PLANT-SOIL INTERACTIONS

NICK CHRISTIANS
IOWA STATE UNIVERSITY

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BACKGROUND

- BORN IN IOWA
- DORDT COLLEGE, SIOUX CENTER
- COLORADO STATE
- ASSISTANT SUPERINTENDENT, FLAT IRONS COUNTRY CLUB
- SUPERINTENDENT, PUEBLO, COLO.
- GRAD SCHOOL, OHIO STATE UNIV.
- IOWA STATE, 1979

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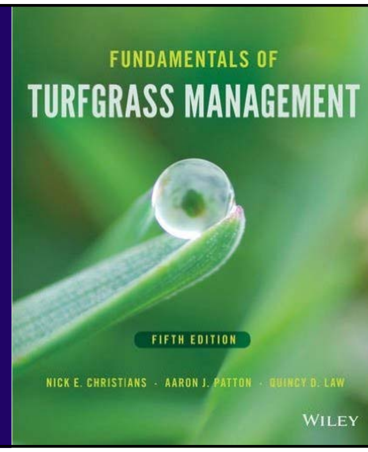

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IOWA TURFGRASS BLOG

iaturf.blogspot.com

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TURF SOILS

MANY SOIL PROBLEMS
- Perennial
- Traffic
- Areas unfit for Agriculture

SOIL MODIFICATION
- USGA
- PAT

FEW FIELDS WITH SO MANY SCAMS, MISINFORMATION

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SOIL SCIENCE

- SOIL CHEMISTRY
  - ABILITY TO DELIVER NUTRIENTS
- SOIL PHYSICS
  - SOLID, LIQUID AND GASEOUS
  - FORM AND STRUCTURE
  - BULK DENSITY
  - INFILTRATION
  - POROSITY
  - SOIL MODIFICATION

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INTERPRETATION IS THE KEY

- CHEMICAL TESTS CONSISTENT
- INTERPRETATION VARIES

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BASIC PRINCIPLES

AND TERMINOLOGY

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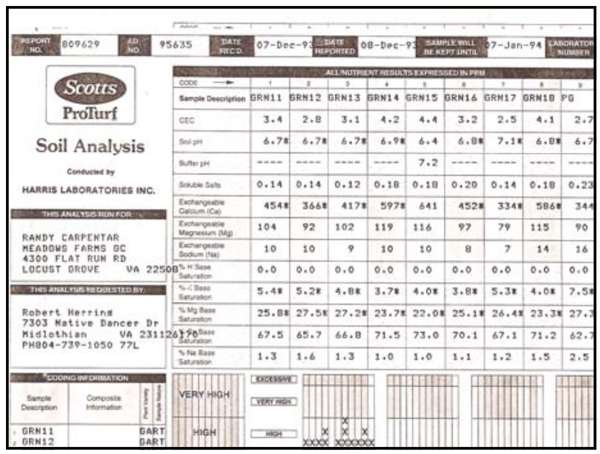

REPORT NO. 809629 | AD NO. 95635 | DATE REC'D. 07-Dec-93 | DATE REPORTED 08-Dec-93 | SAMPLE WILL BE KEPT UNTIL 07-Jan-94 | LABORATORY NUMBER

Scotts ProTurf

Soil Analysis

Conducted by

HARRIS LABORATORIES INC.

THIS ANALYSIS RUN FOR:

RANDY CARPENTAR
MEADOWS FARMS GC
4300 FLAT RUN RD
LOCUST GROVE VA 22508

THIS ANALYSIS REQUESTED BY:

Robert Herring
7303 Native Dancer Dr
Midlothian VA 231126170
PH804-739-1050 77L

ALL NUTRIENT RESULTS EXPRESSED IN PPM

CODE →	1	2	3	4	5	6	7	8	9
Sample Description	GRN11	GRN12	GRN13	GRN14	GRN15	GRN16	GRN17	GRN18	PG
CEC	3.4	2.8	3.1	4.2	4.4	3.2	2.5	4.1	2.7
Soil pH	6.7*	6.7*	6.7*	6.9*	6.4	6.8*	7.1*	6.8*	6.7
Buffer pH	----	----	----	----	7.2	----	----	----	----
Soluble Salts	0.14	0.14	0.12	0.18	0.18	0.20	0.14	0.18	0.23
Exchangeable Calcium (Ca)	454*	366*	417*	597*	641	452*	334*	586*	344
Exchangeable Magnesium (Mg)	104	92	102	119	116	97	79	115	90
Exchangeable Sodium (Na)	10	10	9	10	10	8	7	14	16
% H Base Saturation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% K Base Saturation	5.4*	5.2*	4.8*	3.7*	4.0*	3.8*	5.3*	4.0*	7.5*
% Mg Base Saturation	25.8*	27.5*	27.2*	23.7*	22.0*	25.1*	26.4*	23.3*	27.3
% Ca Base Saturation	67.5	65.7	66.8	71.5	73.0	70.1	67.1	71.2	62.7
% Na Base Saturation	1.3	1.6	1.3	1.0	1.0	1.1	1.2	1.5	2.5

CODING INFORMATION

Sample Description	Composite Information	Plant Variety	Sample Nature
GRN11		G	ART
GRN12		G	ART

VERY HIGH

HIGH

EXCESSIVE

VERY HIGH

HIGH

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FIRST THREE LINES FILLED WITH INFORMATION

CEC

pH

BUFFER pH

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CATION EXCHANGE CAPACITY (CEC)

THE ABILITY TO EXCHANGE CATIONS

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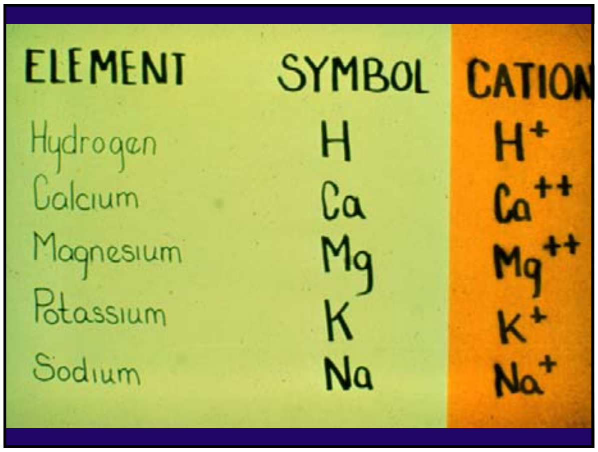

ELEMENT	SYMBOL	CATION
Hydrogen	H	H^+
Calcium	Ca	Ca^{++}
Magnesium	Mg	Mg^{++}
Potassium	K	K^+
Sodium	Na	Na^+

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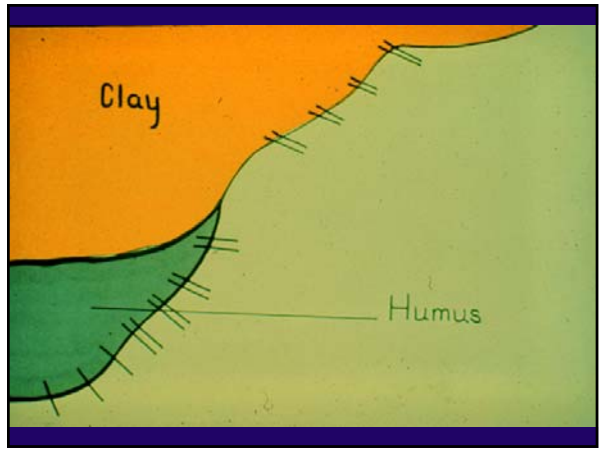

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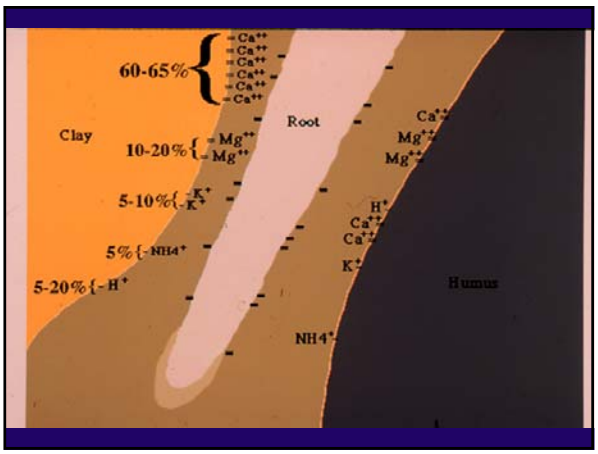

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CATION EXCHANGE CAPACITY

SOIL TYPE	meq/100g
• SAND	• <1 - 8
• CLAY	• 80 - 120
• ORGANIC MATTER	• 150 – 500
• CLAY LOAM SOIL	• 25 – 30
• SAND GREEN	• <1 - 14

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CATION EXCHANGE CAPACITY

1 milliequivalent (meq)

6.02×10^{20}

602,000,000,000,000,000,000

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CATION EXCHANGE CAPACITY

SOIL TYPE	meq/100g
• SAND	• <1 - 8
• CLAY	• 80 - 120
• ORGANIC MATTER	• 150 – 500
• CLAY LOAM SOIL	• 25 – 30
• SAND GREEN	• <1 - 14

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pH

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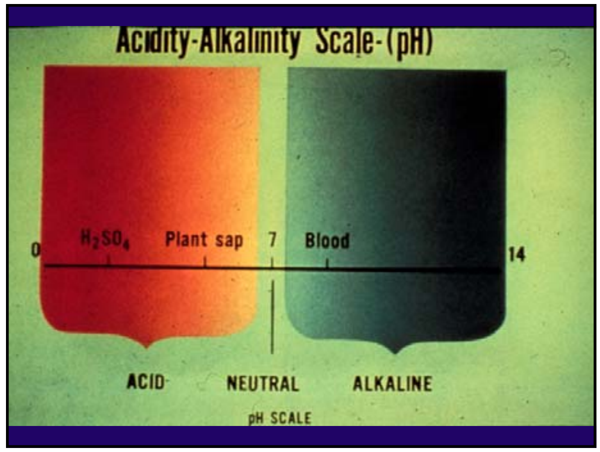

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pH

Ca^{++}, Mg^{++},

(Al) H^{+} K^{+} Na^{+}

ACIDIC 7 8.2 ALKALINE

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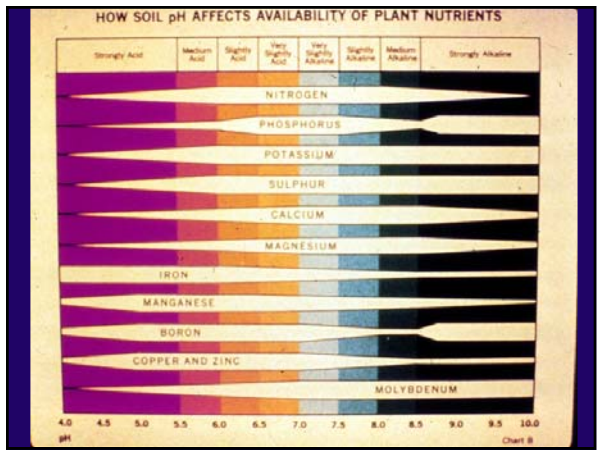

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LIMING

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LIME

CALCIUM CARBONATE

$CaCO_3$

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LIME

RAISES

pH

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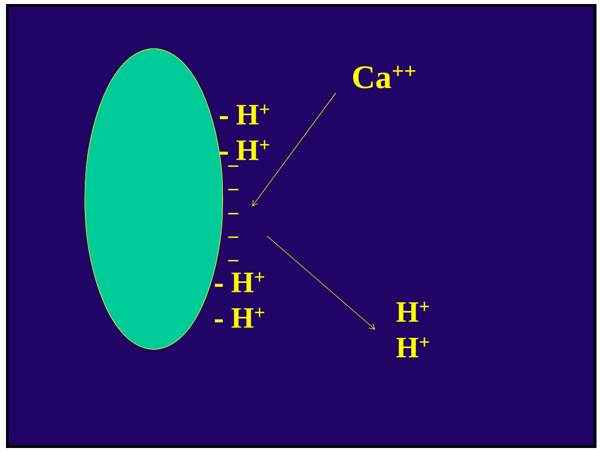

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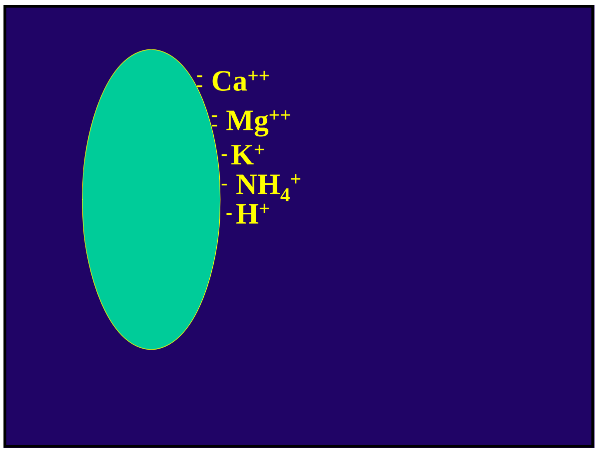

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BUFFER pH

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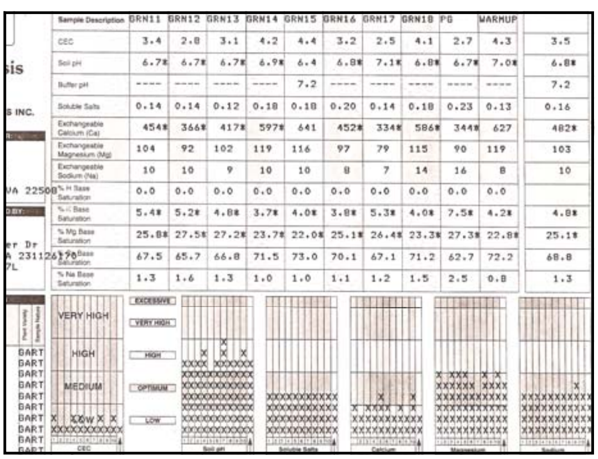

Sample Description	GRN11	GRN12	GRN13	GRN14	GRN15	GRN16	GRN17	GRN18	PG	WARMUP	
CEC	3.4	2.8	3.1	4.2	4.4	3.2	2.5	4.1	2.7	4.3	3.5
Soil pH	6.7*	6.7*	6.7*	6.9*	6.4	6.8*	7.1*	6.8*	6.7*	7.0*	6.8*
Buffer pH	----	----	----	----	7.2	----	----	----	----	----	7.2
Soluble Salts	0.14	0.14	0.12	0.18	0.18	0.20	0.14	0.18	0.23	0.13	0.16
Exchangeable Calcium (Ca)	454*	366*	417*	597*	641	452*	334*	586*	344*	627	482*
Exchangeable Magnesium (Mg)	104	92	102	119	116	97	79	115	90	119	103
Exchangeable Sodium (Na)	10	10	9	10	10	8	7	14	16	8	10
% H Base Saturation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
% K Base Saturation	5.4*	5.2*	4.8*	3.7*	4.0*	3.8*	5.3*	4.0*	7.5*	4.2*	4.8*
% Mg Base Saturation	25.8*	27.5*	27.2*	23.7*	22.0*	25.1*	26.4*	23.3*	27.3*	22.8*	25.1*
% Ca Base Saturation	67.5	65.7	66.8	71.5	73.0	70.1	67.1	71.2	62.7	72.2	68.8
% Na Base Saturation	1.3	1.6	1.3	1.0	1.0	1.1	1.2	1.5	2.5	0.8	1.3

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BUFFERING

RESISTANCE TO CHANGE

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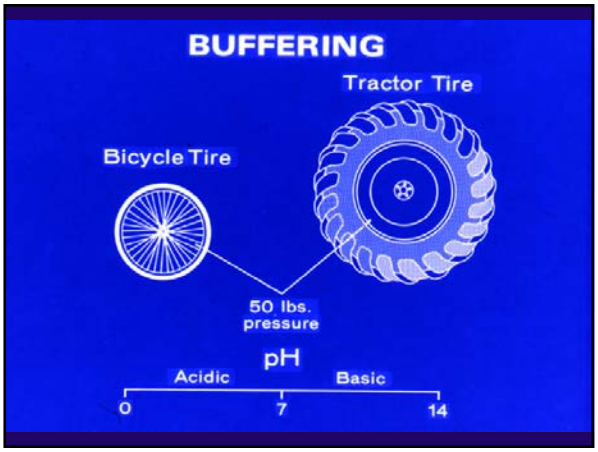

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Table 7.3. Amount of $CaCO_3$, or its equivalent, in pounds per acre required to raise the pH to 6.5, based on the buffer pH.

Buffer pH	lb $CaCO_3$/acre required for 2-in. Depth	3-in. Depth	6-in. Depth	8-in. Depth
7.0	0	0	0	0
6.9	0	0	0	0
6.8	200	300	600	800
6.7	400	700	1300	1700
6.6	700	1100	2100	2800
6.5	900	1400	2800	3700
6.4	1200	1800	3500	4700
6.3	1400	2100	4200	5600
6.2	1700	2500	5000	6700
6.1	1900	2900	5700	7600
6.0	2200	3200	6400	8600
5.9	2400	3600	7100	9500
5.8	2600	4000	7900	10600
5.7	2900	4300	8600	11500

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GYPSUM

$CaSO_4$

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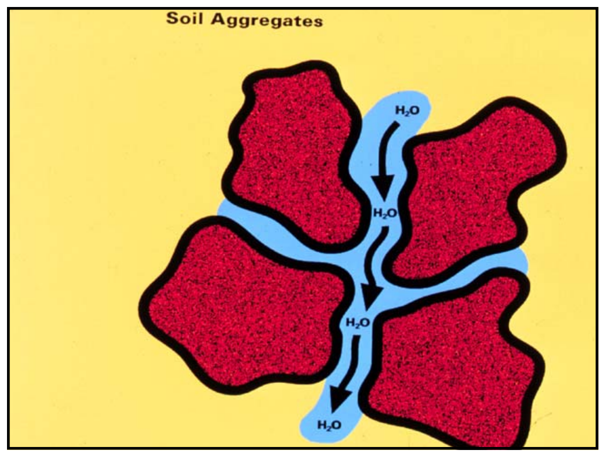

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SODIUM Na^+

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SODIUM

- NOT AN ESSENTIAL ELEMENT
- NATURALLY OCCURING
- SEWAGE EFFLUENT
- CAN DAMAGE PLANTS
- MONOVALENT (1+)
- LARGE HYDRATED SIZE
- CAN DAMAGE SOIL STRUCTURE

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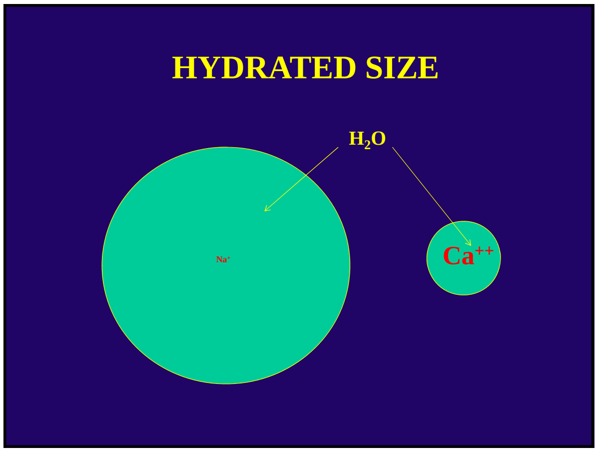

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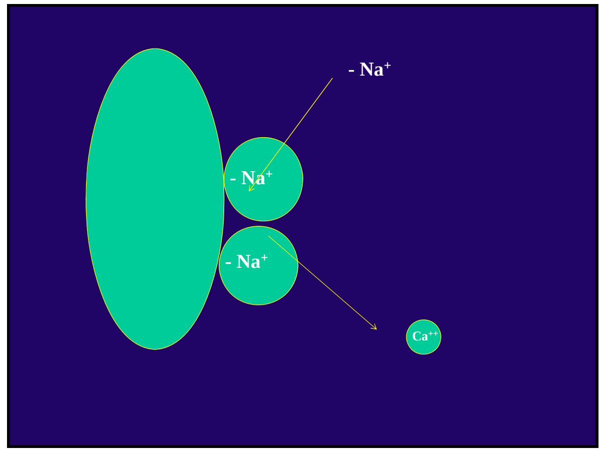

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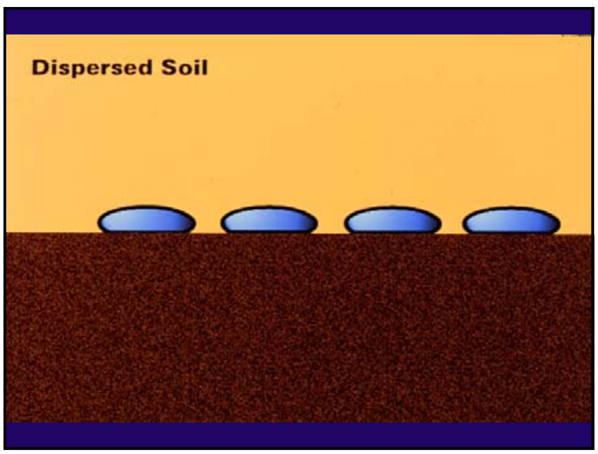

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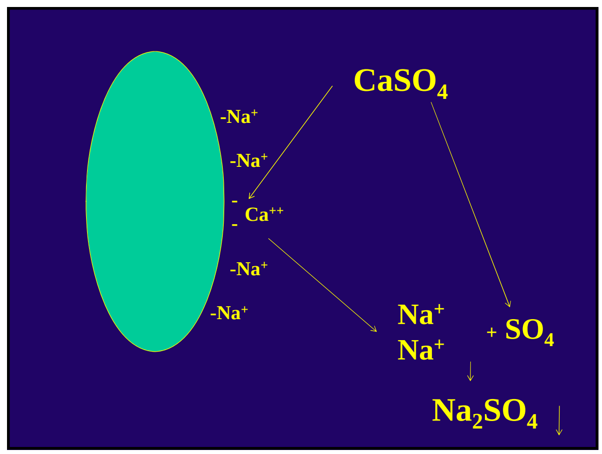

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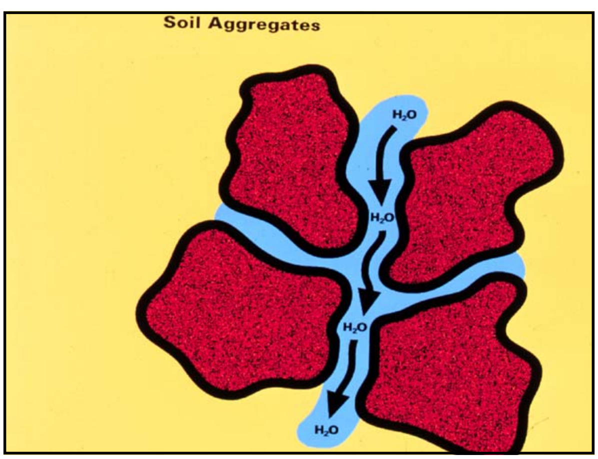

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GYPSUM

- CALCIUM SULFATE $CaSO_4$
- Calcium replaces Na^+ on cation ex. Sites
- Sodium sulfate leaches from soil
- Soil structure is <u>Slowly</u> restored

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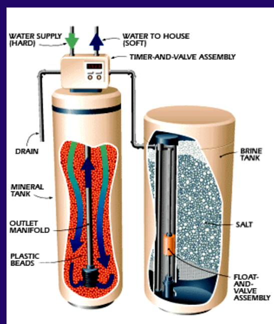
WATER SOFTENER



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SODIUM ADSORPTION RATIO - SAR

- RATIO OF SODIUM TO CALCIUM AND MAGNESIUM
- ESTIMATE OF AMOUNT OF SODIUM THAT WILL ACCUMULATE IN IRRIGATED SOIL
- 5 TO 15 DEPENDING ON SOIL TYPE

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SODIUM ADSORPTION RATIO SAR

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

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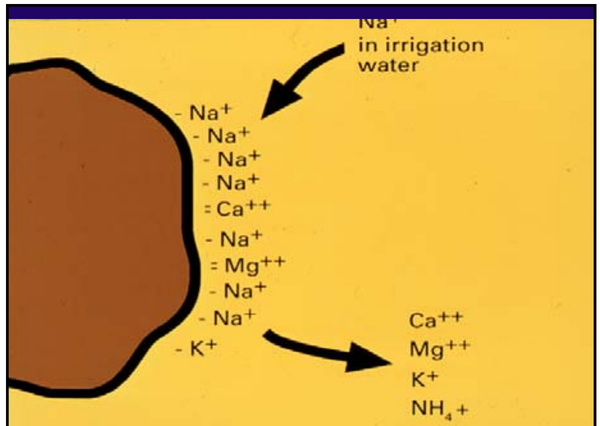

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CALCIUM AND MAGNESIUM

- DIVALENT (++)
- SMALLER HYDRATED SIZE

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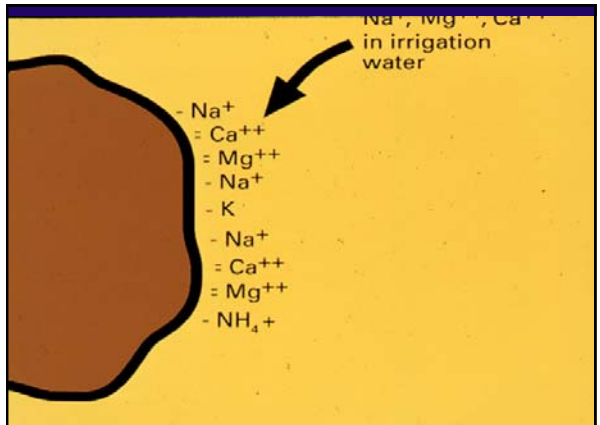

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BICARBONATES

- CAN REACT WITH Ca and Mg
- RESULTS IN HIGHER SAR

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ADJUSTED SAR - SAR_{ADJ}

ADJUSTED FOR BICARBONATES

BICARBONATES REMOVE Ca and Mg

THE WIDER THE DIFFERENCE BETWEEN SAR AND SAR_{ADJ}, THE GREATER THE BICARBONATE PROBLEM

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ACID INJECTION

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SULFURIC ACID REACTS WITH BICARBONATES

$$H_2SO_4 + HCO_3 \rightleftharpoons HSO_4 + H_2CO_3$$

$$H_2CO_3 \rightleftharpoons H_2O + CO_2$$

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ACID INJECTION

- SULFURIC ACID
- REACTS WITH CARBONATE AND BICARBONATE
- PREVENTS THE REMOVAL OF Ca AND Mg FROM SOLUTION
- PREVENTS INCREASE IN SAR

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SULFUROUS GENERATORS

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HOW ABOUT WHEN Na IS LOW AND Ca & Mg ARE PRESENT AND BICARBONATES ARE HIGH?

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