

SPRAYING OF GRAINS WITH INSECTICIDES IN GRAIN ELEVATORS

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Abstract

The direct spraying of grains with insecticides is besides fumigation the most frequently provided measure for the control of stored product pests in Yugoslavia. The treated grains are protected for a longer period of time but due to the pesticide residues they can not be used for some time.

The wheat was treated with deltamethrin and the corn with chlorpiriphosmethyl in the grain elevators. Samples of grains were taken to the laboratory where studies of the efficacy were provided. A satisfactory result with deltamethrin was obtained on the most important stored product pests during the period of 6 to 12 months. However, when samples were taken from the different layers it came out that the application was not always correct. As well, when some fungus were present, the efficacy decreased. The experiment with chlorpiriphosmethyl lasted for 5 months and the obtained results were satisfying.

Introduction

A spraying of the stored grains by insecticided is the most frequent control measure in Yugoslavia, besides fumigation. The formulation of 7% dichlorvos has been registered for the application on the stored grains in the 1975 year (Korunić, 1975). Since then diclorvos has often been used in the treatment of wheat and maize at unloading and loading on ships, wagons, lorries and at their storage in the grain elevators and ware houses. It is to be accented that the grain is being treated in a stream, during elevation, before its putting to a determined place. During the application the insecticide has to

be disposed as equally as possible on the grains since in such a way the best protection of the grains as well as the best control of the insects are provided. The insecticide is mostly applied by adequate equipment, so called Vobamatic and even more frequently by other type of sprayers. Besides a proper application, in order to attain a better result, it is necessary to know the state of the treated commodity. The humidity and temperature, the quantity of dust, the presence of the weed seeds, parts of the stem and other foreign material, the percentage of the breakage, the age of the grain as well as the presence of some insects and fungi are also important factors. Each of these factors, present above the permitted limits, alone or with any others can considerably influence the decreasing of the formulation efficacy.

The researches concerning the efficacy of pirimiphosmethyl in the control of stored product pests (Cogburn, 1976, McCallum Deighton, 1987), chlorpiriphosmethyl (Tyler, Binns, 1977, 1982) and deltamethrin (Duguet, 1982) resulted satisfactorily.

A successful action of methacrifos and pirimiphosmethyl against most important stored product pests was attained in laboratory experiments (Korunić, Hamel, 1981). Since the laboratory research results had proved to be favourable (Hamel, 1985), the studies were widened and all of the quoted active ingredients in Yugoslavia in a few years were registered as means for control of the stored product pests using a direct spraying of grains. The research results, that are going to be discussed, were attained by the spraying of grains by deltamethrin and chlorpiriphosmethyl in a grain elevator and laboratory experiments in the Institute for Plant Protection in Zagreb.

Materials and Methods

a) Treatment of wheat

Two formulations of the active ingredient deltamethrin-DTM (K-Obiol ULV 6 and K-Obiol EC 25) were applied on the grain in a stream before its entrance into a bin. The doses of 0,5 g/t and 0,25 g/t were applied. There were four treatments. In three of them 150 t of new wheat and once 600 t of 10 month old wheat were treated. The spraying was done only once with a Vobamatic. In the applying of ULV formulation 8,4 l (a higher dosage) or 4,2 l (a lower one) of the ready formulation on 100 t of wheat were applied. In the applying of EC formulation, 2 l (a higher dosage) or 1 l (a lower dosage) of it to 100 t of wheat as well as 12 l of water were used. At the end of the treatment the

bins were filled up by wheat.

The samples were taken from the bottom of the bin approximately after every 28 days and the exact time distances were quoted on the tables. The insects *Sitophilus oryzae* (L.), *S. zeamais* Motsch, *Rhizopertha dominica* F., *Tribolium castaneum* Herbst and *Oryzaephilus surinamensis* L. were used in the experiments. 25 adults of each these species were put into a jar containing 100 g of the treated wheat. The experiments were set in three replicates. The acting to the insects was checked 14 days after the exposure on the wheat by counting and removing of the alive and the dead ones. The experiment took place at the temperature of $20 \pm 2^{\circ}\text{C}$ and relative humidity $60 \pm 5\%$. In order to prove a successful efficacy of the insecticide, the emerging of the offspring was observed 45 days after the removing of the insects out of grain. The jars of grain were in the room at the temperature of $27 \pm 1^{\circ}\text{C}$ and relative humidity $65 \pm 5\%$ at that time. The residual acting of the insecticide was observed during a period of 5, 6 and 12 months.

During the transmitting of the grain from one bin to another (150 t), several samples from various levels were taken in order to prove the efficacy of the insecticide. 100 g of the wheat of each sample was disposed into 3 jars. The adults of *S. oryzae* were used in the experiments. The way of checking was the same as previously described. In some of the samples the quantity of DTM residues was expressed.

b) Treatment of maize

The treatment was performed by using chlorpiriphosmethyl - CPM (Reldan 2E) in the dosage of 5 g/t and a contribution of 1 l water to a tone. 200 t of maize in a stream, before its arrival to the conveyor belt was sprayed by a sprayer having a rotational pump. The nozzle (11002) was used for spraying at the pressure of 3550 to 4050 mbar and the stream of the maize was 50 t/h. In the end of the treatment the maize filled a half of the bin capacity. The maize samples were taken before the treatment and immediately after it and after 2, 3 and 5 months as well. Primarily the presence of the alive and the dead insects was registered. A quantity of 100 g of maize was taken twice from the whole of the samples afterwards and 25 adults *Sitophilus granarius* (L) *R. dominica* and *T. castaneum* were put into both samples, in the jars. The checking of the insecticide efficacy is quoted on the table. The experiment took place at the temperature of $20 \pm 2^{\circ}\text{C}$ and relative humidity $60 \pm 5\%$. Since there was a lot of damaged grains and breakage, by sieving through a sieve having the holes of 2,8 mm, the proportion of the big (the whole grains and

the breakage) and tiny (the breakage and the flour) components was stated. The treatments in the grain elevator with the treated grains (cooling, transmitting) as necessarily were performed in the same way as with other stored grains.

Results and Discussion

a₁) Treatment of wheat by ULV formulation of DTM (Table I)

By applying of 0,5 g DTM a favourable efficacy to the used insects during 6 weeks of research was confirmed. Only in the species **O.surinamensis** a 100% mortality was registered after this period. As to the other species during the further period (from 70 to 180 days) the mortality was changable but never less than 70%. By observing the emerging of the offspring, neither the presence of the adults nor of the larvae was registered. It means that the insects which were "alive" or better to say, paralyzed, were not able to cause any considerable damages and to lay eggs. Even if the eggs existed, the first instar larvae died very quickly due to the contact with the insecticide deposit on the grains.

The experiments with the higher dosage of the insecticide were supposed to be conducted during a period of 12 months but the presence of fungi **Aspergillus and Penicillium** was confirmed and the wheat was removed from the grain elevator. Probably the presence of the fungi influenced the slowing down and the decrease in the dying of the insects.

By applying a lower dose a high efficacy to **S.oryzae, S.zeamais and O.surinamensis** was registered after 96 days and a little lower efficacy to **R.dominica and T.castaneum**. After that period the efficacy is on the decrease and it is very low after 180 days. Though the presence of alive insects on the wheat was not registered 6 months after the treatment, it is necessary to take care of it after 5 months, or even earlier, if any insects appear, in order to prevent a harder infestation.

The changable values of the efficacy in the both experiments can be caused by the very nature of the insects or by a application of the insecticide during the treatment or by a negative effect of the transphering from one bin to another. According to the obtained results, it is obvious that the deposit of deltamethrin provided a sufficient protection of the wheat during the quoted period of time.

a₂) Treatment of wheat by EC formulation of DTM (Tables II and III)

A favourable initial and residual acting was obtained during 4 months on **S.oryzae** and **S.zeamais** on the wheat treated by a higher dosage. Later on a varying efficacy but still a satisfactory one was registered during 11 months, then it decreased and the offspring appeared. The similar results were obtained in the species **R.dominica** and **T.castaneum**. The most efficient acting during all the 11 months was noticed on **O.surinamensis**. By observing the offspring neither adults nor larvae during all the 11 months were registered but after the last experiment, when the efficacy was under 50%, the offspring of all the used insects was confirmed. Therefore it is to be said that also in this case, near to the end of the storage, the care must be taken if a presence of the insects is stated.

A lower dosage of DTM had provided a sufficient protection of the grain in the beginning to the extent of 45 days when the efficacy decreased, especially in the species **Sitophilus** which had the offspring. On the basis of the results it can be presumed that this lower dosage can protect wheat during 3 or 4 months of the storage. Possibly the older wheat during the treatment in the fourth case influenced the lower efficacy of the insecticide.

By checking of the wheat samples taken from the bin in order to confirm the presence of the natural insect population, the presence of 2 or 3 dead **Sitophilus spp** was registered. At the same time in the sample taken before the treatment the presence of some alive insects **Sitophilus spp** was stated.

The confirming of DTM efficacy to various levels (Table IV) showed the changeability in the dying of **S.oryzae**. Taken on the whole, the efficacy was satisfying since there no offspring on the treated wheat, except once when the number of the adults was equal to the one on the untreated wheat.

It is interesting to look at the obtained results concerning the residues on the wheat since great differences in the insecticide deposit on the wheat can be seen what clearly points out the deficiencies of such a way of applying the insecticides (Table IV).

b) Treatment of maize by CPM (Tables V and VI)

By checking the samples before the treating, the presence of 1 to 4 alive **T. castaneum** and 1 to 3 dead ones after the treatment were stated. The quantity of the tiny ingredient left by sieving was 2,5% to 8,8% what evidently indicates as well as the presence of 50% breakage in some samples, a bad quality of the treated maize. Due to it even 1 l of water was applied to a tone, though 100 to 300 ml would do. By the checking of the samples in order to confirm the presence of the natural population, either some dead insects or

none were found. At the same time in the nearby bins, on the untreated maize, some alive adults of **T.castaneum** were found.

By observing the CPM acting on the insects of the laboratory breeding, an effective acting of it is confirmed against **S.granarius**. The longer was the duration of the exposition the more successful was the efficacy to **T.castaneum** especially concerning the residual acting after 3 and 5 months. **R. dominica** was used only in the beginning but due to a poor acting of CPM it was used no longer what proved the previously attained laboratory results (Hamel, 1985). The smell of the preparation during the treatment by DTM and CPM was present in the space, even an excitative effect to the respiratory organs was noticed. The wheat treated by CPM was smelling in the beginning but the smell disappeared later on. After the post treatment period of 56 days the wheat can be used for food. The greatest problem during the application of the insecticides was the maintaining of the necessary flow of the insecticides since the flow of the grains often changed and that resulted in an insufficient covering of the grains by the insecticide.

Conclusion

These researches proved the justification of the insecticide applying in wheat and maize protection during a longer period of storage since the applied active substances DTM and CPM in adequate formulations and dosages killed the insects, prevented the development and the spreading of the stored product pests **S.oryzae**, **S.granarius**, **S.zeamais**, **O.surinamensis**, **R.dominica**, **T.castaneum**. A satisfactory efficacy was not achieved only concerning **R.dominica** on the maize treated by CPM.

The problems of application have also been pointed out since in the use of this equipment some errors are possible due to the changeable flow of the grains and the variability of the pressure. The best results would be obtained with built-in sensors which would turn off the nozzles if a determined quantity of the grains is not present.

References

- Cogburn R.R. (1976) Pirimiphos-methyl as a protectant for stored rough rice. Small bin test. J.Econ. Entomol. 69, 369-373
- Duguet J. (1982) K-Othrin in the protection of stored products, Budapest
- Hamel Darka (1985) Studies with Reldan 2E for the registration on stored wheat in Yugoslavia (un published)
- Korunić Z. (1975) Studies with Nuvan 7 for the registration on stored wheat in Yugoslavia (un published)

- Korunić Z., Hamel Darka (1981) Effectiveness of some new insecticides on stored product insects In "Proc. Jugoslavensko savjetovanje o primjeni pesticida" , Opatija 3,425-433 (in Croatian, English summary)
- McCallum Deighton J. (1987) "Actellic" advantages for grain storage In "Proc. of 4th international working conference on stored-product protection, 528-537.
- Tyler P.S. and Birns T.J. (1977) The toxicity of seven organosphorus insecticides and lindane to eighteen species of stored-product beetles. J.stored Prod.Res. 13,39-43 (short communication)
- Tyler P.S. and Birns T.J. (1982) The influence of temperature on the susceptibility to eight organophosphorus insecticides of susceptible and resistant strains of **Tribolium castaneum**, **Oryzaephilus surinamensis** and **Sitophilus granarius**. J.Stored Prod. Res. 18,13-19

Table I Efficacy of ULV formulation of DTM applied on wheat (%)

Days after treatment	S.o.		S.z. Dosage (g DTM/t)		R.d.		T.c.		O.s.	
	0,5	0,25	0,5	0,25	0,5	0,25	0,5	0,25	0,5	0,25
14	100	100	100	100	100	96	100	88	100	100
42	100	100	100	100	100	96	100	79	100	100
70	80	100	85	100	78	100	76	100	100	100
98	100	100	100	100	100	96	100	100	100	100
126	87	96	96	88	72	72	85	92	100	100
154	96	93	83	89	100	88	96	75	100	86
182	65	63	79	73	84	84	71	32	100	91

Insects: *S.oryzae*, *S.zeamais*, *R.dominica*, *T.castaneum*, *O.surinamensis*

Table IV Results obtained in wheat from different levels (mortality of *S.oryzae* in %, progeny, residues)

	ULV		ULV		EC	
TAD	0,50 g DIM/t		0,25 g DIM/t		0,50 g DIM/t	
DRB	0,16 g DIM/t		0,15 g DIM/t		0,24 g DIM/t	
TABE	4 months		5 months		5 months	
	S.o.		S.o. Residues		S.o. Residues	
Level	M	P	M	(g DIM/t)	M	(g DIM/t)
1	99	2	88	0,32	91	0,17
2	91	273	89	0,34	93	0,32
3	99	0	91	0,34	91	0,30
4	100	0	84	0,32	85	0,50
5	100	0	76	0,20	80	0,20
6					72	0,22
Control	0	500	0		0	

TAD- Teoretically applied dosage, DRB- Determined residues in the beginning, TABE- Time after the beginning of the experiment, M- mortality, P-progeny

Table V Results obtained in maize samples before and after the treatment by CPM on *Tribolium castaneum*

T.c. Alive	Before treatment		T.c. Dead	After treatment	
	Weight of sample (g)	Tiny component (%)		Weight of sample (g)	Tiny component(%)
3	1585	3,16	3	2620	6,50
4	2160	2,86	1	1950	2,50
1	980	8,80	3	2880	2,85

Table VI Efficacy of CPM on insects in maize (%)

Insects	Initial			Residual (2 months)			Residual (3 months)			Residual (5 months)		
	24	72	144	24	72	144	24	144	240	24	144	240
S.g.	20	100	-	30	98	100	36	100	-	30	100	-
R.d.	0	0	0									
T.c.				4	76	88	0	72	100	0	64	10

Insects: *S.granarius*, *R.dominica*, *T.castaneum*

Table II Efficacy of EC formulation of DTM applied in the dosage of
0,5 g DTM/t (%)

Days after treatment	Insects				
	S.o.	S.z.	R.d.	T.c.	O.s.
17	100	100	100	96	100
45	100	100	100	83	100
73	100	100	96	96	100
101	100	100	100	100	100
129	100	100	96	100	100
157	95	95	91	91	100
185	73	87	85	50	100
213	99	100	96	87	100
241	96	97	100	84	96
269	100	97	93	95	99
297	100	96	100	100	100
325	100	100	100	92	100
353	37	37	0	41	47

Insects: *S.oryzae*, *S.zeamais*, *R.dominica*, *T.castaneum*, *O.surinamensis*

Table III Efficacy of EC formulation of DTM applied in the dosage of
0,25 g DTM/t (%)

Days after treatment	Insects				
	S.o.	S.z.	R.d.	T.c.	O.s.
16	100	100	100	100	100
45	99	73	82	86	99
86	46	64	71	88	100
149	63	69	93	65	92

Insects: *S.oryzae*, *S.zeamais*, *R.dominica*, *T.castaneum* , *O.surinamensis*

L'AEROSOLISATION DES GRAINS AUX INSECTICIDES DANS LES SILOS

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RESUME

L'application directe d'insecticide sur le grain constitue, avec la fumigation, la mesure la plus fréquemment utilisée pour désinsectiser les denrées stockées en Yougoslavie. Le grain traité est ainsi protégé des ravageurs pour longtemps mais, en raison des résidus de pesticides, il ne peut être utilisé pendant un certain temps.

Des traitements ont été effectués en silo: deltaméthrine sur blé et chlorpyriphos-méthyl sur maïs. Des échantillons ont été portés au laboratoire où ont été entreprises des mesures sur l'efficacité de ces traitements. Avec la deltaméthrine, on a obtenu une protection satisfaisante contre les ravageurs les plus importants, sur une période allant de 6 à 12 mois. Cependant, les mesures effectuées sur échantillons tirés de couches différentes a montré la mauvaise répartition des produits. Et, en outre, en présence de champignons, l'efficacité diminue. L'expérience avec le chlorpyriphos-méthyl a duré 5 mois et les résultats obtenus ont été satisfaisants pendant cette durée.