Using Zinc Phosphide-Coated Cabbage to Manage Belding’s Ground Squirrels in Hay Crops.

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Background/Extent of Problem

- Belding’s ground squirrel causes substantial damage to alfalfa and other hay crops in Northern CA.

- Loss of forage estimated between 17.1% and 65.9% from consumption and burrow destruction.

- Burrowing activity also causes damage.
Background/Extent of Problem

• Historically, Belding’s GS was controlled with 1080-coated cabbage.

• Grain-based baits do not work.

• Burrow fumigants are effective but more costly and often impractical.

• Shooting primary tool currently in use.
Background/Extent of Problem

- In 2014, zinc phosphide-coated cabbage was approved for use on Belding’s GS in Oregon.
- A 24c has since been approved for CA.
- Ambiguity existed about efficacy of bait.
- Research in NV showed limited efficacy against Townsend’s GS (42%).
Background/Extent of Problem

Benefits
- Potentially more effective
- Potentially cheaper
- Little secondary toxicity risk
Background/Extent of Problem

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- Potentially cheaper
- Little secondary toxicity risk

Concerns
- Uncertain palatability
- Does efficacy vary regionally?
- Prebaiting necessary?
- Potential primary toxicity risk
- Bait mixing concerns
  - Quality control
Objectives

1. Determine the importance of prebaiting, ground squirrel density, and regional differences on efficacy.

2. Determine peak time of day for bait consumption.

3. Determine impact of time since application on bait consumption.

4. Develop potential management program.
Methods—Efficacy

- Fields were selected in the Butte Valley, Klamath Basin, and Alturas area during 2016 ($n = 6$) and 2017 ($n = 14$).
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• Each field was monitored using visual counts before and after treatment.
Methods—Efficacy

- Fields were selected in the Butte Valley, Klamath Basin, and Alturas area during 2016 ($n = 6$) and 2017 ($n = 14$).
- Each field was monitored using visual counts before and after treatment.
- Half were pre-treated while other half were not.
Methods—Impact of Timing

• Determined impact of bait timing by using 20 remote-triggered cameras targeted toward cabbage bait across 6 fields.
Methods—Impact of Timing

- Determined impact of bait timing by using 20 remote-triggered cameras targeted toward cabbage bait across 6 fields.

- Camera data also may provide insight into long-term palatability.
## Results—Efficacy

<table>
<thead>
<tr>
<th>Prebaited</th>
<th>Area</th>
<th>Year</th>
<th>GS's before</th>
<th>GS's after</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>West 1</td>
<td>2016</td>
<td>7</td>
<td>2</td>
<td>71%</td>
</tr>
<tr>
<td></td>
<td>West 2</td>
<td>2016</td>
<td>56</td>
<td>5</td>
<td>91%</td>
</tr>
<tr>
<td></td>
<td>West 5</td>
<td>2017</td>
<td>40</td>
<td>7</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>West 6</td>
<td>2017</td>
<td>12</td>
<td>3</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td>West 7</td>
<td>2017</td>
<td>17</td>
<td>3</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>West 8</td>
<td>2017</td>
<td>17</td>
<td>8</td>
<td>53%</td>
</tr>
<tr>
<td></td>
<td>West 9</td>
<td>2017</td>
<td>62</td>
<td>7</td>
<td>89%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Mean:</strong> 78%</td>
</tr>
<tr>
<td></td>
<td>East 2</td>
<td>2016</td>
<td>30</td>
<td>8</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>East 4</td>
<td>2017</td>
<td>10</td>
<td>8</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>East 5</td>
<td>2017</td>
<td>18</td>
<td>12</td>
<td>33%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Mean:</strong> 42%</td>
</tr>
<tr>
<td>No</td>
<td>West 3</td>
<td>2016</td>
<td>53</td>
<td>20</td>
<td>62%</td>
</tr>
<tr>
<td></td>
<td>West 4</td>
<td>2016</td>
<td>64</td>
<td>12</td>
<td>81%</td>
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<tr>
<td></td>
<td>West 10</td>
<td>2017</td>
<td>14</td>
<td>7</td>
<td>50%</td>
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<tr>
<td></td>
<td>West 11</td>
<td>2017</td>
<td>24</td>
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<td>58%</td>
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<td>West 12</td>
<td>2017</td>
<td>58</td>
<td>6</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>West 13</td>
<td>2017</td>
<td>17</td>
<td>10</td>
<td>41%</td>
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<tr>
<td></td>
<td>West 14</td>
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<td>12</td>
<td>37%</td>
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<td><strong>Mean:</strong> 60%</td>
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<tr>
<td></td>
<td>East 1</td>
<td>2016</td>
<td>28</td>
<td>18</td>
<td>36%</td>
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<tr>
<td></td>
<td>East 3</td>
<td>2017</td>
<td>8</td>
<td>6</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>East 6</td>
<td>2017</td>
<td>16</td>
<td>11</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Mean:</strong> 31%</td>
</tr>
</tbody>
</table>
Results—Efficacy

Increased efficacy
- Region: $F_{1,16} = 13.4, P = 0.002$; West = 23% greater efficacy
- Prebait: $F_{1,16} = 11.1, P = 0.004$; Prebait = 18% greater efficacy
- Density: $F_{1,16} = 18.4, P < 0.001$; Density = 0.65% greater efficacy/GS
Results—Consumption Hours

$F_{10,371} = 3.1, P = 0.001$
Results—Number of Applications

$F_{3,371} = 3.1, P = 0.001$
Results—Time Since Application

![Graph showing consumption index over time with markers for Day 1 and Day 2.]

\[ F_{2,18} = 7.0, \ P = 0.006, \ R^2 = 0.44 \]
Other Research of Note

- Both mechanical and hand mixing did not differ.
  - Mechanical closer to desired concentration (101% vs. 115%) and less variable
  - Mechanical mixer easier to use
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- Moisture loss was consistent ($F_{1,3} = 52.4$, $P = 0.005$, $R^2 = 0.95$).

![Graph showing percent moisture loss over hours post-mixing](image-url)
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  - Mechanical mixer easier to use

• Moisture loss was consistent ($F_{1,3} = 52.4$, $P = 0.005$, $R^2 = 0.95$).

• Zinc phosphide degradation was consistent ($F_{5,34} = 2.8$, $P = 0.042$).
Discussion

- Cabbage bait ranges from highly efficacious to very low efficacy (20–91%).
  - More effective in west
  - Prebaiting important
  - Density important factor
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- Consider burrow fumigation and shooting when baiting likely ineffective.
  - Gas cart & Al Ph = 98–100%
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• Consider burrow fumigation and shooting when baiting likely ineffective.
  - Gas cart & Al Ph = 98–100%

• Nontarget risks initially appear limited.