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

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Abstract
The field experiment was conducted on the farm of Pomology Department of Horticulture, College of Agriculture, VNMKV, Parbhani during *Hasta bahar* 2016 and 2017 in order to investigate bio-efficacy of newer insecticides against pomegranate aphid. 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 flonicamide 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, *Hasta bahar*, 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]. It is extensively cultivated in Spain, Morocco, Egypt, Iran, Afghanistan, Arabia and Baluchistan. Its cultivation spread further to other countries like China, Japan, USA, USSR, Pakistan and India. During 1986, the area under pomegranate cultivation in India was increased due to the introduction of high yielding soft seeded variety "*Ganesh*" in the state of Maharashtra, Karnataka and Gujarat (Bose, 1986) [6].

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 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].

Through scanning of literature revealed a total of 91 insects, 6 mites and 1 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, (*Rhipiphorothrips 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, (*Aceriagranati* 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, 5] 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

1. Year and Seasons: *Hasta bahar* 2016 and 2017
2. Crop: Pomegranate
3. Variety: *Bhagwa*
4. Design: Randomized Block Design
5. Replications: Three
6. Treatments: Eight
7. Spacing: 4 m x 4 m
8. Number of plant: 2 plants per treatment per replication vegetables and fruit crops. Both nymphs and adults suck the cell sap from plant parts including fruits

Table 1: Treatment details

Tr. 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.

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 2).

Pooled data of *Hasta bahar* 2016 and 2017

A. Performance after first spray

The post treatment observations recorded at 1 and 3 DAS (Table 2) indicated that all the insecticidal treatments were significantly superior over control in reducing aphid population. Among these treatments the plants treated with thiamethoxam 25 WG recorded minimum aphid count (2.61 and 2.98 aphids/10 cm twig). It was followed by flonicamid 50 WG (3.15 and 2.23 aphids/10 cm twig) and these two treatments were found statistically at par with each other.

On 7 and 14 DAS, the results showed that the treatment of thiamethoxam 25 WG was most effective in minimizing aphid population (3.53 and 4.96 aphids/10 cm twig) followed by flonicamid 50 WG (3.77 and 5.46 aphids/10 cm twig) and fipronil 5 SC (5.06 and 7.21 aphids/10 cm twig). There was no statistical difference in their effectiveness against aphids.

B. Performance after second spray

All the insecticides under investigation were observed to be significantly superior over control in reducing the population of aphids on pomegranate at all the days of observations after second spray.

At 1 days after second spray significantly minimum number of aphids (1.96 aphids/10 cm twig) were recorded from the plants treated with thiamethoxam 25 WG followed by flonicamid 50 WG (2.13 aphids/10 cm twig).

The lowest incidence of aphids was observed in thiamethoxam 25 WG (2.00, 2.63 and 3.83 aphids/10 cm twig) treated plants followed by flonicamid 50 WG (2.21, 3.00 and 4.48 aphids/10 cm twig) and fipronil 5 SC (3.42, 3.90 and 5.78 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 reducing aphid incidence.

C. Performance after third spray

According to the observations recorded on 1 DAS thiamethoxam 25 WG was found to be the most superior treatments (0.82 aphids/10 cm twig) closely followed by flonicamid 50 WG (1.00 aphids/10 cm twig).

At 3 days after third spray the superiority of thiamethoxam 25 WG (0.96 aphids/10 cm twig) over other treatments was observed. It was followed by flonicamid 50 WG (1.25 aphids/10 cm twig) and fipronil 5 SC (1.90 aphids/10 cm twig). These three treatments were statistically at par with each other.

On 7th day after third spray thiamethoxam 25 WG was the most superior treatment (1.15 aphids/10 cm twig) followed by flonicamid 50 WG (1.50 aphids/10 cm twig). It indicated that these insecticides were comparatively more effective than rest of the spray treatments.

The data recorded on 14 DAS showed that thiamethoxam 25 WG was the most superior treatment (1.71 aphids/10 cm twig) followed by flonicamid 50 WG, fipronil 5 SC and cyantraniliprole 10. 26 OD (1.92, 2.88 and 3.09 aphids/10 cm twig), respectively. It indicated that those four insecticides were at par with each other and comparatively more effective.

Considering the typical damage caused by aphids on developing fruits of pomegranate responsible for loss in the economic yield of the crop, spraying of these molecules *viz.*, cyantraniliprole 10.26 OD @ 75 g a.i/ha, buprofezin 25% SC @ 250 g a.i./ha, spinosad 45 SC @ 73 g a.i./ha, lambda cyhalothrin 5% EC @ 15 g a.i./ha, fipronil 5 SC @ 75 g a.i./ha, flonicamid 50 WG @ 75 g a.i./ha and thiamethoxam 25 WG @ 50 g a.i./ha can be effectively advocated in spray schedules against pomegranate aphids.

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) [11] 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 against Chrysopids on pomegranate (Pooled data of *Hasta bahar* 2016 and 2017)

A. Performance after first spray

The data related to effect of different insecticides on Chrysopids are presented in Table 3.

The data showed that the pre treatment population of Chrysopids was ranged from 0.50 to 0.92 Chrysopids/10 cm twig. At 1, 3 and 7 DAS, highest number of Chrysopids was observed in the treatment buprofezin (0.57, 0.67 and 0.77 Chrysopids/10 cm twig) which was at par with cyantraniliprole (0.46, 0.54 and 0.61 Chrysopids/10 cm twig).

At 14 DAS, the treatment buprofezin (0.90 Chrysopids/10 cm twig) was found least toxic and recorded highest population of Chrysopids followed by cyantraniliprole (0.73 Chrysopids/10 cm twig) and flonicamid (0.63 Chrysopids/10 cm twig) which were statistically at par with each other. While lowest population was found in lambda cyhalothrin at all days of observations after first spray.

B. Performance after second spray

The population of the Chrysopids was ranged from 1.27 to 1.50 Chrysopids/10 cm twig during a span of 14 days in untreated plants. The data recorded at 1, 3 and 7 DAS revealed that maximum population was observed in Buprofezin (0.73, 0.79 and 0.88 Chrysopids/10 cm twig) which was at par with cyantraniliprole (0.52, 0.56 and 0.71 Chrysopids/10 cm twig).

At 14 DAS, Buprofezin was safer treatment (1.00 Chrysopids/10 cm twig) followed by cyantraniliprole (0.88 Chrysopids/10 cm twig) and flonicamid (0.67 Chrysopids/10 cm twig) which were statistically at par with each other.

C. Performance after third spray

The population of the Chrysopids was slowly increased from 1.53 to 1.79 Chrysopids/10 cm twig during a span of 14 days in untreated plants. At 1, 3 and 7 DAS, the maximum population of chrysopids was recorded in buprofezin (0.92, 0.98 and 1.05 chrysopids/10 cm twig) which was statistically at par with cyantraniliprole (0.65, 0.71 and 0.77 Chrysopids/10 cm twig).

At 14 DAS, buprofezin was found safer treatment (1.25 chrysopids/10 cm twig) followed by cyantraniliprole and flonicamid (0.96 and 0.84 chrysopids/10 cm twig) which were at par with each other. While lambda cyhalothrin and fipronil were most harmful treatments.

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, Spiromesifen 22.9 SC @ 96 g a.i./ha, flonicamid 20 WP @ 50 g a.i./ha and acephate 75 WP @ 584 g a.i./ha were comparatively less toxic to *Chrysoperla* on pomegranate.

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

A. Performance after first spray

The data related to effect of different insecticides on coccinellids are presented in Table 4.

The population of coccinelids was ranged from 1.27 to 1.84 coccinellids/10 cm twig. At 1 and 3 DAS, maximum number was observed in buprofezin (1.38 and 1.50 coccinellids/10 cm twig).

At 7 and 14 DAS, the treatment of buprofezin (1.65 and 1.78 coccinellids/10 cm twig) was found least toxic followed by cyantraniliprole (1.50 and 1.71 coccinellids/10 cm twig) and flonicamid (1.34 and 1.63 coccinellids/10 cm twig) which were statistically at par with each other.

B. Performance after second spray

At 1 and 3 DAS, the treatment buprofezin was the safest (1.34 and 1.44 coccinellids/10 cm twig). Whereas, at 7 and 14 DAS, buprofezin and cyantraniliprole were equally safer.

C. Performance after third spray

The population of the coccinellids was slowly increased from 2.53 to 2.75 coccinellids/10 cm twig during a span of 14 days in untreated plants. At 1 and 3 DAS, the maximum number of coccinellids population was recorded in buprofezin (1.28 and 1.40 coccinellids/10 cm twig). At 7 DAS, the treatment of buprofezin and cyantraniliprole recorded maximum number of coccinellids (1.61 and 1.17 coccinellids/10 cm twig). However, at 14 DAS buprofezin, cyantraniliprole and flonicamid (1.86, 1.46 and 1.32 coccinellids/10 cm twig) were equally least toxic. While lambda cyhalothrin and fipronil were found highly toxic (0.36 and 0.42 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, spiromesifen 22.9 SC, flonicamid 20 WP and acephate 75 WP 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].

Table 2: Bio-efficacy of newer insecticides against thrips infesting pomegranate (Pooled data of *Hasta bahar* 2016 and 2017)

Tr. No.	Treatments	Conc. (%)	Average No. of thrips/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	11.90 (3.51)	1.84 (1.53)	2.19 (1.63)	2.38 (1.69)	3.52 (2.01)	1.48 (1.39)	1.71 (1.48)	2.05 (1.59)	3.27 (1.92)	1.07 (1.25)	1.44 (1.38)	1.75 (1.48)	2.82 (1.81)
T_2	Buprofezin 25 SC	0.05	8.11 (2.88)	4.00 (2.12)	4.52 (2.24)	5.27 (2.40)	8.09 (2.93)	3.69 (2.05)	4.07 (2.13)	4.63 (2.26)	7.34 (2.80)	2.94 (1.85)	3.25 (1.93)	3.88 (2.09)	5.96 (2.54)
T_3	Spinosad 45 SC	0.014	12.48 (3.60)	1.67 (1.45)	1.86 (1.52)	2.27 (1.66)	3.30 (1.94)	1.15 (1.28)	1.34 (1.35)	1.88 (1.53)	3.07 (1.88)	0.73 (1.10)	1.04 (1.24)	1.61 (1.44)	2.56 (1.75)
T_4	Lambda cyhalothrin 5 EC	0.003	10.65 (3.33)	2.84 (1.82)	3.15 (1.90)	3.50 (1.99)	4.67 (2.26)	2.34 (1.67)	2.50 (1.72)	3.15 (1.90)	4.48 (2.23)	1.79 (1.51)	2.19 (1.62)	2.71 (1.79)	4.09 (2.13)
T_5	Fipronil 5 SC	0.015	11.38 (3.44)	2.38 (1.68)	2.77 (1.80)	3.09 (1.89)	4.34 (2.20)	1.94 (1.56)	2.27 (1.66)	2.57 (1.74)	3.96 (2.10)	1.40 (1.37)	1.75 (1.49)	2.21 (1.62)	3.30 (1.93)
T_6	Flonicamid 50 WG	0.015	7.77 (2.86)	3.67 (2.04)	3.90 (2.10)	4.44 (2.22)	6.46 (2.63)	3.40 (1.97)	3.67 (2.04)	4.07 (2.13)	6.44 (2.63)	2.80 (1.81)	3.07 (1.88)	3.96 (2.11)	5.15 (2.37)
T_7	Thiamethoxam 25 WG	0.01	8.81 (3.01)	3.15 (1.90)	3.50 (2.00)	3.73 (2.04)	5.50 (2.45)	2.82 (1.82)	3.06 (1.88)	3.38 (1.97)	5.15 (2.37)	2.46 (1.72)	2.59 (1.75)	3.04 (1.88)	4.59 (2.22)
T_8	Untreated Control	-	10.40 (3.30)	10.42 (3.30)	10.46 (3.31)	10.79 (3.36)	11.38 (3.44)	11.44 (3.46)	12.21 (3.56)	13.52 (3.74)	14.17 (3.83)	14.29 (3.85)	14.86 (3.92)	15.56 (4.01)	16.69 (4.14)
S.E.±			0.25	0.09	0.09	0.10	0.12	0.10	0.10	0.12	0.12	0.09	0.10	0.13	0.16
C.D. at 5%			NS	0.29	0.27	0.30	0.36	0.29	0.32	0.36	0.37	0.28	0.32	0.39	0.50

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

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

Tr. 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	0.79 (1.13)	0.46 (0.98)	0.54 (1.02)	0.61 (1.05)	0.73 (1.11)	0.52 (1.01)	0.56 (1.03)	0.71 (1.10)	0.88 (1.17)	0.65 (1.07)	0.71 (1.10)	0.77 (1.12)	0.96 (1.20)
T_2	Buprofezin 25 SC	0.05	0.65 (1.07)	0.57 (1.03)	0.67 (1.08)	0.77 (1.12)	0.90 (1.18)	0.73 (1.11)	0.79 (1.13)	0.88 (1.17)	1.00 (1.22)	0.92 (1.19)	0.98 (1.22)	1.05 (1.24)	1.25 (1.32)
T_3	Spinosad 45 SC	0.014	0.73 (1.11)	0.30 (0.89)	0.36 (0.92)	0.40 (0.95)	0.55 (1.02)	0.21 (0.84)	0.27 (0.87)	0.36 (0.92)	0.40 (0.95)	0.15 (0.80)	0.23 (0.85)	0.32 (0.90)	0.52 (1.01)
T_4	Lambda cyhalothrin 5 EC	0.003	0.50 (1.00)	0.02 (0.72)	0.04 (0.74)	0.06 (0.75)	0.19 (0.83)	0.00 (0.71)	0.00 (0.71)	0.04 (0.73)	0.15 (0.81)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.09 (0.76)
T_5	Fipronil 5 SC	0.015	0.86 (1.16)	0.04 (0.73)	0.11 (0.78)	0.17 (0.82)	0.23 (0.85)	0.00 (0.71)	0.07 (0.75)	0.17 (0.82)	0.21 (0.84)	0.00 (0.71)	0.00 (0.71)	0.02 (0.72)	0.15 (0.80)
T_6	Flonicamid 50 WG	0.015	0.65 (1.07)	0.34 (0.91)	0.40 (0.95)	0.48 (0.99)	0.63 (1.06)	0.29 (0.89)	0.34 (0.91)	0.52 (1.01)	0.67 (1.08)	0.27 (0.88)	0.38 (0.94)	0.55 (1.02)	0.84 (1.15)
T_7	Thiamethoxam 25 WG	0.01	0.92 (1.19)	0.23 (0.85)	0.30 (0.89)	0.34 (0.91)	0.46 (0.98)	0.17 (0.82)	0.19 (0.82)	0.25 (0.86)	0.32 (0.90)	0.02 (0.72)	0.13 (0.79)	0.19 (0.82)	0.25 (0.86)
T_8	Untreated Control	-	0.75 (1.11)	0.81 (1.15)	0.92 (1.19)	1.11 (1.27)	1.23 (1.31)	1.27 (1.33)	1.32 (1.35)	1.36 (1.36)	1.50 (1.41)	1.53 (1.42)	1.59 (1.44)	1.65 (1.46)	1.79 (1.51)
S.E.±			0.06	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.05	0.06	0.06
C.D. at 5%			NS	0.09	0.10	0.11	0.12	0.13	0.15	0.14	0.17	0.14	0.15	0.17	0.18

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

Table 4: Effect of newer insecticides on coccinellids in pomegranate (Pooled data of *Hasta bahar* 2016 & 2017)

Tr. 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	1.84 (1.52)	1.02 (1.23)	1.13 (1.27)	1.50 (1.41)	1.71 (1.49)	0.90 (1.18)	1.07 (1.25)	1.31 (1.34)	1.63 (1.46)	0.73 (1.11)	0.92 (1.19)	1.17 (1.29)	1.46 (1.40)
T_2	Buprofezin 25 SC	0.05	1.75 (1.48)	1.38 (1.37)	1.50 (1.41)	1.65 (1.46)	1.78 (1.50)	1.34 (1.35)	1.44 (1.39)	1.65 (1.46)	1.86 (1.53)	1.28 (1.33)	1.40 (1.38)	1.61 (1.45)	1.86 (1.53)
T_3	Spinosad 45 SC	0.014	1.50 (1.39)	0.69 (1.09)	0.94 (1.20)	1.17 (1.29)	1.32 (1.35)	0.59 (1.04)	0.75 (1.12)	0.88 (1.17)	0.98 (1.21)	0.36 (0.91)	0.59 (1.04)	0.67 (1.07)	0.75 (1.11)
T_4	Lambda cyhalothrin 5 EC	0.003	1.27 (1.31)	0.28 (0.88)	0.30 (0.89)	0.36 (0.93)	0.57 (1.03)	0.15 (0.80)	0.17 (0.82)	0.23 (0.86)	0.42 (0.96)	0.00 (0.71)	0.00 (0.71)	0.04 (0.74)	0.36 (0.92)
T_5	Fipronil 5 SC	0.015	1.71 (1.45)	0.40 (0.95)	0.71 (1.10)	0.96 (1.21)	1.17 (1.29)	0.25 (0.87)	0.36 (0.92)	0.63 (1.06)	0.65 (1.07)	0.00 (0.71)	0.07 (0.75)	0.23 (0.85)	0.42 (0.95)
T_6	Flonicamid 50 WG	0.015	1.54 (1.42)	0.90 (1.18)	1.05 (1.24)	1.34 (1.35)	1.63 (1.46)	0.73 (1.11)	0.90 (1.18)	1.04 (1.24)	1.46 (1.40)	0.44 (0.97)	0.77 (1.13)	0.88 (1.17)	1.32 (1.34)
T_7	Thiamethoxam 25 WG	0.01	1.61	0.52	0.77	1.02	1.23	0.40	0.57	0.75	0.84	0.11	0.27	0.40	0.52

			(1.43)	(1.01)	(1.13)	(1.23)	(1.32)	(0.95)	(1.03)	(1.12)	(1.15)	(0.78)	(0.88)	(0.94)	(1.01)
T_8	Untreated Control	-	1.71 (1.47)	1.77 (1.51)	1.90 (1.55)	2.07 (1.60)	2.25 (1.66)	2.27 (1.67)	2.31 (1.68)	2.38 (1.70)	2.48 (1.73)	2.53 (1.74)	2.57 (1.75)	2.65 (1.77)	2.75 (1.80)
S.E.±			0.17	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.06	0.06	0.06	0.08
C.D. at 5%			NS	0.11	0.12	0.13	0.13	0.12	0.13	0.14	0.16	0.17	0.17	0.19	0.26

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

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