Enhancing ALMANAC for Simulating Switchgrass Biomass Nitrogen Removal

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Rationale:
The conversion of dedicated energy crops such as switchgrass (Panicum virgatum L.) to usable energy is versatile because they can be combusted for heat and electrical power or converted to liquid fuels. Decision–making tools to predict switchgrass yield and N removal would aid switchgrass production and processing. The economics of biomass production are strongly affected by time of harvest and fertilizer needs; therefore, modifying ALMANAC model to predict nutrient removal in response to nutrient supply would aid producers and contractors in economically optimizing harvest date and fertilization.

Objective:
To develop logic for ALMANAC to simulate ‘Alamo’ switchgrass N removal in harvested biomass of switchgrass by enhancing the existing N uptake logic

Material and Methods

Locations:

<table>
<thead>
<tr>
<th>Trial number</th>
<th>Trial name</th>
<th>Location</th>
<th>Pertinent objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Growth curve</td>
<td>Fayetteville, AR</td>
<td>Development/Verification</td>
</tr>
<tr>
<td>2</td>
<td>Senescence</td>
<td>Fayetteville, AR</td>
<td>Validation</td>
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<tr>
<td>3</td>
<td>N rate trial</td>
<td>Fayetteville, AR</td>
<td>Validation</td>
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<tr>
<td>4</td>
<td>N rate trial</td>
<td>Pinetree, AR</td>
<td>Validation</td>
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<tr>
<td>5</td>
<td>Poultry litter</td>
<td>Fayetteville, AR</td>
<td>Validation</td>
</tr>
<tr>
<td>6</td>
<td>Poultry litter</td>
<td>Haskell, OK</td>
<td>Validation</td>
</tr>
</tbody>
</table>

Relevant Findings:

**N removal logic development:**

Nitrogen removal logic was developed based on an existing N-uptake ALMANAC algorithm, which was previously developed as a N growth stress constraint. This algorithm was modified with new equations based on the research findings presented above.

A. The rate of decline of N% during the growing season diminished following an exponential decay-3-parameters equation.

B. During the post-season, the N% decreased linearly from peak yield to the minimum value of 0.40% at DOY 356. AGB in later years had a higher N% at peak yield, which was always reduced to 0.40% at DOY 356.

C. Fraction of N% between crown and AGB was 0.54 at DOY 356.

Model Verification:
The new Nrem logic was verified. It correctly simulated Nrem at the same location in which the logic was developed (trials 1 and 2).

The new logic was not validated. I was unable to simulate Nrem in other locations (trials 3-6).

Conclusions:
The reasons for inaccuracy of the enhanced logic when applied to different locations:

1. Default soil input values were used owing to lack of soil characterization in validation sites
2. Important factors affecting N removal were not considered in the model because they were not elucidated by data analysis. New studies for revealing the factors that affect N removal are essential for improving the proposed equations.

Statistical Analysis:

**Verification:** simulation was considered acceptable if modeled values fit within the 95% confidence interval of the fitted model of observed values.

**Validation:** model was considered validated if the linear regression of observed and simulated Nrem values had intercept and slope values not significantly different from zero and one, respectively, at α=0.05.