Efficacy of biopesticides against pomegranate sucking pests under laboratory condition

Elango,E.[1]*, Sridharan,S.[1], Saravanan, P.A.[1] and Balakrishnan, S.[2]

ABSTRACT

The acute toxicity of Spinosad, NSKE, horticultural mineral oil and entomopathogens at the recommended concentration was evaluated against pomegranate sucking pests like thrips, *Scirtothrips dorsalis* Hood, whitefly, *Siphoninus phillyreae* Haliday, two tailed mealy bug, *Ferrisia virgata* (Cockerell). The study revealed that among all treatments, spinosad 45% SC (0.0125%) were showing more mortality in thrips (53.33%), whitefly (55.55%) and mealy bugs (48.88%) followed by NSKE (5%) thrips (43.33%), whitefly (45.55%) and mealy bugs (42.22%). Azadirachtin 10000 ppm (0.02%) at 48 hours after treatment showed more percent mortality in thrips (40.83%), whitefly (41.11%) and mealy bugs (39.99%) respectively.

Keywords: Pomegranate, Bioassay, NSKE, *Siphoninus phillyreae*, *Ferrisia virgata*

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INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit crop of arid and semiarid regions of the world. It is believed to have originated from Iran. India is one of the leading producers of pomegranate in the world. In India, it is cultivated in over 1.13 lakh ha with an annual production of 7.44 lakh tonnes and productivity of 6.6 tonnes /ha. The export of pomegranate fruits is around 35,000 Tonnes/annum (Pal *et al.,* 2014). Currently, in India pomegranate is cultivated in 2.09 thousand ha with 2442 MT production (NHM, 2017). Pomegranate, one of the important fruit crops in India is being cultivated in arid and semiarid regions of Gujarat, Maharashtra, Karnataka, Uttar Pradesh, Andhra Pradesh and Tamil Nadu.

In Tamil Nadu, the concept of high density planting and ultra-high density planting is being introduced and followed in pomegranate and mango. Pomegranate is cultivated under high density planting in important districts of Tamil Nadu *viz.*, Coimbatore, Erode, Tiruppur and Karur. The cultivation of crop under high density demands the study on the level occurrence of various sucking pests. The pomegranate sucking pests feed on leaves and tender shoots. It causes severe damage to flowers, fruits, twigs and leaves by desapping, which results in loss of quality of fruits and reduction in yield (Balikai *et al.,* 2011). Sucking pest were considered as a minor pest in pomegranate but in recent years, the pest has assumed a serious form (Karuppuchamy *et al.,* 1998). It was also observed that the infestation resulted in significant flower and immature fruit drop. Hence compared to the defoliator pests, the sucking pests cause more damage to the pomegranate crop under high density planting. So the management of sucking pests under high density planting is essential. Chemicals pesticides are recommended for controlling sucking pests. The present investigation was planned to evaluate such new insecticides Azadirachtin 10000 ppm (0.02%), Spinosad 45% SC (0.0125%), NSKE (5%), Horticultural mineral oil (0.2%), *Beauveria bassiana* ($1x10^9$ cfu/g) and *Lecanicillium lecanii* ($1x10^8$ cfu/g) against pomegranate sucking pests like Thrips, *Scirtothrips dorsalis* Hood, Whitefly, *Siphoninus*

phillyreae Haliday and two tailed mealy bug, *Ferrisia virgata* (Cockerell).

METRIALS AND METHODS

Mass Culturing of Test Insects

The adults of thrips and whitefly were collected from infested twigs and released on the pomegranate seedlings in the pot kept under net house at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore. In order to increase the infestation, the plant was supplied with more nitrogen fertilizer and exposed to sunlight with a little watering. The population of pests established in the potted plant was used for laboratory studies

Two tailed mealy bug *Ferrisia virgata* was collected from the pomegranate field available at the orchard of the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Red pumpkin was used to mass culture the mealy bug under laboratory condition. Initially the red pumpkin under half mature condition was purchased from the market with the stalk. The fruit was washed well with normal water to remove the soil particles and other debris. Then the water washed pumpkin was treated in Bavistin 0.1% solution for 30 min to remove the contamination of fungal pathogen, subsequently the pumpkin was treated with antibacterial solution streptomycin sulphate 0.05% solution for 10 minutes and dried under shade. The damage or injury on the pumpkin was filled with molten wax. The pumpkin was tied with a thread along furrows and kept inside the insect rearing cage on an iron stand kept on a spreader filter paper. Before keeping the fruit, the cage was cleaned by removing spiders and ants. The grown up mealy bugs collected were released on the fruit with the help of a brush. The setup was kept for 25-30 days. The mealy bugs slowly established on the pumpkin were utilized for efficacy study.

Test insecticides

Insecticides tested against pomegranate pests, spinosad 45% SC (Tracer®), Azadirachtin 1% EC, Neem seed kernel used in the research were obtained from EID Parry, Chennai. Fresh horticultural mineral oil used in research was purchased from Hindustan Petroleum Corporation Limited (HPLC), Cochin, Kerala. The entomopathogens, *Beauveria bassiana* ($1x10^9$cfu/mg) and *Lecanicillium lecanii* ($1x10^8$cfu/mg) used in the study were purchased from International Panacea Ltd., New Delhi.

Bioassay

The efficacy of biopesticides on pomegranate sucking pests was assessed under laboratory condition in the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Leaf dip bioassay

Fresh leaves of pomegranate were dipped in different botanical insecticide solutions for one minute. The leaves treated with treatment solution were shade dried on a filter paper in open air and thirty thrips, whitefly and adult mealy bugs adults were released on the treated leaves kept inside the separate plastic containers. Small pin holes were made on top of the containers for ventilation. Totally three replications were maintained for each treatment. Based on the mobility of body parts and change in the colour of the body the mortality of pests was confirmed and the data recorded at 24 and 48 hours after treatment (HAR). The experiment was conducted using Completely Randomized Design (CRD).

Contact bioassay

Fresh leaves of pomegranate were placed in a plastic container along with thirty thrips, whitefly and mealy bugs. The treatment solution was sprayed directly on the leaf with insects in plastic container. Totally three replications were maintained for each treatment. The mortality of pests was assessed based on the mobility of body parts and change in the colour of the body at 24 and 48 HAT and expressed as percent mortality. The experiment was conducted using Completely Randomized Design (CRD).

Statistical analysis

The data collected under laboratory experiments in completely randomized design were analyzed 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 analyzed. The mean values of the treatments were compared using DMRT at 5 per cent level of significance

RESULTS

Toxicity of botanicals to thrips

The acute toxicity of neem products, spinosad, mineral oil and entomopathogens against *Scirtothrips dorsalis* through contact method is presented in Table 1. Mortality of thrips was maximum in spinosad 45% SC which recorded 40.0 and 66.6 per cent mortality of thrips on 24 and 48 hours after treatment (HAT), followed by neem seed kernel extract 5% which recorded 31.6 and 55.5 per cent mortality of thrips at 24 and 48 (HAT), respectively. The performance of *Beauveria bassiana* ($1x10^9$cfu/g), *Lecanicillium lecanii* ($1x10^8$ cfu/g) and horticultural mineral oil (0.2%) was poor, which registered the mean mortality of 35.0 per cent in horticultural mineral oil (0.2%), 23.3 per cent in *Lecanicillium lecanii* ($1x10^8$ cfu/g) and 13.3 percent in *Beauveria bassiana* ($1x10^9$cfu/g). Leaf dip method under laboratory condition also showed superior performance of spinosad 45% SC (0.0125%) which registered 35.0 and 65.0 per cent mortality of thrips 24 and 48 (HAT) followed by Azadirachtin 10000 ppm (0.02%) which effected 31.6 and 50.0 per cent mortality 24 and 48 HAT respectively (Table 1.)

Table 1. Toxicity of biopesticides to *Scirtothrips dorsalis* under laboratory condition

Treatments	Dosage (g or ml/ Litre)	Mortality of thrips (%)					
		Contact bioassay			Leaf dip bioassay		
		Hours after treatment (HAT)			Hours after Release (HAR)		
		24	48	Mean mortality	24	48	Mean mortality
T_1-Azadirachtin 10000 ppm (0.02%)	2	25.00^{b}	51.66^{bc}	38.33	31.66^{a}	50.00^{ab}	40.83
T_2- Spinosad 45% SC (0.0125%)	0.2	40.00^{a}	66.66^{a}	53.33	35.00^{a}	65.00^{a}	50.00
T_3-NSKE (5%)	50	31.66^{ab}	55.00^{ab}	43.33	23.33^{a}	46.66^{ab}	34.99
T_4-Horticultural mineral oil (0.2%)	2	25.00^{bc}	45.00^{c}	35.00	28.33^{a}	43.33^{b}	35.83
T_5-*Beauveria bassiana*($1x10^9$ cfu/g)	2	10.00^{d}	16.66^{e}	13.33	5.00^{b}	13.33^{c}	9.16
T_6-*Lecanicillium lecanii* ($1x10^8$ cfu/g)	2	16.66^{cd}	30.00^{d}	23.33	3.33^{b}	18.33^{c}	10.83
T_7-Untreated control	--	0.00^{e}	0.00^{f}	0.00	0.00 (0.00)^{b}	0.00 (0.00)^{d}	0.00
SE d		2.6376	2.7905	--	5.6873	4.7922	--
CD (P=0.05)		5.6577	5.9857	--	12.1993	10.2794	--

HAT- Hours after treatment, HAR- Hours after release;*Mean of three replications; Values in the parentheses are arc sine transformed values. Means followed by the common letter (s) are not significantly different at P=0.05 level by DMRT

Toxicity of botanicals to whitefly

In contact method is presented in the table 2. The data on the mortality of whitefly was higher in treatment spinosad 45% SC which recorded 38.8 and 53.3 per cent mortality of whitefly 24 and 48 hours after treatment. The treatments NSKE 5% and azadirachtin 10000 ppm were found statistically on par in their effectiveness with spinosad 45% SC (0.0125%) both 24 and 48 HAT. The performance of *Be. bassiana* ($1x10^9$cfu/g), *Le. lecanii* ($1x10^8$ cfu/g) and horticultural mineral oil (0.2%) was poor, which registered the mean mortality of whitefly 32.7 per cent in horticultural mineral oil (0.2%), 24.4 per cent in *Le. lecanii* ($1x10^8$ cfu/g) and 22.2 percent in *Be. bassiana* ($1x10^9$cfu/g). Leaf dip method under laboratory condition using is presented in table 2. The treatment spinosad 45% SC (0.0125%) registered 47.7 and 63.3 per cent

mortality of whitefly on 24 and 48 hours of treatment followed by neem seed kernel extract 5% which showed 34.4 and 56.6 per cent mortality of whitefly on 24 and 48 hours treatment. Azadirachtin 10000 ppm treatment effected 31.1 and 51.1 per cent mortality 24 and 48 hours after treatment. Horticultural mineral oil (0.2%), *Be. bassiana* ($1x10^9$cfu/g) and *Le. lecanii* ($1x10^8$ cfu/g) effected 38.8, 31.1 and 28.8 per cent mortality of whitefly at 48 hours after treatment respectively.

Table 2. Toxicity of bio pesticides to whitefly (*Siphoninus phillyreae*) under laboratory condition

Treatments	Dosage (g or ml per litre)	Mortality of whitefly (%)					
		Contact bioassay			Leaf dip bioassay		
		Hours after treatment (HAT)			Hours after Release (HAR)		
		24	48	Mean mortality	24	48	Mean mortality
T_1-Azadirachtin 10000 ppm (0.02%)	2	34.44^{ab}	48.88^{a}	41.66	31.11^{bc}	51.11^{ab}	41.11
T_2- Spinosad 45% SC (0.0125%)	0.2	38.88^{a}	53.33^{a}	46.10	47.77^{a}	63.33^{a}	55.55
T_3-NSKE (5%)	50	35.55^{ab}	50.00^{a}	42.77	34.44^{b}	56.66^{a}	45.55
T_4-Horticultural mineral oil (0.2%)	2	26.66^{b}	38.88^{b}	32.77	21.11^{cd}	38.88^{bc}	29.99
T_5-*Be. bassiana* ($1x10^9$ cfu/g)	2	14.44^{c}	30.00^{c}	22.22	15.55^{d}	31.11^{c}	23.33
T_6-*Le. lecanii* ($1x10^8$ cfu/g)	2	16.66^{c}	32.22^{bc}	24.44	17.77^{d}	28.88^{c}	23.32
T_7-Untreated control	--	0.00^{d}	0.00^{d}	0.00	0.00^{e}	0.00^{d}	0.00
SE d		2.8035	2.3186	--	3.1770	3.7166	--
CD (P=0.05)		6.0135	4.9735	--	6.8148	7.9722	--

HAT- Hours after treatment ,HAR- Hours after release;*Mean of three replications; Values in the parentheses are arc sine transformed values. Means followed by the common letter (s) are not significantly different at P=0.05 level by DMRT

Toxicity of botanicals to mealy bug

The results on the acute toxicity of plant products, mineral oil and entomopathogens studied against mealy bug through contact bioassay presented in (Table 3) revealed the maximum mortality in the spinosad 45% SC (0.0125%). The mortality of mealy bugs recorded at 24 and 48 hours after treatment were 38.8 and 58.8 per cent respectively, whereas, neem seed kernel extract 5% and Azadirachtin 10000 ppm (0.02%) showed 52.2 and 51.1 per cent mortality respectively, after 48 hours of treatment in contact method. Horticultural mineral oil (0.2%), *Le.lecanii* ($1x10^8$ cfu/g) and *Be. bassiana* ($1x10^9$cfu/g) effected 36.6, 31.1 and 26.6 per cent mortality of mealy bug at 48 hours after treatment respectively.The treatment spinosad 45% SC (0.0125%) registered 33.3 and 54.4 per cent mortality of mealy bug on 24 and 48 hours of treatment followed by neem seed kernel extract 5% which showed 30.0 and 52.2 per cent mortality of mealy bug at 24 and 48 hours treatment. The next effective treatment was Azadirachtin 10000 ppm (0.02%) which recorded 51.1 per cent mortality of mealy bug 48 hours after treatment in leaf tip method bioassay.

Table 3. Toxicity of bio pesticides to mealy bug (*Ferrisia virgata*) under laboratory condition

Treatments	Dosage (g or ml per litre)	Mortality of mealy bug (%)					
		Contact bioassay			Leaf dip bioassay		
		Hours after treatment (HAT)			Hours after Release (HAR)		
		24	48	Mean mortality	24	48	Mean mortality
T_1-Azadirachtin 10000 ppm (0.02%)	2	25.55^{bc}	51.11^{a}	38.33	28.88^{a}	51.11^{a}	39.99
T_2- Spinosad 45% SC (0.0125%)	0.2	38.88^{a}	58.88^{a}	48.88	33.33^{a}	54.44^{a}	43.88
T_3-NSKE (5%)	50	32.22^{ab}	52.22^{a}	42.22	30.00^{a}	52.22^{a}	41.11
T_4-Horticultural mineral oil (0.2%)	2	20.00^{c}	36.66^{b}	28.33	18.88^{b}	34.44^{b}	26.66
T_5-*Be.bassiana* ($1x10^9$ cfu/g)	2	17.77^{c}	26.66^{c}	22.21	17.77^{b}	32.22^{b}	24.99
T_6-*Le. lecanii* ($1x10^8$ cfu/g)	2	21.11^{c}	31.11^{bc}	26.11	15.55^{b}	31.11^{b}	23.33
T_7-Untreated control	--	0.00^{d}	0.00^{d}	0.00	0.00^{c}	0.00^{c}	0.00
SE d		2.6881	2.3735	--	2.9139	3.2915	--
CD (P=0.05)		5.7660	5.0912	--	6.2504	7.0604	--

HAT- Hours after treatment, HAR- Hours after release;*Mean of three replications; Values in the parentheses are arc sine transformed values. Means followed by the common letter (s) are not significantly different at P=0.05 level by DMRT

DISCUSION

The acute toxicity of spinosad 45% SC (0.0125%) showed 66.6 per cent mortality of thrips at 48 hours after treatment followed by neem seed kernel extract 5% which recorded 55.5 per cent. In leaf dip assay also superior performance of spinosad 45% SC (0.0125%) which registered 65.0 per cent mortality of thrips was noted followed by azadirachtin 10000 ppm which effected 50.0 per cent mortality at 48 hours after treatment. The reports of Walunj *et al.* (2014) showed the effectiveness of spinosad 45% SC at 0.2 ml /lit recorded significantly least number of thrips 0 to 2.0 per twigs or fruiting bodies on 5th day after spray in pomegranate. Likewise, susceptibility of chilli thrips *S.dorsalis* to neem formulation of varying azadirachtin content as revealed by the lower LC50 values (0.09 – 0.20 ppm) reported by Roy and Gurusubramanian (2011) is in agreement with the present finding. The work of Aliakbarpour *et al*. (2011) demonstrating the efficacy of neem oil on the control of thrips in chillies, which action is similar to the results obtained in the present study. Mortality of whitefly was maximum in treatment spinosad 45% SC (0.0125%) which recorded 53.3 per cent mortality of whitefly at 48 hours after treatment. Neem seed kernel extract 5% which showed 50.0 per cent mortality of whitefly at the same period of time. Spinosad 45% SC (0.0125%) recorded 54.4 per cent mortality of mealy bug at 48 hours after treatment followed by neem seed kernel extract 5% which showed 52.2 per cent mortality of mealy bug in the same period of observation. The report of Rajendra Singh *et al.* (2011) on the efficacy of NSKE@ 5% showed the mortality of mango mealy bug which effected mortality up to 23.1 and 26.7% 48 hours after treatment. This finding is in full agreement with that observed in the present study. The satisfactory control of pest by *V. lecanii* in the present study is in agreement with that reported by Kulkarni *et al.* (2003) and

Jayachakravarthy (2001) on *Ferrisia virgata* and *M. hirsutus*, respectively. Among the biopesticides tested against sucking pests of pomegranate, the maximum mortality was noted in spinosad 45% SC (0.0125%). The next effective treatment was neem seed kernel extract 5% and azadirachtin 10000 ppm.

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K.Elango[1]*, S. Sridharan[1], P.A. Saravanan[1] and S.Balakrishnan[2]

[1]Department of Agricultural Entomology,

[2] Department of Spices and Plantation Crops,

Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India.

*Corresponding Author

Mobile: 8675619656/9445159656

E-mail: elaento@gmail.com