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EXIT™/VARGON™ – A New Reduced-Risk Rodenticide for the Control of Burrowing Rodents

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Abstract: EXIT™/VARGON™ is a new, reduced risk, non-toxic, environmentally friendly rodenticide developed in Canada. The product will be marketed as EXIT™ in Canada and VARGON™ in the United States. United States, Canadian and international patents have been applied for. The product was given reduced risk status for the control of burrowing rodents in May 1999 and has been accepted for joint review by the PMRA and EPA under the North American Free Trade Agreement.

Laboratory and field research trials conducted within both the United States and Canada to determine efficacy for control of ground squirrels (*Spermophilus* spp.) showed 100% efficacy in the laboratory and 94% to 98% efficacy when used in the field according to label directions. Laboratory trials conducted in Canada to determine efficacy for control of Norway rats (*Rattus norvegicus*) showed 100% efficacy in the laboratory. Preliminary field trials have been carried out with promising results.

EXIT™/VARGON™ is a concentrated mixture of alpha-olefin sulfonate and mustard seed powder (*Brassica hirta*) in water. Prior to application, the concentrate is diluted 1 part concentrate to 24 parts water to form the field solution. The field solution is applied as a foam to individual burrows through an air-aspirating nozzle. All treated animals become unconscious due to anoxia within 1 minute and death by asphyxiation occurs in less than 3 minutes from the start of application. Application equipment consists of a water tank, 12-volt 3.6-gpm Shur Flow pump, a hose reel, and 100 feet of ½-inch garden hose. The nozzle is a 3-gallon per minute aspirating nozzle with a 12-inch to 16-inch extension tube to create foam. The foam expands 3 to 4 times as it exits the nozzle and fills most burrows in 15 to 20 seconds. Prior to application, burrow entrances are blocked with a wire basket or perforated plastic cones to prevent escape of target animals. Foam is applied through the basket or cone into the burrow.

The product can be applied at any time and does not depend on the feeding patterns of the target species for efficacy. Application can be made in early spring prior to emergence, throughout the summer when the animals are active, or in late fall after the rodents begin to hibernate. Burrows must be examined and certified free of threatened or endangered species prior to using EXIT™/VARGON™. The product is very site specific, and selected areas such as playing fields, grazing areas, parks, etc. can be targeted for treatment while wildland areas can be left as habitat for the ground squirrels. Periodic treatments will keep the selected areas free of target species. The product is biodegradable, environmentally friendly, and essentially non-toxic. It is safe to handle and easy to apply. Treated animals die and remain in their burrows. As the product has no systemic toxicity, there is no secondary poisoning risk to humans or other species.

Key Words: reduced risk, foam rodenticide, burrowing rodents, non-toxic, biodegradable, species specific, site specific, emergence, hibernation

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INTRODUCTION

Burrowing rodents, including ground squirrels (*Spermophilus* spp.) and rats (*Rattus* spp.), cause millions of dollars damage to crops, stored foodstuffs, and livestock annually. Additional millions are spent in efforts to limit and control rodent pests. Control of burrowing rodents is usually carried out through the use of poison baits or trapping. Neither method is particularly efficient. Trapping is about 30% - 60% effective, but re-invasion occurs almost immediately. In the case of poisons, they are initially effective but efficacy drops rapidly with the emergence of alternate food sources for the target population. Rats in particular are noted for bait shyness and quickly learn to avoid poison baits.

The ground squirrel problem was so severe across the provinces of Alberta and Saskatchewan that the federal government allowed the emergency use of 3% strychnine in the summer of 2001 after it had been previously banned from use. The use of 3% strychnine

may exacerbate the ground squirrel problem in the long term. Predators eating ground squirrels killed with strychnine die. This results in severe reduction of the predator population, which in turn results in an increase in the ground squirrel population. The ground squirrels recover much faster than their natural enemies.

A completely new rodenticide has been developed in Canada. It is not a poison, and it selectively kills target rodents quickly and painlessly in their burrows. It poses no threat to the environment, predators, scavengers, or applicators. The product is called EXIT™ and was granted reduced risk status for the control of burrowing rodents by the EPA in the United States in May 1999. It was accepted for joint review by the EPA and PMRA under the North American Free Trade Agreement. A complete registration package was prepared and submitted to the EPA in the U.S. and the PMRA in Canada in January 2001 (Mach 2000).

Upon registration, the product will be marketed as

EXIT™ in Canada and VARGON™ in the United States. Trademarks have been granted to both names in their respective jurisdictions.

VARGON™ and EXIT™ refer to the same product. In order to avoid confusion in this paper, the product is identified as EXIT™ where testing took place in Canada and VARGON™ where it took place in the United States. The product was called EH-2001 for testing purposes in Colorado in 2000. It is now identified as VARGON™ in the United States.

DEVELOPMENT

EXIT™ was developed in Cochrane, Alberta by Don Sutherland of Sutherland Management Services after purchasing a 10-acre residential homestead surrounded by 6,000 acres of wild pasture in 1985. For 10 years every conceivable method of control including poisons, trapping, fumigation, drowning, and shooting was attempted with limited results. Re-invasion occurred almost immediately after any control method was halted. This prompted some serious research on an inexhaustible supply of subjects.

In 1995, Sutherland, and his associate, Dave Schmunk, discovered that ground squirrels in a confined space could be rendered unconscious if the space was filled with foam. They concluded that if foam would disrupt their respiratory system to the point they became unconscious, an additive may carry the process one step further and result in the death of the affected animal. It would be a far more effective and humane way to control them than poisons or trapping. They experimented with various additives to the foam to determine if any would give the above results. The essential additive was finely-ground mustard seed, and the end result was a product that rendered ground squirrels unconscious within 1 minute and dead after 2 minutes.

Application techniques were perfected while clearing the homestead of ground squirrels. The final result is that both the homestead and a 40-acre buffer zone around it are clear of ground squirrels. Invaders are easily identified and the buffer is maintained with minimal effort.

PRODUCT AND APPLICATION

EXIT™ / VARGON™ concentrate is a mixture of a foaming agent and finely ground mustard powder. Prior to application, the concentrate is diluted 1 part concentrate to 24 parts water to form the field solution. The field solution is pumped under pressure through an aspirating nozzle with a 12-inch to 16-inch extension tube to facilitate application into the burrow.

The foam expands 3 to 4 times as it exits the nozzle and fills most burrows in 15 to 20 seconds. Prior to application, burrow entrances are blocked with a wire basket or perforated plastic cones to prevent escape of target animals. As the foam is injected under pressure, it completely fills the burrow including any anticlinal cavities not normally filled by water flooding. If the

burrow has more than one entrance, the foam will rise to the surface at the untreated entrances.

APPLICATION EQUIPMENT

Truck Mounted System

- plastic water tank (400-L or two 205-L plastic drums)
- 12-volt, 3.6-gpm diaphragm pump with a demand switch (run off truck battery)
- 100-ft garden hose and hose reel
- shutoff valve
- 3-gpm aspirating nozzle with extension
- wire basket or perforated plastic cones

Back Pack System

- 20-L forestry back pack
- 3-gpm back pack aspirating nozzle

PATENTS

Patents are pending in Canada and the United States as well as Europe, Africa, Asia, Australia, North and South America, and India. Sutherland and Schmunk have jointly filed international patent applications under the Patent Cooperation Treaty (PCT). Applications cover both the formulation and method of application for EXIT™/VARGON™.

ENVIRONMENTAL CONSIDERATIONS

EXIT™/VARGON™ is very site and species specific and is environmentally friendly. The ingredients in EXIT™/VARGON™ are found in commonly used products and present no danger to users. The product causes anoxia within 1 minute and death by asphyxiation in less than 3 minutes. There are a number of precautions that must be taken to ensure that only targeted species are treated. These are:

1. Examine the site prior to application
2. Identify the target species and mark the active burrows
3. Check for evidence of other species (visual identification, tracks, feathers, etc.)
4. Identify and mark burrows containing other or endangered species (e.g., burrowing owls)
5. Treat only burrows marked as target species

FIELD TESTING – ALBERTA 2000

A field study was conducted in June 2000 by Sutherland Management Services in cooperation with the town of Cochrane under Research Permit #17-RP-00 (Sutherland 2000). The purpose was to examine the suitability and efficacy of EXIT™ to control ground squirrels in an urban environment.

The test site was a vacant field within the town of Cochrane. Within the field, a 1.87-acre plot was established as the treatment area. This plot was surrounded by a 3.78-acre buffer zone that included a tree nursery. A 0.6-acre control plot was established 75 meters to the north of the test plot. The two plots were

separated by a drainage ditch that inhibited migration between them.

All burrows in the control and treatment plots were plugged with dirt and examined the following day for those re-opened from within. These were designated as active burrows for the efficacy determination. Active burrows in the treatment plot were identified with numbered flags and mapped. There were 289 active burrows identified in the treatment plot. All were treated with EXIT™ and the entrances re-plugged. No burrows were treated in the control plot and no re-opened burrows in this plot were re-plugged.

The buffer zone surrounding the treatment plot was monitored throughout the test to prevent invasion of the test site. Whenever a live ground squirrel was sighted in the buffer zone it was followed to its burrow and treated with EXIT™. All burrows in the buffer zone were eventually treated and the entrances plugged with dirt.

Open Burrow Census

Application of EXIT™ in the treatment plot and buffer zone was carried out over 3 days starting June 13 and finishing June 15. The first census was carried out on June 14 and any open burrows re-treated. The second census was conducted in June 15 and open burrows re-treated. A final census was conducted on June 16. A total of 7 open burrows were recorded for the 3 census days. All of these had been opened from above. Results are shown in Table 1.

Body Count

A total of 158 carcasses were retrieved during the treatment. Of these, 45 were from the treatment plot and 113 from the buffer zone. Carcasses were retrieved by reaching into the burrow with a gloved hand after an escape attempt was detected. All retrieved carcasses were put back in the burrows and the entrances plugged with dirt. Results are shown in Table 2.

Table 1. Open burrow census

Day	Treated Burrows	Opened Burrows	% Open Burrows
1	284	3	1.1%
2	289	2	0.7%
3	289	2	0.7%

Table 2. Body count

Day	Treatment Plot	Buffer Zone	Total
0	43	50	93
1	2	52	54
2	0	9	9
3	0	2	2
<i>Total</i>	45	113	158

Confirmed Kills

In all testing carried out, confirmed kills were considered to include the following:

1. Animals observed entering the burrows prior to treatment that did not attempt to escape during the treatment.
2. Animals that made an escape attempt, but were not retrieved for a carcass count because they retreated into the burrow during treatment, or slid back down the burrow after becoming unconscious. Also included are animals that made an escape attempt from a burrow entrance too small to reach into for carcass retrieval.
3. Animals retrieved after treatment.

Of 207 confirmed kills, 62 were in the treatment plot and 145 in the buffer zone. See Table 3 for details of confirmed kills.

Application Time

There were 296 burrow treatments within the treatment plot, including 7 re-treatments of burrows re-opened by invaders or scavengers after the initial application. Application times ranged from 2 to 200 seconds. Total application time for the test was 95 minutes 11 seconds. The average application was 19 seconds and the median application time per burrow was 12 seconds.

Efficacy

Efficacy was determined by two methods, open burrow census and visual count census.

Open Burrow Census

A burrow that has been opened from within by the inhabitant of the burrow will have excavated dirt in a symmetrical volcano like ring surround the entrance. A burrow that has been opened from above by an invader or scavenger will have excavated dirt spread only on one side of the burrow. All of the burrows re-opened in the treatment plot following the initial treatment were of the scavenger/invader variety. No re-treated and re-packed burrows were re-opened a second time.

Efficacy using the open burrow method was determined by comparing the number of unopened burrows with open burrows after the final count. Efficacy using all re-opened burrows was calculated as 98.8%. Efficacy using only burrows re-opened from within was calculated as 100%.

Visual Census

Both the treatment plot and control plot were surveyed twice a day for two (2) days following end of treatment on the treatment plot. In the post treatment census, 114 ground squirrels were recorded for the control plot. There were no ground squirrels observed in the treatment plot on either of the census days. Results are shown in Table 4.

Table 3. Confirmed kills

Day	Observed Entering Burrows	Escape Attempts	Carcass	Total
	No Escape Attempt	No Carcass Retrieved	Retrieved	
0	6	19	93	118
1	7	13	54	74
2	3	0	9	12
3	0	1	2	3
<i>Total</i>	<i>16</i>	<i>33</i>	<i>158</i>	<i>207</i>

Table 4. Post treatment visual census

Day	Plot	Time	Visual Count	Weather
June 16, 2000	Treatment	11:32	0	Cloudy, windy
	Control	11:37	61	Scattered raindrops
	Treatment	11:45	0	Temperature +7°C
	Control	11:51	68	
	Treatment	12:00	0	
June 17, 2000	Treatment	10:40	0	Sunshine
	Control	10:45	96	Light Wind
	Control	10:52	114	Temperature +16°C
	Treatment	11:00	0	

Efficacy using the Visual Census method was 100%, as no active ground squirrels were observed in the treatment plot on either of the days the visual census was carried out.

Reagent Used

The treatment plot and the buffer zone had hosted a large ground squirrel population for many years. Burrows were well developed and the average application required 3.5 L of field solution (140 ml concentrate) and took about 20 seconds to apply.

FIELD TESTING – COLORADO 2000

A field trial commissioned by Exit Holdings L.L.C. to determine the efficacy of VARGON™ on Wyoming ground squirrels (*Spermophilus elegans*) was conducted by Genesis Laboratories of Wellington, Colorado in May 2000 in Grand County, Colorado. Treatment and control plots were selected in each of two study sites. The treatment plots were 3.51 acres and 5.75 acres, respectively. Each treatment plot was surrounded by a 45-m buffer zone. Ground squirrel counts were carried out by closed burrow and visual census. The pre-treatment census was carried out over a period of 5 days prior to the start of the treatment. Treatment commenced on May 17 and continued until the morning of May 19. Post-treatment censusing began 2 days after the initial application of VARGON™ and continued for 5 days. It was completed on May 23, 2000.

VARGON™ was applied to all open burrows in the test and buffer zones over the course of the treatment. After the initial treatment of all burrows within the census and buffer zones was complete, any ground squirrels observed would be followed to burrows within the plot borders and the burrows immediately treated. As well, any opened or missed burrows were treated as they were discovered.

Efficacy

Efficacy results were based on the changes of activity indices of the control and treatment plot censusing techniques. Closed burrow and visual census activity of each treated plot was compared to the control plot in the same block to calculate individual plot efficacy.

The mean efficacy of the two test plots of the closed burrow and visual census method was 95.6% and 90.8%, respectively. According to the closed burrow and visual census methods, the test substance efficacy was calculated to be 96.5% and 94.0 %, respectively on plot A. The efficacy of the closed burrow method for plot C was 94.6% and 87.5% by the visual census method. Closed burrow census results are in Table 5. Visual census results are shown in Table 6.

The application of VARGON™ was effective in controlling Wyoming ground squirrels with a mean efficacy of 93.2% according to the two census methods. The results of the two field tests give EXIT™/VARGON™

Table 5. Results of the closed burrow census technique

Plot	Plot Type	Closed Burrow Census Points (Total #)		Efficacy (%)
		Pre-Treatment	Post-Treatment	
A	Treatment	313	11	96.5
B	Control	259	277	-6.9
C	Treatment	104	5	94.6
D	Control	198	177	10.6
<i>Mean of Treatment Plots</i>		229	227	95.6
<i>Mean of Control Plots</i>		209	8	1.9

Table 6. Results of the visual census technique

Plot	Plot Type	Squirrel Activity (Total #)		Efficacy (%)
		Pre-Treatment	Post-Treatment	
A	Treatment	42	2	94.0
B	Control	15	12	20.0
C	Treatment	24	3	87.5
D	Control	24	25	-4.2
<i>Mean of Treatment Plots</i>		20	19	90.8
<i>Mean of Control Plots</i>		33	6	7.9

an efficacy far exceeding any commercially available rodenticide. It is safer to use, environmentally benign, and humane. It is easy to use and can be applied rapidly over large areas. It is very site specific (applied only to the inside of identified burrows) and has no run-off or residual effects. It can be applied safely to such sites as playing fields, parks, schoolyards, and residential areas. EXIT™/VARGON™ foam disappears on the surface in about 20 minutes, depending on weather conditions, and in 2 - 4 hours in the burrows. There is minimal residue once the foam breaks down, and any residue remaining is readily biodegradable.

NORWAY RATS

Laboratory testing on Norway rats (*Rattus norvegicus*) was conducted by Alpha Wildlife Research and Management Ltd. at the Exit Holdings L.L.C. facility in Kamloops, British Columbia in June 1999. Twenty-four Norway Rats were submerged individually in EXIT™ foam under simulated burrow conditions and were observed throughout the process. All rats in the testing ceased movement in less than 3 minutes, and none revived after being removed from the foam.

Preliminary field tests were carried out at a grain storage facility near Krydor, Saskatchewan by Sutherland Management Services and Exit Holdings L.L.C. on April 22 and June 27, 2001. Rat activity was very evident during the first test. Burrow entrances were located around the foundations of the grain bins and all located burrows were treated with EXIT™ foam. Eleven rat carcasses were recovered from the treatment of 7 burrows. On the second occasion, June 27, there was little rat activity in evidence. Only a few burrows were

located, and these were burrows missed in the initial treatment. Two rat carcasses were recovered from the treatment of the burrows missed in the first treatment.

The site was visited a third time in September 2001. On this occasion, only one rat burrow was located in the vicinity of the grain storage bins. It is evident that the application of EXIT™ had a significant effect on the rat population at this location.

Rat burrows proved to be easier to treat than ground squirrel burrows. Several had multiple entrances that were successfully blocked with perforated cones. The clustering of entrances near the storage bin foundations contributed to the ease of treatment. In the case of ground squirrels, burrows are scattered over a wide area that requires more searching and moving of the application apparatus for a treatment to be successful.

CONCLUSION

During the laboratory testing of ground squirrels and Norway rats, 33 of the animals killed by EXIT™/VARGON™ were autopsied. The apparent cause of death was asphyxiation (anoxia) caused by blockage of the trachea and the alveoli with foam. The amount of foam found in the trachea and lungs in each case was less than ½ cc.

Based on this, the amount of EXIT™/VARGON™ concentrate used can be calculated:

$$1/2 \times 1/4 \times 1/25 = 1/200 \text{ cc or } 5 \text{ mg of concentrate}$$

Given that the oral LD₅₀ (rat) for EXIT™/VARGON™ is >5,050 mg/kg, a 30-pound coyote could eat:

$$5050/5 \times 30/2.205 = 13,740 \text{ times the lethal concentration required to kill one ground squirrel.}$$

The active ingredients in EXIT™/VARGON™ are alpha-olefin sulfonate and *Brassica hirta*. These are essential commonplace ingredients in hair shampoo and mustard, respectively.

There are no vapours produced by either the concentrate or field solution. If the product is used in accordance with the label directions (safety glasses and gloves for mixing, gloves and long pants for application), applicators will be exposed to less active ingredient over a full season than the amount contained in the shampoo for one shower and the mustard for one hot dog per year.

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