Managing Salinity in Walnuts

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Quad County Walnut Institute
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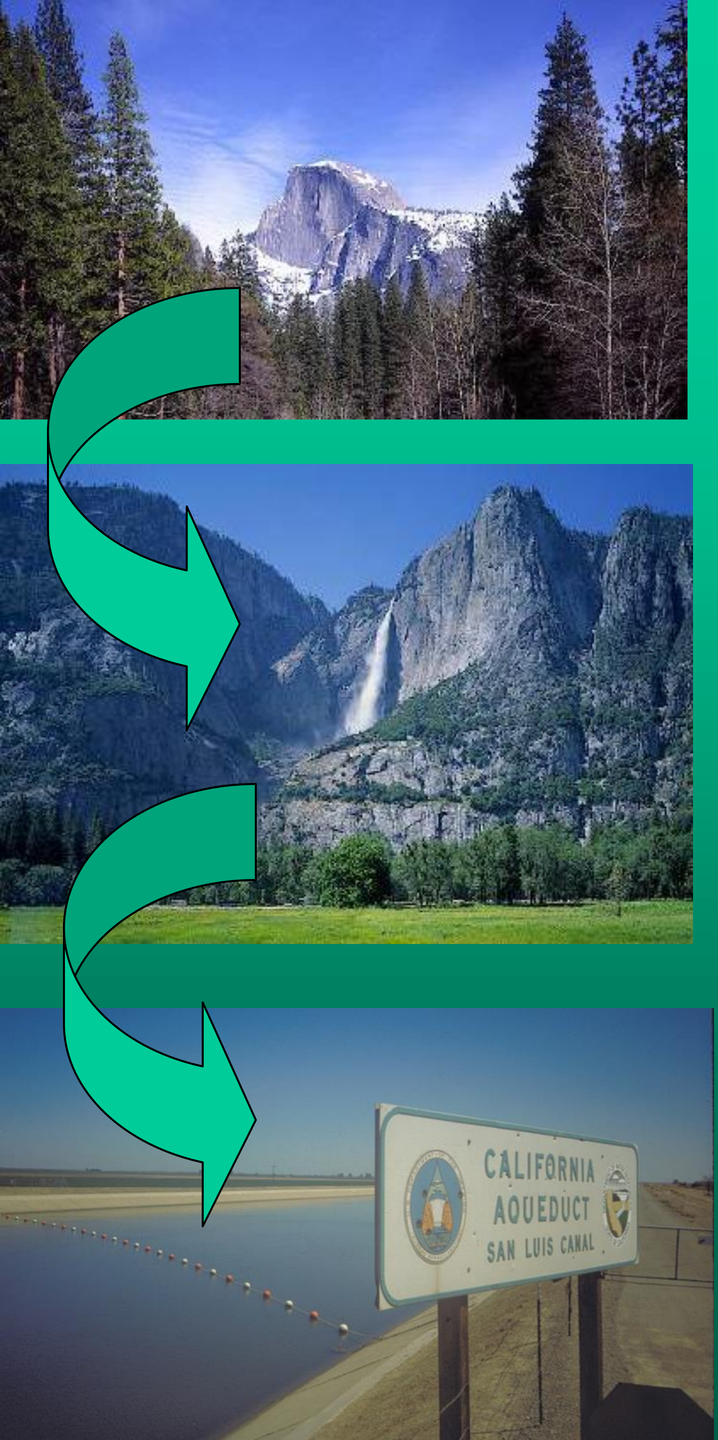


Higher Salinity in 2014?

- **Surface waters**
  - Reduced runoff -> higher salt load
  - Reduced supply -> use well water
- **Well water**
  - Often higher in salts

Where do they come from?

- Salts are found in all irrigation waters
    - Mineralization of soils
    - Fertilizers
    - Manures and composts
- Salts can accumulate in root zone and damage crops

What salts are in the water?

- Sodium (Na^{+})
- Calcium (Ca^{2+})
- Magnesium (Mg^{2+})

Cations

- Chloride (Cl^{-})
- Sulfate (SO_4^{2-})
- Bicarbonate (HCO_3^{-})

Anions

Boron (B), Carbonate (CO_3^{2-}), Nitrate (NO_3^{-}), Potassium (K^{+})

How is salinity measured?

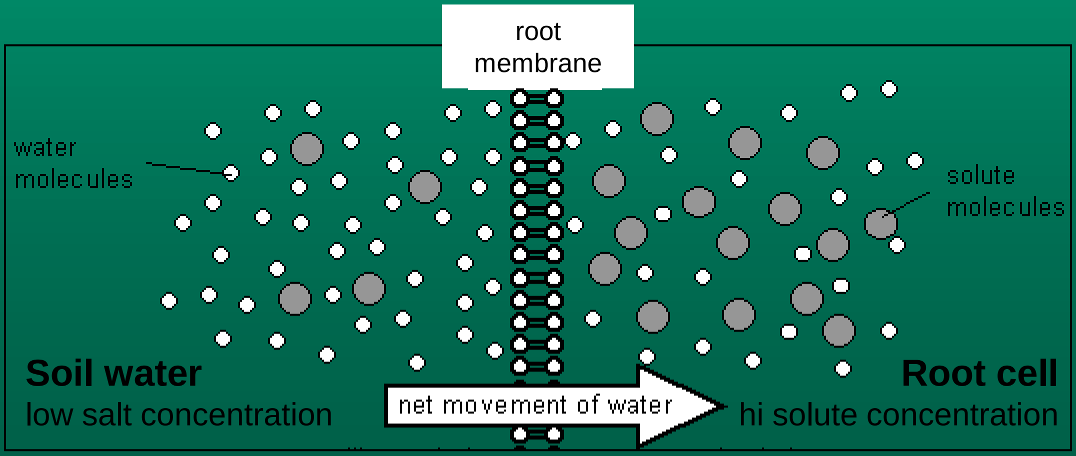
- Electrical Conductivity (EC)
  - ECw = salinity of the water
  - ECe = salinity of the soil
  - The units:
    - dS/m = mmhos/cm
    - uS/cm = 1000 x dS/m
- Total Dissolved Solids (TDS)
    - mg/L = ppm

How does salt effect walnuts?

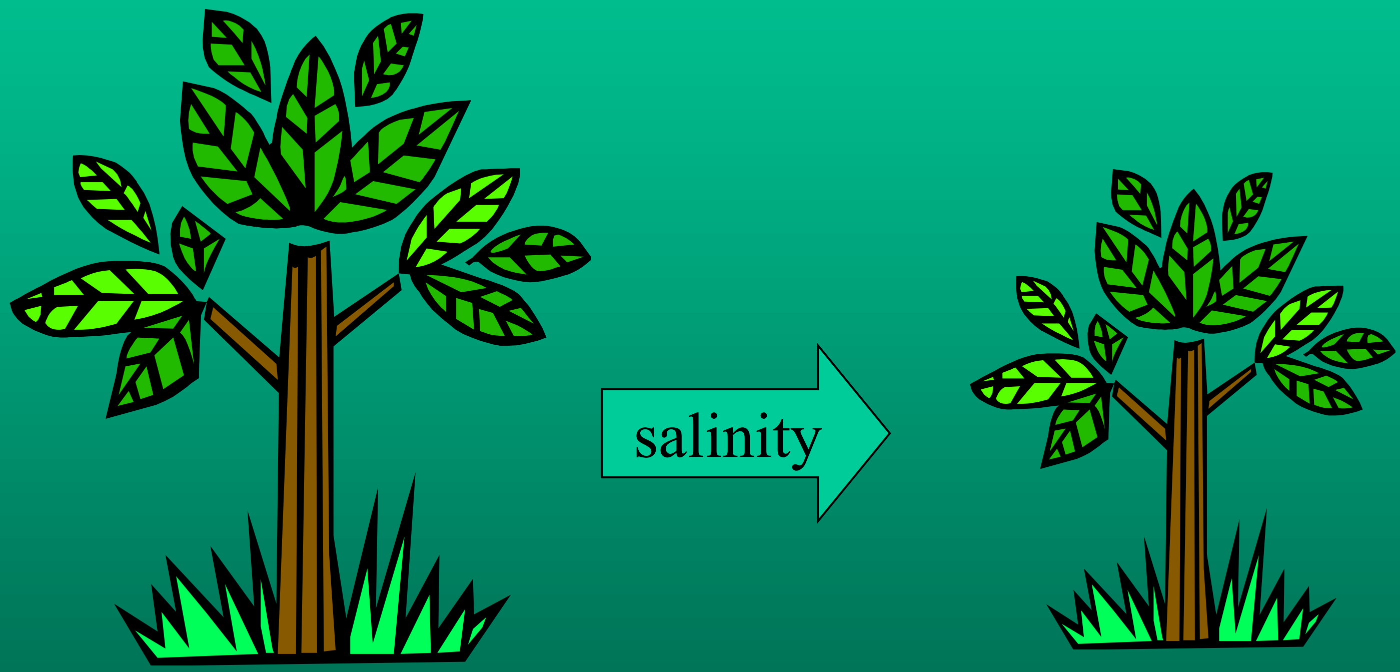
1. Overall salinity
   - EC (dS/m)
2. Specific ion toxicity
   - Sodium (Na)
   - Chloride (Cl)
   - Boron (B)

How does salt effect walnuts?

- Overall salinity
  - High salt restricts osmotic flow
    - uses more energy to exclude salt in the root zone and take in water
  - Symptoms: water stress
    - Less growth
    - Lower yields



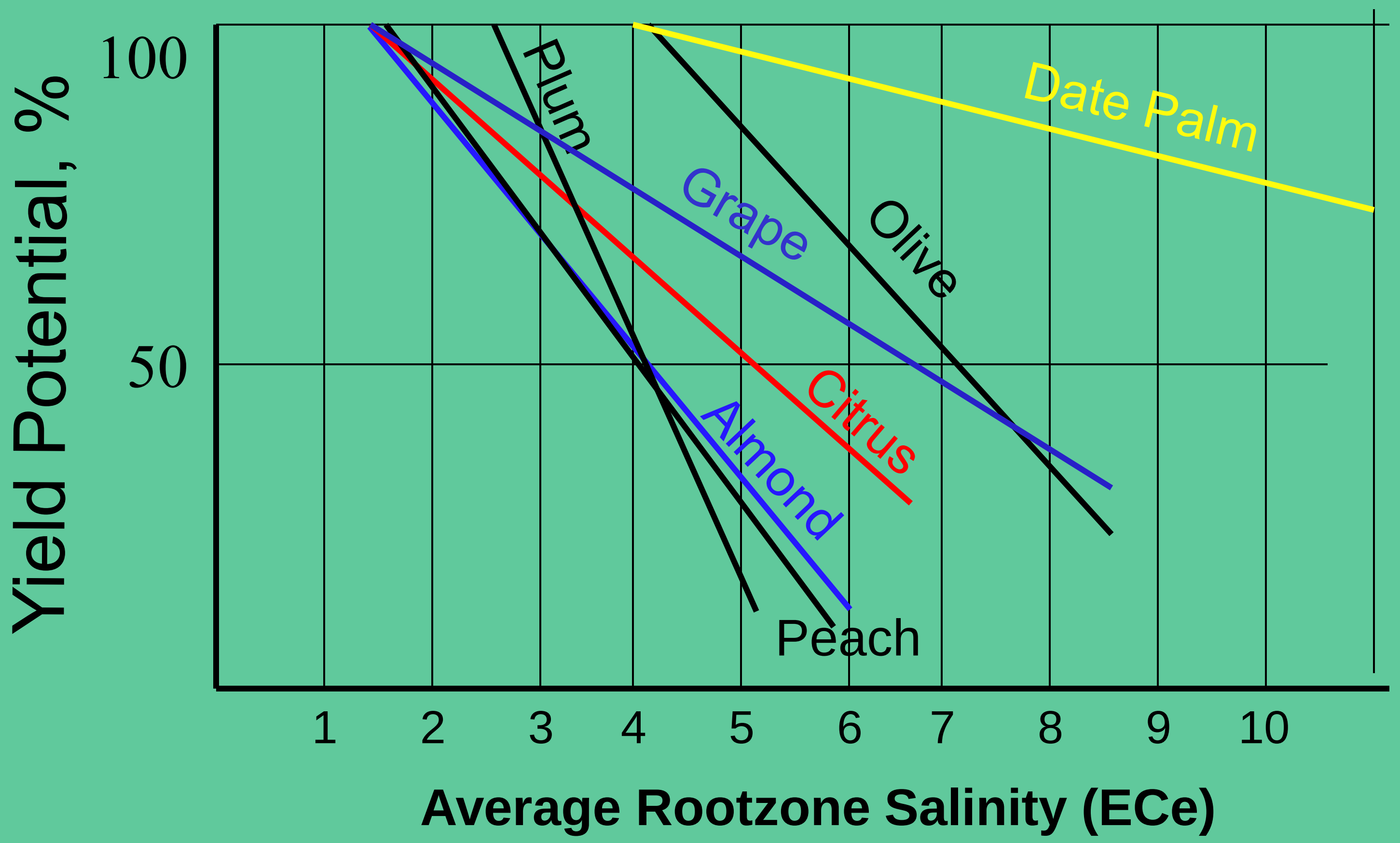
The overall osmotic effect is stunting of plant growth



Non-stressed crop

Salt-stressed crop

Tree Salt Tolerance



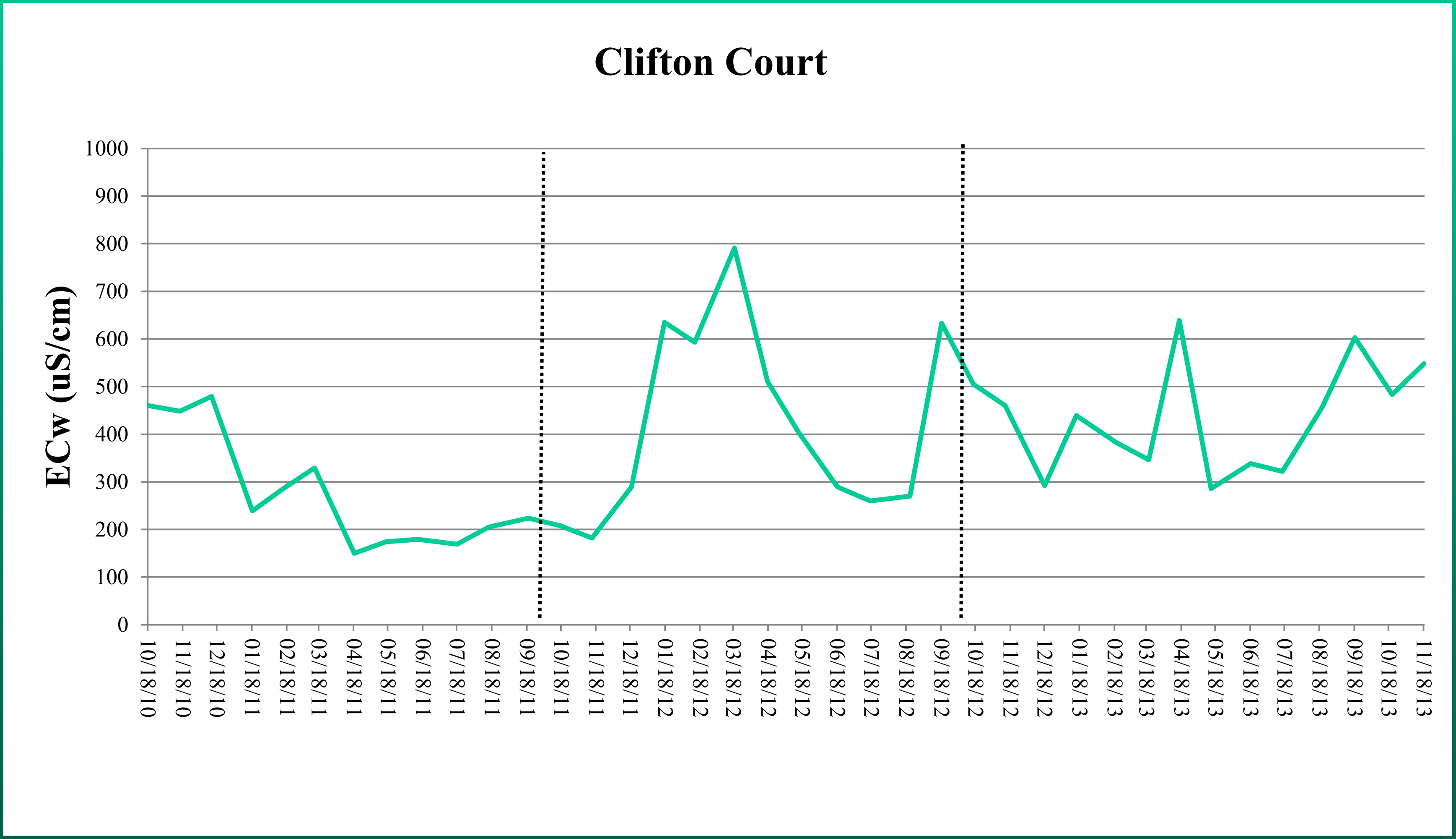
Maas and Grattan 1999

How much salt is too much ?

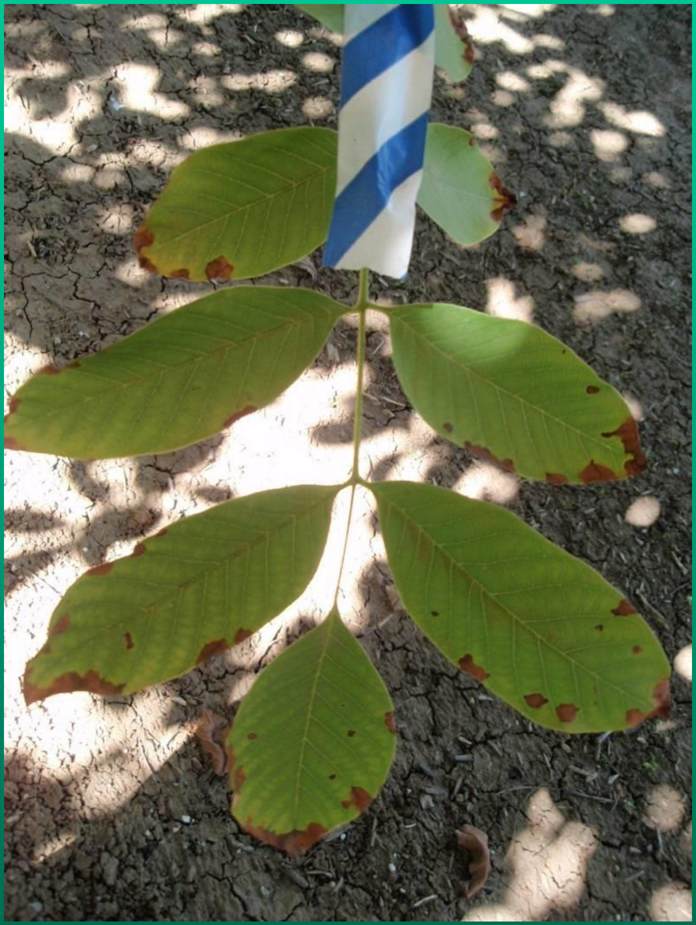
	Salt Effects on Yield EC (dS/m)		
Source of Salinity	None	Increasing	Severe
Soil/Rootzone (ECe)	<1.5	1.5-4.8	>4.8
Irrigation Water (ECw)	<1.1	1.1-3.2	>3.2

- What does “Increasing Effect” mean
  - For irrigation water: (assumes full ETc + 15% LF)
    - 1.5 ~ 10% yield reduction
    - 1.9 ~ 25 % yield reduction
    - 2.8 ~ 50% reduction

ECw varies over the season



Specific Ion toxicity



Boron (B), Chloride (Cl) and sodium (Na)

Specific Ion Toxicity
(Na, Cl, B)

- Normal plant nutrients
- Accumulate in the wood & leaves
  - Interfere with normal cellular processes
  - Reduced photosynthesis
- Roots can regulate uptake
- Rootstocks vary in regulation ability

Salt Tolerance of Walnut Rootstocks

Salt Tolerance of Walnut Rootstocks

Leaf Analysis

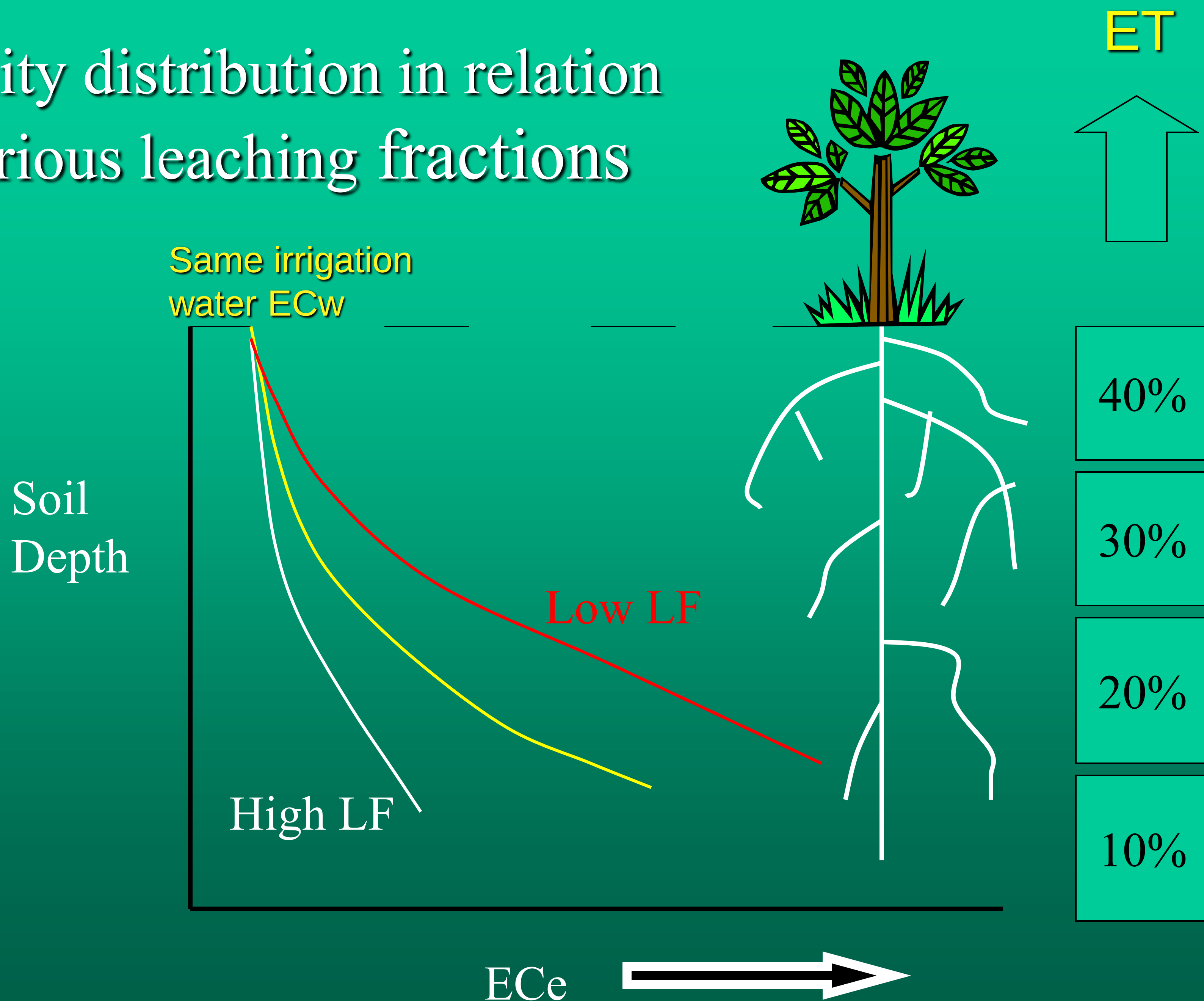
ROOTSTOCK	Boron (ppm)	Chloride (%)	Sodium (ppm)
Black	480 b	0.7 c	56 b
Paradox	667 a	1.8 b	87 b
English	704 a	2.1 a	125 a
Excess Level	300	0.3	100

Salt Tolerance of Walnut Rootstocks

Salinity Management

- Apply more water!
  - Leach salts below root zone
    - Apply the full crop water use (ETc)
    - Apply an additional 15-20% “leaching fraction”
    - Many years the rainfall provides the leaching fraction!
- More frequent in-season irrigations
  - Keep the upper root zone wetter - it will be easier for the tree to extract water and exclude the salt
- Apply fertilizer modestly (they are salts!)

Salinity distribution in relation to various leaching fractions



Resources

UC Drought Management website

http://ucmanagedrought.ucdavis.edu/

UC ANR publications

http://anrcatalog.ucdavis.edu/

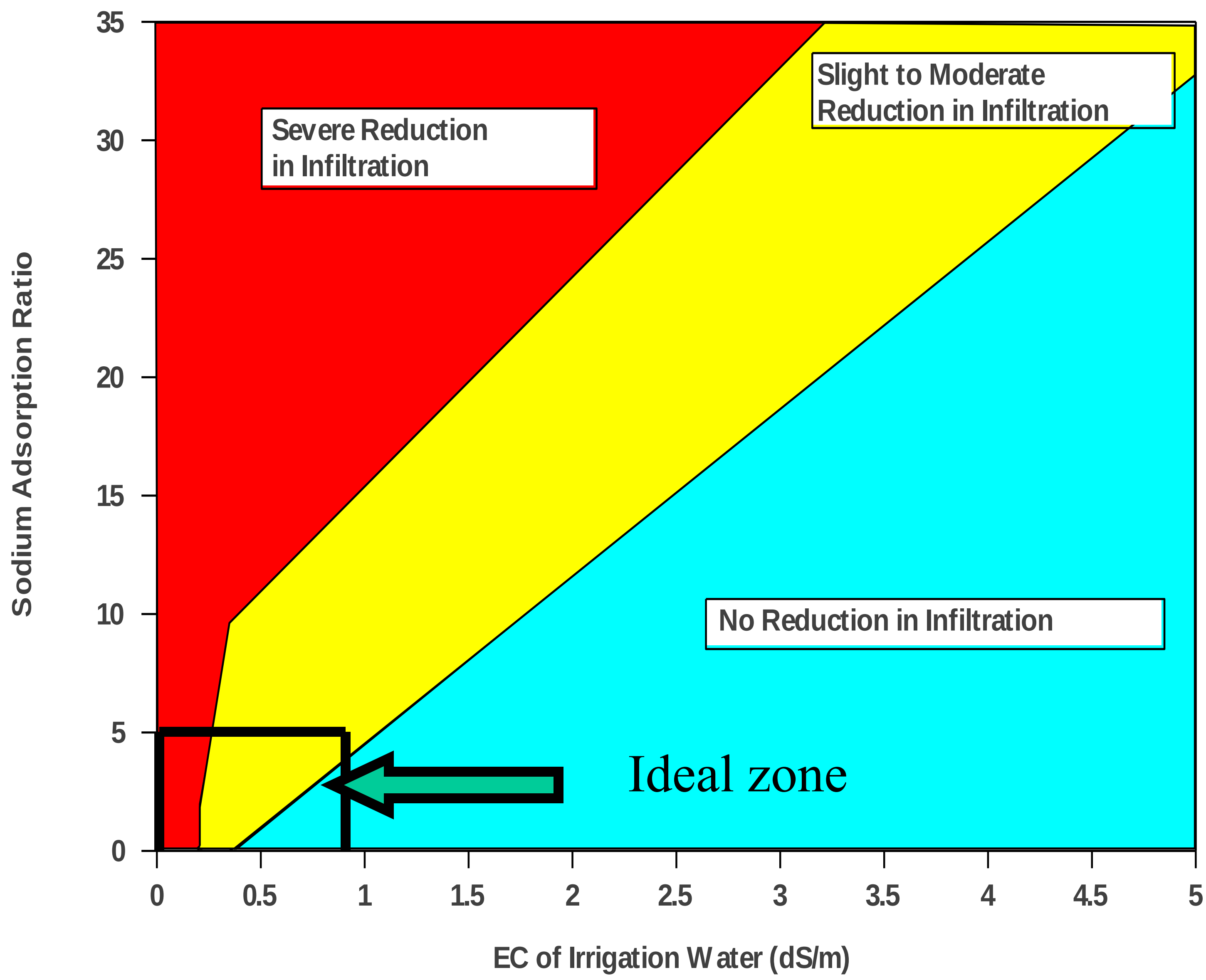
- Agriculture Salinity & Drainage ($25)
- Irrigation Water Salinity & Crop Production (free)

Water infiltration

- Electrical Conductivity (ECw)
  - Low EC -> poor water infiltration
- Sodium Absorption Ratio (SAR)
  - High SAR -> poor water infiltration

$$SAR = \frac{Na^{+}}{\sqrt{\dfrac{Ca^{2+} + Mg^{2+}}{2}}}$$

Concentrations are in meq/L

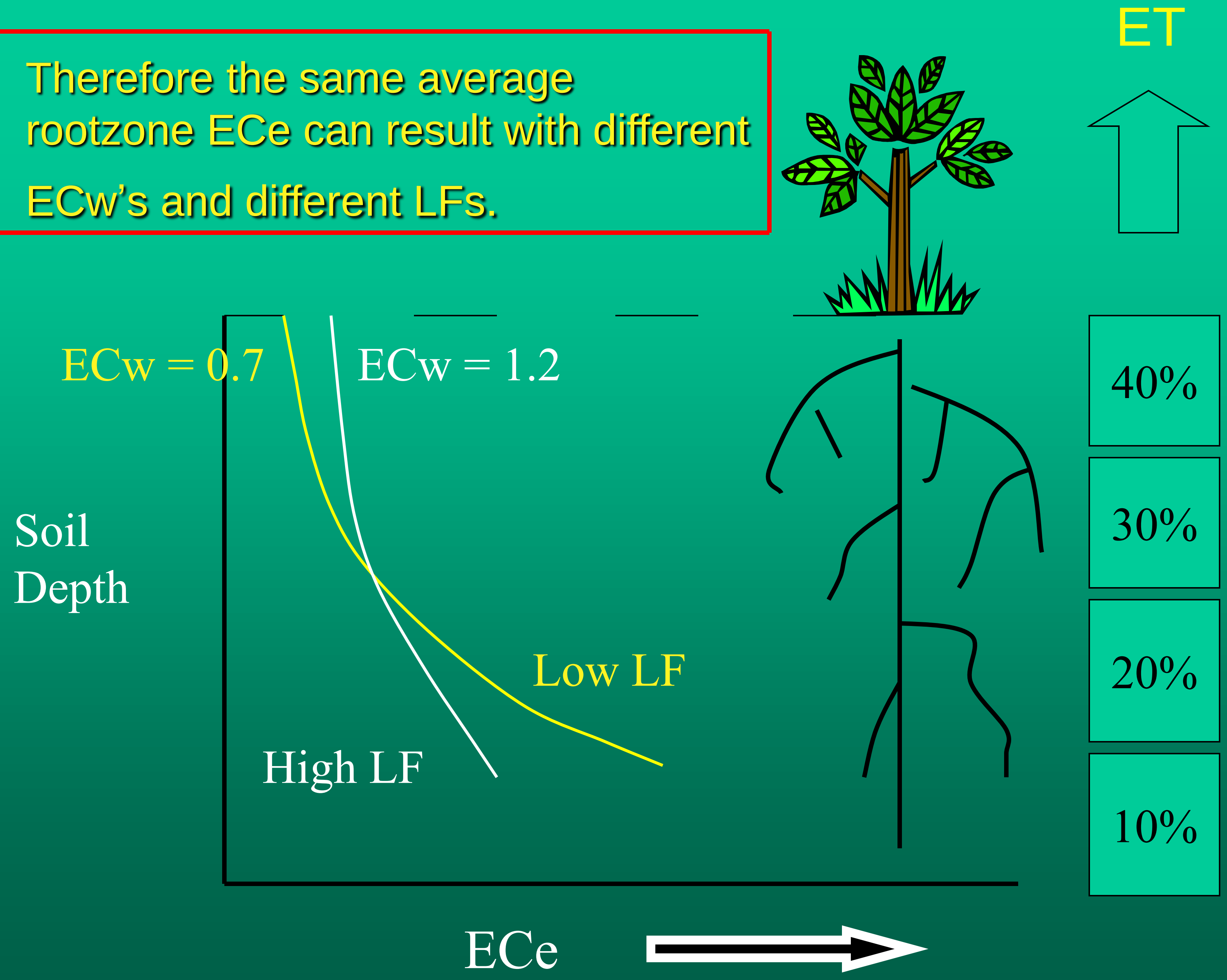

Sodium Adsorption Ratio
35
30
25
20
15
10
5
0
Severe Reduction in Infiltration
Slight to Moderate Reduction in Infiltration
No Reduction in Infiltration
Ideal zone
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
EC of Irrigation Water (dS/m)

How much salt is too much ?

EC (dS/m)	Salt Effects		
	None	Increasing	Severe
Soil (ECe)	<1.5	1.5-4.8	>4.8
Water (ECw)	<1.1	1.1-3.2	>3.2

- What does "Increasing Effect" mean
  - Soil : every 1 dS/m over 1.5 reduces yield by ~ 20%
    - 2.5 = 20% reduction
    - 3.5 = 40 % reduction
    - 4.5 = 60% reduction

Therefore the same average rootzone ECe can result with different ECw's and different LFs.



Tolerance to ion toxicity is generally controlled by the rootstock