Herbicide Type and Application Timing to Control Spore Reproduction in Japanese Climbing Fern (*Lygodium japonicum*)

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Collaborators: Dr. Kimberly Bohn, Dr. Gregory MacDonald, Dr. Mack Thetford, Dr. Patrick Minogue
Local Research Team

Team Fern

Dr. Kimberly Bohn
Me
Nathan Moores
Justin McKeithen
Japanese climbing fern

Biology & Anatomy

Rachis

Frond

Pinnule

Sporangia

Lobe
Japanese climbing fern

Biology - Life Cycle

Sporophyte

Gametophyte

Spores

Mature Fronds

Sporangia

Spores

Jan  ➔  Feb  ➔  Mar  ➔  Apr  ➔  May  ➔  Jun  ➔  Jul  ➔  Aug  ➔  Sep  ➔  Oct  ➔  Nov  ➔  Dec
Past Research

Herbicide Studies

- Aimed at the treatment of mature plant foliage
- 3 herbicides initially used
- Glyphosate was best at controlling mature plant foliage

Spore Germination Studies

- Aimed at limiting spore development and germination
- Herbicide treatments conducted on individual plants
- Two herbicides - (glyphosate and metsulfuron methyl)
Past Research

Experimental Design

- Glyphosate
- Metsulfuron methyl
- Control

1. Late July
2. August
3. Mid September
4. Late September

B Buffer row not included in the treatments

* A total of 12 treatments are randomized within each paired rows within the buffers.
## Past Research

### Treatment and Harvest Schedule

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

*harvested 1 week early due to severe plant deterioration*
Current Research

Objectives

1. To determine if reduced gametophyte development is similar when herbicides applied at a plot-level scale
2. To see if the combination of glyphosate and metsulfuron methyl would further reduce gametophyte development
3. To compare effect of herbicide type and treatment timing across two climate zones in FL
Current Research

Broadcast and Combination Treatments

JCF

Nathan Mooers
(Grand Master Slayer of JCF)
Current Research

Treatment Locations

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

Panhandle and Central Florida JCF Broadcast Treatment Sites

Coordinate System: Albers
Central Meridian: 96°00'W
1st Std Parallel: 29°00'N
2nd Std Parallel: 60°00'N
Latitude of Origin: 40°00'N
Current Research

Experimental Design

<table>
<thead>
<tr>
<th>Location</th>
<th>Treatment Period</th>
<th>Treatment Type</th>
<th>Replicates</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></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

- glyphosate @ 2% v:v
- metsulfuron methyl @ 2oz./ac
- gly + met @ same rates
- control
Current Research

Plot Sizes

**Panhandle sites**
Treatments applied to 10ft x 20ft (200 sqft) plots

**Central Florida sites**
Treatments applied to fern patches

Heather Van Heuvlen
Co-Grand Master Slayer of JCF
Spore Collection

Methods

- At harvest, fronds stored in paper bags
- Spores shaken and separated from dry foliage
- Total spore weights per plant (g) measured
Spore Yield

Data Analysis

- ANOVA to test response of spore weight as a function of herbicide type and application timing

- Significant differences between treatments tested at α= 0.05
Past Research

Results: Post-Treatment Spore Yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Date / Harvest Date</th>
<th>Ave. total wt (g) of spores per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>Jul22 / Sep3</td>
<td>d</td>
</tr>
<tr>
<td>Metsulfuron Methyl</td>
<td>Aug 12 / Sep23</td>
<td>b</td>
</tr>
<tr>
<td>Control</td>
<td>Sep3 / Oct15</td>
<td>bc</td>
</tr>
<tr>
<td></td>
<td>Sep 24 / Nov5</td>
<td>cd</td>
</tr>
</tbody>
</table>

- Glyphosate: Glyphosate
- Metsulfuron Methyl: Metsulfuron Methyl
- Control: Control

Ave. total wt (g) of spores per plant

Treatment Date / Harvest Date
Growth Chamber Experiments

Methods

Chamber Settings

4 Chambers:

30°C
75% humidity
100% light (~ 350-400μmol PAR)
14hr/day photoperiod
% Cover of Gametophytes

Data Analysis

• Each ‘run’ analyzed separately
• Mixed-model ANOVA to test response of gametophyte cover:
  • Growth chamber treated as a random ‘block’
  • Herbicide type application timing were fixed effects
• Significant differences between treatments tested at α=0.05
Results & Management Implications

Herbicide Type

- Early studies: metsulfuron methyl = a reduction in gametophyte development
Past Research

Results – Percent (%) Cover of Gametophytes

Run 1: November

Run 2: February
Management Implications

All Studies

Herbicide Type

- **Early studies**: metsulfuron methyl = a reduction in gametophyte development
- **Current study**: Gly + Met = a reduction in gametophyte development (n.s.)
Current Research

Preliminary Results

Blackwater River State Forest

Ocala National Forest

% Cover of Gametophytes

July  | August  | September

- Gly
- Met
- Gly + Met
- Control

July  | August  | September
Management Implications

All Studies

Herbicide Type

- **Early studies**: metsulfuron methyl = a reduction in gametophyte development
- **Current study**: Gly + Met = a reduction in gametophyte development (n.s.)

Herbicide Timing

- **Early studies**: July / August = best time to apply herbicide
Past Research

Results – Percent (%) Cover of Gametophytes

Run 1: November

Run 2: February
Management Implications

Herbicide Type

- **Early studies**: metsulfuron methyl = a reduction in gametophyte development
- **Current study**: Gly + Met = a reduction in gametophyte development (n.s.)

Herbicide Timing

- **Early studies**: July / August = best time to apply herbicide
- **Current study**: September = lowest % cover @ both locations (n.s.)
Current Research

Preliminary Results

Blackwater River State Forest

Ocala National Forest

% Cover of Gametophytes

July
August
September

[Graphs showing data for different months and forests, with specific values indicated by red ellipses]
Management Implications

All Studies

Herbicide Type
- Early studies: metsulfuron methyl = a reduction in gametophyte development
- Current study: Gly + Met = a reduction in gametophyte development (n.s.)

Herbicide Timing
- Early studies: July / August = best time to apply herbicide
- Current study: September = lowest % cover @ both locations (n.s.)

Location
- Inconclusive
Current Research

Preliminary Results

Blackwater River State Forest

Ocala National Forest

% Cover of Gametophytes

July  | August  | September

July  | August  | September

Gly   | Met     | Gly + Met | Control

Gly   | Met     | Gly + Met | Control
Current Research

Concerns

- % cover is somewhat subjective
- Spores grow where water collects
- 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
Oh nooo!!!
Acknowledgements

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  - Justin McKeithen
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  - Jesse Goyer
Thank you!!!

Questions?