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Research Article

MANAGEMENT OF WHITEFLY, *BEMISIA TABACI* (GENNADIUS) IN BUSHY LAC HOST, *FLEMINGIA SEMIALATA* AT THRISSUR, KERALA

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ABSTRACT

Flemingia semialata is an established host plant of lac insects and is widely grown to promote lac cultivation in India. One of the most destructive pests that can cause significant yield loss in many crops is a sap sucking whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), which is also found to infest the *Flemingia sp*. They cause vast damage to the host plants during feeding by reducing the rate of photosynthesis through the excretion of honeydew and by transmitting a large number of plant pathogenic viruses. Although there are several methods to control whitefly infestation, the commonly adopted practice is the application of chemical pesticides, owing to their efficiency in whitefly control. This study focused to test the effectiveness of two chemical: Thiamethoxam 25% WG (Actara®) and Phosmet 70 % WP (Imidan®) and an organic pesticide: Neem Oil, in whitefly control on *F. semialata*. The experimental design consisted of two different concentrations of each pesticide i.e., Phosmet 0.5 ml/L, 1ml/L, Thiamethoxam 0.25g/L, 0.5 g/L, Neem oil 1ml/L, 2ml/L applied on 21 test plants in sets of three and also on three regions of the test plants i.e, upper, middle and lower. The number of whiteflies was counted after 6, 12 and 24 hours of pesticide application. The results revealed that, among all the treatments, Thiamethoxam 0.5mg/L was found to be the most effective with highest percentage of reduction over control in the number of whiteflies in all the time intervals. The leaves in the middle and lower regions of the test plants showed relatively higher loads of whiteflies than those in the upper region throughout the experiment. Although, Neem oil is an environment friendly natural pesticide, Thiamethoxan has negligible volatilization properties and high degradation rates in the soil and therefore could be successfully and safely applied on the lac insect host plants during the pre-inoculation stages to lessen the whitefly attack.

Keywords: *Flemingia semialata*, Thiamethoxam, Neem Oil, Phosmet.

INTRODUCTION

Lac is a natural resin of animal origin, secreted by a tiny scaly phytophagous insect known as *Kerrialacca* Kerr, belonging to the family Tachardiidae (Kerriidae), super family Coccoidea of the order Hemiptera. The resin, dye and wax produced by these insects have extensive industrial applications and are therefore economically significant. India is one of the leading lac producers in the world. There are many traditional lac host plants in India, primarily, *Butea monosperma* (Palas), *Ziziphus mauritiana* (Ber) and *Schleichera oleosa* (Kusum) but for an escalated production, lac cultivation has been promoted on a type of bushy plant of the species *Flemingia*, chiefly due to their quick growing nature and easy manageability among the farmers. In these species, lac cultivation could be established within two years on plantation basis as opposed to longer gestation periods on the conventional host plants. One most the destructive pests that can cause significant yield loss in lac production is a whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae). They cause vast damage to the host plants during feeding by reducing the rate of photosynthesis through the excretion of honeydew and also by the transmitting a large number of plant pathogenic viruses including begomoviruses, Carlaviruses, criniviruses, ipomoviruses, and torradoviruses. This

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honeydew also acts as a medium for the growth of sooty mold on the leaves and fruits, thus reducing photosynthetic activities. The whitefly is not just a serious pest of the *Flemingia* species, but also of many ornamental and vegetables such as brinjal, chili, cotton, okra, potato, tomato, and tobacco (Khan *et al,* 2015; Alessandro *et al,* 2016; Kunjwal *et al,* 2018; Perring *et al,* 2018). The feeding by *B.tabaci* can lead to the yellowing and crumpling of the leaves reducing the quality of the cultivation (Kunjwal and Srivatsava, 2018). Although there are several methods to control whitefly infestation, such as the use of insect growth regulators and Entomo Pathogenic Fungi, the most effective method is the application of chemical pesticides (Smith *et al,* 2018) mainly inferring to the quick action of such pesticides. This study focused on the effectiveness of two chemical and one organic pesticide in whitefly control.

MATERIALS AND METHODS

The present study was carried out during April 2019, in the lac insect gene bank of Kerala Forest Research Institute (KFRI), Peechi, in the Thrissur district of Kerala, India, where *F.semialata* plants are grown in large numbers for conservation of lac insect genetic resources collected from various parts of South India. *F.semialata*is a non-native plant species of Kerala but is grown in large numbers in the northern parts of India for extensive lac cultivation. During the study period, these plants were subject to severe infestation by whiteflies on their leaves. In order to eradicate these pests, three pesticides namely, Neem Oil (organic pesticide), Actara and Imidan (chemical pesticides) were used to check their efficacy in whitefly control. The experimental design consisted of two different concentrations of each pesticide i.e., Imidan 0.5 ml/L, Imidan 1ml/L, Actara 0.25g/L, Actara 0.5 g/L, Neem oil 1ml/L and Neem oil 2ml/L.

The experiment was carried out in triplets with a total of 21 plants. Three plants were set as control in which only water was sprayed. The rest of the plants were selected in sets of three for the application of each pesticide concentration. Enumeration of the whiteflies was carried out by dividing each test plant into three sections- upper, middle and lower and three leaves from each section were selected for counting, since the leaves of *F.semialata* are trifoliate. The number of whiteflies was noted down before the treatment with the pesticides on the selected plants. The pesticides were then sprayed on the underside of the leaves where the whiteflies were occurring in high numbers. The number of whiteflies on these leaves was counted at different time intervals i.e., 6 hours, 12 hours and 24 hours post the application of the pesticides. For convenience, the spraying of the pesticides was done at 6 AM, the initial counting was carried out at 12 PM, the second counting, at 6 PM, and the final counting was at 6 AM on the next day.

The following formula was used to calculate the percentage of reduction of white flies,

$$\text{Percentage of reduction } \frac{\text{Old value} - \text{New value}}{\text{New value}} \text{X100}$$

The data obtained was tabulated and subjected to statistical analysis and the results were expressed as whitefly population by number. F test (ANACOVA) which is a descriptive statistic was calculated using SPSS statistics software version 20.0. The performance of the different pesticide concentrations in whitefly control and the number of whiteflies on the different regions of the test plants during each test time intervals was tabulated (Table 1 and Table 2). The number of reduction of whiteflies on the different regions of the test plants post the treatments were also expressed in percentage.

RESULTS AND DISCUSSION

The ANACOVA test showed that there is a significant difference among the three selected pesticides regarding the effectiveness of control of the whitefly *B. tabaci.* Results of the study are presented in Table 1. The study carried out in different time intervals brought about varying outcomes. The overall mean result represented in the table reveals that all the treatments were considerably superior over the control. Before the application of the pesticides, the mean number of the whitefly population was the highest in the test plants for Actara 0.5g/L (96.33) and the least in the test plants for the application of Neem oil 1ml/L (19.67). After 6 hours of the application of the pesticides, the mean number of whiteflies were the least (7.44) for 0.5 g/L of Actara, followed by 1ml/L of Neem oil (9.33), 0.25g/L of Actara (10.11), 1ml/L of Imidan (13.78), 0.5ml/Lof Imidan (22.22) and 2ml/L of Neem oil (25.22). Again, 12 hours post the application of the pesticides, the mean number of whiteflies were found to increase in the order of the pesticide concentration of Actara 0.5g/L (2.89), Neem oil 2ml/L (5.22), Neem oil 1ml/L (7.11), Imidan 1ml/L (8.78), Actara 0.25 g/L (16.22), Imidan 0.5 ml/L (29.00)and Control (55.89). After 24 hours of the pesticide application, the mean number of the whitefly population was found to be the lowest in 0.5 g/L of Actara (7.11) and highest in the control (46.56).

Among all the treatments, Actara 0.5mg/L was found to be the most effective (mean=7.44) after 6 hours of treatment, followed by Neem oil 1ml/L (mean=9.33) and Actara 0.25mg/L (mean=10.11). After 12 hours and 24 hours of treatment, there was a slight modification in the order of their effectiveness. Therefore, the average number of whiteflies decreased after 6 hours and 12 hours after the pesticide application. However, there was a small increase in their numbers after 24 hours. The p-values in the table also specify that, after 6 hours, 12 hours and 24 hours, the treatment effects are significantly different. Table 2 represents the abundance of whiteflies in selected regions of the test plants (upper, middle and lower), during the experimental set up. The control showed highest settlement of these insects in the leaves of the middle (1224) and lower regions (867) of the test plants. In the rest of the experimental set up, with different pesticide concentrations, 5 out of 6 of them, the leaves in the upper regions of the plants showed relatively less loads of whiteflies throughout the experiment. From Table 2, after 6 hours of spray, it is evident that Actara 0.5gm/L showed highest percentage of

reduction in the number of whiteflies with 94% reduction in the middle region of the test plants followed by the lower regions with 88 % decrease. Actara 0.25gm/L also showed 79% reduction in the lower region, followed by 67 %and 63% in the leaves of the upper and middle regions respectively. Imidian 1ml/L and Neem Oil 1ml/L also indicated similar reduction trends with 69% and 63% in the middle regions of the test plants respectively. After 12 hours of pesticide application, Actara 0.5gm/L showed 100% reduction in the number of whiteflies in the upper region, and 86% reduction by Imidan 1ml/L and Neem Oil 2ml/L in the lower and middle regions respectively. However, post 24 hours of spray, Actara 0.25gm/L, Neem Oil 1ml/L and Neem Oil 2ml/L showed maximum reduction, all in the upper region leaves of the test plants. Figure 1 shows the graphical illustration of effectiveness of different pesticide concentrations in whitefly control at different time intervals.

Table1. Performance of different pesticide concentrations on the*Flemingia* sp. at different time intervals.

Test	Control	Imidan 0.5ml/L	Imidan 1ml/L	Actara 0.5g/L	Actara 0.25g/L	Neemoil 1ml/L	Neemoil 2ml/L	P-value
Before treatment Mean ± SD	63.11±76.59^{b}	31.22±31.4^{c}	23.44±31.79^{cd}	96.33±11.35^{a}	30.33±35.58^{c}	19.67±27.01^{d}	23.56±35.79^{cd}	
After 6hour of treatment Mean ± SD	77.22±83.06^{a}	22.22±26.92^{b}	13.78±26.53^{bc}	7.44±13.25^{d}	10.11±14.26^{c}	9.33±16.68^{c}	25.22±40.31^{b}	0.000
After 12 hour of treatment Mean ± SD	55.89±60.5^{a}	29.00±36.96^{b}	8.78±21.24^{d}	2.89±5.90^{e}	16.22±25.33^{bc}	7.11±10.73^{d}	5.22±6.52d^{e}	0.000
After 24 hours of treatment Mean ±SD	46.56±43.93^{a}	22.67±23.85^{b}	10.56±23.84^{d}	7.11±11.37^{e}	13.00±22.22^{c}	11.22±16.06^{d}	14.56±29.65^{c}	0.002

Values are represented as Mean ± Standard deviation; Means values having the same superscripts in the rows are not significantly different from each other ($P<0.05$).

Table 2. Number of white flies counted (Percentage of reduction) at different time intervals before and after treatments.

Test	Plant region	Before treatment	After 6 hours	After 12 hours	After 24 hours	Total No. of white flies	Mean
Control	Upper	15	33(-120)	19 (42)	27 (-42)	94	23.5
	Middle	347	364 (-5)	313 (14)	200 (36)	1224	306
	Lower	206	298 (-45)	171 (43)	192 (-12)	867	216.75
Imidan 0.5ml/L	Upper	0	0 (0)	0.00 (0)	0 (0)	0	0
	Middle	107	73 (32)	71 (3)	66 (7)	317	79.25
	Lower	174	127 (27)	190 (-50)	138 (27)	629	157.25
Imidan 1ml/L	Upper	86	82 (5)	66 (20)	74 (-12)	308	77
	Middle	114	35 (69)	12 (66)	20 (-67)	181	45.25
	Lower	11	7 (36)	1.00 (86)	1 (0)	20	5
Actara 0.5gm/L	Upper	1	2 (-100)	0 (100)	0 (0)	3	0.75
	Middle	712	46 (94)	19 (59)	40 (-111)	817	204.25
	Lower	154	19 (88)	7 (63)	23 (-229)	203	50.75
Actara 0.25gm/L	Upper	3	1 (67)	1 (0)	0 (100)	5	1.25
	Middle	204	75 (63)	61 (19)	108 (-77)	448	112
	Lower	73	15 (79)	39 (-160)	9 (77)	136	34
Neem Oil 1ml/L	Upper	8	14 (-75)	19 (-36)	0 (100)	41	10.25
	Middle	148	55 (63)	38 (31)	60 (-58)	301	75.25
	Lower	21	15 (29)	7 (53)	41 (-486)	84	21
Neem Oil 2ml/L	upper	3	3 (0)	4 (-33)	0 (100)	10	2.5
	middle	127	169 (-33)	24 (86)	99 (-313)	419	104.75
	lower	82	55 (33)	19 (65)	32 (-68)	188	47

In the current study, it was observed that, Actara 0.5 and 0.25 mg/ L sprayed plant groups showed better performance in control of white flies followed by Imidan 1ml/L and Neem oil 1ml/L. The insecticide Actara exhibited high level of efficacy in decreasing the number of white flies similar to the report by Abdelhady *et al.*, 2014 that the traditional compound, Actara gave high efficacy against *B. tabaci* Biotype "Q". Several other studies have also revealed the use of traditional compounds such as oils, formulations of neem like Azdrachtin and Actara as sprays on different vegetables (Abdel Salam *et al.,* 1971; Abdel-Salam *et al.,* 1972; Shaheen *et al.,* 1973; Darwish & Farghal, 1990; Halawa *et al.,* 1992; Hegab & Moawad, 1994; Hassan, 1996) in checking *B. tabaci.*

In the present study, the chemical pesticide Imidan has found to be advantageous in controlling the white fly after Actara. Reported Imidacloprid, (a compound chemically similar to Imidian) to be the most effectual in the chemical control of whiteflies populations in brinjal also proved the safer application of Imidacloprid to natural enemies. However, it was found to be toxic for the sucking pests when compared to conventional insecticides.

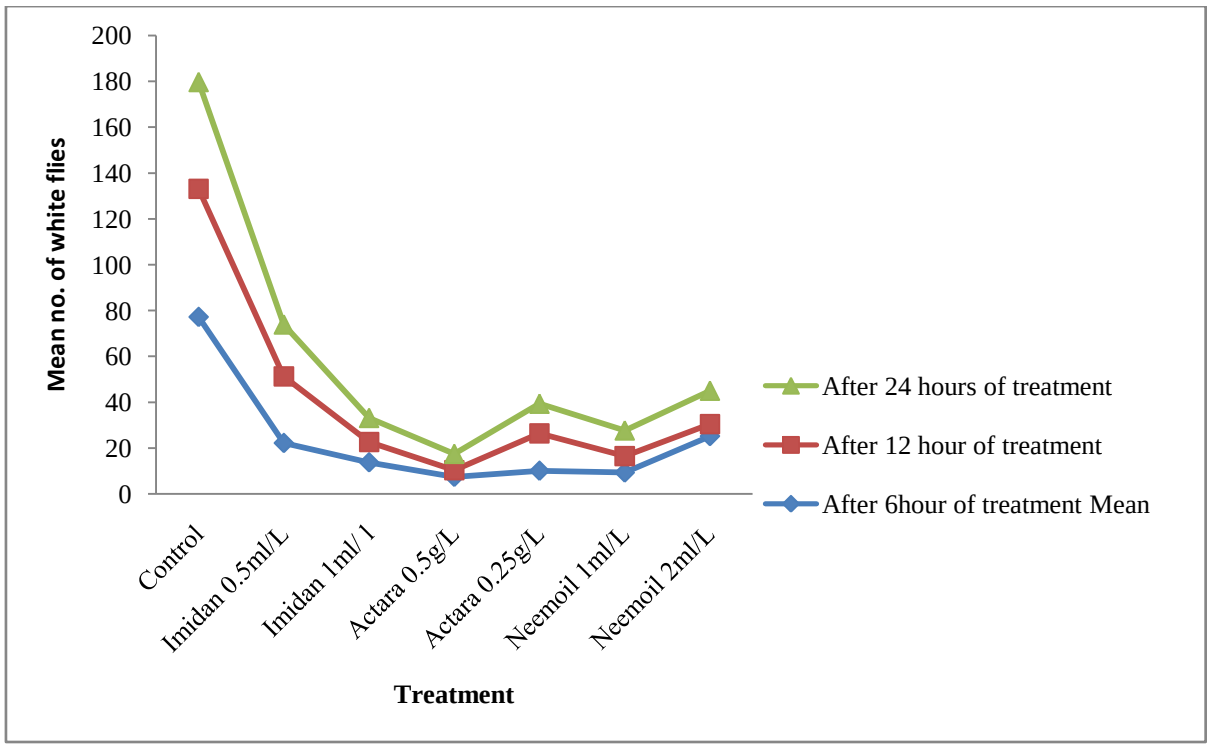

Figure 1.Graphicalrepresentationofeffectivenessof different pesticide concentrations in whitefly control at different time intervals.

From the current observations, Neem oil 2ml/L concentration showed moderate efficacy in controlling *B.tabaci* as observed in the studies by DilipShriram Ghongade and K. S.Sangha, 2021 and Hafeez *et al.*, 2015, where Neem Ban oil was found to be much more effective than entomopathogenic fungi formulation. A mixture of Neem oil at 1.5% and 2%, neem seed water extract at 3%, and Baythroid TM had also considerably diminished the mean percent infestation of cotton by whitefly, jassid and thrips (Masood Khan Khattak *et al*, 2006). The average number of whiteflies was found to decrease up to 12 hours of pesticide application; however, this number tends to increase slightly after 24 hours of spray (Table 2). The first 24 hours of pesticides application on leaf surfaces is crucial since these compounds tends to highly evaporate and degrade during this time period. This could mean that the effectiveness of the treatments decrease with increase in the post spray duration which possibly explains the increase in the number of whiteflies after 24 hours of spray. Furthermore, *Flemingiasp* has hairy leaves and the rate of evaporation loss from such leaf surfaces is much elevated than from soil surfaces due to the lower adsorption capacity of plants (Boehncke *et al*., 1990). The settlement or abundance of whiteflies was relatively higher in the leaves of the middle regions of the test plants. This observation lies in accordance with the studies by Tsueda and Tsuduki, 2014, where *B. tabaci* adults were found to settle on the middle leaves of tomato plants sensing the volatile compounds emitted by those leaves. Interestingly, the mean percent reduction of whiteflies was also found to be superior in the leaves of the middle parts after the application of the pesticide.

CONCLUSION

Neem oil is an environment friendly natural pesticide; however, neem oil when not applied with care could clog the breathing pores of lac insects, leading to their deaths. Since Actara and Imidan are volatile compounds, they are safe to be applied on lac insects, even though both these pesticides are harmful to the environment. Actara 0.5g/L was found to be most effective in the control of whiteflies, especially after 12 hours of treatment, however the effect of Actara 0.25 g/L was found to last even after 24 hours of spray, with considerable reduction in the number of whiteflies. Hence, Actara 0.25g/L, with its mild chemical concentration, could be successfully and safely applied on the lac insect host plants to diminish the whitefly attack, without having much concern on the environment as well as lac insects.

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