Types of Substrates and Fertigation in Hydroponic Systems

Summer School Greenhouse Hydroponics:
Automation & Management, Geisenheim 2019

PLANTA®

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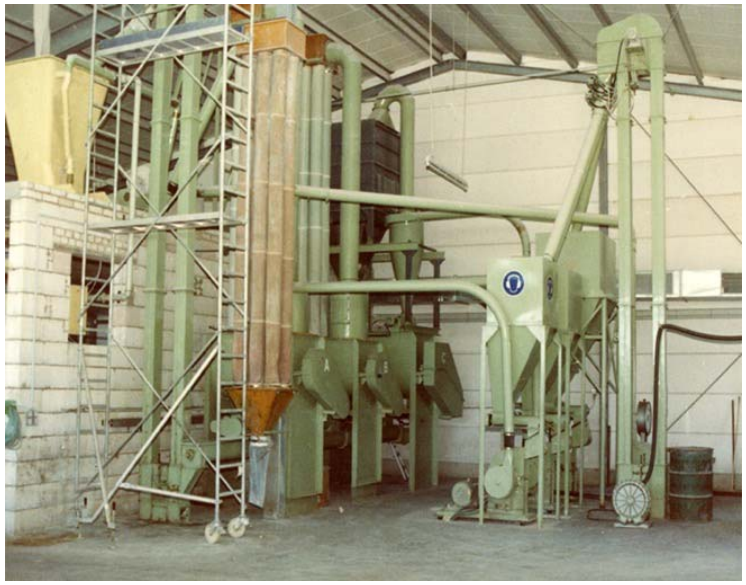
Head of laboratory

Facts about Planta Fertilizers:

- Founded 1976
- Located in Regenstauf, near Regensburg in Bavaria
- Producer of water-soluble NPK fertilizer blends
- Products are sold in 44 countries in the world
- Applied in horticulture, fruit- and vegetable growing and agricultural purposes



Production in 1987

Production in 2019

Focus on and importance of the product quality

- Usage of high quality, technical raw materials with lowest sodium and chloride levels
- 100 % solubility and high solution speed
- Product adapted to the user conditions to reach optimum results…

The right fertilizer is an important basis for cultivating in hydroponic systems

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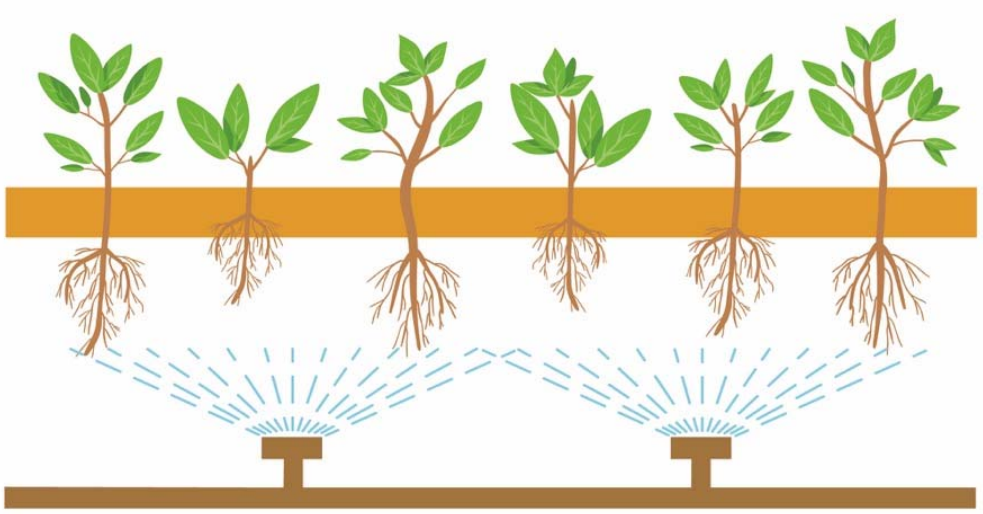
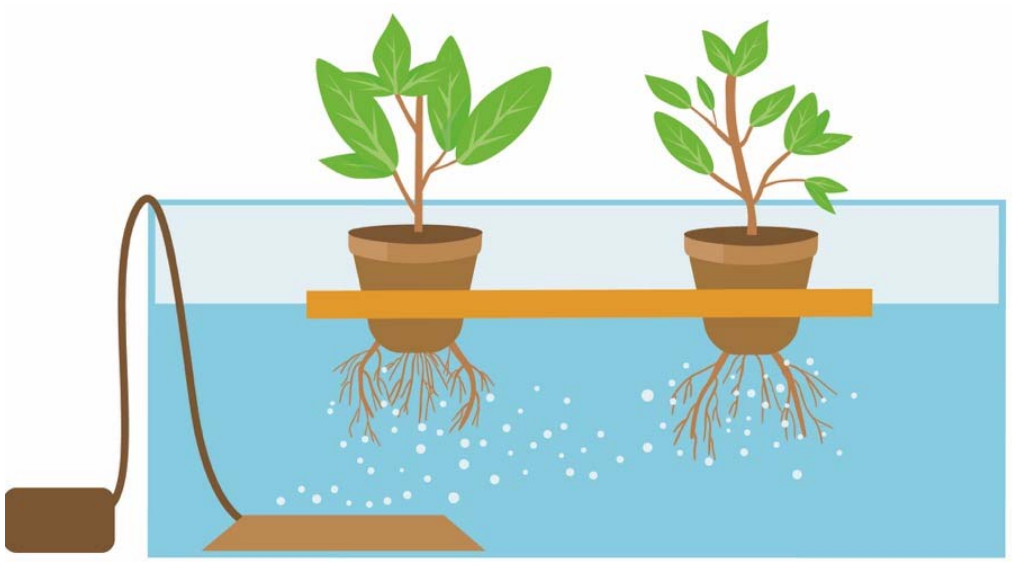


Aeroponic

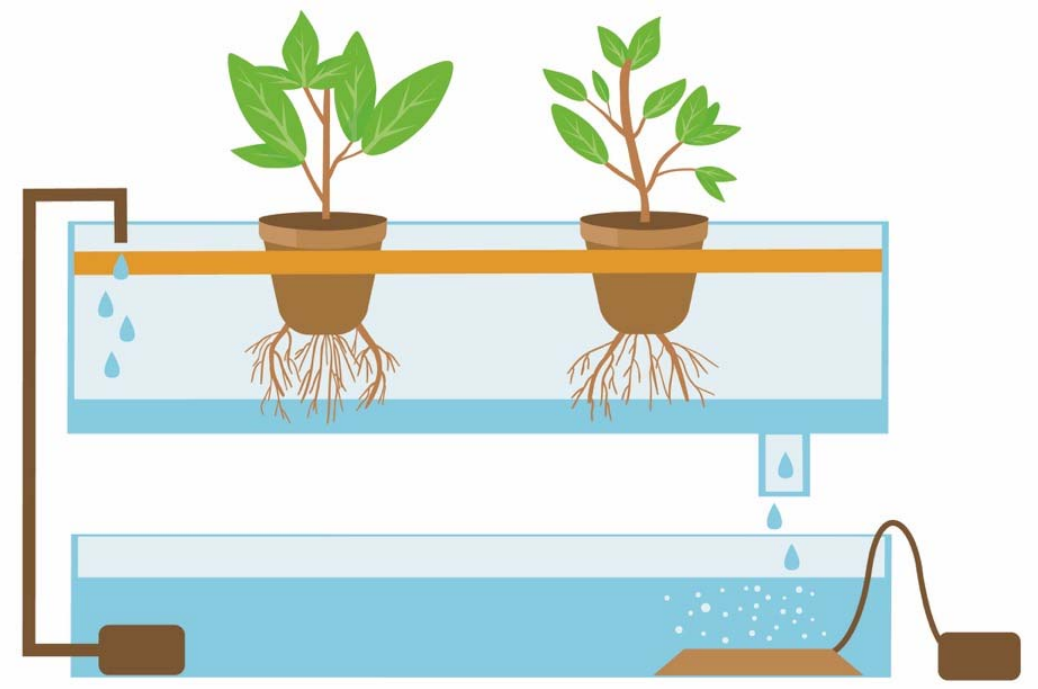
Drip Irrigation

source: iStock.com/Lilkin

Hydroponic Systems



Deep Water Cultivation



Nutrient Film Technique (NFT)

source: iStock.com/Lilkin

Hydroponic Systems

Handling the drain solution:

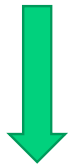
- run-to-waste system

- recirculating system

  ☞ Important to test nutrient levels before reusing the water to avoid too low or too high nutrient levels

Hydroponic Systems

Hydroponic systems with no / inert substrates have no or only a small buffer capacity



Water quality and nutrient content have to be optimally as even small deviations can cause significant problems

Hydroponic Systems

Regulatory aspects of hydroponics on organic production:

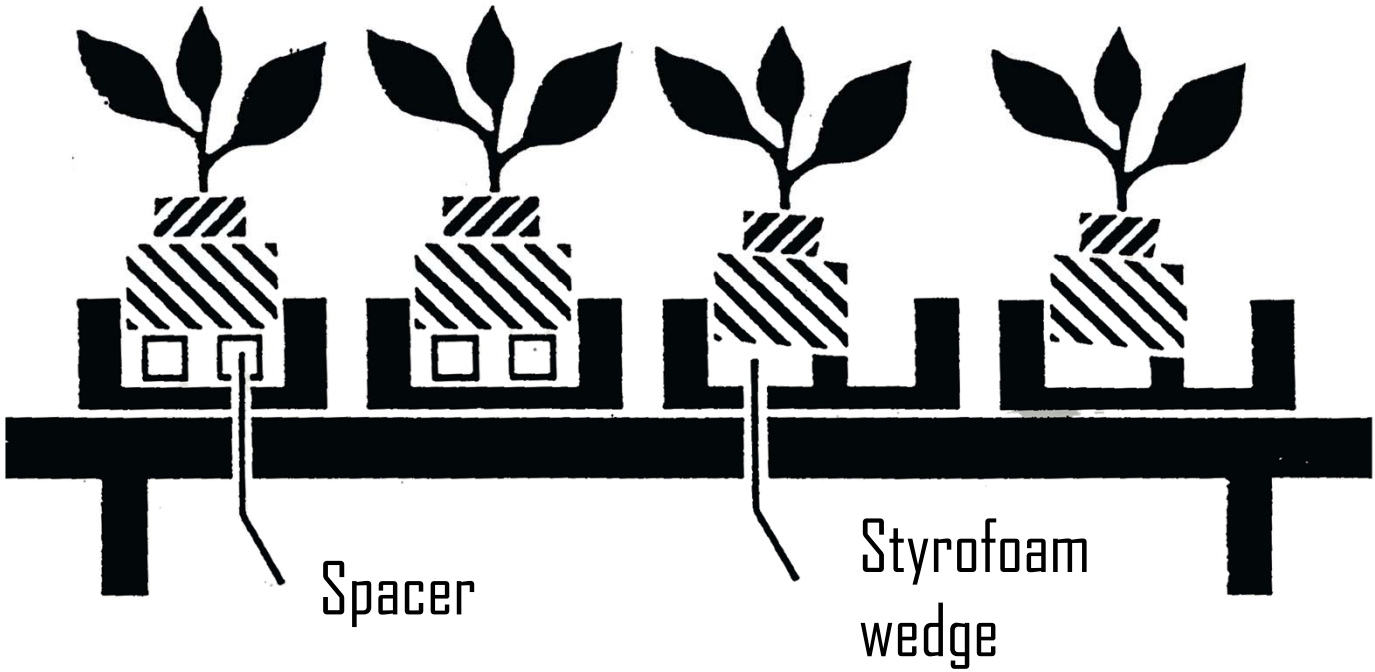
European Regulation EC 889/2008, Title 2, Chapter 1 Article 4:

Hydroponic production is prohibited.

Substrates for hydroponics

Common types of substrates…

- Expanded clay
- Perlite
- Vermiculite
- PUR foam (“Oasis”)
- Rock wool
- Coco Peat



Substrates for hydroponics

Requirements of these substrates:

- Inert (chemical neutral)
- Sterilely (germ-free)
- Poor in nutrients
- pH 5-7 (in aqueous solutions)
- High porosity
- Constant volume

Water Quality

Substances contained in water

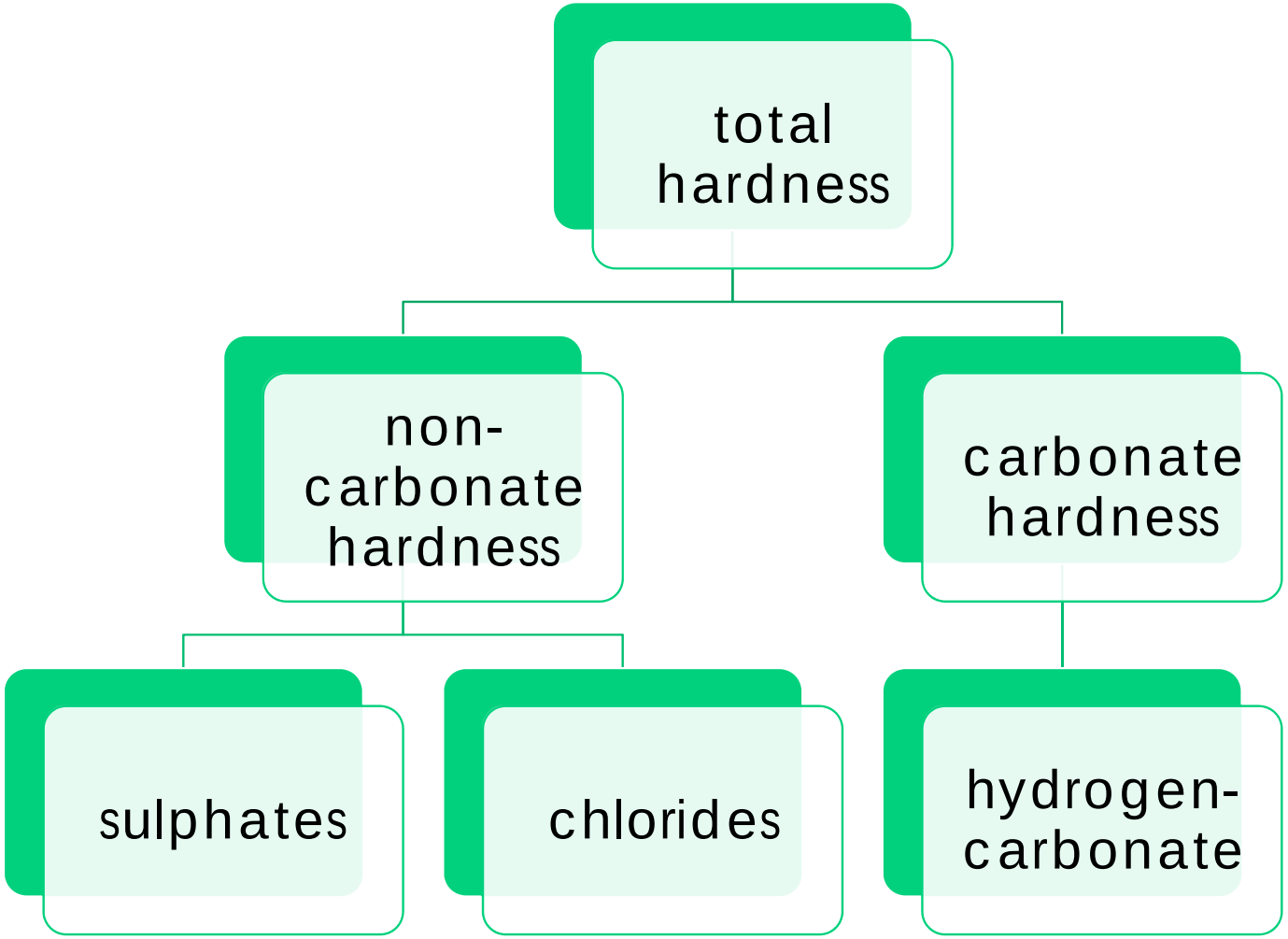
Organic matter:	Inorganic matter:
• Germs • Others	• Solids • Colloids • Salts (diluted)

Water Quality

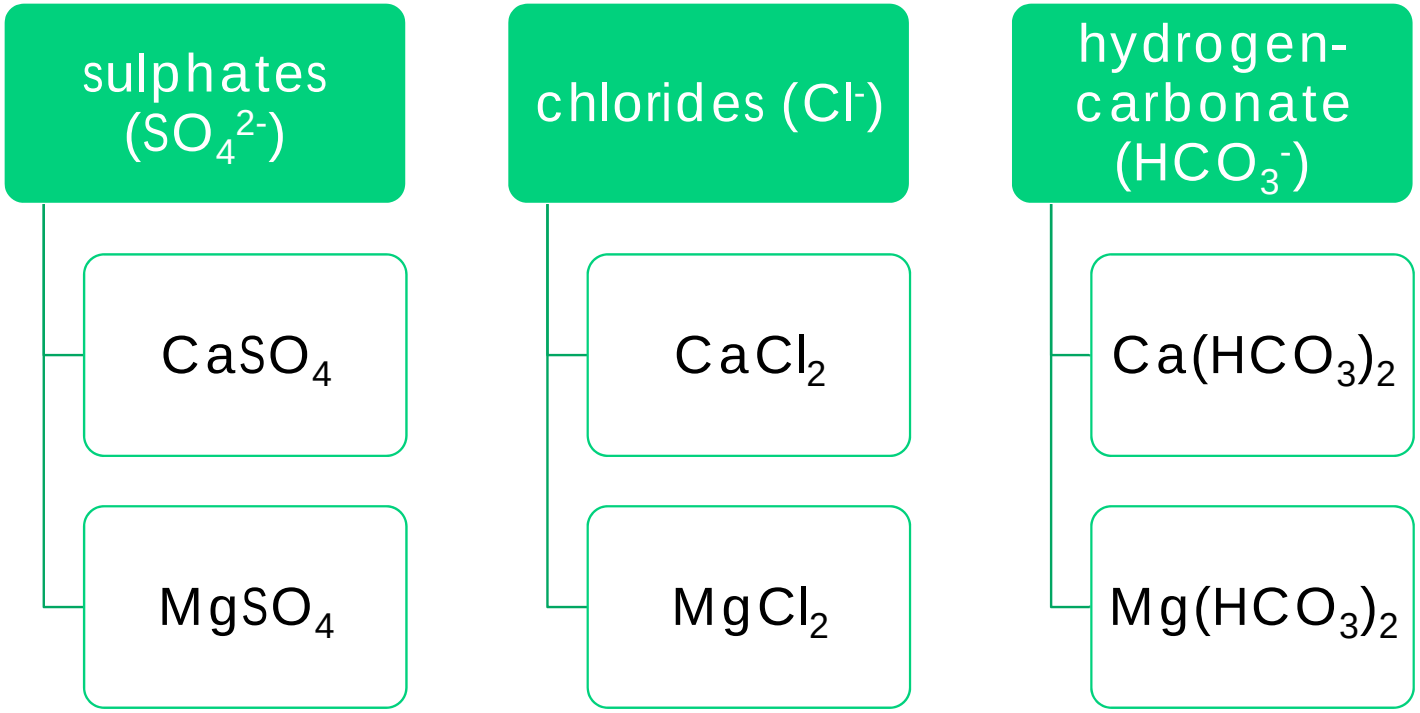
Limits for water quality according to Dr. Molitor Geisenheim

Electrical conductivity µS/cm: 500 Total salt content mg/l : 250	
Ions mg/l: - Calcium: 150 - Sodium: 30 - Chloride: 30 - Sulfate: 80 - Nitrate: 50	- Iron: 1,2 - Manganese: 0,1 - Zinc: 0,3 - Copper: 0,1 - Boron: 0,25 - Fluoride: 0,5

Water hardness / carbonate hardness



Water hardness / carbonate hardness



Water hardness / carbonate hardness

Carbonate hardness:

is a measure of the water hardness caused by the presence of carbonate and bicarbonate HCO_3^- anions. Carbonate hardness is usually expressed either in degrees KH (dKH) (from the German "Karbonathärte") or ion mmol/l HCO_3^-

1° dKH = 10 mg CaO/l or 17,8 mg $CaCO_3$/l
1° dKH = 0,357 mol/l HCO_3^- (= Acid binding capacity)
1 mmol/l $HCO3^-$ = 2,8 Grad dKH

pH-value:

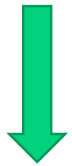
Influenced by carbonate hardness (HCO_3^--ions):

$HCO_3^- + H_2O \Rightarrow H_2CO_3 + OH^-$ increases pH

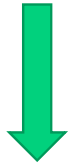
Hardness unit conversion.						
	1 mmol/L	1 ppm, mg/L	1 dGH, °dH	1 gpg	1 °e, °Clark	1 °fH
mmol/L	1	0.009991	0.1783	0.171	0.1424	0.09991
ppm, mg/L	100.1	1	17.85	17.12	14.25	10
°dH	5.608	0.05603	1	0.9591	0.7986	0.5603
gpg	5.847	0.05842	1.043	1	0.8327	0.5842
°e, °Clark	7.022	0.07016	1.252	1.201	1	0.7016
°fH	10.01	0.1	1.785	1.712	1.425	1

Fertilization of hydroponic systems

The inert growth media have no or only a small buffer capacity and are unable to provide nutrients



All essential nutrients have to be provided with the irrigation water



Fertilizers must be carefully chosen by the water quality, mainly the bicarbonate (HCO_3^-) concentration

Fertilization considerations

a. In case of high nutrient contents in water (N, Mg, Ca) these amounts have to be considered for calculation of nutrient solution.

b. If there is no Ca contained in water, it has to be added if necessary (important nutrient).

Fertilization considerations

Calcium deficiency at tomatoes

Fertilization considerations

c. Compensation of too high HCO_3^- contents:

- Ammonium ions are acting pH lowering

  Physiological acting:

  per absorbed NH_4^+ ion, the plant sets out an H^+ ion

- The NH_4^+ ion is neutralising the HCO_3^- ion

$$HCO_3^- + H^+ \longrightarrow H_2CO_3 \longrightarrow H_2O + CO_2$$

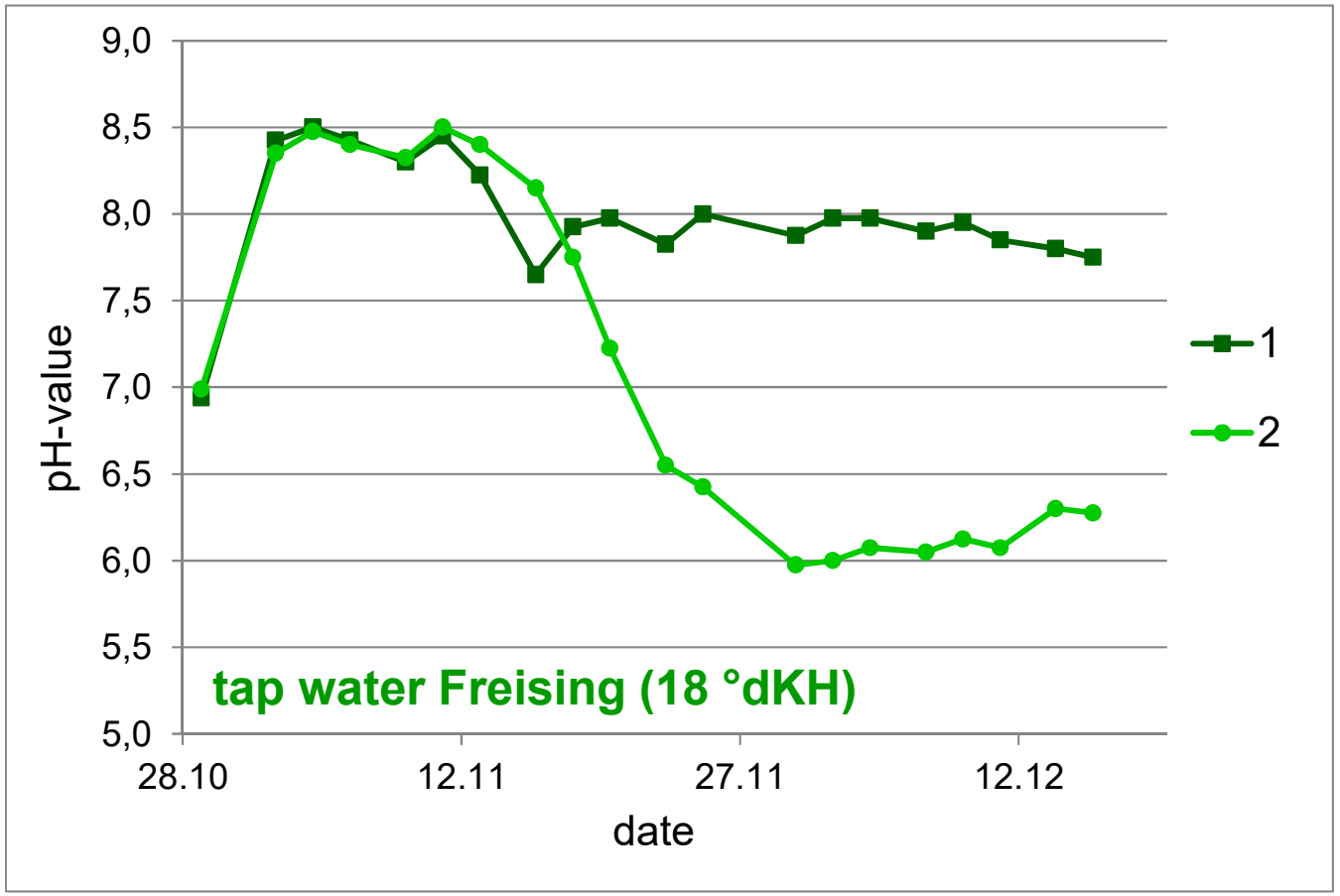
Example of zucchini in NFT

Zucchini in nutrient film technique

Influence of water quality and N-form on the pH-value of the nutrient solution

Var. 1: 90 % NO_3-N 10 % NH_4-N
Var. 2: 70 % NO_3-N 30 % NH_4-N

Example of zucchini in NFT



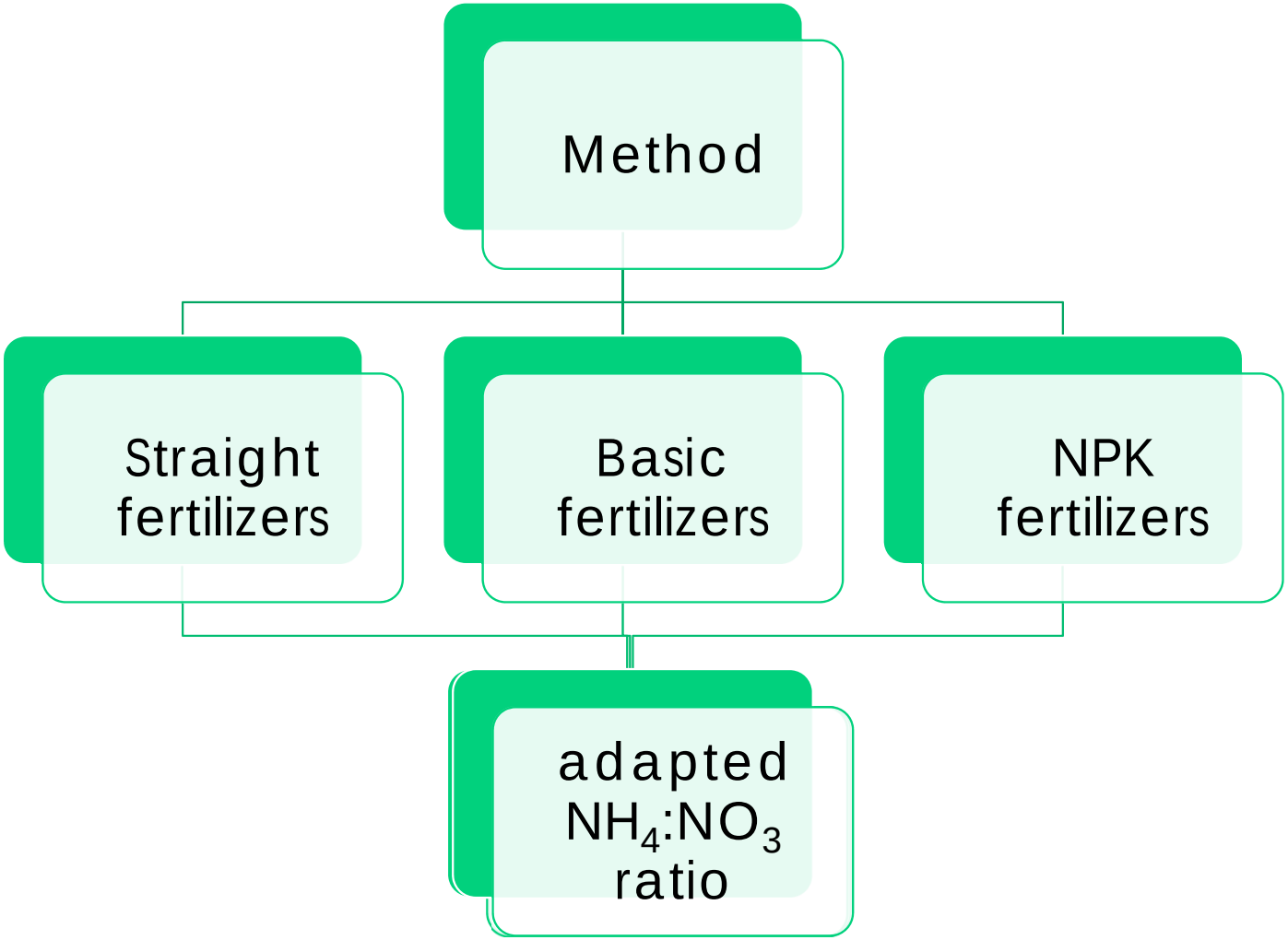
Dr. Susanne Amberger-Ochsenbauer, Institute for horticulture, FH Weihenstephan

Fertilization considerations

Other methods:

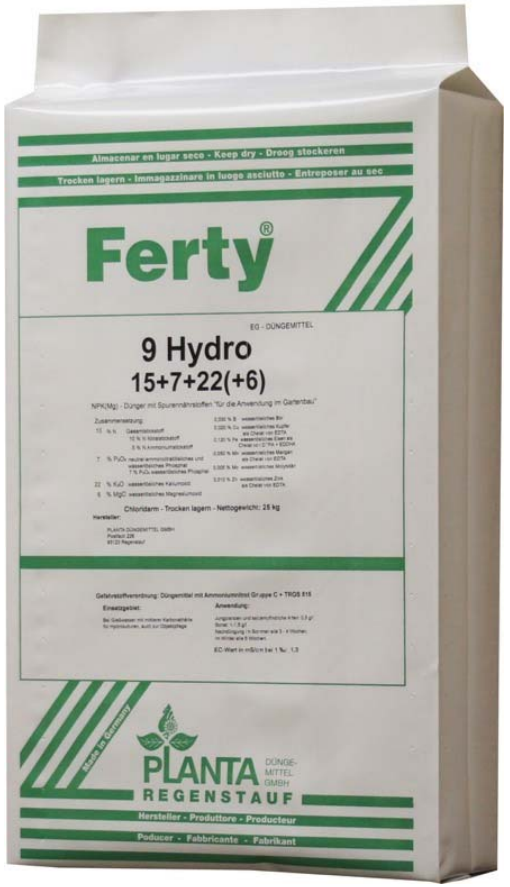
- Neutralisation by acids: Caution with high acidifying effect
- A simple method is mixing different waters (e.g. well water with rain water)

Kinds of suitable fertilizers

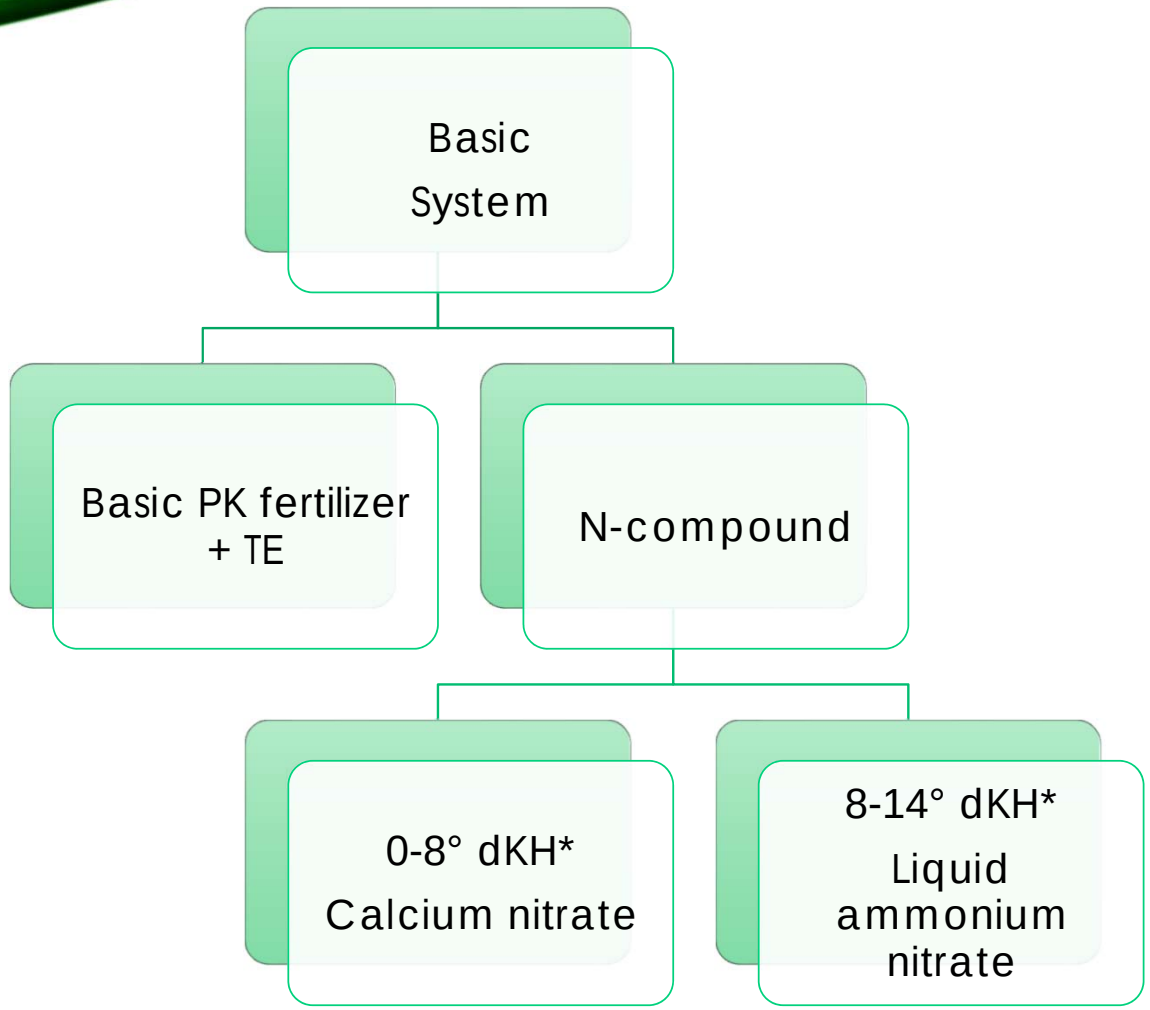


NPK fertilizers

Composition Ferty 9 Hydro	
15 % N	Total nitrogen
10 % NO_3	Nitrate nitrogen
5 % NH_4	Ammonium nitrogen
7 % P_2O_5	water-soluble phosphate
22 % K_2O	water-soluble potassium oxide
6 % MgO	water-soluble magnesium oxide
0.030 % B	water-soluble boron
0.002 % Cu	water-soluble copper, EDTA chelated
0.120 % Fe	water-soluble iron, DTPA and EDDHA chelated
0.050 % Mn	water-soluble manganese, EDTA chelated
0.010 % Mo	water-soluble molybdenum
0.010 % Zn	water-soluble zinc, EDTA chelated



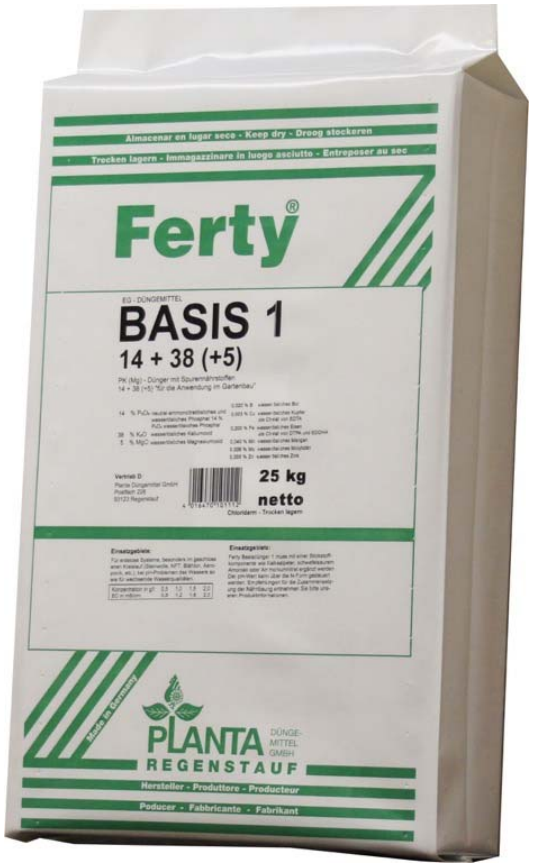
Basic fertilizer system



*orientation value; effect depends on amount of nitrogen used

Basic fertilizer system

Composition Ferty Basic 1	
14 % P_2O_5	water-soluble phosphate
38 % K_2O	water-soluble potassium oxide
5 % MgO	water-soluble magnesium oxide
0.020 % B	water-soluble boron
0.003 % Cu	water-soluble copper, EDTA chelated
0.200 % Fe	water-soluble iron, DTPA and EDDHA chelated
0.040 % Mn	water-soluble manganese, EDTA chelated
0.006 % Mo	water-soluble molybdenum
0.005 % Zn	water-soluble zinc, EDTA chelated



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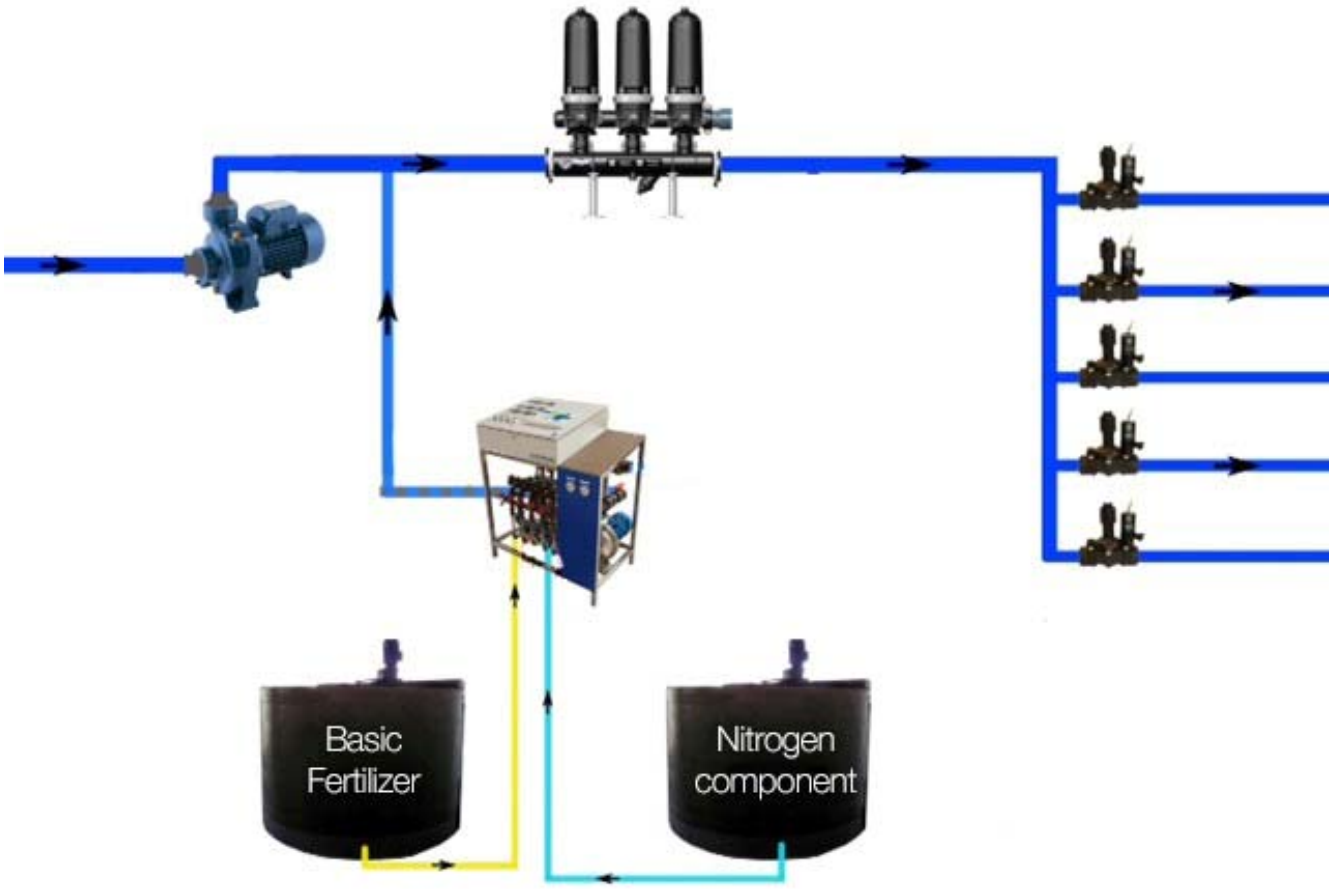

Straight fertilizers

User mixes the fertilizer himself from all required salts.
This has the advantage, that the user can adjust the nutrient solution exactly to the plant needs.

Disadvantage arises by handling many different products with stock and purchasing on the one side and weighing and mixing errors on the other side

Special fertilizers

Special kind of NPK fertilizers with acidic components.

- Products for soft water are containing calcium in combination with NPK, with nitrate contents of the nitrogen up to 100 % for stabilizing the pH-value

- Products for hard water are neutralizing bicarbonate in the water and prevent pH rising

Future of hydroponic systems

Thank you very much for your attention!

For further questions / information /
think-tank cooperations:

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www.plantafert.com

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