Fiera Pordenone
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Fertigation and fertilizers for new growing systems

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Introduction

- Mineral Nutrition without soil
- Managing the Nutrient Solution
- Recipes & Recipes
- What about micronutrients
- Healthy Plants for Healthy People

Mineral nutrition without soil

Soil Solution = Nutrient Solution

Media culture hydroponics	• Limited nutrient buffering capacity
Liquid hydroponics and aeroponics	• No nutrient buffering capacity

Hydroponics

- Perlite
- Rockwool
- Coconut coir
- Peat
- …

Media culture hydroponics

- Nutrient Film Technique
- Deep Flow Technique
- Deep water
- Floating rafts
- …

Solution or Liquid hydroponics

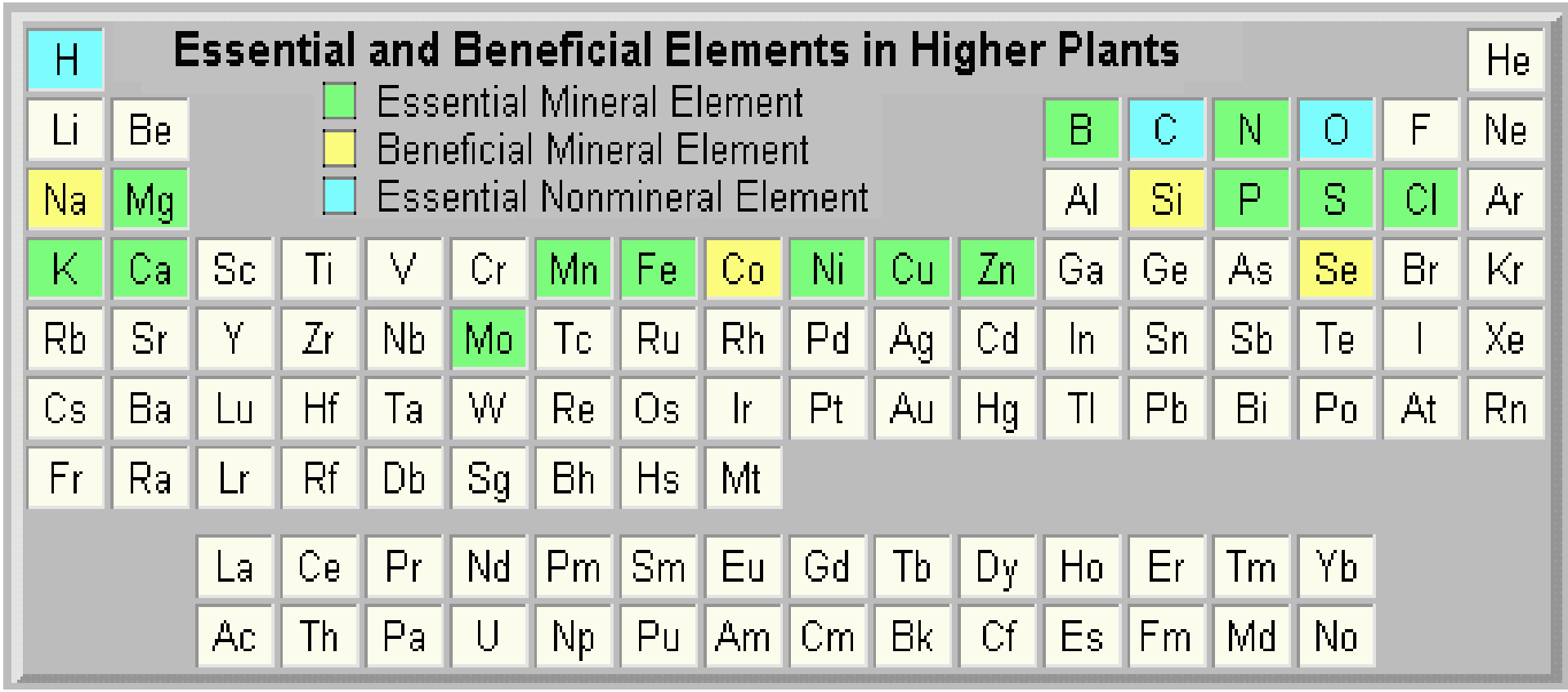
Aeroponics

Roots suspended in air. Depending on the droplet size:

- Root mist technique (RMT)
- Fog feed technique (FFT)

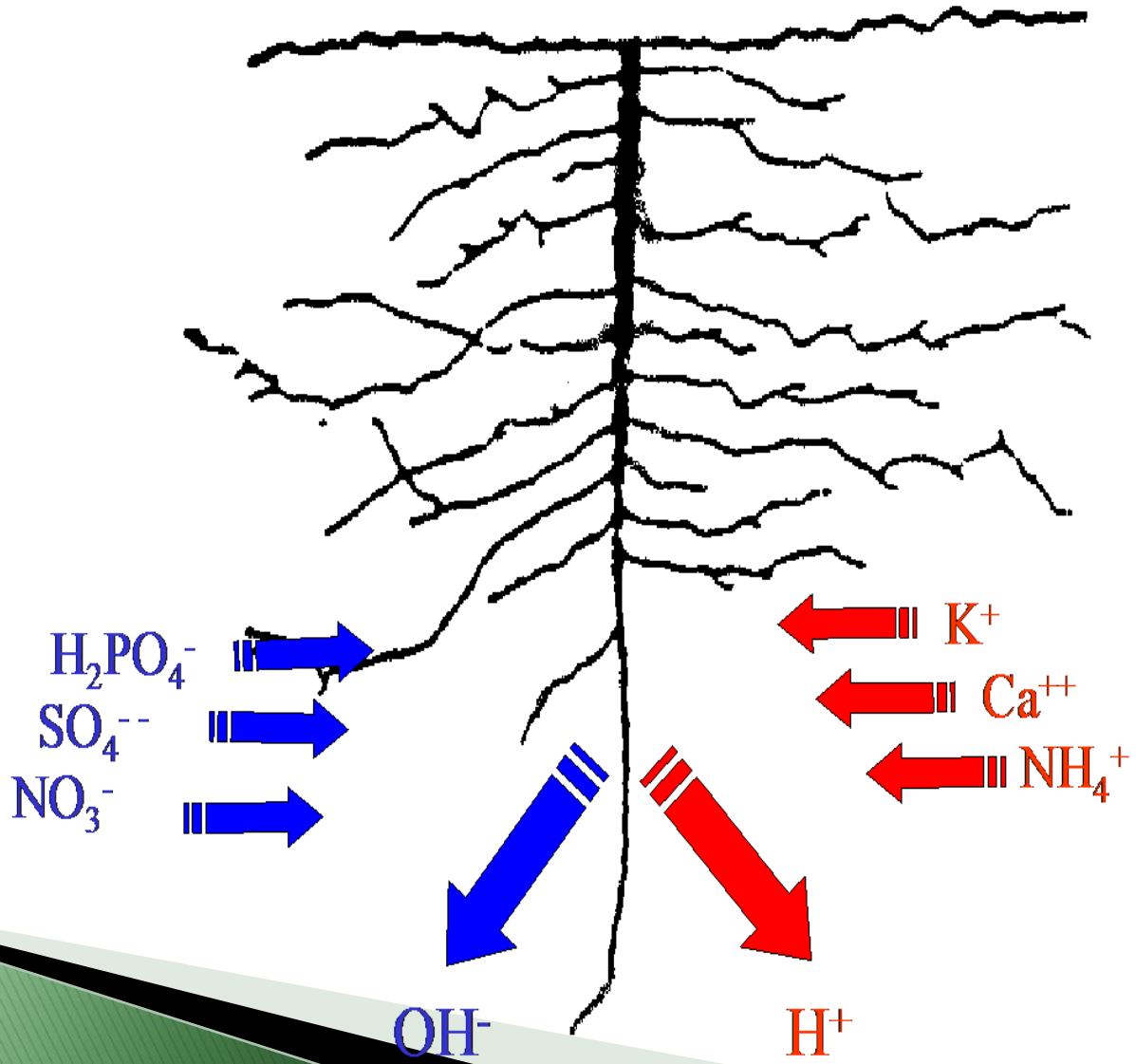
Growing tanks

Recipes & Recipes & Recipes



http://soils.wisc.edu

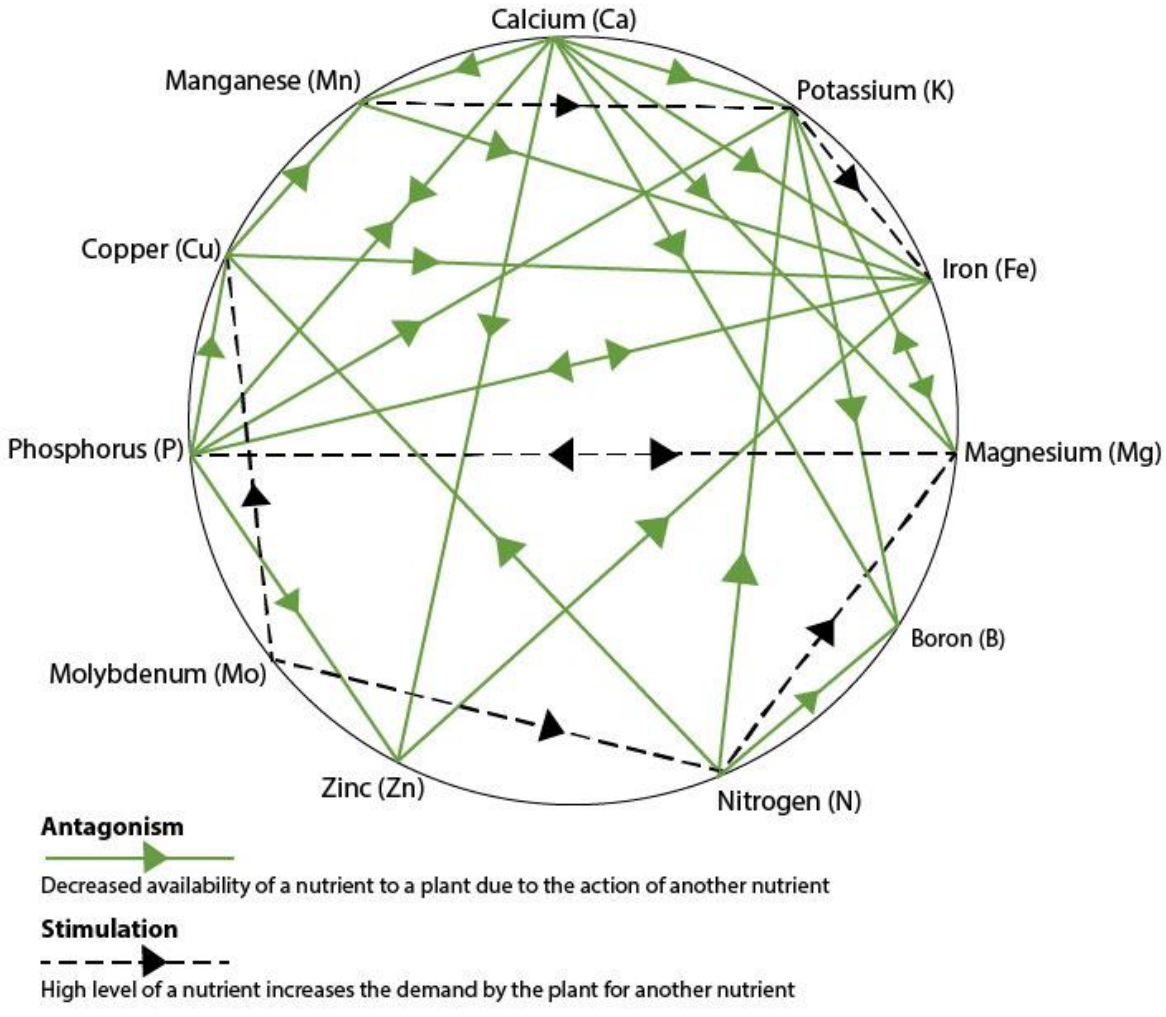
Mineral nutrition



Key factors

Right quantity of nutrients - Right proportion between nutrients

Mulder's Chart



Starting from Quality of source water

- **Alkalinity** water ability to neutralize acid (ppm calcium carbonate $CaCO_3$ equivalents)
- **EC** - Electrical Conductivity (quantity of total dissolved salts)
- **Concentration** of specific elements
  - Essential (Ca, Mg and S)
  - Contaminants (Na and Cl)

System with stock tanks

- A tank B tank + acid
- Single nutrients tanks + acid

Alkalinity can be corrected by acids or by nutrents mix

Separated tanks to avoid precipitation

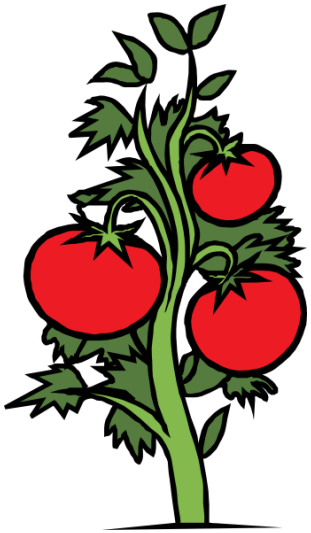
Vegetative crops

- Ratio of nutrients not adjusted while growing
- EC adjusted on basis of the season and the species needs

Table 2. Comparison of the nutrients (in ppm) supplied by the three different recipes for lettuce, herbs and leafy greens.

	Jack's Hydro-FeED (16-4-17)	Jack's Hydroponic (5-12-26) + Calcium nitrate	Modified Sonneveld's solution
Nitrogen (N)	150	150	150
Phosphorus (P)	16	39	31
Potassium (K)	132	162	210
Calcium (Ca)	38	139	90
Magnesium (Mg)	14	47	24
Iron (Fe)	2.1	2.3	1.0
Manganese (Mn)	0.47	0.38	0.25
Zinc (Zn)	0.49	0.11	0.13
Boron (B)	0.21	0.38	0.16
Copper (Cu)	0.131	0.113	0.023
Molydenum (Mo)	0.075	0.075	0.024

- *from Mattson&Peters*



Fruit crops

- Ratio adjusted for shifting between vegetative and reproductive growth

Table 6. Recipe for tomatoes in winter according to crop growth stage (units are ppm).

	Weeks 0-6 Higher N, Ca and Mg for vegetative growth	Weeks 6-12 Lower N, higher K for reproductive growth	Week 12+ Maintain balance of vegetative / reproductive growth
Nitrogen (N)	224	189	189
Phosphorus (P)	47	47	39
Potassium (K)	281	351	341
Calcium (Ca)	212	190	170
Magnesium (Mg)	65	60	48
Iron (Fe)	2.00	2.00	2.00
Manganese (Mn)	0.55	0.55	0.55
Zinc (Zn)	0.33	0.33	0.33
Boron (B)	0.28	0.28	0.28
Copper (Cu)	0.05	0.05	0.05
Molydenum (Mo)	0.05	0.05	0.05

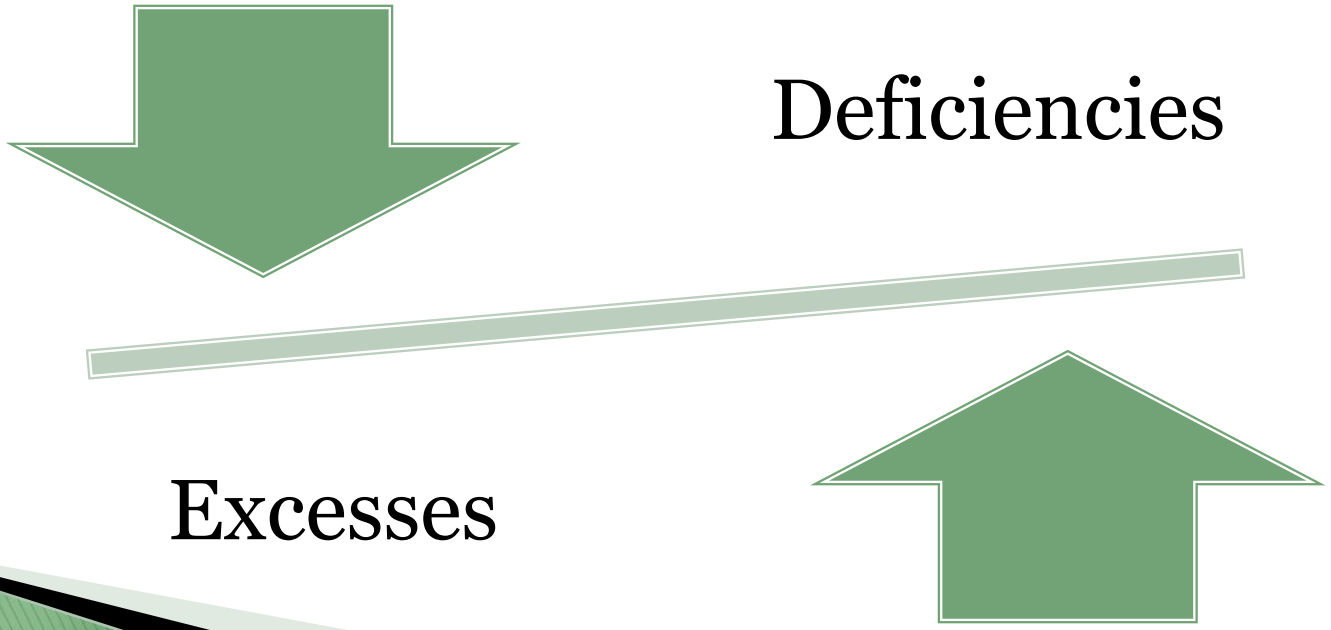
Source: Sunco, Ltd., and University of Arizona, Controlled Environment Agriculture Center, http://tinyurl.com/ljlj785/

Ready commercial fertilizers vs. Single salts

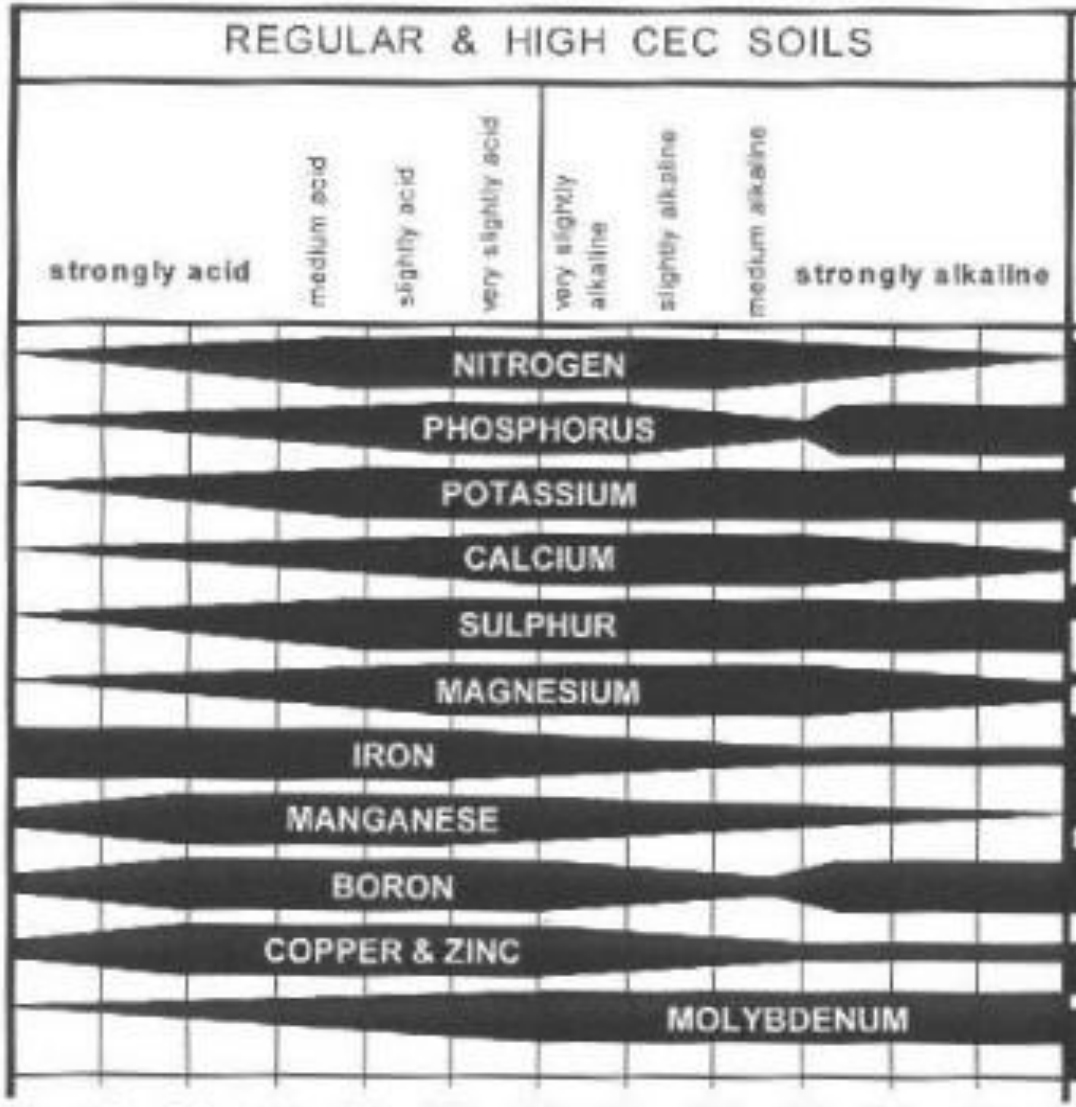
Small surface Home growing	Large surface Commercial growing
Easy to use	Cheaper
Focused on specific target	Fast to change
	Focused on individual target

What about micronutrients

Very low concentration
very profound impact on growth



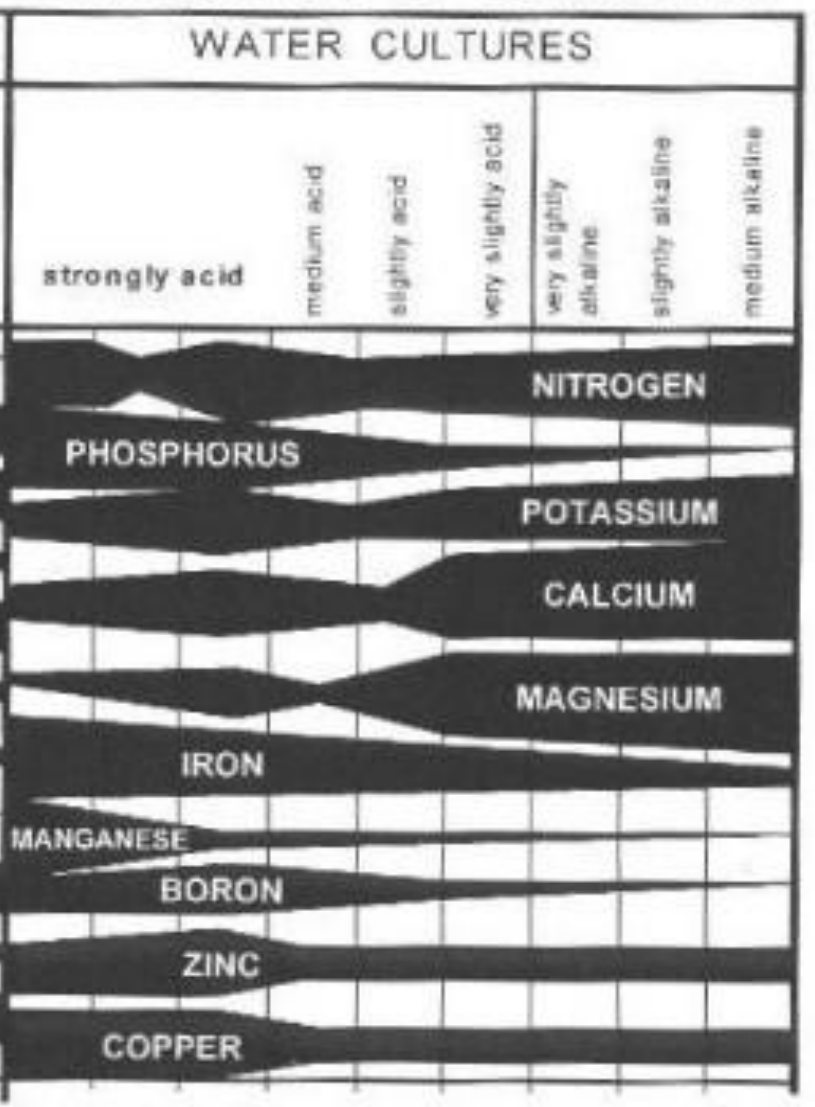
HOW pH AFFECTS PLANT NUTRIENT UPTAKE



pH OF SATURATED SOIL

(pH below 5.5 cuts primary nutrients)

EXPERIMENTAL AVAILABILITY OF NUTRIENTS



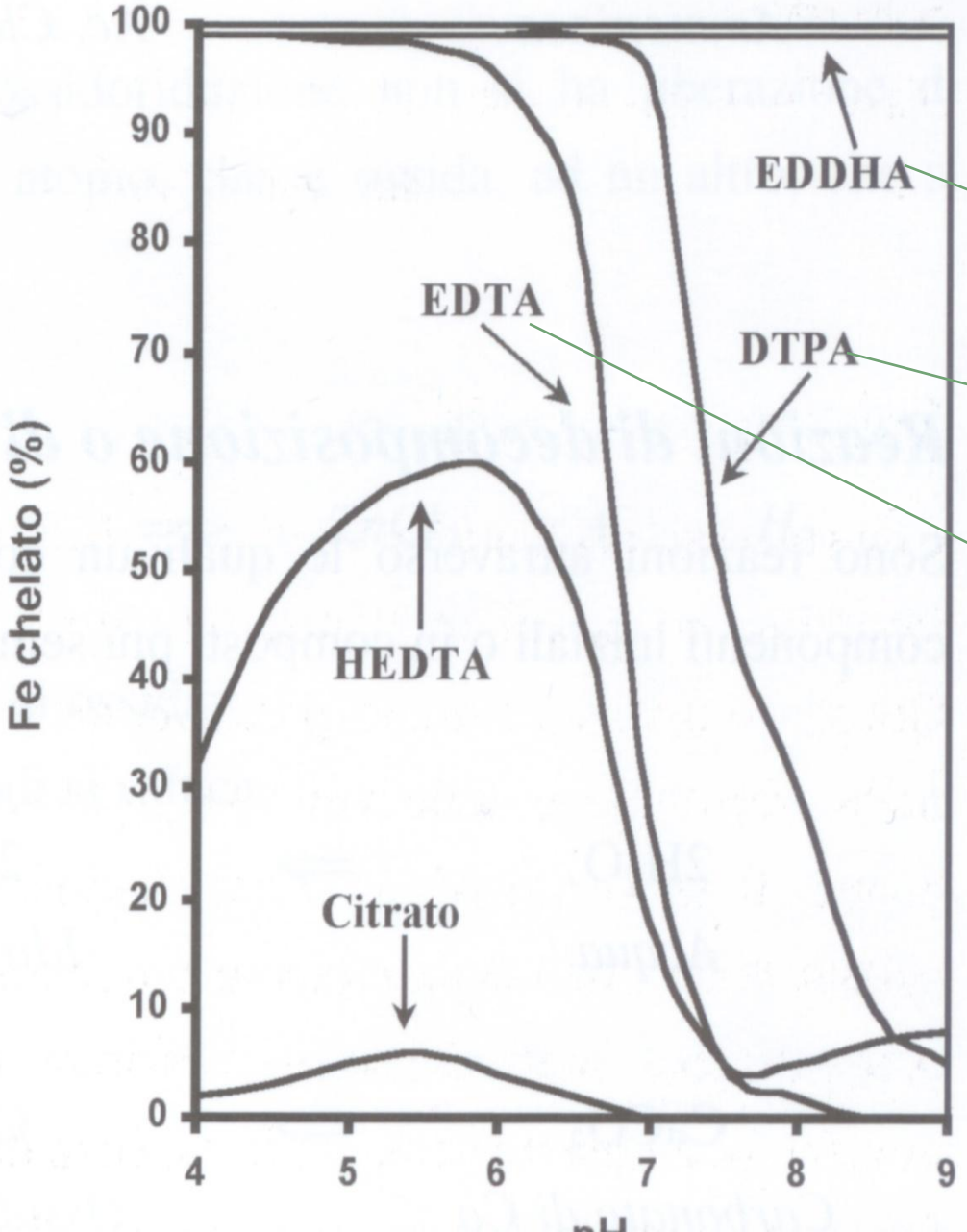
pH OF NUTRIENT WATER OR SATURATED SOILLESS MEDIUMS

(pH above 5.5 cuts phosphorus & manganese)

Chelates

- Protection from oxidation, precipitation and immobilization
- Cations can be chelated, anions not (complexed)

- EDTA = Ethylene Diamine Tetraacetic Acid
- DTPA = Diethylene Triamine Pentaacetic Acid
- HEDTA = Hydroxyethyl Ethylene Diamino Triacetic Acid
- EDDHA = Ethylene Diaminebis (2-hydroxy phenylacetic Acid)



The most stable, but on soil

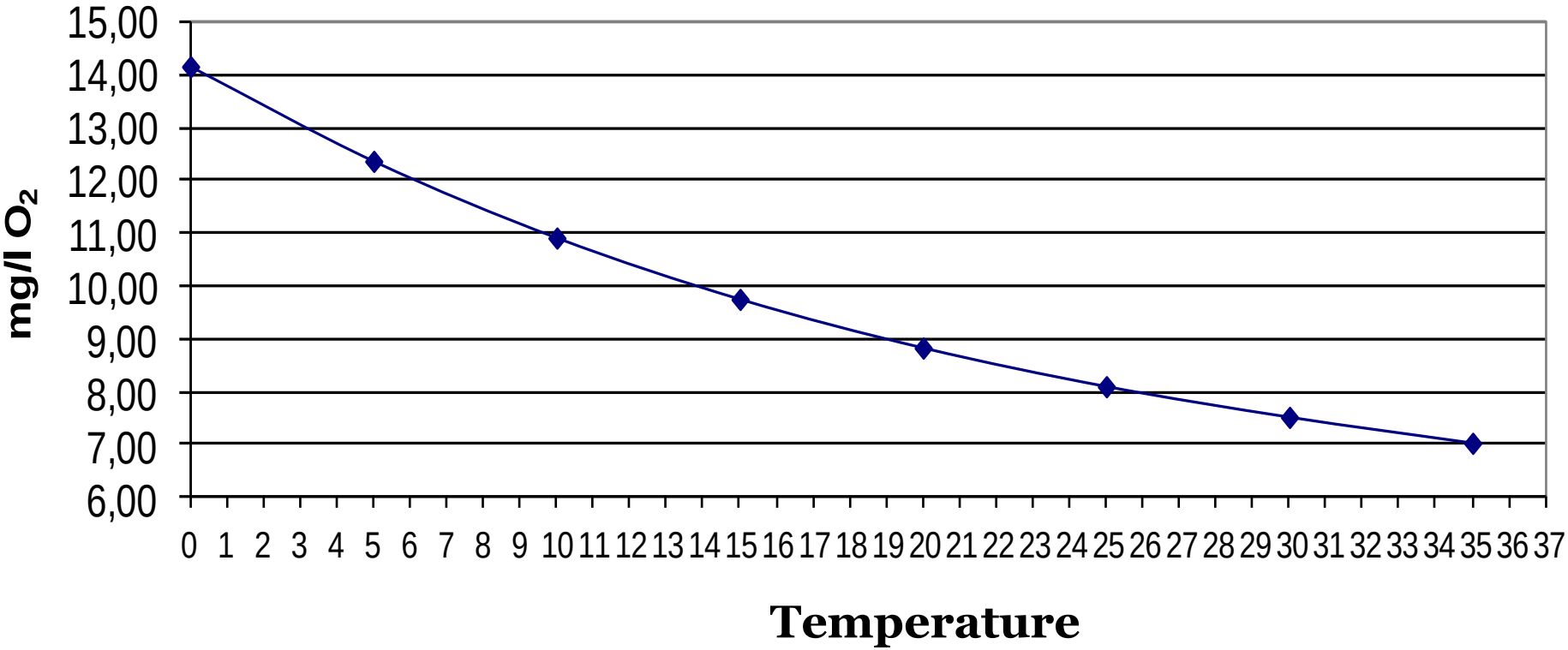
Stable under acidic and neutral conditions; low affinity to calcium

Stable under acidic conditions; high affinity for calcium

1. *Mantain pH within the optimal range of 5.5 – 6.0*

2. *Blended of chelated elements may help*

It's not a mineral nutrient, but…



Managing nutrient solution

- Monitor pH, EC, temperature daily (O_2 for Deep water systems)

- Periodically full chemical testing
- Tissue sampling; care for tissues - young leaves show higher levels of mobile nitrogen and potassium, lower calcium, iron and manganese

Healthy plants… for healthy people

Not only food without pesticides…

- Nutraceutical products - Novel food
- MAP's
- Molecular Farming

Novel food

- Adding Si , Se, I (antioxidants, preventing some pathologies etc.) in nutrient solution
- Increasing content in beneficial substances by modifying EC or some elements

- **Nitrate content** problems: possibility to avoid/limiting content

Medicinal & Aromatic Plants

Nutrients and optimization of ratio can increase active ingredients and essential oils

from Achillea to Zingiber

through Basil and Cannabis too

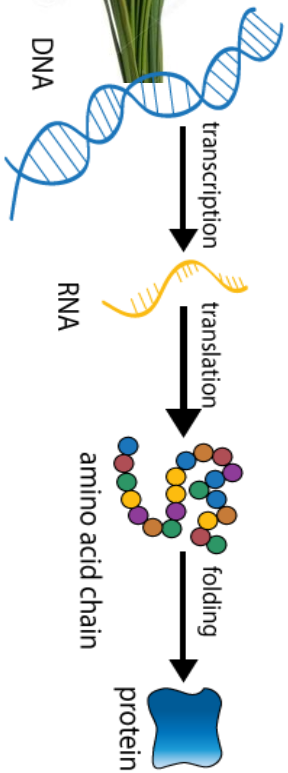
AQUA FARM

Molecular Farming

Plants as bioreactors, for large-scale production of recombinant proteins

- Diagnostic reagents
- Vaccines
- Drugs

- Leafy crops
- Cereal seeds




Thanks for
your attention
Grazie

Thanks to

- Dott. Silvio Fritegotto
- ANTESIA – Associazione Nazionale Tecnici Specialisti In Agricoltura
- Transactiva Srl – Molecular Farming

Abstract

- Vertical Farms are the most innovative approach to the methods of soilless cultivation. They offer the possibility to grow in a multi-layer system, in closed and controlled environment, in urban or not suitable for agriculture areas. It is possible to optimize the use of water and nutrients through total recycling and to avoid agrochemicals. Thus, this allows to focus attention on the physiological aspects of crop production and the more sustainable techniques promoting the process at their best. For the methods used in VF - Hydroponics and Aeroponics – substrates are used only as supports for the plants, so the nutrient solution is an essential input, interacting with light, temperature and relative humidity. In nutrient solution not only providing all of the essential elements in the right quantity and proportion, appropriate to the species and to the objectives, is important, but also its proper managing during the cycles. A really targeted fertigation allows to work, as known, also on the quality and healthiness of the product.