Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(2): 1407-1410

Received: 16-01-2020
Accepted: 18-02-2020

Pynhunlin Nola Kharkrang Dohling
Ph.D., Scholar, Division of Entomology, IARI, New Delhi, India

Jayaraj Padhi
Professor, Department of Entomology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

B Adhikari
Faculty of Agricultural Sciences, SoA DU, Bhubaneswar, Odisha, India

M Reshma
M.Sc. (Ag.), Department of Entomology, OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
Pynhunlin Nola Kharkrang Dohling
Ph.D., Scholar, Division of Entomology, IARI, New Delhi, India

Field efficacy of different insecticides against aphids (*Aphis gossypii* Glover) in chilli

Pynhunlin Nola Kharkrang Dohling, Jayaraj Padhi, B Adhikari and M Reshma

Abstract
Field studies were carried out during *Rabi* season of 2016-17 and 2017-18 at the Central Horticultural Research Station, Odisha University of Agriculture and Technology, Bhubaneswar in randomized block design with six insecticidal treatments which were replicated four times and tested against aphids in chilli variety "Utkal Ava". Among them, sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8ml/l proved to be superior than other treatments in effective management of aphids infesting chilli. Further, cyazypyr 10.26 OD @ 1.8 ml/l was found to be the least effective treatment against this pest.

Keywords: Aphids, sequential spraying, neem oil, chilli

1. Introduction
In India, chilli is grown all over the country. Green chilli is cultivated under an area of 311 thousand hectare with production of 3761 thousand metric tonnes, while that of dried chilli is under an area of 844 thousand hectare with production of 2106 thousand metric tonnes [1]. Andhra Pradesh is the largest producer of chilli in the country with an area of 2, 06, 000 hectare and production of 8,83,000 tonnes followed by Telangana (area:1,20,160 hectare, production: 3,37,005 tonnes). In Odisha, a total area of 65,500 hectare was under chilli crop with total production of 64,500 tonnes [2].

This crop is being infested with wide range of insect pests of which aphids are one of the major production constraints. Mosaic disease transmitted by aphids cause 20-30 percent loss in yield and nymphs and adults of aphids suck the cell sap from the under surface of the leaves and growing shoots and secrete honey-dew on which black sooty mould develops; the black coating affects the photo-synthetic activity of the plants and they are also important insect vectors of chilli mosaic[3].It leads to leaf yellowing, curling, distortion and stunted growth of the plant.

In order to combat the insect pest outbreaks, farmers are solely dependent on pesticides, as chemical control serve as first line of defence in any crop eco-system and farmers can get a faster control by using these which are easy to apply and less expensive as it is difficult to obtain so through other means. Therefore, keeping the aforesaid consideration in view, the present investigation was carried out to evaluate the efficacy of new molecules of insecticides alone as well as in combination with neem oil in the field to keep these molecules in the pipeline for management of aphids in chilli.

2. Materials and methods
A field experiment was conducted during two consecutive *Rabi* season of 2016 and 2017 in a randomized block design with four replications at the Central Horticultural Research Farm, AICRP on Vegetable Crops, Orissa University of Agriculture and Technology (O.U.A.T), Bhubaneswar (latitude of 20^0 15' N and longitude of 85^0 52' E.) at an elevation of 25.5 meters above MSL. A promising chilli variety "Utkal Ava" was raised on a nursery bed of $3m^2$ (3.0 m x 1.0 m) for a month before planting in the main field. Fertilizers were applied in form of urea, diammonium phosphate and murate of potash @ 125:60:100 (N:P:K) kg/ha as the recommended practice. The seeds were sown at a spacing of 50cm x 30cm and the border crop maize was also transplanted from the nursery bed at 15 days after its sowing. The young

seedlings were irrigated as and when needed for seedling establishment and further plant growth except during the period of intermittent rains. This experiment includes six treatments including one alone and others in combination with neem oil along with an untreated control *viz.* T_0 = Application of neem cake @ 1.0 kg/sq.mt in the seed bed, seed treatment with imidacloprid 70 WG @ 8g/kg, spraying of cyazypyr 10.26 OD @ 1.8 ml/l 2-3 days before transplanting and growing of two rows of hybrid maize (variety "PAC-712") at a spacing of 60cm x 30cm as border crop in the main field along with silver agri-mulch polythene sheet, T_1- T_0 + spray of Acephate 75 SP @ 1.5 g/l + Neem oil 1000 ppm @ 2.0 ml/l at 7days interval starting from 7 DAT till fruit formation, T_2 - T_0 + spray of Fipronil 5 SC @ 1.0 ml/l + Neem oil 1000 ppm @ 2.0 ml/l at 7days interval starting from 7 DAT till fruit formation, T_3- T_0 + spray of Imidacloprid 70WG @ 2 g/15 l + Neem oil 1000ppm @ 2 ml/l at 7 days interval till fruit formation, T_4 - T_0 + spray of Cyazypyr 10.26 OD @ 1.8ml/l at 7days interval starting from 7 DAT till fruit formation, T_5- T_1 + T_2 + T_3 + T_4 sequentially including T_0 and T_6 - Control. All the treatments were applied at specific dosages in the form of foliar sprays with the help of a 15 litre knapsack sprayer fitted with hollow cone nozzle. Eight sprayings in total were taken up. The insecticides were applied starting from 7 days after transplanting (DAT) up to fruit formation stage of the crop. The spraying was stopped after 56 DAT. During application, care was taken to obtain uniform coverage of insecticides in each plot and on each plant so as to avoid drifting of insecticides while spraying.

During cropping season of *Rabi*, 2016 and 2017, observations were recorded in the main field on the population of aphids from two leaves each at the top, middle and bottom canopy per plant from five randomly selected plants per subplot in each replication at weekly interval. The population was counted visually and by using a lens having magnification of 30X. Observations were taken one day before and one day after spray starting from 7 DAT up to 56 DAT during treatment period and continued till 77 DAT and then average was calculated. The data so obtained for these insect counts were suitably transformed [4] and analysed statistically to arrive at meaningful conclusion.

3. Results and discussion

The data generated on population of aphids in terms of numbers per leaf at pre-treatment and post-treatment periods during *Rabi* 2016, 2017 and pooled over two years have been presented in Table 1, 2 and 3, respectively. It is clearly evident from Table 1 that on an average the population of aphids one day before spraying (DBS) was 0.12 per leaf in all the treatments including control at 7 days after transplanting (DAT), whereas, the mean population was reduced to 0.08 per leaf due to insecticidal treatments one day after spraying (DAS) during *Rabi*, 2016. The corresponding reduction in aphid population at 14, 21, 28, 35, 42, 49 and 56 DAT were 0.10, 0.10, 0.07, 0.17, 0.27, 0.20 and 0.58 per leaf. The insecticidal effect on reducing aphid population persisted up to subsequent spray as was revealed by the data recorded in 1 DBS at different days after transplanting. This was also observed at 63, 70 and 77 DAT even after cessation of spray.

An introspection into the Table 1 revealed that all the insecticides were effective in restricting aphid population throughout the investigation period as compared to untreated control. Sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l (T_5) at 7 days interval starting from 7 DAT till fruit formation proved effective in suppression of aphid population, which accounted for 66.60, 71.00, 75.00, 60.00, 48.00, 78.00 and 73.00 per cent reduction in aphid population at 1 DAS in comparison to 1 DBS at 14, 21, 28, 35, 42, 49 and 56 DAT, respectively. This was followed by imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l (T_3) treated plots which recorded a population reduction of 66.60, 66.60, 66.60, 50.00, 44.00, 77.00 and 70.00 per cent at 1 DAS in comparison to 1 DBS in the corresponding periods. Fipronil 5 SC @ 1.0 ml/l + neem oil @ 0.2 ml/l was the next best treatment followed by acephate 75 SP @ 1.5 g/l + neem oil @ 0.2 ml/l. Cyazypyr 10.26 OD @ 1.8 ml/l was least effective in suppressing the aphid population.

During the second year of experimentation, similar trend was observed as far as the aphid population was concerned. The results thus obtained was indicated in Table 2 which envisaged that on an average the population of aphids at 1 DBS was 0.10 per leaf in all the treatments including control at 7 DAT. The mean population was reduced to 0.07 per leaf due to insecticidal treatments at 1 DAS. The reduction in aphid population at 1 DAS at 14, 21, 28, 35, 42, 49 and 56 DAT were 0.07, 0.08, 0.06, 0.13, 0.21, 0.20 and 0.49 per leaf, respectively. The effect of the insecticides in reducing the aphid population persisted up to subsequent spraying as indicated by the data recorded in 1 DBS at different days after transplanting. Data pertaining to the insecticidal effects on aphid population revealed that sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l (T_5) proved effective in reduction of aphid population, which accounted for 66.60, 71.00, 75.00, 80.00, 66.60, 77.78 and 72.20 per cent at 1 DAS in comparison to 1 DBS at 14, 21, 28, 35, 42, 49 and 56 DAT, respectively. The next best treatment was by imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l (T_3) treated plots where a population reduction of 40.00, 66.60, 66.50, 50.00, 44.00, 69.00 and 70.00 per cent was noticed at 1 DAS in comparison to 1 DBS; which was followed by fipronil 5 SC @ 1.0 ml/l + neem oil @ 0.2 ml/l, acephate 75 SP @ 1.5 g/l + neem oil @ 0.2 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l. During the post treatment period, the mean population of aphid ranged from 0.15 to 0.90 per leaf in different insecticidal treatments at 63 DAT to 77 DAT, whereas the control plot exhibited maximum population (3.65/leaf) which was reduced to 1.75 per leaf at 77 DAT.

Efficacy of different insecticides on aphid population in chilli pooled over two years indicated a similar trend as in case of first and second year of investigation. The pooled data is presented in Table 3 which indicated that sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8ml/l (T_5) achieved maximum reduction at 49 DAT (77.89%) and at 56 DAT (72.86%) which was followed by imidacloprid (77.46% and 70.90%) at 49 and 56 DAT, respectively.

The present research findings regarding aphid incidence indicated that all the insecticides except cyazypyr were effective in restricting aphid population compared to untreated control. Sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l (T_5) proved superior than other treatments.

It was reported that imidacloprid (70 g/ha) was the best treatment in controlling aphids (99.76% reduction) which is in agreement with the present finding [5]. Another finding on aphid population indicated that among all six insecticidal treatments, imidacloprid 17.8 SL @ 200 ml/ha was most

effective and provided maximum mortality (72.62%) and was significantly superior over all other treatments [6]. It was reported that imidacloprid 200 SL at 30 g a.i. /ha recorded 85 and 58 per cent reduction of aphids [7]. A group of researchers reported that among the test chemicals, imidacloprid recorded significantly the lowest mean aphid population (1.30 and 0.73/leaf in 2007, 2008, respectively) as against 10.23 and 6.43 aphids, respectively in untreated control plot. Fipronil was found to be the next most effective insecticide in minimizing the aphid population followed by acephate [8]. Study conducted by another group of researchers reported that spraying of imidacloprid 200 SL @ 120 g a.i. /ha, fipronil 80 WG @ 40 g a.i. /ha and acephate 75 SP @ 468.75 g a.i. /ha also exhibited good results with mean population reduction of 64.7, 64.2 and 63.6 per cent, respectively [9]. A recent finding showed that fipronil 200 SC @ 150 ml/ha significantly reduced the aphid population (4.07 aphid/ 3 leaves) and imidacloprid 200 SL @ 250 ml/ha recorded 4.31 aphid per 3 leaves [10]. Hence, the present finding derived ample support from the findings of the above authors.

4. Conclusion

The effect of various treatments imposed on aphids infesting chilli revealed that all the treatments except cyazypyr were effective in managing its population compared to untreated control. Sequential spraying of acephate 75 SP @ 1.5 g/l+ neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l+ neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l+ neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l proved superior than other treatments during both the periods of investigation accounting for more than 70.09 per cent reduction in aphid population. The other insecticides in their order of efficacy against aphid were imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, acephate 75 SP @

Table 1: Effect of various insecticides on aphid population in chilli during *Rabi*, 2016

Treatments	No. of aphids/leaf									
	7 DAT		14 DAT		21 DAT		28 DAT		35 DAT	
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS
T_1	0.12 (0.79)	0.06 (0.75)	0.12 (0.79)	0.06 (0.75)	0.06 (0.75)	0.06 (0.75)	0.12 (0.79)	0.06 (0.75)	0.18 (0.82)	0.18 (0.82)
T_2	0.12 (0.79)	0.06 (0.75)	0.18 (0.82)	0.12 (0.79)	0.24 (0.86)	0.12 (0.79)	0.30 (0.89)	0.12 (0.79)	0.24 (0.86)	0.12 (0.79)
T_3	0.18 (0.82)	0.12 (0.79)	0.30 (0.89)	0.18 (0.82)	0.36 (0.93)	0.12 (0.79)	0.18 (0.82)	0.06 (0.75)	0.36 (0.93)	0.18 (0.82)
T_4	0.12 (0.79)	0.12 (0.79)	0.06 (0.75)	0.06 (0.75)	0.06 (0.75)	0.06 (0.75)	0.06 (0.75)	0.06 (0.75)	0.24 (0.86)	0.24 (0.86)
T_5	0.12 (0.79)	0.06 (0.75)	0.18 (0.82)	0.06 (0.75)	0.42 (0.96)	0.12 (0.79)	0.24 (0.86)	0.06 (0.75)	0.30 (0.89)	0.12 (0.79)
T_6	0.12 (0.79)	0.18 (0.82)	0.48 (0.99)	0.50 (1.00)	0.72 (1.10)	0.54 (1.02)	0.60 (1.05)	0.42 (0.96)	0.54 (1.02)	0.48 (0.99)
SE(m) ±	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.01
CD (P=0.05)	NS	0.07	0.06	0.08	0.07	0.06	0.07	0.06	0.08	0.03

Treatments	42 DAT		49 DAT		56 DAT		63 DAT	70 DAT	77 DAT
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS			
T_1	0.36 (0.93)	0.36 (0.93)	0.18 (0.82)	0.12 (0.79)	1.08 (1.26)	0.90 (1.18)	1.15 (1.28)	0.80 (1.14)	0.60 (1.05)
T_2	0.42 (0.96)	0.24 (0.86)	0.78 (1.13)	0.24 (0.86)	1.20 (1.30)	0.84 (1.16)	1.10 (1.26)	0.20 (0.84)	0.35 (0.92)
T_3	0.54 (1.02)	0.30 (0.89)	0.78 (1.13)	0.18 (0.82)	0.60 (1.05)	0.18 (0.82)	0.45 (0.97)	0.20 (0.84)	0.30 (0.89)
T_4	0.18 (0.82)	0.18 (0.82)	0.30 (0.89)	0.30 (0.89)	0.90 (1.18)	0.82 (1.15)	0.65 (1.07)	0.30 (0.89)	0.35 (0.92)
T_5	0.54 (1.02)	0.28 (0.88)	0.82 (1.15)	0.18 (0.82)	0.66 (1.08)	0.18 (0.82)	1.25 (1.32)	0.30 (0.89)	0.05 (0.74)
T_6	1.14 (1.28)	0.96 (1.21)	1.14 (1.28)	2.22 (1.65)	2.58 (1.75)	4.86 (2.31)	1.75 (1.50)	1.40 (1.38)	0.85 (1.16)
SE(m) ±	0..04	0.03	0.04	0.05	0.03	0.04	0.04	0.03	0.03
CD (P=0.05)	0.12	0.09	0.11	0.13	0.10	0.12	0.12	0.09	0.09

Figures in parentheses are $\sqrt{x}$+0.5 transformed values NS = Non-significant
DBS = Day before spraying, DAS = Days after spraying DAT = Days after transplanting

Table 2: Effect of various insecticides on aphid population in chilli during *Rabi*, 2017

Treatments	No. of aphids/leaf									
	7 DAT		14 DAT		21 DAT		28 DAT		35 DAT	
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS
T_1	0.10 (0.77)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.10 (0.77)	0.05 (0.74)	0.15 (0.81)	0.15 (0.81)
T_2	0.10 (0.77)	0.05 (0.74)	0.15 (0.81)	0.10 (0.77)	0.20 (0.84)	0.10 (0.77)	0.25 (0.86)	0.10 (0.77)	0.20 (0.84)	0.10 (0.77)
T_3	0.10 (0.77)	0.05 (0.74)	0.25 (0.86)	0.15 (0.81)	0.30 (0.89)	0.10 (0.77)	0.15 (0.81)	0.05 (0.74)	0.30 (0.89)	0.15 (0.81)
T_4	0.10 (0.77)	0.10 (0.77)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.20 (0.84)	0.20 (0.84)
T_5	0.10 (0.77)	0.05 (0.74)	0.15 (0.81)	0.05 (0.74)	0.35 (0.92)	0.10 (0.77)	0.20 (0.84)	0.05 (0.74)	0.25 (0.86)	0.05 (0.74)
T_6	0.15 (0.81)	0.15 (0.81)	0.40 (0.95)	0.40 (0.95)	0.60 (1.05)	0.45 (0.97)	0.50 (1.00)	0.35 (0.92)	0.45 (0.97)	0.40 (0.95)
SE(m) ±	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
CD (P=0.05)	NS	0.05	0.06	0.06	0.07	0.05	0.07	0.06	0.07	0.04

Treatments	42 DAT		49 DAT		56 DAT		63 DAT	70 DAT	77 DAT
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS			
T_1	0.30 (0.89)	0.30 (0.89)	0.15 (0.81)	0.10 (0.77)	0.90 (1.18)	0.75 (1.12)	0.90 (1.18)	0.65 (1.07)	0.55 (1.02)
T_2	0.35 (0.92)	0.20 (0.84)	0.65 (1.07)	0.15 (0.84)	1.00 (1.22)	0.70 (1.09)	1.30 (1.34)	0.80 (1.14)	0.40 (0.95)
T_3	0.45 (0.97)	0.25 (0.86)	0.65 (1.07)	0.20 (0.81)	0.50 (1.00)	0.15 (0.81)	0.40 (0.95)	0.30 (0.89)	0.15 (0.81)
T_4	0.15 (0.81)	0.15 (0.81)	0.25 (0.86)	0.25 (0.86)	0.75 (1.12)	0.70 (1.09)	0.40 (0.95)	0.35 (0.92)	0.35 (0.92)
T_5	0.45 (0.97)	0.15 (0.81)	0.45 (0.97)	0.10 (0.77)	0.55 (1.02)	0.15 (0.81)	0.45 (0.97)	0.35 (0.92)	0.40 (0.95)
T_6	0.95 (1.20)	0.80 (1.14)	0.95 (1.20)	1.85 (1.53)	2.15 (1.63)	4.05 (2.13)	3.65 (2.03)	3.05 (1.88)	1.75 (1.50)
SE(m) ±	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.03
CD (P=0.05)	0.09	0.09	0.10	0.08	0.10	0.09	0.11	0.09	0.10

Figures in parentheses are $\sqrt{x}$+0.5 transformed values NS = Non significant
DBS = Day before spraying, DAS = Days after spraying DAT = Days after transplanting

Table 3: Effect of various insecticides on aphid population in chilli pooled over two years

Treatments	No. of aphids/leaf									
	7 DAT		14 DAT		21 DAT		28 DAT		35 DAT	
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS
T_1	0.11 (0.78)	0.05 (0.74)	0.11 (0.78)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.17 (0.81)	0.05 (0.74)	0.16 (0.81)	0.16 (0.81)
T_2	0.11 (0.78)	0.05 (0.74)	0.16 (0.81)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)	0.22 (0.85)	0.11 (0.78)
T_3	0.11 (0.78)	0.11 (0.78)	0.27 (0.87)	0.16 (0.81)	0.33 (0.91)	0.11 (0.78)	0.19 (0.83)	0.05 (0.74)	0.33 (0.91)	0.16 (0.81)
T_4	0.11 (0.78)	0.11 (0.78)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.05 (0.74)	0.22 (0.85)	0.22 (0.85)
T_5	0.11 (0.78)	0.05 (0.74)	0.16 (0.81)	0.03 (0.73)	0.38 (0.94)	0.11 (0.78)	0.19 (0.83)	0.05 (0.74)	0.27 (0.87)	0.08 (0.76)
T_6	0.16 (0.81)	0.16 (0.81)	0.44 (0.97)	0.45 (0.97)	0.66 (1.07)	0.49 (0.99)	0.55 (1.02)	0.38 (0.94)	0.49 (0.99)	0.44 (0.97)
SE(m) ±	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
CD (P=0.05)	NS	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.03

Treatments	42 DAT		49 DAT		56 DAT		63 DAT	70 DAT	77 DAT
	1 DBS	1 DAS	1 DBS	1 DAS	1 DBS	1 DAS			
T_1	0.33 (0.91)	0.33 (0.91)	0.16 (0.81)	0.11 (0.78)	0.99 (1.22)	0.82 (1.15)	0.90 (1.23)	0.72 (1.10)	0.57 (1.03)
T_2	0.38 (0.94)	0.22 (0.85)	0.71 (1.10)	0.22 (0.85)	1.10 (1.26)	0.77 (1.12)	1.20 (1.30)	0.50 (0.99)	0.37 (0.93)
T_3	0.49 (0.99)	0.27 (0.87)	0.71 (1.10)	0.16 (0.81)	0.55 (1.02)	0.16 (0.81)	0.42 (0.96)	0.25 (0.86)	0.22 (0.85)
T_4	0.16 (0.81)	0.16 (0.81)	0.27 (0.87)	0.27 (0.87)	0.82 (1.15)	0.76 (1.12)	0.52 (1.01)	0.32 (0.90)	0.35 (0.92)
T_5	0.49 (0.99)	0.21 (0.84)	0.63 (1.06)	0.14 (0.79)	0.60 (1.05)	0.16 (0.81)	0.85 (1.14)	0.32 (0.90)	0.22 (0.85)
T_6	1.04 (1.24)	0.88 (1.17)	1.04 (1.24)	2.03 (1.59)	2.36 (1.69)	4.55 (2.22)	2.70 (1.76)	2.22 (1.63)	1.30(1.33)
SE(m) ±	0.02	0.02	0.02	0.04	0.03	0.03	0.04	0.03	0.03
CD (P=0.05)	0.07	0.06	0.07	0.11	0.09	0.09	0.11	0.09	0.09

Figures in parentheses are $\sqrt{x}$+0.5 transformed values NS = Non-significant
DBS = Day before spraying, DAS = Days after spraying, DAT = Days after transplanting

1.5 g/l + neem oil @ 2.0 ml/l that also accounted for nearly 18.96 to 56.20 per cent reduction in aphid population.

Sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l + neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l also produced a mean red ripe fruit yield of 93.10 q/ha without any significant difference between themselves except acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l and this treatment increase the yield potential by 99.79% whereas, other treatments increase the yield level by 66.74 to 93.56 per cent. Highest benefit cost ratio of 1.41 was noticed in (sequential spraying of acephate 75 SP @ 1.5 g/l+ neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l+ neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l) followed by imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l alone (1.23). The benefit cost ratio of the control plot was higher than the cyazypyr 10.26 OD @ 1.8ml/l because of the higher cost of the insecticide.

From the entire investigation it was concluded that sequential spraying of acephate 75 SP @ 1.5 g/l + neem oil @ 2.0 ml/l, fipronil 5 SC @ 1.0 ml/l+ neem oil @ 2.0 ml/l, imidacloprid 70 WG @ 2 g/15 l + neem oil @ 2.0 ml/l and cyazypyr 10.26 OD @ 1.8 ml/l proved to be the best treatment among all the treatments tested in terms of higher efficacy on aphids infesting chilli during *Rabi,* 2016 and 2017.

5. Acknowledgement

The authors would like to express sincere gratitude to Dr. S. K. Panda, Professor and former Head of the Department, Department of Entomology, O.U.A.T and Dr. S. Sarkar, Junior Pathologist, AICRP on Vegetable Crops, O.U.A.T., Bhubaneswar for their encouragement and help towards completion of the research work.

6. References

1. National Horticulture Board. Area production statistics. State level estimates- Horticulture Crops Estimates for the Year 2017-18 (First Advance Estimates). http://nhb.gov.in. Viewed on 2nd March, 2018.
2. Spices Board of India. www.indianspices.com. 2016-17. Viewed on 10th May of, 2018.
3. Nagarjuna Group. Ikisan Agri Informatics and Services. Chilli, 2019, 22. www.ikisan.com/ka-chilli-insect-management.html.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research. Edn 3, John wiley and sons, New York, 1984, 680p.
5. Kumar KP, Reddy DJ, Narendranath VV. Bio-efficacy of selected insecticides against pest complex in chilli (*Capsicum annuum* Linn). Pesticide Research Journal. 2001; 13(1):36-41.
6. Singh V. Bio-efficacy and dissipation of residue of some insecticides in chilli. M.Sc. (Ag.) Thesis, Department of Entomology, College of Agriculture, Indira Gandhi Agricultural University, Raipur (Chhattisgarh). 2001, 83.
7. Kumar BV, Kuttalam S. Efficacy of new insecticide spirotetramat 150 OD against chilli aphid *Myzus persicae* (Sulzer). Journal of Plant Protection and Environment. 2011; 8(2):18-23.
8. Nayak US, Soni VK, Senapati S. Comparative efficacy of certain insecticides against thrips (*Scirtothrips dorsalis*) and aphids (*Aphis glossypii* G.) on chilli. Journal of Plant Protection and Environment. 2014; 11(1):44-48.
9. Kumar VR, Swaminathan, Singh H. Bio-efficacy of newer insecticides against sucking insect pests of chilli. Annals of Plant Protection Sciences. 2015; 23(1):69-73.
10. Tukaram CV, Karnatak AK, Srivastava RM. Bio-efficacy of newer insecticide molecules against pest complex of chilli. Octa Journal of Environmental Research. 2017; 5**(**2):129-139.