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Toxicity of conventional insecticides against the field population of *Amrasca devastans* (Distant) (Homoptera: Cicadellidae)

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Abstract
Research was conducted to evaluate the toxicity of different conventional insecticides against the field strain of *Amrasca devastans* (*Distant*). *A. devastans* is the pest of economically important crops belongs to the family solanaceous and malvaceous which includes cotton, okra and brinjal and has the potential to become the major pest of these crops, that's why different insecticides (Bifenthrin, Deltamethrin, Dimethoate and Acephate) were being utilized to suppress this pest. The immoderate utilization of insecticides become the cause of developing resistance in jassid. To monitor the LC_{50} in *A. devastans* against these insecticides laboratory trials were conducted and adults of *A. devastants* were released in leaves immersed with recommended dose of insecticide concentration. Results revealed that the population of *A. devastans* showed lowest LC_{50} against dimethoate (2.48 ppm) and highest LC_{50} against deltamethrin (60.61 ppm). Highest LC_{50} against deltamethrin showed that *A. devastans* have developed resistance against this particular insecticide. LC_{50} of Acephate is (16.48 ppm) followed by Bifenthrin with (5.57 ppm) and Diamethoate with (2.485 ppm). Lowest LC_{50} in case of Bifenthrin and Diamethoate showed that there are still chances of developing resistance in these insecticides against jassid. Judicious utilization of conventional insecticides which have various mode of action may help farmer to remain the jassid population underneath the Economic Threshold Level.

Keywords: Conventional insecticides, toxicity, cotton jassid

Introduction
Cotton (*Gossypium hirsutum* L) is known with different names (oil seed crop, cash crop and fiber crop etc.) in the various parts of the world due to its distinct characters and economic importance, it is commonly called as a white gold. It is sown as a yearly crop in both humid and hot temperate regions (Ozyigit *et al.*, 2007) [19]. Pakistan economy is largely based on cotton crop because it is an important source of raw material for textile industry. Cotton contributed 0.8 percent in total GDP and 4.5 percent in agriculture sector (GOP, 2018) [12]. It provides seed cake which is essential for animal feed and organic manure (Chidda, 1997) [11].
The production of cotton is declined by 17.5 percent to 9.861 million bales which involved both biotic and abiotic factors (GOP, 2018) [12]. In biotic factors most drastic one is the insect pest which become the cause of 30 to 40 percent yield losses (Haque, 1991) [15]. Cotton is attacked by both chewing and sucking pest. Sucking pest are very deleterious to cotton crop they damage the crop directly by sucking cell sap and feed on the lower sides of the leaf, and cause damage indirectly by producing honey dew and transmitting viral diseases (Shuli *et al.*, 2018) [26].
Amrasca devastans Dist. causes 24.5 percent yield losses in India (Bhat *et al.*, 1986) [10] and 18.8 percent losses in Pakistan (Ali *et al.*, 1995) [7]. *A. devastans* causes acute damage by inserting virulent enzymes in the epidermis of leaf and induces the ''hopper burn'' disease (Ghosh and Chakraborty, 2015) [14]. Symptoms shown by plants bearing jassid attack may leads to stunted plant growth with downward curling of the leaves, appearance of reddish color on the border of leaves, drought which finally leads to the drastic loss in yield (Balakrishnan *et al.*, 2007) [8] Singh *et al.*, 2008) [33].
Majority of the Asian farmers mainly depends on chemical insecticides to manage the *A. devastans* because other management practices have lesser impact in relation to the jassid control. Different insecticides with different groups like organophosphates (Ghauri *et al.*, 1983) [13], neonicotinoids (Razaq *et al.*, 2005) [23] and Pyrethroids (Razaq *et al.*, 2006) [21] are

being utilized for the control of this pest. Now a days, conventional insecticides are recommend as the best controlling chemicals against the cotton pests complex such as Armyworm, American bollworm, Whitefly, Mealy bug and Jassid in Pakistan (Ahmad *et al.,* 1999) [5] (Satpathy *et al.,* 2004) [30] (Suryawanshi *et al.,* 2000) [34].

Extensive utilization of synthetic insecticides causes resurgence, replacement and resistance in insect pest (Rohini *et al.,* 2012) [24]. Most of the sucking insect pests like mosquito, whitefly and aphid have been documented as the dangerous pests due to their ability to develop resistance against the different groups of insecticides which include IGR's, spinosyns, oxadiazine and avermectins (Basit *et al.,* 2013) [9] (Khan *et al.,* 2011) [17]. Attack of *A. devastans* is also exceeding day by day and has developed resistance against organophosphate groups and pyrethroid groups (Ahmad *et al.,* 1999) [5] (Sagar *et al.,* 2013) [28].

Resistance monitoring is an ideal approach to check the status of an insecticide resistance in different insect pest in the field. Systematic insecticide resistance monitoring is a key aspect of integrated pest management that could provide basic information for selecting appropriate insecticides for insect pest control (Roush and Miller, 1986) [25]. Therefore, present study was conducted to inspect the toxicity of pyrethroids and organophosphates against field population of *A. devastans.* The major focus of the study is to monitor resistance of conventional insecticides against *A. devastans.*

Materials and Methods
The research was conducted during Kharif season 2018 in Integrated Pest Management Laboratory, Department of Entomology, Bahauddin Zakariya University Multan, Pakistan.

Insect Rearing
Collection of immature of *A. devastans* were made from different cotton field areas of Multan. The immature with 1st instar was separated from field population and shifted to the other rearing cages along with the okra leaves to maintain its population for the further bioassays. The rearing cage with the specific measurement (22×12×9 cm) were capped from the top with muslin cloth for aeration. The population was perpetuated for minimum of two generations reared from 1st instar to mature emergence in which the okra leaves were used as a food. Older leaves were replaced with the fresher one with regular interval of 24 to 48 hours. The bioassays were conducted on the 48 hours old adults.

Insecticides
Four commercially available conventional insecticides used for bioassays are given below in table 1.

Bioassays
Cotton leaf were immersed in a recommended dose of insecticide and were placed against the jassid, this method is also known as the leaf dip bioassay method. This bioassay method were used to measure the susceptibility of *A. devestans* adults against different conventional insecticide (Saddiq *et al.,* 2017) [27]. 5 treatments (concentration, causing > 0% and <100% mortality) with the water as a solvent were used with the three replicates. The fresh leaves of cotton with their petioles were dipped in each mention concentration of insecticide with the time interval of 10 to 15 second and then allowed to dry for at least 45 to 50 minutes by placing them on the blotting paper at room temperature. Air dried leaves were then settled in a recommended plastic cups with a side hole from which the petiole is passed away so that the plastic cups were handled easily. An aspirator was used to collect the adults from the rearing cages and then released into the cups. Five to ten adults jassid were allowed to release in each cup. The pieces of muslin cloth were used to cover the each plastic cup so that the proper aeration were provided to the test insect. Petiole of leaf was covered with the cotton to avoid the desiccation and drying of leaves. After 2 days of exposure to the insecticide the mortality was examined. The adult which shows no respond with the mild touch of camel hair brush were considered dead (Afzal *et al.,* 2015) [1].

Table 1: Details of insecticides which were evaluated in the experiment given in table.

S. No.	Trade name	Common name	Insecticides groups	Dose per Acre
1	Talstar 10EC	Bifenthrin	Pyrethroids	250 ml acre^{-1}
2	Decis Super 10 EC	Deltamethrin	Pyrethroids	80 ml acre^{-1}
3	Danadim Progress 40 EC	Dimethoate	Organophosphate	400 ml acre^{-1}
4	Acephate 75 EC	Acephate	Organophosphate	250 gm acre^{-1}
5	Control		Water only	

Data analysis
For each insecticide, Chi square(χ^2), Standard error (SE), LC_{50} value or 95% confidence limit were calculated by Probit analysis with EPA Probit analysis program (version 1.5) (EPA, 1999).

Results and Discussions
The LC_{50} of all tested insecticides are given below in (Table 2). Toxicity of bifenthrin was statistically similar to the toxicity of diamethoate and acephate (overlapping of 95% CIs) but significantly differ from deltamethrin (non-overlapping of 95% CIs). Toxicity of deltamethrin was statistically similar with the toxicity of acephate (overlapping of 95% CIs) but significantly differ from that of diamethoate (non-overlapping of 95% CIs). Toxicity of diamethoate was statistically similar with the toxicity of acephate (overlapping of 95% CIs). Results showed that population of *A. devastans* give highest LC_{50} against deltamethrin (60.61 ppm) and lowest LC_{50} against dimethoate (2.485 ppm). Acephate give LC_{50} of (16.48 ppm) followed by bifenthrin and dimethoate with LC_{50} of (5.51 ppm) and (2.485 ppm) respectively. Highest LC_{50} in case of deltamethrin (60.61 ppm) confirmed that *A. devastants* have developed resistance against deltamethrin and lowest LC_{50} showed that there are still chances of resistance development in acephate with LC_{50} of (16.48 ppm), bifenthrin and dimethoate with LC_{50} of (5.51 ppm) and (2.485 ppm) respectively.

Table 2: Toxicity of bifenthrin, deltamethrin, dimethoate and acephate on the field strains of *A. devastans.*

Insecticides	N	Slopes	χ^2	Df	P	LC_{50} [95% CI] (mg/l)
Bifenthrin	90	3.12 ± 1.07	0.94	4	0.91	1. 5.57 (1.590-8.004)
Deltamethrin	90	3.13±0.97	1.190	4	0.87	2. 60.61 (24.946-90.669)
Dimethoate	90	2.66±0.89	6.613	4	0.15	3. 2.485 (0.616-3.881)
Acephate	90	1.78 ±0.46	2.359	4	0.670	4. 16.48 (7.307-27.123)

Amrasca devastans is one of the most devastating insect pests of cotton (Razaq *et al.*, 2014) [22]. This pest is controlled through the repeated sprays of different groups of insecticides in different field crops in the past few decades. Conventional insecticides are being used against insect pest including complex of cotton crop, including *Helicoverpa armigera* (Hubner) (Qayyum *et al*., 2015), *Spodoptera litura* (Fabricius) (Ahmad *et al*., 2007) and *Aphis gossypii* (Glover) (Ahmad and Arif, 2008) [3] [4] [20]. Moreover resistance has been reported in the specie *Earias vittella* (Fabricius), *Oxycarenus hyalinipennis* (Costa) and *Bemisia tabaci (Gennadius)* populations from Pakistan [6] [16] [34].
Results showed that population of *A. devastans* has developed more resistance to deltamethrin with the LC_{50} value of 60.61 ppm then followed by the Acephate with 16.48 ppm, Bifenthrin with 5.57 ppm and Diamethoate with 2.485 ppm. The highest LC_{50} may be due to non-judicious use of insecticides in field crops [30]. On the other hand, the effectiveness of bifenthrin, dimethoate and acephate is due to their various mode of action as this give more effective control.
Our results confirm that there are still chances of development of resistance it is compulsory to minimize the use of ineffective insecticides such as deltamethrin and to use the strategies of insecticide resistance management approaches to evade resistance development in *A. devastans*. Thus it is recommended using such chemical insecticides or mixture of insecticides having various mode of action chemistries for the management of *A. devastans.*

Conclusion
A. devastans is a sucking pest and have a potential to cause qualitatively as well as quantitatively losses to cotton plant. Conventional insecticides are mainly used to suppress the population of this deleterious sucking pest. Our study conclude that non-judicious use of chemical insecticides cause resistance in insects like in case of deltamethrin with LC_{50} of (60.61 ppm), so highest LC_{50} of deltamethrin showed it's ineffectively as compare to effective chemicals like acephate, dimethoate and bifenthrin. So it is concluded that acephate, dimethoate and bifenthrin with lowest LC_{50} should use to control *A. devastans*.

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