Natural Resources Conservation Service – Caribbean Area
654 Plaza, Suite 604
654 Muñoz Rivera Ave.
Hato Rey, PR 00918-4123
Voice 787.766.5206
Web: http://www.pr.nrcs.usda.gov

Technical Note

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Contact:
Edwin G. Más. Caribbean Area Technology Transfer Specialist
787-832-4040 x3741

TROPICAL CROPS SALT TOLERANCE DATABASE

Purpose

The purpose of this technical note is to provide guidance in the selection of selected tropical crops for high saline-sodic soils in Puerto Rico and the US Virgin Islands.

Discussion

Salts are naturally found in soils as a result of rock and primary mineral weathering. Soils affected by excess salt content (saline soils) are usually found in arid and semi-arid zones of the world (Bonnet, 1960)[1]. In these areas, salts accumulate primarily because net annual evapotranspiration exceeds precipitation, and salts cannot be leached out of the soil profile. In other areas artesian groundwater can move salts from deeper parts of the soil profile to the surface. Other naturally occurring salt sources to soils are precipitation-salts originating from marine aerosols, stream and river waters, and marine waters. Human-induced salinization processes are irrigation with high salt content water from either surface water or ground water, excessive use of fertilizers, and irrigation with treated effluent water from sewage treatment plants.

There are various estimates of the distribution and extent of saline soils worldwide. In 1960, Bonnet (1960) quoted estimates made by the United Nations in the 1950 that nearly 10% of the land-area was influenced by excess salts. Carrow and Duncan (1998) estimate that one- third of all irrigated land is influenced by salinity. Eswaran et al. (2001)[2] estimate that saline soils are $950x10^6$ ha (or 33% of the arable land area). Recently, Australia has experienced marked increases in land area influenced by salts due to changes in land use and is now estimated at 25% of all land area (Carrow and Duncan, 1998)[3]. A more recent phenomenon is the increase in golf-course construction near coastal sites, especially in the Pacific Basin (Carrow and Duncan, 1998). Other areas in the Caribbean area include the Valle de Lajas, an area of approximately 17,000 acres in the southwest part of Puerto Rico, and the Valle de Neiba in the southwest part of the Dominican Republic near Haiti (Bonnet, 1960).

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[1] *Bonnet, J.A. 1960. Edafología de los suelos salinos y sódicos. Estacion Experimental Agricola, Universidad de Puerto Rico. 337 p.*

[2] *Eswaran, H., R. Lal, and P.F. Reich. 2001. Land degradation: An overview. P. 20-35. In E.M. Bridges et al., (eds). Response to land degradation. Oxford & IBH Publishing CO. Pvt. Ltd. New Delhi, Calcutta. ISBN 81-204-1492-2*

[3] *Carrow, R.N, and R.R. Duncan. 1998. Salt-affected turfgrass sites: Assessment and management. Ann Arbor Press, Chelsea MI. 185 pp.*

Soluble salts are usually chlorides, sulfates, and bicarbonates of calcium, magnesium and to a minor extent sodium. The total soluble salt concentration is measured by the electrical conductivity (EC) of the solution from a soil-water mixture. As the total salt concentration increases, the EC increases. Soils with a “high” salt content (saline soils) are nonsodic soils containing sufficient high soluble salts to adversely affect the growth of most plants. Saline soils usually have pH between 7.0 and 8.4, yet acidic pH can occur in some situations. Figure 1 shows a saline-sodic soil at the Lajas Valley, PR.

Figure 1. Saline-sodic soil at Lajas Valley, Puerto Rico.

Salt-related problems occurring from existing salts in the soil or in irrigation water are:

(i) plant water deficits
(ii) ion toxicities of specific ions, and
(iii) ion imbalances that lead to other nutritional problems. Although the laboratory procedure is use for classifying salt-affected soils, different plants exhibit varying types and degree of expression of the symptoms.

The threshold EC and slope concept has its greatest value in providing general salt tolerance guidelines for specific crops in order to make crop selection and management decisions. Within a given species, cultivar or ecotype salinity threshold values and slope values can vary greatly. Table 1 shows the salt tolerance of some common tropical crops and forages grown in the Caribbean Area, Pacific Basin and Hawaii.

Table 1. Salt tolerance of some common tropical crops and forages grown in the Caribbean Area, Pacific Basin and Hawaii.

Crop	Scientific name	Variety	Salinity effect threshold (dS/m)	% Yield decrease per subsequent dS/m increase	Comment	Reference
Grass						
Sudan grass	*Sorghum sudanense*		2.8	4.3		(7), (5), (3) as cited by (6)
Orchard grass	*Dactylis glomerata* L.		1.5	6.2		(8)
Bermuda grass	*Cynodon dactylon* (L.) Pers.		6.9	6.4		(7), (5), (3) as cited by (6)
Bermuda grass, common	*Cynodon dactylon* (L.) Pers.		4.3	2.3		(4)
Seashore paspalum	*Paspalum vaginatum*		8.6	1.6		(4)
Zoysiagrass	*Zoysia spp.*		2.4	3.1		(4)
St. Augustinegrass	*Stenotaphrum secundatum*		6.5	1.7		(4)
Horticultural						
Kidney bean	*Phaseolus vulgaris* L.	Not reported	1.0	19.0	Tolerance based on seed yield.	(7), (8), (3) as cited by (6)
Kidney bean	*Phaseolus vulgaris* L.	Not reported	1.0	19.4		(1)
Carrot	*Daucus carota*		1	14		(5), (3) as cited by (6)
Garden cucumber	*Cucumis sativus* L.	Not reported	2.5	13.0	Tolerance based on fruit yield.	(2), (3) as cited by (6), (5), (7), (8)
Squash	*Cucurbita maxima d uchesne*	winter	2.5	12.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Squash	*Cucurbita pepo melopepo*	scallop	3.2	16.0		(7), (2)
Squash		zucchini	4.7	9.4		

Squash	*Cucurbita pepo melopepo*	scallop	3.2	16.0	Tolerance based on fruit yield.	(8)
Squash		zucchini	4.9	10.5		
Squash	*Cucurbita pepo melopepo*	zucchini	4.9	10.5		(5)
Garden lettuce	*Lactuca sativa* L.	Not reported	1.3	13.0		(2), (3) as cited by (6), (5), (7), (8)
Garden onion	*Allium cepa* L.	Not reported	1.2	16.1		(2), (3) as cited by (6), (5), (7)
Garden onion	*Allium cepa* L.	Not reported	1.2	16.0	Tolerance based on bulb yield.	(8)
			1.2	8.0	Tolerance based on seed yield.	
Cayenne pepper	*Capsicum annuum* L.	Not reported	1.5	14.1		(2), (3) as cited by (6), (5), (7), (8)
Irish potato	*Solanum tuberosum* L.	Not reported	1.7	12.0		(2), (3) as cited by (6), (7), (8)
Irish potato	*Solanum tuberosum* L.	Not reported	1.5	14.0		(5)
Corn	*Zea mays* L.	Not reported	1.8	7.4		(3) as cited by (6), (8)
Corn	*Zea mays* L.	Not reported	1.7	12.0	Grain and forage yields of DeKalb XL -75 grown on an organic muck soil decreased about 26 % per dS/m above a threshold of 1.9 dS/m.	(7), (8)
Corn	*Zea mays* L.	Not reported	1.7	12.3		(1), (5)
Sweet corn	*Zea mays* L.	Not reported	1.7	12.0		(2), (3) as cited by (6), (5), (7), (8)
Sweet potato	*Ipomoea batatas* (L.) Lam	Not reported	1.5	11.0		(2), (3) as cited by (6), (5), (8)
Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported	2.5	9.9		(2), (3) as cited by (6), (5)

Garden tomato	*Solanum lycopersicum* var. *lycopersicum*	Not reported	2.5	9.9	Tolerance based on fruit yield.	(8)
		Cerasiforme (Cherry)	1.7	9.1		
Eggplant	*Solanum melongena esculentum*	Not reported	1.1	6.9	Tolerance based on fruit yield.	(7), (8)
Cabbage	*Brassica oleracea* L.	Not reported	1.8	9.7		(2), (3) as cited by (6), (5), (7), (8)
Peanut	*Arachis hypogaea* L.	Not reported	3.2	29.0		(7), (8), (3) as cited by (6)
Sunflower	*Helianthus annuus* L.	Not reported	4.8	5.0	Tolerance based on seed yield.	(8), (5)
Date palm	*Phoenix dactylifera* L.	Not reported	4.0	3.6	Tolerance based on fruit yield.	(8), (3) as cited by (6)
Kenaf	*Hibiscus cannabinus* L.	Not reported	8.1	11.6		(8)
Okra	*Abelmoschus esculentus* (L.) Moench.	Not reported	1.0	10.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Fruits						
Cantaloupe	*Cucumis melo* L.	Not reported	2.5	9.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Cantaloupe	*Cucumis melo* L.	Not reported	1.0	8.4	Tolerance based on fruit yield.	(8), (5)
Celery	*Apium graveolens*	Not reported	1.8	6.2		(7), (8)
Celery	*Apium graveolens*	Not reported	1.0	12.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Sweet orange	*Citrus sinensis (L.)* Osbeck	Not reported	1.7	15.9		(3) as cited by (6), (7)
Lemon	*Citrus* spp.	Not reported	1.0	12.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Lemon	*Citrus* spp.	Not reported	1.5	12.8	Tolerance based on fruit yield.	(8)
Avocado	*Persea americana mill*	Pollock	1.0	15.0	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Guava	*Psidium guajava* L.		4.7	9.8		(8)
Grape fruit	*Citrus x paradisi macfady*	Not reported	1.2	13.5		(8)

Agronomic						
Sorghum	*Sorghum bicolor*	Not reported	6.8	16	Tolerance based on grain yield.	(7), (8), (5)
Sorghum	*Sorghum bicolor*	Not reported	4.8	12	Slope estimated. Slope may have been nonlinear or not reported.	(3) as cited by (6)
Soybean	*Glycine max*	Not reported	5	20	Tolerance based on seed yield.	(7), (8), (5), (3) as cited by (6)
Rice	*Oryza sativa* L.	Paddy	3.0	12.2		(3) as cited by (6)
Rice	*Oryza sativa* L.	Paddy	3.0	12.0	Because paddy rice is grown under flooded conditions, values refer to the electrical conductivity of the soil water while the plants are submerged. Less tolerant during seedling stage. Tolerance based on grain yield.	(8)
Rice	*Oryza sativa* L.	Paddy	3.0	12.0	Paddy rice is grown under flooded conditions, thus electrical conductivity of the soil water refers to the plants while submerged. Less tolerant during seedling stage.	(7)
Sugarcane	*Saccharum officinarum* L.	Not reported	1.7	5.9		(3) as cited by (6), (7), (8)

Summary

Many soils with salinity problems could be utilized in some extent for crop production. A detail survey of the land, market and technology must be considered to properly manage this resource for farming, ranching or wildlife uses. This list can be used to select plant species with higher potential of survival, shelter and/or marketing that can be planted in saline-sodic soils in the Caribbean Area.

Reference

Sotomayor, David, Ortega, S. & Mas, E. 2004. Tropical Crop Nutrient Extraction & SALT Tolerante Database. Agronomy & Soils Dept. Univ. of Puerto Rico, Mayaguez, PR.