HOW TO CONTROL A PEST'S PEST—FLEA AND RODENT EFFICACY

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ABSTRACT: Fleas have caused health and sanitation problems for centuries. Most rodents are hosts to fleas. Baker Crop Protection Chemicals (BCPC) recently entered the rodenticide market (via SLN) with an efficacious fumigant for single burrow rodents, MAGNACIDE® H Herbicide/Rodenticide (a.i. acrolein). Noting that most burrowing rodents are flea infested, BCPC undertook an experiment to determine if fleas also succumb to acrolein under simulated field treatment scenarios. Results of the study under laboratory conditions demonstrated that fleas do succumb to acrolein treatments as well as the specific rodents targeted for treatment. This study also established rodent death rates from exposure to acrolein in a simulated closed system at 4 to 6 minutes, at a treatment rate of 20 milliliters.

KEY WORDS: acrolein, fumigant, fleas, MAGNACIDE®, burrowing rodents, efficacy

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INTRODUCTION

Baker Crop Protection Chemicals is a division of Baker Performance Chemicals, Incorporated, a Houston, Texas-based corporation. Baker Crop Protection Chemicals specializes in agricultural water treatment. Baker Crop Protection Chemicals (BCPC) entered the rodenticide market in the early 1990s with strong encouragement from both customers and government agencies. The stimulus for entering this market was the loss of other rodenticide products due to registration, environmental and humane treatment issues. Early field efficacy demonstrated 90% mortalities on specific single burrow rodents (pocket gophers, ground squirrels). Ross O'Connell and Jerry Clark, Control and Eradication Specialists with the California Department of Food and Agriculture, presented the results of a field trial using MAGNACIDE® H Rodenticide on the California ground squirrel (*Spermophilus beecheyi*) at the 1992 Vertebrate Pest Conference. "The lower application rate (20 cc) of acrolein was as efficacious as the higher rate. This degree of control (approximately 90%) by either activity index is excellent, and shows the material to be very promising. Acrolein, if registered, used at the 20 cc rate should cost about 13 cents per burrow opening, making it more economical than the other fumigants" (O'Connell and Clark 1992). MAGNACIDE® H Rodenticide has subsequently been registered in California, Washington, Oregon, Nebraska, Utah, Wyoming and Idaho as a Special Local Need--Section 24(c).

Acrolein, the active ingredient in MAGNACIDE® H Rodenticide (92% minimum) is a three carbon aldehyde ($CH_2=CH-CHO$), with a molecular weight of 56.06. It is a clear, colorless liquid with an extremely irritating odor. Acrolein is classified as acutely toxic, based on its acute inhalation LC_{50} in rats (26 ppm/1-hr exposure, 8.3 ppm/4-hr exposure). Asphyxiation is the mode of death for single burrowing rodents exposed to MAGNACIDE® H Rodenticide in a closed burrow system. In soil metabolism and dissipation studies, acrolein has a very short half-life (hours) and is readily metabolized by soil bacteria. Simplified application procedures for the use of MAGNACIDE® H Rodenticide are as follows:

1. Locate the burrow to be treated.
2. Insert nozzle of jet gun assembly.
3. Cover with dirt.
4. Pull trigger--dispense metered dose.
5. Remove nozzle of jet gun.
6. Tamp down soil, if necessary.
7. Repeat application at next burrow.

MAGNACIDE® H Rodenticide has proven to be efficacious with smaller single burrow rodents but the amount of time from exposure to death has not been firmly established. Once a burrow was treated, in many cases it was immediately covered with dirt to increase efficacy, which limited animal retrieval. Many of the carcasses that were retrieved after treatment were flea infested. Since the animal being treated is in a closed environment, the question arises as to whether the acute toxicity of acrolein affect the fleas infesting the animal targeted for treatment. The question of flea control was especially pertinent with recent outbreaks of rodent/flea transmitted respiratory diseases on the Navajo Indian Reservations in northern New Mexico.

The flea has caused health and sanitation problems for many centuries. The rat was the rodent that carried the flea which spread the bubonic plague through Europe, killing at least 25 million people. In more recent times, India has been plagued with flea-infested rats spreading disease. Common rodents that are flea carriers which create commercial, agricultural and residential problems include: Pocket gophers, ground squirrels, prairie dogs, woodchucks, muskrats, chipmunks, tree squirrels, voles or meadow mice, nutria, beavers, deer mice, cotton rats, kangaroo rats, rice rats, wood rats, Norway rats, black rats and house mice.

Fleas are found all over the world. There are an estimated 1600 to 1700 species of flea. The bodies of the fleas are well adapted for their lifestyle; they are small,

wingless insects, flattened from side to side. Adult fleas vary in size from 1/25 to 1/4 inch (1 to 6.3 mm) and are black to brownish black in color. They are relatively good jumpers and have excellent mobility through hair or feathers. Their mouth parts are well adapted for piercing the skin and sucking blood.

The larvae are whitish, legless, blind, wormlike and less than 1/4 inch (6.3 mm) when full grown. The pupae are enclosed in cocoons that become encrusted with soil particles and debris, making them almost impossible to detect. Fleas lay four to eight eggs after each blood meal, (several hundred eggs during a lifetime). The eggs are laid off the host in the dirt, bedding or nest of the host. Occasionally, the eggs are laid by the adult female while on the host, but they eventually fall to the ground or other surfaces. It is interesting to note that fleas can have a delayed hatching time period. The life cycle of the flea is as follows: Eggs⇒Larvae 2 to 3 weeks; Larvae 9 to 200 days⇒Pupae; 7 days to 1 year. The egg, larva and pupal stages are rarely seen. Most fleas require 30 to 75 days to complete a life cycle when optimum conditions exist.

Fleas move about readily on the host and frequently transfer from one animal to another. Adult fleas are long-lived and able to survive several weeks off the host without feeding. Both sexes suck blood (Patrick and Hamman).

The objective of this study, under laboratory conditions, was to answer two questions. 1) How long after application of MAGNACIDE® H Rodenticide does death occur in the rodents? 2) Are the fleas living on the target rodent affected by MAGNACIDE® H Rodenticide?

METHOD AND MATERIALS

Study design proved to be challenging since burrowing rodents are not commercially available, flea suppliers are very specialized, acrolein is a very volatile material, and conditions must be simulated so as to give reliable results. The study was undertaken at MB Research Laboratories, Inc., Spinnerstown, Pennsylvania. Mr. Dan Cervan of MB Research Laboratories was the study director and participated in the study design.

One male and one female Wistar albino rat (burrowing rodents are not commercially available) were selected from larger groups of commercially available rodents and received from Ace Animals, Inc. The male weighed 224 grams and the female 225 grams. The weight of the rats was closely simulated to the California Ground Squirrel. Two hundred fleas (*Ctenocephalides felis felis*) were received from EL Labs in separate containers of 100 fleas per container.

Two identical 55 liter glass aquarium-style chambers (60x31x32 cm) with impermeable lids were used for this study. The bottom of each chamber was covered with common soil (obtained from the grounds of MB Research) to a depth of approximately one inch. A mercury thermometer was placed in each chamber to ensure a temperature between 65 and 75°F prior to initiation of dosing. This temperature range would ensure optimum temperature testing conditions.

The male rat was placed in one chamber and the female in the second chamber. One separate vial labeled as containing 100 live fleas was opened and placed in each chamber. The chambers were immediately covered to prevent escape of the fleas.

The chambers were monitored to ensure that at least 90% of the fleas left the vial and infested the resident rat. The chamber temperature was then recorded and 20 ml of MAGNACIDE® H Rodenticide (acrolein) was poured into the dirt at the bottom of each chamber. The 20 ml rate has been determined by previous field trials (O'Connell and Clark 1992) to give optimum efficacy on this size rodent.

Each chamber was monitored until each rat died, and the time of death recorded. After a period of two hours, each chamber was opened and a flea attractant light and trap (Pulvex Flea Trap Model 2002, Zena Corp.) were placed inside the chambers. The overhead lights in the exposure area were then turned off and the trap allowed to remain in the chamber for one hour.

After one hour, the room was re-illuminated and the chambers, traps and carcasses were visually inspected for flea activity.

This study was conducted in accordance with the applicable Good Laboratory Practices Regulations of the EPA/FIFRA, 40 CFR Part 160.

RESULTS

Upon initiation of the study, the fleas were noted to immediately infest the rats. Within minutes of the MAGNACIDE® H Rodenticide administration, the fleas which infested the rats became animated and were noted jumping off the animals.

Both rats succumbed after the introduction of MAGNACIDE® H Rodenticide into each chamber. The male rat died within four minutes, the female within six minutes.

No live fleas were observed in the chambers or on the traps. The fleas were not readily visible nor accessible in the dirt at the bottom of the chamber. All efforts to locate additional live or dead fleas were stopped at the designated time period. There was no evidence of any movement indicative of live flea activity at the one hour time period. The rats were not combed for fleas, but were visually examined by ruffling the fur.

CONCLUSION

Under the conditions of this study, the application of MAGNACIDE® H Rodenticide resulted in a quantifiable timed mortality in the exposed rodents (4 to 6 minutes). Fleas exposed during this study also showed evidence of mortality to MAGNACIDE® H Rodenticide.

RECOMMENDATIONS

Further work is recommended to quantify numbers for mortality in fleas rather than using activity as an indicator.

LITERATURE CITED

O'CONNELL, R., and J. CLARK. 1992. A study of acrolein as an experimental ground squirrel burrow fumigant. *In* Proc. 15th Vert. Pest Conf., California.

PATRICK, C., and P. HAMMAN. FLEAS, Texas Agricultural Extension Service, The Texas A&M University System, L-1738.