

**PRELIMINARY STUDIES REGARDING INSECTICIDAL EFFECT OF DIATOMACEOUS EARTH AGAINST THE RICE WEEVIL, *Sitophilus oryzae* L. (Coleoptera: Curculionidae), ON STORED WHEAT**

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**Abstract:** Laboratory trials were carried out to evaluate the impact of Romanian diatomaceous earth (DE) samples with their insecticidal properties to control one of the most important pest in stored grain, rice weevil, *Sitophilus oryzae*. It was tested the efficacy of two local DE deposits, Pătârlagele (Buzău), Adamclisi (Constanța) respectively, compared with commercial formulations SilicoSec and PyriSec. The experiments were carried out at temperature of 25°C and relative humidity (RH) levels 60±5%. Mortality of pest was counted at 7, 14 and 21 days after exposure (DAT) at the following DE dose rates: 100, 300, 500 and 900 ppm. The mortality of adults normally increased with increasing dose rates and DAT. With almost 100 % mortality even at 300 ppm dose the most effective were the commercial products PirySec and SilicoSec. Romanian DEs were more effective at dose rate 900 ppm, but also registered satisfactory mortality at dose 500 ppm (85-94%). Taking into account the results achieved, we can consider it a good possibility to obtain a Romanian mineral insecticide for stored products protection against pests.

**Key words:** *Sitophilus oryzae*, diatomaceous earth, stored wheat

## INTRODUCTION

The products stored long time suffer high loses because of the pests. Choosing the pesticides for the stored products pests is limited because of strong requirements imposed by the necessity to their safely use. The care for the security and public and environmental health gives the attention focused on the studies about development of the alternatives for the stored products pests. On the other hand, using long time the insecticides to control the stored products pests can determine serious problems with the resistance of the pests against the insecticides. For this reason it is necessary to reduce the dependence to chemicals by implementation of the alternative methods to control the stored products pests.

The use of diatomaceous earth (DE) is a promising alternative in stored product protection. DE is a naturally occurred siliceous dust formed by the fossilized remains of unicellular algae species namely diatoms. DEs are probably the most efficacious natural dusts used as insecticides (Korunic 1998). DEs act in the insects' exoskeleton (cuticle) causing rapid desiccation resulting in death through water loss. They are non-toxic to mammals (rat oral LD50 >5000 mg/kg of body weight) and leave no toxic residues on the product.

Several DEs, based on natural deposits, are now commercially available and have proved very effective against stored grains. However, the search of newer, naturally-occurring DEs that are more effective in insect control is still in progress. Many researchers underline the need for using new DEs, which are effective at low dose rates. Some newer DEs have been already evaluated with promising

results (Athanassiou and al. 2003, 2004, 2005a, b, 2009, Kavallieratos and al., 2007, Rojht and al. 2010, Subramanyam and Roesli, 2000).

Stored product pests laboratory from RDIPP Bucharest had in the last years the concerns to find non-toxic methods to control pests damaging agro-products stored (Ciobanu and Drosu, 2009, Drosu and al., 2011).

In this paper it is presented the results of the evaluated insecticidal activity of different origin DEs (two local DEs from Romania and commercial products SilicoSec and PyriSec) against rice weevils adults at the temperature of 25°C and relative humidity 60±5%.

## MATERIAL AND METHOD

The samples from two local DEs deposits from Romania (Buzău Valey-Pătârlagele and South of Dobroudja-Adamclisi), named PatRom and AdRom respectively, were tested in order to evaluate the efficacy against rice weevil, *Sitophilus oryzae* in stored wheat. They were compared with commercial products SilicoSec (Biofa, Germany) and PyriSec (Agrinova, Germany).

The bioassays were done in 3 X 3 replicates (each series of tests was repeated three times, by preparing new lots each time). In this series of tests, the DEs were applied in 1 kg lots at the DE dose rates of 100, 300, 500 and 900 ppm (one lot per dose). The grain was left previously for 7 days at the appropriate conditions to equilibrate with the desired relative humidity levels. Based on the standard procedure, the lots are placed in glass jars, and shaken manually for approx. 3 min., to achieve equal distribution of the DE dust to the entire grain mass. There were an additional series of lots with untreated grain which served as a control. Then, 3 samples, of 50 g each, were taken from each lot, and these samples were placed in small glass vials, which are closed, apart from a 1.5 cm hole at the top, covered with fine mesh for ventilation. Then, 50 adults, <21 days old were placed in each lot. The lots were placed in controlled room at temperature of 25°C, and relative humidity level of 60±5%. The mortality was assessed after 7, 14 and 21 days of exposure in the treated substrate.

## RESULTS AND DISCUSSIONS

Insecticidal efficacy of DE is highly influenced by several factors such as temperature, type of DE formulation and dose rate, exposure interval (Kavallieratos et al. 2007). DE has physical action, since the DE particles grasp insect cuticle meanwhile weevils are moving on treated wheat (Athanassiou et al., 2005). Further exposure means active contact with DE particles, which damages weevil wax layer and insect dies through desiccation (Korunic, 1998). The lowest mortality between rice weevil adults were 7 days after treatment and the highest mortality was obtained after 21 days of exposure. Althready known effective dose rate of SilicoSec for successfully rice weevil treating in wheat is between 500 and 900 ppm (Athanassiou et al., 2005). The results of our studies are presented in table 1. The mortality of rice weevil in wheat treated with SilicoSec was at dose rate 900 ppm 100%, at 500 ppm was 99.6% and at 300 ppm, 97.7%; for PyriSec mortality was 100% even at dose rate of 300 ppm, after 21 days exposure.

In the samples with wheat treated with Romanian products the results are: for PatRom at dose rate 500 ppm the mortality of rice weevil was 94.0% and at dose rate 900 ppm, 100%, for AdRom at 500 ppm dose the mortality was 85.0% and at 900 ppm 97.3%.

Generally the most efficient were PyriSec and SilicoSec at 900 ppm with 100% mortality after 21 days exposure, but with very good mortality (100 and 97.7% respectively) at the dose 300 ppm, following by Romanian samples with satisfactory mortality (94 and 85%) at dose rate 500 ppm and almost 100% at 900 ppm.

In our investigation commercial products based on DE and Romanian DEs have satisfactory effect on rice weevil adults at dose rates which are acceptable to environmental, people health and it has no influence on quality of stored products (Korunic, 1998). Therefore it can be used for control of this pest on stored wheat. The mortality of beetle increased with increasing dose rates. Romanian DE shows insecticidal properties against rice weevils at the dose 500 ppm that can be more checked. Concentrations higher than 1000 ppm are inappropriate for pest control, because they

influence several physical and mechanical properties of grain (Korunic et al., 1996; Subramanyam and Roesli, 2000).

**Table 1**  
**Insecticidal effect of diatomaceous earth against the *Sitophilus oryzae* on stored wheat**

Variant	Dose rate (ppm)	Mortality (% after ... ..days)		
		7	14	21
Pyri Sec	100	88.5	92.2	99.2
	300	100	-	-
	500	100	-	-
	900	100	-	-
Silico Sec	100	37.8	40.7	58.8
	300	55.2	72.9	97.7
	500	64.4	89.6	99.6
	900	77	97	100
PatRom	100	42.2	44	52.9
	300	52.2	58.5	79.6
	500	57	68.8	94
	900	71.5	97.7	100
AdRom	100	43.3	46.3	58.8
	300	38.9	42.2	61.1
	500	57.4	62.5	85.2
	900	67.8	81.4	97.3
Control	-	26.6	26.6	30

## CONCLUSIONS

- The use of diatomaceous earth (DE) is a promising alternative in stored product protection and several DEs, based on natural deposits, are now commercially available and have proved very effective against stored grains.
- Romanian samples of diatomaceous earth had satisfactory effect on rice weevil adults at dose rates of 500 ppm, acceptable to environmental and people health, being a promising possibility to obtain a Romanian mineral insecticide for stored products protection against pests.

## REFERENCES

- CIOBANU MARIA, SONICA DROSU, 2009. Stored products protection with some non-toxic methods, Scientific Papers, USAMV Bucharest, Series A, Vol. LII, 2009, ISSN 1222-5339, 385-391
- DROSU SONICA, MARIA CIOBANU, MARIA OPREA, MARIA TUDORACHE, V. FĂTU, 2011. Alternative methods of stored grains protection against pest agents, Analele Universității Craiova, Seria Agricultură, Montanologie, Cadastru, Vol. 41, nr. 2, 141-148
- ATHANASSIOU, C. G., N. G. KAVALLIERATOS, F. C. TSAGANOU, B. J. VAYIAS, C. B. DIMIZAS, AND C. T. BUCHELOS. 2003. Effect of grain type on the insecticidal efficacy of SilicoSec against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). Crop. Protect. 22: 1141-1147.
- ATHANASSIOU, C. G., N. G. KAVALLIERATOS, AND N. S. ANDRIS. 2004. Insecticidal effect of three diatomaceous earth formulations against adults of *Sitophilus oryzae* (Coleoptera: Curculionidae) and *Tribolium confusum* (Coleoptera: Tenebrionidae) on oat, rye and triticale. J. Econ. Entomol. 97: 2160-2167.
- ATHANASSIOU, C. G., B. J. VAYIAS, C. B. DIMIZAS, N. G. KAVALLIERATOS, A. S. APAGREGORIOU, AND C. T. BUCHELOS. 2005. Insecticidal efficacy of diatomaceous earth against *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) and *Tribolium confusum* du Val (Coleoptera: Tenebrionidae) on stored wheat: influence of dose rate, temperature and exposure interval. J. Stored. Prod. Res. 41: 47-55.
- ATHANASSIOU CG, KAVALLIERATOS NG. 2005. Insecticidal effect and adherence of PyriSec in different grain commodities. Crop Protection 27:703-710.
- ATHANASSIOU CG, FRANK A. H., GEORGE P.O. AND JAMES E. TH. 2009. Insecticidal Effect of Diatomaceous Earth Against Three Species of Stored-Product Psocids on Maize, Rice, and Wheat. J. Econ. Entomol. 102(4): 1673-1680
- KAVALLIERATOS N. G., ATHANASSIOU, C. G., VAYIAS B. J., MAISTROU S. N. 2007. Influence of temperature on susceptibility of *Tribolium confusum* (Coleoptera: Tenebrionidae) populations to three modified diatomaceous earth formulations. Fla. Entomol., 90: 616-625.
- KORUNIC Z., FIELDS P. G., KOVACS M. I. P., NOLL J. S., LUKOW O.M., DEMIANYK C. J., SHIBLEY K. J. 1996. The effect of diatomaceous earth on grain quality. Postharvest Biol. Technol., 9: 373-387.
- KORUNIC, Z. 1998. Diatomaceous earths, a group of natural insecticides. J. Stored. Prod. Res. 34: 87-97.
- ROJHT HELENA, ATHANASSIOU CG, VAYIAS B.J., KAVALLIERATOS NG, TOMANOVIĆ Ž., VIDRIH M., KOS KATARINA, TRDAN S. 2010. The effect of diatomaceous earth of different origin, temperature and relative humidity against adults of rice weevil (*Sitophilus oryzae* [L.], Coleoptera, Curculionidae) in stored wheat. Acta agriculturae Slovenica, 95 - 1, 13-20
- SUBRAMANYAM, BH., ROESLI, R., 2000. Inert dusts. In: Subramanyam, Bh., Hagstrum, D.W. (Eds.), Alternatives to Pesticides in Stored-Product IPM. Kluwer Academic Publishers, Dordrecht, pp. 321-380.