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Potential of bifenthrin and chlorfenapyr for the management of *Rhyzopertha Dominica* (Fab.) and *Tribolium Castaneum* (Herbst)

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Abstract
The *Tribolium castaneum* (Herbst) and *Rhyzopertha Dominica* (Fab.) are potential pests of stored wheat products that causes destruction to stored grains all over the world. The current investigation was planned to examine the potential of bifenthrin and chlorfenapyr for *T. castaneum (*red flour beetle) and *R, Dominica (*Lesser grain borer). A total of 50g sample of wheat was taken in jars. Both bifenthrin and chlorfenapyr were applied at concentrations of 0.25, 0.5, 1, 2, and 4ppm, separately. Factorial design under CRD was used and each treatment was replicated thrice. The rate of mortality recorded timely at intervals of 12, 24, 48, 72 and 96 hours accordingly. All the treatments showed statistically significant results with doubling the dose of insecticide but some were non-significant as well. However, the highest mortality caused by chlorfenapyr was noted98.746% in case of *T. castaneum* while 89.643% in case of *R. Dominica* after 96 hours. Results showed that chlorfenapyr proves more lethal against *R. Dominica* and bifenthrin proves more lethal against *T. castaneum*.

Keywords: Mortality rate, chlorfenapyr, bifenthrin, *Tribolium castaneum*, *Rhyzopertha Dominica*

1. Introduction

Most important stored grains in Pakistan are wheat, rice, maize, sorghum and millet. While wheat is staple food crop of Pakistan. It is one of most important crop and as well a big source of income and food. From 2020-2021, the production of wheat remained 26.0 million tones.

In Pakistan, the *R, Dominica* is considered as economically important pest of stored grain (Chanbang *et al*., 2008) [2]. In comparison with other pests of stored grains, both *Rhyzopertha Dominica (*Lesser grain borer) *and Tribolium castaneum (*red flour beetle) are causing massive destruction of wheat grains. It's too tough to control the *R. Dominica* because of its development inside the grain (Vardeman, *et al*., 2007) [18].

In maize sequenced developmental growth generally considered as basic characters for attaining resistance against the destruction caused by *R. Dominica*. A relationship between breakdown rate as well as splitting of wheat grains caused by lesser grain borers was also observed (Kavallieratos *et al*., 2012-Chanbang *et al*., 2008 [22, 2], and those grains varieties with hard skin seed shells have been noted as much more tolerant (Chanbang, *et al*., 2008) [2]. However, an experiments was performed on African varieties which had shown that are harsh hard as well as husk protection can provided the resistance to *R. Dominica* (Chougourou *et al*., 2013) [3], but the experiment of (Astuti *et al*., 2013) [1] performed in Indonesia had evaluated that high phenolic ingredients and hardness can maximizes the resistance against damage caused by *R. Dominica*. In case of wheat, the susceptibility is not correlated with kernel seed coat hardness but directly correlated with the percentage of total protein (Watts and Dunkel, 2003) [19].

By knowing the earlier advantages of every method for controlling pests, we can select the most leading pest management strategies (Espino *et al*., 2014) [5].The *R. Dominica* in both larval and adult stages can deteriorate whole wheat grains (Chougourou *et al*., 2013) [3]. The adult stages of lesser grain borer are long lived, with strong wings and laying 1 to 7 eggs per day during various months by female (Flinn and Hagstrum, 1994) [7] while overall egg production by a female *R. Dominica* during her life time is 200-500. Last instar larva of *R. Dominica* gradually act as an adult present in the feeding cavity of grain. The normal life period for the pupil stage is approximately up to 8 days at 25 ºC and 5 to 6 days at the

Temperature of 28 ºC. The healthy pupa is approximately 3.9 mm long, with coloring whitish brown white. However, some appendages on the rounded end of pupal body are also present that depends on its sexual discrimination. In case of male pupa, two segments are present that are convergent, but in females, three segments are present that are divergent (Nguyen DT. 2006) [23].

The most potential pest of stored grain products which causes the severe damage and potential source of economic losses throughout the global is *T. castaneum* (Danahaye, *et al*., 2004) [4]. This pest stayed within food present in store houses, storage mills, god owns as well as on many important plants. The adults and larvae both feed on the already damaged grains. These pests cause the weight, nutrients and quality losses and damage the stored product grains completely (Haq., *et al*., 1992) [10].

Bifenthrin as pyrethroid was invented in 1990s that is an effective protectant of stored gains product (Wilkin, *et al*., 1994-1999) [2]. Bifenthrin insecticide is registered in various European countries. Bifenthrin is used for controlling the *R. Dominica* and *T. castaneum* but efficacy of the bifenthrin is low because pests develop resistance against bifenthrin. Many authors had investigated the resistance of insects against the organophosphates such as Chlorpyrifos-methyl, Malathion as well as pirimiphos-methyl (Zettler, 1990) [21], and pyrethroid such as fenvalerate, bioresmethrin as well as deltamethrin (Lorini and Galley, 1999).

Chlorfenapyr that is parole group have leading effect on mortality of pests specially *T. castaneum and R. Dominica* (Romero, *et al*., 2010, Davies, *et al.,* 2012) [17, 24]. Chlorfenapyr act as pro-insecticide which is nontoxic for mammals. (Romero, *et al*., 2010, Raghavendra, *et al*. 2011) [10, 15]. By the effect of chlorfenapyr, cytochrome P450s in insect changes into metabolite CL 303268 or tralopyril form which is most toxic metabolite. The removal of the Nethoxymethyl group from the compound causes oxidation process in the body of *T. castaneum*. (Romero, *et al*., 2010, Raghavendra, *et al*. 2011) [10, 15].

In this article, we studied the potential of insecticides (chlorfenapyr and bifenthrin) against *R. Dominica* and *T. castaneum.*

2. Materials and Methods

2.1 Experimental Site

The research was done to find out the “Potential of bifenthrin and chlorfenapyr for the management of *R. Dominica* and *T. castaneum* in the Grain Research Training and Storage Management Cell, Department of Entomology, University of Agriculture Faisalabad, during the session 2018-2019.

2.2 Experimental Layout

Collection of Insects

The test insect pests, *R. Dominica* and *T. castaneum* were collected from infected cereals as well as wheat from different places like grain market, go down, and storage structures of farmer and also from house bins. The collected populations were reared on wheat grains and used for more investigation.

Rearing of Insects

From grain market, go down etc. pest population was gathered in a jar, the populations of *R. Dominica* and *T. castaneum* were reared separately, having moisture content 14%, at temperature 28±2 °C and 65±5% RH and each population was labeled separately. For the *R. Dominica* wheat and for *T. castaneum* flour was used as food and rearing media. In each jar containing 50g sterilize wheat, 30 adults of *R. Dominica* were released and this jar closed with muslin cloth. Then these insects were allowed to lay eggs and multiply for 20 days. After laying eggs, adult of both strains was sieved from the jars. In order to obtain homogenous population, sample along with laid eggs put in jars again and to prevent the escaping of newly borers from jar, they were covered with muslin cloth and then jar placed in the incubator at 28±2 °C and65±5% R.H. The mortality data was collected after 12, 24, 48, 72 and 96 hours of exposure against chlorfenapyr. The generation appeared then used for further experiments.

2.3 Insecticide Bioassay

a. Application of Chlorfenapyr

Five concentrations of chlorfenapyr 4, 2, 1, 0.5 and 0.25ppm were prepared in distilled water. Filter papers were used for the purpose of insecticide application to examine the potential of insecticides on *R. Dominica* and *T. castaneum*. Every concentration of the insecticide was replicated 3 times with the help of complete randomized design or CRD. Then each concentration was applied on filter paper and distributed these concentrations fully on filter paper. The petri dishes covered properly to prevent the pests from escaping. Then the petri dishes were kept into the incubator under the temperature of 28±2 °C and 65±5% relative humidity. Then the mortality data was recorded after 12, 24, 48, 72 and 96 hrs. of exposure against chlorfenapyr. The generations of pests appeared then used for further experiments.

b. Application of Bifenthrin

Five concentrations of bifenthrin 4, 2, 1, 0.5 and 0.25ppm were prepared in distilled water. Filter papers were used for the purpose of insecticide application to examine the potential of insecticides on *T. castaneum* and *R. Dominica*. Every concentration of insecticide was replicated three times with the help of complete randomized design or CRD. Then each concentration was applied on filter paper and distributed these concentrations fully on filter paper. The petri dishes covered properly to prevent the pests from escaping. Then the petri dishes were kept into the Incubator under the temperature of 28±2 °C and 65±5% relative humidity. Then the mortality data was recorded after 12, 24, 48, 72 and 96 hrs of exposure against bifenthrin.

2.4 Statistical analysis

The mortality data for adult insects was calculated by using Abbott’s formula (Abbott, 1925) [25] and the corrected mortality data as well as all the other treatments were calculated statistically by using Factorial design under CRD with the help of software Statistic 8.1 and Statistical. The significant as well as non-significant results were compared with each other by using Tukey’s HSD test.

3. Results

For determinations of mortality rate in *T. castaneum* and *R. Dominica* caused by bifenthrin and chlorfenapyr, this study was conducted. Lab strain of both *R. Dominica* and *T. castaneum* were used. For bifenthrin, five concentrations (0.25, 0.5, 1, 2 and 4ppm) and for chlorfenapyr (0.25, 0.5, 1, 2 and 4ppm) were used. The possession of application was noted after (12, 24, 48, 72 and 96) hour of exposure period.

- **ANOVA table evaluating the effect of insecticides (chlorfenapyr and bifenthrin) against mortality rate of *T. castaneum***

Table: ANOVA table evaluating the effect of insecticides (chlorfenapyr and bifenthrin) against mortality rate of *T. castaneum*

SOV	DF	SS	MSS	F value	P
Insecticides	1	777.5	777.5	57.07**	0.000001
Concentrations	4	658.3	164.6	12.08**	0.000087
Insecticides*Conc.	4	232.7	58.2	4.27*	0.011643
Error	20	272.5	13.6		
Total	29	1941.0			

ANOVA table showed that there were considerable differences between the main effects that showed highly significant results however the effect of interaction was significant for the mortality of *T. castaneum.*

Table 1: Mortality effects of Chlorfenapyr and Bifenthrin at different concentrations of against *T. castaneum*

Time (hours)	Concentrations (ppm)	Mortality ± S.E*	
		(Bifenthrin)	(Chlorfenapyr)
12	0.25	7.85±1.12 c	6.86±2.31 c
	0.5	10.10±2.24bc	10.23±1.06 bc
	1	15.72±1.94 abc	11.29±1.06bc
	2	19.09±3.37 ab	12.41±1.89abc
	4	21.34±2.24a	14.59±1.12abc
24	0.25	31.39±1.16cd	26.963±3.894228d
	0.5	33.71±2.01 bcd	31.45±4.49 cd
	1	41.39±2.09bcd	38.20±2.97 bcd
	2	47.44±2.21 ab	38.20±2.97 bcd
	4	57.90±3.82a	43.81±1.94 abc
48	0.25	40.47±5.95 c	46.34±1.220bc
	0.5	46.42±4.12bc	48.77±2.11abc
	1	53.57±3.57abc	57.31±1.21 abc
	2	55.95±5.18abc	58.53±1.21ab
	4	64.28±4.12 a	64.63±1.22 a
72	0.25	65.72±4.48 ab	60.48±3.26b
	0.5	68.15±4.75ab	59.25±4.27 b
	1	77.91±0.12 a	65.42 ±4.45ab
	2	80.48±1.22a	65.42±4.45 ab
	4	80.48±1.22 a	75.29±1.23 ab
96	0.25	75.60±3.22 d	93.74±2.49ab
	0.5	80.47±3.22 cd	95.13±1.32 ab
	1	86.58±2.44bc	94.99±1.25 ab
	2	91.45±1.21ab	98.74±1.25 a
	4	96.33±2.11 ab	98.74±1.25a

This table showed that the percentage mean corrected mortality values for bifenthrin and chlorfenapyr at different time intervals against *T. castaneum*. All the exposure periods are significant from each other. Highest percent mean mortality caused by bifenthrin was calculated 96.33% after 96 hrs. and for chlorfenapyr mean mortality 98.74% was calculated after 96 hr.

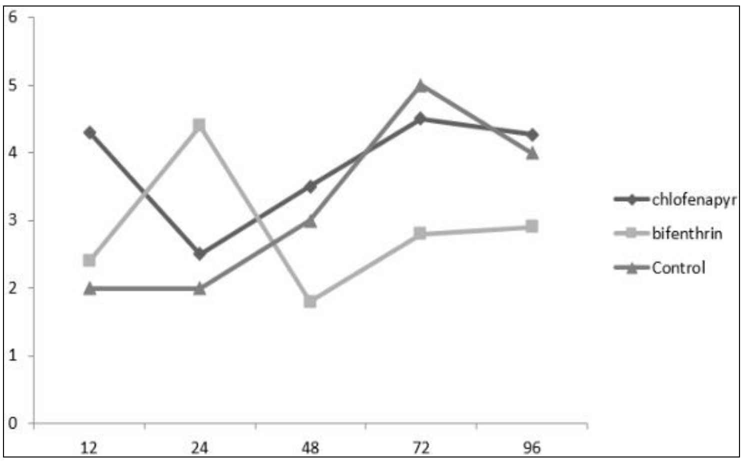

Fig 1: Mortality effects of Chlorfenapyr and Bifenthrin at different concentrations of against *T. castaneum*

Table: ANOVA table evaluating the effect of chlorfenapyr and bifenthrin against mortality rate of *R. Dominica*

SOV	DF	SS	MSS	F value	P
Insecticides	1	1357.3	1357.3	36.215**	0.000007
Concentrations	4	675.2	168.8	4.504**	0.009323
Insecticides*Conc.	4	36.2	9.1	0.242	0.911288
Error	20	749.6	37.5		
Total	29	2818.3			

ANOVA table showed that there were considerable differences between the main effects that gave highly significant results however the effect of interaction was non-significant for the death rate of *R. Dominica.*

Table 2: Mortality effects of Chlorfenapyr and Bifenthrin at different concentrations against *R. Dominica*

Time (hours)	Concentrations (ppm)	Mortality ± S.E*	
		Bifenthrin	Chlorfenapyr
12	0.25	4.78±1.27c	4.48±1.12 c
	0.5	5.76±1.95 c	6.73±1.12 bc
	1	8.00±0.97bc	7.79±1.09bc
	2	9.13±1.81bc	14.57±3.00 ab
	4	12.35±1.94abc	17.97±1.12 a
24	0.25	19.53±2.29cd	7.68±2.56d
	0.5	20.68±1.98cd	16.66±2.22cd
	1	24.13±1.99 bc	26.91±1.28abc
	2	29.88±4.14abc	37.03±4.42 ab
	4	37.92±3.98ab	41.02±2.56 a
48	0.25	26.43±3.04 cd	18.60±1.160 d
	0.5	33.33±6.08abcd	18.60±1.160 d
	1	26.20±7.20cd	27.90±1.163 bcd
	2	42.52±2.29abc	36.04±1.16 abc
	4	47.12±2.30a	44.18±2.01 ab
72	0.25	43.92±7.75 c	46.66±3.52 c
	0.5	42.85±5.45 c	54.66±1.33 bc
	1	47.61±3.14c	61.32±1.33abc
	2	48.69±5.18c	74.66±1.33ab
	4	54.76±4.29bc	77.33±1.33 a
96	0.25	72.430±6.818 d	87.82±2.34 abcd
	0.5	76.36±3.93cd	90.53±1.35abc
	1	78.99±3.47 bcd	93.23±1.35 abc
	2	81.62±3.47abcd	95.93±2.34ab
	4	89.49±4.72abcd	98.64±1.35 a

This table showed that the percentage mean corrected mortality values for bifenthrin as well as chlorfenapyr at different time intervals against *R. Dominica* (fig. 1). All the exposure periods are significant from each other. Highest percent mean mortality for bifenthrin was calculated 89.49% after 96 hrs. And for chlorfenapyr mean mortality was calculated 98.64% after 96 hr.

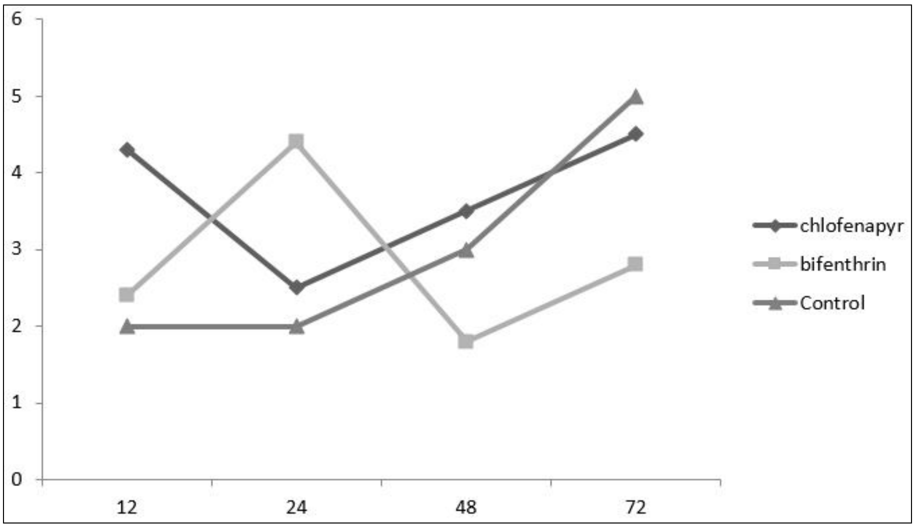

Fig 1: Mortality effects of Chlorfenapyr and Bifenthrin at different concentrations against *R. Dominica*

Discussions

For the purpose of experimentation, pest strain of both *T. castaneum* and *R. Dominica* were utilized. Present study Summarizes that large amount of adult mortality caused by bifenthrin at (4ppm) against *T. castaneum* was noted 97%. While in case of *R. Dominica*, highest mortality calculated was 89.493% at 4ppm.

When filter papers at various concentrations were treated with chlorfenapyr, maximum adult mean percent mortality against *R. Dominica* recorded at 4ppm was 98.643%. While in case of *R. Dominica* maximum mean mortality estimated at 4ppm was 98.643%. All over results related to this research exhibited that value of mortality for both *R. Dominica* and *T. castaneum* rises by increasing the doses of chlorfenapyr and bifenthrin.

Conclusion

The present research concluded that both bifenthrin as well as chlorfenapyr have significant results against *T. castaneum* and *R. Dominica.* While chlorfenapyr proves more lethal against *R. Dominica* and bifenthrin proves more lethal against *T. castaneum*

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