Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(3): 1471-1479
Received: 01-03-2018
Accepted: 05-04-2018

VS Bambhaniya
College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

AV Khanpara
College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

HN Patel
College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
VS Bambhaniya
College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Bio-Efficacy of insecticides against sucking pests; Jassid and Thrips infesting tomato

VS Bambhaniya, AV Khanpara and HN Patel

Abstract
The field experiment was carried out to study the bio-efficacy of different insecticides against sucking pests; whitefly and aphid infesting tomato at instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh-Gujarat during the prevailing year 2017. The results from the three sprays on whitefly have revealed that imidacloprid 0.005 per cent, difenthiuron 0.05per cent, acetamiprid 0.008 per cent and thiacloprid 0.024 per cent were found to be the most effective insecticides. The results of relative efficacy of nine different insecticides against aphid have revealed that flonicamid 0.015 per cent, imidacloprid 0.005 per cent, clothianidin 0.025 per cent and dimethoate 0.03 per cent gave very good results against aphid.
The highest cost benefit ratio (1:77.51) was obtained from the treatment of imidacloprid 0.005 followed by acetamiprid 0.008 per cent (1:74.83), dimethoate 0.03 per cent (1:74.06) and flonicamid 0.015 per cent (1:26.80). Other insecticides register lower yield and economic. Significantly higher yield of 15278 kg/ ha was recorded from plots protected against the sucking pests of tomato while yield of 11620 kg/ ha was recorded from the unprotected plots. The increase in yield in protected plots over unprotected plots was found to be 3657 kg/ ha. This showed 31.47 per cent increase in yield and 23.93 per cent avoidable loss.

Keywords: tomato, bio-efficacy, jassid, thrips and yield loss

Introduction
In India, Tomato is one of the most important vegetable crops due to its immense commercial and nutritive value and wide range of climatic adaptability. It ranks second to potato. Andhra Pradesh, Bihar, Karnataka, Uttar Pradesh, Orissa, Maharashtra, Madhya Pradesh and Assam, are the largest producer of tomato in our country. The highest productivity of tomato is incurred by Spain having 66.8 t /ha while India has only 17.50 t ha-1. When we focus, on national scenario we get that, Madhya Pradesh contributed maximum production 2177 thousand million tonnes but the highest productivity was occupied by Himanchal Pradesh (41.663 t ha-1) (Anonymous, 2014-15b) [4]. The estimated area under tomato in India is 6.33 lakh hectares with 124.25 lakh tonnes of fruit production. In India tomato is cultivated in an area of 8.79 lakh hectares with production of about 182.26 lakh tonnes and productivity of 20.7 tonnes/ha. In Gujarat, this crop occupied 44000 ha area with production of 11.57 lakh tonnes and productivity is 26.3 tonnes/ha (Anonymous, 2014) [3].
With increasing quest of higher demand of this vegetable crop in India and elsewhere, there is considerable increase in its area which had earlier no history of its cultivation. Due to this, there is considerable upsurge in the already reported pests and record of new invasive pest like tomato leaf miner south American tomato moth, *Tuta absoluta* (Sridhar *et al.,* 2014) [30]. Amongst various pests reported in India, as many as sixteen have been observed feeding from germination to the harvesting stage which not only reduce its yield but also deteriorate the quality (Butani, 1977) [6]. The important insect pests of tomato are fruit borer (*H. armigera*), whitefly (*B. tabaci*), leaf hopper (*Amrasca devastans*), leaf miner (*L. trifolii*), potato aphid (*M. persicae*) and hadda beetle (*Epilachana dodecastigma*) (Sharma *et al.,* 2013a) [31]. The most common and serious insect pest of tomato is fruit borer, (*H. armigera*) due to its direct attack on fruits, high mobility, voracious feeding habit, high fecundity, multivoltine and overlapping generations.
The tomato crop is attacked by several sucking pests causing appreciable damage to crop the major sucking pest infesting the tomato crop are as under (Butani and Jotwani, 1984 and kalloo, 1986) [7, 13].
Among the various insect pest, thrips, *Haolothrips ganglbaueri* Schmuts, commonly known as blossom thrips and jassid, *Amrasca bigutula bigutula* Ishida, commonly known as leaf hopper are major sucking pest limiting profitable cultivation of tomato in Gujarat state.
The thrips occasionally appear in large number and damage tomato plant by lacerating the leaf

tissues and imbibing the oozing sap. As a result of damage, the tender foliage becomes spotted and pale and silver strip appear on the affected leaves. The thrips also infest flowers, which when severly damaged wilt, fade and drop prematurely without bearing any fruit (Butani and Jotwani, 1984) [7].

In spite of the fact that insect pests have been an issue in agriculture as the centuries progressed, phenomenon of pest outbreaks have expanded with the change of pest complexities during the recent four decades. Pest richness and distribution changes with abiotic elements and meteorological parameters assume an urgent part in upsurge and biology of any pest. Temperature is the most pivotal abiotic element affecting the rate of growth, development of insect and is particularly critical for insect as pest control measures must be timed precisely. Relative humidity, precipitation, wind velocity and temperature are the major climate parameters that generally coordinate the action of a specific insect. Relationship between pest migration and abiotic components helps in inferring at precision models that supports estimate of pest occurrence. In tomato, where pest management plays an important role in harvesting its maximum potential, numbers of insecticide applications though increases the yield, but are economical up to a certain extent. The increased insecticide applications coupled with high cost result in escalation of cost of cultivation which further makes the crop uneconomical due to non-remunerative price of the crop produce. Their massive overuse and frequent misuse has led to the problems of three Rs *viz.;* resistance of pesticides, resurgence of pest and residues as well as toxicity hazards to non-target animals. The present study was planned and undertaken to evaluate efficacy and economics of various insecticides such as imidacloprid, spinosad, acetamiprid, clothianidin, thiacloprid, dinotefuran, difenthiuron, flonicamid and dimethoate for the management of major sucking pests of tomato. Looking to the importance of sucking pest, *viz*; *B. Tabaci*, *A.gossypii*, and *T. tabaci* and *S. dorsalis* on tomato crop, the following aspect was studied during the course of investigation.

- Bio-efficacy of insecticides against sucking pests; jassid and thrips infesting *kharif* tomato.

Materials and Methods

The experimental investigation on bio- efficacy of insecticides against sucking pests; jassid and thrips infesting tomato was carried out at the instructional farm, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat during *Kharif* 2016 under field condition. The detail of the materials used and method employed for the said aspect of study is described here under.

Table

S. No	Technical name	Concentration (%)	Dose/10 litre of water	Manufacture name
T_1	Imidacloprid 30.5 SC	0.005%	1.6 ml	Bayer Crop Science Ltd.
T_2	Spinosad 45 SC	0.009%	2 ml	Dow agro sciences Ltd.
T_3	Acetamiprid 20 SP	0.008%	4 g	Rallis India Ltd.
T_4	Clothianidin 50 WDG	0.025%	5 g	Sumitomo Chemical Pvt. Ltd.
T_5	Thiacloprid 24 SC	0.024%	10 ml	Bayer Crop Science Ltd.
T_6	Dinotefuran 20 SG	0.01%	5 g	PI Industries Ltd.
T_7	Difenthiuron 50 WP	0.05%	10 g	Syngenta India Ltd.
T_8	Flonicamid 50 WG	0.015%	3 g	United Phosphorus Ltd.
T_9	Dimethoate 30 EC	0.03%	10 ml	Rallis India Ltd.
T_{10}	Control (No Spray)	--	--	--

Application of treatments

All the recommended agronomical practices were followed. All the insecticides were applied in the form of foliar spray with the help of knapsack spryer. For deciding the quantity of spray fluid required per plot, the control plot was sprayed with water and the required spray fluids were determined. Spray fluid was prepared by mixing measured quantity of water and insecticide. Care was also taken to rinse the sprayer thoroughly before and after each spray with soap water to avoid contamination from treatment to treatment. First spray was given at appearance of pest. Second and third spray was done at 15 days after first spray.

Method of recording observations

All the recommended practice was adopted for raising the crop. Observations on pest population was recorded from 5 randomly selected plants before 24 hours and after 2, 5 and 10 days of spraying from three leaves were selected representing top, middle and bottom regions of each plant. The per cent reduction in pest population over control was calculated by using following formula.

$$\text{Per cent reduction in population} = \frac{X1-X2}{X1} \times 100$$

Where,

X_1 = population in control plots

X_2 = population in treated plots

Yield and economics

With a view to evaluate the effect of different pesticides on the tomato yield, the tomato crop was harvested from each net plot. The harvested yield were weighed and converted on hectare basis. Economics of all treatments will be worked out by considering the price of products' cost of insecticides and labor charges. CBR will be worked out to compare the economics of different insecticidal treatments. The per cent increased yield over control will be also calculated by using following formula (Pradhan, 1969).

$$\text{Yield increased over control (\%)} = \frac{T - C}{C} \times 100$$

Where,

T= Yield of respective treatment (kg /ha)

C= Yield of control (kg/ha)

Statistical analysis

Statistical analysis of data was carried out as per the analysis of variance technique given by Panse and Sukhatme (1985) [19].

Results and Discussion

A field experiment was conducted for the chemical control of sucking pests viz jassid and thrips of tomato during *kharif* season of the year 2016 at Junagadh Agricultural University, Junagadh. The results of the experiment are discussed as under.

Jassid

First spray

Two days after spraying

The per cent reduction in pest population over control of jassid recorded at the second day after spraying in different insecticidal treatments is presented in Table 1. Treatment of Imidacloprid 0.005 per cent proved to be significantly the most effective with 47.78 per cent reduction in jassid population (2.45 jassid/3 leaves). It was statistically at par with Flonicamid 0.015 per cent with 44.56 per (2.52 jassid/3 leaves).

Dinotefuran 0.01 per cent with 40.38 per cent (2.62 jassid/3 leaves), Thiacloprid 0.024 per cent with 39.33 per cent (2.64 jassid/3 leaves), Clothianidin 0.025 per cent with 39.07 per cent (2.65 jassid/3 leaves), Acetamiprid 0.008 per cent with 37.77 per cent (2.67 jassid/3 leaves) and Dimethoate 0.03 per cent with 37.33 per cent (2.68 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Difenthiuron 0.05 per cent with 35.42 per cent (2.72 jassid/3 leaves) and Spinosad 0.009 per cent with 31.59 per cent (2.80 jassid/3 leaves) reduction of Jassid over control and remained less effective treatment than other.

Table 1: Efficacy of insecticides against Jassid, *A. biguttula biguttula*, on tomato after first spray during *Kharif* 2016

S. No	Treatments	Before Spray	Population of jassid/3 leaves/plant		
			2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	3.54 (12.51)	2.45*(6.00) [47.78]	1.97(3.89) [65.48]	2.08(4.33) [61.27]
2	Spinosad 45 SC	3.42 (11.70)	2.80(7.86) [31.59]	2.48(6.13) [45.60]	2.77(7.67) [31.39]
3	Acetamiprid 20 SP	3.30 (10.89)	2.67(7.15) [37.77]	2.07(4.30) [61.84]	2.60(6.74) [39.71]
4	Clothianidin 50 WDG	3.48 (12.09)	2.65(7.00) [39.07]	1.98(3.92) [65.21]	2.09(4.37)[60.91]
5	Thiacloprid 24 SC	3.50 (12.25)	2.64(6.97) [39.33]	2.01(4.03) [64.24]	2.12(4.48) [59.92]
6	Dinotefuran 20 SG	3.31 (10.98)	2.62(6.85) [40.38]	2.00(3.99) [64.59]	2.09(4.37) [60.91]
7	Difenthiuron 50 WP	3.48 (12.11)	2.72(7.42) [35.42]	2.37(5.62) [50.13]	2.70(7.27) [34.97]
8	Flonicamid 50 WG	3.37 (11.36)	2.52(6.37) [44.56]	1.93(3.72) [66.99]	1.94(3.76) [66.36]
9	Dimethoate 30 EC	3.37 (11.33)	2.68(7.20) [37.33]	2.02(4.08) [63.79]	2.26(5.09) [54.47]
10	Control	3.46 (11.99)	3.39 (11.49)	3.36 (11.27)	3.34 (11.18)
S.Em. ±		0.071	0.034	0.042	0.046
C.D. at 5%		NS	0.10	0.12	0.13
C.V. %		3.61	2.17	3.32	3.34

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of jassid recorded at the five day after spraying in different insecticidal treatments is presented in Table 1. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 66.99 per cent reduction in jassid population (1.93 jassid/3 leaves).

Imidacloprid 0.005 per cent with 65.48 per cent (1.97 jassid/3 leaves), Clothianidin 0.025 per cent with 65.21 per cent (1.98 jassid/3 leaves), Dinotefuran 0.01 per cent with 64.59 per cent (2.0 jassid/3 leaves), Thiacloprid 0.024 per cent with 64.24 per cent (2.01 jassid/3 leaves) and Dimethoate 0.03 per cent with 63.79 per cent (2.02 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed second group of effective treatments. Acetamiprid 0.008 per cent with 61.84 per cent (2.07 jassid/3 leaves) and Difenthiuron 0.05 per cent with 50.13 per cent (2.37 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Spinosad 0.009 per cent with 45.60 per cent (2.48 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Ten days after spraying

The per cent reduction in pest population over control of jassid recorded at the ten day after spraying in different insecticidal treatments is presented in Table 1. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 66.36 per cent reduction in jassid population (1.94 jassid/3 leaves).

Imidacloprid 0.005 per cent with 61.27 per (2.08 jassid/3 leaves), Clothianidin 0.025 per cent with 60.91 per cent (2.09 jassid/3 leaves), Dinotefuran 0.01 per cent with 60.91 per cent (2.09 jassid/3 leaves), Thiacloprid 0.024 per cent with 2.12 per cent (2.01 jassid / 3 leaves) and Dimethoate 0.03 per cent with 54.47per cent (2.32 jassid/3 leaves) reduction of jassid over control and remained next effective group of treatments. Acetamiprid 0.008 per cent with 39.71 per cent (2.60 jassid/3 leaves), Difenthiuron 0.05 per cent with 34.97 per cent (2.70jassid/3 leaves) and Spinosad 0.009 per cent with 31.39 per cent (2.77 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Second spray

Two days after spraying

The per cent reduction in pest population over control of jassid recorded at the second day after spraying in different insecticidal treatments is presented in Table 2. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 80.90 per cent reduction in jassid population (1.42 jassid/3 leaves).

Imidacloprid 0.005 per cent with 77.98 per cent (1.53 jassid/3 leaves) and Dinotefuran 0.01 per cent with 77.79 per cent (1.54 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed second group of effective treatments. Thiacloprid 0.024 per cent with 77.14 per cent (1.56 jassid/3 leaves), Clothianidin 0.025 per cent with 76.85 per cent (1.57 jassid/3 leaves), Dimethoate 0.03 per cent with 76.48 per cent (1.58jassid/3 leaves) and Acetamiprid 0.008 per cent with 65.19 per cent (1.92 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Spinosad 0.009 per cent with 52.68 per cent (2.24 jassid/3 leaves) and Difenthiuron 0.05 per cent with 52.39 per cent (2.25 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Table 2: Efficacy of insecticides against Jassid, *A. biguttula biguttula,* on *kharif* tomato after second spray during *kharif* 2016

Sr. No.	Treatments	Population of jassid/3 leaves/plant		
		2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	1.53*(2.34) [77.98]	1.23(1.52) [86.93]	1.48(2.20) [80.93]
2	Spinosad 45 SC	2.24(5.03) [52.68]	2.01(4.03) [65.34]	2.26(5.11) [55.71]
3	Acetamiprid 20 SP	1.92(3.70) [65.19]	1.53(2.33) [79.96]	1.62(2.62) [77.29]
4	Clothianidin 50 WDG	1.57(2.46) [76.85]	1.27(1.62) [86.07]	1.56(2.43) [78.94]
5	Thiacloprid 24 SC	1.56(2.43) [77.14]	1.53(2.33) [79.96]	1.57(2.46) [78.68]
6	Dinotefuran 20 SG	1.54(2.36) [77.79]	1.31(1.72) [85.21]	1.53(2.35) [79.63]
7	Difenthiuron 50 WP	2.25(5.06) [52.39]	1.94(3.75) [67.75]	2.24(5.03) [56.41]
8	Flonicamid 50 WG	1.42(2.03) [80.90]	1.02(1.03) [91.14]	1.11(1.23) [89.34]
9	Dimethoate 30 EC	1.58(2.50) [76.48]	1.46(2.13) [81.68]	1.77(3.14) [72.79]
10	Control	3.26 (10.63)	3.41 (11.63)	3.40 (11.54)
S.Em. ±		0.046	0.066	0.043
C.D. at 5%		0.13	0.19	0.12
C.V. %		4.24	6.93	4.05

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of jassid recorded at the five day after spraying in different insecticidal treatments is presented in Table 2. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 91.14 per cent reduction in jassid population (1.02jassid/3 leaves).

Imidacloprid 0.005 per cent with 86.93 per cent (1.23 jassid/3 leaves), Clothianidin 0.025 per cent with 86.07 per cent (1.27 jassid/3 leaves), Dinotefuran 0.01 per cent with 85.21 per cent (1.31jassid/3 leaves), Dimethoate 0.03 per cent with 81.68 per cent (1.46 jassid/3 leaves), Thiacloprid 0.024 per cent with 79.96 per cent (1.53 jassid/3 leaves) and Acetamiprid 0.008 per cent with 79.96 per cent (1.53 jassid/ 3 leaves) reduction of jassid over control and remained next effective group of treatments. Difenthiuron 0.05 per cent with 67.65 per cent (1.94jassid/3 leaves) and Spinosad 0.009 per cent with 65.34 per cent (2.01jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Ten days after spraying

The per cent reduction in pest population over control of jassid recorded at the ten day after spraying in different insecticidal treatments is presented in Table 2. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 89.34 per cent reduction in jassid population (1.11jassid/3 leaves).

Imidacloprid 0.005 per cent with 80.93 per cent (1.48 jassid/3 leaves), Dinotefuran 0.01 per cent with 79.63 per cent (1.53 jassid/3 leaves), Clothianidin 0.025 per cent with 78.94 per cent (1.56 jassid/3 leaves), Thiacloprid 0.024 per cent with 78.68 per cent (1.57 jassid/3 leaves) and Acetamiprid 0.008 per cent with 77.29 per cent (1.62 jassid/3 leaves) reduction of jassid over control and remained next effective group of treatments. Dimethoate 0.03 per cent with 72.79 per cent (1.77 jassid/3 leaves), Difenthiuron 0.05 per cent with 56.41 per cent (2.24 jassid/3 leaves) and Spinosad 0.009 per cent with 55.71 per cent (2.26 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Third spray

Two days after spraying

The per cent reduction in pest population over control of jassid recorded at the second day after spraying in different insecticidal treatments is presented in Table 3. All the treatment found statistically effective against jassid as compared to control. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 91.77 per cent reduction in jassid population (0.93jassid/3 leaves).

It was statistically at par with Imidacloprid 0.005per cent with 88.51 per (1.10 jassid/3 leaves) and Dinotefuran 0.01 per cent with 87.94 per cent (1.12 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed second group of effective treatments. Clothianidin 0.025 per cent with 87.17 per cent (1.16 jassid/3 leaves), Thiacloprid 0.024 per cent with 85.16 per cent (1.25 jassid/3 leaves), Acetamiprid 0.008 per cent with 84.78 per cent (1.26 jassid/3 leaves) and Dimethoate 0.03 per cent with 82.96 per cent (1.33 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Difenthiuron 0.05 per cent with 66.79 per cent (1.86 jassid/3 leaves) and Spinosad 0.009 per cent with 60.57 per cent (2.03jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Table 3: Efficacy of insecticides against Jassid, A. biguttula biguttula, on tomato after third spray during kharif 2016

S. No	Treatments	Population of jassid/3 leaves/plant		
		2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	1.10*(1.20) [88.51]	0.82(0.67) [93.43]	1.06(1.13) [89.60]
2	Spinosad 45 SC	2.03(4.12) [60.57]	1.77(3.13) [69.31]	2.06(4.23) [61.08]
3	Acetamiprid 20 SP	1.26(1.59) [84.78]	0.95(0.90) [91.17]	1.27(1.62) [85.09]
4	Clothianidin 50 WDG	1.16(1.34) [87.17]	0.88(0.77) [92.45]	1.15(1.32) [87.85]
5	Thiacloprid 24 SC	1.25(1.55) [85.16]	0.91(0.83) [91.86]	1.37(1.87) [82.79]
6	Dinotefuran 20 SG	1.12(1.26) [87.94]	0.89(0.80) [92.15]	1.13(1.28) [88.22]
7	Difenthiuron 50 WP	1.86(3.47) [66.79]	1.61(2.59) [74.60]	1.87(3.50) [67.80]
8	Flonicamid 50 WG	0.93(0.86) [91.77]	0.77(0.59) [94.21]	0.91(0.83) [92.36]
9	Dimethoate 30 EC	1.33(1.78) [82.96]	1.07(1.15) [88.72]	1.34(1.80) [83.44]
10	Control	3.23 (10.45)	3.19 (10.20)	3.30 (10.87)

S.Em. ±	0.076	0.041	0.080
C.D. at 5%	0.22	0.12	0.23
C.V. %	8.68	5.57	9.03

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of jassid recorded at the five day after spraying in different insecticidal treatments is presented in Table 3. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 94.21 per cent reduction in jassid population (0.77 jassid/3 leaves).

Imidacloprid 0.005 per cent with 93.43 per cent (0.82 jassid/3 leaves) and Clothianidin 0.025 per cent with 92.45 per cent (0.88 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed second group of effective treatments. Dinotefuran 0.01 per cent with 92.15 per cent (0.89 jassid/3 leaves), Thiacloprid 0.024 per cent with 91.86 per cent (0.91 jassid/3 leaves), Acetamiprid 0.008 per cent with 91.17 per cent (0.95 jassid/3 leaves) and Dimethoate 0.03 per cent with 88.72 per cent (1.07jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Difenthiuron 0.05 per cent with 74.60 per cent (1.61 jassid/3 leaves) and Spinosad 0.009 per cent with 69.31 per cent (1.77 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

Ten days after spraying

The per cent reduction in pest population over control of jassid recorded at the ten day after spraying in different insecticidal treatments is presented in Table 3. Treatment of Flonicamid 0.015 per cent proved to be significantly the most effective with 92.36 per cent reduction in jassid population (0.91 jassid/3 leaves).

Imidacloprid 0.005 per cent with 89.60 per cent (1.06 jassid/3 leaves) and Dinotefuran 0.01 per cent with 88.22 per cent (1.13 jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed second group of effective treatments. Clothianidin 0.025 per cent with 87.85 per cent (1.15 jassid/3 leaves), Acetamiprid 0.008 per cent with 85.09 per cent (1.27 jassid/3 leaves), Dimethoate 0.03 per cent with 83.44 per cent (1.34 jassid/3 leaves) and Thiacloprid 0.024 per cent with 82.79 per cent (1.37jassid/3 leaves) reduction of jassid over control and remained statistically at par with each other formed third group of effective treatments. Difenthiuron 0.05 per cent with 67.80 per cent (1.87 jassid/3 leaves) and Spinosad 0.009 per cent with 61.08 per cent (2.06 jassid/3 leaves) reduction of jassid over control and remained less effective treatment than other.

The findings are in close relation with those of Acharya *et al.* (2002) [1], Gosalwad *et al.* (2008) [10], Sujay *et al.* (2013) [31] and Ahmed *et al.* (2014) [2].

Thrips

First spray

Two days after spraying

The per cent reduction in pest population over control of thrips recorded at the second day after spraying in different insecticidal treatments is presented in Table 4. All the treatment found statistically effective against thrips as compared to control. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 45.83 per cent reduction in thrip population (2.12 thrips/3 leaves).

Difenthiuron 0.05 per cent with 38.96 per cent (2.25 thrips/3 leaves), Imidacloprid 0.005 per cent with 37.63 per (2.27 thrips/3 leaves), Flonicamid 0.015 per cent with 35.22 per cent (2.32 thrips/3 leaves), Acetamiprid 0.008 per cent with 34.13 per cent (2.34 thrips/3 leaves) and Dimethoate 0.03 per cent with 32.44 per cent (2.37 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed second group of effective treatments. Clothianidin 0.025 per cent with 30.88per cent (2.39 thrips/3 leaves), Dinotefuran 0.01 per cent with 28.22 per cent (2.44 thrips/3 leaves) and Thiacloprid 0.024 per cent with 26.41 per cent (2.47 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments.

Table 4: Efficacy of insecticides against thrips, on tomato after first spray during *harif* 2016

Sr. No.	Treatments	Before Spray	Population of thrips/3 leaves/plant		
			2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	2.77 (7.65)	2.27*(5.17) [37.63]	1.66(2.76) [67.18]	1.71(2.91) [68.57]
2	Spinosad 45 SC	2.68 (7.16)	2.12(4.49) [45.83]	1.54(2.36) [71.93]	1.63(2.66) [71.27]
3	Acetamiprid 20 SP	2.84 (8.07)	2.34(5.46) [34.13]	1.86(3.47) [58.73]	1.85(3.43) [62.95]
4	Clothianidin 50 WDG	2.64 (6.97)	2.39(5.73) [30.88]	2.20(4.85) [42.33]	2.04(4.15) [55.18]
5	Thiacloprid 24 SC	2.68 (7.18)	2.47(6.10) [26.41]	1.79(3.19) [62.06]	2.08(4.33) [53.23]
6	Dinotefuran 20 SG	2.63 (6.90)	2.44(5.95) [28.22]	2.38(5.68) [32.46]	2.45(6.00) [35.20]
7	Difenthiuron 50 WP	2.72 (7.42)	2.25(5.06) [38.96]	1.64(2.69) [68.01]	1.80(3.23) [65.11]
8	Flonicamid 50 WG	2.71 (7.33)	2.32(5.37) [35.22]	1.85(3.42) [59.33]	1.98(3.92) [57.66]
9	Dimethoate 30 EC	2.83 (8.03)	2.37(5.60) [32.44]	1.83(3.36) [60.04]	1.85(3.43) [62.95]
10	Control	2.71 (7.34)	2.88 (8.29)	2.90 (8.41)	3.04 (9.26)
S.Em. ±		0.072	0.089	0.074	0.057
C.D. at 5%		NS	0.26	0.22	0.17
C.V. %		4.63	6.5	6.59	4.87

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of thrips recorded at the five day after spraying in different insecticidal treatments is presented in Table 4. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 71.93 per cent reduction in thrips population

(1.54 thrips/3 leaves).
Difenthiuron 0.05 per cent with 68.01 per cent (1.64 thrips/3 leaves) and Imidacloprid 0.005 per cent with 67.18 per (1.66 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed second group of effective treatments. Thiacloprid 0.024 per cent with 62.06 per cent (1.79 thrips/3 leaves), Dimethoate 0.03 per cent with 60.04 per cent (1.83 thrips/3 leaves), Flonicamid 0.015 per cent with 59.33 per cent (1.85 thrips/3 leaves) and Acetamiprid and remained statistically at par with each other formed third group of effective treatments. Clothianidin 0.025 per cent with 42.33 per cent (2.20 thrips/3 leaves) and Dinotefuran 0.01 per cent with 32.46 per cent (2.38 thrips/3 leaves) reduction of thrips over control and remained less effective treatments.

Ten days after spraying

The per cent reduction in pest population over control of thrips recorded at the ten day after spraying in different insecticidal treatments is presented in Table 4. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 71.27 per cent reduction in thrips population (1.63 thrips/3 leaves). It was statistically at par with Imidacloprid 0.005 per cent with 68.57 per cent (1.71 thrip/3 leaves) reduction of thrips.
Difenthiuron 0.05 per cent with 65.11 per cent (1.80 thrips/3 leaves), Acetamiprid 0.008 per cent with 62.95 per cent (1.85 thrips/3 leaves), Dimethoate 0.03 per cent with 62.95 per cent (1.85 thrips/3 leaves) and Flonicamid 0.015 per cent with 57.66 per cent (1.98 thrips/3 leaves) reduction of thrip over control and remained statistically at par with each other formed third group of effective treatments. Clothianidin 0.025 per cent with 55.18 per cent (2.04 thrips/3 leaves), Thiacloprid 0.024 per cent with 53.23 per cent (2.08 thrips/3 leaves) and Dinotefuran 0.01 per cent with 35.20 per cent (2.45 thrips/3 leaves) reduction of thrips over control and remained less effective treatments.

Second spray

Two days after spraying

The per cent reduction in pest population over control of thrips recorded at the second day after spraying in different insecticidal treatments is presented in Table 5. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 85.75 per cent reduction in thrips population (1.18 thrips/3 leaves). It was statistically at par with Imidacloprid 0.005 per cent with 82.68 per cent (1.30 thrips/3 leaves) reduction of thrips.
Difenthiuron 0.05 per cent with 75.10 per cent (1.56 thrips/3 leaves), Acetamiprid 0.008 per cent with 74.38 per cent (1.58 thrips/3 leaves), Dimethoate 0.03 per cent with 73.46 per cent (1.61 thrips/3 leaves) and Flonicamid 0.015 per cent with 71.72 per cent (1.66 thrips/3 leaves) reduction of thrips over control and remained third effective group of treatments. Clothianidin 0.025 per cent with 67.31 per cent (1.79thrips/3 leaves), Thiacloprid 0.024 per cent with 65.57 per cent (1.83thrips/3 leaves) and Dinotefuran 0.01 per cent with 53.17 per cent (2.14 thrips/3 leaves) reduction of thrips over control and remained less effective treatment than other.

Table 5: Efficacy of insecticides against thrips, on tomato after second spray during*kharif*2016

S. No	Treatments	Population of thrips/3 leaves/plant		
		2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	1.30*(1.69) [82.68]	1.05(1.10) [89.27]	1.25(1.55) [85.67]
2	Spinosad 45 SC	1.18(1.39)[85.75]	0.93(0.86) [91.61]	1.22(1.49) [86.22]
3	Acetamiprid 20 SP	1.58(2.50) [74.38]	1.22(1.49) [85.47]	1.31(1.72) [84.10]
4	Clothianidin 50 WDG	1.79(3.19) [67.31]	1.47(2.16) [78.94]	1.59(2.53) [76.61]
5	Thiacloprid 24 SC	1.83(3.36) [65.57]	1.68(2.81) [72.61]	1.81(3.26) [69.87]
6	Dinotefuran 20 SG	2.14(4.57) [53.17]	1.93(3.74) [63.54]	2.11(4.47) [58.68]
7	Difenthiuron 50 WP	1.56(2.43) [75.10]	1.22(1.49) [85.47]	1.53(2.33) [78.46]
8	Flonicamid 50 WG	1.66 (2.76) [71.72]	1.32 (1.74) [83.04]	1.42 (2.03) [81.23]
9	Dimethoate 30 EC	1.61 (2.59) [73.46]	1.23 (1.52) [85.18]	1.76 (3.09) [71.44]
10	Control	3.12 (9.76)	3.20 (10.26)	3.29 (10.82)
S.Em. ±		0.048	0.073	0.057
C.D. at 5%		0.14	0.21	0.17
C.V. %		4.71	8.36	5.79

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of thrips recorded at the five day after spraying in different insecticidal treatments is presented in Table 5. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 91.61 per cent reduction in thrips population (0.93thrips/3 leaves). It was statistically at par with Imidacloprid 0.005 per cent with 89.27 per cent (1.05 thrips/3 leaves) reduction of thrips.
Acetamiprid 0.008 per cent with 85.47 per cent (1.22 thrips/3 leaves), Difenthiuron 0.05 per cent with 85.47per cent (1.22 thrips/3 leaves), Dimethoate 0.03 per cent with 85.18per cent (1.23thrips/3 leaves), Flonicamid 0.015 per cent with 83.04 per cent (1.32thrips/3 leaves) and Clothianidin 0.025 per cent with 78.94 per cent (1.47 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments. Thiacloprid 0.024 per cent with 72.61 per cent (1.68thrips/3 leaves) and Dinotefuran 0.01 per cent with 63.54 per cent (1.93 thrips/3 leaves) reduction of thrips over control and remained less effective treatments.

Ten days after spraying

The per cent reduction in pest population over control of thrips recorded at the ten day after spraying in different insecticidal treatments is presented in Table 5. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 86.22 per cent reduction in thrip population (1.22thrips/3 leaves).
Imidacloprid 0.005 per cent with 85.25 per cent (1.25thrips/3 leaves) and Acetamiprid 0.008 per cent with 84.10 per cent (1.31 thrips/3 leaves) reduction of thrips over control and

remained statistically at par with each other formed second group of effective treatments. Flonicamid 0.015 per cent with 81.23 per cent (1.42 thrips/3 leaves), Difenthiuron 0.05 per cent with 78.46 per cent (1.53 thrips/3 leaves), Clothianidin 0.025 per cent with 76.61 per cent (1.59 thrips/3 leaves) and Dimethoate 0.03 per cent with 71.44 per cent (1.76 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments. Other treatments are less effective in control of thrips.

Third spray

Two days after spraying

The per cent reduction in pest population over control of thrips recorded at the second day after spraying in different insecticidal treatments is presented in Table 6. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 92.22 per cent reduction in thrip population (0.91thrips/3 leaves).

Imidacloprid 0.005 per cent with 91.00 per cent (0.98 thrips/3 leaves), Acetamiprid 0.008 per cent with 89.69 per cent (1.05 thrips/3 leaves) and Flonicamid 0.015 per cent with 88.28 per cent (1.12 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed second group of effective treatments. Clothianidin 0.025 per cent with 85.09 per cent (1.26 thrips/3 leaves), Difenthiuron 0.05 per cent with 83.88 per cent (1.31 thrips/3 leaves), Dimethoate 0.03 per cent with 82.38 per cent (1.37 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments. Thiacloprid 0.024 per cent with 77.50 per cent (1.55 thrips/3 leaves) and Dinotefuran 0.01 per cent with 69.16 per cent (1.81thrips/3 leaves) reduction of thrips over control and remained less effective treatment than other.

Table 6: Efficacy of insecticides against thrips, on tomato after third spray during *kharif* 2016

Sr. No.	Treatments	Population of thrips/3 leaves/plant		
		2 DAS	5 DAS	10 DAS
1	Imidacloprid 30.5 SC	0.98*(0.96) [91.00]	0.79 (0.63) [93.71]	1.06 (1.13) [88.29]
2	Spinosad 45 SC	0.91 (0.83) [92.22]	0.77 (0.59) [93.97]	1.05 (1.10) [88.60]
3	Acetamiprid 20 SP	1.05 (1.10) [89.69]	0.89 (0.80) [91.83]	1.03 (1.06) [89.01]
4	Clothianidin 50 WDG	1.26 (1.59) [85.09]	1.00 (1.00)[89.79]	1.42 (2.03) [78.96]
5	Thiacloprid 24 SC	1.55 (2.40) [77.50]	1.23 (1.52) [84.48]	1.44 (2.08) [78.44]
6	Dinotefuran 20 SG	1.81 (3.29) [69.16]	1.57 (2.46) [74.89]	1.81 (3.26) [66.21]
7	Difenthiuron 50 WP	1.31 (1.72) [83.88]	0.99 (0.99) [89.89]	1.17 (1.38) [85.69]
8	Flonicamid 50 WG	1.12 (1.25) [88.28]	0.93 (0.86) [91.22]	1.14 (1.29) [86.63]
9	Dimethoate 30 EC	1.37 (1.88) [82.38]	1.03 (1.06) [89.18]	1.47 (2.15) [77.72]
10	Control	3.27 (10.67)	3.13 (9.80)	3.11 (9.65)
S.Em. ±		0.071	0.035	0.062
C.D. at 5%		0.21	0.10	0.18
C.V. %		8.43	4.91	7.38

* Square root transformations. Figures in parenthesis ( ) are retransformed values. Figures in parenthesis [ ] are per cent reduction over control. DAS: Day after spray.

Five days after spraying

The per cent reduction in pest population over control of thrips recorded at the five day after spraying in different insecticidal treatments is presented in Table 6. Treatment of Spinosad 0.009 per cent proved to be significantly the most effective with 93.97 per cent reduction in thrip population (0.77 thrips/3 leaves). It was statistically at par with Imidacloprid 0.005 per cent with 93.71 per cent (0.79thrips/3 leaves) reduction of thrips.

Acetamiprid 0.008 per cent with 91.83 per cent (0.89thrips/3 leaves), Flonicamid 0.015 per cent with 91.22 per cent (0.93 thrips/3 leaves), Difenthiuron 0.05 per cent with 89.89 per cent (0.99thrips/3 leaves), Clothianidin 0.025 per cent with 89.79 per cent (1.00 thrips/3 leaves) and Dimethoate 0.03 per cent with 89.18 per cent (1.03 thrip/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments. Thiacloprid 0.024 per cent with 84.48 per cent (1.23 thrips/3 leaves) and Dinotefuran 0.01 per cent with 74.89 per cent (1.57 thrips/3 leaves) reduction of thrips over control and remained less effective treatments.

Ten days after spraying

The per cent reduction in pest population over control of thrips recorded at the ten day after spraying in different insecticidal treatments is presented in Table 6. Treatment of Acetamiprid 0.008 per cent proved to be significantly the most effective with 89.01 per cent reduction in thrip population (1.03 thrips/3 leaves).

Spinosad 0.009 per cent with 88.60 per cent (1.05 thrips/3 leaves), Imidacloprid 0.005 per cent with 88.29 per cent (1.06 thrips/3 leaves), Flonicamid 0.015 per cent with 86.63 per cent (1.14 thrips/3 leaves) and Difenthiuron 0.05 per cent with 85.69 per cent (1.17 thrips/3 leaves) reduction of thrip over control and remained statistically at par with each other formed second group of effective treatments. Clothianidin 0.025 per cent with 78.96 per cent (1.42 thrips/3 leaves) and Thiacloprid 0.024 per cent with 78.44 per cent (1.44 thrips/3 leaves) reduction of thrips over control and remained statistically at par with each other formed third group of effective treatments. Dimethoate 0.03 per cent with 77.72 per cent (1.47 thrips/3 leaves) and Dinotefuran 0.01 per cent with 66.21 per cent (2.11 thrips/3 leaves) reduction of thrips over control and remained less effective treatments.

The findings are in close relation with those of Reddy *et al.* (2005) [23], Singh *et al.* (2005) [28], Patel *et al.* (2006) [20], Seal *et al.* (2006) [25], Prasad and Ahmed (2009) [22], Mandal (2012) [15], Thaniya and Thomas (2013) [32], Vanisree *et al.* (2013) [33].

Yield obtained from different insecticidal treatment plots

Treatment wise data on yield of healthy tomato fruit are presented in Table 7 revealed that the highest fruit yield of 21235 kg/ ha was obtained from the treatment of Imidacloprid 0.005 per cent which was statistically at par with Flonicamid 0.015 per cent, Clothianidin 0.025 per cent, Difenthiuron 0.05 per cent, Acetamiprid 0.008 per cent and Dimethoate 0.03 per cent which recorded 20617, 20494, 20123, 19691 and 19012

kg/ ha yield, respectively. The insecticidal treatments of Thiacloprid 0.024 per cent and Spinosad 0.009 per cent were the next in the order giving yields of 17778 and 17593 kg/ ha, respectively. The treatment Dinotefuran 0.01 per cent gave the lowest yield of 16728 kg/ ha and it did not differ significantly from the control treatment which registered 11235 kg/ ha of yield. As far as the increase in yield is concerned, the maximum per cent increase (89.00%) was recorded from the treatment of Imidacloprid 0.005 per cent. The treatments which gave higher percentage of yield include Flonicamid 0.015 per cent, Clothianidin 0.025 per cent, Difenthiuron 0.05 per cent, Acetamiprid 0.008 per cent and Dimethoate 0.03 per cent t recording 83.50, 82.41, 79.10, 75.26 and 69.22 per cent increase yield over control. The other treatments gave less than 60 per cent increase in yield like Thiacloprid 0.024 per cent and Spinosad 0.009 per cent and Dinotefuran 0.01 per cent.

Table 7: Effect of different insecticidal treatments on the yield of tomato during *kharif*- 2016

Sr. No	Treatments	Yield of healthy tomato fruit (Kg/ha)	Yield increase over control (%)
1	Imidacloprid 30.5 SC	21235	89.00
2	Spinosad 45 SC	17593	56.59
3	Acetamiprid 20 SP	19691	75.26
4	Clothianidin 50 WDG	20494	82.41
5	Thiacloprid 24 SC	17778	58.23
6	Dinotefuran 20 SG	16728	48.89
7	Difenthiuron 50 WP	20123	79.10
8	Flonicamid 50 WG	20617	83.50
9	Dimethoate 30 EC	19012	69.22
10	Control	11235	--
S.Em. ±		827	--
C.D. at 5%		2457	--
C.V. %		7.76	--

According to Sandeep and Subash (2013) [24] the highest marketable fruit yield and economic returns were obtained in Imidacloprid 17.8 SL + Spinosad 45 SC (259.06q/ha). Ghosh *et al*. (2009) recorded maximum reduction of thrips (89.8%) population with consequential increase in yield (53.2%) over control in Acetamiprid. Patel *et al*. (2009) [21] reported that the plots treated with Difenthiuron registered highest yield (115.75 q/ha) in chili.

Economics of different insecticidal treatments

The data on economics of three applications of the nine different insecticides against tomato sucking pests; jassid and thrips during *Kharif*-2016 are presented in 8. The data revealed that the cost of treatment was maximum in clothianidin 0.025 per cent (11100/ha) followed by Dinotefuran 0.01 per cent (6525/ha), Spinosad 0.009 per cent (5400/ha), Difenthiuron 0.05 per cent (5220/ha) and Flonicamid 0.015 per cent (4275/ha). The gross realization was maximum from treatment of Imidacloprid 0.005 per cent (318525/ha) followed by Flonicamid 0.015 per cent (309255/ha), Clothianidin 0.025 per cent (307410/ha), Difenthiuron 0.05 per cent (301845/ha), Acetamiprid 0.008 per cent (295365/ha) and Dimethoate0.03 per cent (285180/ha). Net realization (net gain) was received maximum 150000/ha from treatment of Imidacloprid 0.005 per cent with 77.51 C:B followed by Flonicamid 0.015 per cent (140730/ha with 26.80 C:B), Clothianidin 0.025 per cent (138885/ha with 11.50 C:B), Difenthiuron 0.05 per cent (133320/ha with 21.52C:B), Acetamiprid 0.008 per cent (126840/ha with 74.83 C:B) and Dimethoate 0.03 per cent (116655/ha with 74.06 C:B).The insecticidal treatments of Thiacloprid 0.024 per cent and spinosad 0.009 per cent and Dinotefuran 0.01 per cent were less effective in control of tomato sucking pests (jassid and thrips) and register the lower yield and economic.

Table 8: Economics of different insecticidal treatments against sucking pest infesting tomato during *Kharif*- 2016

Sr. No.	Treatment	Insecticide used for 3 spray (ml or gm/ha)	Cost of insecticide (Rs/ha)	Total cost for 3 application* (Rs/ha)	Yield (kg/ha)	Gross** realization (Rs/ha)	Net realization (Rs/ha)	C:B Ratio (CBR)
1	Imidacloprid 30.5 SC	240	960	1935	21235	318525	150000	77.51
2	Spinosad 45 SC	300	5400	6375	17593	263895	95370	14.96
3	Acetamiprid 20 SP	600	720	1695	19691	295365	126840	74.83
4	Clothianidin 50 WDG	750	11100	12075	20494	307410	138885	11.50
5	Thiacloprid 24 SC	1500	3600	4575	17778	266670	98145	21.45
6	Dinotefuran 20 SG	750	6525	7500	16728	250920	82395	10.98
7	Difenthiuron 50 WP	1500	5220	6195	20123	301845	133320	21.52
8	Flonicamid 50 WG	450	4275	5250	20617	309255	140730	26.80
9	Dimethoate 30 EC	1500	600	1575	19012	285180	116655	74.06
10	Control	--	--	975	11235	168525	--	--

*Labour charges @ 325/ha/spray. ** Market value of tomato @ 15/kg.

References

1. Acharya S, Mishra HP, Dash D. Efficacy of insecticides against okra Jassid, *Amrasca biguttula biguttula* Ishida. Annals of Plant Protection Sciences, 2002; 10(2):230-232.
2. Ahmed S, Nisar MS, Shakir MM, Imran M, Iqbal K. Comparative efficacy of some neonicotinoids and traditional insecticides on sucking insect pests and their natural enemies on *Bt*-121 cotton crop. Journal of Animal and Plant Sciences. 2014; 24(2):660-663.

3. Anonymous. Indian horticulture database. National Horticulture Board, Ministry of Agriculture. 2014, 4. [Fide: http://nhb.gov.in/areapro/IndianHor.2013.pdf.]
4. Anonymous. Ministry of Agriculture, Government of India, 2014-2015b or www.nhb.gov.in (NHB Database 2014-2015).
5. Bharati MS, Shetgar SS, Sawant CG. Bio-efficacy of different insecticides against brinjaljassid (*Amrasca biguttula biguttula*) and whitefly (*Bemisia tabaci*). Journal of Entomological Research. 2015; 39(4):369-372.
6. Butani DK. Insect pest of vegetables-tomato. Pesticides, 1977; 11:33-36.
7. Butani DK, Jotwani MG. Tomato, in "Insects in Vegetables" publ. By Periodical Expert Book Agency. Delhi. 1984, pp. 22-34.
8. Ghosh A, Chatterjee ML, Chakraborti K, Samanta A. Field evaluation of insecticides against chillithrips (*Scirtothrips dorsalis* Hood). Annals of Plant Protection Science, 2009; 17(1):69-71.
9. Ghosal A, Chatterjee ML, Bhattacharya A. Bio-efficacy of neonicotinoids against *Aphis gossypii* Glover of okra. Journal of Crop and Weed. 2013; 9(2):181-184.
10. Gosalwad SS, Kwathekar BR, Wadnekar DW, Asewar BV, Dhutraj DN. Bioefficacy of newer insecticides against sucking pest of okra. Journal of Maharastra Agricultural Universities. 2015; 33(3):343-346.
11. Gupta PK, Ansari NA, Tewari HD, Tewari JP. Efficacy of different insecticides against Whitefly (*Bemisia tabaci* Gen.) in tomato crop and control of Tomato Leaf Curl Virus. Pesticide Research Journal. 2007; 19(2):218-219.
12. Idris M, Mandal SK. Newer insecticides against whitefly vector, *Bemisiatabaci* and Tomato Yellow Vein Mosaic Virus. International Journal of Plant Protection. 2014; 42(1):97-98.
13. Kalloo. Insect, mites and nemetodes in "Tomato" Publ. By Allied Publishers Private Limited, Ahmadabad. 1986, 403.
14. Konar A, More KA, Dutta Ray KS. Population dynamics and efficacy of some insecticides against aphid on okra. Journal of Crop and Weed. 2013; 9(2):168-171.
15. Mandal SK. Field evalution of alternet use of insecticides against chilli thrip, *scirtothrips dorsalis* Hood. Annals of Plant Protection Sciences, 2012; 20(1):59-62.
16. Morita M, Ueda T, Yoneda T, Koyanagi T, Haga T. Flonicamid, a novel insecticide with a rapid inhibitory effect on aphid feeding. Pest Management Science, 2007; 63(10):969-973.
17. Muhammad A, Muhammad HB, Muhammad A, Muhammad AK. Efficacy of some insecticides against whitefly (*Bemisiatabaci* Genn.) infesting cotton under field conditions. Pakistan Journal of Life and Social Sciences. 2009; 7(2):140-143.
18. Nderitu JH, Kasina JM, Kimenju JW, Malenge F. Evaluation of synthetic and neem based insecticides for managing aphids on okra (Malvaceae) in Eastern Kenya. Journal of Entomology. 2008; 5(3):207-212.
19. Panse VG, Sukhatme PV. Statistical method for agriculture workers. I. C. A. R., New Delhi, 1985; pp. 361.
20. Patel BH, Patel JJ, Bhatt HV, Maghodiya AB, Bhalala MK. Bioefficacy of thiomethoxam 25 WG and difenthiuron 50 WP against thrip, *Scirtothrip dorsalis* Hood, infesting chilli. Indian Journal of Entomology. 2006; 68(3):274-275.
21. Patel BH, Koshiya DJ, Korat DM, Vaishnav PR. Evaluation of some insecticides against thrips, *Scirtothrips dorsalis* infesting chilli. Karnataka Journal of Agriculture Sciences. 2009; 22(2):327-330.
22. Prasad NVVSD, Ahmed K. Efficacy of spinosad 45 SC against thrips, *Scirtothrips dorsalis* Hood and Pod borer, *Spodoptera exigua* (Hubner) on chillies. Pesticide Research Journal. 2009; 21(1):49-51.
23. Reddy AV, Shreehari G, Kumar AK. Evalution of certain new insecticides against chilli thrip (*Scirtothrips dorsalis*) and mites (*Polyphago tarsonemus latus*). Research on crops, 2005; 6(3):625-626.
24. Sandeep K, Subash S. Field efficacy of some systemic insecticides and microbial pesticides (module) against aphid, *Aphis gossypii* (Glover) and fruit borer *Helicoverpa armigera* (Hubner) on tomato in Punjab. Agriculture for Sustainable Development. 2013; 1(1):1-6.
25. Seal DR, Clomperlikb M, Richardsc ML, Klassena W. Comparative effectiveness of chemical insecticides against the chillithrips, *Scirtothrips dorsalis* Hood, on pepper and their compatibility with natural enemies. Crop Protection, 2006; 25:949-95.
26. Shinde ST, Shetgar SS, Badgujar AG. Bio-efficacy of different insecticides against major pest of okra. Journal of Entomological Research. 2011; 35(2):133-137.
27. Shivanna BK, Gangadhara NB, Nagaraja R, Basavaraja MK, Kalleswara Swamy CM, Karegowda C. Bioefficacy of new insecticides against sucking insect pests of transgenic cotton. International Journal of Science and Nature. 2011; 2(1):79-83.
28. Singh V, Thakur BS, Chandraker MK. Bio-effacacy of insecticides against insect pest of chilli. Environmental Ecology, 2005; 23(3):600-604.
29. Sreekanth PN, Reddy KMS. Efficacy of different insecticides against sucking pests of cotton. Environment and Ecology, 2011; 29(4A):2035-2039.
30. Sridhar V, Chakravarthy AK, Asokan R, Vinesh LS, Rebijith KB, Vennila S. New record of the invasive South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in India. Pest Management in Horticultural Ecosystems. 2014; 20(2):148-154.
31. Sujay AGK, Sharma RK, Shankarganesh K, Sinha SR, Sharma K. Efficacy of newer insecticides against sucking insect pests of okra. Indian Journal of Plant Protection. 2013; 41(2):113-115.
32. Thania SV, Thomas BM. Bioefficacy and safety evaluation of newer insecticides and acaricides against chilli thrips and mites. Journal of Tropical Agriculture. 2013; 51(1-2):111-115.
33. Vanisree K, Upendhar S, Rajasekhar P, Ramachandra Rao G, Srinivasa Rao V. Field evaluation of certain newer insecticides against chilli thrips, *Scirtothrips dorsalis* (Hood). Science Park Research Journal. 2013; 1(20):1-13.
34. Vichiter S, Ramesh C. Testing the new molecule polo 50 WP (Diafenthiuron) against cotton whitefly. *Bemisia tabaci* (Gen). Pestology, 2009; 33(3):50-52.
35. Zitter TA, Everett PH. Effect of an aphid-transmitted yellowing virus on yield and quality of staked tomatoes. Plant Disease, 1982; 66:456-458.