Conditions Affecting Herbicide Control of Grasses

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Aquatic Weed Control Short Course 2018
Grasses and Varying Environments

• Many problematic grasses are able to tolerate a wide variety of environmental conditions
Environment and Herbicide Efficacy

- Environmental conditions prior to, during, and after herbicide application affect efficacy
  - Direct: absorption and translocation
  - Indirect: growth and physiology

From Tao et al. 2016
Differences in height between control and treated plants

Control  Salinity  Drought  Cold  Heat

American Phytopathological Society, 2018
Factors affecting herbicide efficacy

• Leaf traits affect how much herbicide is taken up by plants
  • Cuticle width
  • Leaf number and size
  • Leaf angle

From Tao et al. 2016

Benjamin Cummings
Factors affecting herbicide efficacy

- Plants that are not actively growing may see limited translocation of systemic herbicides
  - Photosynthetic rate
Factors affecting herbicide efficacy

- Biomass can affect management success in rhizomatous species
- Root to shoot ratios
- Regrowth potential

Jailisse Knowles

Delaware Invasive Species Council

Chis Evans, Bugwood.org
Site of Absorption and Translocation

Foliar-Translocated (Phloem) (i.e. glyphosate)

Foliar or Root Uptake (Xylem and Phloem) (i.e. aminopyralid, clopyralid, picloram, metsulfuron)

Foliar-Contact herbicide (i.e. diquat)

Xylem (i.e. tebu thiuron)

Fabian Menalled, Montana State University
Environmental Conditions

- Flooding
- Drought
- Salinity
- Light
- Climate
Flooding
Effects of Flooding

- Tolerance varies with species
- ↓ leaf area
- ↓ photosynthesis (can recover in flood tolerant species)
- May initially limit number of leaves exposed to herbicide applications
Flooding

- Flooded conditions may limit herbicide efficacy in torpedograss (Quincy et al. 2018)

![Shoot Biomass (g)](chart)

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>0</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot Biomass (g)</td>
<td></td>
<td></td>
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</tbody>
</table>

- Fluazifop: bc b
- Imazapyr: bc b
- Glyphosate: e
- Sethoxydim: de
- Untreated: a
Flooding

• Flooded conditions may limit herbicide efficacy in torpedograss
  • Translocation issue?

Greg MacDonald
Drought
Effects of Drought

- Upright leaf angle
- ↓ photosynthesis, growth
- ↓ leaf area, leaf number
- ↑ leaf cuticle thickness
  - Composition of cuticle can change → more hydrophobic
Drought

• Water-stress has decreased efficacy of ACCase-inhibiting herbicides for certain grass species (Pereira 2010, Pereira et al. 2011)
  • Goosegrass
  • Plantain signalgrass
Salinity
Effects of Salinity

- Tolerance varies with species
- ↓ photosynthesis, growth
- ↓ leaf area, leaf number
- ↑ leaf thickness
- ↑ root:shoot ratios

From Tao et al. 2016

Jailisse Knowles
Salinity

• Salinity decreased efficacy of glyphosate and imazapyr in torpedograss, not in phragmites (more salt tolerant) (Prince et al. 2018)
Salinity

Torpedograss rhizome biomass 60 DAT with glyphosate

[Graph showing the effect of glyphosate on belowground biomass in saline and freshwater conditions]
Light
Effects of Light

- **High light:**
  - ↑ photosynthesis
  - ↑ leaf thickness and cuticle development
- **Low light:**
  - ↓ leaf thickness
  - ↑ leaf area
  - ↓ leaf number
  - ↓ photosynthesis
  - ↓ root:shoot ratios
Light

• Shade has been shown to increase injury by contact herbicides (Mellendorf et al. 2015, Thompson and Nissen 2002)

• Higher light intensity may increase injury by systemic herbicides (Varanasi et al. 2016)
Temperature and Climate Change
Effects of High Temperature

• ↑ cuticle permeability
• ↓ photosynthesis
• ↓ biomass
• ↓ leaf area
Temperature

• Mixed effects, species dependent

• Increased effects in some grasses (johnsongrass, bermudagrass) → increased absorption of herbicide (Jordan 1977; McWhorter and Azlin 1978)

• Decreased effects in others (large crabgrass, green foxtail), → greater metabolism, volatilization of herbicides, or other changes (Smeda and Putnam 1990; Johnson and Young 2002)
Effects of CO$_2$

- ↑ leaf thickness
- ↑ photosynthesis (C$_3$ species)
- ↑ root:shoot ratios
Climate Change

• Increased temperature and atmospheric $[\text{CO}_2]$ may reduce herbicide efficacy in certain grasses, like phragmites (Prince et al. 2017)
Take-Away:

- Consider the environmental conditions when planning, try to apply when growing conditions are ideal
- Flooding $\rightarrow$ may decrease efficacy
- Drought $\rightarrow$ may decrease efficacy
- Salinity $\rightarrow$ may decrease efficacy
- Light $\rightarrow$ depends on herbicide (contact vs. systemic)
- Temperature $\rightarrow$ depends on species
Questions?

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References


