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# Zinc Phosphide-coated Cabbage for Managing Belding's Ground Squirrels

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**ABSTRACT:** Belding's ground squirrels (*Urocitellus beldingi*) cause extensive damage in alfalfa and other hay crops throughout substantial portions of the Intermountain West. Recent management efforts have largely focused on shooting, burrow fumigation, and occasionally grain baits. However, these tools are often either too costly to implement or ineffective. In 2015, the California Department of Pesticide Regulation approved a Special Local Needs permit to use zinc phosphide-coated cabbage for managing Belding's ground squirrels in Siskiyou, Modoc, and Lassen Counties. This baiting strategy could provide a cost effective and efficacious management approach, although efficacy data were lacking. Therefore, we established a study to assess the importance of spatial variability of location sites, prebaiting, and ground squirrel density on efficacy of zinc phosphide-coated cabbage for Belding's ground squirrel management across impacted hay-growing regions in northeastern CA. We also assessed potential differences in bait mixing strategies (in a tub via hand mixing vs. the use of a commercial-style cement mixer) on targeted zinc phosphide concentrations, as well as the degradation rate of zinc phosphide and moisture content of cabbage under environmental conditions.

We did not detect a significant difference between hand and mechanical mixing. However, mechanical mixing was closer to the target level ( $\bar{x}$  = 101% vs. 115% for mechanical and hand mixing, respectively), was more precise, and allowed for the mixing of larger batches. As such, mechanical mixing was the strategy we used for field application. Furthermore, both moisture content (0.29% loss per hour) and zinc phosphide concentration (31% loss in 48 hours) steadily declined during a three-day observation period, indicating a fairly minimal window of exposure for nontarget species. See Baldwin et al. (2018) for additional details on lab testing of mixing methods and residual zinc phosphide levels associated with cabbage bait.

During field trials, we found that prebaiting increased overall efficacy by approximately 18%, with efficacy 23% greater in the western (eastern Siskiyou and western Modoc Counties) vs. eastern portions (south-central Modoc County) of the study area. The tested bait was also substantially more efficacious when initial ground squirrel populations were larger, presumably due to a greater need for forage at high densities. Ground squirrel activity was relatively consistent throughout the day, although peaks were noted from 09:00 to 11:00 and from 13:00 to 15:00. Consumption of cabbage bait diminished throughout the day after initial application. Consumption was again high the following morning, but again diminished throughout the remainder of the day. Ideal times for bait application were likely before 09:00 and again before 13:00, although ground squirrels continued to feed on bait throughout the day. Zinc phosphide-coated cabbage bait appears to be an effective management option when prebaiting is used in Siskiyou County and in western portions of Modoc County. Additional research is needed to determine methods to increase efficacy in central and eastern Modoc County. See Baldwin et al. (2019) for additional details on this study.

**KEY WORDS:** alfalfa, baiting, Belding's ground squirrel, cabbage bait, prebait, rodent control, *Urocitellus beldingi*, zinc phosphide

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*Information included in this paper can be found in the following publications:*

## LITERATURE CITED

Baldwin, R. A., B. G. Abbo, and D. A. Goldade. 2018. Comparison of mixing methods and associated residual levels of zinc phosphide on cabbage bait for rodent management. *Crop Protection* 105:59-61.

Baldwin, R. A., H. Halbritter, R. Meinerz, L. K. Snell, and S. B. Orloff. 2019. Efficacy and nontarget impact of zinc phosphide-coated cabbage as a ground squirrel management tool. *Pest Management Science* 75:1847-1854.