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APPLICATION OF PROTECT-IT™ IN PROCESS OF INTEGRATED PEST MANAGEMENT OF STORED GRAINS

Abstrakt

Alternative way to chemical control of stored-product insects is use of diatomaceous earth (DE), which is effective as insecticidal dust. Preparation Protect-It™ was used in this experiment for investigation of DE efficacy, world wide registered for protection of stored-products against pests. Detrimental species *Rhizopertha dominica* was examined on all small grain species - wheat, barley, rye, oat and triticale. Applied pesticide rate of 1,0 g/kg was caused statistically significant higher percentage of mortality compared with rate of 0,5 g/kg. Mortality percentage of *R.dominica* is higher after longer exposure. In relation to type of grain exist statistically significant difference in adult mortality. Within rye and triticale statistically significant lower percentage of mortality was achieved.

Key words: *diatomaceous earth, Rhizopertha dominica, small grains.*

INTRODUCTION

Harmful stored-product insects cause up to 5-10% damage of stored grain every year. Since there is recorded high pest infestation of stored grain, synthetic pesticides are traditionally used for controlling of this insect populations, as fumigants, for spraying of empty warehouse. Furthermore, someone use contact insecticides in stored grain. During application of this method, there is no correction of poor stored grain quality and no consideration about causes of pest appearance. This problem become more complex later, because of appearance of residues in grain and insect

resistance.

Alternative way to chemical control of stored-product insects is use of diatomaceous earth (DE), which is effective as insecticidal dust (Golob, 1997). A few DE formulations have commercial usage in numerous countries of the world and they have successful usage in stored product protection (Subramanyam and Roesli, 2000). Commercial DE formulations have low toxicity level to mammals, they do not contain chemical insecticides, do not leave detrimental residues, they are effective against resistant species and they are persistent. They have physical mechanism of action and they can be applied with similar technology as synthetic pesticides (Subramanyam et al., 1994; Korunić, 1998).

Preparation Protect-It™ was used in this experiment for investigation of DE efficacy, world wide registered for protection of stored-products against pests. Detrimental species *Rhizopertha dominica* was examined on all small grain species - wheat, barley, rye, oat and triticale. Economical importance of this species is great, because it is developing in products with small percent of moisture and grain drying can not stop her appearance and propagation (Flinn et al., 2010).

MATERIAL AND METHODS

Investigations were conducted in laboratory conditions according to method of Collins (1990) and modified method for assessment of biological efficacy of insecticides in stored-product pests control (OEPP/EPPO, 2004 a, b).

Protect-It™ was used for investigation of DE efficacy, world wide registered preparation for protection of stored-products against pests. It contains 83,7% of amorphous SiO₂, 10% of silica aerogel, 3% of Al₂O₃, 1% of Fe₂O₃ and less than 1% of CaO, MgO, TiO₃ and P₂O₃.

Adults of *R. dominica* were used in investigation, raised in insectarium of Institute for pesticides in Belgrade. Colonies were raised on whole wheat kernel at 26±1°C and 60±5% relative humidity (r.h.). Age of adults was from 2-4 weeks.

Within small grain species, there were used seed of wheat, barley, oat, rye and triticale without pesticides and insects infestation, with moisture before treatment ranged from 11.0–11.8%. Applied rates of preparation were 0,5 and 1,0 g/kg. After pesticide application on 500 g of grain for every treatment, treated grain is hand mixed about one minute and than mixed in rotating mixer during 10 minutes.

Plastic boxes from 200 ml were filled each with 50g of treated grains in four replications. Boxes were placed in thermostat on 27±1 °C and 55-60% r.h. Next day, in each box were incorporated 25 adults of *R. dominica*. Mortality of exposed adults was determined after 7 and 14 days of exposure by sieving.

Average values of mortality of *R. dominica* adults and significance of difference between means were determined from statistical analysis of data using software STATISTICA 6.0.

RESULTS

Established percentage of *R. dominica* mortality, after seven days of exposure with DE application rate of 0,5 g/kg, was low, below 19,4%. In relation to grain species (table 1.), the lowest mortality was achieved in rye (7%), and the highest in oat (33%). Similar percentage of mortality of *R. dominica* was realised after 14 days of exposure, with same application rate of DE. Adult mortality with application rate of 0,5g/kg was 28,6% in average, wherein examined species the highest percentage of mortality (48%), was recorded in oat again. This results are showing that pesticide Protect-It™ manifest low efficacy against *R.dominica* adults with applied rate of 0,5 g/kg.

Table 1. Mortality of *Rhyzoperta dominica* adults after 7 days and 14 days of exposure (%).

Type of grain	Percentage of insect mortality after 7 days of exposure					
	Application rate 0,5 g/kg			Application rate 1,0 g/kg		
	\bar{x}	S	S_x^2	\bar{x}	S	S_x^2
Wheat	26.000	10.066	5.033	79.000	7.572	3.786
Barley	19.000	11.489	5.745	88.000	6.532	3.266
Rye	7.000	3.830	1.915	75.000	9.452	4.726
Oat	33.000	12.806	6.403	84.000	7.303	3.651
Triticale	12.000	3.266	1.633	62.000	14.787	7.394
Average	19.400	12.601	2.818	77.600	12.542	2.804
Type of grain	Percentage of insect mortality after 14 days of exposure					
	Application rate 0,5 g/kg			Application rate 1,0 g/kg		
	\bar{x}	S	S_x^2	\bar{x}	S	S_x^2
Wheat	38.000	18.037	9.018	88.000	9.238	4.619
Barley	30.000	16.166	8.083	98.000	4.000	2.000
Rye	10.000	6.928	3.464	85.000	10.520	5.260
Oat	48.000	16.330	8.165	86.000	5.164	2.582
Triticale	17.000	2.000	1.000	79.000	5.033	2.517
Average	28.600	18.503	4.137	87.200	9.047	2.023

The more greater efficacy against *R. dominica* was achieved with DE application in rate of 1 g/kg. After seven days, the highest adult mortality was performed in barley (88%), oat (84%) and wheat (79%). Realized mortality in average was 77,6%, after seven days of exposure.

After 14 days, average value was increased on 87,2%. Percentage of mortality after 14 days ranged between 79% (triticale) and 98% (barley). Lower limit of mortality is showing great efficacy of this pesticide in applied rate of 1g/kg.

Low percentage of *R. dominica* mortality in wheat (19%), after short exposure was determined by Vayuas et al. (2009). Authors were used commercially available formulation DE-Silico sec™. Wakil et al., (2010) stated the same results. However,

percentage of mortality reached 100% after 96 hours. Kljajić et al. (2010) and Kavallieratos et al. (2010) also recorded that mortality percentage of *R. dominica* during application of Protect-It™ in wheat, increased proportionally in relation to duration of adults exposure. Athanassiou et al. (2011) confirmed this investigations after examination several DE formulations of different origin on mortality of *R.dominica* after 7 and 14 days.

With increasing of applied rate of Protect-It™ DE efficacy rising (table 1). However, commercially available DE formulations applied in high rate are not more acceptable in relation to some other materials which ruin human health and environment (Vayias and Stephou, 2009). High DE rates changed hectoliter mass of kernel (Korunić et al., 1998). Furthermore, they affect creation of high percent of silica crystals in air which can cause respiratory problems (silicosis) after long exposure of employees (Athanassiou and Korunić, 2007). One of possible solution of negative consequences during application of high DE rates is combination with other methods like extreme temperatures (Dowdy,1999; Dowdy and Fields, 2002), enteropathogen fungicides (Lord, 2001; Akbar et al., 2004, Michalaki et al., 2006) or low insecticide dosage (Korunić, 2001; Stathers, 2003; Athanassiou et al., 2004) (cit.loc., Athanasoiou and Korunić, 2007).

Table 2. Analyses of variance for percentage of adult mortality of *R. dominica* after 7 days of exposure.

Source of variation	Sum of Squares	Df	Mean Square	F-Ratio
Applied rate of pesticide	34 339,6	1	34 339,6	397,9 **
Type of grain	2522,4	4	630,6	7,3 **
Interaction application rate x grain species	802,4	4	200,6	2,32
Error	2588	30	86,3	
Total	40 252,4	39		

*-Significance of difference in effect on adults mortality

Table 3. Significant of difference in effect of grain species on percentage of adults mortality of *R.dominica* after 7 days.

	Wheat	Barley	Rye	Oat	Triticale
Wheat	-	0,21	2,26*	1,29	3,34*
Barley	-	-	2,48*	1,08	3,56*
Rye	-	-	-	3,56*	1,08
Oat	-	-	-	-	4,63*

*-Significance of difference in effect on adults mortality

Within rye and triticale statistically significant lower percentage of mortality was achieved, compared with wheat and barley. This difference between grain species was recorded already after 7 days of exposure and confirmed after 14 days.

Table 4. Analyses of variance for percentage of adult mortality of *R. dominica* after 14 days of exposure.

Source of variation	Sum of Squares	Df	Mean Square	F-Ratio
Applied rate of pesticide	34 339.6	1	34 339.6	293.75**
Type of grain	2 817.6	4	704.4	6.03**
Interaction application rate x grain species	1734.4	4	433.6	3.71**
Error	3 508	30	116.9	
Total	42 399.6	39		

*-Significance of difference in effect on adults mortality

There are numerous authors which were examined DE efficacy in relation to the grain type (Athanasios et al., 2003; Athanasios and Kavallieratos, 2005; Athanasios and Korunić, 2008;; Vayias et al. 2009) (cit. loc. Vayias and Stephou, 2009). Authors were included in their investigations the four most important stored-grain species – wheat, barley, corn and rice. There were statistically significant differences in DE efficacy in corn and rice. Vayias and Stephou (2009) explained different DE efficacy on grain type by variations in physical and chemical characteristics of seeds.

Table 5. Significant of difference in effect of grain species on percentage of adults mortality of *R.dominica* after 14 days

	Wheat	Barley	Rye	Oat	Triticale
Wheat	-	0.18	2.86*	0.74	2.77*
Barley	-	-	3.05*	0.55	2.96*
Rye	-	-	-	3.60*	0.09
Oat	-	-	-	-	3.5*

CONCLUSION

Alternative way to chemical control of stored-product insects is use of diatomaceous earth (DE), which is effective as insecticidal dust. Usage of DE have numerous advantages as protection measure of stored grain. Commercial DE formulations have low toxicity level to mammals, they do not contain chemical insecticides, do not leave detrimental residues, they are effective against resistant species and they are persistent. They have physical mechanism of action and they can be applied with similar technology as synthetic pesticides

Preparation Protect-It™ was used in this experiment for investigation of DE efficacy, world wide registered for protection of stored-products against pests. Applied pesticide rate of 1,0 g/kg was caused statistically significant higher percentage of mortality compared with rate of 0,5 g/kg. Mortality percentage of *R.dominica* is higher

after longer exposure.

In relation to type of grain exist statistically significant difference in adult mortality. Within rye and tritcale statistically significant lower percentage of mortality was achieved, compared with wheat and barley.

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PRIMENA PROTECT-IT™ U PROCESU INTEGRALNE ZAŠTITE USKLADIŠTENOG ŽITA

Abstrakt

Alternativa hemijskoj kontroli skladišnih insekata jeste upotreba diatomejske zemlje (DZ), koja se efektivno koristi kao insekticidna prašina. Za ispitivanje efikasnosti DZ u ovom eksperimentu korišćen je preparat Protect-It™, registrovan širom sveta za zaštitu skladišnih proizvoda od štetnih insekata. Smrtnost štetne vrste *Rhizopertha dominica* ispitivana je na svim vrstama strnih žita - pšenici, ječmu, raži, ovsu i tritikaleu. Primenjena koncentracija pesticida od 1,0 g/kg izazvala je statistički značajno veći procenat smrtnosti u odnosu na koncentraciju 0,5 g/kg. Procenat smrtnosti *R. dominica* je veći nakon duže ekspozicije. Postoji statistički značajna razlika u smrtnosti adulta u odnosu na vrstu žita. Kod raži i tritikalea ostvaren je statistički značajno manji procenat smrtnosti adulta.

Ključne reči: diatomejska zemlja, *Rhizopertha dominica*, strna žita.