

# Salinity, Sodicty and Flooding Tolerance of Selected Plant Species of the Northern Cheyenne Reservation

## Information Highlight for the General Public

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## Introduction

The Northern Cheyenne Reservation, located in southeastern Montana, covers 445,000 acres and is bordered on the east by the Tongue River and on the west by the Crow Reservation. One concern about coal bed methane (CBM) development in this region is the impact that CBM product water could have on native and culturally significant plants on the Northern Cheyenne Reservation.

This research was undertaken to assess the tolerance of native and culturally significant plant species to salinity, sodicty, and flooding associated with management and disposal of CBM product water. A list of thirty-one plant species was acquired from the Environmental Protection Agency and the Northern Cheyenne Tribe. Tolerances to salinity, sodicty, flooding, and pH of plants on this list have been thoroughly researched to predict how they would respond to saline-sodic water produced from CBM development.

## Scientific Basis

Table 3 provides a summary of sensitivity ratings of the thirty-one plant species found within the Northern Cheyenne Reservation to soil solution salinity ( $EC_e$ ), exchangeable sodium percentage, flooding, and changes in soil pH. The following explanations (a through d) have been provided to help the reader understand Table 3.

### a) Salinity Tolerance Ratings

Scientific references have categorized most plants by degree of sensitivity or tolerance to salinity. Table 1 explains the general rating of plant salinity tolerances used in this report. The  $EC_e$ , which measures the salinity of the soil water that is available to plants, was used to rate the salinity.

**Table 1. Salinity tolerance ratings.**

$EC_e$	Salinity Tolerance Rating	Abbreviation
< 2 dS/m	Sensitive	S
2-4 dS/m	Moderately Sensitive	MS
4-6 dS/m	Moderately Tolerant	MT
> 6 dS/m	Tolerant	T

### b) Sodium Tolerance Ratings

Sodicity is expressed as SAR (sodium adsorption ratio), ESP (exchangeable sodium percentage), or as the specific sodium concentration. The rating scheme used for plant tolerances to sodium is listed in Table 2.

**Table 2. Sodium tolerance ratings.**

Sodium Tolerance Rating	Abbreviation
Extremely sensitive	ES
Very tolerant	VT
Data not available to justify a rating.	No data available

### c) Flooding Tolerance Ratings

- Intolerant: Unable to withstand flooding for more than a few days.
- Moderately tolerant: Able to withstand short-term flooding, approximately two weeks in duration, but not long-term flooding.
- Tolerant: Able to withstand relatively long-term flooding, up to one year or more, but may still be damaged by consecutive years of flooding.

#### d) pH/Alkalinity Tolerance Ratings

The ideal pH ranges are given. While plant species may be able to survive outside of the given ranges, they are likely to be negatively impacted, either through direct physical damage or through competition with species better adapted to the given pH.

#### Summary of Findings

**Table 3. Summary of sensitivity ratings of thirty-one native and culturally significant plant species of the Northern Cheyenne Reservation to soil solution salinity (EC<sub>e</sub>), exchangeable sodium percentage, flooding, and changes in soil pH.**

Common Name	Scientific Name	SALINITY Rating	SALINITY Acceptable Upper Limit EC <sub>e</sub> (sat) dS/m	SODIUM Tolerance Rating	Flooding Rating Limits, Inundation	pH range
1. June Service Berry	<i>Amelanchier alnifolia</i>	S	2.0	ES; ESP 2-10, SAR 1.6-8.0	MT short term, 2 weeks	no data
2. Red Osier Dogwood	<i>Cornus stolinifera</i>	S	2.0	no data available	MT short term, 2 weeks	6.5-7.9
3. Common spikerush	<i>Eleocharis palustris</i>	MS	4.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9
4. Horsetail, Field	<i>Equisetum arvense</i>	MS	4.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.2
5. Wild licorice/American	<i>Glycyrrhiza lepidota</i>	MT	6.0	VT; ESP 60, SAR 48	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.2
6. Goose Berry, red shoot	<i>Ribes setosum</i>	S	2.0	ES; ESP 2-10, SAR 1.6-8.0	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9
7. Mint/Field	<i>Mentha arvensis</i>	S/MS	2.0	ES; ESP 2-10, SAR	no data available	4.8-7.9

				1.6-8.0		
8. Horsemint/W. Bergamot	<i>Monarda fistulosa</i>	MS	4.0	no data available	no data available	5.5-7.9
9. Water Plant/Water Cress	<i>Nasturium officinale</i>	MS	4.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.2
10. Sweet Medicine	<i>Oxtropis lambertii</i>	MS	4.0	no data available	no data available	5.5-7.9
11. Chokecherry	<i>Prunus virginiana</i>	S	2.0	ES; ESP 2-10, SAR 1.6-8.0	I very short term; < 2 weeks	4.8-7.9
12. Cottonwood, G. Plains	<i>Populus deltoides</i>	MS	4.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9
13. Box Elder	<i>Acer negundo</i>	MT	6.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9
14. Green ash	<i>Fraxinus pennsylvania</i>	MT	6.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	6.5-7.9
15. Sand bar willow	<i>Salix exigua</i>	MS	4.0	no data available	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9
16. Snow Berry	<i>Symphoricarpos occidentalis</i>	MS	4.0	ES; ESP 2-10, SAR 1.6-1.8	T long term, 1 year -; not tolerant of permanent flooding	4.8-7.9

17. Cattail	<i>Typha latifolia</i>	MS	4.0	no data available	T long term, 1 year +; not tolerant of permanent flooding	4.8-7.9
18. Wild Plum	<i>Prunus americana</i>	S	2.0	ES; ESP 2-10, SAR 1.6-1.8	T long term, 1 year +; not tolerant of permanent flooding	no data
19. Sweet grass	<i>Hierochloe odorata</i>	MS	4.0	no data available	no data available	4.8-7.2
20. Quaking aspen	<i>Populus tremuloides</i>	S	2.0	no data available	T long term, 1 year +; not tolerant of permanent flooding	no data
21. Saw beak sedge	<i>Carex stipata</i>	MS	4.0	no data available	T long term, 1 year	5.0-7.9
22. Leafy aster	<i>Aster foliactus</i>	S	2.0	no data available	T long term, 1 year +; not tolerant of permanent flooding	4.8-7.2
23. Stinging nettle	<i>Urtica dioica</i>	MS	2.0	no data available	I very short term, < 2 weeks	4.8-7.2
24. Bulrush	<i>Scirpus nevadensis</i>	MT/T	6.0	no data available	T long term, 1 year +; not tolerant to permanent flooding	4.8-7.9
25. Arrow leaf	<i>Sagittaria latifolia</i>	MS	4.0	no data available	T long term, 1 year +; not tolerant of permanent flooding	4.8-7.9
26. Golden currant	<i>Ribes aureum</i>	MS	4.0	ES; ESP 2-10, SAR	no available data	4.8-7.9

				1.6-8.0		
27. Skunkbush sumae	<i>Rhus trixobata</i>	MT	6.0	no data available	MT short term, 2 weeks	6.5-7.9
28. Milkweed, showy	<i>Asclepias speciosa</i>	MS	4.0	no data available	I very short term, < 2 weeks	4.8-7.2
29. Western yarrow	<i>Achillea millefolium</i>	MS	4.0	no data available	I very short term, < 2 weeks	4.8-7.9
30. Raspberry red	<i>Rubus idaeus</i>	S	2.0	ES; ESP 2-10, SAR 1.6-8.0	no data available	4.8-7.9
31. Rose Bush	<i>Rosa arkansa</i>	MS	4.0	no data available	MT short term, 2 weeks	4.8-7.9

## Explanations and Descriptions of Plant Responses

### a) Salinity

Generally, the most likely effect of salinity on plants is stunted growth. Increased salinity requires plants to use more energy to get water from the soil, which leaves the plant with less energy available for growth. Moderately salt-stressed plants usually appear normal, although their leaves may be darker green, thicker and more succulent than non-stressed plants. Visual symptoms (leaf burn, necrosis, and defoliation) sometimes occur, particularly in woody species. At high levels, salinity can cause physical damage and mortality. Plant sensitivity to salinity changes throughout the growing season. While most crops are relatively tolerant to salinity during germination, young developing seedlings are particularly vulnerable to salinity damage during emergence and early development. After the plants are established, they generally become increasingly tolerant of salinity in later growth stages.

One of the main effects of salinity is the delay of germination and seedling development. This delay may prove fatal if the salt-stressed seedlings encounter additional stresses, such as water stress, extreme temperature fluctuations and/or surface crusting. Also, because of evaporation at the soil surface, salt concentration in the seedbed is often higher than deeper in the soil profile. This means that roots of emerging seedlings are exposed to a greater degree of stress than indicated by usual salinity measurements which are usually averaged from soil samples taken throughout the soil profile. Plant loss during this seedling stage can reduce the plant population density to below optimal levels and significantly reduce yields.

## **b) Sodicty**

The two main risks of high sodium levels in soil water are toxic effects and impacts on plant growth from changes in soil structure. Excess sodium present in soil water can cause soil dispersal, especially in soils with high clay contents. Soil dispersal causes loss of soil structure and surface crusting. Surface crusting leads to reduced hydraulic conductivity, reduced water infiltration, and increased water runoff. These conditions can make seedling establishment very difficult, if not impossible. Decreased drainage from sodium-induced soil dispersal can also increase the sodicty in the root zone. If water containing salts is not allowed to drain below the root zone, the salt concentration of soil water will increase as plants take up water by transpiration and as evaporation occurs. For more information on sodic soils, see ["The Basics of Salinity and Sodicty Effects on Soil Physical Properties."](#)

Sodium-induced dispersal also makes it difficult for plant roots to get the water and nutrients they need to survive. This occurs because sodic soils are likely to become and remain water logged, resulting in anaerobic conditions. If anaerobic conditions persist for more than a few days, roots fail to obtain sufficient oxygen, which reduces plant growth and can cause plant injury and eventually death.

## **c) pH/Alkalinity**

pH is a measure of acidity or alkalinity. In general, pH less than 7 is considered acidic, pH equal to 7 is neutral, and pH greater than 7 is alkaline. The direct effect of alkalinity on plant growth is not well known. However, it is well documented that most plant species do well within a defined pH range. When abrupt changes in pH occur, plant communities shift, with more tolerant species replacing those that are less tolerant. In general, most native and culturally significant plants in arid and semi-arid environments are adapted to slightly, moderately, and strongly alkaline conditions (pH > 8).

## **d) Bicarbonates**

Carbonate and bicarbonate salts are common in the waters and soils of eastern Montana, the presence of which increases soil alkalinity. Leaf burn, a known effect of bicarbonate salts on plants, occurs when bicarbonate rich water comes into contact with growing plant tissue. However, only a few very sensitive crops are negatively affected by bicarbonates. Levels high enough to affect plants are unlikely to occur under normal irrigation conditions with good drainage. Continuous flooding or frequent inundation can change these results.

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