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Research Article

Bioefficacy of different insecticides against pomegranate insect pests and their impact on natural enemies

C. Satyanarayana, A. M. Nadaf, Siddanna Thoke

Abstract

A field experiment was conducted during *rabi* 2021-22 and 2022-23 at Horticulture Research and Extension Centre, Vijayapur, Karnataka, India, to evaluate the bioefficacy of different insecticides against pomegranate insect pests and their impact on natural enemies. During 2021-22, Cyantraniliprole 10.26% OD @ 70 g.a.i/ha recorded significantly lowest population of aphids (10.42 and 1.91 per 5cm twig), and thrips (6.33 and 1.22 per 5cm twig) at 7 days after imposition of treatment during first and second spray, respectively. Further, Cyantraniliprole 10.26% OD @ 70g.a.i/ha recorded the lowest fruit damage (6.67%) by pomegranate fruit borer and the highest damage reduction over control (84.53%) on fruits. Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha was next best with higher population reduction over control in different pests viz., aphids (91.89%), thrips (91.24%). However, Emamectin benzoate 5% SG @ 220g.a.i/ha recorded lower fruit damage (7.11%) and higher reduction over control (83.51%). Cyantraniliprole 10.26% OD @ 70 g.a.i/ha was also found to be safer for natural enemies. At harvest, Cyantraniliprole 10.26% OD @ 70 g.a.i/ha recorded the highest yield (13.21 t/ha), followed by, Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha (12.97 t/ha). A similar trend was observed during 2022-23 for pest control and the impact of different insecticides on natural enemies.

Keywords aphids, insecticides, predators, thrips

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Introduction

Pomegranate (*Punica granatum* L.) is a widely consumed fruit and contains a lot of nutrients that help prevent cell damage and have a soothing effect on health. The fruit also has antidiabetic, antihypertensive, antimicrobial, and anti-tumor properties [1]. Further, it is a prominent fruit crop in dry regions worldwide and India is one of the leading producers with a cultivated area of 2.76 lakh hectares and an annual production of 31.48 lakh tonnes during 2021-22 [2]. However, the crop suffers from an array of biological and climatic stress components of which insect pests are the major production constraints. A total of 91 insects, 6 mites, and one snail pest are known to attack pomegranate crops [3]. Aphids are known to devitalize the tender portions leading to deformation of the tender leaves and other growing buds. Further, they are known to excrete huge quantities of sugary substances on which fungal development is observed. When the pest becomes severe it leads to the shedding of the reproductive parts [4].

Fruit borer is another major pest that inflicts pomegranate fruits. The larvae bore into the fruits in the initial stage which is coupled with microbial infection and abscission of the floral parts leading to the huge crop loss. This pest is mainly controlled by insecticides. However, there are a series of problems related to health and ecosystem [5]. Several chemicals have been employed to contain the insect pests inflicting the crops; however, no satisfactory results have been achieved so far. Hence, the present investigation was planned to assess the chemicals which have different functional mechanisms to curb the sucking pests and the fruit borer.

Methodology

The experiment was conducted at Horticulture Research and Extension Centre, Vijayapur during *rabi* 2021-22 and 2022-23. The trial was laid out in Randomized Block Design (RBD) with seven treatments and three replications comprising 10 trees per treatment per replication. Seven treatments *viz*., T_1- Lambda cyhalothrin 4.9% CS @ 12.5g.a.i./ha, T_2- Fipronil 80%WG @ 40 g.a.i./ha, T_3- Imidacloprid 17.8 SL @71.8 g.a.i./ha, T_4- Cyantraniliprole 10.26% OD @ 70 g.a.i./ha, T_5- Buprofezin 25%SC@ 375g.a.i./ha, T_6- Emamectin Benzoate 5% SG @ 220g.a.i./ha and T_7-Untreated Control were imposed on 7 years old pomegranate plantation of Bhagwa cultivar planted with 12ft X 12ft spacing (between plants X between rows). The crop was grown as per the practices prescribed by the University of Horticultural Sciences, Bagalkot [6]. Treatments were imposed once the population crossed the Economic Threshold Level (ETL) and subsequent spray was taken up after two weeks. Insecticides were applied as high-volume sprays @ 1000 liters of spray fluid per hectare.

Sucking pest population

Aphids, *Aphis punicae* Passerini, and thrips, Scirtothrips dorsalis Hood population was recorded on 5 cm shoot length per twig one day before spray (1DBS) and 3, 7 days after spray (DAS). In each plot, 3 plants were randomly selected and tagged and 4 twigs per plant in four directions (North, East, South, and West) were randomly selected in each plant to observe the pest population. The data was expressed as a number per 5 cm twig. Percent reduction of the population was calculated at 7 days after the second spray.

Pomegranate fruit borer

Observation on fruit damage caused by pomegranate fruit borer, *Deudorix isocrates*, Fabricius was recorded at the fruit maturity stage. A total of 25 fruits per plant were randomly selected to calculate the fruit damage by observing healthy and damaged fruits on 3 randomly selected and tagged plants in each plot. Percent, fruit damage, and percent reduction over untreated control were calculated.

Predators

Observations on predators i.e., Coccinellids and Green lacewing were recorded at 1DBS and 3, 7 DAS on randomly selected 4 twigs per plant from the four directions (North, East, South, West) on 3 plants per plot. Data was expressed as a number per twig.

Yield

At harvest, fruit yield recorded per plot was extrapolated to yield per hectare and expressed as tonnes per hectare.

The observations recorded on the population of thrips, aphids, coccinellids, and Green lacewing were ($\sqrt{0.5+x}$) transformed and the observations on percent fruit damage and percent reduction over control were arc sine transformed. The data was subjected to a single-factor Analysis of Variance (ANOVA).

Results and Discussion

A day before spray (DBS), the population of aphids and thrips was uniform and there was no significant difference among the treatments during *rabi* 2021-22 and 2022-23.

Aphids population

A significant difference was observed among the treatments after the first and second spray during the year 2021-22. The Cyantraniliprole 10.26% OD was the best by registering minimum aphid population of 10.22 and 10.42 per 5cm twig at 3 and 7 days after imposition of treatment, respectively, during the first spray (Table 1).

Table 1. Bioefficacy of different insecticides against aphids in pomegranate crop

TN.	Treatments	2021-22						2022-23					
		Population of aphids/5cm twig					ROC at 7DAT (after 2nd spray) (%)	Population of aphids/5cm twig					ROC at 7DAT (after 2nd spray) (%)
			1st Spray		2nd Spray				1st spray		2nd spray		
		1DBT	3DAT	7DAT	3DAT	7DAT		1DBT	3DAT	7DAT	3DAT	7DAT	
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	15.22 (4.03)	15.11 (4.01)	16.86 (4.22)	15.67 (4.08)	13.47 (3.80)	47.46	13.42 (3.80)	12.94 (3.73)	15.75 (4.09)	13.86 (3.85)	12.89 (3.73)	45.73
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	14.78 (3.97)	11.78 (3.57)	13.25 (3.77)	10.22 (3.35)	5.83 (2.61)	77.26	12.83 (3.72)	10.33 (3.37)	11.78 (3.57)	8.47 (3.08)	4.92 (2.43)	79.28
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	15.89 (4.10)	10.53 (3.39)	10.89 (3.45)	7.22 (2.87)	2.08 (1.75)	91.89	13.61 (3.82)	8.06 (3.01)	9.36 (3.22)	6.28 (2.70)	1.50 (1.58)	93.68
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	15.33 (4.04)	10.22 (3.35)	10.42 (3.38)	6.97 (2.82)	1.91 (1.71)	92.55	12.81 (3.71)	7.89 (2.98)	8.94 (3.15)	5.86 (2.62)	1.25 (1.50)	94.74
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	15.97 (4.12)	14.00 (3.87)	15.86 (4.10)	13.97 (3.87)	12.39 (3.66)	51.68	13.56 (3.81)	12.14 (3.62)	14.94 (3.99)	13.42 (3.80)	12.14 (3.62)	48.88
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	15.64 (4.08)	14.55 (3.94)	16.47 (4.18)	14.36 (3.91)	13.33 (3.79)	48.01	13.83 (3.85)	12.72 (3.70)	15.22 (4.03)	13.67 (3.83)	12.56 (3.68)	47.12
T_7	Untreated control	14.86 (3.98)	16.92 (4.23)	20.67 (4.65)	22.72 (4.87)	25.64 (5.16)	-	12.75 (3.71)	14.53 (3.94)	18.89 (4.46)	20.42 (4.63)	23.75 (4.97)	-
SEm±		-	0.05	0.06	0.11	0.07	-	-	0.06	0.05	0.06	0.04	-
CD at 5 %		NS	0.16	0.18	0.33	0.22	-	NS	0.18	0.17	0.18	0.13	-

Figures in the parentheses represents are (√0.5+x) transformed values, NS- Non significant, DBT- Day Before Treatment, DAS- Days After Treatment, ROC- Reduction Over untreated Control, TN.- Treatment Numbers

Similarly, 6.97 and 1.91 aphids per 5cm twig were registered at 3 and 7 days after imposition of treatment, respectively, during the second spray with 92.55 percent reduction over control. These results are in line with reports of Solankar et al., [7] who found Cyantraniliprole 10.26% OD as one of the best among the different chemicals tested against the pomegranate aphids. Imidacloprid 17.8 % SL was next best and registered a 91.89 percent reduction over control and similar observations were made by Abd Ella, [8] who reported Imidacloprid as an effective chemical in controlling pomegranate

aphid. Fipronil 80 %WG (77.26% ROC), Buprofezin 25 %SC (51.68% ROC), and Emamectin Benzoate 5% SG (48.01 ROC) were significantly superior over untreated control (25.64 aphids/5cm twig). These findings corroborate with experimental results of Deepak Kumar et al., [9] who reported that Fipronil 80 WG and Buprofenzin 25SC as less effective chemicals compared to other insecticides in controlling aphids in chili crops, further, Chandrakar et al., [10] found Emamectin benzoate and Lambda cyhalothrin as less effective chemicals against aphids in chili crop. A similar trend was observed during 2022-23 where the Cyantraniliprole 10.26% OD and Imidacloprid 17.8 % SL were again best in controlling the aphids by recording 94.74 and 93.68 percent reduction over control, respectively. Among the different treatments, untreated control recorded the highest aphid population (23.75/5cm twig) at 7 DAT, during the second spray.

Thrips population

The observation on the thrips population taken on 3DAT and subsequent intervals showed significant differences among treatments (Table 2) during 2021-22. Cyantraniliprole 10.26% OD registered significantly lowest thrips population (5.08 and 4.34 thrips/5cm twig) at 3DAT during the first and second spray, respectively which was followed by, Imidacloprid 17.8 SL (5.28 and 4.75 thrips/5cm twig) at 3DAT. Thrips control pattern at 7DAT during the first and second spray was similar to 3DAT and Cyantraniliprole 10.26% OD

Table 2. Bioefficacy of different insecticides against thrips in pomegranate crop

TN.	Treatments	2021-22						2022-23					
		Population of thrips/5cm twig					ROC at 7DAT (after 2nd spray) (%)	Population of thrips/5cm twig					ROC at 7DAT (after 2nd Spray) (%)
		1DBT	1st Spray		2nd Spray			1DBT	1st Spray		2nd Spray		
			3DAT	7DAT	3DAT	7DAT			3DAT	7DAT	3DAT	7DAT	
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5g.a.i/ha	8.67 (3.11)	7.95 (2.99)	10.78 (3.43)	10.03 (3.32)	8.25 (3.04)	49.82	7.64 (2.94)	6.78 (2.79)	9.83 (3.29)	9.03 (3.17)	6.86 (2.80)	52.88
T_2	Fipronil 80 % WG @ 40g.a.i/ha	9.44 (3.23)	5.64 (2.57)	7.00 (2.83)	5.03 (2.45)	1.61 (1.61)	90.21	7.25 (2.86)	4.58 (2.36)	5.20 (2.49)	3.11 (2.03)	1.17 (1.47)	91.96
T_3	Imidacloprid 17.8 % SL @ 71.8g.a.i/ha	8.75 (3.12)	5.28 (2.50)	6.67 (2.77)	4.75 (2.39)	1.44 (1.56)	91.24	6.83 (2.79)	4.25 (2.29)	4.78 (2.40)	3.00 (2.00)	1.05 (1.43)	92.79
T_4	Cyantraniliprole 10.26% OD @ 70g.a.i/ha	9.00 (3.16)	5.08 (2.47)	6.33 (2.71)	4.34 (2.31)	1.22 (1.49)	92.58	7.00 (2.82)	4.11 (2.26)	4.61 (2.37)	2.83 (1.96)	0.81 (1.34)	94.44
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	8.92 (3.15)	5.89 (2.75)	7.81 (2.97)	6.25 (2.69)	5.33 (2.52)	67.58	7.64 (2.94)	5.28 (2.51)	6.78 (2.79)	5.84 (2.61)	4.45 (2.33)	69.44
T_6	Emamectin Benzoate 5% SG @ 220g.a.i/ha	8.64 (3.1)	6.14 (2.78)	7.94 (2.99)	6.75 (2.78)	5.50 (2.54)	66.55	6.95 (2.82)	5.53 (2.55)	7.00 (2.82)	6.33 (2.71)	4.55 (2.35)	68.75
T_7	Untreated control	9.08 (3.15)	10.72 (3.42)	13.44 (3.80)	14.33 (3.91)	16.44 (4.17)	-	7.78 (2.96)	8.83 (3.13)	11.78 (3.57)	12.42 (3.66)	14.56 (3.94)	-
SEm±		-	0.05	0.04	0.05	0.07	-	-	0.04	0.07	0.05	0.08	-
CD at 5 %		NS	0.14	0.13	0.16	0.22	-	NS	0.12	0.23	0.14	0.25	-

Figures in the parentheses represents are ($\sqrt{0.5+x}$) transformed values, NS- Non significant, DBT-Day Before Treatment, DAS- Days After Treatment, ROC- Reduction Over untreated Control, TN.- Treatment Numbers

and Imidacloprid 17.8 SL recorded 92.58% and 91.24% ROC, respectively. Present findings corroborate with reports of Jagginavar et al., [11] wherein they observed a significantly lower population of thrips infesting pomegranate in a plot treated with Cyantraniliprole 10.26% OD in comparison with Thiacloprid 240 SC and imidacloprid17.8 SL. Further, Solankar et al., [7] found Cyantraniliprole 10.26% OD as the most effective chemical to contain thrips in pomegranate. All the other treatments recorded significantly lower thrips populations compared to untreated control. Similar trend was observed during 2022-23 wherein Cyantraniliprole 10.26% OD and Imidacloprid 17.8 % SL recorded higher ROC (94.44 and 92.79%, respectively) compared to Fipronil 80% WG (91.96% ROC), Buprofezin 25 % SC (69.44% ROC), Emamectin Benzoate 5% SG (68.75% ROC) and Lambda cyhalothrin 4.9 % CS (52.88% ROC) (Table 2). These results corroborate with findings of reports of Deepak Kumar et al., [9] who reported that Fipronil 80 WG and Buprofenzin 25SC as less effective compared to other treatments in controlling thrips in chilli crop. As per the reports of Chandrakar et al., [10], Emamectin benzoate and Lambda cyhalothrin are not the most effective in controlling the chili thrips. The untreated control registered the highest thrips population 8.83 and 12.42 thrips/5cm twig at 3DAT during the first and second spray, respectively.

Pomegranate fruit borer

Damage due to fruit borer in different treatments varied significantly; however, the highest damage was registered in the untreated control. Cyantraniliprole 10.26% OD recorded significantly lowest fruit damage (6.67 and 5.78 %) and highest ROC (84.53 and 85.22 %) during 2021-22 and 2022-23, respectively (Table 3).

Table 3. Bioefficacy of different insecticides against pomegranate fruit borer, *Deudorix isocrates*

TN.	Treatments	Dose (g.a.i/ha)	Pomegranate fruit borer			
			2021-22		2022-23	
			Fruit damage (%)	ROC (%)	Fruit damage (%)	ROC (%)
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	12.5	19.11 (25.92)	55.67	17.33 (24.59)	55.69
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	40	8.00 (16.43)	81.44	6.67 (14.96)	82.95
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	220	14.22 (22.12)	67.01	13.33 (21.40)	65.92
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	70	6.67 (14.96)	84.53	5.78 (13.89)	85.22
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	375	13.33 (21.40)	69.08	12.44 (20.65)	68.19
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	71.8	7.11 (15.45)	83.51	6.22 (14.43)	84.10
T_7	Untreated control	-	43.11 (41.04)	-	39.11 (38.71)	-
SEm±		-	0.58	-	0.54	-
CD at 5 %		-	1.78	-	1.66	-

Figures in the parentheses represents arc sine transformed values and outside values are original values ROC- Reduction Over Untreated Control, TN.- Treatment Numbers

These findings are the same as the reports of Nikita Chauhan and Divender Gupta [12] who observed the significantly lowest fruit borer infestation in a treatment with three successive sprays of Cyantraniliprole compared to other treatments. Emamectin Benzoate 5% SG @ 220 g.a.i/ha was statistically on par with Cyantraniliprole 10.26% OD and registered 7.11 and 6.22 percent fruit damage with 83.51 and 84.10 percent ROC during 2021-22 and 2022-23, respectively. Other treatments Fipronil 80 % WG, Buprofezin 25 % SC, Imidacloprid 17.8 % SL, and Lambda cyhalothrin 4.9 % CS registered lower ROC (81.44%, 69.08%, 67.01%, and 55.67%) during the 2021-22 and (82.95%, 68.19%, 65.92% and 55.69%, respectively) during 2022-23. Among the different treatments, untreated control recorded the highest fruit damage (43.11 and 39.11%) during 2021-22 and 2022-23, respectively. Cyantraniliprole is an anthranilic diamide and it affects ryanodine receptors (RyR) [13, 14]. Cyantraniliprole is the first insecticide with cross-spectrum activity to control both chewing and sucking insect pests [15]. These groups of insecticides also possess antifeedant properties [16]. Due to its unique mode of action, Cyantraniliprole was the most effective in controlling aphids, thrips, and fruit borer in the present study.

Impact of different insecticides on predatory populations

The observations on natural enemies viz., Coccinellids and Green lacewing during 2021-22 and 2022-23, showed that Cyantraniliprole is safe and does not have a deleterious effect on the predatory population compared to other treatments (Tables 4 and 5). Present findings are in line with Vinothkumar (2021) [17] who reported that Cyantraniliprole is safer than natural enemies in potato crop ecosystem.

Table 4. Effect of different insecticides on coccinellids population in pomegranate crop

TN.	Treatments	2021-22					2022-23				
		Population of coccinellids/twig					Population of coccinellids/twig				
		1DBT	1st Spray		2nd Spray		1DBT	1st Spray		2nd Spray	
			3DAT	7DAT	3DAT	7DAT		3DAT	7DAT	3DAT	7DAT
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	3.55 (2.13)	2.89 (1.97)	2.89 (1.97)	3.47 (2.11)	3.78 (2.18)	2.72 (1.92)	2.67 (1.91)	3.72 (2.17)	3.33 (2.08)	4.22 (2.28)
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	2.83 (1.95)	2.75 (1.92)	3.42 (2.10)	3.78 (2.18)	4.03 (2.24)	3.03 (2.01)	3.00 (1.99)	2.80 (1.95)	2.56 (1.88)	2.75 (1.93)
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	3.17 (2.04)	3.25 (2.06)	3.78 (2.19)	3.47 (2.11)	3.69 (2.16)	2.09 (1.75)	2.25 (1.80)	3.20 (2.04)	3.86 (2.18)	4.25 (2.29)
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	2.92 (1.97)	3.58 (2.14)	4.33 (2.31)	4.00 (2.23)	4.33 (2.31)	3.25 (2.06)	3.17 (2.04)	3.95 (2.22)	3.45 (2.10)	4.14 (2.26)
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	2.78 (1.94)	3.22 (2.05)	3.75 (2.18)	3.34 (2.08)	3.56 (2.13)	2.45 (1.86)	2.55 (1.88)	3.09 (2.01)	3.00 (1.98)	3.75 (2.17)
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	3.67 (2.15)	3.50 (2.11)	3.75 (2.18)	4.25 (2.29)	4.00 (2.22)	3.17 (2.03)	2.44 (1.85)	2.78 (1.94)	2.89 (1.97)	2.78 (1.94)
T_7	Untreated control	2.92 (1.98)	3.17 (2.03)	4.22 (2.28)	2.89 (1.97)	4.11 (2.26)	2.33 (1.82)	2.08 (1.75)	3.11 (2.02)	3.42 (2.09)	3.56 (2.12)
SEm±		-	-	-	-	-	-	-	-	-	-
CD at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in the parentheses represents are ($\sqrt{0.5+x}$) transformed values, NS- Non significant, DBT- Day Before Treatment, DAS- Days After Treatment, ROC- Reduction Over untreated Control, TN.- Treatment Numbers

Table 5. Effect of different insecticides on Green lacewings population in pomegranate crop

TN.	Treatments	2021-22					2022-23				
		Population of Green lacewings/twig					Population of Green lacewings/twig				
		1DBT	1st Spray		2nd Spray		1DBT	1st Spray		2nd Spray	
			3DAT	7DAT	3DAT	7DAT		3DAT	7DAT	3DAT	7DAT
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	2.67 (1.91)	3.00 (2.00)	2.78 (1.94)	3.11 (2.02)	3.00 (1.99)	2.00 (1.73)	2.19 (1.78)	2.03 (1.74)	2.44 (1.85)	2.67 (1.91)
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	1.92 (1.70)	2.11 (1.76)	1.89 (1.69)	2.42 (1.84)	2.58 (1.89)	2.33 (1.82)	2.33 (1.82)	2.75 (1.94)	1.92 (1.71)	2.56 (1.88)
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	2.78 (1.94)	2.22 (1.79)	2.44 (1.85)	1.75 (1.65)	2.97 (1.99)	1.67 (1.63)	1.78 (1.67)	2.89 (1.97)	2.55 (1.88)	3.08 (2.02)
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	1.83 (1.68)	3.14 (2.03)	3.33 (2.08)	3.33 (2.06)	3.17 (2.04)	2.42 (1.85)	2.55 (1.88)	3.61 (2.14)	3.19 (2.04)	3.75 (2.18)
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	2.92 (1.97)	1.92 (1.70)	2.25 (1.80)	1.94 (1.71)	2.75 (1.93)	1.78 (1.66)	1.92 (1.70)	3.25 (2.06)	3.00 (1.99)	3.20 (2.04)
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	1.66 (1.63)	2.17 (1.78)	3.09 (1.99)	2.47 (1.85)	2.83 (1.96)	2.28 (1.80)	2.44 (1.83)	3.09 (2.02)	2.44 (1.85)	3.25 (2.04)
T_7	Untreated control	2.75 (1.92)	2.44 (1.83)	2.47 (1.86)	3.25 (2.06)	3.14 (2.03)	2.45 (1.85)	2.67 (1.91)	2.89 (1.95)	3.11 (2.03)	2.78 (1.94)
SEm±		-	-	-	-	-	-	-	-	-	-
CD at 5 %		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in the parentheses represents are ($\sqrt{0.5+x}$) transformed values, NS- Non significant, DBT- Day Before Treatment, DAS- Days After Treatment, ROC- Reduction Over untreated Control, TN.- Treatment Numbers

Fruit yield

Cyantraniliprole registered the highest produce (13.78 and 14.09 t/ha) and the highest B: C ratio of 3.35 and 3.42, during 2021-22 and 2022-23, respectively (Table 6 and 7). Similar observations were made by Nikita Chauhan and Divender Gupta [12] who found significantly higher yields in cyantraniliprole treated plots. Imidacloprid was the second alternative which registered 12.97 and 13.27 t/ha fruits, during 2021-22 and 2022-23, respectively. Untreated control recorded the lowest fruit yield (5.61 and 7.37 t/ha during 2021-22 and 2022-23, respectively).

Table 6. Effect of different insecticides on fruit yield of pomegranate

TN.	Treatments	Dose (g.a.i/ha)	Yield (t/ha)	
			2021-22	2022-23
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	12.5	8.34	9.12
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	40	12.33	13.20
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	71.8	12.97	13.27
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	70	13.78	14.09
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	375	10.17	11.25
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	220	9.67	11.04
T_7	Untreated control	-	5.61	7.37
SEm±			0.19	0.23
CD at 5 %			0.75	0.81

Table 7. Cost economics of different insecticides used for pomegranate pest control

TN.	Treatments (1)	Cost of Cultivation (Rs.) (2)	Cost of insecticide (Rs.) (3)	Total cost (4)	Pomegranate price (Rs/Q) (5)	2021-22				2022-23			
						Yield Q/ac (6)	Gross return (Rs.) 7= (5X 6)	Net return 8= (7-4)	B:C ratio 9= (7/4)	Pome yield (Rs/ Q) 10	Gross return 11= (5 X 10)	Net return 12= (10-4)	B:C ratio 13= (10/4)
T_1	Lambda cyhalothrin 4.9 % CS @ 12.5 g.a.i/ha	38100	44	38144	10000	8.34	83400	45256	2.19	9.12	91200	53055.1	2.39
T_2	Fipronil 80 % WG @ 40 g.a.i/ha	38100	797	38897	10000	12.33	123300	84403	3.17	13.2	132000	93103	3.39
T_3	Imidacloprid 17.8 % SL @ 71.8 g.a.i/ha	38100	1461	39561	10000	12.97	129700	90139	3.28	13.27	132700	93138.18	3.35
T_4	Cyantraniliprole 10.26% OD @ 70 g.a.i/ha	38100	3070	41170	10000	13.78	137800	96630	3.35	14.09	140900	99729.82	3.42
T_5	Buprofezin 25 % SC @ 375g.a.i/ha	38100	1063	39163	10000	10.17	101700	62537	2.60	11.25	112500	73336.8	2.87
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	38100	8025	46125	10000	9.67	96700	50575	2.10	11.04	110400	64274.4	2.39
T_7	Untreated control	38100	-	38100	10000	5.61	56100	18000	1.47	7.37	73700	35600	1.93

Conclusion

The results indicate that Cyantraniliprole 10.26% OD @ 70 g.a.i. /ha was the best chemical to control aphids and thrips in pomegranate crops. Besides, due to its cross-spectrum activity, it was effective in controlling the pomegranate fruit borer and did not have any significant deleterious effect on natural enemies' population.

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