Protection of stored plant products from rodent pests using chlorophacinone

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Abstract

Apart from some preventive measures, advisably taken during construction of storage facilities or at the time of product storage, treatments with chemical rodenticides have been the most widely practiced method of controlling commensal rodents. Their control in storages is normally carried out after animal presence has been observed, and treatments from early autumn onwards, throughout the season, provide the best effect. The paper shows the effects of baits with lower content of the active ingredient chlorophacinone than recommended for protecting stored plant products from rodents. The experiments were set up using the relevant OEPP/EPPO method. Different contents (0.005% and 0.0075%) of the active ingredient chlorophacinone were used in a ready for use (RB) paste bait formulation. Baits were laid in boxes along rodent routes, underneath pallets with sacks and in places where major damage was observed. Baits for house mice were placed at a rate of 10-20 g per 1-3 m, while 30-50 g of baits for brown rats were laid at specific points. Daily bait intake was monitored over a period of 10 d and the portions were replaced with new ones as needed. Placebo baits were laid in identical boxes for 4 d before the experiment began. The abundance of house mice was estimated based on the highest and lowest daily intake of bait divided by the species' daily food requirement.

The data in this experiment show that 0.005% and 0.0075% chorophacinone contents in RB baits changed neither palatability nor bait efficacy in controlling house mouse and brown rat indoors. The average efficacy of chorophacinone was 87-93% against house mouse and 90-100% against brown rat.

Keywords: Chlorophacinone, Rodent, Storage, Efficacy

1. Introduction

Two highy adaptable commensal rodent species, house mouse *Mus musculus* L. and brown rat *Rattus norvegicus* (Berkenhout), have fully adjusted to conditions existing in storage facilities, which provide them with hiding places and readily accessible food resources. Daily food intake of a house mouse is equivalent to 15% of its body weight, which is 1.4 kg annually (Gwinner, 1996). It normally visits food sources near its lair some 20-30 times overnight (Mallis, 1982). Daily food intake of a brown rat is around 28 g, i.e. 100 animals consume a tonne of stored products annually (Buckle and Smith, 1994). Apart from causing damage by feeding, rodents are also able to pollute nine times as much food with their feces, urine, hair and other impurities (Drummond, 2001; Brown et al., 2007).

Protection of stored plant products from commensal rodents was considerably improved in the mid-20th century just after World War Two (Buckle and Smith, 1994; Fall and Jackson, 1998). Nearly three decades later, Davis (1972) and other researchers developed a new approach to rodent control. Integrated pest management (IPM) has thus become undoubtedly the most efficient and most significant strategy of plant protection in terms of ecological and economic concerns (Spragins, 2006), but it has still not taken root fully (Haines, 2000). As a result of technical/technological variability regarding warehouse construction, types of stored plant products, location, environment, climatic and various other factors, it is almost impossible to employ a uniformed approach and strategy of protection from commensal rodents. Their ability to learn, change and adapt to various environmental conditions (Mallis, 1982) adds importance to a development of new and updating of existing methods of protection.

Chlorophacinone (2-[(4-chlorophenyl)phenylacetyl]-1H-indene-1,3(2H)-dione) is one of the most potent of first generation anticoagulant rodenticides which has been used throughout the world as an effective compound for controlling all common commensal and agricultural rodent pests (Santini, 1986; Advani, 1995; Parshad, 1999). Chlorophacinone is moderately palatable to commensal rodents, and its results are best after intake over several successive days. As in other anticoagulants, its mechanism of activity is based on blocking protrombine formation and prevention of blood coagulation. Due to its ecotoxicological properties, chlorophacinone has been categorized as a group I poison (Tomlin, 2006) and has been used since 1961 for controlling rodent pests (Hadler and Buckle, 1992).

As commercial rodenticides are available in various formulations and with different active ingredient contents (Marsh et al., 1977; Advani, 1992), we have compared the efficacies and palatability of RB formulations containing 0.0075% and 0.005% chlorophacinone.

2. Materials and methods

2.1. Sites

The experiments were set up in several storage facilities and their surroundings upon an area totaling 2500 m^2 in which rodents had been observed. The products stored (maize, wheat, barley, sunflower and oats) were either packed in sacks or stored in bulk in feed mixing rooms.

2.2. Experimental design and baiting

The experiments were set up in compliance with the relevant OEPP/EPPO method (EPPO, 1999) and the ready-for-use baits were prepared by adding chlorophacinone to broken cereal grains along with an attractant and fixative adjuvant.

Unpoisoned baits were laid out for 4 d at the beginning and in the end of experiment in order to estimate rodent numbers by census. Poisoned baits were distributed at more or less identical places as placebo baits, underneath pallets, along rodent routes and in places where they had been observed previously. Baits with different chlorophacinone contents were offered simulataneously in separate storage buildings with approximately the same level of infestation over a period of 10 d. During prebaiting and baiting, daily intakes were recorded and new baits were added as required. All baits were offered in identical commercial plastic boxes. Baits for house mice were distributed at a rate of 10-20 g per 1-3 m, while 30-50 g of baits for brown rats were laid out at specific points. Rodent presence was monitored over the following 20 d.

2.3. Data processing

Commensal rodent numbers were evaluated based on the highest and lowest daily intakes of poisonous bait divided by daily requirement, and using the census method (EPPO, 1999). To establish the significance of differences between methods evaluating rodent numbers, Student's T-test was used at a significance level of at least $P<0.05$ (Sokal and Rohlf, 1995). Bait efficacy was calculated using Abbott's formula (Abbott, 1925).

3. Results

Based on census data and visual observation, more than 90 house mice and 40 brown rats were present at the beginning of experiment, and 12 house mice and 4 brown rats at the end (Table 1). Chlorophacinone average efficacy in all baits used was 86.8% for house mouse and 90% for brown rat.

Table 1 Placebo bait intakes (g) in all storage facilities and rodent numbers estimated by census baiting.

Species	Estimation time	Σ placebo bait intakes	Placebo bait intakes/day	Estimated animal numbers
Mus musculus	Beginning	1810	543	91
	End	224	71	12
Rattus norvegicus	Beginning	2468	1124	40
	End	349	113	4

In the experiment involving house mouse, maximum daily intake was recorded on the second day of baiting (Fig. 1). Different active ingredient contents had no effect on daily intakes and palatability of baits. Twenty days after the experiment was completed, house mice were found sporadically.

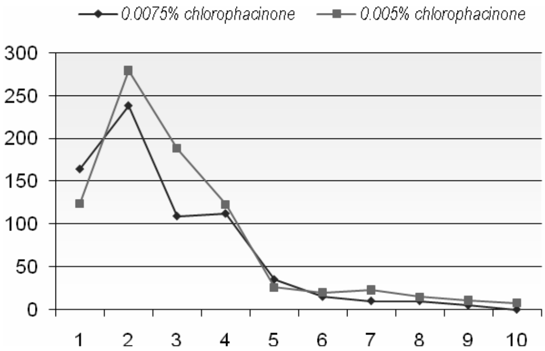

Figure 1 Palatability of the rodent baits in experiment with *Mus musculus*.

In the brown rat experiment, the intake of 0.005% and 0.0075% chlorophacinone baits was highest on the third and fourth day, respectively (Fig. 2). Different contents of the active ingredient had no effect on bait intake and palatability. Brown rats were not found 20 d after the end of experiment.

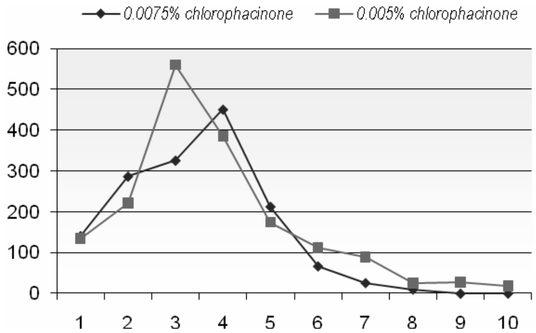

Figure 2 Palatability of rodent baits in experiment with *Rattus norvegicus*.

Data on maximum and minimum daily intakes of poisonous baits and the required daily food portions for commensal rodents indicated a presence of 87 house mice and 40 brown rats at the beginning of the experiment (Fig. 3, Table 2). The estimated efficacy of baits containing 0.005% chlorophacinone against house mouse and brown rat was 87% and 93%, respectively, and it was lower than the efficacy of baits containing 0.0075% chlorophacinone, which achieved 90% and 100% efficacy.

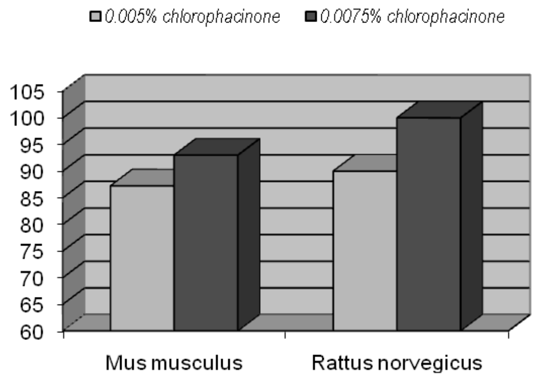

Figure 3 Efficacy levels of the applied rodenticides.

Table 2 Efficacy of products tested for controlling house mouse and brown rat in storage facilities.

Species	Baits	Estimated numbers*		Efficacy (%)
		Beginning	End	
Mus musculus	0.005% chlorophacinone	47	6	87
	0.0075% chlorophacinone	40	3	93
Rattus norvegicus	0.005% chlorophacinone	20	2	90
	0.0075% chlorophacinone	16	0	100

*Animal numbers were estimated based on maximum and minimum daily intakes of poisonous baits

Student's t-test showed significant statistical differences between the estimated numbers of commensal rodents on the chosen site (P=0.0065; df=3).

4. Discussion

Rodent control in storage facilities normally begins after their presence has been observed, and the best effects are ensured by deratization in early autumn and throughout the season (Ružić, 1983). Based on their estimated numbers and visual observations, it is possible to decide whether the level of infestation in any particular site is high enough to conduct an experiment.

The content of active ingredient in baits was not found to affect their palatability. The highest intakes of poisonous baits were recorded during the initial 4 d of the experiment for house mouse, and 5 d for brown rat. Chlorophacinone content in baits had no effect on daily palatablity of baits. Figs. 1 and 2 show a significant reduction in bait intakes during the last several days of the experiment.

The average efficacy of baits containing 0.005% chlorophacinone in controlling commensal rodents in storage facilities was 87% against house mouse and 90% against brown rat, and it was lower than the efficacy of baits containing 0.0075% chlorophacinone, which achieved 93% and 100% efficacy, respectively. However, after inspecting the facilities again 20 d after the end of experiment, house mice were found sporadically and irrespective of bait concentration. No brown rats were found. Marsh et al. (1977) had reported similar effectiveness in laboratory experiments with baits containing 0.005 and 0.01% chlorophacinone. According to Advani (1995), the efficacy of a tracking powder containing 0.2% chlorophacinone was 88% against house mouse.

The experimental data and visual observations, as well as the basic ecotoxicological properties of chlorophacinone, suggest that 0.005% chlorophacinone in RB formulations can achieve satisfactory results in controlling commensal rodent species in storage facilities.

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