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Research Article

EFFECTIVENESS OF NEW CHEMISTRY INSECTICIDES AGAINST *BACTROCERA ZONATA* (*DIPTERA: TEPHRITIDAE*)

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ABSTRACT

Fruit fly is quarantine pest so infested fruit and vegetables restricted to export. *Citrus* fruit is important fruit crop in Pakistan which exports to other countries. Large numbers of insect pest are attacked to *Citrus* fruit in which fruit fly is one of most major pests now days in Pakistan. Fruit fly has short life cycle, high fecundity, and wide host ranges that why difficult to control. The present study was carried to check the efficacy of new chemistry insecticides against *Bactrocera zonata* and their behavior in *Citrus* fruits. Fruit fly was collected from different fruit orchards and brought them into the laboratory. Fruit fly colony was maintained in the plastic jars to developed large population which need in the bioassay study. To check the efficacy of new chemistry insecticides, bottle and leaf dip method was used. Result demonstrated that maximum percentage mortality (50.00±2.88, 53.33±4.40 and 60.00±2.88) was recorded in trichlorfon treated bottle with 16 ppm concentration n after 24 h, 48 h, and 72 h exposure of insecticides, respectively. Trichlorfon was the most effective insecticide to control fruit fly in both bottle and leaf dip method at 16 ppm dose while Emmamectin benzoate and spinosad were also effective as compared to others. Feedings behavior was more affected by trichlorfon treated plants as compared to remaining. Hence, it can be concluded that trichlorfon was efficient insecticides to control fruit fly in *Citrus*.

Keywords: *Bactrocera zonata*, Management, Insecticides, Behavior, Insect pest.

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INTRODUCTION

Horticultural crops have great effect for human diet which is our importance as for food and medicine point of value. *Citrus* is an important fruit crop throughout the world, in Pakistan, it is important because it can export to other countries in return large amount of income. *Citrus* fruit attacked most insect pest and diseases. Fruit fly is major insect which can caused in the form direct and indirect form (Alyokhin *et al*., 2001; Ekesi and Billah, 2007). Fruit fly polyphagous in nature and have wide range of hosts, short life cycle, high fecundity rate, and lay egg inside the host that is why difficult to control (Armstrong, 2003; Follett and Armstrong, 2004). The larvae feed inside the fruit which can cause the rotting of the fruit so that that is inconsumable for human. Fruit can be completely destroying by fruit larvae because it has three instar (Dhillon *et al*., 2005). Losses due to fruit vary from variety to variety, area, and environmentally condition. The losses range 30–80% in different fruit and vegetables (Ekesi *et al*., 2006). Loss causes by fruit fly 5–100% (Syed, 1970) 60–80% (Jalaluddin *et al*., 1999), and 90–100% (Kapoor, 1993).

Fruit fly belong to family *tephritidae* and order *Diptera*, the *tephritidae* family have five economically important genra which included *anestrepha*, *ceratitis*, *dacus*, *rhagoletis,* and most important one *bactrocera*, which is very important pest of fruit and vegetables. The family has more than 400 plants host throughout the world (White and Elson-Harris, 1992; USDA., 2012).

For the control of fruit fly, different experiment has been done under laboratory condition, direct application of insecticides (Wang *et al*., 2013), in the field condition (Yee *et al*., 2007; Rahman and Broughton, 2016), applied on fruit to exposure of residues and aged in the laboratory condition (Maklakov *et al*., 2001; Yee, 2008; Yee and Alston, 2012), application on infested fruit (Wise *et al*., 2009) and apply on artificial substrate to determine the determine limit of insecticides (Mosleh *et al*., 2011).

To determine the efficacy of different insecticides against fruit fly (Reissig, 2003; Oke, 2008; Khursheed and Raj, 2012) also field experiment conducted of fruit fly (Yee and Alston, 2006; Oke and Sinon, 2013; Macfadyen *et al*., 2014). Different types of insecticides apply to check the efficacy under laboratory condition against fruit fly (Reynolds *et al*., 2014).

The study will be conducted under laboratory condition to check the efficacy of new chemistry insecticides. The behavior of fruit fly also check against different new chemistry insecticides. This study may be helpful in the future for control of fruit fly in the *Citrus* orchards.

To meet this pest new chemistry insecticides will be checked with following objectives:

- To determine the efficacy of new chemistry insecticides against fruit fly
- To determine the new chemistry insecticides feeding behavior against fruit fly.

METHODS

Insect's culture

Fruit fly was collected from different various fruit orchards of Punjab and brought them into the laboratory conditions. Fruit fly colony maintained in the plastic jars to developed large population which need in the bioassay study. Artificial diet was provided as a food.

Bioassay using the bottle and dip method

To test the different insecticides efficacy, bottle bioassay was used. Different concentration of new chemistry was made in acetone and for control simple acetone will be used. The size of bottle was 2.5 cm diameter and height 4.7 cm. 150 mL of each concentration of insecticides and acetone was applied inside the bottle. After the application, bottle will be dried for thirty minutesby rotating the bottle.

In each bottle, 20 mix population of fruit was placed and cap of bottle secured loosely (Boina *et al*., 2009). The data on mortality of fruit fly were recorded after 24, 48, and 72 h. The experiment was laid under completely randomized design with five replications.

To determine the effectiveness of new chemistry insecticides, leaf dip method was used. 1.5% of agar solution was made and cooled it. The agar solution was put on 55 mm petri dish and then put *Citrus* leaf on it. Leaf disc was dipped in the prepare concentration for thirty second and simple water was used as control. These dipped leaf disc then dry for 1 h in the hood. After drying, 25 number of fruit fly mixed population was transferred which was anesthetization with carbon dioxide for 1 s (Tiwari *et al*., 2012). The temperature of laboratory was 25±5°C and relative humidity 60%. Data were taken after the 24, 48, and 72 after the treatment. Four replications were used for this experiment.

Feeding behavior of fruit fly

For feeding behavior against the new chemistry insecticides were determined using different concentration. *Citrus* plants which were at young stage and size up to two feet treated with different concentration for control only water spray and then dried for thirty minutes. After drying, the plants were placed under the cage. The 50 fruit fly was placed into the cage. After 24, 48, and 72 h, data were taken by calculating the fly on each treated plant, wall of cage, and dead. Three replications were used in this experiment.

Statistical analysis

The data were collected and analyzed with Statistic 8.1 software.

RESULTS AND DISCUSSION

The contact residual toxicity of insecticides was determined under laboratory condition using two method such as bottle method and leaf dip method. Five insecticides were used with four replications of each treatment. Data were recorded after 24 h, 48 h, and 72 h. The present study results demonstrated that trichlorfon was most toxic among the tested insecticides followed by Spinosad, Novaleuron, Emmamectin Benzoate, and Buprofezin against *Bactrocera zonata*.

The maximum percentage mortality (50.00±2.88, 53.33±4.40, and 60.00±2.88) was recorded in trichlorfon treated bottle with 16 ppm concentration n after 24 h, 48 h, and 72 h exposure of insecticides, respectively.

The percentage mortality of *B. zonata* using Spinosad, Novaleuron and Emmamectin Benzoate was (41.66±4.40, 50.00±7.63, and 61.66±4.40), (45.00±2.88, 55.00±7.63, and 56.66±6.00) and (28.33±4.40, 46.66±1.66, and 40.00±2.88) after 24 h, 48 h, and 72 h, respectively. The minimum percentage mortality (25.00±5.77, 31.66±8.81 and 25.00±10.40) was recorded in Buprofezin treated bottle method after 24 h, 48 h, and 72 h (Table 1). During the study, toxicity of Buprofezin was reduced after 72 h while increased 48 h of application in the bottle methods. Minimum percentage mortality was recorded in all treatment at low concentrations (2, 4, and 8 ppm). In the present study, trichlorfon was found most toxic insecticide against *B. zonata* while some other scientists had reported that Emmamectin benzoate most toxic insecticide (Khan and Naveed, 2017).

In the leaf dip method, trichlorfon was found most toxic insecticide after 72 h while found least toxic after 24 h of post treatment. Trichlorfon was most toxic insecticides and give 37.33±3.52, 44.00±2.30, and 54.66±3.52% mortalities of *B. zonata* after 24, 48, and 72 h of post-treatment, respectively. Among all tested insecticides, trichlorfon was recorded toxic insecticides at high concentration (16 ppm).

Emmamectin benzoate and spinosad was showed equal mortalities (48.00±2.30) of *B. zonata* after 72 h of treatments (Table 2). After 24 and 48 h of post-treatment, spinosad showed almost 40% of mortalities of *B. zonata*. Trichlorfon was comparatively effective but *B zonata* develop resistance against this insecticide (Nadeem *et al*., 2012). Some other scientist reported that Emmamectin benzoate comparatively more toxic ((Ishaaya *et al*., 2002) while in the present study, Emmamectin benzoate was comparatively less toxic to trichlorfon against *B. zonata*.

Feeding behavior of *B. zonata* was assed against insecticides, result showed that trichlorfon was found most toxic insecticide after 72 h while rest insecticides found least toxic of post-treatment. Trichlorfon was most toxic insecticides and give 37.33±3.52, 44.00±2.30, and 54.66±3.52% mortalities of *B. zonata* after 24, 48, and 72 h of post-treatment, respectively (Table 3). Among all tested insecticides, trichlorfon was recorded toxic insecticides at high concentration (16 ppm).

Table 1: Efficacy of insecticides against fruit fly, *Bactrocera zonata* by bottle method under laboratory condition

Bottle method				
Treatment	**Conc. (ppm)**	**±SE mortality**		
		24 h	**48 h**	**72 h**
Trichlorfon	2	6.66±1.66^{cd}	5.00±0.00^{bc}	8.33±4.40^{c}
	4	18.33±1.66^{c}	16.66±4.40^{b}	20.00±2.88^{c}
	8	33.33±4.40^{b}	40.00±2.88^{a}	36.66±4.40^{b}
	16	50.00±2.88^{a}	53.33±4.40^{a}	60.00±2.88^{a}
Buprofezin	2	1.66±1.66^{B}	1.66±1.66^{B}	5.00±2.88^{A}
	4	10.00±2.88^{B}	5.00±2.88^{B}	3.33±1.66^{A}
	8	11.66±4.40^{AB}	6.66±4.40^{B}	13.33±3.33^{A}
	16	25.00±5.77^{A}	31.66±8.81^{A}	25.00±10.40^{A}
Emmamectin Benzoate	2	1.66±1.66^{C}	1.66±1.66^{C}	5.00±2.88^{B}
	4	10.00±2.88^{BC}	5.00±2.88^{C}	3.33±3.33^{B}
	8	20.00±2.88^{AB}	20.00±2.88^{B}	30.00±2.88^{A}
	16	28.33±4.40^{A}	46.66±1.66^{A}	40.00±2.88^{A}
Spinosad	2	3.33±1.66^{C}	1.66±1.66^{C}	5.00±2.88^{B}
	4	15.00±2.88^{BC}	6.66±4.40^{C}	10.00±2.88^{B}
	8	26.66±4.40^{AB}	21.66±4.40^{B}	30.00±2.88^{A}
	16	41.66±4.40^{A}	50.00±7.63^{A}	61.66±4.40^{A}
Novaleuron	2	1.66±1.66^{C}	3.33±1.66^{C}	5.00±2.88^{C}
	4	18.33±1.66^{B}	21.66±6.00^{BC}	18.33±1.66^{BC}
	8	25.00±2.88^{B}	25.00±2.88^{B}	35.00±5.77^{B}
	16	45.00±2.88^{A}	55.00±7.63^{A}	56.66±6.00^{A}

Mean values in columns having different letters are statistically significant (α=0.05)

Table 2: Efficacy of insecticides against fruit fly, *Bactrocera zonata* by Leaf dip method under laboratory condition

Leaf dip method				
Treatment	**Conc. (ppm)**	**±SE Mortality**		
		24 h	**48 h**	**72 h**
Trichlorfon	2	4.00±2.30^{C}	4.00±2.30^{C}	9.33±1.33^{C}
	4	17.33±1.33^{B}	18.66±3.52^{B}	17.33±1.33^{BC}
	8	26.66±3.52^{AB}	17.33±1.33^{B}	30.66±5.33^{B}
	16	37.33±3.52^{A}	44.00±2.30^{A}	54.66±3.52^{A}
Buprofezin	2	6.66±1.33^{BC}	4.00±2.30^{C}	5.33±1.33^{C}
	4	16.00±2.30^{B}	12.00±6.11^{BC}	4.00±2.30^{C}
	8	18.66±4.80^{B}	25.33±3.52^{AB}	26.66±4.80^{B}
	16	32.00±2.30^{A}	40.00±2.30^{A}	49.33±1.33^{A}
Emmamectin Benzoate	2	8.00±2.30^{C}	4.00±2.30^{C}	2.66±2.66^{C}
	4	12.00±2.30^{C}	13.33±4.80^{BC}	6.66±3.52^{C}
	8	25.33±3.52^{B}	26.66±4.80^{AB}	25.33±3.52^{B}
	16	40.00±2.30^{A}	42.66±3.52^{A}	48.00±2.30^{A}
Spinosad	2	8.00±2.30^{CD}	4.00±2.30^{C}	9.33±3.52^{C}
	4	20.00±2.30^{BC}	17.33±3.52^{B}	25.33±4.80^{B}
	8	26.66±3.52^{B}	24.00±2.30^{B}	32.00±4.00^{B}
	16	40.00±2.30^{A}	40.00±4.00^{A}	48.00±2.30^{A}
Novaleuron	2	8.00±2.30^{B}	4.00±2.30^{C}	4.00±4.00^{C}
	4	12.00±2.30^{B}	26.66±4.80^{B}	16.00±4.61^{BC}
	8	28.00±2.30^{A}	26.66±4.80^{B}	34.66±3.52^{AB}
	16	37.33±3.52^{A}	49.33±2.66^{A}	48.00±4.61^{A}

Mean values in columns having different letters are statistically significant (α=0.05)

Table 3: Effect of insecticides against fruit fly, *Bactrocera zonata* feeding behavior under laboratory condition

Feeding behavior				
Treatment	Conc. (ppm)	±SE Mortality		
		24 h	48 h	72 h
Trichlorfon	2	4.00±2.30C	4.00±2.30C	9.33±1.33C
	4	17.33±1.33B	18.66±3.52B	17.33±1.33BC
	8	26.66±3.52AB	17.33±1.33B	30.66±5.33B
	16	37.33±3.52A	44.00±2.30A	54.66±3.52A
Buprofezin	2	6.66±1.33BC	4.00±2.30C	5.33±1.33C
	4	16.00±2.30B	12.00±6.11BC	4.00±2.30C
	8	18.66±4.80B	25.33±3.52AB	26.66±4.80B
	16	32.00±2.30A	40.00±2.30A	49.33±1.33A
Emmamectin Benzoate	2	8.00±2.30C	4.00±2.30C	2.66±2.66C
	4	12.00±2.30C	13.33±4.80BC	6.66±3.52C
	8	25.33±3.52B	26.66±4.80AB	25.33±3.52B
	16	40.00±2.30A	42.66±3.52A	48.00±2.30A
Spinosad	2	8.00±2.30CD	4.00±2.30C	9.33±3.52C
	4	20.00±2.30BC	17.33±3.52B	25.33±4.80B
	8	26.66±3.52B	24.00±2.30B	32.00±4.00B
	16	40.00±2.30A	40.00±4.00A	48.00±2.30A
Novaleuron	2	8.00±2.30B	4.00±2.30C	4.00±4.00C
	4	12.00±2.30B	26.66±4.80B	16.00±4.61BC
	8	28.00±2.30A	26.66±4.80B	34.66±3.52AB
	16	37.33±3.52A	49.33±2.66A	48.00±4.61A

Mean values in columns having different letters are statistically significant (α=0.05)

CONCLUSION

In general, trichlorfon is comparatively safe alternative to the insecticides in use for the control of *B. zonata*. Trichlorfon was most toxic among the tested insecticides followed by Spinosad, Novaleuron, Emmamectin Benzoate, and Buprofezin against *B/zonata*.

CONFLICTS OF INTEREST STATEMENT

We declare no conflicts of interest.

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