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Grower's Guide to Identifying and Correcting Nitrogen, Phosphorus, and Potassium Deficiencies in Luffa Production[1]

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Luffa, commonly known as sponge gourd, refers to two main types: smooth luffa (*Luffa aegyptiaca* Mill.) and angled luffa (*Luffa acutangular* (L.) Roxb.). It is a climbing vegetable in the cucumber family, Cucurbitaceae (Liu et al. 2024). Grown for centuries across Asia, luffa is prized for its young, edible fruits, which are consumed as vegetables, and its mature, fibrous fruits, which are used as natural sponges (Partap et al. 2012; Azeez et al. 2013). In regions like Florida and California, luffa is gaining popularity as an alternative vegetable crop, thanks to favorable growing conditions and rising demand for Asian specialty produce (Molinar 2012; Xie et al. 2016). Successful cultivation of luffa relies heavily on proper nutrient management, particularly for nitrogen (N), phosphorus (P), and potassium (K). Nutrient mismanagement can lead to deficiencies that cause stunted growth, leaf discoloration, and reduced yields. Early diagnosis and intervention are crucial for ensuring healthy growth and maximizing profitability. This Extension publication provides practical guidance for growers, Extension agents, and students on identifying and correcting N, P, and K deficiencies in luffa.

Optimal Ranges of Nitrogen, Phosphorus, and Potassium in Luffa

A sufficient supply of N, P, and K is critical for optimal growth and fruit production in luffa plants. The ideal range of N in luffa leaf tissue is 3.5% to 6.0% (35,000 to 60,000 ppm) on a dry weight basis. Nitrogen within this range promotes healthy foliage and vigorous growth; however, levels exceeding 6.0% can lead to excessive vegetative growth, nutrient imbalances, and reduced fruit yields and quality (Li et al. 2023).

The recommended P range in luffa leaf tissue is 0.35% to 1.25% on a dry weight basis (Mills and Jones 1996). Plants within this range exhibit strong root development, healthy leaf color, and consistent fruit production. Excess P, though rare, can cause imbalances with other nutrients, particularly micronutrients like zinc, iron, and copper, which may become less available or even deficient (Mills and Jones 1996). Insoluble phosphate compounds may form as a result of chemical interactions between high levels of P and these micronutrients, making them less available to plants. For example, excess phosphate ions (PO_4^{3-}) can form insoluble zinc phosphate precipitates ($Zn_3(PO_4)_2$) in the soil, reducing zinc availability. Additionally, excessive P can suppress the root uptake mechanisms responsible for absorbing certain micronutrients, particularly zinc. This imbalance can lead to deficiency symptoms such as interveinal chlorosis, stunted growth, or poor fruit development, even when micronutrients are present in sufficient quantities in the soil.

Potassium is essential for plant health, water relations, and fruit yield and quality. It is typically applied in balanced proportions with N and P in an NPK fertilizer program. For example, a fertigation ratio of 1:0.6:1 (N:P:K) has been shown to enhance luffa fruit yields, underscoring the importance of balanced nutrient management for high luffa productivity (Murthy et al. 2020).

Identifying Nutrient Deficiencies of Luffa Leaves and Plants

Nutrient deficiencies in luffa may appear as distinct or overlapping symptoms in the leaves and overall plant, often reducing yield and fruit quality. Early detection of these symptoms allows for timely corrective measures to maintain healthy growth and optimize productivity. The following tables and figures describe and illustrate the deficiencies for nitrogen, phosphorus, and potassium.

Nitrogen Deficiency in Luffa Leaves

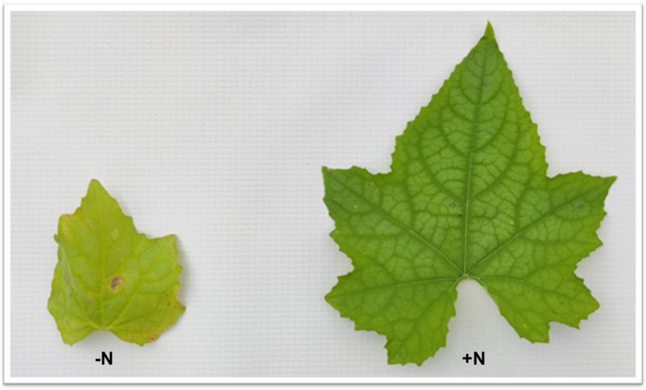

Figure 1. Comparison of two luffa leaves, one with nitrogen deficiency (−N, left) and one with sufficient nitrogen (+N, right). Plants were grown in a modified Hoagland nutrient solution, with or without nitrogen supplementation.
Credit: Qiansheng Li, UF/IFAS

Nitrogen Deficiency in Luffa Plants

Figure 2. Comparison of two luffa plants: one exhibiting nitrogen deficiency (−N) and the other with sufficient nitrogen (+N). The plants were grown in a modified Hoagland nutrient solution, with or without nitrogen supplementation.
Credit: Qiansheng Li, UF/IFAS

Phosphorus Deficiency in Luffa Leaves

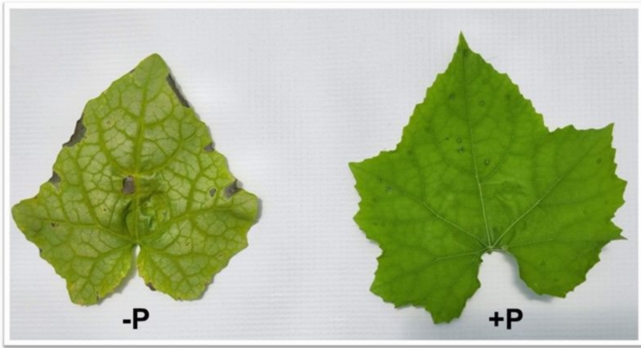

Figure 3. Comparison of two luffa leaves, one with phosphorus deficiency (−P, left) and one with sufficient phosphorus (+P, right). Plants were grown in a modified Hoagland nutrient solution, with or without phosphorus supplementation.
Credit: Qiansheng Li, UF/IFAS

Phosphorus Deficiency in Luffa Plants

Figure 4. Comparison of two luffa plants: one exhibiting phosphorus deficiency (−P, left) and the other with sufficient phosphorus (+P, right). The plants were grown in a modified Hoagland nutrient solution, with or without phosphorus supplementation.
Credit: Qiansheng Li, UF/IFAS

Potassium Deficiency in Luffa Leaves

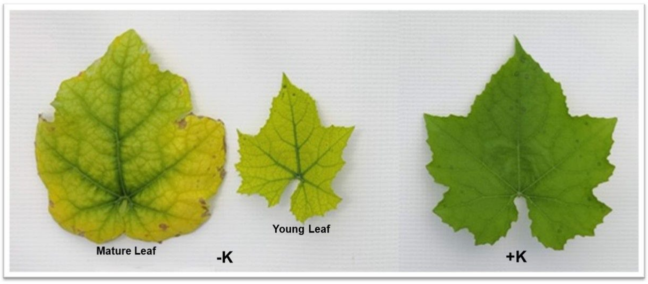

Figure 5. Comparison of three luffa leaves: two showing potassium deficiency (−K, left and center) and one with sufficient potassium (+K, right). The plants were grown in a modified Hoagland nutrient solution, with or without potassium supplementation.
Credit: Qiansheng Li, UF/IFAS

Potassium Deficiency in Luffa Plants

Figure 6. Comparison of two luffa plants: one exhibiting potassium deficiency (−K, left) and the other with sufficient potassium (+K, right). The plants were grown in a modified Hoagland nutrient solution, with or without potassium supplementation.
Credit: Qiansheng Li, UF/IFAS

Fertilizer Applications to Correct Nitrogen, Phosphorus, and Potassium Deficiencies

Nitrogen (N), phosphorus (P), and potassium (K) deficiencies in luffa are easily preventable or treatable with proper fertilizer management. Although specific UF/IFAS recommendations for N, P, and K fertilizer applications in luffa production are not currently available for Florida, guidelines for similar crops in the Cucurbitaceae family, such as cucumber, can be adapted for the time being. Typically, the following application rates can be used: 150 lb/A of N and either 120 lb/A each of phosphorus (P_2O_5) and K_2O for medium soil test levels of P and K or 80 lb/A each of P_2O_5 and K_2O for low soil test levels of P and K (Liu et al. 2024).

It is recommended to split applications of N, P, and K, incorporating them into the soil pre-plant and as a side dressing during the growing season. For luffa plants in fertigation, N, P, and K can be applied in multiple micro-doses through the irrigation system over the course of the season. If using dry granular fertilizer, it should be applied at planting to ensure nutrient availability during early root development. Given the relatively immobile nature of phosphorus in soil, adequate early application is crucial to prevent deficiencies later in the plant's growth.

For more detailed information, refer to chapter 2 in the most recent edition of the *Vegetable Production Handbook of Florida* on fertilizer management.

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Tables

Table 1. Comparative assessment of leaf symptoms under nitrogen-deficient and nitrogen-sufficient conditions in luffa. The classifications are based on distinct visual characteristics and the progression of symptom expression.

Symptom stage	Nitrogen deficiency (−N)	Sufficient nitrogen (+N)
Early symptoms	Early symptoms show pale yellowish-green chlorosis starting from leaf margins and progressing inward.	The leaves maintain uniform rich dark green coloration throughout all leaf tissues.
Advanced symptoms	Advanced symptoms include mature green leaves gradually forming a mottled pattern of irregular green and yellow areas, or they may turn completely yellow with necrotic spots, indicating tissue damage or cell death.	The leaf structure remains fully developed with strong, prominent veins and no signs of yellowing or necrotic damage.
Severe/late symptoms	Severe deficiency results in premature leaf senescence and abscission, particularly affecting older leaves first due to nitrogen mobility.	The leaves exhibit extended longevity with sustained photosynthetic activity and delayed natural senescence.

Table 2. Diagnostic characteristics of nitrogen deficiency versus sufficient nitrogen supply in luffa plants. The classifications are based on different plant characteristics and diagnostic approaches.

Diagnostic category	Nitrogen deficiency (−N)	Sufficient nitrogen (+N)
Whole-plant morphology	The plant exhibits significant growth stunting with shortened internodes, reduced vine extension, and limited branching patterns.	The plant displays vigorous vegetative growth with extended vine length, normal internode spacing, and abundant lateral branching with robust structure.
Biomass and photosynthetic capacity	Overall plant biomass is markedly reduced with fewer total leaves and a lower leaf area index (LAI), thus affecting photosynthetic capacity.	The plant maintains high biomass accumulation with numerous leaves providing optimal leaf area for maximum photosynthetic efficiency.
Root system development	Root system development is compromised with reduced root hair formation, affecting nutrient and water uptake efficiency.	The root system is well-developed with extensive root hair networks, ensuring efficient nutrient absorption and water uptake.
Structural integrity	The overall structure of the plants appears weak, suggesting insufficient nitrogen to support healthy growth and development.	The plant appears to be thriving with strong structural integrity, indicating sufficient nitrogen bioavailability for optimal growth.

Table 3. Comparative assessment of leaf symptoms under phosphorus-deficient and phosphorus-sufficient conditions in luffa. The classifications are based on symptom progression and severity levels.

Diagnostic category	Phosphorus deficiency (−P)	Sufficient phosphorus (+P)
Early-stage symptoms	The leaf exhibits signs of chlorosis, with yellowing between the veins, which remain green and appear less vibrant with faded coloration.	The leaf is a healthy, uniform dark green color with a vibrant appearance and no signs of yellowing or chlorosis.
Advanced-stage symptoms	Visible purplish or bronze spots, along with necrotic areas, indicate tissue death due to severe phosphorus deficiency.	The leaf structure is well-developed with no visible spots, necrosis, or tissue damage, reflecting healthy growth and efficient nutrient uptake.
Developmental appearance	The leaf appears smaller, stunted, and underdeveloped when compared to healthy leaves, indicating impaired growth and photosynthesis.	The leaf appears larger, fully expanded, and well-developed, indicating optimal phosphorus levels and normal physiological function.

Table 4. Diagnostic characteristics of phosphorus deficiency versus sufficient phosphorus supply in luffa plants. The classifications are based on different aspects of plant response to P availability.

Diagnostic category	Phosphorus deficiency (−P)	Sufficient phosphorus (+P)
Morphological growth	The plant is noticeably smaller, exhibiting stunted growth with fewer leaves and limited vine extension.	The plant is significantly larger and more vigorous, with a longer vine and more developed leaves.
Structural integrity	The plant's overall structure appears weaker and underdeveloped, indicating low phosphorus uptake.	The plant appears well-developed, with a larger leaf area, indicating efficient phosphorus absorption.
Root and reproductive development	Root system development is severely compromised with poor root hair formation, limiting nutrient uptake efficiency and affecting reproductive processes, including delayed flowering and reduced fruit set.	The root system is well-developed with extensive root networks, ensuring efficient phosphorus absorption and supporting optimal reproductive development, including timely flowering and successful fruiting.

Table 5. Comparative assessment of leaf symptoms under potassium-deficient and potassium-sufficient conditions in luffa. The classifications are based on symptom severity and progression stages.

Diagnostic category	Potassium deficiency (–K)		Sufficient potassium (+K)
	Mature leaf	Young leaf	
Early-stage symptoms	The leaf exhibits pronounced yellowing (chlorosis), especially around the edges, which is a typical symptom of potassium deficiency.	The young leaf exhibits early signs of chlorosis, with yellowing starting between the veins.	The leaf is uniform green, showing no signs of yellowing or necrosis.
Intermediate symptoms	The veins remain green, while the tissue between them turns yellow.	Although the young leaf is affected less than the mature leaf, early signs of potassium deficiency are visible.	The leaf appears healthy, robust, and well-developed, indicating that potassium levels are sufficient.
Advanced symptoms	Browning and tissue death are visible around the leaf margins, indicating a severe deficiency.	The leaf is smaller and may be stunted compared to a healthy, young leaf.	Both the veins and the tissue between them are consistently green, indicating sufficient potassium availability.

Table 6. Diagnostic characteristics of potassium deficiency versus sufficient potassium supply in luffa plants. The classifications are based on symptom type and deficiency severity progression.

Diagnostic category	Potassium deficiency (–K)	Sufficient potassium (+K)
Morphological effects	The plant is notably stunted, with shorter vines and fewer leaves compared to the healthy plant.	The plant is considerably larger and more vigorous, with longer vines and more abundant leaf growth.
Chlorotic symptoms	The leaves, particularly the older and lower ones, exhibit yellowing (chlorosis) around the edges, a common symptom of potassium deficiency.	The leaves are healthy and uniformly green, with no signs of yellowing, browning, or other deficiency symptoms.
Reproductive impact and stress tolerance	The plant experiences delayed flowering, poor fruit set, and reduced fruit quality. Plants are also more susceptible to drought and disease due to weakened cell structure and water imbalance.	The plant has timely flowering, better fruit development, and enhanced resistance to abiotic stress and disease.

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