4R Nutrient Stewardship[†]: New Mexico Specifics

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[†] An Educational Program Initiated by the International Plant Nutrition Institute (IPNI)

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Remember what an agronomist is

- **Agronomist /ə-'grän-ə-məst/ noun**:
  - One who studies the science of soil management and crop production
  - One who applies the various soil and plant sciences to soil management and crop production; scientific agriculture

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Or…

- from Greek: ***Agros*** (field) and ***nomos*** (to manage)
- The branch of agriculture that treats of the principles and practices of crop production and field management.
- First started, perhaps, in 1843 in Rothamsted, England to study fertilizer use.

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And Continues in the U.S.

General Goals for Both Horticultural and Field Crops

- **Turf**
  - Attractive
  - Healthy
  - Withstand Rigors of Intended Use
- **Row Crops**
  - Chile, Corn, Sorghum, Wheat, others
    - Yield
    - Quality
    - Profitability
- **Pecans**
  - Yield
  - Quality
- **Forages & Grains**
  - Alfalfa
  - Small grains for silage
  - Small grains for grain

Fertilization Contributes to

Turf

- Color
- Density
- Uniformity
- Growth Rate

Agronomic Crops

- Growth Rate
- Yield
- Crop Quality
- End User Nutrition
- Flour Quality

Properly Fertilized Crops Are

- Better able to compete with weedy species
- Recover better from stress
  - Environmental
  - Biotic

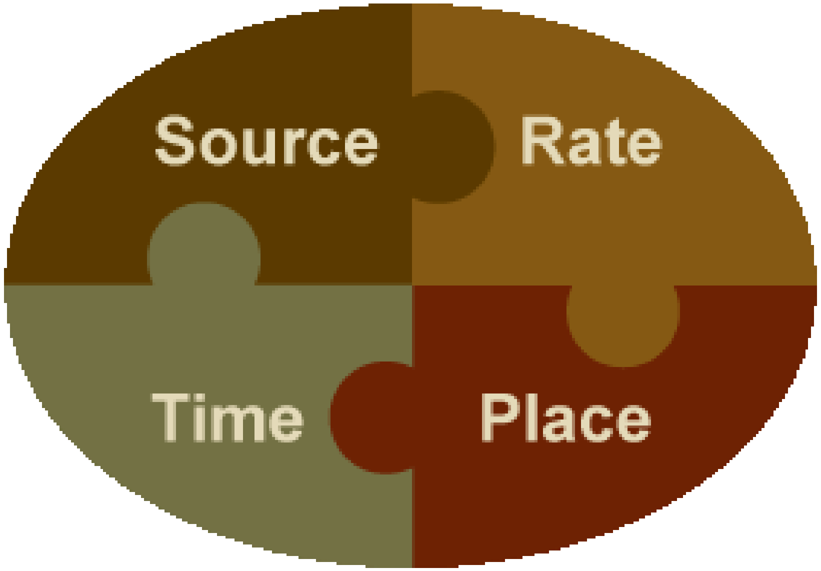
So, I could tell you that you need

- 200 – 250 lb N/A
- 80 lb P_2O_5/A
- 120 lb K_2O/A
- Plus other nutrients

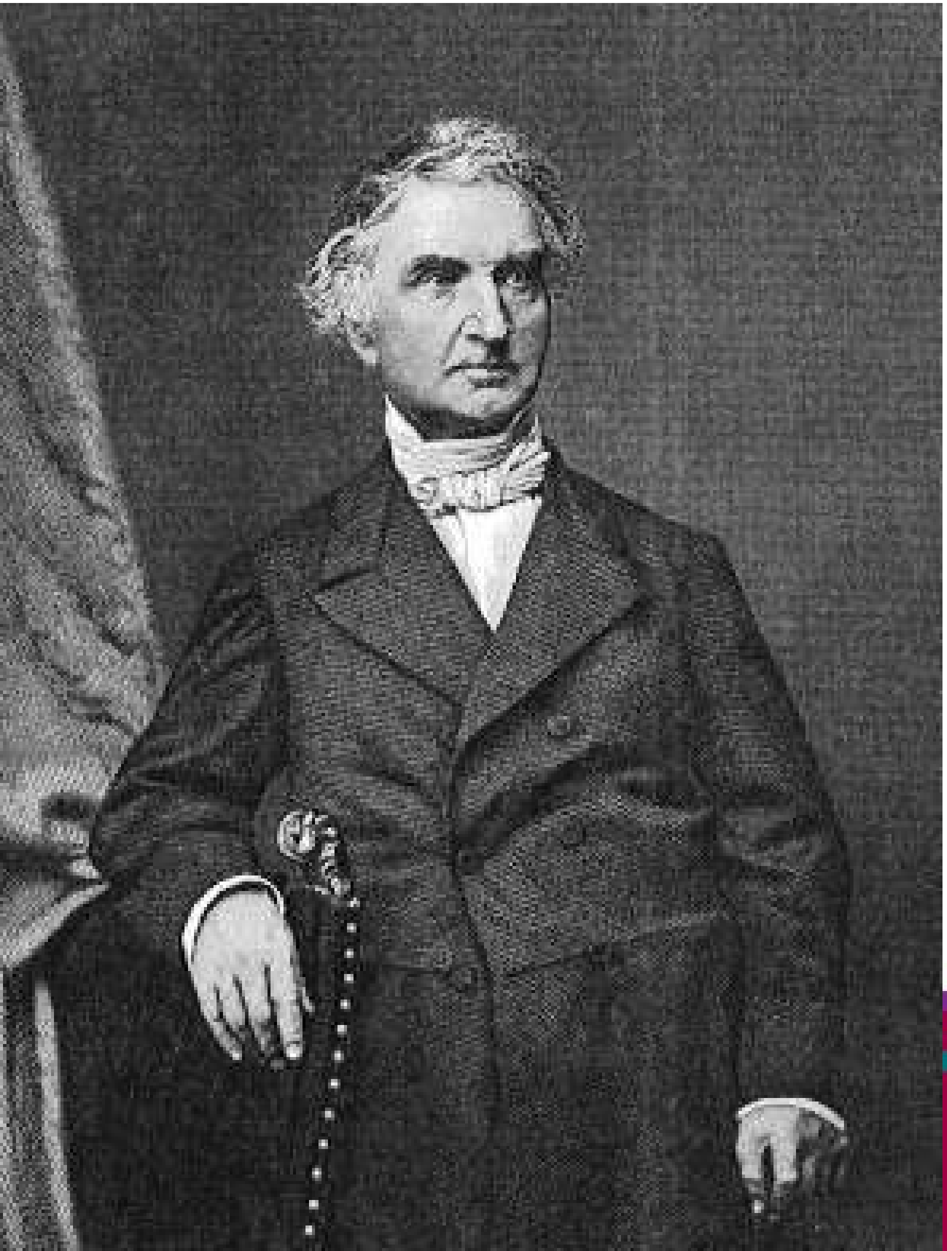
- *However, ...*

But it is NOT <u>all</u> about rate!

- THE 4 R's
  - **Right Source**
  - Right Time
  - Right Place
  - Right Rate



Liebig’s Law of the Minimum



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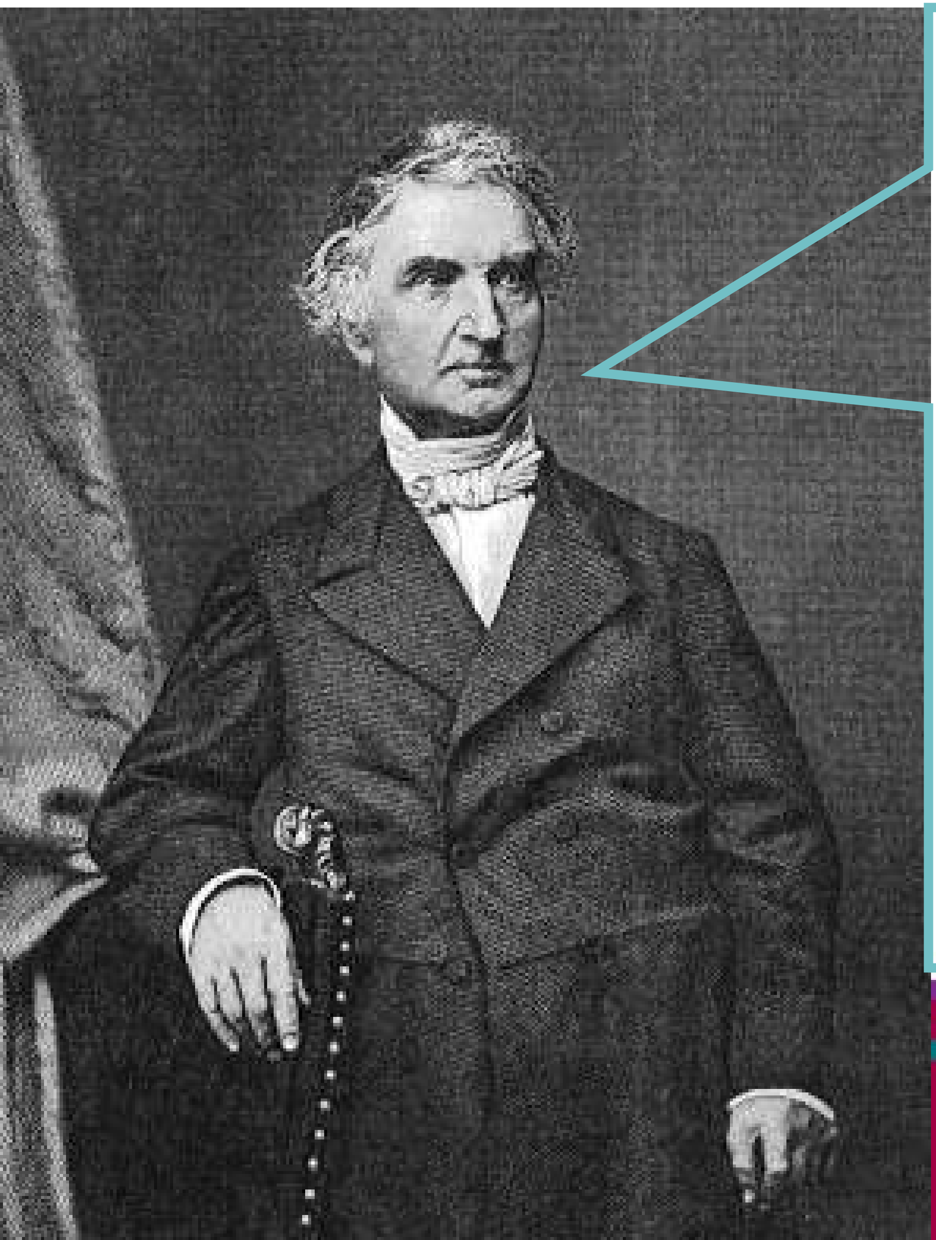


Yield & Performance is Limited by the Nutrient in Least Supply

(all other factors – water, salinity, pests, environment -held constant)


Water is a BIG “other” factor

Alfalfa Yield and Water

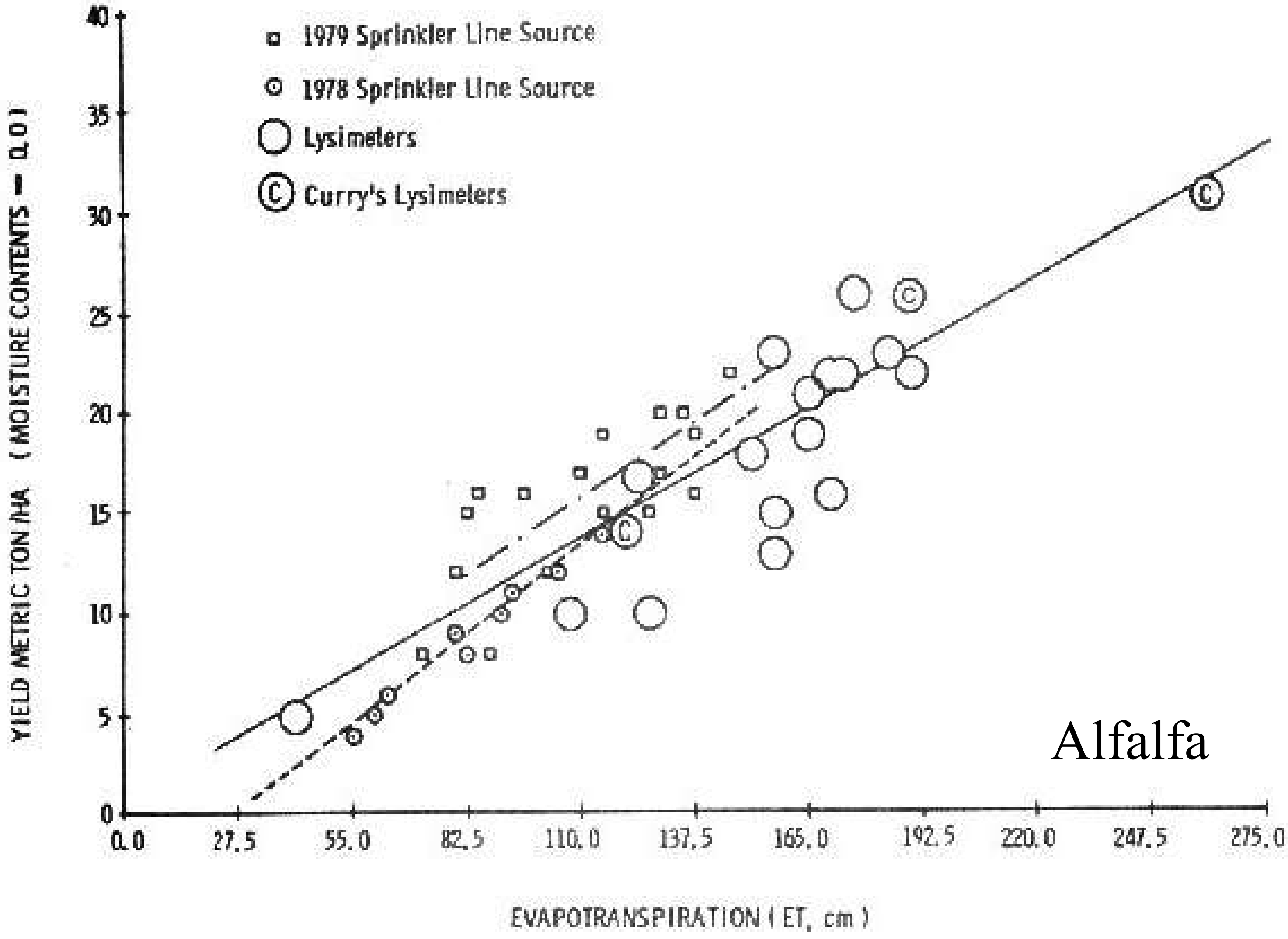
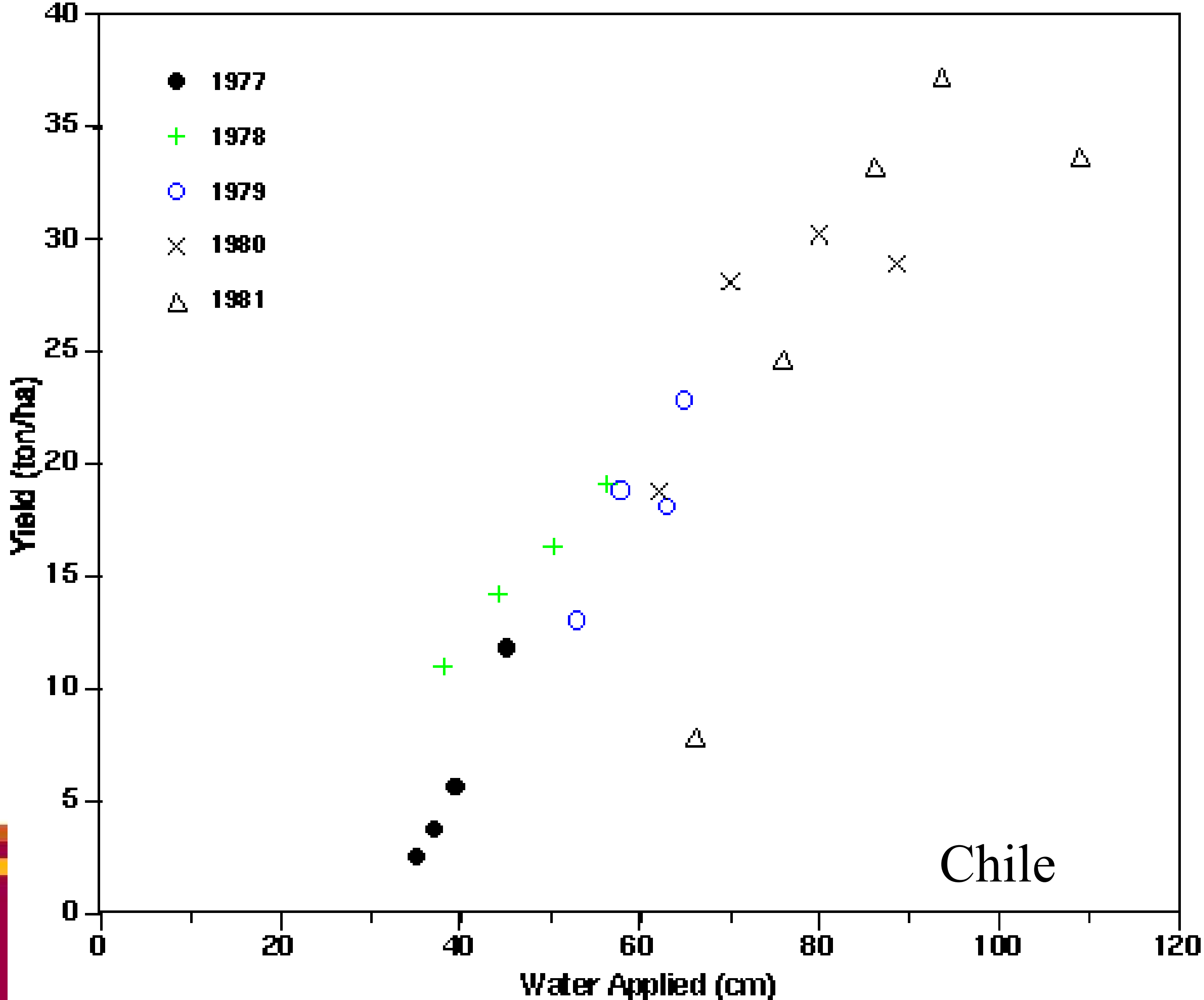
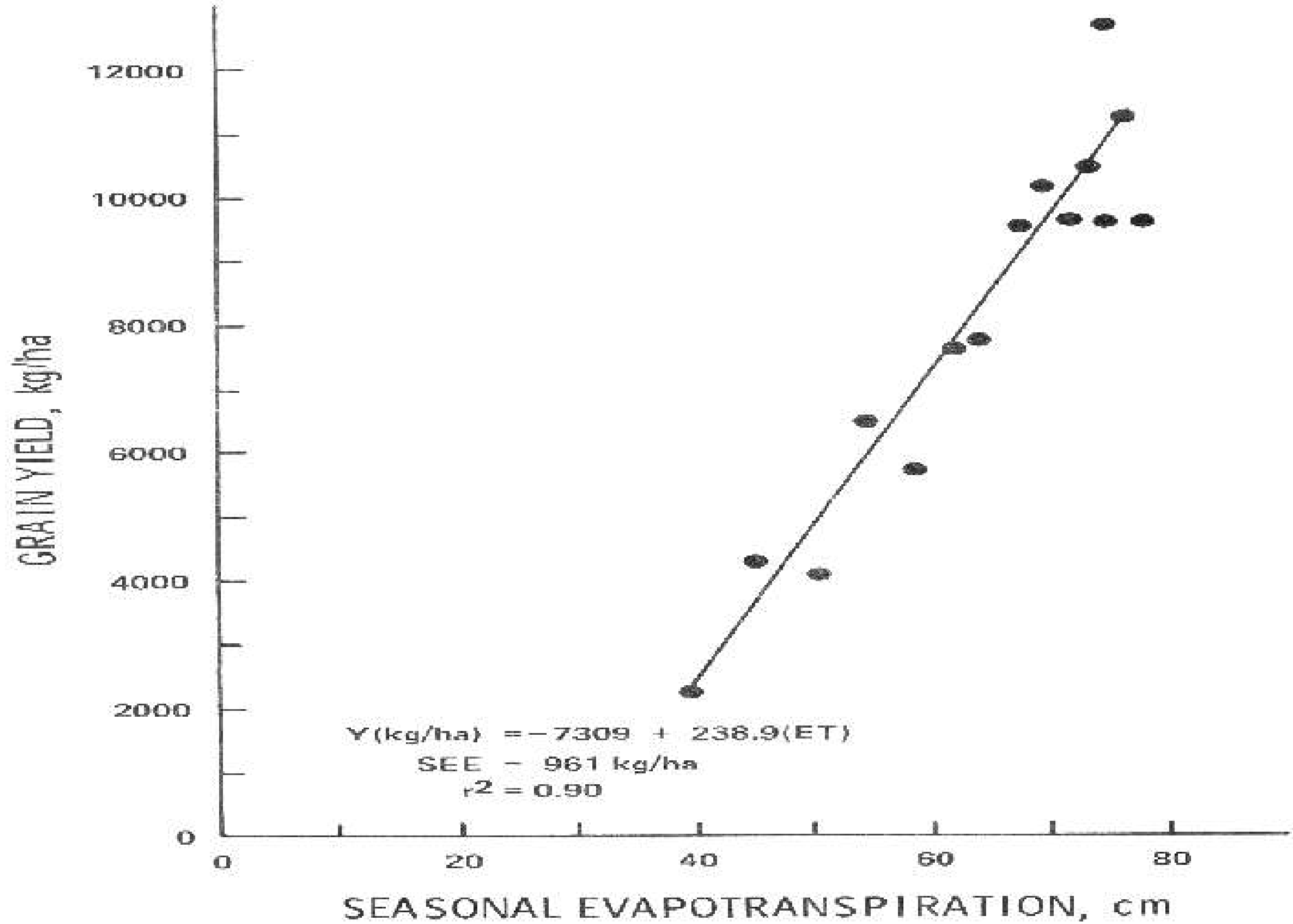


Fig. 1. Water-production function for alfalfa New Mexico.

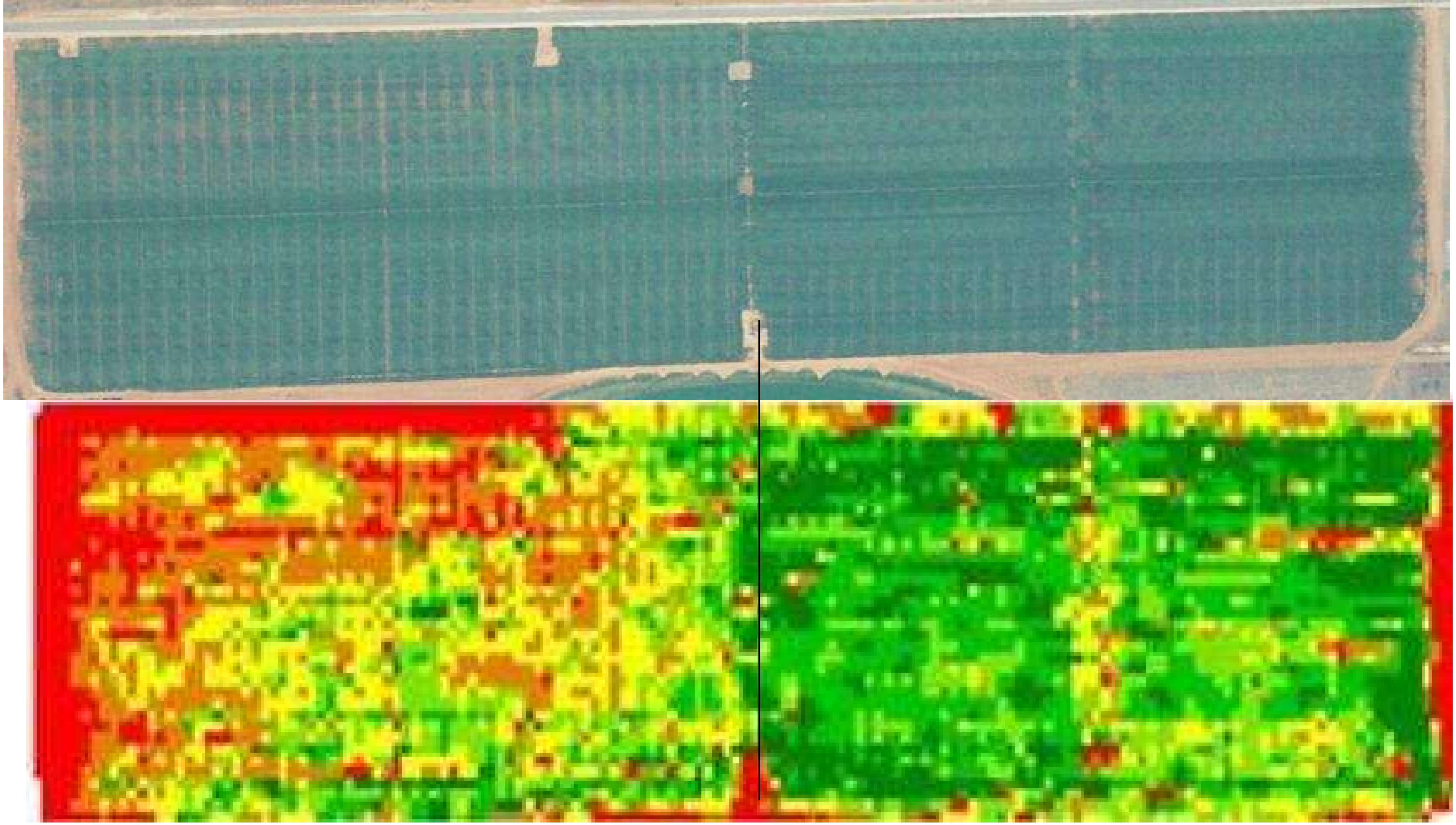
Chile Yield and Water



Corn for Grain Yield and Water



gure 13. The water-production function of the high-N corn SLS plot, 1982.

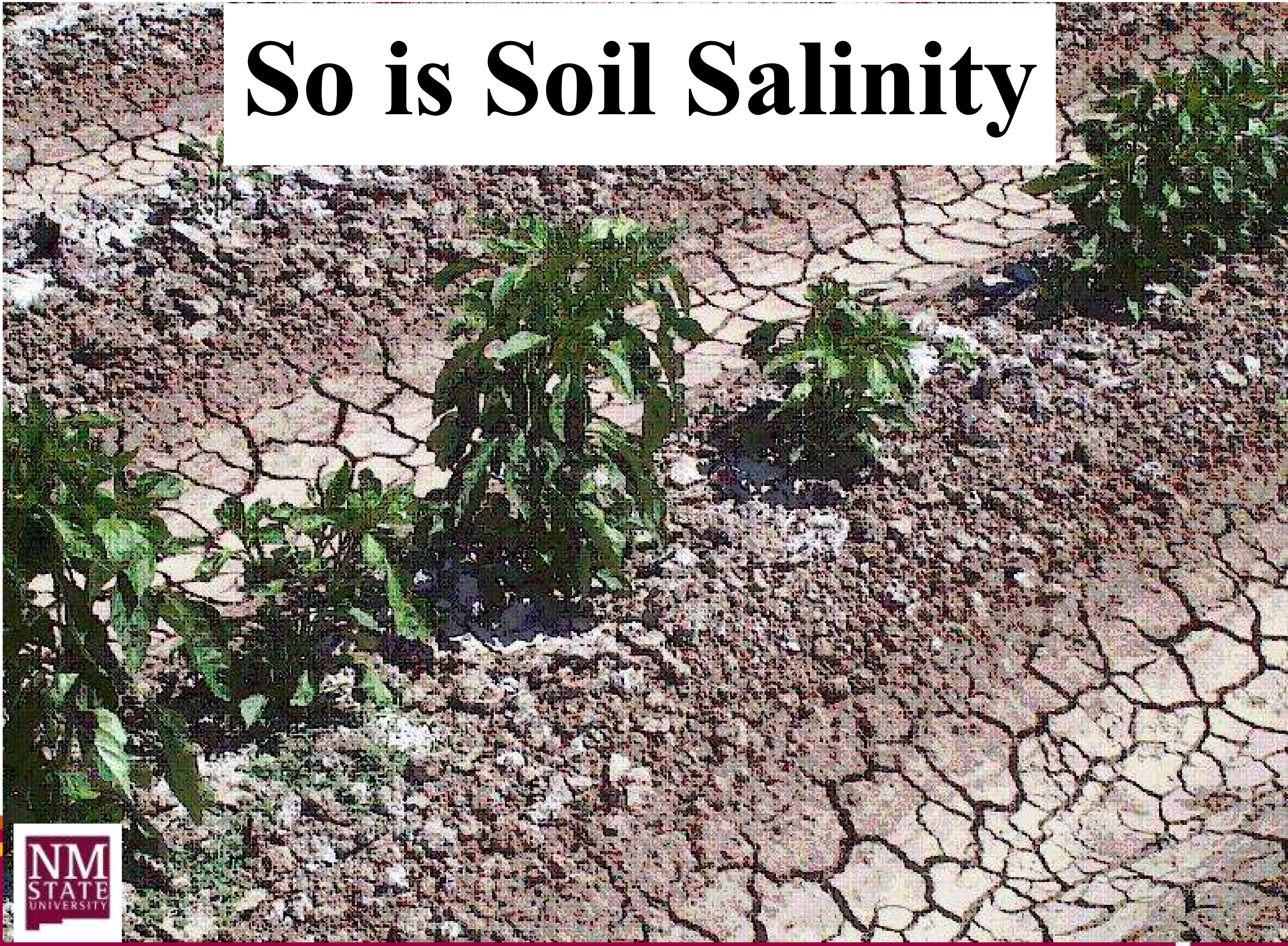


Uphill side **Downhill side**

Friction losses

Soil Type Impacts Crop Response to Irrigation

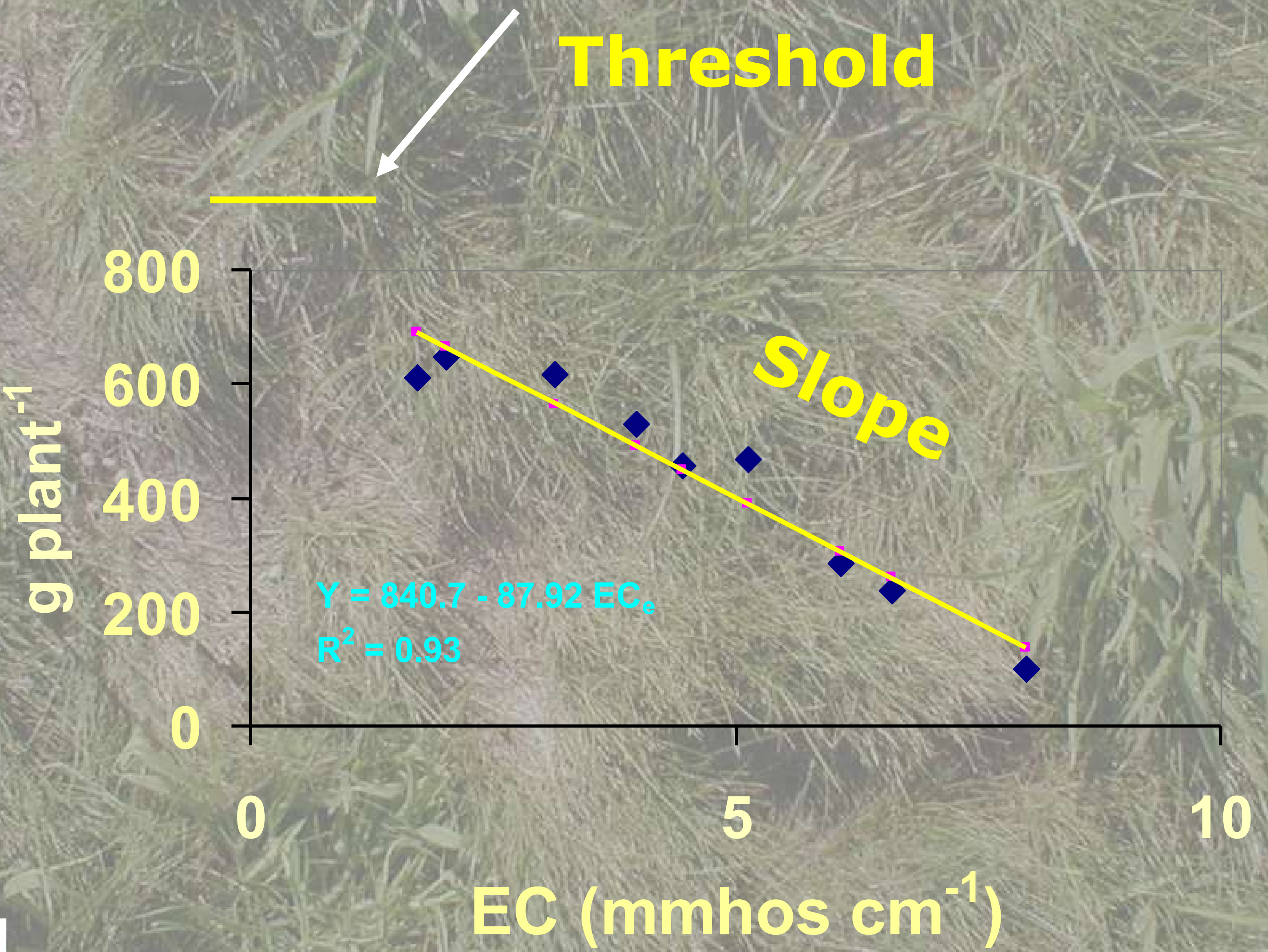
So is Soil Salinity



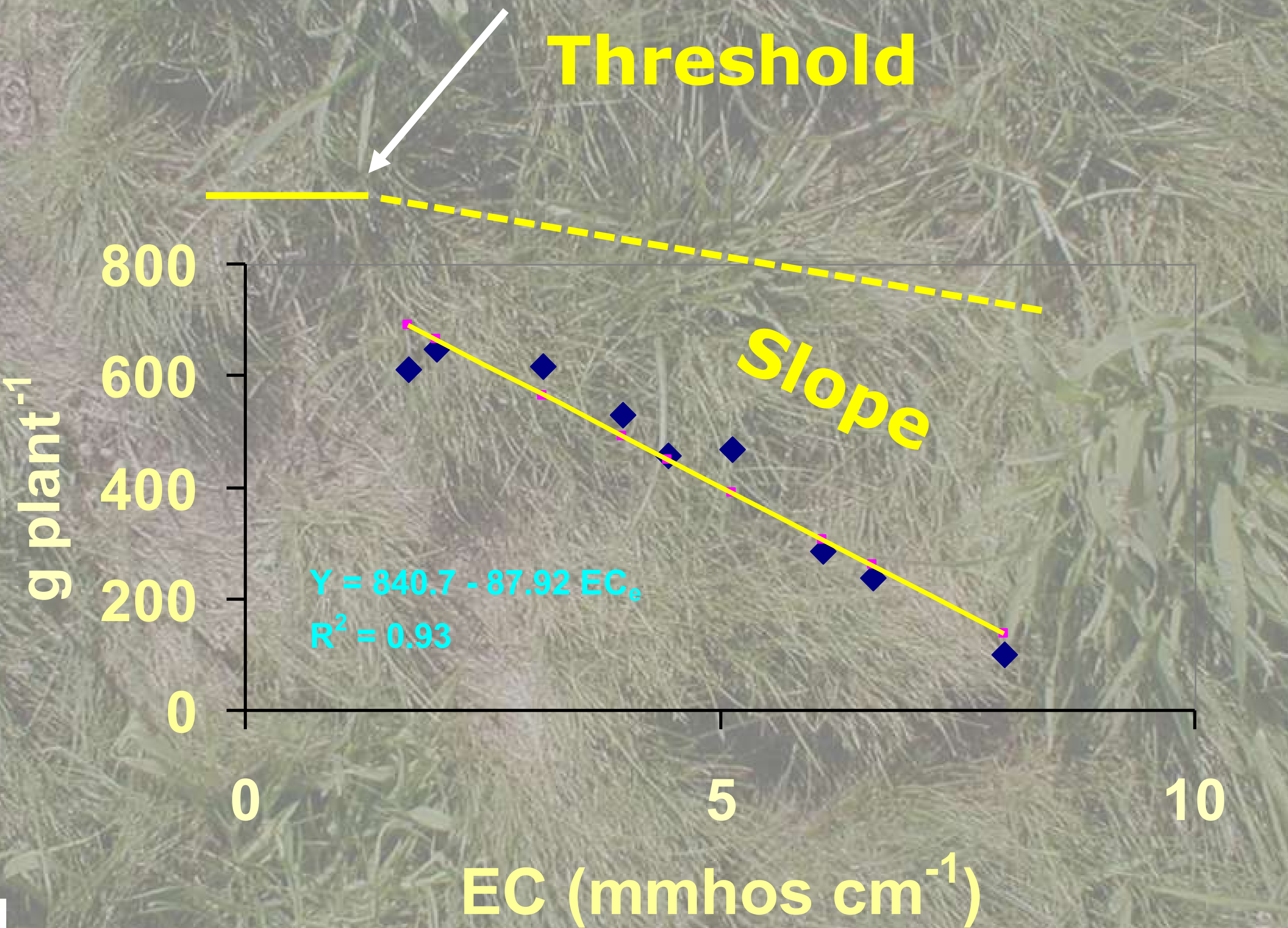
Measured by electrical conductivity (e.c.)

- RO Reject Water
- Soft Water
- Tap Water
- Spring Water
- RO Water
- Distilled Water
  - 0 mmhos/cm

Increasing Salinity



Yield/Performance as a function of EC_e



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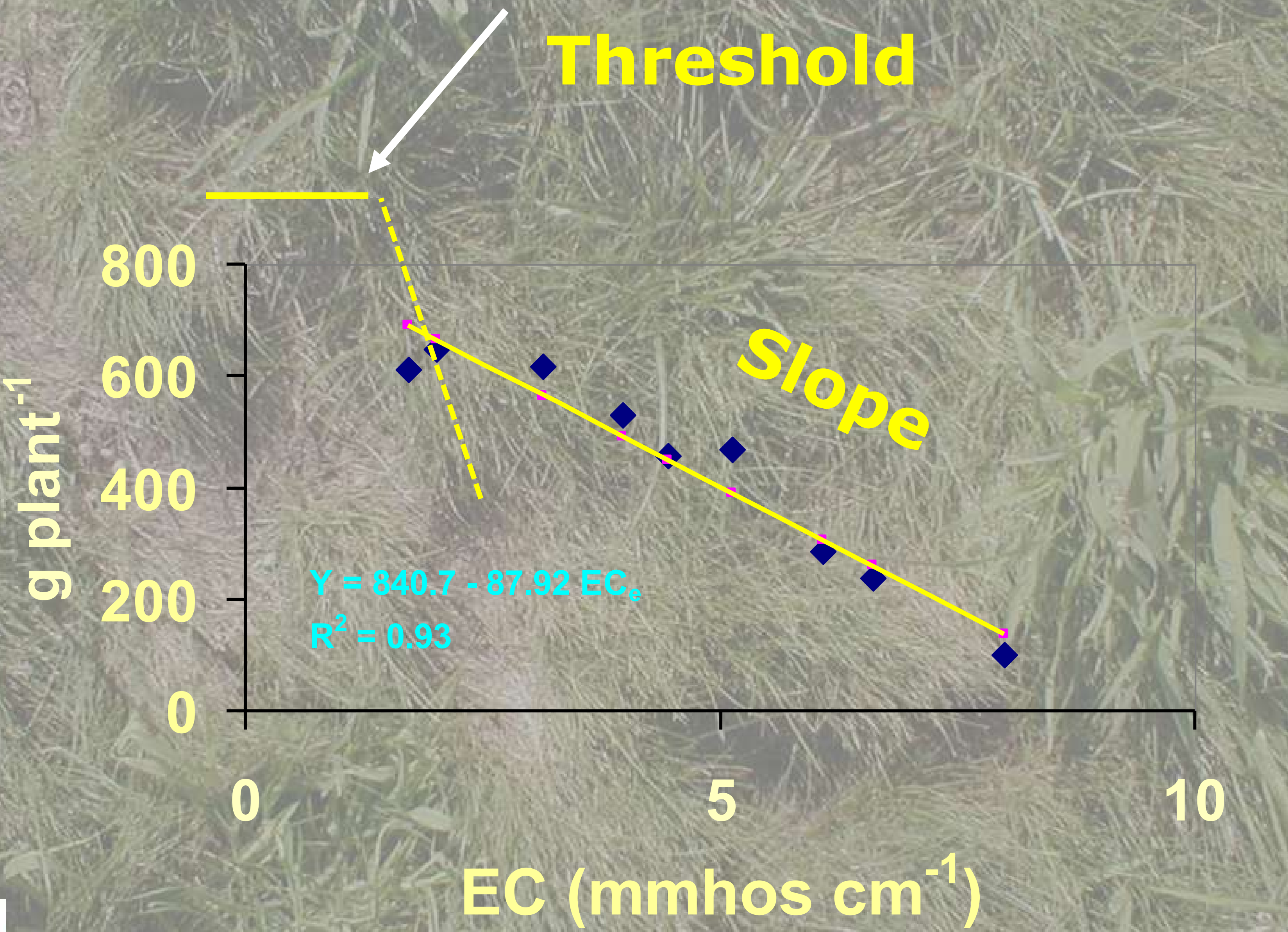

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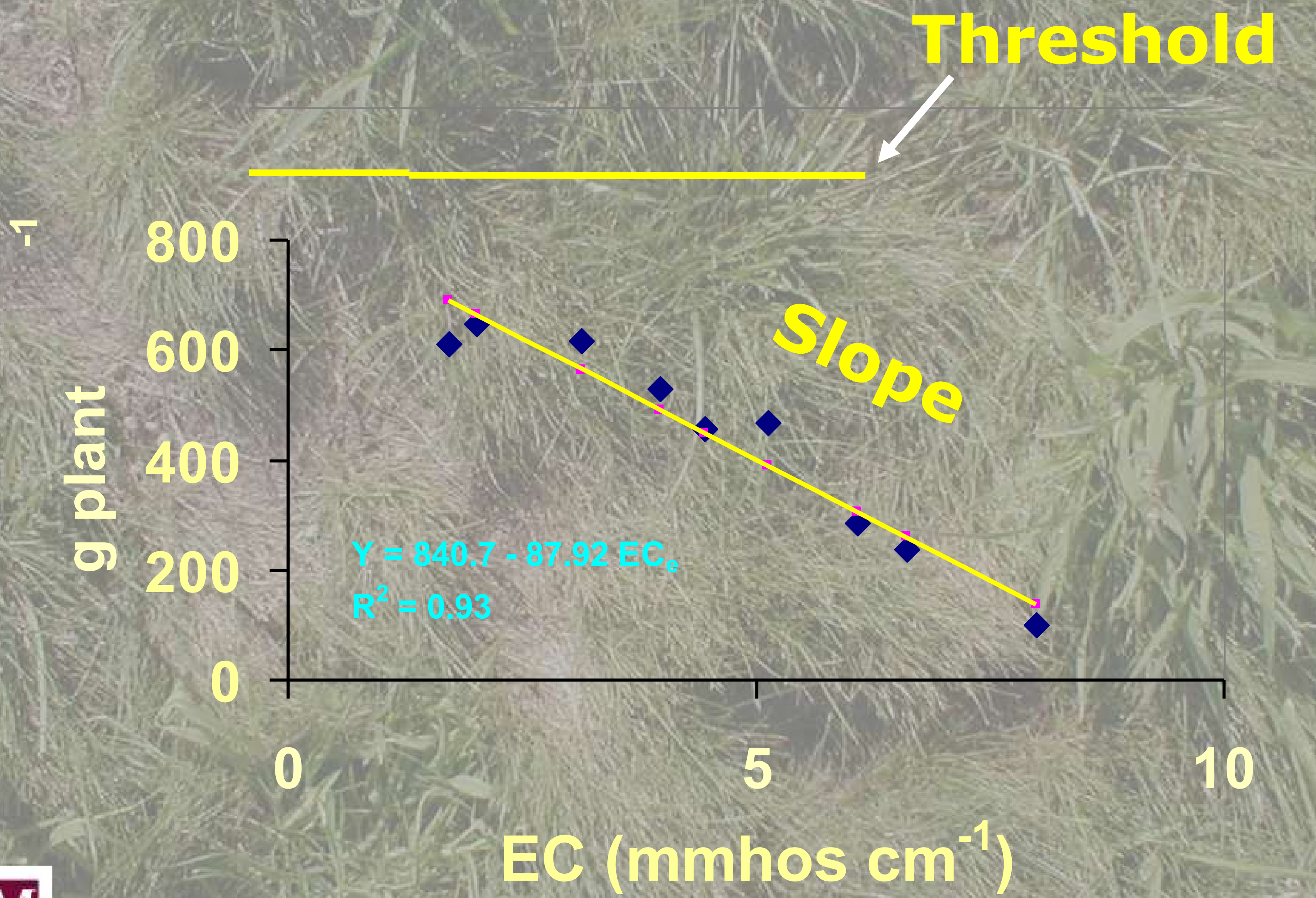
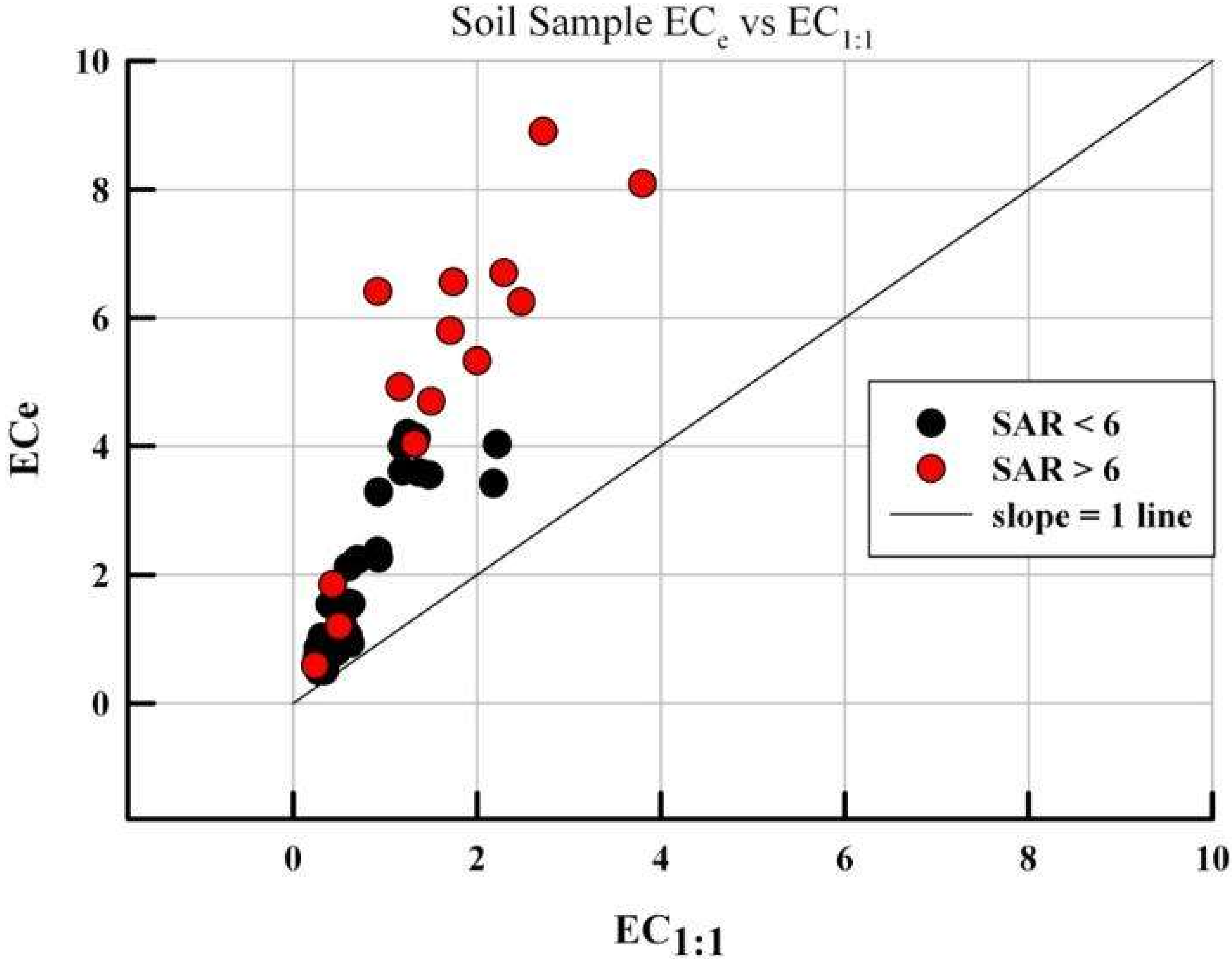


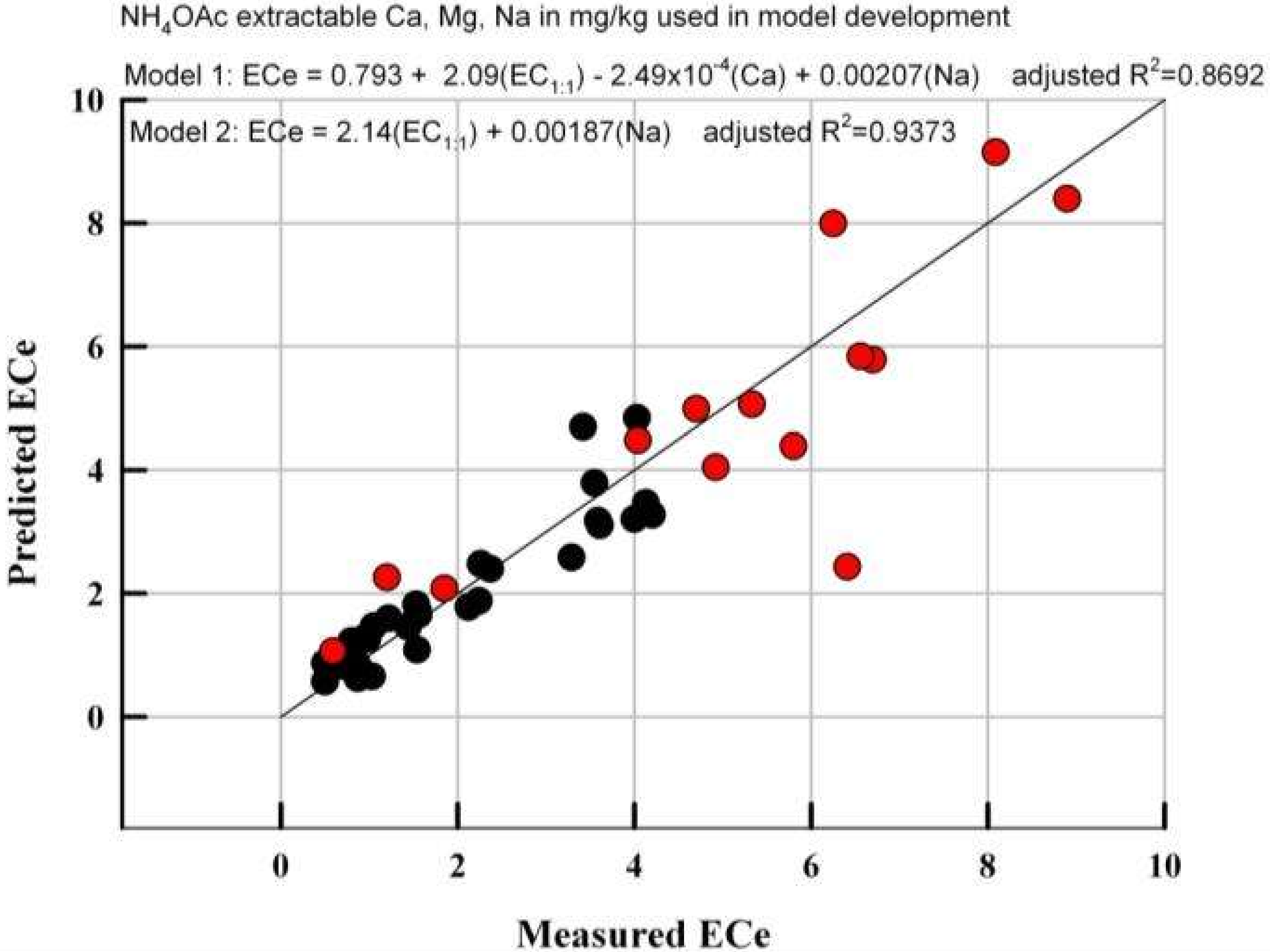
Yield/Performance as a function of EC_e

Saturated Paste is Best & Preferred when EC>0.5 mmhos/cm



Soil Sample EC_e vs $EC_{1:1}$
ECe
$EC_{1:1}$
0
2
4
6
8
10
SAR < 6
SAR > 6
slope = 1 line

Predicted Soil ECe vs Measured ECe



Salinity & Sodium

Sodium Promotes Dispersion

No or Reduced Aggregates

Sodium Adsorption Ratio

$$SAR = \frac{[Na^+]}{\sqrt{([Ca^{2+}] + [Mg^{2+}])/2}}$$

(concentrations are in mmol/L)

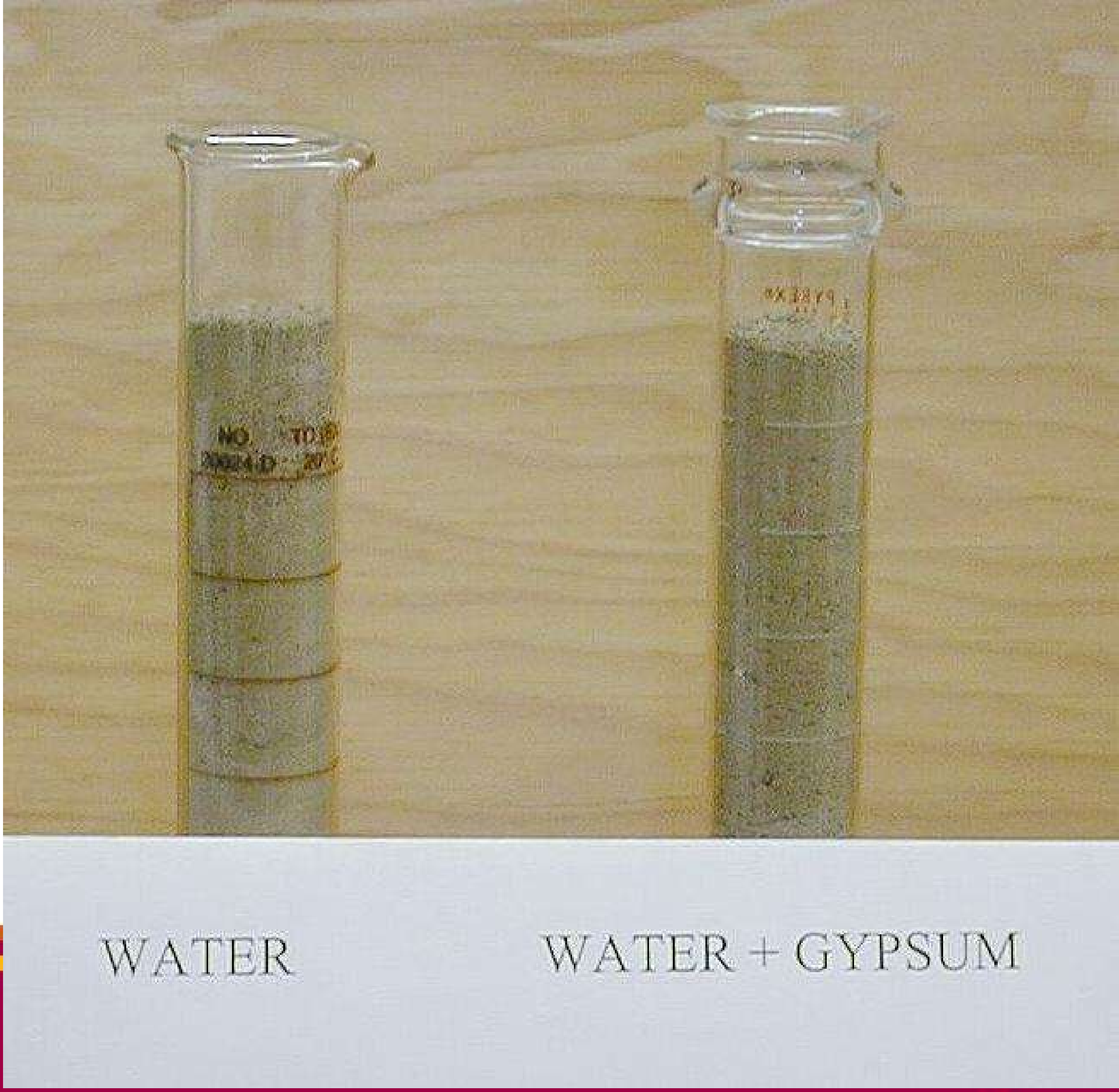
- **High SAR = Unstable Soil**
- **Low SAR = Stable Soil**

Manage Sodium in Soil with Calcium (Gypsum ($CaSO_4$))

Excess water must be applied!!

Must also be good drainage!

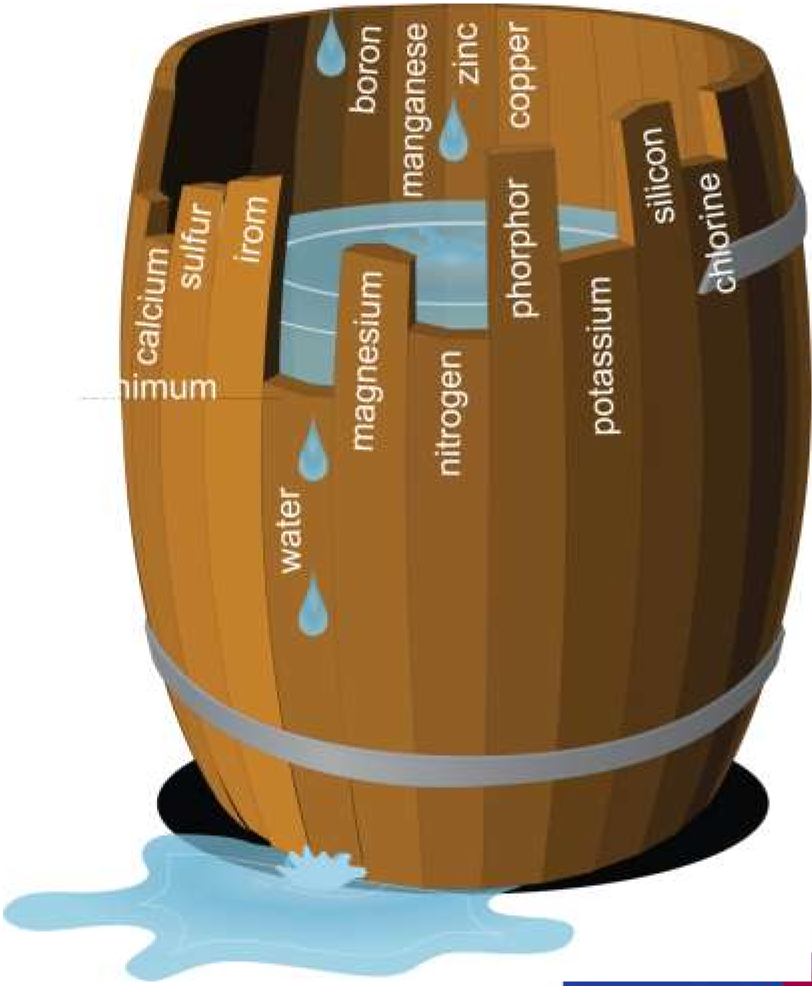
TIME = 0

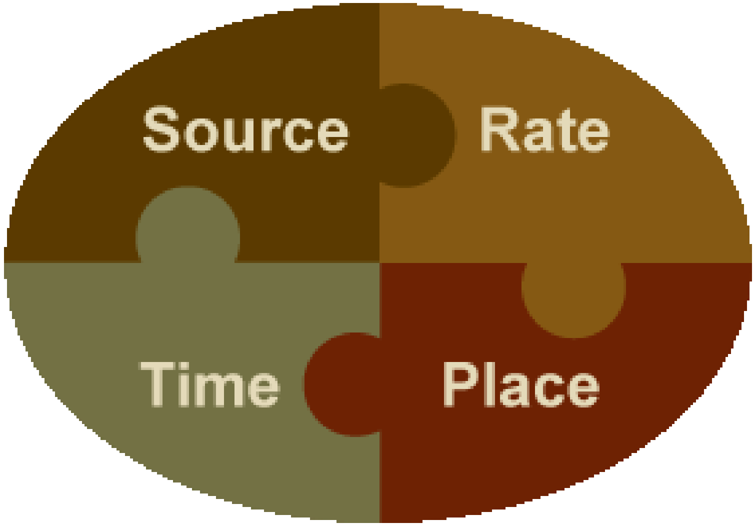


TIME = 24 hours

Gypsum rate determined from soil Exchangeable Sodium Percentage (ESP) and sodium concentration in the soil.

Liebig's Law of the Minimum





Need to know what you need in order to determine a Source

Determined by Soil Sampling
Past History

Appropriate Tests for NM Soils (Guide A146)

- Saturated paste pH
- Saturated paste EC
- Sodium Adsorption Ratio (SAR) SP
- Organic Matter
- Nitrate-N or Total Inorganic-N
- Phosphorus (Olsen)
- Potassium (Water or Ammonium Acetate)
- DTPA Extractable
  - Fe
  - Zn
  - Mn
  - Cu
- Optional (if already known)
  - Texture
  - Soil Lime %

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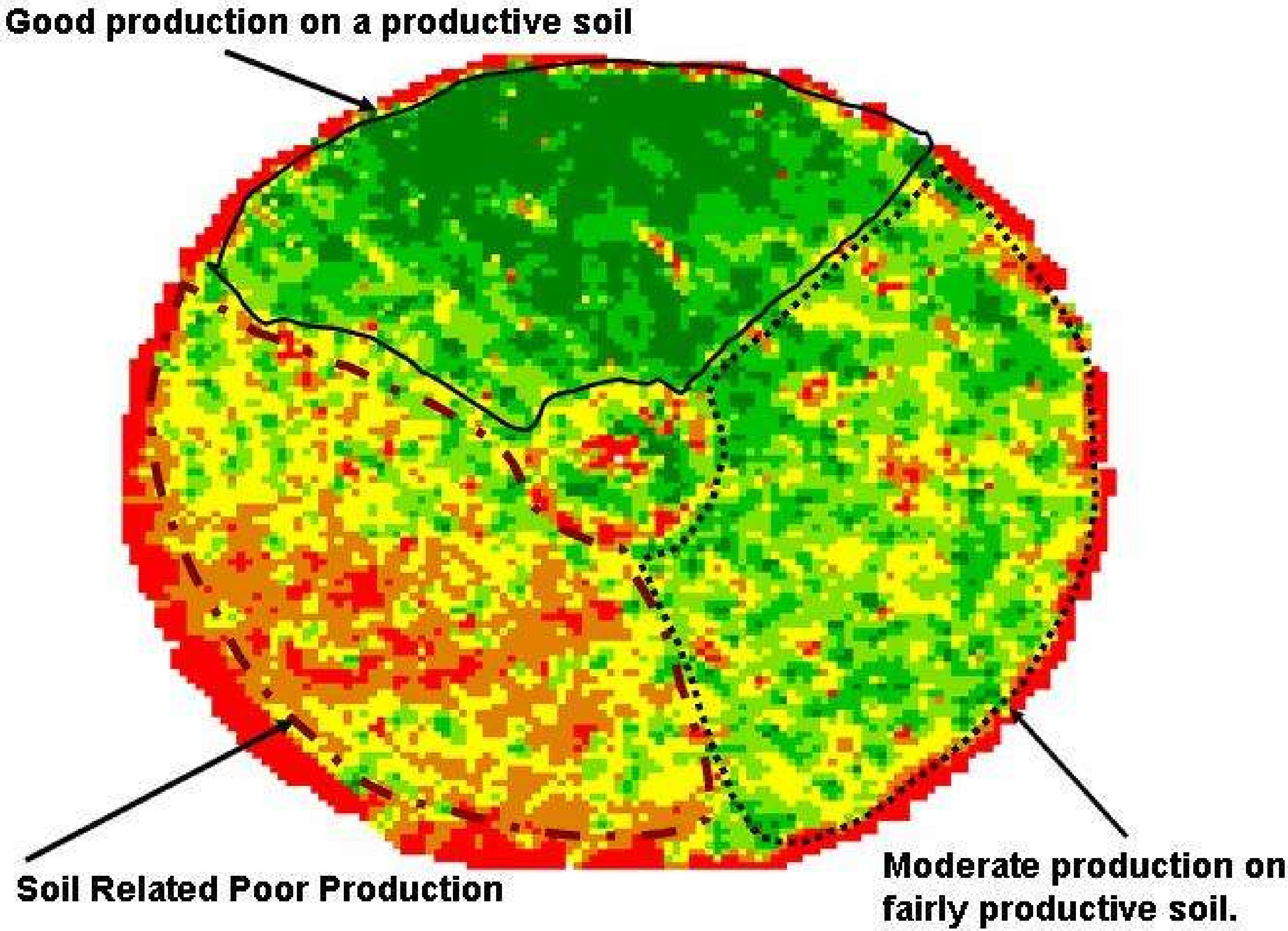
Sampling is KEY to the 4R program

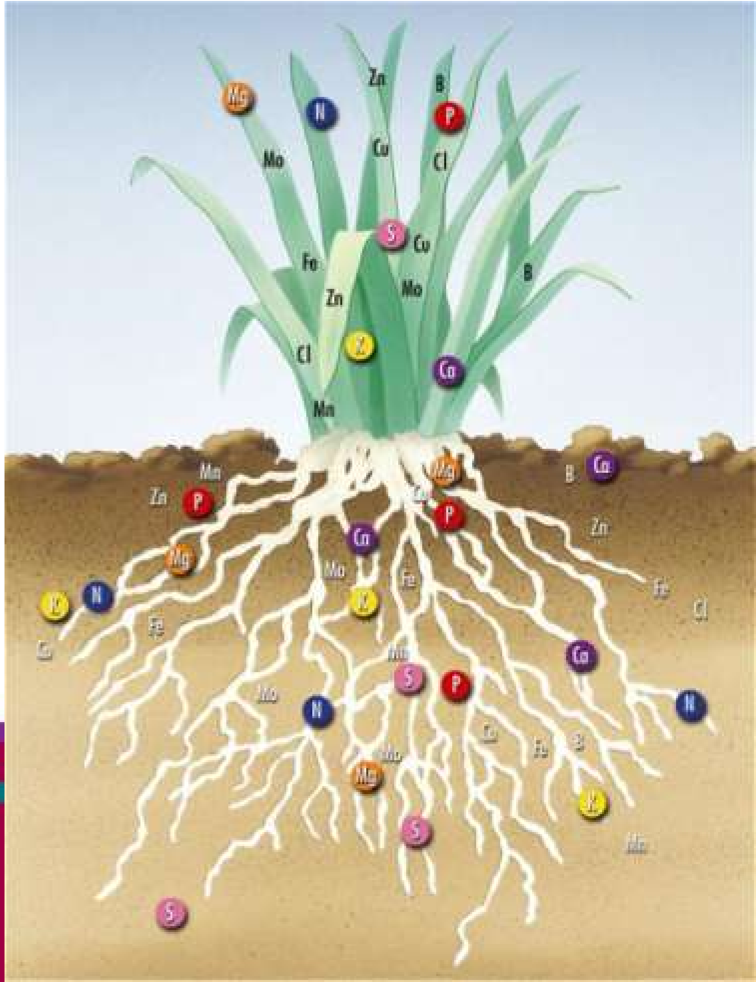
Be Representative

Be Representative!



Plant Nutrition

- **Soil testing identifies nutrients needed for productivity**
  - Low
  - Moderate
  - Sufficient
  - Excessive



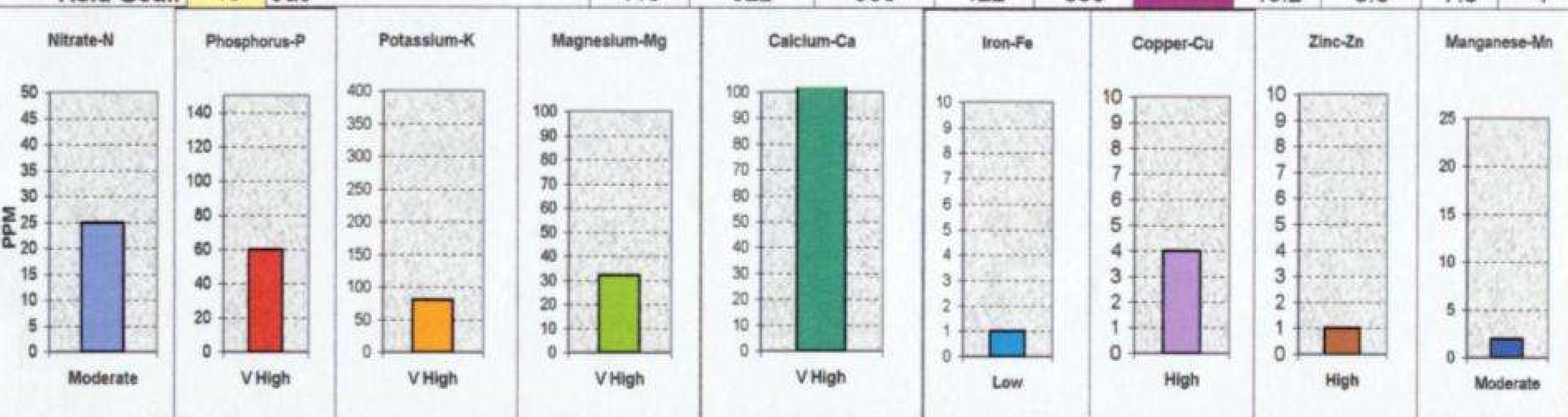
Interpretation

Zip Code: 88210 | Depth of Sample (in): 12 | Sodium Adsorb. Ratio: 4.1 | ESP: 4.8

Phone:

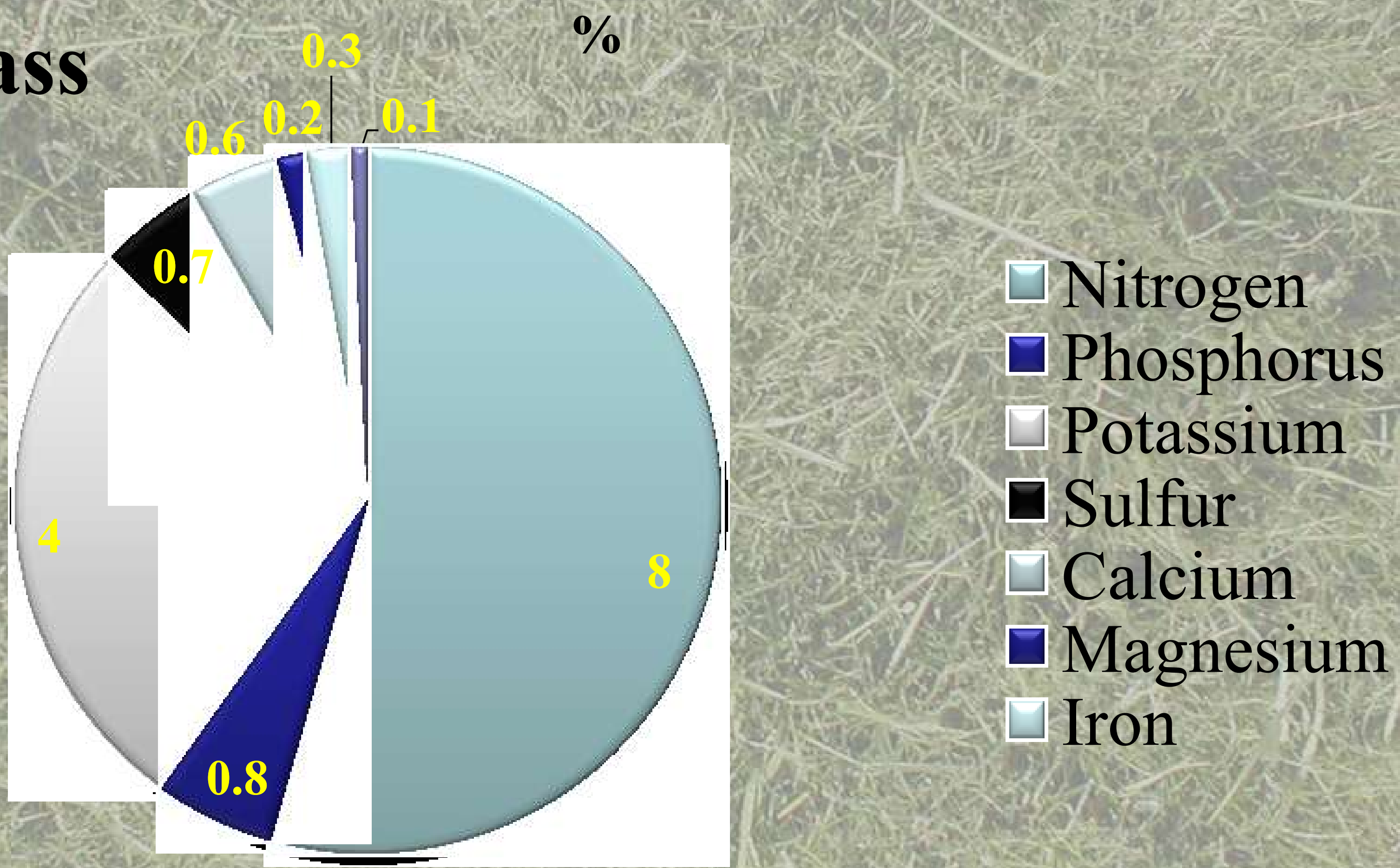
Note: **E.C.**-Electrical Conductivity or Saltyness, **O.M.**-Organic Matter, and **ESP**-Exchangeable Sodium %.

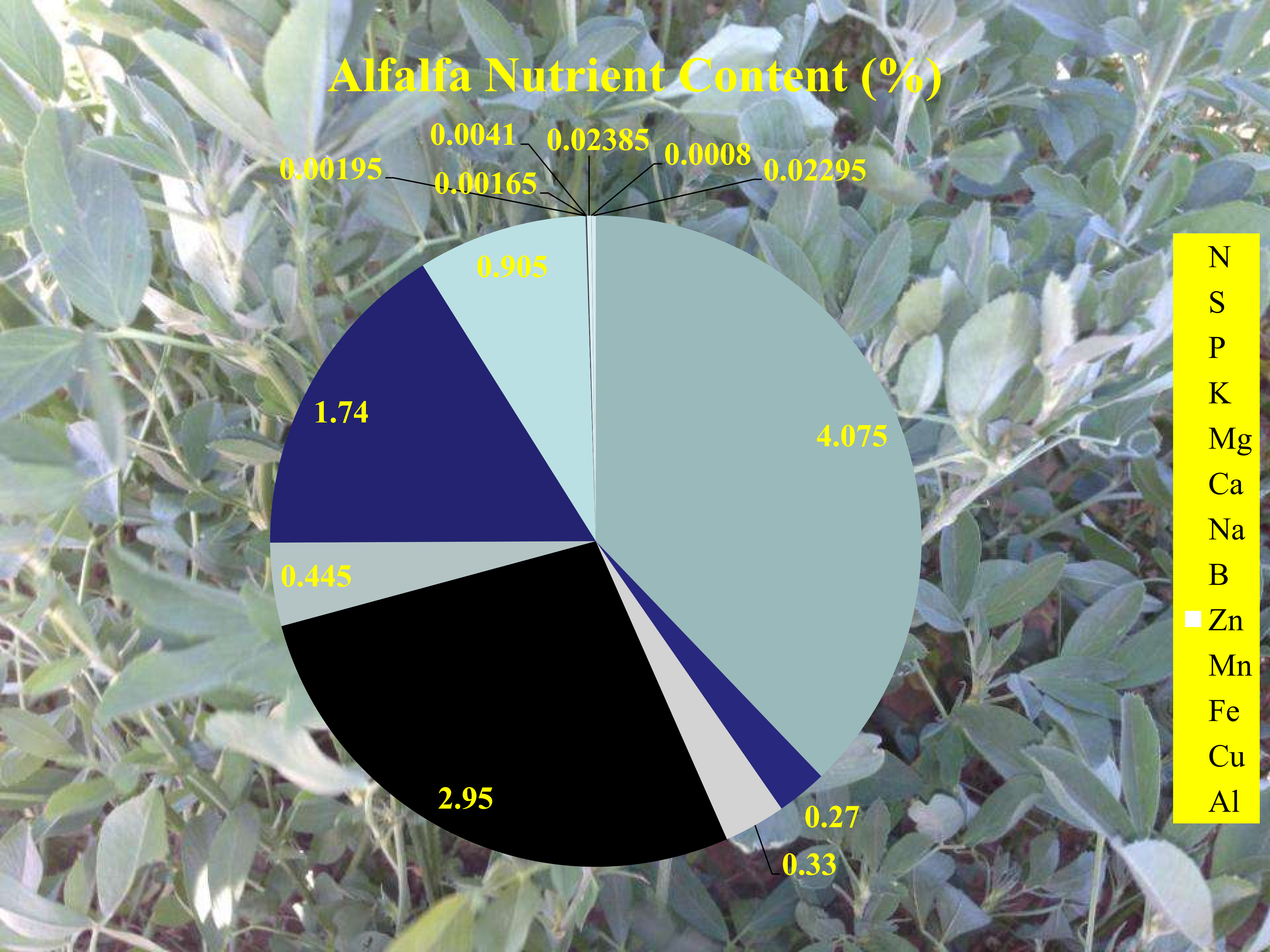
Samp. ID (#)	pH (#)	E.C. (mmhos/cm)	Soil Texture (class)	O. M. (%)	NO_3-N (ppm)	P (ppm)	K (ppm)	Mg (meq/l)	Ca (meq/l)	Na (meq/l)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)
	8.5	3.1	Loam	0.50	25	60	80	2.67	8.59	9.7	4	1	2	1
Crop to grow:		Pasture, grass, G stand, L. season			lbs/ac	P_2O_5 (lbs/ac)	K_2O (lbs/ac)	lbs/ac	lbs/ac		lbs/ac	lbs/ac	lbs/ac	lbs/ac
Yield Goal:		15	t/ac		110	522	366	122	653		15.2	3.8	7.6	4



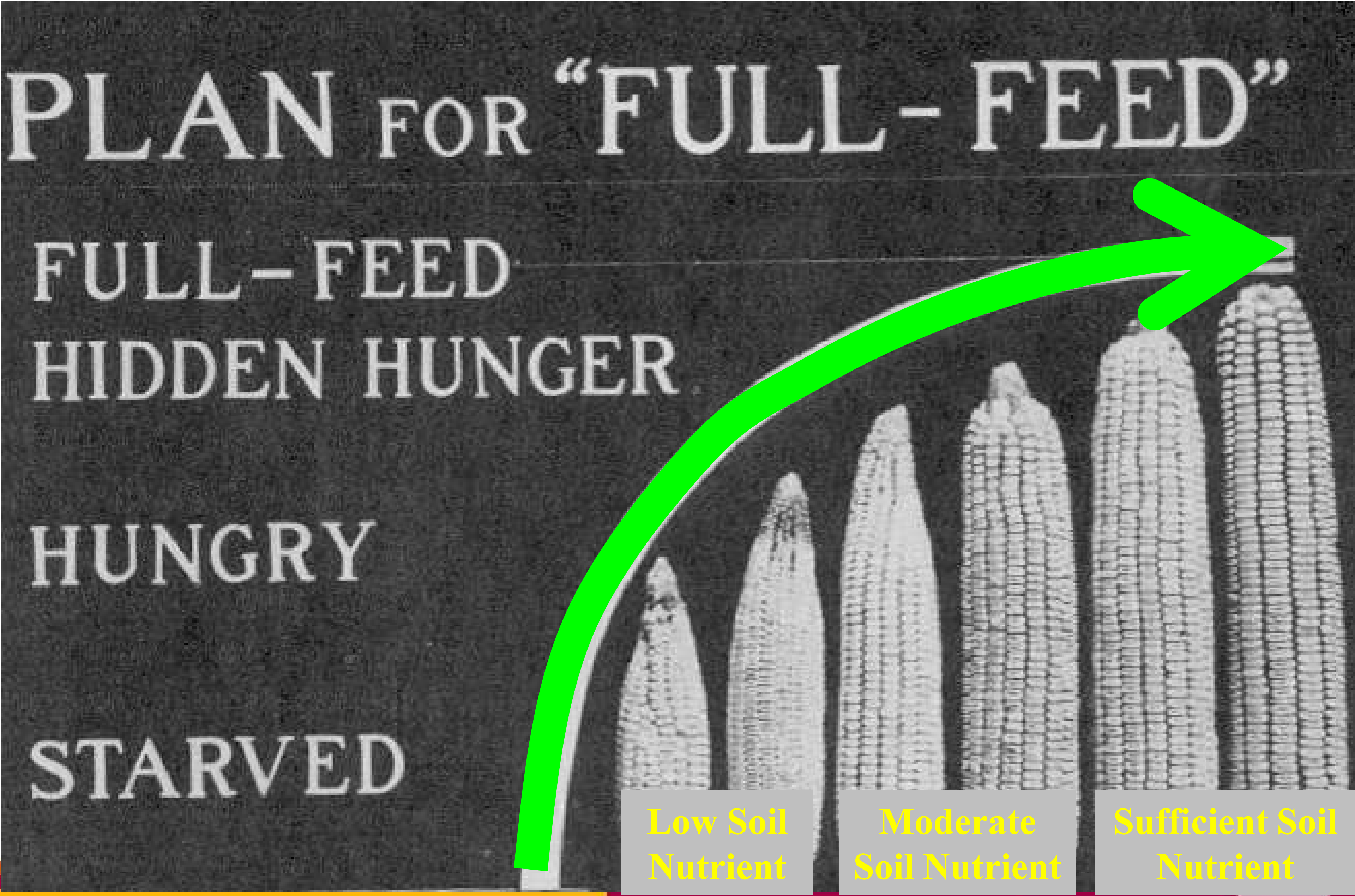
Minerals Required for Plant Growth

Turfgrass





Alfalfa Nutrient Content (%)
0.0041
0.02385
0.0008
0.02295
0.00195
0.00165
0.905
1.74
4.075
0.445
2.95
0.27
0.33
N
S
P
K
Mg
Ca
Na
B
Zn
Mn
Fe
Cu
Al



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Nutrient Recommendation

Nutrient Recommendation:		N lbs/ac	P_2O_5 lbs/ac	K_2O lbs/ac
Recommended Nutrient Rate:		180	0	0
Organic Nutrient Source (Liquid or Solid Manure):		72	240	544
Irrigation Water Credits (ppm NO_3-N):	5	20		
Other Nutrient Sources (Standing Legume Crop.):				
Supplemental Nutrient Rate:		88	0	0
Available Nutrients > Crop Requirements:		NO	Caution P	Caution K

General Note:	Apply P and K in the spring. Split N into 2-4 applications with the first in e

N – P_2O_5 – K_20, others

N Credits = Soil Organic Matter SOM also improves micronutrient availability & water holding capacity

Legume N Credit

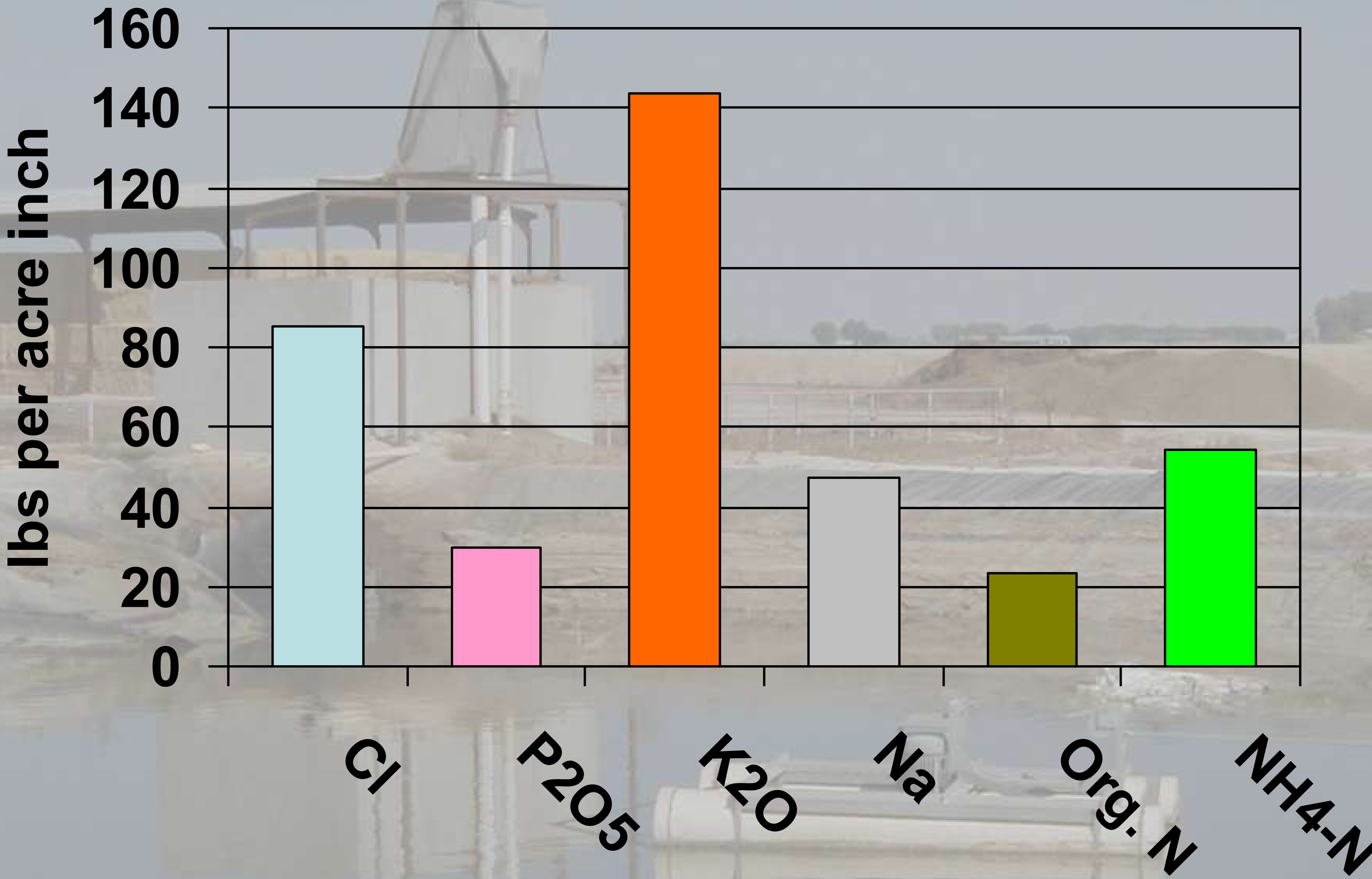
Manure Nutrient Credit

- Average 35 lb Total N/dry ton (8-12 lb available N).
- NMSU Soil Test Interpretation Workbook will subtract out
  - potential volatilization losses of the NH_4 content
  - De-nitrification (N_2) losses depending on soil organic matter levels and soil drainage class
  - Mineralized N from the organic N pool in manure is estimated based on literature or C:N ratio

Other Manure Nutrient Credits per Dry Ton

Nutrient	Pounds per Dry Ton
Phosphorus	24
Potash	50
Calcium	63
Magnesium	15
Iron Credit	7.2
Zinc	0.3
Total Salt	51

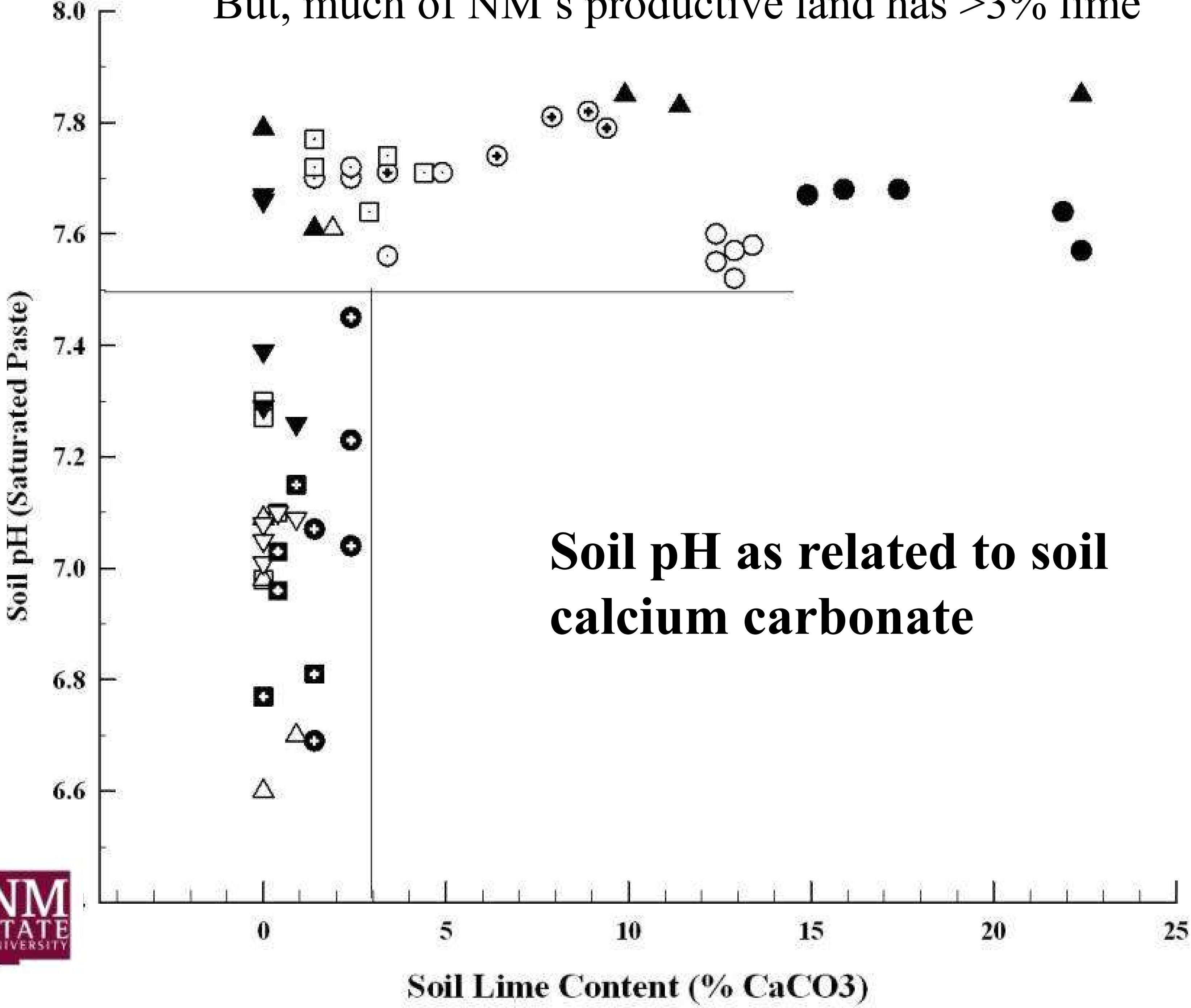
Effluent Characteristics



706 lb total salt per acre inch

Fall 2003, n = 48 sampled dairies

But, much of NM's productive land has >3% lime



Soil pH as related to soil calcium carbonate

Soil pH = 7.3
Iron = 12 ppm (VH)
Free lime = medium (~2%)

Choices:

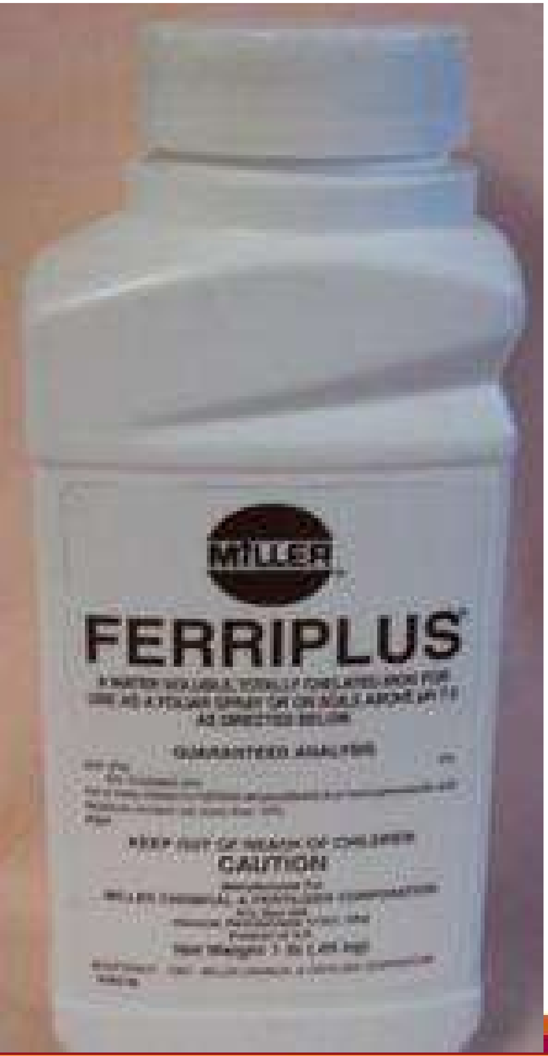
- Elemental S
- Ironite
- Sequestar
- Fe-EDDHA
- Fertilome's Chelated (EDTA) Liquid Iron Product

Client results

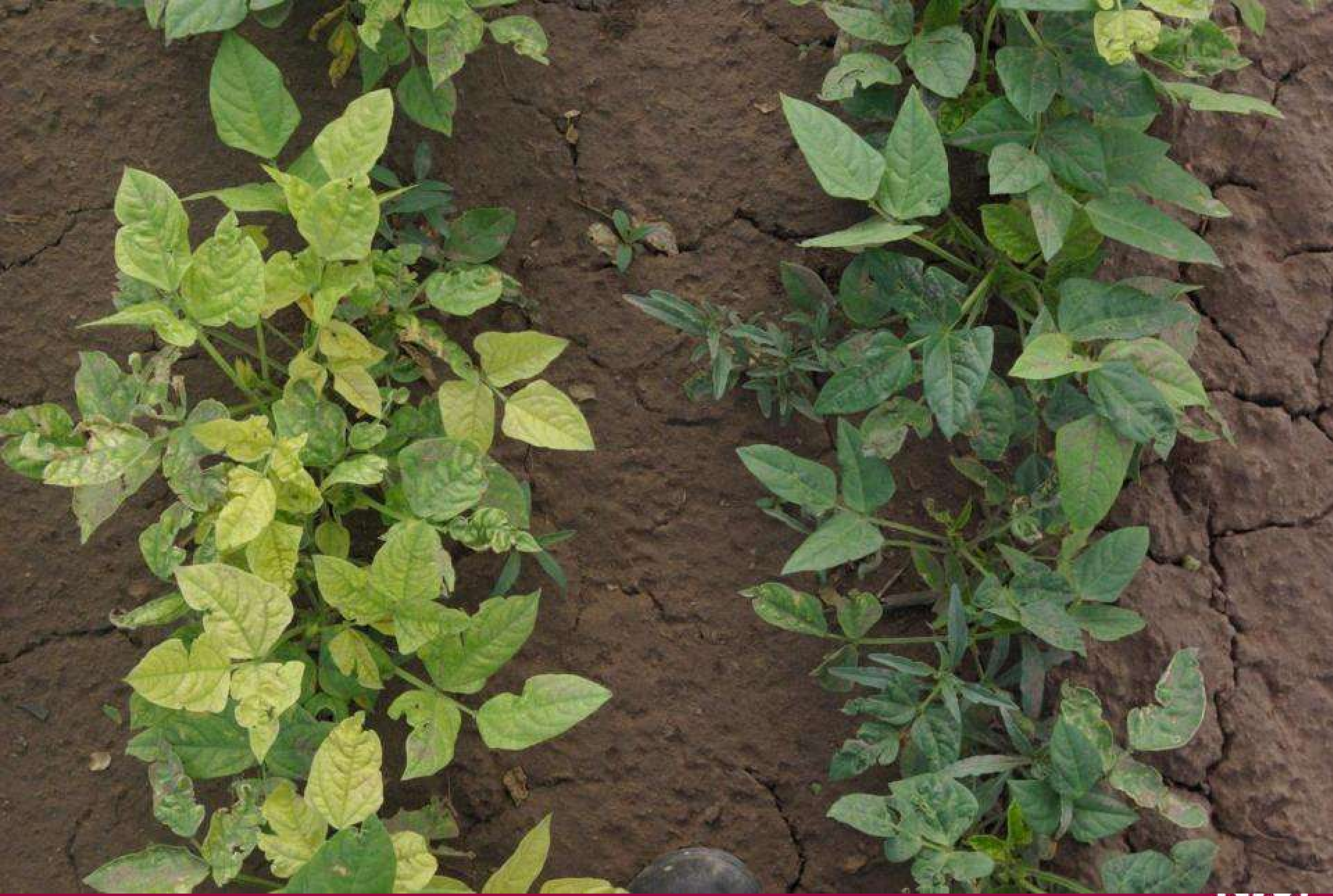
- Fertilome & Ironite is a very rich green color. Most successful products.
- EDDHA had not greened up much


Soil pH >7.5
% Lime = 20%

EDDHA Chelate

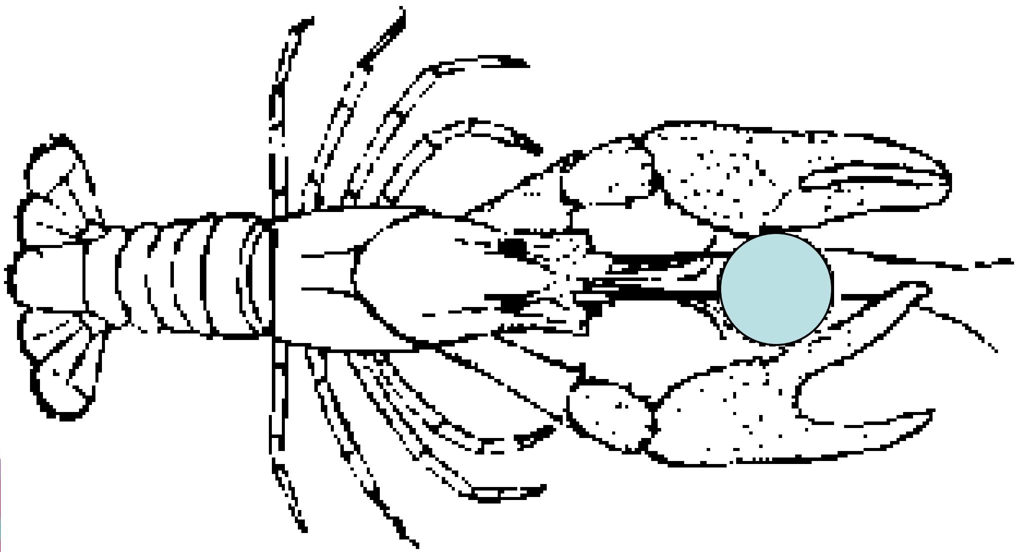


- Miller's Ferriplus
- Some additional N may help the chelate do a better job.

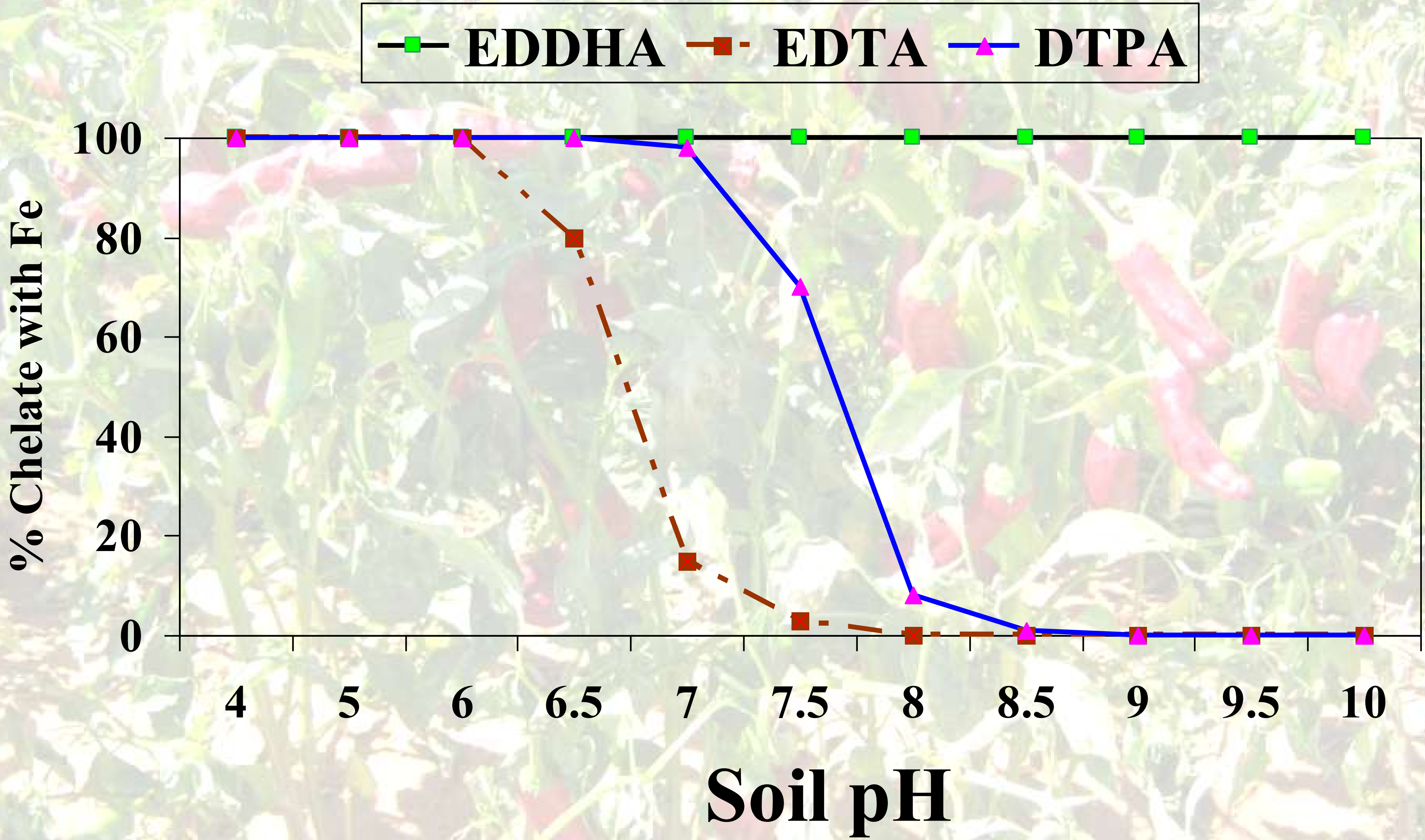


The Chelates

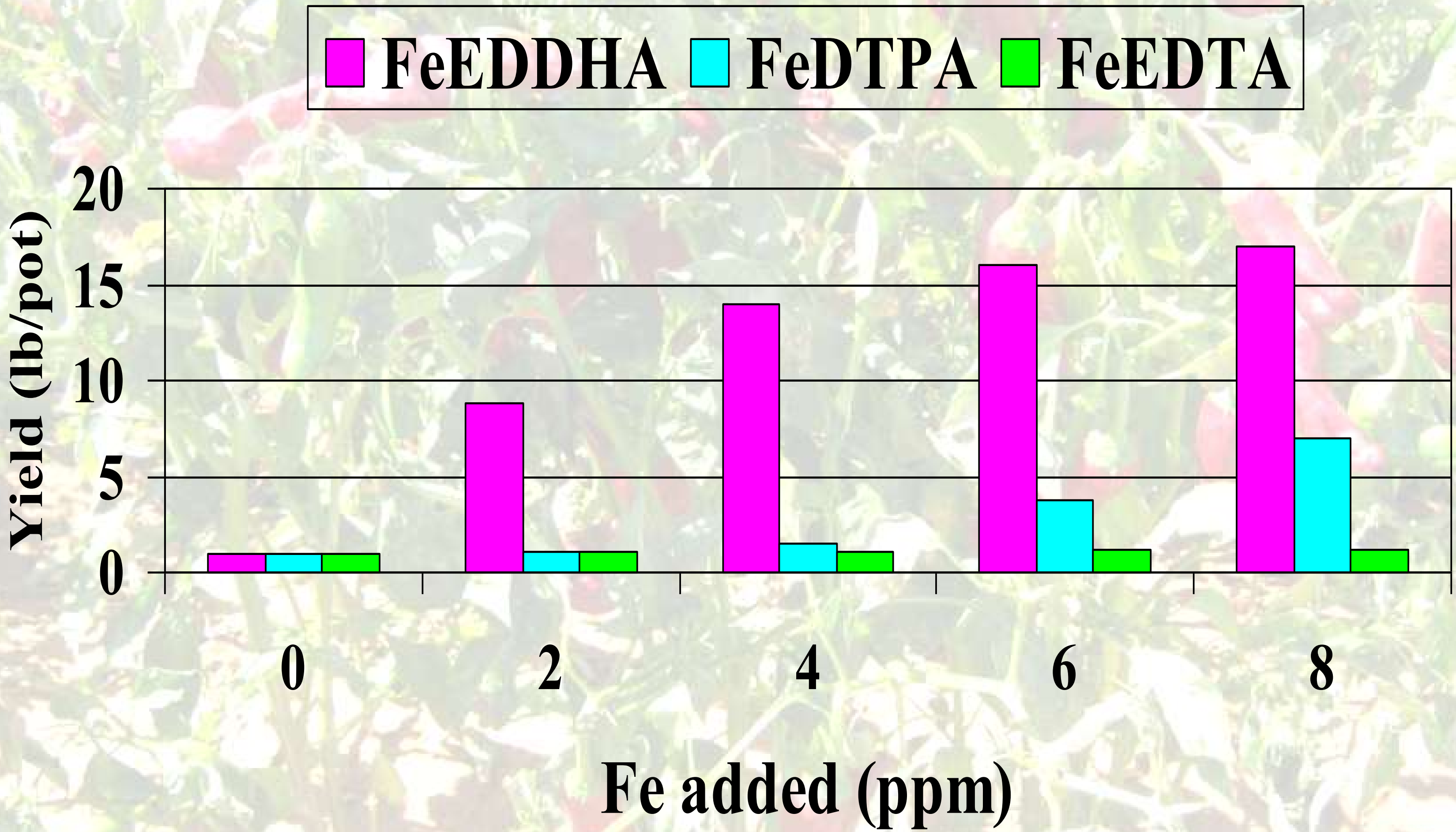
- Organic Molecules that “hold” metals like Iron, Zinc, Nickel, etc.
- Hampene
  - (Fe)EDTA
- Sequestrene 138
  - (Fe)DTPA
- Miller’s Ferriplus
  - (Fe)EDDHA



Stability and Availability



Chelate Effectiveness



Remember

- Using problems like iron deficiency is an opportunity to test different sources of iron. Not only for effectiveness but for cost.

Milorganite?
Composted WWTP solids?

Nutrient Sources

- Incomplete
  11-52-0
- Complete
  10-10-10
- Solids
- Liquids
- Quick Release
- Slow Release
  - Includes organics

Quick Release N Fertilizers

Carrier	Grade	% N	Residual Response	Burn Potential	Leaching Potential
UREA	46-0-0	45-46	short	High	Moderate
Ammonium sulfate	21-0-0	20.5 - 21	short	High	High
Potassium nitrate	13-0-44	13	short	High	High

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Slow Release N Fertilizers

Carrier	Grade	% N	Residual Response	Burn Potential	Leaching Potential
IBDU	Variable 24-4-12	Variable 24	Moderate	Moderate Low	Low
Sulfur Coated Urea	21-0-0	20.5 – 21	Moderate	Low	Low
Resin-coated	24-0-0 to 35-0-0	13	Mod to Long	Low	Low
Methylene coated and ureaformaldehyde	38-0-0	38	Mod to Long	Low	Low

IBDU = isobutylidene diurea

Nitrogen can be volatilized Especially in high pH soils

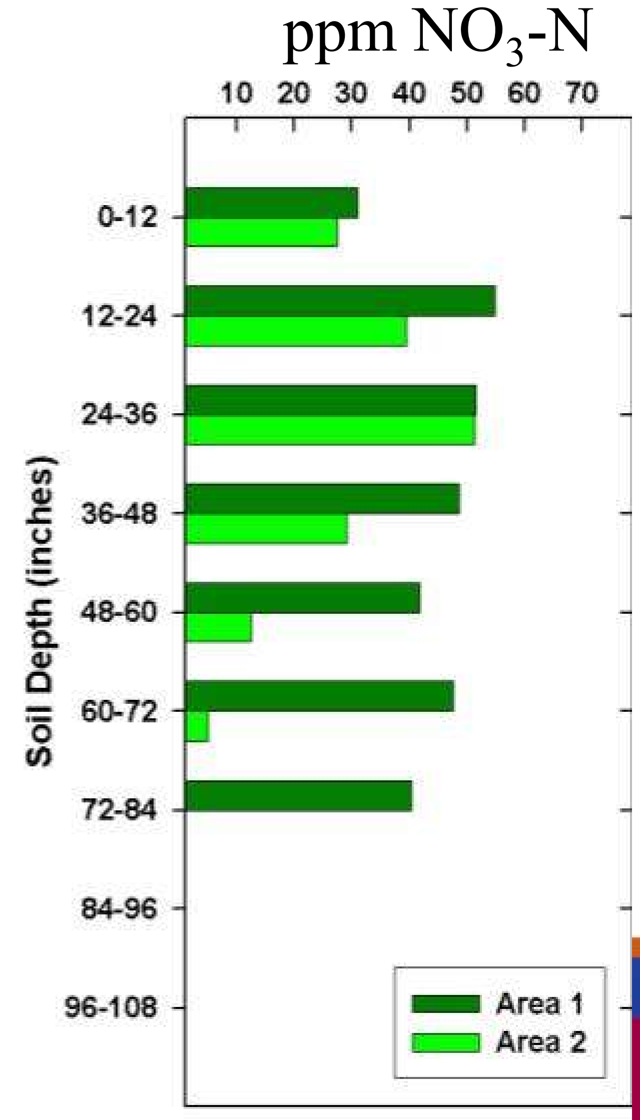
- Some products have been demonstrated to lower volatilization rate
  - Agrotain® on urea if not able to irrigate in
  - Or be sure to irrigate in with at least 3/10” to ½” of water immediately after application.

Nitrogen Carriers

- Ammonium Sulfate (NH_4^+)
- Urea (CH_4N_2O)
- UAN (Urea Ammonium Nitrate)
- Calcium Nitrate ($Ca(NO_3)_2$)
- Ammonium Nitrate (NH_4NO_3)
- Organic Sources through Mineralization

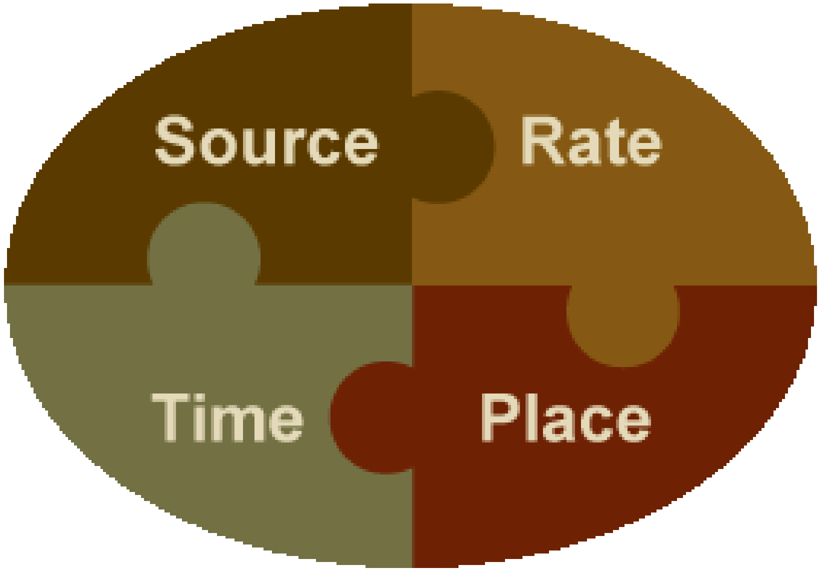
Beware of Volatilization / Leaching

- Ammonium containing fertilizers subject to volatilization losses.
  - Additives may reduce volatility (eg. Agrotain)
- Nitrate containing fertilizers subject to leaching with too much applied water.



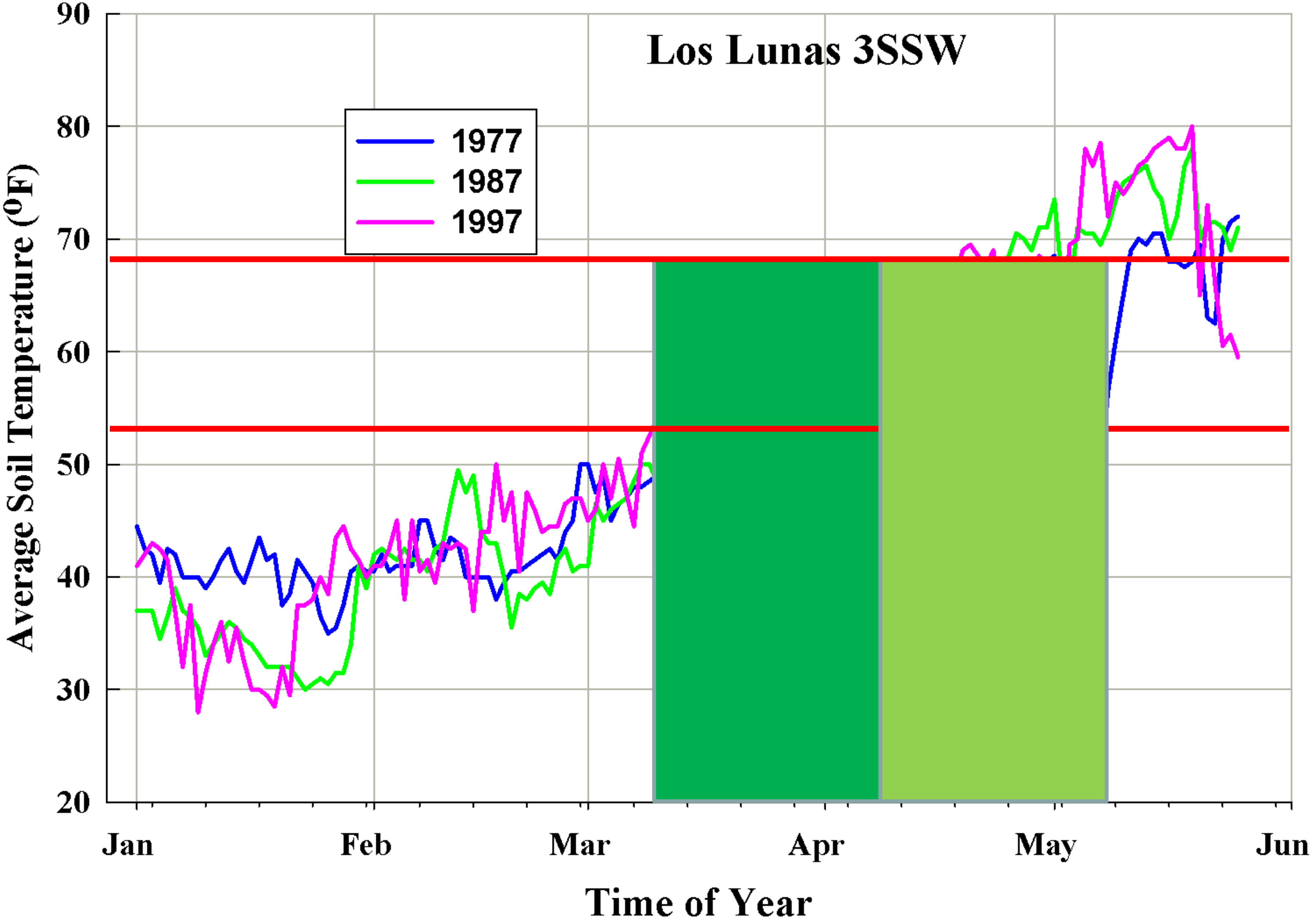
The 4 R's

- Right Source
- **Right Time**
- Right Place
- Right Rate



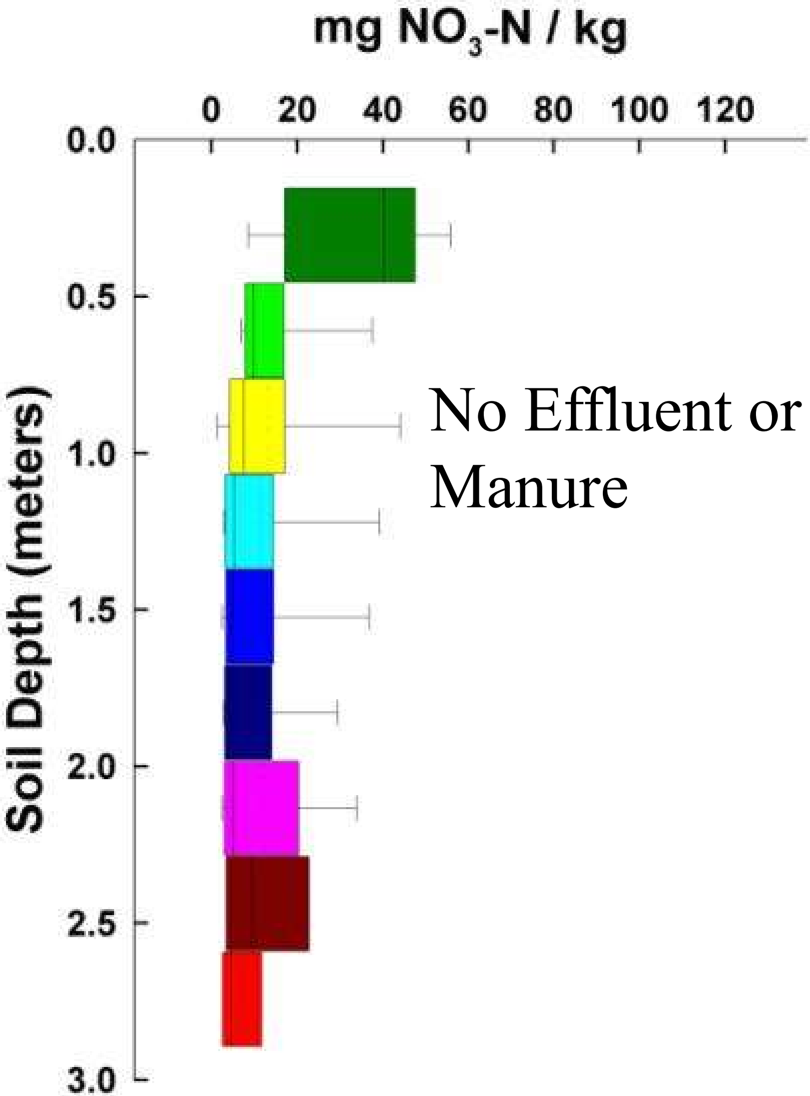
TIMING OF N APPLICATION Example: Apples

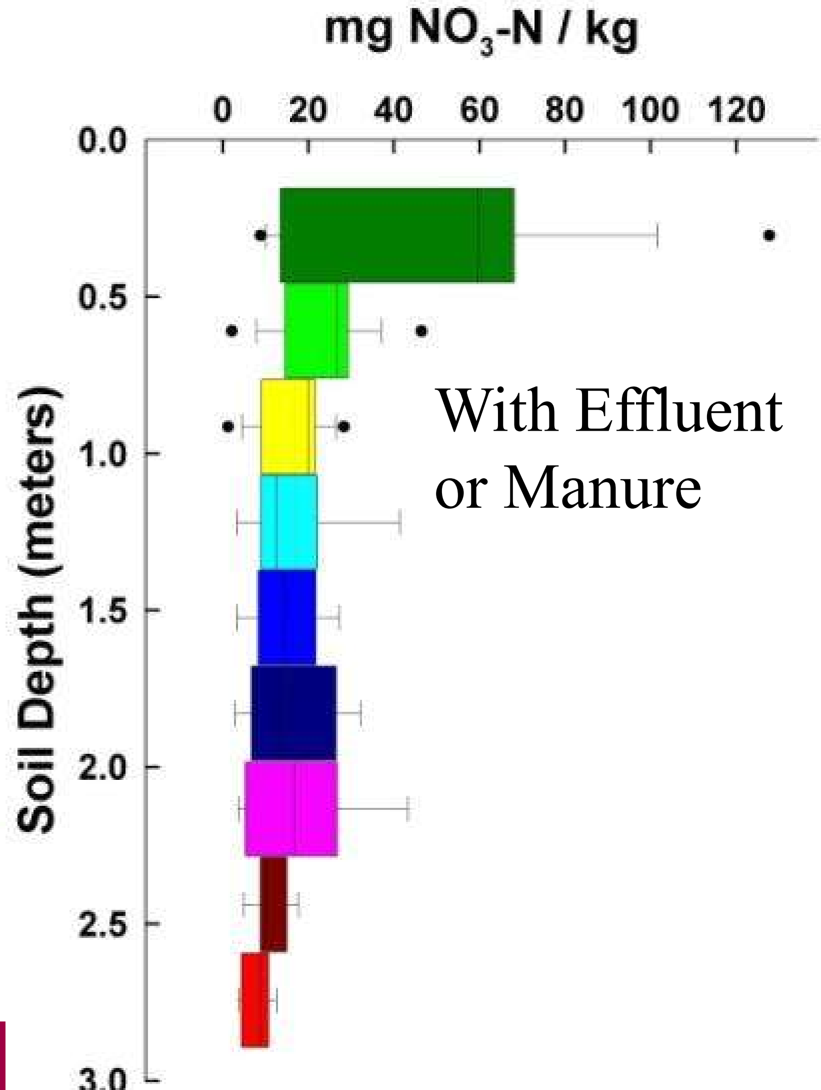
- **N uptake by apple roots begins about 3 weeks after bud-break.**
- **BUT – Soil Temperature also affects uptake**
  - **Soil Temps 54°F to 68°F enable tree to take up more N**
    - **1/3 N remains in roots**
    - **2/3 N moved to shank, stem, and new growth**



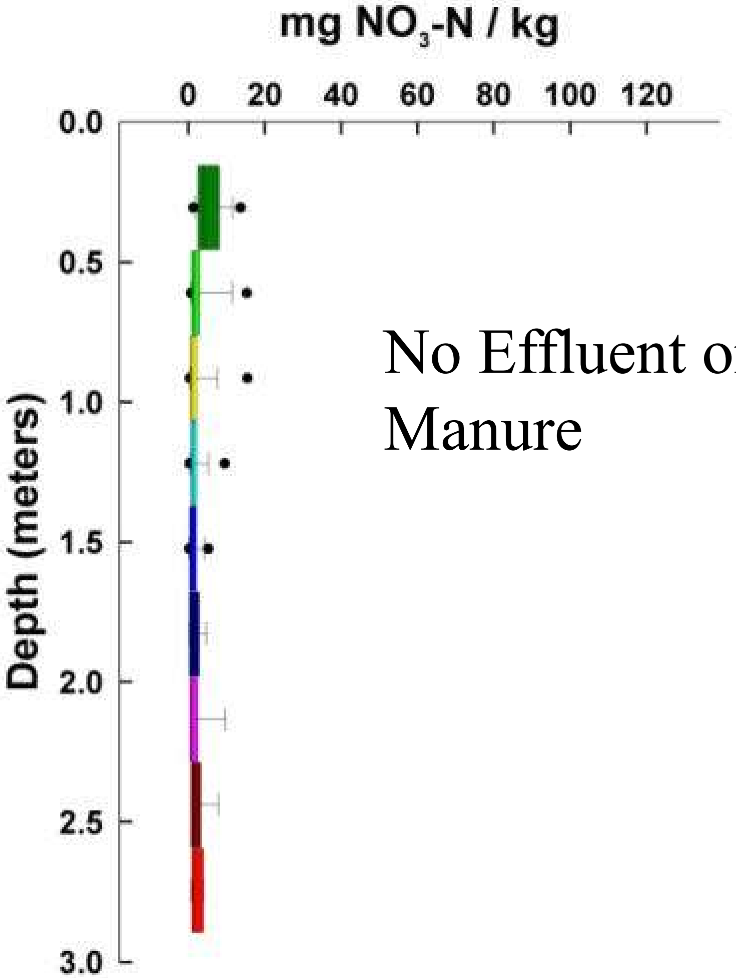
Los Lunas 3SSW
1977
1987
1997
90
80
70
60
50
40
30
20
Average Soil Temperature (^{0}F)
Jan
Feb
Mar
Apr
May
Jun
Time of Year

Timing Important for Irrigated Fields
Flood/Furrow Irrigated Fields

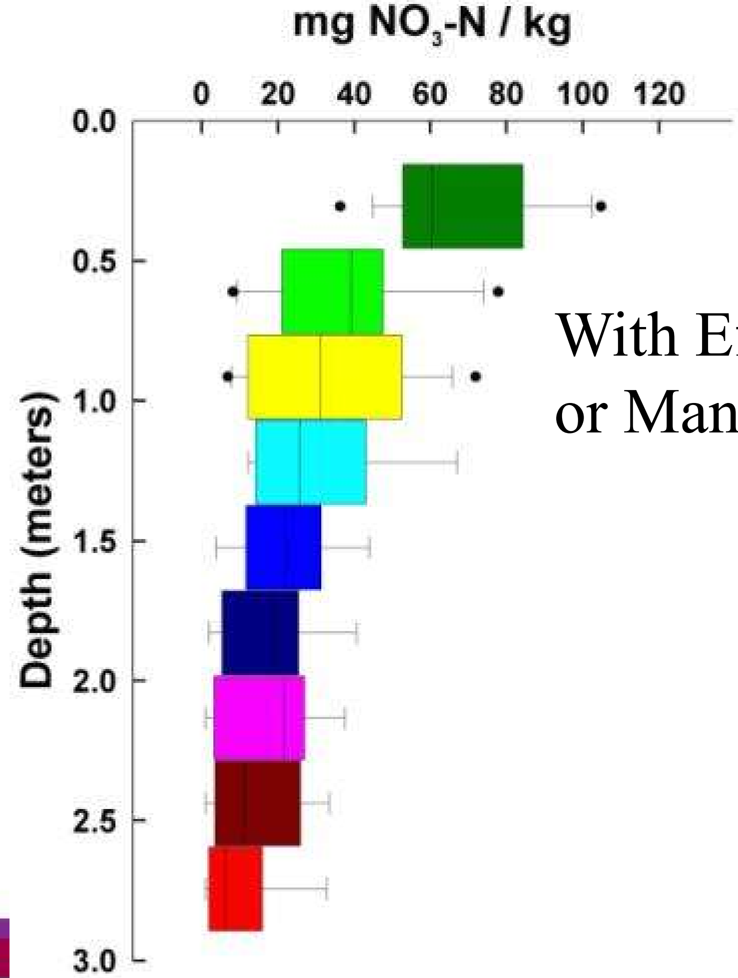




Pivot Irrigated Fields

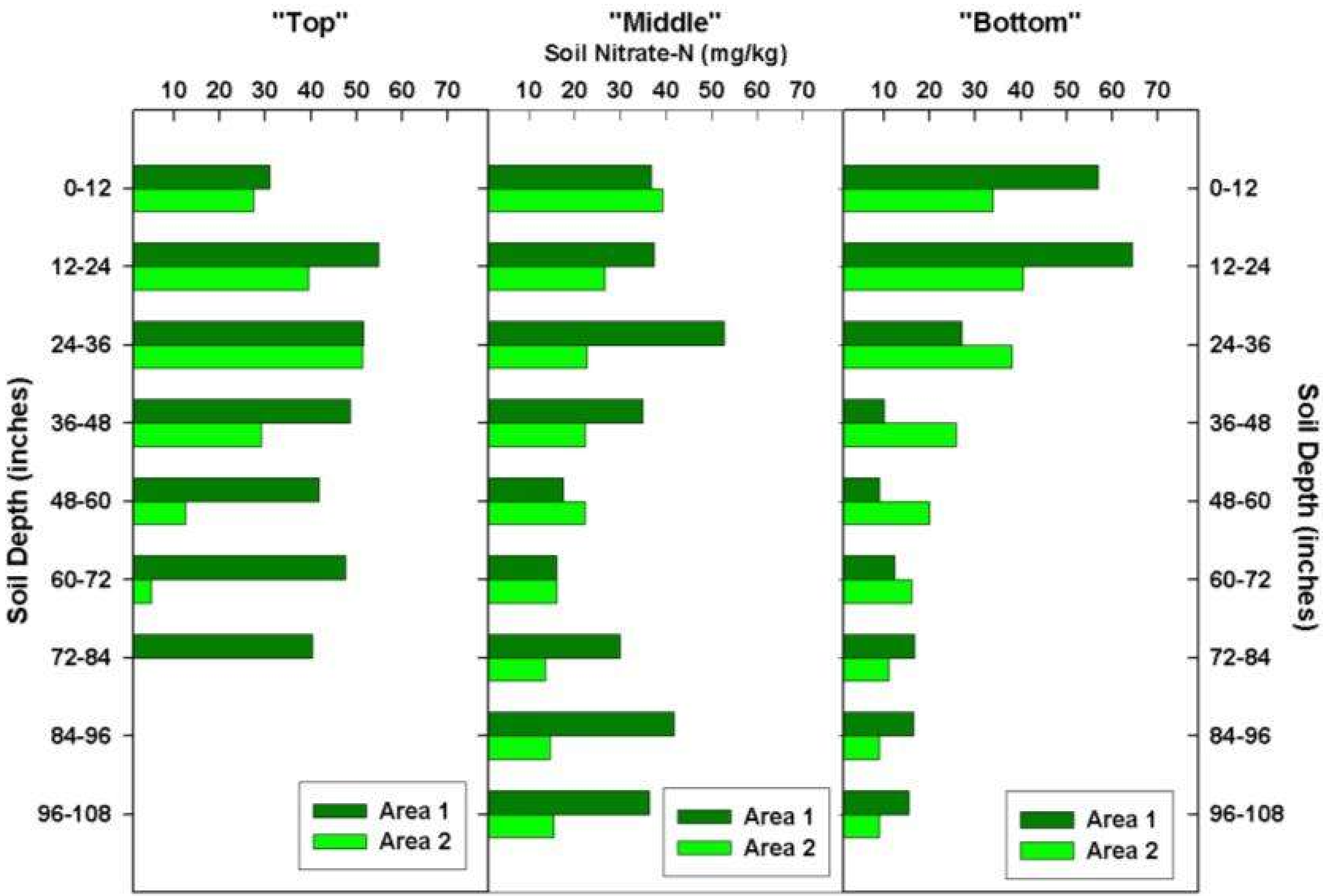


No Effluent or Manure



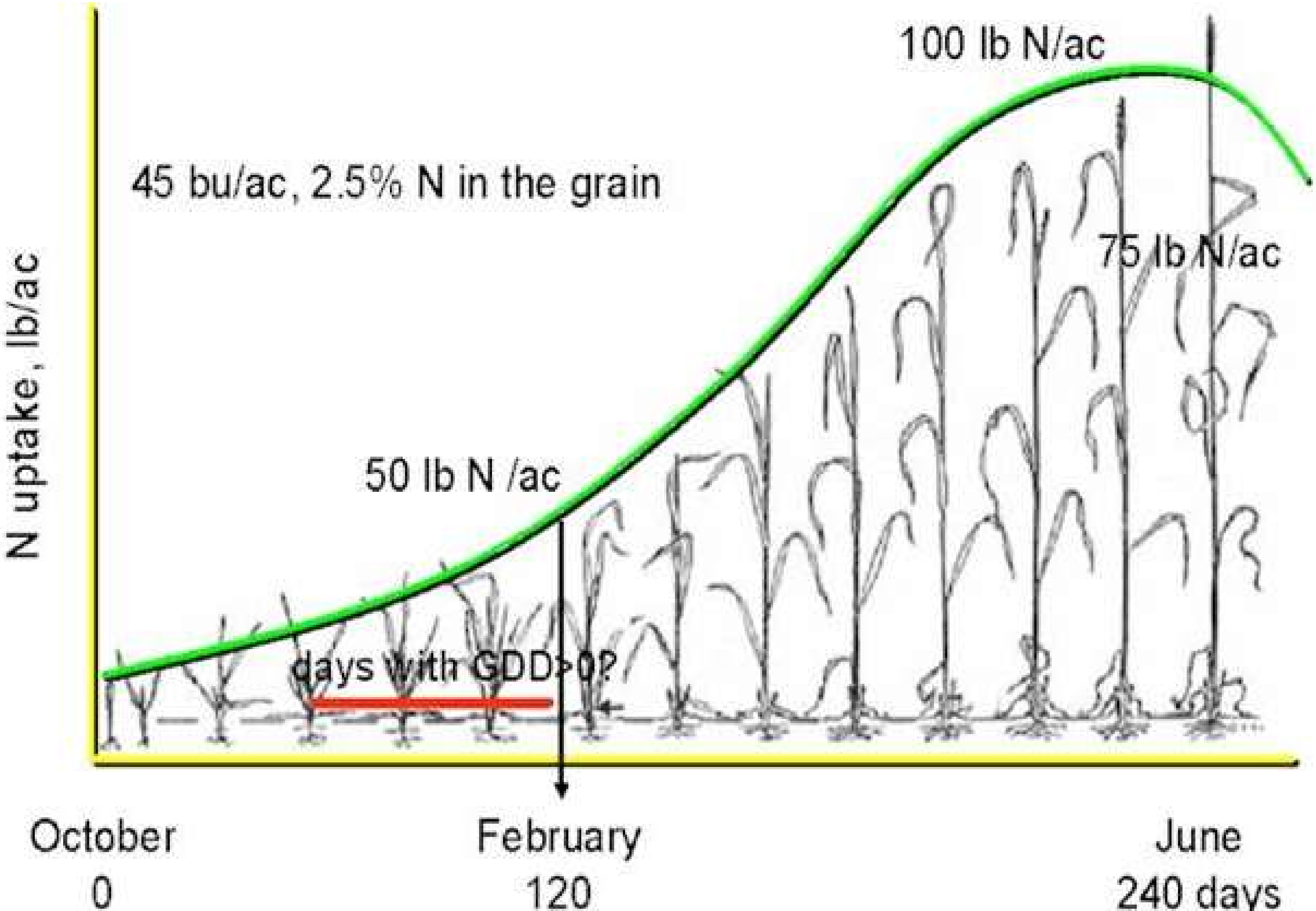
With Effluent or Manure

Leaching

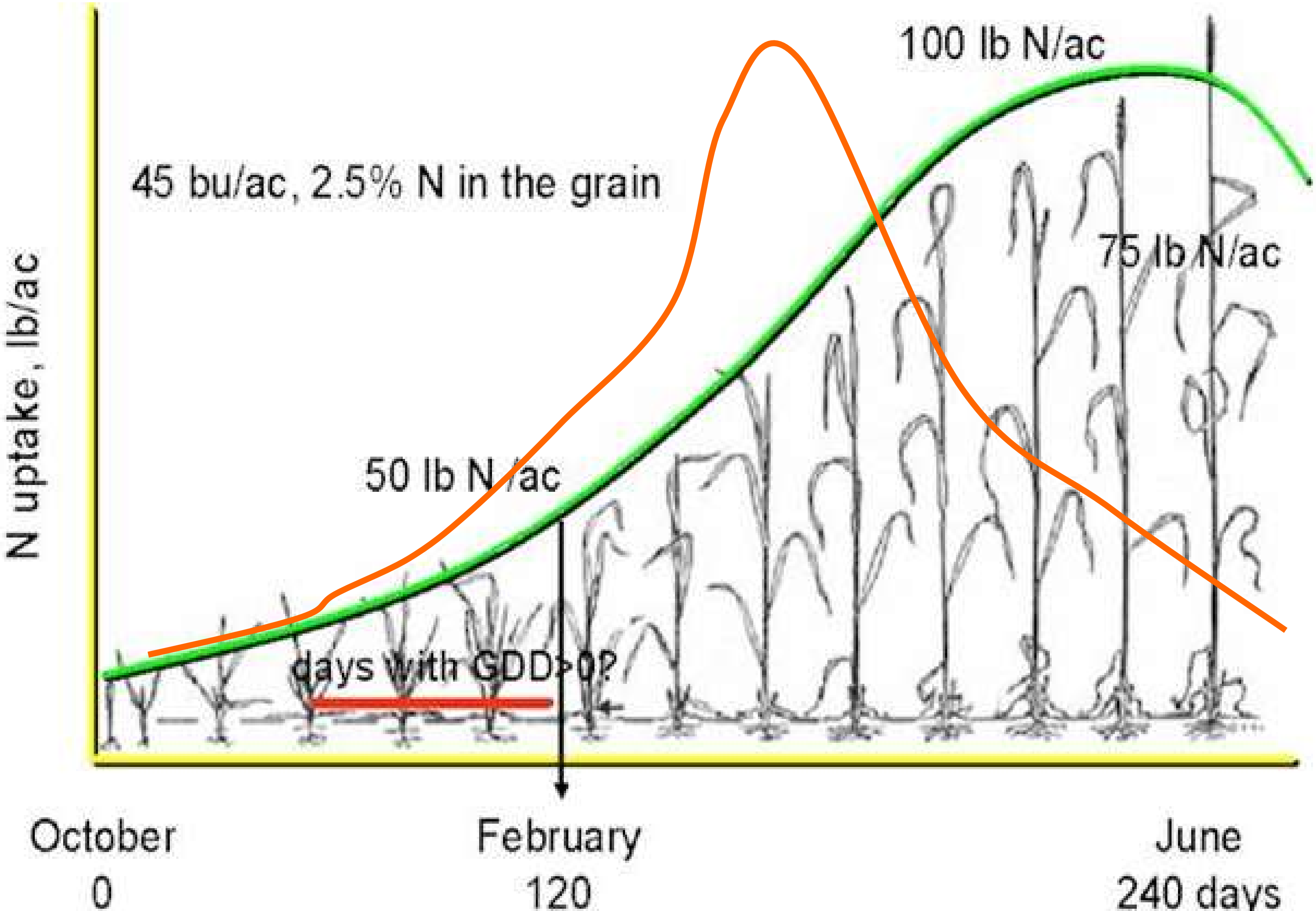


"Top"
"Middle"
"Bottom"
Soil Nitrate-N (mg/kg)
10 20 30 40 50 60 70
Soil Depth (inches)
0-12
12-24
24-36
36-48
48-60
60-72
72-84
84-96
96-108
Area 1
Area 2

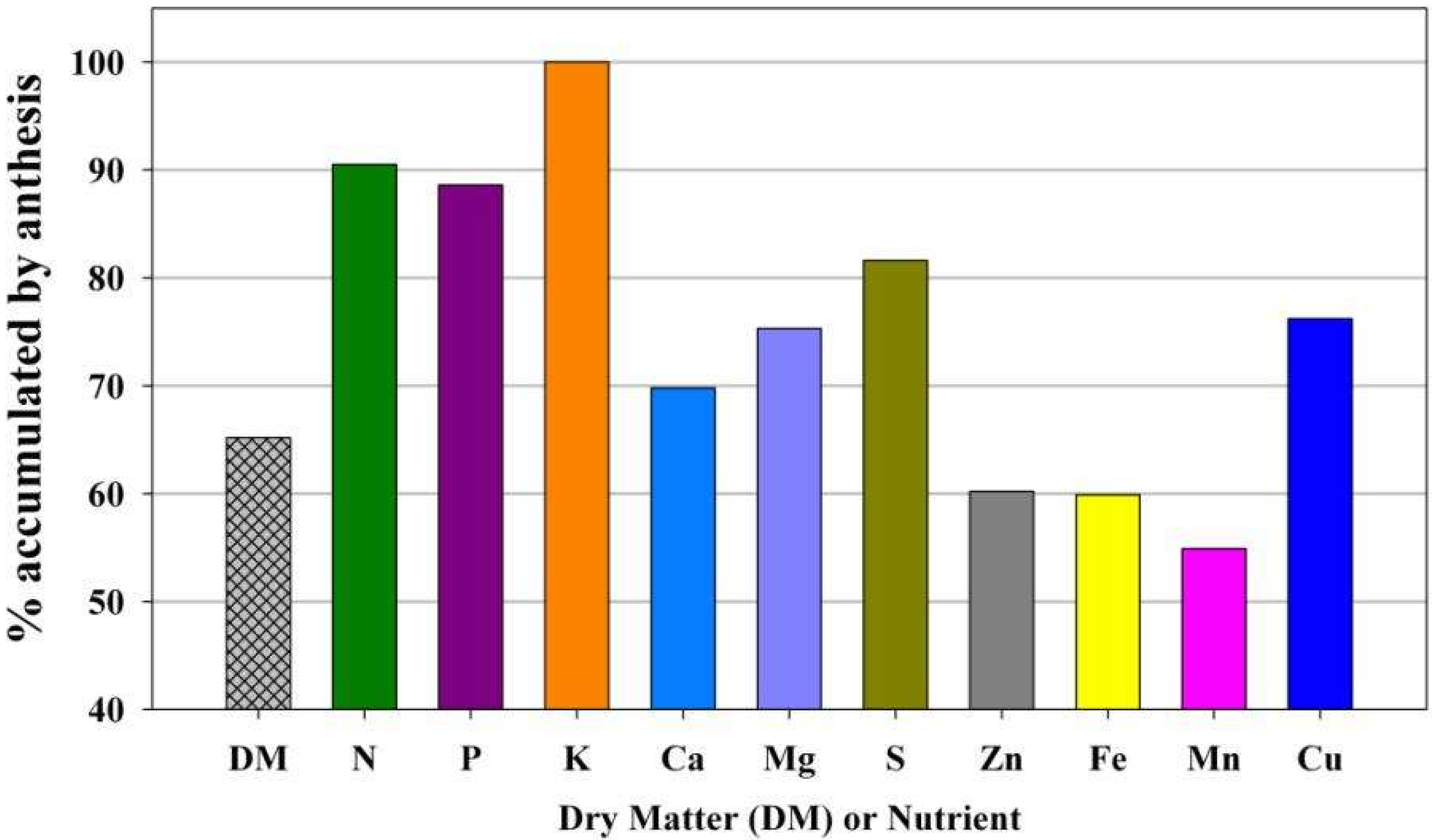
Timing Applications – small grains example



Timing Applications



Proportion of Above-ground DM & Nutrients in Irrigated Spring Wheat



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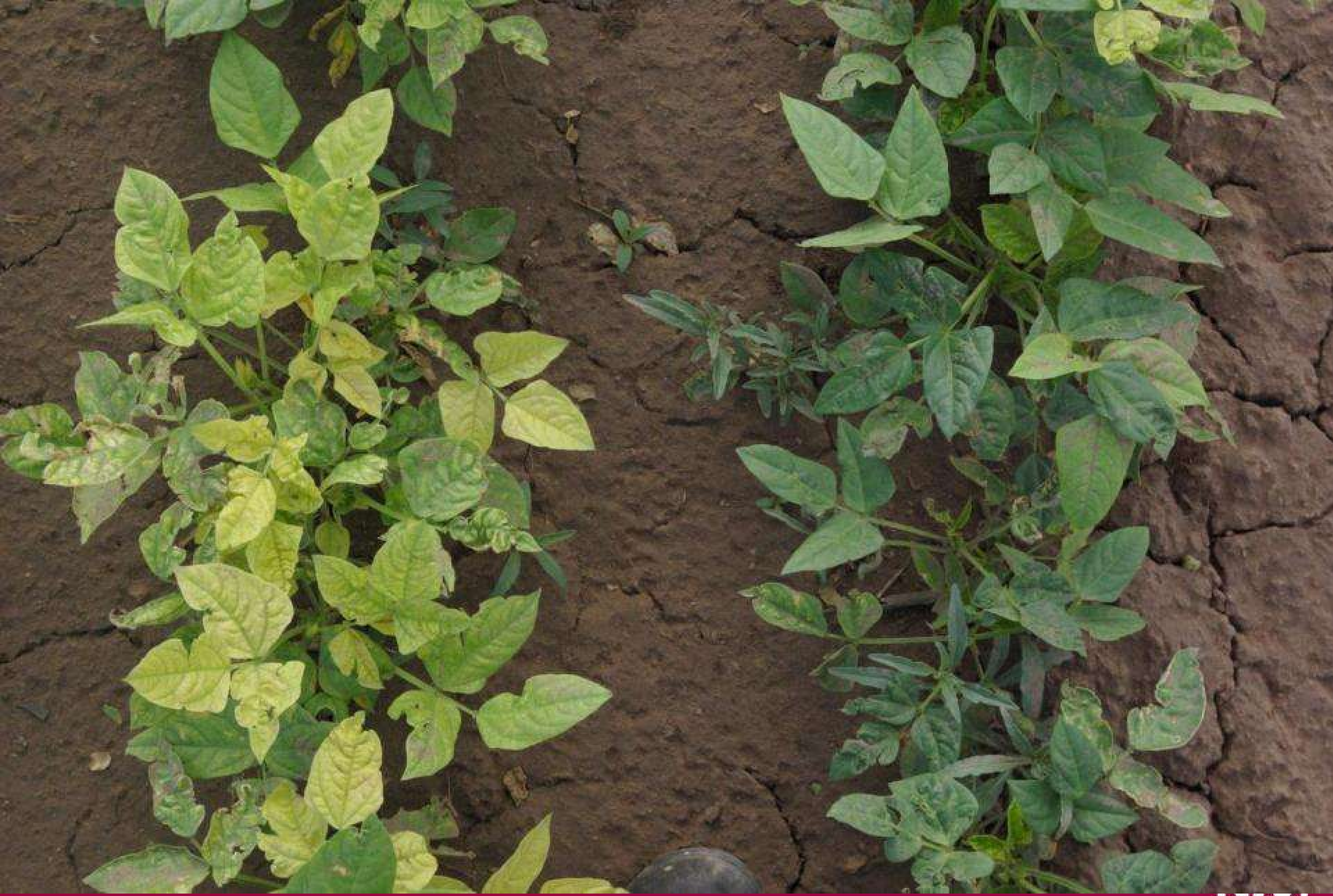
Strawberry before EDDHA application

Wendy **Brunswick** **Chandler** **Allstar**

Strawberry after EDDHA



The 4 R's

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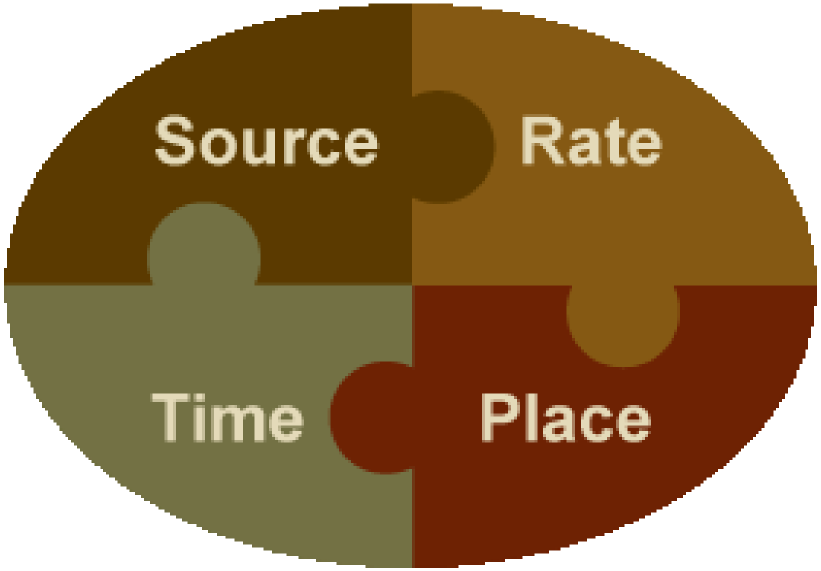
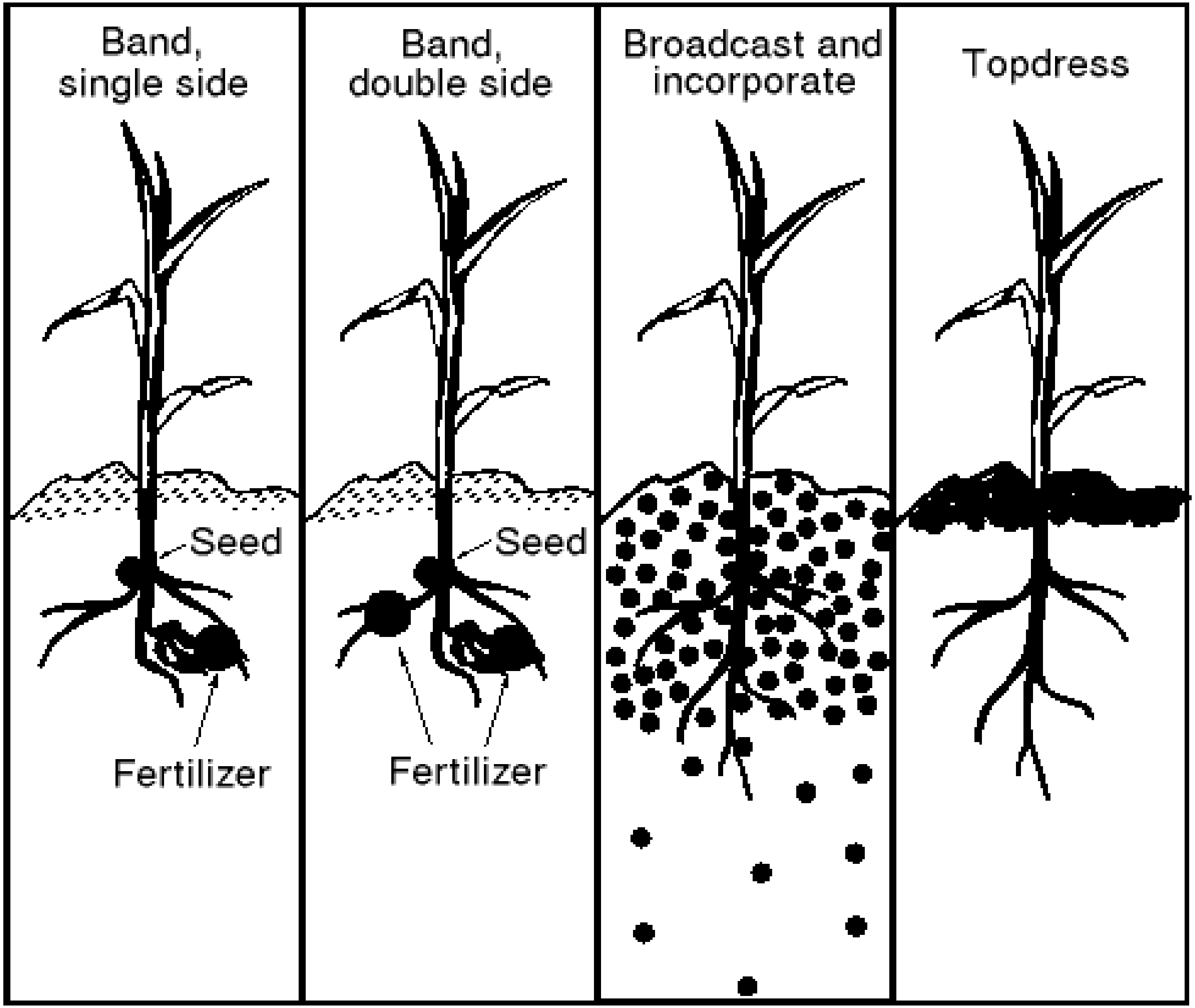
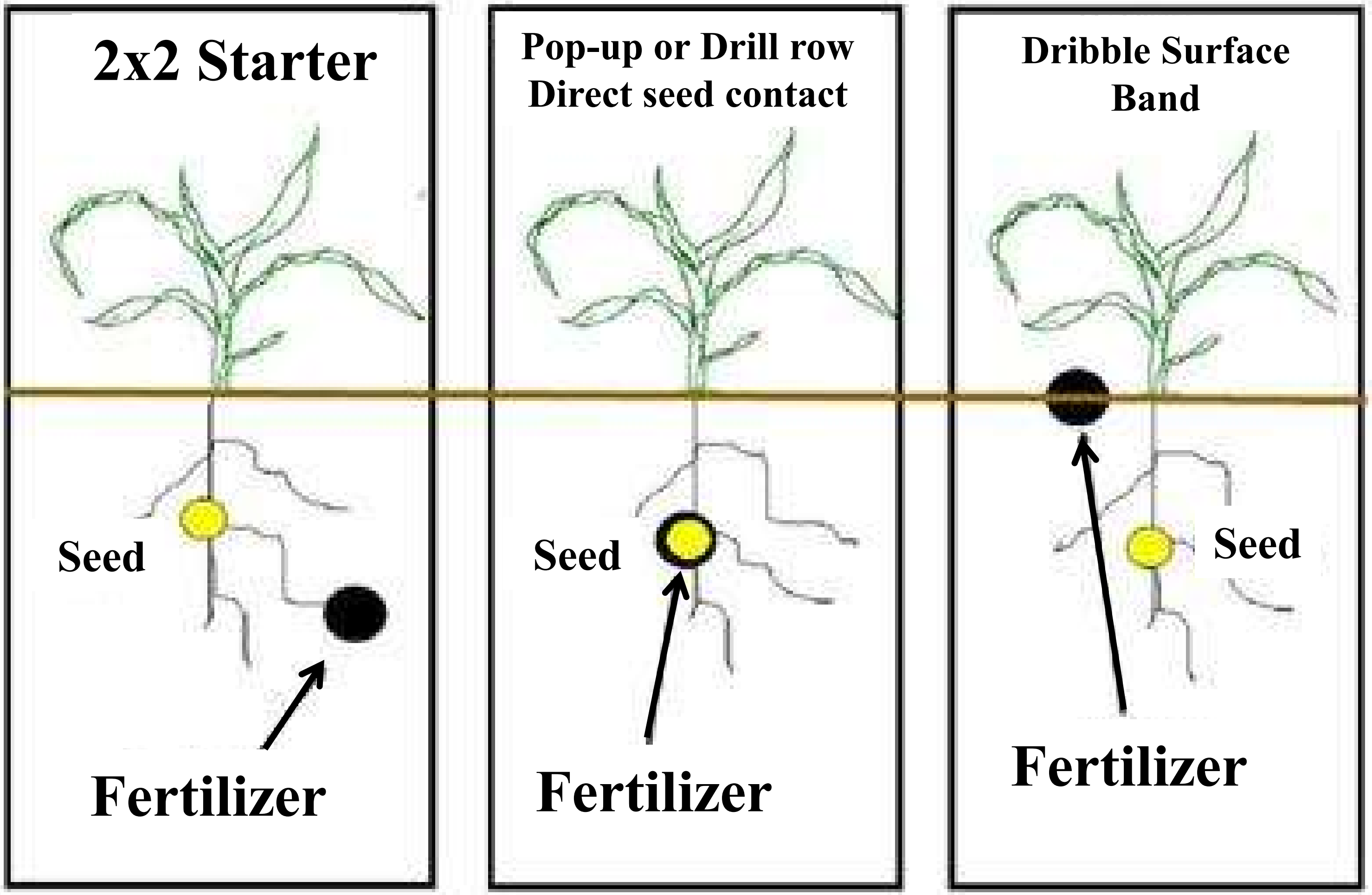


Definitions

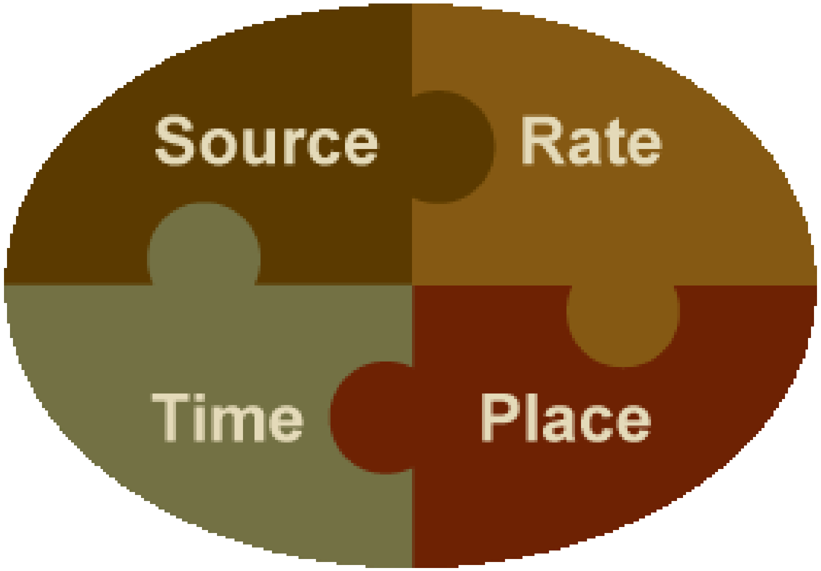


Starter Fertilizer Configurations



The 4 R's

- Right Source
- Right Time
- Right Place
- **Right Rate**



Insert Soil Test Results
Help Me
Load Soil Test
Soil Test Details
Sampling Date
Plot
Crop
Texture
Silt loam
Layer Depth
20
cm
CEC
meq/100g
Bulk Density
1.20
ton/m3
OM
2.20
(%)
EC
Extract
ds/m
pH
Paste
Average Temp.
(°C)
SAR
For soil extract only
Soil Lab
Smart Soil Lab
Nutrient Application Rules
Smart Nutrient Application Rules
Soil Test Results
Elements
N
P
K
Ca
Mg
S
B
Fe
Mn
Zn
Cu
Extraction Method
Kjeldhl
Olsen
Mehlich-1
Ammoniu...
Ammoniu...
KCl 40
Hot Water
DTPA
DTPA
DTPA
DTPA
Test Results *
ppm
10.00
30.00
22.00
1804.00
480.00
8.00
4.000
2.300
0.800
Interpretation
Low
High
Adequate
Adequate
Excessive
Adequate
High
Low
Adequate
Interpretation Chart
Excessive
High
Adequate
N
P
K
Ca
Mg
S
B
Fe
Mn
Zn
Cu
Mo
Na
Cl

Nutrient Rate Recommendation

Nutrient Recommendation:		N lbs/ac	P_2O_5 lbs/ac	K_2O lbs/ac
Recommended Nutrient Rate:		180	0	0
Organic Nutrient Source (Liquid or Solid Manure):		72	240	544
Irrigation Water Credits (ppm NO_3-N):	5	20		
Other Nutrient Sources (Standing Legume Crop.):				
Supplemental Nutrient Rate:		88	0	0
Available Nutrients > Crop Requirements:		NO	Caution P	Caution K

General Note: Apply P and K in the spring. Split N into 2-4 applications with the first in e

N – P_2O_5 – K_20, others

Green Manures

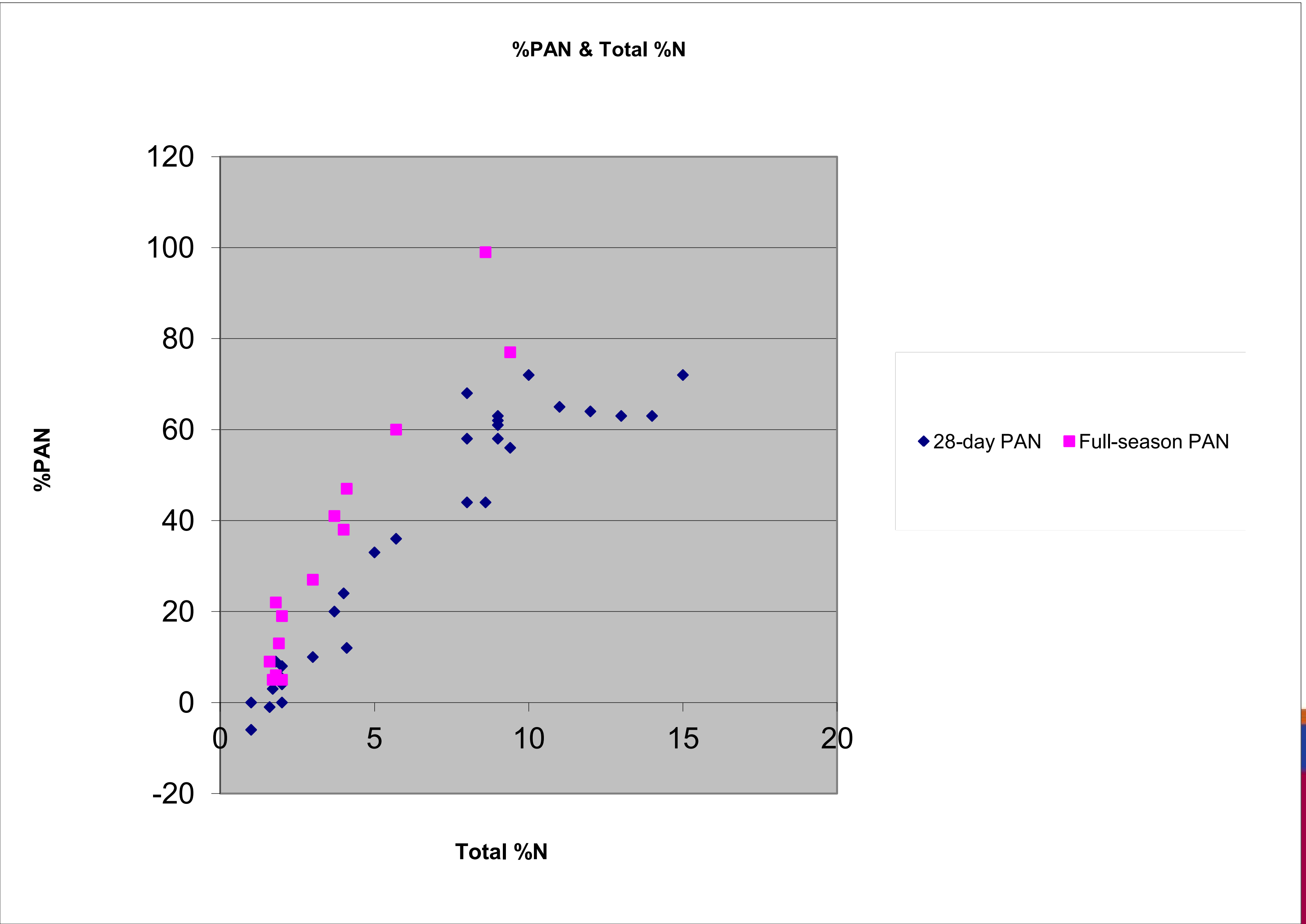
Determining Organic Source Rate

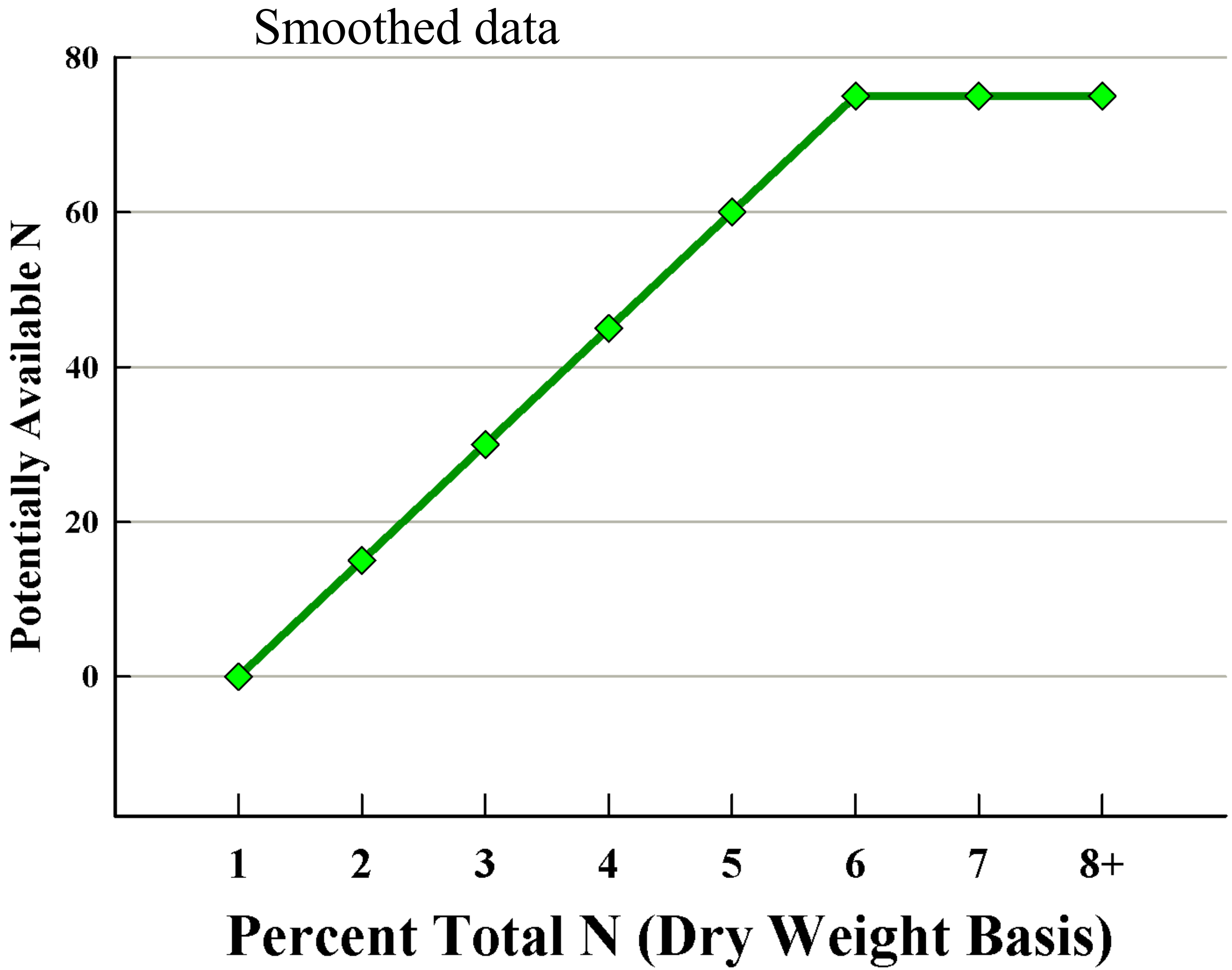
- Verify C:N Ratio
- Season = 125 days
  - 2200 GDD (0°C base)
- §: Chicken Composts similar to uncomposted 4% N material

Total N	C:N	PAN† (% of Total N)	
% of DW		28 d	Season
	Uncomposted Materials		
1	35	<0	0
2	18	0	15
3	12	15	30
4	9	30	45
5	7	45	60
6	<6	60	75
7	<6	60	75
8+	<6	60	75
	Composts§		
1	30	0	10
2-3	10-15	5	15

†Dan Sullivan, OSU

Measured Data




Smoothed data
80
60
40
20
0
Potentially Available N
1
2
3
4
5
6
7
8+
Percent Total N (Dry Weight Basis)

When low soil nutrients Cool Season Grasses

Grass	lb N/1000 sq ft
Tall fescue	2-4
Perennial ryegrass	2-4
Creeping bentgrass	3-8

When low soil nutrients Warm Season Turf

Grass	lb N/1000 sq ft
• Improved bermudagrass	• 4-8
• Buffalograss	• 0-2
• St. Augustinegrass	• 2-4
• zoysiagrass	• 2-4

4R Nutrient Stewardship