Tree Irrigation Water Fact Sheet

Applicable to conservation practices containing trees and/or shrubs

USDA Natural Resources Conservation Service - North Dakota **July 2009**

Can I use my well water to irrigate my tree planting? It depends upon the water and soil quality.

Assuming the proper tree or shrub species has been selected to match the soil characteristics, irrigation water is needed only for the first three years during plant establishment or during extreme droughts. *More frequent or long-term irrigation will require investigations beyond the scope of this fact sheet.*

Irrigation water interacts with specific soil properties in many and varied ways. Landowners should conduct water and soil quality tests prior to planting, if there is any doubt about water quality. For water samples, request a "Complete Mineral Chemistry Water Test." Water and soil test kits are available from the ND State Health Department and NDSU Extension Service county offices, respectively. Private labs also provide soil and water test kits. The kits usually contain directions on proper sample collection techniques. When requesting a soil analysis, indicate you want recommendations on the feasibility of irrigating the site for plant production.

Basic Soil Characteristics Affecting Irrigation and Plant Growth After identifying the soils on which the tree or shrubs will be, or are planted, investigate the following soil characteristics.

- Soil Depth: There must be adequate space for tree roots to expand, and for storage and release of precipitation and irrigation water. Soils should be at least 20" deep before any limitation to rooting depth, such as hard pan, coarse gravel and sand, sodic layer (defined later), or permanently high water table. Deep soils can be irrigated more often with greater amounts of water, thereby, reducing the accumulation of salts from irrigation water.
- Soil Texture: Loams to fine sandy loams provide ideal growing conditions for most tree roots, assuming adequate high quality water is available. Coarser material, such as sands and gravels are characterized by rapid water infiltration and suitable soil aeration, but do not provide adequate water storage for ideal tree growth. Irrigating fine textured soils, (higher percentage silts and clays) in some cases, can lead to a buildup of damaging salts and low soil aeration. Coarse textured soils allow leaching of salts, but require large amounts of irrigation water that cannot be supplied by most household well systems.
- Soil Structure: The arrangement of sand, silt, clay, and organic matter into aggregates determines soil structure. Good soil structure allows good air exchange, good soil aeration, and adequate infiltration rates of irrigation water and precipitation. Structure is easily damaged by improper or excessive tillage, and can be destroyed by compaction from foot and machine traffic when soils are wet.
- Soil Infiltration: Soil texture, soil structure, and moisture content affect water infiltration rates into the soil. Coarse textured and non-compacted soils have the greatest infiltration rates. As water content within a soil increases, the infiltration rate will decrease.
- Soil Permeability: Soils with moderate to high permeability are able to drain excess water from soil pore spaces quickly enough to prevent tree root stress. Soils with reduced permeability can become saturated with water, causing tree stress or even death. Permeability is determined by soil texture and structure. Fine textured soils have naturally slow permeability. Improper tillage or mismanagement of soil can destroy structure, reducing permeability and plant health.

- Salinity: Saline soils contain sufficient soluble salts to adversely affect plant growth. As soil salt content increases, the plant's ability to extract water from the soil is reduced. At high soil salt concentrations, plants are unable to overcome the osmotic tensions holding water tightly to soil particles, causing them to suffer drought-like conditions.
- Sodicity: Sodic soils contain exchangeable sodium, with or without soluble salts, which affects plant growth. Soils with excessive sodium also have poor structure with greatly reduced permeability and infiltration.
- Alkalinity: North Dakota soils usually have a pH greater than 7 (alkaline). Though most trees and shrubs prefer a soil pH of 6.5 to 7, many adapted trees and shrubs are able to thrive on North Dakota soils with a pH as high as 8. Some introduced trees and shrubs are especially sensitive to high pH soils.
- Soil Drainage: Irrigation should not add so much water that the rooting zones of trees become waterlogged. As long as the soil has moderate permeability, this is unlikely if irrigation is from a household well.
- Soil Topography: Topography affects how much water soaks in, runs off, or evaporates from a site. Steep south aspects are hotter and drier than north aspects. Flatter slopes absorb more precipitation than steeper slopes. Trees planted at the base of a hill tend to grow better than trees planted on the hill top because more water comes to the base of the slope from overland and near surface flows. Steep south aspects will require more irrigation than better positioned parts of the topography.
- Erosion Control: Reducing soil erosion helps maintain organic matter, plant nutrients, water, infiltration rates, and soil structure, all benefiting the tree and shrub planting.

<u>Water Quality</u>: Irrigation water quality is determined by its salt and suspended material content. Principle salts include the cations of calcium, magnesium, and sodium and the anions carbonate, bicarbonate, sulfate and chloride. The most important salt factors are the total concentration and type of salts. See Chart 1.

Drip irrigation line on a new tree planting.

<u>Interpretation of classifications in Chart 1</u>

- C1 – Low salinity – Can be used for irrigation with few limitations
- C2 – Medium salinity – Can be used if a moderate amount of leaching occurs.
- C3 – High salinity – Cannot be used on soils of moderately slow permeability. Even with adequate permeability, special salinity management practices may be needed.
- C4 – Very high salinity – Not suitable for irrigation except in special circumstances.
- S1 – Low sodium – Can be used on almost all soils with little danger of causing problems.
- S2 – Medium sodium – Will cause problems on fine textured soils, especially under low leaching conditions. Can be used on coarse textured soils with moderately rapid permeability.
- S3 – High Sodium – Will produce harmful conditions on most soils without extreme mitigation procedures.
- S4 – Very high sodium – Not suitable for irrigation except in rare situations where water and soil quality, in combination with special management, might mitigate the negative effects of the sodium.

Use Chart 1 to determine probability that irrigation water is suitable for irrigating trees and shrubs. Individual test values only estimate the impact on soil salinity and plant responses.

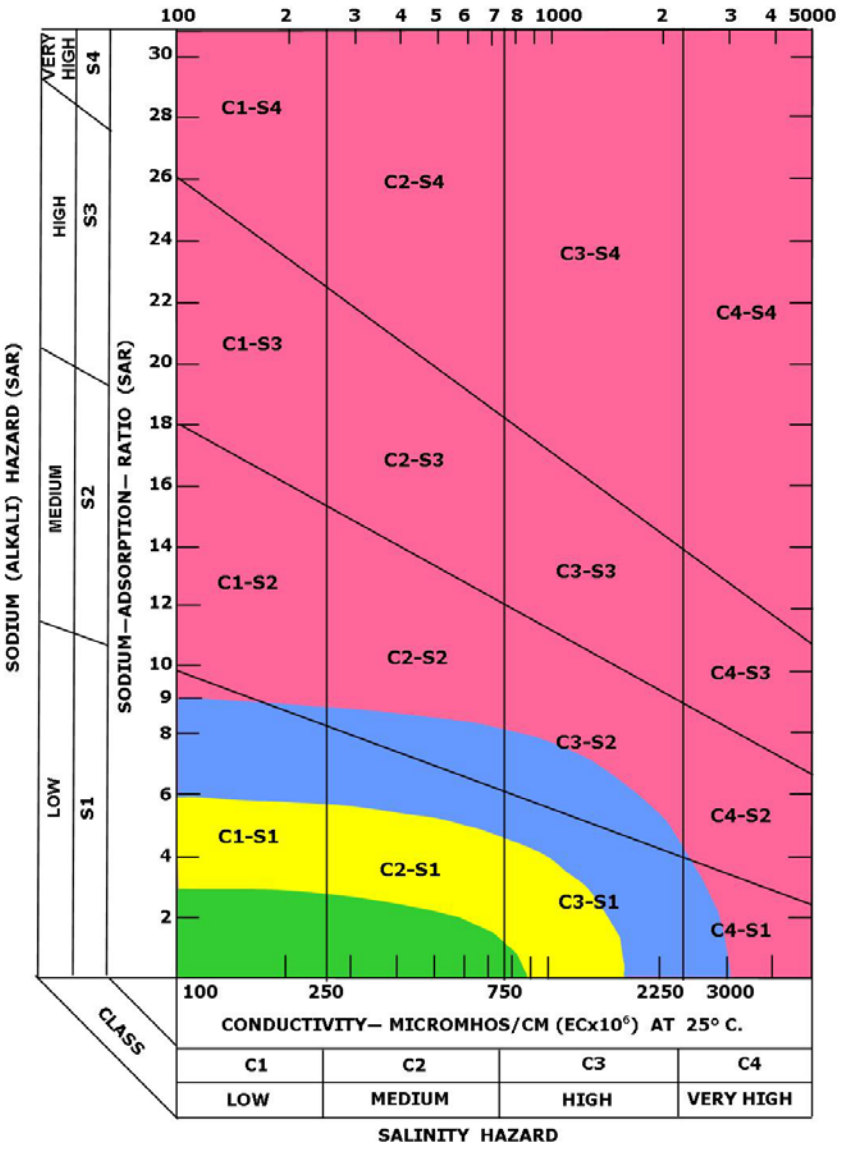

Chart 1: Diagram for classification of irrigation waters from USDA Ag Handbook 60. Colored bars were added to the original chart specifically for this fact sheet.

Chart Legend

Water salinity levels generally acceptable for all trees and shrubs.

Water salinity in C3 category is acceptable only on well drained soils but problematic on clays. It may lead to a soil salinity buildup injurious to woody plants, over time. Use saline tolerant plants and practice salinity mitigation/minimization practices.

Salinity and sodicity levels are too high for all but the most salt tolerant species, even when special management is applied. This water could be used in limited situations when the only alternative is let the plant die.

Unsuitable for trees and shrubs without treatment. For a few specific situations, a limited use of this water may be able to help plants during an extended drought.

Note: For most plants, one or two applications of water from the green, yellow or blue categories will usually not harm the plant. Salinity problems are cumulative and generally worsen the longer saline water is applied. Long-term application of water that "scores" in the blue or red areas of the chart, on all but the coarsest textured soils, will often result in salinity or sodicity levels injurious to plants, if extensive mitigation is not provided.

For much of North Dakota, our natural precipitation is adequate to leach salts deeper in the soil profile, lengthening the interval before salinity-sodicity problems develop.

Conductivity - The total concentration of soluble salts is expressed in terms of micromhos/centimeter for water and millimhos/centimeter (deciSiemens/meter) for soil. When comparing values ensure units are identical.

Sodium Adsorption Ratio - The proportion of sodium to magnesium, and calcium in the water.

Detailed water and soil test interpretations, definitions, and conversions can be found at:

Testing and Interpreting Salt-Affected Soil for Tree and Shrub Plantings, Montana Tech Note 60

Testing and Interpreting Salt-Affected Water for Tree and Shrub Plantings, Montana Tech Note 61

Note: Though not often addressed in salinity recommendations, trees and shrubs are sensitive to irrigation water with chloride concentrations above 150 mg/l. Chloride concentrations above 350 mg/l can cause severe growth problems. The higher the chloride levels in the water the quicker the trees and shrubs will exhibit browning leaf margins and loss of vigor.

Repeated, frequent irrigation can cause a salinity or sodicity problem in soils, even with water that is low in salts. The problem develops faster in areas of low precipitation and on fine textured soils. In some situations, "clean" water, low in salts, can actually create a sodicity problem by leaching the more soluble magnesium and calcium salts from the soil thereby increasing the percentage of sodium salts remaining in the soil.

Procedures to minimize and/or delay the onset of salinity / sodicity problems:

- Manage the planting to reduce evaporation from the soil surface.
  - Avoid tillage, which dries soil and increases surface salt concentrations.
  - Maintain herbaceous cover between rows to minimize exposed soil surface.
  - Maintain herbaceous wind barriers (tall vegetation such as corn, tall wheatgrass, etc) to reduce soil surface exposure to evaporative winds.
  - Use mulches around plants to cover exposed soil, minimize weed competition, and cool the soil surface.
- Manage the planting to harvest more of the available precipitation.
  - Design planting (dense shrubs or close in-row spacing) to effectively trap drifting snow within the planting.
  - Establish herbaceous barriers between rows and around the planting, to capture drifting snow.
  - Maintain good soil structure by avoiding excessive tillage, applying mulch, and minimizing wheel and foot traffic on wet soils, facilitating rapid infiltration of rain water.
  - Where possible, direct rain water runoff to the planting.
- Manage irrigation water to retard salt build-up.
  - Select plants appropriate for the site that will require little if any irrigation.
  - Irrigate only when needed.
  - Irrigate infrequently with large amounts of water rather than frequently with smaller amounts of water.
  - When possible, thoroughly saturate the top 2-3' of soil profile to leach salts below the root zone.
  - Avoid sprinkler irrigation as salts concentrate through evaporation of the smaller water droplets before they can reach the ground.
  - Use drip irrigation to put water only where needed.

If the water is too bad to drink, it's probably too bad for your trees. Even if you can drink it, it might be bad for plants in the long run. Conduct water and soil tests to know for sure.

Where to get help: Contact your local NRCS, or Cooperative Extension Service.

References:

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