Using Willow Riparian Buffer Strips for Biomass Production and Riparian Protection

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Willow Buffers for Riparian Protection and biomass Production

Runoff from agricultural fields: can transport nutrients, sediment, and agro-chemicals to streams
Willow Buffers for Riparian Protection and Biomass Production

Willow biomass production system
Decades of worldwide knowledge and experience

Tailor biomass production system for riparian buffers

Riparian Buffer
Willow buffers for biomass production and riparian protection

Research questions

- What is the potential biomass production from willow riparian buffers?
- How effective are willow riparian buffers in nutrient and carbon sequestration?
- What is the impact of first year coppicing on buffer performance?
- What are the long term impacts of biomass harvest on nutrient and carbon sequestration?
Willow buffers for biomass production and riparian protection
PEI Project Site

RCBD design with three blocks (replicates) and two management practices (coppicing and harvest treatments) and two Salix clones (sub-treatments)
Willow buffers for biomass production and riparian protection

Data collected

- Plant data
  - Biomass yield (allometric & sampling) 8 trees per plot/species (48 trees/species)
  - Root growth (pit excavation & soil cores)
  - Nutrient (N & P) and carbon (leaf, root & wood)
  - Transpiration (stem flow gauge)

- Soil Data
  - Baseline and annual data
  - Nutrient supply rate (PRS probes)

- Shallow groundwater data
  - Levels (Mini-divers)
  - lysimeters

- Sedimentation data
  - Overland flow (sediment traps)
Soil core sampling

Lysimeter shallow groundwater sampling

Sap flow measurement in 2009 Coppice plot
Harvested Plot
December 2009

6666 stems/ha

2.0m
0.75m
Non-Harvested and Harvested Plots
July 2010
# Site Soil Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Hovingh 2</th>
<th>Hovingh 3</th>
<th>Waugh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SV1</td>
<td>Viminalis</td>
<td>SV1</td>
</tr>
<tr>
<td>Soil Texture</td>
<td>fine sandy loam</td>
<td>fine sandy loam</td>
<td>fine sandy loam</td>
</tr>
<tr>
<td>pH</td>
<td>5.9</td>
<td>5.5</td>
<td>6.4</td>
</tr>
<tr>
<td>Organic matter</td>
<td>3.95</td>
<td>4.08</td>
<td>3.16</td>
</tr>
</tbody>
</table>

## Nutrient Supply Rate (µg/10cm²)

<table>
<thead>
<tr>
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<th>Hovingh 3</th>
<th>Waugh</th>
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</thead>
<tbody>
<tr>
<td>NO₃-N</td>
<td>48.6</td>
<td>22.8</td>
<td>46.7</td>
</tr>
<tr>
<td>Ca</td>
<td>422.6</td>
<td>638.0</td>
<td>467.8</td>
</tr>
<tr>
<td>Mg</td>
<td>69.2</td>
<td>115.0</td>
<td>104.8</td>
</tr>
<tr>
<td>K</td>
<td>208.1</td>
<td>460.8</td>
<td>423.2</td>
</tr>
<tr>
<td>P</td>
<td>13.4</td>
<td>16.0</td>
<td>9.4</td>
</tr>
<tr>
<td>Mn</td>
<td>1.4</td>
<td>1.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Question 1: Biomass production

Biomass Yield in Tree Compartments

Biomass Weight (kgDM tree\(^{-1}\))

- SV1 Viminalis

- Biomass Weight (kgDM tree\(^{-1}\))
  - Leaf
  - Wood
  - Root
Question 1: Biomass production

Annual above-ground biomass yield at two sites

Clone and Site

Yield (tDM ha\(^{-1}\) yr\(^{-1}\))

<table>
<thead>
<tr>
<th>Clone and Site</th>
<th>Yield (tDM ha(^{-1}) yr(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dasyclados 'SV1'</td>
<td>NO(_3)-N 48.6</td>
</tr>
<tr>
<td>Viminalis '5027'</td>
<td>NO(_3)-N 46.7</td>
</tr>
<tr>
<td>Waugh</td>
<td>NO(_3)-N 41.6</td>
</tr>
<tr>
<td>Hovingh 2</td>
<td>NO(_3)-N 22.8</td>
</tr>
<tr>
<td>Hovingh 3</td>
<td>NO(_3)-N 10.4</td>
</tr>
</tbody>
</table>

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Question 1 - Biomass Production

Annual Biomass Yield (tDM ha\(^{-1}\) yr\(^{-1}\))
Waugh Site (6666 stems/ha)

- Dasyclados 'SV1'
  - Not Coppiced: 11.62
  - Coppiced: 20.49

- Viminalis '5027'
  - Not Coppiced: 15.08
  - Coppiced: 15.97

[Diagram showing the annual biomass yield for each species and coppicing condition with corresponding values.]
Question 2 – Nutrient and carbon accumulation

Concentration of N & P in Willow Compartments

### Nitrogen

- **Wood**
  - SV1: 2
  - Viminalis: 3
- **Root**
  - SV1: 9
  - Viminalis: 10
- **Leaf**
  - SV1: 25
  - Viminalis: 30

### Phosphorous

- **Wood**
  - SV1: 0.5
  - Viminalis: 0.5
- **Root**
  - SV1: 5
  - Viminalis: 5
- **Leaf**
  - SV1: 3
  - Viminalis: 3
Question 2 – Nutrient and carbon accumulation

N Accumulation (g tree$^{-1}$)

- **Nitrogen**
  - Not Coppiced
  - Coppiced
  - Dasyclados ‘SV1’
  - Viminalis ‘5027’

- **Phosphorous**
  - Not Coppiced
  - Coppiced
  - Dasyclados ‘SV1’
  - Viminalis ‘5027’
Question 2 – Nutrient and carbon accumulation

Annual above and below-ground N & P Accumulation

**Nitrogen**

- Total N (kg ha\(^{-1}\) yr\(^{-1}\))

**Phosphorous**

- Total P (kg/ha/yr)

Clone and Treatment:
- Not Coppiced
- Coppiced

Clones:
- Dasyclados 'SV1'
- Viminalis '5027'

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Question 2 – Nutrient and carbon accumulation

Above and Below Ground Carbon Sequestration

- Dasyclados 'SV1'
- Viminalis '5027'

C Sequestration (t ha\(^{-1}\) yr\(^{-1}\))

- Leaf
- Wood
- Root

Not Coppiced
Coppiced
Not Coppiced
Coppiced
Conclusions

- Very high biomass productivity in riparian areas
- \( \text{NO}_3 \) supply rate is important factor
- Substantial amounts of carbon and nutrients can be accumulated in willow riparian buffers
- Overall, clone viminalis ‘5027’ superior to dasyclados ‘SV1’ in PEI
- Coppicing increased productivity which leads to increased carbon and nutrient sequestration
- Need better understanding of below ground role
Thank You

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