The Cost and Effectiveness of Small-Scale Fennel Control Methods

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Abstract
This study examined which of three methods would work most effectively at killing fennel (Foeniculum vulgare) in a small-scale infestation while costing the least in two sites in Salinas. The methods are: digging individual plants with a shovel; chopping the plants repeatedly during the summer with a machete, or chopping the plants and immediately spraying with an herbicide. The pictures here show the results of each of the four different treatment methods used. The Cost and Effectiveness of each treatment method is also recorded.

Methods:
I randomly selected a total of 100 fennel plants in two sites in Salinas, CA: Natividad Creek Park and Upper Carr Lake. There were 50 plants per site and all 100 plants were randomly assigned to four different treatment methods. There were 25 plants per group. Two plants per group were used for each method. Treatment methods began on July 10th, 2006. The results of this study are shown on Table 1.

• Control: These plants received no treatment other than to remove any flower heads that were produced during the season to prevent them from spreading seeds.
• Chop Repeatedly: These plants were chopped with a machete to 20cm or less and then immediately sprayed with the herbicide Rodeo, which is glyphosate (Roundup) without a surfactant. This was the only treatment method that had two people working together on the same plant.
• Chop and Spray: These plants were chopped with a machete to 20cm or less and then immediately sprayed with the herbicide Rodeo. This is the most common method used in Canada and is more effective than Roundup.
• Dig: These plants were dug up with a shovel with the intent to remove as much of the root as possible.

The time spent on each plant for all methods except the control was recorded to factor in the cost of labor. The cost of labor was assumed to be $10 per hour for this study. The amount of herbicide used was also recorded.

The treatments were stopped on September 4th, 2006 which included a final round of chopping and an assessment of all of the plants. The plants were visually evaluated and placed into one of three categories:

• Dead: These plants showed no new growth and were often brown and shriveled.
• Stressed: These plants were obviously unhealthy and often had yellowing, drooping leaves.
• Alive: These plants were green or showed signs of new growth.

Results:

Effective at killing Fennel:
• The most successful method was digging the individual plants with 100% mortality. Chop and spray was a close second with 96% mortality (Figure 1).
• The chopping repeatedly method was completely ineffective (Figure 1).

Cost per Method:
• The most expensive method was digging with an average of $3.49/plant (Figure 2, Table 1).
• The least expensive was to chop and spray with an average labor cost of $0.60/plant, assuming a pay rate of $10/hour for two people. This does not include the cost of Rodeo used. Chopping repeatedly was also inexpensive (Figure 2, Table 1).

Discussion:
My results show that chopping and spraying each plant with herbicide was the most effective and least expensive method. However, I didn’t take into account the cost of the Rodeo used. I used about 10ml mixed with water and no surfactant in a standard, 1-lter spray bottle and still had about half of the mixture left after treating 25 plants with that method. The Rodeo I used was already available and so the herbicide did not need to be purchased. Rodeo sells for about $50.00 - $60.00 per gallon.

Though Roundup is a common glyphosate formulation than Rodeo, I chose Rodeo because my research shows that it may be safer to use in riparian areas, and is the better choice when one is seeking to reduce the impact upon the aquifer zone. Several studies have shown that it is the surfactant associated with Roundup and often added to Rodeo that seems to be lethal to amphibians. All of my herbicide applications took place upland of the nearby waterways and without the use of any surfactant.

Digging was the most effective at killing the fennel plants but it was extremely time consuming with each plant ranging about 30 minutes to dig out and one notable plant taking over an hour – 68 minutes – to dig out. It is possible that this time may be reduced by using a different tool, such as a pulaski or mattock instead of a shovel, however only the shovel was used in this study.

Conclusion:
• If herbicide application is not an issue then chopping and spraying each fennel plant with Rodeo is the best treatment method.
• If soils are soft and the infestation is small (and/or herbicide application is not appropriate), digging up each individual fennel plant is the best treatment method.

Table 1:
The average cost of each method per plant, as well as the range of cost. (Note the maximum cost for digging).

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost Range</th>
<th>Average Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chop Repeatedly</td>
<td>$2.22 - $5.16</td>
<td>$3.42</td>
</tr>
<tr>
<td>Chop and Spray</td>
<td>$2.08 - $4.98</td>
<td>$3.39</td>
</tr>
<tr>
<td>Dig</td>
<td>$0.77 - $2.31</td>
<td>$1.33</td>
</tr>
</tbody>
</table>

Figure 1:
The cumulative percent of fennel survivorship in each of the four treatment methods. * Two of the plants listed as dead in the chop repeatedly method were missing during the assessment.

Figure 2:
The average cost of labor for each method (not counting the control), assuming a pay rate of $10.00 per hour.

Acknowledgments:
I would like to thank the Watershed Institute and Return of the Natives for providing my tools and Return of the Natives Restoration Education Project at the Watershed Institute.

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