

Salinity Basics – Soil Testing

Robert Flynn, Ph.D.

Associate Professor, Extension Plant Sciences

505-748-1228

rflynn@nmsu.edu



Salinity Refers to:

- **Presence of the major dissolved inorganic ions in water:**
 - Mg^{+2} Ca^{+2} Na^{+} K^{+}
 - Cl^{-} SO_4^{-2} HCO_3^{-} CO_3^{-2}
- **In Soil: salinity refers to the soluble plus readily dissolvable salts in the soil, or more usually, in a water extract of a soil sample.**

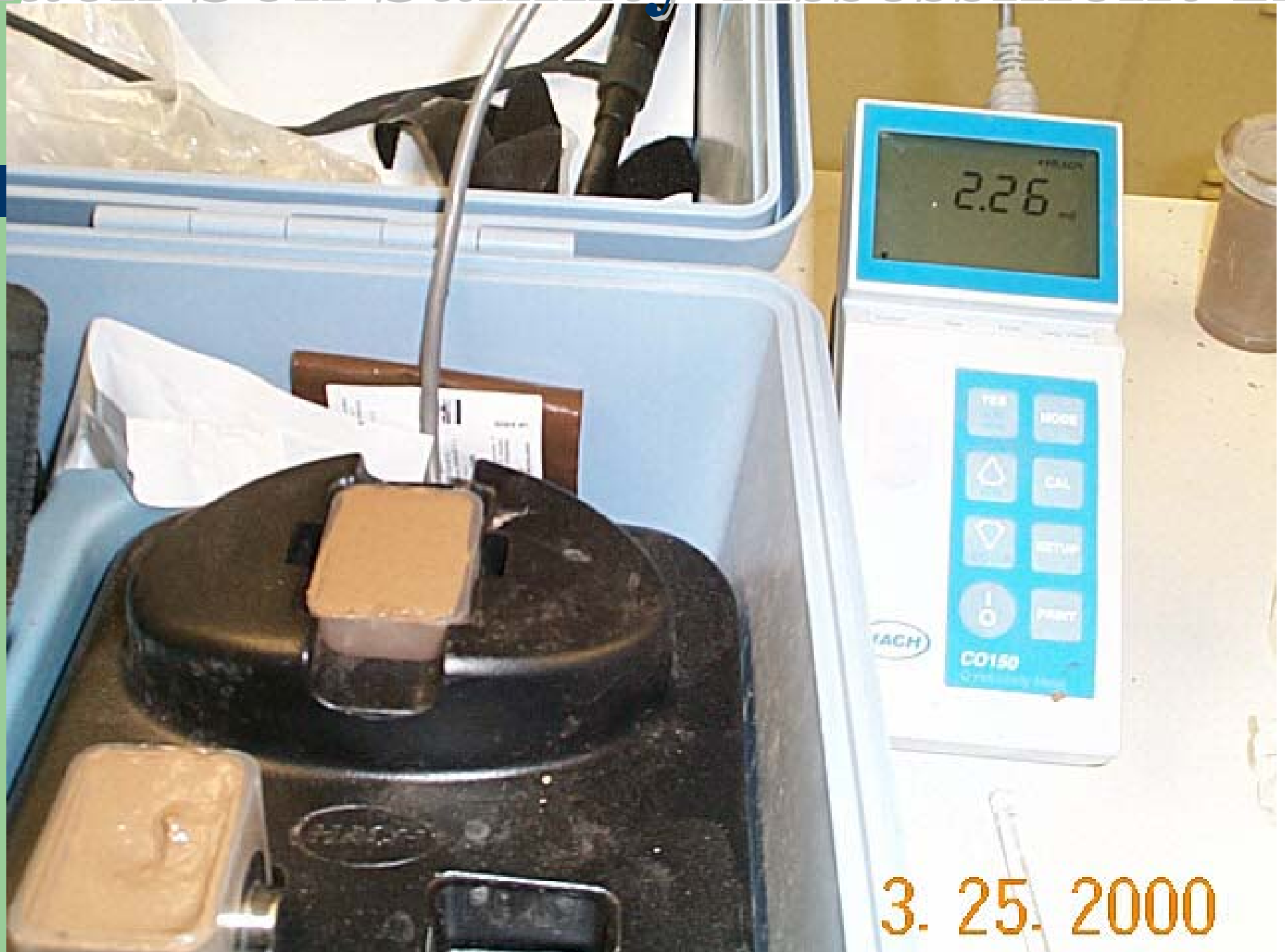
Total Salinity

- Easily measured in the field using electrical signals from various sensors.
- Great for diagnosing, surveying, and monitoring soil salinity, and for assessing the adequacy of leaching and drainage.
- Because the absolute and relative amounts of salts are influenced by the soil to water ratio used for the extract...

The Saturated Paste Is Used:

- This water content varies with soil texture but is used because it is the lowest amount of water for most soils for which enough sample can be retrieved for testing.
- It is also better related to soil-water contents under field conditions.
- For these reasons, crop tolerance to salinity also is expressed in terms of the of the saturated paste extract (EC_e)

Hach Soil Salinity Assessment Kit



Extraction Ratios 1:1, 1:5, Etc.

- These are easier to make and require far less time,
- But they are less well related to field soil water composition and content.
- Most labs compensate by using 1 part soil to 2 parts water by volume, since it is closer to the saturation paste
- This is fine for monitoring changes over time.

Demonstration Time

- What exactly is the lab measuring?



Fertilizers are Salts too

- Most nitrogen and potash fertilizers have high salinity indexes.
- Phosphate fertilizers have low salinity indexes.
- When applied too close to seed or on foliage the compounds with high salt indexes can wilt or kill plants.
- So be careful!

7.1

2.7

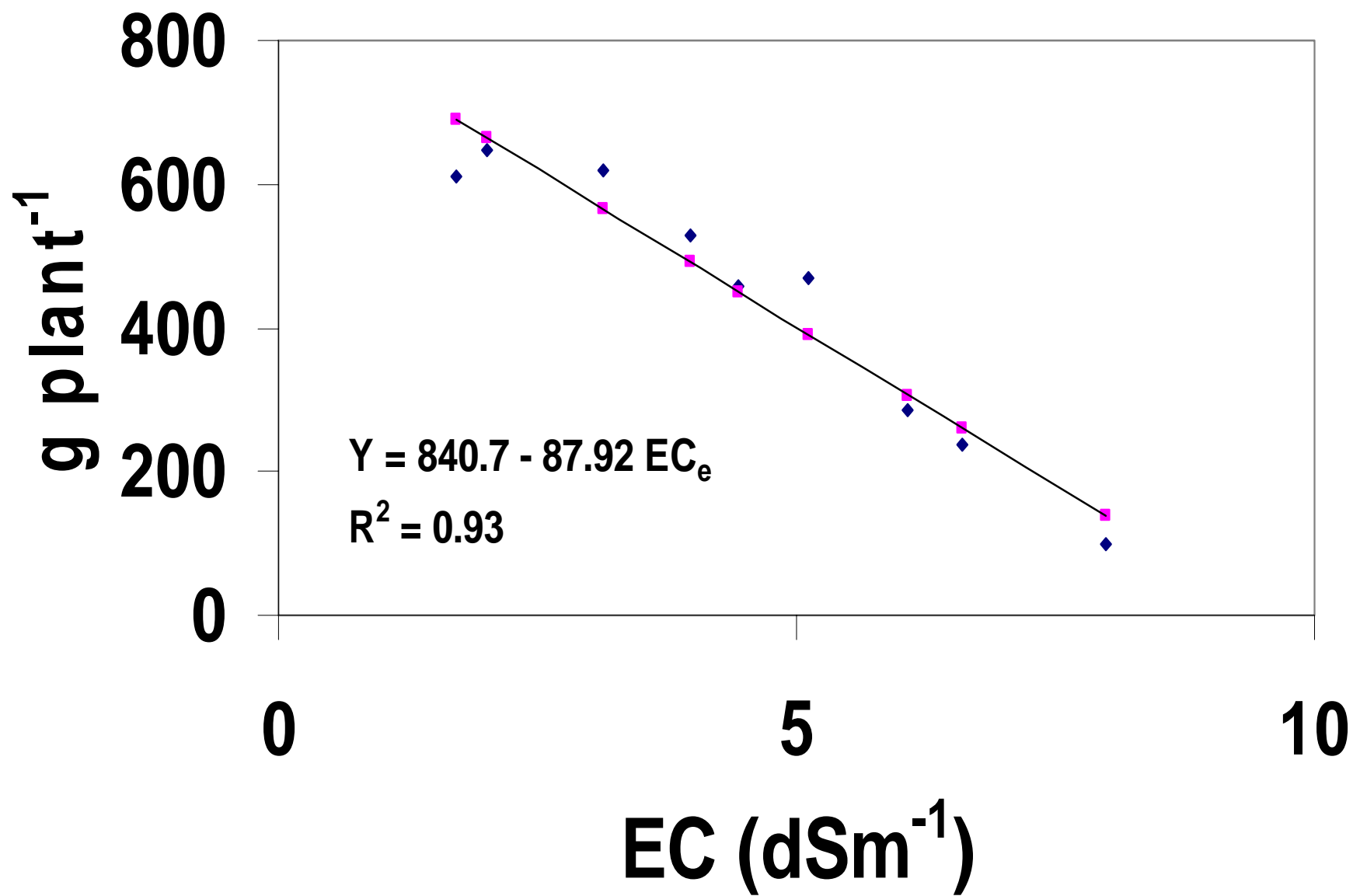
4.3

1.5

8.2

1.7

3.2



Yield as a function of EC_e

Plant Selection

- Chile
- Threshold = 1.7 dS/m
 - Slope = 12% per unit (1 dS/m) above the threshold
 - A crop grown on a soil with an ec reading of 3.7 would potentially experience a 24% yield depression.
- Chile is Moderately Sensitive to Salinity

Plant Selection

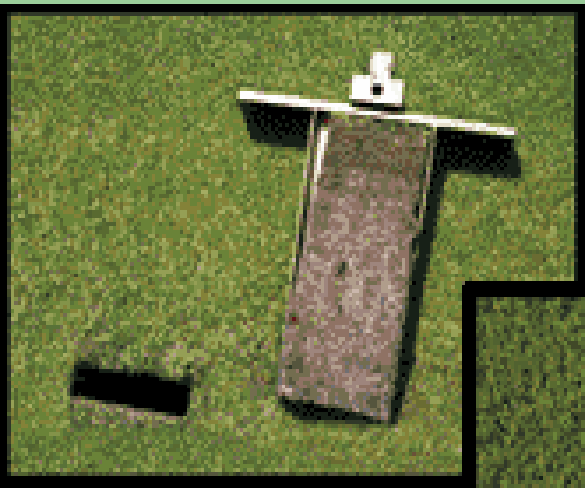
- Cotton
- Threshold = 7.7 dS/m
 - Slope = 5.2% per dS/m above the threshold
 - A crop grown on a soil with an ec reading of 8.7 would potentially experience a 5.2% yield depression.
- Cotton is Tolerant to Salinity

Plant Selection

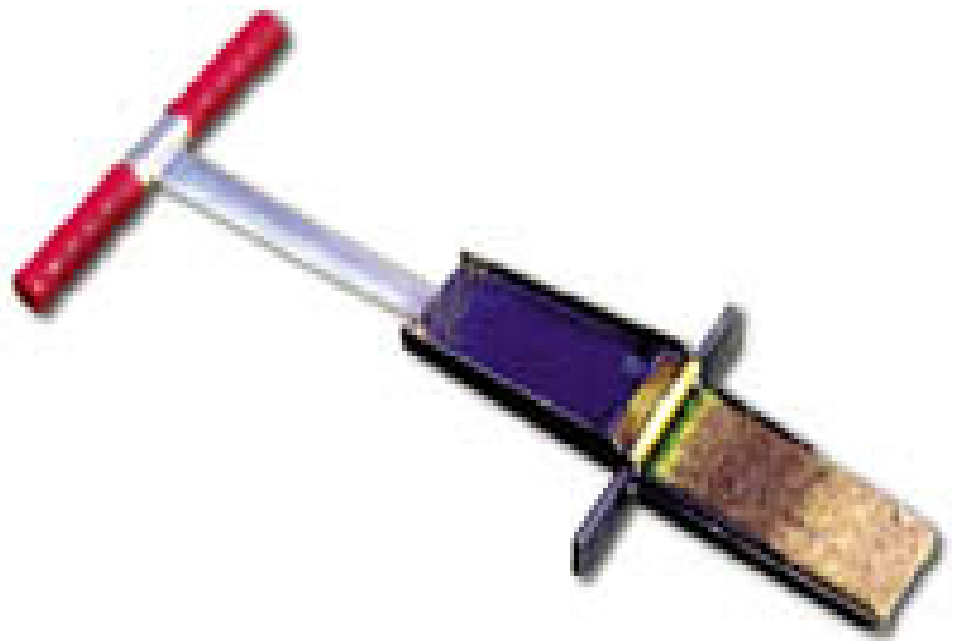
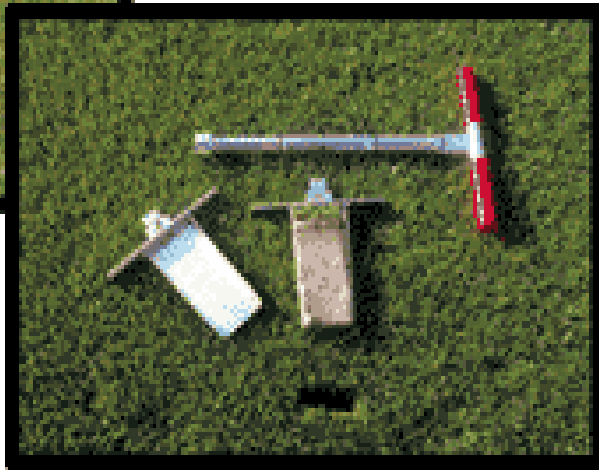
- One more: Alfalfa
 - Threshold = 2.0 dS/m
 - Slope = 7.3% per dS/m above the threshold
 - Alfalfa grown on a soil with an e.c. reading of 3.7 would potentially experience a 12.4% yield depression.
- Alfalfa is Moderately Sensitive to Salinity

Take Home Lesson:

- **Choose plants based on threshold and sensitivity values**
- **Determined from Soil Testing!**



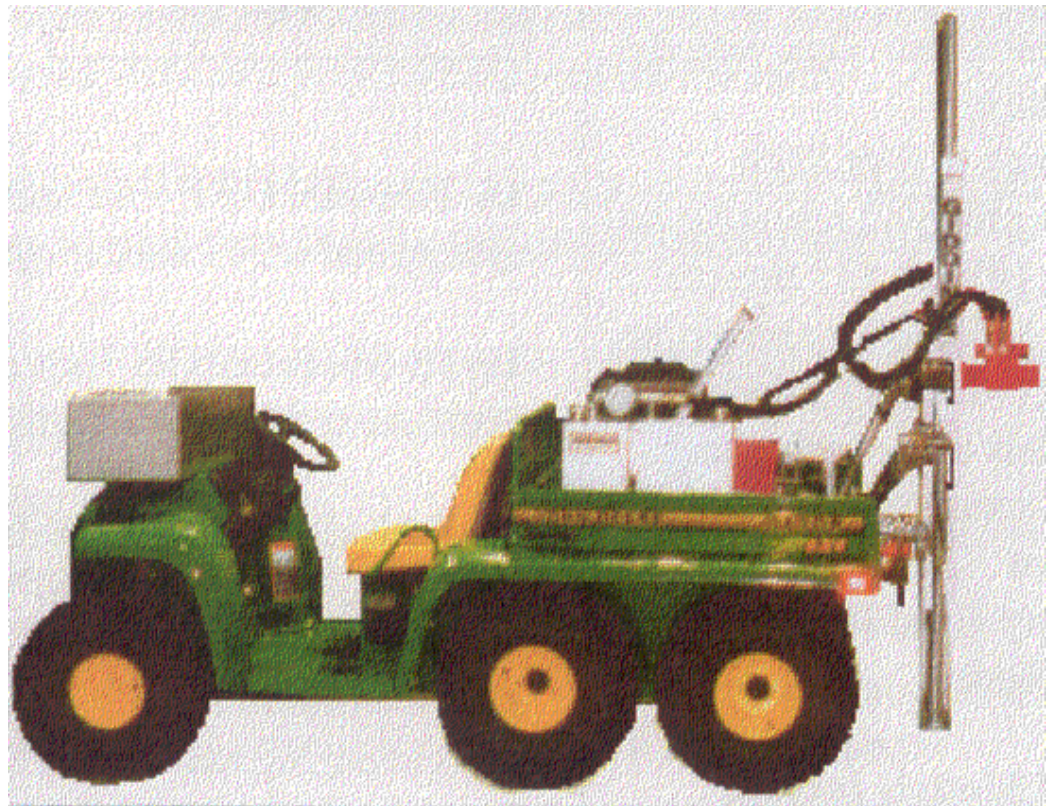
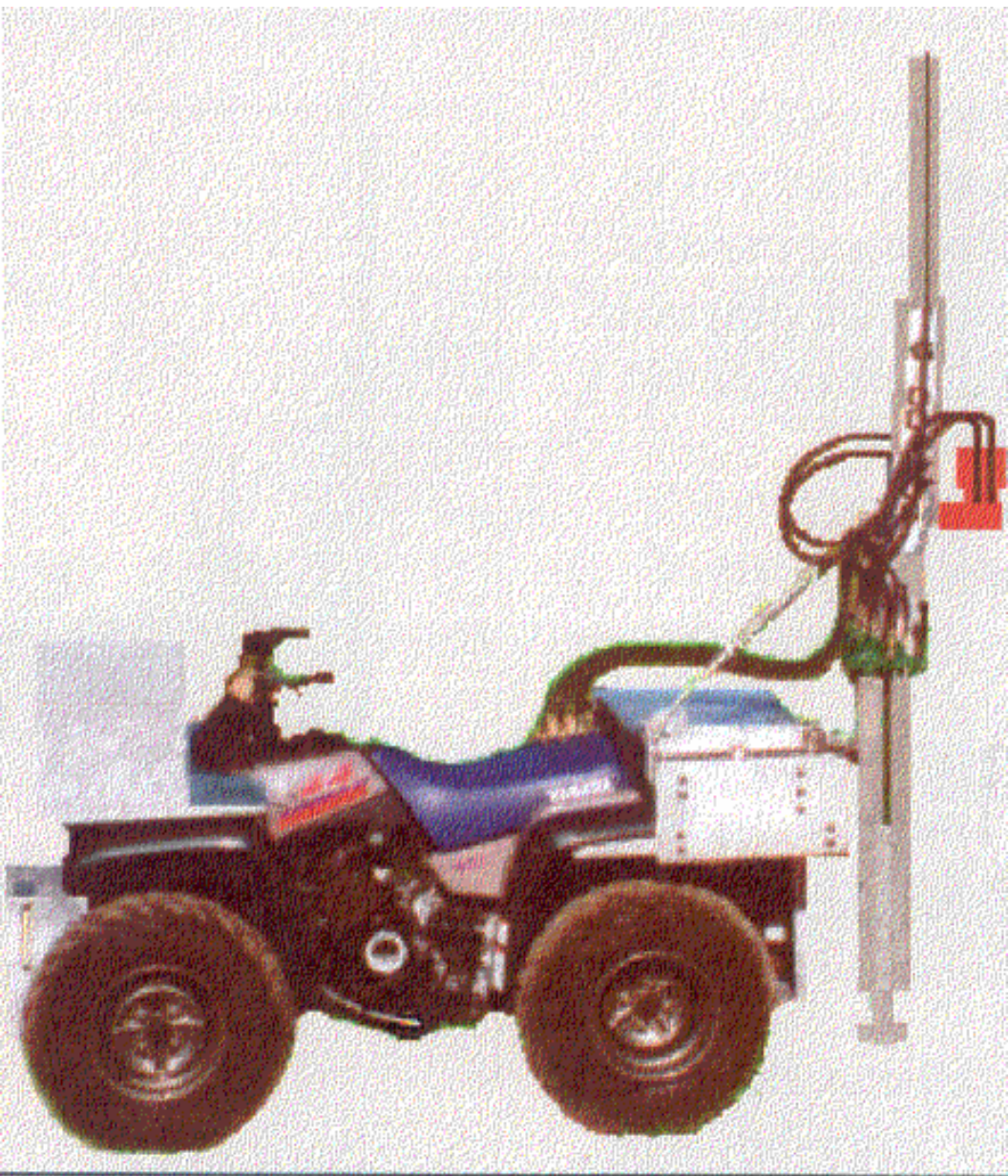
Soil samples can be replaced or saved for future study.



Getting a Sample







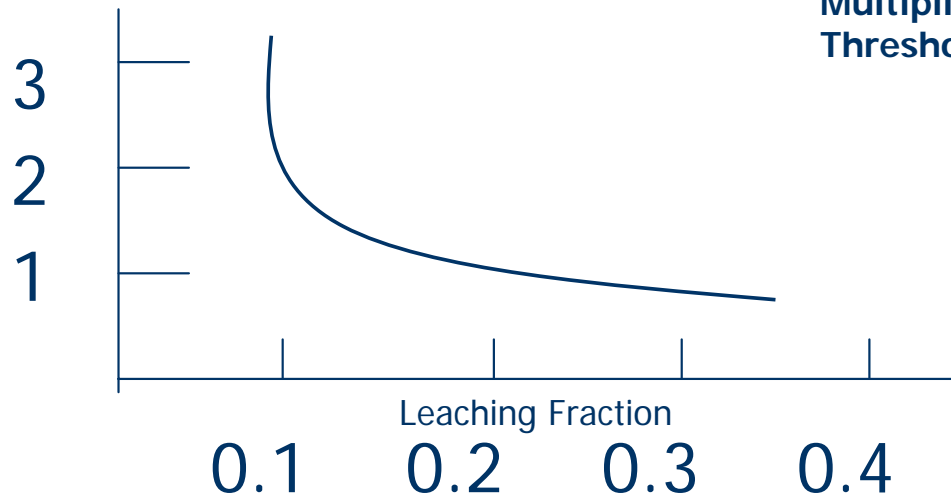


Soil Potassium

Management

- Leaching Fraction
 - $LF = EC_w / (5(EC_e) - EC_w)$
 - EC w is irrigation water salinity
 - Soil EC corresponds to an acceptable yield potential.

Multiplication factor



Multiplication factor = Divide Salinity
Threshold of the crop by the EC of the water.

Salt Management

Alternate Row Irrigation



1.2 dS/m



2.2 dS/m

Sodium Affected (Alkali) Soil

- Has enough sodium adsorbed on the clay particles to interfere with plant growth.
- Does not have to be saline!
- Sodium hazards related to soil texture
- Use the Sodium Adsorption Ratio (SAR) as an index of the sodium permeability hazard.

Sodium Affected Soil

- $SAR = Na / (((Ca + Mg) / 2)^{1/2})$
- No Problems if SAR is less than 6
- Increasing problems for SAR levels between 6 and 9
- Above 9 and there are problems.

Amendments for Sodium Soils

- A Source of Calcium
 - Gypsum or other source
- Reduce water pH and bicarbonate content by adding sulfuric acid
- Incorporate Elemental Sulfur as long as there is free lime (calcium carbonate) present in the soil. One lb S = 5 lb Gypsum

A simple test of presence of free lime





The "Fizz" Test



How Much Lime (CaCO_3)

1% = 460 lb / 1000 sq ft 6" deep

15% = 6,885 lb / 1000 sq ft 6" deep

(All must be neutralized before pH can be lowered!)

WHAT TO TEST FOR

SOILS

- Nitrate-N
- BiCarbonate P
- Ammonium Acetate K
- Organic Matter
- pH
- Salinity
 - ✓ ec
 - ✓ ESP (sodium)

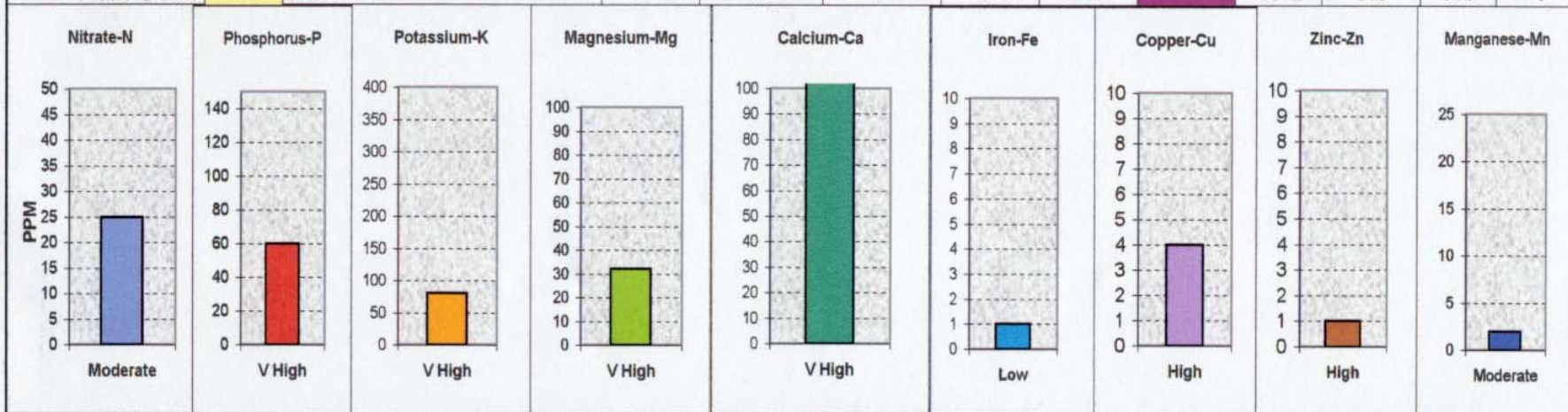
Recommended Soil Test

- Saturated paste pH
- Saturated paste E.C.
- Saturated paste Mg, Ca, Na
- Calculated SAR, estimated ESP
- Organic matter
- Soil texture estimate

New Mexico State University-Soil Test Interpretation Report

County: Eddy		Field ID: 1,2,3		Crop Rotation: Corn, Silage	
Client Name: Test Person		Comments from the form:		Acres: 10	Irr. Water Added (acin): 18
Address:		Corn for Silage			
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.	Soil Texture	O. M.	NO ₃ -N	P	K	Mg	Ca	Na	Cu	Zn	Mn	Fe	
(#)	(#)	(mmhos/cm)	(class)	(%)	(ppm)	(ppm)	(ppm)	(meq/l) ▼	(meq/l) ▼	(meq/l) ▼	(ppm)	(ppm)	(ppm)	(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 ₂ O ₅ (lbs/ac)	K ₂ O (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



Nutrient Recommendation:	N lbs/ac	P ₂ O ₅ lbs/ac	K ₂ O lbs/ac	Mg lbs/ac	Ca lbs/ac	Fe lbs/ac	Cu lbs/ac	Zn lbs/ac	Mn lbs/ac
Recommended Nutrient Rate:	180	0	0	0	0	0	0	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	0	0	0	0	0	0
Available Nutrients > Crop Requirements:	NO	Caution P	Caution K	NO	NO	NO	NO	NO	NO

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

Specific Notes: This is a Test.

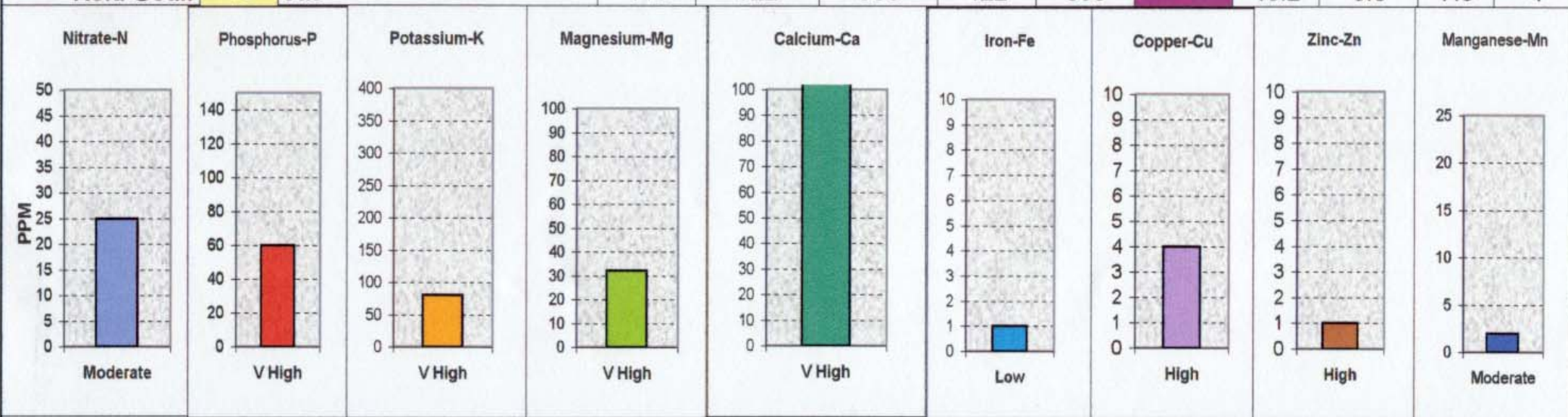
Robert P. Flynn, Ph.D. Agronomy and Soils cc: Eddy County Extension Agent	Suggested Fertilizer Blend		391 lbs/ac	Urea, 46% N	3,913 lbs Total Needed
	Total Blend (lbs):	3,913	0 lbs/ac	MAP (11-52-0)	0 lbs Total Needed
	Total Blend (lbs/ac):	391	0 lbs/ac	KCl (0-0-62)	0 lbs Total Needed

Interpretation

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Questions on Salinity?

- Contact Robert Flynn at
 - 505-748-1228
 - rflynn@nmsu.edu
- Test your soil
- Additional Resources
 - Western Fertilizer Handbook
 - California Fertilizer Assoc.
 - Interstate Publishers, Inc.
 - “The use of saline waters for crop production”
 - J.D. Rhoades et al.
 - FAO Irrigation and Drainage Paper 48