



Centurion
UNIVERSITY

*Shaping Lives...
Engineering Communities...*

Hydroponics Technology





Centurion
UNIVERSITY
Shaping Lives...
Empowering Communities...

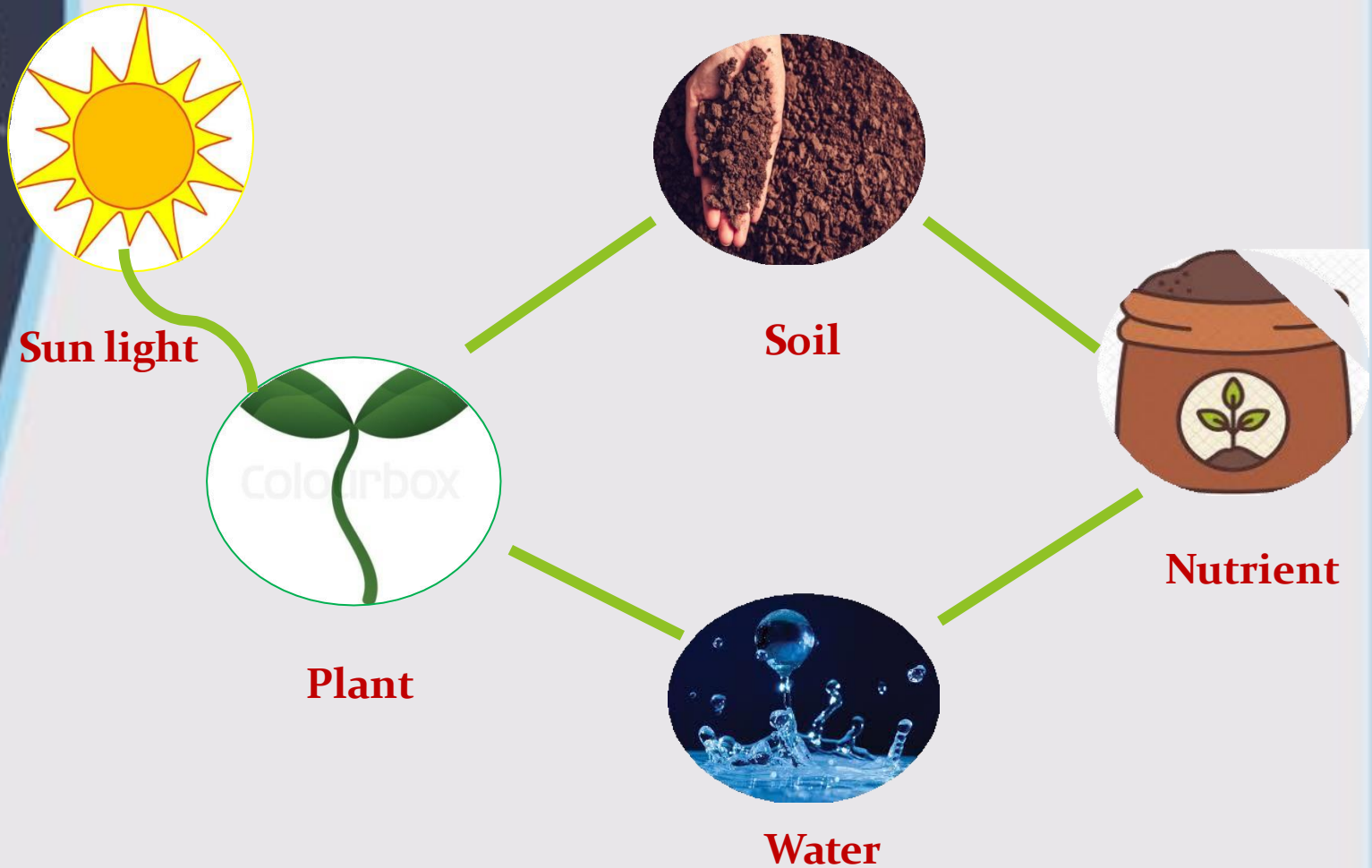
Historical Background

- ❖ The classic work on growing terrestrial plants without soil was published by Sir Francis Bacon in 1627, in the book named 'Sylva Sylvarum'.
- ❖ It was Professor William Frederick Gericke (1937), who finally introduced the term hydroponics and wrote the book named 'Complete Guide to Soilless Gardening'
- ❖ Hydroponics did not reach India until 1946. The first research studies were started at the Government of Bengal's Experimental Farm at Kalimpong in the Darjeeling district.



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities*

What does a plant need to grow ?



Soil is just a medium to provide nutrients to the plant. Water is as good a medium as soil.



Centurion
UNIVERSITY

Shaping Lives...
Engineering Communities...



- The word hydroponics has derived from combining the two Greek words, hydro, meaning water, and ponos, meaning labor (i.e., working water).
- It is a method of growing plants using a solution of suitable nutrients instead of soil and the plants need some type of inert medium to support the root system.

**Greater
control of
nutrients**

**No soil
needed**

**Saves
water**

**Plants grow
faster and
larger**

**Better
utilization
of space**

Advantages

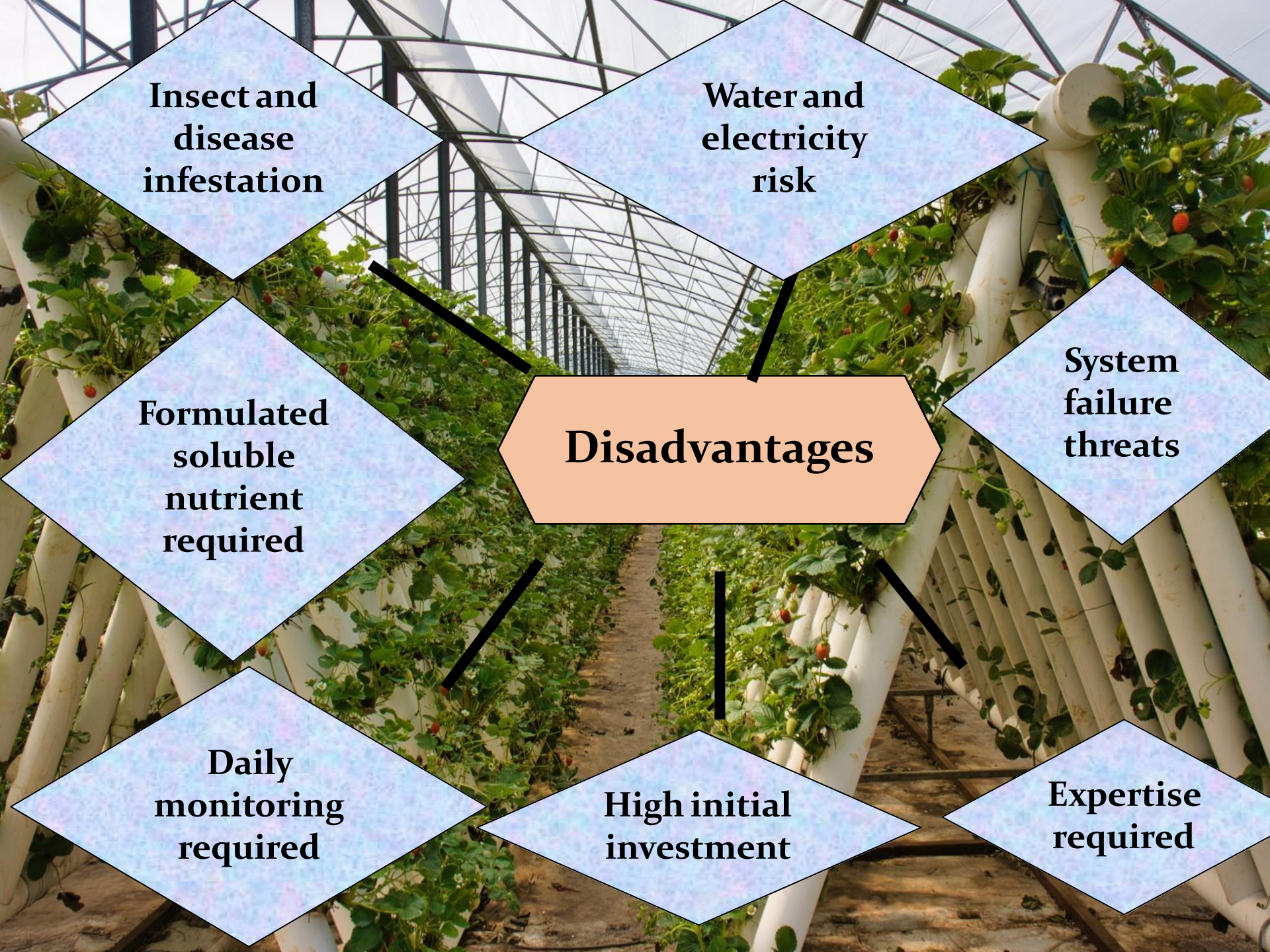
**Off season
production**

**No tillage,
Weeds, less
pests**

**Controlled
climate**

**Less labor
intensive**

**Ease of
harvesting**



Insect and disease infestation

Water and electricity risk

System failure threats

Disadvantages

Formulated soluble nutrient required

Daily monitoring required

High initial investment

Expertise required



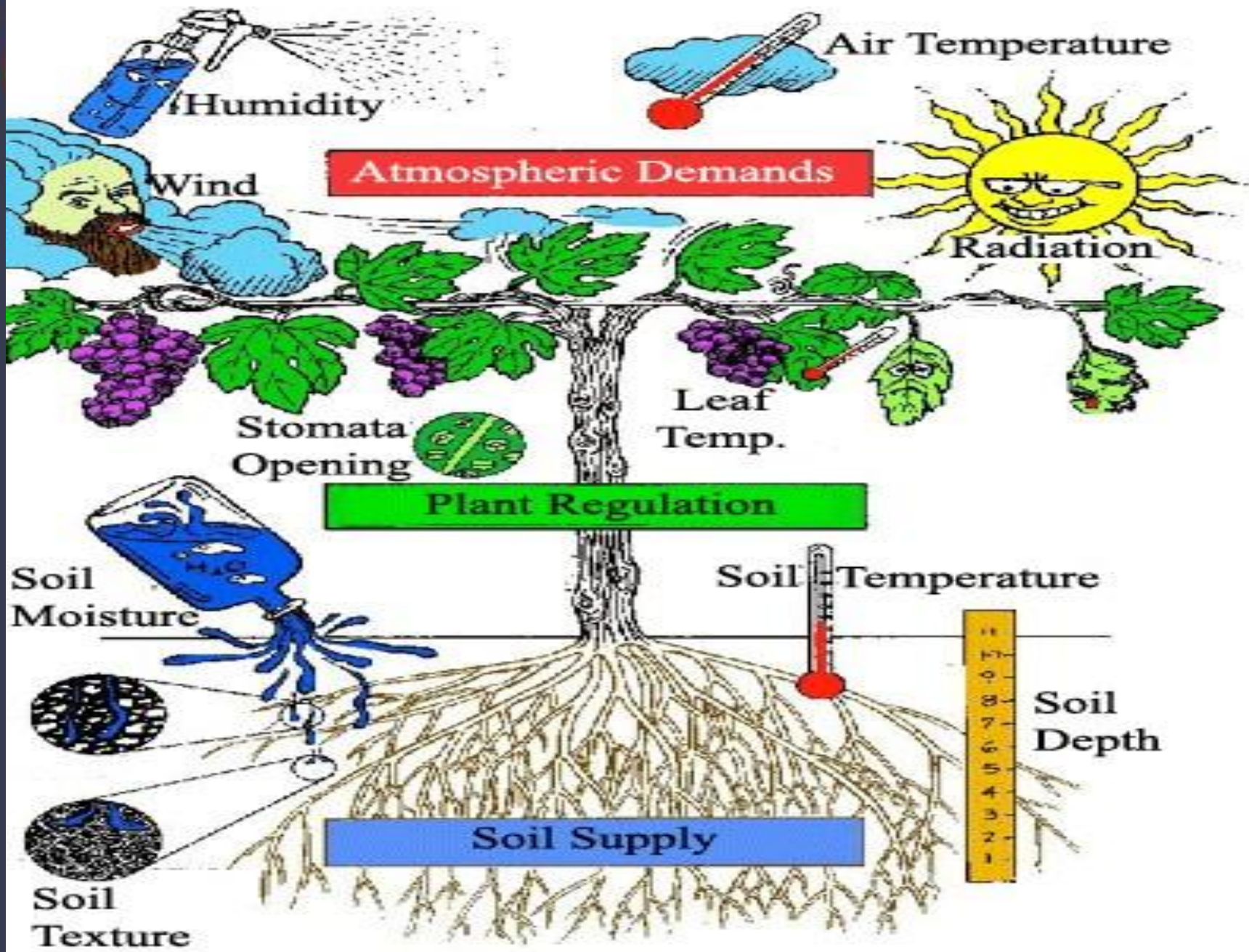
Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Scope and Importance of hydroponics

- ❖ Hydroponics scope is very good especially in India as most of the vegetable supplies available are with residual chemicals and harmful to our health. No matter how rich or poor we are, these vegetable supplies are same for all of us and affect to us and our children.
- ❖ Entrepreneurs with visions could enter into commercial farming and flood hydroponic vegetables to the super market stores on big margin and earn tax free, market slump free regular income.



**Session-2: Plant Growth Requirements,
Importance of light, temperature and
humidity**



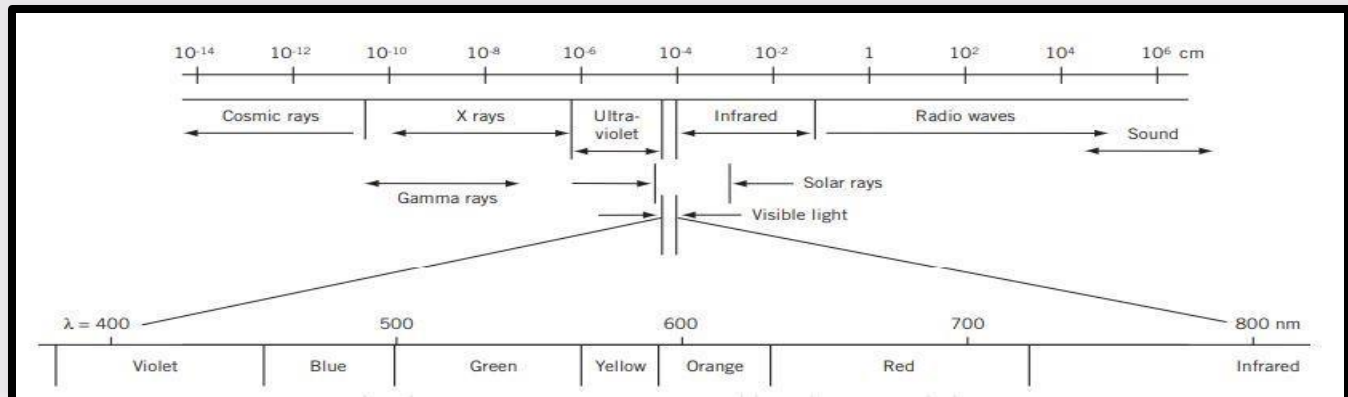


Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Importance of light to the plants

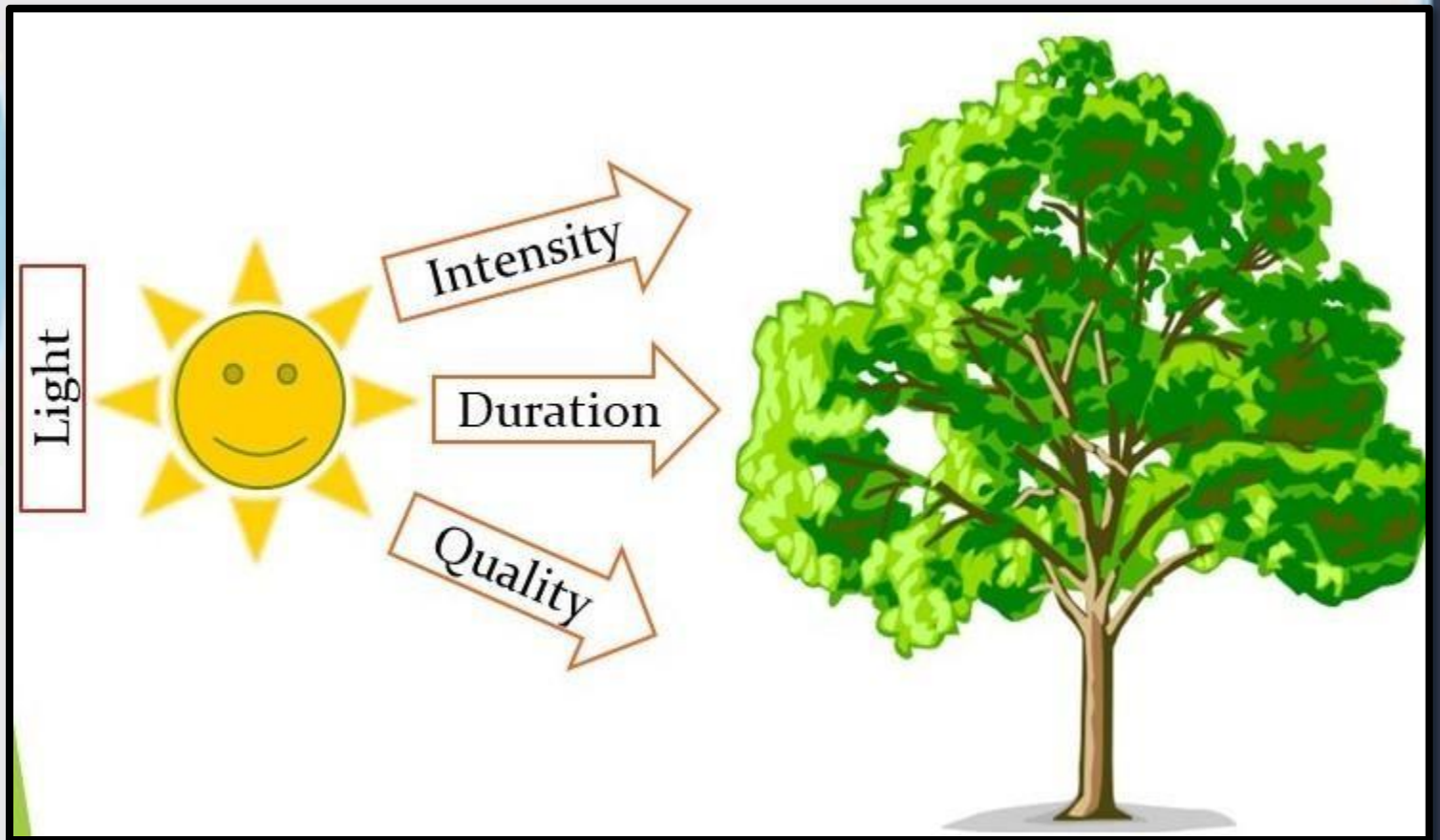
- ▶ Light is an essential factor in maintaining plants.
- ▶ The rate of growth and length of time a plant remains active is dependent on the amount of light it receives.
- ▶ Light energy is used in photosynthesis, the plant's most basic metabolic process.
- ▶ When determining the effect of light on plant growth there are three areas to





Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...



Light affects plant growth in three different ways:

- a. Intensity
- b. Duration
- c. Quality



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Importance of temperature on crop plants

Growth and development

Leaf production, expansion and flowering

Physical and chemical processes within the plants

Enzymatic activities

Biochemical reactions in crops

Temperature



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

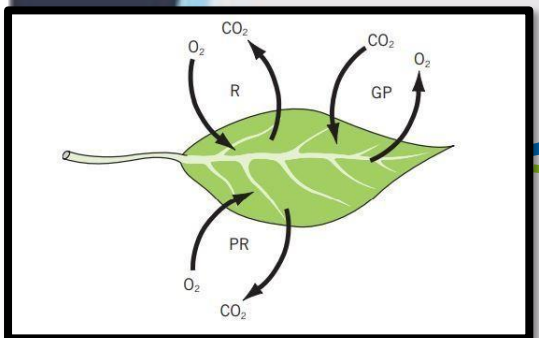
Effects of humidity on crops

Humidity

Keeping the stomata open

Cooling of the plant

Reduce transpiration loss





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Horizontal air flow fans are a good way of moving air to avoid varied temperatures in the greenhouse



Source: Premier Tech Horticulture



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Improving the microclimate

- ▶ To improve the microclimate, you can keep extra humidity in the plants by providing good coverage.
- ▶ In addition, it can also be improved by watering.
- ▶ An irrigation pipe is the best option to moisten the top layer of the substrate than an irrigation tube.
- ▶ Especially for countries with a warmer climate, it is therefore necessary to have an irrigation pipe to improve the microclimate.
- ▶ By moistening the top layer of the substrate, water from the substrate can evaporate better, which improves the microclimate.

Nutrient requirements, deficiencies and toxicities





Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

There are seventeen essential nutrients that are supplied to crops. Of these, three are available through water uptake and gas exchange (the air): Carbon through CO_2 , hydrogen, and oxygen.

Six macronutrients are N, P, K, Ca, Mg and S and others are micronutrients



Lastly added essential micronutrient is Ni and it is essential for regulating N metabolism, grain filling and seed viability.



Centurion

Role of different nutrients in plant growth

TABLE I: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient family	Nutrient	Percentage of plant	Form taken up by plants (ion)	Mode of uptake	Major functions in plants
Primary	Carbon	45	Carbon dioxide (CO ₂), bicarbonate (HCO ₃ ⁻)	Open stomates	Plant structures
	Oxygen	45	Water (H ₂ O)	Mass flow	Respiration, energy production, plant structures
	Hydrogen	6.0	Water (H ₂ O)	Mass flow	pH regulation, water retention, synthesis of carbohydrates
	Nitrogen	1.75	Nitrate (NO ₃ ⁻), ammonium (NH ₄ ⁺)	Mass flow	Protein/amino acids, chlorophyll, cell formation
	Phosphorus	0.25	Dihydrogen phosphate (H ₂ PO ₄ ⁻), HPO ₄ ²⁻ , phosphate (PO ₄ ³⁻)	Root interception	Cell formation, protein syntheses, fat and carbohydrate metabolism
	Potassium	1.5	Potassium ion (K ⁺)	Mass flow	Water regulation, enzyme activity
Secondary	Calcium	0.50	Calcium ion (Ca ²⁺)	Mass flow	Root permeability, enzyme activity
	Magnesium	0.20	Magnesium ion (Mg ²⁺)	Mass flow	Chlorophyll, fat formation and metabolism
	Sulfur	0.03	Sulfate (SO ₄ ²⁻)	Mass flow	Protein, amino acid, vitamin and oil formation
Micro	Chlorine	0.01	Chloride (Cl ⁻)	Root interception	Chlorophyll formation, enzyme activity, cellular development
	Iron	0.01	Iron ion (Fe ²⁺ , Fe ³⁺)	Root interception	Enzyme development and activity
	Zinc	0.002	Zinc ion (Zn ²⁺)	Root interception	Enzyme activity
	Manganese	0.005	Manganese ion (Mn ²⁺)	Root interception	Enzyme activity and pigmentation
	Boron	0.0001	Boric acid (H ₃ BO ₃), borate (BO ₃ ³⁻), tetraborate (B ₄ O ₇)	Root interception	Enzyme activity
	Copper	0.0001	Copper ion (Cu ²⁺)	Mass flow	Enzyme activity
	Molybdenum	0.00001	Molybdenum ions (HMoO ₄ ⁻ , MoO ₄ ²⁻)	Mass flow	Enzyme activity and nitrogen fixation in legumes



Centurion
UNIVERSITY

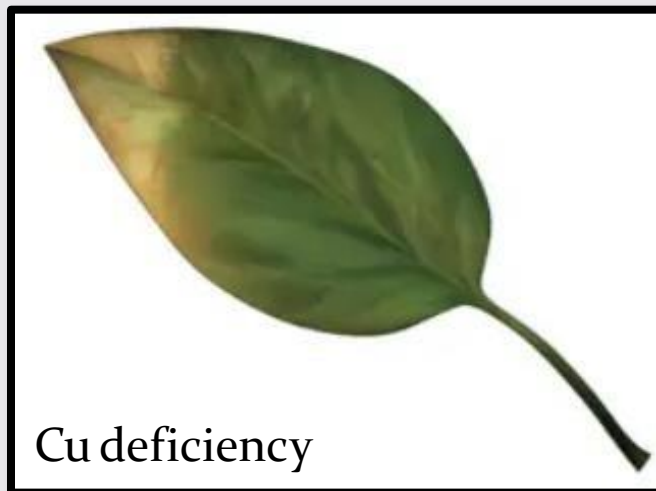
Shaping Lives...
Empowering Communities...



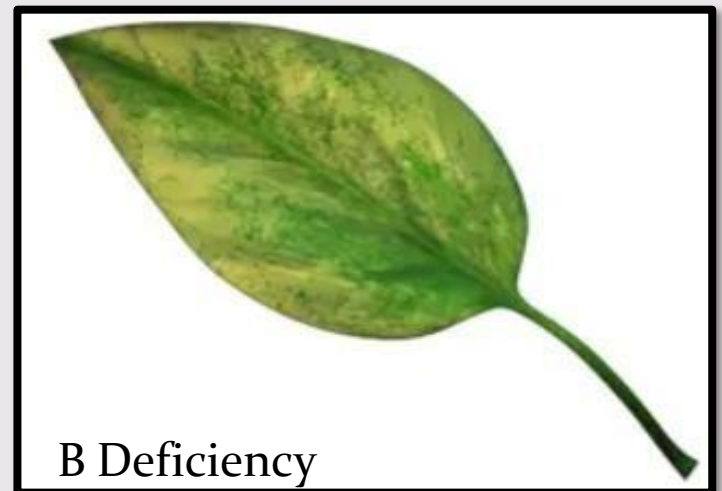
Mg Deficiency



Fe deficiency



Cu deficiency



B Deficiency



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities*

Toxicity Symptoms for Essential Elements

- N:** Restricted root system. Potatoes form only small tubers, and flowering and seed production can be retarded.
- P:** Sometimes copper and zinc deficiency occurs in the presence of excess phosphorus
- K:** Oranges develop coarse fruit at high potassium levels. Excess potassium may lead to magnesium deficiency and possible manganese, zinc, or iron deficiency
- S:** Reduction in growth and leaf size. Leaf symptoms often absent or poorly defined. Sometimes interveinal yellowing or leaf burning.



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Mg: Mg: Very little information available on visual symptoms.

Ca: Usually associated with excess carbonate

Fe: It appears as necrotic spots.

Cl: Burning or firing of leaf tip or margins. Bronzing, yellowing, and leaf abscission and sometimes chlorosis. Reduced leaf size and lower growth rate



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Mn: Sometimes chlorosis, uneven chlorophyll distribution, and iron deficiency (pineapple). Reduction in growth.

Cl: Burning or firing of leaf tip or margins. Bronzing, yellowing, and leaf abscission and sometimes chlorosis. Reduced leaf size and lower growth rate

Zn: Excess zinc commonly produces iron chlorosis in plants.

Cu: Reduced growth followed by symptoms of iron chlorosis, stunting, reduced branching, thickening, and abnormal darkening of rootlets.

Mo: Leaves turn golden yellow



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Hydroponic Growing Systems - basic concepts and designs



**Centurion
UNIVERSITY**

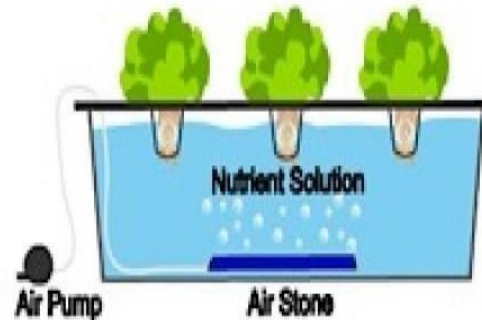
*Shaping Lives...
Empowering Communities*

Types of Hydroponics

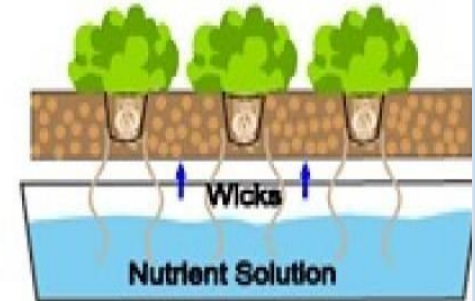
Nutrient Film Technique



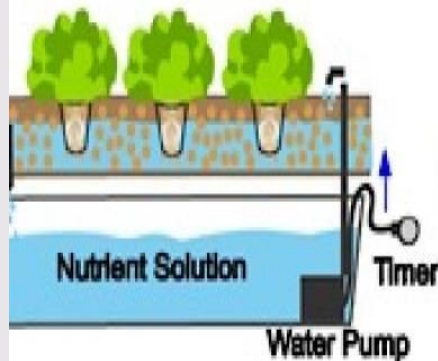
Deep Water Culture (DWC)



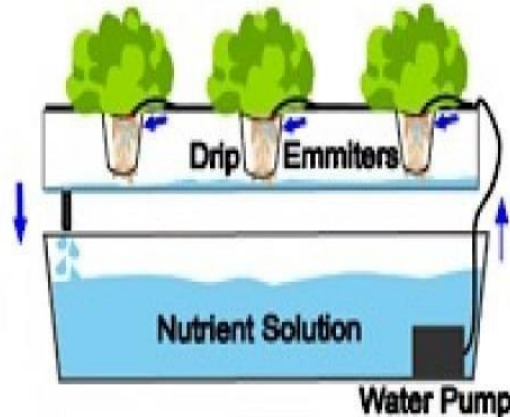
Wick System



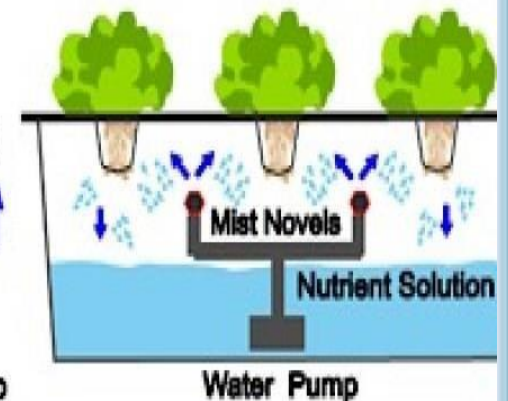
Ebb And Flow



Drip System



Aeroponics



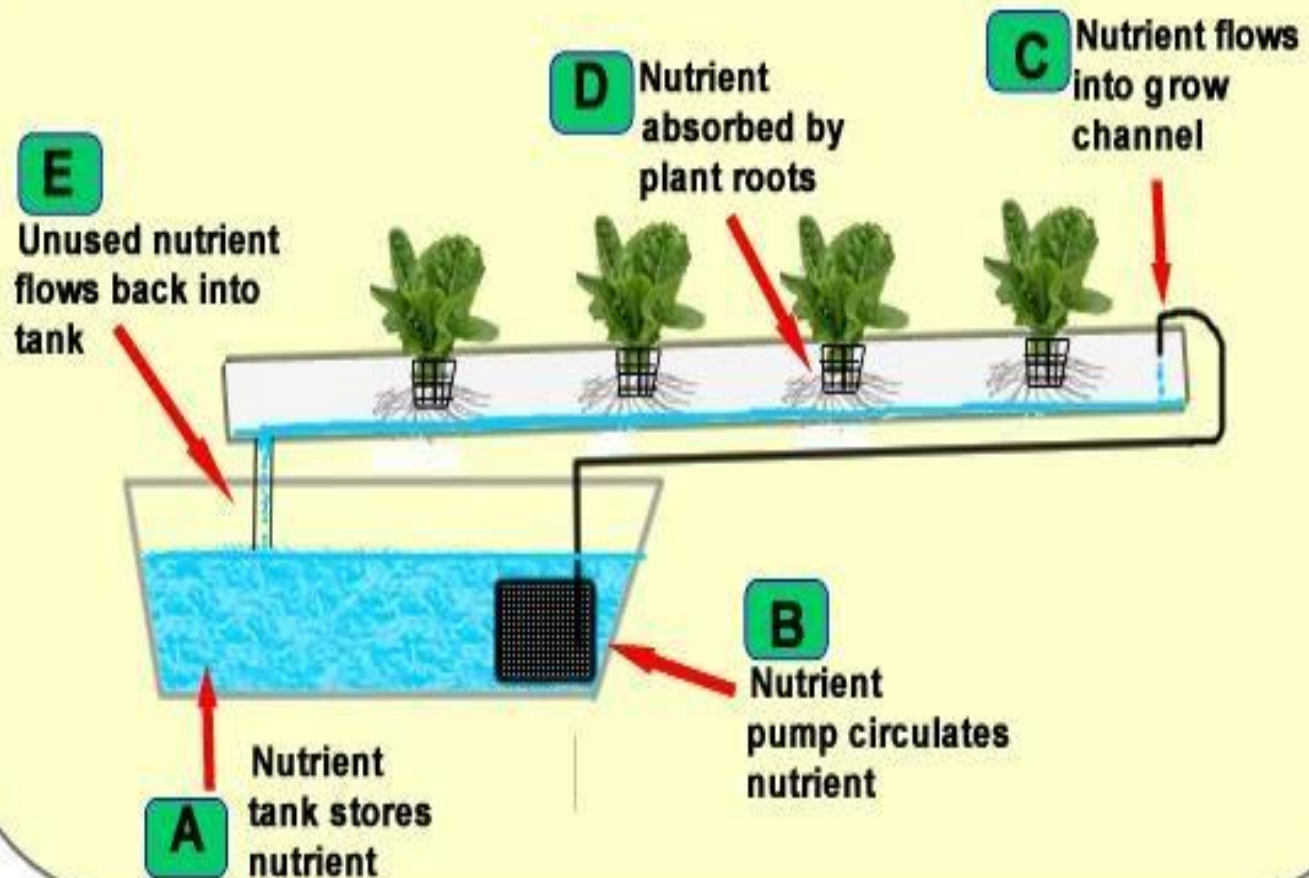


Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities

1. Nutrient film technique systems

Nutrient Film Technique





Centurion
UNIVERSITY

*Shaping Lives
Empowering Communities*





Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

Pros of a nutrient film technique system

➤ **Low consumption:**

Since NFT hydroponics recirculate the water they do not demand large quantities of water or nutrients to function.

➤ **Modular design:**

Nutrient film technique systems are perfect for large-scale and commercial endeavors. Once you have one channel set up and functioning, it is very easy to expand.



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Cons of nutrient film technique system

➤ **Pump failure:**

If the pump fails and the channel is no longer circulating the nutrient film, your plants will dry out. In a matter of hours, your entire crop can perish if it is not being supplied with water.

➤ **Overcrowding:**

If the plants are spaced too close together or the root growth is too proliferate, the channel can become clogged. If the channel is obstructed by roots, water will be unable to flow and your plants will starve.



Centurion
UNIVERSITY

*Shaping Lives
Empowering Communities*

Deep water culture, Ebb & Flow



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities*

2. Deep water culture systems

Deep water culture hydroponics are simply plants suspended in aerated water. Deep water culture systems, also known as a DWC system, are one of the easiest and most popular methods of hydroponics on the market. A DWC system dangles net pots holding plants over a deep reservoir of oxygen-rich nutrient solution. The plant's roots are submerged in the solution, providing it with perpetual access to nutrition, water, and oxygen. Deep water culture is considered by some to be the purest form of hydroponics.



Methi grown in deep water hydroponics



Coriander grown in deep water hydroponics



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities*

Pros of deep water culture systems

❖ **Low maintenance:**

Once a DWC system is set up, there's very little maintenance required. Just replenish the nutrient solution when needed and make sure your pump is running oxygen to the air stone.

❖ **DIY appeal:**

Unlike many hydroponic systems, deep water culture systems can be made cheaply and easily at home, with a quick run to your pet store and local nursery to pick up the air pump and nutrients.



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities*

Cons of deep water culture systems

❖ Limitations

Deep water culture systems are adept at growing herbs and lettuce but they struggle with larger and more slow-growing plants. DWC systems are not ideal for anything that flowers.

❖ Temperature control

It's important that your water solution does not exceed 68°F and does not go below 60°F. In a DWC system, the water is static and not recirculating, so it can be more difficult to regulate temperature.



Centurion
UNIVERSITY

*Shaping Lives
Empowering Communities*

3. Ebb and flow systems





Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities

Pros of Ebb and flow systems

❖ **Versatility:**

With an ebb and flow system, you can grow much larger plants than in most other hydroponic systems. Fruits, flowers, and vegetables alike respond very well to ebb and flow hydroponics.

❖ **DIY appeal:**

There are hundreds of ways to construct your own ebb and flow hydroponic system at home. A visit to the hardware store and pet store will provide you with all the supplies you need to construct an ebb and flow system.



Centurion
UNIVERSITY
*Shaping Lives
Empowering Communities*

Cons of Ebb and flow systems

❖ Pump failure:

Like any hydroponic system reliant on a pump, if the pump ceases to work, your plants will die. You do have to monitor your ebb and flow system to ensure that the system's performance is not compromising the health of your plants.

❖ Rot & disease:

Sanitation and maintenance are essential to an ebb and flow system. If the bed is not draining properly, root diseases and rot can set in. A dirty ebb and flow system can grow mold and attract insects. If you neglect cleanliness, your crops will suffer.



Centurion
UNIVERSITY

*Shaping Lives
Empowering Communities*

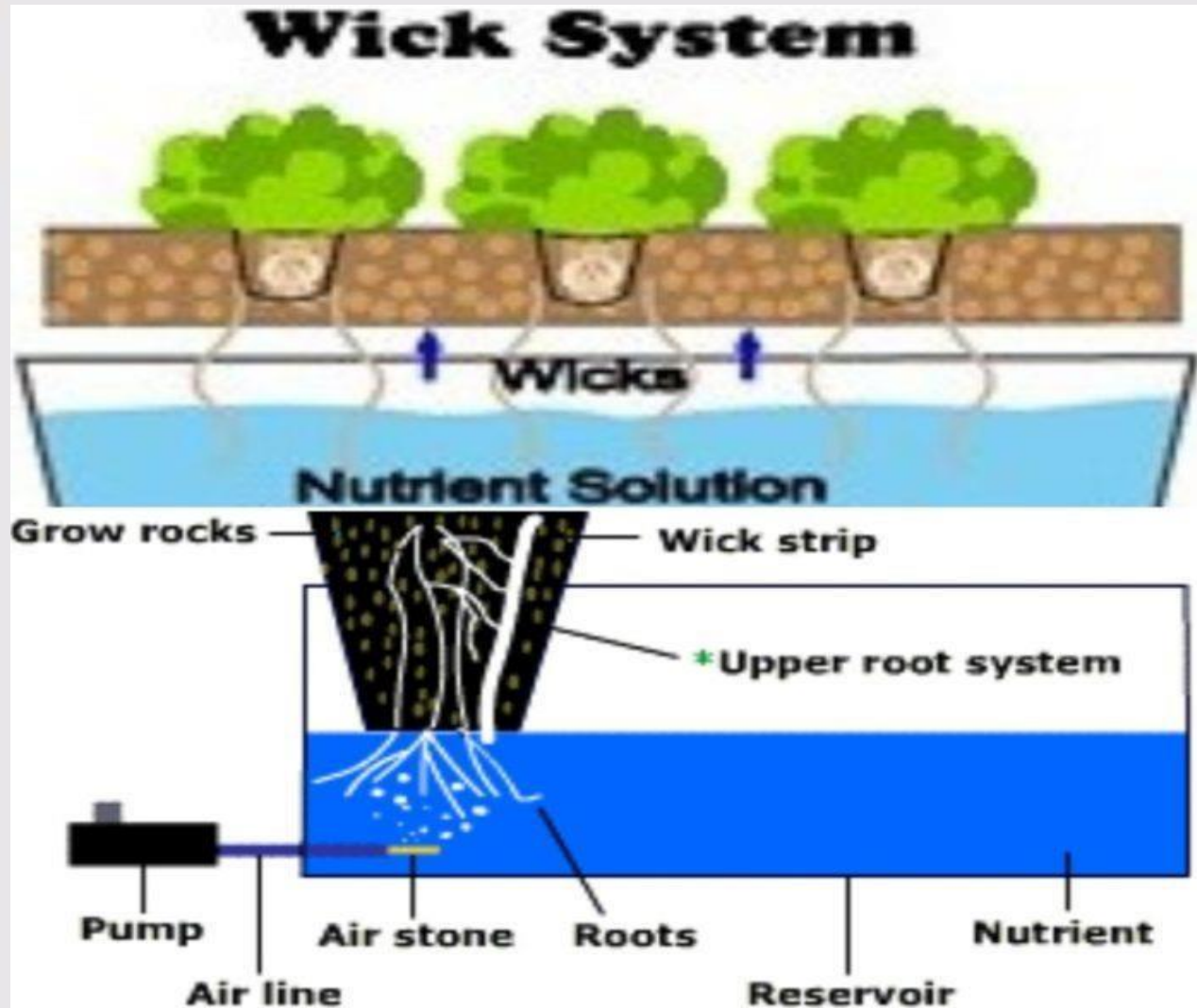
Other Techniques - wick systems, flood & drain, bag culture, aeroponics, etc.



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

4. Wick systems





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Pros of a wick system

- ❖ Simplicity
- ❖ Space-efficient

Cons of a wick system

- ❖ Limitations
- ❖ Susceptible to rot



**Centurion
UNIVERSITY**

*Shaping Lives...
Empowering Communities...*

5. Drip systems





**Centurion
UNIVERSITY**

*Shaping Lives
Empowering Communities*





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Pros of a drip system

- ❖ Variety of plant options
- ❖ Scale

Cons of a drip system

- ❖ Maintenance
- ❖ Complexity

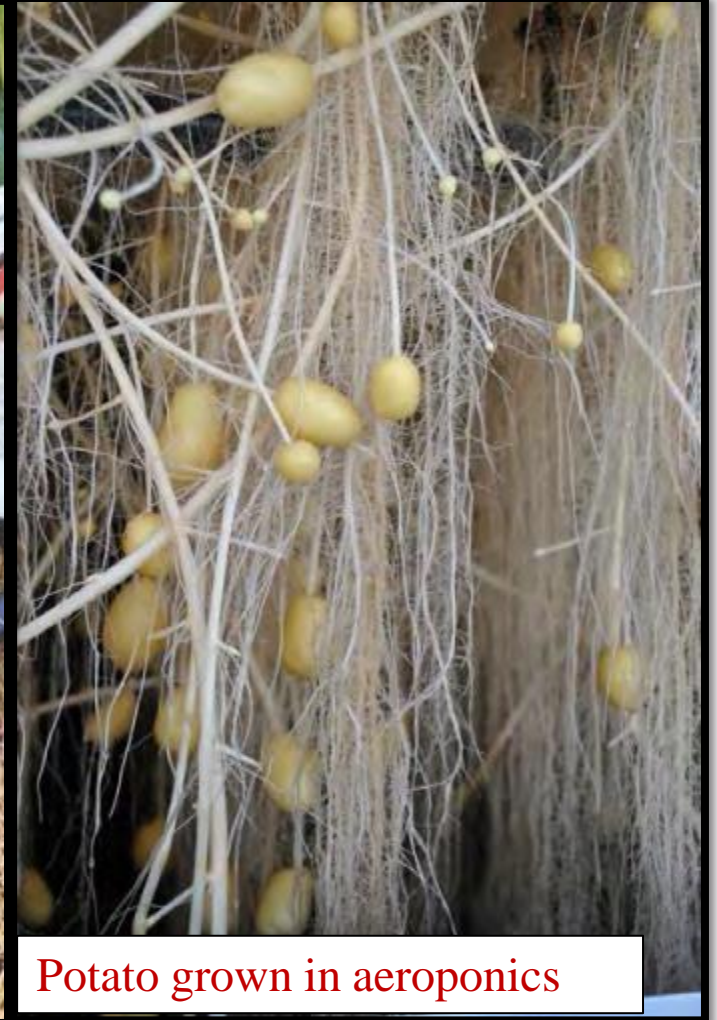


Centurion
UNIVERSITY
Shaping Lives
Empowering Communities

6. Aeroponics



Anthurium flower production



Potato grown in aeroponics

Source: Purdue University Cooperative Extension Service



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Pros of an aeroponics system

- ❖ Oxygen surplus
- ❖ Mobility

Cons of an aeroponics system

- ❖ Expensive
- ❖ Maintenance



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Sowing and crop establishment in hydroponics

Growing Media types, properties and uses



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Rockwool





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Coco coir

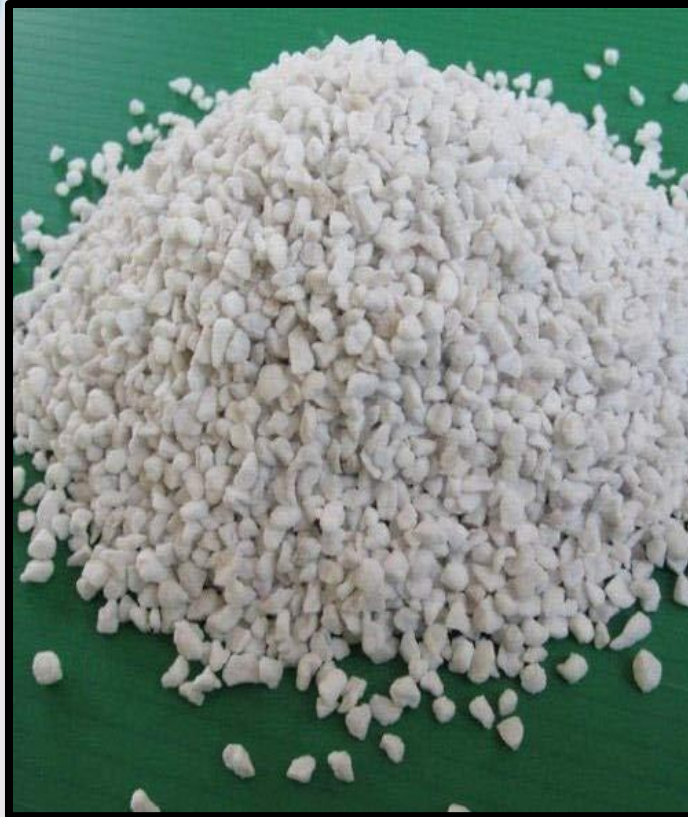




**Centurion
UNIVERSITY**

*Shaping Lives...
Empowering Communities...*

Perlite





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Vermiculite





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Oasis Cubes





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Sand





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Rice Hulls





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Identification of crops and their suitability to hydroponics system



Centurion
UNIVERSITY

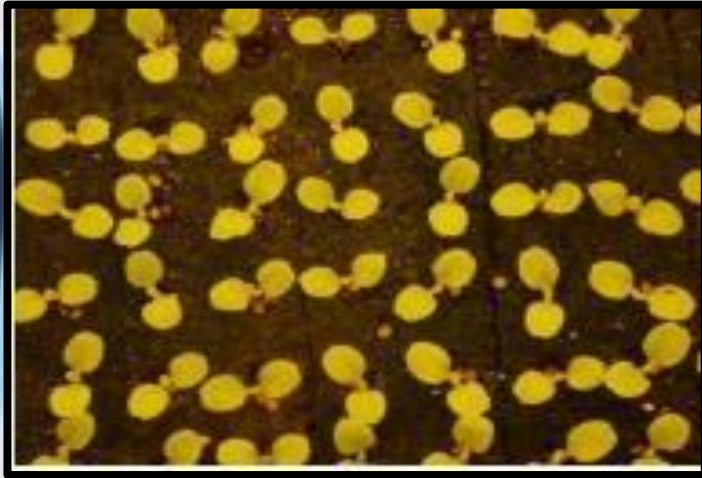
*Shaping Lives...
Empowering Communities...*

Warm Season Crops	Cool Season Crops
Spinach	Broccoli
Baby Spinach	Lettuce - all varieties of lettuce
Coriander , parsley , Celery	Cauliflower & cabbage
Amaranthus (Red,Green& Bi-color variety)	Strawberry - Perennial in nature , requires, cool season for flowering and fruiting.
Swisschard	Kale
Mint and most of Indian herb varieties	Bokchoy , Watercress



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities*



Day 5 - Nursery



**Day 11 – Transplanting at
hydroponics system**



Day 21 – Transplant



Day 35 – Harvest



Centurion
UNIVERSITY

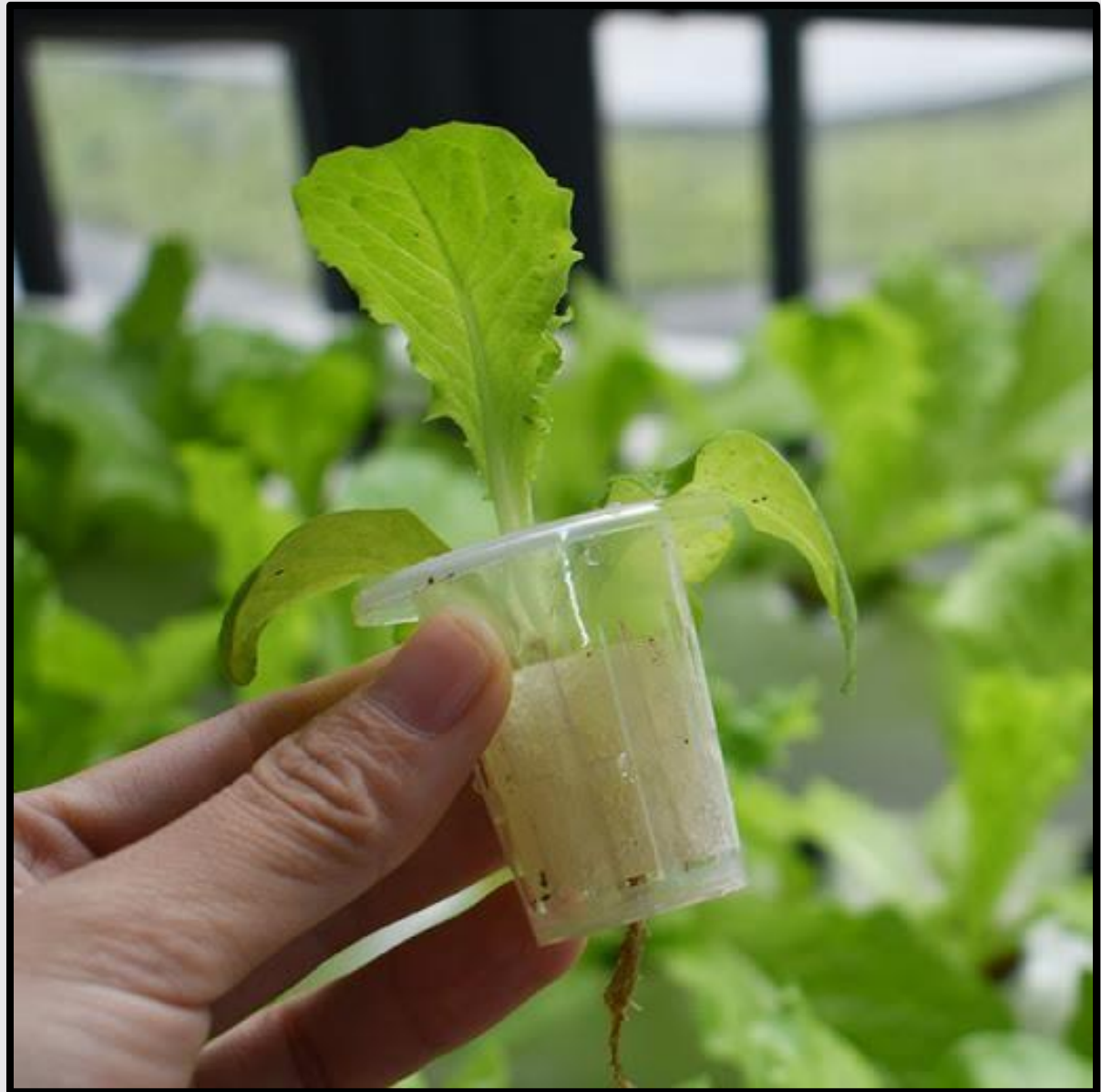
*Shaping Lives
Empowering Communities*





Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*





Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

Propagation: Seed vs. cuttings

- Firstly, as with any type of propagation, you need to decide whether you want to grow from seeds or cuttings.
- Generally, growers who propagate from seed do so because it gives them peace of mind that their plants will be disease and pest free.



Centurion
UNIVERSITY

Shaping Lives...
Empowering Communities...

- However, the main draw back with seeds is that the characteristics of plants you produce can be inconsistent.
- Whereas, with cuttings you are producing plants that are identical to their healthy parent, this is why cuttings are also referred to as ‘clones’.



**Centurion
UNIVERSITY**

*Shaping Lives...
Empowering Communities...*



**Assessment of water quality,
principal factors involving EC and pH**



Centurion
UNIVERSITY

*Shaping Lives...
Empowering Communities...*

Thank you...