

Woodrat Control in Citrus Groves with Zinc Phosphide and Diphacinone¹

David L. Kerns and Lawrence M. Sullivan

Abstract

Two studies were conducted investigating the efficacy of Prozap (zinc phosphide), Ramik Green, and Ramik Brown (diphacinone) rodenticides on woodrats infesting citrus. Based primarily on using feeding activity as an indication of population density, Zinc phosphide (ZP) provided a rapid knockdown of the rat population, and offered 60 to 75% control. However, this product is known to cause "bait-shyness" following the initial application so additional control with subsequent applications of ZP targeting the same rat population would not likely result in a significant increase in control. Ramik Green and Ramik Brown are slow acting anticoagulant rodenticides, and performed similarly to each other. Anticoagulant rodenticides are not known to cause bait-shyness. In this study, these products only offered 20 to 38% control, but it is possible that these values may be artificially low since the rats may have been preferentially feeding on stored oat groats used to gauge feeding activity rather than consuming the anticoagulant baits.

Introduction

Woodrats (*Neotoma spp.*), also commonly called packrats, have heavily infested citrus groves in both the Yuma, Hyder and Phoenix areas. These infestations appear to be more troublesome in groves surrounded by desert or near riparian areas. Woodrats can damage citrus trees in a number of ways. They build their dens in the central crotch of the trees or on the ground among low-lying branches. The dens are primarily constructed from the leaves and small branches from the tree thereby causing serious defoliation which in turn decreases the fruit producing potential of the tree. In addition, the rats bite through the stem of hanging fruit causing the fruit to fall to the ground. Significant yield losses have been reported for navel oranges and lemons.

It is predicted that a regimen using a combination of both anticoagulant and acute rodenticides may provide effective woodrat control. However, there are currently no anticoagulant rodenticides registered for use in tree crops in Arizona.

Common rodenticide use for woodrat control includes Prozap, zinc phosphide (ZP) and anticoagulant rodenticides. ZP is an acute (non-anticoagulant) toxicant that rapidly kills rodents after they ingest a single, lethal dose. However, the ingestion of a sub-lethal dose produces a learned taste aversion referred to as "bait-shyness". Rodents that survive a sub-lethal dose of ZP associate the resulting discomfort with the ZP bait and subsequently will no longer consume the bait. Therefore, the ZP bait becomes ineffective against bait-shy rodents.

¹ The authors wish to sincerely thank the Arizona Citrus Research Council for supporting this project. This is the final report for project 2001-12 "Woodrat Control in Citrus Groves with Zinc Phosphide and Diphacinone".

Anticoagulant rodenticides require multiple feedings by the target rodent and are slow acting - usually causing death several days after the ingestion of a lethal dose. Since there is no association of discomfort with ingestion of the anticoagulant bait, bait-shyness does not occur.

The objective of this study was to evaluate the efficacy of using the non-anticoagulant, rodenticide bait (ZP on oats) to provide an initial level of control followed by one of two anticoagulant bait formulations to control woodrats in citrus groves. The anticoagulant baits used in this study were Ramik Brown, formulated on a fish flavored substrate, and Ramik Green, formulated on an apple flavored substrate.

Materials and Methods

Zinc Phosphide Study

This experiment was conducted in a grove of about 20 year old lemon trees located south of Wellton, Arizona. Treatment areas consisted of 25 trees each (approx. 0.25 acres) arranged in a 5 x 5 block with each tree serving as an experimental unit. One group of 25 trees was designated as an untreated control, and two groups of 25 trees each were designated as ZP treatments. Each treatment area was separated by at least four trees.

Bait stations were used to deliver the untreated and ZP bait. The bait stations were constructed from 5-in diameter black plastic corrugated pipe cut to 20-in in length. Bait stations were secured near the base of each tree with 0.25-in steel reinforcement rod stakes. A pre-measured amount (454 g) of untreated oat groats (hulled, whole oats) were placed in the center portion of each bait station on 27 June. After 24 h, the remaining oats were removed and weighed. This procedure was repeated for 2 more days to determine an index of consumption and to establish the bait stations as food source for the rats. On the fourth night, 454-g of Prozap, was placed in each of the ZP designated bait stations and 454-g oat groats were placed in each station in the control tree. Consumption was measured 24-h after treatment.

On the fifth night, new bait stations were placed at the base of each tree in the ZP treatment areas (to eliminate the “garlic” odor of the Prozap which is thought to play a role in cuing bait-shyness.), and 454-g of oat groats were placed in each bait station in both the treatment and control area. After 24 h, the amount of oat groats remaining in each station were weighed and compared to pre-Prozap consumption data as an index of woodrat activity. In addition to the initial feeding index as a comparative evaluation of population density, rat dens were counted in each plot to provide an index of relative population density.

After the fifth night, in addition to collecting data on oats consumption, all the rat dens in each treatment area were dismantled and the numbers of dead and live rats encountered in the dens and in the immediate area were counted.

All data were analyzed using an F protected GLM ($P < 0.05$) and means were separated using a pairwise t-test ($P < 0.05$).

Diphacinone Study

This study was conducted in the same lemon grove but in a different location within the grove as the zinc phosphide study. The experimental design was similar to the zinc phosphide study but instead of ZP, two diphacinone treatments, Ramik Green (RG) and Ramik Brown (RB) were evaluated.

Bait stations containing 454-g of oat groats were placed under each tree on 9 July and removed and weighed after 24 h. This procedure was repeated for two additional nights and then the oats in the Ramik plots were replaced with 454-g of RG or RB, while the untreated plots continued to be baited with 454-g oat groats. After 24-h, the remaining RG, RB, or oats were removed from each bait station and weighed. Each station was then re-baited with 454-g of the respective treatment. This procedure was repeated for eight consecutive nights. After the eighth night, 454-g of oat groats were placed in each of the bait stations and consumption was recorded after 24-h and re-baited with 454-g of oat groats. This procedure was conducted for three consecutive nights. In addition to the initial feeding index as a comparative evaluation of population density, rat dens were counted in each plot to provide an index of relative population density.

After the final night of oat groats consumption measurement, all the rat dens in each treatment area were dismantled and the numbers of dead and live rats encountered in the dens and in the immediate area were counted.

All data were analyzed using an F protected GLM ($P < 0.05$) and means were separated using a pairwise t-test ($P < 0.05$).

Results and Discussion

Zinc Phosphide Study

Den counts averaged 1.08 and 0.72 dens per tree in the untreated and ZP treated plots respectively. Although these were statistically different ($P < 0.05$), mean consumption of oat groats during the first three days were statistically similar (Figure 1). Thus, we can assume that the rat populations based on feeding activity indices were similar. After 24-h of treatment with ZP, there was a 62.3% reduction in feeding activity in the ZP plots relative to the control (Figure 1). These data suggest that ZP may induce approximately 60% mortality 24-h after treatment. However, based on live and dead rat counts, the ZP induced 71.74% mortality relative to the untreated (Figure 2). Because the rat carcasses could be dispersed beyond the vicinity of dens, exact counts were not possible. Therefore, mortality or control estimates are inexact, but probably fall somewhere between 60 and 75%.

Rats that feed on ZP but are not killed develop a learned, taste-aversion response to avoid ZP called bait-shyness. Because of this phenomenon, after the initial treatment with ZP, subsequent treatments of the same rat populations with ZP are ineffective in inducing much additional mortality.

Diphacinone Study

Den counts in the control, RG, and RB plots were not statistically different and average approximately 0.75 dens per tree. Similarly, mean oat groat consumption during the first three days were not statistically different among the treatments suggesting that the plots contained similar rat activity and population densities (Figure 3). Once the oat groats in the RG and RB treated plots were replaced with their respective rodenticides, consumption dropped dramatically (Figure 3). This finding was not unexpected since it was not known how much RG or RB woodrats would consume relative to oat groats, but could also indicate that the rats had a preferred alternative food source.

At days 12, 13 and 14 when the rodenticides were replaced with oat groats, consumption increased but there were statistical differences among treatments (Figure 3). At day 12, both the RG and RB treated plots had significantly fewer oats consumed than the untreated, but did not differ from each other (Figure 3). Oat groats consumption was 25.75 and 21.01% lower in the RG and RB plots respectively relative to the untreated. On day 13, consumption in the RG treated plots did not differ from the untreated, while the RB was significantly lower (17.45%). While on day 14, consumption in both the RG and RB treated plots (38.38 and 38.50% relative to the untreated respectively) were significantly less than the untreated, but did not differ from each other (Figure 3). A 20 to 38% reduction in feeding activity is much smaller than we expected for these rodenticides. When the dens were dismantled, we found large quantities of oat groats stored inside the dens. It is possible that the rats preferred to feed on the stored oat groats over the RG and RB baits and simply avoided the poison. Under circumstances where oat groats are not available, mortality may be much higher. It is not uncommon for rodenticides to be less effective on well fed rat populations than when food is scarcer.

There was a lot of variability in the live and dead rat counts taken at the conclusion of the study, and thus we could not detect any significant differences among the treatments (Figure 4). Similar to the ZP study, it is possible that many of the rats hid or the carcasses were dispersed, thus avoiding detection. Since RG and RB are slower acting than ZP, it is possible that anticoagulant poisoned rats dispersed and those that fed on the rapidly acting ZP died before they could disperse.

Based on our findings, ZP appears to offer some control of woodrat infestations of citrus, but, due to bait-shyness and the reproductive potential of the rats, the level of control is not adequate to provide long term control. If ZP is used, an anticoagulant rodenticide should be used as a follow up if available. Currently there are no anticoagulant rodenticides labeled for use in citrus, but a Section 24C registration is possible in the future. When using any of the rodenticide baits, it is best to also limit the rat population's food resources by eliminating weeds and other food sources, and to dismantle all dens to lessen the probability or rapidity of re-infestation.

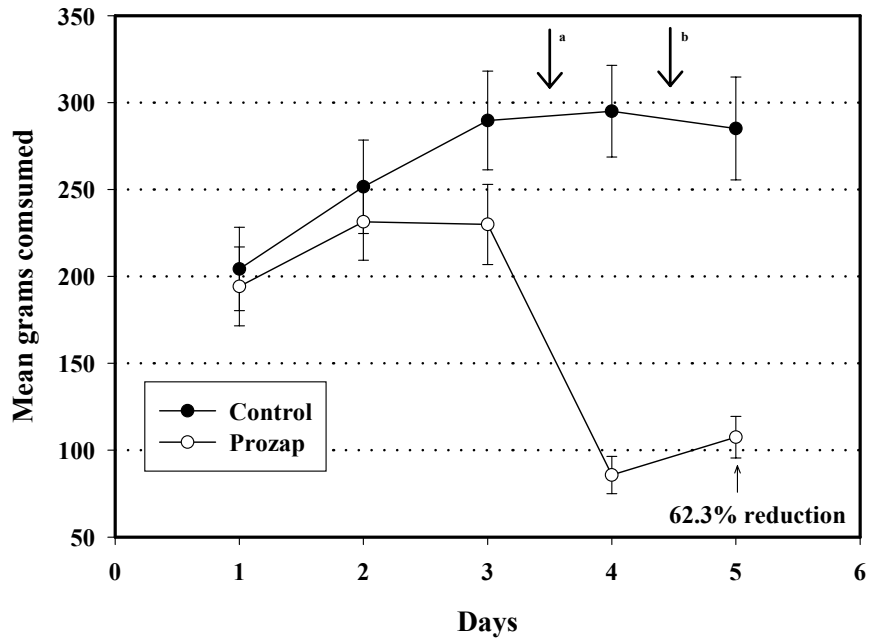


Figure 1. Consumption of oat groats and Prozap (ZP) by woodrats in citrus. ^aPoint where ZP was substituted for oat groats in the ZP plots. ^bPoint where oat groats were re-introduced in ZP plots in place of ZP.

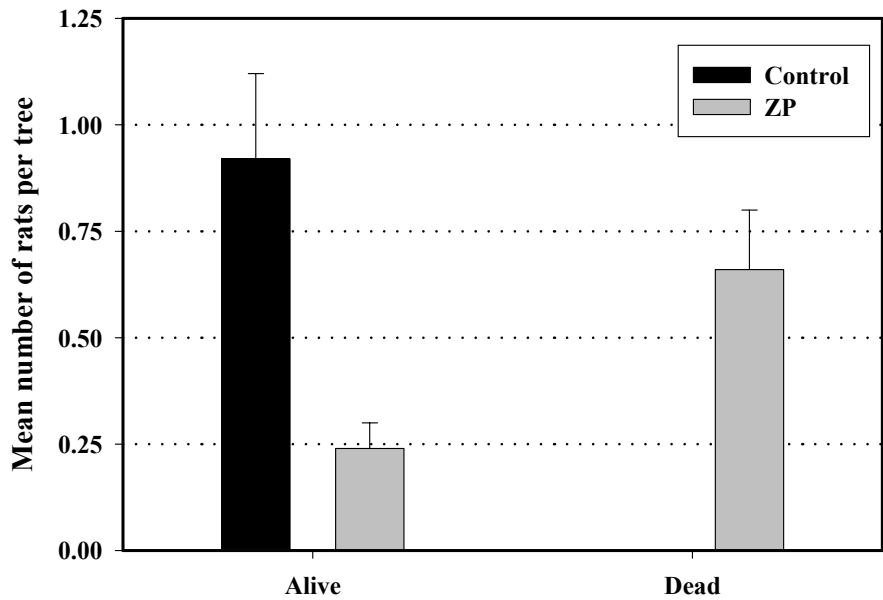


Figure 2. Number of live and dead woodrats encountered at the end of the test when the dens were dismantled.

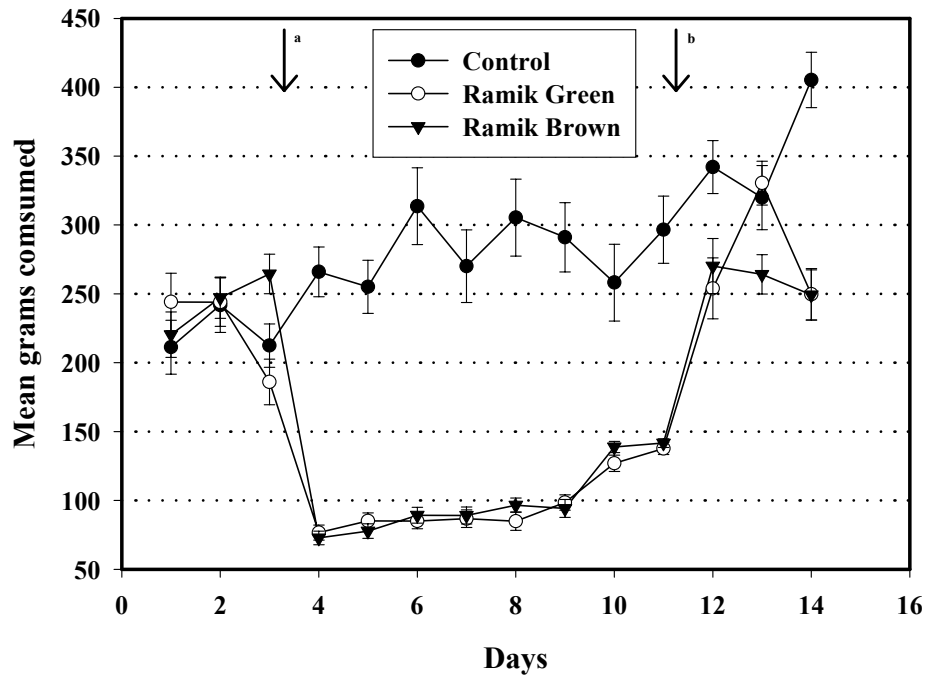


Figure3. Consumption of oat groats, Ramik Green (RG) and Ramik brown (RB) by woodrats in citrus.

^aPoint where RG and RB were substituted for oat groats in the treated plots.

^bPoint where oat groats were re-introduced in treated plots in place of the poisons.

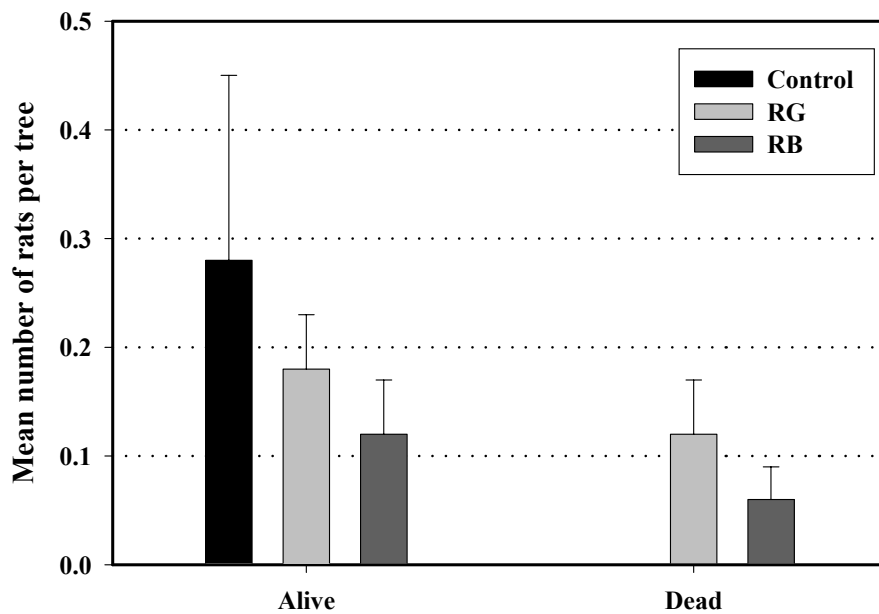


Figure 4. Number of live and dead woodrats encountered at the end of the test when the dens were dismantled.