Competitive Interactions Between Appalachian Hardwood Species and Different Groundcovers on the Steep Slopes of Strip Mine Sites

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Special Thanks to:

My committee:
Dr. David Buckley
Dr. Jennifer Franklin
Dr. Arnold Saxton

As well as:
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Mountainside Coal Company
National Coal Company
Beth Aubuchon
Chris Miller
John Johnson

Brief Summary of Coal Mining in Tennessee

• Started in the late 1700’s
• Became large scale in mid 1800’s
• Tenth of nineteen states to have coal production
• Mine for bituminous coal
• Largest mining industry in Tennessee by the early 1900’s
• Different forms of mining
Problems with Mining

Upon completion of mining on a site...
There is substantial change in the environment
Mountains and mine sites in general are left with.....

• No vegetation
• Little or no topsoil
• Little or no organic matter

Problems with Mining

Lack of vegetation, topsoil, and organic matter on mine sites can potentially lead to:

• Reduced water quality
• Soil erosion
• Mass failure

With previous lack of regulations, there was little effort in reclamation

However...

1977: Surface Mining Control and Reclamation Act (SMCRA) was passed

Creation of the Office of Surface Mining (OSM)

Previous Efforts

Appalachian Regional Reclamation Initiative (ARRI) was established with USAID

Reforestation was desired!
1. Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone and/or the best available material
2. Loosely grade the topsoil or topsoil substitute established in step one to create a noncompacted growth medium.
3. Use ground covers that are compatible with growing trees
4. Plant two types of trees - early successional species for wildlife and soil stabilization, and commercially valuable crop trees
5. Use proper tree planting techniques
Previous Efforts

What kind of ground covers should be used in relation to reforestation?

1. Sparse for the first year
2. Dense in the following years

Ground covers that have been used:

**Grasses of choice**
- winter rye (Secale cereale)
- Foxtail Millet (Setaria italica)
- Redtop (Agrostis gigantea)
- Perennial Ryegrass (Lolium perenne)

**Legumes of choice**
- Kobe Lespedeza (Lespedeza striata var. Kobe)
- Birdsfoot Trefoil (Lotus corniculatus)
- White Clover (Trifolium repens)

Grasses of choice

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Justification for research

Lack of information on steep slopes

A steep slope is defined as a slope that falls between 20% and 45% (30 CFR Ch. Vi, 7.3/4 edition, § 705.1)

Some problems steep slopes present:
- Extreme erosion rates
- Mass slope failure

Ground covers being used in project

Four different ground covers are going to be utilized during this experiment:

1. Alfalfa (Medicago sativa: Evermore variety)
2. Switchgrass (Panicum virgatum: Blackwell variety)
3. Grey goldenrod (Solidago nemoralis)
4. Annual ryegrass (Lolium multiflorum)

- Found in most of the lower 48 states
- Found in all 50 states
- Can be found in all 50 states
Tree species being utilized in the project
Four different tree species are going to be utilized during this experiment:
1. Shagbark hickory (Carya ovata)
2. Northern red oak (Quercus rubra)
3. Black cherry (Prunus serotina)
4. American chestnut (Castanea dentata)
   - Populations decimated by chestnut blight (Cryphonectria parasitica)
   - Do not colonize aggressively
   - Slow growing stem
   - Intolerant of shade and grow best in full sunlight
   - Considered climax species

Factors Affecting Growth of Trees
- Sunlight
- Rainfall
- Topographic position
- Environmental Disturbances
- Soil Nutrients
- Competition

Competition
Increased competition can cause...
- Decreased photosynthesis
- Increased water stress
- Decreased transpiration
- Decreased shoot growth
- Decreased cambial growth
- Decreased survivorship
Objectives

1. To determine the influence of each ground cover on resource availability
2. To assess the performance of the trees that are planted within each ground cover
3. To assess the performance of the groundcover

Hypotheses

To determine the influence of each ground cover on resource availability

1. Photosynthetically active radiation (PAR) and transpiration (An index of moisture availability) in the seedlings will be significantly greater in plots without ground cover than in the plots that are planted with ground cover.
2. PAR and transpiration will be lowest in the seedlings in the plots planted with switchgrass.
3. The alfalfa ground cover treatment will have the highest PAR and transpiration.

Hypotheses

To assess the performance of the trees that are planted within each ground cover

1. Northern red oak and American chestnuts will have the greatest survival and the most growth of the species.
2. Shagbark hickory and black cherry will exhibit the most growth and survival on the plots without ground cover.
3. Northern red oak and American chestnut will exhibit the highest survival and the most growth on the plots planted with alfalfa.
Hypotheses

To assess the performance of the groundcover

1. The ground cover planted around the American chestnut will exhibit the least amount of growth and lowest survival due to the American chestnuts' vigorous growing potential and fibrous root system.

Materials

Site Locations

- TN/KY State line

Materials

Site Information

- King Mountain
  - Mined by: Mountainside Coal Company
  - Elevation: 394 meters
  - Aspect: West facing slope (287° Azimuth)

- Zeb Mountain
  - Mined by: National Coal Company
  - Elevation: 701 meters
  - Aspect: Southeast facing slope (151° Azimuth)

- Windrock Mountain
  - Mined by: Premium Coal Company
  - Elevation: 850 meters
  - Aspect: West facing slope (290° Azimuth)
Materials

Groundcover Placement

<table>
<thead>
<tr>
<th>Site</th>
<th>Groundcover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Mountain</td>
<td>Goldenrod</td>
</tr>
<tr>
<td>Windrock Mountain</td>
<td>Switchgrass</td>
</tr>
<tr>
<td>Bare Alfalfa</td>
<td>1= Shagbark hickory</td>
</tr>
<tr>
<td></td>
<td>2= Northern red oak</td>
</tr>
<tr>
<td></td>
<td>3= American chestnut or black cherry</td>
</tr>
</tbody>
</table>

Groundcover Placement

Seedling placement in plots

Top of slope

Bottom of slope

Seedling placement in plots

<table>
<thead>
<tr>
<th>Plot</th>
<th>Seedling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shagbark hickory</td>
</tr>
<tr>
<td>2</td>
<td>Northern red oak</td>
</tr>
<tr>
<td>3</td>
<td>American chestnut</td>
</tr>
<tr>
<td>4</td>
<td>Black cherry</td>
</tr>
</tbody>
</table>

Methods

Transpiration

Measured using a LI-COR LI-1600 Steady State Porometer
Methods
Photosynthetically Active Radiation
To be measured using a Ceptometer
- 10 cm
- 1 meter

Methods
Growth and Survival
- To be measured during dormant season
- Root collar diameter (mm) at ground level to be measured with calipers
- Total stem height (cm) to be measured from ground to tallest live bud
- Percent survival to be calculated

Methods
Performance of Ground Cover
- Measured using 1 m² quadrats
- Measured every tree on the second, seventh, and eleventh rows
Methods

Statistical Analysis

To be analyzed using ANOVA in SAS, Version 9.2

- Assessing the influence of ground covers on resource availability
  - Randomized block design (RBD) with split-plot and sampling

- Assessing the performance of the trees
  - Randomized block design with split-plot

- Assessing the performance of the ground covers
  - Randomized block design with split-plot and sampling

Questions?