LOUISIANA SALINITY FIELD REFERENCE FOR AGRICULTURE

INTRODUCTION

The salinity of groundwater and surface water across Louisiana remains an area of interest for agricultural commodities. Both horizontal (sea level rise and storm surges) and lateral (over-pumping and increased use of aquifers) saltwater intrusion have created a growing concern for tolerance of quintessential Louisiana crops. Though coastal communities see fluctuations in salinity from horizontal intrusion, central and northern Louisiana experience similar salinity problems from lateral aquifer salinity. Each of these cases has an impact on irrigation water used for our state's agricultural commodities, which translates into economic decline. This article serves as a reference guide for salinity ranges and how to determine the salinity of your irrigation water.

Sprinkler Irrigation for Potted Plants

WATER QUALITY TERMINOLOGY

Salinity – The measure of all dissolved salts in water, which includes mostly chloride, sodium, sulfate, magnesium, calcium and potassium.

Chloride – The measure of a single salt (contributor to salinity). Normally this is the most prevalent of salts in seawater.

Total dissolved solids (TDS) – The measure of minerals, salts, metals, cations or anions dissolved in water. This analysis tests for inorganic salts, principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulfates and some small amounts of organic matter. In pure water, TDS is approximately equal to salinity.

Parts per million (ppm) – The measure of concentration for total dissolved solids. For reference: 1 ppm is equivalent to 1 milligram per liter (mg/L).

Parts per thousand (ppt) – The amount of salts in seawater is commonly measured in parts per thousand. For reference: 1 ppt is equivalent to 1,000 ppm.

EFFECTS ON SOIL SALINITY

Excess salts in soil or irrigation water can cause an imbalance of nutrients for plants which results in accumulation of ions thus reducing infiltration of water into the soil. Salinity has negative effects on crop yield, plant growth, coloration and defoliation. Plants can be more sensitive to high salinity environments in the seedling stage, after transplanting or when under additional stress from disease, weather, insects or nutrients. If water from the immediate area is known to have increased salinity, it's best to check your plants' sensitivity and tolerance to optimize growth.

SAMPLING TECHNIQUES FOR WATER

There are many good service labs that can conduct salinity testing for irrigation water. The LSU AgCenter Soil Testing and Plant Analysis Lab has a routine water test package for irrigation and pond water. It is always best practice to have samples sent through certified labs for confirmation on any field test using handheld equipment. To decrease the volume of samples sent in for analysis, one could send confirmation samples on a specific schedule for your operation (e.g., monthly, quarterly) and test in the field with an electrical conductivity (EC) meter more frequently. An EC meter is an affordable tool to have handy for quick reference analysis of water. The EC meter measures electrical flow through the water using salt as a gradient. It is reported in units of microsiemens per centimeter (µS/cm) or decisiemens per meter (dS/m). There are many variables that can change the conversion of electrical conductivity to total dissolved solids (TDS), including nonlinear responses as EC increases and temperature. For simplicity, the following conversion is typically used for field-based calculations:

TDS (mg/L) = EC (dS/m) x 640 (EC from 0.1 to 5 dS/m)
TDS (mg/L) = EC (dS/m) x 800 (EC > 5 dS/m)

By using the simplistic calculation for TDS, the salinity (in parts per thousand) can then be calculated by the following equation:

Salinity (ppt) = TDS (mg/L) / 1,000

These formulas are simplistic field-level calculations for quick salinity estimates. The most accurate readings would consider temperature and ion concentration variables. For this caliber testing, samples should be sent off for laboratory analysis.

The following table shows calculations for µS/cm or dS/m readings that can be used for easy conversions using the above formulas. If salinity is an issue for your water source, printing the following page and laminating it for easy conversion of EC readings to salinity can be helpful.

CONVERSION CHART

uS/cm	dS/m	UNITS	SALINITY (IN PPT)
100	0.10	64	0.06
250	0.25	160	0.16
500	0.50	320	0.32
750	0.75	480	0.48
1,000	1.00	640	0.64
1,250	1.25	800	0.80
1,500	1.50	960	0.96
1,750	1.75	1,120	1.12
2,000	2.00	1,280	1.28
2,250	2.25	1,440	1.44
2,500	2.50	1,600	1.60
2,750	2.75	1,760	1.76
3,000	3.00	1,920	1.92
3,250	3.25	2,080	2.08
3,500	3.50	2,240	2.24
3,750	3.75	2,400	2.40
4,000	4.00	2,560	2.56
4,250	4.25	2,720	2.72
4,500	4.50	2,880	2.88
4,750	4.75	3,040	3.04
5,000	5.00	4,000	4.00
5,250	5.25	4,200	4.20
5,500	5.50	4,400	4.40
5,750	5.75	4,600	4.60
6,000	6.00	4,800	4.80
6,250	6.25	5,000	5.00
6,500	6.50	5,200	5.20
6,750	6.75	5,400	5.40
7,000	7.00	5,600	5.60
7,250	7.25	5,800	5.80
7,500	7.50	6,000	6.00
7,750	7.75	6,200	6.20
8,000	8.00	6,400	6.40
8,250	8.25	6,600	6.60
8,500	8.50	6,800	6.80
8,750	8.75	7,000	7.00
9,000	9.00	7,200	7.20
9,250	9.25	7,400	7.40
9,500	9.50	7,600	7.60

uS/cm	dS/m	UNITS	SALINITY (IN PPT)
9,750	9.75	7,800	7.80
10,000	10.00	8,000	8.00
10,250	10.25	8,200	8.20
10,500	10.50	8,400	8.40
10,750	10.75	8,600	8.60
11,000	11.00	8,800	8.80
11,250	11.25	9,000	9.00
11,500	11.50	9,200	9.20
11,750	11.75	9,400	9.40
12,000	12.00	9,600	9.60
12,250	12.25	9,800	9.80
12,500	12.50	10,000	10.00
12,750	12.75	10,200	10.20
13,000	13.00	10,400	10.40
13,250	13.25	10,600	10.60
13,500	13.50	10,800	10.80
13,750	13.75	11,000	11.00
14,000	14.00	11,200	11.20
14,250	14.25	11,400	11.40
14,500	14.50	11,600	11.60
14,750	14.75	11,800	11.80
15,000	15.00	12,000	12.00
15,250	15.25	12,200	12.20
15,500	15.50	12,400	12.40
15,750	15.75	12,600	12.60
16,000	16.00	12,800	12.80
16,250	16.25	13,000	13.00
16,500	16.50	13,200	13.20
16,750	16.75	13,400	13.40
17,000	17.00	13,600	13.60
17,250	17.25	13,800	13.80
17,500	17.50	14,000	14.00
17,750	17.75	14,200	14.20
18,000	18.00	14,400	14.40
18,250	18.25	14,600	14.60
18,500	18.50	14,800	14.80
18,750	18.75	15,000	15.00
19,000	19.00	15,200	15.20
19,250	19.25	15,400	15.40

MANAGING HIGH SALINE IRRIGATION WATER

Though there are many factors that can increase the naturally occurring ions in the soil, combining with high salinity irrigation water and amendments (including those high in salts or pH) can magnify the salt concentrations. There are numerous mitigation techniques for high salinity irrigation water whether from underground wells, surface water or coastal zones. The first step is to get accurate salinity readings to consider adopting best management practices. In this case, it would be best to have the samples tested at a certified lab for the most accurate results. Water coming from underground wells will be more consistent over time and require minimal testing, while surface water or tidal areas have a variable flow that may cause results to vary, thus needing samples to be taken multiple times for accuracy. For surface water, tributaries or other tidal movement areas, the United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA) or state agencies, like the Louisiana Department of Environmental Quality (LDEQ), may have beacons actively monitoring salinity in your immediate area. The second step is to optimize irrigation schedules and fertilizer application. Any over or under-application of water and fertilizer can initiate stress on the plant, which will intensify the effect of salinity. One short-term technique for decreasing the salinity of irrigation water is to dilute it by blending with alternative sources. The most utilized in this case is rainwater collection. This is a good practice for small-sized operations or those experiencing an abnormal spike in salinity. Another technique for low water volume operations is solar distillation to remove salts. For short-term solutions in larger operations, there may be investment opportunities in onsite water storage to switch to when abnormal salinity occurs. This water can be a reserve if needed for dilution or direct watering. If high salinity water is prevalent, then long-term solutions may include alternating irrigation techniques, such as moving from well water to surface water. Practices such as tailwater recovery and on-farm surface water storage can help create sustainable alternative water sources. Additionally, desalinization pumps can be purchased for areas in coastal zones, but before deciding on a pumping strategy, one must weigh all costs, including filtration systems, the volume of water produced and storage components.

COMMON LOUISIANA CROPS

For the following commodities, the electrical conductivity ranges indicate where the listed crop will experience 10% reduction in growth and quality. This means when considering the salinity of irrigation, it's best to be lower than the indicated range. For accurate threshold values or highest recommended electrical conductivity for optimal plant growth, consult the Expanded Commodity Table on the next page.

SENSITIVE	MODERATE SENSITIVE	MODERATE TOLERANCE	TOLERANCE
EC = LESS THAN 3.0	EC = 3.0-6.0	EC = 6.0-9.0	EC = 9.0-12.0
Pecan	Corn	Oats	Cotton
Strawberry	Rice	Sorghum	
Citrus	Soybean	Wheat	
Sweet potato	Sugarcane		
	Watemelon		

COMMON LOUISIANA GRASSES

For the following grasses, the electrical conductivity ranges indicate where the listed grass will experience 10% reduction in growth and quality. This means when considering the salinity of irrigation, it's best to be lower than the indicated range. For accurate threshold values or highest recommended electrical conductivity for optimal plant growth, consult the Expanded Commodity Table below.

SENSITIVE	MODERATE SENSITIVE	MODERATE TOLERANCE	TOLERANCE
EC = LESS THAN 3.0	**EC = 3.0-6.0**	**EC= 6.0-9.0**	**EC= 6.0-9.0**
Centipede	Carpet	Tall fescue	Bermuda
		Perennial rye	St. Augustine
		Annual rye	Seashore paspalum
		Bahia	
		Zoysia	

EXPANDED COMMODITY TABLE

This list was derived from U.S. Department of Agriculture (USDA) Plant Tolerance, 2012 publications. The common and botanical names are listed for the selected plant types. The threshold value is the electrical conductivity where the initial reduction of maximum yield is expected, while the yield loss is calculated by the slope of yield reduction per unit of salinity increase above the threshold. For more details on the values the tolerance is based on (seed, tuber, grains, etc.) and tolerances of other crops, please review the following USDA manual:

Grieve, C.M., S.R. Grattan and E.V. Maas. 2012. Plant salt tolerance. In: W.W. Wallender and K.K. Tanji (eds.) ASCE Manual and Reports on Engineering Practice No. 71 Agricultural Salinity Assessment and Management (2nd Edition). ASCE, Reston, VA. Chapter 13 pp:405-459.

COMMON NAME	BOTANICAL NAME	THRESHOLD VALUE	YIELD LOSS		
			10%	25%	50%
Alfalfa	*Medicago sativa* L.	2.0	3.4	5.4	8.8
Almond	*Prunus duclis*	1.5	2.0	2.8	4.1
Apricot	*Prunus armeniaca* L.	1.6	2.0	2.6	3.7
Artichoke	*Helianthus tuberosus* L.	0.4	1.4	3.0	5.6
Artichoke	*Cynara scolymus* L.	6.1	7.0	8.3	10.4
Asparagus	*Asparagus officinalis* L.	4.1	9.1	16.6	29.1
Barley	*Hordeum vulgare* L.	8.0	10.0	13.0	18.0
Bean, common	*Phaseolus vulgaris* L.	1.0	1.5	2.3	3.6
Bean, mung	*Vigna radiata* L.	1.8	2.3	3.0	4.2
Beet, red	*Beta vulgaris* L.	4.0	5.1	6.8	9.6

EXPANDED COMMODITY TABLE

COMMON NAME	BOTANICAL NAME	THRESHOLD VALUE	YIELD LOSS		
			10%	25%	50%
Bermudagrass	*Cynodon dactylon* L.	6.9	8.5	10.8	14.7
Blackberry	*Rubus macropetalus*	1.5	2.0	2.6	3.8
Broadbean	*Vicia faba* L.	1.6	2.6	4.2	6.8
Broccoli	*Brassica oleracea* L.	1.3	1.9	2.9	4.5
Cabbage	*B. oleracea* L.	1.8	2.8	4.4	7.0
Canola	*Brassica campestris* L.	9.7	10.4	11.5	13.3
Canola	*B. napus* L.	11.0	11.8	12.9	14.8
Carrot	*Daucus carota* L.	1.0	1.7	2.8	4.6
Cauliflower	*Brassica oleracea* L.	1.5	2.2	3.2	5.0
Celery	*Apium graveolens* L.	1.8	3.4	5.8	9.9
Clover	*Trifolium hybridum* L.	1.5	2.3	3.6	5.7
Corn	*Zea mays* L.	1.7	2.5	3.8	5.9
Cotton	*Gossypium hirsutum* L.	7.7	9.6	12.5	17.3
Cowpea	*Vigna unguiculata* L.	2.5	3.4	4.8	7.0
Cucumber	*Cucumis sativus* L.	2.5	3.3	4.4	6.3
Eggplant	*Solanum melongena* L.	1.1	2.5	4.7	8.3
Eggplant	*Foeniculum vulgare*	1.4	2.0	3.0	4.5
Fescue, tall	*Festuca elatior* L.	3.9	5.8	8.6	13.3
Flax	*Linum usitatissimum* L.	1.7	2.5	3.8	5.9
Foxtail, meadow	*Alopecurus pratensis* L.	1.5	2.5	4.1	6.7
Garlic	*Allium sativum* L.	3.9	4.6	5.6	7.4
Grape	*Vitis vinifera* L.	1.5	2.5	4.1	6.7
Grapefruit	*Citrus x paradisi*	1.2	1.9	3.1	4.9
Harding grass	*Phalaris tuberosa* L.	4.6	5.9	7.9	11.2
Lemon	*Citrus limon* L.	1.5	2.3	3.5	5.4
Lettuce	*Lactuca sativa* L.	1.3	2.1	3.2	5.1
Love grass	*Eragrostis sp.*	2.0	3.2	5.0	8.0
Onion, bulb	*Allium cepa* L.	1.2	1.8	2.8	4.3
Orange	*Citrus sinensis* L.	1.3	2.1	3.2	5.1
Orchardgrass	*Dactylis glomerata* L.	1.5	3.1	5.5	9.6
Pea	*Pisum sativum* L.	3.4	4.3	5.8	8.1
Peach	*Prunus persica* L.	1.7	2.2	2.9	4.1
Peanut	*Arachis hypogaea* L.	3.2	3.5	4.1	4.9
Pepper	*Capsicum annuum* L.	1.5	2.2	3.3	5.1
Plum	*Prunus domestica* L.	2.6	2.9	3.4	4.2

EXPANDED COMMODITY TABLE

COMMON NAME	BOTANICAL NAME	THRESHOLD VALUE	YIELD LOSS		
			10%	25%	50%
Potato	*Solanum tuberosum* L.	1.7	2.5	3.8	5.9
Radish	*Raphanus sativus* L.	1.2	2.0	3.1	5.0
Rice, paddy	*Oryza sativa* L.	3.0	3.8	5.1	7.2
Rye	*Secale cereale* L.	11.4	12.3	13.7	16.0
Ryegrass, perennial	*Lolium perenne* L.	5.6	6.9	8.9	12.2
Sesbania	Sesbania exaltata	2.3	3.7	5.9	9.4
Sorghum	*Sorghum bicolor* L.	6.8	7.4	8.4	9.9
Soybean	*Glycine max* L.	5.0	5.5	6.3	7.5
Spinach	*Spinacia oleracea* L.	2.0	3.3	5.3	8.6
Squash, scallop	*Cucurbita pepo* L. *var melopepo* L.	3.2	3.8	4.8	6.3
Squash, scallop	*C. pepo* L. *var melopepo* L.	4.9	5.9	7.3	9.7
Strawberry	*Ipomoea batatas*	1.0	1.3	1.8	2.5
Sudan grass	*Sorghum sudanense*	2.8	5.1	8.6	14.4
Sugarbeet	*Beta vulgaris* L.	7.0	8.7	11.2	15.5
Sugarcane	*Saccharum officinarum* L.	1.7	3.4	5.9	10.2
Sunflower	*Helianthus annuus* L.	4.8	6.8	9.8	14.8
Sweet potato	*Ipomoea batatas* L.	1.5	2.4	3.8	6.0
Tomato	*Lycopersicon lycopersicum* L.	2.5	3.5	5.0	7.6
Tomato, cherry	*L. lycopersicumvar var cerasiforme*	1.7	2.8	4.4	7.2
Triticale	*X Triticosecale*	6.1	10.1	16.1	26.1
Turnip	*Brassica rapa* L.	0.9	2.0	3.7	6.5
Watermelon	*Citrullus lanatus*	3.3	5.6	9.1	14.9
Wheat	*Triticum aestivum* L.	6.0	7.4	9.5	13.0
Wheat (semidwarf)	*T. aestivum* L.	8.6	11.9	16.9	25.3
Wheatgrass	*Agropyron sibiricum*	3.5	6.0	9.8	16.0
Wheat, durum	*T. turgidum L. var. durum*	5.9	8.5	12.5	19.1

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