(4) Nutrient uptake : soil & root interactions

Steven Falivene (NSW Department of Primary Industries)

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Soil uptake factors

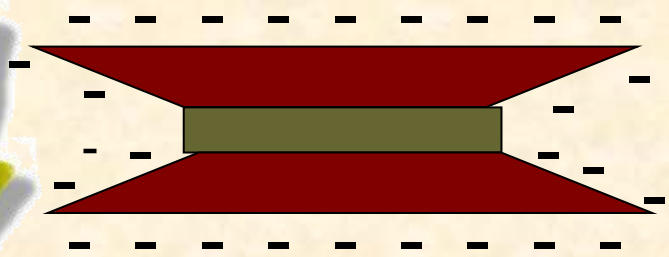
NSW DEPARTMENT OF
PRIMARY INDUSTRIES

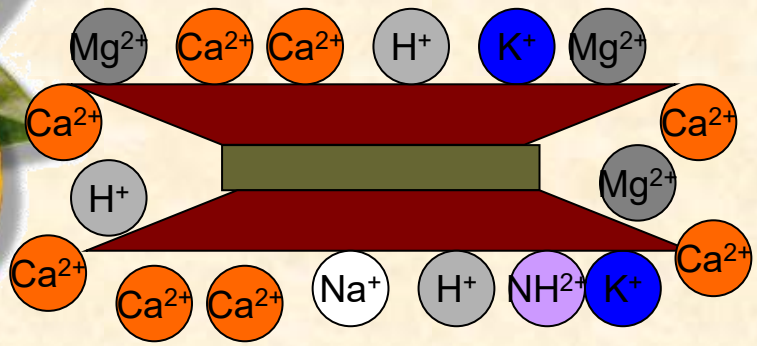
Nutrient soil uptake & antagonism

- Only a brief overview of some aspects of soil uptake
- Main discussion on soil science issues in soil seminar

+ charged nutrients

Negative charged clay (-)





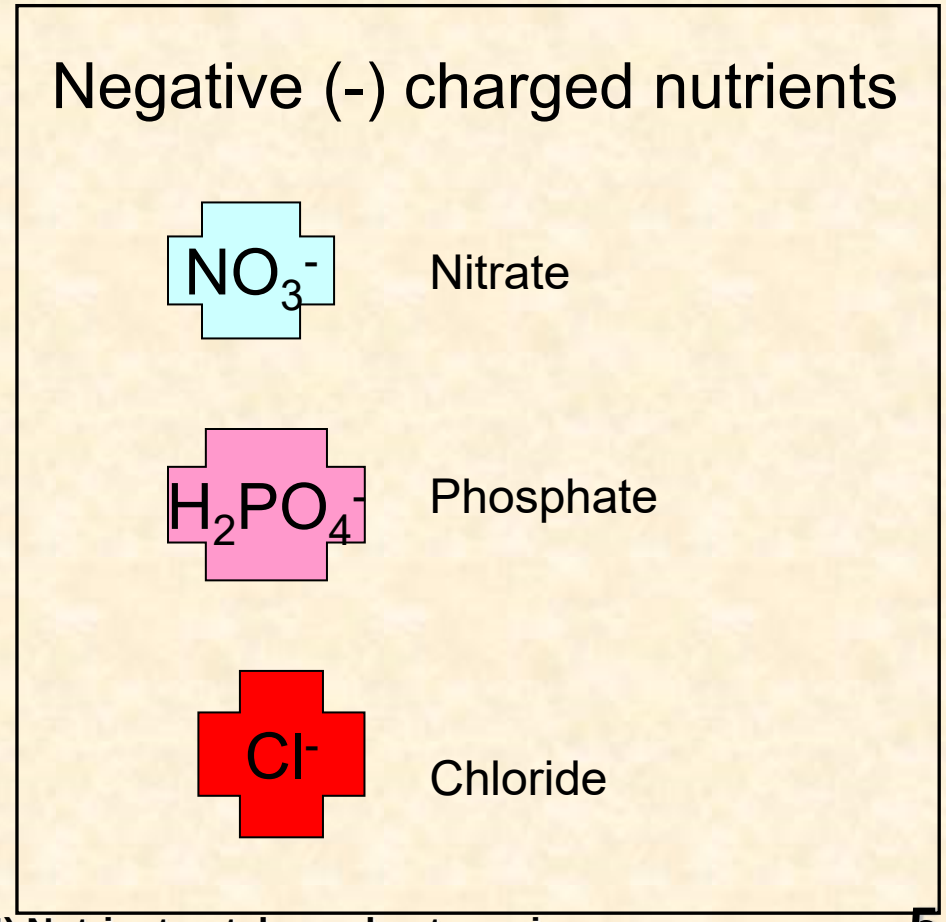
Positive (+) charged nutrients

- Ca^{2+} Calcium
- Mg^{2+} Magnesium
- K^{+} Potassium
- NH_4^{+} Ammonium
- H^{+} Hydrogen
- Na^{+} Sodium

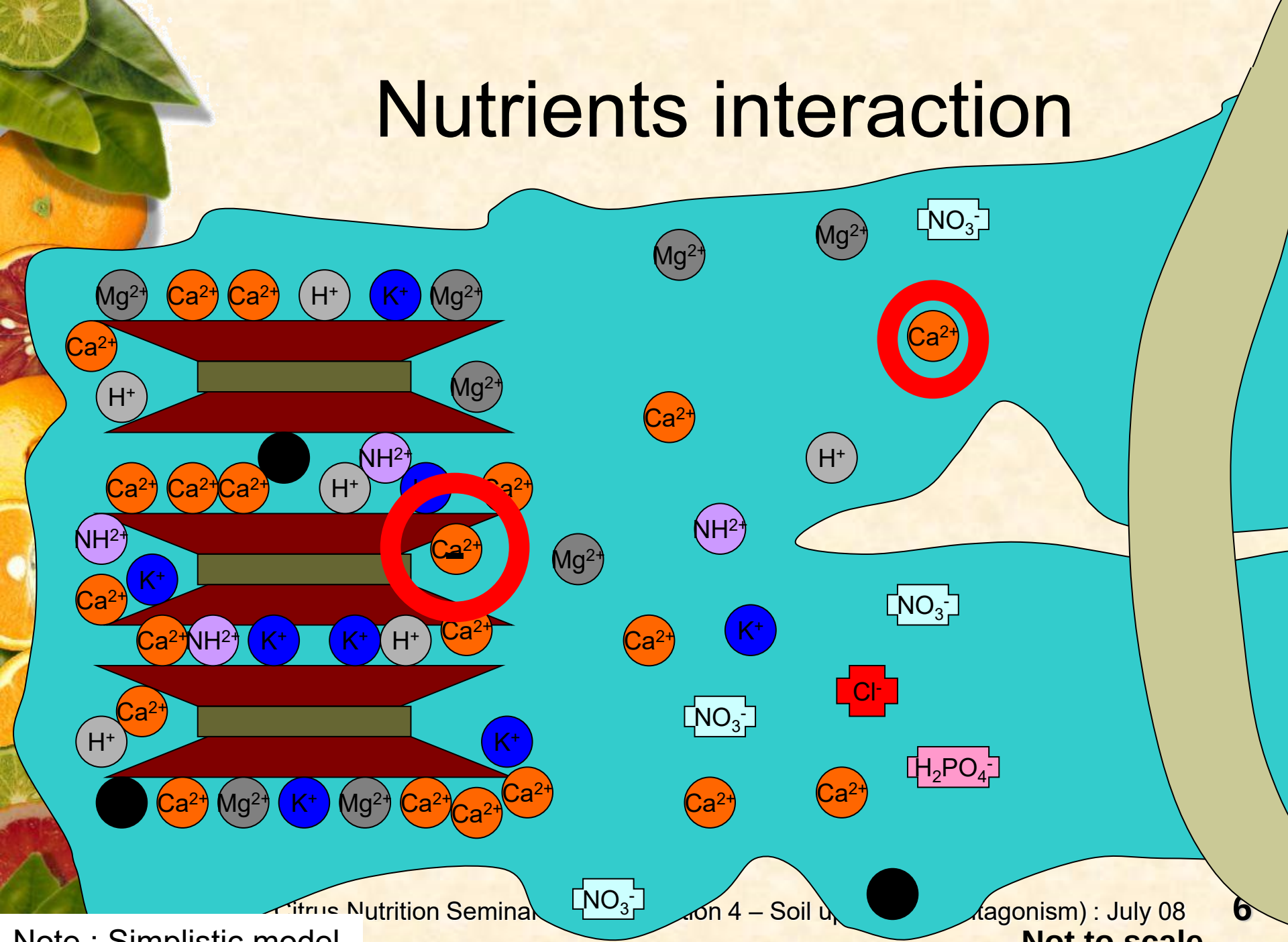
Note : Organic matter also can hold + charged nutrients

- Charged Nutrients

- Mostly do not stick on clay, free moving in solution
  - A minor amount stick on clays/OM.
  - Leachable, excepts phosphate)



Nutrients interaction



Note : Simplistic model

Not to scale

Nutrient Uptake

Negative (Anion)		Positive (Cation)	
Cl^-	Chloride	K^+	Potassium
NO_3^-	Nitrate	Na^+	Sodium
HPO_4^{-2}	Phosphate	NH_4^+	Ammonium
SO_4^{-2}	Sulphate	Ca^{+2}	Calcium
MoO_4^{-2}	Molybdenum	Zn^{+2}	Zinc
BO_3^{-2}	Boron	Mn^{+2}	Manganese
		Mg^{+2}	Magnesium
		Cu^{+2}	Copper

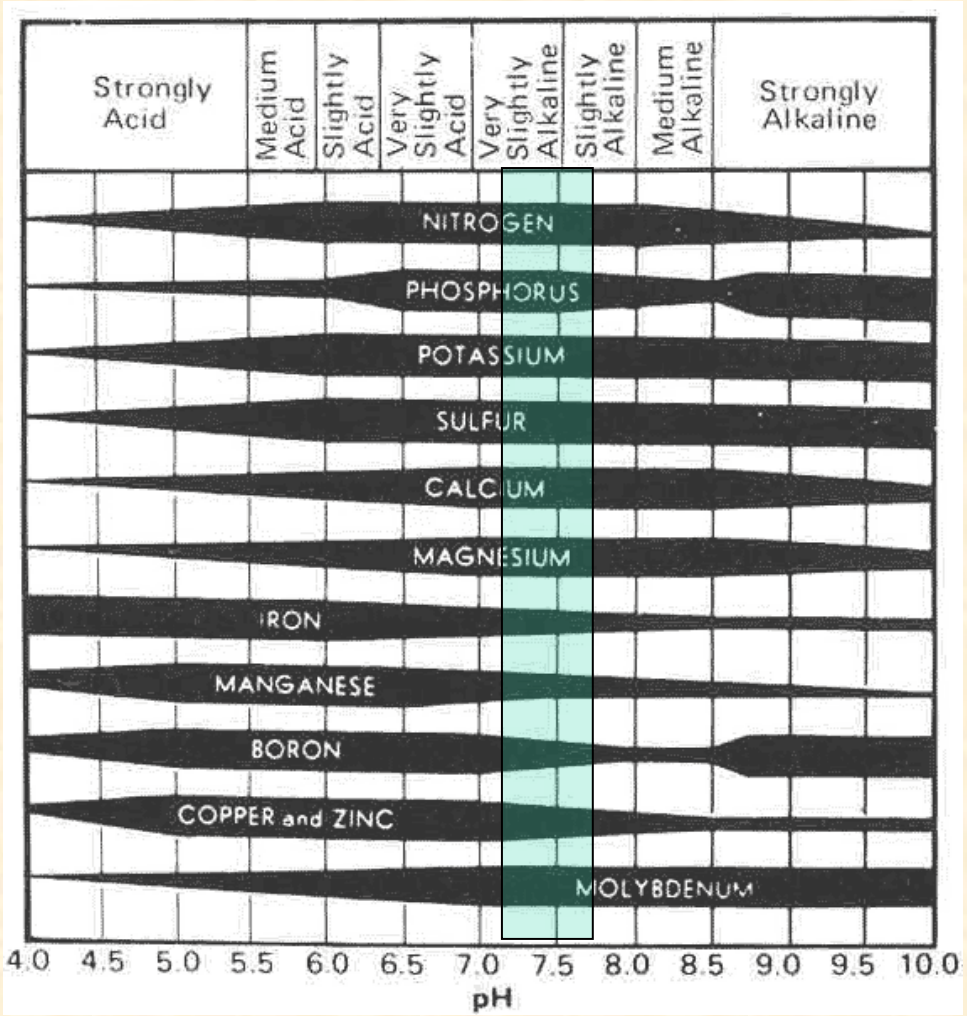
Nutrient Uptake

- Competition can occur between nutrients for uptake and this can contribute to nutrient antagonism
  - Calcium and magnesium are both positively charged ions. As you increase the level of one it will reduce the effective uptake of another.

Nutrient Uptake

- Calcium is a special nutrient that is absorbed better by young growing root tips
  - Encouraging good root growth may assist in calcium uptake during cell division
    - Phosphorus
    - Vegetative pruning

Nutrient Uptake & Soil pH



Nutrient Antagonism

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Nutrient Antagonism

- The examples provided are only to give an indication of the possible degree and severity of possible antagonistic nutrient effects
  - The extent of the antagonism may differ in your circumstances
  - Most nutrient antagonisms occur when high fertiliser rates are applied
- Some nutrient antagonisms in leaf levels can be caused by extra growth that dilutes other nutrients !
  - Observe leaf flush when interpreting

Nutrient Antagonism

- Nitrogen application
  - Phosphorus :
    - High levels of N can suppress leaf P levels
    - Sometime responses in leaf P level are more associated with changing N levels than P fertiliser application
    - Often very difficult to have both P & N in excessive levels

(Smith, 1966)

Nutrient Antagonism

- Nitrogen application effect on:
  - Potassium :
    - High levels of N can have a slight/moderate suppress of leaf K levels
    - Ammonium competes directly with K (Dass et.al. 1997)
  - Boron
    - High levels of N can help to suppress soil B toxicity effects

Nutrient Antagonism

- Nitrogen application effect on
  - Magnesium : (Smith, 1966)
    - These elements are synergistic (i.e. high N will help to increase Mg
    - The effect is more pronounced on acidifying fertilisers (i.e. urea, ammonium sulphate)
    - The effect can be cancelled in high K situations
  - Salinity
    - Higher nitrate (-) can be used as a strategy to reduce Cl (-) levels (Suspect partly why high N rates in Israel & Spain)

Nutrient Antagonism

- Phosphorus application effect on
  - Nitrogen : decreased N leaf levels (Embleton T.W etal, 1952)
  - Calcium : increased Ca leaf levels (Embleton T.W etal, 1952)
  - Zinc : decrease Zn levels (Chapman, 1968)
  - Iron : decrease Fe levels (Zegri, 2003)

Nutrient Antagonism

- Potassium application effect on:
  - Magnesium
    - Strong reduction effect (Wier, 1969)
  - Calcium
    - Moderate reduction effect (Wier, 1969)
  - Nitrogen
    - Significant reduction effect (Wier, 1969)
  - Zinc
    - Moderate reduction effect (Dass etal, 1997)

Nutrient Antagonism

- Calcium application effect on:
  - Nitrogen :
    - Acidic soil not strong affect on leaf N (Smith, 1966)
    - However alkaline soil high Ca can significantly reduce leaf N (Smith, 1966)

Nutrient Antagonism

- Calcium application effect on:
  - Sodium/Salinity
    - Significant effects on reducing sodium uptake in saline conditions, also assisted to increase levels of other nutrients because of reduction of sodium competition (Gobran et.al. 2001)

Nutrient Antagonism

- Sulphate can help to reduce the uptake of chloride
- Zinc application effect on:
  - Synergistic to K (Smith, 1966), however high K suppress Zn (Rodriguez, 2005)

References

- Anderson, T. F.G. Martin. 1969. Effects of soil pH and calcium on the growth and mineral uptake of young citrus trees. Proceedings Florida State horticultural Society 82; 7-12, 1969
- Chapman H. 1968. Mineral Nutrition. Citrus Industry volume 2, Chapter 3
- Embleton T.W, JD Kirkpatrick, ER Parker. 1952. Visible response of phosphorus deficient orange trees to phosphatic fertilisers, and seasonal changes in mineral constituents of leaves. Proceedings American Society for horticultural science, 60, 55-64
- Embleton T.W., CK Labanuskas, WW Jones. 1963. Interrelations of leaf sampling methods and nutritional status of orange trees and their influence on the macro and micro nutrient concentration in orange leaves. Proceedings American Society for horticultural science, V82, 131-141
- Gobran Y.N., LF Guindy, AM Khalil, FG Nakhia. 2001. Response of Balady mandarin trees suffering from salt stress to soil amendments of gypsum and sulfur. Annals of Agric. Sci., Moshtohor, Vol 39(1) 525-544
- Jones WW, TW Embleton, KW Opitz. 1971. Effects of foliar applied Mg on yield, fruit quality and macro nutrients of Washington navel orange. J. Amer. Soc. Hort. Sci. 96(1): 68-69. 1971
- Rodriguez VA, AM Mazza, GC Martinez, AR Ferrero. 2005. Zn and K influence in fruit size of Valencia orange. Rev. Bras. Frutic., Jaboticabal - SP V27 n. 1, p 132-135, Abril
- Smith PF. 1966. Leaf analysis of citrus. Nutrition of fruit crops. Chapter 8, Horticultural Publications. Edited NF Childers, Rutgers, NJ. 1966, p208-228
- Wier CC. 1969. Potassium and magnesium nutrition of citrus trees. Trop. Agric. Trin., Vol 46, No.2 April