Practical Turfgrass Physiology

(Keeping stuff from dying)

Zac Reicher
http://turf.unl.edu/

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Plant energy processes

1. Photosynthesis
2. Respiration
3. Growth
4. Storage

The healthier the plant going into stress, the better the survival
1. Photosynthesis (Ps)

CO₂ + H₂O + Sun ⇒ CHO + O₂

• C₃ grasses: cool-season
• C₄ grasses: warm season

Temperature controls photosynthesis

Photosynthesis (Ps)

• At higher temps, photorespiration decreases Ps efficiency
  CO₂ + H₂O + Sun ⇒ CHO + O₂
  CO₂ + H₂O + Sun ⇒ CHO + CO₂

• Cooling turf?
• Syringing
• Fans
• Climate change?
  • ↑ CO₂
  • ↑ temps
Other Ps determinants

- Leaf area
- Mowing height
- Mowing frequency
- Damaged leaves
- Vertical mowing
- Topdressing
- Smooth rollers
- Walking mowers
- Traffic

Optimum mowing heights for turfgrass species

<table>
<thead>
<tr>
<th>Species</th>
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<tbody>
<tr>
<td>Creeping bentgrass</td>
<td>0.125-0.5</td>
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<td>Annual bluegrass</td>
<td>0.25-1.0</td>
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<td>Kentucky bluegrass</td>
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<td>Fine fescue</td>
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<td>Perennial ryegrass</td>
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<td>Zoysiagrass</td>
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</table>
Other Ps determinants

• Shade, especially morning shade
Other Ps determinants

• Nitrogen
• RuBisCo
• Magnesium
• Pigments?
  • Darkening pigments may increase temps and increase photorespiration
  • Sun-screening type pigments may reduce photosynthesis

2. Respiration

The process of converting stored energy into usable energy

\[
\text{CHO + O}_2 \Rightarrow \text{H}_2\text{O + CO}_2 + \text{ATP (Energy)}
\]
Temperature controls respiration

Other factors affecting Rd

\[ \text{CHO} + \text{O}_2 \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{ATP} \text{ (Energy)} \]

Soil oxygen

- Saturated soils
- O2 diffuses 10,000 times faster in air than water
- High temperature in soils
- Hot vs cold flooding
- Drainage
- Clay
- Low oxygen, anaerobic respiration
  19 times less efficient and produces ethanol (toxic), but can be done for a short amount of time
Soil oxygen

- Soil preparation
- Clay
- Layers
- Traffic management
- Aerification
- Light weight mowers
- Alternate mowing patterns
- Drainage
- Soil modification
Tine spacing

inches  |  2x2  |  2x3  |  2x4  |  2x6  |  3x4  |  3x6  |  4x6  |
holes/sq ft |   36  |   24  |   18  |   12  |   12  |    8  |    6  |
1/2" tine  |   4.9  |   3.3  |   2.5  |   1.6  |   1.6  |   1.1  |   0.8  |
3/4" tine  |   11.1 |   7.4  |   5.5  |   3.7  |   3.7  |   2.5  |   1.8  |
1" tine    |   19.6 |  13.1  |  10.8  |   8.6  |   8.6  |   4.4  |   3.3  |

Percent surface area affected by aerification tine size and spacing.
3. Growth

- Irreversible expansion of plant size or number
- Plant growth is most affected by season
  - Cool-season grasses:
    - Shoot growth: 64-75F (18-24C)
    - Root growth: 50-64F (10-18C)
  - Warm-season grasses
    - Shoot growth: 60-95F (27-35C)
    - Root growth: 75-85F (24-29C)

Life span?

- Turfgrass crowns are perennial
- Leaves and roots are fairly short-lived (30-60 days) depending on:
  - Season
  - Temperature
  - Traffic
Major effects on growth

- Season
- Temperature
- Water
- Soil type
- N rate and timing

Root length and density affected by rootzone temperatures.

Figure 4: Seasonal rooting pattern of Kentucky Bluegrass as affected by N programming.

Adequate nitrogen

Higher
Relative shoot growth
Lower
Minimal
Relative root growth
Extensive
Excessive nitrogen
Effects on growth

- Mowing height affects
  - Shoot density
  - Rooting depth
  - Root growth rate
  - Raising mowing height during the summer?
- Mowing frequency
- Vertical mowing, aerification

Effects on growth

- Genetics
- Shade
  - Narrow leaves, longer leaves, fewer tillers, more upright growth
- Growth regulators
- Other nutrients
  - Phosphorus – improves root growth and establishment when applied at seeding
  - Potassium – some stress tolerance
  - Preemergence herbicides androoting?
- Pigments?
4. Storage

- Used by plant to grow and/or recover
- Storage is affected by photosynthesis, respiration and growth

Factors affecting storage

- N rate and timing

Factors affecting storage

- Water (saturation)
- Potassium?

Effects of soil saturation on water soluble carbohydrate content in 5 creeping bentgrass cultivars.

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<th>Depth of waterlogging**</th>
<th>Control*</th>
<th>6&quot;</th>
<th>2&quot;</th>
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*Control = well-drained treatment without saturation
**Saturation at 6, 2, and 0.4 inches below the soil surface, respectively.
Energy balance

\[
Ps - Rd = G + S
\]

### Cool

### Warm

### Warmer

### Hot

#### 1. N fertilization

#### 2. Spring (cool, sunny days, cool nights)

#### 3. Spring fertilization

#### 4. Summer (hot, sunny days, hot nights)

#### 5. Summer fertilization (heavy)

#### 6. Fall (cool, sunny days, cool nights)

#### 7. Fall fertilization

#### 8. Late fall (cool, sunny days, cold nights)

#### 9. Late Fall N

#### 10. Mowing at the highest optimum height

#### 11. Mowing at the lowest height

#### 12. Regular mowing

#### 13. Scalping

#### 14. Skipping a mowing

#### 15. Rolling greens instead of mowing

#### 16. Aerification, verticutting, topdress

#### 17. Growth regulators

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Growth Chamber Study (U Minn)

Growth chamber methods

- Three grass species (creeping bentgrass, Kentucky bluegrass, annual bluegrass)
- Four N rates (0, 0.5, 1, 2 lbs N/M)
- Three temperature regimes (Sept. 15, Oct. 15, Nov. 15)
- Three replications, two growth chamber runs

Growth Chamber Results: N Uptake

Field Studies
Wisconsin and Minnesota

Applied 0.5 or 1.0 lbs N/1000 in Sep, Oct, or Nov and monitored uptake through the following June.

Total fertilizer N uptake: Fall - June

- September 15th:
  80% of fertilizer N applied was taken up
  86% recovered 28 days after application
- October 15th:
  19% of fertilizer N applied was taken up
  79% recovered 28 days after application
- November 15th:
  11% of fertilizer N applied was taken up
  61% recovered 28 days after application
Conclusions

- Fall N does not stimulate deeper rooting that fall
- Fall N uptake potential is low in fall, and even lower in spring
- Color can be enhanced in fall/winter/spring with much smaller amounts of N

Why? Water uptake

- Plant depends on water to move nutrients to root surface
- 90% of water in plant is used for cooling
- Low cooling need in fall = low water uptake
- How does this work in other climates with longer falls and extended green and growth than in MN or WI?
- Maximum rooting = maximum water uptake = maximum cooling = maximum nutrient uptake, etc. etc. etc.

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