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THE COMPARATIVE TOXICITY OF SOME INSECTICIDES AND PLANT EXTRACTS AGAINST PEACH FRUIT FLY (*BACTROCERA ZONATA*)

Saddam Hussain[1], Muhammad Asrar[1*], Dilbar Hussain[2], Syed Makhdoom Hussain[1], Bilal Rasool[1], Hina Anwar[3], Muhammad Azeem[1], Ghulam Hussain Khan[1] and Sabeen Asghar[1]

[1]Department of Zoology, Government College University, Faisalabad, Pakistan
[2]Department of Entomology, Ayub Agricultural Research institute, Faisalabad, Pakistan
[3]Department of Applied Chemistry, Government College University, Faisalabad, Pakistan

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***Corresponding Author**:
Muhammad Asrar
E-mail: asrar_agr@yahoo.com

ABSTRACT

Fruit flies decrease economic percentage of Pakistan by damaging variety of fruits and vegetables and reduce agricultural production. Eleven Species of fruit flies are recorded from Pakistan, but three of which *Bactrocera dorsalis, Bactrocera cucurbitae , Bactrocera zonata* that attack on apple, mango, beer, guava, musk melon, bitter ground and snake ground are serious pest species. In this research work Laboratory studies were carried out in Ayub Agriculture Research Institute Faisalabad to check efficacy of different insecticides and plant extracts after the time intervals of 6, 12, 24 and 48 hours against peach fruit fly on guava fruit. Emerging adult flies were used in the experiment. Six insecticides viz., Corajin (DU PONT ®/20 EC) Imidacloprid (Crown ®/20 SL) Aceta maprid (Admire ®/20 SL) Steward (DU PONT ®/12.5 EC) Flufenoxuron (Cascade®/05 ES) and NitenPyramid (Capstar®/10 SL) at their recommended doses and two botanical extracts viz ., Neem seed oil and kur-tuma fruit extract were used for peach fruit fly. The order of toxicity on the basis of mortality after 48 hours was recorded as Coragen > Steward > Flufenoxuron > Acetamiprid > Niten pyramid > Imidacloprid > Neem seed oil > Kor-tuma fruit extract.

Keywords: Fruit fly, Comparative toxicity, Botanical extract, Insecticides

INTRODUCTION

Pakistan has great potential in fruit export, due to its taste. According to statistics, fruits, vegetables and condiments contribute to the economy up to 2 billion dollars, which is almost 26% of the total amount of all crops. Only the export of fruits during 2013-14 contributed to the national economy about Rs. 2,366.5 billion. The production of horticulture crops is a signal of market demand of fruits and vegetable. According to FAO (2014) the fruits like mango, citrus, banana, grapes, guava, apple and date, are the main fruits of Pakistan in terms of production and exports. Mango, citrus and dates contribute almost 78% of the total value of Pakistan's fruit export and in the world production ranking, Pakistan is having 6th position in mango and dates and 20th position in apple production (Akhtar *et al.*, 2009).

Fruit flies are discussed as most destructive insect pests that damage variety of fruits and vegetables and reduce agricultural production, which trim down economic percentage. There are about eleven Species are recorded from Pakistan, but three of which *bactrocera dorsalis, Bactrocera cucurbitae* and *Bactrocera zonata* that attack on apple, mango, beer, guava, musk melon, bitter ground, snake ground are serious species (Nadeem *et al.*, 2012). Main hosts of peach fruit fly are mango, apple, guava, bitter ground and musk melon in Pakistan (Gul *et al.*, 2015).

Guava fruit is seriously damaged by different environmental factors and pests which include diseases, birds, insects and mites. Among insects, fruit flies especially *Bactrocera* species are the most important pests. According to a survey conducted by the National Fruit Fly Research (NFFR) laboratory, Dera Ismail Khan, KPK, Pakistan, it was observed that the percent relative abundance of the 3 economically important species, Bactrocera species as *Bactrocera dorsalis* (hendel), *Bactrocera Cucurbitea* and *Bactrocera zonata (saunders)* in guava orchard was 3.22, 16.44 and 80.34 percent, respectively (Marwat and Baloch, 1986). This indicated that *Bactrocera zonata* might cause maximum loss to guava orchard due to its high prevalence in the orchards and has greater economic importance. The oriental fruit fly

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Bactocera dorsalis (Bezzi) causes 5-100 percent losses to various fruits in Pakistan (Syed *et al.*, 1970). Losses due to fruit flies, up to 80 percent have been reported in guava fruits (Kafi, 1986). Meanwhile, Kapoor (1993) reported that ber fruit fly could cause 90-100 percent damage to ber fruit.

Bactrocera zonata is one of the most destructive and serious pest of different fruits. It reduced economic yield, directly by fruit damage and indirectly by chemical treatment, as different chemicals which are used for the control of fruit fly are not only harmful for human bodies but also damage to other living bodies (Mahmoud and Shoeib, 2008).

Damage of fruit fly signs and symptoms of oviposition punctures mostly come into view on attacked fruits. Fruits having high sugar content level, such as peaches, emanate sugary liquid droplets that mostly solidify adjacent to the oviposition perforate. The dry droplet becomes visible in brown colour, resinous deposit (EPPO, 2005). On hatching, larvae feed their way into the inside of the host fruit pulp. The activity of first-instar larvae is limited to the area beneath the oviposition penetrate. But second-instar and third-instar of larvae are voracious attackers: these larvae go deeper in to the host fruit pulp and are in charge to the complete decline of host crops (CAB International, 2011).

Integrated Management of *Bactrocera zonata* is based on many strategies as Sanitary Measures;Proper field cleanliness is important. Attacked host fruitsare plucked and ground is also cleaned by collecting them and is buried deep in the soil. If some fruits are not picked on the trees they become the source of later invasion after harvest, so all fruits should be picked carefully (Plantwise, 2013).Physical control is mainly based on the covering orbagging of individual fruits to avoid female oviposition. This control has proved to be efficient (CAB International, 2011). Chemical controls stand on bait sprays and on comparativelyless hazardous insecticides as malathion is thought to be the most proficient control methods existing (Roessler, 1989).

Different methods are used for the control of fruit fly as baiting and cultural practices are used, but these are not very significant methods as compared to chemical method (Ahmad *et al.*, 2005). Cultural practices and baiting are not much effective in greater areas, and the effectiveness of these control methods is also slow. On the other hand, chemical control is faster in action and mortality rate is also high in insecticidal control method.

MATERIALS AND METHODS

The research work was carried out at experimental area & laboratories of Entomological Research Institute Ayub Agricultural Research Institute (AARI), Faisalabad during 2017-18. The research area is 186.54 m above the Sea level (Amjad *et al*., 2000) having hot summer with mean highest temperature of 35.10 ^{0}C, mean lowest temperature 25.19 ^{0}C and cold winter. During hottest month daily maximum temperature can reach up to 47 ^{0}C and daily minimum temperature can be as low as 19.07 ^{0}C. Moreover experiment site experiences less than 510 mm average annual rainfall and frequently dust storms (mid of April to end of May).

Field Collection

Fruit flies were collected from infested Guava orchards. Different localities of Faisalabad and Bhakkar were visited for the collection of infested guava fruits. In Faisalabad Dagora and Nagoki Sarliyen villages, as well as in Bhakkar the infested fruits were collected from Zurkani-wala and Sial villages. Infested fruits were placed in cages.

Rearing of fruit flies in AARI Lab

Infested fruits having pupae and larval stages of flies were carried in rearing jars and supplied feed. A sand layer was made at Bottom of jar for the purpose of eggs for new generation. Fruits were changed after every 14 days. Glass jars were placed in room temperature and proper aeration was made necessary for flies.

Treatments

The comparative effectiveness of the following nine treatments for peach fruit fly was evaluated on the basis of their mortality rate observed during different time intervals. Newly emerging peach fruit fly samples were used in the experiment under standard constant environment (27±2 $^\circ$C, 65±5% RH and L: D 16:8 h).

Treatments were applied as follow:

T1: Coragen
T2: Aceta maprid
T3: Imidacloprid
T4: Steward
T5: Flufenoxuron
T6: NitenPyramid
T7: Neem seed extract
T8: kour-tum fruit extract
T9: Control

For proper management of peach fruit fly 2 ml neem seed oil and kor-tuma extracts were poured in 500 ml of water hence 2% solution was obtained and applied by given method against peach fruit fly

Micro syringe applicator with measurement of 0.1 um was used in the experiment, required insecticide or botanical extract were filled in the applicator and then it was applied on the thorax region of fruit fly. Untreated control group was treated with tap water only. Experiment and control groups were enclosed in the labelled aerated vials.

Data Analysis

The sample organisms were observed for mortality of the adults after 3, 6, 12, 24 and 48 hours of treatment. The collected data was analyzed with Analysis of Variance (ANOVA) technique and means were compared by Least Significant Difference (LSD) test at 5% P value. The percentage mortality was calculated in each treatment by sticking with a formula.

$$\text{Percent Mortality} = \frac{\text{Number of insect died}}{\text{Total number of insect present}} \times 100$$

RESULTS

The insecticides in this research experiments were Coragen (DU PONT® /20 EC), Imidacloprid (Crown® /20 SL), Aceta maprid (Admire® /20 SL), Steward (DU PONT® /12.5 EC), Flufenoxuron (Cascade® /05 ES) and NitenPyramid (Capstar® /10 SL) and two plant extracts viz. Kor-tuma fruit extract and Neem seed oil, all these treatment were applied at

recommended dose.Mortality caused by the selected insecticides was checked after 3, 6, 12, 24, 48, 72 hours after treatment. The collected data were analyzed with Analysis of Variance (ANOVA) technique and means were compared by Least Significant Difference (LSD) test at 5% P value. Toxicity of the insecticides amplified with the increment of exposure time and concentration.

In this research work most effective insecticide against peach fruit fly was Coragen (DU PONT® /20 EC) in the results of 5th observation after 48 hours 90% of total population was killed. Results for Steward Treatments were also in high percentage. Steward (DU PONT® /12.5 EC) killed about 84% of total population of peach fruit fly after 48 hour. Flufenoxuron (Cascade® 05 ES) was used and in the last observation the insecticide was proved to be good as its mortility was percentage was recorded 82 after 48 hours, while in the case of Aceta maprid(Admire® /20 SL) the mortality was 68% after 48 hours. In the last observation less effective niten pyramid gave 66% mortality. Fruit fly was much resistant or the effects of Imeda Chloprid was recorded very poor against fruit fly 64% mortality was recorded. In the case of plant extracts the effect was recorded as slow and less mortality was seen. Neem seed oil was observed in the last observation about 54% mortality found and the remaining kor-tuma fruit extract was on least number with the percentage of 38% against peach fruit fly.

Efficacy of different insecticides varies with time, some insecticides destroyed the population suddenly while other were time taking but action was more efficient. In the 5 observations of experiment against the application of coragen (DU PONT® /20 EC) after 3 hours, 6 hours, 12 hours, 24 hours and 48 hours the results of mortality were recorded 38%, 58%, 68%, 78%, and 90% respectively.

After 3 hours, 6 hours, 12 hours, 24 hours and 48 hours aceta maprid (Admire® /20 SL) percentage showed mortality of fruit fly 16%, 30%, 46%, 54% and 68% respectively. Third treatment was against imeda chloprid (Crown ® 20 SL), the mortality against aceta maprid(Admire ® 20 SL) after 3 hours, 6 hours, 12 hours, 24 hours and 48 hours was recorded as 22%, 30%, 40%, 48% and 64% respectively.

In the fourth treatment the chemical steward (DU PONT ®12.5 EC) was applied on fruit fly and the results for mortality after the treatment of 3 hours, 6 hours, 12 hours, 24 hours and 48 hours were 36%, 52%, 60%, 72% and 84% respectively, so the results indicate that steward is also a good chemical for the control of peach fruit fly following coragen.

Observations taken after 3 hours, 6 hours, 12 hours, 24 hours and 48 hours for the mortality of peach fruit fly against flufenoxuron (Cascade® /05 ES) was recorded as 24%, 44%, 54%, 64% and 82% respectively. Flufenoxuron is not a common insecticide against fruit flies, but in lab condition the results were better for the control of fruit flies.

In the same pattern last taken treatment insecticide NitenPyramid (Capstar® /10 SL) was observed with the time intervals of 3 hours, 6 hours, 12 hours, 24 hours and 48 hours and the mortality percentage was 18%, 30%, 44%, 54% and 66% was recorded respectively.

In the insecticidal observation it seemed that these chemicals are faster as well as are more efficient for the control of peach fruit fly as compared to botanical extracts. Botanical extracts are slow in action but are environmental friendly as compared to insecticides. Neem is a famous botanical insect controlling agent used in the whole globe especially in Asia. In the taken experiments five observations were taken against the control of peach fruit fly by neem seed extract, and after 3 hours mortality was about 18%, after 6 hours, 12 hours, 24 hours and 48 hours the mortality was recorded 28%, 34%, 44% and 54% respectively. In the same manner other botanical extract was selected kor-tuma fruit extract and the mortality percentage against peach fruit fly at the time intervals of 3 hours, 6 hours, 12 hours, 24 hours and 48 hours were 12%, 14%, 22%, 30% and 38% recorded respectively.

DISCUSSION

The insecticides of synthetic origin are being used on large scale to control various insect pests. It is considered that the application of insecticides is quick control method for insect pests. And in 3rd world countries like Pakistan insecticides are often used because Formers in the countries are not well aware about biological control. But plant extract is being used now a day to control agricultural pest.

Coragen was tested by Bassi *et al.* in the field experiments in Europe; it showed high biological activity as regards the apple condling moth, Colorado potato beetle as well as European grapevine moth. Results were taken in 2008-09, when coragen was recorded as a registered insecticide in many countries. And it was taken successfully as a tool in integrated pest management. In this research study coragen was proved as a good fruit fly controlling insect pests present on fruits. So coragen can not only be used for Colorado potato beetle (*Leptinotarsa decemlineata*), European grapevine moth (*Lobesia botrana*) and apple codling moth (*Cydia pomonella*) but fruit flies can also be controlled with significant results.

Coragen is used for the control of diverse species of spiders. With the change in concentrations sensitivity of coragen also changed. In the results of Dinter *et al.* (2008) applied 10 to 60 gram pynaxypyr /ha. The formulations of coragen and altocor were insensitive upto 750 gram /ha, but these insecticides were decleared as a good controlling chemicals with slow environmental impacts. In this regard coragen is proved to be excellent chemical tool for the use in integrated pest management (IPM) Programmes.

Imedacloprid is mostly used for the control of soft bodied insect pests of cotton in Pakistan. Hu and prokopy (1998) tried imedacloprid on apple maggot flies and checked the efficacy of imedacloprid against these flies for the period of about 7 days. After the tests in laboratory imedacloprid was found best as if it is orally ingested, and mortality was stabilized after 4 days of treatment but in present studies where imedacloprid is applied on thorax region of *Bactrocera zonata* and after 2 days mortality was recorded 64% from total population under laboratory conditions.

Imeda cloprid and aceta maprid were already checked on fruit flies by Chuang and Hau (2008), with the use of methyl eugenol. In the results imedacloprid and aceta maprid caused about 60-80% mortality at about 24 to 72 hours after treatment, in the same manner current study resulted the mortality caused by amedacloprid 54% after 24 hours while after 48 hours mortality was recorded about 68% and aceta maprid caused 48% mortality after 24 hours and after 48 hours mortality was recorded 64%.

In some research experiments Haider *et al.* (2011) worked in Multan on different insecticides under the laboratory reared population of fruit flies (*Bactrocera zonata*). In the experiment different insecticides including steward were used, results of the research work showed the hierarchy of insecticides in order to their effects. In the resistance pattern diptrex was more resistance followed by caracron, confidor, talstar, karate, melathion and deltamethrinafter 24 hours of treatment.

Flufenoxuron is not widely used for the control of fruit flies, Abd-Elhady and heikal worked in 2011 for the control of mites and spiders by using Flufenoxuron. After the three weeks of treatment of Flufenoxuron, results for mortality clears about 78.64 to 87.70%, as in the current research work parameters are different so Flufenoxuron caused 82% mortality in 5th observation for fruit flies, so there are many similarities in the result patterns of previous work and current studies on flufenoxuron.

Although Botanical extracts are slow in action but these cheap replacements for insecticides are also environmental friendly. In a research study *Citrullus colocynthis* (kor-tuma) mortality differences were checked by Ur-rehman *et al.* in 2009 on fruit flies for guava by changing extract solvent. In the ether mortality was recorded 27.27% in acetone 24.53% and among these 3 solvents ethanol extract caused 34.55% mortality. In my research work kor-tuma fruit extract was proved to be last option as percentage mortality against kor-tuma after 24 hours was 30% and 38% after 48 hours of treatment which was comparatively at lowest position among both insecticides and botanical extracts.

Different concentrations of neem (600, 300, 150, 75, 37.5 and 18.7 ppm) were used by Mahmoud and Shoeib (2008) against fruit fly *Bactrocera zonata* under laboratory conditions by fruit dip method. Result were significantly similar with my research work and mortality was recorded about 65.8% which increased control of fruit flies up to 89.0% because egg hatching decreased upto 76.2% at 600 ppm. In my research experiments neem seed oil proved to be good among both of botanical extracts, as Kor-tuma caused about 38% mortality after 48 hours of exposure while at same time observations neem seed oil caused 54% mortality.

Fruit flies attacking in the areas where fruit plants are on the boundaries of other cereal as well as commercial field crops can be controlled successfully by alternative options used in this research work which also reduce field pests, as a replacement for the using well known fruit fly controlling chemicals and among these chemicals coragen (DU PONT® /20 EC) proved to be the best one insecticide.

Table 1
LT_{50} of given mortality data against peach fruit fly.

Insecticide/botanical Extract	LT 50 (Lower, Upper)	X^2	SLOPE	P
Coragen	3.29268 (-6.17802, 8.95602)	4.86624	0.0322948	0.182
Aceta Maprid	25.6686 (19.6402, 33.9331)	6.65358	0.0268938	0.084
Imeda Chloprid	29.3405 (22.0917, 41.4564)	1.6672	0.0225860	0.644
Steward	7.25195 (-2.25278, 13.3195)	3.23113	0.0274016	0.353
Flufenoxuron	14.5302 (8.89370, 19.6294)	4.68836	0.0326786	0.196
Niten pyramid	26.5570 (20.1397, 35.8214)	5.19408	0.0252190	0.158
neem Seed oil	38.5694 (28.9054, 61.4716)	2.29587	0.0192508	0.513
kor tuma fruit extract	60.8112 (44.3943, 115.142)	1.54509	0.0180768	0.672

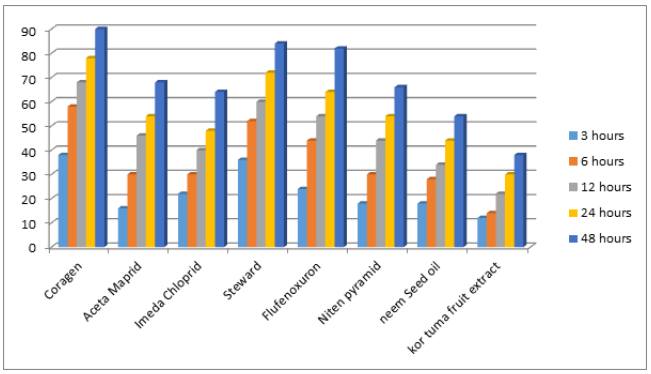

Fig. 1
Percentage mortality of *Bacterocera zonata* after 3, 6, 12, 24 and 48 hours.

Authors' contributions

GH and SA helped in collection of infested fruits; DH guided in rearing the fruit flies. SH reared, took experimental work and summarized that data; BR and MA helped in statistical analysis. MA revised and corrected mistakes. SMH read and approved the final manuscript.

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