Quantifying the Role of Native Warm Season Grasses in Sequestering Soil Organic Carbon in a Coastal Plain Soil

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Conversion of C3 to C4 grasses
The BIG Questions were.....

✓ Can we successfully convert a thick cool season sod into native warm season grasses?
  • In mid-1990’s, establishment success NWSG highly variable.

✓ Will converting long-term cool season grass systems into warm season grass systems increase or decrease the total carbon pool at various soil depths?
What do we know?

Cool season grasses (C3) are generally shallower rooted and less drought tolerant.

Long term stands (15-25 yrs.) have developed shallow C-pools which seldom exceed 5% Soil Organic Carbon (SOC).

Cool season grasses are highly competitive and can preclude the quick establishment of warm season grasses.
What do we know?

✓ Warm-season grasses (C4)

- Produce large amounts of biomass (up to 4-12 tons/ac.)
- Have deep, fibrous roots in non-restrictive soils
- Adapted to a wide range of soil conditions
- High water use efficiency i.e. drought tolerant
- Low nutrient needs and high soil acidity tolerance.
Increasing soil carbon storage

✓ Starting land management/soil condition critical.

✓ Greatest potential is from converting tilled or marginal land to permanent vegetation.

✓ When converting cropland to cool season pastures:

  • Average annual increase in soil C of .3 to .5 tons of soil C/ac. per year (Conant, et al., 2001)

  • Increases expected for about 25 years (soil’s saturation point), with the largest increases seen in the first several years
Increasing soil carbon storage

Decreasing decomposition rate of plant residues and soil organic matter

• Eliminate tillage
• Use plant species which are more resistant to decomposition i.e. warm season grasses
  ▪ Greater lignin content
  ▪ Wider C to N ratio
Downer sandy loam-NJ State Soil

Deep, well drained, prime farmland soil. Mostly woodland. Some acreage is cultivated for high-value vegetable and fruit crops. Moderate limitation-droughty.

Downer soils occur on 291,319 acres in 11 counties of southern New Jersey.

Also occurs in Maryland and Delaware
Cape May PMC Study Design

✓ Plot size-16’ x 20’
✓ Species replicated 4 times
✓ Number of species - 6
✓ Seeded into killed sod with no-till drill, June 11, 1999.
✓ Plots irrigated due to excessive drought that summer. (bad idea)
Warm Season Grass Species

- 'Atlantic' coastal panicgrass
- 'Carthage' switchgrass
- 'Niagara' big bluestem
- 'Suther' little bluestem
- 'Suther' indiangrass
- 'Pete' eastern gamagrass
Tye No-till drill
Summer 1999 - Excessively dry
Seedling growth - 2000
### Seedling Count Sept. 2000

<table>
<thead>
<tr>
<th>Species</th>
<th>Avg/sq. mtr.</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic PAAM</td>
<td>24.2</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>Niagara ANGE</td>
<td>10</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Suther SONU/SCSC</td>
<td>25.5</td>
<td>37</td>
<td>18</td>
</tr>
<tr>
<td>Pete TRDA</td>
<td>3.2</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Carthage PAVI</td>
<td>8.2</td>
<td>20</td>
<td>3</td>
</tr>
</tbody>
</table>
Management - Prescribed Burning

Burning frequency every year or two.
Run, Forrest.... Ruuuuuuuuuun
0-2 in. depth results

- Big Bluestem
- Coastal Panicgrass
- Eastern Gamagrass
- Little Bluestem/Indiangrass
- Switchgrass

0-2 inches

Total soil C (%)

- 1999
- 2003
- 2010
- 2014
2-6 in. depth results

Total soil C (%)

Big Bluestem
Coastal Panicgrass
Eastern Gamagrass
Little Bluestem/Indiangrass
Switchgrass

1999
2003
2010
2014

2-6 inches
12-24 in. depth results

12-24 inches

Total soil C (%)

- Big Bluestem
- Coastal Panicgrass
- Eastern Gamagrass
- Little Bluestem/Indiangrass
- Switchgrass

Year:
- 1999
- 2003
- 2010
- 2014
24-26 in. depth results

24-36 inches

Total soil C (%)

- Big Bluestem
- Coastal Panicgrass
- Eastern Gamagrass
- Little Bluestem/Indiangrass
- Switchgrass

Graph showing total soil C (%) for different grass species from 1999 to 2014.
Study Summary

✓ Conversion of C3 to C4 grass stands took 3 years for NWSG to become fully established. Some cool season regrowth was competitive.

✓ No significant change in soil carbon by depth (15 years) in any NWSG species.

✓ The 2003 data suggests that initial soil C concentrations in the upper 24 in of the soil profile may have already been near the saturation point for the sandy coastal soil under the previous cool season grass stand.
Conclusions/Hypotheses

✓ Significant increases in soil carbon takes time........decades

✓ Rate and amount of soil carbon increase is highly dependent on land use prior to conversion (i.e. tilled cropland, mined land, pasture, etc.)

✓ Coarse textured soils in warmer climates don’t retain as much carbon and become C saturated at shallower depths.
on the Bright Side

- No net loss of carbon with conversion from a C3 to a C4 grass stand. (no-till drill seeding)
- Higher potential biomass production of NWSG (forage, biofuels)
- Greater resiliency under extreme weather conditions.
- Improved wildlife habitat for some species
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