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Evaluation of strychnine and zinc phosphide baits to control northern pocket gophers (*Thomomys talpoides*) in alfalfa fields in Alberta, Canada

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This study compared the effectiveness of Sanex 0.40% strychnine-treated oats, Fairview 0.37% strychnine-treated grains, and United Agri Products 2% zinc phosphide-treated oats to control northern pocket gopher (*Thomomys talpoides*) populations in alfalfa fields in Alberta, Canada. The poison baits were tested during three phenological periods corresponding to the reproduction, summer juvenile dispersal, and early fall mound building activities. Overall, less than 17% of the pocket gopher populations were controlled by any poison bait during the reproduction and early fall periods. In summer, there was a significant difference ($P<0.05$) between poison baits as measured by the relative frequency of active and inactive burrow systems. The Sanex poison bait was significantly ($P<0.05$) more effective (36%) in terms of reduced pocket gopher activity than the other baits ($\leq 15\%$). I suggest that the effectiveness of poison baits to control pocket gophers may be greater in mid-summer after hay harvest, when the young of the year disperse to establish their own burrow system. However, because of the overall poor performance of all tested poison baits in alfalfa fields, more research and development work based on animal behaviour should be carried out to improve bait acceptance. © 1998 Elsevier Science Ltd. All rights reserved

Keywords: northern pocket gopher; poison baits; strychnine; zinc phosphide

Introduction

Poison baiting is recommended as the most practical and effective method to control northern pocket gophers (*Thomomys talpoides*) (Turner *et al.*, 1973; Chase *et al.*, 1982). Strychnine is the most widely used toxicant for pocket gopher control (Tickes, 1983; Lee *et al.*, 1990) and, in western Canada, strychnine-treated grains are popular (Bonnefoy *et al.*, 1994). However, Tickes *et al.* (1982) and Tickes (1983) reported population control of less than 25% with these baits and concluded that they were unacceptable for the control of pocket gophers. Whereas new zinc phosphide-oat baits are presently marketed in western Canada for the control of pocket gophers, reliable information concerning their efficacy is lacking. In the past, zinc phosphide-treated grains controlled less than 45% of pocket gopher populations (Tickes *et al.*, 1982; Tickes, 1983) and also appeared inadequate for the control of this fossorial rodent.

If poison baits must be used to control northern pocket gopher populations, one should determine when during the growing season the animals are more inclined to accept them. My objective was to compare the ability of one zinc phosphide and two strychnine baits to control pocket gophers in alfalfa fields, during the growing season.

Materials and methods

The study was carried out in two 65 ha alfalfa fields, in Mundare and Willingdon, in central Alberta. Three commercial baits were tested: the Sanex (Wilson Laboratories, Dundas, Ontario) 0.40% strychnine-oats, the Fairview (Lethbridge, Alberta) 0.37% strychnine-grain mixture and the United Agri Products (UAP, Calgary, Alberta) 2% zinc phosphide-oats.

The poison baits were tested during three phenological periods corresponding to reproduction (25 April–27 May), summer juvenile dispersal (24 June–26 August), and early fall mound building activities (9 September–21 October) (Proulx *et al.*, 1995a; Proulx, 1997). Tests lasted 3 weeks (with data obtained once per week) during the reproduction and early fall periods, and 7 weeks during summer. During the reproduction period, however, the zinc phosphide-oats were unavailable, and the Fairview grains were evaluated only during two of the three weeks of testing. New test sites were selected from week to week, and they were > 100 m apart from each other. Each week, 48 different active burrow systems (> 10 m apart) with overnight signs of burrowing activities were selected in alfalfa fields. Twelve of them were controls, i.e., oats without poison were deposited in their tunnels. The other 36 burrow systems received poison baits, i.e., 12 burrow systems/poison bait. On day 1 of a weekly test, early in the morning, a total of 20 g of bait was placed in the main tunnel of burrow systems, at two locations. This is a sufficient amount to kill an adult and its young co-habiting the same burrow system (Proulx, 1995; Proulx and Cole, 1996). Baits were placed 20–30 cm into the tunnels. Thereafter, the openings were carefully plugged back with their original dirt plug. On day 3, all burrow systems were re-opened. The counting of plugged and unplugged systems occurred 24 h after opening, on day 4. The 'open hole' technique is the most reliable indirect activity measure (Engeman *et al.*, 1993) as it takes into consideration the fact that pocket gophers do not leave their burrow system open when they are underground (Barnes *et al.*, 1970; Proulx *et al.*, 1995b). The number of open control systems divided by 12 was therefore considered to be the proportion of animals which abandoned their burrow system or died of natural causes. The number of open control systems was deducted from that of each experimental group in order to estimate the true control efficacy of the different poison baits. The Fisher Exact Probability test and the Chi-square test for *k* independent samples were used to compare the overall killing effectiveness of the different poison baits during each period, as measured by the relative frequency of active and inactive burrow systems (Siegel, 1956). A 0.05 level of significance was used for all tests. On the basis of the performance standard set by the US Environmental Protection Agency Draft Registration Guidelines (Fagerstone *et al.*, 1981), a poison bait was found acceptable if it controlled at least 70% of the pocket gopher populations.

Results

Reproduction (25 April–27 May)

Only one control burrow system was found open during the three weeks of testing. There was no significant difference ($P = 0.143$, Fisher) between the Sanex and the Fairview baits in the relative frequency of active and inactive burrow systems. Two out of 12 burrow systems treated with Sanex oats remained open, and therefore were considered inactive, during each week (*Figure 1*). Overall, the Sanex poison bait achieved a 17% control as measured by reduced activity (*Table 1*). After 2 weeks of testing, only one out of 24 burrow systems treated with Fairview grains became inactive, indicating an overall 4% control (*Table 1*).

Summer (24 June–26 August)

No control burrow systems were found open during the 6 July and 13 August weeks. During the other weeks, between one and three control burrow systems were found open and they were deducted from the number of burrow systems rendered inactive by poison baits for these weeks. There was a significant difference ($\chi^2 = 15.41$, df = 2, $P < 0.005$) between poison baits in the relative frequency of active and inactive burrow systems. The Sanex poison bait rendered 30 out of 84 (36%) burrow systems inactive and was markedly more effective than the Fairview bait (15%) and the zinc phosphide-oats (13%) (*Table 1*).

The Sanex bait controlled between 30 and 58% of the pocket gopher populations during most weeks (*Figure 1*). It performed better from mid- to late July, after the first hay cut. During the two August weeks, however, the effectiveness of the Sanex bait dropped considerably. The control level accomplished with the Fairview grains was <25% during all weeks except in late July where it increased to 42% (*Figure 1*). The effectiveness of the zinc phosphide baits to control

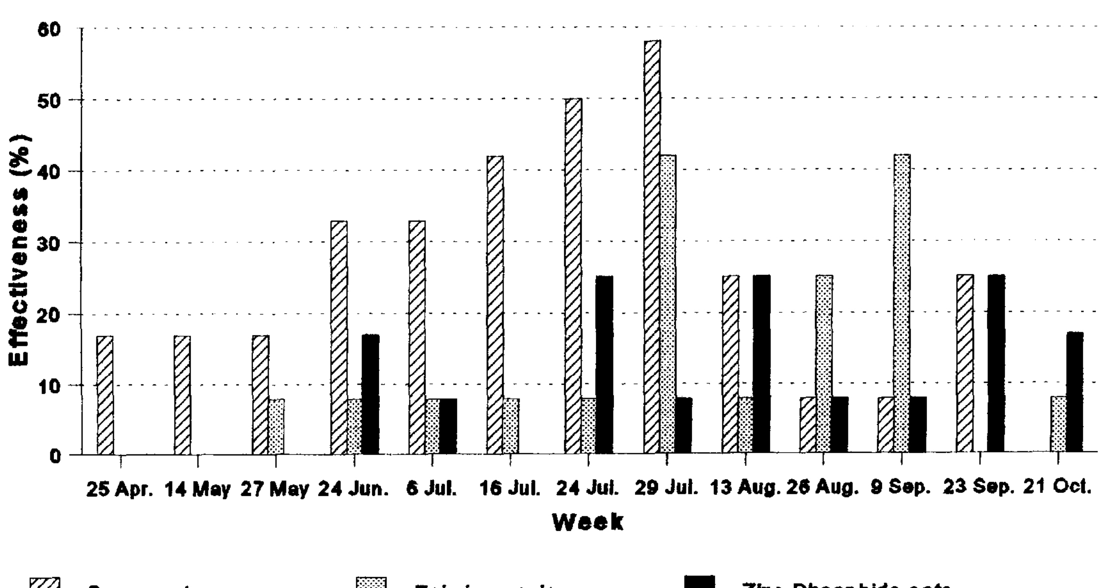

Figure 1. Effectiveness (%) of Sanex 0.40% strychnine-oats, Fairview 0.37% strychnine-grains, and UAP 2% zinc phosphide-oats in controlling northern pocket gopher populations in alfalfa fields, April–October 1996, Alberta, Canada

Table 1. Estimates of pocket gopher control, as measured by the relative frequency of inactive burrow systems, with Sanex 0.40% strychnine-oats, Fairview 0.37% strychnine-grains, and UAP 2% zinc phosphide-oats, from April to October, 1996 in Alberta

	Ratio of inactive/treated burrow systems (%)			
Period	Sanex oats	Fairview grains	Zinc phosphide oats	χ^2
Reproduction	6/36 (17)	1/24 (4)	Not available	—[a]
Summer	30/84 (36)	13/84 (15)	11/84 (13)	15.41[b]
Early fall	4/36 (11)	6/36 (17)	6/36 (17)	0.70[c]
Total	40/156 (25)	20/144 (14)	17/120 (14)	8.86[b]

[a]No significant difference between poison baits ($P = 0.143$, Fisher).
[b]Significant difference between poison baits ($P < 0.05$).
[c] No significant difference between poison baits ($P > 0.05$).

pocket gophers was low throughout the summer. The maximum control level achieved with zinc phosphide-oats was 25% during 2 weeks. During the other weeks, this bait controlled less than 17% of the animals.

Early fall (9 September–21 October)

There were ≤3 control burrow systems found open each week. While the Fairview bait was more effective (42%) in early September, before the mid-September hay harvest, the efficacy of the Sanex and zinc phosphide baits improved slightly, immediately after the harvest (*Figure 1*). There was no significant difference ($\chi^2 = 0.70$, df = 2, $P > 0.05$) between the poison baits in the relative frequency of active and inactive burrow systems. Overall, less than 17% of the pocket gopher populations were controlled by poison baits in early fall (*Table 1*).

Total (28 April–22 October)

There was a significant difference ($\chi^2 = 8.86$, df = 2, $P < 0.02$) between poison baits in the relative frequency of active and inactive burrow systems. The Sanex strychnine bait was the most effective poison bait and it achieved an overall control level of 25%. Each of the other poison baits controlled only 14% of the pocket gopher populations (*Table 1*).

Discussion

Poison baits that are currently available for the control of northern pocket gophers performed poorly. Considering that a poison bait should control at least 70% of a rodent population in order to be considered effective (Barnes, 1973; Capp, 1976; Fagerstone *et al.*, 1981), a control level met by Proulx's (1997) border control strategy with traps, none of the baits tested in this study should be considered appropriate for the control of northern pocket gopher populations in alfalfa fields. Since female adults can produce, on average, six young during the summer (Proulx, 1996), the control levels recorded in this study are inadequate.

Hand-baiting was used in this study because it allows better control of the placement of bait in unplugged tunnels. Despite this, the overall control level achieved during summer 1996 with the most effective poison bait, the Sanex strychnine-treated oats, was 25%. There is no apparent reason for the discrepancy between the efficacy of the Sanex and Fairview baits. The Fairview grains were probably simply less attractive than the Sanex oats. Nevertheless, our study is in agreement with Tickes *et al.* (1982) and Tickes (1983) who found that 0.3–0.5% strychnine-treated grains (e.g., oats, wheat, milo) distributed with burrow builders were ineffective and controlled only 0–25% of pocket gopher populations as measured by the relative frequency of active and inactive burrow systems.

This study pointed out that zinc phosphide-treated oats did not effectively control pocket gophers. Past evaluations showed that zinc phosphide-treated grains usually controlled 20% or less of the pocket gopher populations (Tickes, 1983). A maximum 45% control was also reported by Tickes *et al.* (1982) with 2% zinc phosphide-treated milo. The poor or inconsistent efficacy of zinc phosphide to control field rodents is well known and Marsh (1987) pointed out that it could, in part, be compensated for by prebaiting. However, prebaiting is neither practical nor cost-effective because finding and opening pocket gopher burrow systems is so labour intensive.

Whereas this study showed that marketed poison baits were inadequate for the control of pocket gophers, the effectiveness of strychnine baits appeared to improve after the mid-summer hay harvest. At this time of year, juveniles have already initiated their dispersal movements to establish their own burrow system or take over unoccupied burrow systems (Proulx *et al.*, 1995a; Proulx, 1997). Considering that invading pocket gophers readily accept the burrow systems, nests, and latrines of previous occupants (Proulx *et al.*, 1995b), poison baits may be used in conjunction with Proulx's (1997) border control strategy to control pocket gopher populations. This strategy involves the removal of resident pocket gophers through trapping, and the use of traps in unoccupied burrow systems at the border of pocket gopher-free fields to intercept immigrating animals. It is possible that poison baits left in these unoccupied burrow systems would be readily accepted by invading pocket gophers, particularly if the availability of alfalfa plants is reduced, as it is after a hay harvest. This possibility should be tested in simulated natural environments with 'resident' (i.e., those that excavate their own burrow system and nest) and 'invading' (i.e., those released in a burrow system where the original occupant has been removed) pocket gophers, and in the field under various environmental conditions.

One major reason why pocket gophers do not readily accept poison baits relates to bait attractiveness. Previous studies showed that pocket gophers preferred wet baits (i.e., vegetables and fruits) to dry ones (grains, pellets, etc.) (Pawlina *et al.*, 1993; Proulx *et al.*, 1993). Tickes (1983) also pointed out that gophers preferred fresh alfalfa over almost all other bait materials. Milo, wheat, oats and barley are used by the pesticide industry because they are easily handled and last longer (Tietjen, 1973); however, they are not accepted by pocket gophers (Tickes, 1983). While the pesticide industry should try to improve the attractiveness of baits, more work should be carried out to better understand the behaviour of pocket gophers encountering them in their tunnel system. As pointed out by Proulx (1996), behaviour is the first line of defence of pocket gophers against poison. In this study, pocket gophers usually plugged the tunnel area where the poison bait had been introduced into the burrow system and often used the bait itself as plugging material. Whereas the bait was usually mixed with dirt or left untouched in the tunnel system, some of it may have been cached. However, it is uncertain if pocket gophers return to those caches (Proulx, 1996). Furthermore, Matschke *et al.* (1994) found that while pocket gophers may remove most of the oat groat baits deposited in their burrow systems, only a few actually consume the baits. They suggested that this low bait consumption may be due to a seasonal preference for green alfalfa vegetation over the grain bait. In our study, however, a wet and cold spring delayed the development of green shoots in our experimental fields and should have increased bait acceptance by pocket gophers. Likewise, in fall, when the quantity and quality of green vegetation are reduced, one would expect greater control effectiveness. However, this did not happen. Obviously, there is still much to be learned about pocket gopher behaviour and bait acceptance.

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