Effect of Fire on Plants

Factors Affecting Plant Response to Fire Damage

- Physical
- Physiological
- Morphological
- Phenological

Physical Resistance to Heat

- Lethal Temperature to Plant Tissue - 140°F
  - Coagulation of Proteins
  - Cellular Membranes Rupture
- Ambient Temperature at Time of Burning Impacts Temperature Rise Needed to Reach Lethal Point
Physical Resistance to Heat

• Heat Resistance Varies
  – Moisture Content
  – Among Plants within the Same Species
  – Between Species
  – Among Organs of the Same Plant
    • Location in Relation to Flame
    • Seed Coat
    • Moisture Content

<table>
<thead>
<tr>
<th>Temperature °F</th>
<th>Exposure Time for Lethality (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>147</td>
<td>3</td>
</tr>
<tr>
<td>142</td>
<td>5</td>
</tr>
<tr>
<td>140</td>
<td>31</td>
</tr>
<tr>
<td>126</td>
<td>660</td>
</tr>
</tbody>
</table>
(Data from Hare 1961)

• Dormant Tissue (Low in Water Content) Have Increased Heat Resistance
• “Watered” Bluestem was Killed in Four (4) Hours by the Same Heat Intensity that Required sixteen (16) Hours to Kill Drought-Hardened Plants (Hare 1961)
• Bark is a Natural Insulator - Evergreen Bark Better than Hardwood Bark of the Same Thickness
Fire-caused mortality is result of killing cambium (source of new growth) and phloem (pipeline for photosynthates) by heat.

Physical Resistance to Heat

- A Plant Already at 95 ºF Require only about Half the Temperature Rise as One at 50 ºF to Reach Lethal Temperature

- Lethal Temperature Occurs as a Result of the Combination of Temperature and Exposure

Physiological - Morphological - Phenological Influences

- Growth Forms of Plants Responsible for Susceptibility to Fire
- Perennial Sod-Forming More Tolerant than Most Other Growth Forms
- Plants with Less Dead Material are Less Susceptible
Relative elevation of buds important to fire resistance, but not sole regulator of heat damage potential. Relative compactness of bunchgrasses and amount of standing fuel largely regulate temperature and duration of heat exposure to growing points.

Compact bunches, elevated buds, and high amount of standing fuel = greatest potential for fire damage.

Loosely arranged bunch, little standing fuel = low probability of heat damage if buds not elevated.

Many sodgrasses produce so little standing fuel that probability of heat damage is low (ex. Buffalograss).

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Physiological - Morphological - Phenological Influences

• Less Vigorous Plants are More Susceptible
• Root Sprouting Plants Invigorated
• Fire Preconditions Plants for Insects and Disease
• Any Species of Plant will Not React Consistently to Fire Since Characteristics of Fire are Widely Variable
Physiological - Morphological - Phenological Influences

Frequently, there is a shift from vegetative to reproductive activity during the year of the burn.

Heat Effect on Plant Tissue

- Vascular plants easily killed by heat
- Generally 140 degrees for 2 minutes is lethal to growing plants

Heat Effect on Plant Tissue

- Plant moisture increases the plants susceptibility to heat
- 3 minutes to kill 166% moisture Stipa comata at 140 degrees
- 100 minutes to kill 28% moisture Stipa comata at 140 degrees
Heat Effect on Seeds

- Seeds very tolerant to heat
- Grass seeds can tolerate 180 - 240 degrees for 5 minutes
- Little effect on seeds at soil surface
- Sometimes heat can increase germination

Fire Adaptations

- Bark insulation
- Seed serotiny
- Growth form

Fire Adaptations

Bark insulation

- Very little heat damage if bark is .4 inches thick (pine)
Fire Adaptations

Serotiny

- Heat above 140 degrees melts resinous bonds
- Legumes
- Redbud
- Jack pine

Redbud thickets can usually be traced back to a fire.
Fire Adaptations

Growth Form

• Bunchgrass with old growth susceptible
• Growing point close to surface are susceptible
• Rhizomatous grasses fire-tolerant
• Growing annuals usually killed outright

• Little bluestem: bunchgrass
• Sand Sage: resprouts

Soil Texture - water holding capacity greatly influences post burn plant growth

CLAY SOIL
High H2O holding capacity
Water available for plant regrowth

SANDY SOIL
Low H2O holding capacity
Water stress following burning
Summer Fire Effects on Prickly Pear Cactus

Medium Motte
(31 Pads)
Summer Fire

1 Month Post-Fire

1 Year Post-Fire

Prickly Pear Motte Mortality
North Texas; Ansley (submitted)

n=3; P< 0.05

Motte Mortality (%)

Years Post-Fire

Summer
High Winter
Low Winter
Control
Mesquite Response to Seasonal Fires
North Texas 1992-1995

Percent Top-kill

<table>
<thead>
<tr>
<th>Year</th>
<th>Site 1</th>
<th>Site 2</th>
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<tbody>
<tr>
<td>1992</td>
<td>96</td>
<td>42</td>
</tr>
<tr>
<td>1993</td>
<td>33</td>
<td>69</td>
</tr>
</tbody>
</table>

Site 1: Cool/Warm Grass Mix
Site 2: Warm Grass

Questions?