EFFICACY TEST OF *SCOOT MOLE* REPELLANT AT 1 QUART PER 10,000 SQUARE FEET APPLICATION RATE:

FINAL REPORT

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Summary

The mole repellant product *Scoot Mole* manufactured by PEST SOLUTIONS of Grand Rapids, Michigan was tested on replicated paired plots located in a residential area from early-October to early-November 1997. The paired plots were matched as closely as possible for variables that may have impacted the performance of the repellant. The repellant was applied as per manufacturer's specifications to ten 10-foot by 20-foot treatment plots. Each of the ten paired control plots received the same amount of water that had been applied to the treatment plots. Effective control of mole activity was attained on 8 of the 10 sites by day 4 of the study. Control was attained by day 8 on one additional site and the remaining site was dropped from the analysis because extensive human activity on one member of the pair made any reasonable assessment of effectiveness impossible. On 7 of the 9 sites on which control of mole activity was attained, the control continued through day 30, the final day of the study. On site #3 control continued at least through day 13 and on site #5 there was control until at least day 17. The results of this study overwhelmingly **indicate that *Scoot Mole* will effectively repel moles when applied as per manufacturer's specifications at a rate of 1 quart per 10,000 square feet.** The total duration of effective control was not established in this study. However, on average, effective control of mole activity will last a minimum of 30 days (the duration of this study).

Research Protocol

The research reported herein was conducted by Drs. Glenn R. Dudderar and Scott R. Winterstein. Glenn Dudderar retired as an associate professor from the Department of Fisheries and Wildlife at Michigan State University in December 1998. He was the extension program leader and extension wildlife specialist. He has over 30 years of professional experience in the field of wildlife damage control and is a nationally recognized expert on wildlife damage control. Scott Winterstein is an associate professor in the Department of Fisheries and Wildlife at Michigan State University. In his position as a wildlife biometrician, he has over 13 years of experience designing studies of wild animal populations and analyzing the resultant data.

While Dr. Dudderar was and Dr. Winterstein is on the faculty at Michigan State University (MSU), this study was neither reviewed nor certified by Michigan State University. However, all research methodologies employed follow best scientific standards and procedures and meet or exceed the appropriate guidelines outlined by the MSU All University Committee on Animal Use and Care and by the MSU Office of Radiation, Chemical and Biological Safety.

This efficacy trial was conducted from 8 October - 6 November 1997 at a large multi-building apartment complex in East Lansing, Michigan. This apartment complex was selected because it is typical of the residential environment in which the product would be used. The apartment complex is a series of 2 - 3 story buildings, separated by lawns of varying sizes. The lawns are well tended and most are at least partially shaded by one or more of a variety of shade trees. The lawns generally receive low to medium human usage and are watered and cut on a regular basis by a lawn-care company.

Ten paired sites were selected for use in the study. Each member of each of the sets of sites was marked with small flags at each corner and had to (1) be at least 10 feet wide by 20 feet long, (2) be free of concrete walks or drives on at least 3 sides, and (3) have obvious mole activity as evidenced by conspicuous tunnels. Paired sites were matched as closely as possible relative to (1) percentage of the 200 square foot test area shaded by trees or buildings, (2) slope, and (3) distance from roads, sidewalks and buildings. Paired sites were a minimum of 10 feet apart and the member of each pair of sites that received the repellant was randomly determined by flipping a coin.

Prior to application of the repellant, the mole tunnels on each of the sites were recorded. During the late morning and early afternoon of 8 October 1997, the repellant was applied as per manufacturer's specifications to the 10 sites randomly selected to receive the repellant. These sites were designated as treatment plots 1 through 10. Also on 8 October 1997, the corresponding member of each pair of sites (designated as control plots 1 through 10) received an amount of water equal to that which had been applied to the treatment plots. Therefore, to the best of our ability, the treatment and control plots had been matched as closely as possible relative to environmental factors that might impact the effectiveness of the repellant and had received identical treatments with the exception that no repellant was applied to the control plots.

The day of repellant application (8 October 1997) was designated day 1 of the trial. Each site was checked daily for mole activity during the first few days of the trial. The visitation schedule for each site, presented according to the "Day of Trial", is given in Table 1. No reliable data could be collected on days 20 and 21, because snow fell on those days completely obscuring the tunnels. On day 1, following the application of the repellant to the treatment plots and water to the control plots, all mole tunnels on all sites were flattened by walking on them. On each day that sites were checked for mole activity, all active tunnels were flattened. On each day that sites were checked, each plot was scored as either being active (new tunnels were present or existing flattened tunnels had been repaired) or inactive (no new or repaired tunnels evident). Active tunnels were also identified as either being on the edge of the plot (within 1.5 feet of the plot boundary) or in the interior of the plot. A new tunnel that entered and exited a plot without going into the interior of the plot, was designated an exploratory tunnel and was not considered evidence of activity.

Data Analysis

As the initial step in the analysis, the activity history (Table 1) of each site was examined for evidence of effective control of mole activity. One of the original 10 sites was dropped from the analysis for reasons beyond the control of the researchers. Extensive human activity on one member of the pair made any reasonable assessment of effectiveness on site #10 impossible. Henceforth, all analyses refer to the nine usable sites. The data were examined to determine for each site the earliest trial day on which effective control had been attained (Table 2). Effective control was defined as no mole activity for a minimum of seven consecutive calender days.

A chi-square analysis was used to determine if the observed activity pattern differed from that which would have occurred had the repellent been completely ineffective (and also did not attract moles). If the repellant was completely ineffective, then mole activity on control plots should have been independent of mole activity on treatment plots. If this were true, 1/4 of all of the observations should have been observed in each of the four possible outcome categories -- (1) Control active and Treatment active, (2) Control active and Treatment inactive, (3) Control inactive and Treatment active, and (4) Control inactive and Treatment inactive. The data were examined for days 2 - 30 of the study for the 9 sites that produced usable results (Table 3).

Overall mole activity was also compared between treatment and control plots for six-day intervals beginning at day 2. For each 6-day interval (see Table 4) the data were arrayed in a 2x2 matrix with *treatment* and *control* forming the horizontal rows and *active* and *inactive* forming the vertical columns. A chi-square test was again used to determine if there was any difference in activity on treatment versus control plots.

All statistical tests were considered significant at an alpha of 0.05. This means that we were willing to accept that 5 times out of 100 we would declare a significant difference when one really did not exist. Finding significance when none really exists is termed Type I error and it is a necessary evil associated with the random sampling error inherent in experimentation.

Results

Effective control of mole activity was attained on day 2 for four of the 9 sites (Sites #1, #4, #6 and #9; Tables 1 and 2) and by day 3 for three sites (Sites #2, #5, and #8). Control of mole activity was attained on day 4 on Site #3 and not until day 8 on Site #7 (Tables 1 and 2). Control of mole activity on the treatment plots continued for the duration of the study (through day 30) on all but two sites. On Site #3, mole activity resumed on the treatment plot by day 15 and continued through day 30 (Table 1). On Site #5, mole activity on the treatment plot was evident from day 22 through day 30 (Table 1). On 4 of the sites (Sites #1, #4, #6, and #7), once control of mole activity had been established on the treatment plots, no evidence of mole activity was ever again observed (Table 1). On Sites #8 and #9, mole activity was observed one time (day 10 on both sites) after control had been established (Table 1). On the final site, Site #2, mole activity was observed on two separate occasions (days 13 and 25) after control had been established (Table 1).

Overall mole activity was dramatically reduced on the treatment plots from day 2 - 30 when compared to the control plots, when all 9 sites are examined. Of the 126 possible chances for mole activity to be observed on treatment plots, it was recorded only 24 times. Of the 126 possible chances for mole activity to be observed on control plots, it was recorded 103 times. This difference in activity is highly significant (chi-square = 99.1, Probability of getting a value this large by random chance alone is less than 0.01), indicating that the repellant effectively reduced mole activity.

When the paired activity histories (the mole activity evident on the treatment plot and control plot at each site on each observation day) for all 9 sites were examined for days 2 - 30, a significant departure from randomness was detected (Table 3A), indicating that the repellant effectively controlled mole activity. The number of cases in which (on the same day on the same site) there was mole activity detected on the control plot but not on the treatment plot far exceeded the value that would have been predicted (64.3% vs. 25%) had the repellant been ineffective. Additionally, the number of cases in which there was activity on the treatment plot but not on the control plot was only about 1/16 of the predicted value (1.6% vs. 25%), if the repellant was ineffective (Table 3A).

When the site on which control only lasted about 2 weeks (Site #3) and the site on which control lasted about 3 weeks (Site #5) are removed from the analysis, mole activity was detected on treatment plots on only 10 of 98 days (Table 3B). Further, 4 of these days were on Site # 7 prior to day 8 when control was established (Table 1). Of the remaining 6 days, three were on Site #2 (days 2, 13, and 25), two were on Site #8 (days 2 and 10) and one was on Site #9 (day 10). These results indicate that once control was established on a site, mole activity essentially ceased.

When the activity histories are examined by 6-day intervals (Table 4), there is a significant reduction in mole activity on the treatment plots for each interval. This indicates that even

during periods when overall mole activity was reduced (days 2 - 6), it was still significantly lower on the treatment sites than on the control sites. Additionally, these results indicated that control was particularly effective for days 25 - 30 of the trial (Tables 1 and 4).

Conclusions

Overall, the results overwhelmingly support the conclusion that *Scoot Mole* is an effective mole repellant when applied as per manufacturer's specifications. The mole repellant performed well under the conditions in which it is most likely to be used -- on residential lawns. The sites we selected for this study are good to excellent mole habitat. In addition to being well established (over 5 years old) lawn areas, many of the sites bordered undeveloped woods. The owners of the sites had not used kill-traps or poisons to control their mole populations and there was only limited use of insecticides, resulting in abundant food for the moles.

Some level of effective control of moles was attained on all 9 of the usable sites. On one site the repellant was effective for about 2 weeks (Site #3) and on another site is was effective for about 3 weeks (Site #5). On the remaining 7 sites *Scoot Mole* was essentially effective for the duration of the month-long study. On 8 of the sites, control of mole activity was established within 4 days of application, as would be expected for a repellant of this type. On one site (Site #7) control of mole activity was not established until day 8. This is 3 or 4 days longer than generally expected, but should not be considered an unusually long period of time.

While we have no definite explanation for the results obtained on Sites #3 and #5, they should not be interpreted as evidence that the repellant is ineffective. Rather they should be viewed as representing the normal variability expected when dealing with wild animals in their natural habitat. No repellant is 100% effective against 100% of the animals 100% of the time. Certain animals, for unknown reasons, will simply not respond at all to the repellent. Other animals will take longer to respond to the repellent than predicted (perhaps on Site #7) or the effectiveness may be impacted by soil conditions. For example, experience has shown that generally mole repellants perform least well and take longer to establish control in very sandy soils.

Finally, it should be noted, that the treatment plots used in this study were only 200 square feet, smaller than the typical area that would be treated by the typical user of *Scoot Mole*. The treatment plots were also fairly close to the control plots and were surrounded by untreated mole habitat. The size and configuration of the plots were dictated by the study areas available to us and probably resulted in increased activity by moles using travel tunnels to cross through, but not forage in, a treatment plot. We did not differentiate between foraging tunnels and travel tunnels. We would predict, that when a more typical size area is treated with *Scoot Mole*, the results will be even better than those we observed.

Table 1. Activity histories on 9 sites used to test the efficacy of the mole repellant *Scoot Mole*.[a]

Day of Trial	Site #1		Site #2		Site #3		Site #4		Site #5	
	Treat	Cntrl	Treat	Cntrl	Treat	Cntrl	Treat	Cntrl	Treat	Cntrl
1	SM	H_20	SM	H_20	SM	H_20	SM	H_20	SM	H_20
2	--	--	+	+	+	--	--	+	+	+
3	--	--	--	--	+	--	--	+	--	+
4	--	--	--	--	--	--	--	+	--	+
5	--	+	--	+	--	--	--	+	--	+
6	--	+	--	+	+	+	--	+	--	+
7										
8	--	+	--	--	--	+	--	+	--	+
9										
10	--	+	--	--	--	--	--	+	--	+
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13	--	+	+	+	--	+	--	+	--	+
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15	--	+	--	+	+	+	--	+	--	+
16										
17	--	+	--	+	+	+	--	+	--	+
18										
19										
20 SNOW										
21 SNOW										
22	--	+	--	+	+	+	--	+	+	+
23										
24										
25	--	+	+	+	+	+	--	+	+	+
26										
27										
28	--	+	--	+	+	+	--	+	+	+
29										
30	--	+	--	+	+	+	--	--	+	+

[a]Treat = treatment; Cntrl = control; SM = *Scoot Mole* applied; H_20 = water only applied; -- = no mole activity observed; + = mole activity observed; a blank space for any date indicates that no data were collected that day.

Table 1 Cont. Activity histories on 9 sites used to test the efficacy of the mole repellant *Scoot Mole.*[a]

Day of Trial	Site #6		Site #7		Site #8		Site #9	
	Treat	Cntrl	Treat	Cntrl	Treat	Cntrl	Treat	Cntrl
1	SM	H_20	SM	H_20	SM	H_20	SM	H_20
2	--	+	+	+	+	+	--	--
3	--	+	+	+	--	+	--	--
4	--	+	+	+	--	--	--	--
5								
6								
7	--	+	+	+	--	--	--	--
8	--	+	--	+	--	+	--	--
9								
10	--	+	--	+	+	+	+	+
11								
12	--	+	--	+	--	+	--	--
13								
14	--	+	--	+	--	+	--	+
15								
16	--	+	--	+	--	--	--	--
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18								
19	--	+	--	+	--	+	--	+
20 SNOW								
21 SNOW								
22	--	+	--	+	--	+	--	+
23								
24								
25	--	+	--	+	--	+	--	+
26								
27								
28	--	+	--	+	--	+	--	+
29								
30	--	+	--	+	--	+	--	+

[a]Treat = treatment; Cntrl = control; SM = *Scoot Mole* applied; H_20 = water only applied; -- = no mole activity observed; + = mole activity observed; a blank space for any date indicates that no data were collected that day.

Table 2. Effective control periods for 9 sites used to test the efficacy of the mole repellant *Scoot Mole* over a 30-day period.

Treatment Site Number	Days of Effective Control	Notes
1	2 - 30	
2	3 - 30	
3	4 - 13	Control lost for days 15 - 30. No reapplication of repellant was attempted.
4	2 - 30	
5	3 - 17	Control lost for days 22 - 30. No reapplication of repellant was attempted.
6	2 - 30	
7	8 - 30	
8	3 - 30	
9	2 - 30	

Table 3. Activity histories for treatment and control plots for days 2 - 30 of efficacy test of the mole repellant *Scoot Mole*.

A. All 9 sites for days 2 - 30

		Control		
		Number Active	Number Inactive	Chi-Square[a]
Treatment	Number Active	22 (17.5%)	2 (1.6%)	
	Number Inactive	81 (64.3%)	21 (16.7%)	111.8

B. Sites 1 - 2, 4 and 6 - 9 for days 2 - 30

		Control		
		Number Active	Number Inactive	Chi-Square[a]
Treatment	Number Active	10 (10.2%)	0 (0.0%)	
	Number Inactive	70 (71.4%)	18 (18.4%)	119.3

[a]Chi-square test for a random distribution of mole activity in control and treatment plots. If the repellant is ineffective, each of the four cells should contain an equal number (25%) of the observations. A chi-square value greater than 3.84 indicates a significant departure from randomness. High values in the "Control Active" / "Treatment Inactive" cell indicate a significant reduction in activity on treatment plots.

Table 4. Activity histories for 9 treatment and 9 control plots for days 2 - 30 of efficacy test of the mole repellant *Scoot Mole*.

	Number Active	Number Inactive	Chi - Square[a]
Days 2 - 6			
Treatment	9	28	
Control	24	13	12.3
Days 7 - 12			
Treatment	3	23	
Control	19	7	20.2
Days 13 - 18			
Treatment	3	20	
Control	21	2	28.2
Days 19 - 24			
Treatment	2	11	
Control	13	0	19.1
Days 25 - 30			
Treatment	7	20	
Control	26	1	28.1

[a]Chi-square test for differences in mole activity between treatment and control plots. A chi-square value greater than 3.84 indicates a significant reduction in activity on treatment plots.