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# Bioefficacy of some insecticides against aphids infesting bell pepper

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**Abstract**
Bioefficacy of some insecticides was studied against aphids on bell pepper crop in two consecutive years 2019 and 2020 in the experimental field of Department of Entomology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry Nauni, Solan. The study comprised of various treatments *viz.*, fenazaquin, deltamethrin, dimethoate, ethion and fenpropathrin at less than recommended (x), recommended (X) and double the recommended dose (2X). The results of this study revealed that among all the applied treatments dimethoate @ 400 g a.i. $ha^{-1}$ ($T_9$) was found most effective during both the years followed by fenpropathrin @ 150 g a.i. $ha^{-1}$ ($T_{15}$). However, deltamethrin applied @ 7 g a.i. $ha^{-1}$ was the least effective treatment against aphids on bell pepper crop. The percent reduction value in aphid population in the plots treated with dimethoate at the recommended dose @ 200 g a.i. $ha^{-1}$ ($T_8$) was found statistically at par with $T_9$. Similarly, the percent reduction value in aphid population in the plots treated with fenpropathrin at the recommended dose @ 75 g a.i. $ha^{-1}$ ($T_{14}$) was found statistically at par with $T_{15}$.

**Keywords:** Bioefficacy, aphids, bell pepper, recommended dose and double the recommended dose

## Introduction
India's diverse climate ensures availability of all varieties of fresh vegetables. It is the second largest producer of vegetables in the world next only to China. Vegetables are rich sources of vitamins and their consumption provides taste, palatability, increases appetite and provides fibre for digestion. Hence, vegetables are imperative for maintaining human health and preventing various diseases (Walia *et al.*, 2010) [1]. They are good sources of carbohydrates, proteins, Vitamin A, B & C and minerals. As per dieticians, daily requirement of vegetables is 75-125 g of green leafy vegetables, 85 g of other vegetables and 85 g of roots and tubers with other food. Out of these vegetables, bell pepper (*Capsicum annuum*) is one of the most important vegetable crop belonging to the family Solanaceae and it plays an important role in human nutrition (Kumar *et al.*, 2017) [2]. It is a vegetable from a flowering plant native to America. This vegetable has many names depending on the place and type such as chilli pepper, green pepper, red pepper, paprika and bell pepper. It is also popularly known as Shimla Mirch in India. It is a perennial plant, which is being cultivated around the world. In India, bell pepper is cultivated on area of 35 thousand ha with an annual production of 560 thousand MT (NHB, 2021) [3] whereas in Himachal Pradesh where this study was conducted, it is grown over an area of 2.85 thousand hectares with an annual production of 48.86 thousand MT (NHB, 2022) [4].

Bell pepper holds a very coveted position as a leading off-season vegetable by generating cash revenues to the farmers by selling the produce in the neighbouring states and metropolitan cities. Bell pepper has achieved the position of a high value cash crop in India during recent years. The high market price it fetches is attributed to the heavy demand from the urban consumers and even a small blemish on the fruit will drastically reduce its market value (Roopa and Kumar, 2014) [5]. The production of bell pepper has been facing many problems like infestation of insect pests. Some of the important insect pests of bell pepper are aphids, whiteflies fruit borer, tobacco caterpillar and mite.

Among these pests aphid is one of the most important pest of bell pepper in India. Aphids do not directly attack the fruits of bell pepper but nymphs and adults of aphids attack bell pepper indirectly by sucking the cell sap from leaves, twigs and stems of the plant. Infestation of aphids results in loss of vitality of plant which ultimately results in the curling and distortion of the affected plant parts. Aphid infestation also results in the reduction of photosynthetic activity in plants due to the formation of sooty mold fungus on honey dew secreted by aphids

(Das, 2013) [6]. Currently various management practices are available to manage the infestation of aphid but none of these practices match the effectiveness of chemical control.

Insecticides are the important tool in pest management, but their excessive use can cause severe ecological consequences like destruction of natural enemy fauna, which leads to pest resurgence, occurrence of secondary pest and selection for resistance (Kumari *et al*. 2005) [7]. Therefore, keeping in view the incidence of aphids on bell pepper and use of insecticides to control them, this study was undertaken to determine the bioefficacy of some insecticides *viz.*, fenazaquin, deltamethrin, dimethoate, ethion and fenpropathrin against aphids infesting bell pepper.

## Materials and Methods

A supervised field trial was conducted to study the bioefficacy of some insecticides *viz.*, fenazaquin, deltamethrin, dimethoate, ethion and fenpropathrin against aphids infesting bell pepper in the experimental farm of Department of Entomology, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP), India in two consecutive years 2019 and 2020. Seeds of bell pepper variety (Solan Bharpur) was sown in Randomized Block Design (RBD) with sixteen treatments including untreated control replicated thrice in the plots of size 3 × 2 m at spacing of 60 × 45 cm as per standard packages of practices of the university (Anonymous, 2014) [8]. Treatments mentioned in Table 1 were applied twice on bell pepper at an interval of 10 days at respective doses using a knapsack sprayer fitted with a solid cone nozzle. Control plots were sprayed with water only.

With the buildup of sufficient pest population, before spray on bell pepper crop, the observation of pest population was recorded from each replication as pre-count and after the application of various treatments observation were recorded at an interval of 1, 3, 5, 7 and 10 days. Population of aphids were recorded from five randomly selected plants from each plot by examining three leaves (top, middle and bottom) by counting the number of aphids per leaf. Henderson and Tilton, 1955 [9] formula was adopted to calculate the percent reduction of non-uniform and live pest population

$$\text{Percent reduction in population} = 100\left(1 - \frac{Ta}{Tb} \times \frac{Cb}{Ca}\right)$$

Where, Ta = Number of aphids after treatment
Tb = Number of aphids before treatment
Ca = Number of aphids in untreated control after treatment
Cb = Number of aphids in untreated control before treatment.

The percent reduction in aphid population was calculated at 1, 3, 5, 7 and 10 day intervals. The data obtained were assigned arcsine or angular transformations analyzed statistically.

**Table 1:** Treatments applied on bell pepper

| Treatment | Insecticide | Trade name | Dose rate (g a.i./ha) |
|---|---|---|---|
| **$T_0$** | **Control** | | **-** |
| T1 | Fenazaquin 10% EC (x) | Magister, Du Pont | 84 |
| T2 | Fenazaquin 10% EC 10% EC (X) | | 125 |
| T3 | Fenazaquin 10% EC (2X) | | 250 |
| T4 | Deltamethrin 2.8 % EC (x) | Decis, Bayer | 7 |
| T5 | Deltamethrin 2.8 % EC (X) | | 10 |
| T6 | Deltamethrin 2.8 % EC (2X) | | 20 |
| T7 | Dimethoate 30% EC (x) | Tafgor, Rallis India Ltd. | 134 |
| T8 | Dimethoate 30% EC (X) | | 200 |
| T9 | Dimethoate 30% EC (2X) | | 400 |
| T10 | Ethion 50% EC (x) | Fosmite, Pesticides India Ltd. | 500 |
| T11 | Ethion 50% EC (X) | | 750 |
| T12 | Ethion 50% EC (2X) | | 1500 |
| T13 | Fenpropathrin 30% EC (x) | Meothrin, Sumitomo | 50 |
| T14 | Fenpropathrin 30% EC (X) | | 75 |
| T15 | Fenpropathrin 30% EC (2X) | | 150 |

## Results and Discussion

### Percent reduction in aphid population following two sprays in 2019 and 2020

The data depicted in Table 2 and 3 revealed that all the insecticides under study were significantly superior over untreated control in reducing the aphids population at 0, 1, 3, 5, 7 and 10 days after spray (DAS) during both the years. Observations of pre-count (one day before spray) revealed the uniformity in distribution pattern of aphid population in both the years i.e. 17.17 to 19.07 and 18.98 to 20.73 aphids per plant in 2019 and 2020, respectively.

All the treatments applied were found to be statistically superior over untreated control during both the years. The plots treated with treatment $T_9$ i.e., double the recommended dose of dimethoate @ 400 g a.i. ha$^{-1}$ provided maximum percent reduction over control i.e., 83.89 and 85.43 percent in 2019 and 2020, respectively which was statistically at par with treatment $T_8$ (recommended dose of dimethoate @ 200 g a.i. ha$^{-1}$) showing 80.77 and 83.24 percent reduction in aphids population during 2019 and 2020, respectively. The plots sprayed with dimethoate, showed highest percent reduction in aphid's populations after 5 days of treatment.

The plots treated with double dose of fenpropathrin @ 150 g a.i. ha$^{-1}$ ($T_{15}$) was the next best treatment with 82.62 and 84.27 percent reduction in aphid's population which was found statistically at par with the recommended dose of fenpropathrin @ 75 g a.i. ha$^{-1}$ ($T_{15}$) showed 79.95 and 82.23 percent reduction in the consecutive years 2019 and 2020, respectively. The next best effective treatment in the series was ethion @ 1500 g a.i. ha$^{-1}$ ($T_{12}$) which provides 63.89 and 65.82 percent reduction in the population of aphids in 2019 and 2020, respectively. However, the recommended dose of ethion 750 g a.i. ha$^{-1}$ ($T_{11}$) was not found effective against aphids with 47.94 and 50.35 percent reduction in 2019 and 2020, respectively. Fenazaquin and deltamethrin were found to be least effective in reducing the population of aphids.

**Table 2:** Bioefficacy of some insecticides against aphids on bell pepper in first year (2019)

| Treatments | Insecticides | Dosage g a.i./ha | Pre-count (No. of aphids/ plant) | Mean percent reduction (1st spray 2019) | | | | | | Mean percent reduction (2nd spray 2019) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 DAS | 3 DAS | 5 DAS | 7 DAS | 10 DAS | Mean | 1 DAS | 3 DAS | 5 DAS | 7 DAS | 10 DAS | Mean | Pooled over spray (2019) |
| $T_0$ | Untreated control | - | 17.72 | - | - | - | - | | - | - | - | - | - | | - | |
| $T_1$ | Fenazaquin (x) (10% EC) | 84 | 17.73 | 44.08 (41.58) | 41.98 (40.36) | 37.65 (37.83) | 34.15 (35.74) | 30.17 (33.29) | 37.61 (37.76) | 44.41 (41.77) | 42.98 (40.94) | 38.65 (38.42) | 35.15 (36.34) | 29.17 (32.67) | 38.07 (38.03) | 37.84 (37.90) |
| $T_2$ | Fenazaquin (X) (10% EC) | 125 | 17.17 | 47.04 (43.28) | 43.71 (41.36) | 41.37 (40.01) | 37.27 (37.60) | 35.45 (36.51) | 40.97 (39.75) | 48.04 (43.86) | 44.71 (41.94) | 42.37 (40.58) | 38.27 (38.19) | 35.12 (36.31) | 41.70 (40.17) | 41.33 (39.97) |
| $T_3$ | Fenazaquin (2X) (10% EC) | 250 | 17.80 | 49.47 (44.68) | 46.40 (42.92) | 44.14 (41.61) | 42.81 (40.85) | 40.94 (39.76) | 44.75 (41.96) | 50.14 (45.06) | 47.40 (43.49) | 45.14 (42.19) | 43.81 (41.43) | 40.28 (39.37) | 45.35 (42.31) | 45.05 (42.14) |
| $T_4$ | Deltamethrin (x) (2.8%EC) | 7 | 18.53 | 37.29 (37.61) | 42.04 (40.40) | 35.22 (36.38) | 29.62 (32.95) | 26.77 (31.12) | 34.19 (35.69) | 37.62 (37.81) | 42.71 (40.79) | 35.55 (36.57) | 29.95 (33.15) | 25.43 (30.24) | 34.26 (35.71) | 34.22 (35.71) |
| $T_5$ | Deltamethrin (X) (2.8%EC) | 10 | 17.70 | 39.34 (38.82) | 44.31 (41.71) | 40.77 (39.66) | 36.19 (36.96) | 31.77 (34.28) | 38.48 (38.28) | 40.34 (39.41) | 44.98 (42.10) | 41.77 (40.24) | 36.53 (37.16) | 31.10 (33.86) | 38.94 (38.55) | 38.71 (38.42) |
| $T_6$ | Deltamethrin (2X) (2.8%EC) | 20 | 18.37 | 44.47 (41.81) | 47.99 (43.83) | 43.40 (41.19) | 40.48 (39.48) | 39.28 (38.79) | 43.12 (41.02) | 45.14 (42.19) | 48.98 (44.40) | 43.73 (41.38) | 41.48 (40.07) | 38.61 (38.40) | 43.59 (41.29) | 43.36 (41.15) |
| $T_7$ | Dimethoate (x) (30% EC) | 134 | 18.10 | 75.85 (60.56) | 77.27 (61.51) | 80.02 (63.45) | 76.51 (60.99) | 73.67 (59.12) | 76.67 (61.13) | 76.85 (61.24) | 78.27 (62.19) | 81.02 (64.20) | 77.51 (61.69) | 73.01 (58.69) | 77.33 (61.60) | 77.00 (61.36) |
| $T_8$ | Dimethoate (X) (30% EC) | 200 | 18.53 | 78.85 (62.61) | 80.51 (63.80) | 84.62 (66.91) | 81.01 (64.17) | 79.90 (63.34) | 80.90 (64.17) | 82.07 (63.81) | 84.40 (65.04) | 81.32 (53.94) | 79.59 (65.42) | 75.47 (63.36) | 80.57 (62.32) | 80.77 (64.01) |
| $T_9$ | Dimethoate (2X) (30% EC) | 400 | 19.07 | 81.73 (64.72) | 83.57 (66.11) | 86.23 (68.22) | 83.33 (65.93) | 81.23 (64.34) | 83.22 (64.17) | 83.40 (65.96) | 85.24 (67.43) | 87.90 (69.71) | 84.99 (67.22) | 81.23 (64.37) | 84.55 (66.94) | 83.89 (66.39) |
| $T_{10}$ | Ethion (x) (50% EC) | 500 | 17.50 | 43.99 (41.53) | 46.80 (43.15) | 42.73 (40.80) | 39.48 (38.91) | 37.61 (37.81) | 42.12 (40.44) | 44.99 (42.10) | 47.80 (43.72) | 43.73 (41.38) | 40.48 (39.49) | 36.94 (37.41) | 42.79 (40.82) | 42.46 (40.63) |
| $T_{11}$ | Ethion (X) (50% EC) | 750 | 18.20 | 49.91 (44.93) | 52.70 (46.53) | 48.80 (44.29) | 45.16 (42.20) | 41.48 (40.07) | 47.61 (43.61) | 50.91 (45.50) | 53.70 (47.11) | 49.79 (44.87) | 46.16 (42.78) | 40.81 (39.68) | 48.28 (43.98) | 47.94 (43.80) |
| $T_{12}$ | Ethion (2X) (50% EC) | 1500 | 18.83 | 65.05 (53.75) | 70.05 (56.81) | 64.93 (53.67) | 60.87 (51.27) | 56.90 (48.95) | 63.56 (52.89) | 66.05 (54.35) | 71.05 (57.44) | 65.93 (54.28) | 61.87 (51.85) | 56.24 (48.57) | 64.23 (53.30) | 63.89 (53.09) |
| $T_{13}$ | Fenpropathrin (x) (30% EC) | 50 | 17.50 | 53.03 (46.72) | 57.87 (49.51) | 54.24 (47.41) | 50.63 (45.34) | 48.26 (43.98) | 52.81 (46.59) | 54.03 (47.29) | 58.87 (50.09) | 55.24 (47.99) | 51.63 (45.92) | 47.59 (43.60) | 53.47 (46.98) | 53.14 (46.79) |
| $T_{14}$ | Fenpropathrin (X) (30% EC) | 75 | 17.33 | 81.07 (64.22) | 83.73 (66.24) | 80.32 (63.69) | 78.59 (62.42) | 76.14 (60.74) | 79.97 (63.47) | 80.52 (64.99) | 82.17 (66.75) | 77.69 (64.41) | 80.34 (63.14) | 78.9 (60.30) | 79.92 (63.92) | 79.95 (63.43) |
| $T_{15}$ | Fenpropathrin (2X) (30% EC) | 150 | 17.87 | 83.89 (66.39) | 85.21 (67.40) | 82.51 (65.28) | 80.18 (63.56) | 78.29 (62.23) | 82.02 (64.97) | 85.56 (67.71) | 86.21 (68.22) | 84.17 (66.59) | 81.85 (64.80) | 78.29 (62.23) | 83.22 (65.91) | 82.62 (65.43) |
| | Mean | | | 58.34 | 60.28 | 57.80 | 54.42 | 51.86 | | 58.34 (50.87) | 60.28 (52.11) | 57.80 (49.78) | 54.42 (48.57) | 51.86 (48.94) | | |

Figures in parentheses are arc sin transformed values, DAS-Days after spray

C.D. = 4.054

**Table 3:** Bioefficacy of some insecticides against aphids on bell pepper in second year (2020)

| Treatments | Insecticides | Dosage g a.i./ha | Pre-count (No. of aphids/ plant) | Mean percent reduction (1st spray 2020) | | | | | | Mean percent reduction (2nd spray 2020) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 DAS | 3 DAS | 5 DAS | 7 DAS | 10 DAS | Mean | 1 DAS | 3 DAS | 5 DAS | 7 DAS | 10 DAS | Mean | Pooled over spray (2020) |
| $T_0$ | Untreated control | - | 19.8 | - | - | - | - | | - | | | | | | | |
| $T_1$ | Fenazaquin (x) (10% EC) | 84 | 20.73 | 45.75 (42.54) | 43.65 (41.33) | 39.34 (38.83) | 34.66 (36.04) | 31.20 (33.93) | 38.92 (38.53) | 47.08 (43.31) | 45.98 (42.67) | 40.67 (39.61) | 35.99 (36.85) | 31.20 (33.94) | 40.19 (39.27) | 39.55 (38.90) |
| $T_2$ | Fenazaquin (X) (10% EC) | 125 | 19.43 | 48.70 (44.24) | 45.37 (42.33) | 43.07 (40.99) | 37.94 (38.01) | 36.27 (37.01) | 42.27 (40.52) | 50.70 (45.38) | 48.37 (44.05) | 45.07 (42.15) | 39.94 (39.18) | 37.27 (37.61) | 44.27 (41.67) | 43.27 (41.10) |
| $T_3$ | Fenazaquin (2X) (10% EC) | 250 | 19.80 | 51.13 (45.63) | 48.07 (43.87) | 45.81 (42.58) | 43.26 (41.11) | 41.62 (40.16) | 45.98 (42.67) | 53.14 (46.78) | 51.07 (45.59) | 47.81 (43.72) | 45.26 (42.26) | 42.62 (40.74) | 47.98 (43.82) | 46.98 (43.25) |
| $T_4$ | Deltamethrin (x) (2.8%EC) | 7 | 20.60 | 38.96 (38.60) | 43.71 (41.37) | 36.88 (37.38) | 30.38 (33.42) | 27.25 (31.43) | 35.44 (36.44) | 39.29 (38.79) | 44.71 (41.95) | 37.55 (37.77) | 32.38 (34.66) | 26.92 (31.21) | 36.17 (36.88) | 35.80 (36.66) |
| $T_5$ | Deltamethrin (X) (2.8%EC) | 10 | 19.17 | 41.01 (39.80) | 45.65 (42.48) | 42.43 (40.63) | 36.85 (37.36) | 32.63 (34.81) | 39.71 (39.02) | 43.01 (40.96) | 48.65 (44.21) | 44.43 (41.78) | 38.85 (38.54) | 33.63 (35.42) | 41.71 (40.18) | 40.71 (39.60) |
| $T_6$ | Deltamethrin (2X) (2.8%EC) | 20 | 19.83 | 46.14 (42.77) | 49.65 (44.78) | 45.07 (42.15) | 40.98 (39.79) | 39.84 (39.12) | 44.34 (41.72) | 48.14 (43.91) | 52.65 (46.50) | 47.07 (43.30) | 42.99 (40.95) | 40.84 (39.70) | 46.34 (42.88) | 45.34 (42.30) |
| $T_7$ | Dimethoate (x) (30% EC) | 134 | 20.10 | 77.52 (61.68) | 78.93 (62.66) | 82.02 (64.92) | 77.29 (61.52) | 74.09 (59.41) | 77.97 (62.04) | 79.52 (63.08) | 81.93 (64.83) | 84.02 (66.45) | 79.29 (62.91) | 75.09 (60.07) | 79.97 (63.47) | 78.97 (62.75) |
| $T_8$ | Dimethoate (X) (30% EC) | 200 | 20.20 | 80.52 (63.80) | 82.17 (65.04) | 86.29 (68.26) | 81.39 (64.45) | 80.83 (64.05) | 82.24 (65.12) | 82.52 (65.28) | 85.17 (67.38) | 88.29 (69.77) | 83.39 (65.95) | 81.83 (64.78) | 84.24 (66.68) | 83.24 (65.89) |
| $T_9$ | Dimethoate (2X) (30% EC) | 400 | 20.40 | 83.39 (65.98) | 85.24 (67.40) | 87.90 (69.64) | 83.76 (66.25) | 81.85 (64.83) | 84.43 (66.82) | 85.39 (67.57) | 88.24 (69.95) | 89.90 (71.47) | 85.76 (67.85) | 82.85 (65.59) | 86.43 (68.49) | 85.43 (67.64) |
| $T_{10}$ | Ethion (x) (50% EC) | 500 | 18.98 | 45.65 (42.48) | 48.47 (44.10) | 44.40 (41.76) | 40.05 (39.25) | 38.12 (38.10) | 43.34 (41.14) | 47.65 (43.64) | 51.47 (45.82) | 46.40 (42.92) | 42.05 (40.41) | 39.12 (38.69) | 45.34 (42.29) | 44.34 (41.72) |
| $T_{11}$ | Ethion (X) (50% EC) | 750 | 19.53 | 51.57 (45.88) | 54.37 (47.49) | 50.46 (45.25) | 45.83 (42.59) | 42.18 (40.48) | 48.88 (44.34) | 54.57 (47.61) | 57.03 (49.02) | 53.79 (47.16) | 49.16 (44.50) | 44.52 (41.84) | 51.82 (46.03) | 50.35 (45.18) |
| $T_{12}$ | Ethion (2X) (50% EC) | 1500 | 19.83 | 66.72 (54.75) | 72.05 (58.08) | 66.43 (54.57) | 61.50 (51.63) | 57.39 (49.23) | 64.82 (53.65) | 68.72 (55.98) | 75.05 (60.23) | 68.43 (55.79) | 63.50 (52.82) | 58.39 (49.81) | 66.82 (54.89) | 65.82 (54.27) |
| $T_{13}$ | Fenpropathrin (x) (30% EC) | 50 | 20.02 | 54.69 (47.68) | 59.54 (50.48) | 55.91 (48.37) | 50.95 (45.53) | 49.02 (44.43) | 54.02 (47.30) | 56.69 (48.83) | 62.54 (52.25) | 57.91 (49.53) | 52.95 (46.67) | 50.02 (44.99) | 56.02 (48.45) | 55.02 (47.87) |
| $T_{14}$ | Fenpropathrin (X) (30% EC) | 75 | 19.99 | 82.73 (65.48) | 85.40 (67.54) | 81.97 (64.86) | 79.18 (62.85) | 76.85 (61.25) | 81.23 (64.39) | 84.73 (67.04) | 88.40 (70.10) | 83.97 (66.39) | 81.18 (64.29) | 77.85 (61.94) | 83.23 (65.95) | 82.23 (65.16) |
| $T_{15}$ | Fenpropathrin (2X) (30% EC) | 150 | 19.75 | 85.56 (67.69) | 86.87 (68.75) | 84.06 (66.49) | 80.58 (63.86) | 79.28 (62.90) | 83.27 (65.94) | 87.56 (69.39) | 89.87 (71.45) | 86.06 (68.11) | 82.58 (65.35) | 80.28 (63.62) | 85.27 (67.58) | 84.27 (66.75) |
| | Mean | | | 60.01 (51.27) | 61.94 (52.51) | 59.47 (51.11) | 54.97 (48.24) | 52.56 (46.74) | | 61.914 (52.50) | 64.74 (54.39) | 61.42 (52.41) | 57.02 (49.55) | 53.49 (47.33) | | |

Figures in parentheses are arc sin transformed values, DAS-Days after spray
C.D. = 3.842

## Discussion

Results of our study revealed that treatment $T_9$ (dimethoate @ 400 g a.i. $ha^{-1}$) was most effective against aphids during both the years i.e. 2019 and 2020. The bioefficacy of dimethoate against aphids on tomato was also studied by Sharma and Kumar (2020) [10] and according to their findings dimethoate 30 EC 0.03% was the second-best treatment after thiamethoxam 25 WG 0.008% with lowest aphid population i.e. 1.12 and 0.93 aphids per plant, respectively. In a similar study conducted by Patel *et al.*, 2017 [11] dimethoate 30 EC (1 mL $L^{-1}$) was found third effective treatment against aphids after thiamethoxam and imidacloprid. Furthermore, Patil *et al.* (2018) [12] reported that average percent reduction in aphid population on cowpea was maximum in plots treated with imidacloprid (56.62 percent) which was on par with dimethoate (55.60 percent). The difference in percent reduction was may be due to different climatic conditions and edaphic factors. It was observed from the data of both the sprays that after 5 days of spray treatment $T_9$ provided maximum percent reduction in aphid population.

As per the findings of present study, treatment $T_{15}$ (fenpropathrin @ 150 g a.i. $ha^{-1}$) was proved to be the next most effective treatment against aphids after $T_9$ (dimethoate) during both the consecutive years 2019 and 2020. The test insecticides studied in present study followed the same trend in both the years. In an investigation, Zafar *et al.*, (2016) [13] revealed that fenpropathrin was the second-best treatment on *Brassica campestris* which provides 80 percent mortality of aphid population with single application whereas methamidophos was the most effective treatment during their investigation with 84 percent mortality of aphids. In contrary results of another study conducted by Dake *et al.*, (2019) [14] on sunflower revealed that fenpropathrin was not effective against aphids. They reported 4.67 mean number of aphids per leaf after one day of application of fenpropathrin (0.001 percent). Similarly findings of another study done by Vadja and Kalasariya (2015) [15] against aphid on cluster bean showed that cartap hydrochloride 0.1 percent, ethion 0.05 percent, spiromesifen 0.024 percent, abamectin 0.003 percent and fenazaquin 0.02 percent gave 64.11, 57.45, 56.77, 52.55 and 47.30 percent mortality rate, respectively which was found to be less effective, whereas imidacloprid 0.006 percent was found to be most effective against aphids which provided 89.69 percent reduction in pest population. Bhure *et al.*, (2019) [16] also studied the relative bioefficacy of different insecticides among which imidacloprid was most effective followed by deltamethrin (0.00125 percent) against aphids (14.00 aphids/three leaves).

## Conclusion

From the present study, it was concluded that dimethoate was most effective against aphids on bell pepper followed by fenpropathrin as compared to the other insecticides tested. However, the percent reduction value in the aphid population in the plots treated with dimethoate at the recommended dose ($T_8$) and the percent reduction value in the aphid population in the plots treated with fenpropathrin at the recommended dose ($T_{14}$) were found statistically at par with $T_9$ and $T_{15}$, respectively. Hence, dimethoate and fenpropathrin at the recommended dose can be used effectively for the management of aphids on bell pepper.

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