Saline and Sodic Soils in Idaho

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Introduction

Saline and sodic soil and water are a concern in moisture-limited irrigated agriculture, because of the lower quality water and high evaporation rates. Salts, a combination of an acid and a base, are common in the soil and important to crop production. Table 1 shows some of the common salts found in soil and their use in agriculture. These salts are important components to plants and their growth. A common misconception is that salts are all bad and only get worse at higher concentrations. Actually, salts are necessary and many salts are the plant available form of essential elements. This paper will describe the common methods of determining whether a soil has a salinity or sodicity problem and will address management practices to remediate these soils and prevents soils from getting worse.

What are saline, sodic and saline-sodic soils?

Saline soils have high levels of soluble salts in the root zone that affect the plant's ability to compete with the soil for water. Salts reduce the osmotic potential in the plant roots and in the soil. In a normal soil the osmotic potential is greater in the roots than in the surrounding soil, enabling water to move into the roots. As the salt concentration in the soil increase, either by adding additional salts or the soil drying out, the osmotic potential of the soil increases. If the osmotic potential is greater than that of the roots, water will not move into the roots. One of the symptoms of saline soils are wilted and unhealthy plants in soil that appears to have adequate moisture. This diagnosis is easily confirmed with a soil test. Table 2 gives the accepted soil test requirements for saline (and sodic) soils. Salinity is determined my measuring the electrical conductivity (EC) of a saturated paste extract or 1:1 soil water mixture. The units of EC are dS/m. Most soil tests will report EC values using these units, however some soil test labs still report EC using mmhos/cm. The conversion is 1:1 so a value of 1.2 dS/m = 1.2 mmhos/cm. Saline soils will often have a white crust of salts that remain on the soil surface as water evaporates. Salts by definition are water soluble and hence will move up and down in the soil profile with irrigation and evaporation. Plants growing in saline soils will appear to be water stressed because of the plants inability to get water from the soil (osmotic pressure).

In order to speed up the process of soil analysis, many soil test labs do not make a saturated paste but use a 1:1 soil water slurry to measure EC. These values are lower than a saturated paste but are somewhat correlated. If you have a 1:1 EC value that gives cause for concern, it would be wise to ask the lab to run a saturated paste extract on the sample. Table 3 illustrates the relationship between 1:1 and saturated paste extract values. It is important to know which method is being used to measure EC.

Sodic soils have sodium in high concentrations on the soil exchange sites. Sodium has a very strong attraction to water and has a large hydration radius. This means that the sodium ion, which is quite small, becomes larger than many other cations like calcium and magnesium when it is hydrated. The hydrated sodium cation is attracted to the negative charge soil particles and since it is so large and monovalent, it forces the soil particles apart. This action causes surface crusting and destroys the soil structure which results in poor water infiltration.

Visual symptoms of sodic soils are dark brown crusts on the soil surface due to the dispersion of the soil organic matter. Because of the low infiltration, there will often be ponding in lower field areas. By the ti[illegible] al s[illegible]ns are apparent in both the saline and sodic soils, the problem is severe and re[illegible] n w[illegible] difficult. The best method by far is yearly soil samples to monitor the prog[illegible] of th[illegible]

Saline-sodic soils ha[illegible] ares[illegible]h problems. Fortunately, saline-sodic soils have good soil structure so water [illegible] mo[illegible] ugh the profile. The salt in the soil helps to keep the soil flocculated and main[illegible] stru[illegible] The major concern is the large percentage of sodium on the exchange site[illegible] or i[illegible] n water that is low in salts can easily leach the salts and cause the soil to be [illegible] odic[illegible]

Visual symptoms of [illegible] ne-s[illegible] il will be very similar to the saline soils, drought stressed plants in soils with [illegible] e m[illegible] The can be a problem if a soil sample is not collected and analyzed. If th[illegible] ptio[illegible] ad[illegible] that soil is saline and remediation practices for a saline soil a implemented [illegible] pro[illegible] will get even worse. It is very important that a soil sample be collected before a[illegible] edia[illegible] implemented.

Water Quality

Soils may have very [illegible] cur[illegible] n of salt from parent material or management practices. Irrigation water, [illegible], ca[illegible] a large source of soluble salts, particularly ions that have direct effects on plants [illegible] s bo[illegible] Unknowingly, high concentrations of salt can be added to fields via the irrig[illegible] rste[illegible] i[illegible] very important to take a water sample at the same time you soil sample, if a s[illegible] dic [illegible] n is suspected. The quality of water is determined by measuring the EC and th[illegible] n a[illegible] ontration (SAR). The SAR is the proportion of Na to Ca and Mg in the water. El[illegible] con[illegible] ty value for water will be much lower than soil EC for the severity of problem[illegible] gi[illegible] ge of EC values for water and the corresponding severity of problem. These [illegible] an[illegible] converted to an actual quantity of salt added per acre foot of water. This is [illegible] d b[illegible] multiplying the EC of the water by 640 to get ppm and then ppm is multiplied by 2[illegible] et l[illegible] er acre foot of water. Thus water with an EC of 1.15 dS/m will have 2000 [illegible] pe[illegible] loc[illegible] of water. To determine how much of this salt sodium is, an SAR needs t[illegible] ula[illegible] ate[illegible] that is high in salt or has a high SAR will have to be mixed with other wa[illegible] usa[illegible] nary cropping systems or more tolerant crops will have to be used.

Lagoon water samp[illegible] trea[illegible] same as an irrigation water samples. Lagoon water from the average dairy in [illegible] onl[illegible] 2.5% dry matter, the balance being liquid. Many lagoon water samples can [illegible] EC [illegible] 6[illegible] dS/m, which is about 4,350-10,500 lb of salts per acre foot of water. Thi[illegible] tes[illegible] a large amount of salt is being added to the soil when lagoon water is applied. Y[illegible] il s[illegible] need to be collected to ascertain the change in EC and what management pra[illegible] eed[illegible] implemented

What can I do about a sa[illegible] l? S[illegible] oil? Saline-sodic soil?

A saline soil is the [illegible] mm[illegible] m of soil and of the three types it is the easiest to remediate. In order to brin[illegible] il i[illegible] production, the soluble salts in the root zone need to be removed. This can be d[illegible] one[illegible] ways. First the salts can be leached below the root zone with adequate low sa[illegible] iate[illegible] and the salts can be removed from the system through leaching and artificial dra[illegible] ast,[illegible] ob[illegible] can be adapted to, by controlling the concentration and location [illegible] salt[illegible] ical growth periods and/or selecting tolerant crops.

Leaching the salts [illegible] npl[illegible] y using water which has an EC lower than the level we are trying to get the so[illegible] e s[illegible] never b[illegible] less saline than the salinity of the water that

determine he EC of the soil. As a rule o thumb, the E will
ches of wa r applied. This d es not mea hat we only eed to
ood. Six in hes of water need to pass thr ugh the rooti g zone.
3.2 dS/m i the top 2 feet, th n it will tak e 6 inches of ater
r the EC to 1.6 dS/m. It will ke another inches of w ter to
ion is not a problem in saline soils, the p blem comes n
in. That qu stion is beyond t e scope of his paper and vill not

an imperm able layer that ha e become aline do not h ve the
zone. To r medy this, artific l drainage must be built n
ot zone. H wever this may b unfeasible f r a number f
ally imposs ble to build this t pe of struc ure. Secondly, if
in place, th n there has to be way of ge t ng rid of the
f is a large roblem and remo res drainag as a reasona le
n for many fields in Idaho.
th a saline oil s to irrigate i excess at t es when the plant
or use irrig tion practices tha move the a ts away, e.g. water
nove salts wa d the dry fur ow and out f the root zo e of a
rant plants may be the only s lution in s s with poor

med by ad ing fertilizers, ch micals or a y other soil
ments such as fer ilizers, are alts themse ves. By addi g
n as a nutri nt deficiency wil only exace bate the prob em.
from the r ot zone is the onl way to re ediate a salin soil.
luble salts, owever because e soil is di persed, leach g is
tep in recla ming a sodic soil s replacing e Na ion on the
n such as C . Soil amendmen such as g sum are app ed to
n requirem nt can be calcula d as follo :

$$ent.ESP - d sire dESP) \times CEC \times 0.021$$

t, ESP is t e exchangeable s dium perc ntage, CEC is the
is a conver ion factor that ass mes CEC s recorded in
is worked n a given time to eact with t e soil, then
t the solub e salts. If the fiel is irrigate oo soon, the the
ing Na still on the exchange tes and the soil will be w rse
odic soils is getting an adequa e source o Ca to replace he

y, still has ood soil structure and wat r oves easily
il, the Na o the exchange sit s needs to e replaced by Ca,
quate Ca, t en the salts can b leached. I he soil is hea ily
the solubl salts will be rem ved, leavin the Na on the
dispersed a d the structure w l be lost. It ill be nearly
e. It s imp rtant hat the Na e replaced f rst before the soil
ected alwa s get a soil sampl . Never im ements pract ce
and water sample.

Management in Idaho

The influx of Dairies into Idaho has brought an increase in animal manures and waste that needs to be disposed of. These products have great nutrient value and can be a source of cost savings to crop producers if managed wisely. Excessive applications and inadequate irrigation to leach salts from the manure has caused crop growth problems in many fields. This problem has been exacerbated as crop producers have switched from furrow irrigation to sprinkler irrigation. By trying to improve irrigation the probability of having a salinity problem has increased. Proper management can alleviate many of the problems that may arise. Here are some management tips to control salinity problems in manured fields.

- Calculate the leaching fraction and irrigate accordingly
- Irrigate in the fall when the soil is dry and water will move readily through the system
- Collect soil and water samples to follow trends of EC and Na (Just a good practice anyway for nutrient management)
- Put less manure on fields with poor infiltration and drainage

Very few fields in Idaho have a significant salinity or sodicity problem. It's important that steps be taken now to prevent more fields from having these a problems. Saline and sodic soils do not have to become a problem in Idaho. With wise management and the coordination of irrigation and animal waste application Idaho soils can be managed.

Table 1. Salts common in Idaho soils. The first column contains the cation, the second column is the anion and the final column is the common name.

Common forms of salts found in soil		
Cations (+)	Anion (-)	Common Name
Calcium	Sulfate	Gypsum
	Carbonate	Calcite (lime)
Sodium	Chloride	Halite (table salt)
	Sulfate	Glauber's Salt
	Bicarbonate	Baking soda
	Carbonate	Sal soda
Magnesium	Sulfate	Epsom salt

Table 2. Accepted soil test values for designating saline, sodic and saline-sodic soils.

Class	Electrical Conductivity (dS/M)*	Exchangeable Sodium Percentage (ESP)	Sodium Adsorption Ration (SAR)	pH	Soil Physical Condition
Normal	<4.0	<15	<13	<8.3	Normal
Saline	>4.0	<15	<13	<8.3	Normal
Saline-Sodic	>4.0	>15	>13	<8.3	Normal
Sodic	<4.0	>15	>13	>8.3	Poor

Table 3. Relationship of 1:1 soil slurry EC to saturated paste EC.

1:1 Extract	Saturated Paste	Classifications
mmhos/cm	mmhos/cm	
0.01-0.45	0.0-2.0	Salt sensitive plants can be grown
0.46-1.5	2.0-4.0	Sensitive plants will be affected
1.51-2.9	4.0-8.0	Medium tolerant plants will be affected
2.91-8.5	8.01-16.0	Most plants will be affected
>8.5	>16.0	Severe saline conditions

Table 4. EC of irrigation water, crop requirements to tolerance and amount of requisite leaching.

Water Class	EC	Comments
Low	0-0.4	Most crops, most soils, some leaching
Moderate	0.4-1.2	Moderate tolerance, more leaching
High	1.2-2.25	Tolerant crops, well drained
Very high	2.25-5.0	Very tolerant, excess water, drainage