Research Article

Toxicity of selective insecticides against sap sucking insect pests of cotton (*Gossypium hirsutum*)

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Abstract

The most devastating cotton crop pests including sucking insect pests like jassid, *Amrasca biguttula* and aphid, *Aphis gossypii*. The severe attack of these sucking pests in Pakistan causes yield losses of about 28 percent to the cotton crop. Chemical control such as the use of various insecticides is mainly practiced to minimize yield losses in cotton crops. Here we evaluated the toxicity of some selective insecticides under field conditions to screen out an effective insecticide against these sucking insect pests of cotton. The insecticides tested were imidacloprid 250ml/acre, acetamiprid 150ml/acre, nitenpyram 200ml/acre, movento 250ml/acre, buprofezin 600gm/acre and chlorfenapyr 225ml/acre. The results of this study revealed that all the insecticides tested were effective against *A. gossypii*, after 96 hours of spray, except buprofezin and movento, the other insecticides caused immature and adult mortality. Nitenpyram and buprofezin exhibited the highest mortality rate of adult aphids after 24 h of spray. When spraying nitenpyram@200ml/acre, acetamiprid@150ml/acre, and imidacloprid@250ml/acre, the highest mortality of *A. biguttula* adults was recorded after 96 hours of spray. Imidacloprid, acetamiprid, nitenpyram, and buprofezin were statistically equally effective at the immature stage with mortality of *A. biguttula* after 96 hours of spraying. In addition, acetamiprid and nitenpyram were more effective after 24 hours of spray, but imidacloprid, chlorfenapyr, movento, and buprofezin were less effective and showed low mortality at immature *A. biguttula* stage.

Keywords: *Aphis gossypii*; *Amrasca biguttula*; Insecticides; mortality; neonicotinoids; toxicity

Introduction

Gossypium hirsutum L. (Cotton) is seen as the bedrock of Pakistan's economy, as it is a major foreign exchange outlet and plays a vital role in the country's financial growth

[1]. There are several reasons for declining cotton yields where insect pests are the major factors causing yield losses of 30-40% include bollworms and sucking insect pests in Pakistan [2-5], but 28% yield losses

are caused by sucking cotton pest attacks [6]. About the appearance of 162 insect species on countless cotton-growing phases [7, 8]. Cotton insect pests, including jassid, *A. biguttula* Ishida (Hemiptera, Cicadellidae), an aphid, *A. gossypii* (Hemiptera: Aphidae), are major insect sucking pests [1, 9]. The severe attack of these extraction pests causes yellowing of the leaves, which inhibits the plant's development and growth, and ultimately dries up due to cell sap damage [10].

Various management strategies were used [11, 12], but chemical insecticides remain essential for insect pest management [13-15]. However, the misapplication of chemical insecticides causes hormesis and resistance development in insect pests [16-19] and multiple potential side effects on non-target insects (for a review, see ref. 20). Many species of jassid and aphid have been referred to be resistant to pyrethroids [3]. We cause injury by scraping the sap from the leaves beneath the surface. Numerous researchers have performed previous studies on the ability of various pesticides to fight pests [20-29]. In this article, we have compared the effectiveness of various insecticides against sucking cotton insect pests like jassid and aphid.

Materials and Methods

Description of the study area

The experiment was conducted on the cotton crop during July 2019 to monitor the toxicity of various insecticides to the cotton jassid (*A. biguttula*) and aphid (*A. gossypii*) sucking insect pest under field conditions in Okara District, Tehsil Renala Khurd, Chak 33/1.A.1 Punjab (Pakistan). This experiment was laid out with three replications and six procedures in Randomized Complete Block Design, along with supervision. For each treatment having a row to row distance of 2.5 ft and each plot size was 5m x 3 m. During thinning, the plant to sector distance was kept at 60-75 cm. Under court, all the agronomic procedures performed were uniform in the entire cotton field. The crop was visited daily to monitor the jassids,

aphid population and was sprayed on cotton crop after the output of a sufficient jassids and aphid population.

Insecticides

Six insecticides were achieved from different sources were used. These were imidacloprid @250ml/acre, acetamiprid @150ml/acre, nitenpyram @200ml/acre, buprofezin @600gm/acre, movento @250ml/acre, and chlorfenapyr @225ml/acre.

Bioassay

The foliar bioassay was conducted on picked cotton plants. Test solutions were prepared in distilled water at the recommended field doses against jassids and aphids for each of the insecticides mentioned above. The insecticides were applied to the field in the form of a spray using a knapsack hand sprayer with a capacity of 20 liters fitted with a hollow cone nozzle [1]. Pre-treatment data were recorded before spray, and post-treatment data were recorded at 24, 48, 72 and 96 h intervals to determine the toxicity of the above-listed chemicals. Individuals were declared dead if they are not responsive after being brushed with a camel hair brush or show no movement. The targeted insect pest population was counted at each procedure from 21 randomly selected leaves from one row of the cotton crop. Margin plants are not selected to prevent drift and mitigate boundary impact.

Data analysis

Corrected percent mortality of each sucking pest in each treatment was calculated using the formula given by Schneider-Orelli's Formula [21], analysis of variance and mean needed to be comparing t- table value at 95% (1.943). T1= Spray with imidacloprid (Confidor 20% SL) @ 250 ml/acre. T2= Spray with acetamiprid@ 150 ml/acre. T3= Spray with nitenpyram (Nockout 25 SP) @ 240 gm/acre. T4= Spray with buprofezin@ 600 ml/acre. T5= Spray with movento@ 250 ml/acre. T6= Spray with chlorfenapyr @ 225 ml/acre. T7= control.

Results

Aphid, *Aphis gossypii*

Adult stage

After 96 hours of spray, all the insecticides tested caused considerably high mortality to cotton aphid (*A. Gossypii*) at the adult stage. Total mortality was recorded after 96 hours 98.06b, which is highly effective at the adult stage against aphid (Table 1). Total mortality-4.16a was observed under field conditions in imidacloprid, after 24

hours. In the case of acetamiprid 54.24a, mortality was recorded after 24 hours as 50 percent mortality was the highest mortality rate. Nitenpyram and buprofezin were highly effective against cotton sucking pest since it causes total mortality after 24 hours (Table 1). Therefore, all of these insecticides tested were statistically equal and highly effective at adult stage with aphid mortality 98.06b (Table 1).

Table 1. Corrected percent mortality of different insecticides for which insects under which conditions are required (Adult aphid)

Treatment	Trade name	Dose	Population change (- or +) after spray			
Common name		Dose/Acre	24 hours	48 hours	72 hours	96 hours
Imidacloprid	Confidor	250ml/acre	-4.16 a	88.58 ab	98.06 b	98.06 b
Acetamiprid	Mospilan	150ml/acre	54.24 a	98.06 ab	98.06 b	98.06 b
Nitenpyram	Gravitan	200ml/acre	98.06 a	98.06 a	98.06 a	98.06 a
Buprofezin	Corrado	600ml/acre	98.06 a	98.06 a	98.06 a	98.06 a
Spirotetramat	Movento	250ml/acre	88.30 a	98.06 ab	98.06 b	98.06 b
Chlorfenapyr	Pirate	225ml/acre	33.37 a	98.06 ab	98.06 b	98.06 b

Mean followed by the common letter in the respective category are not significantly different from each other and needed to compare at 95% t- table value (1.943)

Nymph stage

In *Aphis gossypii* Movento's immature phase, nitenpyram and imidacloprid caused maximum mortality after 24 hours 91.70ab, 81.70a and 80.48a (Table 2). Movento, nitenpyram, and imidacloprid were highly successful against aphid's nymphal stage. Buprofezin and chlorfenapyr recorded the lowest population after 24 hours, 25.52a and 32.29a, since they caused 25 to 32 percent mortality and it was considered marginal mortality. The average mortality of all insecticides measured was 98.06b after 96 hours at the immature stage (Table 2).

Jassid, *Amrasca biguttula*

Adult Stage

The maximum population decline was documented by nitenpyram@ 200ml / acre in the adult stage of cotton jassid 77.42a after 24 hours, and the minimum mortality in the adult stage of *A. biguttula* was caused by movento@ 250ml / acre 26.46a and

chlorfenapyr@ 225ml / acre 26.72a (Table 3). Because the effectiveness of these two insecticides was statistically identical after 24 hours of spray. Therefore, after the operation, they induced around 26 percent mortality. After 96 hours, reduction in the population 59.94bc was recorded by movento@ 250ml / acre (Table 3). After 96 hours, nitenpyram was highly effective against *A. biguttula* and triggered 92.75bc (Table 3).

Nymph Stage

In case of immature stage of *A. biguttula*, after 24 hours of spray, maximum population reductions were recorded by nitenpyram and acetamiprid, 66.61a, 60.75a, whereas chlorfenapyr@ 225ml/acre caused 28.03a mortality and after 96 hours, it was caused 32.29a mortality. Nitenpyram and acetamiprid were caused highest mortality of *A. biguttula* at immature stage, and after 96

hours of application 86.04bc, 88.07bc
mortality were recorded (Table 4).

Table 2. Corrected percent mortality of different insecticides for which insects under which conditions are required (t-table 1.943) at 95% (Nymph aphid)

Treatment	Trade name	Dose	Population change (- or +) after spray			
Common name		Dose/Acre	24 hours	48 hours	72 hours	96 hours
Imidacloprid	Confidor	250ml/acre	80.48 a	95.93 ab	98.06 b	98.06 b
Acetamiprid	Mospilan	150ml/acre	75.37 a	98.06 ab	98.06 b	98.06 b
Nitenpyram	Gravitan	200ml/acre	81.70 a	98.06 ab	98.06 b	98.06 b
Buprofezin	Corrado	600ml/acre	25.52 a	39.16 ab	88.02 bc	94.58 c
Spirotetramat	Movento	250ml/acre	91.70 ab	98.06 bc	79.61 a	92.22 b
Chlorfenapyr	Pirate	225ml/acre	32.29 a	79.09 ab	89.09 b	98.06 bc

Mean followed by the common letter in the respective category are not significantly different from each other and needed to compare at 95% t- table value (1.943)

Table 3. Corrected percent mortality of different insecticides for which insects under which conditions are required (t table 1.943) at 95% (Jassids adult)

Treatment	Trade name	Dose	Population change (- or +) after spray			
Common name		Dose/Acre	24 hours	48 hours	72 hours	96 hours
Imidacloprid	Confidor	250ml/acre	39.73 a	73.06 ab	88.58 b	90.47 bc
Acetamiprid	Mospilan	150ml/acre	47.74 a	78.97 ab	84.51 b	91.28 bc
Nitenpyram	Gravitan	200ml/acre	77.42 a	85.63 ab	85.68 b	92.75 bc
Buprofezin	Corrado	600ml/acre	34.60 a	58.70 ab	80.34 b	88.77 bc
Spirotetramat	Movento	250ml/acre	26.46 a	48.76 ab	57.98 b	59.94 bc
Chlorfenapyr	Pirate	225ml/acre	26.72 a	71.97 ab	85.71b	85.71b

Mean followed by the common letter in the respective category are not significantly different from each other and needed to compare at 95% t- table value (1.943)

Table 4. Corrected percent mortality of different insecticides for which insects under which conditions are required (t-table 1.943) at 95% (Jassids nymph)

Treatment	Trade name	Dose	Population change (- or +) after spray			
Common name		Dose/Acre	24 hours	48 hours	72 hours	96 hours
Imidacloprid	Confidor	250ml/acre	38.82 a	74.31 ab	81.55 b	82.05 bc
Acetamiprid	Mospilan	150ml/acre	60.75 a	78.69 ab	85.55 b	88.07 bc
Nitenpyram	Gravitan	200ml/acre	66.61a	76.77 ab	82.83 b	86.04 bc
Buprofezin	Corrado	600ml/acre	34.24 a	49.29 ab	61.19 b	74.57 bc
Spirotetramat	Movento	250ml/acre	36.09 a	49.28 ab	51.38 b	53.58 bc
Chlorfenapyr	Pirate	225ml/acre	28.03 a	28.03 a	-33.37 a	32.29 a

Mean followed by the common letter in the respective category are not significantly different from each other and needed to compare at 95% t- table value (1.943)

Discussion

In this study, we evaluated the effectiveness of various insecticides against the sucking pest of cotton. The findings should be that all the insecticides evaluated were significantly effective against aphids and jassids where high mortalities were reported at different time durations. The insecticides used in our studies, such as nitenpyram and buprofezin, showed high efficiency compared to other insecticides by reducing the increasing aphid population. The results of our present study are consistent with those of [30, 31], where they documented the sublethal effects of nitenpyram's short-term and chronic exposure to the cotton aphid *A. gossypii*. Our results showed that nitenpyram directly exposed to even low doses caused sublethal effects on the reproduction and longevity of the aphids. Our findings are also in line with [32], where they studied novel insecticide potency with an accelerated inhibitory effect on aphid feeding. Their results showed strong and rapid toxicity of the novel insecticide flonicamid against various aphid species, *Myzus persicae*, *A. gossypii*, *Erysini rhopalosiphum*, and *Graminum schizaphis*. [33] studied buprofezin 25 EC 's comparative bio-efficacy against sucking cotton bugs, and its immunity to natural enemies. Their results indicated that buprofezin was highly effective against the cotton sucking pest *A. gossypii* and had no adverse effects on the population of natural enemies. Buprofezin, is an inhibitor of chitin synthesis that can combat hemipteran pests, especially melon aphid, *A. gossypii*. Buprofezin should influence the biological characteristics by decreasing the chitin content due to the inhibition of chitin synthase activity in the subsequent melon aphid generation [34]. Concerning jassids, all our results are consistent with previously reported results from [1, 21, 35-40]. They have also confirmed that neo-nicotinoids, i.e., nitenpyram and imidacloprid, effectively reduce the population. In addition, [41] reported that after seven days of

application, nitenpyram and acephate reduced the jassids population below ETL. Whereas [42] observed that nitenpyram reduced Jassids population significantly over 14 days. All the results discussed above suggested that all the insecticides used in this experiment showed efficiency in managing cotton sucking pests, i.e., aphids and jassids. Nitenpyram, acetamiprid, and buprofezin could be found among the insecticides tested in our study as potential candidate insecticides for the management of *A. gossypii* and *A. biguttula* in cotton crops due to their greater efficacy and lower toxicity to natural enemies associated with them. Our present study has provided a theoretical basement for insecticides in cotton crops under IPM to control sucking pests.

Conclusion

The present study concluded that among different tested insecticides, nitenpyram, acetamiprid, and buprofezin were the most effective insecticides for nymphal and adult stages of *A. gossypii* and *A. biguttula* in cotton crops under field conditions. This study provided a theoretical basis for the use of effective insecticides against sucking insect pests of cotton.

Authors' contributions

Conceived and designed the experiment: A Abbas, S Hussain & C Ri-zhao, Performed the experiment: S Hussain & A Abbas, Analyzed the data: Z Xinzi, W Ying, S Ahmad & M Usman, Contributed materials/ analysis/ tools: A Abbas, S Hussain & C Ri-zhao, Wrote and revised the manuscript: A Iqbal, A Abbas & F Ullah.

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