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Plant Materials Center
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Helping People Help the Land

Plant Materials for Salt-Affected Sites
in the Northern Great Plains

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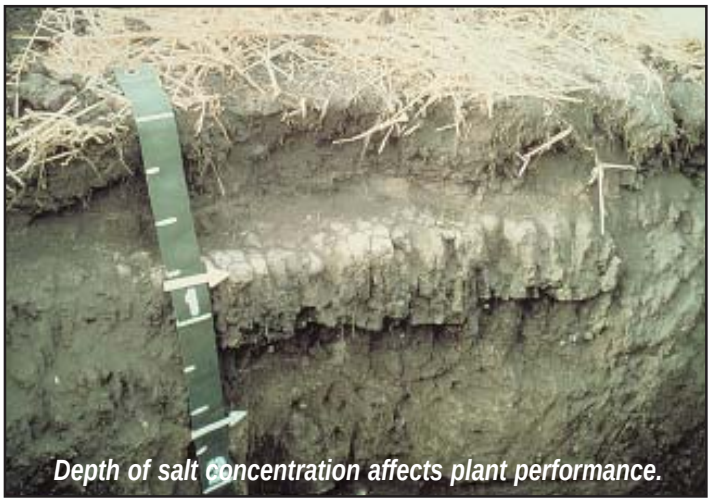
Plant performance can vary dramatically on sites affected by increased salt concentrations. Matching the salt tolerance of the species to the conditions at the site is an important consideration in the success of any new plantings. Many soils in the Northern Great Plains developed directly or indirectly from marine sediments that are naturally high in salts. Excess salts injure plants by disrupting the uptake of water into the roots.

Identifying the Problems

The following diagnosis summary is included in the Design and Installation Guide, Conservation Standard 610, Salinity and Sodic Soil Management, found in Section IV of the North Dakota Field Office Technical Guide (FOTG). Refer to this document or your State's FOTG for more complete information.

- **Discharge soils** have subsoils that are high in calcium carbonate and usually have a dominant upward movement of water. They occur around or near wetlands. Excessive evaporation and capillary rise may bring salts into the root zone. This is especially a concern during periods of seasonal high water tables and when the soil surface is cultivated or lacks vegetation. **The key to managing saline discharge soils is to control the amount of saline water entering the plant root zone**. This can be accomplished by establishing permanent vegetation with deep-rooted plants that reduce surface evaporation and utilize excess water.
- **Saline seeps** are most common south and west of the Missouri River. They usually occur in cultivated areas. Excess water from precipitation moves through soils in the upland recharge area, dissolving salts as it percolates. Once it reaches an impermeable layer, the deep percolating water moves laterally until it reaches the soil surface (discharge area). Symptoms may include decreased crop yield, excessive fall moisture, salt crusts, vigorous kochia or foxtail barley growth, or stunted trees with leaf chlorosis. **The key to managing saline seeps is to utilize the water in the recharge area.** One way to achieve this is to plant deep-rooted perennial forages.
- **Naturally occurring saline/sodic soils** develop due to soil forming factors and not from human intervention. These soils are moderately to strongly saline due to saline parent material, landscape position or a saline water source. Soils high in sodium (sodic soils) may present physical restrictions to plant growth. High pH generally occurs in sodic soils and affects plant growth by reducing availability of some plant nutrients. **Managing these areas as permanent vegetation is highly recommended.**

Soil salinity and related sodicity problems can be very complex and additional information may be necessary for proper identification and management (USDA, NRCS 1996; USDA, ARS 1983; Seelig 2000). See your county Extension agent or district conservationist for more information regarding these soils. Saline and sodic soils are identified on maps created by the USDA Natural Resources Conservation Service.



Depth of salt concentration affects plant performance.

Measuring Salts in the Soil

A soil test is the best way to determine the severity of the soluble salt and/or sodium problems in the soil. Local experts can provide sampling instructions. There are several tests to quantify or qualify soil salinity (USDA, NRCS 2002a). Electrical conductivity (EC) provides an overall measure of water-soluble salts. EC is usually measured in decisiemens per meter (dS/m) of a saturated extract. The higher the number, the higher the salt concentration. Measurements from 0 to 2 are considered non-saline with little or no injury to plants. Measurements greater than 16 are considered strongly saline with extremely limited plant growth. Handheld conductivity meters are available which can help delineate saline area boundaries. Measurements can be quite variable depending on specific site conditions (i.e., salt depth, time of year, surface residue) at the time of measuring, and calibration of the equipment.

Salt-affected sites should be disturbed as little as possible. Once vegetation is destroyed, salts move to the soil surface through evaporation and revegetation becomes extremely difficult.

Seeding

Perennial forages, especially cool-season grasses, have the highest tolerance to salt-affected soil conditions. Plant species selection is critical, as is the use of recommended varieties adapted to the plant hardiness zones found in the Northern Great Plains (Sedivec et al 2001). The best time to seed a forage or cover crop in salt-affected soils is in late fall (mid-October to December) as a dormant seeding. The seeded crop can benefit from the diluting effect of early spring moisture on the surface salts. Proper seedbed preparation is critical (USDA, NRCS 2003a). Seeding into surface residue or applying mulch after the seeding operation will reduce evaporation from the soil surface and protect emerging seedlings. Plant species with larger seed, such as tall wheatgrass, have greater seedling vigor and are easier to establish on salty areas. A shallow seeding depth is less critical with larger seed. Native grass species such as alkali sacaton and Nuttall's saltgrass are adapted to high salt concentrations once established. They are not recommended for seeding, however, as the small seed makes establishment difficult. Inland saltgrass is another species common on salt-affected sites. It is not on the recommended seeding list because of limited seed availability and poor establishment. Barley is a salt tolerant small grain that can work well as a cover crop. Oats, sorghum, and sudangrass are considered moderately sensitive.

Fall or winter dormant seeding into standing residue is recommended on salt-affected sites.

Plant Tolerance Levels

A range of generally accepted soil salinity ratings for forage plants, native forbs and legumes, and tree and shrub species is shown in Tables 1 through 3, respectively. The plants have been grouped into three tolerance groups: 1) tolerant, 2) moderately tolerant, and 3) moderately sensitive (Franzen et al 1994). The ranges listed for EC (of saturated extract) are the upper limits that established plants will survive. The plant species are listed in the order of decreasing salinity tolerances. Plants are usually more sensitive at germination and early growth. Some varieties of plants are more tolerant than others.

Herbaceous Forage Plants

Herbaceous forage plants, especially cool-season grasses, are generally considered the most effective cover on salt-affected sites (Table 1). Tall wheatgrass, slender wheatgrass, and western wheatgrass are the most frequently used strongly tolerant species. Switchgrass, prairie cordgrass, and buffalograss are the only warm-season species listed in the table.

Table 1. Herbaceous forage plants. Salinity tolerance and estimated EC range (* = wet sites).

Tolerant (EC 15-25)
*beardless wildrye
tall wheatgrass
Russian wildrye
*NewHy hybrid wheatgrass
slender wheatgrass
Altai wildrye
*tall fescue
*western wheatgrass
*strawberry clover
Moderately Tolerant (EC 10-15)
crested wheatgrass
thickspike wheatgrass
intermediate wheatgrass
pubescent wheatgrass
*creeping foxtail
*prairie cordgrass
Canada wildrye
buffalograss
Moderately Sensitive (EC 5-10)
*meadow bromegrass
smooth bromegrass
yellow sweetclover
birdsfoot trefoil
*cicer milkvetch
*orchardgrass
alfalfa
*switchgrass
*reed canarygrass
*alsike clover
*white clover
red clover

Native Forb and Legume Species

Little information is available on the salt tolerance of native forbs and legumes. However, personal experience and limited references indicate the species listed in Table 2 may have a slight tolerance depending on specific site conditions (Niu 2006).

Table 2. Native forbs and legumes. Salinity tolerance and estimated EC range.

Moderately Sensitive (EC 2-6)
blanketflower
yarrow
yellow coneflower
fringed sagewort
purple prairieclover
primrose
stiff sunflower
Maximilian sunflower
Lewis flax
Canada milkvetch
two-grooved milkvetch
scarlet globemallow

Tree and Shrub Species

Tree and shrub species are generally not recommended for planting on salt-affected sites. However, some species are considered moderately tolerant to moderately sensitive (Table 3). Older bare-root stock and/or potted stock are recommended for planting rather than small seedlings because of the greater salt tolerance of larger plants. Russian olive and Siberian elm, which are rated moderately tolerant, are generally not recommended because they can become invasive.

Table 3. Trees and shrubs. Salinity tolerance and estimated EC range.

Moderately Tolerant (EC 8-15)	Moderately Sensitive (EC 4-8)
seaberry	chokecherry
silverberry	'Freedom' honeysuckle
fourwing saltbush	Scotch pine
silver buffaloberry	blue spruce
golden currant	juneberry
hawthorn	villosa lilac
caragana	creeping juniper
green ash	Siberian larch
Rocky Mountain juniper	American plum
common lilac	Siberian crabapple
ponderosa pine	boxelder
skunkbush sumac	laurel willow
Austrian pine	

Overall Management Considerations

- √ Manage the soil surface to minimize soil water evaporation and concentration of salts.
- √ Cool-season grasses are generally more salt tolerant than forb, legume, tree, or shrub species. Avoid planting trees and shrubs on salt-affected sites whenever possible.
- √ Barren areas without soil surface cover and high salt concentrations will be extremely difficult to revegetate. Other management options may be necessary and local experts should be consulted.

Blanketflower, yellow coneflower, Lewis flax, and purple prairieclover may be tolerant to low levels of salinity depending on site conditions.

Management Options (USDA, NRCS 2005).

Annual Cropping
Salt Tolerant Crops
barley
sugarbeets
safflower
High Water Use Crops
sweetclover
alfalfa
safflower
Longer Growing Season Crops
corn
sunflowers
Permanent Cover
Salt Tolerant Permanent Cover
tall wheatgrass
slender wheatgrass
western wheatgrass
High Water Use Permanent Cover
alfalfa
switchgrass
meadow bromegrass
intermediate/pubescent wheatgrass
Longer Growing Season Permanent Cover
alfalfa

Prairie cordgrass plants established from rhizomes on a salt-affected site in eastern South Dakota.

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http://plants.usda.gov

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http://www.nrcs.usda.gov/technical/efotg/

http://www.ag.ndsu.edu/pubs/

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