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Beneficial insects not affected by Imidacloprid while feeding on aphids in maize cropping system

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Abstract
Insecticides can cause hazards to predator's upto third trophic level in the eco-system. Aphids usually feeed on maize and its predator lady beetle feeds on aphids. Research was conducted in tritrophic interaction in which lady beetle adults were reared on aphids fed with maize. In these studies Imidacloprid was used to treat the maize at low, recommended and high dose. Whole of the experiment was repeated to observe mortality three times. Each time replications were similar. Results showed that, when treated with low, recommended, higher doses, imidaclporid showed mortality at all three concentrations. However, higher mortalities were caused at higher concentration. Results exclusively reveal that if lady beetle will feed on aphids which will be exposed by the imidaclporid in the fields will not result in reduction of population dynamics at large scale. Hence as conclusion, it is found that if we use imidaclporid at recommended dose, it will not affect upto third trophic level.

Keywords: lady beetle, aphids, maize, imidacloprid

Introduction
Maize is one of the important cereal crops of irrigated and rain fed areas in the world. Due to its high yielding potential and short growth duration, it's considered as an important crop in agriculture. Maize contributes 4.6% of total grain food production in the worldwide. Maize plays an important role in food and fodder production. It is used for manufacturing of corn sugar, corn oil, corn protein, corn flask and corn syrup in industries (MINFAL, 2009) [27].

Maize crop yield is affected from different insect pests. Grain losses due to insect's pests account 10-15% (Jaipal and Dass, 1993) [16]. Proper plant protection measures should be adopted to prevent losses due to insect pest. Major insect pest of maize include aphid, cut worm, stem borer, shoot fly, root worm (Kumar *et al.* 1992) [20]. The maize leaf aphid feed on maize, its heavy infestation leaves wilt, curl and show yellow color forming dead patches. Aphid infestation cause 40% severely infested stalk (Atwal, 1976) [3]. Usually the damage of aphid is undervalued, it disturbs the physiology of plant, that damage estimates and control recommendation are difficult to make (Pierre *et al.* 1966) [29]. Early season growing crop produced maximum grain yield as compared to late season grown crop (Widstorm *et al.* 1984). Significant reduction in yield due to crop sowing too early or too late. Control measure should be adopted by determining the infestation timing.

Certain important pest of maize stem in which one is aphid which has great potential to cause severe losses in yield, if no control measure isadopted (Messelink, 2014) [25]. Aphididae family has 4700 species in which 100 species of aphididae family important agriculture pest (Blackman, 2007) [4]. Aphid has a negative impact on crop yield through direct feeding injury, through transmission of plant viruses between different plants, and express development of resistance against insecticides (Sewell, 1990, Quisenberry, 2007, Katis, 2007) [32, 31, 19]. Aphids causes plant undergrowth due to excreted of Honey dew and cause the spread of the sooty mold fungus. Sooty mold decreases the value of fruit in markets. Due to their potential to produce resistance against insecticide therefore biological control method used to suppress the aphid population.

Lady Bird beetle are the best predator recorded in North America alone (Whitwer, 1995). In 1888 California, the Australian Ladybird beetle (*Rodolia cardinalis in*) has been used successfully as biological control agent against the aphids (Gullino, 199). Lady Bird Beetle feeding on aphid adults and nymphs and other minute insects (Whitwer, 1995). Insecticide have adverse effect on natural enemies it has been confirmed in the control of cowpeas aphid(3).Population of aphid continuously decreases by increasing the population of ladybird beetle (*Coccinella*), but population of aphids increases, when natural enemy population decreased. Tuey (Messelink, 2014) [25]. Also interrelated a high aphid population to the high population of the beetles (Coccinella). Some ladybird beetles are successful natural enemy as compared to other. The life cycle of Ladybird beetle depend on temperature, rainfall relative humidity and food. Mostly 3-4 weeks require from egg to adult or 6 weeks during cool environment. During winter season ladybird beetle laid 50-300 eggs in her life cycle between aphid colonies. Egg of ladybird beetle feed on aphid for 2-3 weeks and then pupate. After 7-10 days adult emerge. Ladybird beetle have five generation in a year. At low temperature adult of ladybird beetle hibernate of leafs, sometime Beetles are present under side of leaves, cracks, plant waste in a cooled temperature (Blackman, 2007) [4]. Grubs are most active during day time. Grub mostly present on the upper side of plant near aphid (Blümel, 2004).

The most important species of aphid are Aphid gossypii Glover, Myzuspersicae. These species have a broad verities of host plant (El-Heneidyand Abdel-Samad, 2001; Fuchsberg *et al.*, 2007) [8, 9]. It is important to identify the relationship between plant cultivars, prey and predators during integrated pest management (El-Heneidy and Abdel-Samad, 2001) [8]. Beetle species are polyphagous in nature and consume all type of aphid species (Hodek, 1996) [13]. Aphid species are most

suitable prey of Beetle which help in Development and reproduction of Beetle (Kalushkov, 1998; Kalushkov and Hodek, 2004) [17]. The duration of Adult Beetle Development, egg laying ability and egg hatching ability of predator depend on the Aphid species (Michaud, 2000; Cabral *et al.*, 2006) [26, 5]. A tri-trophic interaction creates more complex layer (Price *et al.*, 1980) [30] as the aphid nutritional quality may change according to the host plant nutrient, predators preference may change to predates on aphid. (Hodek, 1993; Giles *et al.*, 2002a, b; Vanhaelen *et al.*, 2002; Wu *et al.*, 2010) [12, 11, 37, 39].*Coccinella*use a biological control agent on different agricultural crop (Ghanim and El-Adl, 1987) [10]. A lot of literature available regarding aphid species as a suitable host for *Coccinella undecimpunctata* (Abdel Salam, 2004) [1].

Materials and Methods

Experimental Design

The experiment was conducted at Postgraduate laboratory, Department of Entomology, University of Agriculture, Faisalabad using the Completely Randomized design (CRD) consisting of three treatments having three replications. In each replication fifteen petri-dishes were used. The adults of ladybird beetle were collected from the field and reared under the laboratory conditions temperature $(26\pm2)^0$C and relative humidity (60±5%) without the exposure of insecticides. Aphid population was maintained on maize leaves. The adults of *Coccinella septempunctata* were feed on the aphid population as a food source.

Insecticide Preparation and Applications

Imidacloprid @ 0.1%, 0.2% and 0.3% was tested against the adult population of ladybird beetle (*Coccinella septempunctata*) under the laboratory conditions. The stock solution of tested pesticide was prepared and different required concentrations were formed.

Mortality tests of Adult Ladybird Beetle (*Coccinella septempunctata*)

Three mortality tests were conducted by using the Imidacloprid with three different concentrations viz. 0.1%, 0.2% and 0.3%. In each petri-dish one ladybird beetle (*Coccinella septempunctata*) with thirty treated aphids were released.

Results

First mortality test results of adult lady bird beetle

1st mortality test results in (Fig 1. a) showed that after the application of Imidacloprid @ 0.1% maximum mortality of ladybird beetle was (13%) at 1st and 2nd day while minimum (0%) was at 6thand 7th day. While in case of control treatment maximum mortality % was (6.6%) at 4th day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.1% concentration as compared to control.As (df) = 1, (F) = 6.437831, (P-value) = 0.044242.

1st mortality test results in (Fig 1. b) showed that after the application of Imidacloprid @ 0.2% maximum mortality of ladybird beetle was (13%) at 1st and 2nd day while minimum (0%) was at 6th and 7th day. While in case of control treatment maximum mortality % was (6.6%) at 1st day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.2% concentration as compared to control. As (df) = 1, (F) = 10.91628, (P-value) = 0.016327.

1st mortality test results in (Fig 1. c) showed that after the application of Imidacloprid @ 0.3% maximum mortality of ladybird beetle was (20%) at 1st day while minimum (6.66%) was at 4th, 6th and 7th day. While in case of control treatment maximum mortality % was (6.6%) at 4th and 5th day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.3% concentration as compared to control. As (df) = 1, (F) = 14.72155, (P-value) = 0.00859.

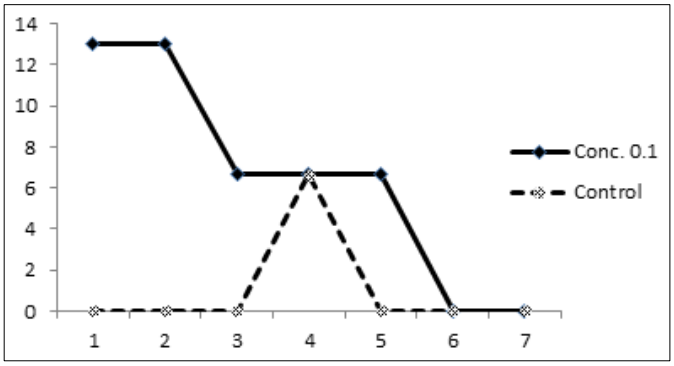

Fig 1.a: mortality test of adult lady bird beetle

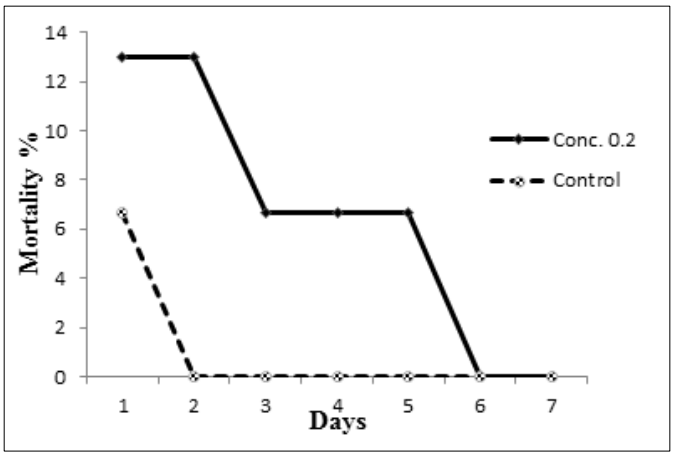

Fig 1.b: mortality test of adult lady bird beetle

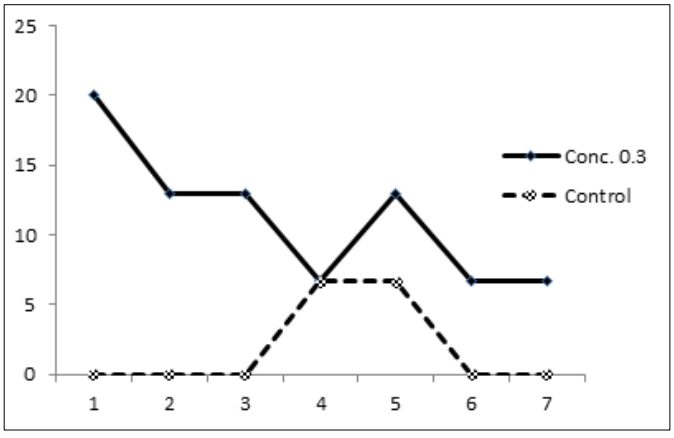

Fig 1.c: mortality test of adult lady bird beetle

Second mortality test results of adult lady bird beetle

After 2nd mortality test results in (Fig 2. a) showed that after the application of Imidacloprid @ 0.1% maximum mortality of ladybird beetle was (13%) at 1st and 3rd day while minimum (0%) was at 6th and 7th day. While in case of control treatment

maximum mortality % was (6.6%) at 3rd day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.1% concentration as compared to control. As (df) = 1, (F) = 10.91628, (P-value) = 0.016327.

After 2nd mortality test results in (Fig 2. b) showed that after the application of Imidacloprid @ 0.2% maximum mortality of ladybird beetle was (13%) at 1st and 2nd day while minimum (0%)was at 6th and 7th day. While in case of control treatment maximum mortality % was (6.6%) at 1st day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.2% concentration as compared to control. As (df) = 1, (F) = 7.8777041, (P-value) = 0.030894.

After 2nd mortality test results in (Fig 2. c) showed that after the application of Imidacloprid @ 0.3% maximum mortality of ladybird beetle was (26.6%) at 1st day while minimum (6.6%) was at 5th, 6th and 7th day. While in case of control treatment maximum mortality % was (6.6%) at 2nd day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.3% concentration as compared to control. As (df) = 1, (F) = 20.86442, (P-value) = 0.00382.

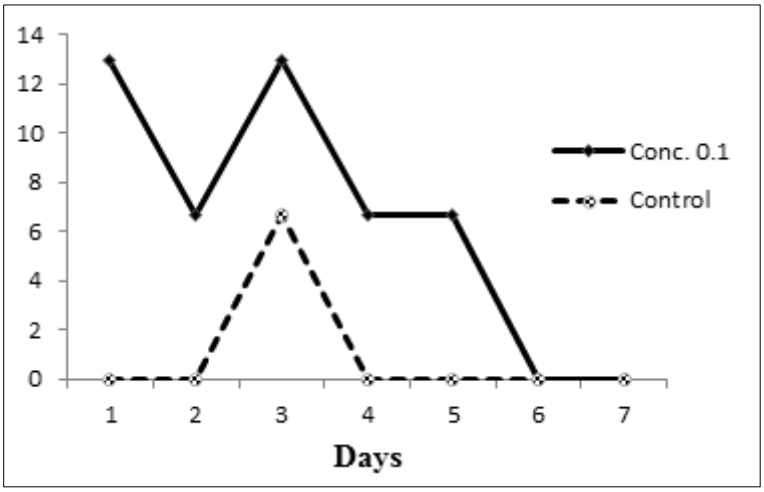

Fig 2.a: mortality test of adult lady bird beetle

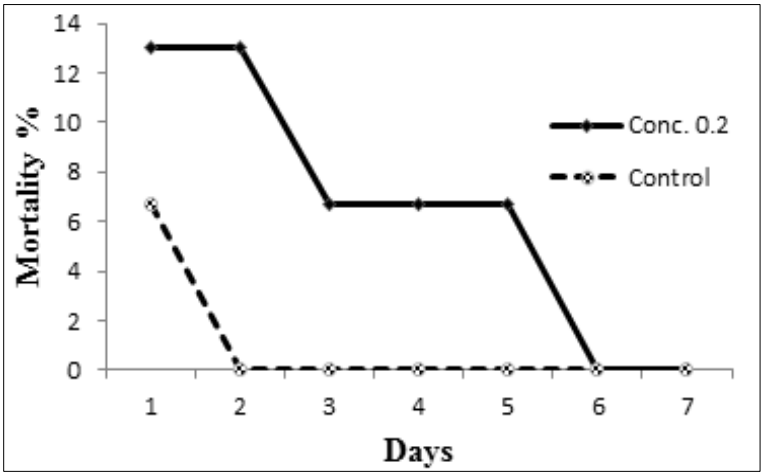

Fig 2.b: mortality test of adult lady bird beetle

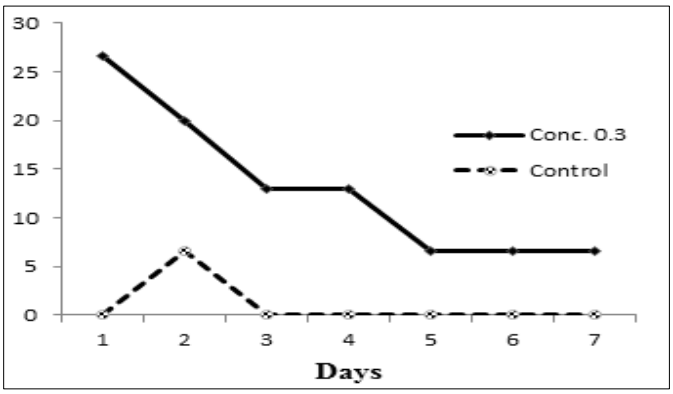

Fig 2.c: mortality test of adult lady bird beetle

Third mortality test results of adult lady bird beetle

3rd mortality test results in (Fig 3. a) showed that after the application of Imidacloprid @ 0.1% maximum mortality of ladybird beetle was (13%) at 2nd day while minimum (0%) was at 1st and 3rd day. While in case of control treatment maximum mortality % was (6.6%) at 4th and 5th day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.1% concentration as compared to control. As (df) = 1, (F) = 3.740389, (P-value) = 0.10128.

3rd mortality test results in (Fig 3. b) showed that after the application of Imidacloprid @ 0.2% maximum mortality of ladybird beetle was (13%) at 1st and 2nd day while minimum (0%) was at 5th, 6th and 7th day. While in case of control treatment maximum mortality % was (6.6%) at 1st and 2nd day.

Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.2% concentration as compared to control. As (df) = 1, (F) = 7.988706, (P-value) = 0.030099.

3rd mortality test results in (Fig 3. c) showed that after the application of Imidacloprid @ 0.3% maximum mortality of ladybird beetle was (20%) at 1st and 2nd day while minimum was at 7th day. While in case of control treatment maximum mortality % was (6.6%) at 4th day. Overall results showed that there is significant difference in mortality % of ladybird beetle on 0.3% concentration as compared to control. As (df) = 1, (F) = 13.16648, (P-value) = 0.010984.

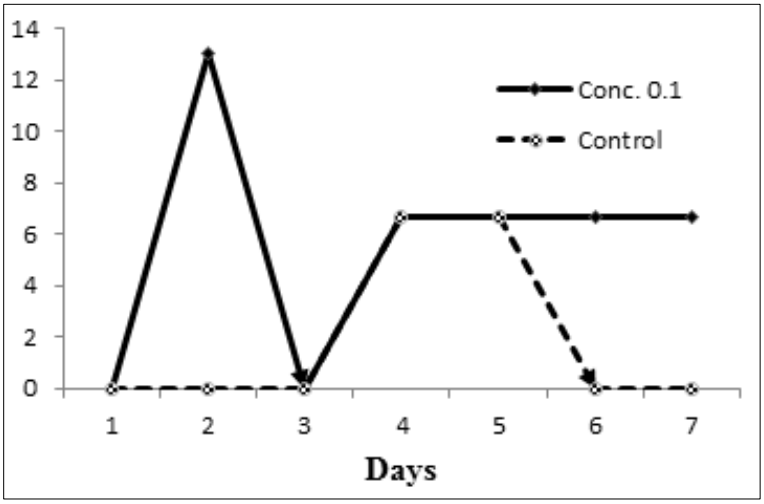

Fig 3.a: mortality test of adult lady bird beetle

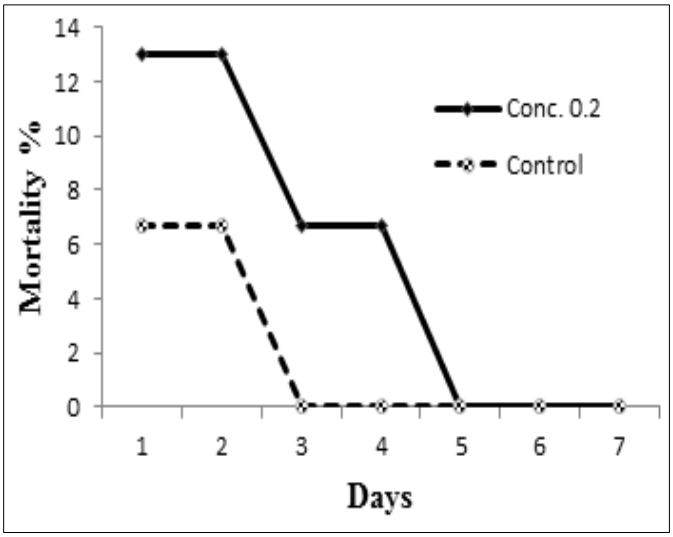

Fig 3.b: mortality test of adult lady bird beetle

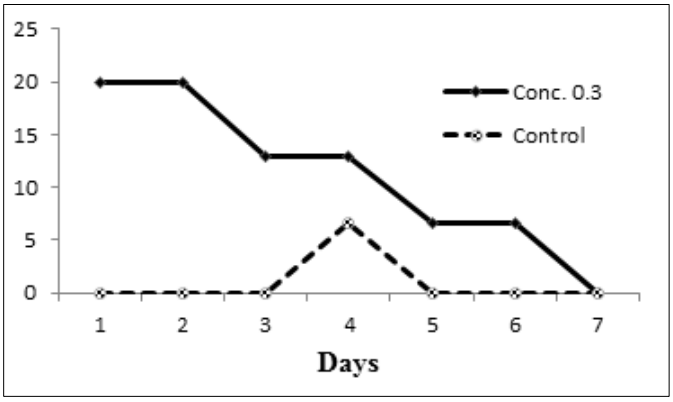

Fig 3.c: mortality test of adult lady bird beetle

Discussion

Some important predators Ladybird beetles (*Coccinella septempunctata*) are severely affected by the application of the different insecticides in the maize field crop. The present study was conducted under laboratory condition to check the effect of different concentration of the insecticide against ladybird beetle. Adult and grubs of ladybird beetle were found highly sensitive to the higher concentration of insecticide. Higher concentration in the field may have very detrimental consequences in the field after spray. Effect of insecticide reduced the predation capability of the ladybird beetle (*Coccinella septempunctata*) against the prey. Singh *et al.* (2004) [33] observed that efficiency of predation for both stages adult and grubs of (*Coccinella septempunctata*) were considerably reduced resulting in the meeting with insecticides treated prey. Our results were in agreement to the above study as predation efficiency decreased treated the prey with insecticides. Liu and Sengonca, (2002) [21] insecticides (GCSC-BTA) were not found much toxic against the ladybird beetle (*Coccinella septempunctata*) and other predators. It shows minimum mortality of the ladybird beetle and other predatory insects. Our study results were not in agreement to the above study as mortality was maximum for the predators when their prey treated with insecticides.

Meena *et al.* (2002) [24] described that the different concentrations of the azadiractin, endosulfan, malathion and karanji pongamiapinata pod extracts cause no detrimental effects and were found relatively safe to the Coccinella beetles and some other predators. Our study results were in contradiction to the above study as insecticides which used in present experiment cause high rate of mortality to the predators Coccinella beetles.

The use of lower concentration of insecticides were found to be increases the survival rate of Coccinella beetle and also help in the suppression of the population of aphid below ETL.

(Mann *et al.*, 1991; Oakley *et al.*, 1996) [23, 28]. Our study results were in agreement to the above study the lower concentration of insecticides decrease the mortality percentage of ladybird beetle.

Singh *et al.*, (2001) [33] described that insecticides extreme exposure may reduce the foraging capability and behavioral responses of the insects.

Carbosulfan was better as compared to pyrethroids group (imidacloprid) in controlling the aphid different species (Ahmad and Arif, 2008) [2]. In insecticide treated area there were minimum disturbance in the natural enemies population as *Coccinella septempunctata* and *Chrysoperla carnea* (Iqbal *et al.*, 2005) [15]. Our results were not in agreement to the above studies.

Conclusion

Mortality at lower concentration was lower while mortality increased with higher concentration revealing that predators were unaffected at recommended dose of fields.

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