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Assessing salinity and sodicity in the field – a guide for farmers and extension persons

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Salinity affected soils contain very high proportions of soluble salts (Na^{+}, Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}) in both the soil solution and on clay particles. Many plants either fail to grow in saline soils or their growth is significantly retarded. However, there are a few plants (salt tolerant) that are able to tolerate and grow effectively on saline soils. Tables of salt tolerant field crops, vegetables and fruits, grasses and forages, woody crops, ornamental shrubs, trees and ground cover etc. are available in the literature for guidelines (Tanji, 1996). Where you have a crop growing on soils that are saline they often exhibit water stress symptoms (rolled and / or drooping leaves) even though the soil is wet.

A convenient way of measuring soil salinity in the field is to measure the *electrical conductivity* (EC) of a 1:5 soil to water solution with a conductivity meter. The meter must be correctly calibrated according to the manufactures instruction before use.

Sodic soils contain a higher than desirable proportion of *exchangeable sodium percentage* (ESP) on the clay particles. When in contact with water, sodic soils disperse into tiny fragments, which block soil pores on drying. They are difficult to manage, are often hard-setting and susceptible to erosion and waterlogging. Sodicity can be simply estimated by the degree of cloudiness of a sample placed in water.

A saline soil can also be sodic and *dispersion* is prevented by the concentration of salt. This soil can disperse once the salts are leached out. To accurately identify an area of sodic/ saline-sodic soils it is recommended that samples be sent to a laboratory to test for ESP. In addition, requests should also be made to the laboratory to quantify the amendment required (e.g. gypsum) for reclamation of the respective sodic or saline-sodic soil. This should follow the implementation of reclamation plan for sodic or saline-sodic soils. This will be discussed in a later brochure.

Measuring sodicity using the turbidity test

- Place 2 cm of air-dry soil in the bottom of a clean glass jar with a lid.
- Carefully add 10 cm of rainwater or distilled water to give a 1:5 ratio of soil to water.
- Gently pour this water down the side of the glass jar without disturbing the soil at the bottom.

- Place the lid on the jar and invert the jar slowly and gently once and then retun to its original position (avoid any shaking). Then let stand for 4 hours, with no vibrations or bumping.

Estimating the turbidity (soil sodicity) in a 1:5 soil/water suspension:

1. Clear or almost clear – non-sodic.
2. Partly cloudy – medium sodicity.
3. Very cloudy – high sodicity.

- A white plastic spoon or spatula that reflects light, when placed in the centre of the suspension can help identify the level of turbidity.

Estimating turbidity using a spatula or white plastic spoon visibility

1. Plastic spatula visible – not sodic.
2. Plastic spatula partly visible – medium sodicity.
3. Plastic spatula not visible – high sodicity.

Visual indicators of salinity:

- The species that occupy these areas are often salt tolerant and may include several plant species and halophytes.
- Where you have a crop growing on soils that are saline they often exhibit water stress symptoms (rolled and / or drooping leaves) even though the soil is wet.

Soil Properties

- Saline soils often exhibit a fluffy surface.
- Whitish salt crusts are often observed on top of mounds, aggregates or slightly elevated areas in the field when the surface is dry.

Visual indicators of sodicity:

- Poorer vegetation than normal, few or stunted plants and trees.
- With respect to a growing crop, variable height growth is often observed within the field along with yield variations at harvest.
- Symptoms of water stress not long after a rainfall or irrigation event.
- Poor penetration of rain or irrigation waters into the soil due to surface crusting.

Soil Properties

- Hard-setting surface horizon often observed in soils with a sandy loam topsoil.
- Surface crusting.
- Soapy feel when wetting and working up for texture assessment.
- *pH* > 8.5.
- Cloudy water in puddles that may form on the soil surface.
- Shallow rooting depth.

A field test for sodicity

Sodicity is generally identified in the laboratory by measuring the ESP level in the soil. In the field we measure the problem caused by the sodium, that is the cloudiness or turbidity caused by soil dispersion.

Test the surface and the subsoil separately to best assess the problem.

- Take clean bucket into the field and collect samples from both the surface 0 – 10 cm depth interval, according to standard procedures.
- Collect samples randomly from a minimum of 5 locations over a uniform 1 – 2 ha representative area of the field.
- Spread the soil from the bucket into a thin layer on a clean plastic sheet. Place in a well-ventilated location to allow it to air-dry, which may take several days.
- If necessary break the air-dry soil down into pieces of 1 cm diameter, and mix the soil thorough in the bucket before commencing the test.

Testing for salinity

- After assessing sodicity, completely stir the whole soil sediment in the jar for 15 seconds and then let it stand for a further 15 minutes.
- Measure the electrical conductivity (EC) of the solution in deci-Siemens per metre (dS/m) and record the value. For sandy or loamy soils if the EC > 0.4 dS/m the soil is classified as saline. For clay soils, if the EC is > 0.7 dS/m the soil is classified as saline.
- Using the pH meter measure the pH of the solution. Soils with a pH > 8.5 are sodic, whereas those with a pH < 8.5 may or may not be sodic.

Glossary of terms

Cation exchange capacity (CEC): The amount of cations that the soil can hold bound to the surfaces of particles. Cations are bound by negative charges on the soil particles, so the CEC is also a measure of the amount of negative charge in the soil. Most of the CEC in soil occurs on clay or organic matter. CEC can be measured in several ways, all of which involve leaching the soil with a salt solution, and measuring the cations which are displaced. It ranges from about 1 $cmol_c$/kg in sands to about 40 $cmol_c$/kg in clays.

Dispersion: Under some conditions, individual clay particles in soil repel each other. When the soil is wet, the particles are free to move away from each other, which causes swelling, and movement of clay into pores. On the surface, dispersion can be seen as cloudiness or turbidity in the water. When the soil dries, all the individual clay particles come together. The pores that remain are too small to readily transmit water or air, and the soil is very hard and dense. The opposite of dispersion is flocculation, where clay particles are attracted together, even in water, to form packets or microaggregates. Since these microaggregates are larger than the individual clay particles, the pores between them are also larger, and a flocculated soil has a soft, permeable, crumbly structure. In most soils clay can be made to disperse by disturbing the soil. In sodic soils, some clay disperses spontaneously.

Electrical conductivity (EC): The ability of a material to conduct electricity. The EC of water or a soil extract can be used to estimate its salt concentration. Measuring the EC of soil solution is difficult because of the very small volumes of water that can be extracted from the soil. Therefore, water is normally added to the soil for measurement. Salt tolerance of most plants has been calibrated against the saturation extract EC (ECe). EC is normally measured in a 1:5 soil:water extract (i.e. 10 g soil plus 50 mL water), giving EC1:5. The relationship between EC1:5 and ECe depends mainly on texture, so it is possible to make approximate conversions between the two units (see Table 1 below). The preferred unit for EC is dS/m (decisiemens per metre), but µS/cm (microsiemens per centimetre), or mS/cm (millisiemens per centimetre) are also commonly used.

Table 1. Approximate conversion factors between electrical conductivity of a 1:5 soil : water extract ($EC_{1:5}$) and a saturation extract (EC_e).

Texture	Clay content (%)	To convert $EC_{1:5}$ to EC_e multiply by
Sand, loamy sand, clayey sand	<10	15
Sandy loam, find sandy loam, light sandy clay loam	10-20	13
Loam, fine sandy loam, silt loam, sandy clay loam	20-30	11
Clay loam, silty clay loam, fine sandy clay loam, sandy clay, silty clay	30-45	9
Medium clay	45-55	8
Heavy clay	>55	6

Exchangeable sodium percentage (ESP): A property of soil. The amount of exchangeable Na^+ divided by the cation exchange capacity (CEC), multiplied by 100.

pH The scale of measurement of acidity and alkalinity. A pH of 0 – 6 is acid, around 7 is neutral, and 8 – 14 is alkaline. Soil pH can be measured using pH indicator kits (change of colour), or by measuring the pH of a soil extract (water or a $CaCl_2$ solution) with a pH meter. pH is slightly lower when measured in $CaCl_2$ than when\measured in water. Soil pH varies between approximately 4 and 10. The pH of common everyday drinks and household items are presented in the table below.

Substance/product	pH
Coca cola	2.6
Orange juice	4.3
7-Up soda	4.4
Listerine mouth wash	5.5
Tea	6.8
Pantene shampoo	7.2
Ajax liquid	7.8
Green tea	7.9
Detergent in water	9.7
Kitchen cleaner	10.9

Salinity: The salt content of soil or water. The salinity of soil is estimated by measuring the electrical conductivity of soil extracts, or by measuring the electrical conductivity of the whole soil using conductivity probes or an EM38 meter. The salinity of water is estimated by measuring the electrical conductivity.

Sodic Soil: A soil that has a high ESP somewhere in the profile. A commonly used definition is as follows: a sodic soil is one with an ESP of 6 – 14 somewhere in the top metre of the profile and a highly sodic soil is one with an ESP > 15 somewhere in the top metre.

Sodicity: The proportion of the cation exchange capacity of the soil that is balanced by Na^+. It is usually expressed as the ESP, but may also be expressed as the sodium absorption ratio, free alkali content and salinity of water.

References

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