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Management of pomegranate aphids, *Aphis punicae* (Passerini) with newer insecticides

RY Khandare, DR Kadam and NE Jayewar

Abstract
The field experiment was conducted on the farm of Pomology Department of Horticulture, College of Agriculture, VNMKV, Parbhani during *Ambia bahar* 2016 and 2017 in order to study management of pomegranate aphids with newer insecticides. The results revealed that treatment with thiamethoxam 25 WG @ 50 g a.i./ha was found most superior in reducing the population of aphids followed by flonicamid 50 WG @ 75 g a.i./ha and fipronil 5 SC @ 75 g a.i./ha. As regard the safe of insecticides to natural enemies, the treatment comprised of lambda cyhalothrin 5 EC @ 15 g a.i./ha and fipronil 5 SC @ 75 g a.i./ha were highly toxic to coccinellids and chrysopids, whereas, buprofezin 25 SC @ 250 g a.i./ha and cyantraniliprole 10.26 OD 75 g a.i./ha were found comparatively safer.

Keywords: Bio-efficacy, pomegranate, aphid, *Aphis punicae*

Introduction

Pomegranate (*Punica granatum* L.) is one of the most adaptable subtropical minor fruit crop, commonly known as *anar, dalim* or *dalimbe* and belongs to one of the smallest families of plant kingdom, Punicaceae. Pomegranate is native to Iran, where it was first cultivated around 2000 BC and spread to the Mediterranean countries (Evereinoff, 1949) [9]. Pomegranate cultivation is unique in its own way because of its drought tolerant hardy nature, low maintenance cost, steady and good yields, fine table and therapeutic values, better keeping quality and possibilities of throwing the plant into rest during period when irrigation potential is low, particularly in the hot, semi-arid and desert regions of India *viz.*, Maharashtra, Uttar Pradesh, Andhra Pradesh, Gujarat, Karnataka and Tamil Nadu where its cultivation has spread extensively. In India, it is cultivated on 208.73 thousand ha area with a production of 2442.39 thousand MT and the productivity is 11.70 MT per ha. Maharashtra ranks first in area 136.75 thousand ha with a production of 1578.04 thousand MT and productivity of 11.54 MT per ha (Anonymous, 2017) [2].

A total of 91 insects, 6 mites and one snail pest feeding on pomegranate crop in India. The most obnoxious enemy is pomegranate butterfly, *Deudorix* (*Virachola*) *isocrates* (Fabricius) which may destroy more than 50 per cent of fruits. Overuse and improper use of insecticides has led to resurgence of many other pests like thrips, (*Rhipiphoro thrips cruentatus* Hood, *Scirtothrips dorsalis* Hood *Anaphothrips oligochaetus* Karny), (aphids, *Aphis punicae* Passerini), Pomegranate whitefly: (*Siphoninus phillyreae* Haliday and spiralling whitefly: *Aleurodicus dispersus* Russell), mealy bug, (*Pseudococcus lilacinus* Cockerell) and mites, (*Aceria granati* Can. & Massal and *Oligonychus punicae* Hirst.). These sucking pests occur during the flowering and fruiting stage of the crop and thereby reduce the vigour of the plant in addition to excretion of honeydew on the leaves and development of sooty mould on leaves and fruits (Balikai *et al*., 2009) [1, 3].

The species of aphids, *A. punicae* (Passerine) infesting pomegranate is a polyphagous pest known to cause damage to several seasonal field crops, vegetables and fruit crops. Both nymphs and adults suck the cell sap from plant parts including fruits. It is also known to affect photosynthetic activity of the plant by attracting sooty mould to grow on the honey dew secretion. Butani (1979) [7] reported the pomegranate aphid, *A. punicae* is an important sucking pest which causes severe damage to flower buds, flowers, fruits, twigs and leaves by desapping which results in both quantitative and qualitative loss of fruits. The affected parts gets discolored and disfigured. It secretes honey dew on which sooty mould develops. Biradar and Shaila (2004) [4] reported that in recent years pomegranate aphid, *A. punicae* has assumed a serious form and noticed occurring regularly throughout the year with more abundance in winter.

Material and Methods

The field investigations were carried out to evaluate the efficacy of some insecticide molecules against major sucking insect pests of pomegranate.

Experimental details

- Season and Year: *Ambia bahar* 2016 and 2017
- Crop: Pomegranate
- Variety: *Bhagwa*
- Design: Randomized Block Design
- Replications: Three
- Treatments: Eight
- Spacing: 4 m x 4 m
- Number of plant: 2 plants per treatment per replication

Treatment details

T. No.	Treatments	Concentration (%)	Active ingredients (g a.i./ha)	Dose (ml or g/ha)
1.	Cyantraniliprole 10.26% OD	0.015	75	750
2.	Buprofezin 25% SC	0.05	250	1000
3.	Spinosad 45% SC	0.014	73	160
4.	Lambda cyhalothrin 5% EC	0.003	15	300
5.	Fipronil 5% SC	0.015	75	1500
6.	Flonicamid 50% WG	0.015	75	150
7.	Thiamethoxam 25% WG	0.01	50	200
8.	Untreated control	-	-	-

Application of insecticides

With the initiation of infestation of aphids, the first spray of insecticide was applied followed by two sprays at an interval of 15 days. The spray volume for treatment application was calibrated by spraying control plants with plain water. Spraying was taken up early in the morning hours. The required quantity of insecticide was mixed in small quantity of water in a beaker and then added to the bucket containing required volume of water. Spraying was done using high volume knapsack sprayer with hollow cone nozzle.

Methods of recording observations

Two observation plants comprised one treatment in each replication and four twigs (10 cm each) of four side directions of each plant (*i.e.* East, West, South and North) were properly labeled. The observations on total number of nymphs of aphids were recorded on the newly grown twig of the observation plants at one day before and 1, 3, 7 and 14 days after application of insecticides. Simultaneously count of natural enemies was also taken to judge the safety of the test molecules.

Results and Discussion

The data regarding aphid count before spray revealed that population of aphids was uniform throughout the experimental treatments, since the average pre-treatment population of aphids was statistically non-significant. Similarly, the average pre-treatment population was more than five nymphs or adults per twig justifying the need of spraying (Table 1).

Pooled data of *Ambia bahar* 2016 and 2017

A. Performance after first spray

Pooled data on incidence of aphids of two seasons *i.e. Ambia bahar* 2016 and 2017 are presented in Table 1. The pre-treatment count of aphids before initiation of the spray treatments was in the range of 8.56 to 12.34 aphids/10 cm twig.

The data recorded at 1 and 3 DAS, revealed that thiamethoxam 25 WG treated plants showed lowest incidence (2.04 and 2.21 aphids/10 cm twig) followed by flonicamid 50 WG (2.19 and 2.36 aphids/10 cm twig) which were statistically at par with each other and significantly superior over rest of the treatments.

The data recorded on 7 and 14 DAS showed that thiamethoxam 25 WG was the most superior treatment (2.81 and 4.07 aphids/10 cm twig) followed by flonicamid 50 WG (2.90 and 4.52 aphids/10 cm twig) and fipronil 5 SC (4.15 and 6.00 aphids/10 cm twig) showing no statistical difference in their efficacy. It indicated that those three insecticides were comparatively more effective than rest of the spray treatments.

Table 1: Bio-efficacy of newer insecticides against aphids infesting pomegranate (Pooled data of *Ambia bahar* 2016 and 2017)

T. No.	Treatments	Conc. (%)	Average No. of aphids/10 cm twig												
			Pre-count	1st spray				2nd spray				3rd spray			
				1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS
T_1	Cyantraniliprole 10.26 OD	0.015	10.54 (3.30)	3.36 (1.96)	3.59 (2.02)	4.46 (2.22)	7.48 (2.82)	2.77 (1.81)	2.81 (1.81)	3.13 (1.90)	5.25 (2.40)	1.27 (1.32)	1.69 (1.48)	2.67 (1.78)	3.11 (1.88)
T_2	Buprofezin 25 SC	0.05	10.40 (3.16)	3.56 (2.01)	3.71 (2.05)	4.46 (2.21)	7.73 (2.87)	3.00 (1.87)	3.04 (1.88)	3.77 (2.07)	5.83 (2.52)	1.54 (1.42)	1.84 (1.53)	2.88 (1.82)	3.50 (2.00)
T_3	Spinosad 45 SC	0.014	9.08 (3.06)	4.13 (2.15)	4.52 (2.23)	5.92 (2.53)	8.90 (3.05)	3.71 (2.05)	4.07 (2.13)	4.44 (2.22)	7.21 (2.78)	2.71 (1.79)	2.75 (1.80)	3.94 (2.11)	4.86 (2.31)
T_4	Lambda cyhalothrin 5 EC	0.003	8.56 (2.90)	4.25 (2.17)	4.90 (2.32)	6.13 (2.57)	8.96 (3.08)	3.82 (2.08)	4.42 (2.22)	4.86 (2.31)	7.42 (2.81)	3.09 (1.89)	3.05 (1.88)	4.28 (2.18)	5.13 (2.36)
T_5	Fipronil 5 SC	0.015	11.90 (3.52)	2.98 (1.86)	3.34 (1.95)	4.15 (2.15)	6.00 (2.55)	2.46 (1.72)	2.48 (1.72)	2.90 (1.84)	4.77 (2.29)	1.11 (1.26)	1.21 (1.30)	1.81 (1.49)	2.86 (1.82)
T_6	Flonicamid 50 WG	0.015	12.34 (3.58)	2.19 (1.64)	2.36 (1.69)	2.90 (1.84)	4.52 (2.23)	1.31 (1.34)	1.36 (1.34)	2.15 (1.63)	3.53 (2.00)	0.58 (1.04)	0.82 (1.15)	1.10 (1.27)	1.94 (1.55)
T_7	Thiamethoxam 25 WG	0.01	12.34 (3.58)	2.04 (1.58)	2.21 (1.65)	2.81 (1.82)	4.07 (2.10)	1.23 (1.28)	1.27 (1.33)	1.98 (1.51)	3.04 (1.82)	0.44 (0.97)	0.63 (1.03)	0.75 (1.10)	1.48 (1.41)
T_8	Untreated Control	-	11.71 (3.47)	11.80 (3.51)	11.82 (3.51)	12.73 (3.63)	13.88 (3.79)	14.03 (3.81)	15.07 (3.94)	15.92 (4.05)	16.84 (4.14)	16.92 (4.17)	17.86 (4.28)	19.00 (4.42)	21.06 (4.63)
S.E.±			0.38	0.09	0.09	0.11	0.15	0.11	0.13	0.11	0.16	0.08	0.09	0.13	0.16
C.D. at 5%			NS	0.27	0.29	0.34	0.46	0.34	0.40	0.34	0.49	0.26	0.29	0.40	0.48

Figures in parentheses are $\sqrt{x+0.5}$ transformed values DAS: Days after Spray NS: Non-Significant

B. Performance after second spray

The aphid population on untreated plants showed gradual increase from 14.03 to 16.84 aphids/10 cm twig during a span of 14 days. All insecticidal treatments were significantly superior over control in minimizing the pest incidence.

The data recorded at 1 DAS, revealed that thiamethoxam 25 WG treated plants showed lowest incidence (1.23 aphids/10 cm twig) followed by flonicamid 50 WG (1.31 aphids/10 cm twig) which were statistically at par with each other and significantly superior over other test insecticides.

The observations recorded on 3, 7 and 14 DAS showed that thiamethoxam 25 WG was the most superior treatment (1.27, 1.98 and 3.04 aphids/10 cm twig) followed by flonicamid 50 WG (1.36, 2.15 and 3.53 aphids/10 cm twig) and fipronil 5 SC (2.48, 2.90 and 4.77 aphids/10 cm twig. There was no statistical difference in these treatments in their effectiveness against this pest.

C. Performance after third spray

According to the observations recorded on 1 DAS of third spray, thiamethoxam 25 WG (0.44 aphids/10 cm twig) and flonicamid 50 WG (0.58 aphids/10 cm twig) were found to be the most superior treatments. Those were found at par with each other.

The post treatment count of live population of aphids at 3, 7 and 14 days after third spray clearly indicated the superiority of thiamethoxam 25 WG (0.63, 0.75 and 1.48 aphids/10 cm twig) over other treatments. It was followed by flonicamid 50 WG (0.82, 1.10 and 1.94 aphids/10 cm twig) and fipronil 5 SC (1.21, 1.81 and 2.86 aphids/10 cm twig), at 3, 7 and 14 DAS, respectively. These three treatments were statistically at par with each other and were significantly superior over rest of the treatments in minimizing aphid incidence.

The present results are compared with the reports of earlier researchers on chemical control of pomegranate aphids (*A. punicae*) infesting many field crops are discussed here. Spraying of thiamethoxam 25 WG @ 0.2 g/L and imidacloprid 200 SL 0.25 ml/L was reported to be effective against aphids infesting pomegranate (Ananda *et al*., 2009) [1]. Krambekar *et al*. (2013) reported that new compounds, thiamethoxam 25 WG @ 0.2 g/l and imidacloprid 70 WG 0.2 g/l were most effective against aphids, *A. punicae* infesting pomegranate. Jadhav (2015) [10] observed that the treatments comprised of clothianidin 50 WDG @ 20 g a.i./ha, thiamethoxam 25 WG @ 25 g a.i./ha, imidacloprid 17.8 SL @ 25 g a.i./ha and fipronil 5 SC @ 50 g a.i./ha were the most effective treatments against pomegranate aphids at 14 DAS and were at par with each other. Dongarjal (2017) [8] reported that best treatments to control *A. punicae* population infesting pomegranate were clothianidin 20 g a.i./ha, thiamethoxam 25 g a.i./ha and flonicamid 50 g a.i./ha which were found at par with each other.

Effect of newer insecticides on chrysopids on pomegranate (Pooled data of *Ambia bahar* 2016 and 2017)

A. Performance after first spray

The data related to effect of newer insecticides on the population of chrysopids are presented in Table 2.

The pre count of chrysopids was ranged from 0.67 to 0.98 chrysopids/10 cm twig before application of insecticides. At 1, 3 and 7 DAS, the population of chrysopids was significantly lower in insecticidal treatments than the control. Amongst the insecticides, the maximum number of chrysopids was recorded in the treatment buprofezin (0.77, 0.84 and 0.94 chrysopids/10 cm twig) followed by cyantraniliprole (0.67, 0.75 and 0.84 chrysopids/10 cm twig) and were found at par with each other. The highest population was observed in control (1.09, 1.19 and 1.29 chrysopids/10 cm twig).

At 14 DAS, the maximum number of chrysopids was observed in the treatment of buprofezin, cyantraniliprole and flonicamid (1.04, 0.94 and 0.77 chrysopids/10 cm twig). The control showed more population of chrysopids than all insecticidal treatments. Whereas, lambda cyhalothrin was most harmful treatment recording the least population of 0.34 chrysopids/10 cm twig.

Table 2: Effect of newer insecticides on chrysopids in pomegranate (Pooled data of *Ambia bahar* 2016 and 2017)

T. No.	Treatments	Conc. (%)	Mean No. of chrysopids (larvae)/10 cm twig												
			Pre-count	1st spray				2nd spray				3rd spray			
				1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS
T_1	Cyantraniliprole 10.26 OD	0.015	0.94 (1.18)	0.67 (1.08)	0.75 (1.12)	0.84 (1.16)	0.94 (1.20)	0.67 (1.08)	0.75 (1.12)	0.88 (1.17)	1.00 (1.22)	0.67 (1.08)	0.81 (1.14)	0.94 (1.20)	1.06 (1.25)
T_2	Buprofezin 25 SC	0.05	0.86 (1.16)	0.77 (1.12)	0.84 (1.14)	0.94 (1.19)	1.04 (1.23)	0.90 (1.17)	0.98 (1.20)	1.06 (1.24)	1.15 (1.27)	0.94 (1.19)	1.04 (1.24)	1.17 (1.28)	1.32 (1.34)
T_3	Spinosad 45 SC	0.014	0.73 (1.09)	0.36 (0.92)	0.40 (0.95)	0.52 (1.01)	0.65 (1.07)	0.34 (0.91)	0.38 (0.94)	0.44 (0.97)	0.54 (1.02)	0.23 (0.84)	0.29 (0.88)	0.38 (0.93)	0.42 (0.94)
T_4	Lambda cyhalothrin 5 EC	0.003	0.79 (1.13)	0.15 (0.81)	0.15 (0.81)	0.19 (0.83)	0.34 (0.91)	0.06 (0.75)	0.07 (0.75)	0.09 (0.76)	0.13 (0.79)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_5	Fipronil 5 SC	0.015	0.90 (1.17)	0.23 (0.85)	0.27 (0.88)	0.32 (0.90)	0.40 (0.95)	0.11 (0.78)	0.11 (0.78)	0.23 (0.85)	0.28 (0.88)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_6	Flonicamid 50 WG	0.015	0.67 (1.08)	0.42 (0.96)	0.44 (0.97)	0.59 (1.04)	0.77 (1.13)	0.46 (0.98)	0.57 (1.03)	0.57 (1.03)	0.77 (1.13)	0.40 (0.95)	0.50 (1.00)	0.67 (1.08)	0.84 (1.16)
T_7	Thiamethoxam 25 WG	0.01	0.77 (1.12)	0.27 (0.88)	0.32 (0.90)	0.46 (0.98)	0.57 (1.03)	0.19 (0.83)	0.25 (0.87)	0.36 (0.92)	0.46 (0.98)	0.11 (0.78)	0.11 (0.77)	0.17 (0.82)	0.27 (0.87)
T_8	Untreated Control	-	0.98 (1.22)	1.09 (1.26)	1.19 (1.30)	1.29 (1.34)	1.44 (1.39)	1.46 (1.40)	1.50 (1.42)	1.57 (1.44)	1.67 (1.47)	1.69 (1.48)	1.73 (1.49)	1.86 (1.53)	1.94 (1.56)
S.E.±			0.09	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.06
C.D. at 5%			NS	0.12	0.14	0.13	0.13	0.15	0.16	0.15	0.17	0.16	0.16	0.18	0.19

Figures in parentheses are $\sqrt{x+0.5}$ transformed values DAS: Days after Spray NS: Non-Significant

B. Performance after second spray

The post treatment count of live population of chrysopids at 1, 3 and 7 days after second spray clearly indicated the safety of buprofezin (0.90, 0.98 and 1.06 chrysopids/10 cm twig) which was at par with cyantraniliprole (0.67, 0.75 and 0.88 chrysopids/10 cm twig). Whereas, at 14 DAS buprofezin, cyantraniliprole and flonicamid (1.15, 1.00 and 0.77 chrysopids/10 cm twig) were safer and at par with each other. Lambda cyhalothrin and fipronil (0.13 and 0.28 chrysopids/10 cm twig) proved highly lethal to the chrysopids.

C. Performance after third spray

At 1, 3 and 7 DAS, the population of chrysopids was significantly lower in insecticidal treatments than the control. Amongst the insecticides, the maximum count was recorded in buprofezin (0.94, 1.04 and 1.17 chrysopids/10 cm twig) which was statistically at par with cyantraniliprole (0.67, 0.81 and 0.94 chrysopids/10 cm twig).

The data recorded on population of chrysopids at 14 DAS showed that buprofezin was safer treatment (1.32 chrysopids/10 cm twig) followed by cyantraniliprole (1.06 chrysopids/10 cm twig) and flonicamid (0.84 chrysopids/10 cm twig) which were statistically at par with each other. While the population was not observed from the plants treated with lambda cyhalothrin and fipronil.

Similar findings were observed by the earlier workers. Sontakke *et al*. (2013) [12] documented that buprofezin 25 EC at 150 g a.i./ha was highly effective in checking the sucking pests of cotton and it had no adverse effects on the population of natural enemies. Dongarjal (2017) [8] reported that plants treated with buprofezin 25 SC @ 250 g a.i./ha and flonicamid 20 WP @ 50 g a.i./ha were comparatively less toxic to *Chrysoperla* on pomegranate.

Effect of newer insecticides on coccinellids on pomegranate (Pooled data of *Ambia bahar* 2016 and 2017)

A. Performance after first spray

The data pertaining to effect of newer insecticides on the population of coccinellids (Pooled data of *Ambia bahar* 2016 and 2017) is presented in Table 3. The population of the coccinellids was ranged from 1.42 to 2.67 coccinellids/10 cm twig before application of insecticides. At 1 DAS, the population of coccinellids was significantly lower in insecticidal treatments than the control. Among the insecticides evaluated, the maximum number of coccinellids population was recorded in buprofezin 25 SC (1.30 coccinellids/10 cm twig) and it was significantly safer than other test molecules.

At 3 and 7 DAS, maximum count was observed in the treatment buprofezin (1.38 and 1.48 coccinellids/10 cm twig) which was at par with cyantraniliprole (1.05 and 1.25 coccinellids/10 cm twig). However, at 14 DAS buprofezin (1.79 coccinellids/10 cm twig), cyantraniliprole and flonicamid (1.73 and 1.59 coccinellids/10 cm twig) equally safer.

Table 3: Effect of newer insecticides on coccinellids in pomegranate (Pooled data of *Ambia bahar* 2016 and 2017)

T. No.	Treatments	Conc. (%)	Mean No. of coccinellids (Grubs and adults)/10 cm twig												
			Pre-count	1st spray				2nd spray				3rd spray			
				1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS	1 DAS	3 DAS	7 DAS	14 DAS
T_1	Cyantraniliprole 10.26 OD	0.015	2.67 (1.77)	0.86 (1.16)	1.05 (1.24)	1.25 (1.32)	1.73 (1.49)	0.75 (1.12)	0.90 (1.17)	1.17 (1.29)	1.50 (1.41)	0.65 (1.07)	0.77 (1.13)	1.05 (1.23)	1.36 (1.36)
T_2	Buprofezin 25 SC	0.05	2.25 (1.63)	1.30 (1.34)	1.38 (1.37)	1.48 (1.41)	1.79 (1.51)	1.31 (1.34)	1.46 (1.40)	1.59 (1.44)	1.82 (1.52)	1.21 (1.31)	1.34 (1.35)	1.46 (1.39)	1.71 (1.48)
T_3	Spinosad 45 SC	0.014	2.32 (1.65)	0.57 (1.03)	0.67 (1.08)	0.77 (1.13)	1.36 (1.36)	0.48 (0.99)	0.52 (1.01)	0.65 (1.06)	0.94 (1.19)	0.23 (0.85)	0.44 (0.96)	0.52 (1.00)	0.67 (1.07)
T_4	Lambda cyhalothrin 5 EC	0.003	1.42 (1.36)	0.27 (0.87)	0.29 (0.88)	0.38 (0.93)	0.67 (1.08)	0.13 (0.79)	0.17 (0.82)	0.21 (0.84)	0.32 (0.90)	0.02 (0.72)	0.04 (0.74)	0.11 (0.78)	0.19 (0.82)
T_5	Fipronil 5 SC	0.015	2.11 (1.60)	0.38 (0.94)	0.46 (0.98)	0.61 (1.05)	1.01 (1.23)	0.25 (0.86)	0.29 (0.88)	0.36 (0.92)	0.63 (1.05)	0.09 (0.76)	0.11 (0.78)	0.21 (0.84)	0.30 (0.88)
T_6	Flonicamid 50 WG	0.015	2.15 (1.62)	0.69 (1.09)	0.84 (1.15)	0.96 (1.20)	1.59 (1.44)	0.59 (1.04)	0.65 (1.07)	0.88 (1.16)	1.36 (1.35)	0.40 (0.94)	0.50 (0.99)	0.67 (1.08)	1.04 (1.24)
T_7	Thiamethoxam 25 WG	0.01	2.15 (1.62)	0.44 (0.97)	0.50 (1.00)	0.65 (1.07)	1.21 (1.31)	0.36 (0.92)	0.42 (0.96)	0.52 (1.01)	0.77 (1.13)	0.15 (0.80)	0.23 (0.85)	0.30 (0.89)	0.42 (0.95)
T_8	Untreated Control	---	1.52 (1.40)	1.69 (1.48)	1.80 (1.51)	1.96 (1.57)	2.27 (1.66)	2.27 (1.67)	2.34 (1.68)	2.42 (1.71)	2.57 (1.75)	2.57 (1.75)	2.61 (1.76)	2.69 (1.79)	2.82 (1.82)
S.E.±			0.15	0.04	0.04	0.04	0.04	0.04	0.06	0.07	0.06	0.05	0.06	0.08	0.09
C.D. at 5%			NS	0.11	0.13	0.14	0.13	0.13	0.17	0.20	0.20	0.16	0.18	0.25	0.28

Figures in parentheses are $\sqrt{x+0.5}$ transformed values DAS: Days after Spray NS: Non-Significant

B. Performance after second spray

The post treatment count of live population of coccinellids at 1 and 3 days after second spray clearly indicated the safety of buprofezin (1.31 and 1.46 coccinellids/10 cm twig). Whereas, at 7 DAS buprofezin (1.59 coccinellids/10 cm twig) and cyantraniliprole (1.17 coccinellids/10 cm twig) were statistically at par showing minimum effects on coccinellid population. At 14 DAS buprofezin, cyantraniliprole and flonicamid (1.82, 1.50 and 1.36 coccinellids/10 cm twig) were comparatively safer.

C. Performance after third spray

The population of the coccinelids was slowly increased in untreated plants from 2.57 to 2.82 coccinellids/10 cm twig during a span of 14 days. At 1 and 3 DAS, the population of coccinelids was significantly higher in the treatment buprofezin (1.21 and 1.34 coccinellids/10 cm twig).

At 7 DAS, the buprofezin and cyantraniliprole (1.46 and 1.05 coccinellids/10 cm twig) were equally safer to the predator.

The data recorded on population of coccinelids at 14 DAS showed that buprofezin, cyantraniliprole and flonicamid (1.71, 1.36 and 1.04 coccinellids/10 cm twig) were statistically equally safer. Whereas, lowest count was found in lambda cyhalothrin and fipronil treatments (0.19 and 0.30 coccinellids/10 cm twig).

Similar findings were observed by the earlier workers *i.e.* Dongarjal (2017) [8] who reported that plants treated with buprofezin 25 SC and flonicamid 20 WP and were comparatively less toxic to coccinellids in pomegranate ecosystem. Buprofezin 25 EC at 150 g a.i./ha was effective in checking the sucking pests of cotton and it had no adverse effects on the population of natural enemies (Sontakke *et al*., 2013) [12].

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