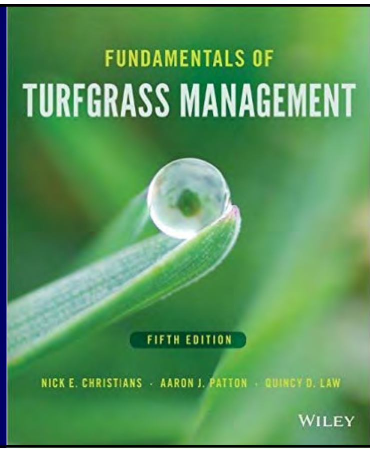
WHAT ABOUT THE MICRONUTRIENTS?

NICK CHRISTIANS
IOWA STATE UNIVERSITY

17 ESSENTIAL ELEMENTS

- CARBON C
- HYDROGEN H
- OXYGEN O
- PHOSPHORUS P
- POTASSIUM K
- NITROGEN N
- SULFUR S
- CALCIUM Ca
- IRON Fe
- MAGNESIUM Mg
- BORON B
- MANGANESE Mn
- COPPER Cu
- ZINC Zn
- MOLYBDENUM Mo
- CHLORINE Cl
- NICKEL Ni



MACRONUTRIENTS

- 1000 mg/kg (PPM) or more
- C, H, O, N, P, K, S, Mg, AND Ca

MICRONUTRIENTS

- Less than 100 mg/kg (PPM)
- Mo, Cu, Zn, Mn, B, Fe, Cl, and Ni

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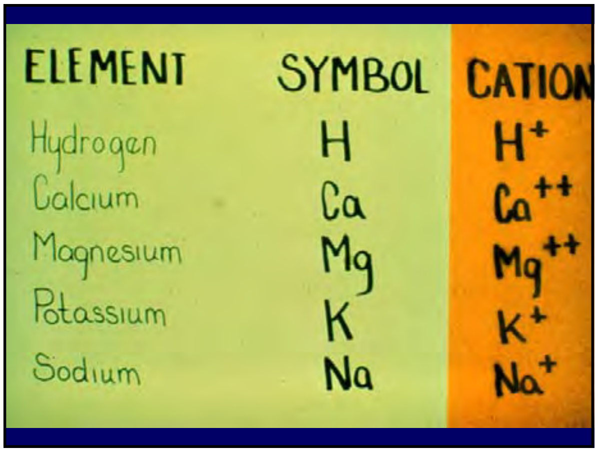
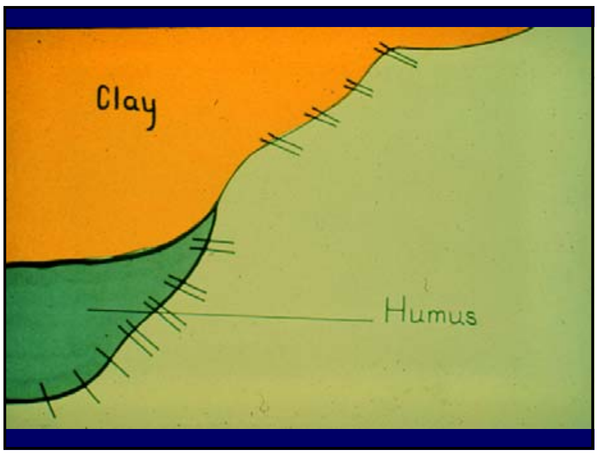
CATION EXCHANGE CAPACITY (CEC)

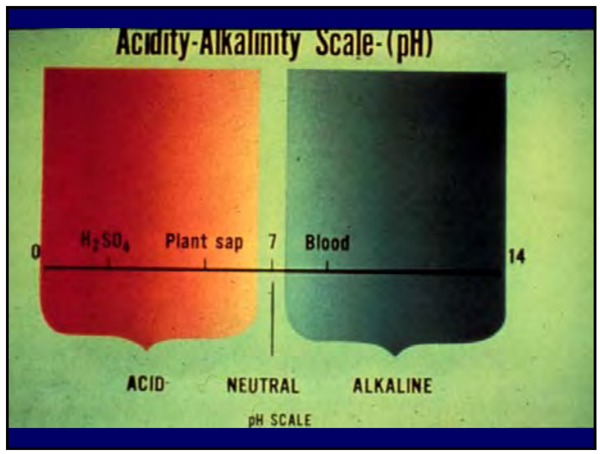
THE ABILITY TO EXCHANGE CATIONS

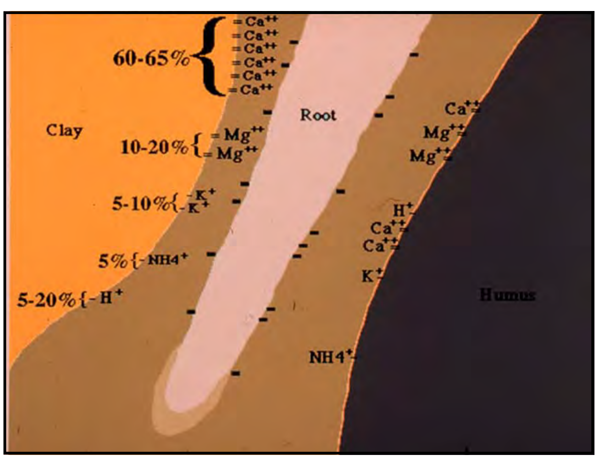


ELEMENT	SYMBOL	CATION
Hydrogen	H	H^+
Calcium	Ca	Ca^{++}
Magnesium	Mg	Mg^{++}
Potassium	K	K^+
Sodium	Na	Na^+

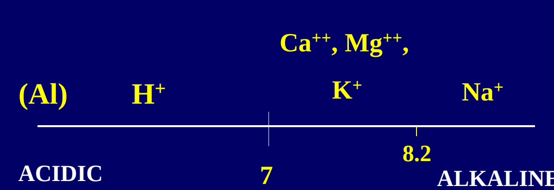
pH

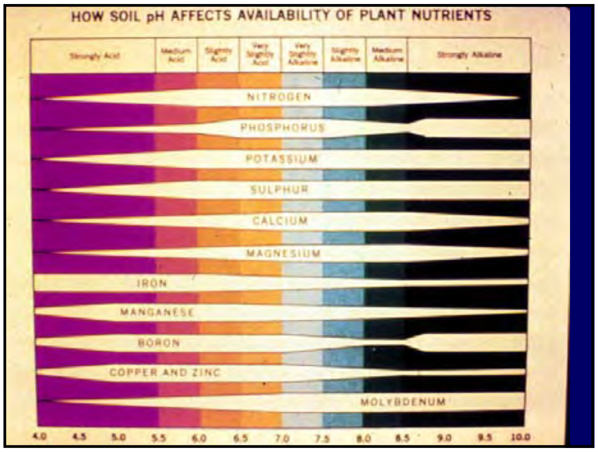






pH

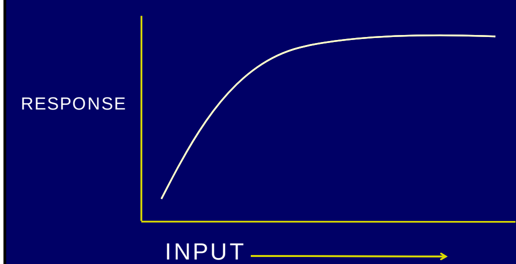


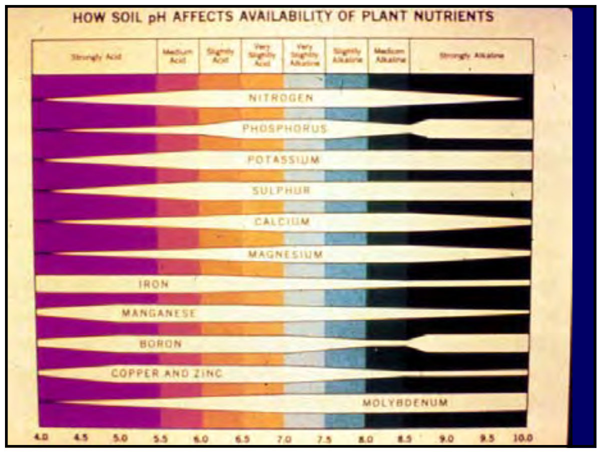


MAGNESIUM (Mg)

- CENTER OF CHLOROPHYLL
- SYMPTOM - CHLOROSIS
- LOW pH AND LOW CEC

CURVE OF DIMINISHING RETURNS





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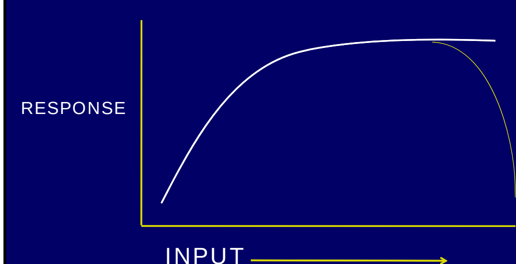


SULFUR (S)

- YELLOWING OF YOUNGER LEAVES
- SLOW GROWTH
- RARE IN MOST OF U.S. BECAUSE OF HIGH SULFUR COAL

IRON (Fe)

- COFACTOR FOR CHLOROPHYLL FORMATION
- SYMPTOM - CHLOROSIS
- HIGH pH
- MOST COMMON OF ALL MICRONUTRIENT DEFICIENCIES

Chlorosis

SUMMER INDUCED CHLOROSIS

- DAVID DEVETTER, MS STUDENT
- DEVELOPS DURING HIGH TEMPERATURE PERIODS
- NOT OBSERVED IN SPRING AND FALL
- USUALLY ON SAND, ALSO ON SOIL
- IT IS AN IRON PROBLEM

OUR OBSERVATIONS

- Summer-induced iron chlorosis
  - Appears from late July to early September
  - Goes away if left untreated
  - Bentgrass and bluegrass
  - Widespread
    - Multiple countries
    - Golf courses
    - Sports fields
    - Home lawns

  * While common on sand soils it is present in finer textured soils as well

Study #1: Nutrient trial

- Objective: determine if summer-induced chlorosis can be corrected by nutrient treatments
- RCBD with three blocks and 18 treatments

Study #3: Preventive iron application

- Objective: determine if early iron applications can prevent summer-induced iron chlorosis
- RCBD with three blocks and nine treatments

Conclusions

- Summer-induced chlorosis was caused by an iron deficiency
- Soil temperature may play a role in summer-induced iron chlorosis
- Summer-induced iron chlorosis can be treated with iron fertilization
- Higher rates of iron lead to more color recovery
- Treating before symptoms occur does not work
- Control of chlorosis depends on timing of iron fertilization

Study #3: Preventive iron application

- The answer was no
- Fe had to be applied following the onset of chlorosis

CALCIUM

- YOUNGER LEAVES TURN REDDISH-BROWN
- FADES TO RED
- LOW pH CONDITIONS

Study #6: Field heating treatments

- Objective: generate summer-induced iron chlorosis by increasing root zone soil temperature during the spring of 2007

CALCIUM

- New emphasis on Ca in 90's
  - Ca applied to Calcareous ($CaCO_3$) sands
- Ca/Mg ratios
  - Gypsum ($CaSO_4$)
  - Other expensive amendments
- Calcareous sands for greens and sports fields
  - Soil test methods?

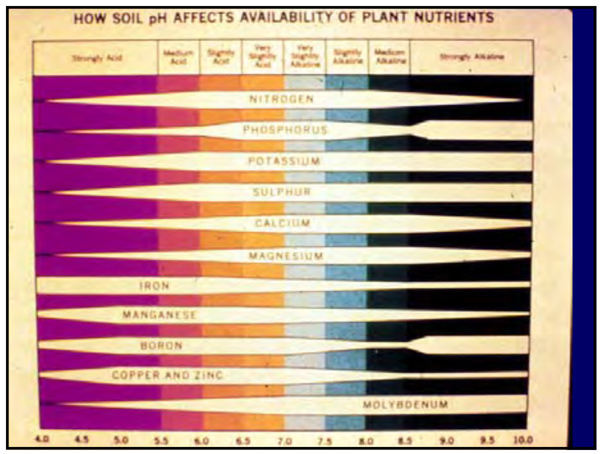
Rod St. John

- Sales to turf industry in mid 90's
- Strong emphasis on Ca
  - High markup
- Good soils background
- Began MS in 2000
  - Ca uptake from sand media
- Ph.D in 2002
  - Soil testing
  - Ca/Mg ratios etc.

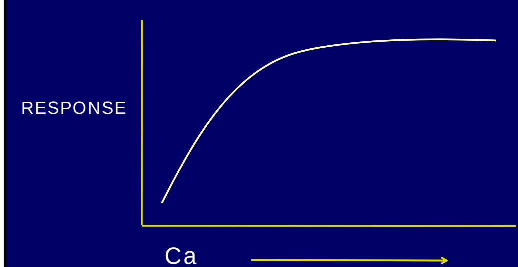
MANGANESE

- YELLOWING SIMILAR TO IRON DEFICIENCY
- VEINS REMAIN GREEN - TIPS MAY REMAIN GREEN
- LEAVES DROP

Ca/Mg Ratios



CURVE OF DIMINISHING RETURNS



Zinc Toxicity

Grant Spear
MS student Iowa State

ZINC TOXICITY

- SOIL TESTING LABS
  - 18 TO 20 PPM TOXIC
- OBSERVED
  - 50 TO 63 PPM WITH NO DAMAGE

BORON

1 TO 2 ppm

SEWAGE EFFLUENT

SUMMARY

- CREEPING BENTGRASS CAN TOLERATE MUCH HIGHER LEVELS OF ZN THAN ONCE THOUGHT
- LEVELS TERMED EXCESSIVE BY SOIL TESTING LABS ARE WELL WITHIN THE TOLERANCE LEVELS OF CREEPING BENTGRASS

COPPER (Cu)

MIKE FAUST MS PROJECT ‘98 TO ‘99

0 to 600 ppm Cu

Cu reduced Bentgrass rooting at 200 ppm and above. Approximately 50% reduction at 600 ppm