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EFFECTIVENESS OF SLOW-RELEASE INSECTICIDE (CHLORPYRIFOS 10% W/W) AGAINST *SITOPHILUS ORYZAE* (L.) (COL. CURCULIONIDAE) IN PACKAGED WHEAT[1,2]

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RINGKASAN

Kumbang beras dewasa, *Sitophilus oryzae* (L.) telahpun didedahkan kepada pelepas-pelepas bebas perlahan chlorpyrifos (10% w/w) yang mempunyai ukuran 1, 5, 15, 20 dan 25 cm^2 di dalam bungkusan gandum. Kematian kumbang beras dewasa yang sepenuhnya diperolehi selepas didedahkan selama 30 hari bagi bungkusan-bungkusan yang mengandungi pelepas-pelepas yang berukuran 20 dan 25 cm^2. Namun begitu, peneluran tidak dapat dihalang kerana anak F_1 kumbang terus muncul di antara 30 dan 60 hari, tetapi kebanyakan daripada anak-anak yang muncul didapati mati apabila diperiksa selepas 60 hari. Tiada kekurangan berat bijian yang bererti diperhatikan bagi bungkusan-bungkusan yang mempunyai pelepas-pelepas 5 hingga 25 cm^2 di antara 60 dan 90 hari. Walau bagaimanapun, di dalam rawatan-rawatan ini, kerosakan awal bijian akibat dimakan oleh kumbang dewasa dan pertumbuhan larva di antara 30 dan 60 hari adalah bererti. Potensi penggunaan formulasi racun serangga bagi mengawal serangga-serangga bijian yang disimpan atau biji-benih adalah dibincangkan.

INTRODUCTION

Under poor conditions of storage, food grains and seeds often have to be protected with insecticides against insect damage. Only a few safe insecticides can be applied directly to grain and these usually have short residual lives. Most are organophosphorus compounds which have relatively short persistence and usually fail to provide good protection of grain over long storage. Thus, there has been a search for formulations with extended effective lives. These reduce the need for reapplication, and improve their handling and safety to users and the environment. The Hercon(R) controlled release insecticide dispenser, based on a polymeric delivery system, has shown good promise for use against insect pests (KYDONIEUS *et al.*, 1975). GILLENWATER and MCDONALD (1977) evaluated the efficacy of Hercon insecticidal dispensers containing respectively, 5 and 16% w/w malathion, 15% w/w chlorpyrifos, and 8.5 w/w stirofos against stored product insects. These slow-release insecticides showed no loss of efficacy against adult *Tribolium confusum* during 4 years. Chlorpyrifos has also been incorporated into polyvinyl chloride, polyurethane foam and polyamide, all of which provide excellent control of mosquito larvae over 22 and 24 week periods, compared with 1 to 2 weeks using chlorpyrifos emulsion (MILLER *et al.*, 1973). Tests conducted by KENAGA *et al.*, (1965) and STRONG and SBUR (1968) indicated that chlorpyrifos was extremely effective against stored product insects. LIM and SUDDERUDDIN (1977) found chlorpyrifos the most toxic to adult *Sitophilus oryzae*, with an LC_{50} of 10.09 mg/l.

This laboratory study was conducted to determine the effectiveness of Hercon slow-release dispenser containing 10% w/w chlorpyrifos[3] against *S. oryzae* in wheat packages.

MATERIALS AND METHODS

The culture of *S. oryzae* was started from individuals obtained from Dr. L.B. Smith, Agriculture Canada, Winnipeg. The insects were cultured on hard spring wheat (moisture content about 12%) in 1 lb jar. After being held on the wheat for 1 week for egg-laying, they were then removed by screening through a 2.0 mm sieve. The stock

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[2]Mention of a pesticide or trade name of product does not imply endorsement of recommendation for use.

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cultures were held in a chamber at 28° ± 2°C and 50 ± 5% RH. Four weeks after initial infestation, the newly emerged adults were then collected by screening for use in the experiments.

The slow-release insecticide dispensers provided by the Herculite Protective Fabrics Corp., N.Y. consisted for chlorpyrifos impregnated into a synthetic fabric as active agent reservoir sealed protectively between the outer plastic layers *(Figure 1)*. The active ingredient was expressed as percent by weight of the fabric. Dispensers were cut into sizes of 1, 5, 15, 20 and 25 cm^2 as test dosages. Each patch was glued to the inner wall of a 12 x 20 cm clear polyethylene bag (0.1 mm) containing 400 g clean wheat tempered to a moisture content of 12%. The content of each bag was artificially infested with 10 pairs of one-week old rice weevils and each treatment was replicated 3 times. The bags were heat-sealed and stored in a chamber at 28° ± 2°C and 50 ± 5% RH for observation over the test period. For the controls, the same procedure was repeated using dispensers without the toxicant.

(a) The number of dead and living adults present in each bag were counted. Weevils were collected by screening the grain through a 2.0 mm sieve. Moribund weevils were counted as dead. A moribunds insect was defined as showing a slight movement only of an appendage when lightly probed, but appearing unlikely to recover.

The content of the bags were examined at 30-days interval over a storage period of 3 months. At each examination, the assessment was made as follows:–

(b) For each bag of grain (both undamaged and bored) collected in the sieve in step (a), the dust component which consisted of fragments and frass resulting from weevil infestations were separated. Both the grain and the dust components were then weighed.

After the assessment, surviving adult weevils were reintroduced into the bag which was sealed for later observation.

RESULTS AND DISCUSSION

Table 1 shows the mean numbers of dead and living adult weevils per 400 g-

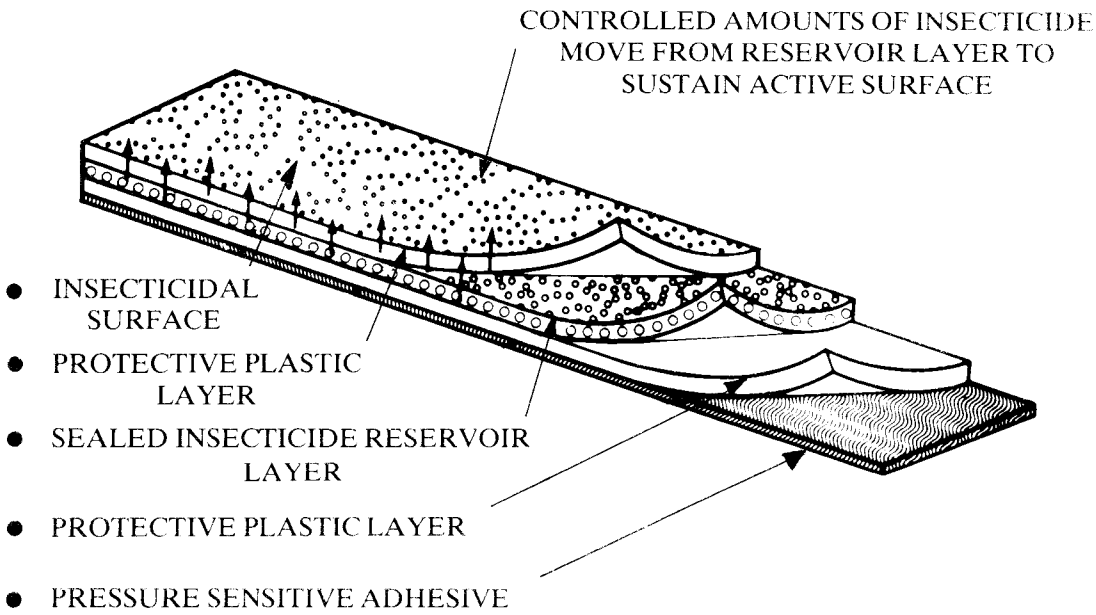

Figure 1. A schematic cross-section of a typical HERCON delivery system

package of treated and untreated wheat, stored over the 90 days period. All the adult weevils were killed by the 30 day counts in packages treated with dispensers measuring 20 and 25 cm^2, but oviposition was not prevented. F_1 progeny of weevils continued to emerged between 30 and 60 days of storage. However, in these treatments, most of the progenies that emerged were killed when examined at 60 days. Apparently, the cumulative amount of toxicant released from the dispensers after 30 days was sufficient to kill the emerged progenies. No further development of weevils or grain damage *(Table 2)* were observed after 60 days in packages treated with 15, 20 and 25 cm dispenser. At the end of the experiment, no live weevils were recorded in these packages. According to QUISUMBING and KYDONIEUS (1977), the cumulative loss of toxicant (chlorpyrifos) from the same dispenser at room temperature (21.2 to 26.7°C) after 30 days was 0.99 mg/cm^2 of dispenser. The rate of release was also found to be quite uniform

TABLE 1: MEAN NUMBER OF DEAD AND LIVING ADULT *S. ORYZAE* PER 400g PACKAGE OF WHEAT, RECORDED OVER 90 DAYS OF STORAGE

Dispenser size cm^2 = dosage	Mean[a] number of dead (D) and living (L) after					
	30 days		60 days		90 days	
	D	L	D	L	D	L
1.0	2.7	17.3	98.7	95.0	102.3	68.7
5.0	2.7	12.3	101.3	73.0	93.0	22.7
10.0	11.3	8.7	90.7	14.7	28.7	9.0
15.0	14.3	5.7	81.0	9.0	12.0	0
20.0	20.0	0	138.3	0.7	0.7	0
25.0	20.0	0	123.0	0	0	0
Control	0	20.0	4.7	153.0	21.0	328.0

[a]Mean of 3 replicates.

TABLE 2: WEIGHT LOSS OF WHEAT (g) RESULTING FROM WEEVIL INFESTATION OVER 90 DAYS OF STORAGE

Dispenser size cm^2 = dosage	Mean[a] weight loss of wheat, g, per package after		
	30 days	60 days	90 days
1.0	1.42 a, 1	8.98 a, 2	12.61 a, 3
5.0	1.32 a, 1	5.56 a, 2	8.65 bd, 2
10.0	1.26 a, 1	4.75 a, 2	5.15 cd, 2
15.0	0.95 b, 1	7.05 a, 2	7.36 d, 2
20.0	0.86 b, 1	5.34 a, 2	5.45 d, 2
25.0	0.98 b, 1	5.22 a, 2	5.27 d, 2
Control	1.48 a, 1	7.42 a, 2	12.03 a, 3

[a]Means in the same column followed by the same letters and in the same row followed by the same numbers are not significantly different at 5% level according to the New Duncan Multiple Range Test.

and the cumulative loss after 60 days was about 0.19 mg/cm^2. Therefore, the cumulative release of chlorpyrifos in the wheat packages treated with 20 and 25 cm^2 dispensers after 30 days would be about 1.8 and 2.3 mg, respectively, assuming that the release rates of toxicant are of the same order. These amounts of toxicants were then equivalent to 4.5 and 5.8 ppm for treatment with 20 and 25 cm^2 dispensers respectively, but these may not have been uniformly distributed in the grain package. The amount of chlorpyrifos released after 60 days may be higher still, thereby resulting in complete mortality of adult weevils in the packages. WILLIAMS *et al.*, (1978) demonstrated that wheat treated with 4 ppm chlorpyrifos resulted in 100% mortality of adult *S. oryzae* within 9 days of exposure.

In grain packages treated with smaller size dispensers of 1, 5 and 10 cm^2, weevils continue to develop and high weevil population were recorded at the end of experiment. Evidently, these dosages did not prevent weevil development over the storage period. The mean weight loss of grain after 90 days of storage in the packages treated with 1.0 cm^2 dispenser and untreated controls were 12.61 and 12.03 g respectively. No significant loss in weight of grain was noted in packages treated with 5.0 to 25.0 cm^2 dispensers between 60 and 90 days *(Table 2)*. However, in these treatments, initial grain damage by adult feeding and larval development between 30 and 60 days was significant.

It was suggested that a compound with a stronger vapor or fumigant action in the same formulation would be more efficient for killing immature weevils and the effective dosages would be subsequently reduced. Based on the range of reported acute oral and dermal single-dose LD_{50} values of technical chlorpyrifos in rats (acute oral LD^{50} = 82 – 163 mg/kg; acute dermal = 202 mg/kg) it may be classified as moderate in its acute toxicity to mammals (MARSHALL and ROBERTS 1978). Clearly, more research and laboratory evaluation of this compound are needed before they can be put to practical use. However, the slow-release formulation of chlorpyrifos or other efficacious compounds may be suitable for protecting grain and seeds over long period from insect infestation without the need for repeated treatment. Furthermore, this new formulation is easier to apply and provides greater safety to the users when compared to the conventional dust or spray treatments.

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SUMMARY

Adult rice weevils, *Sitophilus oryzae* (L.) were exposed to slow-release chlorpyrifos (10% w/w) dispensers of sizes 1, 5, 15, 20 and 25 cm^2 in wheat packages. Complete mortality of adult weevils resulted after 30 days exposure in the packages treated with dispensers measuring 20 and 25 cm^2. However, oviposition was not prevented as F_1 progeny of weevils continued to emerge betweed 30 and 60 days, but most of the progeny that emerged were dead when examined at 60 days. No significant loss in weight of grain was noted in packages treated with 5 to 25 cm^2 dispensers between 60 and 90 days. However, in these treatments, initial grain damage by adult feeding and larval development between 30 and 60 days was significant. The potential use of the insecticide formulation for controlling insects of stored grains or seeds was discussed.

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