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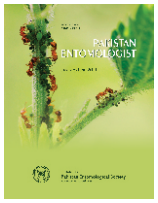

LABORATORY BIOASSAY FOR DETERMINATION OF RESIDUAL TOXICITY OF DIFFERENT INSECTICIDES AGAINST TWO PREDATORS, *CHRYSOPERLA CARNEA* (CHRYSOPIDAE: NEUROPTERA) AND *COCCINELLA SEPTEMPUNCTATA* (COCCINELLIDAE: COLEOPTERA)

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ABSTRACT

A laboratory bioassay was conducted for the determination of residual toxicity of different insecticides against two predators, *Chrysoperla carnea* (Chrysopidae: Neuroptera) and *Coccinella septempunctata* (Coccinellidae: Coleoptera). The results revealed that all of the evaluated insecticides, except Rapid®, Refree® and Novastar®, proved safe for 3rd instar larvae of *C. carnea* as well as for both 3rd instar larvae and adult *C. septempunctata* when releases were made at 7 days post treatment intervals. It can be concluded on the basis of present results that Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® would be used where *C. carnea* and *C. septempunctata* are used for the management of soft bodied insect pests like whitefly, jassid, aphids etc. The releases of *C. carnea* should be made 7 days post treatment of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® for its better performance.

Keywords: Cotton agro-ecosystem, Insecticides, Predators, Residual toxicity

INTRODUCTION

In Pakistan, whitefly has become a dangerous cotton pest and has the potential of destabilizing cotton production. It damages the cotton plant by sucking cell sap ensuring 50% decrease in boll yield (Ashfaq *et al.*, 2010) and by transmitting vector of leaf curl virus disease (CLCV) (Ahmad, 1999), which is great threat to our cotton-based economy (Amjad *et al.*, 2009). It transmits more than hundred plant viruses belonging to Begomovirus (Geminiviridae), Grinivirus (Closteroviridae) and Carlavirus (Potyviridae) (Jones, 2003). A severe infestation of whitefly decreases production (Chu *et al.*, 2001) and contaminates leaves and lint with honeydew that not only promotes development of sooty moulds (Byrne *et al.*, 1990) but also makes the leaves and fibers stick and blackish. The blackish leaves devoid of the ability of performing photosynthetic activity; whereas, the sticky and black lint becomes unfit for sale in the local as well as international market (Denholm and Birnie, 1990). Whitefly transmitted CLCV disease affected 554000 acres of cotton and caused 20.7% decrease in bales production in 1993 (Govt. of Punjab, 1995). The production of cotton was reduced from 11.42 million bales in 1991 to 8.29 in 1992 and further down to 6.52 million bales in 1993 due to spread of CLCV by whitefly (Khan and Ullah, 1994). Its several biological features, including multivoltinism, wide host range, migratory and dispersal potentials, high reproductive rate, adaptiveness to high temperature, potential to transmit many destructive plant viruses and ability to acquire resistance to wide classes of insecticides have made it very destructive pest of many crops (Ellsworth and Jones, 2001).

Many efforts have been reported for the management of *B. tabaci* using predators and parasitoids (Onillon, 1990). But the researchers are facing a lot of issues while using natural enemies in IPM of whiteflies (Oliveira *et al.*, 2001). Predators of whiteflies belong to 9 orders and 31 families (Nordlund and

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Legaspi, 1996). Most of the predators of *B. tabaci* are beetles (Coccinellidae), true bugs (Miridae, Anthocoridae), lacewings (Chrysopidae), mites (Phytoseiidae) and spiders (Araneae) (Gerling *et al.*, 2001). *Chrysoperla carnea* Stephens is one of the important predators and has been relatively suppressed due to pesticides use on several crops (Shalaby, 2012). Its larvae are voracious and efficient predators for various phytophagous arthropods (McWen *et al.*, 2001). One larva of *C. carnea* can consume as many as 500 aphids in its life. *Chrysoperla carnea* plays an important part in biocontrol of many small soft bodied homopterous pests (Michaud, 2001). Performance of this predator against different insect pests on different crops has been evaluated by several researchers (El-Khouly, 2006; Shalaby, 2012). *Coccinella septempunctata* L. (CSL) commonly called lady bird beetle is a potential predator of soft bodied insects like aphids, whiteflies, jassids and small lepidopterous larvae and can be used for the biological control of *T. tabaci, T. vaporariorum* and thrips in a greenhouse (Solomon, 1949; Victor, 1997; Deligeorgidis, 2005).

Chemical control is the most effective tactic for the management of cotton insect pests, but it should only be used as last option (Amjad *et al.*, 2009), judiciously in combination with proper spray technology and only when economic threshold levels approaches to reduce pesticide loads (Bakhetia *et al.*, 1996). A large number of insecticides have been used for the management of insect pest complex of cotton (Ashfaq *et al.*, 2010). Such insecticides include neonecotinoids (Abbas *et al.*, 2012), pyrethroids and organophosphate insecticides (Attique and Rashid, 1983) and IGRs (Ishaaya and Horowitz, 1995). New chemistry insecticides against insect pest complex of cotton have also been reported by several Pakistani researchers (Amjad *et al.*, 2009). But the residual effects of such insecticides on whitefly predators like *C. carnea* and *C. septempunctata* have not been explored. The present study was carried out in the laboratory to investigate whether the insecticides used in cotton against whitefly or other sucking insect pests are lethal or not.

MATERIALS AND METHODS

Mass rearing of *C. septempunctata*

The population of *C. septempunctata* was mass cultured on the artificial diet as described by Sarwar and Saqib (2010). Wild population of adult *C. septempunctata* was collected from wheat field and released into the rearing cages of dimension 4 x 4 x 4 ft^3. The rearing cages were also provided with folded papers for egg deposition by the female *C. septempunctata*. The eggs deposited by the females on the walls of cages were removed and collected by camel hair brush; while the papers with eggs deposited by females were cut into small pieces. The eggs thus collected were placed on sterilized and moistened blotting paper kept in petridish. The petridishes with eggs were then placed inside the incubator maintained at 28±1°C and 65% RH. The petridishes were observed daily and newly emerged grubs were removed instantaneously from the petridish and shifted to new petridishes with camel hair brush. These petridishes with grubs were provided with 5 g dietary media described by Sarwar and Saqib (2010). The grubs were observed daily till molting. After each molting the grubs were shifted to new petridish having 5 g of dietary media. The pupae formed were separated into petridishes and kept under observation till the adults. Following this methodology, the mass culture of *C. septempunctata* was maintained in the laboratory.

Acquisition of the required stages of *C. carnea*

The required stages (3rd instar) of *C. carnea* were acquired from the biocontrol lab of Entomological section, Nuclear Institute for Agriculture and Biology, Faisalabad.

Insecticides

Nine concentrations of each of ten available formulations of systemic insecticides (Table 1) recommended against sucking insect pests were bioassayed in the laboratory conditions against 3rd instar individuals of *C. carnea* as well as 3rd instar and adult individuals of *C. septempunctata* as described below.

Experimental layout and data collection

Laboratory bioassay of insecticides against two predators was conducted in the insecticides resistance laboratory of Entomological Research Institute, Ayub Agriculture Research Institute, Faisalabad during 2011. Leaves of highly infested plants with whitefly eggs and nymphs were picked from the field and brought into the laboratory. They were washed with spray of water and dried. The lower sides of the leaves were sprayed with different concentrations of ten selected insecticides and simple water by atomizer and shad-dried for 30 minutes. Leaf-disks of 6 inches diameter of the treated leaves were cut and set inside the petridishes. Ten 3rd instar individuals of each of *C. carnea* and *C. septempunctata* were released on the treated leaf-disks separately at two post treatment release intervals (release at 3 and 7 days post treatment intervals). Similar experiment was laid out for adults of *C. septempunctata* releasing its ten adults on treated leaf-disks separately at two post treatment release intervals (release at 3 and 7 days post treatment intervals). The petridishes were marked with the respective treatments and kept at laboratory conditions (30 ± 2°C, 60 ± 5% RH and 12:12 photoperiod). The experiment was laid out under Completely Randomized Design (CRD) and repeated thrice. The individuals were shifted from treated leaf-disks to untreated leaf-disks with whitefly young ones after 24 hrs. The number of predator individuals died three and seven days after shifting were counted and percentage corrected mortality was calculated using Henderson and Tilton formula (Henderson and Tilton, 1955), if mortality was observed in the control treatment.

Statistical analysis

The collected data regarding the mortality of 3rd instar individuals of *C. carnea* as well as 3rd instar and adult individuals of *C. septempunctata* were analyzed statistically using Probit analysis technique (Finney, 1971) to determine LD_{50}, chi-square (χ^2) and confidence interval values.

Table 1
List of insecticides used for bioassay against predators.

Pesticide (active ingredient)	Insecticide Brand		Field dose rate.	Labeled pests	Dose rates tested(ml, g/L)
	Trade name	Formulation			
Acetamiprid	Rapid®	50 WDG	50 g/acre	Whitefly and other soft bodied insects	9.6, 4.8, 2.4, 1.2, 0.6, 0.3, 0.15, 0.075, 0.0375.
Pyriproxyfen	Priority®	10.8EC	500 ml/acre	Whitefly, jassid, scale insects	80, 40, 20, 10, 5, 2.5, 1.25, 0.625, 0.3125
Thiacloprid	Talent®	480SC	125 ml/acre	Whitefly, Jassid, Codling moth, Aphid	20, 10, 5, 2.5, 1.25, 0.625, 0.3125, 0.15625, 0.078125
Fipronil	Refree®	5 SC	480 ml/acre	Whitefly and other soft bodied insects	7.68, 3.84, 1.92, 0.96, 0.48, 0.24, 0.12, 0.06, 0.03
Thiomethoxam	Actara®	25 WG	50 g/acre	Whitefly and other soft bodied insects	0.8, 0.4, 0.2, 0.1, 0.05, 0.025, 0.0125, 0.00625, 0.003125
Diafentiuron	POLO®	500 EC	200 ml/acre	Whitefly and other soft bodied insects	0.4, 0.8, 1.6, 3.2, 0.2, 0.1, 0.05, 0.025, 0.0125
Imidacloprid	Ascort®	70 WDG	75 g/acre	Jassid, aphids, thrips, whitefly	40, 20, 10, 5, 2.5, 1.25, 0.625, 0.3125, 0.15625
Imidacloprid	Confidor®	200 SL	250 ml/acre	Whitefly, jassid, and other soft bodied insects	0.5, 1.0, 2.0, 4.0, 0.25, 0.125, 0.0625, 0.03125, 0.0156
Nitenpyram	Pyramid®	10SL	200 ml/acre	Jassid, aphids, leaf hoppers, citrus psylla	32, 16, 8, 4, 2, 1, 0.5, 0.25, 0.125.
Abamectin + Bifenthrin	Novastar®	56 EC	300 ml/acre	Lepidopterous and soft bodied insects	0.15, 0.075, 0.0375, 0.01875, 0.3, 0.6, 1.2, 2.4, 4.8

RESULTS

Toxicity of insecticides against 3rd instar *C. carnea* at different post treatment intervals

The toxicity of insecticides evaluated against 3rd instar of *C. carnea* varied significantly when their releases were made at 3 and 7 days post treatment interval as none of the 95% fiducial limits against evaluated insecticides for 3rd instar overlaped each other (Table 2 & 3). When LC_{50} values of the insecticides were compared with their respective field recommended dose rates, it was found that Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® were comparatively safe; whereas, Rapid®, Refree® and Novastar® were toxic insecticides against 3rd instar larvae of *C. carnea* as the LC_{50} values of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® were higher and that of Rapid®, Refree® and Novastar® were lower than their respective field recommended doses when release of *C. carnea* were made 3 and 7 days post treatment interval (Table 2 & 3).

It was concluded from above results that all of the evaluated insecticides, except Rapid®, Refree® and Novastar®, proved safe for 3rd instar larvae of *C. carnea* when releases were made at 3 and 7 days post treatment intervals. Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® would be used where *C. carnea* are used for the management of whiteflies. The releases of *C. carnea* should be made 7 days post treatment of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® for its better performance.

Table 2
Lc_{50} values of different insecticides for 3rd instar of *C. carnea* 3 days post treatment.

Pesticides (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 (g/acre)	1.1 (4)	- 642.4		Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	4.6 (4)	1142.8	735.8 – 1474.8	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	4.2 (4)	682.8	541.9 – 850.3	Safe
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	10.3 (4)	- 93.1	- 966.1 – 38.4	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	6.5 (4)	973.8	796.2 – 1234.5	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	4.0 (4)	2083.9	1647.9 – 2982.8	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	5.6 (4)	2519.7	1958.8 – 3758.3	Safe
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	1.7 (4)	778.9	654.7 – 898.2	Safe
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	4.1 (4)	735.9	609.4 – 889.6	Safe
Novastar® (abamectin + bifenthrin)	Evermictin+Pyrethroid	300 ml/acre	2.2 (4)	- 652.4	-558.2 – 56.2	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

Table 3
Lc_{50} values of different insecticides for 3rd instar larvae of *C. carnea* 7 days post treatment.

Pesticide (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 g/acre	14.4 (4)	20.9	[illegible]	Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	2.1 (4)	2800	2033.2-5022.2	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	1.9 (4)	2294.7	1718.2-3768.2	Safe
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	11.3 (4)	399.7	-157.1 – 672.9	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	3.1 (4)	2623.1	1923.5 – 4570.7	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	1.9 (4)	3603.5	2514.9 – 7343.6	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	2.8 (4)	3900.3	2689.2 – 8348.7	Safe
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	13.8 (4)	693.2	303.4 – 1394.5	Safe
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	1.6 (4)	2549.3	1869.3-4443.3	Safe
Novastar® (abamectin + bifenthrin)	Evermictin+ Pyrethroid	300 ml/acre	12.6 (4)	43.1	-458.9 – 170.3	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

Toxicity of insecticides against 3rd instar and adult *C. septempunctata* at different post treatment intervals

The toxicity of insecticides evaluated against 3rd instar as well as adult of *C. septempunctata* varied significantly when their releases were made at 3 and 7 days post treatment interval as none of the 95% fiducial limits against evaluated insecticides for respective released stage overlaped each other (Table 4, 5, 6 & 7). When LC_{50} values of the insecticides were compared with their respective field recommended dose rates, it was found that Priority®, Actara® and Polo® were comparatively safe; whereas, Rapid®, Talent®, Refree®, Ascort®, Confidor®, Pyramid® and Novastar® were toxic insecticides against 3rd instar larvae and adults of *C. septempunctata* at their field recommended doses when their releases were made at 3 day post treatment interval as the LC_{50} values of Priority®, Actara® and Polo® were higher and that of Rapid®, Talent®, Refree®, Ascort®, Confidor®, Pyramid® and Novastar® were lower than their respective field recommended doses (Table 4 & 5). However, at 7 days post treatment intervals, Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® were comparatively safe; whereas, Rapid®, Refree® and Novastar® were toxic insecticides against 3rd instar larvae and adults of *C. septempunctata* as the LC_{50} values of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® were higher and that of Rapid®, Refree® and Novastar® were lower than their respective field recommended doses (Table 6 & 7).

It was concluded from above results that all of the evaluated insecticides, except Rapid®, Refree® and Novastar®, proved safe for both 3rd instar larvae and adult of *C. septempunctata* when releases were made at 7 days post treatment intervals. Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® would be used where *C. septempunctata* are used for the management of whiteflies. The releases of *C. septempunctata* should be made 7 days post treatment of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® for its better performance.

DISCUSSION

Biological and chemical control tactics are often found incompatible in pest management system (Solangi *et al.*, 2007). That's why; conservation of entomophagous insect fauna through application of compatible and selective

Table 4
Lc_{50} values of different insecticides for 3rd instar of *C. septempunctata* 3 days post treatment.

Pesticide (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 g/acre	3.3 (4)	35.9	23.3 – 51.2	Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	12.1 (4)	623.4	592.4 – 678.4	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	3.2 (4)	99.1	73.9 – 118.2	Toxic
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	5.7 (4)	378.5	333.4 – 423.1	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	6.9 (4)	93.4	66.5 – 123.1	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	6.1 (4)	479.2	401.2 – 501.4	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	7.4 (4)	66.9	48.9 – 88.9	Toxic
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	9.4 (4)	188.9	159.9 – 210.6	Toxic
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	8.9 (4)	179.8	149.5 – 199.6	Toxic
Novastar® (abamectin + bifenthrin)	Evermictin+ Pyrethroid	300 ml/acre	5.8 (4)	156.9	133.7 – 178.6	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

Table 5
Lc_{50} values of different insecticides for adult of *C. septempunctat* 3rd days post treatment.

Pesticide (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 g/acre	4.7 (4)	44.9.9	33.3 – 62.3	Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	10.9 (4)	599.2	568.9 – 623.5	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	4.4 (4)	112.3	97.5 – 134.9	Toxic
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	6.2 (4)	4103	389.6 – 427.4	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	7.3 (4)	88.3	61.8 – 104.3	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	7.9 (4)	399.4	379.2 – 423.3	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	6.1 (4)	71.2	55.8 – 94.6	Toxic
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	8.2 (4)	214.7	195.4 – 236.7	Toxic
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	9.1 (4)	194.9	178.2 – 211.7	Toxic
Novastar® (abamectin + bifenthrin)	Evermictin+ Pyrethroid	300 ml/acre	7.2 (4)	210.7	188.9 – 22.7	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

Table 6
Lc_{50} values of different insecticides for 3rd instar of *C. septempunctat* 7 days post treatment.

Pesticide (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 g/acre	9.5 (4)	34.7	18.7 – 55.4	Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	1.9 (4)	3196.6	2546.8 – 3564.6	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	3.2 (4)	4435.2	4123.7 – 4654.8	Safe
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	7.4 (4)	416.7	356.8 – 487.6	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	5.7 (4)	3674.9	3293.8 – 3986.5	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	3.8 (4)	5674.2	5147.6 – 5935.5	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	1.7 (4)	6694.4	6385.3 – 7123.6	Safe
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	11.3 (4)	745.3	678.3 – 878.4	Safe
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	2.9 (4)	4544.8	4006.9 – 5178.3	Safe
Novastar® (abamectin + bifenthrin)	Evermictin+ Pyrethroid	300 ml/acre	10.7 (4)	167.9	101.5 – 219.6	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

Table 7
Lc_{50} values of different insecticides for adults of *C. septempunctat* 7 days post treatment.

Pesticide (active ingredient)	Type	FRD	χ^2(df)	LC_{50} (g, ml/L)	95% fiducial limits	Category
Rapid® (acetamiprid)	Neonecotinoid	50 g/acre	11.5 (4)	47.2	31.7 – 61.9	Toxic
Priority® (pyriproxyfen)	IGR	500 ml/acre	3.7 (4)	4088.4	3556.8 – 4783.3	Safe
Talent® (thiacloprid)	IGR	125 ml/acre	5.1 (4)	5445.7	4231.5 – 6265.7	Safe
Refree® (fipronil)	Phenylpyrzole	480 ml/acre	6.8 (4)	458.7	402.5 – 503.6	Toxic
Actara® (thiomethoxam)	Neonecotinoid	50 g/acre	7.1 (4)	5576.9	4898.5 – 6033.7	Safe
Polo® (diafentiuron)	Neonecotinoid	200 ml/acre	4.7 (4)	6012.4	5558.6 – 7012.8	Safe
Ascort® (imidacloprid)	Neonecotinoid	75 g/acre	2.9 (4)	4567.8	3486.9 – 5126.9	Safe
Confidor® (imidacloprid)	Neonecotinoid	250 ml/acre	10.6 (4)	901.5	821.4 – 1001.4	Safe
Pyramid® (nitenpyram)	Neonecotinoid	200 ml/acre	3.5 (4)	6012.7	5436.8 – 6873.7	Safe
Novastar® (abamectin + bifenthrin)	Evermictin+ Pyrethroid	300 ml/acre	13.5 (4)	245.7	195.3 – 324.7	Toxic

FRD = Field recommended doses; LC_{50} = Lethal concentration at which 50% individual die; χ^2 = Chi-squared value; df = degree of freedom

pesticides is the main criteria for integrated plant protection (Vogt, 1994). Among the naturally occurring biological control agents, the *C. carnea* and Coccinellid predators are most commonly occurring entomophagous insect predators which actively feed on soft bodied insects (Nadeem *et al*. 2011). A variety of insecticides being used in cotton agroecosystem against various insect pests were screened out by laboratory bioassay in this study at various post treatment intervals. All of the evaluated insecticides, except Rapid®, Refree® and Novastar®, proved safe for both 3rd instar larvae of *C.carne* when their releases were made at 7 days post treatment intervals. These results indicate that the residual toxicity of these insecticides persists for less than 7 days; that's why, the residual toxicity of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® becomes safer for *C. carne*. These results are in contradiction to the results of various researchers. For examples, Vogt (1994) documented moderately to extremely harmful toxic effect of insecticides against *C. carnea* larvae under field conditions. Paulian (1998) determined toxic residual effects of 28 pesticides against *C. carnea* under laboratory conditions. Singh and Varma (1986) reported toxic effect of endosulfan, phosalone, quinalphos, monocrotophos, phenthoate, fenitrothion, carbaryl, cypermethrin and fenvalerate against *C. carnea* larval 72-h post exposure interval. Nasreen *et al*. (2004) reported that among tested insecticides (Agrimec, Larvobt, Pirate, Thiodan, Larvin, Arrivo, Steward, Curacron and Tracer), Spinosad, Thiodicarb and Indoxacarb exhibited selectivity for *C. carnea* eggs, whereas, chlorfenapyr, cypermethrin and endosulfan were found moderately selective and profenofos was toxic to *C. carnea*. Nasreen *et al*. (2005) evaluated the residual toxicity of diafenthiuron, buprofezin, thiodicarb, imidacloprid, carbosulfan, methamidophos, acetamiprid and thiamethoxam against various stages of *C. carnea* and reported these insecticides as toxic against *C. carnea*. Nadeem *et al.* (2011) documented few eggs, pupae and larvae of *C. carnea* in insecticide treated cotton plots. Rezaei *et al.* (2007) reported that imidacloprid was found harmless (*E* = 27.44%); whereas, propargite (*E* = 49.78%) and pymetrozine (*E* = 66.9%) were slightly harmful. Our results also showed that Ascort (Imidacloprid) was safe to *C. carnea* at 7 days post treatment interval.

All of the evaluated insecticides, except Rapid®, Refree® and Novastar®, proved safe for both 3rd instar larvae and adult of *C. septempunctata* when releases were made at 7 days post treatment intervals. These results indicate that the residual toxicity of these insecticides persists for less than 7 days; that's why, the residual toxicity of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® becomes safer for the both predators. Gesraha (2007) also reported that Actara and Confidor were less toxic to *C. undecimpunctata* L. 7 days post treatment. The results of He *et al.* (2012), who reported that imidacloprid when applied systemically at field recommended dose for cotton exhibited no toxicity to *Serangium japonicum* and did not affect its functional response, also confirmed our results for imidacloprid. Arif *et al*. (2012) also reported Pyramid®, Advantage® and imidacloprid as safe insecticides against coccinellid predators and recommended these insecticides in agroecosystem where integration of insecticides and coccinellid-predators based IPM strategy is required. These results are also in agreement with the results of present study about Pyramid® and imidacloprid. In conclusion, Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® would be used where *C. carnea* and *C. septempunctata* are used for the management of whiteflies and jassids. The releases of *C. carnea* and *C. septempunctata* should be made 7 days post treatment of Priority®, Talent®, Actara®, Polo®, Ascort®, Confidor® and Pyramid® for its better performance.

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