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IMPACT OF NEW INSECTICIDE MOLECULES ON INSECT PESTS OF POMEGRANATE AND THEIR EFFECT ON PREDATORS

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ABSTRACT

An experiment was undertaken in the field, during *rabi* 2021-22 and 2022-23 at Horticulture Research and Extension Centre, Vijayapur, Karnataka, India, to assess the impact of different insecticides against pomegranate insect pests and their effect on predators. During 2021-22, Cyantraniliprole 10.26% OD @ 90 g.a.i/ha recorded lowest population of thrips (6.55 and 1.44 per 5cm twig), and aphids (10.64 and 2.13 per 5cm twig) at 7 days after imposition of treatment during first and second spray, respectively. Further, it also recorded lowest fruit damage (7.17%) by fruit borer and highest reduction over control (83.45%). The Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w @ 37+114 g.a.i/ha was on par with Cyantraniliprole 10.26% OD with higher pest population reduction over control in different pests *viz*., thrips (91.17%), aphids (91.68%) and lower fruit damage (7.25%). The Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w were also relatively safer to natural enemies. The Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w were superior over other treatments with 14.64 t/ha and 14.59t/ha yield. The trend observed during 2022-23 for pest control and effect of new insecticide molecules on predators was same as in previous year.

Key words : Insecticides, Thrips, Aphids, Predators, Yield.

Introduction

The pomegranate (*Punica granatum* L.) is a very extensively consumed fruit, by large population and a good source of chemicals, which have strong anti-oxidative and anti-inflammatory properties. The fruit also is a good panacea against diabetes, hypertension, microbial infection and tumors (Vensa *et al*., 2019). It is mainly grown in dry and partly dry regions world over. In India, pomegranate is cultivated over an area of area of 2.76 lakh hectares with production of 31.48 lakh tonnes per hectares per annum during 2021-22 (Anonymous, 2022). However, the crop is ravaged by several biological and climatic factors and the insect pests are the major cause factors for the reduction in the yield. As many as 91 insect, 6 mite and one snail pests are known to infest the crop (Balikai *et al*., 2009). Among the different piercing and sucking insect pests the crop suffers predominantly by the aphids which suck the sap from the tender portion of the plant. The parts which are affected by the different stages of the aphid get devitalized and deformed. Aphids excrete large quantity of sugary substance on which fungi develop, which in turn reduces the photosynthetic area. Infestation due to aphids also led to the sizable quantity of flower and fruit drop (Sreedevi and Verghese, 2009). In the later parts of the season fruit borer is prominent pest to infest both cultivated and wild pomegranate species. The caterpillars pierce through the fruit rind and after entering the fruit feeds on the developing seeds. The entry hole made by the caterpillars leads to the secondary infection and fruit drop. The decrease in the yield is estimated to be 50-90 percent. The control of fruit borer is mainly relied on insecticides. However, there are several associated problems of the insecticides' use *viz.*, insecticide resistance, ill effects on health, pollution of the ecosystem etc. (Sumit and Divender, 2018). Many chemicals have been put in to use to mitigate the insect pests affecting the crop; however, results are not enduring hitherto. Hence, an experiment was designed to assess the impact of new insecticides with novel modes of action to control the pests of pomegranate and their effect on predators.

Materials and Methods

An investigation was undertaken at Horticulture Research and Extension Centre, Vijayapur during *rabi* 2021-22 and 2022-23 comprising 7 treatments *viz*., T_1-Lambda cyhalothrin 4.9% CS @ 12.5g.a.i./ha, T_2-Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114g.a.i/ha,T_3-Cyantraniliprole 10.26% OD @ 90g.a.i./ha,T_4-Sulfoxaflor 3.7% @ 37g.a.i/ha, T_5-Bifenthrin 11.2% SC @ 114g.a.i/ha, T_6-Emamectin Benzoate 5% SG @ 220g.a.i./ha and T_7-Untreated Control. The experiment was laid out in Randomized Block Design (RBD) with 3 replications.

Seven year old Bhagwa cultivar with 12ft × 12ft spacing (plant to plant × row to row) was used for imposition of treatments. The crop was raised by following Recommended Package of Practices (Anonymous, 2016). The treatments were imposed after reaching the Economic Threshold Level (ETL) and the second spray was taken up 15 days after first spray. The insecticides were applied as high volume sprays @ 1000 litres of spray fluid per hectare.

Piercing and sucking insect pests

On 5cm shoot length per twig a day before spray and 3, 7 days after each spray, thrips, *Scirtothrips dorsalis* Hood and aphids, *Aphis punicae* Passerini population was recorded. 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 number per 5cm twig. Per cent reduction of population was calculated at 7 days after second spray.

Fruit borer

Observation on fruit damage caused by pomegranate fruit borer, *Deudorix isocrates*, Fabricius was recorded at 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. Per cent fruit damage and per cent reduction over untreated control was calculated.

Predators

The observations on Predators *viz*., Coccinellids and Green lace wing were recorded a day before spray and 3, 7 days after each spray on randomly selected 4 twigs per plant from the four directions (North, East, South and West) on randomly selected 3 plants in each plot. Data was expressed as number per twig.

Yield

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

The data generated was subjected to single factor Analysis of Variance (ANOVA) after the ($\sqrt{0.5+x}$) transformation of observations on early season pests and predators. Per cent fruit damage and percent reduction over control was arc sine transformed.

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.

Thrips population

There was significant difference among the different treatments at different intervals during 2021-22 (Table 1). Significantly lowest thrips population (5.30 and 4.56 thrips/5cm twig) was recorded in Cyantraniliprole 10.26% OD @ 90 g.a.i/ha at 3DAT during first and second spray, respectively and was statistically on par with Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha (5.35 and 4.60 thrips/5cm twig). The scenario at 7 DAT during first and second spray was similar to 3 DAT and Cyantraniliprole 10.26% OD @ 90g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha recorded 91.32% and 91.17% population reduction over control (ROC), respectively. The results are in line with findings of Jagginavar *et al*. 2018 who reported the most effective control of thrips by Cyantraniliprole 10.26% OD compared to Thiacloprid 240 SC and Imidacloprid 17.8 SL. Solankar *et al*. (2021) also observed effective control of thrips in pomegranate by Cyantraniliprole 10.26% OD. Rest of the treatments performed better than the untreated control. During 2022-23, Cyantraniliprole 10.26% OD and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha again recorded higher ROC (93.09 and 92.76%, respectively) compared to Sulfoxaflor 3.7% @ 37g.a.i/ha (90.65% ROC), Bifenthrin 11.2% SC @ 114g.a.i/ha (68.44% ROC), Emamectin Benzoate 5% SG @ 220 g.a.i/ha (67.76% ROC) and Lambda cyhalothrin 4.9% CS @ 12.5 g.a.i/ha (52.13% ROC) (Table 1). These results corroborate with findings of reports of Renkema *et al*. (2018) and Balakrishnan *et al*. (2009), who reported the control of Strawberry thrips and cotton thrips by Sulfoxaflor and Bifenthrin, respectively. Chandrakar *et al*. (2020) did not find the effective control of chilli thrips by Emamectin benzoate and Lambda cyhalothrin.

Table 1 : Bioefficacy of different insecticides against thrips in pomegranate crop.

Tr. No.	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 @ 12.5 g.a.i/ha	8.89 (3.06)	8.17 (2.94)	11 (3.39)	10.25 (3.28)	8.47 (2.99)	49.15	7.86 (2.89)	7.00 (2.74)	10.05 (3.25)	9.25 (3.12)	7.08 (2.75)	52.13
T_2	Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w @ 37+114 g.a.i/ha	8.97 (3.08)	5.35 (2.42)	6.57 (2.66)	4.60 (2.26)	1.47 (1.40)	91.17	7.25 (2.78)	4.38 (2.21)	4.92 (2.33)	3.10 (1.89)	1.07 (1.25)	92.76
T_3	Cyantraniliprole 10.26% OD @ 90 g.a.i/ha	9.22 (3.12)	5.30 (2.41)	6.55 (2.66)	4.56 (2.25)	1.44 (1.39)	91.32	7.22 (2.78)	4.33 (2.20)	4.83 (2.31)	3.05 (1.88)	1.03 (1.24)	93.09
T_4	Sulfoxaflor 3.7% w/w @ 37g.a.i/ha	9.66 (3.19)	5.86 (2.52)	7.22 (2.78)	5.25 (2.40)	1.83 (1.53)	88.98	7.47 (2.82)	4.8 (2.30)	5.42 (2.43)	3.33 (1.96)	1.39 (1.37)	90.65
T_5	Bifenthrin 11.2% SC w/w @ 114 g.a.i/ha	9.14 (3.10)	6.11 (2.57)	8.03 (2.92)	6.47 (2.64)	5.55 (2.46)	66.67	7.86 (2.89)	5.5 (2.45)	7 (2.74)	6.06 (2.56)	4.67 (2.27)	68.44
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	8.86 (3.06)	6.36 (2.62)	8.16 (2.94)	6.97 (2.73)	5.72 (2.49)	65.64	7.17 (2.77)	5.75 (2.50)	7.22 (2.78)	6.55 (2.66)	4.77 (2.30)	67.76
T_7	Untreated control	9.3 (3.13)	10.94 (3.38)	13.66 (3.76)	14.55 (3.88)	16.66 (4.14)	-	8.00 (2.92)	9.05 (3.09)	12 (3.54)	12.64 (3.62)	14.78 (3.91)	-
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.

Table 2 : Bioefficacy of different insecticides against aphids in pomegranate crop.

Tr. No.	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) (%)
		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	15.44 (3.99)	15.33 (3.98)	17.08 (4.19)	15.89 (4.05)	13.69 (3.77)	47.10	13.64 (3.76)	13.16 (3.70)	15.97 (4.06)	14.08 (3.82)	13.11 (3.69)	45.28
T_2	Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w @ 37+114 g.a.i/ha	16.11 (4.08)	10.48 (3.31)	10.70 (3.35)	7.23 (2.78)	2.15 (1.63)	91.68	13.83 (3.79)	8.18 (2.95)	9.21 (3.12)	6.13 (2.57)	1.51 (1.42)	93.70
T_3	Cyantraniliprole 10.26% OD @ 90 g.a.i/ha	15.55 (4.01)	10.44 (3.31)	10.64 (3.34)	7.19 (2.77)	2.13 (1.62)	91.84	13.03 (3.68)	8.11 (2.93)	9.16 (3.11)	6.08 (2.57)	1.47 (1.40)	93.82
T_4	Sulfoxaflor 3.7% w/w @ 37g.a.i/ha	15 (3.94)	12 (3.54)	13.47 (3.74)	10.44 (3.31)	6.05 (2.56)	76.66	13.05 (3.68)	10.55 (3.32)	12 (3.54)	8.69 (3.03)	5.14 (2.37)	78.52
T_5	Bifenthrin 11.2% SC w/w @ 114 g.a.i/ha	16.19 (4.09)	14.22 (3.84)	16.08 (4.07)	14.19 (3.83)	12.61 (3.62)	51.28	13.78 (3.78)	12.36 (3.59)	15.16 (3.96)	13.64 (3.76)	12.36 (3.59)	48.41
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	15.86 (4.04)	14.77 (3.91)	16.69 (4.15)	14.58 (3.88)	13.55 (3.75)	47.64	14.05 (3.81)	12.94 (3.67)	15.44 (3.99)	13.89 (3.79)	12.78 (3.64)	46.65
T_7	Untreated control	15.08 (3.95)	17.14 (4.20)	20.89 (4.62)	22.94 (4.84)	25.86 (5.13)	-	12.97 (3.67)	14.75 (3.91)	19.11 (4.43)	20.64 (4.60)	23.97 (4.95)	-
SEm±		-	0.06	0.08	0.12	0.08	-	-	0.07	0.06	0.07	0.05	-
CD at 5%		NS	0.22	0.25	0.37	0.27	-	NS	0.22	0.19	0.23	0.17	-

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.

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

Tr. No.	Treatments	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	19.61(26.28)	54.96	17.83(24.98)	54.86
T_2	Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w @ 37+114 g.a.i/ha	7.25(15.22)	83.37	6.33(14.57)	83.99
T_3	Cyantraniliprole 10.26% OD @ 90 g.a.i/ha	7.17(15.53)	83.45	6.28(14.51)	84.12
T_4	Sulfoxaflor 3.7% w/w @ 37g.a.i/ha	14.72(22.56)	66.15	13.83(21.83)	64.97
T_5	Bifenthrin 11.2% SC w/w @ 114 g.a.i/ha	13.83(21.83)	68.20	12.94(21.08)	67.21
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	7.61(16.01)	82.44	6.72(15.02)	82.88
T_7	Untreated control	43.61(41.33)	-	39.55(39.00)	-
SEm±		0.61	-	0.57	-
CD at 5%		1.85	-	1.75	-

Figures in the parentheses represents arc sine transformed values and outside values are original values.
ROC – Reduction Over Untreated Control.

Table 4 : Effect of different insecticides on fruit yield of pomegranate.

Tr. No.	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	9.67	8.89
T_2	Sulfoxaflor 3.7% + Bifenthrin 11.2% SC w/w @ 37+114 g.a.i/ha	71.8	14.59	13.72
T_3	Cyantraniliprole 10.26% OD @ 90 g.a.i/ha	70	14.64	13.76
T_4	Sulfoxaflor 3.7% w/w @ 37g.a.i/ha	40	13.75	12.88
T_5	Bifenthrin 11.2% SC w/w @ 114 g.a.i/ha	375	11.8	10.72
T_6	Emamectin Benzoate 5% SG @ 220 g.a.i/ha	220	11.59	10.22
T_7	Untreated control	-	7.92	6.16
SEm±			0.25	0.21
CD at 5 %			0.83	0.67

Aphids population

During the year 2021-22, Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha were significantly superior over other treatments. The Cyantraniliprole 10.26% OD @ 90 g.a.i/ha recorded lowest aphid population of 10.44 and 10.64 per 5cm twig at 3 and 7 days after imposition of treatment, respectively, whereas, Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha recorded 10.48 and 10.70 per 5cm twig at 3 and 7 days after treatment, during first spray (Table 2). However, they were statistically on par with each other. Similarly, Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha recorded 91.84 and 91.68 percent reduction over control, during second spray. Solankar *et al*. (2021) reported Cyantraniliprole 10.26% OD as the best chemical against pomegranate aphids. Sulfoxaflor 3.7% @ 37g.a.i/ha (76.66% ROC), Bifenthrin 11.2% SC@ 114g.a.i/ha (51.28% ROC), Emamectin Benzoate 5% SG @ 220 g.a.i/ha (47.64 ROC) were superior over untreated control (25.86 aphids/5cm twig). These findings corroborate with experimental results of Koch *et al*. (2022) and Jiang *et al*. (2019), who reported the control of the aphid population in cotton and soybean by Sulfoxaflor and Bifenthrin, respectively. Emamectin benzoate and Lambda cyhalothrin were not effective against chilli thrips as per the reports of Chandrakar *et al*. (2020). During 2022-23

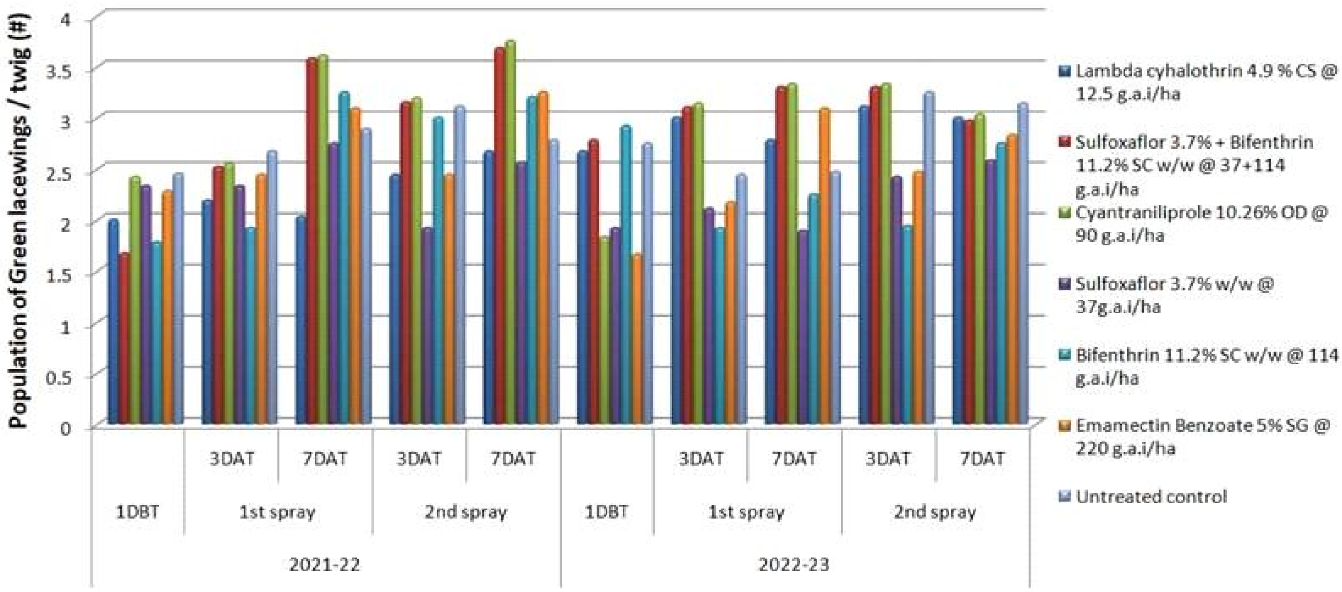

Fig. 1 : Effect of different insecticides on Green lace wings population in pomegranate crop.

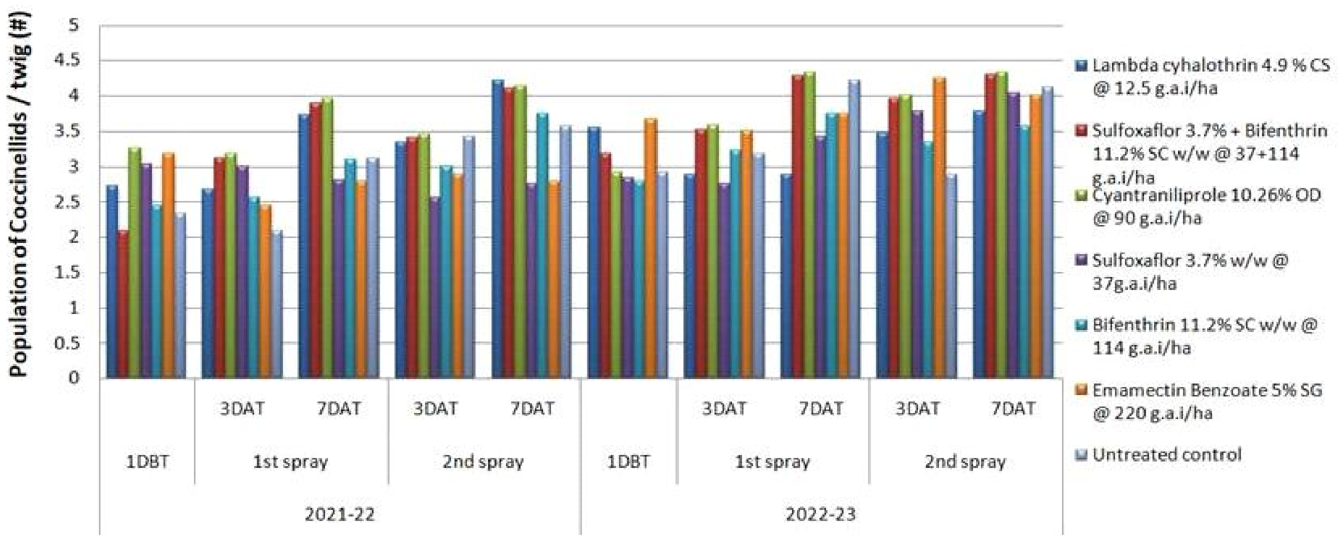

Fig. 2 : Effect of different insecticides on Coccinellids population in pomegranate crop.

also Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha registered higher per cent reduction over control (93.82 and 93.70, respectively), during second spray.

Pomegranate fruit borer

The Cyantraniliprole 10.26% OD recorded significantly lowest fruit damage (7.17 and 6.28%) and highest ROC (83.45 and 83.99%) and was statistically on par with Sulfoxaflor 3.7% + Bifenthrin 11.2% SC @ 37+114 g.a.i/ha, which recorded 7.25 and 6.33 per cent fruit damage with 83.37 83.99 per cent reduction over control, during 2021-22 and 2022-23, respectively (Table 3). Nikita and Divender (2023) also reported highest reduction of pomegranate fruit borer by Cyantraniliprole. Other treatments Emamectin benzoate 5% SG, Bifenthrin 11.2% SC, Sulfoxaflor 3.7% and Lambda cyhalothrin 4.9 % CS registered lower ROC (82.24%, 68.20%, 66.15% and 54.96%) during the 2021-22 and similar trend was observed during 2022-23.

Cyantraniliprole is an anthranilic diamide and it affects ryanodine receptors (RyR) (Sattelle *et al.*, 2008 and IRAC, 2012). Cyantraniliprole is the first insecticide with cross-spectrum activity to control both chewing and sucking insect pests (Anonymous, 2012). These groups of insecticides also possess the antifeedant properties (Gonzales-Coloma *et al.*, 1999). Due to its unique mode of action, Cyantraniliprole was the most effective in controlling thrips, aphids and fruit borer in the present study.

Impact of different insecticides on predatory population

The observations on natural enemies *viz.*, Green lace wing and Coccinellids during 2021-22 and 2022-23, revealed that Cyantraniliprole 10.26% OD and Sulfoxaflor 3.7% + Bifenthrin 11.2% are relatively safer to predatory population (Figs. 1 and 2). Vinothkumar (2021) found Cyantraniliprole 10.26% OD @ 125 and 150g.a.i/ha as safer to natural enemies in potato crop ecosystem.

Fruit yield

Cyantraniliprole 10.26% OD @ 90 g.a.i/ha recorded highest fruit yield of 14.64 and 13.76t/ha and was on par with Sulfoxaflor 3.7% + Bifenthrin 11.2% which recorded 14.59 and 13.72t/ha, during 2021-22 and 2022-23, respectively (Table 4). Nikita and Divender, 2023 also reported higher yield in pomegranate plots sprayed with Cyantraniliprole. Untreated control recorded a lowest fruit yield (7.92 and 6.16 t/ha during 2021-22 and 2022-23, respectively).

Conclusion

It is found from the study that Cyantraniliprole 10.26% OD @ 90 g.a.i/ha and Sulfoxaflor 3.7% + Bifenthrin 11.2% are effective chemicals to control the sucking pest population *viz.,* aphids and thrips and fruit borer with least negative impact on predatory population in pomegranate crop

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