Using Organic Herbicides on Roadsides and ROW: Evaluating Effectiveness and Costs

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Note: Unpublished data in results: Do Not Cite
Why Manage Roadsides?

• Maintain road and shoulder structure
• Reduce maintenance and operations costs
• Maintain visibility
• Reduce fire hazards
• Reduce driving dangers and debris
• Aesthetically pleasing
• Low water usage
• Be good managers
• And others...
IPM and the Public

• As part of our Integrated Pest Management program for roadsides managers are striving to reach targets and improve methods of weed control

• The public is also concerned about roadside managers using herbicides, especially glyphosate

• The public is also interested in the use of organic herbicides as a potential substitute for glyphosate-based herbicides
Experimental Purpose

• We designed an experiment to test the use of glyphosate, non-glyphosate synthetic herbicides, and organic herbicides to control roadside vegetation in San Diego County
Research Objectives

• 1- Evaluate the **efficacy** of non-glyphosate and organic herbicides
• 2- Determine the **number of applications** to achieve targeted level of weed control
• 3- Determine **costs** to achieve desired levels of weed control

Example target conditions
Minimal residual vegetation
Practical Considerations

• Tests were conducted on roadsides (not test sites) with standard roadside equipment (injection sprayer w/ boomless ‘nutating’ nozzles) to ensure roadside effects would be incorporated in the experiment

• Herbicides had to control a broad spectrum of weeds on site (annuals, perennials, grasses, broadleaves)
Practical Considerations

- Use rates had to be less than 10%, standard truck configuration ~8% max
- Applications had to conform to typical work schedule
  - Repeat applications at 1-month intervals
- High deference for applicator and public safety = low signal words, Caution label or lower (no Warning or Danger labels)
Quick Tangent on Organics and Safety

• The term organic (per gov’t regulations) relates to the origin of the chemical and how it is manufactured.
• In general, USDA “organic” products comes from natural sources and/or have not been synthesized.
• Organic herbicides can have Caution, Warning or Danger signal words on label.
• Signal word determines acute toxicity, it is not related to organic certification.
• For example, organic Danger products can cause more acute harm than synthetic Caution products.
Site Locations

• Plots located in 3 sites in San Diego County:
  • Valley Center
  • Ramona
  • Otay Mesa
Ramona

Otay Mesa

Valley Center
Methods

• 7 treatments (3 organic, 3 synthetic, 1 untreated control) with 3 replications at each site = 21 plots, randomly in a linear pattern at 50 GPA

• Treatments were 100 ft. long and only middle 80 ft. were measured (20 ft. buffer between treatments) and 4-8 ft. wide depending on shoulder

• Organic and synthetic products sprayed on different ends of site to reduce any cross contamination, and prevent mis-applications
Chemicals and Rates

• Synthetic Herbicides:
• Glyphosate @ 72 ozs./ac. (2.25 qts./ac)
• Cheetah Pro (glufosinate) @ 48 ozs./ac. and 34 ozs./ac. (max annual rate)
  • NOTE: Glufosinate current (2022) label rate: 82 ozs./ac./app. and 246 ozs./ac. annual max, which is 3X higher annual rate then used in this study
• Milestone (aminopyralid) @ 5 ozs./ac and Oust (sulfometuron-methyl) @ 3 ozs. /ac.
Chemicals and Rates

• Organics: Rejected more than 20 organic products that did not meet project requirements

• We used:
  • Weed Zap = Clove oil (45%) + cinnamon oil (45%) @ 5% (maximum single application rate)
  • Fireworxx = Caprylic acid (44%) + capric acid (36%) @ 6-8% (9% maximum single application rate)
    • Caprylic + Capric acids can come in Caution (Fireworxx) or Warning (Suppress) labelled products. We used Caution label product (different % a.i.’s)
A Note on Organics: Stop Use Notices

• Two other organics were selected, but were stopped

• Two organic products were selected, however CDFA issued a stop use order alleging the products were adulterated with glyphosate and other synthetic active ingredients
Data Collection

• Data were collected:
• 7 d Before T (pretreatment) and then 7, 14 and 30 DAT (days after treatment) after each follow up treatment
• Repeated treatments monthly as needed (surveyed 7, 14, 30, 37, 44, 60, 67, 74, 90 DAT, etc.)
• And then monthly surveys (120, 150 DAT)

• Collected data on weed control (10=100% control, 0= no control), and end of season biomass
Results: Study Sites

• Sites were dominated by non-native winter annual weeds
• Mostly annual grasses (oats, bromes, barleys, perennial ryegrass, fescues)
• Some broadleaves (thistles, tocolote, tumbleweed, mustards, storkbill)
• Few native perennials, few native wildflowers
• All sites received ~40-50% below average rainfall in 2020-2021, i.e. drought, => short growing season, few summer annuals
Results: Objective 1 - Efficacy?

- What was the effectiveness of the non_glyphosate synthetic herbicides and organic herbicides compared to glyphosate and untreated controls?

Unpublished data in results: Do Not Cite
Results: Objective 1 - Efficacy?

- 30 DAT
- Glyphosate had significantly highest control (~70%)
- Other synthetics sig. higher than untreated
- Organics had lowest control, not sig. diff. from untreated

*- indicates significantly different from untreated plots at same DAT
Results: Objective 1 - Efficacy?

• 60 DAT
• 2nd treatment for all herbicides except glyphosate
• Max annual rate for Cheetah Pro and Milestone+Oust

* indicates significantly different from untreated plots at same DAT
Results: Objective 1 - Efficacy?

By 60 DAT No significant differences between any treatment and control plots
• At 60 DAT applied 3\textsuperscript{rd} herbicide treatment
• 2\textsuperscript{nd} glyphosate app.
• 3\textsuperscript{rd} organic app.
From 60 to 150 DAT no sig. diff. between any treatment and control
80% of untreated control plants died (annuals)
Results Objective #1 - Efficacy

- Glyphosate with 2 applications had the fastest and most effective weed control (~80-90%)
- By 44 DAT only glyphosate was significantly higher than control plots
- From 60 DAT to 150 DAT all treatments were not significantly different from control plots, and few summer annuals germinated
- The lack of rainfall killed the annuals quickly
37 DAT, 1 glyphosate app., 2 apps. for other herbicides
Time series of Fireworxx from -7 to 120 DAT

Pretreatment

7 DAT
14 DAT
30 DAT
97 DAT
44 DAT

1st H App

74 DAT
90 DAT
120 DAT

2nd H App

1st H App

3rd H App
Time series of Glyphosate from -7 to 120 DAT

Pretreatment
1st H App
2nd H App

7 DAT
14 DAT
30 DAT
37 DAT
44 DAT
60 DAT
67 DAT
74 DAT
90 DAT
120 DAT
Results: Objective #2 – Number of Applications

• 3 applications of WeedZap never had weed control significantly higher than untreated plots.

• 3 applications of Fireworxx resulted in control significantly higher than untreated plots only one time (37 DAT) (46 vs. 20%, respectively), but significantly less than glyphosate (90 vs. 46%).

• 2 applications of glyphosate averaged 80-90% control.

• 2 applications of Milestone+Oust had significantly higher control than untreated plots, but less than glyphosate.

• Cheetah Pro was less effective than Milestone+Oust, but not significantly different from organics.
Results: Objective #3 - Cost per treatment?

- Cost of herbicides per treatment?

- Labor, equipment, surfactants, maintenance not included
## Results: Objective #3 - Cost per treatment?

<table>
<thead>
<tr>
<th>Herbicide (H)</th>
<th>H Type</th>
<th>Rate (ozs.) at 50 GPA</th>
<th>Cost per Ac.</th>
<th>Ratio of Cost H:Lowest Cost H</th>
<th>Ratio of costs to replicate study results</th>
<th>Gallons of herbicide needed to treat 100 ac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>Synthetic</td>
<td>72</td>
<td>$9.36</td>
<td>1.0</td>
<td>1.0</td>
<td>56.3</td>
</tr>
<tr>
<td>Aminopyralid</td>
<td>Synthetic</td>
<td>5</td>
<td>$12.63</td>
<td>1.8</td>
<td>1.8</td>
<td>3.9</td>
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<tr>
<td>Sulfometuron</td>
<td>Synthetic</td>
<td>3</td>
<td>$4.69</td>
<td>2.3</td>
<td>3.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Glufosinate</td>
<td>Synthetic</td>
<td>41</td>
<td>$19.85</td>
<td>2.1</td>
<td>2.1</td>
<td>32.0</td>
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<tr>
<td>Clove+Cinnamon Oils</td>
<td>Organic</td>
<td>320</td>
<td>$207.14</td>
<td>22.1</td>
<td>33.2</td>
<td>250.0</td>
</tr>
<tr>
<td>Caprylic+Capric acids (8%)</td>
<td>Organic</td>
<td>512</td>
<td>$402.28</td>
<td>43.0</td>
<td>64.5</td>
<td>400.0</td>
</tr>
<tr>
<td>Capry.+Capric(9% max rate)</td>
<td>Organic</td>
<td>576</td>
<td>$452.56</td>
<td>48.4</td>
<td>72.5</td>
<td>450.0</td>
</tr>
</tbody>
</table>

*Purchase prices for each herbicide obtained by SD AWM in Dec 2020-Jan 2021*
Results: Objective #3 - Cost per treatment?

• Summary of costs:
• Organic use rates are much higher than synthetics (4-100X more product)
• This leads to much higher product costs per acre
• Because organics needed more applications costs were 50% higher again than glyphosate (65-73X), or Milestone+Oust (36-40X)

• UPDATE outside of scope of this study: Prices of glyphosate and other herbicides have changed drastically since pandemic lows, cost ratios are not current
Results: Objective #3 - Cost per treatment?

• Summary of costs:

• When treating large acreages, storage of hundreds to thousands of gallons of organic herbicide will be needed
  • 400-450 gallons per 100 ac. treated each application
  • 4,000-4,500 gallons per 1,000 ac. treated each application
What Did Others Find Using Organics on Roads?

- S.L. Young, Weed Tech. 2004
- Northern California

- 5 applications of acetic acid, pine oil and plant essential oils and 2 apps. of glyphosate
- No organic achieved same control (88%) as glyphosate (100%)
- Organic costs were 28-42X higher than synthetics

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Yellow Star Thistle</th>
<th>Buckhorn plantain</th>
<th>Hairy vetch</th>
<th>Slender Oat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>100 a</td>
<td>100 a</td>
<td>100 a</td>
<td>100 a</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>36 b</td>
<td>49 d</td>
<td>60 b</td>
<td>83 a</td>
</tr>
<tr>
<td>Pine Oil</td>
<td>81 a</td>
<td>65 c</td>
<td>100 a</td>
<td>41 b</td>
</tr>
<tr>
<td>Plant Essentials</td>
<td>85 a</td>
<td>84 b</td>
<td>100 a</td>
<td>86 a</td>
</tr>
<tr>
<td>Control</td>
<td>0 c</td>
<td>0 c</td>
<td>0 c</td>
<td>0 c</td>
</tr>
</tbody>
</table>
Summary

• The two organic herbicides, applied 3 times, were less effective than synthetic herbicides at controlling roadside weeds, and only marginally better than untreated plots

• At least three organic herbicide applications were needed throughout the growing season during this drought, synthetics needed 2 apps.
  • In years or areas with more rainfall and a longer growing season, at least 4+ organic applications could be needed to control winter and summer annuals

• The best performing organic herbicide was less effective and much more costly than glyphosate at end of season
  • When treating large areas, will need to store hundreds to thousands of gallons of organic herbicides for each application
Questions?

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THANK YOU to Project Partner
San Diego County Dept. Agriculture, Weights and Measures

Funded by San Diego County