



## BIOCIDAL EFFECT OF DELTAMETHRINE AGAINST *TRIBOLIUM CONFUSUM* DUV. (COLEOPTERA: TENEBRIONIDAE) AND *SITOPHILUS ORYZAE* L. (COLEOPTERA: CURCULIONIDAE) ADULTS IN LABORATORY CONDITIONS

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**Abstract:** *Tribolium confusum* and *Sitophilus oryzae* species are seen in human habitats, mainly in kitchens. They damage the storage products by feeding on crops and disturb people like urban pests in kitchens and homes. Until now, there were no biocidal that could be used to control these species. We carried out to determine the effect of deltamethrin, which is used against some urban pests, on *T. confusum* and *S. oryzae* under laboratory conditions. The recommended dose of the biocidal against urban pests (60 ml/10 liter of water), half dose (30 ml/10 liter of water), and quarter dose (15 ml/10 liter of water) were used in the study. The results showed that the highest amount of the biocidal (60 ml/10 liter of water) resulted in 87.5% mortality in *T. confusum* and 97.5% in *S. oryzae*. The LD<sub>50</sub> value for *T. confusum* is 32.8 and LD<sub>90</sub> is 61.3 ml, and for *S. oryzae*, these values were found to be 18.8 and 38.1 ml, respectively.


**Keywords:** Urban pests, Stored grain pests, Rice weevil, Confused flour beetle


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### 1. Introduction

Various insects and arthropods colonize and reproduce in urban environment. The urban entomology generally deals with the investigation of creepy crawly bugs that plague human-made structures. Some arthropods such as ants, bed bugs, cockroaches, and termites can grow in or around the indoor climate and invade a broad range of substrates, and food sources of humans. Depending on the insect species, these pests can be a reason for aggravation. They can prompt auxiliary harm, their nibbles can cause uneasiness, and presentation to this creepy crawlies can trigger hypersensitive responses. There are many urban pests in human habitats. In addition, some storage pests are seen at home in our kitchens and are considered urban pests from time to time. They often feed on and cause damage to products such as rice, wheat, and flour purchased from shops and used to prepare meals. (Shadia and El-Aziz, 2011; Kocak, 2016; Tyagi et al., 2019).

*Tribolium confusum* Duv. (Coleoptera: Tenebrionidae) and *Sitophilus oryzae* L. (Coleoptera: Curculionidae) are among the most critical species seen in kitchens. These pests significantly reduce grains' nutritional value and seeding characteristics and cause weight losses by feeding on the products. As a result of increasing

populations of pests, mold, mildew, and rotting are observed in the product due to elevated humidity and temperature. Consumption of these products causes essential diseases in humans and animals. In addition, they cause certain diseases such as allergic asthma in humans with their secretions, body scraps, and dirt they produce during feeding. *Tribolium* spp. (Coleoptera: Tenebrionidae) can cause the formation of carcinogenic substances in the product (Stejskal and Hubert, 2006). These two species are widespread in our homes due to the foods found in kitchens. For this reason, these pests are considered urban pests when seen in living areas. These pests are mainly seen in agricultural areas and crop storage (Olejarski et al., 2013; Stejskal et al., 2015; Togantimur and Ozder, 2019). Insecticides and fumigants used against agricultural pests combat these pests in crop storage. In recent years, there have been studies on alternative methods of chemical control against these pests (Athanasios et al., 2016; Karakas, 2016; Ayyıldız and Karaca, 2018; Cetinpolat et al., 2019; Göktürk et al., 2020). However, these insecticides do not apply to human habitats, especially in kitchens. In fact, it is even prohibited. Only licensed biocidal products can be used against urban pests in kitchens. Today, there is no licensed biocidal for controlling *T. confusum* and *S. oryzae*



species. Biocidal, whose active ingredient is deltamethrin used today in the control of urban pests such as mosquitoes, houseflies, cockroaches, and ticks (Cao et al., 2006; Barile et al., 2009; Romero et al., 2009; Jankov et al., 2012; Jahan and Shahid, 2013).

This study analyses the effects of this biocidal (Deltamethrin commercial name is Exdel 5 SC) on *T. confusum* and *S. oryzae* species in laboratory conditions.

## 2. Material and Methods

### 2.1. Insect Culture and Application of Biocidal

The insect species (*T. confusum* and *S. oryzae*) were used in the study and biocidal Exdel 5 SC (5% deltamethrin) were obtained from the entomology laboratory of Ondokuz Mayıs University's Faculty of Agriculture. Anonymous (2016) and Kocak (2016) methods were revised in the study. The recommended dose of the biocidal against urban pests (60 ml / 10 liter of water), half dose (30 ml / 10 lite of water), and quarter dose (15 ml / 10 liters of water) were used in the study. Four repetitions were made for each dose. The tests were conducted in the laboratory at 25±1°C and 60±5% R. H. Plastic containers were used in the study. Different doses of the biocidal were sprayed in these containers (20 cm length, 10 cm width, and 6 cm depth) with a suitable device, 0.5 ml per container. After waiting for 24 hours, 10 adults were placed in the container and brought into contact with the surface. After 30 minutes of contact time, adults on the application surfaces were transferred into clean containers. The mortality was noted over 1<sup>st</sup>, 3<sup>rd</sup> and 5<sup>th</sup> days following application. Dead individuals were counted, and percent mortality was calculated.

### 2.2. Statistical Analysis

The mortality data were corrected by Abbott's formula (Abbott, 1925). Fifty percent lethal dose (LD50) and ninety percent lethal dose (LD90) were determined using the probit analysis by SPSS (Ver. 21) program. The effects of mortality of the *T. confusum* and *S. oryzae* were analyzed using a one-way analysis of variance (ANOVA) (P=0.05), followed by a comparison of means using Duncan's multiple range test (SPSS) (Genc and Soysal, 2018).

## 3. Results

Data obtained on the effect of different doses of deltamethrin biocidal on *T. confusum* and *S. oryzae* adults are given in Table 1.

There was a substantial increase in mortality in both species as the dose increased. At the highest dose of the biocidal, on day 1 (60 ml / 10 liter of water), 67.5% mortality was detected in *T. confusum* and 82.5% in *S. oryzae*. Day three showed 77.5% and 97.5% and day five showed 87.5% and 97.5% mortality in the same species, respectively. On day 5 of the study, the LD<sub>50</sub> value for *T. confusum* was 32.8 and LD<sub>90</sub> 61.3, and for *S. oryzae*, these values were 18.8 and 38.1 ml, respectively.

## 4. Discussion

Many typical insecticides such as flumethrin, lamda-cyhalothrin, permethrin, fenvalerate, deltamethrin, cyfluthrin, and some others had been successfully tested on their activity against a broad spectrum of insects, their activity against ticks was only occasionally a topic of investigations (Liebisch and Liebisch, 2008; Mehlhorn et al., 2008a, Mehlhorn et al., 2008b, Mehlhorn et al., 2010; Schmahl et al., 2008a, Schmahl et al., 2008b, Schmahl et al., 2009a). Deltamethrine, as biocidal, is used against urban pests such as mosquitoes, houseflies, cockroaches, and ticks (Cao et al., 2006; Barile et al., 2008; Romero et al., 2009; Jankov et al., 2012; Jahan and Shahid, 2013). Kemabonta et al. (2014) investigated the toxic and residual effects of Deltamethrin and Chlorpyrifos on *Blattella germanica* L. (Blattodea: Blattellidae). These insecticides were diluted in both aqueous and oil-based solvents and applied to adult insects in the study. In the acute toxicity study, it was concluded that Deltamethrin in an oil-based solution (100%-100%) was more effective than Deltamethrin in the form of a water-based solution (53.30%-43.30%) in both doses applied. In the acute toxicity study of Chlorpyrifos, all treatments on *B. germanica* caused a 100% mortality. As a result of the study, they reported that oil-based solutions of these insecticides were more effective than water-based solutions on *B. germanica* adults.

**Table 1.** Effects of different doses of deltamethrin on *Tribolium confusum* and *Sitophilus oryzae* adults

Pests	Dose (ml/10 lt water)	(Average % death±standard error)			LD <sub>50</sub> -LD <sub>90</sub> (ml) (for 5. day)
		1. day	3. day	5. day	
<i>T. confusum</i>	0	2.50± 2.50 C*e**	2.50± 2.50 De	2.50± 2.50 De	32.86 – 61.30
	15	20.00±5.77 Bc	20.00±5.77 Ce	22.50±4.78 Cd	
	30	27.50± 2.50 Bc	35.00± 2.88 Bc	47.50± 4.78 Bc	
	60	67.50± 4.78 Ab	77.50± 4.78 Ab	87.50± 4.78 Aab	
<i>S. oryzae</i>	0	2.50± 2.50 De	5.00± 2.88 Ce	5.00± 2.88 De	18.83 – 38.12
	15	27.50± 6.29 Cc	35.00± 8.66 Bc	45.00± 2.88 Cc	
	30	62.50± 4.78 Bb	82.50± 4.78 Ab	82.50± 4.78 Bb	
	60	82.50± 4.78 Aa	97.50± 2.50 Aa	97.50± 2.50 Aa	

\*= upper case letters in the same column indicate intra-type dose comparison, \*\*= lower case letters in the same column indicate all doses comparisons (P<0.05).

Shahi et al. (2008) investigated the biological activity of various active substances, including Deltamethrin, against *B. germanica* adults collected from the south of Iran. They reported that the recommended doses of Cypermethrin, deltamethrin, Lambda-cyhalothrin, diazinon, and permethrin+propoxur used in the study were found to have a maximum mortality rate of 20, 35, 90, 100, and 100%, respectively, in *B. germanica* adults.

*Tribolium confusum* is considered stored product. However, it can be found in the kitchen, dining rooms or shelves where the grains are stored in some areas. In such cases, people want to spray against this insect in their kitchens. Today, deltamethrin has products licensed as both biocidal and insecticide. Especially in recent years, various studies have been carried out to determine the biocidal effect of Deltamethrin against urban pests. Barile et al. (2008) conducted the effect of deltamethrin and piperonyl butoxide against *Cimex lectularius* L. (Hemiptera: Cimicidae), one of the most critical urban pests, was investigated. Their study reported that the application of deltamethrin alone was more effective than the application of piperonyl butoxide. Bergh and Quinn (2018) investigated whether deltamethrin-treated curtains could be effective against *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae). They stated that *H. halys* moved away from deltamethrin-treated nets in less than 5 minutes and later died, but they did not die completely. Researchers are reported that deltamethrin-treated nets can be an excellent inhibitor to keep *H. halys* away from humans. Papanikalou et al. (2021) studied the effects of 4 different insecticides (Thiamethoxam, Pirimiphos-Methyl, Alpha-Cypermethrin, and Deltamethrin) against *Ephestia kuehniella* (Zeller, 1879) (Lepidoptera: Pyralidae) and *Tribolium confusum* (Duv., 1863) (Coleoptera: Tenebrionidae). As a result these chemicals increased the mortality rates of *E. kuehniella*, and *T. confusum* compared to the control. Deltamethrine is authorized and can be utilized against urban pests in kitchens. Deltamethrine is not licensed as a biocidal against *T. confusum* and *S. oryzae* species.

## 5. Conclusion

As seen in our study, firstly, Exdel 5 SC biocidal was applied to a particular surface, after 24 hours, insects were brought into contact for 30 minutes, then they were transferred into clean containers, and mortality count was done in clean containers. In other words, this study investigated the residual effect of Exdel 5 SC biocidal on *T. confusum* and *S. oryzae* species. As a result of the study, it has been determined that this biocidal (Exdel 5 SC) has the potential to be used in human habitats against *T. confusum* and *S. oryzae* species.

## Author Contributions

Concept: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Design: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Supervision: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Data collection and/or processing:

Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Data analysis and/or interpretation: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Literature search: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Writing: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%), Critical review: Ş.Y. (25%), A.K.A. (25%), İ.A. (25%) and İ.S. (25%). Submission and revision. All authors reviewed and approved final version of the manuscript.

## Conflict of Interest

The authors declared that there is no conflict of interest.

## Ethical Consideration

Ethics committee approval was not required for this study due to the use of research material not included in the definition of experimental animals in the study (Animal experiment ethics committee regulation on working procedures and principles, Article 4-d).

## References

- Abbott WS. 1925. A method of computing the effectiveness of an insecticide. *J Econ Entomol*, 8: 265-267.
- Anonymous. 2016. Transitional guidance on the biocidal products regulation. Transitional Guidance on PT18 + PT19. URL: [https://echa.europa.eu/documents/10162/23492134/tg\\_efficacy\\_pt18pt19\\_superseded\\_en.pdf/3e7f9fce-60db-3646-9c85-edde1105e39c](https://echa.europa.eu/documents/10162/23492134/tg_efficacy_pt18pt19_superseded_en.pdf/3e7f9fce-60db-3646-9c85-edde1105e39c) (access date: February 12, 2022).
- Athanassiou CG, Rumbos CI, Sakka MK, Vayias BJ, Stephou VK, Nakas CT. 2016. Insecticidal effect of the combined application of spinosad, Beauveria bassiana and diatomaceous earth for the control of *Tribolium confusum*. *Biocont Sci Tech*, 26(6): 809-819.
- Ayyıldız T, Karaca I. 2018. Effects of some bio-preparats to *Sitophilus granarius* (Coleoptera: Curculionidae) adults. *Suleyman Demirel Univ J Nat App Sci*, 22 (2): 671-678.
- Barile J, Nauen R, Nentwig G, Pospischil R, Reid B. 2008. Laboratory and field evaluation of deltamethrin and bendiocarb to control *Cimex lectularius* (Heteroptera: Cimicidae). In Proceedings, Sixth International Conference on Urban Pests, June 13-16, 2008, Budapest, Hungary, pp: 13-16.
- Bergh JC, Quinn NF. 2018. Can the dispersal behavior of *Halyomorpha halys* (Hemiptera: Pentatomidae) inform the use of insecticide-treated netting to mitigate homeowner issues from its fall invasion?. *Environ Entomol*, 47(6): 1501-1508.
- Cao XM, Song FL, Zhao YT, Dong YD, Sun CHX, Nad Lu BL. 2006. Survey of deltamethrin resistance in house flies (*Musca domestica*) from urban garbage dumps in Northern China. *Environ Entomol*, 35(1): 1-9.
- Cetinpolat E, Er MK, Barış C, Işıkber AA, Tunaz H. 2019. Effects of Beauveria bassiana on quantity of F1 larvae and larval mortality of *Tribolium confusum* (Coleoptera: Tenebrionidae). *KSU J Agric Nat*, 22(6): 916-921.
- Genç S, Soysal Mİ. 2018. Parametric and nonparametric post hoc tests. *BSJ Eng Sci*, 1(1): 18-27.
- Göktürk T, Kordali S, Ak K, Kesdek M, Bozhuyuk AU. 2020. Insecticidal effects of some essential oils against *Tribolium confusum* (du Val.) and *Acanthoscelides obtectus* (Say) (Coleoptera: Tenebrionidae and Bruchidae) adults. *Int J Trop Insect Sci*, 40: 1-7.
- Jahan N, Shahidm A. 2013. Evaluation of resistance against deltamethrin and cypermethrin in dengue vector from

- Lahore, Pakistan. *J Anim Plant Sci*, 23(5): 1321-1326.
- Jankov D, Ind D, Kljajic P, Almas R, Andric G, Vukovic S, Grahovac M. 2013. Initial and residual efficacy of insecticides on different surfaces against rice weevil *Sitophilus oryzae* (L.). *J Pest Sci*, 86: 211-216.
- Karakas M. 2016. Toxic, repellent and antifeedant effects of two aromatic plant extracts on the wheat granary weevil, *Sitophilus granarius* L. (Coleoptera: Curculionidae). *Int J Entomol Res*, 1(6): 24-28.
- Kemabonta KA, Ohadiwe A, Adetoro FA. 2014. Toxicological and residual effect of deltamethrin and chlorpyrifos against the German cockroach, *Blattella germanica* L. (Insecta: Blattodea: Blattellidae). *J Entomol Nematol*, 6(7): 90-97.
- Kocak E. 2016. Residual efficacy of a zw formulated insecticide on different surfaces against some stored product pests. *Suleyman Demirel Univ J*, 1(1): 53-57.
- Liebisch G, Liebisch A. 2008. Efficacy of Flectron®-ear tags (cypermethrin) for control of midges (Culicoides), the vectors of bluetongue virus in cattle: field studies and bioassays. *Dtsch Tieraerztl Wochenschr*, 115: 220-230.
- Mehlhorn H, Schmahl G, D'Haese J, Schumacher B. 2008a. Butox® 7.5 pour-on: a deltamethrin treatment of sheep and cattle: pilot study of killing effects on Culicoides species. *Parasitol Res*, 102: 515-518.
- Mehlhorn H, Schmahl G, Schumacher B, D'Haese J, Walldorf V, Klimpel S. 2008b. Effects of Bayofly™ on specimens of Culicoides species when incubated in hair taken from the feet of previously treated cattle and sheep. *Parasitol Res*, 102: 519-522.
- Mehlhorn H, Al-Rasheid KAS, Abdel-Ghaffar KS, Pohle H. 2010. Life cycle and attacks of ectoparasites on ruminants during the year in Central Europe: recommendations for treatment with insecticides (e.g. Butox®). *Parasitol Res*, 107: 425-431.
- Olejarski P, Wegorek P, Zamojska J. 2013. Monitoring and control of stored grain insect pests in grain stores in Poland. *Prog Plant Prot*, 53: 455-461.
- Papanikolaou NE, Kavallieratos NG, Boukouvala MC, Malesios C. 2021. (Quasi)-Binomial vs. Gaussian models to evaluate Thiamethoxam, Pirimiphos-Methyl, Alpha-Cypermethrin and Deltamethrin on Different types of storage bag materials against *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) and *Tribolium confusum* Duv. (Coleoptera: Tenebrionidae). *Insects*, 12(2): 182.
- Romero A, Potter MF, Haynes KF. 2009. Evaluation of piperonyl butoxide as a deltamethrin synergist for pyrethroid-resistant bed bugs. *J Econ Entomol*, 102(6): 2310-2315.
- Schmahl G, Walldorf V, Klimpel S, Al-Quraishy S, Mehlhorn H. 2008a. Efficacy of Oyxfly™ on Culicoides species the vectors of Bluetongue virus and other insects. *Parasitol Res*, 103: 1101-1103.
- Schmahl G, Walldorf V, Klimpel S, Al-Quraishy S, Schumacher B, Jatzlau A, Mehlhorn H. 2008b. Pilot study on deltamethrin treatment (Butox®7.5, Versatrine®) of cattle and sheep against midges (Culicoides species, Ceratopogonidae). *Parasitol Res*, 104: 809-813.
- Schmahl G, Mehlhorn H, Abdel-Ghaffar F, Al-Rasheid K, Schumacher B, Jatzlau A, Pohle H. 2009. Does rain reduce the efficacy of Butox® 7.5 pour on (deltamethrin) against biting midges (Culicoides specimens)? *Parasitol Res*, 105: 1763-1765.
- Shadia E, El-Aziz A. 2011. Control strategies of stored product pests. *J Entomol*, 8(2): 101-122.
- Shahi M, Hanafi-Bojd AA, Vatandoost H. 2008. Evaluation of five local formulated insecticides against German cockroach (*Blattella germanica* L.) in Southern Iran. *Iran J Arthropod-Borne Dis*, 2(1): 21-27.
- Stejskal V, Hubert J. 2006. Arthropods as sources of contaminants of stored products: an overview. In: *Proceedings of the Ninth International Working Conference on Stored-Product Protection*, October 15-18, 2006, Sao Paulo, Brazil, pp: 15-18.
- Stejskal V, Hubert J, Aulicky R, Kucerova Z. 2015. Overview of present and past and pest-associated risks in stored food and feed products: European perspective. *J Stored Prod Res*, 64(2): 122-132.
- Togantimur O, Özder N. 2019. Investigation on insect pest species in grain warehouse and flour mills in Edirne province. *J Tekirdag Agri Fac*, 16(2): 192-201.
- Tyagi SK, Guru PN, Nimesh A, Asrar Bashir A, Patgiri P, Mohod V, Khatkar AB. 2019. Post-harvest stored product insects and their management. ICARAICRP on PHET. Technical Bulletin No.: AICRP on PHET/ Pub/ 2019/02, Central Institute of Post-Harvest Engineering and Technology. Ludhiana, Punjab, India, pp: 36.