Nitrogen Fate Related To Fall Fertilization

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Fall Fertilization

Agronomic Benefits
What Risk to Water Quality?

• Agronomic benefits limited with later fall application dates

• Higher probability of N loss with later fall application dates

• In my opinion fall fertilization represents greatest risk to water quality other than establishment and gross over-application

• Earlier cutoff date, lower rates, or rethinking of practice must be considered
The Fall Fertilization Paradigm Challenge

How is all late-season N going to get into plant?

I don’t think it can!
Mechanism of Nitrogen Uptake Related to Transpiration

Water lost by transpiration

Ions absorbed with water by root hairs

Ions absorbed with water by root hairs
What is Likelihood of Sufficiently High Transpiration Rates in Late Fall to Drive Uptake of Large Volume of Soil Water?
Rainfall – Evapotranspiration Data

Inches of water, Atlantic City (30-yr ave.)

Sum June-July-Aug ET = 18.74
Sum Nov.-Dec. ET = 1.5
ET Late Fall-Early Winter < $\frac{1}{12}$ of max ET period
My Thoughts Why Fall Fertilization Works (Agronomically)

• N (as nitrate?) stored in grass plant during fall uptake period

• Certain minimum mass of N needed to produce characteristics deemed desirable

• Grass can get that mass of N by taking up large volume of water with low N conc. or small volume of water with high N conc.

• Mass = Volume x Concentration
Assume turf area of 1m² needs 10 mg N to achieve quality goals

Rootzone soil water concentration of nitrate-N = 10 mg/L

How much water needs to be taken up by that turf to satisfy needs? 1 L / unit time

Are the EvapoTranspiration (ET) rates sufficient in late-November or early December to move this amount of water through the plants per unit time?

More than likely, ET is less than 1 L / unit time; assume 1/10th of that (0.1 L / unit time)

Under this lower ET rate, what would rootzone soil water concentration of nitrate-N need to be for plants to take up 10 mg N? 100 mg/L
Fall Fertilization Works (Agronomically) Because:

- Relatively high nitrate-N concentration in soil intentionally created to provide sufficient N to plants because ET low (small volume x high conc.)

- Highly doubtful that most of soil water with relatively high N conc. in rootzone will be taken up by turf

- What happens to excess soluble N remaining in soil water?
Timing of Fall Fertilization Study

Mangiafico and Guillard (J. Environ. Qual., 2006)
The soil monolith lysimeter

- Grass plot
- Top soil
- Sub soil

Lysimeter

Collection vessel

- 2 lbs N/1000ft² May-June
- 1 lb N/1000ft² only once at each following dates:
  - Sept. 15
  - Oct. 15
  - Nov. 15
  - Dec. 15

Winterizer formulation
Mangiafico and Guillard


**Spring Hue angle, degrees**

<table>
<thead>
<tr>
<th>Date of Fall Fertilizer Application</th>
<th>Control</th>
<th>Sept. 15</th>
<th>Oct. 15</th>
<th>Nov. 15</th>
<th>Dec. 15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>c</td>
<td>b</td>
<td>a</td>
<td>ab</td>
<td>a</td>
</tr>
</tbody>
</table>

The bars with different letters (a, b, c) indicate the significant differences in the hue angle for each date.
The diagram shows the precolate nitrate-N loss, in lbs/1000ft²/yr, over different dates of fall fertilizer application. The dates are Control (Sept. 15), Sept. 15, Oct. 15, Nov. 15, and Dec. 15. The loss increases with the date of application, indicating a time-dependent effect on nitrate-N loss.
Percent of applied fall fertilizer-N lost in percolate leachate, corrected for control

<table>
<thead>
<tr>
<th>Date of Application</th>
<th>Precip.-Below Temp.-Above</th>
<th>Year 1</th>
<th>Precip.-Normal Temp.-Below</th>
<th>Year 2</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Sept.</td>
<td></td>
<td>2.0</td>
<td></td>
<td>29.1</td>
<td>15.5</td>
</tr>
<tr>
<td>15 Oct.</td>
<td></td>
<td>3.1</td>
<td></td>
<td>56.4</td>
<td>29.8</td>
</tr>
<tr>
<td>15 Nov.</td>
<td></td>
<td>1.6</td>
<td></td>
<td>64.2</td>
<td>32.9</td>
</tr>
<tr>
<td>15 Dec.</td>
<td></td>
<td>16.8</td>
<td></td>
<td>66.1</td>
<td>41.4</td>
</tr>
</tbody>
</table>

Mangiafico and Guillard (*JEQ*, 2006)
<table>
<thead>
<tr>
<th>N Source</th>
<th>Riverhead</th>
<th>St. Charles</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCU</td>
<td>11.6</td>
<td>10.8</td>
</tr>
<tr>
<td>Urea</td>
<td>29.4</td>
<td>46.5</td>
</tr>
</tbody>
</table>

Turfgrass Not As Robust with N Uptake as We Assume It to Be

Universal Recommendation for Some Arbitrary Rate of N is Not Meaningful

• Adherence to set-rate, set date practice not defensible from science standpoint

• Each site unique – cannot assume universal rate correct

• Objective, site-specific testing approaches to guide N fertilization amounts needed

• Without objective test, just guessing
Fall Verdure Nitrate Test
Critical Level of Nitrate-N

Fall verdure
Correlated to Desirable Characteristics
Sap Nitrate Test
Preliminary Results

Sap Nitrate-N in Lower Shoot—Maximum Color in Fall

Four Dates – Oct. 2009

- Relative NDVI vs. Fall verdure sap NO$_3$-N, mg/L

Data points show a trend in the relationship between relative NDVI and sap NO$_3$-N concentration.
My Thoughts on Fall Fertilization

• What is logic of applying N when leaching potential greatest and water uptake by grass plant marginal?

• Turfgrass plant does not defy basic plant physiology with respect to N uptake

• Limited agronomic benefits and higher water quality risks associated with late fall fertilization

• Political reality – compromise on both sides needed
New (or Old) Considerations

• Earlier date of fall application – higher ET in Sept. and Oct. – will allow for more N uptake than Nov. and Dec.
• Classify sites according to N response

• Supply critical mass of N – more frequent, lower rate applications – earlier

• Lower rates

• Pilot testing of meters and/or plant tissue tests
Questions?
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http://www.turf.uconn.edu/guillard.shtml
When nitrate-N in fall verdure **300 to 600 ppm dry weight**, maximum color in following spring.
Mean CM-1000 index

Prob. of exceeding limit

Limit = 5 mg L$^{-1}$

$\rho = 0.0005$

$R^2 = 0.498$

$P_{50} = 349$

Limit = 10 mg L$^{-1}$

$\rho = 0.0004$

$R^2 = 0.501$

$P_{50} = 401$