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Review Article

Effect of insecticides on *Coccinella septempunctata* (Coleoptera; Coccinellidae); A review

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Abstract

Coccinella septempunctata is the generalist, representative predator that is potentially used as biological control agent in many crop pest management programs. A comprehensive and critical review of published and formerly unpublished studies was accomplished to evaluate the effects of insecticides such as imidacloprid, hexaflumuron, dimethoate, deltamethrin, pyriproxyfen, spinosad, lambda-cyhalothrin, bifenthrin, acetamiprid, fenazaquin, quinalphos and neemix on *C. septempunctata*. Data generated clearly indicates severe effects of used insecticides on its neurophysiological and behavioral responses indicating loss of co-ordination, paralysis as well as reduce fecundity, longevity and growth. Further studies are required to focus mainly on the measure to evaluate their real effects under field conditions

Keywords: *C. septempunctata*, Biological control agent, Predatory efficacy, Imidacloprid, Pyriproxyfen

Introduction

The name of coccinellids was firstly originated in Britain where they were commonly called 'Our Lady's bird' or the Lady beetle. They belong to family Coccinellidae of order Coleoptera (Samaha, 2010). There are approximately 6000 known species worldwide and out of which 300 species are found in Indo-Pakistan subcontinent (Akhavan et al., 2013; Rahatullah et al., 2010). Because of their predacious nature, about 90% of approximately 4,200 coccinellids species are known as beneficial. Family Coccinellidae represents six sub-families i.e. Coccinellinae, Chilocorine, Scymninae, Coccidulinae, Sticholotidinae and Epilachninae. Five sub-families (Coccinellinae, Chilocorine, Scymninae, Coccidulinae and Sticholotidinae) are predacious in nature but only one sub-family Epilachninae is phytophagus in nature (Singh and Bras, 2004; Ullah et al., 2012).

Coccinellids have distinctive striking appearance. They can be small upto 1 mm and not longer than 4-9 mm (Koren et al., 2012). Their body may be rounded, elongated, oval and flattened with different colors such as black, orange, red or straw color. They are successfully used in past in controlling many crop pests like aphids, leafhoppers, scale insects mites and other soft bodied insects (Slipinski, 2007). They are distributed all over the world including agro-ecosystems, plains, mountains, forests and grasslands (Urooj, 2016).

C. septempunctata

With family Coccinellidae, the most efficient natural enemy of crop pests is *C. septempunctata* that is potentially used as biological control agent (Hodek and Honek, 2009). Both larvae and adults of *C. septempunctata* are active predators and are highly polyphagus (Yu et al., 2014). Forster (1995) observed the data for insecticidal analysis on *C. septempunctata* and stated that seven-spotted ladybird beetle was the fifth best studied natural predator in insecticides registration framework in Germany.

Habitat

Coccinella septempunctata is a generalist ladybird, present in a wide range of plants and aphid infested crops for instance potato, corn leaf, green bug and pea. Aphids are plant feeders and are a main food source of *C. septempunctata*. *C. septempunctata* feeds on large number of aphids. Aphids damage the plants in several ways such as; they curl and deform the leaves, and stunt their shoots as well as they affect plants as viruses (Raboudi et al., 2002; kaits et al., 2007).

Reproduction and Development

The female of *C. septempunctata* laid their eggs on the surface of leaves that are elongated and oval shaped. The eggs take about four days to hatch and as the eggs hatch; they give rise to four sequential stages of instar larvae before they develop into pupa. The fourth instar larvae are more insatiable than the other instar larvae (Solangi et al., 2007). At high temperature, it develops into light orange pupae. Contradictory, at low temperature it develops into dark-brown or blackish pupae. The adults of *C. septempunctata* are red in color and possess seven black spots on their body (Majerus and Kearns, 1989).

Integrated Pest Management (IPM)

Smith and Van den Bosch was the first to use the term "Integrated Pest Management". IPM is a broad methodology to control pests by using other living organisms known as natural predators (Ehler, 2006). Integrated Pest Management can decrease the dependence upon insecticides that are used to control many insect problems. Moreover, coccinellids have been successfully organized in various integrated management programs and biological control programs against many insect pests on different crops (Ahmed et al., 2016).

Insecticides: Insecticides are toxic chemicals which are used for preventing, destroying, controlling or modifying any pest. Insecticides not only affect the nervous system of insect pests but also harm their exoskeleton (NPIC). Several insecticides are introduced in the market for instance organophosphates (OP) were introduced from 1960s to late 1980s (Akhtar et al., 2009). Insecticides vary in their activity i.e. they are neurotoxins, respiration inhibitors, growth inhibitors and regulators and stomach poisons. The most commonly used insecticides are imidacloprid, hexaflumuron, dimethoate, deltamethrin, pyriproxyfen, spinosad, lambda-cyhalothrin, bifenthrin, acetamiprid, fenazaquin, quinalphos and pimicarb. They are applied in different doses: LC_{50} (Median lethal concentration), LD_{50} (Lethal median dose) or EC_{50} (Median effective concentration) to arthropods (Sánchez-Bayo, 2012).

Effect of Imidacloprid

Imidacloprid is a systematic neonicotinoid, used to control different insects e.g. aphids, whiteflies, termites, fleas, soil insects and some beetles. It affects neurophysiological responses in terms of lack of co-ordination, shocks and cause paralysis in insects (Papachristos and Milonas, 2008). Imidacloprid, a broad-spectrum insecticide, has gained registration in almost 120 different countries (Drobne et al., 2008). Imidacloprid has greater ability to control pest insects when applied in the form of foliar sprays, microcosm or by treating glass plates (Tan et al., 2012). According to Bozsik (2006), imidacloprid appears to be harmless for *C. septempunctata*.

a) Effect on Egg Production

In control microcosm test, on exposure to highest concentration of imidacloprid, the numbers of egg production were reduced for the females. From the control microcosm, the hatching percentage of eggs from females was on normal 87.1%. But on exposure to highest application of imidacloprid, the hatching percentage of egg was decreased to 75.2% for females. The egg hatching rate decreased with increasing the imidacloprid application (Yu et al., 2014).

b) Effects on 2nd instar Larvae

In long-term microcosm toxicity test, single application of imidacloprid causing 50% affects. Mortality in the control group was observed and only 62.5% of control individuals had persisted. In short-term toxicity test, second instar larvae were not affected at all and mortality in the control group was not examined (Yu et al., 2014). According to Yu et al., (2014) higher rate of imidacloprid delayed the development of second and third instar larvae.

c) Effects on 4th instar Larvae

After current application of sub-lethal dose of imidacloprid (LD_{10}) on the fourth instar larvae considerably affected the weight of adult ladybird beetle. On exposure to imidacloprid, the feeding behavior of fourth instar larvae of seven spotted ladybird beetle was reduced. As a result, mortality was greater, development and weight was reduced, pupae and adult size was smaller (Yu et al., 2014).

d) Effect on Survival Rate

In long-term laboratory microcosm test, Yu et al., (2014) observed that, survival rate of *C. septempunctata* larvae was started to decrease from second day after single imidacloprid application.

e) Effect on Feeding Behaviour

According to a hypothesis, imidacloprid may affect the capability of F1 insects by decreasing the activity of their parents. After ladybird beetles being exposed to sub-lethal concentrations of imidacloprid then they were not capable to feed appropriately (Ramirez-Romero et al., 2008; Han et al., 2010). After the application of imidacloprid, *C. septempunctata* showed longer developmental period (from fourth instar larvae to adult), decreased aphid consumption rates as well as adult weight (Skouras et al., 2017).

Effect of Hexaflumuron

Hexaflumuron is a benzoylphenyl urea-type insecticide and an insect growth regulator (IGR) that affects the insect's endocrine system, inhibit growth, disrupts molting and cuticle formation as well as affects the development of seven spotted ladybird beetle (Dhadialla et al., 1998). Hexaflumuron is commonly used insect growth regulator in China with 120 products and have been registered as first active ingredient as reduced-risk insecticide (Yu et al., 2013).

a) Effect on Egg Production: The females produced 1,042 eggs and the number of eggs reduced with increasing the concentration of the hexaflumuron mainly at the two highest application levels (Yu et al., 2013).

b) Effect on Egg Hatching: The percentage of egg hatching was on normal 88.3%. But on exposure to highest concentration of hexaflumuron, the percentage of egg hatching was reduced to 76.9%. By increasing the concentration of hexaflumuron at various levels the mean egg hatching percentages were 88.0, 88.7, 86.1 and 83.57 (Yu et al., 2013).

c) Effects on Larval stages

The long-term toxicity test yield the LR_{50} (304 g a.i. ha^{-1}) for the 2nd instar larvae of ladybird beetle on exposure to single treatment of hexaflumuron and the application rate causing 50% deaths among larvae of *C. septempunctata*. It is effective in immature stages and restrict with chitin synthesis at the time of shedding (Desneux et al., 2007). Highest application of hexaflumuron was related with larger delays in developmental period of *C. septempunctata* (from second instar to next generation). In the controls, the total developmental period of *C. septempunctata* was 28.43 days. On exposure to highest treatment level of hexaflumuron, the time was about of 1.15 longer than in the control. At the highest treatment level, the development times of second (2.60), third (2.90), fourth instar larvae (5.77), the pupae (6.80) and the total generation (32.75) were all considerably longer than the controls (Yu et al., 2013).

d) Effect on Pupal Stage

Yu et al., (2013) examined that concentration up to 1.52 g a.i. ha^{-1} of both control and hexaflumuron resulted in 100% pupation. The mean pupation percentage that received in the test systems was 3.04 g a.i. ha^{-1} and reduced to 88.9% (considerably not different from the control group) and at the maximum application rate, the mean pupation percentage was 73.80% (considerably different from the control group.

e) Effect on Adult Emergence

In the controls and two highest application rates of hexaflumuron, the emergence of ladybird beetle was 100%. On the other hand, in the control test systems and three highest application rates of hexaflumuron, the mean emergence percentages of *C. septempunctata* were 96.7, 95.8, and 94.4%, respectively, although not considerably different from the controls (Yu et al., 2013).

g) Effect on Survival Rate

In test period (0-21 days) performed by Yu et al., (2013), the survival rate of larvae of seven spotted ladybird beetle was affected and decreased from 2nd day after single hexaflumuron application. On 6-day, rate of survival was reduced to 83.3 and 76.7% respectively. At the end of 21day, the survival in the blank control was 96.7%. But at the concentration of 6.08 g a.i. ha^{-1}, survival was 53.3%. He concluded that, effect of hexaflumuron on the survival rate of *C. septempunctata* was larger.

Effect of Dimethoate

Dimethoate is an organophosphorous and used for the control of substantial number of insects such as whiteflies, aphids, mites and plant hoppers. Due to more efficacy and rapid environmental degradation, dimethoate is used in urban areas and agriculture across the world (Mirajkar et al., 2005). Singh (2001) used dimethoate (organophosphate) under laboratory conditions and observed comprehensive locomotory responses in seven spotted ladybird beetles. Dimethoate suppressed the locomotion of *C. septempunctata* and interrupts the normal behavior pattern of seven spotted ladybird beetle.

a) Effect on Locomotory Behaviour

Thornham et al. (2007) reported that male *C. septempunctata* travel more distance than they did in control group, during individual walking events conducted on substrates Al treated with dimethoate. It was observed by Singh (2001) that dimethoate treated AI increased the locomotion of *C. septempunctata*.

b) Time Spent on Walking and Resting

In an experiment it was found that, when upper half of the plant was treated with dimethoate then *C. septempunctata* spent greater period on lower half of the plant. *C. septempunctata* spent greater period walking than on the controls ($F_{4,119} = 9.52$, $P < 0.01$) and spent much time resting on dimethoate treated plants. When upper lower half of the plant was treated with dimethoate then seven spotted ladybird beetles spent much time resting on lower half of the plant than the upper and successful treatments (Singh, 2001).Under laboratory conditions, Singh (2001) noted considerable modifications among treatments of dimethoate regarding to time spent on different parts of the plants ($F16, 342 = 2.647$, $P < 0.0$). When dimethoate applied to the upper half of the plant (apex), then seven spotted ladybird beetles spent less time on the upper half of the plant (LSD $P < 0.05$). On the other hand, when dimethoate applied to the lower half of the plant then, coccinellids spent greater period on upper half of the plant.

c) Time Spent on Stem

Coccinellids spent more time on the stem on dimethoate treated plants and much less time on the control plants (LSD $P < 0.05$). Coccinellids spent considerably much on leaf margins than those on the apex and lower treated plants (Singh, 2001).

d) Predatory Efficacy

Thornham et al., (2007) observed that, predatory efficacy of larvae and adults of *C. septempunctata* were decreased considerably on exposure to dimethoate residues and treated prey.

Effect of Deltamethrin

Deltamethrin is a pyrethroid that kills insects on exposure and through stomach action. However, deltamethrin is a broad-spectrum insecticide and promptly affect the nervous system of insects (Tomlin, 2006; Rehman et al., 2014).

a) Effect on Walking Behavior

In an experiment, for five days the walking behavior of *C. septempunctata* was observed between deltamethrin treated (36 and 82%) plot and untreated plot (14-58%). Observations of seven spotted ladybird beetle resting behavior considered for between 12 and 60% in the treated plot; 38 and 85% in the untreated plot. It was reported that, *C. septempunctata* are present at the tip of plants because aphids feed on the apex of the plant (Majerus and Kearns, 1989). On exposure to deltamethrin residues, reorganization of seven spotted ladybird beetle from the lower end of the canopy toward the ground was observed. This relocation increased walking behavior and reduced food accessibility. First three days after spray, fewer *C. septempunctata* were examined on the upper surface of plant than the lower surface. This may show that deltamethrin causes short-term irritant effect. On 1st, 2nd and 3rd day, the difference in the behavior pattern of ladybird beetles indicate that ladybird beetles walked considerably more often in the plots treated with deltamethrin than those on the untreated. The walking behaviour of adult Coccinella septempunctata becomes stronger and resting was reduced on exposure to deltamethrin (Wiles and Jepson, 1994).

b) Effect on Grooming Behavior

The seven spotted ladybird beetles were observed to groom considerably more regularly in the treated plot on day 1 and on day 1 to 4 and feed less frequently than those in the plot not treated with deltamethrin (Wiles and Jepson, 1994).

The adult behavior of *C. septempunctata* was affected when contact to deltamethrin. On exposure to deltamethrin, grooming of *C. septempunctata* become stronger however, they stimulated toward the lower part of the shelter (Wilis and Jepson, 1994). According to Bozsik (2006), deltamethrin seems to be moderately harmful to seven spotted ladybird beetles and causes greater mortality from 1st to all larval instars of ladybird beetles.

Effect of lambda-Cyhalothrin

Lambda-cyhalothrin is a synthetic pyrethroid and similar to natural insecticide pyrethrin (Muhammad, 2009). Lambda-cyhalothrin affects the nervous system and cause paralysis or death (Tomlin, 1997).

a) Effect on Locomotory Behaviour

It was observed that lambda-cyhalothrin AI treatment reduced the locomotion in seven spotted ladybird beetles. In response to lambda-cyhalothrin PP but not the AI treatment, large locomotory changes were detected (Thornham et al., 2007).

b) Mortality Rate

Lambda-cyhalothrin seems to be moderately harmful to *C. septempunctata* adult because of acute surface contact effects (Bozsik, 2006). In an experiment, lambda-cyhalothrin was moderately harmful according to their LT_{50} values. Lambda-cyhalothrin act as axonal poison and is sodium channel modulator (Bozsik, 2006).

The efficacy of lambda-cyhalothrin on coccinellids population may demonstrate that, the effect of insecticide pressure and their susceptibility to certain insecticides are similar across the world (Sterk et al., 1999).

Effect of Pyriproxyfen

Pyriproxyfen is an insect growth regulator that affects enormous number of insects such as fleas, cockroaches, ticks, ants, carpet beetles and mosquitoes. Pyriproxyfen is influenced by juvenile hormone so that it mainly affects young insects and eggs and restricts their growth (Hallman et al., 2015).The toxicity of pyriproxyfen against third instar and adult of *C. septempunctata* was estimated at three and seven days post treatment interval. At 3-day post treatment interval, pyriproxyfen was moderately safe against 3rd instar and adults of *C. septempunctata* as the LC_{50} value of pyriproxyfen was lower than their field recommended dose. Moreover, at 7-day treatment interval, pyriproxyfen was moderately safe against 3rd instar and adults of *C. septempunctata* as the LC_{50} value of pyriproxyfen was lower than their field recommended dose. The result is that, pyriproxyfen would be used where ladybird beetle was used for the controlling of whiteflies and jassids (Asrar et al., 2014).

It was observed that pyriproxyfen had no side-effects on adult *C. septempunctata*. According to Olszak et al., (1994), in Poland pyriproxyfen had minimal impact on the adult of seven spotted ladybird beetle. According to Bozsik (2006), pyriproxyfen found to be safe for adults of *C. septempunctata*. Asrar et al. (2014) suggested that pyriproxyfen has less lethal effect on *C. septempunctata*.

Effect of Spinosad

Spinosad is first active ingredient as well as broad-spectrum insecticide, belongs to chemical group naturalyte. Due to high efficacy, spinosad has low use generally. Spinosad residue on plant vegetation found to be harmless to foraging honeybees and has less effect on beneficial arthropods such as *C. septempunctata*. Spinosad expressed as solid or liquid (DWO).Under laboratory conditions, toxicity of different insecticides applied under various water levels against *C. septempunctata* was observed after 96 hours of three treatments. Spinosad (30.00%) found to be less toxic against seven spotted ladybird beetles after 96 hours of application. Moreover, it was found that low application of water 2ml/lit caused higher mortality of predators (72.86%). On the other hand, toxicity of different insecticides under various water levels against *C. septempunctata* was also evaluated after one week of their treatment. After one week of their treatment, all insecticides including spinosad (38%) increase their toxicity to predators and causing greater mortality as compared to 96 hours of their treatment. Moreover, it was further found that insecticides with low application of water caused higher mortality of *C. septempunctata* (84.29%) and insecticides applied with high application of water (2ml/5liter) caused less mortality of seven spotted ladybird beetle (Solangi et al., 2007).Spinosad possess impartial effect on the Coccinellidae population. In an experiment, during the dose of first week spinosad highlighted moderately toxic effect and in the second week presented neutral effect (Singh et al., 2004).

Effect of Bifenthrin

Bifenthrin is an insecticide, belongs to pyrethroid family of chemicals and similar to natural insecticide pyrethrin. Bifenthrin affects the nervous system and kills arthropods through stomach action (ingestion). Bifenthrin is more toxic to insects than mammals because mammals have larger body size, higher body temperature and low sensitivity of the ion channel sites (Bradberry, 2005).

Skouras et al.(2017) evaluated the LD_{50} values for all larval instars (first, second, third and fourth) from the Kalamata population and Argos respectively. The effect of bifenthrin on seven spotted ladybird beetle larvae was different on exposure but bifenthrin was proved to be more toxic and caused high mortality to all larval instars of seven spotted ladybird beetle. The susceptibility of first instar larvae to bifenthrin was greater due to larval weight. Moreover, larval weight increases from first to fourth instar larvae and resistant factor between Kalamata and Argos population for fourth instar larvae was 4.49 and 2.19.

Under laboratory conditions, toxicity of bifenthrin applied under various water levels against *C. septempunctata* after 96 hours of three treatments was observed. Bifenthrin (56%) was found to be toxic against seven spotted ladybird beetles after 96 hours of application. On the other hand, toxicity of different insecticides under various water levels against *C. septempunctata* was also evaluated after one week of their treatment. After one week of their treatment, all insecticides including bifenthrin (76%) increase their toxicity to predators and causing greater mortality as compared to 96 hours of their treatment. Moreover, it was further found that insecticides with low application of water caused higher mortality of *C. septempunctata* (84.29%) and insecticides applied with high application of water (2ml/5liter) caused less mortality of seven spotted ladybird beetle (Solangi et al., 2007).

Effect of Acetamiprid

Acetamiprid also known as ethanimidamide is an insecticide belongs to neonicotinoid. It interrupts the function of nervous system of insects thereby, causing paralysis (USEPA).

It was observed that acetamiprid was less toxic to seven spotted ladybird beetle larvae. But according to Youn et al. (2003) acetamiprid caused 100% mortality at 40 mg a.i. /L. Further he noticed that fourth instar was more susceptible to acetamiprid than the second, third and fourth instar respectively. In a laboratory bioassay, performed by Asrar et al. (2014) residual toxicity of different insecticides including acetamiprid against *C. septempunctata* at 3 and 7 days post interval was determined. At 3-day post treatment interval, acetamiprid (neonicotinoid) was toxic against 3rd instar larvae and adults of seven spotted ladybird beetles as the LC_{50} values of acetamiprid were lower than their field recommended doses. Moreover, acetamiprid was toxic against third instar and adults of *C. septempunctata* at 7-day post treatment interval.

Effect of Fenazaquin and Quinalphos

Fenazaquin is an insecticide and miticide belongs to chemical class Quinazoline. It is used to control mites and insects mainly whiteflies and quinalphos is also used to control pests (U.S. EPA 2007).

Ahmad and Ahmad (2009) reported the comparative toxicity of two insecticides to adults of *C. septempunctata*. Quinalphos and fenazaquin was applied with different concentrations. For each spray one ml of each insecticide concentration was applied. The percentages were recorded after 24, 48 and 72 h as well as toxicity of quinalphos and fenazaquin was also recorded.

The two insecticides (quinalphos and fenazaquin) were proved to be highly toxic to adults of *C. septempunctata*. The fenazaquin with LC_{50} (0/0123055%) value was found to be highly toxic against adults of *C. septempunctata* in 72h and lower and upper fiducial limits were found to be 0.00740146 and 0.0204589, correspondingly at 95% confidence. Contradictory, the quinalphos with LC_{50} (0.0453297%) value was found to be moderately toxic against adults of *C. septempunctata* in 72h and lower and upper fiducial limits were found to be 0.0301508 and 0.0681241 and, correspondingly at 95% confidence. According to Thomas and Phadke (1991), quinalphos was proved to be less toxic from first instar to adults of the Coccinellids than chlropyrifos but Shukla et al., (1994) proposed that it was found to be toxic to seven spotted ladybird beetles.

Effect of Neemix

Neemix, a neem insecticide, is used to control pea aphid (Stark and Rangus, 1994). The azadirachtin is the principle active ingredient in neem and found to be oxidized limonoid (Mordue and Blackwell, 1993). Azadirachtin affects chemoreceptors of insects in several ways such as, prevent feeding and oviposition as well as affects overall fitness. 1000 ppm azadirachtin and 250 ppm azadirachtin and 30% neem oil was reported by Kaethner (1991) and on exposure to dried residues on bean plants those two neem insecticides caused no damage to the eggs, second instar or adults of seven spotted ladybird beetle. On the other hand, neem was considered to be toxic, causing mortality and morphogenetic deficiencies to seven spotted ladybird beetles on direct sprays.

Kaethner (1991) identified that neem insecticides may be harmless to seven spotted ladybird beetles on the basis of criteria developed by the International Organization of Biological Control (IOBC) thereby, causing less mortality (30%) in laboratory studies (Hassan, 1992). Kaethner (1991) reported that the addition of neem oil to 1000 ppm azadirachtin and 250 ppm azadirachtin did cause greater morphogenetic abnormalities but did not cause greater mortality. At LC_{50} (1,120 ppm), Neemix was considered to be more toxic to fourth instars.

At the time of larval stage of untreated insects, two hormones are produced such as ecdysone and juvenile hormone and these are carefully balanced during all larval stages. But at the time of final instar, the level of juvenile hormone decreases, causing ecdysone level to surge (Rosomer and Stoffolano, 1994). Azadirachtin, an active ingredient, affects the normal concentration of ecdysone and juvenile hormone. At LC_{50}, toxicity studies of adults show that Neemix is not toxic to *C. septempunctata* (Kaethner, 1991). Individual-level bioassays of one life stage are very beneficial for gaining information on the total effect of insecticides (Cairns, 1983) but according to Stark and Wennergren (1995) when difference in the susceptibility of life stages was present then total risk of a insecticides could not be assessed by observing one life stage. Further results suggest that it is necessary to observe complete life stage (from first instar to adult) of a species to evaluate the entire risk of insecticides (Banken and Stark, 1997).

Table - 1: Characterization of relative toxicity of insecticides on *C. septempunctata*

Insecticides Common Name	Chemical Group	Toxicity Class	References
Imidacloprid	Neonicotinoids	Toxic	(Yu et al., 2014)
Hexaflumuron	Benzoylureas	Toxic	(Yu et al., 2013)
Dimethoate	Organophosphate	Safe	(Singh et al., 2001)
Deltamethrin	Pyrethroids	Toxic	(Wiles and Jespon, 1994)
Lambda-cyhalothrin	Pyrethroids	Toxic	(Bozsik, 2006)
Pyriproxyfen	Pyriproxyfen	Safe	(Asrar et al., 2014)
Spinosad	Naturalyte	Toxic	(Solangi et al., 2007)
Bifenthrin	Pyrethroids	Toxic	(Solangi et al., 2007)
Acetamiprid	Neonicotinoids	Toxic	(Skouras et al., 2017)
Fenazaquin	Quinazoline	Highly Toxic	(Ahmad and Ahmad, 2009)
Quinalphos	-	Highly Toxic	(Ahmad and Ahmad, 2009)
Neemix	-	Safe	(Kaethner, 1991)

Conclusion

Insecticides and their natural enemies i.e. *C. septempunctata* are used for controlling pests mainly aphids meanwhile; these insecticides have severe effects on the biological and physiological processes of *C. septempunctata*. The effects of insecticides on natural enemies' especially *C. septempunctata* should be carefully taken into considerations when they are incorporated into IPM programs. Many scientists have performed appreciable experimental work to evaluate the toxic effects of different insecticides on *C. septempunctata*. Further research is also required to gain more knowledge to prevent *C. septempunctata* from the harmful effects of insecticides

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