/L	21.76 (4.55)	20.40 (4.57)^{b}	16.21 (4.09)^{cde}	15.68 (4.02)^{de}	30.31
5	Pongamia oil (foliar spray)	5 ml/l	20.82 (4.61)	18.26 (4.33)^{b}	14.24 (3.84)^{cd}	12.24 (3.57)^{cd}	45.6
6	Thiamethoxam 25 WG	0.25 g/l	20.89 (4.64)	11.52 (3.47)^{a}	(1.23)^{a}	0.51 (1.00)^{a}	97.7
7	Untreated control	-	21.60 (4.52)	21.03 (4.64)^{b}	(3.47)^{a}	22.50 (4.80)^{f}	-

Statistical analysis

The data on different parameters as stated above were subjected to one way ANOVA, whereas, observations regarding pest intensity were first square root transformed and then subjected to one way ANOVA. The differences in the observations among the different treatments were compared by following Duncan's Multiple Range Test (DMRT).

Result and Discussion

This experiment was conducted at Agriculture and horticulture Research Station Ullal, Mangalore during 2021-22 to evaluate the efficacy of insecticidal molecules and various Biopesticides against whitefly in coconut. The mean results of two sprays obtained were presented below.

The results made a day before imposition (DBI) of the treatments indicated that non-significant differences in the average pest grade of whitefly among all the treatments. Population ranged between 20.60 to 21.93 egg spirals per palm (Table 3). Among the treatments at a day after treatment (DAT), Thiamethoxam 25 WG (T_6) foliar spray recorded a significantly lower population (11.52 egg spirals/palm) and was statistically superior over remaining treatments and it was followed by Azadirachtin 10000 ppm (T_1) with 17.26 egg spirals per palm and rest of the treatments were on par with the control (Table 3).

At 7th day after imposition of treatments Thiamethoxam 25WG (T_6) foliar spray stood superior, followed by Azadirachtin 10000 ppm (T_1) with 1.0 and 9.12 egg spirals per palm respectively. Whereas pongamia oil (T_5) recorded 14.24 egg spirals per palm. Foliar spray of remain treatments found least effective and on par with each other statistically.

Similar trend was also recorded during 15th DAT Thiamethoxam 25WG (T_6) foliar spray recorded least whitefly population followed by foliar application of Azadirachtin 10000 ppm (T_1) with 7.29 egg spirals per palm. While foliar spray of *L. lecanii* (15.68 egg spirals/ palm) and *B. bassiana (*16.10 egg spirals/ palm) and *Metarhizium anisopliae* (17.25egg spirals/ palm) and remaining treatments were found least effective and on par with each other statistically, followed by 22.50 egg spirals per palm in

untreated control.

The results of the experiment revealed that thiamethoxam 25WG (T_7) at 0.25g/l remained as the most superior treatments in terms of reduction of whitefly population. The pest population reduced drastically on very first day after treatment with highly significant difference compared with control and there was no buildup of the population. The present finding can be supported by the findings of Pradhan (2019) who reported that thiamethoxam (T_7) at 0.2g/l was effective in controlling whitefly population.

In the present study it was found that the azadirachtin 10,000 ppm foliar spray was the next best treatment. However, the effectiveness of azadirachtin foliar spray was noticed only from 3rd day after treatment this finding is in agreement with the findings of Pradhan (2019) who reported that azadirachtin foliar spray was effective at 6th and 8th DAT with 94 per cent mortality. Among the bio pesticides, *B. bassiana* (T_2) and *L. lecanii* (T_4) failed to colonize and cause epizootics in whitefly population, there was no significant difference between the above treatments and untreated control. However, Gurulingappa *et al*. (2011) [13] reported that *L. lecani* and *B. bassiana* reduce the survival and fecundity of *Aphis gossypii* in okra which is contradictory with the present findings, this might be due to change in weather condition and microclimate of the field since Biopesticides colonize only in congenial condition.

Conclusion

Among the insecticides Thiamethoxam 25 WG proved most effective in controlling pest whereas Azadirachtin caused a significant reduction in pest population. Biopesticides were failed to establish during this study it may be due to weather parameters, it requires congenial weather for its growth.

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