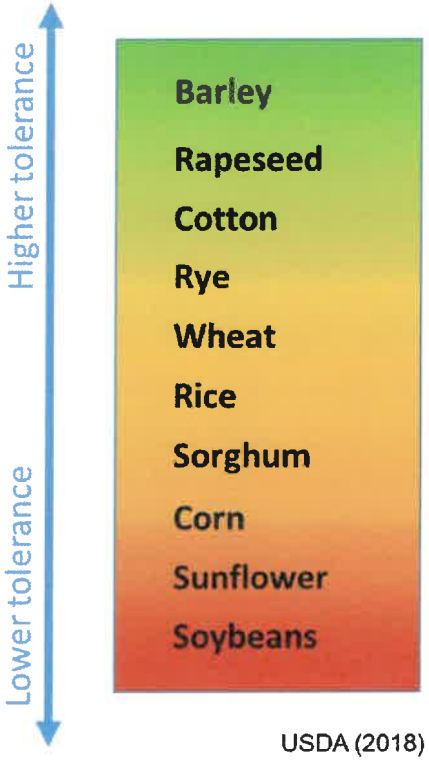
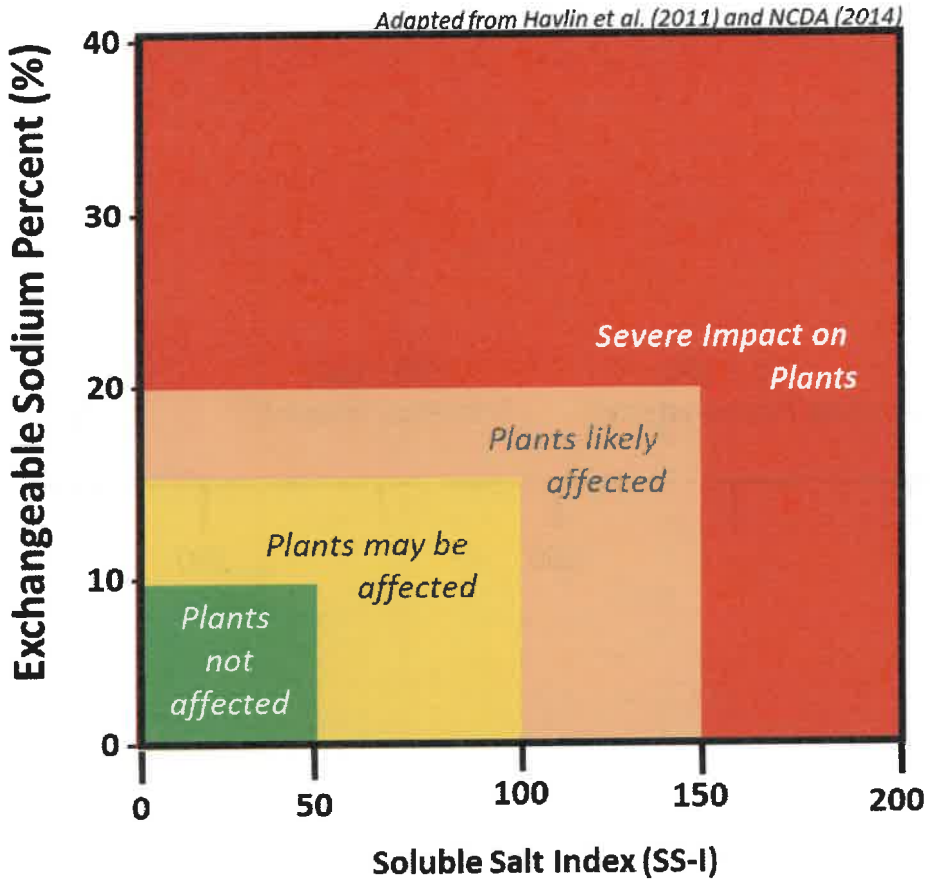
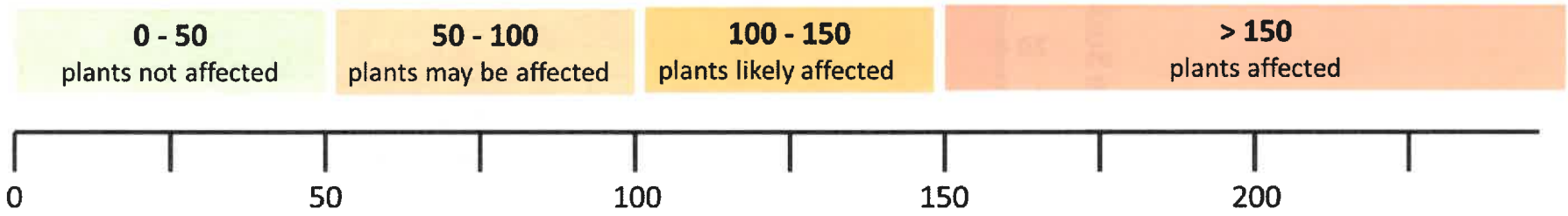
Use of Tolerant Plants



USDA (2018)


Adapted from Havlin et al. (2011) and NCDA (2014)
Exchangeable Sodium Percent (%)
40
30
20
10
0
Severe Impact on Plants
Plants likely affected
Plants may be affected
Plants not affected
0
50
100
150
200
Soluble Salt Index (SS-I)

SS-I : Soluble Salt Index



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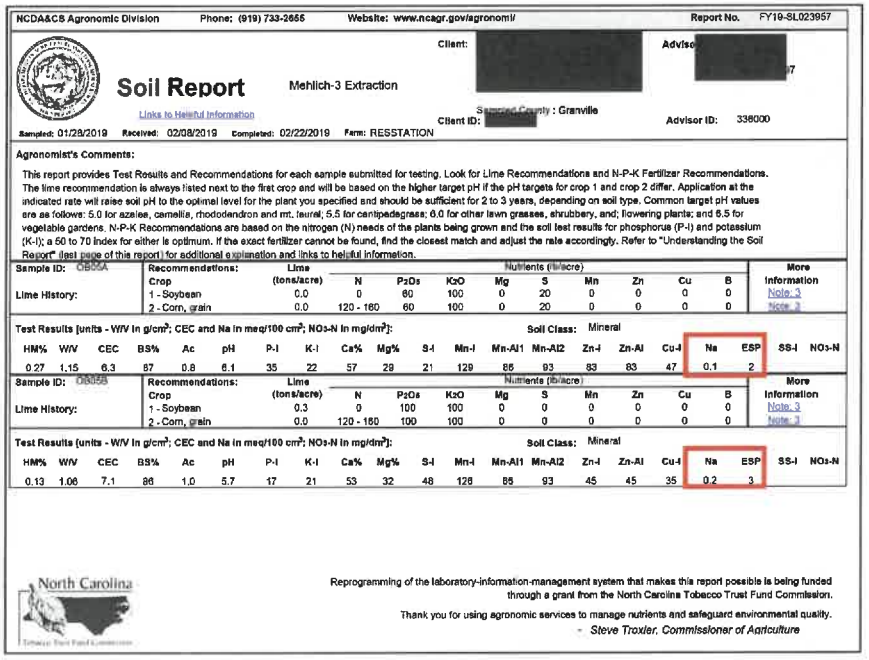
CROP AND SOIL SCIENCES

Types of NCDA Soil Test Reports

Predictive (Standard) Soil Test Report



NCDA&CS Agronomic Division Phone: (919) 733-2655 Website: www.ncagr.gov/agronomi/ Report No. FY19-SL023957

Soil Report Mehlich-3 Extraction

Links to Helpful Information

Client: [redacted] Advisor: [redacted]

Sampled County : Granville

Client ID: [redacted] Advisor ID: 338000

Sampled: 01/28/2019 Received: 02/08/2019 Completed: 02/22/2019 Farm: RESSTATION

Agronomist's Comments:

This report provides Test Results and Recommendations for each sample submitted for testing. Look for Lime Recommendations and N-P-K Fertilizer Recommendations. The lime recommendation is always listed next to the first crop and will be based on the higher target pH if the pH targets for crop 1 and crop 2 differ. Application at the indicated rate will raise soil pH to the optimal level for the plant you specified and should be sufficient for 2 to 3 years, depending on soil type. Common target pH values are as follows: 5.0 for azalea, camellia, rhododendron and mt. laurel; 5.5 for centipedegrass; 6.0 for other lawn grasses, shrubbery, and; flowering plants; and 6.5 for vegetable gardens. N-P-K Recommendations are based on the nitrogen (N) needs of the plants being grown and the soil test results for phosphorus (P-I) and potassium (K-I); a 50 to 70 index for either is optimum. If the exact fertilizer cannot be found, find the closest match and adjust the rate accordingly. Refer to "Understanding the Soil Report" (last page of this report) for additional explanation and links to helpful information.

Sample ID: OB05A	Recommendations:	Lime	Nutrients (lb/acre)								More Information
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	
Lime History:	1 - Soybean	0.0	0	60	100	0	20	0	0	0	0	Note: 3
	2 - Corn, grain	0.0	120 - 160	60	100	0	20	0	0	0	0	Note: 3

Test Results (units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO3-N in mg/dm³): Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO3-N
0.27	1.15	6.3	87	0.8	6.1	35	22	57	29	21	129	86	93	83	83	47	0.1	2		

Sample ID: OB05B	Recommendations:	Lime	Nutrients (lb/acre)								More Information
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	
Lime History:	1 - Soybean	0.3	0	100	100	0	0	0	0	0	0	Note: 3
	2 - Corn, grain	0.0	120 - 160	100	100	0	0	0	0	0	0	Note: 3

Test Results (units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO3-N in mg/dm³): Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO3-N
0.13	1.06	7.1	86	1.0	5.7	17	21	53	32	48	128	86	93	45	45	35	0.2	3		

North Carolina Tobacco Trust Fund Commission

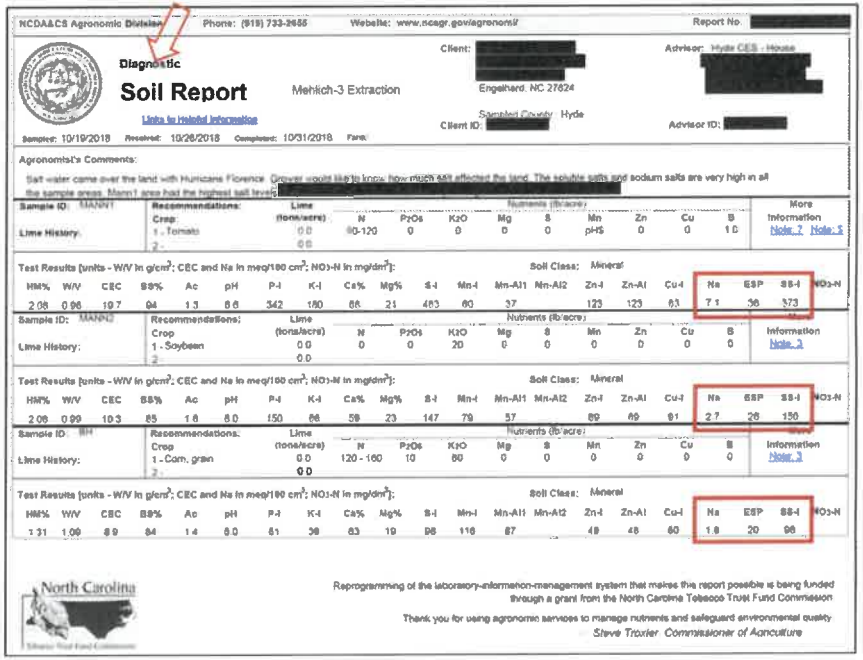
Reprogramming of the laboratory-information-management system that makes this report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.

- *Steve Troxler, Commissioner of Agriculture*

Na – sodium
ESP – Exchangeable sodium percent

Diagnostic Soil Test Report



NCDA&CS Agronomic Division Phone: (919) 733-2655 Website: www.ncagr.gov/agronomi/ Report No. [redacted]

Diagnostic

Soil Report Mehlich-3 Extraction

Client: [redacted] Engelhard, NC 27824 Advisor: Hyde CES - House [redacted]

Links to Helpful Information

Sampled County: Hyde

Client ID: [redacted] Advisor ID: [redacted]

Sampled: 10/19/2018 Received: 10/26/2018 Completed: 10/31/2018 Farm:

Agronomist's Comments:

Salt water came over the land with Hurricane Florence. Grower would like to know how much salt affected the land. The soluble salts and sodium salts are very high in all the sample areas. Mann1 area had the highest salt levels. [redacted]

Sample ID: MANN1	Recommendations:	Lime	Nutrients (lb/acre)								More Information
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	
Lime History:	1 - Tomato	0.0	80-120	0	0	0	0	pH-S	0	0	1.0	Note: 7 Note: 5
	2 -	0.0										

Test Results (units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO3-N in mg/dm³): Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO3-N
2.08	0.96	19.7	94	1.3	6.6	342	180	66	21	483	60	37		123	123	63	7.1	36	573	

Sample ID: MANN2	Recommendations:	Lime	Nutrients (lb/acre)								More Information
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	
Lime History:	1 - Soybean	0.0	0	0	20	0	0	0	0	0	0	Note: 3
	2	0.0										

Test Results (units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO3-N in mg/dm³): Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO3-N
2.06	0.99	10.3	85	1.8	6.0	150	86	58	23	147	79	57		89	89	91	2.7	26	150	

Sample ID: BH	Recommendations:	Lime	Nutrients (lb/acre)								More Information
	Crop	(tons/acre)	N	P_2O_5	K_2O	Mg	S	Mn	Zn	Cu	B	
Lime History:	1 - Corn, grain	0.0	120 - 160	10	80	0	0	0	0	0	0	Note: 3
	2 -	0.0										

Test Results (units - W/V in g/cm³; CEC and Na in meq/100 cm³; NO3-N in mg/dm³): Soil Class: Mineral

HM%	W/V	CEC	BS%	Ac	pH	P-I	K-I	Ca%	Mg%	S-I	Mn-I	Mn-AI1	Mn-AI2	Zn-I	Zn-AI	Cu-I	Na	ESP	SS-I	NO3-N
1.31	1.06	8.9	84	1.4	6.0	61	38	63	19	98	116	87		48	48	60	1.8	20	96	

North Carolina Tobacco Trust Fund Commission

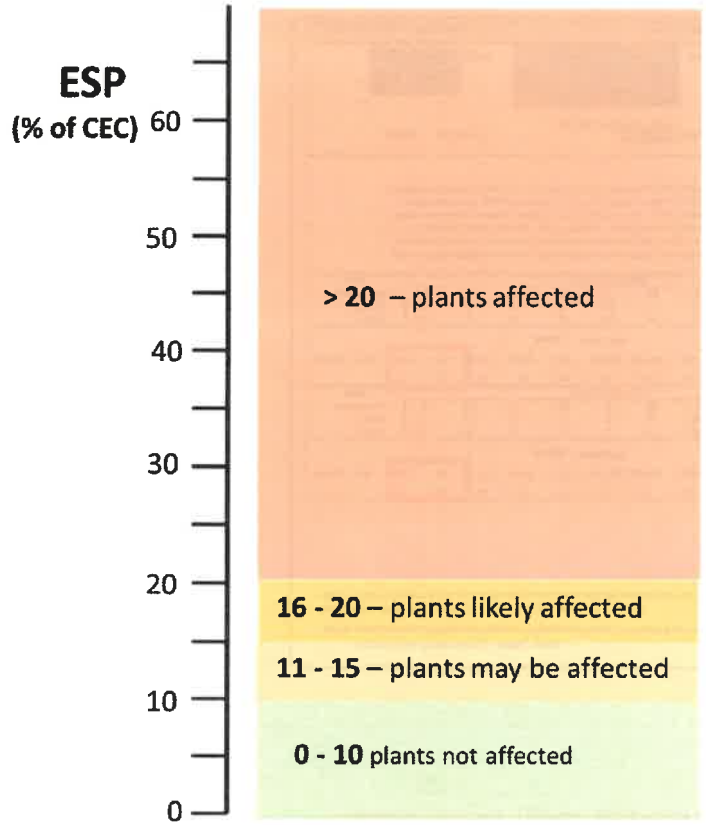
Reprogramming of the laboratory-information-management system that makes the report possible is being funded through a grant from the North Carolina Tobacco Trust Fund Commission.

Thank you for using agronomic services to manage nutrients and safeguard environmental quality.

Steve Troxler, Commissioner of Agriculture

Na – sodium
ESP – Exchangeable sodium percent
SS-I – Soluble Salt Index

Exchangeable Sodium Percent (ESP)



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Consider Crops that have more Salt Tolerance

Table 1. Tolerance of crops to soil salinity.*

	High Tolerance	Medium Tolerance	Low Tolerance
Field crops	Barley, sugar beet, rapeseed, cotton	Rye, wheat, oats, rice, sorghum, corn, flax, sunflower, castorbeans, soybeans	Beans
Forages	Alkali sacaton, saltgrass, nuttall alkaligrass, bermudagrass, Rhodes grass, Canada wildrye, western wheatgrass, barley, birdsfoot trefoil	White sweet clover, perennial ryegrass, mountain brome, strawberry clover, dallis grass, sudan grass, hubam clover, alfalfa, tall fescue	White clover, meadow foxtail, alsike clover, red clover, ladino clover, burnet
Vegetables	Asparagus, spinach	Tomato, broccoli, cabbage, bell pepper, cauliflower, lettuce, sweet corn, potatoes, sweet melon	Radish, celery, green beans, strawberries
Fruit crops	Date palm	Pomegranate, fig, olive, grape	Pear, apple, orange, grapefruit, prune, plum, almond, apricot, lemon, avocado

*In each class, crops are listed in order of salt tolerance.

From Diagnosis and Improvement of Saline and Alkali Soils, *U.S. Department of Agriculture, Agricultural Handbook No. 60, 1954.*

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Methods to Mitigate Issues with High Salinity Source Water

- Natural Precipitation
- Subsurface Drainage Systems (Ditches and Tile)
  - -Promotes leaching by moving soil through the soil profile
- Surface Drainage (Precision Grading)
- Irrigation Application Uniformity
  - -Adequate coverage (Proper nozzle spacing and operation)
  - -Reduce over-application
- Irrigation Scheduling (Soil Moisture Monitoring)
- Alternative Water Sources
- Consider Salt Tolerant Crops

Crop Rescue Irrigations

TABLE NC3-3 PERMISSIBLE NUMBER OF IRRIGATIONS WITH BRACKISH WATER BETWEEN LEACHING RAINS FOR CROPS OF DIFFERENT SALT TOLERANCES 1/

Irrigation Water		Irrigations allowed between Leaching (heavy) Rainfalls		
Total Salts (ppm)	Electrical Conductivity (millimhos per cm at 25° C)	Good Salt Tolerance	Moderate Salt Tolerance	Poor Salt Tolerance
640	1		15	7
1280	2	11	7	4
1920	3	7	5	2
2560	4	5	3	2
3200	5	4	2-3	1
3840	6	3	2	1
4480	7	2-3	1-2	
5120	8	2	1	

1/ The information in this table was obtained from USDA Agriculture Information Bulletins Nos. 213 and 283.

Assumptions

1. No leaching rainfalls between irrigations
2. There is no existing salt accumulation in the soil

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Irrigation Water (EC_w) Thresholds for Yield Reduction by Crop

Crop	No Reduction		10% Reduction	
	mmhos/cm	ppm	mmhos/cm	ppm
Cotton	5.1	3264	6.4	4096
Soybean	3.3	2112	3.7	2368
Peanuts[1]	1.1	704	1.4	896
Potato	1.1	704	1.7	1088
Sweet Potato	1	640	1.6	1024
Watermelon[1]	1.3	832	na	na
Canteloupe	1.5	960	2.4	1536
Cabbage[1]	1.2	768	1.9	1216
Corn	1.1	704	1.7	1088

*Levels Reported by Texas A&M University Extension- Irrigation Water Quality Standards

[1]Levels Reported By New South Wales Department of Primary Industries

Soil Root Zone Salt Tolerance of Selected Crops

Table 2-34 Salt tolerance of selected crops [1/]

Common name	Botanical name	Salt tolerance threshold [2/] (EC_t)	Yield decline [3/] (Y_d)	Qualitative salt tolerance rating [4/]
		mmho/cm	% per mmho/cm	
Field crops				
Barley	*Hordeum vulgare*	8.0	5.0	T
Bean	*Phaseolus vulgaris*	1.0	19	S
Broad bean	*Vicia faba*	1.6	9.6	MS
Corn	*Zea Mays*	1.7	12	MS
Cotton	*Gossypium hirsutum*	7.7	5.2	T
Cowpea	*Vigna unguiculata*	4.9	12	MT
Flax	*Linum usitatissimum*	1.7	12	MS
Guar	*Cyamopsis tetragonoloba*	8.8	17.0	T
Millet, foxtail	*Setaria italica*	—	—	MS
Oats	*Avena sativa*	—	—	MT
Peanut	*Arachis hypogaea*	3.2	29	MS
Rice, paddy [5/]	*Oryza sativa*	3.0	12	S
Rye	*Secale cereale*	11.4	10.8	T
Safflower	*Carthamus tinctorius*	—	—	MT
Sesame	*Sesamum indicum*	—	—	S
Sorghum	*Sorghum bicolor*	6.8	16	MT
Soybean	*Glycine max*	5.0	20	MT
Sugar beet	*Beta vulgaris*	7.0	5.9	T
Sugarcane	*Saccharum officinarum*	1.7	5.9	MS
Sunflower	*Helianthus annuus*	—	—	MS
Triticale	*x Triticosecale*	6.1	2.5	T
Wheat	*Triticum aestivum*	6.0	7.1	MT
Wheat (semidwarf)	*T. aestivum*	8.6	3.0	T
Wheat, durum	*T. turgidum*	5.9	3.8	T

Example: Corn

EC_e = 5.4 mmho/cm

EC_t = **1.7** mmho/cm

Y_d = **12** % per mmho/cm

$Y_r = 100-12(5.4-1.7)$

$Y_r = 55.6$ %

Example: Cotton

EC_e = 5.4 mmho/cm

EC_t = **7.7** mmho/cm

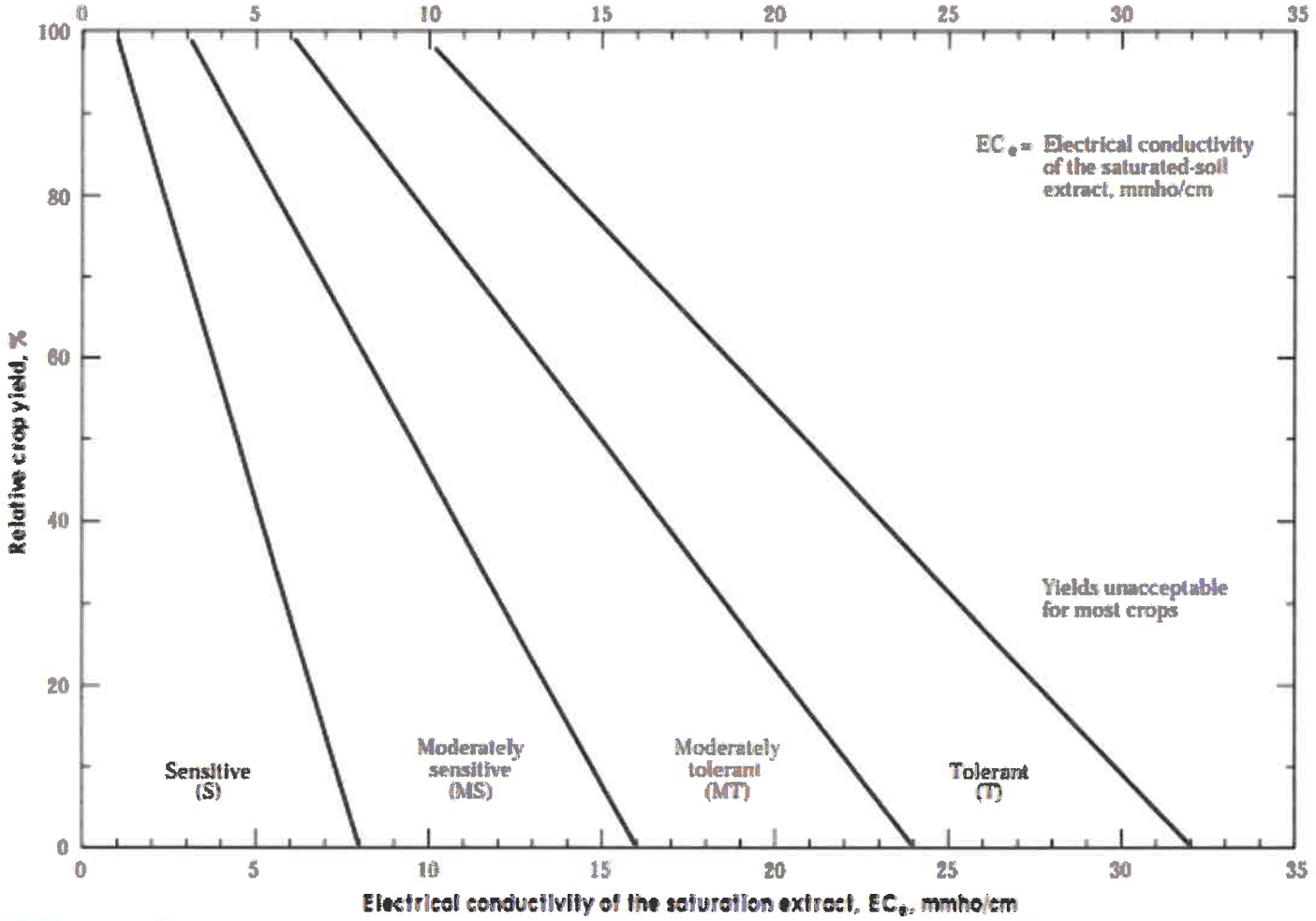
Y_d = **5.2** % per mmho/cm

$EC_e < Ec_t$

$Y_r = 100$ %

Yield Declines

Figure 2-32 Divisions for classifying crop tolerance to salinity (adapted from Maas 1986)



$$Y_r = 100 - Y_d(EC_e - EC_t)$$

Where:

Y_r = Relative Yield
Y_d = yield decrease/ unit salinity increase
EC_e = avg root zone salinity
EC_t = threshold salinity

Leaching Accumulated Salts out of the Root Zone

Determining Required Leaching Fraction

The leaching fraction is commonly calculated using the following relationship:

$$LF = \frac{EC_{iw}}{EC_e} \qquad (1)$$

where

LF = leaching fraction - the fraction of applied irrigation water that must be leached through the root zone

EC_{iw} = electric conductivity of the irrigation water

EC_e = the electric conductivity of the soil in the root zone

- Depends on irrigation water quality
- Accumulated salts
- Crop tolerance
- Internal soil drainage capacity

Estimated leaching requirements to remove salts	
Volume of salt-free water	**Reduction of salt content in soil**
6 inches	50%
12 inches	80%
24 inches	90%

*University of Georgia Extension
"Soil Salinity Testing, Data Interpretation and Recommendations"
-Assumes good internal drainage and well structured soils.

Relative tolerance of selected crops to foliar injury from saline water applied with **sprinklers**

		Na	Cl
◆ Potato	5-10 meq/L	(115-230 ppm)	(175-350 ppm)
◆ Corn	10-20 meq/L	(230-460 ppm)	(350-700 ppm)
◆ Cotton	>20 meq/L	(>460 ppm)	(>700 ppm)

Typically, NCDA recommends not spraying if Na or Cl is greater than 70 ppm!

Irrigation Water Quality- Salinity

Typical values for source water

Freshwater: < 1,000 ppm (1 ppt)
Slightly saline: 1,000 to 3,000 ppm (1-3 ppt)
Moderate saline: 3,000 to 10,000 ppm (3-10 ppt)
Highly saline: 10,000 to 35,000 ppm (10-35 ppt)
Ocean water: 35,000 ppm (+35 ppt)

- ***Low Salinity, No Restrictions***

  ECi < 0.7 mmho/cm, **450 ppm** *(0.45 ppt)* or 450 mg/L

- ***Moderate Restrictions***

  ECi < 0.7-3.0 mmho/cm, **448-1920 ppm** *(0.45- 1.9 ppt)* or 450 mg/L-2000 mg/L

- ***Severe Restrictions***

  ECi > 3.0 mmho/cm, **>2000 ppm** *(>2 ppt)* or 2000 mg/L

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Salinity and Irrigation Management

- Salts in water are measured with:

  -**EC_e** or **electrical conductivity**

  Units are dS/m, where:

  1 dS/m = 1 mmho/cm = 1mS/cm = 640 ppm or 640 mg/L

  Useful Conversions: 1 ppm = 1 mg/L, 1 % = 10,000 ppm

- Salt accumulation due to irrigation depends on:

  -water quality (salt content)

  -irrigation volume

  -amount and distribution of rainfall

  -internal drainage