

## Introduction to Hydroponic for Asian Leafy Greens

Getting your plant nutrients right is the foundation of successful hydroponic farming. Hydroponic plants rely on the nutrient solution provided for all the nutrient needs, making precise nutrient management essential for healthy plant growth and development. This guide will walk through the fundamentals of nutrient management, from understanding the basics to identifying deficiencies. With proper monitoring and timely adjustments, you will be able to maintain optimal plant health, improve yields.

### Understanding Plant Nutrition Basics

Plants need nutrients to grow properly. These nutrients work together to support growth, maintain plant health, and strengthen natural defenses against pests and diseases. The right fertiliser mix delivers these essential nutrients in balanced amounts that plants can use.

Two key measurements help manage nutrients effectively EC (electrical conductivity) measures the nutrient concentration in your solution, whilst pH (potential of hydrogen) indicates the acidity level that affects nutrient uptake throughout the growing cycle.

Regular lab nutrient analysis helps identify nutrient deficiencies and maintain proper EC and pH levels, ensuring essential plant requirements plant.



Healthy plant growth through effective fertiliser management

**Table 1.** List of essential nutrients and their functions

Macro nutrients	Functions	* Optimal Range (ppm)	Micro nutrients	Functions	* Optimal Range (ppm)
<b>Nitrogen (N)</b>	Formation of proteins and amino acids. Essential for vegetative growth.	150-200	<b>Iron (Fe)</b>	Essential for chlorophyll formation and efficient photosynthesis.	1-5
<b>Phosphorus (P)</b>	Energy from sunlight (ATP) used to transfer important in development of root system.	25-50	<b>Copper (Cu)</b>	Supports enzyme function and plant metabolism, helping plants produce energy and protect cells from damage.	0.02-0.2
<b>Potassium (K)</b>	Regulates water uptake and transport. Essential for flower and fruit development.	150-200	<b>Manganese (Mn)</b>	Activate enzymes that break down nutrients and produce energy for plant growth.	0.5-2
<b>Calcium (Ca)</b>	Strengthens cell walls and supports strong plant structure.	100-150	<b>Zinc (Zn)</b>	Essential for plant hormones that regulate growth and development.	0.05-0.5
<b>Magnesium (Mg)</b>	Essential for chlorophyll production and healthy green leaf development.	25-50	<b>Boron (B)</b>	Works with calcium to strengthen cell walls and help plants use calcium more effectively.	0.1-1
<b>Sulphur (S)</b>	Important for protein synthesis, enzyme activity, and disease resistance.	25-75	<b>Chlorine (Cl)</b>	Maintains electrical balance with other nutrients in plant cells for proper function.	1-5

\* ppm means "parts per million" - a unit for measuring very small concentrations.

### Visual Signs of Nutrient Deficiencies in Asian Leafy Greens

Plants show clear warning signs when they lack proper nutrients. Patterns of yellowing leaves inform you which nutrients are deficient. New leaves might stay small and misshapen instead of growing normally. Watch for yellowing between the leaf veins or along leaf edges. Poor nutrient levels also affect the whole plant structure, leading to weak stems and poor root growth. The examples below show common nutrient deficiency signs in Asian leafy greens, and the next section will help you identify which nutrients are lacking based on these visual symptoms. Asian leafy greens are particularly susceptible to iron deficiency, which commonly appears as leaf yellowing and turning white in severe deficiency.



**Kangkong**

- Upper Leaves are pale
- Sparse foliage
- Spindly growth



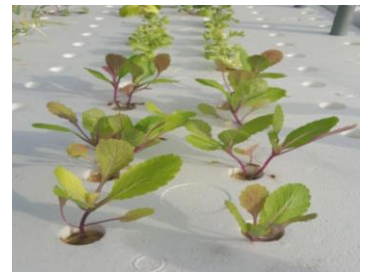
**Amaranthus**

- Leaves are pale
- Stunted growth
- Leaf tip necrosis



**Gailan**

- Leaves are yellowing
- Stunted growth
- Discoloration in mature leaves



**Leaf Mustard**

- Narrow Leaves
- Purplish stem and leaf vein
- Stunted growth

## Identifying Nutrient Deficiency Symptoms

Plants can develop problems from various causes that often look similar at first glance. Finding the right solution depends on correctly identifying whether the problem comes from living organisms (biotic) or non-living factors (abiotic) like nutrient deficiencies.

### Signs of Living Organisms (Biotic):

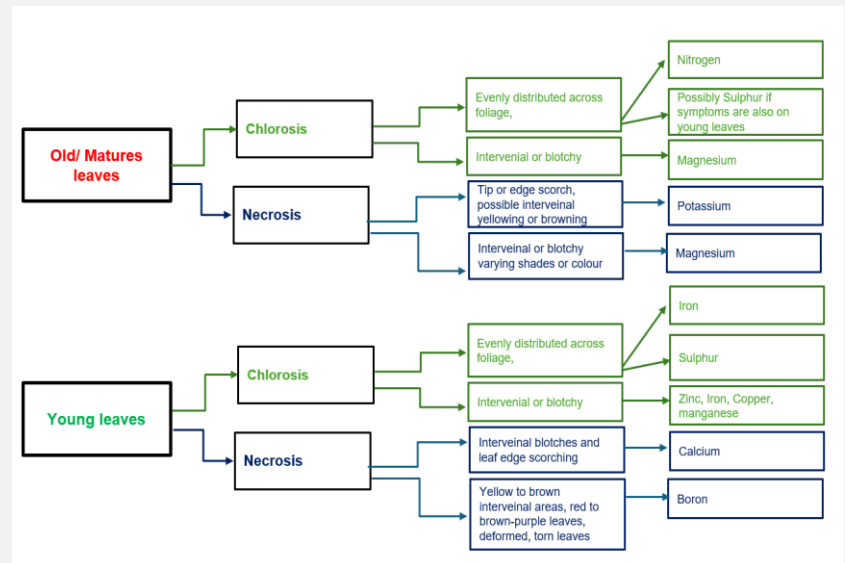
- Insects leave visible traces like webbing, eggs, or cocoons
- Fungi appear as fuzzy growth or powdery coating
- Bacterial damage shows up as slimy or water-soaked areas

### Signs of Non-Living Causes (Abiotic):

- Whole plant appears unhealthy
- Overall stunted growth
- Yellowing leaves
- Bronze or brown discolouration

Use the diagnostic flow chart (Figure 1) to help identify nutrient deficiency symptoms in your plants.

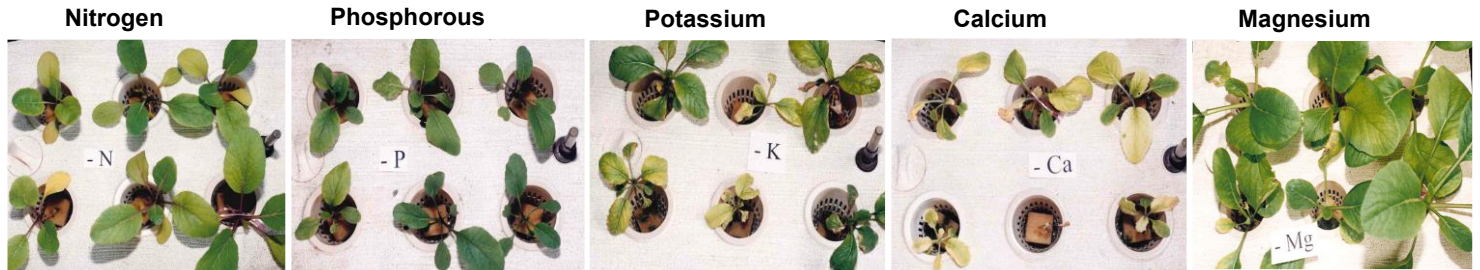
Figure 1. Flow chart to identifying nutrient deficiencies



Older/Matures leaves are fully expanded with a darker green colour and thicker, more rigid texture compared to young leaves

## Nutrient Deficiency Symptoms in Hydroponics

### Choy-sum after 30 days



- |  |  |  |  |   |
|--|--|--|--|---|
| <ul style="list-style-type: none"> <li>• General yellowing of older leaves at bottom of plants</li> <li>• Stunted and smaller leaves than normal</li> <li>• Purple colouration along leaf stem and midrib</li> </ul> | <ul style="list-style-type: none"> <li>• Severe leaf discolouration</li> <li>• Stunted growth</li> <li>• Older leaves turning dark green or reddish purple-vein</li> </ul> | <ul style="list-style-type: none"> <li>• Older leaves wilting</li> <li>• Scorching inward from the leaf margin</li> <li>• Interveinal chlorosis</li> </ul> | <ul style="list-style-type: none"> <li>• Severe leaf discolouration</li> <li>• Often progressive, starting with lighter green before full colour loss</li> <li>• Leaves appear distinctly yellow, white, or pale cream coloured</li> </ul> | <ul style="list-style-type: none"> <li>• Mild leaf discolouration</li> <li>• Often progressive, starting with lighter green before full colour loss</li> <li>• Plant able to grow, absence of stunted growth</li> </ul> |
|--|--|--|--|---|

### Amaranthus after 25 days



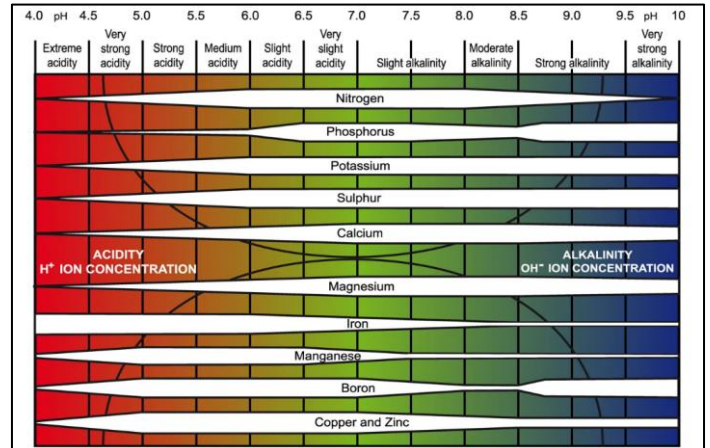
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| <ul style="list-style-type: none"> <li>• Severe leaves discolouration</li> <li>• Often progressive, starting with lighter green before full colour loss</li> <li>• Leaves appear distinctly yellow, white, or pale cream-coloured</li> </ul> | <ul style="list-style-type: none"> <li>• Leaves discolouration</li> <li>• Stunted growth</li> <li>• Leaves appear distinctly yellow</li> </ul> | <ul style="list-style-type: none"> <li>• Chlorosis, showing green midrib of leaves surrounding yellowing leaf tissue</li> <li>• Stunted growth</li> </ul> | <ul style="list-style-type: none"> <li>• Resilience to keep growing</li> <li>• Plants tolerates deficient condition</li> </ul> | <ul style="list-style-type: none"> <li>• Distinct interveinal chlorosis of older leaves</li> <li>• Yellowing between veins beginning on old leaves</li> <li>• Necrotic and cupping of leaves.</li> </ul> |
|--|--|---|--|--|

## pH and EC Management for Asian Leafy Greens

For Asian leafy greens, maintaining the correct EC and pH is essential for nutrient uptake and healthy growth. Even with proper fertilisation and correct EC, your leafy greens may show deficiency symptoms if pH levels drift outside the optimal range. In general, these crops perform best in the slightly acidic range ie pH 5.5- 6.5. (Table 2).

Check pH levels daily, especially during periods of rapid growth when plants take up nutrients quickly.

If your leafy greens show nutrient deficiency signs despite regular fertilisation, check your pH levels first before adjusting your nutrient formula.



The pH table indicates which nutrients plants can uptake at different pH levels- Source: [www.pda.org.uk/impact-of-ph-on-nutrient-availability/](http://www.pda.org.uk/impact-of-ph-on-nutrient-availability/).

**Table 2.** Recommended EC and pH Ranges for Asian Greens in Hydroponics

Type of Crops	EC (* mS/cm)	pH	Remark
<b>Brassicac family</b> Bok choy (pak choy), choy sum, gai lan (Chinese broccoli), napa cabbage (wong bok), mizuna, komatsuna, tatsoi, Chinese cabbage, mustard greens (gai choy)	2.0 - 2.5	5.5 - 6.8	Generally, prefer moderate nutrient levels with slightly acidic conditions
<b>Amaranth family</b> Chinese spinach (yin choy), red amaranth, green amaranth	1.8 - 2.5	6.0 - 7.0	Prefer higher nutrient concentrations and can tolerate neutral pH
<b>Water-loving greens</b> Water spinach (kangkong), watercress	1.5 - 2.0	5.5 - 6.5	Moderate nutrient needs with preference for slightly acidic condition

\* mS/cm stands for millisiemens per centimetre, measures how much nutrients are dissolved in your water.

## pH and EC Measurement Procedures

### pH Measurement

1. Calibrate your pH meter with standard buffer solutions (pH 4, 7, or 10) before use.
2. Rinse the electrode with distilled water between measurements to prevent cross-contamination.
3. Immerse the electrode fully in your nutrient solution and wait for the reading to stabilise before recording.
4. After each measurement, rinse the electrode with distilled water and store properly to maintain accuracy.

### EC Measurement

1. Calibrate your EC meter with standard potassium chloride (KCl) solution (1.41 mS/cm) before use.
2. Immerse the probe fully in your nutrient solution.
3. Gently stir the solution and wait for the reading to stabilise before recording.
4. Record the measurement and clean the probe with distilled water after each use.

### Maintenance Tips

Calibrate your meters regularly with buffer solutions to ensure accuracy—typically every few weeks or before critical measurements. Store electrodes in appropriate storage solution when not in use and replace them when readings become unstable or drift consistently.



## Best Practices for Nutrient Management

Regular monitoring helps ensure optimal plant growth by maintaining proper nutrient levels and growing conditions. Replenish fertiliser tanks with fresh water to compensate for evaporation, which concentrates nutrients and can lead to salt buildup. Check electrical conductivity (EC) and pH levels daily to track nutrient strength and acidity levels in your system. Use properly calibrated meters for accurate readings, following the measurement procedures outlined earlier in this guide. This routine monitoring allows you to make timely adjustments before nutrient imbalances affect plant health and productivity.

Keep detailed records of daily measurements and make gradual adjustments rather than large corrections when levels drift outside target ranges. Replace the entire nutrient solution periodically to prevent nutrient imbalances and maintain optimal growing conditions.

By implementing these practices consistently, you will create a stable growing environment that supports healthy plant development and maximises your crop yields whilst minimising waste and input costs.

### Regular Monitoring

- Check pH levels daily and maintain between 5.5-6.5 for optimal nutrient uptake
- Monitor EC readings daily to keep levels between 1.5-2.5 mS/cm
- Calibrate pH and EC meters regularly according to manufacturer specifications

### Fertiliser Management

- Proper fertiliser storage area in shaded area
- Monitoring and documenting expiry dates before use
- Application rate (amount to apply) specified on the label

### Solution Management

- Replenish nutrient solution if needed to ensuring optimal nutrient ratio due to intensive crop cycles
- Adjust EC levels when adding fresh solution to maintain optimal concentration
- Analyse nutrient solution weekly to monitor nutrient balance and system health



Find out more!

The Singapore Food Agency (SFA) had recently announced the \$70 mil Agri-food Cluster Transformation (ACT) Fund 2 which supports capability development, productivity improvements, and infrastructure upgrades. Farms can leverage on the Capability Upgrading component of ACT Fund 2 to adopt energy-efficient equipment and technologies from SFA's pre-qualified list. This will help farms improve energy efficiency and manage production costs to strengthen long-term resilience.

Let us know  
your thoughts



<https://go.gov.sg/ing24io>

### About the Author

Mohd Suhaime, knowledgeable in hydroponic farming with over four decades of expertise, is a member of the Agri-Technology and Food Innovation Department. His portfolio includes contributing to the "Singapore Urban Farming Project", a collaborative smart farming initiative, and implementing a Soilless Strawberry Cultivation project with Pokka Singapore. Additionally, Suhaime provides technical guidance to the local farming community.

### Reference:

1. Kozai, T. (2018). Smart Plant Factory: The Next Generation Indoor Vertical Farms. Springer Nature <https://doi.org/10.1007/978-981-13-1065-2>.
2. Hashimi et al. (2023) A Review of Diagnostic techniques of visual symptoms of nutrients deficiencies in plant. A Review of Diagnostic techniques of visual symptoms of nutrients deficiencies in plant. International Journal of Agriculture and Research 6:2. <https://www.ijojournals.com/index.php/ar/index>
3. Viegas et al., (2018) Growth and visual symptoms nutrient deficiency in mangosteens (*Garcinia mangostana* L.) . American Journal of Plant Sciences 9: 1014-1028. [https://www.scirp.org/pdf/ajps\\_2018041915291125.pdf](https://www.scirp.org/pdf/ajps_2018041915291125.pdf)