United Nations
World Food Programme
联合国世界粮食计划署

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SOILLESS CULTURE

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Cloud School
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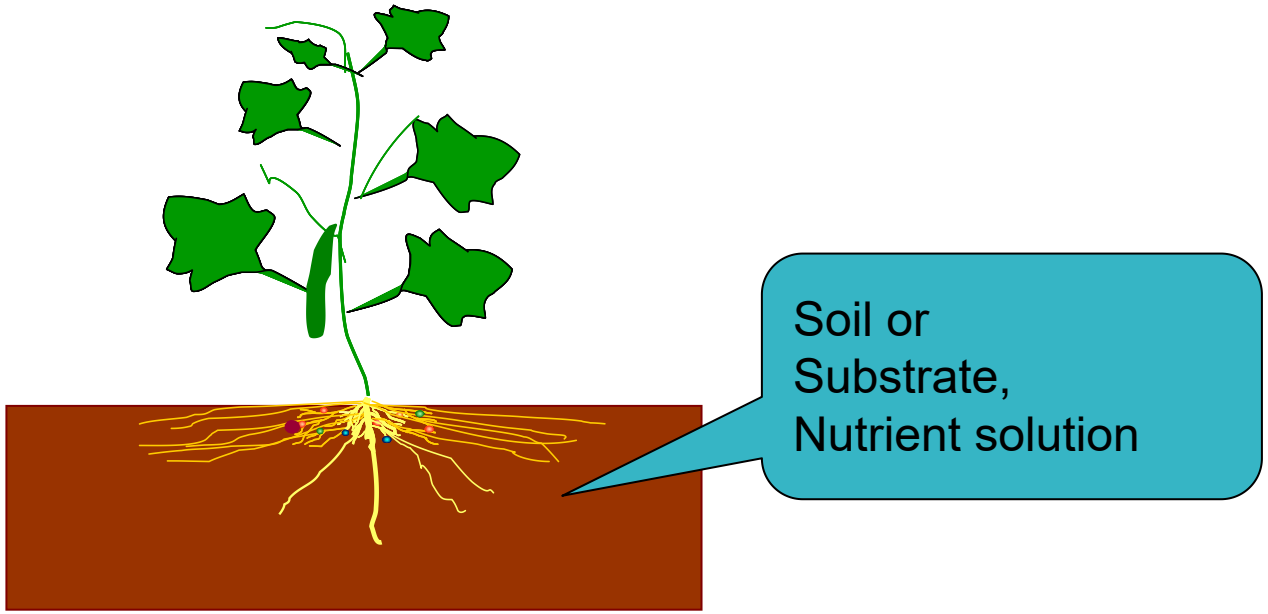
Water and Nutrients



Soil provides four needs to the plant:

(1) a supply of water,

(2) a supply of essential nutrients,

(3) a supply of oxygen,

(4) support for the plant root system.

What kinds of water source can be used to make nutrient solution?

- Rain water
- Well water
- Melted snow
- Distilled seawater
- Tap water

stable quality

- Surface water
  (river, stream, etc)
- Waste water

- unstable quality
- unknown / variable chemical composition
- infected by pathogens ??

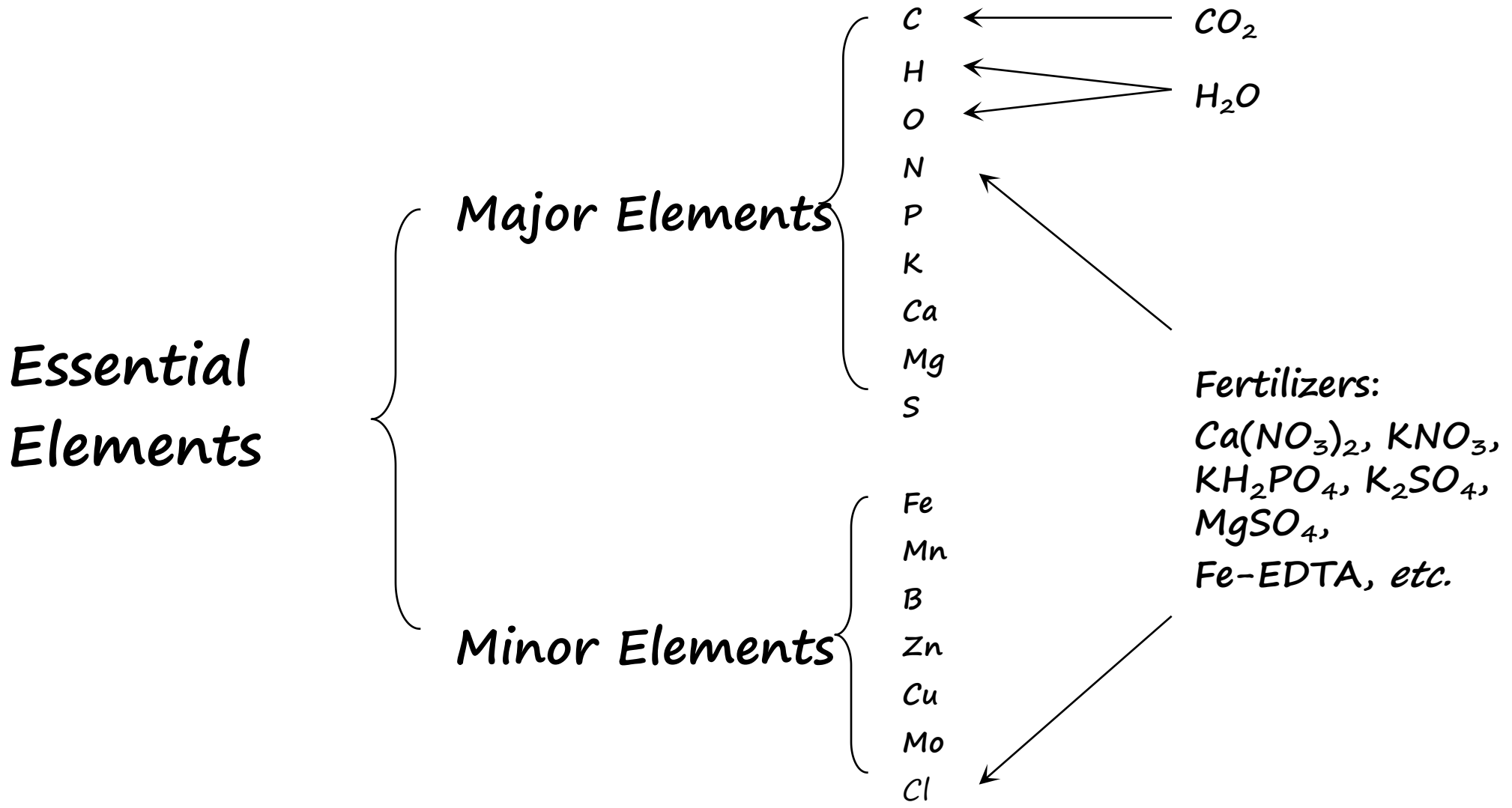
(Van Os, 2004)

Water quality

- A complete analysis of the water to be used for any type of soilless culture system is essential.
- Most soilless culture systems require relatively pure water.
- Natural water supplies usually contain sizeable concentrations of some of the essential elements, which will affect the nutrient formulae.

Filtering or other forms of pretreatment are required to ensure that the water used to prepare the nutrient solution is free from undesirable organisms, as well as suspended matter.

Essential elements for higher plants growth



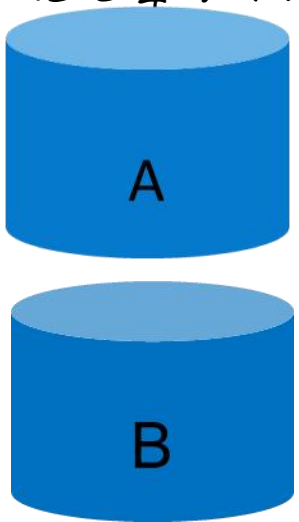
Methods of mixing fertilizers

There are two principal systems for mixing fertilizers:

- The bulk tank system
- The injector or proportion system

Nutrient tank

- At least two stock tanks are needed. This is because certain fertilizer sources when mixed together in concentrated form will lead to insoluble precipitates. The most common of these are calcium phosphate ($Ca_3(PO_4)_2$) and calcium sulfate ($CaSO_4 \cdot 2H_2O$).

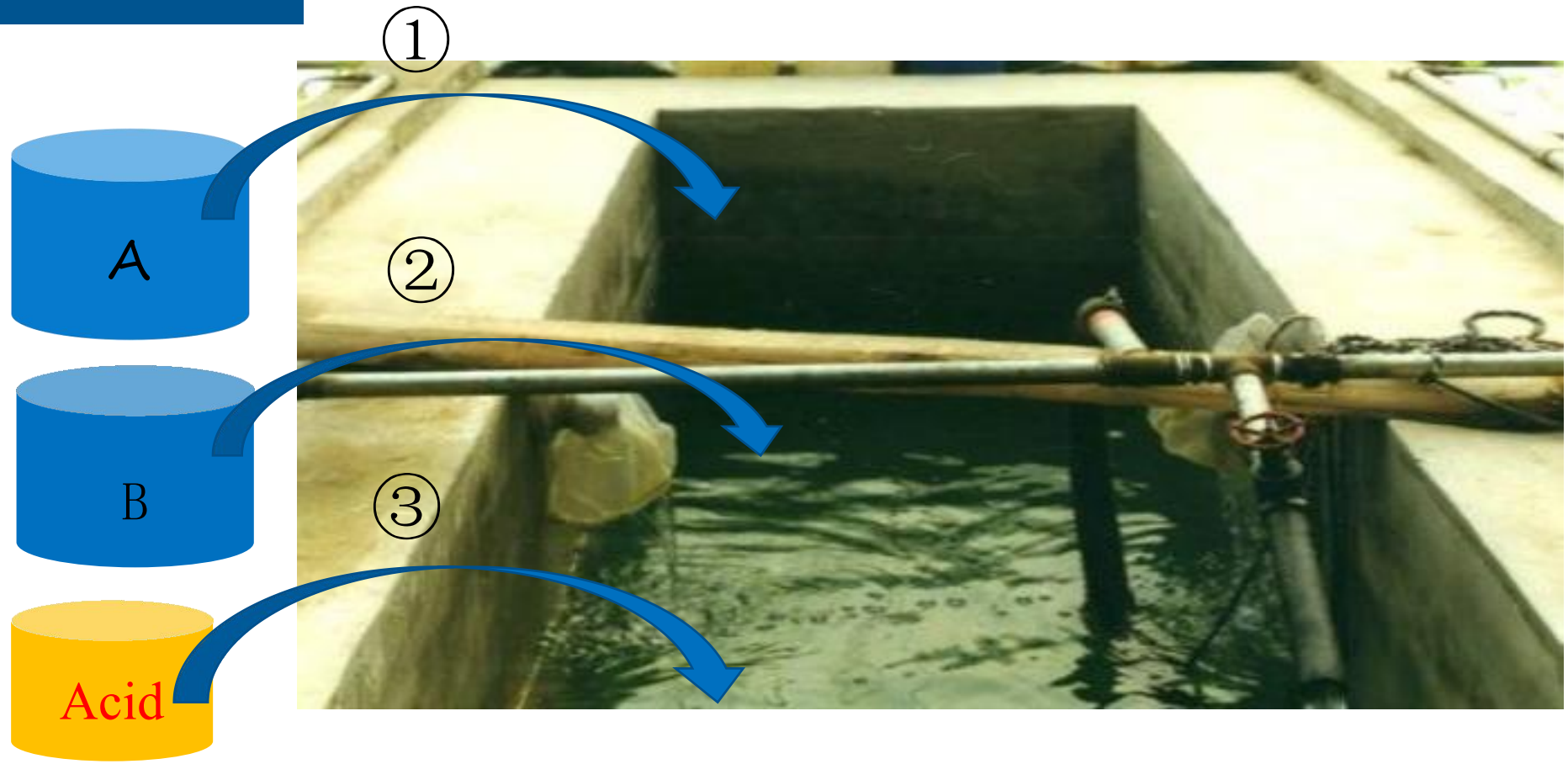


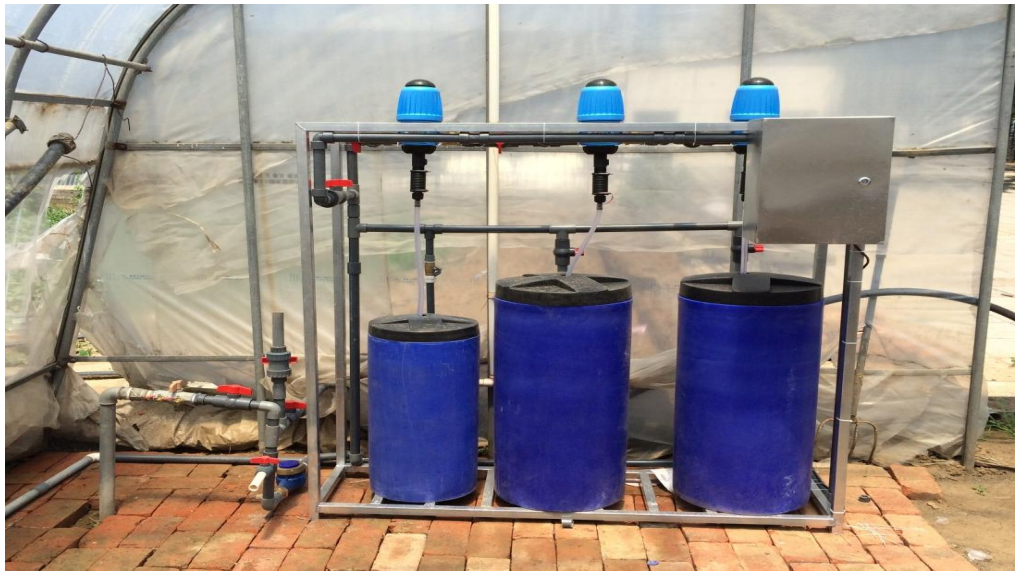
A: contains potassium nitrate, calcium nitrate and iron chelate

B: contains the phosphorus source, magnesium sulfate, micronutrients, potassium chloride, or some of the potassium nitrate

Preparing the nutrient solution

Bulk tank





Proportion system

Fertigation system

Factors affected nutrient formulae

Hundreds of different formulae have been used in soilless culture over the years. It's impossible to say which one is the best. Because conditions may be dissimilar. An optimum formulation would depend on the follow variables:

a) water analysis
b) plant species and variety
c) stage of plant growth
d) season & weather (temperature, light intensity, sunshine hours)

Acidity and alkalinity (pH)

- PH value is a measure of acidity or alkalinity.
- The pH of the solution refers to the concentration of hydrogen ions (H+) in the solution.
- The pH of the solution is important because certain plant nutrition aspects are influenced by pH such as solubility of essential elements. Most elements are absorbed best with a pH of 5.5 to 7.0.

PH

- The pH of the nutrient solution can be adjusted by adding acid or alkali.
- Solutions of either sodium or potassium hydroxide (NaOH, KOH) are suitable alkalis for raising the pH.
- Solutions of sulphuric or phosphoric acid(H_2SO_4, H_3PO_4) are often used for lowering the pH.
- A pH meter is used to monitor the pH of nutrient solution.
- The pH of a balanced nutrient solution won't shift greatly during recirculated use.
- Although daily monitoring of nutrient solution is recomm[illegible] daily pH adjustment is unnecessary.

Electrical conductivity (EC)

- Electrical conductivity is an estimate of the total soluble salt content of the water.
- EC varies not only to the concentration of salts present, but also to the chemical composition of the nutrient solution.

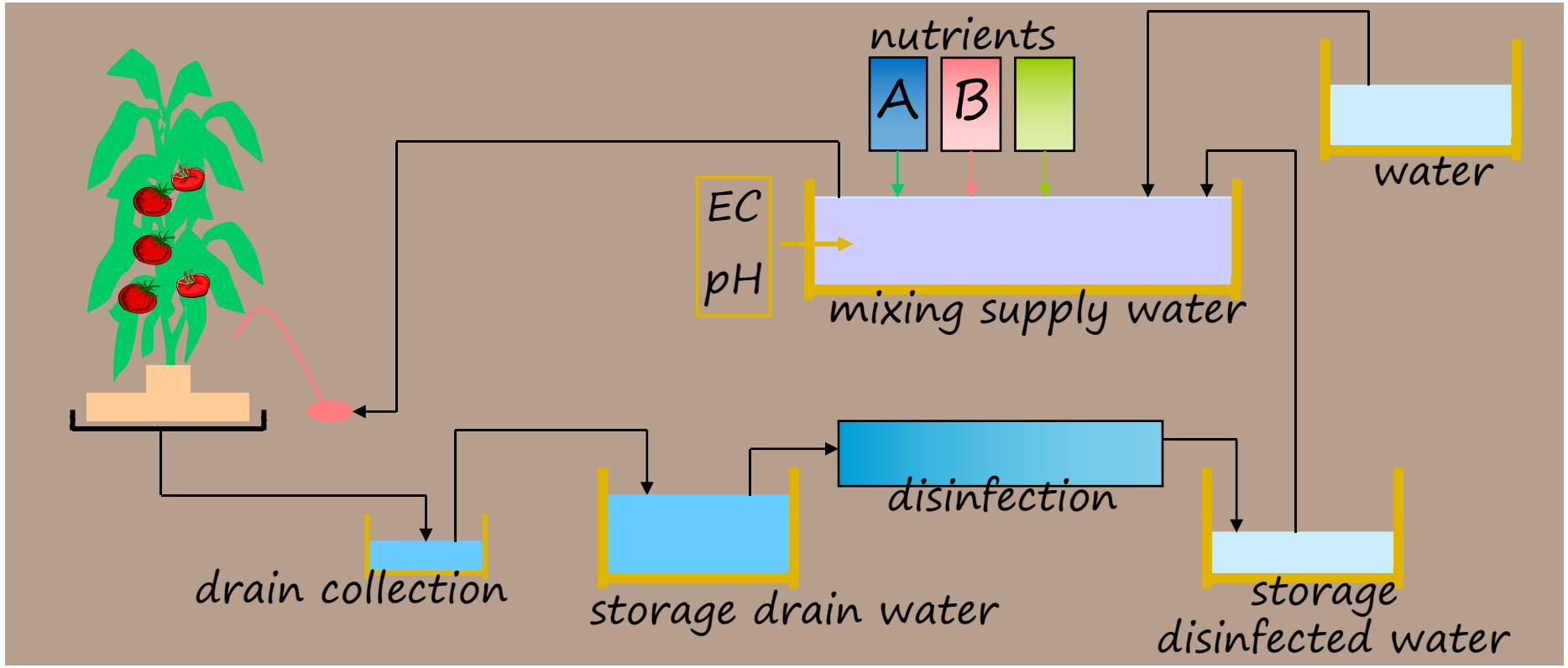
EC

- EC is often expressed as millimhos/cm (mS/cm), with the desired range 2.0 to 4.0.
- We should adjust EC according to different plant species and different conditions.
- The lower values (1.5-2.5) are preferred by crops such as lettuce, 2.0-3.0 are preferred by cucumbers, while higher values (2.5-3.5) are better for tomatoes.
- In winter or poor light conditions higher EC is bett

Steering water content in substrate

- Irrigation starting time
- Irrigation stopping time
- Irrigation – frequency
- Water volume per irrigation

Closed system



(Van Os, 2004)

With the introduction of closed systems, the risk of spreading pathogens increased dramatically.

Disinfection of nutrient solution

Methods	Caption
Heat treatment	Effective, expensive
UV radiation	Easily operated
Ozone	Effective, human exposure to ozone may cause irritation of mucous membrane.
Slow sand filtration	Low cost, reliable

Heat treatment

Dosage: 95°C for 30 s
Energy: 1 m^3 gas to heat 1 m^3 nutrient solutionfor
Advantage:
Reliable and easily to understand the principle.
Disadvantage:
The cost (gas) to heat the water is high.

(Van Os, 2004)

UV radiation

Advantage:
UV radiation is an easily operated method to disinfect nutrient solution.
Disadvantage:
The risk that pathogens can hide behind suspended particles is considered a big disadvantage.

Thank You

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