Online Training Course on Hydroponic for Caribbean and Latin American Countries

Nutrition of Hydroponics

By Fiadini Putri

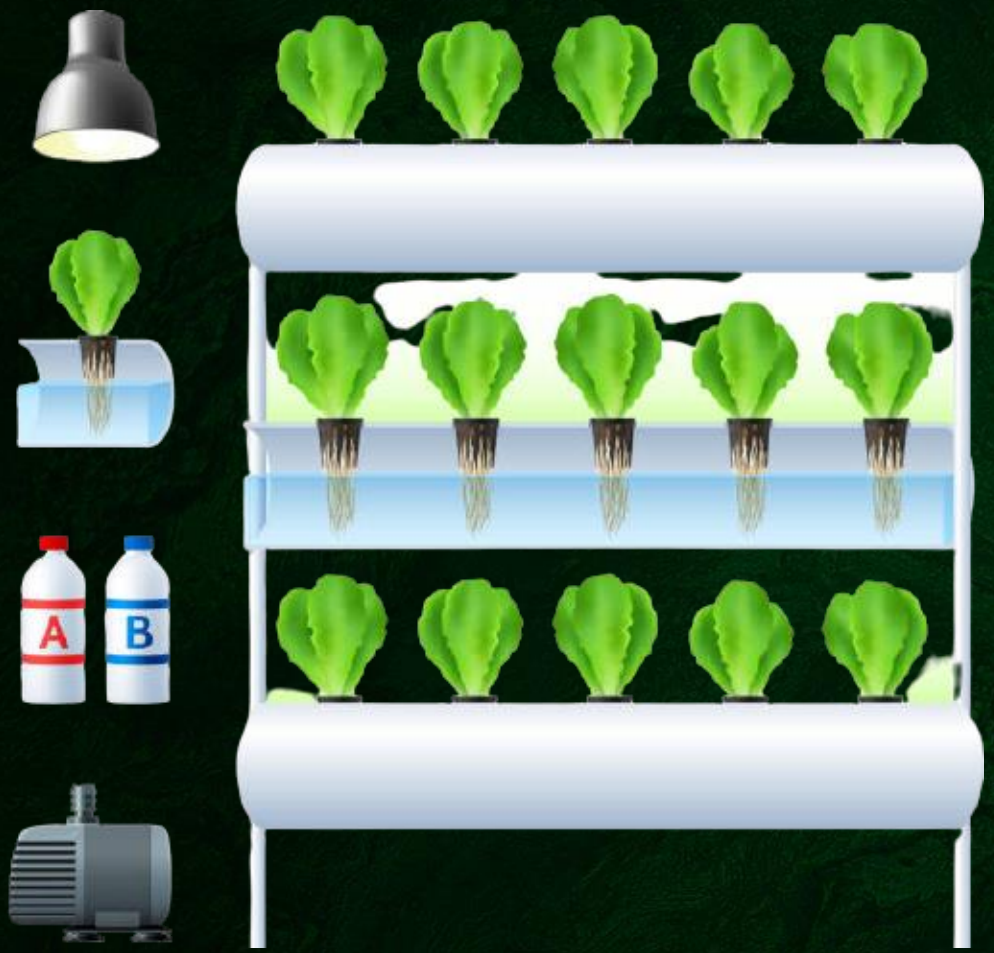
AGENCY FOR AGRICULTURE EXTENSION
AND HUMAN RESOURCES DEVELOPMENT
AGRICULTURE MINISTRY

Professional
Competitiveness
Entrepreneurship

http://bppsdmp.pertanian.go.id

Objectives

- Participants are expected to understand the importance of hydroponic nutrients
- Participants are able to prepare the hydroponic nutrients



Hydroponics is the science of growing plants without soil.

Advantages of Hydroponics

- You can grow anywhere
- Uses 20 times less water than soil based gardening
- Your environment can made sterile, which means less pesticides.
- Production increases 3 to 10 times in the same amount of space.
- Can exist in places where weather and soil conditions are not favorable for traditional food production.
- No mulching, tilling, changing of soil and weeding
- Harvesting is easier.
- High quality yield, more nutritional balance

Disadvantages of Hydroponics

Some of hydroponic system isn't cheap

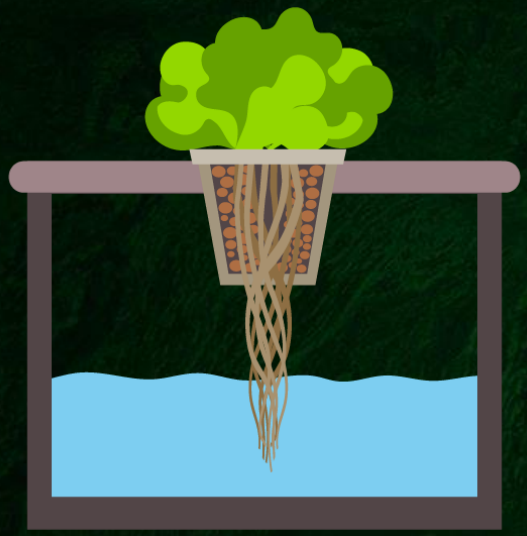
Constant monitoring is required.

Hydroponic system are vulnerable to power outages

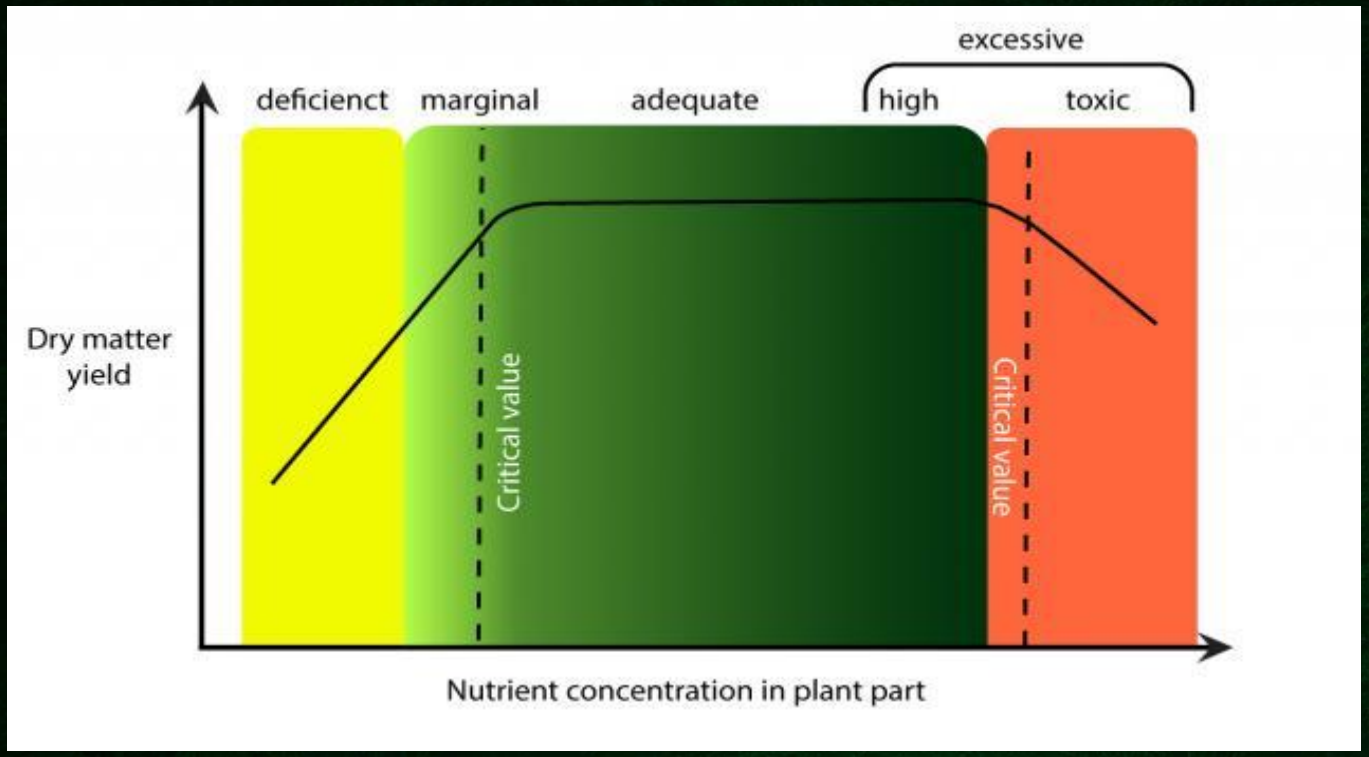
Growing a hydroponic garden demands technical expertise

If a disease appears, all plants in the system will be affected

if the system fails plant death wi ll occur rapidly



Nutrient solution to Hydroponic is just like fertilizers to soil.



The key to successful management of a fertilizer program is to ensure adequate concentrations of all nutrients throughout the life cycle of the crop.

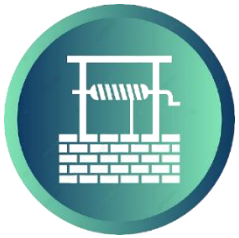
Water Quality

Water Sources

Tap water

Rain water

Underground water

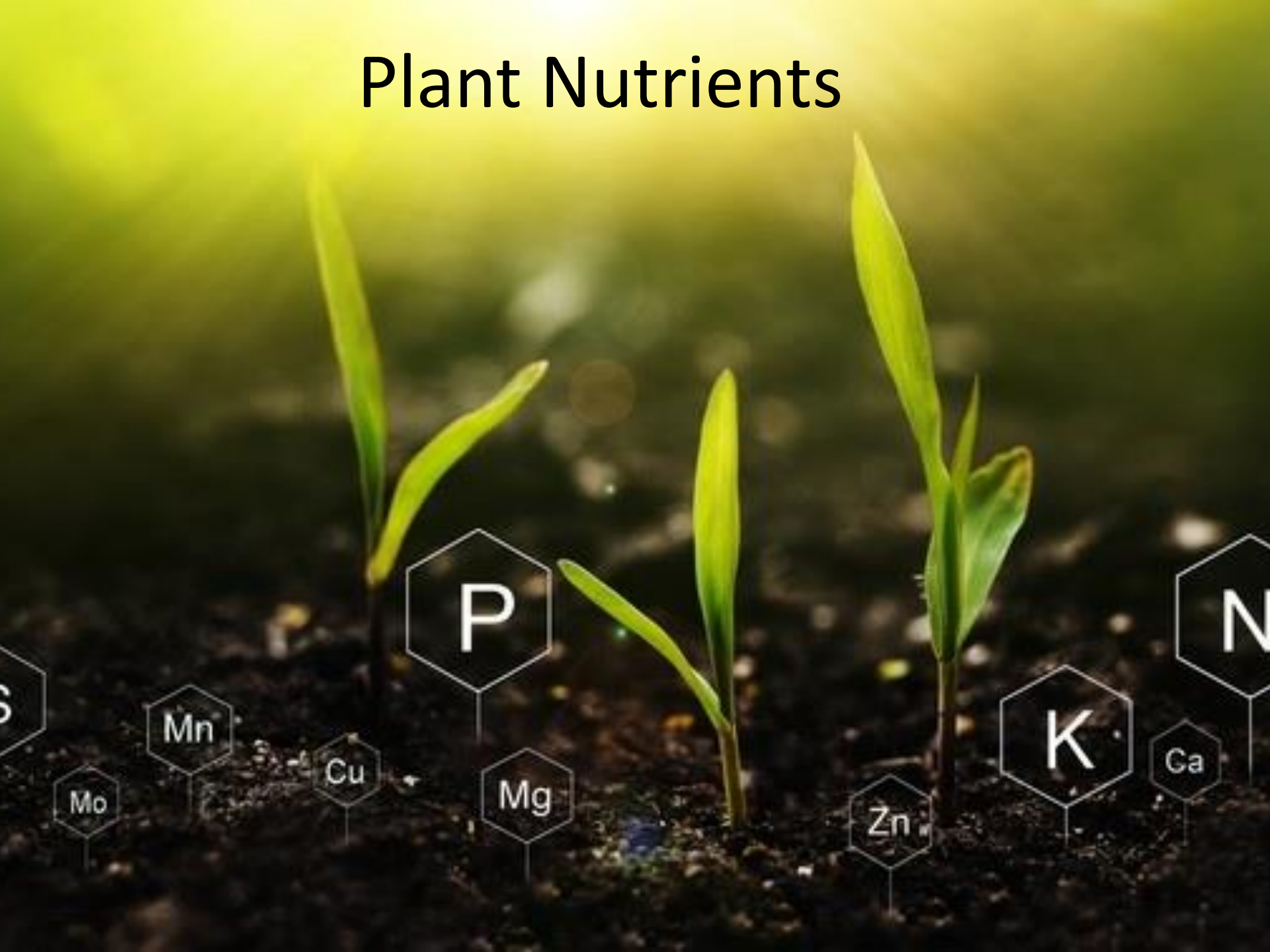


Surface water

Electrical Conductivity (EC)

pH

Plant Nutrients



To be classified as “essential”, the element needs to meet the following criteria:

- The plant cannot complete its life cycle without it.
- The elements’ function cannot be replaced by another element
- The element is directly involved in the plant’s growth and reproduction.

Hydroponic Nutrient

Plant Nutrients

Macro Nutrient

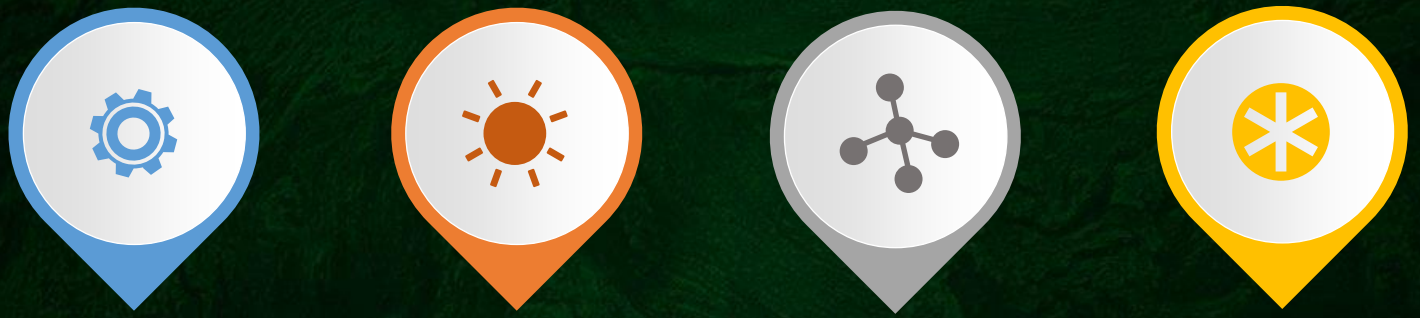
Nitrogen (N)
Phosphorus (P)
Potassium (K)
Magnesium (Mg)
Sulfur (S)
Calcium (Ca)

C, H, O

Micro Nutrient

Iron (Fe)
Manganese (Mn)
Boron (Bo)
Zinc (Zn)
Chlorin (Cl)
Molybdenum (Mo)
Copper (Cu)

Based on functions of essential elements they are classified under four categories:



Biomolecules
Carbon, hydrogen, oxygen and nitrogen..

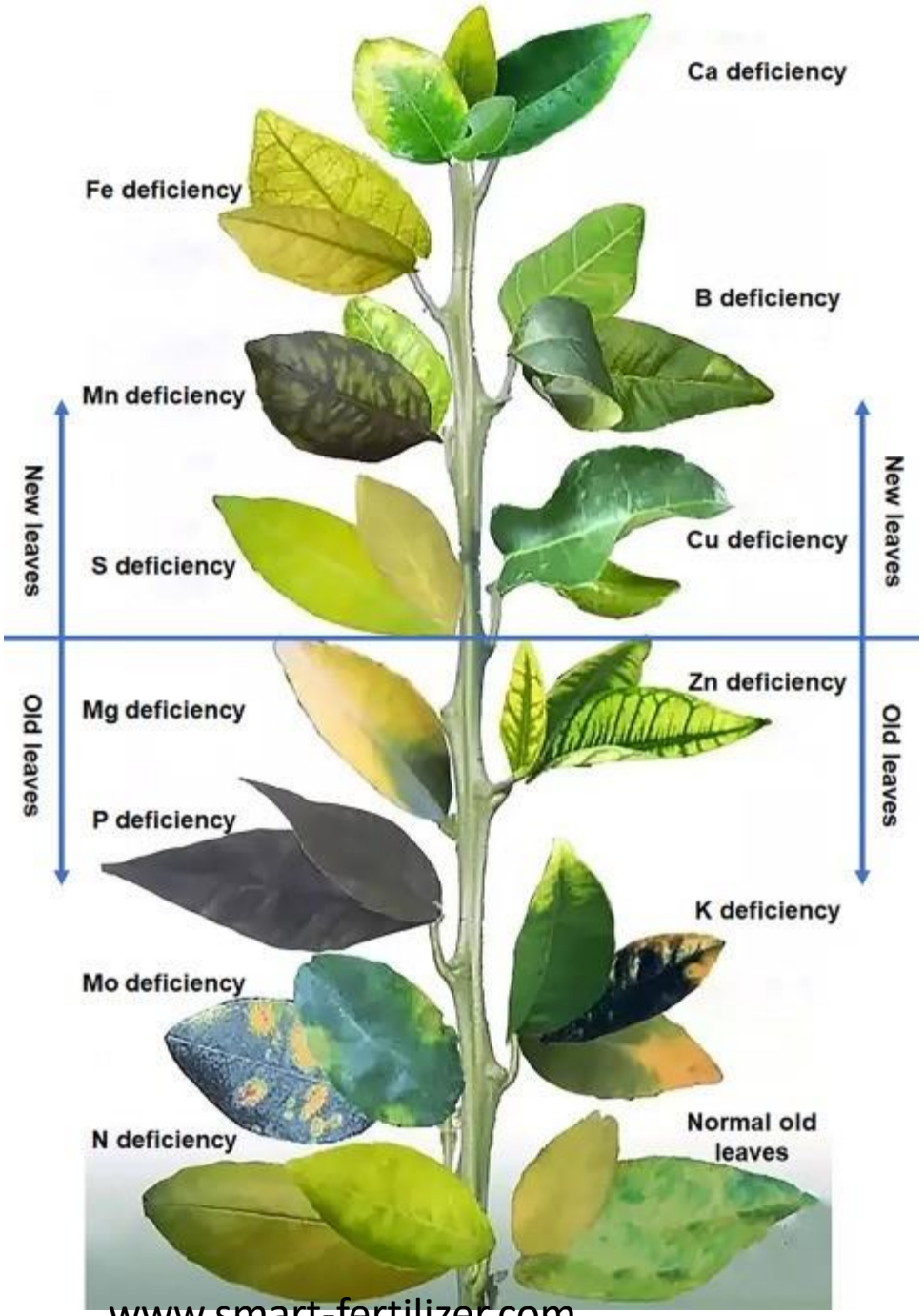
Energy
Magnesium in chlorophyll and phosphorus in ATP.

Enzymes
Mg ion and Zn ion.

Osmotic Potential
Potassium. It plays an important role in opening and closing of stomata.

Element	Function in Plant
N	Responsible for vegetative growth and the building block of for protein in the plant
P	Critical in root development, crop maturity, and seed production.
K	Activates enzymes and important to a plants ability to withstand extreme temperatures and drought.
B	Important in sugar transport, cell division, and amino acid production.
Cl	Used in turgor regulation, resisting diseases, and photosynthesis reactions.
Cu	Component of enzymes, involved with photosynthesis.
Fe	Component of enzymes, essential for chlorophyll synthesis and photosynthesis.
Mo	Involved in nitrogen metabolism, essential in nitrogen fixation.
Mn	Chloroplast production, cofactor in many plant reactions, activates enzymes.
Zn	Component of many enzymes, essential for plant hormone balance and auxin activity.

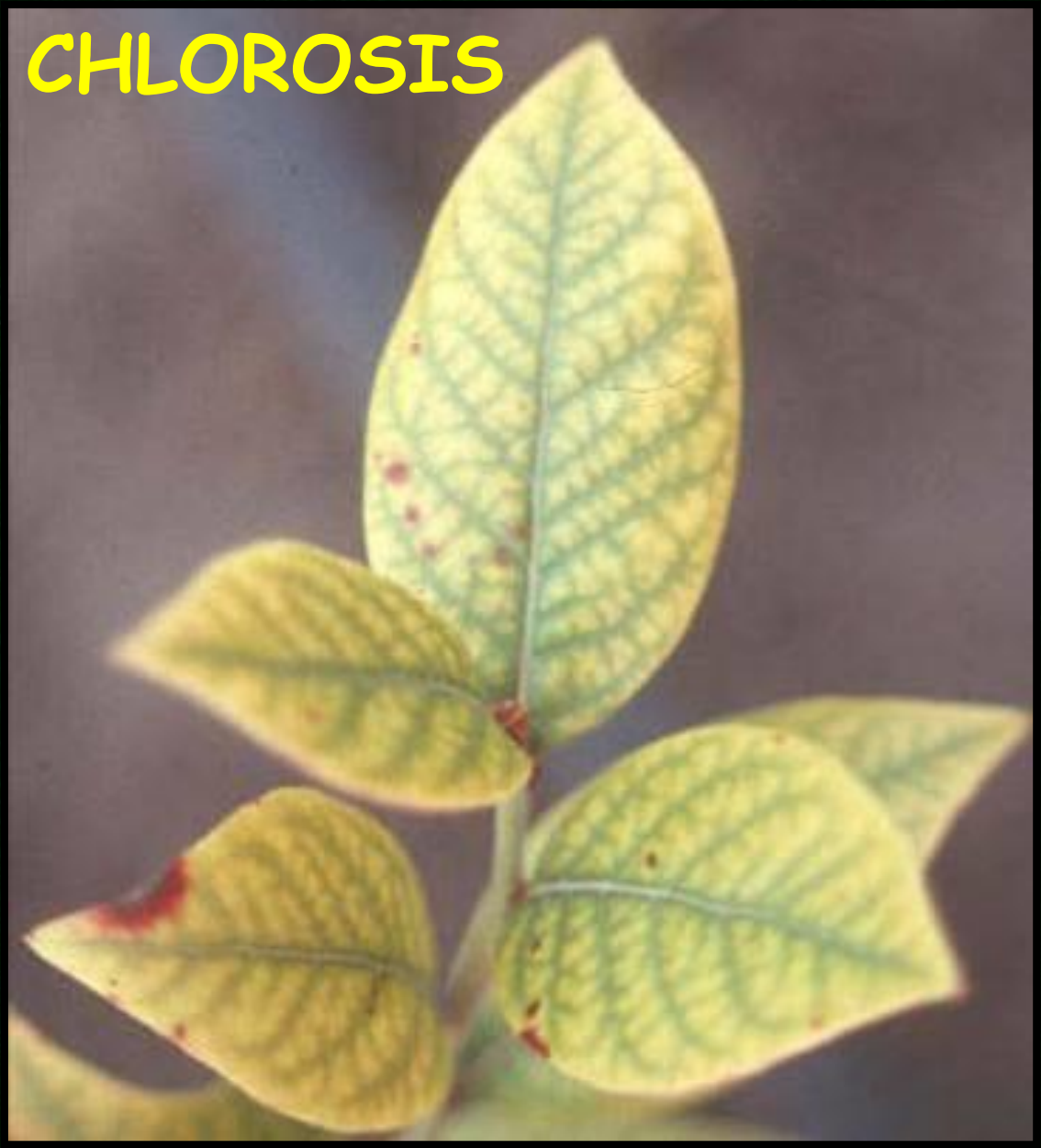
https://ncsoy.org/article/soybean-fertility/


Ca deficiency
Fe deficiency
B deficiency
Mn deficiency
New leaves
New leaves
Cu deficiency
S deficiency
Zn deficiency
Old leaves
Mg deficiency
Old leaves
P deficiency
K deficiency
Mo deficiency
N deficiency
Normal old leaves

Deficiency symptoms of Essential elements:

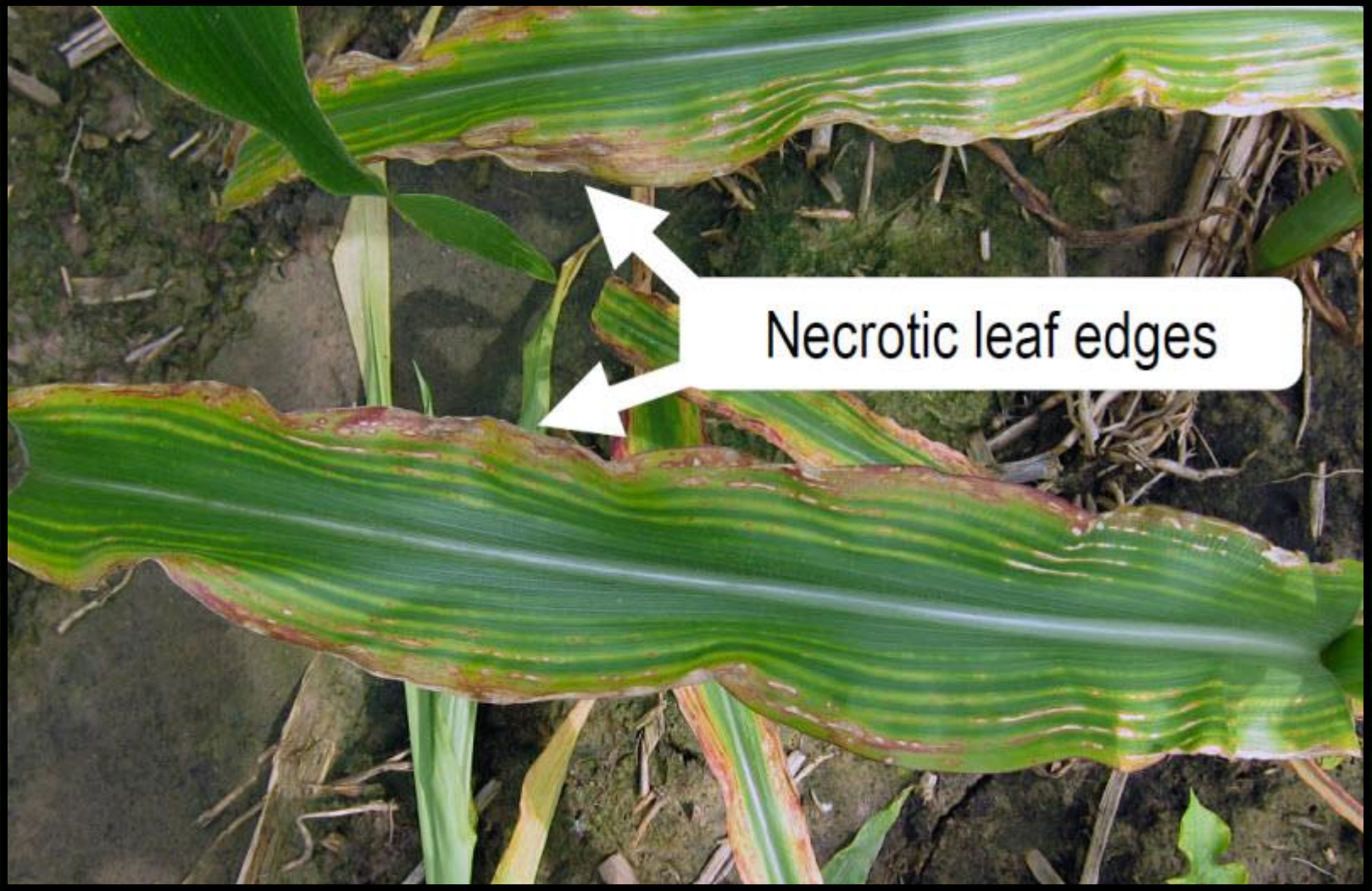
- **Chlorosis:**
  - Loss of chlorophyll leading to yellowing of leaf.
  - The deficiency of elements: N, K, Mg, S, Fe, Mn, Zn and Mo.

CHLOROSIS



Necrosis:

- Death of leaf tissue.
- Caused due to deficiency of Ca, Mg, Cu and K.


Necrotic leaf edges

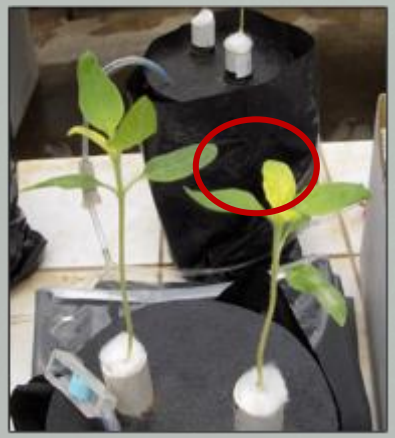
- **Stunted growth and premature fall of leaves and buds:**

  Deficiency of N, K, Mg, S, Fe, Mn, Zn and Mo
- **Inhibition of cell division:**

  Deficiency of N, K, S, Mo.
- **Delay flowering:**

  Deficiency of N, S, Mo.

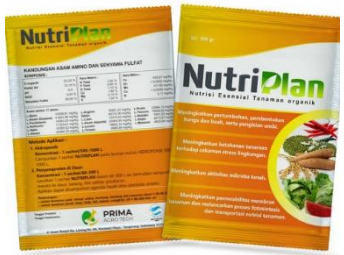
- N



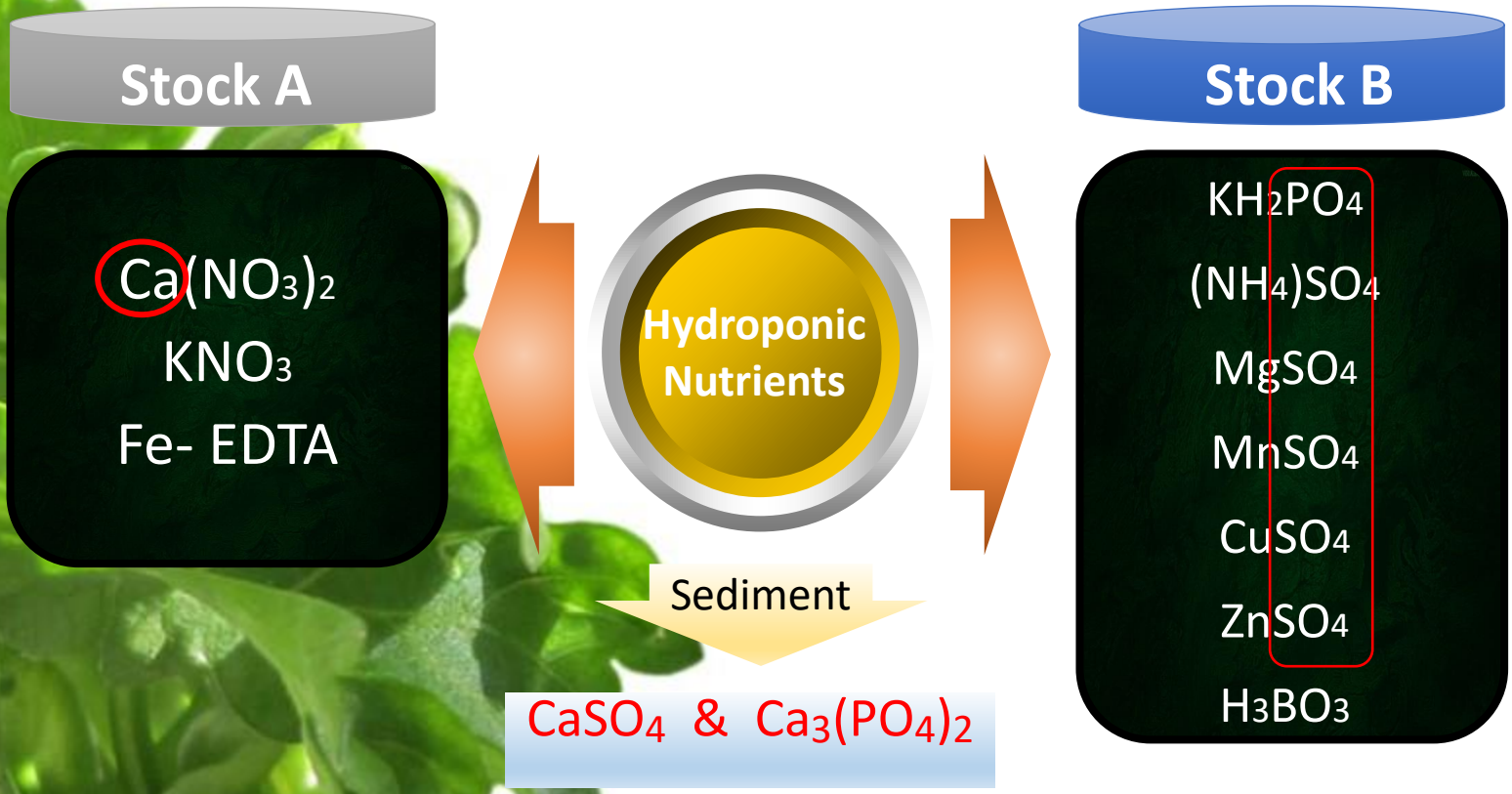
- Fe

Hydroponic Nutrients

AB MIX



Hydroponic Nutrient



Hydroponic Nutrient

1

Find out the nutrient tolerant range

?

2

Determine what plant needs:

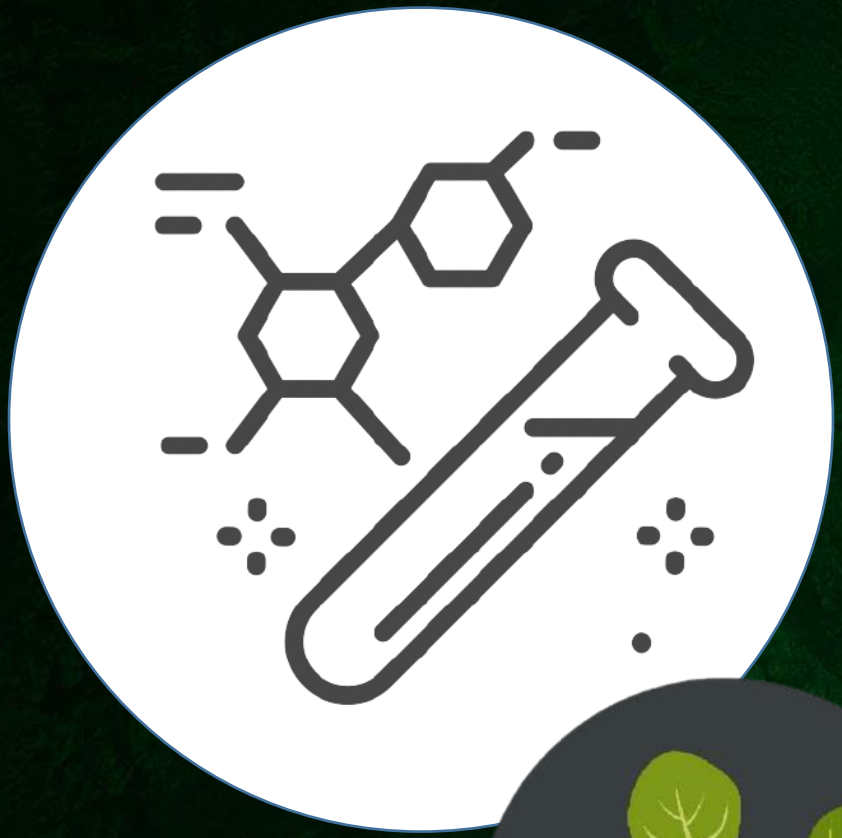
- Plants types & variety
- The part that is utilized
- Plant age
- Antagonistic properties among the nutrients

3

Calculating the nutrient composition

Nutrient	Antagonism with
Nitrogen	Potassium
Phosphorous	Zinc
Potassium	Nitrogen, Calcium, Magnesium
Sodium	Potassium, Calcium, Magnesium
Calcium	Magnesium, Boron
Magnesium	Calcium
Iron	Manganese

Sanchez *et al*. 2021



Calculating the Hydroponic Nutrients composition

Hydroponic Nutrient

Nutrient tolerate range

Nutrient elements	ppm
NITROGEN (N, 14)	140 – 300
PHOSPOROUS (P, 31)	31 – 80
POTASSIUM (K, 39)	160 – 400
CALCIUM (Ca, 40)	100 – 200
MAGNESIUM (Mg, 24)	24 – 75
SULFUR (S, 32)	32 – 400
IRON (Fe, 56)	0,75 – 5
BORON (B, 11)	0,06 – 1
MANGANESE (Mn, 55)	0,11 – 2
ZINC (Zn, 65)	0,04 – 0,68
COPPER (Cu, 64)	0,02 – 0,75
MOLIBDENUM (Mo, 96)	0,001 – 0,04

Plant needs

Lettuce, mustard greens	Tomatoes
250	250
80	60
300	350
160	170
80	50
125	65
1,0	12
0,5	2,0
0,5	0,1
0,25	0,3
0,18	0,1
0,01	0,2

Macro elements	Atomic weight
Nitrogen (N)	14.01 (14)
Phosphorus (P)	30.97 (31)
Potassium (K)	39.10 (39)
Calcium (Ca)	40.08 (40)
Magnesium (Mg)	24.31 (24)
Sulphur (S)	32.06 (32)
Oxygen (O)	16.00 (16)
Carbon (C)	12.01 (12)
Hydrogen (H)	1.008 (1)
Micro elements	**Atomic weight**
Iron (Fe)	55.85 (56)
Boron (B)	10.81 (11)
Manganese (Mn)	54.94 (55)
Zinc (Zn)	65.37 (65)
Copper (Cu)	63.54 (64)
Molybdenum (Mo)	95.94 (96)
Chlorine (Cl)	35.45 (35)
Sodium (Na)	22.99 (23)

Macro and micro element atomic weight which can be used in the calculation of hydroponic fertilizer formula

Hydroponic Nutrient

Calculating the amount of compounds

$5Ca(NO_3)_2.NH_4.NO_3.10H_2O$ → 185 g in 1.000 L x 100/18,5 = **1000 g**

Ca = 18,5 %

NO_3 = 14,2 %

NH_4 = 1,3 %

Ca → 185 ppm

The amount of NO_3 and NH_4 :

NO_3 = 14,2 % x 1000 = 142 g/1.000 L

NH_4 = 1,3 % x 1000 = 13 g/1.000 L

Eq. The requirements element for water spinach

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13			185		

Hydroponic Nutrient

$MgSO_4.7H_2O$ → 62 g in 1.000 L x 100/9,7 = **639 g**

Mg = 9,7 %

S = 13 %

Mg → 62 ppm

The amount of S :

S = 13 % x 639 = 83 g/1.000 L

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13			185	62	83

Hydroponic Nutrient

The amount K_2SO_4 → 27 g in 1.000 L x 100/18,4 = **147 g**

S = 18,4 %

K = 44,8 %

S → 27 ppm

The amounts of K :

K = 44,8 % x 147 = 66 g/1.000 L

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13		66	185	62	83+27

Hydroponic Nutrient

The amount of **KNO_3** → 80 g in 1.000 L x 100/14 = **571 g**

NO_3 = 14 %

K = 39 %

NO_3 → 80 ppm

The amount of potassium is

K = 39 % x 571 → 223 g/1.000 L

Nutrients	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Amounts	142+13+80		66+223	185	62	83+27

Hydroponic Nutrient

The amount of
$NH_4.H_2.PO_4$
NH_4 = 12 %
P = 27 %
NH_4 ⟶ 15 ppm

⟶ 15 g in 1.000 L x 100/12 = **125 g**

The amount of P :
P = 27 % x 125 = 34 g/1.000 L

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13+80+15	34	66+223	185	62	83+27

Hydroponic Nutrient

Amount KH_2PO_4

P = 22,8 %

K = 28,7 %

P → 28 ppm

→ 28 g in 1.000 L x 100/22,8 = **123 g**

The Amount of K :

K = 28,7 % x 123 = 35 g/1.000 L

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13+80+15	34+28	66+223+35	185	62	83+27

Hydroponic Nutrient

Complete micronutrients pack

Fe : 1,3 ppm
Mn : 0,68 ppm
Cu : 0,68 ppm
Bo : 0,35 ppm
Zn : 0,28 ppm
Mo : 0,03 ppm

The amounts of micronutrients is **40 g/1.000 L**

Nutrient	N	P	K	Ca	Mg	S
g/1.000L	250	62	300	185	62	110
Sum	142+13+80+15	34+28	66+223+35	185	62	83+27

Hydroponic Nutrient

Stock	Compound	Amounts g/1.000 L
A	$5Ca(NO_3)_2.NH_4.NO_3.10H_2O$	1000
B	$MgSO_4.7H_2O$	639
B	K_2SO_4	147
A or B	KNO_3	571
B	$NH_4.H_2.PO_4$	125
B	KH_2PO_4	123
A	Complete Micro Element	40

Diluted into 1000 liters of solution

Hydroponic Nutrient

Dosage

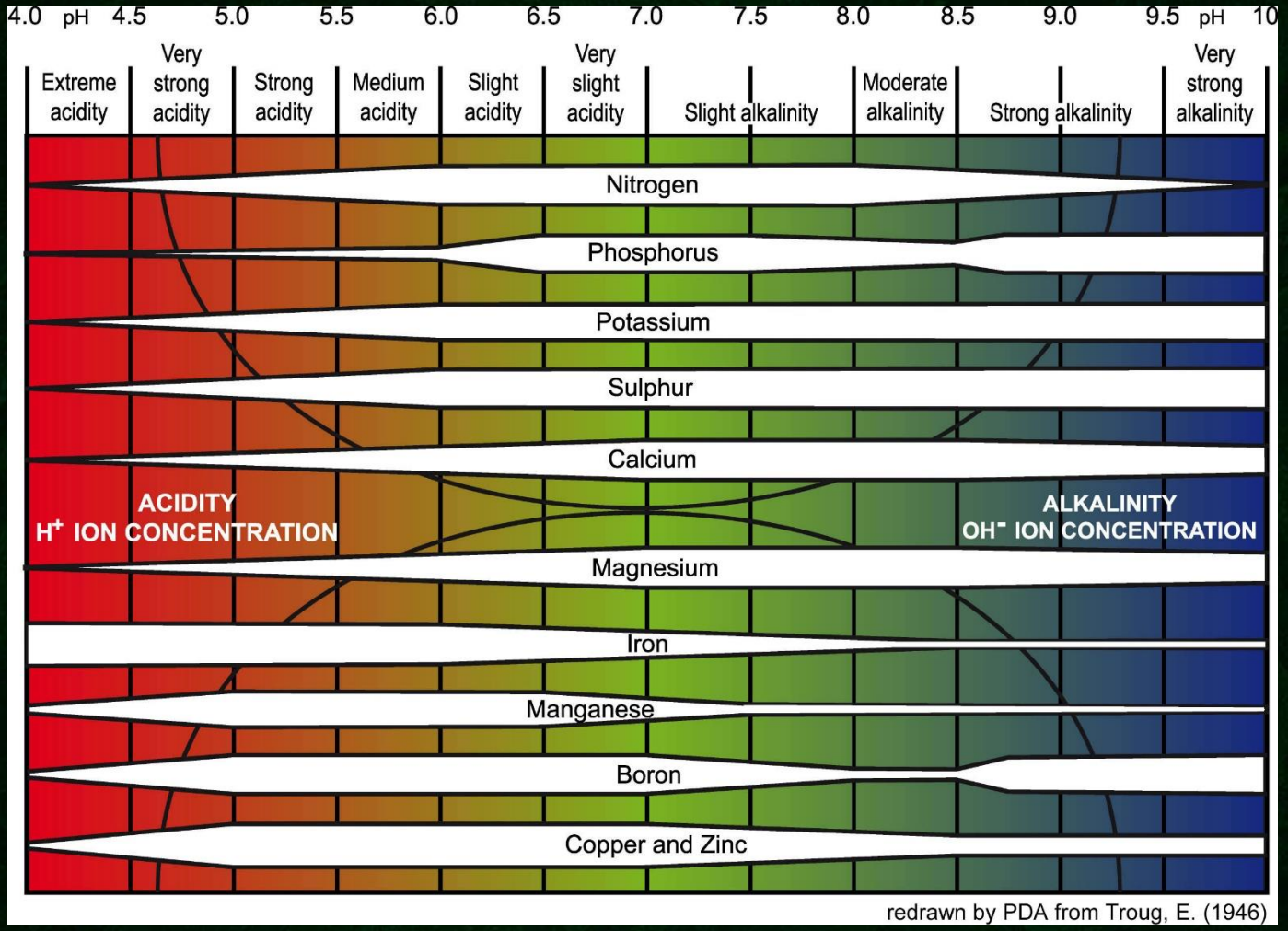
Dissolved into 5 liters of solution per stock

Stock A 5 Liter
Stock B 5 Liter

Example:
If we need 600 liters of solution, the stock needed is :
600 Liter / 200 = 3 L of Stok A and 3 L of Stok B

Example : composition formula of commercial hydroponic nutrient

Elements	Leafy vegetable (lettuce, spinach, kale, mustard)	Fruit (Tomato, eggplant, paprika pepper, cucumber, melon	Ornamental plant (Broccoli, Adenium, Orchid, Cauliflower)	Tuber (shallot, potato, carrot, radish)
	(%)	(%)	(%)	(%)
N	20.7	17.9	18.6	18.6
Ca	14.5	14.3	12.9	13
K	24.8	28.1	30.4	28.8
Mg	5.1	5.6	5.1	5.6
S	8.9	9.5	7.7	9.6
P	5.1	6.5	6.8	5.6
Fe	0.10	0.09	0.09	0.09
Mn	0.05	0.04	0.05	0.04
Cu	0.05	0.04	0.05	0.04
B	0.03	0.02	0.02	0.02
Zn	0.02	0.02	0.02	0.02
Mo	0.001	0.001	0.001	0.001


4.0 pH 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 pH 10
Extreme acidity
Very strong acidity
Strong acidity
Medium acidity
Slight acidity
Very slight acidity
Slight alkalinity
Moderate alkalinity
Strong alkalinity
Very strong alkalinity
Nitrogen
Phosphorus
Potassium
Sulphur
Calcium
ACIDITY
H+ ION CONCENTRATION
ALKALINITY
OH- ION CONCENTRATION
Magnesium
Iron
Manganese
Boron
Copper and Zinc
redrawn by PDA from Troug, E. (1946)

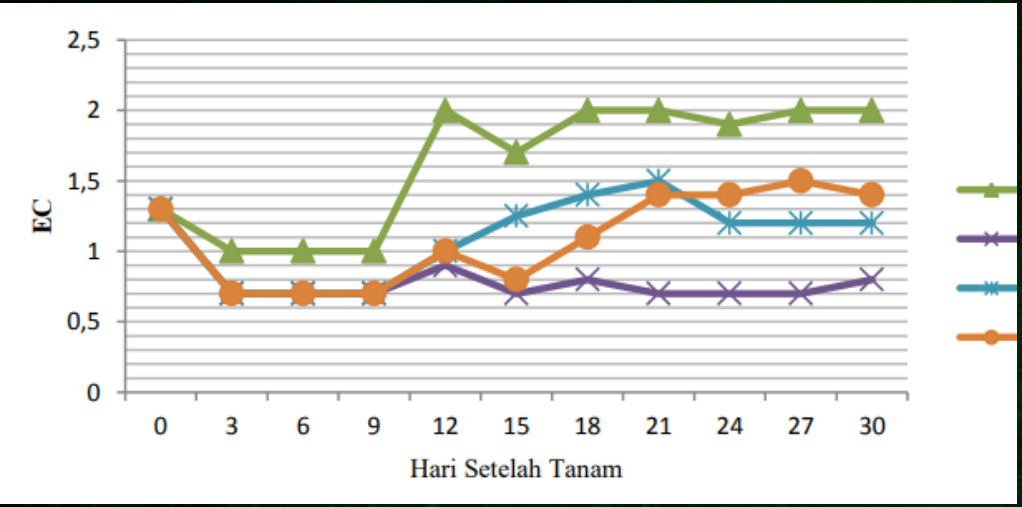
Hydroponic Nutrients from NPK

For 10 L of nutrient solution

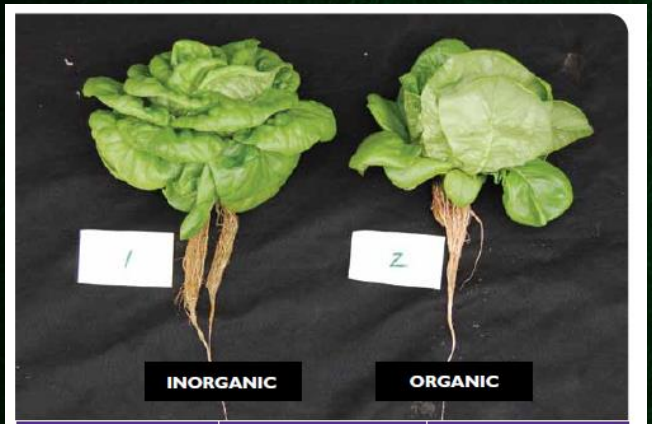
- NPK (16-16-16) : 10 g (1 table spoon)
- KCl : 10 g (1 table spoon)
- Gandasil / green growmore (leaf fertilizer) : 5 g
- 10 L fresh water

- NPK (16-16-16) : 15-30 g
- KCl : 10 g (1 table spoon)
- Gandasil D / red growmore (leaf fertilizer) : 5 g
- Urea : 15-20 g (vegetative) 7-10 g (generative)
- 10 L fresh water

Organic hydroponics?



Tanjung et al. 2018



Treatment	Fresh Weight (g)	Dry Weight (g)
Inorg (1)	268a	11.2a
Org (2)	177a	6.0b

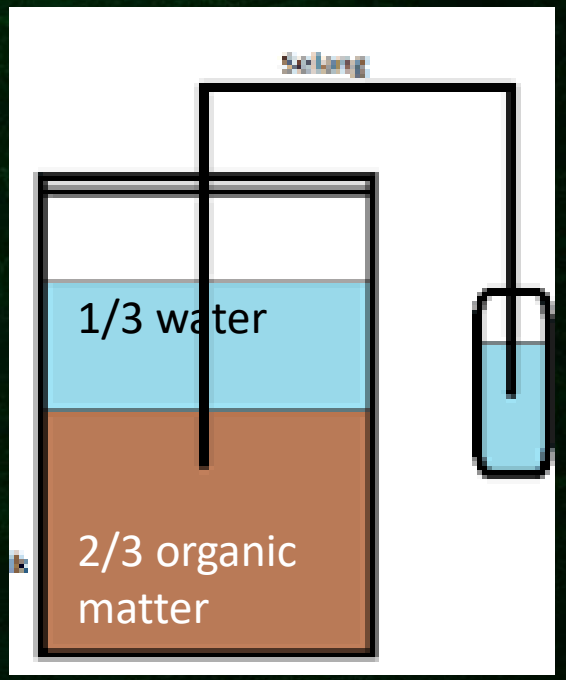
Averages with the same lesser are not statistically different from each other.

Williams *et al.* 2013

- Most Countries do not allow hydroponics to be labeled organic
- Nutrient content in organic fertilizers is uncertain (elements, pH, EC)

Liquid Organic Fertilizer

- 1 sacks of chicken/ goat manure (20 kg)
- ½ sacks of rice bran (10 kg)
- Rice straw or legume leaf (30 kg)
- Brown sugar 100 g
- Bio activator (EM1/ EM4) 50 ml
- 100 L capacity of bucket or container
- Aerator hose
- Water
- Mineral plastic bottle



7-10 days

Filtered

1 L for 100 L solution

WHAT IS ECO ENZYME?

Fruit Waste 3 : Brown sugar 1 : Water 10

Eco Enzyme

@zerowaste.id_offical

3 Months

High Acidity / low PH

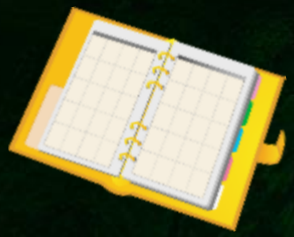
Orange peel : 2.87

Diluted > 1000 times before use as fertilizer

Added to AB Mixed nutrients solution for hydroponics maintain to 1200 ppm

Hydroponic Nutrient

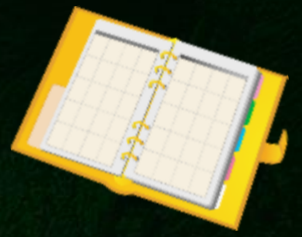
Managing the Quality of Hydroponic Nutrition



Tips

- Water quality - salinity, concentration of harmful elements dissolved in water (such as sodium, chloride and boron);
- The nutrients needed and their concentration in hydroponic nutrient solutions;
- Nutritional balance;
- The pH of the hydroponic nutrient solution and its effect on nutrient uptake by plants.

Hydroponic Nutrient



Tips

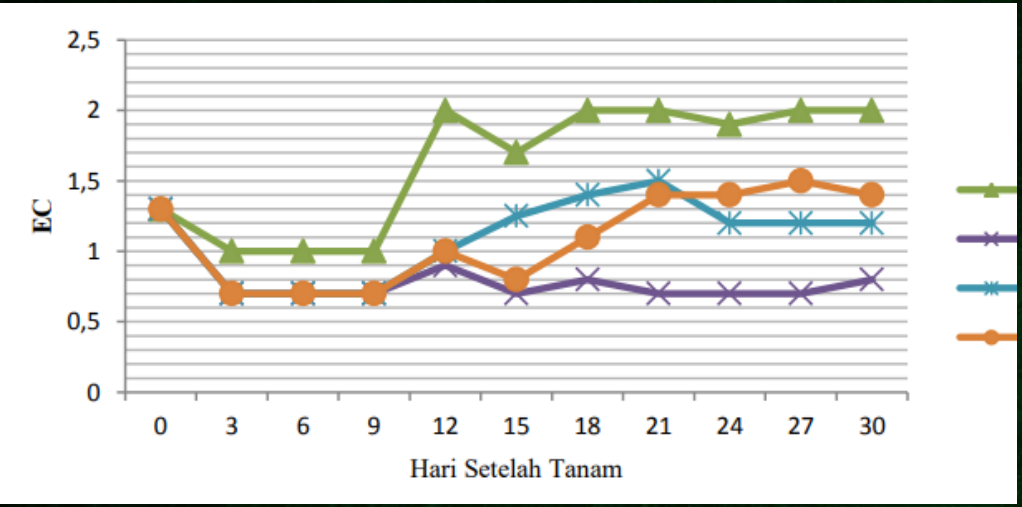
To use in the circulation system

- Periodically check the pH and EC of the nutrient solution
- The volume of the nutrient solution is adjusted to the number of plants
- The volume of nutrient solution must be maintained from the beginning of planting until harvest
- The water discharge is between 1-2 liters / minute and the slope of the gutter is between 3-5% (NFT)

To use of non-circulating systems

Nutrient solution is splashed into the substrate and stop before water drips out from the bottom of the pot

Organic hydroponics?



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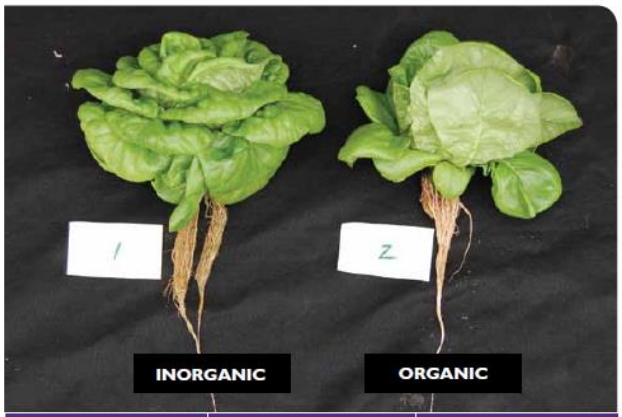

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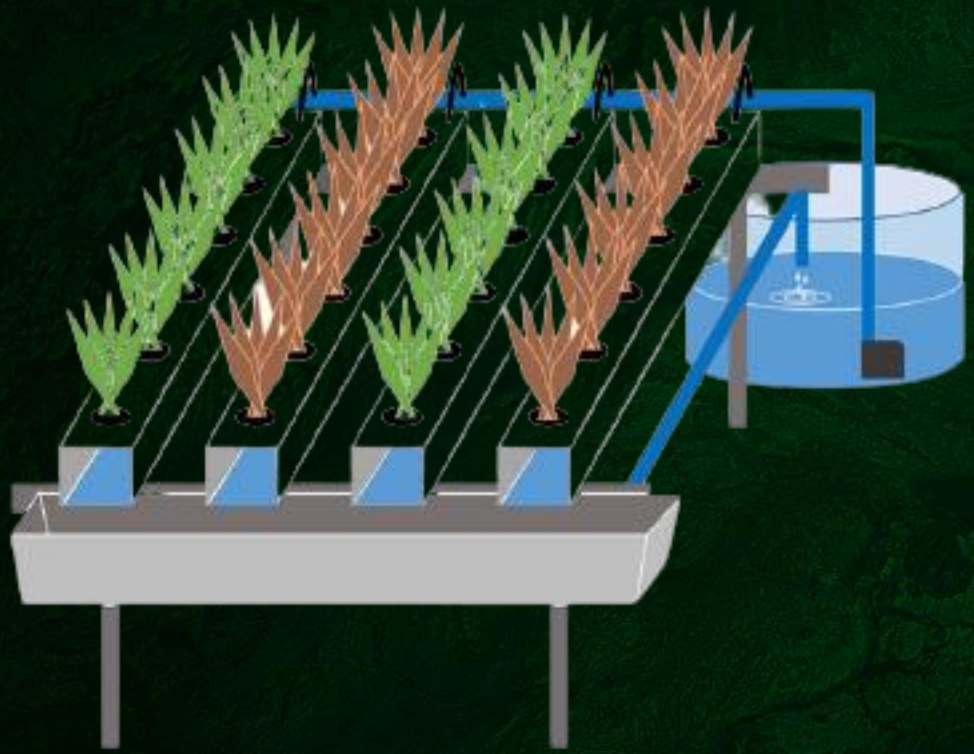
Hydroponics



Aquaponic

https://www.utakatikotak.com/_blank/kongkow/detail/14997#

Hydroponic nutrient in Aquaponic

- Water from fish pond (Tilapia fish) used in Aquaponics, Basil and lettuce yield reduced 56 and 67% from hydroponic (Yang and Kim 2020)

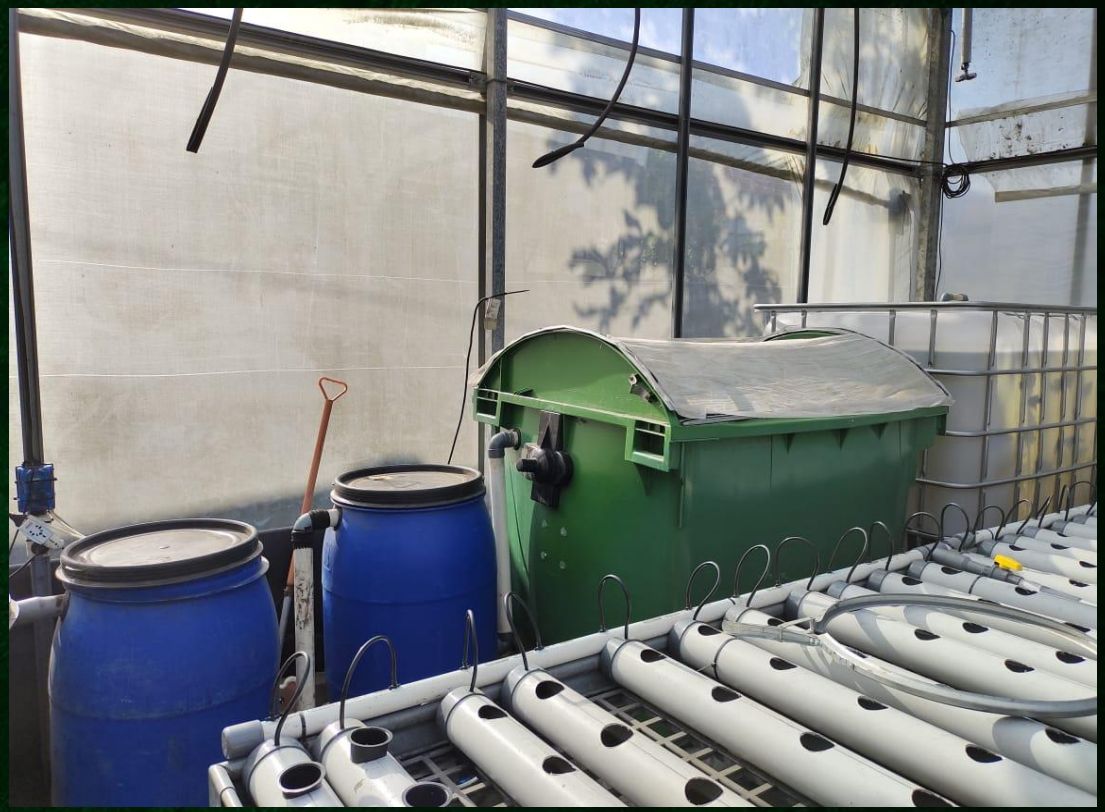
- Nutrient from aquaculture sludge similar with conventional nutrient (Ezziddine *et al* 2021)

Aquaponic in the bucket
(catfish and kangkong)

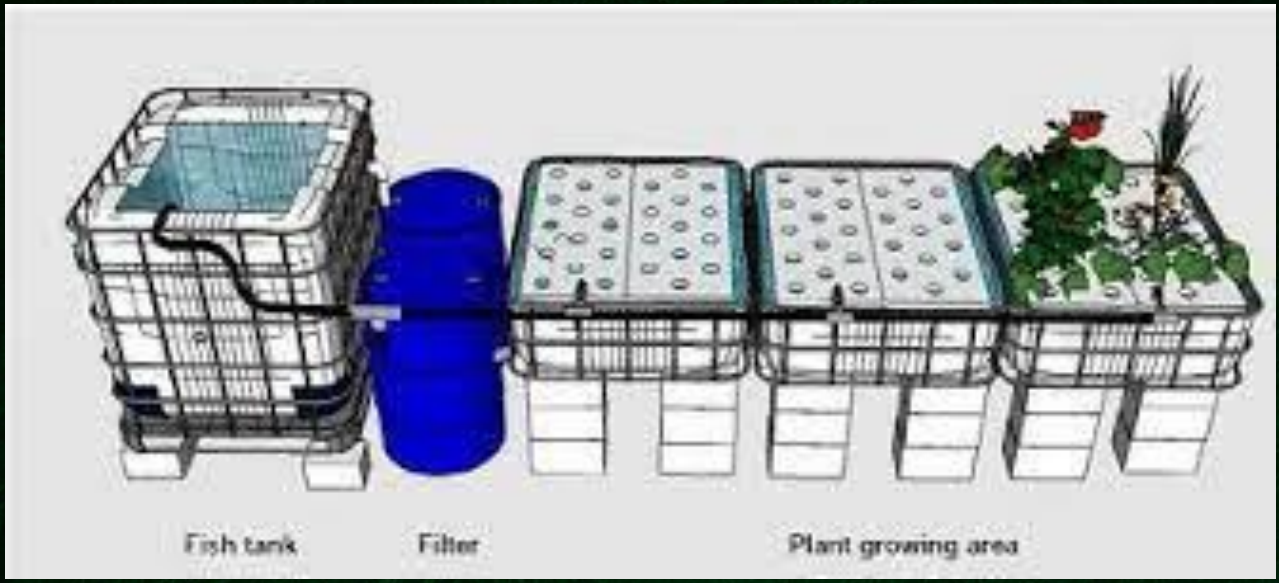
Simple aquaponic (tilapia and
celery)

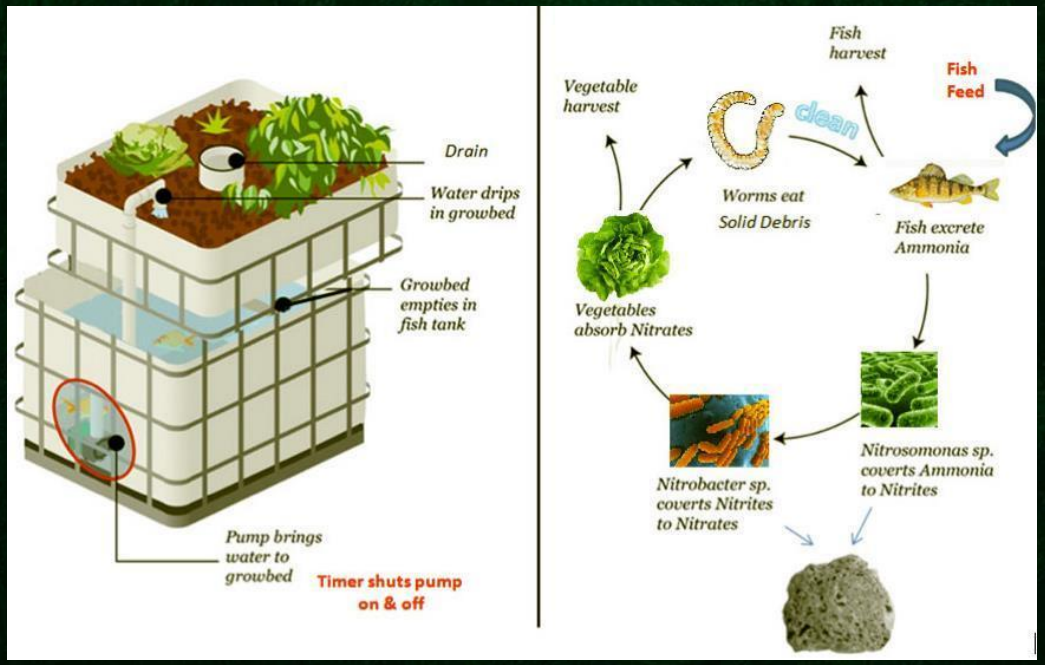
Without filter

Using filter



Aquaponic system in ICAT Lembang

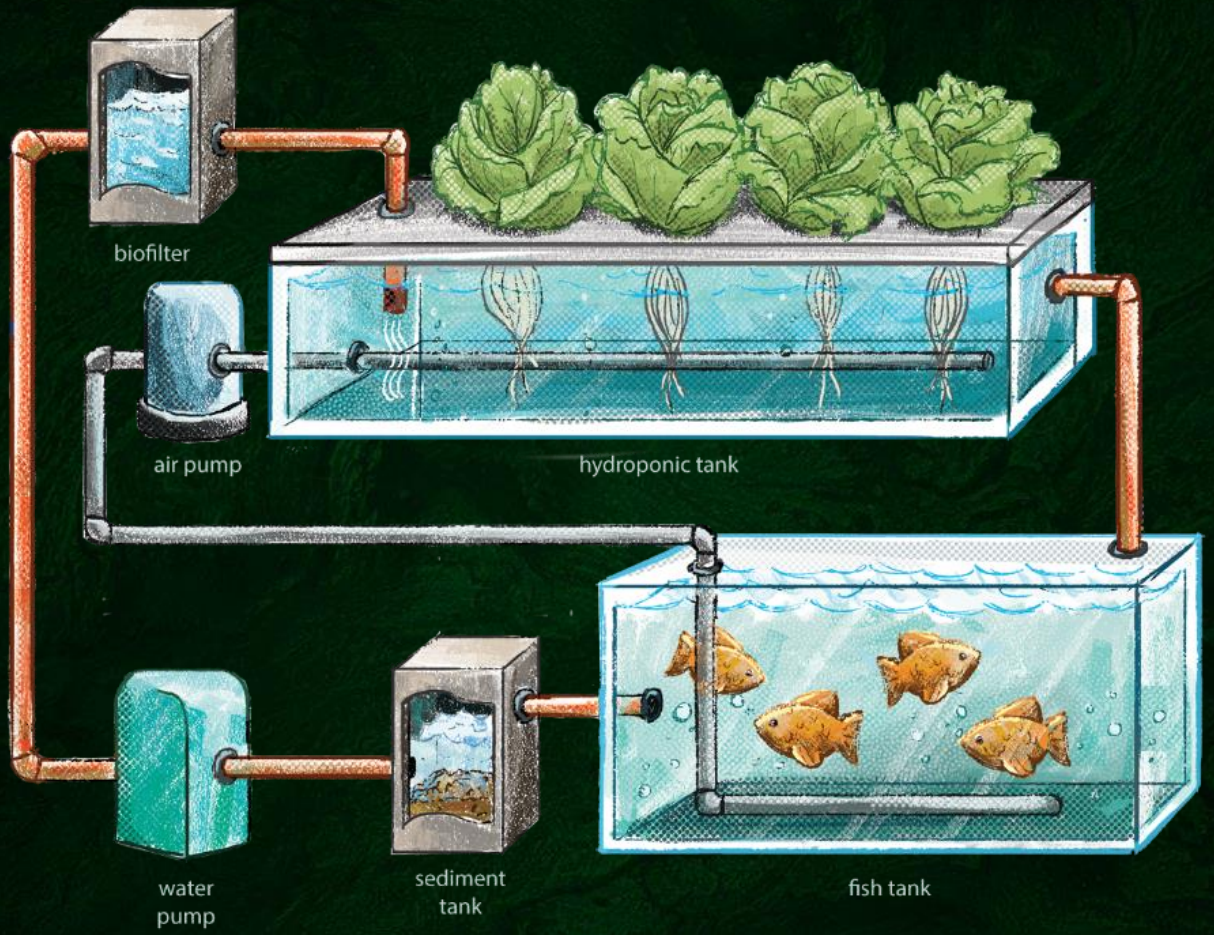

Fish tank
Filter
Plant growing area


Drain
Water drips in growbed
Growbed empties in fish tank
Pump brings water to growbed
Timer shuts pump on & off
Fish harvest
Fish Feed
Vegetable harvest
clean
Worms eat Solid Debris
Fish excrete Ammonia
Vegetables absorb Nitrates
Nitrosomonas sp. coverts Ammonia to Nitrites
Nitrobacter sp. coverts Nitrites to Nitrates

Biofilter

Bio ball

Kaldness


biofilter
air pump
hydroponic tank
water pump
sediment tank
fish tank

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THANK YOU!