Salinity and irrigation

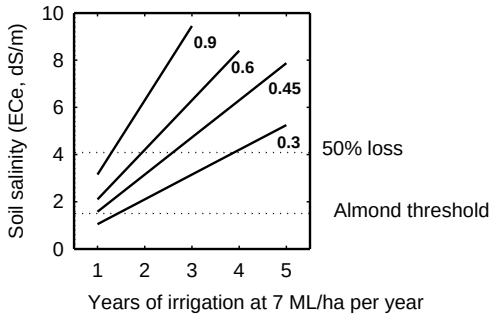
Measurement of the concentration of salt in water

The ease with which water conducts electricity is proportional to the concentration of the salts in the water. The conductivity to electricity of irrigation water and soil solution is measured in either micro-Siemens per cm (µS/cm) or deci-Siemens per metre (dS/m) with 1000 µS/cm = 1 dS/m. The salt concentration is also quantified by measuring the weight of salt in water, this is expressed as parts per million (ppm) with 10,000 ppm equivalent 1 gram of salt in 1 litre of water. Water with a conductivity of 1 dS/m contains about 660 ppm of salt.

What is the main source of salts in irrigated soil?

Salt is present in irrigation water and it remains behind in the soil when the added water is lost via evaporation from the soil surface or via plant use (when plants extract water from the soil they exclude more than 95% of salt in the water). If these salts are not leached in water draining from the root zone, then they accumulate and this increases soil salinity

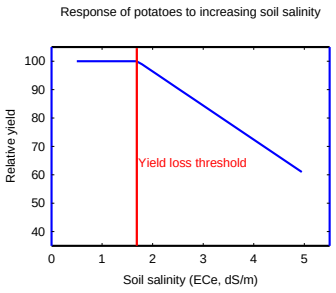
The effect of irrigation with different salinity waters on soil salinity when salts are not leached



Effects of salinity on plants

Salt depresses plant growth by decreasing osmotic potential of the soil solution. The effect is known as the osmotic effect and it acts on the plant in a manner similar to soil drought. Salt also depresses plant growth by increasing the concentration of sodium and chloride in the plant. As the concentration rises these salts poison (exert a toxic effect) on the plant metabolism. The osmotic effect of salinity is exerted without the salt entering the plant, whereas the toxic effect is only exerted by salt which enters the plant.

Plant yield declines above a threshold level of soil salinity



Crop	Threshold soil salinity (dS/m)	Soil salinity at 10% yield loss
Almond	1.5	2.0
Grapevine	1.5	2.5
Broccoli	2.8	3.9
Cabbage	1.8	2.8
Potato	1.7	2.5
Onion	1.2	1.8
Carrot	1.0	1.7

Managing salinity – flushing salt from the root zone soils

Both the osmotic and toxic effects of soil salinity on plants can be reduced by removing salts from the soil. Whenever the amount of rain or irrigation is in excess of the soil water deficit (SWD), that is amount required to refill the soil, then the excess drains. The draining water carries the salt downward and out of the root zone. This process is referred to as leaching. The excess is quantified by expressing the depth of water leaching as a fraction of the SWD.

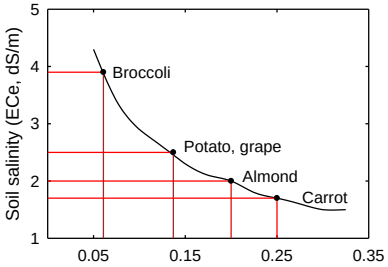
- Three pieces of information are required when planning to use irrigation in the control the soil salt concentration; they are:
  a. the amount of water required to refill the soil profile = soil water deficit (SWD)
  b. the value of soil salinity at which the crop suffers a 10% salinity induced decline in yield ($ECe_{10\%}$)
  c. the salinity of the irrigation water (ECi)
- b and c are used to calculate a leaching requirement (LR) with:

$$LR = \frac{ECi}{(5\ x\ ECe10\%) - ECi}$$

- the depth of irrigation (Di) required to replenish soil water deficit and flush soil salt is of irrigation required is:

$$Di = \frac{SWD}{1 - LR}$$

Leaching requirement to prevent 10% yield loss when water salinity is 1.4 dS/m



- Crops with a high threshold to salinity have lower leaching requirements – compare broccoli and carrots

Worked example for potato

a. the SWD = 40 mm
b. the $ECe_{10\%}$ = 2.5 dS/m
c. the ECi = 1.4 dS/m

- to maintain soil salinity below 2.5 dS/m an extra 6 mm of irrigation will need to added

$$LR = \frac{1.4}{(5\ x\ 2.5) - 1.4} = 0.13$$

$$Di = \frac{40}{1 - 0.13} = 46\ mm$$

Managing salinity – avoidance and reducing toxic effects

Avoidance

- Growth within a season can be divided into stages – some growth stages are more sensitive to salinity
- If possible, apply water from the more saline source during less sensitive growth stages

Reducing toxic effects

- Sodium and chloride enter the plant through the leaves more readily than through the roots
- Do not apply saline water via irrigation systems which wet the leaves, that is via overhead sprinklers

The sensitivity of grapes to irrigation with saline water in different growth stages under drip irrigation and overhead sprinkler irrigation. Yield as percent of that in control (non-saline) vine.

Growth stage		Bud burst	Flowering	Veraison	Harvest	Leaf fall
Yield	Drip	100%	97%	100%	100%	
	Overhead sprinkler	97%	90%	83%	-	