Managing Nutrients in Greenhouse Horticulture

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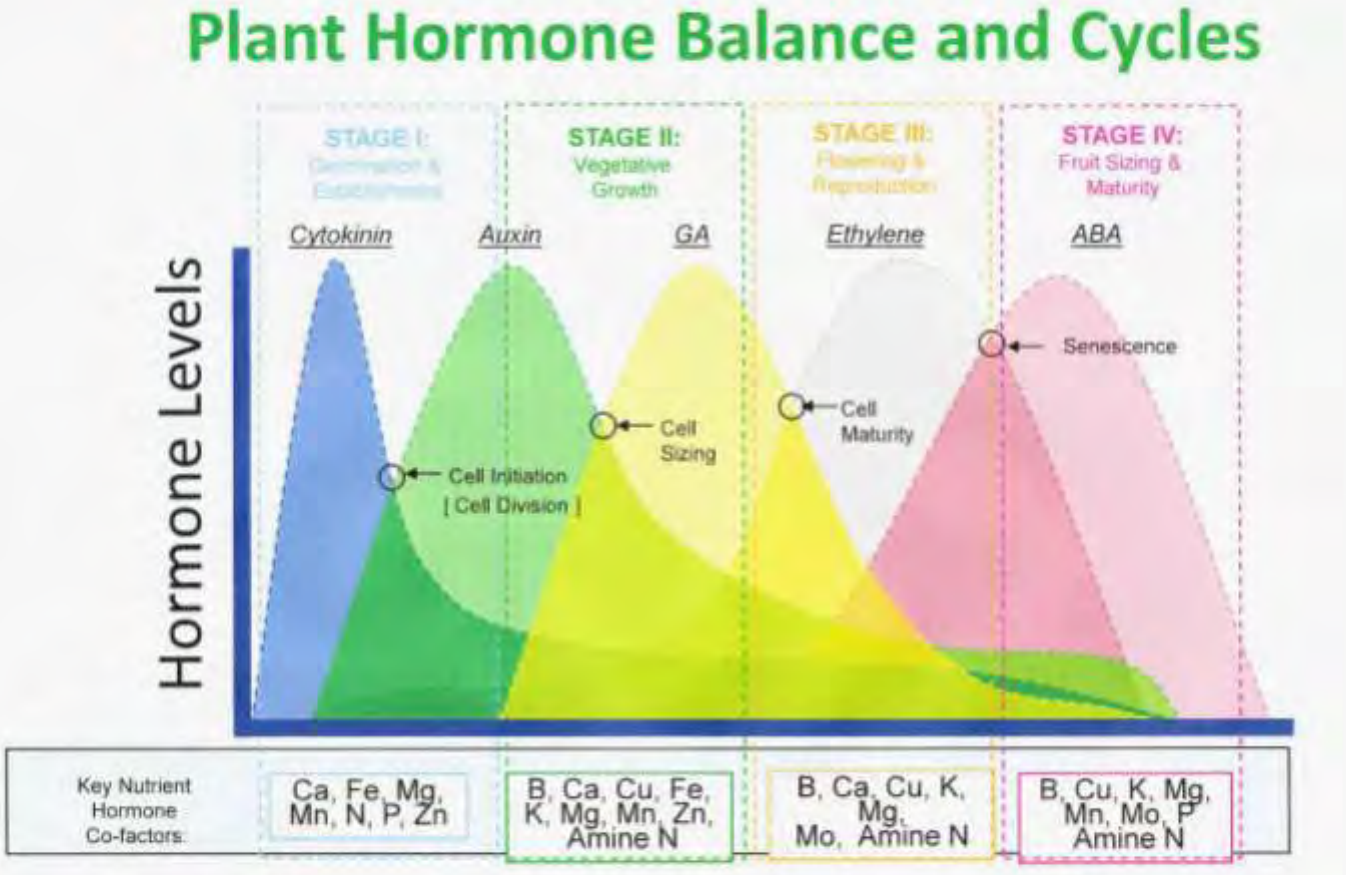
Plant HORMONE PRODUCTION follows approx. cycles with changing NUTRIENT requirements



Any imbalance in these hormone cycles at any time can irreversibly reduce genetic expression

*Source: * ©Stoller USA*

Environmental Factors Also Affect Plant Growth

30ºC

20ºC

Drought

Light

Pests

High Level (NO_3)

Potassium
Zinc
Manganese
Chloride
Copper
Molybdenum
Calcium
Boron

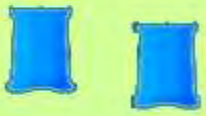
Optimal Zone of Growth

Flood

Shadows

Diseases

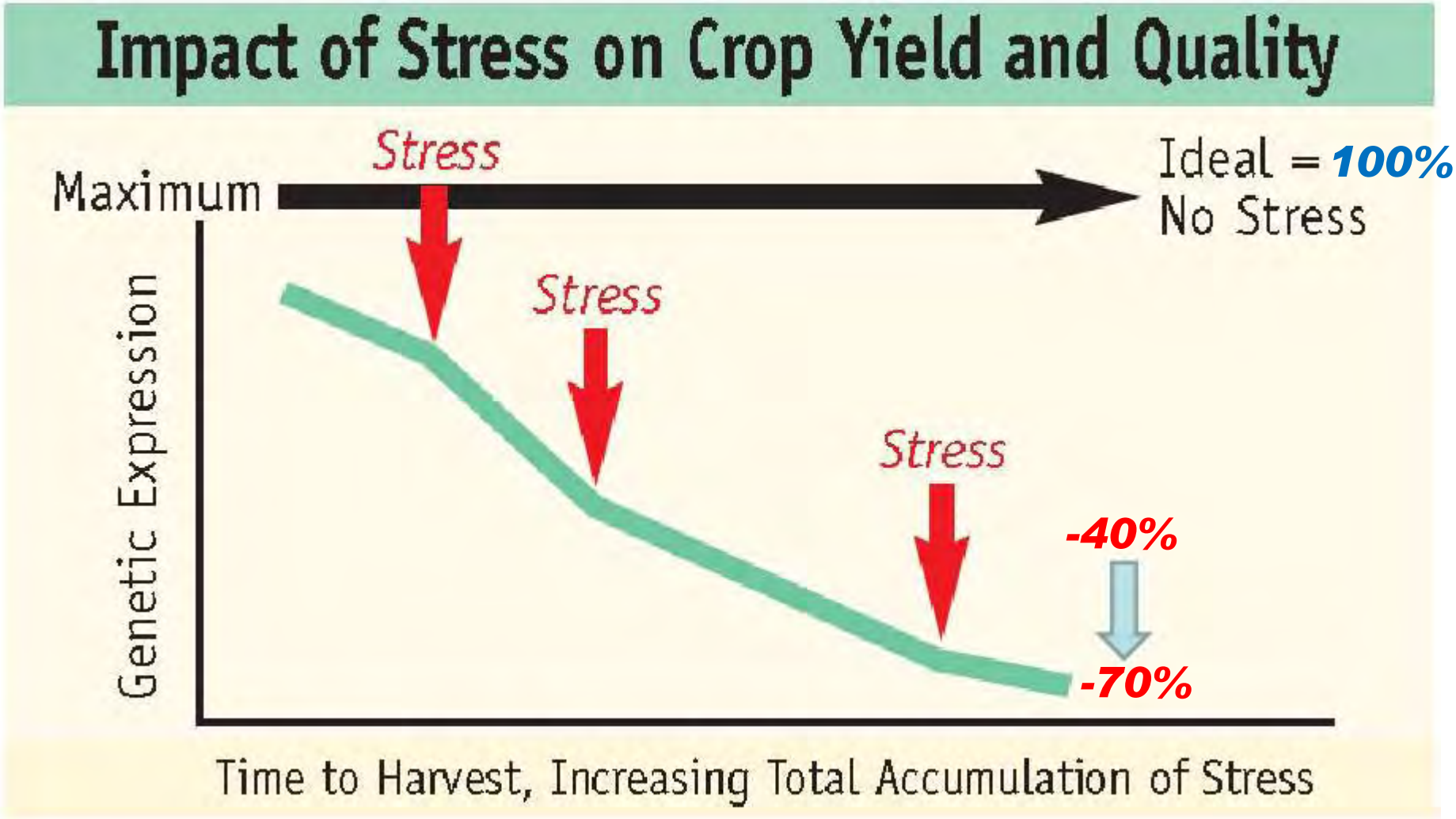
Low Level



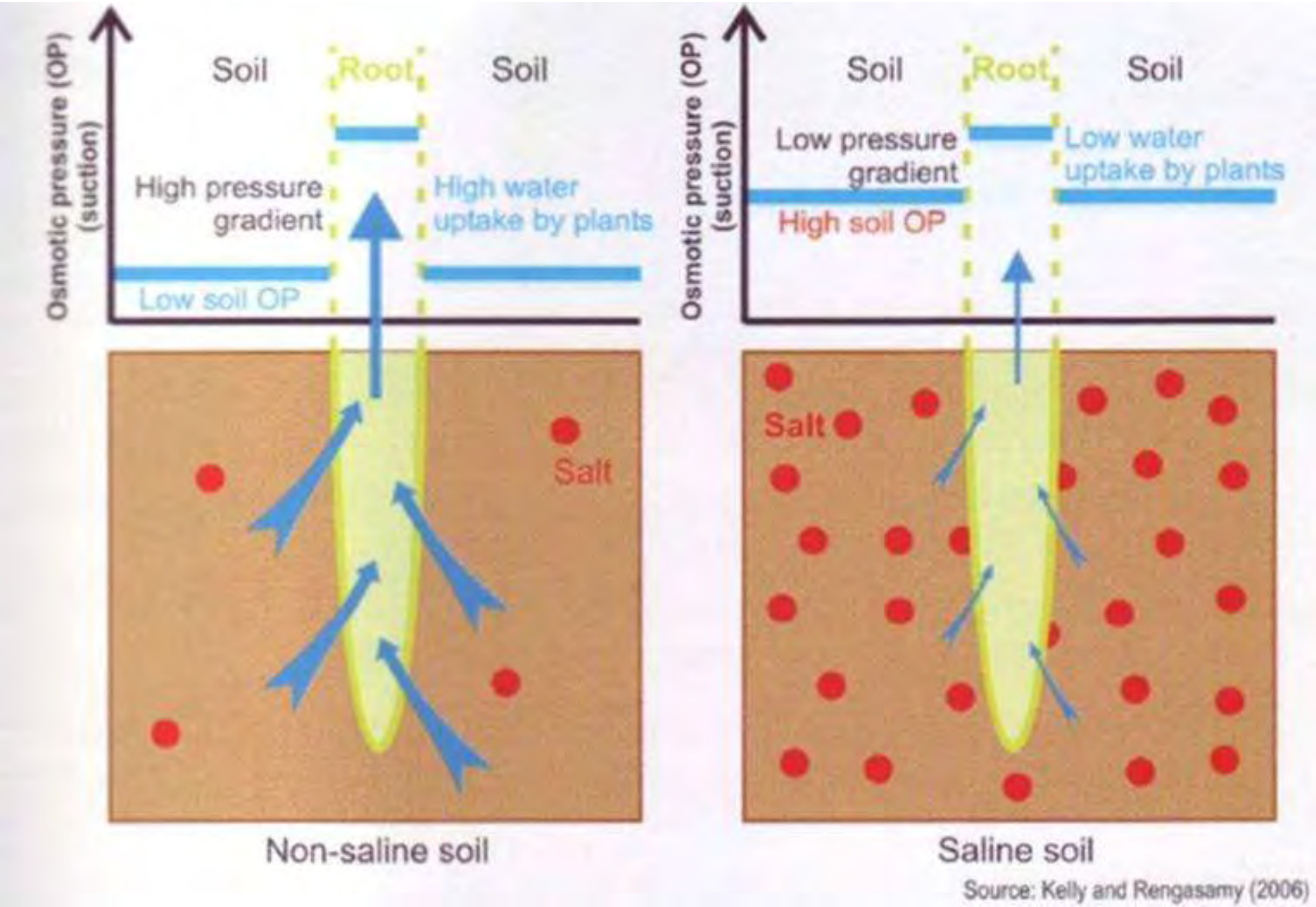
Deficiencies

Temperature | Humidity | Luminosity | Plagues | Nitrogen | Nutritional

STRESSES
Reduces Maximum Production Potential

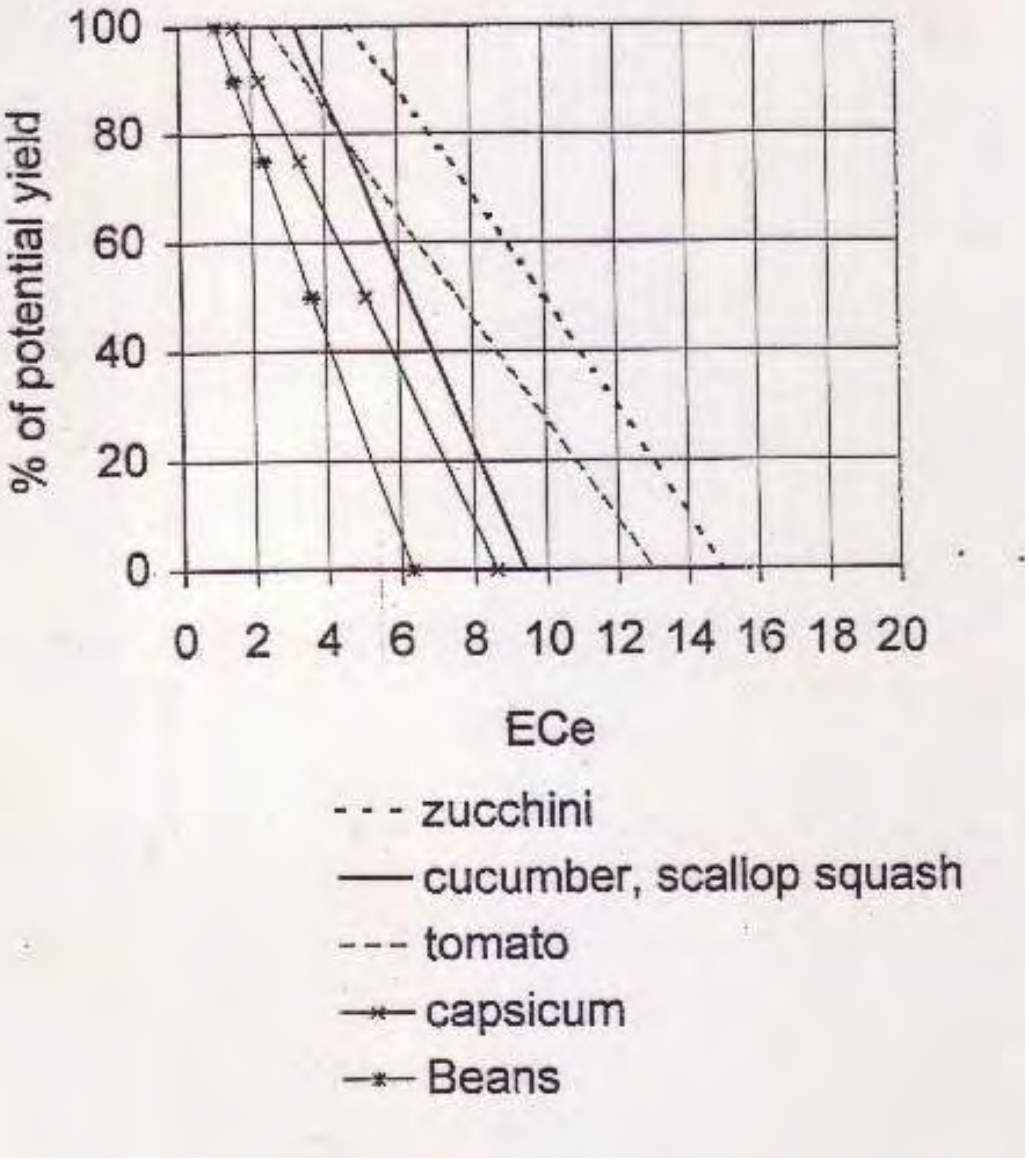


Effects of high Salinity on Root Uptake of soil water



Source: Kelly and Rengasamy (2006)

Yield vs soil salinity



Nutrition

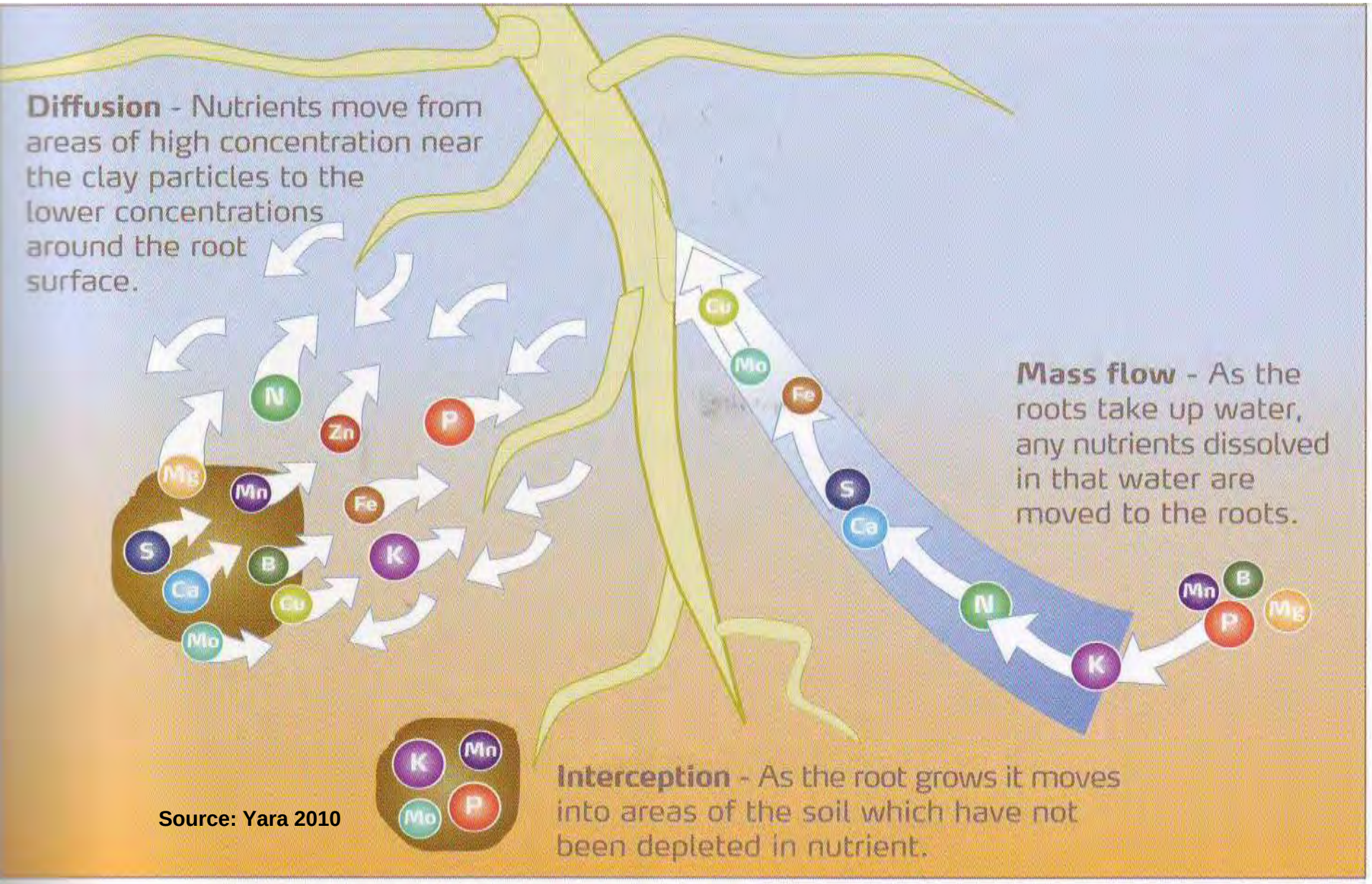
Cation Exchange Capacity

- Capacity of the soil to hold cations (trace elements and other cations – with a +ve charge)

- eg Calcium, potassium, magnesium, sodium

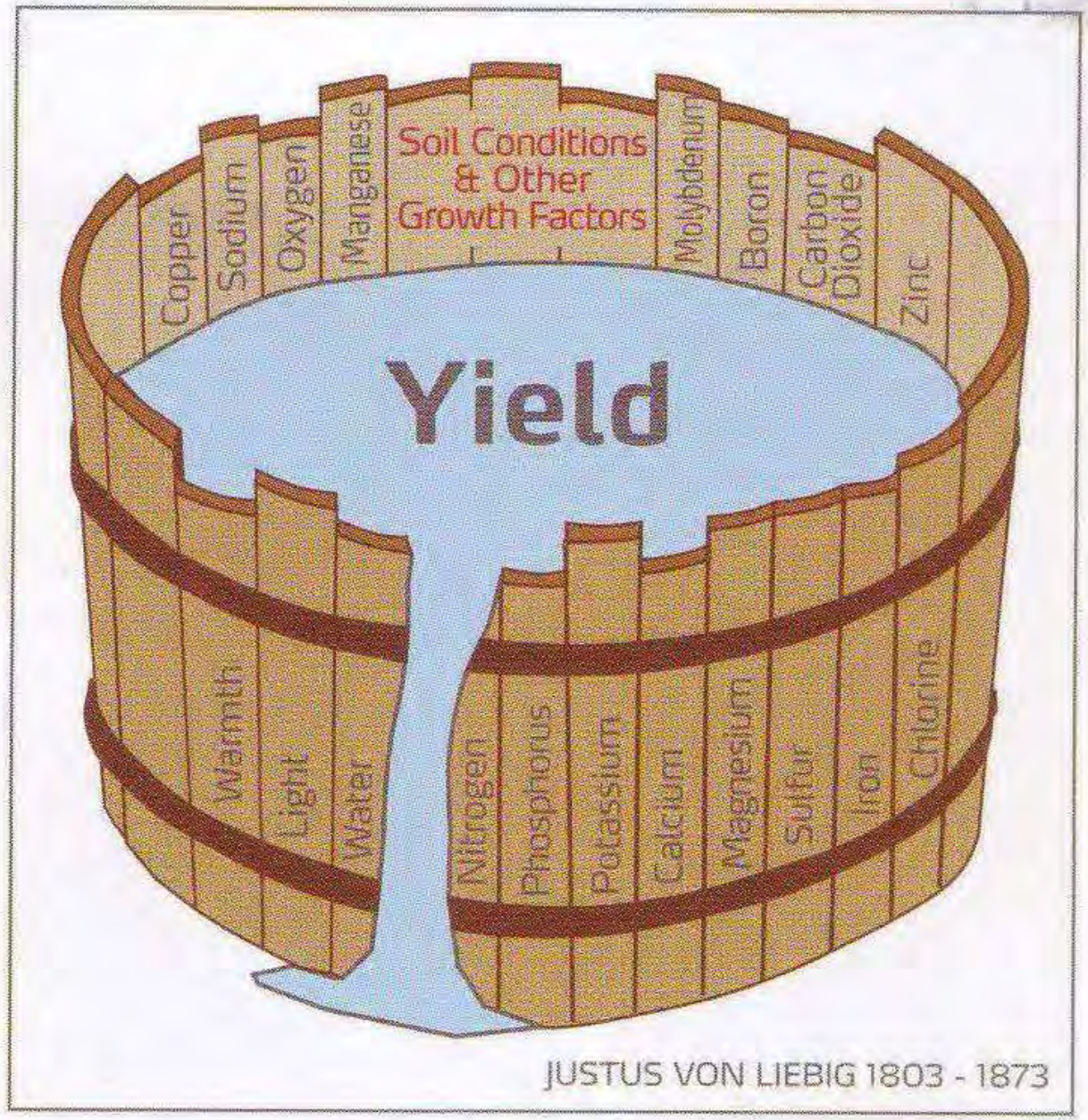
- CEC is the key to the soils nutrient holding (and releasing) ability

3 Means of Nutrient Uptake



Source: Yara 2010

A Deficiency of any Single Nutrient is Enough to Limit Yield



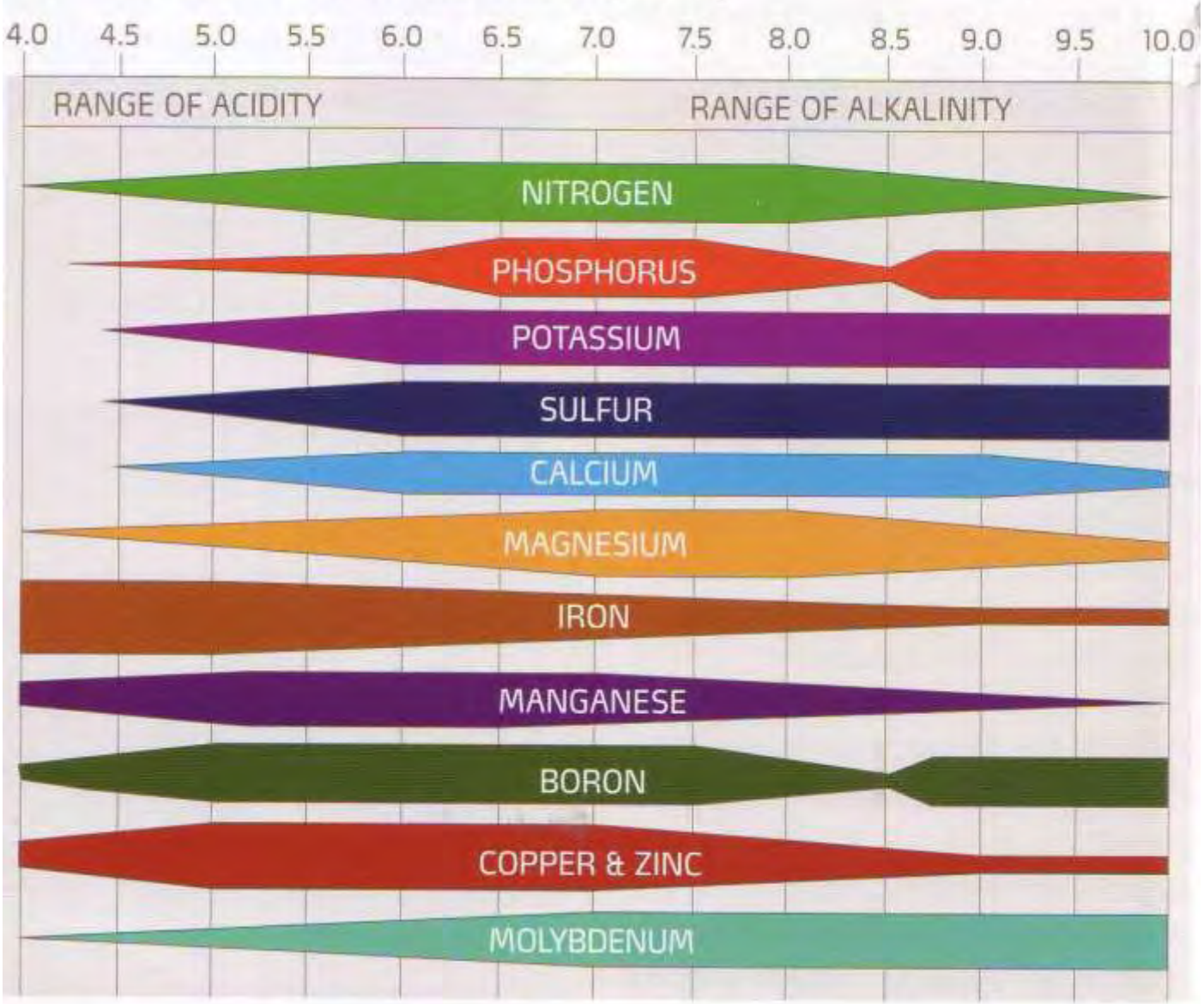
Source: Yara 2010

Soil pH

- Measure of the acidity or alkalinity of the soil from 0 to 14, where 0 is max. acidity, 7 is neutral and 14 is max. alkalinity

- pH is a logarithmic scale where each step is a 10X multiple of the one before – ie pH 8 is 10X more alkaline than 7 and 4 is 10X more acidic than 5

Influence of soil pH on Nutrient availability



The role of Key Nutrients
In plant nutirtion

Role of Nitrogen (N)

Important for:

- Crop Quality
- Increasing the size of produce
- Building plant protein
- Lifting total soluble solids (TSS)
- Plays a key role in sugar content
- N balance is important for timely maturation

Nitrogen
Excess

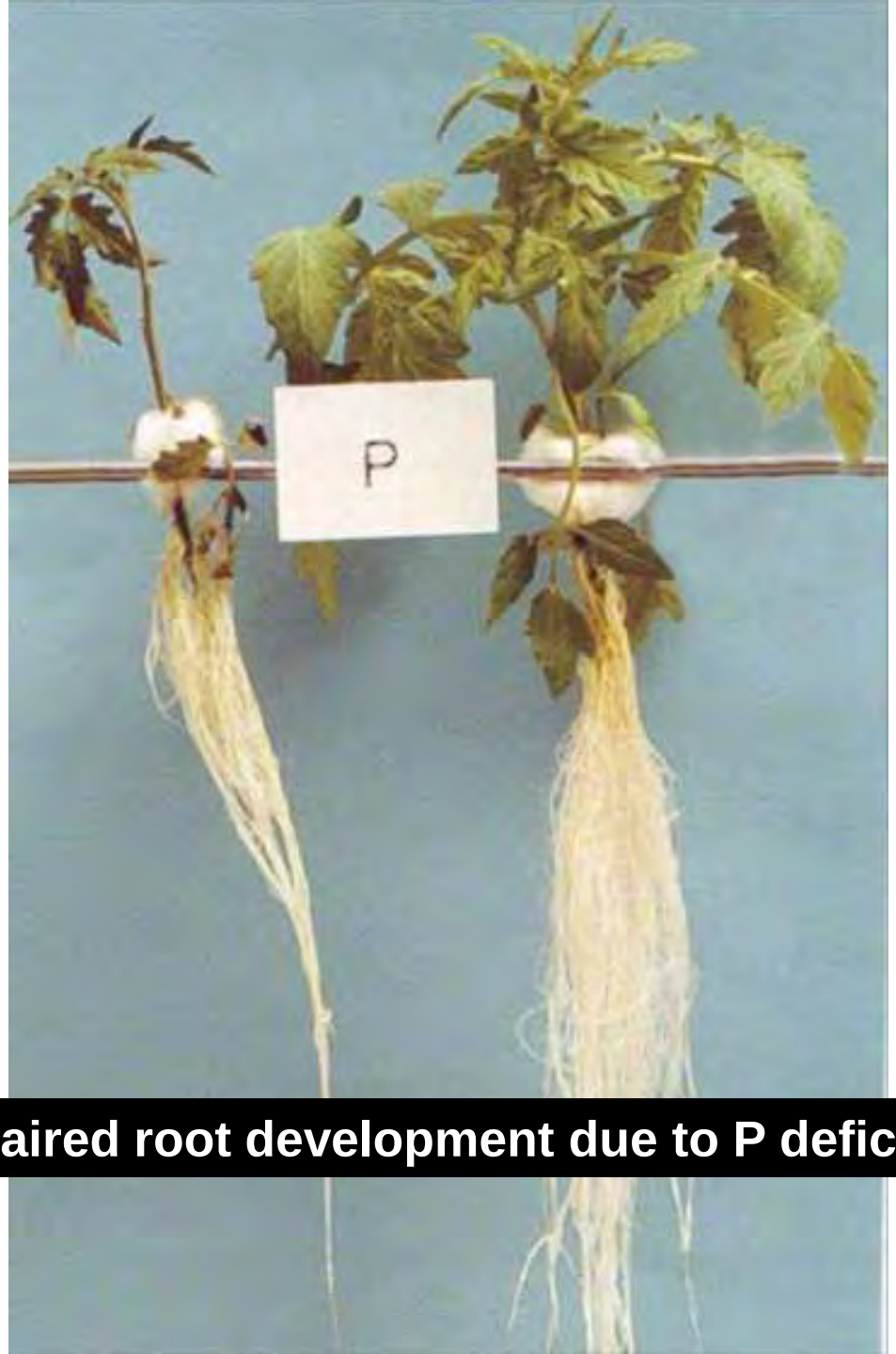
- Poor Crop Quality
- Softer fruit and vegetables (Ca imbalance)
- Smaller fruit (K imbalance)
- Hollow fruit
- Poor shelf life
- Delay in maturity and colour development
- Susceptible to disease
- Inhibit potassium and copper uptake

Excess Nitrogen - Soft Fruit

Role of Phosphorus (P)

Important for:

- Reduction of seedling transplant shock
- Root development
- Good uptake of other nutrients
- More continuous fruit production
- Reduction in root disease



Impaired root development due to P deficiency

Source: Yara 2010

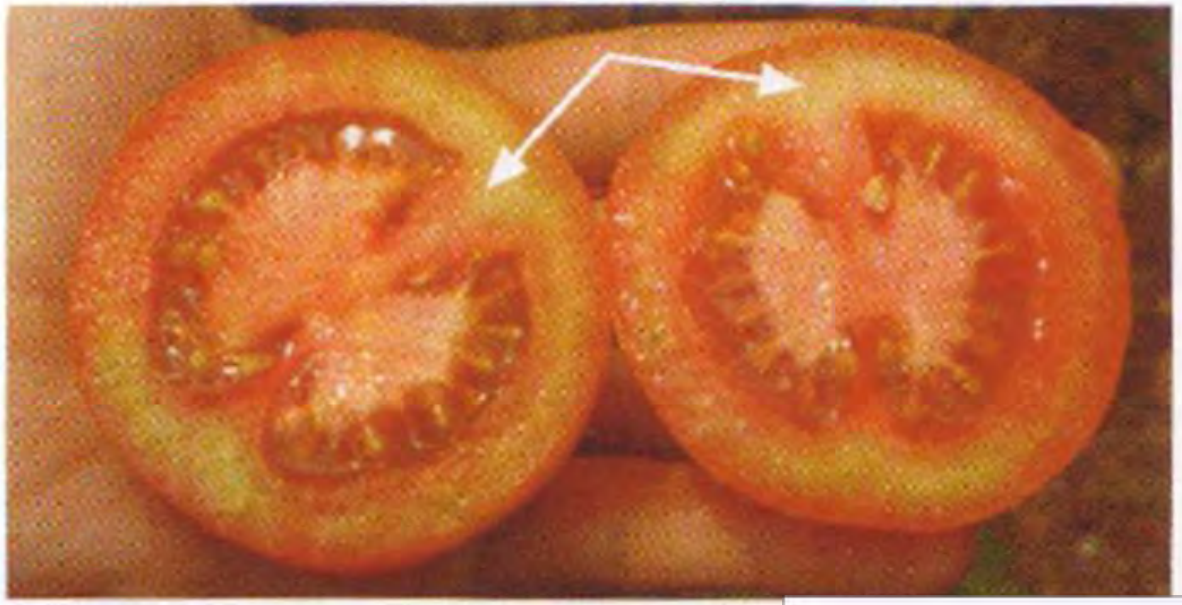
Phosphorus
Excess

- Reduced uptake of Iron
- Reduced uptake of Copper
- Reduced uptake of zinc

Potassium (K)
Role

Important for:

- Regulating water balance and water loss eg wilting
- Production and transport of sugars
- Synthesis of protein
- Increasing the thickness of the outer cell walls
- Improving frost and drought tolerance
- Fruit quality TSS and sugars
- Firmer fruit and shelf life



Internal White Tissue

Potassium deficiency causes Blotchy Ripening
Photo courtesy: Applied Plant Research, Naaldwijk (NL)

Source: Yara 2010

Potassium

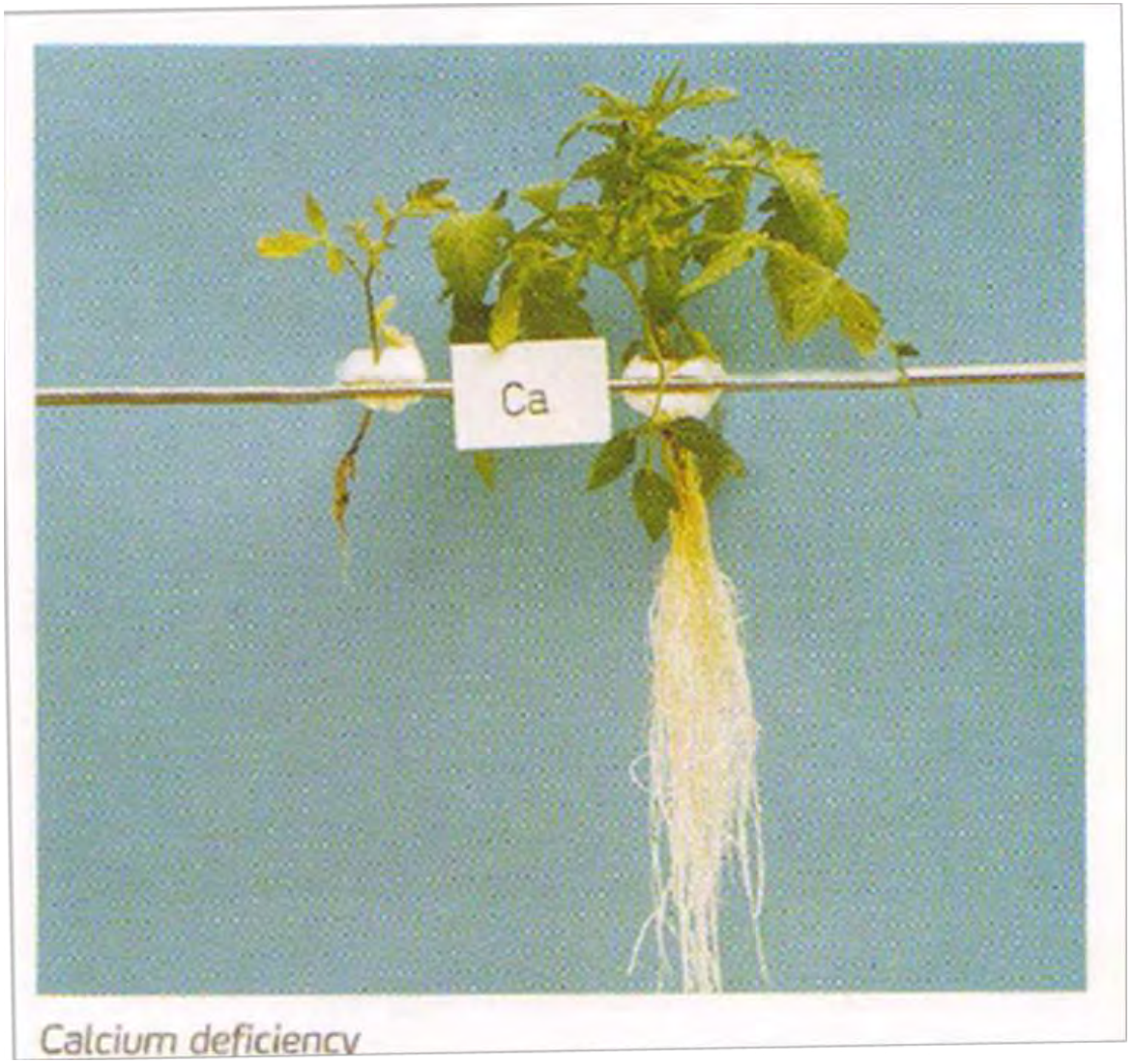
Excess

- Reduces available calcium
- Reduces available magnesium

Role of Calcium (Ca)

Important for

- Growing points, roots and tip development
- Cell wall strength
- Fruit retention on the plant
- Shelf life
- Reducing wilting and loss of water
- Reducing blossom end rot



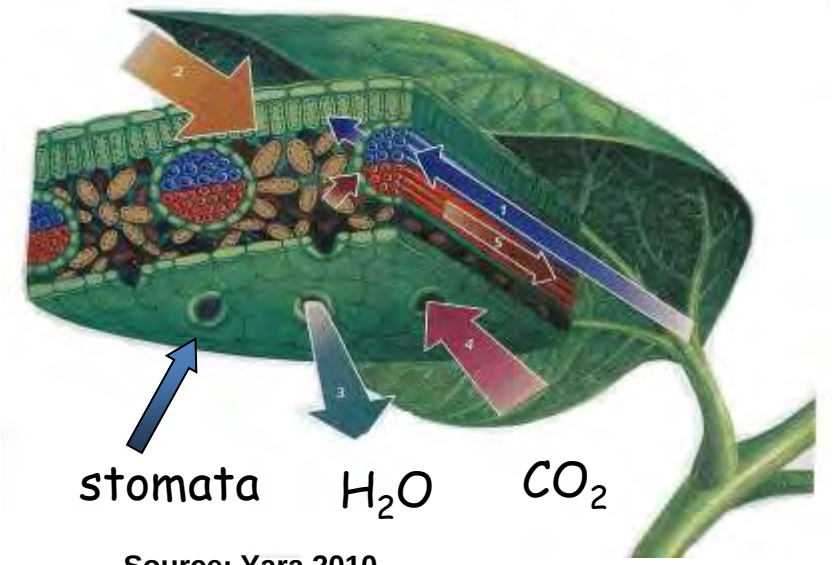
Calcium deficiency

Source: Yara 2010

Blossom end rot – combination of calcium deficiency and plant stress in hot weather

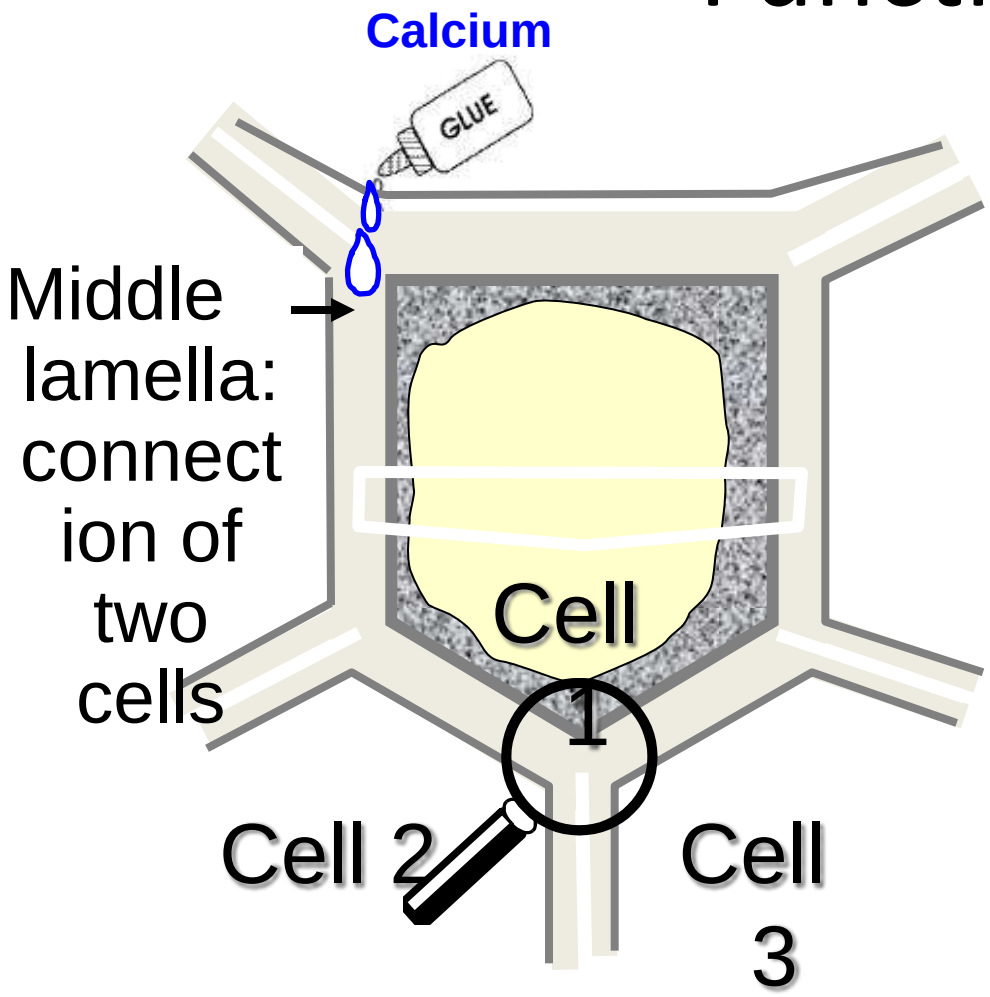
Ca is needed to overcome stress

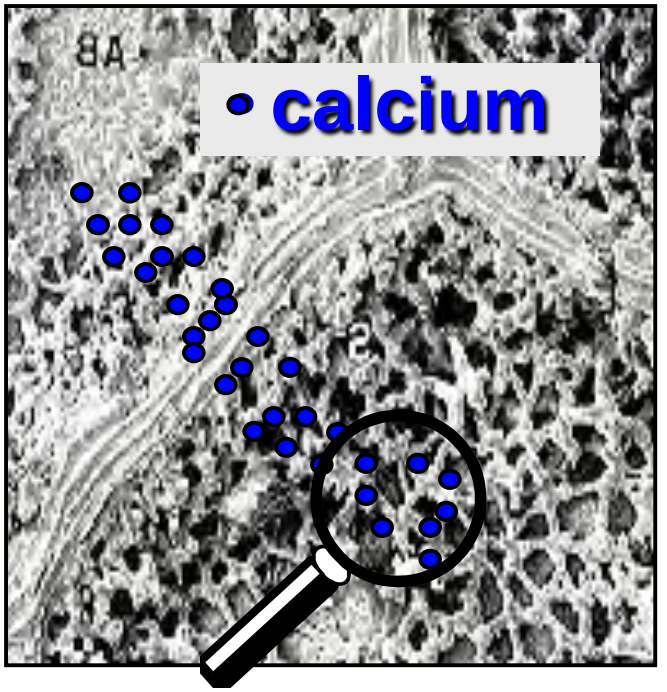
- Involved in stress signaling and osmoregulation (water escaping from leaves through leaf pores)
- Plants require more calcium under stress conditions



Source: Yara 2010

Calcium acts as a glue. Structural Function





Source: Yara 2010

Calcium
Excess

- Inhibit uptake of potassium
- Inhibit uptake of magnesium
- Reduce fruit shelf life
- Boron improve uptake and mobility

Role of Magnesium (Mg)

Important for:

- Chlorophyll production
- Maintaining active photosynthesis
- Sugar content
- Protein content
- Flavour

Magnesium
Excess

- Inhibit uptake of potassium
- Inhibit uptake of calcium
- Reduce fruit shelf life

Role of Zinc (Zn)

Important for:

- Helping carbohydrate production
- Protein production – nitrogen use
- Auxin production - regulates growth
- Affects flower pollination and yield
- Improves plants resistance to root diseases
- Excess P can reduce uptake
- Excess Cu can reduce uptake

Role of Manganese (Mn)

- Chlorophyll synethesis
- Photosynthesis
- N utilisation – protein production
- Vitamin C – Fruit
- High pH soils – low levels found in plants

Role of Boron (B)

Important for:

- Plant hormones eg Auxins
- Movement of plant sugars
- Strength of plant cell walls
- Pollen viability
- Flower and fruit development
- Critical for the uptake of calcium
- Helping with Ca movement through the plant

Role of Copper (Cu)

Important for:

- Flavour
- Sugar content
- Water use efficiency
- Pollen formation, viability and fertilisation – fruit set
- Strength of cell walls
- Colour of fruit or vegetable

Copper
Excess

- Inhibit zinc uptake
- High nitrogen – higher levels of copper

Role of Iron (Fe)

Important for

- Chlorophyll formation (green leaves)
- Photosynethsis and respiration
- Key role in growth and yield
- K, Ca, Mg, Mn, Zn and copper compete with Fe

Role of Molybdenum (Mo)

Important for:

- Needed by plants to utilise nitrogen – the higher the nitrogen the greater the need for Mo
- Pollen formation
- High soil P will limit uptake of Mo
- High soil Sulphates (S) will limit uptake of Mo

Benefits of building calcium levels

- Builds stronger cell walls (combine with boron nutrition)
- Enhances root growth
- Correlation with less disease
- Reduces sodium levels inside the plant

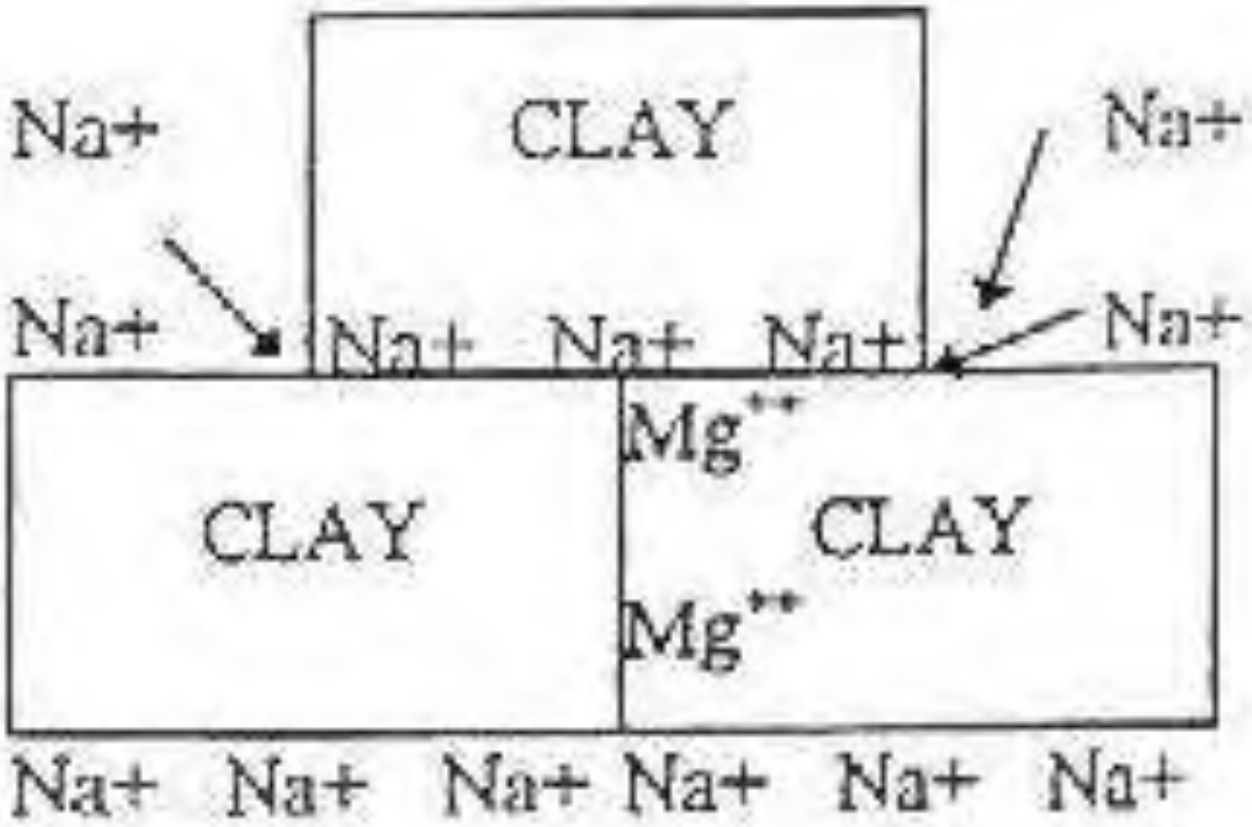
Remember that calcium follows the plant transpiration path (usually to the leaves) and that foliar application is needed for optimal fruit quality

Role of Calcium in

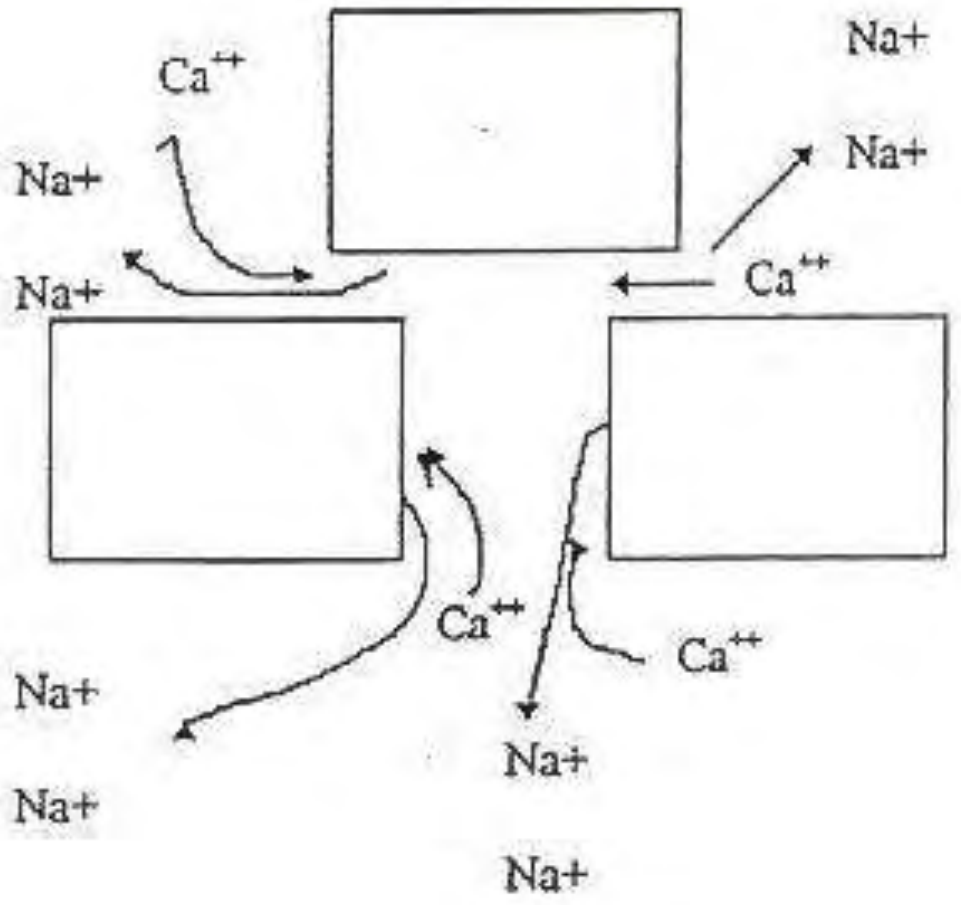
Sodium Management

(salinity and sodicity issues)

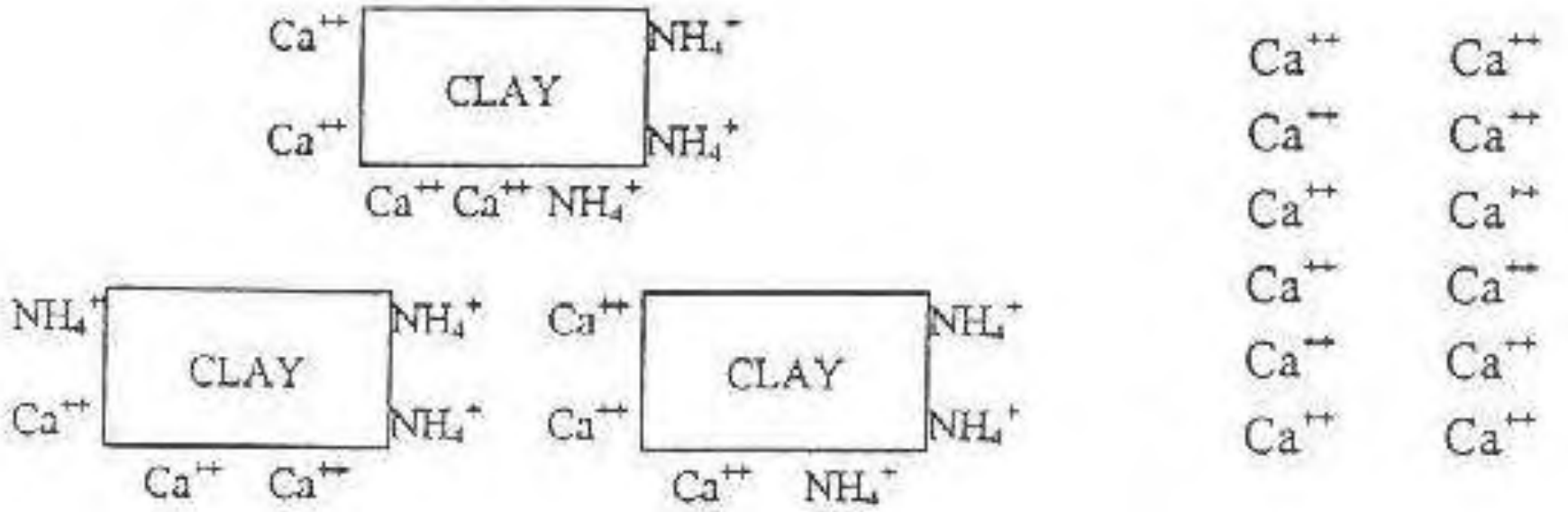
Sodium in the soil water solution dominating the clay particle



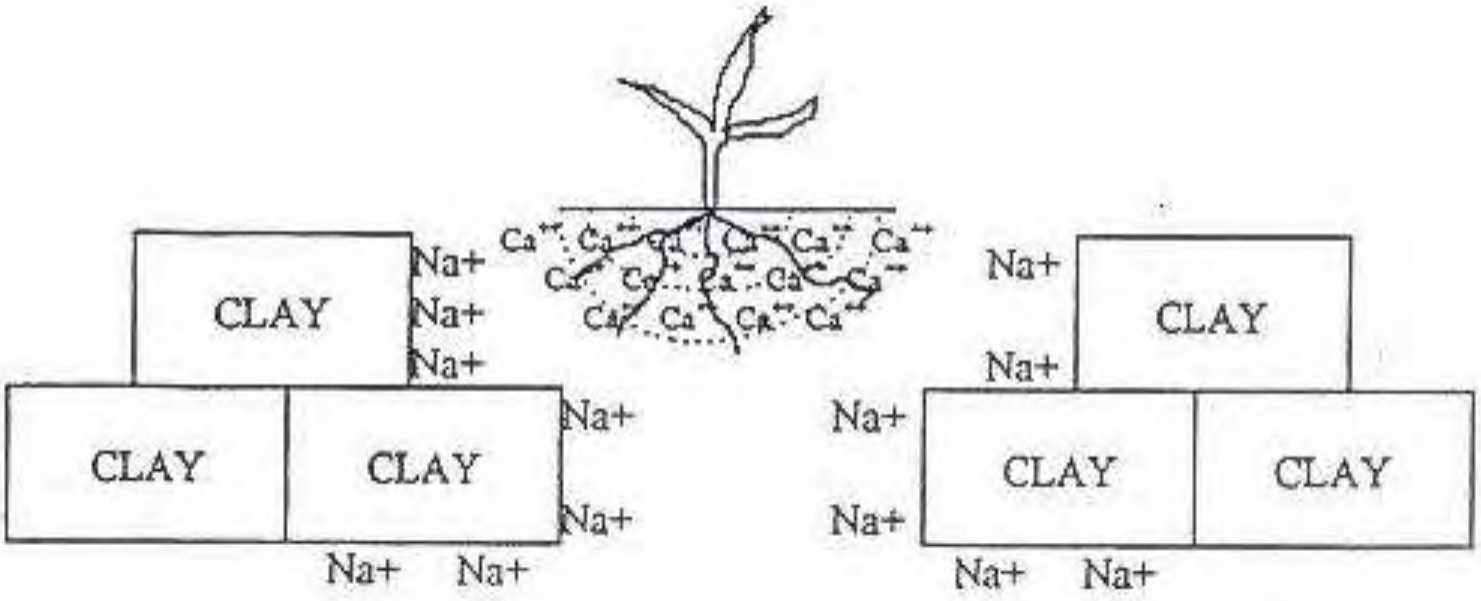
Calcium moving in and sodium moving out



If there is enough soluble calcium – it will beat the sodium to the sites



If sodium is persistent in the soil or water – keep the calcium levels high in the root zone alone



SALT INDEX

Calcium Nitrate	**52.4**
Calcium Chloride	**58.4**
Potassium Thiosulfate	**64.0**
Potassium Nitrate	**73.6**
Ammonium Thiosulfate	**84.4**
Urea-ammonium Nitrate Solution	**95.0**
Ammonium Nitrate	**104.7**

Summary

- Need to know in your soil do you have a salinity or sodicity problem or both.
- Monitor leaf test for high sodium levels
- Effective leaching of sodium can occur during winter rainfall and early season irrigation.
- Soil amendments need to be used if sodium is to be unlocked and leached.

Summary

- Type of amendments will be determined by the ability to leach through irrigation or just rainfall
- Type of amendments will be influenced by the need for calcium
- Aim to manage salinity and sodicity around the effective root zone.