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Cooperative Extension

Leaching for Maintenance

Factors to Consider for Determining the Leaching Requirement for Crops

As a result of the application of irrigation water containing soluble salts, a salt load is continually added to the soil. Soil salts have to be removed on an ongoing basis through maintenance leaching to prevent yield losses from a salinity buildup. Leaching considerations include: **(1)** crop sensitivity to salinity, **(2)** presence of a high water table, **(3)** efficiency of the irrigation system being used, **(4)** the crop consumptive use, and **(5)** drainage. Salinity is only a problem when salts are allowed to accumulate to a level which reduces crop yield.

Often a soil salinity problem develops in an area with a high water table. The salinity problem cannot be effectively removed by reclamation leaching, or prevented by maintenance leaching unless the water table can be controlled. If the high water table is the result of water *"perching"* above a restricting layer near the soil surface which isn't very thick, sometimes deep ripping can be a method of breaking up the layer and allowing drainage to occur. If deep ripping is not deemed to be an adequate solution, then tile drains or drainage wells will usually be required. Their purpose is to remove a portion of the subsurface water and transport it from the site to ***an acceptable salt-sink for safe disposal.*** In this day of heightened environmental concerns, an acceptable disposal site may be difficult to find. When drainage is adequate, salinity becomes a problem only if the salts applied with the irrigation water are ***allowed to accumulate*** to a concentration which reduces yields. This can happen whenever underirrigation occurs over the long-term irrespective of whether natural drainage is adequate or inadequate.

When the build-up of soluble salts in a well drained soil becomes or is expected to become excessive, the salts can be leached by applying more water than that needed by the crop for consumptive use. ***The portion of water applied which is required to pass through the root zone to control salts at a specific level is called the LEACHING REQUIREMENT.***

The LEACHING REQUIREMENT (LR) can be estimated from the crop tolerance salinity, as defined by the electrical conductivity of a saturated paste extract of the soil at which no yield loss occurs, EC_e, and the salinity of the irrigation water, as defined by the electrical conductivity of the applied irrigation water, EC_w. Although several methods exist for estimating the leaching requirement, each with its own limitations and benefits, the most widely used equation is provided below.

$$LR = \frac{EC_w}{5(EC_e) - EC_w}$$

Frequently, the number obtained for the LR from the above equation is incorrectly multiplied by the crop seasonal consumptive use to obtain an estimate of the amount of water required on a seasonal basis for salinity control. This leaching amount is then added to the consumptive use to obtain an estimate of the total amount of irrigation water required to be applied (assuming a 100% irrigation efficiency). *Such an approach is totally incorrect.*

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This information has been reviewed by university faculty.

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The correct approach is to divide the consumptive use by one minus the LR, as shown below.

$$\text{APPLIED WATER} = \frac{\text{CONSUMPTIVE USE}}{1 - \text{LR}}$$

Without belaboring the point, it should be noted that the uniformity of water distribution over the field and the field application efficiency have not been considered in this calculation. One approach is to use the above estimate of water required for salinity maintenance and divide by the irrigation uniformity. This may provide a high estimate, and may not prevent the development of localized saline areas. Although excess salts may be leached below the root zone, the distribution of the infiltrated water depths over the field may be variable enough that localized saline areas develop. This variability becomes a much more crucial consideration as the amount of water applied per acre and the crop consumptive use decreases. Therefore, the leaching estimates will need to be adjusted to take into account specific problems inherent in the irrigation system, the soil variability, and the accuracy with which the applied water is known. These considerations result in a fairly lengthy list of interactions that challenge the ingenuity of a good farm manager.

The following graph (Figure 1) provides estimates of the amount of leaching water required, over and above the water applied for consumptive use, on a crop year basis for three combinations assuming 100% irrigation efficiency of the crop, desirable soil salinity, and water salinity. The calculations are based on consumptive use estimates from Erie and French (1982). Remember, the average salinity of saturated soil extracts (EC_e) in the root zone should be less than the threshhold EC_e for the crop to minimize salinity effects on crop yields. Additionally, the EC_e of the seed zone should be less than 2 dS / m to facilitate seedling establishment. Normally, these EC_e values will be higher than the EC of the irrigation water.

Figure 1 is provided to illustrate the rapidly increasing nature of the leaching requirement as the water salinity increases, particularly for the more salt sensitive crops of alfalfa and lettuce. One of the short comings of the approach used is that it is not capable of handling the upper limits of salinity effects on crop growth. Simulations of crop water production functions has shown that yields of 100% cannot be achieved for alfalfa or lettuce with irrigation waters exceeding salinity levels of 2.5 and 2.1 dS / m,

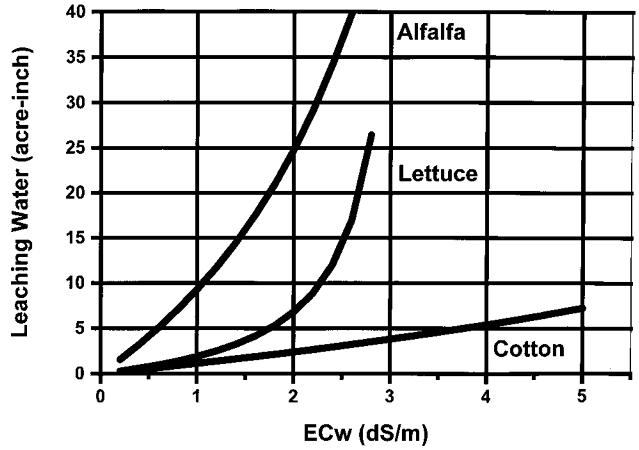

Figure 1. Required Leaching Water

respectively (for more details, see *Simulated Crop-Water Production Functions for Several Crops When Irrigated with Saline Waters* by J. Letey and A.Dinar in Hilgardia 54:1.

The estimates assume the leaching is conducted to maintain maximum yield potential. Obviously if too much extra water has to be added to maintain those yields, there is a good potential that a producer will lose money trying to keep the salinity at a low level. In such cases, the willingness to accept some yield loss (e.g. 10%) due to the buildup in salinity may be a better approach. The EC_e to be used in the leaching requirement equation can be obtained from Extension Bulletin No. 8557, *Interpreting Soil Salinity Analyses*. For the crops of cotton, alfalfa and lettuce these threshold salinities are about 7.7, 2.0 and 1.3 dS / m.

Table 1 provides the some of the numbers in tabular form that were used to develop the curves for cotton, alfalfa and lettuce for Figure 1. Obviously, the smaller amounts are not an important consideration because of the inability to accurately control the amount of irrigation water applied. The blank spaces at the bottom of the alfalfa and lettuce columns occur because an excessively large amount of water would be required at the given EC_w to maintain the soil EC_e at the zero yield loss level! Thus, a grower would be wise to either grow a more salt tolerant crop than alfalfa or lettuce, or dilute this water with water having a lower salt content from a different well if at all possible, if EC_w exceeds 3.0. Also, be wary of using these estimates when leaching requirements exceed about 30%, which will be the case when the irrigation water salinity exceeds the threshold salinity of the particular crop.

Table 1. Annual Leaching Water Required.
(Consumptive Use values used in the calculations: Cotton=41 ac-in/ac, Alfalfa=74 ac-in/ac; Lettuce=8.5 ac-in/ac)

Ecw (mmhos/cm) or (dS/m)	Cotton acre-inches/acre	Alfalfa acre-inches/acre	Lettuce acre-inches/acre
.20	.22	1.55	.28
.40	.44	3.23	.60
.60	.66	5.07	.96
.80	.89	7.08	1.39
1.00	1.13	9.29	1.89
1.20	1.37	11.73	2.49
1.40	1.62	14.45	3.22
1.60	1.87	17.48	4.12
1.80	2.12	20.90	5.28
2.00	2.39	24.77	6.80
2.20	2.66	29.19	
2.40	2.93	34.29	
2.60	3.22		
2.80	3.51		
3.00	3.80		
3.20	4.11		
3.40	4.42		
3.60	4.74		
3.80	5.07		
4.00	5.40		
4.20	5.75		
4.40	6.10		
4.60	6.47		
4.80	6.84		
5.00	7.23		