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Bioefficacy and compatibility of new insecticides molecules against sucking pests of pomegranate

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Abstract
The field experiment was conducted to assess the bio-efficacy of different insecticide molecules and the efficiency of new insecticide molecule Lambda-cyhalothrin 4.9 CS in combination with the fungicide and soluble fertilizer against the pest complex infesting pomegranate viz., aphids and thrips. Among the evaluated treatments, the treatment of Cyantraniliprole 10.26 % OD @ 0.9 ml and combination treatment of Lambda-cyhalothrin 4.9 CS (each at 0.3ml) + Propineb 50 WP (1gm) with soluble fertilizer (00:52:34) (5 g per lit) were found equally effective for the control of sucking pests viz. aphids and thrips on pomegranate followed by treatment of Flubendiamide 19.92 %+ Thiacloprid 19.92 SC at @ 0.4 ml per litre of water. The combination treatment of Lambda-cyhalothrin 4.9 CS (each at 0.3ml) + Propineb 50 WP(1gm) with soluble fertilizer (00:52:34) (5 g) recorded least population of aphids i.e.16.4 as against 29.8 per 5 cm twig in untreated control and least population of thrips i.e. 3.47 as against 16.19 per 5 cm twig in untreated control, found most effective for the control of sucking pest of pomegranate as a sustainable approach in pest management.

Keywords: Bioefficacy, Aphids, Thrips, Pomegranate, Lambda-cyhalothrin 4.9 C

Introduction
The pomegranate, *Punica granatum* L., is a fruit that belonging to the Punicaceae family. Pomegranate is one of the favourite table fruit from ancient times in tropical as well as sub-tropical regions of the world and it is originated from Iran. Pomegranate is a well-known arid-zone horticultural crop that is widely grown around the world, but particularly in Mediterranean countries such as Spain, Afghanistan and to some extent in Russia, Japan, China and United States. It has been grown all over India. The fruit is the symbol of abundance and this is valued for its medicinal properties as well as its cold, refreshing juice. Pomegranate juice which is high in tannins and has anti-atherosclerotic property, due to its effective anti-oxidative properties also lowers blood pressure (Aviram and Dornfeld, 2001) [4]. India ranking first in area (261’000 ha) and production (2315’000 MT) of pomegranate with the average productivity was 8.86 t ha-1 during year 2019-20. Maharashtra ranks first in India, with 1,47.91'000 ha and 1789.46'000 MT produced, contributing for 62.91 % pomegranate area, followed by Gujrat (30510 ha) and Karnataka (25970 ha). Farmers are interested in growing this crop because of its export potential. The exportation trade from India is 80547.74MT (worth 96,190,548.00 US$) during year 2019-20 (Anonymous, 2019) [2]. Pomegranate export demand is expected to rise in the future. Several insect and non-insect pests, along with diseases, damages such a valued fruit crop. In India, 91 insects, a snail pest and 6 mites have been identified causing problems on the pomegranate crop. Thrips (*Scirtothrips dorsalis* H.) and aphids (*Aphis punicae* P.) are the most common pests in the pomegranate area throughout different fruiting seasons which cause serious damage by desapping as well as scaring the rinds of fruit which has resulted into threatening the export quality of fruits (Balikai *et al.*, 2011) [5]. Furthermore, growers particularly in commercial agriculture use a variety of pesticide combinations which is extensively followed by most professional fruit, flower and vegetable producers or growers. Insecticides combined with fungicides as well as liquid fertilizer are used for controlling pests and diseases in pomegranate cultivation. The application of such pesticides separately requires huge number of labours, spraying equipments and vast quantity of water. Therefore, the present investigation was made to study effectiveness of new insecticide molecule in combination with fungicides and liquid fertilizer for pest control in pomegranate as a sustainable pest management strategy.

Materials and Methods

The present investigation was carried out at experimental farm of AICRP on Arid Zone Fruits, Department of Horticulture, MPKV, Rahuri, Dist.- Ahmednagar (MS). In this Randomized block design was used with three separate blocks each consisting of twelve plants of pomegranate variety 'Bhagwa' (three-year-old) with maintained at the spacing of 4.5 x 3.0 m for fruits production in the *ambia bahar* season. For each treatment, 5 L spray fluid was prepared by taking into account spray fluid rate of 500 l/ha. Battery Powered Knapsack Sprayer having the hollow cone nozzle was used for doing spraying operation. During each treatment, the plant was fully sprayed from all sides at each spray. The two sprays with interval of 15-20 DAS, both sprays were taken at the vegetative stage. In case of sucking pest's observations, five twigs of each plant were observed to record the number of aphids and thrips on five cm portion of each of twig. Average of 5 twigs was represented the count of average survived aphids and thrips per twig for the assessment of pest infestation. The values of survival populations were subjected to statistical analysis by converting to angular transformed values (T) using formula, T= √n+0.5, where n = Natural count of survived population of aphids and thrips.

Results and Discussion

In present investigation, shown in Table. 1 and Table. 2 it was found that all the treatments were found significantly superior in suppressing aphid and thrips population over untreated control during the period of experimentation. Among the different treatment, the treatment of Cyantraniliprole 10.26 % OD @ 0.9 ml/lit of water was found most effective for the control of aphids & thrips recorded least average survived aphid and thrips populations i.e., 10.0 to 22.8 (15.3) as against 25.0 to 35.34 (29.8) and 1.85 to 4.09 (3.11) as against 15.42 to 17.09 (16.19), respectively per twigs in untreated control on 1st to 15th days after spray observation throughout the period of experimentation.

Whereas, this treatment was also found on par with the combined treatment of Lambda-cyhalothrin 4.9 CS (0.3ml)+ Propineb 50 WP (1gm) + water soluble fertilizer (00:52:34) (5 g/lit. of water) was found most effective for the control of aphids &thrips, recorded least average survived aphids and thrips i.e.12.0 to 22.8 (16.4) as against 29.8 and 2.0 to 4.8 (3.47) as against 16.19, respectively per twigs in untreated control followed by the treatment of Flubendiamide19.92 % + Thiacloprid 19.92 SC@ 0.4 ml was found next effective treatment during the period of experimentation. Whereas, the rest of treatment viz., Lambda-cyhalothrin 4.9 CS @ 0.3 ml, Spinosad 45 SC, Imidacloprid 17.80 SL were found statistically less effective for the aphids and thrips control.

Our preent investigation is confirmative with the effectiveness of lambda-cyhalothrin 4.9 CS against thrips on chilli crop are found most confirmative as reported by Biswajit Patra *et al.* (2015) [6]. Similarly, two sprays of the Cyantraniliprole 10.26 % OD at 90 g a.i. /ha i.e.(0.9 ml per litre) was found most effective and recommended for the control of aphids and thrips infesting pomegranate as when incidence of pest is noticed on pomegranate, which is found confirmative with present findings as reported by (Anonymous, 2020.,) [3] However, it was the evident that, the combination treatment of Cyantraniliprole 10.26 % OD with fungicide (carbendazim, propineb and soluble fertilizer 0:52:34) found effective for the control of aphids and thrips in pomegranate as reported by Lad *et al*. (2018) [7].

Compatibility of Lambda-cyhalothrin 4.9 CS with Fungicide and Water Soluble Fertilizer

As the evidence from the compatibility studies on physical, chemical and phytotoxic effect, shown in Table. 3, the treatment with Cyantraniliprole 10.26 % OD @ 0.9 ml & the combination treatment of Lambda-cyhalothrin 4.9 CS (0.3ml) + Propineb 50 WP (1gm) + water soluble fertilizer (00:52:34) (5 g per lit. of water) was found most effective & proved compatibility for the control of aphids and thrips. The role of acidic & alkaline pH with EC of spray tank solution of Cyantraniliprole 10.26 % OD was slightly lowered, according to evidence from compatibility experiments on physical, chemical and phytotoxic effect & maintain at normal pH i.e., 7.2 to 7.8 and combination treatment of Lambda-cyhalothrin 4.9 CS shows EC and pH at 1.55 to1.99 dS/m and 5.2 to 5.5 without showing any adverse effect on discoloration, foaming, sedimentation, no any phytotoxic effect on foliage and survival of natural enemies. The non-effectiveness of the new molecule Lambda-cyhalothrin 4.9 CS (each at 0.3 & 0.4 ml per lit. of water) alone, without combination of fungicides & soluble liquid fertilizer clearly shows that, the pH & EC of the water source used for spraying played an important role & showed incompatibility as the pH of the spray fluid were slightly alkaline. i.e. nearly 8.0.

The most pesticides are most stable when pH of solution is at about 5. In general, insecticides (particularly organophosphates and carbamates) are more susceptible to alkaline hydrolysis than are fungicides, herbicides or growth regulators & stated that the compound Lambda-cyhalothrin 4.9 CS i.e. Matador has optimum pH 6.5 and this compound stable at pH range between 5 to 9 are agreement with our findings as reported by Annemiek Schielder (2008) [1]. Raymond A. Cloyd (2015) [8] declared that to maximize pesticide effectiveness, for most of insecticides the ideal pH is in between 5 and 7. Similarly, the compatibility of tank mix of lambda-cyhalothrin (LCH) (Karate Zeon® 5 CS), with foliar nutrients urea and magnesium sulphate and fungicide carbendazim (Bavistin®) by assessing the emulsion stability, phytotoxicity, No creaming matter and sediment formation at bottom was observed in any of the combinations of lambda-cyhalothrin at different doses with urea 2 per cent, magnesium sulphate 5 per cent and carbendazim 50 WP 0.1 per cent, which is also corroborative with present findings as reported by R. Kalaiselvi *et al.* (2007) [9]

Conclusion

Among the different treatments, the treatment of Cyantraniliprole 10.26 % OD @ 0.9 ml and combination treatment of Lambda-cyhalothrin 4.9 CS (0.3ml) + Propineb 50 WP (1gm) + water soluble fertilizer (00:52:34) (5 g per litre water) were found equally effective for the control of sucking pests viz. aphids&thrips on pomegranate. Thus, insecticides combined with fungicides and soluble fertilizers are the better option with understanding its compatibility and sequence of formulation mixing before spraying (i.e. W-A-L-E-S) to manage the sucking pests of pomegranate as need base use which could benefit in formulating IPM strategy

Table 1: Pooled data on bioefficacy of the new insecticide molecules against aphids on pomegranate

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived aphids / 5 cm apical twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T_1	Lambda-Cyhalothrin 4.9 CS	0.3	34.54 (5.91)	27.3 (5.27)	18.2 (4.32)	22.7 (4.81)	26.7 (5.21)	29.8 (5.51)	24.9 (5.02)
T_2	Lambda-Cyhalothrin 4.9 CS	0.4	34.10 (5.88)	23.7 (4.91)	15.8 (4.04)	15.8 (4.04)	25.3 (5.08)	28.8 (5.42)	21.9 (4.70)
T_3	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	32.66 (5.76)	26.2 (5.16)	17.5 (4.24)	14.8 (3.91)	28.0 (5.34)	29.3 (5.46)	23.2 (4.82)
T_4	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 + 1.0 g + 5.0 g	35.73 (6.02)	19.8 (4.49)	13.7 (3.76)	12.0 (3.54)	13.9 (3.79)	22.8 (4.88)	16.4 (4.09)
T_5	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	34.67 (5.93)	23.7 (4.91)	16.2 (4.02)	14.5 (3.87)	18.8 (4.40)	27.5 (5.29)	20.1 (4.50)
T_6	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	36.67 (6.09)	20.3 (4.51)	14.3 (3.81)	13.8 (3.79)	15.3 (3.86)	24.3 (4.78)	17.6 (4.15)
T_7	Cyantraniliprole 10.26 % OD	0.75	37.67 (6.18)	22.5 (4.80)	16.5 (4.12)	11.8 (3.51)	15.7 (4.02)	27.5 (5.24)	18.8 (4.35)
T_8	Cyantraniliprole 10.26 % OD	0.9	36.00 (6.04)	19.5 (4.62)	13.2 (3.78)	10.0 (3.24)	11.1 (3.54)	22.8 (4.83)	15.3 (4.0)
T_9	Fipronil 5 SC	1.0	34.29 (5.89)	25.7 (5.14)	17.5 (4.04)	20.0 (4.52)	18.2 (4.32)	25.7 (5.11)	21.2 (4.63)
T_{10}	Spinosad 45 SC	0.25	36.30 (6.06)	26.5 (5.19)	20.5 (4.58)	22.2 (4.50)	15.2 (3.87)	28.0 (5.34)	22.5 (4.70)
T_{11}	Imidacloprid 17.80 SL	0.3	35.67 (6.01)	22.0 (4.98)	17.0 (4.18)	15.5 (4.0)	18.0 (4.30)	29.7 (5.49)	20.9 (4.59)
T_{12}	Untreated control	-	35.34 (5.99)	33.5 (5.83)	33.2 (5.80)	25.0 (5.05)	27.5 (5.29)	32.5 (5.74)	29.8 (5.54)
	S.E.±		0.12	0.10	0.08	0.10	0.10	0.09	-
	CD at 5 %		NS	0.30	0.23	0.29	0.27	0.26	-

Table 2: Pooled data on bioefficacy of the new insecticide molecules against thrips on pomegranate

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived thrips / 5 cm twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Pooled Mean
T_1	Lambda-Cyhalothrin 4.9 CS	0.3	12.1 (3.55)	5.29 (2.40)	3.82 (2.08)	3.21 (1.93)	3.87 (2.09)	5.1 (2.37)	4.26 (2.17)
T_2	Lambda-Cyhalothrin 4.9 CS	0.4	12.23 (3.57)	4.76 (2.29)	3.36 (1.96)	3.06 (1.89)	3.8 (2.07)	5.78 (2.51)	4.15 (2.15)
T_3	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	11.25 (3.43)	5.45 (2.44)	4.3 (2.20)	3.68 (2.05)	4.65 (2.27)	5.81 (2.51)	4.78 (2.29)
T_4	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	11.9 (3.52)	4.6 (2.18)	2.71 (1.79)	2.0 (1.58)	3.20 (1.92)	4.8 (2.31)	3.47 (1.96)
T_5	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	11.07 (3.40)	5.31 (2.41)	3.34 (1.96)	3.15 (1.91)	4.58 (2.25)	5.7 (2.49)	4.42 (2.21)
T_6	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	11.15 (3.41)	4.7 (2.28)	3.69 (2.05)	2.77 (1.81)	3.45 (1.99)	4.64 (2.25)	3.83 (2.07)
T_7	Cyantraniliprole 10.26 % OD	0.75	11.07 (3.40)	4.68 (2.28)	2.88 (1.82)	2.45 (1.72)	3.52 (2.01)	4.28 (2.19)	3.55 (2.00)
T_8	Cyantraniliprole 10.26 % OD	0.9	12.17 (3.56)	4.09 (2.14)	2.69 (1.80)	1.85 (1.53)	3.01 (1.87)	3.89 (2.10)	3.11 (1.89)
T_9	Fipronil 5 SC	1.0	11.14 (3.41)	5.43 (2.44)	4.3 (2.19)	3.16 (1.92)	4.83 (2.08)	5.09 (2.37)	4.36 (2.20)
T_{10}	Spinosad 45 SC	0.25	10.37 (3.30)	5.21 (2.39)	4.31 (2.19)	3.06 (1.89)	4.75 (2.28)	6.21 (2.59)	4.7 (2.27)
T_{11}	Imidacloprid 17.80 SL	0.3	11.7 (3.49)	6.05 (2.56)	3.95 (2.11)	3.6 (2.02)	4.77 (2.30)	5.89 (2.53)	4.85 (2.30)
T_{12}	Untreated control	-	11.8 (3.51)	15.42 (3.99)	15.495 (4.00)	15.91 (4.05)	17.07 (4.19)	17.09 (4.19)	16.19 (4.08)
	S.E.±	-	0.07	0.04	0.02	0.03	0.03	0.02	-
	CD at 5 %	-	NS	0.11	0.08	0.09	0.09	0.08	-

***Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.
DAS – Day After Spray

Table 3: Effect of different insecticide treatments in spray solution mixture on pH and EC

Tr. No.	Treatments	Dose ml/g (per lit.)	Average values of pH at			Average values of EC (dSm^{-1}) at		
			1 hr	24 hr	48 hr	1 hr	24 hr	48 hr
T_1	Lambda-Cyhalothrin 4.9 CS	0.3	7.2	7.56	7.7	0.55	0.5	0.48
T_2	Lambda-Cyhalothrin 4.9 CS	0.4	7.3	7.33	7.8	0.5	0.48	0.48
T_3	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	6.9	7.2	7.3	0.62	0.59	0.47
T_4	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP + Soluble fertilizer 0:52:34	0.3 +1.0 g + 5.0 g	5.2	5.4	5.5	1.9	1.75	1.55
T_5	Flubendiamide 19.92 %+ Thiacloprid 19.92 SC	0.3	7.66	7.73	7.7	1.53	1.51	1.47
T_6	Flubendiamide 19.92 %+ Thiacloprid 19.92 SC	0.4	7.66	7.73	7.7	1.53	1.53	1.51
T_7	Cyantraniliprole 10.26 % OD	0.75	7.8	7.85	7.9	1.41	1.41	1.39
T_8	Cyantraniliprole 10.26 % OD	0.9	7.76	7.83	7.87	1.5	1.49	1.47
T_9	Fipronil 5 % SC	1.0	7.6	7.75	7.86	1.53	1.48	1.48
T_{10}	Spinosad 45 SC	0.25	7.5	7.9	8	1.4	1.39	1.38
T_{11}	Imidacloprid 17.80 SL	0.3	7.3	7.5	7.66	1.4	1.39	1.37
T_{12}	Blank	-	7.9	7.8	8.0	0.52	0.52	0.52

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