The Pharma Innovation Journal 2022; 11(10): 1173-1175

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(10): 1173-1175

www.thepharmajournal.com
Received: 15-07-2022
Accepted: 19-09-2022

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Field efficacy of botanicals against mealybugs, *Ferrisia virgata* Cockerell in pomegranate ecosystem

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Abstract
A field experiment was conducted to study the efficacy of botanicals against pomegranate mealybugs, *Ferrisia virgata* Cockerell during *Ambe* and *Hasta bahar* 2021 at farmer field, Managuli, Vijayapur, UAS, Dharwad, Karnataka. The efficacy of botanical insecticides *viz*., Biodigester solution, Vermiwash, FORS (Fish Oil Rosin Soap), Pongamia leaf extract, *Prosopis juliflora* leaf extract, *Lecanicillium lecanii,* Neem based insecticide and Thiamethoxam 25 WG revealed that all these were significantly superior over control. Among different treatments the Thiamethoxam 25 WG showed most effective treatment against mealybugs with higher percent reduction of 80.75 (%) followed by followed by neem based insecticide (43.43%), *L. lecanii* (41.31%) and FORS (40.14%). Pongamia leaf extract and *P. juliflora* leaf extract treated plants were recorded as least effective treatment with 27.70 and 26.76 percent reduction of mealybugs per shoot over untreated control.

Keywords: pomegranate, mealybugs, *ferrisia virgata,* efficacy of botanicals

Introduction
Pomegranate (*Punica granatum* L.) is emerging as one of the important commercial crop and favorite edible fruit crop of tropical and subtropical regions of the world. The name pomegranate is derived from two Latin words Pomum (apple) and granates (seeded). It belongs to family Punicaceae. It is thought to be indigenous to Iran, where it was first cultivated during 2000 B.C. (Evreinoffa, 1949) [4]. It was extensively cultivated in Mediterranean countries like Morocco, Egypt, Iran, Afghanistan and Arabia. It is also grown extent in China, Japan, USA, USSR, Pakistan and India. In India, pomegranate is popularly known as *Anar* or *Dalima* or *Dodima.* The area under pomegranate cultivation, production and export of fruit from India has significantly increased in the last three decades because of its versatility, hardy nature, wider adaptability, drought resistance, higher yields, excellent keeping quality, remunerative prices, less requirement of water and availability of vegetative propagated planting material (Patil and Karle, 1990) [7]. Pomegranate production is associated with many problems like non-availability of suitable varieties, environmental vagaries, nutritional deficiencies, physiological disorders, post-harvest glut, post-harvest losses, improper storage, transportation facilities, lack of marketing facilities, price fluctuation and biotic constraints like pest and diseases. Among several factors, the losses due to pests and diseases are very high. The 25 to 30 percent of total cost of production is being spent on plant protection and the loss due to biotic constraints could not be managed effectively (Mote *et al.*, 1992 and Zirpe, 1966) [6, 10]. In recent days, mealybugs, *Ferrisia virgata* has become a major constraint because of inappropriate production of quality fruits of pomegranate for domestic and export markets. Mealybugs known to cause damage to several seasonal field crops, vegetables and fruit crops by sucking the juice from tender leaves, shoots and surface of developing fruits and thereby reduce the vigour of the plant and in addition, excretion of honeydew leads to development of sooty mould on leaves and fruits (Balikai *et al*., 2011) [2]. Though, farmers are using number of insecticides, the control of sucking pests is not satisfactory. To overcome the latter constraint it is necessary to develop eco-friendly management practices for sucking pests. Particularly, the management using the bio pesticides and botanical agents will go a long way in stabilizing the quality production without disturbing the pomegranate ecosystem.

Materials & Methods

The field experiment was laid out in completely randomized block design at farmers field, Managuli, Vijayapura, Karnataka during 2021. The pomegranate field of seven year old *var*. Bhagwa planted at 4.5 x 4.5 m spacing was selected. The experiment consisted of nine treatments including untreated check and each treatment was replicated thrice. Two plants of pomegranate were considered as one replication and tagged. Management practices were carried out by following all the recommended package of practices except the plant protection measures against mealybugs in the pomegranate gardens. Treatments were imposed with the help of knapsack sprayer. The first spray were taken up when the crop is uniformly infested by mealybug population. Observation of mealy bugs (nymphs and adults) were carried on ten randomly selected infested pomegranate plants. From each plant, three shoots of 30 cm length were considered and colony counts were taken on the number of active and healthy nymphs and adults. The count of mealybugs were made, 1 day before spraying and after treatment imposition at 1, 3, 5 and 10 days after spray. The subsequent spray were taken at 15 days interval. The data was subjected to ANOVA. Further, obtained data was converted into percent reduction of pest population over control through following formula.

$$\text{Percent reduction over control} = \frac{\text{Insect pest population in control- Insect pest population in treatment}}{\text{Insect pest population in control}} \times 100$$

Statistical analysis

The statistical analysis of the data was done by using analysis of variance (ANOVA) with Web Agri Stat Package (wasp-2) developed by ICAR, Central Costal Agriculture Research Institute, Goa and OPISTAT. Data were transformed by square root transformation before subjecting to DMRT. The interpretation of data was done by using the critical difference was calculated at 0.05 probability level. The level of significance was expressed at 0.05 probability. After analysis, data was tabulated for interpretation of result.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads:

Population of mealybugs (*Ferrisia virgata*)

First spray

The non-significant difference among various treatments before the application of botanicals indicated the uniform distribution of pest in the experimental plots. The mean population of mealybugs ranged from 3.44 to 3.68 per shoot (Table 1).

The data on mean pest population on one day after spraying revealed that all treatments were significantly superior over untreated control. The average number of nymph and adult mealybugs per shoot was ranged from 1.38 to 3.20 in treated plots as against 3.46 in untreated control. The treatment thiamethoxam 25 WG recorded least number of mealybugs (1.38 mealybugs/shoot).

Table 1: Overall efficacy of botanicals against mealybugs on pomegranate during *Ambe* and *Hasta bahar* 2021 (Pooled data)

Sl. No.	Treatments	Dosage (g or ml/l)	Number of Mealybugs/Shoot										Mean	Percent reduction over control
			1st spray					2nd spray						
			1 DBS	1 DAS	3 DAS	5 DAS	10 DAS	1 DBS	1 DAS	3 DAS	5 DAS	10 DAS		
1	Biodigester solution	5%	3.47 (1.99)	2.92 (1.85)^{abcd}	2.55 (1.75)^{bc}	1.72 (1.49)^{bcd}	1.86 (1.54)^{bc}	3.74 (2.06)	3.28 (1.94)^{bcd}	2.72 (1.79)^{bc}	1.60 (1.45)^{bcd}	1.82 (1.52)^{b}	2.77	34.98
2	Vermiwash	5%	3.64 (2.03)	2.98 (1.86)^{abcd}	2.61 (1.76)^{bc}	1.84 (1.53)^{bc}	1.92 (1.55)^{bc}	3.98 (2.12)	3.37 (1.96)^{bcd}	2.82 (1.82)^{bc}	1.72 (1.49)^{bcd}	1.98 (1.57)^{b}	2.81	34.04
3	FORS (Fish Oil Rosin Soap)	5 ml	3.65 (2.04)	2.61 (1.76)^{bcd}	2.10 (1.61)^{c}	1.30 (1.34)^{cde}	1.51 (1.42)^{cd}	3.52 (2.01)	3.01 (1.87)^{bcd}	2.62 (1.76)^{bc}	1.51 (1.42)^{bcd}	1.77 (1.51)^{b}	2.55	40.14
4	Pongamia leaf extract	5%	3.54 (2.01)	3.12 (1.90)^{abc}	2.80 (1.82)^{b}	1.91 (1.55)^{bc}	2.07 (1.60)^{bc}	4.25 (2.17)	3.81 (2.08)^{abc}	3.24 (1.93)^{bc}	2.18 (1.64)^{bc}	2.31 (1.67)^{b}	3.08	27.70
5	*Prosopis juliflora* leaf extract	5%	3.87 (2.09)	3.20 (1.92)^{ab}	2.91 (1.85)^{b}	1.98 (1.57)^{b}	2.18 (1.04)^{b}	4.37 (2.21)	3.90 (2.09)^{ab}	3.32 (1.95)^{b}	2.25 (1.66)^{b}	2.41 (1.71)^{b}	3.12	26.76
6	*Lecanicillium lecanii* (1x10^8 conidia/g)	2 g	3.78 (1.99)	2.39 (1.7)^{cd}	2.01 (1.58)^{c}	1.10 (1.26)^{de}	1.23 (1.32)^{d}	3.11 (1.90)	2.84 (1.83)^{bc}	2.24 (1.65)^{bc}	1.23 (1.32)^{cde}	1.47 (1.40)^{bc}	2.50	41.31
7	Neem based insecticide (10,000 ppm)	3 ml	3.54 (2.01)	2.32 (1.67)^{d}	1.99 (1.58)^{c}	1.04 (1.24)^{e}	1.18 (1.29)^{d}	2.68 (1.78)	2.68 (1.78)^{c}	2.14 (1.62)^{c}	1.18 (1.29)^{de}	1.38 (1.37)^{bc}	2.41	43.43
8	Thiamethoxam 25 WG	0.25 g	3.68 (2.04)	1.38 (1.37)^{e}	0.93 (1.19)^{d}	0.34 (0.92)^{f}	0.49 (0.99)^{e}	2.30 (1.67)	1.32 (1.35)^{d}	0.97 (1.21)^{d}	0.35 (0.92)^{e}	0.56 (1.03)^{c}	0.82	80.75
9	Control	-	3.44 (1.99)	3.46 (1.99)^{a}	3.84 (2.08)^{a}	4.08 (2.14)^{a}	4.35 (2.20)^{a}	4.05 (2.13)	4.07 (2.14)^{a}	4.41 (2.22)^{a}	4.82 (2.31)^{a}	5.04 (2.35)^{a}	4.26	-
	S.Em.±	-	**NS**	**0.15**	**0.14**	**0.12**	**0.13**	**0.51**	**0.38**	**0.33**	**0.26**	**0.33**	-	-
	CD (P=0.05)	-	**NS**	**0.45**	**0.42**	**0.36**	**0.40**	**1.53**	**1.16**	**0.99**	**0.80**	**1.01**	-	-
	CV (%)	-	**10.07**	**10.86**	**9.70**	**7.48**	**8.06**	**8.01**	**8.95**	**8.28**	**9.42**	**9.53**	-	-

Figures in parentheses are $\sqrt{x + 0.5}$ transformed values; Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.05); DBS-Day before spray; DAS-Days after spray;

The next promising treatments for suppressing the pest population were neem based insecticide, *L. lecanii* and FORS with mean population of 2.32 2.39 and 2.61 mealybugs per shoot, respectively and these three are on par with each other. Whereas, untreated control recorded the highest population of 3.46 mealybug per shoot.

Similarly, the same trend was observed at three and five days after spraying.

It was evident from the mealybug population recorded at ten days after treatment which varied from 0.49 to 2.18 per shoot and 4.35 in the untreated control. Lowest population of 0.49 mealybug per shoot was observed in the thiamethoxam 25 WG treated plot and it was showed significantly superior over other botanical treatments. The pongamia leaf extract and *P. juliflora* leaf extract treated plot recorded higher mealybug population of 2.07 and 2.18 per shoot, respectively and it was superior over control.

Second spray

The pre-treatment count recorded a day before spraying indicated that, there was no significant difference among the treatments. However, population of mealybug ranged from 2.30 to 4.05 nymphs and adults per shoot (Table 1).

At one day after spraying, among different chemical treatments thiamethoxam 25 WG recorded least number of 1.32 mealybugs per shoot. The next promising and on par treatments were neem-based insecticide (2.68 mealybugs/shoot), *L. lecanii* (2.84 mealybugs/shoot) and FORS (3.01 mealybugs/shoot). Higher population of 3.81 and 3.90 mealybugs per shoot was recorded in pongamia leaf extract and *P. juliflora* leaf extract treated plant and are on par with each other. However, all the treatments were significantly superior over untreated control (4.07 mealybugs/shoot).

Similarly, same trend was observed at three and five days after spraying of different chemicals.

Mean mealybug population at 10 DAS indicated that, among different treatments, thiamethoxam 25 WG was recorded least incidence of mealybug (0.56 mealybugs/shoot). Whereas, pongamia leaf extract and *P. juliflora* leaf extract treated plant recorded higher number of mealybugs of 2.31 and 1.47 per shoot, respectively. However, all the treatments were significantly superior over untreated control (5.04 mealybugs/shoot).

Mean population and percent reduction over untreated control

From the pooled data, the minimum population of 0.82 mealybug per shoot was recorded in thiamethoxam 25 WG treated plots and it was followed by neem-based insecticide (2.41 mealybugs/shoot), *L. lecanii* (2.50 mealybugs/shoot) and FORS (2.55 mealybugs/shoot) which are on par with each other. Whereas, untreated control recorded the highest population of 4.26 mealybug per shoot (Table 1).

Thiamethoxam 25 WG was found to be superior with 80.75 percent reduction over untreated control which was followed by neem-based insecticide (43.43%), *L. lecanii* (41.31%) and FORS (40.14%). Pongamia leaf extract and *P. juliflora* leaf extract treated plants were recorded as least effective treatment with 27.70 and 26.76 percent reduction of mealybugs per shoot over untreated control.

This is in confirmation with Anand *et al.* (2009) [1] who reported that significantly higher percent reduction of mealybug population was recorded in NSKE and *L. lecanii* ($1x10^{-8}$ conidia/g) treated plots followed by FORS and Honge oil in pomegranate. Kulkarni *et al.* (2003) [5] noticed that azadiracthin and *L. lecani* were effective against mealybugs on pomegranate in Rahuri, Maharashtra. During present study, neem based insecticide was found to be more effective in reducing all sucking pest population on pomegranate. These results are in close confirmation with the findings of Bhargava and Bhatnagar (2005) [3]; Suresh *et al.* (2006) [9] and Praveenkumar (2016) [8] who reported that botanicals was were less effective in controlling the sucking pest population as compared to chemical insecticides but superior over control.

Conclusion

Pomegranate is an export oriented crop and it prone to attack by many insect pests recently, mealybugs. These pests not only reduce the yield but also deteriorates the quality of fruits. Intensive cultivation of a fruit crop often leads to pest build up necessitating more rigid pest control. Pomegranate growers depend on insecticides for their management and take number of sprays at regular intervals that pose many problems including resistance to insecticides and resurgence of secondary pests. The present study was designed to study the bioefficacy of botanicals against infestation of mealybugs on pomegranate. From the present study it was evident that evaluated botanicals were significantly effective against mealybugs. The minimum population of mealybugs was observed in plants treated with thiamethoxam 25 WG followed by neem-based insecticide, *L. lecanii*, FORS, vermiwash, biodigester solution, pongamia leaf extract and *P. juliflora* leaf extract.

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