



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2018; 6(2): 816-820

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Received: 17-01-2018

Accepted: 18-02-2018

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Neonicotinoids not showing an unlike counterproductive rationale for resistance evolution in the dusky cotton bug

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Abstract

Extensive use of pesticides in agriculture provides us a rationale for resistance development in cotton cropping system. Neonicotinoids pesticides including imidacloprid have shown resistance evolution in insects in cotton cropping system. So in these studies, imidacloprid was tested against dusky cotton bug at recommended, low and high concentrations. Imidacloprid was tested at concentrations of 0.1, 0.2, 0.3 ml. Each test was replicated three times in laboratory to observe the mortality of dusky cotton bugs. Mortality results showed that all bugs were dead in a limited time interval in each tested treatment as compared to control, though slightly lower at lower concentration. These results have explicitly shown that imidacloprid not resulted in resistance evolution in dusky cotton bugs in cotton cropping system. These results can further be used to test other sucking pests to observe either pesticides are resulting or not a counterproductive impacts. A hawkish stance should be asserted to observe the resistance evolution in insects against commonly sprayed pesticides.

Keywords: cotton, dusky cotton bug, imidacloprid, neonicotinoids, resistance

1. Introduction

Cotton is most important crop of Pakistan after wheat and it reside in the larger area in Pakistan than other crops. Cotton seed is used in the oil and meal account 80 percent National production of the oilseed. Cotton and that product which made from cotton contribute 10 percent in gross domestic product (GDP) and 55 percent contribution of foreign exchange earnings. In the last 30 years the area of cultivation of cotton in Pakistan will be increased around 7.86 million acres in 2015-16^[1]. Cotton (*Gossypium hirsutum* L.) is an important fiber and cash crop of Pakistan. Cotton used for dual purpose fiber and vegetable oil^[2]. It plays an important role in the economy of Pakistan due to foreign exchange but still behind this the yield of cotton per acre are low in Pakistan as compared to other countries^[3]. Pakistan has a 4th position in the cotton production after China, India and USA^[4].

Transgenic cotton got abundant popularity because they have resistance against lepidopterous insect pest of cotton specially bollworms^[5, 6]. Its cultivation reduced the insecticides, cost of production, environmental contamination and increase cotton yield^[7, 8]. Bt cotton has a gene *bacillus thuringiensis* that produces a protein called Cry 1 toxin protein. When insect ingest Cry1 toxin that resulted disturbed permeability, midgut paralysis and collapse of epithelium. Larva cannot feed, after direct contact their death occurs within 48-72h^[9].

There are several factors that are responsible in the reduction of cotton yield, insect pests are greatest causing 30-40% yield loss^[10, 11]. Almost 93^[12] to 145^[13] mites and insect pest attack cotton crop. These insect pests include chewing as well as sucking insect pests. Among sucking insect pests, *oxycarenus* spp., dusky cotton bug, now a days become common widespread pest of economic importance. Adult and nymph both feed on immature seeds and causing various types of injury including reduction in seed weight, oil content and yield of cotton^[14].

Bt cotton cannot provide resistance against sucking insect pests^[15]. In current years, cotton dusky bug got attention due to its severe attack in abundant numbers on cotton crop. It is usually known as seed cotton bug or cotton stainer^[16, 17]. The coming of Bt cotton with different sowing plan (early sowing) and application of pesticide that control the bollworms have provided favorable condition for minor insect pest as dusky cotton bug^[18, 14].

After severe infestation of Dusky cotton bug the quantitative and qualitative losses occur in cotton crop ^[19, 20]. The adult and nymph both are suck the sap from leaf of early stem and oil from complete seed ^[21, 22].

It damages the seed embryo and reduced the seed viability ^[20, 23]. It reduced the quality of cotton by staining lint ^[24]. The occurrence of the population of dusky cotton bug is increasing Bt cotton than non-Bt cotton due to a reduction in the number of applications of insecticides in bollworm management ^[25]. In spite of vital advances in technology, only partial control measure are available for the control of dusky cotton bug. A common policy favored by farmers to protect cotton crop by using highly effective chemical. Almost 90 percent farmer uses chemical or insecticides for crop protection from insect pests ^[26]. Usually the insecticides which are used over long period of time for particular insect pest, cause resistance development in them ^[27].

2. Material and Method

2.1 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 Dusky cotton bug was collected from the field and reared under the laboratory conditions temperature $(26\pm 2)^\circ\text{C}$ and relative humidity $(60\pm 5)\%$ without the exposure of insecticides.

2.2 Insecticide Preparation and Applications

Imidacloprid @ 0.1%, 0.2% and 0.3% was tested against the population of dusky cotton bug under the laboratory conditions. The stock solution of tested pesticide was prepared and different required concentrations were formed.

2.3 Mortality tests of Dusky cotton bug

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 dusky cotton bug with thirty treated dusky cotton bugs were released. Data was collected after every 6 hours.

3. Results

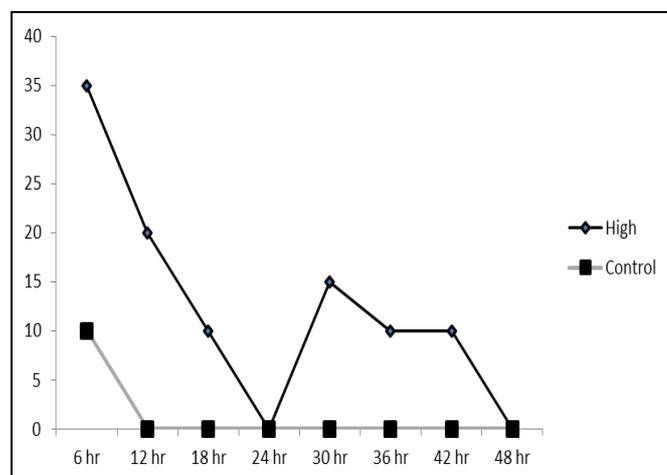


Fig 1(a): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 1(a) showed that after the application of Imidacloprid at high dose maximum mortality of dusky was (35%) after 6 hours while minimum (0%) was

after 24, and 48 hours. While in case of control maximum mortality of dusky cotton bug was (10%) after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As $(df) = 1$, $(F) = 2.674419$, $(Pvalue) = 0.008384$

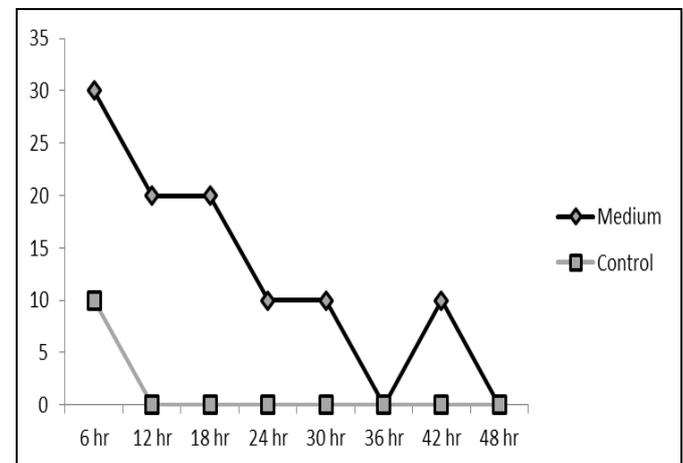


Fig 1(b): Mortality results of dusky cotton bug using imidacloprid at medium concentration as compared to control.

Mortality test results in Fig 1(b) showed that after the application of Imidacloprid at the medium dose maximum mortality of dusky was (30%) after 6 hours while minimum (0%) was after 36, and 48 hours. While in case of control maximum mortality of dusky cotton bug was (10%) after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While overall results showed that there is a significant difference in mortality percentage of dusky cotton bug on High concentration as compared to control. As $(df) = 1$, $(F) = 2.435897$, $(P value) = 0.006603$.

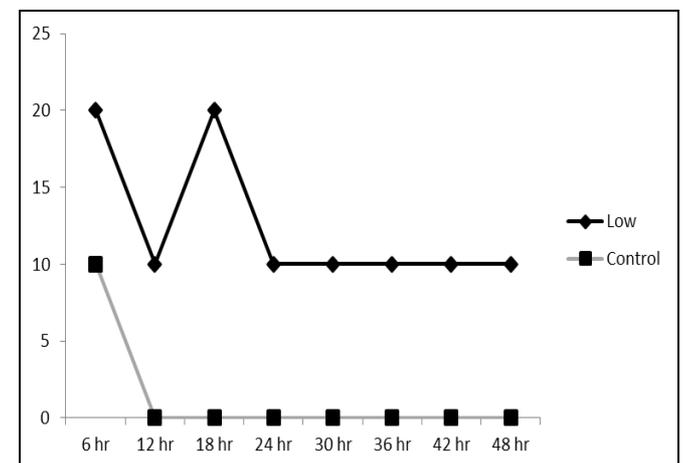


Fig 1(c): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 1(c) showed that after the application of Imidacloprid at low dose maximum mortality of dusky was (20%) after 6 and 18 hours while minimum (10%) was after, 12, 24, 30, 36, 42 and 48 hours. While in case of control maximum mortality of dusky cotton bug was (10%) after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As $(df) = 1$, $(F) = 4.428571$, $(Pvalue) = 0.034041$

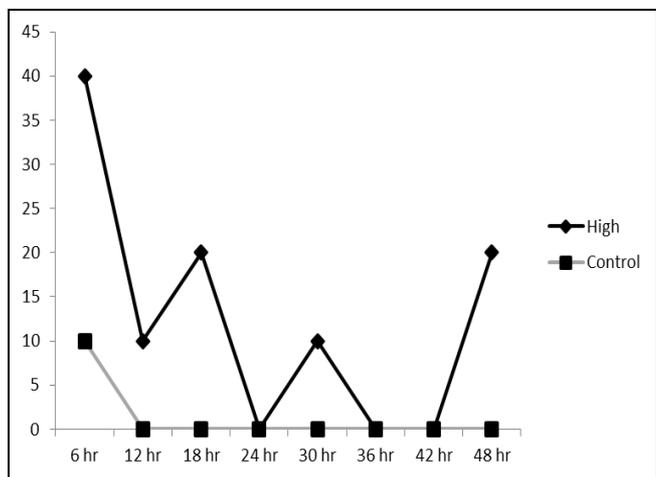


Fig 2(a): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 2 (a) showed that after the application of Imidacloprid at high dose maximum mortality of dusky was (40%) after 6 hours while minimum (0%) was after, 24, 36, and 42 hours. While in case of control maximum mortality of dusky cotton bug was (10%) after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As (df) = 1, (F) = 2.239437, (P value) = 0.025555

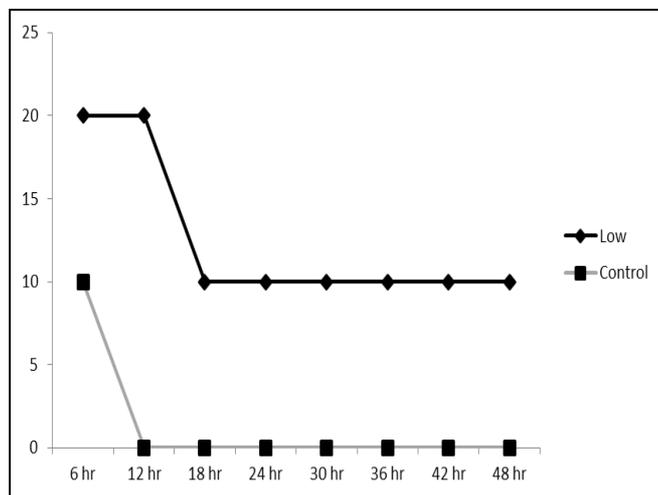


Fig 2(c): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 2(c) showed that after the application of Imidacloprid at low dose maximum mortality of dusky was (20%) after 6 and 12 hours while minimum (0%) was after 36, and 48 hours. While in case of control maximum mortality of dusky cotton bug was after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As (df) = 1, (F) = 4.428571, (P value) = 0.034041.

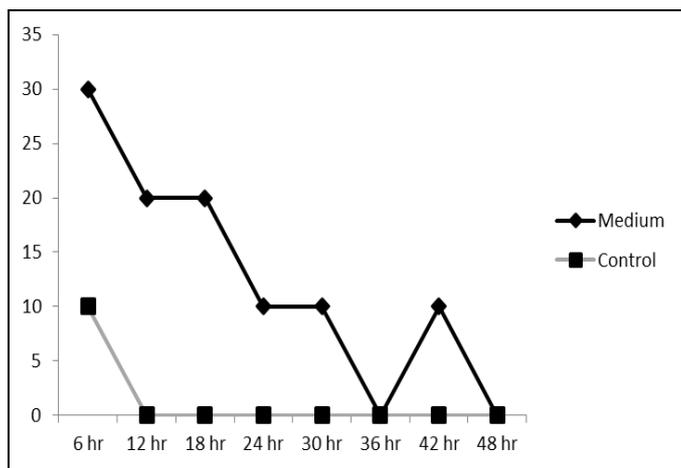


Fig 2(b): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 2 (b) showed that after the application of Imidacloprid at the medium dose maximum mortality of dusky was (30%) after 6 hours while minimum (0%) was after 36, and 48 hours. While in case of control maximum mortality of dusky cotton bug was (10%) after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As (df) = 1, (F) = 2.435897, (Pvalue) = 0.006603

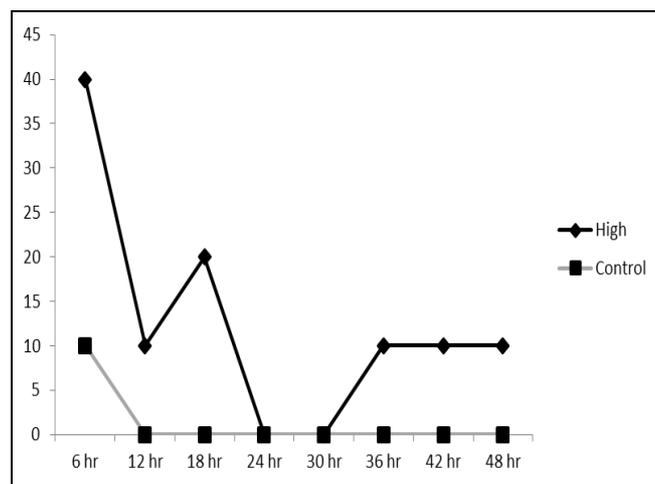


Fig 3(a): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 1(a) showed that after the application of Imidacloprid at the high dose maximum mortality of dusky was (40%) after 6 hours while minimum (0%) was after, 24 and 30 hours. While in case of control maximum mortality of dusky cotton bug was after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on high concentration as compared to control. As (df) = 1, (F) = 2.6, (P value) = 0.014842.

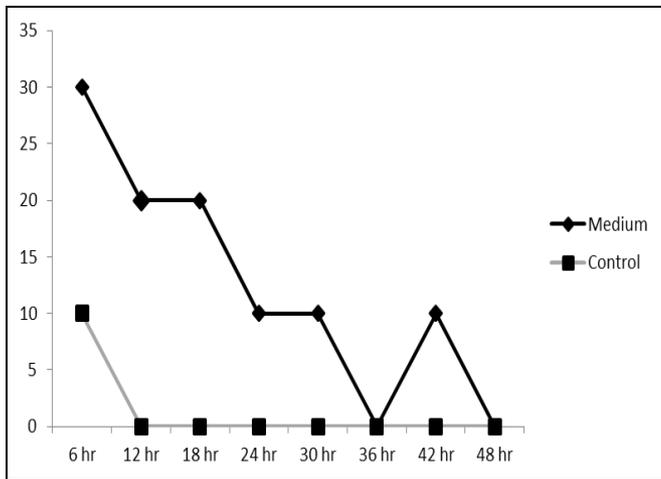


Fig 3(b): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 3 (b) showed that after the application of Imidacloprid at the medium dose maximum mortality of dusky was (30%) after 6 hours while minimum (0%) was after, 36 and 48 hours. While in case of control maximum mortality of dusky cotton bug was after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on high concentration as compared to control. As (df) = 1, (F) = 2.435897, (P value) = 0.006603.

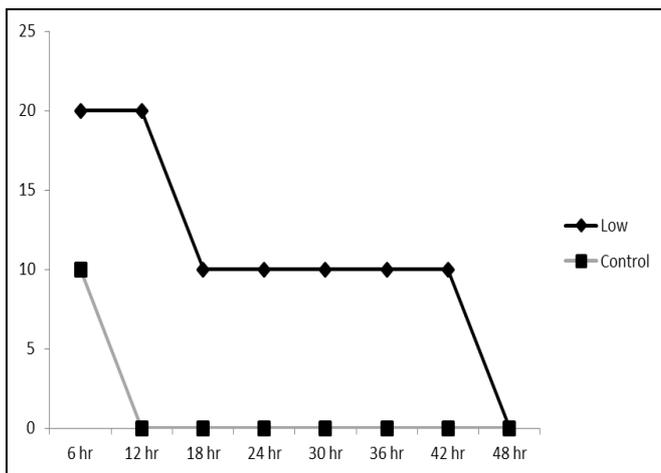


Fig 3(c): Mortality results of dusky cotton bug using imidacloprid at higher concentration as compared to control.

Mortality test results in Fig 3(c) showed that after the application of Imidacloprid at the low dose maximum mortality of dusky was (20%) after 6 and 20 hours while minimum (0%) was after, 48 hours. While in case of control maximum mortality of dusky cotton bug was after 6 hours while minimum (0%) after, 12, 18, 24, 30, 36, 42 and 48 hours. While Overall results showed that there is a significant difference in mortality% of dusky cotton bug on High concentration as compared to control. As (df) = 1, (F) = 2.75, (P value) = 0.001134.

4. Discussion

Our results directed that the mortality rate of dusky cotton bug was more on high dose of imidacloprid than medium and low, [28] in which It was observed that all chemicals, pyrethroids and insecticides mixture was proved highly effective against the population of dusky cotton bug both nymph and adult. It

was observed that pyrethroids and all organophosphate were highly effective for dusky cotton bug [14]. In another study it was found that chemical control by using different insecticides against dusky cotton bug, insecticides kill the pests when it contact with it [29]. In this study we observed that higher concentration of insecticide give more mortality of sucking insect pest dusky cotton bug than medium and low concentration of insecticides. These results were similar to the results in which it was concluded that the mortality of the sucking insect pest was high at higher concentration [30]. We observed that in different mode of action insecticides imidacloprid was having effective results against sucking insect pest. These results were corresponding to other results [22] in which it was concluded that the result of the mortality rate of sucking insect pests was 100% when treated with imidacloprid. Our results were in agreement with studies in which it was observed that low infestation of dusky cotton bug occurred at high concentration of different insecticides [31], high mortality/low infestation of dusky cotton bug was observed at high concentration of imidacloprid. Our results were in also agreement to studies in which it was described that high concentration of some insecticides showed effective control against sucking insect pest [32], because at high concentration of imidacloprid high mortality of dusky cotton bug was observed. Our results were also in agreement with studies in which it was observed that the attack of sucking insect pests was low when high concentration of different insecticides was applied [33], so in our studies low infestation/high mortality of sucking insect pest was observed when sprayed with pesticide. Our results were also in agreement with studies in which high mortality of sucking insect pests was observed at high concentration of imidacloprid. And also increased yield of cotton and reduced population of the sucking insect pest was observed when sprayed high concentration of different insecticides [34].

5. Conclusion

As a conclusion it can be asserted that the standard concentration of pesticides i.e. cypermethrin can yield more better results and can be applied in the field to control dusky cotton bug. No resistance was found to be developed in dusky cotton bug against synthetic pyrethroid, cypermethrin, which can be valuable for upcoming research.

6. Acknowledgement

We acknowledge Miss Easha for her valuable comments on editing the manuscript.

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