SALINE SOILS AND WATER INTAKE

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Salty or saline soils reduce both the quality and quantity of many acres of crops produced on the Columbia Basin project each year. With improved understanding and use of water management, adequate drainage and soil testing, crop damage from salts can generally be eliminated.

SALTS NOT ALKALI

One of the first things to understand is that salty or saline soil problems found on the Columbia Basin project are not generally alkali. The difference between saline and alkali conditions is important. Saline soils contain excesses of soluble salts. Leaching and watering is all that is generally needed on saline soils.

Alkali or sodic soils as they are now being called, differ in that they contain large amounts of sodium attached chemically to the soil particles. Sodic soils require the addition of chemical amendments generally in the form of calcium salts followed by leaching for improvement. Soil tests should be taken to determine if a problem is saline or sodic.

HOW SALINE SOIL PROBLEMS OCCUR

Salts accumulate at the soil surface in saline areas because the water evaporates from the soil leaving the salt as a deposit. Meanwhile more water carrying small amounts of salt move in and evaporate also. The longer this process continues the greater the salt concentration becomes near the soil surface.

The source of water is generally by capillary rise from the water table. Other salt problems can occur. One of these is the concentrating effect of fertilizer and other salts being pushed toward the plant roots by furrow irrigation. Rainfall frequently can cause a temporary problem by pushing salts down into the root zone of new plants.

EFFECT OF SALTS ON THE CROP

Osmotic tension is generally considered to be the harmful mechanism damaging plants in saline soils. Plants have an ability to filter most of the salts out of the water coming into the plant roots. This may eventually leave a higher concentration of salts around the roots than exist in the plants. When this occurs the water is pulled out of rather than into the plant root. The result is a drouthy condition and eventually death of the plant.

The process of moving water into or out of semi-permeable materials such as plant roots by lower or higher salt concentrations is called osmosis. Osmotic tension is the major reason why plants do not do well in saline soils and new seeds are not able to get enough water to germinate.

SALTS OR OSMOSIS REDUCES THE AVAILABLE MOISTURE

Immediately after an irrigation the salt concentration is diluted by the fresh water which came into the soil. As the plant uses water out the salt concentration becomes greater and therefore the osmotic tension builds up rapidly making less of the total water held in the soil available to the plant. See Figure 1.

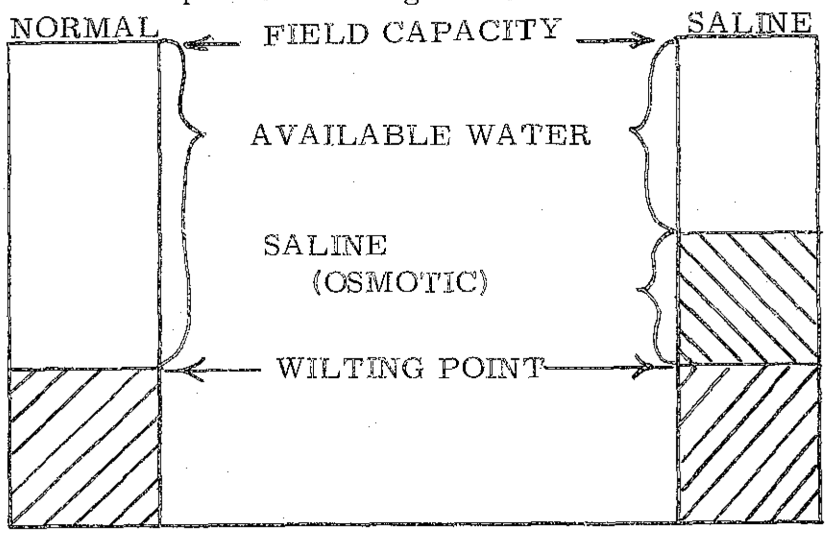

Fig. 1 Increasing salts in the soil reduces the amount of water available for plant growth.

Frequently saline soils may appear quite moist and yet require irrigating because more of the water is held by the salts. Also, capillary rise from close water tables will keep the soil moist and move salts up making the problem worse. Because of the osmotic tension and the capillary rise irrigations cannot be scheduled on the basis of soil moisture content or feel of the soil. Only by knowing how much water goes in and how much comes out can irrigations be properly scheduled on saline soils.

FREQUENT WATERINGS BEST ON SALINE SOILS

Frequent waterings are needed on saline soils to keep the salt concentration low around the roots. If slightly more water is put into the soil than is needed some of the salts will be leached out by the extra water moving down through the profile. When establishing new seedlings, frequent waterings are essential.

Under furrow irrigation care must be taken to locate seeds close to furrow where fresh water will move salts away from rather than toward the seed.

SALTS REDUCE POTATO YIELDS

The effect of salt concentration on the yield of potatoes can be seen in Figure 2. The standard method of measuring salt concentrations is in millimhos per centimeter. This soil test is simple and low in cost. Saline soils should be tested frequently to determine if progress is being made in reducing salts. Salts are not generally harmful if the soil test is less than 2 millimhos per centimeter. If it is over 2 millimhos special care is needed. When the salt test exceded 4 millimhos major leaching is needed.

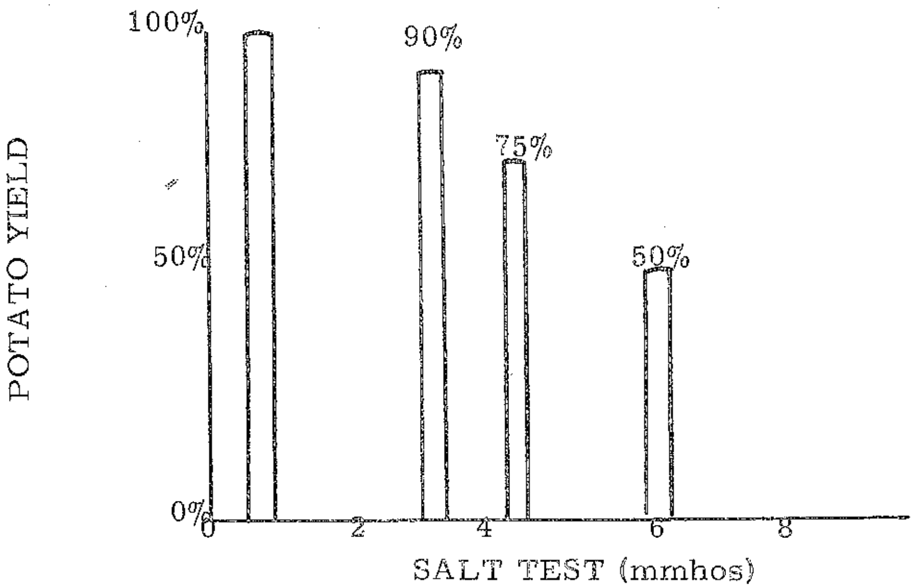

Figure 2. Increasing amounts of salt reduce the yield of potatoes

LEACHING

Major leaching is considered here to be building dykes and filling them with water. The water dissolves the salts and moves them down well below the root zone. The dyke must be surveyed in and spaced with no more than .4 foot of elevation drop between if terracing blades are used to build them.

About 3-acre feet per acre of water must enter the soil to do a good job of major leaching. When properly done it has been common to remove about 90% of the salt with one major leaching operation.

Sprinklers can also be used for major leaching. Where the land has a slope greater than 1% this may be the preferable method. When using sprinkler leaching it is important to run the sprinklers long enough to get the full 3-feet of water into the soil.

AFTER MAJOR LEACHING ANNUAL LEACHING IS REQUIRED

After major leaching salts can reaccumulate by two ways:

1. Small amounts of salts come in with the irrigation water. The

water is used by the plant leaving the salts behind.

2. Capillary rise plant use and soil surface evaporation can again concentrate the salts near the soil surface.

The only way to prevent reaccumulation of salts is by slightly over-irrigating. More water must enter the soil than is taken out by the plant and soil surface evaporation to keep the salts down. On potatoes the plant and soil surface evaporation amounts to about 21 inches of moisture per year. To keep the salts down approximately 24 inches or more of water must enter the soil. See Fig. 3.

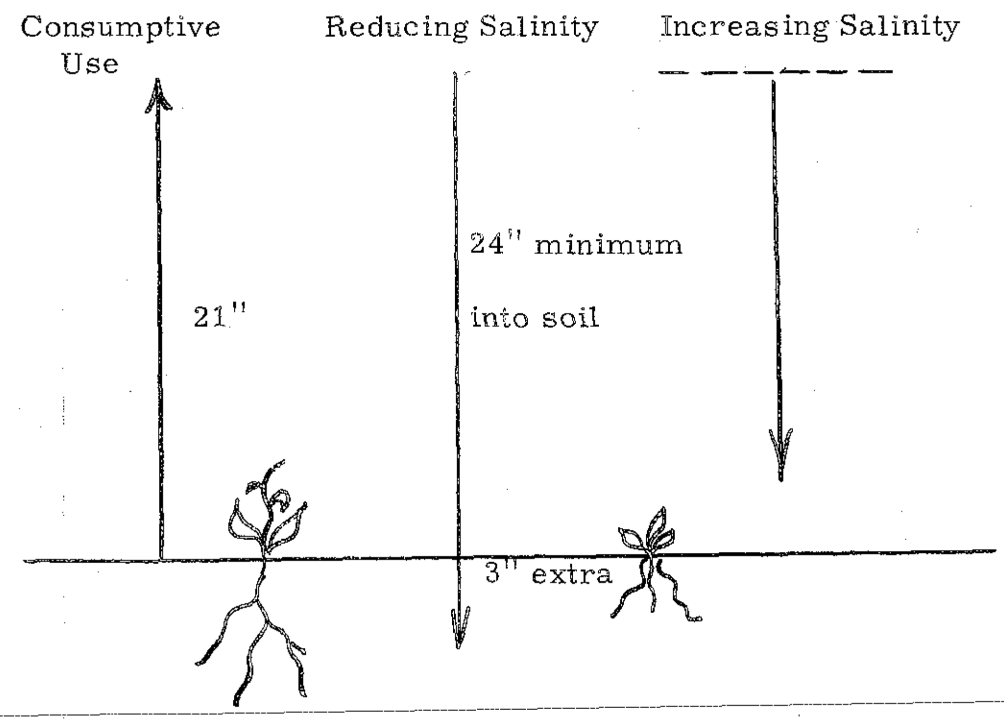

Fig. 3. When growing potatoes 21 inches of water is used out of the ground in a year. To keep salts down 24 inches must enter the soil. The extra 3-inches move down carrying salts into the drainage system.

This means that the extra 3-inches per year of water will be able to move down in the soil and gradually leach the extra salts with it. The extra water and salts should eventually move into a drain and be carried away.

Care should be taken not to excessively over-leach each year as this will also leach excessive amounts of fertilizers and raise the water table in the area. Putting in less than the amount of water used by the crops will of course result in increasing salts.

To be sure that at least 24 inches of water gets into the soil on potatoes considerably more than this must be applied to overcome run-off and other losses of water.

DETERMINE HOW MANY INCHES OF WATER ENTERED THE SOIL

Under sprinkler irrigation it is generally practical to assume that about 70% of the total water supplied entered the root zone. If 24 inches of water must enter the soil the total water to apply would be 24 inches divided by .70 or approximately 34 inches of water. The inches of water applied can be calculated by methods described in Extension Circular 326.

Under surface irrigation runoff losses are frequently high so the percentage of water entering the soil is difficult to calculate. Also, usually the head end of the field is over-watered and the lower end under-watered. For this reason many salt problems occur at the lower end of the run.

A better approach under surface irrigation is to continue watering until the soil is wetted to the tip of a tensiometer located near the bottom of the root zone. See Figure 4. When the water reaches the tip of the tensiometer the needle will move to a wet reading on the tensiometer dial. Once this has occurred, shut off the water. Some drain down of water will occur afterward taking some of the salt down just below the root zone.

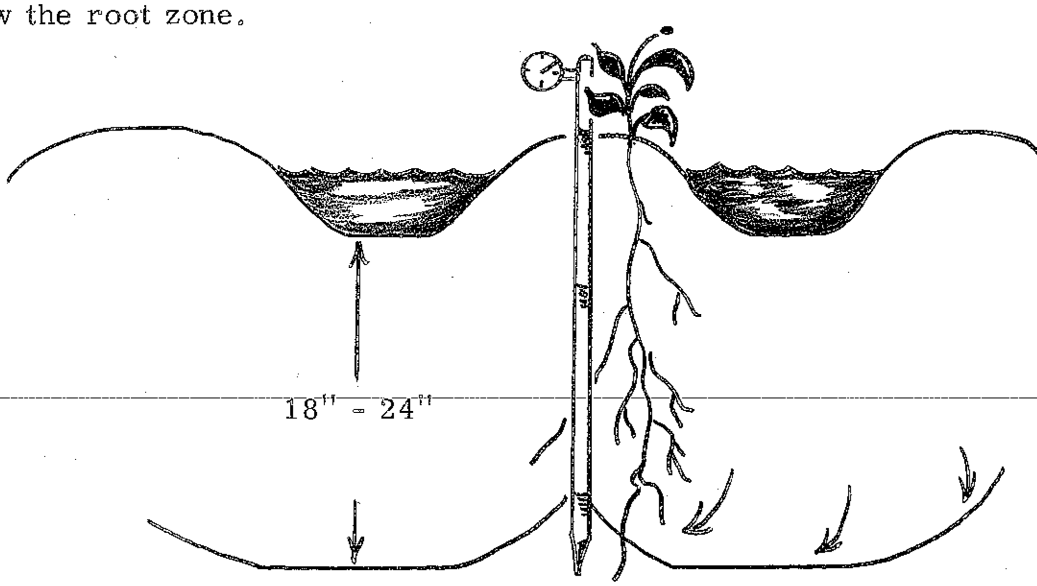

Figure 4. Watering should be long enough to nearly fill the root zone each irrigation. Tensiometers located near the bottom can tell when water has reached that depth.

SCHEDULE IRRIGATIONS

The time to allow between irrigations can be determined very accurately by using the evaporation method. The basic principle is that as one inch of water is evaporated from the standard evaporation pan, approximately one inch of water is used by plants in the field. This relationship between evaporation and plant use has been established by many years of research in Washington.

The greatest difficulty a new user encounters in using the evaporation method is determining how many inches to allow to evaporate between irrigations. When the root zone is only partially filled each irrigation the inches of evaporation between irrigations should not exceed the amount of water put in the soil. If the root zone is filled each irrigation, the inches of usable evaporation allowable between irrigations on potatoes is approximately as follows:

Soil	Usable Evaporation	Days at 0.33 inches per day
Loamy sand (coarse)	1.0 inches	3
Sandy loam	1.3 inches	4
Silt loam (fine)	1.6 inches	5

The approximate days between irrigations is also shown in the above table for a hot weather condition when the evaporation rate is approximately 0.33 inches per day. Additional information on the evaporation scheduling method can be found in Extension Circular 341 available at Washington County Extension offices.

The evaporation rate and the amount of water put into the soil must be compared at all times during the irrigation season. Harmful underwatering has been common in the spring, the fall and during cultivating operations. Underwatering cannot be allowed if salts are to be controlled.

LOW WATER INTAKE RATES

Many saline soils have slow water intake rates. Farming and irrigating practices must be carefully timed on these soils to get enough water in for salt control. On some soils only about one inch of the water enters the soil in a 24-hour irrigation set. This is enough water to wet 6 to 10 inches away from the furrow. In hot weather one inch of water is only enough for about three days between irrigations.

Most of the low intake soils in the Columbia Basin Project are silt loam in texture. They are not generally sodic or alkali soils. The slow water intake appears to be due primarily to the texture and a crust which forms at the bottom of the furrow.

Some of the following ideas may be helpful in improving the intake rates of these soils:

1. Space furrows close. Furrows irrigated on a 24-inch row spacing will get about twice as much water into a soil as 48 inch furrows.

2. Work in plant material. Straw, green manure crops, manure all show some benefit in improving intake rates. Rototilling in the plant materials may be better than moldboard plowing.

Plowing tends to create a straw mat which can slow down the penetration rate of water.

3. Rotate crops to keep plant materials in the soil.

4. Avoid compaction. Don't compact the soil when it is moist. Caution truck drivers not to drive in the same path.

5. Cultivate to break the furrow crust when possible.

CONCLUSION

The management of saline soils, especially on low intake conditions, does require superior management. Appropriate methods must be used to be sure that slightly more water enters the soil than comes out. Where this management is used, many farmers are profitably reclaiming and farming formerly saline areas.