Synthetic Insecticides and Bio-pesticide Affect Natural Enemies of Aphid (*Lipaphis erysimi* Kalt) in Mustard

S.A. Dwivedi¹, R.S. Singh²

**ABSTRACT**

**Background:** The prime intention of this research work was to assess the effect of synthetic insecticides and bio-pesticide against natural enemies of aphid, *Lipaphis erysimi* (Kalt.), mainly ladybird beetle *Coccinella septempunctata* (Linnaeus) and syrphid fly, *Ischiodon scutellaris* (Fabricius) in mustard was evaluated.

**Methods:** The field experiment was conducted at Student Research Farm, Department of Entomology, CSAUA and T Kanpur during Rabi season of 2013-14 and 2014-15. Experiment conducted in Randomized block design with three replication and eight treatments. Imidacloprid, deltamethrin, spinosad, fipronil, thiamethoxam, *Metarhizium anisopliae* and *Beauveria bassiana* were tested against natural enemies and available population of natural enemies of aphid were recorded before 1 day and after 3, 5, 7 and 14 days of spray application. *M. anisopliae* and *B. bassiana* were the most effective with less toxicity to Ladybird beetle and syrphid fly by continuously increasing population after application. Though all the tested chemical insecticides were found toxic to the lady bird beetle and syrphid fly larvae, imidacloprid and thiamethoxam were found relatively safer to other insecticides by recording less mortality after 14 days of spraying during two years testing period.

**Result:** *M. anisopliae*, *B. bassiana*, imidacloprid and thiamethoxam may be used for the management of insect pests because of their less toxicity to beneficial insects.

**Key words:** *B. bassiana*, Imidacloprid, Ladybird beetle, *M. anisopliae*, Syrphid fly.

**INTRODUCTION**

Mustard *Brassica* species, are a very important oilseed crop as its seeds contain >2 per cent erucic acid and <30μg·m⁻¹ of glucosinolates in the oil free meal. Canola oil also contains 5-8 per cent saturated fats, which is lower as compared to other vegetable oils (Raymer, 2002). Insect-pests, diseases and weeds are most important factors responsible for yield reduction in mustard crop. India is the second largest rapeseed-mustard growing country in the world after China contributing about 23.7% acreage and 26% production of total oilseeds. With demand for oilseed running ahead of total oilseeds, the production trends have been unsatisfactory due to attack of various insect pests. It is prone to attack number of insect pests. More than three dozen of pests are known to be associated with various phonological stages of mustard crop in India. Among these, aphid, *Lipaphis erysimi* (Kalt.) most important key pest in all the mustard growing regions of the country (Bakhetia and Sekhon, 1989) Aphids attack plants in two different ways, viz. suck cell sap from leaves, flowers, flower-buds, pod and twigs of the plants and secrete honeydew which acts as a medium for development of sooty mold fungus that diminish the photosynthetic activity of plant. As a consequence, plants lose their vigor and growth becomes stunted (Morzia and Huq, 1991). Among various entomophagous predators and parasitoids live on aphid and play major role to manage pest naturally, coccinellids, *Coccinella septempunctata* Linnaeus; Syrphid fly, *Ischiodon scutellaris* Fabricius and *Diaeretiella rapae* Macnithos endo parasitoid (Farhan et al. 2019) are very common.

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Seven spotted ladybird beetle, *Coccinella septempunctata* (L.), is one of the most potential predators of *L. erysimi* (Kalt.) controlling naturally in the field (Mathur1983, Kalra 1988). Syrphid flies or hover flies (Diptera: Syrphidae) also have substantial influence on the aphid populations and other insect pests. High rates of reproduction and voracities with about 400 aphids per larva to complete its development allow the hover flies to exploit aphid colonies proficiently. (Dixon 2000).

For controlling the *L. erysimi* effectively and to save *C. septempunctata*, insecticides should be applied at appropriate dose and at right time in view the impact of aphids’ damage and importance of predators in the protection of mustard crop against aphid population.

Among various practices recommended for the management of aphid and other pests, use of chemical
insecticides is a common practice among farmers. Frequent uses of insecticides have negative effect on the survival and adaptation of natural enemies (Hossaan and Poehling, 2006). Lady bird beetle (Coccinellidae: Coleoptera) and syrphid fly (Diptera: Syrphidae) are frequently found predators associated with aphid colonies. The most common parasitoid was Aphidius species, Diaeretiella rapae (Hymenoptera: Aphidiidae) occurring in aphid populations. While scanning the literatures, scanty information is available so far impact of synthetic insecticides on natural enemies of aphid, L. erysimi. Keeping in view the impact of insecticides on natural enemies and honeybee in the mustard crop, the present study was conducted to evaluate eight different insecticides against the natural enemies under field condition.

**MATERIALS AND METHODS**

The experiments were carried out in a Randomized Block Design with eight treatments including control and three replications having plot size of 4.5m × 3.5m during Rabi, 2013-2014 and 2014-2015 at Student Instructional Farm, Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur. Mustard variety Varuna was sown by keeping spacing of 45cm × 15 cm. Recommended agronomical practices except plant protection measures were followed for raising the crop. First spray application of respective insecticides was given on ETL level (1.5 aphid index/plant) and second spray 20 days after first spray by using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. During the spray, all necessary precautions were taken to avoid the chances of drifting of spray fluid to other plots. (Table 1).

**Observations of predators**

The observations on predator's intensity were recorded at weekly intervals in all the treatments during both the years. The intensity of the predators’ population on mustard aphid was observed on five randomly selected plants on 10 cm top shoot/inflorescence of the main shoot. The effects of insecticides and bio-pesticides on predators mortality numbers count in mustard crop, the intensity of natural enemies of Lipaphis erysimi were recorded after 3, 5, 7 and 14 days after each spray these techniques used by Bakhetia et al. (1989). General equilibrium positions (GEP) of predators such lady bird beetles adult and grub stage, syrphid fly larval stage were calculated in all the experiments.

**Per cent reduction**

Average population of insect pests and predators for each treatment was calculated. Per cent reduction was calculated by the formula (Arif et al., 2012) given below

\[
\text{Percent reduction} = \left(\frac{\text{Population recorded before spray} - \text{Population recorded after spray}}{\text{Population recorded before spray}}\right) \times 100
\]

**RESULTS AND DISCUSSION**

The screening of safe insecticides for the natural enemies of mustard aphid i.e. ladybird beetle and syrphid larvae. The spraying of synthetic insecticides and bio-pesticides takes place in mustard crop and adverse effects of treatments on predators’ population causing mortality were recorded.

**Effect of different synthetic insecticides and bio-pesticides on Coccinellids and Syrphid larvae population during first spray 2013-14 (Table 2 and 3)**

The data recorded a day before insecticidal application revealed that the population of Coccinellids beetle ranged from 4.25 to 9.58 beetles/5 shoot and 1.8 to 4.1 syrphid larvae/5 shoot. 3rd days after spraying maximum population noted in the treatment of B. bassiana and M. anisopliae 9.94 and 9.88 beetles /5 shoot and on synthetic insecticides imidacloprid found maximum population followed by thiamethoxam 7.23 and 5.19 beetles/ 5 shoot with 24.53 and 23.45 per cent reduction of Coccinellids population minimum number of Coccinellids beetle found on 3.06 beetles/5 shoots with highest percent reduction among the chemical i.e. 60.00 per cent. Maximum number of syrphid larvae population recorded on M. anisopliae and B. bassiana 3.7 and 3.9 larvae/5 shoot with increase 30.00 percent population by B. bassiana and on chemical thiamethoxam andimidacloprid found 2.2 and 1.5 larvae/5 shoot spinosad found hundred per cent mortality. No larvae found three day after spraying against spinosad. Five days after spraying increase population of beetles in M. anisopliae and B. bassiana 1.11 and 9.09 per cent. In chemical maximum percent reduction of beetles found 68.23 per cent of spinosad having most toxic to the predators.

Syrphid larval populations range from 0 to 4.3 maximum on B. bassiana and M. anisopliae 4.0 and 3.9 larvae /5 shoot with increase per cent 33.33 and 2.63 minimum reduction on chemical insecticides 54.05 and 83.33 of thiamethoxam and imidacloprid. Deltamethrin, spinosad and fipronil did not found single larvae. After seven days of application maximum population increases on B. bassiana and M. anisopliae 9.73 and 4.56 per cent both microbial insecticides helpful to increase population of beetles. Spinosad found most mortality of beetles 82.87 percent which prove most harmful compare to other insecticides. Thiamethoxam found safe with less reduction population of beetles found 9.58 per cent.

Maximum population increase in B. bassiana and M. anisopliae up to 4.0 syrphid larvae/5 shoot with percent 33.33 and 5.26 on chemical imidacloprid and thiamethoxam found 1.3 larvae/5 shoots with reducing 56.66 and 64.86% population 14 DAS 14.43 and 8.02 per cent increase population of Coccinellids beetles in the B. bassiana and M. anisopliae respectively. Spinosad caused 84.44 percent mortality of beetles prove most toxic and fipronil and thiamethoxam followed least toxic to the beetle with 3.05 and 6.19 percent reduction of beetle population over control. Mean syrphid population ranged in between 1.2 to 5.0 larvae/
5 shoot having 4.8 and 4.2 larvae/5 shoots on B. bassiana and M. anisopliae with increase population 60.00 and 10.52 respectively. Maximum larvae found on chemical insecticides 2.5 larvae in imidacloprid and thiamethoxam having minimum reducing population 16.66 and 34.28%.

**Effect of different synthetic insecticides and bio-pesticides on Coccinellids and Syrphid larvae population during second spray 2013-14 (Table 2 and 3)**

Natural enemies population counted third days after spraying in treatment spinosad caused 41.17 per cent mortality of Coccinellids beetles followed by deltamethrin with 35.47 per cent loss of predators beetle caused most toxic chemical among the treatment. Thiamethoxam and imidacloprid found least mortality of beetles 17.77 and 23.79 per cent respectively. B. bassiana and M. anisopliae increase beetle population 3.64 and 2.91 per cent respectively. Deltamethrin, spinosad and fipronil did not record single larval caused maximum mortality of syrphid larvae. Thiamethoxam and imidacloprid having 1.4 and 1.5 larvae /5 shoots with 40.00 to 72.00 per cent reduction of population. B. bassiana and M. anisopliae recorded maximum larvae 5.1 and 4.6 larvae/5 shoots with 30.00 and 9.52 per cent increases in population such as result found 5DAS on both microbial insecticides. Thiamethoxam and imidacloprid having 72.00 and 88.00 per cent reduction of population.

After five days of application in the treatment spinosad against prove highest mortality of beetles 77.31 per cent reduction of population found it was not safe for beetles. least mortality found in imidacloprid and thiamethoxam with 12.57 and 18.55 per cent reduction population of beetles. M. anisopliae and B. bassiana increase population of beetles 11.84 and 8.13 per cent both microbial insecticides does not caused any harmful effect on the Coccinellids beetles. 7DAS the population of beetle gradually increase their population in M. anisopliae and B. bassiana having maximum population of beetle 12.77 and 12.42 beetle /5 shoots with increase in 20.01 and 16.07 per cent population. Spinosad have maximum mortality of beetle followed by deltamethrin imidacloprid and thiamethoxam found less mortality of beetles compare with other chemical that was safe up to 14 DAS with 1.23 and 2.83 percent of mortality that was not hundred per cent safe but safe to compare with other. Both microbs insecticides increase population of beetles26.69 and 26.54 per cent by M. anisopliae and B. bassiana.7th and 14th DAS maximum population recorded of syrphid larvae on B. bassiana 5.6 and 5.8 larvae /5 shoots followed by M. anisopliae 4.8 and 5.2 larvae /5 shoots with increase population 16.66 and 14.28, 20.83 and 23.80 per cent respectively. On chemical insecticides minimum larvae population recorded on 0.9 and 1.4 larvae /5 shoots of thiamethoxam followed by imidacloprid 1.3 and 1.8 larvae /5 shoots with reducing population 64.00 and 44.00, 76.92 and 28.00 per cent.

**Effect of different synthetic insecticides and bio-pesticides on Coccinellids and Syrphid larvae population during first spray of 2014-15 (Table 4 and 5)**

Population of natural enemies recorded a day before insecticides spraying revealed that the mean population of Coccinellids beetles ranged from 6.78 to 12.35 beetles /5 shoots and 2.0 to 4.0 Syrphid larvae/5 shoots and did not differ significantly. 3rd DAS the mean population of Coccinellids beetles ranged from 5.57 to 12.34 beetles/5 shoots. Maximum population recorded on the 11.92 on M. anisopliae with increase population 1.18 per cent. Maximum per cent reduction found in spinosad 37.34 with less number of 5.57 beetles /5 shoots. The population varied from 0.0 to 4.8 syrphid larvae/5 shoots maximum increase in population of larvae found in B. bassiana 28.20 per cent with 4.8 larvae /5 shoots followed by M. anisopliae increase 23.80 per cent population with 4.3 larvae/5 shoots. On the chemical per cent of reduction found in fipronil 91.66 % followed by deltamethrin, thiamethoxam and imidacloprid having 66.67, 38.46 and 23.80 percent respectively. In spinosad no larvae found maximum mortality occurred in this plot.

Simultaneously after five and seven days of application population varied from 3.46 to 12.82 and 2.03 to 12.93 beetles/5 shoots respectively. Maximum per cent increase population found in M. anisopliae 8.82 and 9.33 with 12.82 and 12.88 beetles/5 shoots followed by B. bassiana 4.02 and

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**Table 1: Details information of synthetic insecticides and biopesticides.**

| T.N. | Common name | Trade name | Formulation | Rate | Source of supply |
|------|-------------|------------|-------------|------|-----------------|
| 1.   | Imidacloprid| Ultimo     | 17.8 SL     | Rs160/100ml | Sudarsan Chemicals Industries Ltd., Pune, |
| 2.   | Deltamethrin| Decis      | 2.8 EC      | Rs 1800/kg  | Wockhardt, Biotast/Biostadt Agriscience, Mumbai |
| 3.   | Spinosad    | Tracer     | 45SC        | Rs 900/100gm | Dow Agro Science India Pvt. Ltd. Mumbai |
| 4.   | Fipronil    | Regent     | 5 SL        | Rs 125/100 ml | Saraswati Agro Chemicals(India) Pvt. Ltd. Lane 2 |
| 5.   | Thiamethoxam| Actara     | 25 WP       | Rs 25/5gm   | Syngenta India limited 14.J.Tata Road Mumbai |
| 6.   | M. anisopliae| Blomet     | 1.5 WP      | Rs 90/100gm | Biotech International Ltd.B-21, Site-C, Surajpur |
| 7.   | B. bassiana | Biorin     | 1.5 WP      | Rs 90/50gm  | Biotech International Ltd.B-21, Site-C, Surajpur |
| 8.   | Uncontrolled| -          | -           | -            | Greater Noida-201 306 |

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**Table 2: Details information of synthetic insecticides and biopesticides.**

| T.N. | Common name | Trade name | Formulation | Rate | Source of supply |
|------|-------------|------------|-------------|------|-----------------|
| 1.   | Imidacloprid| Ultimo     | 17.8 SL     | Rs160/100ml | Sudarsan Chemicals Industries Ltd., Pune, |
| 2.   | Deltamethrin| Decis      | 2.8 EC      | Rs 1800/kg  | Wockhardt, Biotast/Biostadt Agriscience, Mumbai |
| 3.   | Spinosad    | Tracer     | 45SC        | Rs 900/100gm | Dow Agro Science India Pvt. Ltd. Mumbai |
| 4.   | Fipronil    | Regent     | 5 SL        | Rs 125/100 ml | Saraswati Agro Chemicals(India) Pvt. Ltd. Lane 2 |
| 5.   | Thiamethoxam| Actara     | 25 WP       | Rs 25/5gm   | Syngenta India limited 14.J.Tata Road Mumbai |
| 6.   | M. anisopliae| Blomet     | 1.5 WP      | Rs 90/100gm | Biotech International Ltd.B-21, Site-C, Surajpur |
| 7.   | B. bassiana | Biorin     | 1.5 WP      | Rs 90/50gm  | Biotech International Ltd.B-21, Site-C, Surajpur |
| 8.   | Uncontrolled| -          | -           | -            | Greater Noida-201 306 |
Synthetic Insecticides and Bio-pesticide Affect Natural Enemies of Aphid (*Lipaphis erysimi* Kalt) in Mustard

Table 2: Effect of different synthetic insecticides and bio-pesticides on Coccinellids beetles population (2013-14).

| TN. | T. Name         | Dose | Before Spray | After first spray | Mean of *Coccinellids* population /5 shoots | After second spray |
|-----|-----------------|------|--------------|-------------------|---------------------------------------------|-------------------|
|     |                 | a.i./ha |               | 3DAS  | PROC | 5DAS  | PROC | 7DAS  | PROC | 14DAS | PROC | 3DAS  | PROC | 5DAS  | PROC | 7DAS  | PROC | 14DAS | PROC |
| 1   | Imidacloprid 17.8% SL | 40gm  | 9.58          | 7.23   | 24.53 | 7.25   | 24.32 | 7.23   | 24.53 | 8.11   | 15.34 | 6.18   | 23.79 | 7.09   | 12.57 | 7.63   | 5.91   | 8.01   | 1.23  |
|     |                 |       | (3.10)        | (2.68) | (2.69) | (2.68) | (2.84) | (2.48) | (2.66) | (2.76) | (2.91) |                   |       |                     |
| 2   | Deltamethrin 2.8% EC | 100gm | 5.35          | 4.26   | 20.37 | 4.11   | 23.17 | 4.43   | 17.19 | 5.00   | 6.54   | 4.22   | 0.15   | 3.87   | 22.60 | 4.46   | 10.80 | 4.57   | 8.60  |
|     |                 |       | (2.32)        | (2.06) | (2.02) | (2.10) | (2.23) | (2.05) | (1.96) | (2.11) | (2.25) |                   |       |                     |
| 3   | Spinosad 45% SC | 75gm  | 7.65          | 3.06   | 60.00 | 2.43   | 68.23 | 1.31   | 82.87 | 1.19   | 84.44 | 0.70   | 41.17 | 0.27   | 77.31 | 0.00   | 99.92 | 0.00   | 99.92 |
|     |                 |       | (2.77)        | (1.75) | (1.56) | (1.14) | (1.09) | (0.84) | (0.52) | (0.70) | (0.70) |                   |       |                     |
| 4   | Fipronil 5% SC  | 75gm  | 4.25          | 4.09   | 3.76  | 4.00   | 5.88  | 3.33   | 21.64 | 4.12   | 2.74   | 10.16  | 2.48   | 18.68  | 2.64   | 13.44  | 2.95   | 3.27   |
|     |                 |       | (2.07)        | (2.02) | (2.12) | (1.95) | (2.14) | (1.80) | (1.72) | (1.77) | (1.85) |                   |       |                     |
| 5   | Thiamethoxam25%WG | 25gm  | 6.78          | 5.19   | 23.45 | 5.47   | 19.32 | 6.13   | 9.58  | 6.36   | 6.19  | 5.26   | 17.77 | 5.08   | 18.55  | 5.74   | 9.74   | 6.18   | 2.83   |
|     |                 |       | (2.61)        | (2.27) | (2.34) | (2.47) | (2.52) | (2.29) | (2.25) | (2.39) | (2.58) |                   |       |                     |
| 6   | M. anisopliae1.15% WP | 2000gm | 9.85          | 9.94   | 5.45  | 9.96   | -1.11 | 10.30  | -4.56 | 10.64  | -8.02 | 10.95  | -2.91 | 11.90  | -11.84 | 12.77  | -20.01 | 13.48  | -26.69 |
|     |                 |       | (3.14)        | (3.16) | (3.23) | (3.28) | (3.33) | (3.38) | (3.52) | (3.64) | (3.73) |                   |       |                     |
| 7   | B. bassiana 1.15% WP | 2500gm | 9.35          | 9.88   | -5.56 | 10.20  | -9.09 | 10.26  | -9.73 | 10.70  | -14.43 | 11.09  | -3.64 | 11.57  | -8.13  | 12.42  | -16.07 | 13.54  | -26.54 |
|     |                 |       | (3.06)        | (3.22) | (3.27) | (3.28) | (3.34) | (3.40) | (3.47) | (3.59) | (3.74) |                   |       |                     |
| 8   | Untreated       |       | 7.45          | 8.17   | 0.00  | 8.39   | 0.00  | 8.69   | 0.00  | 10.21  | 0.00  | 10.27  | 0.00  | 10.96  | 0.00  | 12.63  | 0.00  | 13.88  | 0.00  |
|     |                 |       | (2.73)        | (2.85) | (2.89) | (2.94) | (3.19) | (3.20) | (3.31) | (3.55) | (3.79) |                   |       |                     |
| SE(m±) |       | 0.04          | 0.05   | 0.07   | 0.03   | 0.04   | 0.02   | 0.04   | 0.02   | 0.02   |                   |       |                     |
| CD (P=0.05) | N.S  | 0.12          | 0.18   | 0.12   | 0.09   | 0.13   | 0.06   | 0.05   | 0.28   |                   |       |                     |

Note: Figures in bracket parenthesis are under root x+0.5 transformed value, DAS- Day after spraying, PROC-Percent Reduction Over Control.
Table 3: Effect of different synthetic insecticides and bio-pesticides on Syrphid larvae population 2013-14.

| T.N. | T. Name          | Dose a.i./ha | Syrphid larvae/5 shoots | Mean of Syrphid larvae population/5 shoot | Before Spray | After first spray | After second spray |
|------|------------------|--------------|-------------------------|-------------------------------------------|--------------|-------------------|-------------------|
|      |                  |              |                         |                                           |              | 3DAS PROC 5DAS PROC 7DAS PROC 14DAS PROC | 3DAS PROC 5DAS PROC 7DAS PROC 14DAS PROC |
| 1    | Imidacloprid 17.8%SL | 40gm         | 3.0                     | 1.5                                       | 50.00        | 0.5               | 83.33             | 1.3               | 56.66             | 2.5               | 16.66             | 1.5               | 40.00             | 0.3               | 0.88              | 1.3               | 76.92             | 1.8               | 28.00             |
|      |                  |              |                         |                                           | (1.87)       | (1.44)             | (1.34)            | (1.73)            | (1.41)            | (0.89)            | (1.34)            | (1.51)            |
| 2    | Deltamethrin 2.8%EC | 100gm        | 3.0                     | 1.8                                       | 40.00        | 0.0               | 100               | 0.0               | 100               | 1.5               | 50.00             | 0.0               | 100               | 0.0               | 100               | 0.7               | 53.33             | 0.9               | 40.00             |
|      |                  |              |                         |                                           | (1.87)       | (1.51)             | (0.71)            | (0.71)            | (1.41)            | (0.71)            | (0.71)            | (1.14)            | (1.14)            | (1.14)            |
| 3    | Spinosad 45%SC    | 75gm         | 2.4                     | 0.0                                       | 100          | 0.0               | 100               | 0.0               | 100               | 1.2               | 50.00             | 0.0               | 100               | 0.0               | 100               | 0.0               | 100               | 0.0               | 100               |
|      |                  |              |                         |                                           | (1.70)       | (0.71)             | (0.71)            | (0.71)            | (1.30)            | (0.71)            | (0.71)            | (0.71)            | (0.71)            | (0.71)            |
| 4    | Fipronil 5%SC     | 75gm         | 1.8                     | 1.0                                       | 44.44        | 0.0               | 100               | 0.0               | 100               | 1.4               | 22.22             | 0.0               | 100               | 0.0               | 100               | 0.0               | 100               | 0.0               | 100               |
|      |                  |              |                         |                                           | (1.51)       | (1.22)             | (0.71)            | (0.71)            | (1.37)            | (0.71)            | (0.71)            | (0.71)            | (0.71)            |
| 5    | Thiamethoxam 25%WP | 25gm         | 3.7                     | 2.2                                       | 40.54        | 1.7               | 54.05             | 1.3               | 64.86             | 2.5               | 34.28             | 0.7               | 72.00             | 0.7               | 72.00             | 0.9               | 64.00             | 1.4               | 44.00             |
|      |                  |              |                         |                                           | (2.04)       | (1.64)             | (1.48)            | (1.34)            | (1.73)            | (1.37)            | (0.71)            | (0.71)            | (0.71)            | (0.71)            |
| 6    | M. anisopliae 15%WP | 2000gm       | 3.8                     | 3.9                                       | -2.56        | 3.9               | -2.56             | 4.0               | -5.26             | 4.2               | -10.52            | 4.6               | -9.52             | 4.6               | -9.52             | 4.8               | -14.28            | 5.2               | -23.80            |
|      |                  |              |                         |                                           | (2.07)       | (2.09)             | (2.09)            | (2.12)            | (2.16)            | (2.25)            | (2.25)            | (2.25)            | (2.25)            | (2.25)            |
| 7    | B. bassiana 15%WP | 2500gm       | 3.0                     | 3.9                                       | -30.00       | 4.0               | -33.33            | 4.0               | -33.33            | 4.8               | -60.00            | 5.1               | -30.00            | 5.1               | -30.00            | 5.6               | -16.66            | 5.8               | -20.83            |
|      |                  |              |                         |                                           | (1.87)       | (2.09)             | (2.12)            | (2.12)            | (2.30)            | (2.36)            | (2.36)            | (2.46)            | (2.46)            | (2.50)            |
| 8    | Untreated         |              |                         |                                           | 4.1          | 4.3               | 0.00              | 4.3               | 0.00              | 4.7               | 0.00              | 5.0               | 0.00              | 5.3               | 0.00              | 5.3               | 0.00              | 6.2               | 0.00              |
|      |                  |              |                         |                                           | (2.14)       | (2.19)             | (1.19)            | (2.28)            | (2.34)            | (2.40)            | (2.40)            | (2.40)            | (2.52)            | (2.58)            |
|      |                  |              |                         |                                           | SE(m±) 0.38  | 0.25              | 0.10              | 0.23              | 0.38              | 0.17              | 0.12              | 0.17              | 0.25              |
|      |                  |              |                         |                                           | CD (P=0.05) N.S. 1.73 | 0.41              | 1.29              | 1.20              | 1.07              | 1.10              | 0.65              | 1.19              |

Note: Figures in bracket parenthesis are under root x+0.5 transformed value, DAS- Day after spraying, PROC-Percent Reduction Over Control.
### Table 4: Effect of synthetic different insecticides and biopesticides on Coccinellids beetles population 2014-15.

| T.N. | T. Name          | a.i./ha | Mean of Coccinellids population/5 shoot Before Spray | After first spray | After second spray |
|------|-----------------|---------|------------------------------------------------------|------------------|-------------------|
|      |                 |         | Before Spray | 3DAS | PROC | 5DAS | PROC | 7DAS | PROC | 14DAS | PROC | 3DAS | PROC | 5DAS | PROC | 7DAS | PROC | 14DAS | PROC |
| 1    | Imidacloprid 17.8% SL | 40gm    | 9.90 | 8.11 | 18.08 | 7.82 | 21.10 | 8.06 | 18.58 | 9.07 | 8.38 | 8.28 | 8.71 | 8.07 | 11.02 | 8.27 | 8.82 | 9.00 | 0.77 |
|      |                 |         | (3.15) | (2.84) | (2.79) | (2.84) | (3.01) | (2.87) | (2.84) | (2.68) | (2.86) | (3.08) |
| 2    | Deltamethrin 2.8% EC | 100gm   | 6.78 | 5.80 | 14.45 | 5.56 | 17.99 | 5.70 | 15.92 | 6.08 | 10.32 | 4.91 | 19.24 | 4.19 | 31.08 | 3.69 | 39.30 | 5.89 | 3.12 |
|      |                 |         | (2.61) | (2.42) | (2.35) | (2.38) | (2.46) | (2.21) | (2.04) | (1.92) | (2.42) |
| 3    | Spinosad 45% SC  | 75gm    | 8.89 | 5.57 | 37.34 | 3.46 | 61.07 | 2.03 | 77.16 | 1.61 | 81.88 | 1.25 | 22.36 | 0.60 | 62.73 | 0.17 | 89.44 | 0.00 | 99.92 |
|      |                 |         | (2.98) | (2.36) | (1.86) | (1.42) | (1.27) | (1.11) | (0.78) | (0.42) | (0.70) |
| 4    | Fipronil 5% SC   | 75gm    | 9.67 | 9.09 | 5.99 | 8.38 | 13.34 | 8.45 | 12.61 | 9.19 | 4.96 | 7.65 | 16.75 | 7.92 | 13.81 | 8.11 | 16.13 | 8.70 | 5.33 |
|      |                 |         | (3.11) | (3.01) | (2.89) | (2.90) | (3.03) | (2.76) | (2.81) | (2.84) | (3.03) |
| 5    | Thiamethoxan 25% WP | 25gm   | 10.67 | 9.16 | 14.15 | 8.67 | 18.74 | 9.07 | 14.99 | 9.66 | 9.46 | 8.50 | 12.00 | 7.43 | 23.06 | 8.63 | 10.66 | 9.45 | 2.17 |
|      |                 |         | (3.27) | (3.02) | (2.94) | (3.01) | (3.10) | (2.91) | (2.72) | (2.93) | (2.95) |
| 6    | M. anisopliae 1.15% WP | 2000gm | 11.78 | 11.92 | -1.18 | 12.82 | -8.82 | 12.88 | -9.33 | 13.38 | -13.58 | 13.92 | -4.03 | 14.47 | -8.14 | 14.88 | -11.21 | 14.91 | -11.43 |
|      |                 |         | (3.43) | (3.50) | (3.64) | (3.65) | (3.72) | (3.79) | (3.86) | (3.92) | (3.92) |
| 7    | B. bassiana 1.15% WP | 2500gm | 11.67 | 11.88 | -1.79 | 12.14 | -4.02 | 12.27 | -5.41 | 13.19 | -13.02 | 13.30 | -0.83 | 13.87 | -5.15 | 14.31 | -8.49 | 14.48 | -9.78 |
|      |                 |         | (3.42) | (3.51) | (3.55) | (3.57) | (3.70) | (3.71) | (3.79) | (3.84) | (3.87) |
| 8    | Untreated        |         | 12.35 | 12.34 | 0.00 | 12.60 | 0.00 | 12.93 | 0.00 | 13.21 | 0.00 | 13.53 | 0.00 | 13.96 | 0.00 | 14.12 | 0.00 | 15.81 | 0.00 |
|      |                 |         | (3.52) | (3.51) | (3.55) | (3.59) | (3.63) | (3.67) | (3.73) | (3.75) | (3.97) |

SE(m±) 0.05 0.09 0.04 0.04 0.03 0.06 0.04 0.02 0.04
CD (P<0.05) N.S 0.28 0.07 0.10 0.10 0.17 0.11 0.07 0.06

Note: Figures in bracket parenthesis are under root x+0.5 transformed value, DAS- Day after spraying, PROC-Percent Reduction Over Control.
| T.N. | T. Name               | Dose a./ha | Before Spray | After first spray | After second spray |
|------|-----------------------|------------|--------------|------------------|-------------------|
|      |                       |            | Syrphid larvae/5 shoots | 3DAS | PROC | 5DAS | PROC | 7DAS | PROC | 14DAS | PROC | 3DAS | PROC | 5DAS | PROC | 7DAS | PROC | 14DAS | PROC |
| 1    | Imidacloprid 17.8% SL | 40gm       | 2.1          | 1.6              | 23.80             | 1.0              | 52.38             | 1.3              | 38.09             | 2.0              | 4.76              | 0.6              | 70.00             | 0.0              | 100              | 0.6              | 70.00             | 1.9              | 5.00              |
|      |                       | (1.61)     | (1.44)       | (1.22)           | (1.34)            | (1.58)           | (1.04)            | (0.71)           | (1.04)           | (1.54)            |                  |                  |                  |                  |                  |                  |                  |                  |
| 2    | Deltamethrin 2.8% EC  | 100gm      | 3.9          | 1.3              | 66.67             | 0.0              | 100               | 0.0              | 100               | 0.3              | 23.07             | 0.0              | 100               | 0.0              | 100              | 0.0              | 100              | 0.0              | 100              |
|      |                       | (2.09)     | (1.34)       | (0.71)           | (0.71)            | (0.89)           | (0.71)            | (0.71)           | (0.71)           | (0.71)            |                  |                  |                  |                  |                  |                  |                  |                  |
| 3    | Spinosad 45% SC       | 75gm       | 2.0          | 0.0              | 100               | 0.0              | 100               | 0.0              | 100               | 0.0              | 100               | 0.0              | 100               | 0.0              | 100              | 0.0              | 100              | 0.0              | 100              |
|      |                       | (1.58)     | (0.71)       | (0.71)           | (0.71)            | (0.71)           | (0.71)            | (0.71)           | (0.71)           | (0.71)            |                  |                  |                  |                  |                  |                  |                  |                  |
| 4    | Fipronil 5% SC        | 75gm       | 3.6          | 0.3              | 91.66             | 0.0              | 100               | 0.1              | 97.22             | 2.0              | 44.44             | 0.0              | 100               | 0.0              | 100              | 0.1              | 95.00             | 0.2              | 90.00             |
|      |                       | (2.02)     | (0.89)       | (0.71)           | (0.71)            | (0.71)           | (0.71)            | (0.71)           | (0.71)           | (0.71)            |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| 5    | Thiamethoxam 25% WP   | 25gm       | 3.9          | 2.4              | 38.46             | 1.3              | 66.67             | 1.6              | 58.97             | 1.9              | 51.28             | 0.6              | 68.42             | 1.0              | 47.36             | 1.1              | 42.10             | 1.3              | 15.78             |
|      |                       | (2.09)     | (1.70)       | (1.34)           | (1.44)            | (1.54)           | (1.04)            | (1.22)           | (1.26)           | (1.34)            |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| 6    | M. anisopliae 1.15% WP| 2000mg     | 4.2          | 4.3              | -23.80            | 4.3              | -23.80            | 5.3              | -26.19            | 5.1              | 3.77              | 5.3              | 0.00              | 5.7              | -7.54             | 6.6              | -24.52            |
|      |                       | (2.16)     | (2.19)       | (2.19)           | (2.19)            | (2.40)           | (2.36)            | (2.40)           | (2.40)           | (2.48)            |                  |                  |                  |                  |                  |                  |                  |                  |
| 7    | B. bassiana 1.15% WP  | 2500gm     | 3.9          | 4.8              | -28.20            | 4.3              | -10.25            | 5.0              | 28.20             | 5.0              | -28.20            | 5.7              | -14.00            | 5.6              | -43.58            | 6.6              | -32.00            | 6.9              | -38.00            |
|      |                       | (2.09)     | (2.30)       | (2.19)           | (2.34)            | (2.34)           | (2.48)            | (2.46)           | (2.46)           | (2.66)            |                  |                  |                  |                  |                  |                  |                  |                  |                  |
| 8    | Untreated             | 4.0        | 4.0          | 0.00             | 5.60              | 0.00             | 6.3               | 0.00             | 6.3               | 0.00             | 6.7               | 0.00             | 7.0               | 0.00             | 6.3               | 0.00             | 6.3               | 0.00             | 6.3               |
|      |                       | (2.12)     | (2.12)       | (2.25)           | (2.46)            | (2.60)           | (2.68)            | (2.73)           | (2.60)           |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|      | SE(m±)                | 0.42       | 0.31         | 0.08             | 0.25             | 0.34             | 0.21             | 0.15             | 0.21             | 0.22             |                  |                  |                  |                  |                  |                  |                  |                  |
|      | CD (P<0.05)           | N.S        | 1.13         | 1.35             | 1.18             | 0.82             | 1.12             | 1.19             |                  |                  |                  |                  |                  |                  |                  |                  |                  |

Note: Figures in bracket parenthesis are under root x+0.5 transformed value, DAS- Day after spraying, PROC-Percent Reduction over Control.
Effect of synthetic different insecticides and bio-pesticides on Coccinellids beetles and Syrphid larvae population during second spray of 2014-15 (Table 4 and 5)

After third of spraying population intensity of beetles noted 1.22 to 13.53 beetles/5 shoots. Maximum population M.anisopliae and B.bassiana 13.92 and 13.30 beetle/5 shoots with increase population up to 13.58 and 13.02 per cent respectively both microbial insecticides have significant to all treatment. Least reduction found in imidacloprid and thiamethoxam 8.71 and 12.00 percent. Maximum reduction found in spinosad 23.36 percent found no significant for Coccinella beetles. No larvae of syrphid found in deltamethrin and spinosad on any dates of observation hence maximum mortality occurred both insecticides treated plots. Increase in population found only in B.bassiana up to 14.00 percent three days after spraying. 5th and 7th DAS maximum intensity of beetles found in M.anisopliae and B.bassiana 14.47 and 13.87,14.88 and 14.31 beetles/5 shoots having 8.14 and 5.15,11.21 and 8.49 per cent population respectively. Maximum percent mortality found in spinosad 62.73 and 89.44 percent per cent respectively. Least percent of reduction found in syrphid larvae treated thiamethoxam 47.36 and 42.10 in 5 and 7 days after spraying and increase population of larvae found in B. bassiana 43.48 and 32.00 per cent. 14 DAS maximum population ob beetles found in M.anisopliae and B.bassiana 14.91 and 14.48 beetles/5 shoots with increase population 11.43 and 9.78 percent and minimum reduction found in imidacloprid 0.77 percent followed by thiamethoxam with 2.17 percent and maximum mortality found in spinosad prove most toxic to the beetles M.anisopliae and B.bassiana found most effective for syrphid larvae population with increase 24.52 and 38.00 per cent having 6.6 and 6.9 larvae of syrphid fly/5 shoots. Least mortality found in imidacloprid and thiamethoxam 5.00 and 15.78 per cent. It is evident from the data that microbial and new insecticides were found safer than the conventional insecticides. The present findings are in conformity with Awanesh et al. (2014) reported that imidacloprid and thiamethoxam found safe for Coccinella beetles by causing less mortality of beetles in treated chemicals. Maula et al (2010) reported that the lowest mortality of Coccinella septempunctata due to dimethion treated plot. Bana et al. (2014) recorded the minimum population (2.67 and 2.10/10 plants) was recorded in imidacloprid. Amin et al. (2014) found that Imidacloprid showed 57.34% reduction in C. septumpunctata population whereas dimethoate 52.77% reduction in larval population of syrphid flies after seven days of spray application. It is concluded that bifenthrin and imidacloprid can be used for the management of mustard insect pests because of their higher efficacy against aphids and leaf miners and less toxicity to beneficial insects. Patel and Godhani (2017) revealed that there was no significant difference among the different treatments of synthetic insecticides, indicating no much hazardous effects of chemicals under investigation on activity of predators i.e. coccinellids and syrphid fly and parasitoid Diaeretiella rapae. It showed that imidacloprid and thiamethoxam chemicals proved to be safe or less toxic to predators as well as parasitoid in cauliflower ecosystem. Jan et al. (2017) reported that cypermethrin caused toxicity to cabbage looper at lower, recommended and higher doses as compared to bifenthrin and control, nonetheless it also revealed more toxic to predator lady bird beetles as compared to bifenthrin and control. Khedkar et al. (2012), flonicamid (0.015%), clothianidin (0.025%) and thiacloprid (0.024%) found comparatively less toxic to these predators in mustard ecosystem. More or less same trend was also observed for these chemicals under the present study in cauliflower ecosystem. For rest of chemicals, results could not be compared with earlier reports due to the scanty information this investigation also support to my work.

CONCLUSION
It is concluded that bio-pesticide, imidacloprid and thiamethoxam may be used for the management of insect pests because of their less toxicity to beneficial insects.

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Conflict of interest
There is no conflict of interest among authors of the manuscript.

REFERENCES
Amin, M.A., Hameed, A., Rizwan, M. and Akmal, M. (2014). Effect of different insecticides against insect pests and predators complex on Brassica napus L., under field conditions.
International Journal of Scientific Research in Environmental Sciences. 2(9): 340-345.
Arif, M.J., Abbas, Q., Gogi, M.D., Ashfaq, M., Sayyad, H.A., Khan, M.A. andKarar, H. (2012). Performance of some insecticides against canola aphids and associated Coccinellid predators under field conditions. Pakistan Journal of Entomology. 34: 37-41.
Awaneesh Chandra, Malik, Y.P. and Kumar, A. (2014). Efficacy and economics of new insecticides for management of aphid (Lipaphis erysimi) in Indian mustard. Current Advances in Agricultural Sciences. 6(1): 88-90.
Bagal, S.R. and Trechan, K.N. (1945). Life history and bionomics of two predaceous and one mycophagous species of Coccinellids. Journal of Bombay Natural History Society. 504(45): 561-575.
Bakhetia, D.R.C. and Sekhon, B.S. (1989). Insect pests and their management rapeseed mustard. Journal of Oilseeds Research. 6(2): 269-273.
Bana, J.K., Jat, B.L. and Chaudhary, S.K. (2014). Effect of insecticides on Coccinella septempunctata L. Journal of Entomology. 76(4): 352-354.
Dixon, A.F.G. (2000) Insect predator-prey dynamics, In: Ladybird beetles and biological control. Cambridge Univ. Press. United Kingdom.
Farhan, M., Murtaza, G., Ramzan, M., Sabir, M.W., Rafique, M.A. and Ullah, S. (2019). Feeding potential of Chrysoperla carnea on Myzus persicae (Sulzer) under laboratory conditions. Journal of Innovative Sciences. 5(2): 95-99.
Hossain, M.B. and Poehling, H.M. (2006). Effect of a neem based insecticide on different immature life stages of the leaf miner, Leriomyza sativae on tomato. Phytoparasitica. 34: 360-369.
Jan H, Akhtar, M.N., Usman, M. and Akhtar, Z.R. (2017). Insecticidal toxicity up to third trophic level: A case study of Cypermethrin and Bifenthrin. International Journal of Entomology Research. 2(4): 25-30.
Kalra, V. K. (1988). Population dynamics of various predators associated with mustard aphid, L. erysimi Kalt. Journal of Biological Control. 2: 77-79.
Khedkar, A.A., Bhardwaj, T.M., Patel, M.G. and Patel, C.K. (2012). Efficacy of different chemical insecticides against mustard aphid, Lipaphis erysimi (Kaltenbach) infesting mustard. AGRES-An International e-Journal. 1(1): 53-64.
Mathur, K.C. (1983). Aphids of Agricultural Importance and Their Natural Enemies of Jullunder Punjab. In: The aphids. [(Edit.) Behura BK]. The Zoological Society of Orissa, Utkal University, Bhubneshwar, India. pp 229-233.
Maula, A.K.M.M, Shah, M.M.R., Siddique, N.A., Mamun, M.A.A. and Begum, M. (2010). Effectiveness of three insecticides against mustard aphid and predator under field condition. Bangladesh Journal of Agricultural Research. 35: 179-187.
Morzia, B and Huq, S.B. (1991). Evaluation of different genotypes of Indian mustard (Brassica juncea) for their reaction to mustard aphid L. erysimi. Indian Journal of Agricultural Science. 61: 210-213.
Patel, N.M. and Godhani, P.H. (2017). Impact of synthetic insecticides on natural enemies of aphid, Lipaphis erysimi (Kaltenbach) in Cauliflower. Trends in Biosciences. 10(40): 8484-8487.
Rayner, P. L. (2002). Canola: an emerging oilseed crop. Trends in New Crops and New Uses. 1: 122-126.