Control of Japanese climbing fern (Lygodium japonicum) reproduction

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Past Research

Herbicide studies to control mature plants

- 3 herbicides tested: glyphosate, imazapyr, metsulfuron
- Applied to infested plots in mid-September
- **Glyphosate (2% v:v)** was best after 2 years
Anecdotal observations

Post-treatment (late Sept)

Post-treatment (Nov)

Spore dispersal observed following herbicide treatment, particularly after foliage browned.
Japanese climbing fern

Biology - Life Cycle

- Spore bank
- Gametophyte stage
- Sporophyte stage
- Development of fertile fronds
- Spores disperse
Japanese climbing fern

Biology & Anatomy

Rachis
Frond
Pinnule

Sporangia
Lobe
Additional research

Timing of herbicide applications

• Objective: limit spore development and/or viability
• Two herbicides - glyphosate and metsulfuron methyl
• Applied at 4 intervals from July through September
• Treatments conducted on individual plants
## Treatment and harvest schedule

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Period 1</th>
<th></th>
<th>Period 2</th>
<th></th>
<th>Period 3</th>
<th></th>
<th>Period 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Applied</td>
<td>Harvested</td>
<td>Applied</td>
<td>Harvested</td>
<td>Applied</td>
<td>Harvested</td>
<td>Applied</td>
<td>Harvested</td>
</tr>
<tr>
<td>2% v:V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>glyphosate</em></td>
<td>July 22</td>
<td>Sept 3</td>
<td>Aug 12</td>
<td>Sept 23</td>
<td>Sept 3</td>
<td>Oct 8*</td>
<td>Sept 24</td>
<td>Oct 29*</td>
</tr>
<tr>
<td>2 oz. /ac</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>control</em></td>
<td>N/A</td>
<td>Sept 3</td>
<td>N/A</td>
<td>Sept 23</td>
<td>N/A</td>
<td>Oct 15</td>
<td>N/A</td>
<td>Nov 5</td>
</tr>
</tbody>
</table>

*harvested 1 week early due to severe plant deterioration*
Spore Collection and Yield

• At harvest, fronds stored in paper bags
• Spores shaken; separated from dry foliage
• Total spore weights per plant (g) measured

• ANOVA to test response as a function of herbicide type and application timing
Results: Spore Yield

<table>
<thead>
<tr>
<th>Treatment Date / Harvest Date</th>
<th>Glyphosate</th>
<th>Metsulfuron Methyl</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul 22 / Sep 3</td>
<td>d</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td>Aug 12 / Sep 23</td>
<td>d</td>
<td>bc</td>
<td>bc</td>
</tr>
<tr>
<td>Sep 3 / Oct 15</td>
<td>cd</td>
<td>bc</td>
<td>bc</td>
</tr>
<tr>
<td>Sep 24 / Nov 5</td>
<td>cd</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>
Spore germination and Gametophyte development

4 Chambers:
30°C
75% humidity
14 hour day
Gametophyte measurements

Monitored germination response (yes/no) per pot

Measured % cover per pot at Week 5
### Results – Percent Cover of Gametophytes

<table>
<thead>
<tr>
<th>Treatment Dates</th>
<th>2% gly</th>
<th>2oz. met</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 22</td>
<td>c</td>
<td>d</td>
<td>a</td>
</tr>
<tr>
<td>Aug 12</td>
<td>c</td>
<td>d</td>
<td>a</td>
</tr>
<tr>
<td>Sep 3</td>
<td>bc</td>
<td>cd</td>
<td>a</td>
</tr>
<tr>
<td>Sep 24</td>
<td>bc</td>
<td>c</td>
<td>a</td>
</tr>
</tbody>
</table>
Repeated study with glyph-met mix

<table>
<thead>
<tr>
<th>Treatment Dates</th>
<th>July 22</th>
<th>Aug 12</th>
<th>Sep 3</th>
<th>Sep 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Cover of Gametophytes</td>
<td>2% gly</td>
<td>2% gly-2oz. met</td>
<td>Control</td>
<td></td>
</tr>
</tbody>
</table>

- **July 22**: 2% gly (b), 2% gly-2oz. met (ab), Control (b)
- **Aug 12**: 2% gly (b), 2% gly-2oz. met (ab), Control (a)
- **Sep 3**: 2% gly (c), 2% gly-2oz. met (ab), Control (ab)
- **Sep 24**: 2% gly (ab), 2% gly-2oz. met (ab), Control (ab)
Current Research Objectives

1. To determine if reduced gametophyte development is similar when applied at broad, plot-level scale

2. To compare effect of herbicide type and treatment timing across two climate zones in FL
Study sites

Legend
- Interstate Highways
- Rivers
- Lakes
- State Boundaries
- Counties
- Site Location

Panhandle and Central Florida
JCF Broadcast Treatment Sites

Coordinate System: Albers
Central Meridian: 90°01'W
1st Std Parallel: 20°00'N
2nd Std Parallel: 60°00'N
Latitude of Origin: 40°00'N
Plot sizes

Panhandle sites
Treatments applied to 10ft x 20ft plots

Central Florida sites
Treatments applied to fern patches
## Experimental Design

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Herb.</th>
<th>Reps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Aug</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sept</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

- **glyphosate @ 2%**
- metsulfuron methyl 2 oz.
- Glyphosate + metsulfuron control
Preliminary results - % cover

Blackwater River State Forest

<table>
<thead>
<tr>
<th>Treatment Timing</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Cover of Gametophytes</td>
<td>Gly</td>
<td>Met</td>
<td>Gly + Met</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ocala National Forest

<table>
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<th>Treatment Timing</th>
<th>July</th>
<th>August</th>
<th>September</th>
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<tbody>
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<td>% Cover of Gametophytes</td>
<td>Gly</td>
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<td>Gly + Met</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Management Implications

Herbicide Type

- **Individual plants**: metsulfuron more effective than glyphosate
- **Broadscale application**: no difference between herbicides

Herbicide Timing

- **Individual plants**: late July - Early Sept
- **Broadscale application**: location dependent; mid-Sept for both

Location

- Monitoring suggests no difference in timing of spore development on fronds across sites
Future Research

Test Spore viability directly

- % cover is somewhat subjective
- Gametophyte space hogs
- Exact number of spores per pot is not known before trials
Future Research

Quantitative Spore Viability

Developed methodology for spore germination on microscope slides

% of germinants rather than % cover of gametophytes

Microscopic images of JCF gametophyte development
Acknowledgements

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Thank you!!!

Questions?