Practical Turfgrass Physiology

(Keeping stuff from dying)

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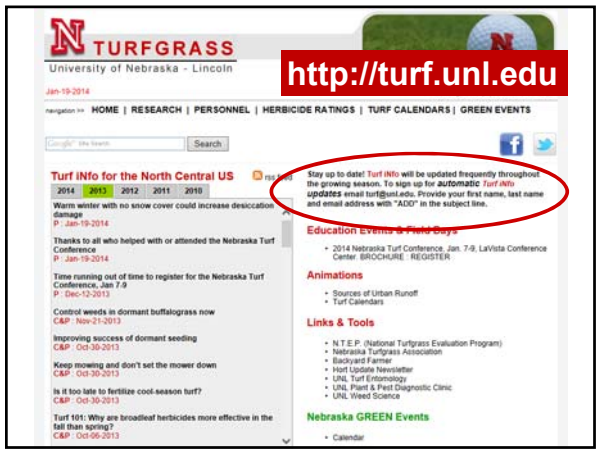

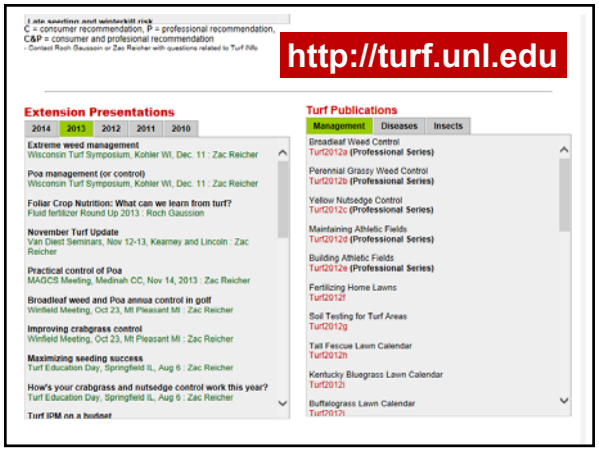

Student interns?

- 3 Creek Ranch, Jackson Hole, WY
- Anchorage Country Club, Anchorage, AK
- Bandon Dunes, Bandon, OR
- Blackstone Country Club, Peoria, AZ
- Brickman Group, Brookfield, IL
- Castle Pines Country Club, Castle Rock, CO
- Columbus Crew, Columbus, OH
- Desert Mountain CC, Scottsdale, AZ
- Erin Hills GC, Erin, WI
- Haymarket Park, Lincoln, NE
- Hazeltine National, Chaska, MN
- Indianapolis Indians, Indianapolis, IN
- Lakeshore Country Club, Chicago, IL
- Loch Lloyd Country Club, Kansas City, MO
- Milwaukee Brewers, Milwaukee, WI
- Minnesota Vikings, Edina, MN
- Oakland Hills, Bloomsfield, MI
- Oakmont Golf Club, Oakmont, PA
- Philadelphia Phillies, Philadelphia, PA
- Sand Hills, Mullen, Nebraska
- Shadow Creek GC, Las Vegas, NV
- TD Ameritrade Park, Omaha, NE
- The Broadmoor, Colorado Springs, CO
- The Plateau Club, Sammamish, WA,
- The Powder Horn, Sheridan, WY
- Three Creek Ranch, Jackson, WY
- TPC Deere Run, Silvis, IL
- TruGreen, Lincoln, NE
- USGA Green Section, Midwest
- Walt Disney World, Orlando, FL
- Westwood CC, Vienna, VA
- Wilmington CC, Wilmington, DE

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Plant energy processes

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

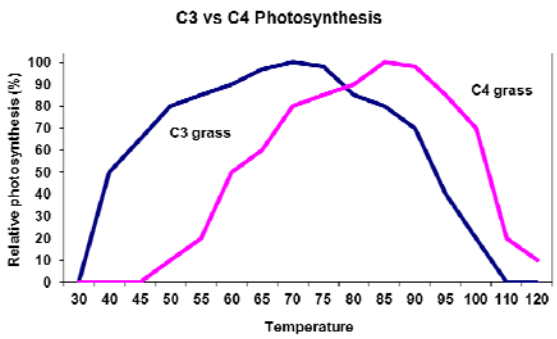
The healthier the plant going into stress, the better the survival

1. Photosynthesis (Ps)

$CO_2 + H_2O + Sun \Rightarrow CHO + O_2$

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

Temperature controls photosynthesis



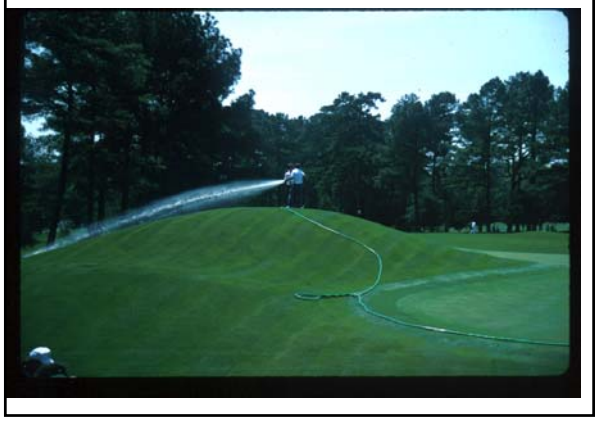
Photosynthesis (Ps)

- At higher temps, photorespiration decreases Ps efficiency

$CO_2 + H_2O + Sun \Rightarrow CHO + O_2$

$CO_2 + H_2O + Sun \Rightarrow CHO + CO_2$

- Cooling turf?
- Syringing
- Fans
- Climate change?
  - ↑ CO_2
  - ↑ temps



Other Ps determinants

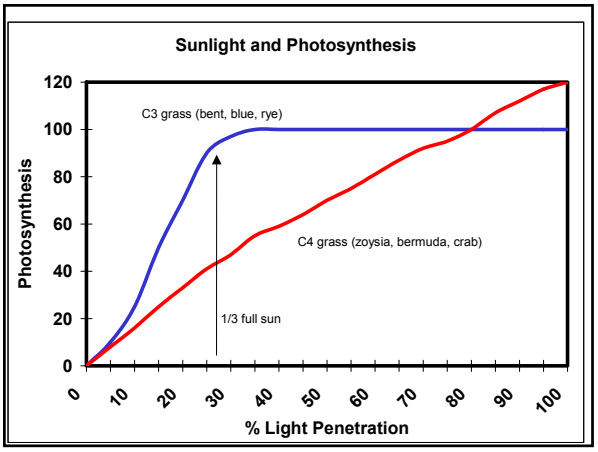
- Leaf area
  - Mowing height
  - Mowing frequency
- Damaged leaves
  - Vertical mowing
  - Topdressing
  - Smooth rollers
  - Walking mowers
  - Traffic

Optimum mowing heights for turfgrass species

Species	inches
Creeping bentgrass	0.125-0.5
Annual bluegrass	0.25-1.0
Kentucky bluegrass	2.0-3.0
Fine fescue	2.0-3.0
Perennial ryegrass	2.0-3.0
Tall fescue	3.0-4.0
Bermudagrass	0.25-1.0
Zoysiagrass	0.50-1.0

Other Ps determinants

- **Shade, especially morning shade**



Other Ps determinants

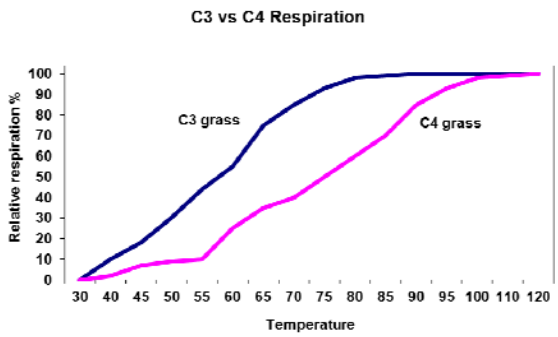
- Nitrogen
  - RuBisCo
- Magnesium
- Pigments?
  - Darkening pigments may increase temps and increase photorespiration
  - Sun-screening type pigments may reduce photosynthesis

2. Respiration

The process of converting stored energy into usable energy

$CHO + O_2 \Rightarrow H_2O + CO_2 + ATP$ (Energy)

Temperature controls respiration



Other factors affecting Rd

$CHO + O_2 \Rightarrow H_2O + CO_2 + ATP$ (Energy)

Soil oxygen

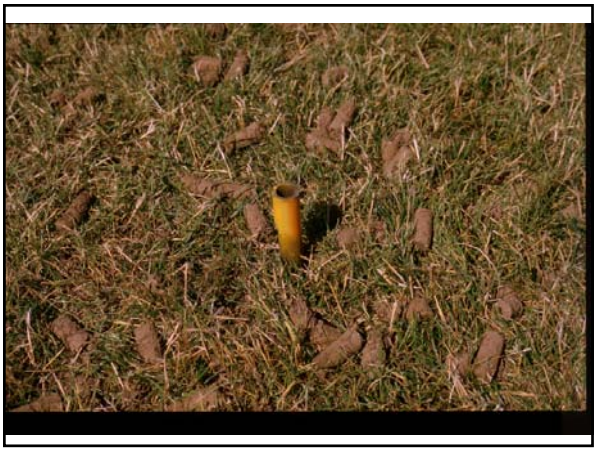
- Saturated soils
  O2 diffuses 10,000 times faster in air than water
- High temperature in soils
- Hot vs cold flooding
- Drainage
- Clay
- Low oxygen, anaerobic respiration
  19 times less efficient and produces ethanol (toxic), but can be done for a short amount of time

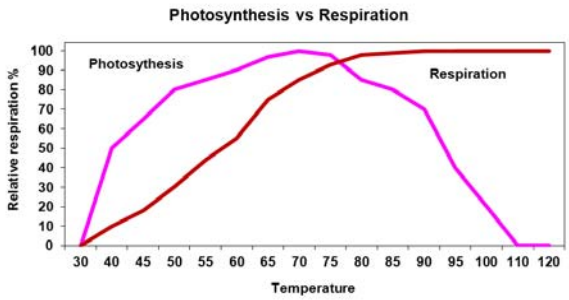
Soil oxygen

- Soil preparation
- Clay
- Layers
- Traffic management
- Aerifcation
- Light weight mowers
- Alternate mowing patterns
- Drainage
- Soil modification

Percent surface area affected by aerification tine size and spacing.

	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	9.8	6.5	6.5	4.4	3.3





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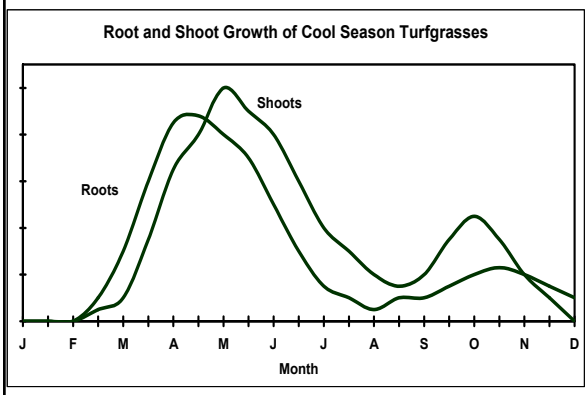
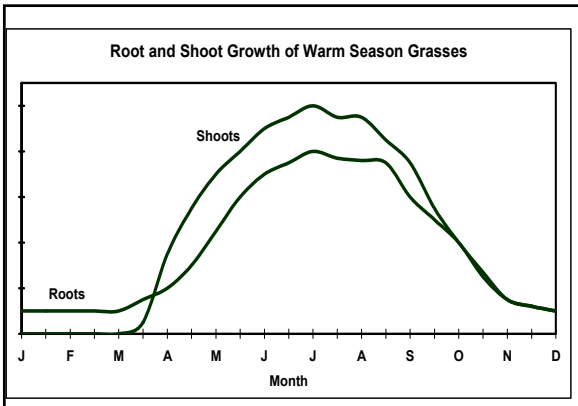
3. Growth

- **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.

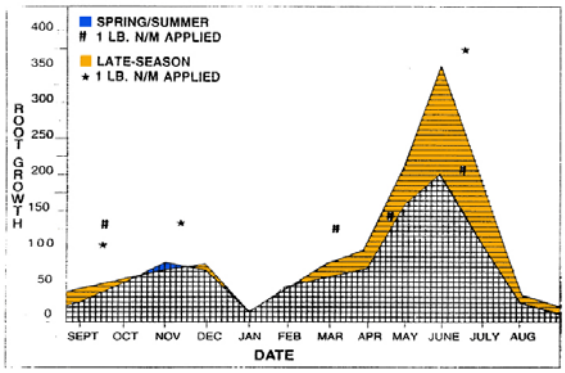
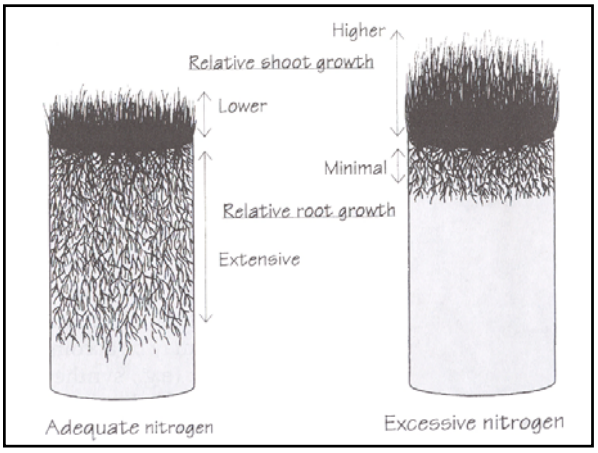
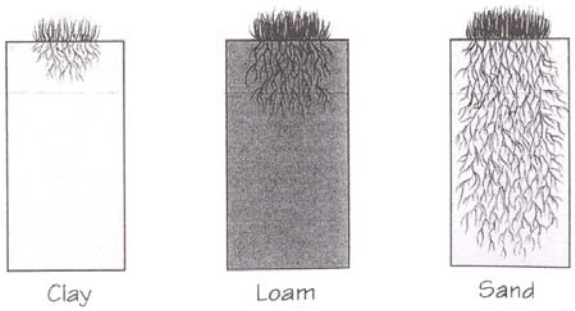


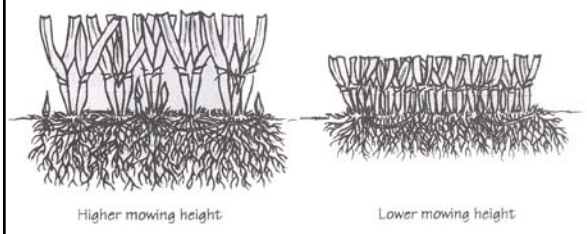
Figure 4. Seasonal rooting pattern of Kentucky bluegrass as affected by N programming.

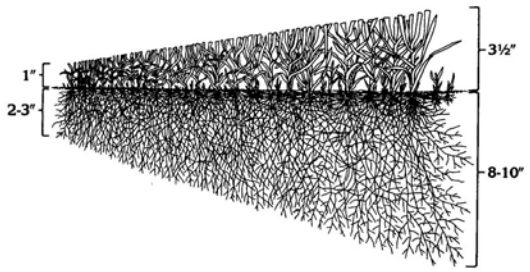




Effects on growth

- 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 and rooting?
- 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

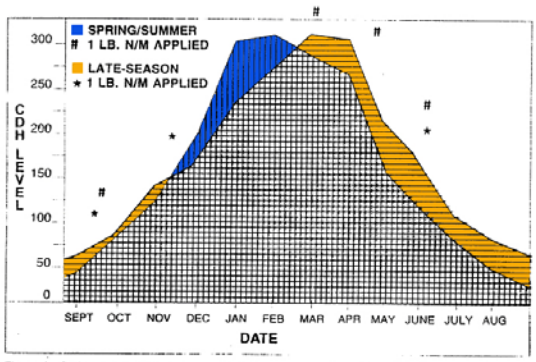


Figure 3. Carbohydrate status of the Kentucky bluegrass plant as affected by N programming.

Factors affecting storage

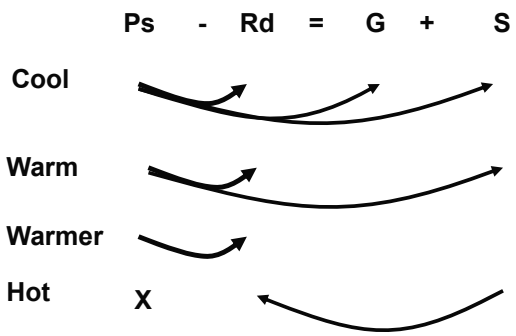
- Water (saturation)
- Potassium?

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

	Depth of water logging**		
Control *	6”	2”	0.4”
84 a	57.5 b	54.3 b	47.3 b

*Control = well-drained treatment without saturation
**Saturation at 6, 2, and 0.4 inches below the soil surface, respectively.

Energy balance

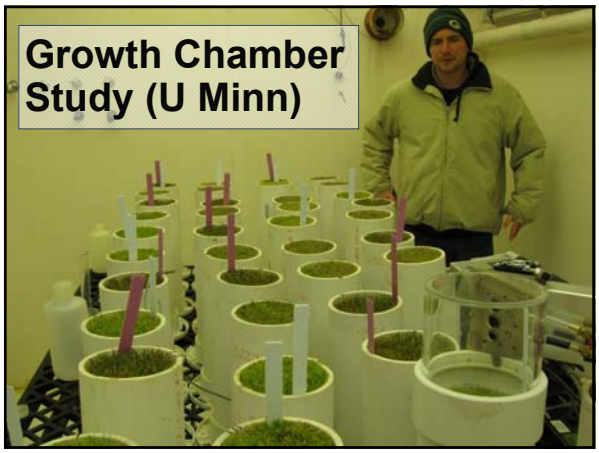


	Ps	-	Rd	=	G	+	S
1. N fertilization	↑		↔		↑		↓
2. Spring (cool, sunny days, cool nights)	↑		↓		↑↑		↓
3. Spring fertilization	↑↑		↓		↑↑↑		↓↓
4. Summer (hot, sunny days, hot nights)	↓		↑		↓		↓
5. Summer fertilization (heavy)	↓		↓		↑		↓↓

	Ps	-	Rd	=	G	+	S
6. Fall (cool, sunny days, cool nights)	↑		↓		↓		↑
7. Fall fertilization	↑↑		↓		↓		↑↑
8. Late fall (cool, sunny days, cold nights)	↑		↓↓		↓↓		↑
9. Late Fall N	↑↑		↓↓		↓↓		↑↑↑

	Ps	-	Rd	=	G	+	S
10. Mowing at the highest optimum height	↑		↔		↓		↑
11. Mowing at the lowest height	↓		↔		↑		↓
12. Regular mowing	↑		↔		↓		↑
13. Scalping	↓		↔		↑		↓
14. Skipping a mowing	↑		↔		↓		↑

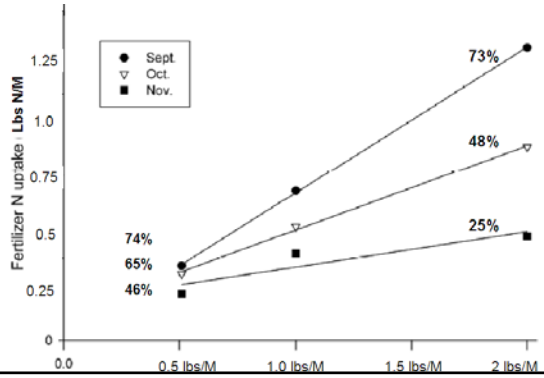
	Ps	-	Rd	=	G	+	S
15. Rolling greens instead of mowing	↑		↔		↓		↑
16. Aerification, verticutting, topdress	↓		↔		↑		↓
17. Growth regulators	↔		↔		↓		↔↑

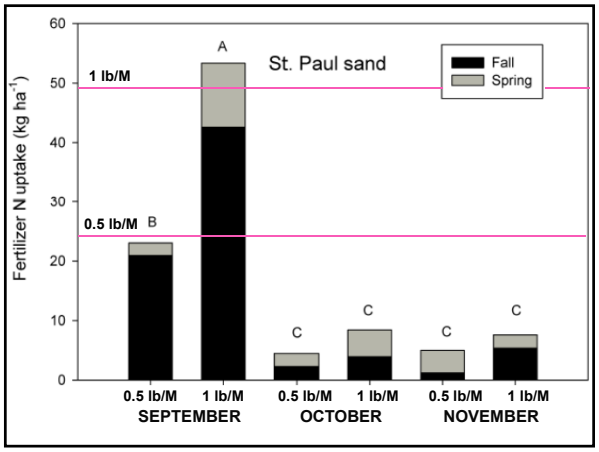


Growth chamber methods

- 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





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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