Optimising pH for Higher Yields in Hydroponic Asian Leafy Vegetables

A practical guide to improving farm yields, based on research findings by SFA

Why pH Management Matters

pH is one of the most critical parameters in hydroponic crop production. It controls how well your plants can take up nutrients from the water. Even a perfectly balanced nutrient solution becomes ineffective at the wrong pH. This can lead to stunted growth, nutrient deficiency symptoms, and lower yields despite doing everything else right.

Most local farms currently follow pH guidelines of 5.5–6.5 for leafy greens. These recommendations, however, were developed based on studies with leafy vegetables commonly grown in temperate climates and may not reflect what works best for Asian leafy vegetables grown here in Singapore. Using a one-size-fits-all target means farms could unknowingly be limiting their crops, or spending time and money on pH adjustments that make little practical difference. Knowing the right pH range for each crop you grow is therefore key to getting the most out of your inputs and improving your overall yields.

What We Set Out to Examine

This study examined four commonly grown Asian leafy green varieties to find the pH levels at which they perform best in hydroponic systems, and whether different crops respond differently to pH. Two questions guided the study: Does pH significantly affect how much you can harvest? And does the ideal pH vary from one crop to another?

Our Approach

Seeds of Xiao Bai Cai, Gailan, Choy Sum, and lettuce were germinated in Oasis foam (Horticubes) and grown under three pH conditions — 6.0, 6.5, and 7.0. pH levels were maintained from seed germination to grow out stage, using phosphoric acid and potassium hydroxide solutions.

Seedlings were grown indoors for 14 days[a] before being transplanted to a Nutrient Film Technique (NFT) hydroponic system in a greenhouse at the Translation Facility (TF) for a further 21 days (Fig. 1). The trial was repeated for three growing cycles.

At harvest, fresh weight, plant height, number of leaves, and leaf greenness (SPAD index) were measured from 10 plants per treatment per cycle — 30 plants in total per treatment. All data were analysed statistically to determine whether the differences observed between pH treatments were meaningful.

Fig. 1 Seedling growth in the indoor nursery (top) and post-transplant NFT system at the Translation Facility (TF) (bottom).

a. Seedlings of Xiao Bai Cai, Gailan, Choy Sum and lettuce should be transplanted between 14-16 days after sowing. Transplanting too early (around 10 days) increases the risk of transplant shock and seedling loss, while waiting beyond 17 days can cause elongation and overcrowding that affects crop quality. When deciding on the right time to transplant, balance seedling readiness with your operational schedule. Since each crop cycle takes 30–42 days to complete, getting the timing right is important for keeping your production on track and maintaining yield efficiency.

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What We Discovered

The key finding of this study is that a single pH range does not work equally well for all Asian leafy greens and that optimal pH can differ even between crops of the same plant family (Table 1). Farms growing multiple varieties should consider managing pH on a crop-by-crop basis.

Xiao Bai Cai and Gailan are tolerant across the full pH range tested. No statistically significant differences in fresh weight, plant height, number of leaves, or leaf greenness were observed for either crop across pH 6.0, 6.5, and 7.0. This gives you flexibility in how you manage pH for these two varieties without affecting yield, which presents a real opportunity to reduce the time and resources spent on pH adjustment and monitoring. Furthermore, their adaptability makes them well-suited for co-cultivation with crops that have more specific pH requirements.

Choy Sum performs best at pH 7.0. Choy Sum achieved a notably higher fresh weight of 73.5g at pH 7.0, compared to 51.9g at pH 6.5 — a yield improvement of ~40%. This finding runs contrary to conventional recommendations, and farms growing Choy Sum are strongly encouraged to trial pH 7.0 as the potential yield gains are substantial.

Lettuce performs best at pH 6.0. Lettuce achieved its highest fresh weight of 82.6g at pH 6.0, compared to 75.2g at pH 6.5 and 74.1g at pH 7.0 — a yield improvement of around 10%. This is consistent with existing research. If you are currently growing lettuce at a higher pH, lowering your to pH 6.0 is worth considering.

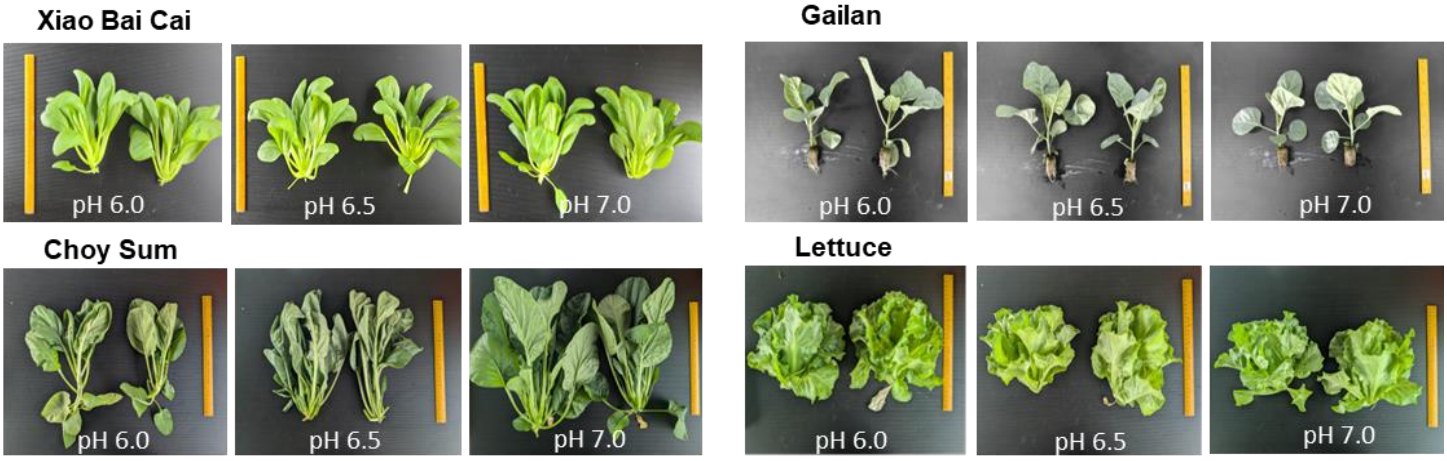

Table 1. Fresh weight (g) per plant, plant height, number of leaves and leaf greenness (SPAD) at harvest for Xiao Bai Cai, Gailan, Choy Sum, and lettuce, grown at pH 6.0, 6.5, and 7.0 (n = 30 per treatment). Xiao Bai Cai and Gailan were not influenced by pH levels. Choy Sum grows best at pH 7 and lettuce grows best at pH 6, as shown in bold.

Crop	pH	Fresh Weight (g)	Plant Height (cm)	No. of Leaves	SPAD*
Xiao Bai Cai	6.0	56.6 a	20.2 a	13.8 a	40.1 a
	6.5	55.7 a	20.7 a	13.4 a	39.8 a
	7.0	51.0 a	19.3 a	11.0 a	42.7 a
Gailan	6.0	42.2 a	22.6 a	6.14 a	54.6 a
	6.5	42.8 a	22.9 a	6.06 ab	56.6 a
	7.0	42.6 a	22.4 a	5.75 b	55.2 a
Choy Sum	6.0	54.7 b	22.9 b	11.2 b	45.2 a
	6.5	51.9 b	23.9 b	11.2 b	45.8 a
	7.0	**73.5 a**	**28.3 a**	**13.8 a**	**46.5 a**
Lettuce	**6.0**	**82.6 a**	**19.4 a**	**18.5 a**	**31.2 a**
	6.5	75.2 b	18.6 a	18.9 a	29.8 a
	7.0	74.1 b	19.0 a	16.1 b	33.4 a

**SPAD is a measure of chlorophyll content, which indicates leaf greenness and overall plant health. Values within each column for each crop sharing the same letter (i.e. a or b) are not significantly different from one another ($p > 0.05$).*

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Implementation Steps

Here are some practical steps to get started.

Set crop-specific pH targets. Use pH 6.0 as your target for lettuce and pH 7.0 for Choy Sum. For Xiao Bai Cai and Gailan, anywhere within the 6.0–7.0 range is fine — no precise target is needed, which means less frequent adjustments overall.

Use the right pH adjustment agents. To lower pH, use an acid such as phosphoric acid (we use a 10% solution). To raise pH, use a hydroxide-based solution such as potassium hydroxide (we used a 5% solution). Always adjust gradually and recheck after 30 minutes to avoid overshooting your target. As these chemicals are highly corrosive, always handle them with appropriate protective gear including gloves and safety glasses.

Monitor pH regularly. Check pH at least once a day, ideally at the same time each day. pH can drift due to plant uptake, evaporation, and microbial activity. During hot weather or periods of rapid growth, more frequent checks are advisable.

Troubleshooting Common Issues

pH drifting too quickly. This usually points to high nutrient uptake by your plants, or a nutrient solution that lacks sufficient buffer capacity. Try increasing how often you monitor and top up your solution and check that your reservoir is large enough for the number of plants you are growing.

pH increase or decrease. This is a common challenge in hydroponic production, influenced by crop type, plant age, and the form of nitrogen your plants prefer. When crops take up nitrate, pH tends to rise; when they take up ammonium, pH tends to fall.

Yield differences between growing season. Even when optimal pH is maintained, yields may vary depending on the environmental conditions. pH is not the only factor that affects yield — temperature, relative humidity, and light levels can all independently influence crop performance, making it difficult to attribute differences to pH alone. Make sure these conditions are consistently tracked across cycles alongside your pH readings.

Note on Growing Substrates. This study used Oasis Horticubes as the growing substrate. If your farm uses a different substrate — such as peat moss or coco coir, which have natural buffering properties — we recommend validating these pH targets under your own conditions before fully adopting them, as substrate choice can affect pH stability and nutrient availability.

The Singapore Food Agency (SFA) had recently announced the $70 million Agri-food Cluster Transformation (ACT) Fund 2 which supports capability development, productivity improvements, and infrastructure upgrades. Farms can leverage the Capability Upgrading component of the 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.

About the Author

Mohd Suhaime, Caleb Beh, and Melissa Chua are from the Farm Advisory Section (FAS) in the Agriculture Technology (AGT) Department, Agrifood Technology Division. With backgrounds in agriculture and a focus on production process optimisation, the team brings a wealth of expertise to this guide — most notably through Mohd Suhaime's 30 years of experience in the sector.

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Best practices guide for crop cultivation covering other topics can be found here.

This guide was developed based on findings from Agritech Translation Programme (AgTP) Project and is intended to support local farms in optimising pH management practices. Results will be shared through the SFA Technical Advisory Programme (TAP). For further information or to find out more about the AgTP, please contact SFA.

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