Plant Indicators of Saline Seep

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Saline seeps can be identified by the presence of different types of vegetation. The different species grow at different levels of salinity and can be of use in approximating the relative severity of the seeps. Once recognized, management practices can be applied to help correct the situation.

Introduction

The number and size of saline seeps has increased dramatically in recent years (Ballantyne, 1963; Worcester, Brun and Doering, 1975). Saline seeps have been described in several papers (Brun and Worcester, 1974, 1975; Worcester, Brun and Doering, 1975; Doering and Sandoval, 1976; Smith, 1975). Saline seeps are areas in fields which are wetter than surrounding areas and have salt concentrations high enough to either inhibit or eliminate crop production. Seepage areas generally result from water percolating beyond the root zone of crops and moving laterally until it approaches the surface. The water can then be lost back to the atmosphere, but the salts, dissolved from the subsurface materials, remain at or very near the surface. Continued movement of water and salts in this manner eventually creates a concentration of salts high enough to be detrimental to the growth of vegetation.

Seepage, then, is associated with excess moisture and salt. Other problem soils also exist. Soils with a high sodium content are characterized by the presence of a dense clay layer at depths commonly of a foot or less. In many cases, these soils have existed for hundreds of years. In some instances, the high sodium soils also have a high salt content. These salts may have existed there for a very long time or may be recent accumulations. The length of time is difficult to determine. This paper is concerned primarily with problem soils which are high in salts—saline seeps.

One of the problems facing the land owner is recognizing and identifying saline seeps at an early stage of development so corrective measures can be taken to retard further development. The most readily observable characteristic of a developed seep is a whitish salt crust on the surface and continuous wetness. Appearance of the salt crust generally indicates an advanced stage of development.

The purpose of this paper is to provide information that can aid in the recognition of a saline seep early in its development. By early detection, preventive measures can be taken to limit growth or eliminate the seep altogether.

Methods and Materials

Ten sites that showed typical saline seep characteristics were chosen in Divide county, North Dakota. A transect was established through each site beginning at the edge of the seep and ending near the center. At regular intervals of approximately five feet along each transect, a sample of the vegetation was cut as near the ground surface as possible. Immediately following the cutting, a 12-inch deep soil core was taken from each area. Sampling to this depth represented the material above the water table in which most of the plant roots were observed.

The harvested plants were sorted by species and the dry weight determined. This allowed quantitative calculation of the per cent composition of the various species present. The electrical conductivity of the soil was measured on a 1:1 soil-to-water extract. This gives a measure of the quantity of salt present in the sample.

Discussion

Saline conditions in soil appear to significantly affect the growth of plants in at least two ways (Raheja, 1966). As the amount of salt in the soil increases, the amount of water available to the plant decreases. As the concentration of salts increases, certain ions may reach levels of concentration sufficient to be toxic to plants. Reduced water uptake by plants may also reduce the

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amount of essential nutrients taken up by plants (Waisel, 1972). Alteration of desirable soil physical conditions may also result, particularly if sodium salts are accumulating.

Some plants have the ability to physiologically adapt to a saline environment (Raheja, 1966). This can result in variations in the composition of plant communities as salinity levels change. This alteration is referred to as competitive exclusion (Unger, 1974). Non-adaptive species disappear from the plant community and are replaced by adaptive species. As a result, plant species tend to occur in a gradient which is dependent on the level of salinity. Climate, topography and soil moisture can somewhat moderate the effects of salinity.

This study indicated that the species composition of plant communities varied with the degree of salinity in the soil. The dominant species found were wild barley, or foxtail (**Hordeum jubatum**), and kochia (**Kochia scoparia**). Foxtail was predominant at lower salt concentrations and kochia was predominant at higher salt concentrations (Figure 1).

At salt concentrations intermediate between these extremes, white prairie aster (**Aster ericoides**), pigweed (**Amaranthus retroflexus**) and curled dock (**Rumex crispus**) were common. Curled dock occurred at the lower salt contents, pigweed at intermediate levels and white prairie aster at the higher concentrations of salt. As illustrated by Figure 1, these various plant species were not mutually exclusive, but were commonly found together at any site. The relative amount of each species varied in association with varying salinity. Other species also occurred, but in minor amounts and in an undefinable pattern. They were therefore not useful as reliable indicators of salinity levels.

Information such as this can be used to visually appraise the status of saline seeps. One early indicator of a possible developing seep problem is an exceptionally lush growth of pigeon grass, green and yellow foxtail (**Setaria viridis** and **Setaria lutescens**) in early spring before seeding or in late fall after harvest. This is caused by high moisture conditions in the soil which, by definition, are associated with saline seeps. This usually precedes the visible surface salt accumulation.

Based on the results of this work and supported by numerous observations throughout North Dakota, indications are that, as the level of salinity increases, the next indicator plant to appear in large numbers is wild barley. At this stage of development, there may or may not be a surface salt crust visible. Excess moisture is often visible at the surface. As the salt concentration continues to increase, the wild barley usually is replaced by a thick growth of kochia. The typical whitish salt crust normally is very evident. Continued salt accumulation eventually eliminates even the kochia and a barren salt crust covers the surface.

All of the stages mentioned are illustrated in Figure 2. This seep is located in Divide county. It is expanding from the bare, salt crusted area, upslope towards the foreground, and the salt concentration decreases in that direction.

If a saline seep is identified at a relatively early stage of development, it can be more easily and more rapidly controlled.

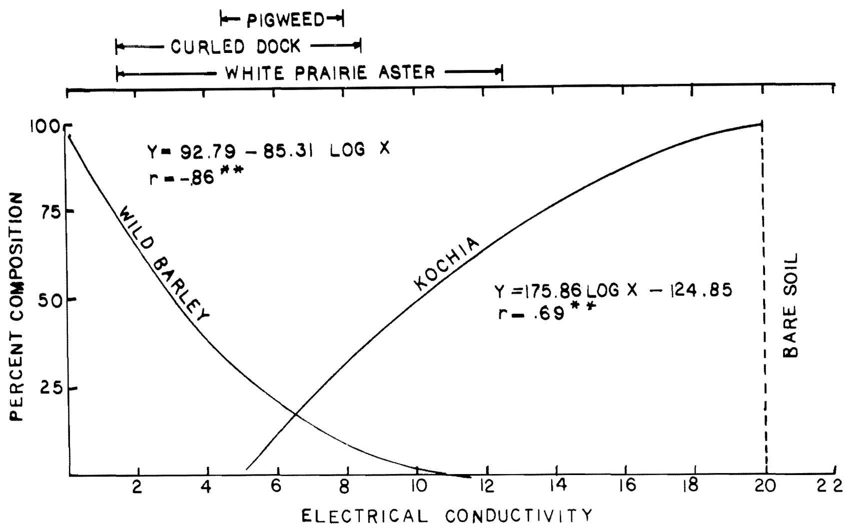

Figure 1. Distribution of species on saline soils. Above electrical conductivity values of 20, vegetation was normally absent.

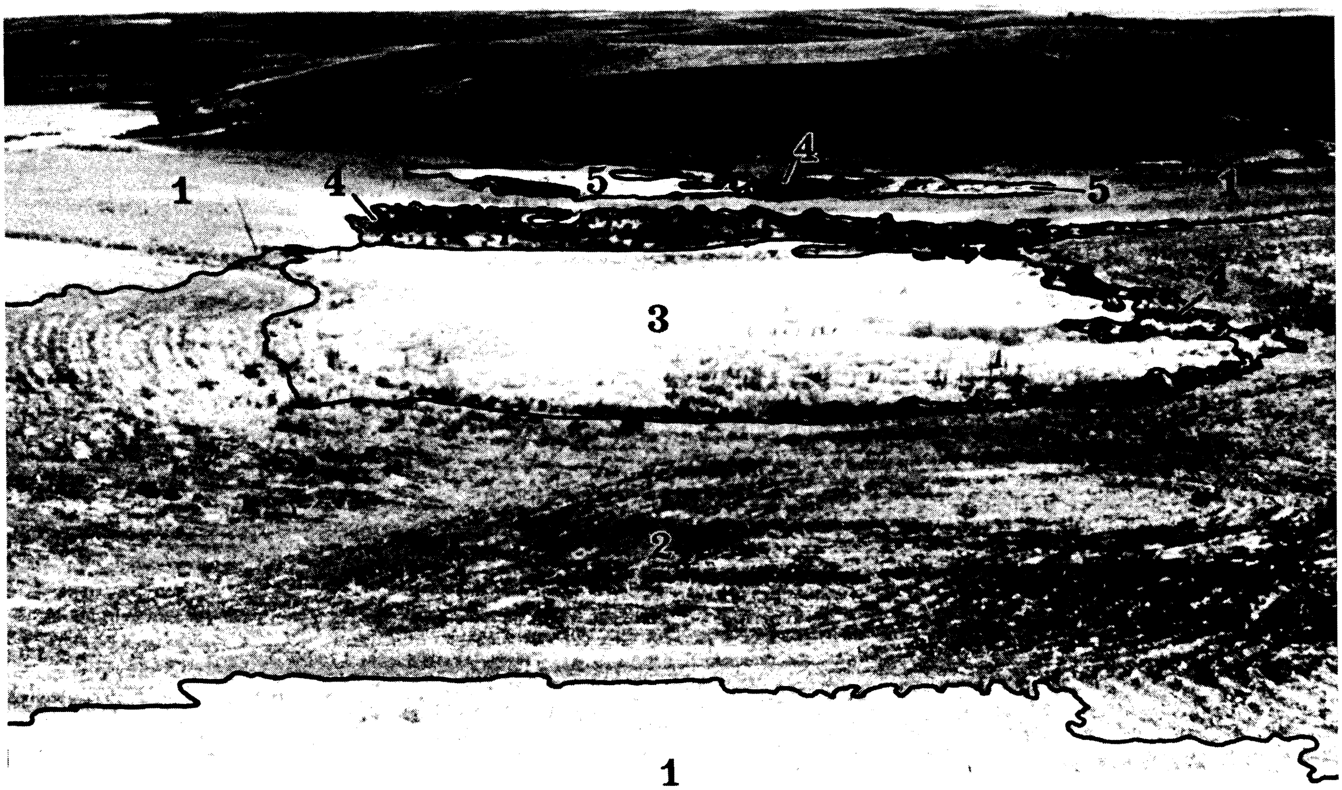

Figure 2. Photograph of an active saline seep in the spring. Area 1 is normal bare soil. Area 2 is dense growth resulting from high moisture. Area 3 is the dense growth of wild barley. Area 4 is kochia. Area 5 is bare soil with white salt crust. Some curled dock can be seen in Area 3. The seep is growing from area 5 towards Area 1 in the foreground.

Methods of control have been previously discussed in detail (Worcester et. al, 1975). Basically, the recommended approach to seep control has been to identify a recharge area, that portion of the landscape which is the source of excess water, and to remove this water by the use of deep rooted legumes, such as alfalfa, in the recharge area. Once the excess water is removed, intensive cropping should be implemented to reduce future accumulations of water below the root zone. Intensive cropping will require careful management of such moisture sources as snow. This may be trapped by standing stubble. It will also require application of proper fertilizer materials to maintain yield levels.

There are no instantaneous cures for the salt itself. Once the source of water is removed, experience has shown that a natural leaching will occur within a period of a few years, and crops can be produced in the previous seep areas. However, before management control measures can be applied, the seeps must be recognized. The information in this article can be helpful in assessing the problem.

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