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Bio efficacy of neem based botanical insecticide against coconut rugose spiralling whitefly, *Aleurodicus rugioperculatus* martin under laboratory conditions

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Abstract
The rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) (RSW) is an invasive insect pest in coconut crop. It caused more economic losses and limited insecticides are available for the management and indiscriminate use of chemical insecticides caused health hazards to human being. It is necessary to evaluate eco-friendly biopesticides are the need of the hour. The present study carried out to assess the efficacy of neem based biopesticide, namely Neemazal- T/S (10000 ppm) against the invasive pests Rugose spiralling whitefly (*Aleurodicus rugioperculatus*) (RSW) under laboratory condition at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The insect bioassays were conducted to evaluate the insecticidal efficacy of Neemazal - T/S (10000 ppm) against RSW and the results of the bioassays revealed that the LC_{50} values as 6.799, 15.878 and 25.408 ppm for the early, late and mixed life stages of RSW, respectively. Similarly, the LC_{90} values as 51.80, 132.10 and 167.10 ppm for the early, late and mixed life stages of RSW the LC_{50} values as 6.799, 15.878 and 25.408 ppm for the early, late and mixed life stages of RSW. In both the cases, calculated $\chi 2$ value was less than the tabular value indicating the goodness of fit. Cent percent mortality were brought by 35 ppm, 75 ppm and 90 ppm concentration on the third day against the early, late and mixed population of RSW.

Keywords: Azadirachtin, bio efficacy, neemazal, coconut rugose spiralling whitefly

Introduction
An invasive species, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), commonly known as the rugose spiraling whitefly (RSW), was observed on coconut palm (*Cocos nucifera* L.) in Pollachi, Tamil Nadu, India. Mode of entry of RSW into India is unknown, In Tamil Nadu, the incidence of rugose spiralling whitefly, *A. rugioperculatus* (Hemiptera: Sternorrhyncha: Aleyrodidae) on coconut was first observed in Anaimalai block, Coimbatore District of Tamil Nadu during August, 2016 (Sundararaj and Selvaraj, 2017) [13]. It mainly infests coconut palms and other broad-leaved hosts in its native range. RSW causes stress to the host plant by removing water and nutrients and also by producing honeydew. Presently, it is spread all over India and the farmers of our nation are facing hard ships due to this infestation of RSW in coconut ecosystem. RSW was also noticed on various host plants such as oil palms, mango, guava and other ornamental plants. Whitefly infestation can cause stress to the plants by imbibing and absorbing nutrients and water. It Also excretes a sticky, liquid substance (Honey dew) promotes sooty mould growth on leaves which in turn affects photosynthetic activity leading to physiological disorders of plants (Elango *et al*. 2020) [2, 3, 4]. The current incidence of RSW in India is alarming and farmers relay on chemical insecticides, which also causes adverse effects to environment and human health. The need of the hour is identification and evaluation biopesticides to manage rugose spiralling whitefly for sustainable pest management. Biopesticides or biological pesticides based on plants metabolites or pathogenic microorganisms and specific to the target pest offer an ecologically sound, effective solution to the pest's problem and safe to a large extent for humans and their environment (Kalra *et al*., 2007; Gupta and Dikshit, 2010; Jarwar *et al*., 2014) [9, 7, 8]. Therefore, recent focus has been on the use of potential botanical plants to manage the pest populations below the threshold levels. Neem based pesticides are some of the widely tested biopesticides against insect pests (Anshul *et al*., 2014). The scientific evidence suggests that azadirachtin based products such as Neemazal T/S, 0.5% and 1% do cause 55.4–67% mortality in whiteflies and a maximum of 68.1–87% adult whitefly control in tomato plants has been recorded (Prijović *et al*., 2011) [12].

Hence, the present study was conducted to assess the insecticidal potential of Neemazal T/S 1% formulation against rugose spiralling whitefly for safer management in coconut.

Materials and Methods

Toxicity of neem based biopesticide (Neemazal – T/S Azadirachtin 1% EC) against RSW under the laboratory condition

The study was conducted under laboratory conditions at the Department of Nano Science and Technology, Tamil Nadu Agricultural University, Coimbatore. The bioassays were conducted under controlled environmental condition with a temperature of 27±2 °C; 70±10% RH and with a photoperiod of 14:10 (L: D). Around 45 numbers of early, late instars nymphs of RSW and 170 nos. of mixed population were collected from west coast tall coconut trees from the coconut garden of Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore (11.0152°N, 76.9326°E). The collected insects were kept in a controlled environment as mentioned above for conducting bioassays. The study was set-up in a Completely Randomized Design, which formed ten treatments. The coconut leaf bits of 10cm length with early instar (first and second instar), late instar (third and fourth instar) and mixed populations (first, second, third, fourth instars nymphs, pupae adults) were collected and kept separately in each box. The commercially market available neem based biopesticide (Neemazal – T/S Azadirachtin 1% EC) was obtained from Coromandel International Limited, Telangana and used for the experiments.

The details of the treatments used for the studies were given in table 1. The coconut leaf bits 10cm size were used to evaluate commercially available biopesticide, Neemazal – T/S Azadirachtin 1% EC against RSW and mortality of different stages of RSW were recorded with optical microscope (40X magnification). All different concentrations of Neemazal – T/S Azadirachtin 1% EC were prepared and sprayed on leaf bits as direct spray method using hand sprayer (Pradhan *et al.* 2020) [11]. The sprayed leaf bits were shade dried, kept in the plastic container and required nos. of different stages of RSW were released. The plastic containers were covered with muslin cloth. Visual observations were noticed with changes in nymph colour from pale yellow to dark brown and no movement was considered as dead.

Table 1: Concentrations of Neemazal – T/S Azadirachtin 1% EC against RSW

Treatment	Dosage (ppm)		
	Early instar	Late instar	Mixed population
T1	3	5	10
T2	5	15	20
T3	10	25	30
T4	15	35	40
T5	20	45	50
T6	25	55	60
T7	30	65	70
T8	35	75	80
T9	40	85	90
T10	45	95	100

Statistical analysis

The data collected under laboratory experiments in completely randomized design were analysed using analysis of variance (ANOVA) using AGRES 3.01 and AGDATA software. Data in the form of percentages were transformed to arcsine values and those in numbers were transformed to $\sqrt{x} + 0.5$ and analysed. The mean values of the treatments were compared using DMRT at 5 per cent level of significance.

Results

Toxicity and pattern mortality of neem based biopesticide (Neemazal – T/S Azadirachtin 1% EC) on early, late instar nymphs and mixed life stages of RSW

The toxicity of Neemazal – T/S Azadirachtin 1% EC to early, late instar nymphs and mixed life stages of RSW, *Aleurodicus rugioperculatus* were studied by leaf bits spray bioassay method and the results of probity regression analysis were shown in table 2. Among the different life stages, the toxicity was higher in early instars nymphs (LC_{50}, LC_{90} values are 6.799 and 51.80 ppm, respectively) followed by late instars nymphs (LC_{50}, LC_{90} values are 15.878 and 132.10 ppm, respectively) and mixed life stages of RSW (LC_{50}, LC_{90} values are 25.408 and 167.10 ppm, respectively ppm). In the above bioassays against different life stages of RSW, the mortality data fitted the probit model, which were confirmed by the Pearson goodness of fit chi-square test (Table 2).

The mortality pattern of Neemazal – T/S Azadirachtin 1% EC against RSW explained that In the early instars nymphs, among the different concentrations tested (3, 5, 10, 15, 20, 25,30,35,40 and 45 ppm) 35 ppm caused higher mortality pattern *viz.*, 68.0, 82.0 and 100 per cent at 24, 48 and 72 hours after treatment (HAT), respectively than other concentrations (fig. 1). Similarly, the insecticidal potential was also assessed against late instars nymphs of RSW, Among the different concentrations (5, 15, 25,35,45,55,65,75,85 and 95 ppm) 75 ppm showed higher mortality pattern *viz.*, 86.00, 95.0 and 100 per cent at 24, 48 and 72 hours after treatment (HAT), respectively than other concentrations (fig. 2). Further, the mortality pattern against mixed life stages of RSW revealed that 80 ppm reported higher mortality *viz.*, 88.00, 96.0 and 100 per cent at 24, 48 and 72 hours after treatment (HAT), respectively than other concentrations (10,20,30,40,50,60,70, 90 and 100 ppm), (fig. 3).

Table 2: Probity regression analysis of mortality data of Neemazal – T/S Azadirachtin 1% EC against Rugose Spiralling Whitefly (RSW) *(A. rugioperculatus* Martin)

S. No.	Particulars	LD_{50}(ppm) (95% fiducially limits)	LD_{90}(ppm) (95% fiducially limits)	Slope	$\chi 2$*	Degrees of freedom
1.	Early instar nymphs of RSW	6.799 (5.07-9.127)	51.80 (24.38- 110.07)	1.539	0.822	5
2.	Late instar nymphs of RSW	15.878 (11.72-21.51)	132.1 (61.69-282.91)	1.432	0.6323	5
3.	Mixed population of RSW	25.408 (28.13-22.95)	167.10 (117.53-505.37)	2.028	2.345	5

A = In each case χ^2value from the goodness of fit test was less than the tabular value, (p = 0.05), indicating that the data fit the probity model

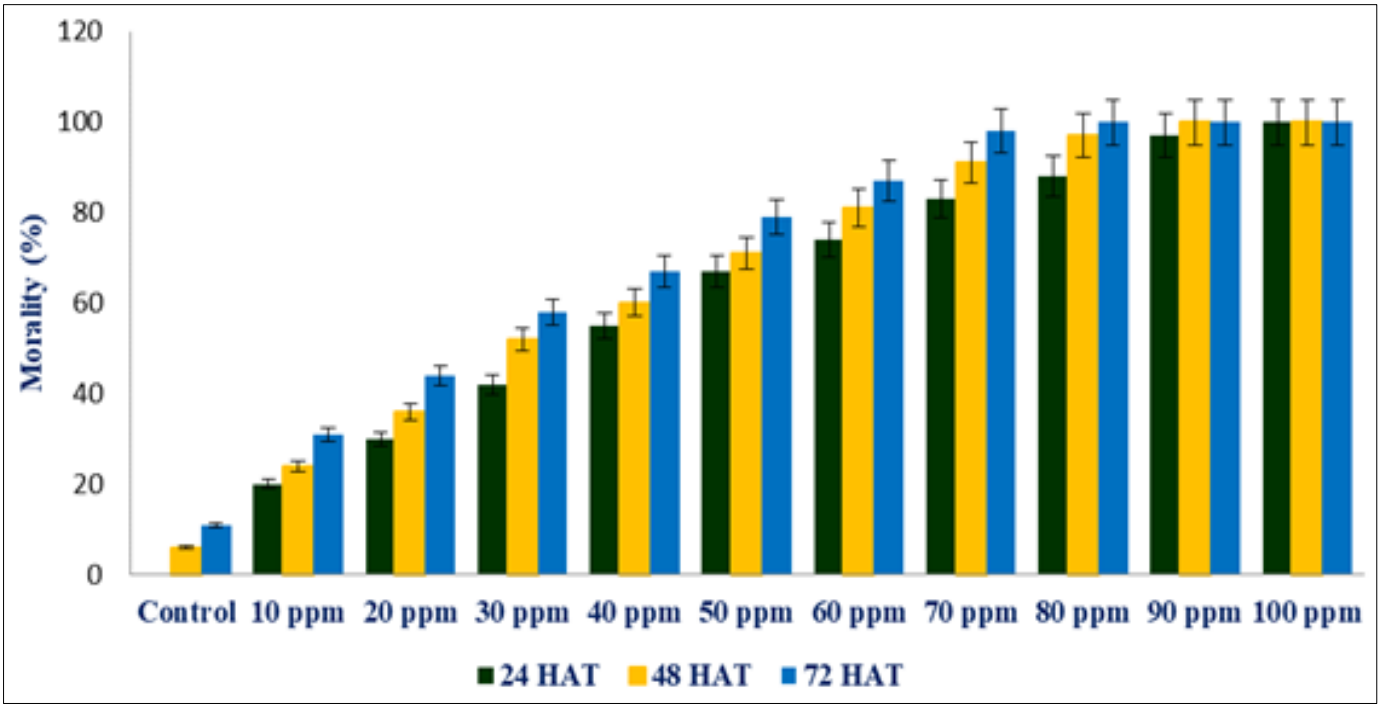

Fig 1: Mortality pattern of Neemazal – T/S Azadirachtin 1% EC against early instar nymphs of Rugose Spiralling Whitefly (RSW)

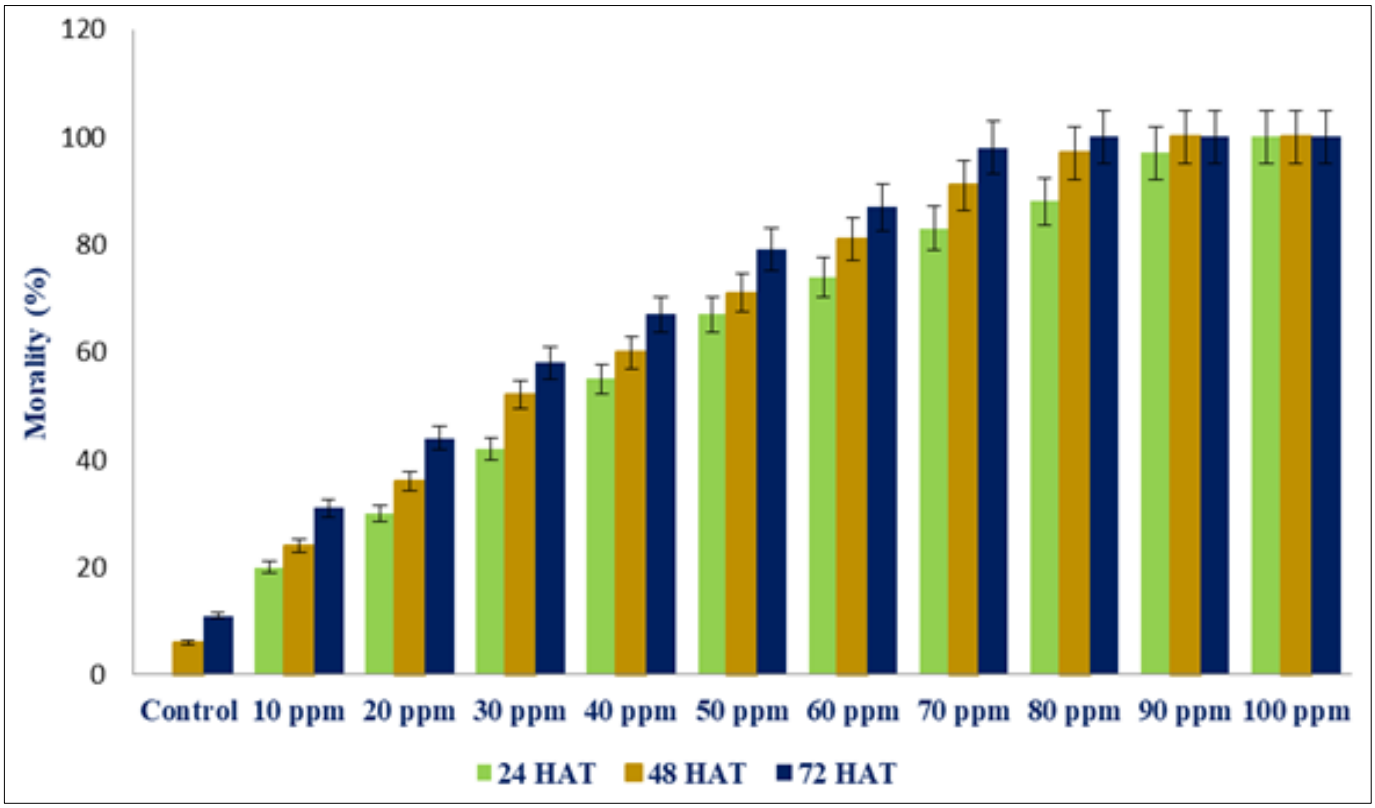

Fig 2: Mortality pattern of Neemazal – T/S Azadirachtin 1% EC against late instar nymphs of Rugose Spiralling Whitefly (RSW)

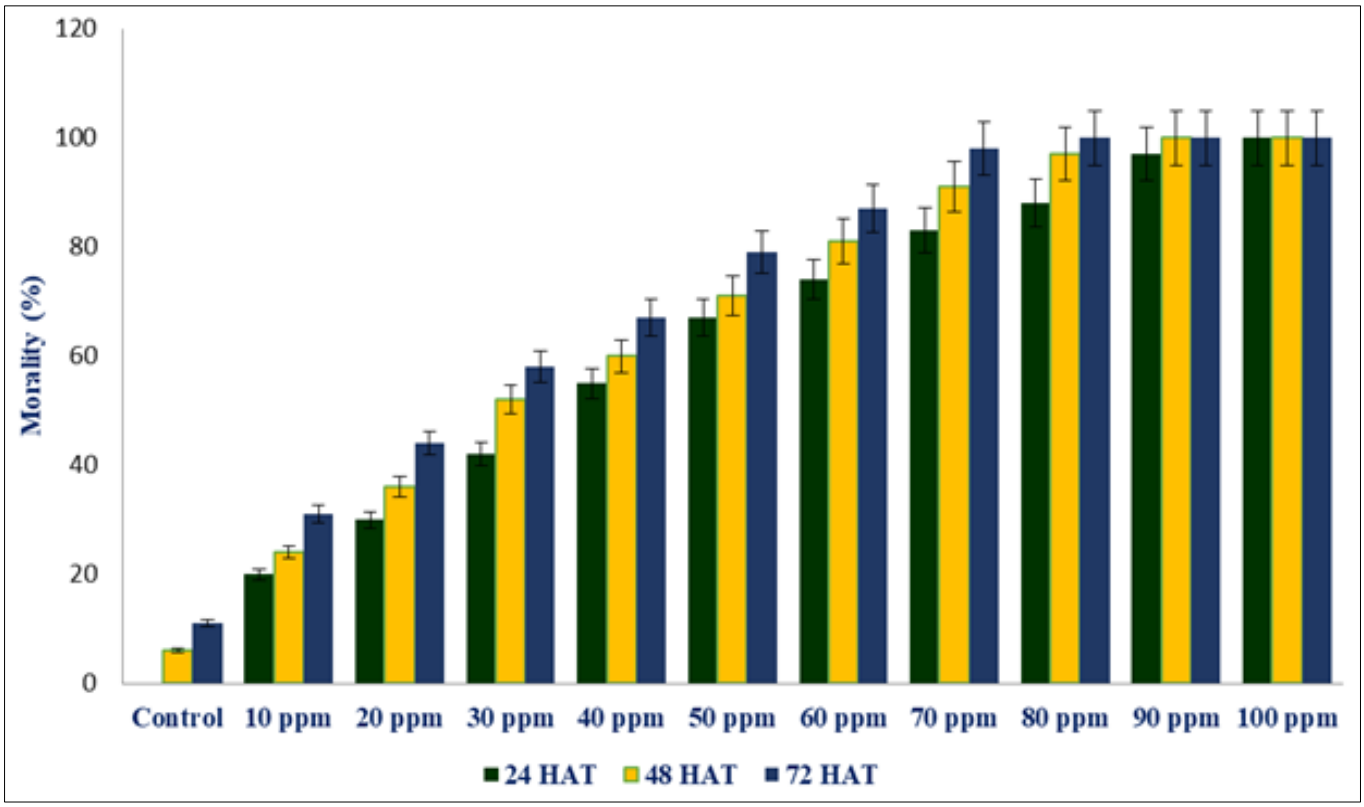

Fig 3: Mortality pattern of Neemazal – T/S Azadirachtin 1% EC against mixed life stages nymphs of Rugose Spiralling Whitefly (RSW)

Discussion

Mostly the studies of the control of *A. rugioperculatus* are related to the natural enemies (Francis *et al*., 2016 and Elango *et al*. 2020) [2, 3, 4]. In the present study various concentrations of Neemazal – T/S Azadirachtin 1% EC were significantly effective against early, late instars nymphs and mixed life stages of RSW, *A. rugioperculatus*. The results of the bioassays revealed that the LC_{50} values as 6.799, 15.878 and 25.408 ppm for the early, late and mixed life stages of RSW, respectively. The toxicity and pattern of mortality was increased with increase in the duration of treatment. The results are in agreement with the findings of Pradhan *et al*. (2020) [11], they have reported that higher mortality with maximum reduction over control was observed in early (36.49%) and against late instars nymphs (35.77%) of rugose spiralling whitefly in coconut. Similarly, Elango and Nelson (2020) [2, 3, 4] reported that direct spray method of bioassay with Neemazal F (AI 5% azadirachtin) at 0.05% and Neemazal T (AI 1% azadirachtin) at 0.2% caused 43.33 and 26.7 per cent mortality, respectively at 24 HAT against nymphs of RSW. Further, the related literatures also concurrence with the present findings, they revealed that Neemazal-T/S at 20g.a.i./ha also reduced 61% population of *Bemisia tabaci* in tomato (Shafe and Basedow, 2003) [5]; Neemazal @ 10000ppm caused 100% nymphs mortality against Sweet potato whitefly in Tomato (Kumar *et al*., 2005) [10] and Neemazal T/S (0.5%) caused 80% nymphs reduction in green house whiteflies, *Trialeurodes vaporariorum* (Duchovskiene *et al*. 2006) [1].

Conclusion

In the recent past, though insecticides showed vital role in insect pest management, the indiscriminate use have resulted in resistance development to many chemical insecticides, detrimental effects to environment and human health. Hence, there is a continuous need of insecticidal phytomolecules for insect pest management. The present study results suggest that Neemazal- T/S @ 10000 ppm concentration could effectively kill the early, late instars nymphs of the invasive pest Rugose spiralling whitefly (RSW), *A. rugioperculatus* in coconut, mango, banana and Guava etc., The benefits of using botanical formulation can helpful for alleviating environmental hazards, delayed onset of developing resistance in the pest populations and safer environment for beneficial organisms.

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