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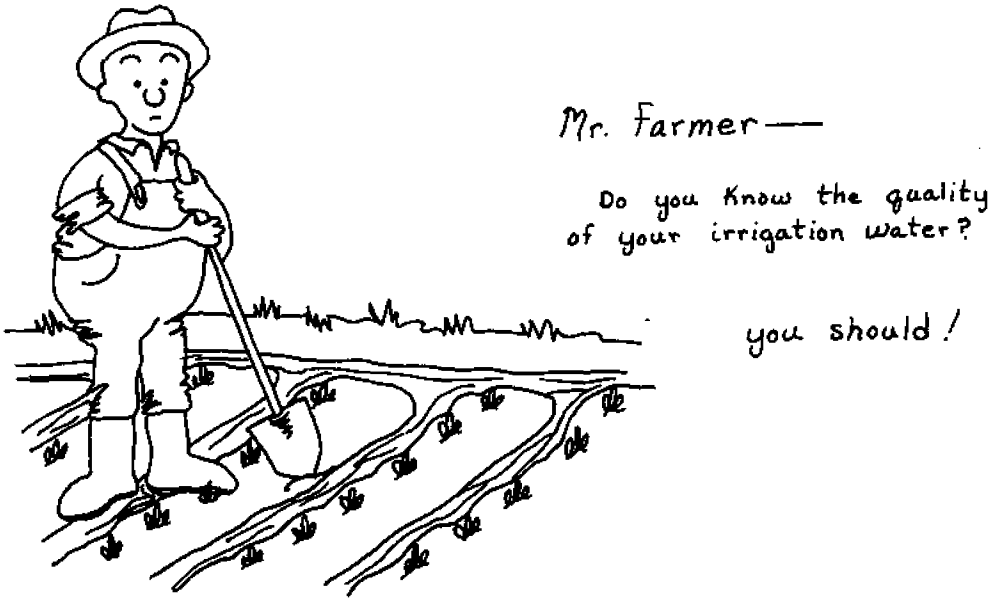

Managing Moderately Saline (Salty) Irrigation Water

David L. Carter

Irrigation water quality often determines the success of irrigated agriculture in many areas of the world. In the Western U. S. many farmers experience crop failures or low yields as a result of irrigating with moderately saline (moderately salty) water. Many of these crop failures could be prevented and yields often could be increased through proper planning and proper irrigation practices.

Approximately 1/5 of the irrigation wells in some sections of Idaho yield moderately saline water. In addition the water in some streams is moderately saline. Using these waters for irrigation may result in low yields and, in some cases, crop failures.

KNOW THE QUALITY OF YOUR IRRIGATION WATER

Total salt, sodium, carbonate plus bicarbonate, and boron concentrations determine irrigation water quality. Total salt concentration or salinity level is the main factor determining the irrigation quality of Idaho waters, although a few waters contain sufficient sodium, boron or carbonate plus bicarbonate to cause problems. The total salt concentration of water can be estimated by measuring its electrical conductivity. This measure can be converted to parts per million or pounds of salt per acre-foot of water. Scientists at the U. S. Salinity Laboratory have developed criteria for classifying irrigation waters according to their salt content in relation to crop production. Applying these criteria to Idaho irrigation waters in relation to crops grown is shown in Table I.

Every farmer should know the quality of his irrigation water. If his irrigation water is moderately saline, and he does not know it, the probability of occasional crop failures is high. Water quality determination services are available through the University of Idaho and some private laboratories, and the cost is normally low. County extension agents can provide plastic sample bottles and assist farmers in getting water samples analyzed by the University of Idaho. Farmers collecting their own samples should be certain that the sample container is clean. A plastic container is preferred, although glass is also suitable, and it should hold about one quart. It is always wise to rinse the container with the water sampled. The sample should represent the stream or well flow. It should be collected from a running portion of the stream or pump effluent. Wells should be pumped a few minutes before samples

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are collected. Where streamflow varies greatly from early spring to midsummer, sampling at both high and low streamflow is advisable. The salt concentration in well water generally does not change with season or from year to year.

Equipment for determining the total salt concentration in water can be obtained for less than $400, and it is easy to operate. Some irrigation districts or farmer groups may wish to purchase such equipment.

It is also beneficial to know the nutrient content of irrigation waters. Some Idaho irrigation waters contain sufficient sulfur and potassium to supply crop needs, and some well waters contain significant amounts of nitrogen.

TABLE I. Water classes in relation to their saline content.

Class of Water	Electrical Conductivity (micro ohms per cm at 25°C)	Parts Per Million (ppm)	Pounds Per Acre-Foot	Comments
Low Salinity Water	0 to 400	0-250	0-700	These waters can be used for irrigating most crops grown on most Idaho soils with a low probability that salt problems will develop. Some leaching is required, but this generally occurs with normal irrigation practices.
Moderate Salinity Water	400-1200	250-750	700-2000	These waters can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most instances without special practices for salinity control. Producing field beans and potatoes with these waters is hazardous and requires special management practices.
High Salinity Water	1200-2250	750-1450	2000-3900	These waters should not be used on soils with restricted drainage. Special management is required even with adequate drainage. Plants tolerant to salinity should be grown. Excess water must be applied for leaching.
Very High Salinity Water	2250-5000	1450-3200	3900-8700	These waters are not suitable for irrigation except under very special circumstances. Adequate drainage is essential. Only very salt-tolerant crops should be grown. Considerable excess water must be applied for leaching.

SALT ACCUMULATIONS AND PLANT GROWTH

Salts are transported by water as it flows in a stream or moves through the soil. If sufficient water is applied so that some of it moves below the root zone of the crop, some salt will be carried with it. This process is known as leaching. Thus, when salt accumulations in the soil need to be removed, more water than the plant needs should be applied to move or leach the salt below the plant root zone. In contrast to leaching, water moving upward transports salt towards the soil surface.

A portion of the water applied for growing crops is evaporated from the soil surface and transpired by the growing crop. As this water leaves the soil, salts are left behind to accumulate in the soil, usually near the soil surface. When the accumulation reaches a critical level for the crop, plant growth is reduced. As the salt continues to accumulate, the effects upon plant growth become more pronounced until the plants die. If the crop matures before salt concentrations reach a level that reduces crop growth, yields are not decreased. In contrast, if salt concentrations reduce plant growth before crop maturity, yields are decreased.

Salts often accumulate gradually to a crop-damaging level before the problem is realized by the farmer. For example, consider a bean crop planted on a nonsaline soil and irrigated with moderately saline water with an electrical conductivity of 1200 micro ohms per centimeter. The beans will grow normally at first, but at about bloom stage after approximately 10 inches of water have been used by evapotranspiration, and 1750 pounds of salt left to accumulate in the soil, the beans will begin to show visual symp-

toms of excess salinity. At that time, the farmer will recognize that something is wrong with the crop, but it is too late to do much about it. Generally, at least a 25 percent yield reduction has already occurred when visual salinity symptoms appear. Visual symptoms appear suddenly, within a few days' period, but they result from a gradual salt accumulation when moderately saline water is used for irrigation. Visual symptoms of salt damage vary with different crops. For example, beans and potatoes exhibit leaf tip burn and death of older leaves whereas alfalfa and sugar beets exhibit only reduced growth. Thus it is important to know the salt content of irrigation water before planting a crop so that extra water can be applied for leaching or a more salt-tolerant crop planted.

LEACHING SALTS FROM SOILS

Where soils are deep and drainage is adequate, excess water can be applied to leach accumulated salts below the plant root zone. Normal irrigation practices result in some leaching, but usually not enough to prevent salinity effects where moderately saline irrigation water is used. Because most moderately saline irrigation waters in Idaho are pumped from wells, generally little water in excess to plant needs is applied.

Farmers having only moderately saline irrigation water should plan to apply excess water for leaching. The higher the total salt concentration in the water, the greater will be the excess water required. It is important to remember that the quantity of salt accumulated in the soil is in direct proportion to the amount of water used in evaporation and transpiration. As the soil dries, there is an upward movement of salts in the soil. Therefore, it is important to apply enough water to leach the accumulated salts to below the plant root zone.

It may not be necessary to apply excess water for leaching at every irrigation or for every crop. If fall, winter and spring precipitation was adequate to leach salts accumulated the previous year, it should not be necessary to apply excess leaching water during the first two or three irrigations unless the irrigation water is highly saline. Generally, during subsequent irrigations, 1.5 to 2.0 times the amount of water removed by evapotranspiration should be applied. For example, if evapotranspiration has removed 2 inches of water since the previous irrigation, 3 to 4 inches of water should infiltrate into the soil during the next irrigation. As crops approach maturity, leaching may be discontinued if the harvested portion of the crop is no longer growing. It may be advisable to leach the soil in the fall after the crop is removed. It may not be possible to apply excess water for leaching during midsummer when evapotranspiration demands are greatest because the irrigation system may not have sufficient capacity. When this is the case, salt should be leached before the peak water use season.

More specific leaching requirements can be determined for particular water, soil and crop situations. Farmers who know their irrigation water is moderately saline should consult county agents or other specialists for guidance. Generally, analyzing the soil for salinity to determine the extent of salt accumulation is required.

TAKE FULL ADVANTAGE OF PRECIPITATION

Water from rainfall or snowmelt is very valuable to the farmer with moderately saline irrigation water. Unfortunately, few of these farmers are taking full advantage of the benefits precipitation can provide. For precipitation to most effectively leach salts, the soil must be wet when the precipitation falls, or in the case of snow, when it melts. Otherwise the water from precipitation will be used to wet the soil. Therefore, irrigating to wet the soil to a depth of 2 to 3 feet in the fall would maximize the leaching from fall, winter and spring precipitation. When the soil is wet beyond the plant root zone, even light precipitation effectively leaches salts. By irrigating in the fall, full advantage of leaching by precipitation will be gained and the soil should not require irrigation in the spring before tillage operations can be carried out.

ROTATING IRRIGATION WATERS

Some farmers have both moderate and low salinity irrigation waters. These farmers may find that using the waters alternately on fields will prevent salt problems that result from continual use of the same water on the same land. The moderately saline water could be used on the more salt-tolerant crops, and the salt accumulated from it could be leached in the fall with the low salinity water. An alternative would be to use the moderately saline water only when the supply of low salinity water is limited. The important point is that the farmer should know the salt content of all his water sources and then manage water use to minimize salt damage.

Some farmers have snowmelt runoff water in the early spring and then must depend upon moderately saline well water the remainder of the growing season. In this case, irrigating the entire farm heavily in the spring with snowmelt water would tend to remove salts accumulated in the soil from the previous season, so that accumulations from the well water for irrigation might not reach levels harmful to the crop during the growing season.

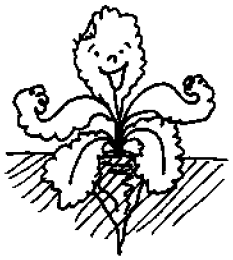
NUTRIENT LOSSES FROM LEACHING

Leaching to remove excess salt also removes nitrogen in the nitrate form. It may be necessary to fertilize to compensate for the nitrogen lost from leaching. Fertilizer practices should be planned so that nitrogen is applied after leaching water has been applied.

CROP SELECTION

Plant species differ in their tolerance to salinity. Field beans are the most salt sensitive crop of major importance in Idaho. Potatoes are slightly more tolerant than field beans. Sugar beets and some pasture grasses are the most salt tolerant crops. The major Idaho crops and their relative tolerance to salinity are listed below:

Bean



Sugar Beet

Sensitive	Semi-Tolerant	Tolerant
Field Beans	Peas	Wheat
Potatoes	Corn	Barley
	Onions	Alfalfa
		Most grasses
		Sugar beets

Selecting the right crop may mean the difference between a successful crop and a crop failure. Attempting to produce field beans during seasons following little or no fall, winter and spring precipitation is a risk for the farmer with irrigation water containing 1300 to 2000 pounds of salt per acre foot (an electrical conductivity between 800 and 1200 micro ohms per centimeter). If weather conditions are right and irrigation managed to maximize leaching, a crop may be harvested, but the yield probably will be reduced. Much less risk would be involved with wheat, barley or sugar beets. Normally sugar beets, barley, wheat, alfalfa and most grasses can be grown year after year with moderately saline water so long as some leaching is accomplished by applying excess water.

The more sensitive crops, beans and potatoes, can be successfully produced in seasons following good fall, winter, and spring precipitation on wet soil. The probability of producing a good yield of these crops with moderately saline water is improved by following practices that maximize salt leaching. But sometimes, selecting a more salt-tolerant crop, is best.

SUMMARY

The following practices are helpful to farmers with moderately saline irrigation waters. The farmer should:

1. Know the quality of his irrigation water.
2. Apply water in excess of evapotranspiration to leach out accumulated salts from the plant root zone.
3. Use precipitation to full advantage for leaching salts accumulated from irrigation water.
4. Rotate irrigations if both low and moderately saline waters are available.
5. Fertilize to replace nitrogen lost to leaching.
6. Select proper crops for the particular situation.

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