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Research Article
Laboratory Evaluation of Some Insecticides Against the Adults of Stink Bug, *Coridius janus* (Dinidoridae: Heteroptera)

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Abstract

Background and Objective: Cucurbits are an important group of vegetables, which have great nutritional and medicinal value. However, stink bug (*Coridius janus*) is very destructive pest which significantly retards the production of cucurbit. There are many methods for the control (biological, chemical and cultural etc.) of bugs but the most effective method remains chemical control. **Methodology:** The prepared dilutions of acetameprid, imidacloprid and spinosad were evaluated in term of toxicity. A parallel control was also set for each insecticide. The experiment was conducted in Completely Randomized Design (CRD) with three replications. **Results:** The collected data was subjected to Probit analysis after converting the data into percent corrected mortality to determine LC_{50}. The LC_{50} value showed that imidacloprid had more toxicity after 12, 24, 48 and 72 h exposure, spinosad showed less toxicity after exposure of 48 h and acetameprid showed very less toxicity after the exposure of 72 h. **Conclusion:** By this study it is concluded that imidacloprid toxicity against the adults of stink bug (*Coridius janus*) is greater than acetameprid and spinosad.

Key words: Toxicity, acetameprid, imidacloprid, spinosad, cucurbits, stink bug, *Aspongopus janus*, *Coridius janus*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Among vegetables cucurbits, including; pumpkin, *(Cucurbita maxima* Pair), winter melon (*Benincasa hispida* Cogn), *Momordica charantia* (L.), snake gourd (*Trichosanthes cucumeria* L.), sponge gourd (*Luffa acutangula* Roxb) and *Cucumis sativus* etc. are considered to be an important group of vegetables, which are of great nutritional and medicinal importance. *Coridius janus* was the major pest of Cucurbitaceae family and caused great damage to its production. It is very destructive pest, which significantly reduced the yield of cucurbit (Abdullah, 1969).

During the 2011-2012, the overall performance of agriculture sector showed a growth of 3.1% largely owing to enlargement in agriculture-connected subsectors. Chief crops accounted for 31.9% of agricultural charge additional and knowledgeable increase of 3.2% in 2012 with 0.2% of unenthusiastic growth (Anonymous, 2012).

Dhillon *et al*. (2005) studies showed that bottle gourde (*Lagenaria vulgaris* Ser) locally known as kadu or lau contain carbohydrates, vitamins and minerals. While, the tender bottle gourd is used to prepare sweet dishes with sugar and milk. Bottle gourd production is more or less hindered by a number of insect pests. However, among them stink bug (*Coridius janus*) is one of the most important problem for the cucurbit vegetables and capable of causing 30-100% yield losses.

The biology of *Aspongopus janus* (*Coridius janus*) was studied by Sharma (1990). Investigation of Sharma (1990) showed that its population was abundant in summer (March-September) but in rare cases its population can be found in winter. The bugs were active in morning and in the evening but under the sunlight, they were sheltered under the leaves. Female laid eggs under the leaves, stems or other parts of host plants in the form of rows.

The persistence and rate of action of monocrotophos against adults of *Coridius janus* and 2nd stage larvae of *Epilachna dodecastigma* in pumpkin plants was studied by Aijaz and Baig (1983). They determined that the mortality of the insects increased with the passage of time. After a fixed interval of time, the death rate was rapidly increased in case of 2nd stage larvae of *Epilachna dodecastigma* as compared to mortality rate of *Aspongopus janus* (*Coridius janus*). The LD_{50} of monocrotophos can be obtained in 2, 3 and 10 days in case of *Epilachna dodecastigma*, when exposed for 1, 3 and 24 h, respectively. While in case of *Coridius janus*, it was up to 2, 6 and 9 days with same exposure duration (Aijaz and Baig, 1983).

Argente and Heinrichs (1983) studied the correlation between insecticide residual level and mortality of insects in the developing stages of rice grain and at harvesting stage. They also determined the relative toxicity of three insecticides, carbaryl (Sevin 85 WP), monocrotophos (Azodrin 16"8 EC and lindane (Agrocide 26 DP) to *Leptocorisa oratorius* (Fab.), (Hemiptera: Alydidae). Results of Argente and Heinrichs (1983) showed that monocrotophos was the most effective and carbaryl was ineffective against rice bug, while lindane provided control only for one day. The tolerance for monocrotophos was not established.

Misbahuddin and Ehteshamuddin (2000) studied the effect of lactate dehydrogenase on the *A. janus* (*Coridius janus*) and *D. cingulatus* to determine its effects after the treatment with sub lethal doses of the systemic insecticide and phosphamidon. Under chemical stress lectate dehydrogenase activity was increased, which suggested its role in the metabolism of carbohydrate in the above mentioned insects due to which more pyruvate converted into lactic acid.

Studebaker and Kring (2003) studies laboratory reared males, females and 3rd instar nymph (*Orius insidiosus*) by exposing them to the residues of 9 insecticides (spinosad, indoxacarb, imidacloprid, tebufenozide, methoxyfenozide, abamectin, emamectin benzoate, fipronil and λ-cyhalothrin). These insecticides were applied in the field of cotton plant, potted plants, green house and glass petri dishes in the laboratory. Spinosad, imidacloprid and indoxacarb showed significantly higher mortality with treated petri dishes than on untreated cotton plants in the field or greenhouse. There were no differences in mortality between fipronil or λ-cyhalothrin. While, imidacloprid was moderately toxic in the field and greenhouse, but was highly toxic in the petri dish bioassay. Spinosad was ineffective in the field or greenhouse bioassays, but it was also highly toxic in the laboratory. Indoxacarb had variable toxicity in the field and greenhouse and high toxicity in the petri dish bioassay.

The efficacy of trichlorofon and deltamethrin against alfalfa plant bug (*Adelphocoris lineolatus* (Goeze) (APB)) and plant bug named as Lygus bugs (Heteroptera: Miridae), which are the major insect pests of alfalfa in Canada (May *et al*., 2003). Trichlorofon effectively controlled the alfalfa plant bug; a kind of stink bug each year. *Lygus* spp. was controlled by both insecticides each year. But deltamethrin showed variation in the control of alfalfa plant bug. Deltamethrin also more affected the beneficial insects as compared to trichlorofon. So, the results proved that trichlorofon showed better performance in the whole study.

Among the sucking pests, complex of jassids (*Amrasca biguttula*, *Nephotettix virescens*, *Aconurella prolixa*, *Balclutha incise* and *Balclutha saltuella*) on leaves, true bugs (*Grapto stethus servus*, *Spilostethus pandurus*, *Aspongopus janus* and *Nezara viridula*) on flower buds and fruits and tree hoppers (*Otinotus oneratus*, *Leptocentrus taurus* and *Tricentrus* sp.) on apical shoot of ash were observed during 2nd week of November to 1st week of January (Chaudhary, 2013).

Iqbal *et al*. (2013) evaluated comparative efficacy of some insecticide like imidacloprid (Confidor 20% SL), (Acelan 20% SL), thiomethoxam (Actara 25 WG) and acephate (Commando 75 SP), against sucking insect pests on *Vigna radiata*. Results indicated that by the application of insecticides, the mortality of the insect pest of mungbean increase the mortality of pests. All the treatments showed significant affection, which showed the difference between all above mentioned insecticides. Whereas, the effect of seed-treatment and detergent did not show distinctive effect on the pest's population. Imidacloprid and thiomethoxam resulted in a maximum mortality of the Jassid. While in case of whitefly; imidacloprid was the most effective and resulted in maximum reduction in its population. Acephate was found the most effective insecticide, which showed the maximum control of thrips.

This study was proposed to evaluate the toxicity of chemical insecticides (acetameprid, imidacloprid and spinosad) against the adults of stink bug, which is the destructive pest of cucurbits as well as for other cash crops like cotton.

MATERIALS AND METHODS

The present study experiment was conducted at the Toxicological Laboratory of Department of Entomology, University of Agriculture Faisalabad, Pakistan during 2013. The major division of the task included:

- Selection of insecticides
- Collection and rearing of stink bug, *Coridius janus*
- Preparation of pesticide dilutions
- Toxicological studies
- Statistical analysis

Selection of insecticides: Acetameprid, imidacloprid and spinosad were selected for the experimentation. All of these insecticides were selected on the basis of their mode of action and their environment friendly response.

Collection of the stink bug (*Coridius janus*): Mixed population of stink bug (*Coridius janus*) was collected from vegetables field in large plastic jars by shaking the infested plant parts inside the jars. The collected population was brought to the toxicology laboratory, separated into adult and immature (nymphs) stages in separate rearing cages. The eggs collected from adult cages were placed on moist filter paper No.1 and then these eggs were put into the incubator and maintained at temperature 30$\pm$5°C and 60-65% R.H. till hatching. The hatched nymphs shifted into nymph cages until their transformation into adults. In this way, culture of *C. janus* was started and maintained to get regained the stages of uniform age and size for various experimentations.

Preparation of pesticide dilutions: Petri dishes used in the trial were cleaned thoroughly with a detergent, rinsed with distilled water and then air dried. A stock solution (D-1) of the highest concentrated dose was prepared for the respective pesticide and then serial dilutions were made by taking half of the stock solution and diluted it with distilled water to the original volume in another measuring cylinder to make D-2. Successive dilutions were made until last dilution for each of the pesticide achieved.

Bioassay with insecticides in the laboratory: Following formulations of insecticides were used for bioassay study: Assail (acetameprid), confidor (imidacloprid) and tracer (spinosad) along with their control.

Toxicological studies: The prepared four dilutions of each insecticide were applied on the cucurbits leaves. These leaves were dipped in respective dilutions for 10 min. The treated leaves were air-dried for 20 min before the release of adults of stink bug (*Coridius janus*). After air-drying, leaves were put into the glass jar of 15 cm length and 9 cm diameter. Four such glass jars, constituting an experimental unit were prepared for each dilution. Ten individuals of adult stage of stink bug (*Coridius janus*) were released in each glass jar. After release, the mouth of glass jars were covered with a firm meshed cloth piece for ventilation.

Then glass jar were placed inside an incubator, maintained at 30$\pm$5°C and 65$\pm$5% R.H. This experiment was replicated three times for each insecticide along with a parallel control was also set for each insecticide. The mortality data was collected after 12, 24, 48 and 72 h post treatment intervals. All the experiments were repeated 3 times to ensure the accuracy of results.

Statistical analysis: The collected data was subjected to Probit analysis after converting the data into percent corrected mortality as described by Henderson and Tilton (1955) to determine LC_{50} and LC_{90}.

RESULTS

The LC_{50} values 2.39, 1.00 and 6.94% were observed for acetameprid, imidacloprid and spinosad, respectively after an exposure of 12 h. Result revealed that all the tested insecticides were toxic to stink bug and toxicity was increased as concentration increased (Table 1). The LC_{50} values 1.82, 0.58 and 3.21% were observed for acetameprid, imidacloprid and spinosad, respectively after an exposure of 24 h. Result revealed that all the tested insecticides were toxic to sting bug. The LC_{50} value showed that imidacloprid had more toxicity and spinosad had lesser toxicity after 24 h (Table 2).

The LC_{50} values 1.68, 0.25 and 1.72% were observed for acetameprid, imidacloprid and spinosad, respectively after an exposure of 48 h. Result revealed that all the tested insecticides were toxic to sting bug. The LC_{50} value showed that imidacloprid had more toxicity and spinosad had lesser toxicity after 48 h (Table 3). The LC_{50} values 0.89, 0.16 and 0.52% were observed for acetameprid, imidacloprid and spinosad, respectively after an exposure of 72 h. Result revealed that all the tested insecticides were toxic to sting bug. The LC_{50} value showed that imidacloprid had more toxicity and acetameprid had lesser toxicity after 72 h (Table 4).

DISCUSSION

The present study support the result of Yazdani *et al.* (2000) who reported that imidacloprid 200 SL was very effective insecticide against jassid. The present study is also in conformity with Misra (2002) and Solangi and Lohar (2007) also reported that confidor (imidacloprid) was most effective in controlling the Jassid population followed by acetamiprid. The present findings can partially be compared with those of Shah *et al.* (2007) who reported that plots had highest yield, which were treated by imidacloprid, followed by acetamiprid.

Decombel *et al.* (2004) study shows that cytotoxic effect of imidacloprid was determined on of *S. exigua* cell line proliferation, which is derived from *Spodoptera exigua* and found that at 20 ppm 50% population of *Spodoptera exigua* is inhibited. But, Su *et al.* (2007) study shows that increasing of gill cell line from Flounder *Paralichthys olivaceus* IC_{50} value

Table 1: LC_{50} values of different concentrations of insecticides for adults of stink bug (*Coridius janus*) at CI 95% after 12 h

Insecticides	Percentage (LC_{50})	Slope±SE	Fiducially limits (95%) Lower	Upper	Regression	Goodness of fit test
Acetameprid	2.39% (23.9 mL L^{-1})	0.57±0.05	1.79	3.42	Y = -0.866+0.073X (Z = -11.72, p = 0.000)	χ^2 = 8.2, df = 7, p = 0.307
Imidacloprid	1.00% (010.0 mL L^{-1})	0.50±0.03	0.78	1.29	Y = -0.366+0.063X (Z = -5.80, p = 0.000)	χ^2 = 6.01, df = 7, p = 0.538
Spinosad	6.94% (69.4 mL L^{-1})	0.44±0.05	3.98	15.90	Y = -1.234+0.085X (Z = -14.50, p = 0.000)	χ^2 = 10.2, df = 7, p = 0.174

Table 2: LC_{50} values of different concentrations of insecticides for adults of stink bug (*Coridius janus*) at CI 95% after 24 h

Insecticides	Percentage (LC_{50})	Slope±SE	Fiducially limits (95%) Lower	Upper	Regression	Goodness of fit test
Acetameprid	1.82% (18.2 mL L^{-1})	0.44±0.04	1.32	2.72	Y = -0.636+0.068X (Z = -9.25, p = 0.000)	χ^2 = 5.1, df = 7, p = 0.643
Imidacloprid	0.58% (5.8 mL L^{-1})	0.44±0.03	0.46	0.75	Y = -0.129+0.060X (Z = -2.15, p = 0.031)	χ^2 = 4.6, df = 7, p = 0.705
Spinosad	3.21% (32.1 mL L^{-1})	0.37±0.04	2.02	6.12	Y = -0.804+0.072X (Z = -11.06, p = 0.000)	χ^2 = 6.2, df = 7, p = 0.507

Table 3: LC_{50} values of different concentrations of insecticides for adults of stink bug (*Coridius janus*) at CI 95% after 48 h

Insecticides	Percentage (LC_{50})	Slope±SE	Fiducially limits (95%) Lower	Upper	Regression	Goodness of fit test
Acetameprid	1.68% (16.8 mL L^{-1})	0.34±0.03	1.13	2.81	Y = -0.545+0.066X (Z = -8.17, p= 0.000)	χ^2 = 3.8, df = 7, p = 0.799
Imidacloprid	0.25% (2.5 mL L^{-1})	0.27±0.02	0.17	0.36	Y = 0.002+0.059X (Z = 0.04, p = 0.968)	χ^2 = 30.9, df = 7, p = 0.000
Spinosad	1.72% (17.2 mL L^{-1})	0.37±0.03	1.19	2.76	Y = -0.572+0.067X (Z = -8.49, p = 0.000)	χ^2 = 2.05, df = 7, p = 0.957

Table 4: LC_{50} values of different concentrations of insecticides for adults of stink bug (*Coridius janus*) at CI 95% after 72 h

Insecticides	Percentage (LC_{50})	Slope±SE	Fiducially limits (95%) Lower	Upper	Regression	Goodness of fit test
Acetameprid	0.89% (8.9 mL L^{-1})	0.43±0.03	0.68	1.20	Y = -0.319+0.062X (Z = -5.08, p = 0.000)	χ^2 = 3.3, df = 7, p = 0.855
Imidacloprid	0.16% (1.6 mL L^{-1})	0.41±0.02	0.12	0.21	Y = 0.373+0.058X (Z = 6.43, p = 0.000)	χ^2 = 0.5, df = 7, p = 0.999
Spinosad	5.2% (0.52 mL L^{-1})	0.47±0.03	0.41	0.66	Y = -0.062+0.060X (Z = -1.05, p = 0.295)	χ^2 = 4.2, df = 7, p = 0.750

was 38.46 μg mL^{-1}. It was observed that Increase of phagocytic cells depending on increasing of concentrations of insecticides (Su *et al*., 2007). The presence of these cells has been reported by Meneses-Acosta *et al*. (2001) who suggested that these cells eliminate cell debris from Sf9 cell culture.

Present study showed that by the exposure of confidor (imidacloprid) after 12 h, 1.11% maximum mortality was observed at highest concentration, while, 0.01% mortality was observed in lowest concentration but 0.00% mortality was observed in control treatment, after 24 h maximum mortality 2.71% was observed at highest concentration, while 1.65% mortality was observed in lowest concentration but 0.00% mortality was observed in control treatment, after 48 h, 5.11% maximum mortality was observed at highest concentration, while 2.13% mortality was observed in lowest concentration but 0.00% mortality was observed in control treatment after 72 h, 3.33% maximum mortality was observed at highest concentration, while 1.66% mortality was observed in lowest concentration but 0.00% mortality was observed in control treatment. Similar results were reported in previous studies (Decombel *et al*., 2004; Su *et al*., 2007; Meneses-Acosta *et al*., 2001).

In the present study, acetameprid showed maximum mortality (2.33%) of adults of *Coridus janus* after 12 h at highest concentration. While, 0.66% mortality was observed at lowest concentration but (0.00%) mortality was observed in control treatment, after 24 h maximum mortality (3.33%) was observed at highest concentration, while 2.00% mortality was observed in lowest concentration but 0.00% mortality was observed in control treatment, after 48 h maximum mortality (4.01%) was observed at highest concentration, while 1.21% mortality was observed in lowest concentration, but 0.07% mortality was observed in control treatment, after 72 h maximum mortality (2.34%) was observed at highest concentration, while 1.3% mortality was observed in lowest concentration, but 0.3% mortality was observed in control treatment.

Previous studies showed that spinosad contain two types of compound spinosyn A and spinosyn D (Sparks *et al*., 2001; Markussen and Kristensen, 2012), which can be obtained from actinomycete bacterium (*Saccharopolyspora spinosa*). By the exposure of spinosad insects exhibit paralysis and tremors, which is caused by fatigue of neuromuscular as it effect central nervous system, which result in death (Salgado *et al*., 1997; Salgado, 1998). In the present study, by the exposure of tracer (spinosad) after 12 h, 3.96% maximum mortality was observed at highest concentration, while 1.01% mortality was observed in lowest concentration, but 0.00% mortality was observed in control treatment. Previous studies also showed similar results for rice striped stem borer (*Chilo suppressalis*), which is one of the most economically important rice pest in Asia, Southern Europe and Northern Africa (He *et al*., 2008), after 24 h, 2.01% maximum mortality was observed at highest concentration, while 0.99% mortality was observed in lowest concentration, but no mortality was observed in control treatment, after 48 h, 3.62% maximum mortality was observed at highest concentration, while 2.33% mortality was observed in lowest concentration, but no mortality was observed in control treatment, after 72 h maximum mortality 3.31% was observed at highest concentration while, 1.43% mortality was observed in lowest concentration, but 0.33% mortality was observed in control treatment.

CONCLUSION

All the treatment (acetamiprid, imidacloprid and spinosad) showed effective mortality of adults of stink bug (*Coridius janus*) of cucurbits. It is also observed that with the passage of time the mortality of pest by the above mention treatment is increased, so the chemical control is suitable for the pest of vegetable pest. Among all the treatment, imidacloprid showed the maximum mortality of the adults of *Crridius janus*. Therefore, the use of imidacloprid is most suitable for control of stink bug.

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