JURNAL AGROEKOTEKNOLOGI TERAPAN
Applied Agroecotechnology Journal

Agroteknologi Universitas Sam Ratulangi e_ISSN:2797-0647

Effect of AB Mix Concentration and Variety on the Growth and Yield of Lettuce (*Lactuca sativa* L.) under a Nutrient Film Technique (NFT) Hydroponic System.

Muhammad Hadid Firdaus*, Rusmana Rusmana, Imas Rohmawati, Kirana Nugrahayu Lizansari

Department of Agroecotechnology, Faculty of Agriculture, Sultan Ageng Tirtayasa University, Serang, Banten, Indonesia

*Corresponding author:
muhammadhadidfirdauss@gmail.com

Manuscript received: 23 Mar 2026.
Revision accepted: 29 Apr 2026.

Abstract. This study evaluated the effect of AB Mix concentration on the growth and yield of lettuce (*Lactuca sativa* L.) varieties grown in a Nutrient Film Technique (NFT) hydroponic system. The experiment was conducted from December 2025 to February 2026 at Allisa Farm, Serang, Banten, Indonesia, using a split-plot design with two factors. The main plot consisted of AB Mix concentrations at 560, 840, and 1000 ppm, while the subplot included three lettuce varieties: Batavia Caipira, Grand Rapids, and Sementel. Data were analyzed by analysis of variance followed by Duncan's Multiple Range Test at the 5% level. AB Mix concentration significantly affected several growth and yield parameters. The 1000 ppm treatment produced the highest number of leaves (19.09), leaf greenness (31.60 SPAD units), root length (21.72 cm), and shoot fresh weight (135.67 g), and supported better plant height during the vegetative stage. Variety also had a significant effect, with Batavia Caipira showing the best performance in number of leaves, leaf greenness, and shoot fresh weight, while Grand Rapids produced the tallest plants. A significant interaction between AB Mix concentration and variety was observed only for leaf area, with the highest value recorded for 1000 ppm AB Mix combined with Batavia Caipira (94.51 cm²).

Keywords: AB Mix concentration, hydroponics, lettuce, NFT system, varieties

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is an important leafy vegetable with high nutritional and economic value. It is widely consumed as a fresh vegetable, salad ingredient, and complement to modern foods (Wibowo & Furoidah, 2021). In addition to its commercial importance, lettuce is recognized as a nutritious vegetable that supports healthy dietary patterns. In Indonesia, lettuce production increased from 663,832 tons in 2020 to 727,467 tons in 2021 and 760,608 tons in 2022, but declined to 686,867 tons in 2023, suggesting that production remains volatile despite rising demand (Badan Pusat Statistik, 2023). This condition suggests that lettuce production has not yet consistently met market needs.

One of the major constraints in lettuce production is the limitation of conventional cultivation systems. Land conversion, declining soil fertility, seasonal dependence, and excessive pesticide use may reduce productivity and result in unstable yields (Sholeh & Wahyuni, 2023). These challenges are increasingly relevant in urban and peri-urban areas, where agricultural land is becoming more limited. Therefore, a more efficient, sustainable, and environmentally friendly cultivation method is needed to support continuous lettuce production and improve crop quality.

Hydroponic cultivation has been widely considered a promising alternative because it enables soilless production with more efficient use of water and fertilizers, faster plant growth, and cleaner yields (Manullang *et al.,* 2021; Sulaiman *et al.,* 2023). Among theAmong available hydroponic methods, the Nutrient Film Technique (NFT) is particularly suitable for leafy vegetables because it continuously supplies water, oxygen, and nutrients to plant roots through a thin flowing film of nutrient solution (Novia *et al.,* 2023). However, the success of NFT cultivation is strongly influenced by nutrient management, particularly the nutrient

concentration supplied to plants during growth. In hydroponics, AB Mix is commonly used as a nutrient source because it provides essential macro- and micronutrients required for plant development (Romalasari & Sobari, 2019). Inappropriate nutrient concentration may inhibit plant growth, whereas excessive concentration may induce osmotic stress and leaf burn (Henry *et al.,* 2018).

Previous studies have reported inconsistent findings regarding the optimum AB Mix concentration for lettuce cultivation. Luckardi *et al.* (2025) recommended a nutrient range of 560–840 ppm as appropriate for seasonal hydroponic crops, including lettuce. In contrast, Hariyono and Prakasa (2023) and Sholeh and Wahyuni (2023) reported that 1000 ppm produced better lettuce growth. These differences indicate that the most effective AB Mix concentration for lettuce under NFT conditions remains uncertain. Since NFT cultivation depends heavily on nutrient solution stability, differences in nutrient concentration can yield different growth and yield responses under the same cultivation system.

In addition to nutrient concentration, varietal differences may also affect nutrient uptake efficiency and plant performance in hydroponic systems. Grand Rapids, Batavia Caipira, and Sementel are among the lettuce varieties commonly cultivated under NFT conditions and are known to exhibit different growth characteristics (East West Seed Indonesia, 2025; Bejo Seed, 2025). Previous studies also showed that varietal differences significantly affect plant height, leaf number, and lettuce yield (Thakulla *et al.,* 2021; Wahyudi *et al.,* 2025). Therefore, evaluating the responses of different lettuce varieties to AB Mix concentrations is important for determining the most suitable treatment combination. Based on these considerations, this study aimed to analyze the effectiveness of several AB Mix concentrations on the growth and yield of three lettuce varieties grown under an NFT hydroponic system. It was hypothesized that AB Mix concentration, variety, and their interaction would significantly affect lettuce growth and yield.

RESEARCH METHODOLOGY

This study employed an experimental method and was conducted from December 2025 to February 2026 at Allisa Farm, Serang City, Banten, Indonesia (6°07'42.3 "S; 106°10'24.8 "E). The equipment used included an NFT hydroponic installation, measuring cylinders, a water pump, a reservoir tank, a TDS meter, a pH meter, a ruler, hoses, a digital balance, a SPAD meter, a seedling tray, net pots, stationery, and documentation tools. The materials consisted of lettuce seeds of Batavia Caipira, Grand Rapids, and Sementel varieties, AB Mix nutrient solution, rockwool, and water. The experiment was arranged in a factorial split-plot design with two factors. The main plot was AB Mix concentration (K), consisting of three levels: k1 = 560 ppm, k2 = 840 ppm, and k3 = 1000 ppm, while the subplot was lettuce variety (V), consisting of three levels: v1 = Batavia Caipira, v2 = Grand Rapids, and v3 = Sementel. The combination of these factors yielded 9 treatment combinations. Each treatment combination was replicated three times, resulting in 27 experimental units. Each experimental unit consisted of two plants, giving a total of 54 observed plants.

RESEARCH IMPLEMENTATION

The NFT installation used PVC channels approximately 4 m long and 2.5 inches in diameter, with 13 planting holes spaced approximately 20 cm apart. The nutrient solution was prepared in a 100 L reservoir by mixing stock solutions A and B at the specified treatment concentration. The 560 ppm solution was prepared using 280 mL stock A and 280 mL stock B, the 840 ppm solution using 420 mL stock A and

420 mL stock B, and the 1000 ppm solution using 500 mL stock A and 500 mL stock B. Lettuce seeds were sown in rockwool cubes for 10 days and transplanted into the NFT system when the seedlings had 3-4 true leaves and well-developed roots. During plant growth, nutrient concentration was monitored daily using a TDS meter, and pH was measured with a pH meter and maintained at 5.5-6.5. The NFT system was checked regularly to ensure smooth nutrient circulation. The observed variables were plant height, number of leaves, leaf greenness index, leaf area, root length, and fresh shoot weight. Plant height and leaf number were measured at 7, 14, 21, 28, 35, and 42 days after transplanting (DAT). Leaf greenness index was measured at 42 DAT using a SPAD meter, leaf area was measured after harvest using ImageJ software, root length was measured from the root base to the longest root tip, and fresh shoot weight was measured using a digital balance.

DATA ANALYSIS

Data were analyzed using a split-plot analysis of variance (ANOVA). The effect of AB Mix concentration was tested using the main plot error, while the effects of variety and interaction were tested using the subplot error. If the ANOVA showed a significant effect at the 5% level, the mean comparisons were continued using Duncan's Multiple Range Test (DMRT) at the 5% level.

RESULTS AND DISCUSSION

Plant Height

AB Mix concentration significantly affected plant height at 28 DAT and had a highly significant effect at 35 DAT. As shown in Table 1, the 1000 ppm treatment produced the highest mean plant height at 28 DAT (18.17 cm) and 35 DAT (22.74 cm), indicating that this concentration supported lettuce growth during the active vegetative stage. However, based on DMRT at the 5% level, the 560 ppm treatment did not differ significantly from the 1000 ppm treatment at either observation time. This result indicates that increasing nutrient concentration did not always produce a significant increase in plant height. This finding is in line with Hariyono and Prakasa (2023), who reported that certain nutrient concentrations may produce better growth responses, but further increases in concentration do not always improve plant growth. The better response at 1000 ppm was likely related to more adequate nutrient availability, which supported cell division and stem elongation during vegetative growth. Suharjo (2024) reported that increasing nutrient concentration could enhance plant height, particularly during the vegetative phase, because sufficient nutrients are required for vegetative organ development. This finding is also supported by Furoidah and Wahyuni (2017), who stated that AB Mix contains essential nutrients, especially nitrogen, that promote leaf and stem growth.

Variety also had a highly significant effect on plant height throughout the observation period. Table 1 shows that Grand Rapids consistently produced the highest mean plant height, reaching 40.16 cm at 42 DAT. This result suggests that varietal differences played an important role in determining plant height under the NFT hydroponic system. According to Oktavia (2022), differences in plant growth among lettuce varieties are closely related to genetic characteristics and their ability to utilize available nutrients under the same growing conditions.

Table 1. Mean plant height of lettuce under different AB Mix concentrations and varieties in a Nutrient Film Technique (NFT) hydroponic system (cm).

Plant Age (DAT)	Concentration (K) (ppm)	Variety (V)			
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)	Mean
7	k1 (560)	4.25	4.75	3.13	4.04
	k2 (840)	3.80	4.55	3.30	3.88
	k3 (1000)	4.62	5.08	2.92	4.21
	Mean	4.22 b	4.79 a	3.12 c	4.04
14	k1 (560)	9.05	10.08	6.42	8.52
	k2 (840)	7.77	9.67	6.83	8.09
	k3 (1000)	9.08	10.67	7.45	9.07
	Mean	8.63 b	10.14 a	6.90 c	8.56
21	k1 (560)	12.30	15.42	10.78	12.83
	k2 (840)	10.63	14.73	10.58	11.98
	k3 (1000)	12.32	16.00	10.67	12.99
	Mean	11.75 b	15.38 a	10.68 c	12.60
28	k1 (560)	16.15	20.08	14.93	17.06 a
	k2 (840)	13.85	19.75	13.80	15.80 b
	k3 (1000)	15.78	22.38	16.33	18.17 a
	Mean	15.26 b	20.74 a	15.02 b	17.01
35	k1 (560)	19.83	27.00	18.87	21.90 a
	k2 (840)	15.17	21.77	16.00	17.64 b
	k3 (1000)	19.75	28.40	20.07	22.74 a
	Mean	18.25 b	25.72 a	18.31 b	20.76
42	k1 (560)	23.95	39.37	23.27	28.86
	k2 (840)	22.15	36.98	23.62	27.58
	k3 (1000)	23.42	44.13	27.15	31.57
	Mean	23.17 b	40.16 a	24.68 b	29.34

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level.

The interaction between AB Mix concentration and variety did not significantly affect plant height at any observation time, as indicated in Table 1. This result suggests that the response of plant height to nutrient concentration was relatively similar among the tested varieties. Plant height was more influenced by the main effects of concentration and variety than by their interaction. A similar finding was reported by Lestari *et al.* (2022), who stated that interaction effects in lettuce cultivated under an NFT system do not always significantly influence growth variables. However, the main effect of nutrient concentration may still be evident in certain parameters.

Number of Leaves

The number of leaves was highly significantly affected by AB Mix concentration at 35 DAT and significantly affected at 42 DAT, while variety significantly affected leaf number at 7 DAT and highly significantly affected it from 14 to 42 DAT. As shown in the Table 2, the 1000 ppm treatment produced the highest mean number of leaves at 35 DAT (12.89 leaves) and 42 DAT (19.09 leaves), indicating that this concentration better supported leaf formation during the later vegetative stage. This response was likely associated with a more adequate nutrient supply to support cell division, new tissue formation, and vegetative development, particularly leaf growth. Sholeh and Wahyuni (2023) reported that nutrient application at 1000 ppm improved lettuce growth by providing sufficient nutrients to support leaf formation. Adequate nutrient availability helps maintain physiological

and metabolic activity, thereby promoting more intensive leaf development and increasing leaf number.

Variety also affected leaf number, with Batavia Caipira showing the highest mean value at 42 DAT (19.28 leaves), as presented in Table 2. This result indicates that Batavia Caipira had a better capacity for leaf formation than the other tested varieties. Such variation may be related to genetic factors, physiological characteristics, and each variety's ability to utilize available nutrients for vegetative growth. Sholeh and Wahyuni (2023) also reported that varietal differences significantly influence lettuce leaf number across observation times, indicating that each variety exhibits a distinct growth response even under the same growing conditions. These differences are closely related to nutrient uptake efficiency, vegetative growth rate, and the capacity of plants to produce leaves during growth.

Table 2. Mean number of leaves of lettuce under different AB Mix concentrations and varieties in a Nutrient Film Technique (NFT) hydroponic system (leaves)

Plant Age (DAT)	Concentration (K) (ppm)	Variety (V)			
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)	Mean
7	k1 (560)	4.83	4.00	5.00	4.61
	k2 (840)	5.00	4.17	4.17	4.44
	k3 (1000)	5.00	4.50	4.67	4.72
	Mean	4.94 a	4.22 b	4.61 ab	4.59
14	k1 (560)	6.83	5.50	6.17	6.17
	k2 (840)	6.17	5.17	6.33	5.89
	k3 (1000)	7.33	5.67	6.33	6.44
	Mean	6.78 a	5.44 b	6.28 a	6.17
21	k1 (560)	7.33	5.33	6.83	6.50
	k2 (840)	7.33	5.33	7.00	6.56
	k3 (1000)	7.33	5.67	8.00	7.00
	Mean	7.33 a	5.44 b	7.28 a	6.69
28	k1 (560)	8.17	5.50	8.83	7.50
	k2 (840)	9.17	5.83	8.50	7.83
	k3 (1000)	10.00	7.33	9.17	8.83
	Mean	9.11 a	6.22 b	8.83 a	8.06
35	k1 (560)	11.17	7.00	10.17	9.44 b
	k2 (840)	11.83	7.00	10.17	9.67 b
	k3 (1000)	15.67	10.33	12.67	12.89 a
	Mean	12.89 a	8.11 c	11.00 b	10.67
42	k1 (560)	16.33	10.67	13.67	13.56 b
	k2 (840)	17.33	9.67	16.50	14.50 b
	k3 (1000)	24.17	16.00	17.00	19.09 a
	Mean	19.28 a	12.11 c	15.72 b	15.70

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level

The interaction between AB Mix concentration and variety did not significantly affect the number of leaves at any observation time, as indicated in Table 2. This finding suggests that leaf formation in each variety responded relatively similarly to changes in nutrient concentration, and that the variation in leaf number was influenced more by the main effects of concentration and variety than by their combination. A similar result was reported by Anisa *et al.* (2023), who found that treatment combinations in hydroponic lettuce cultivation did not significantly affect leaf number. However,

the main effects of the treatments remained evident in certain parameters.

Leaf Greenness Index

Leaf greenness index at 42 DAT was highly significantly affected by both AB Mix concentration and variety. As shown in Table 3, the 1000 ppm treatment produced the highest mean leaf greenness index (31.60 SPAD units), indicating that a higher nutrient concentration better supported chlorophyll formation. This response was likely associated with a more adequate supply of essential nutrients, particularly nitrogen and magnesium, which are directly involved in chlorophyll synthesis. Hariyono and Prakasa (2023) reported that higher AB Mix concentrations improved leaf chlorophyll index because plants received a more suitable nutrient supply to support physiological activity. Similarly, Al Tahbia et al. (2025) reported that AB Mix significantly increased chlorophyll content by providing essential nutrients, including nitrogen, phosphorus, potassium, and magnesium, in a relatively balanced composition. In addition, the SPAD value obtained under the 1000 ppm treatment indicates that this concentration remained within the lettuce tolerance range and did not induce visible leaf burn. Nurrohman (2015) explained that leaf burn in hydroponic crops generally occurs when nutrient concentrations exceed the phytotoxic threshold, resulting in osmotic stress.

Variety also had a highly significant effect on the leaf greenness index, as presented in Table 3. Batavia Caipira showed the highest mean value (31.02 SPAD units), indicating a better capacity for chlorophyll formation than the other tested varieties. This difference may be related to varietal variation in physiological characteristics and nutrient utilization efficiency, particularly nitrogen use for chlorophyll synthesis. Zhang *et al.* (2022) stated that chlorophyll plays a central role in photosynthesis and that the leaf greenness index can be used as a rapid indicator of chlorophyll content, photosynthetic capacity, and plant physiological status. Kurniawan *et al.* (2010) also reported that lettuce leaves with higher chlorophyll content tend to have better quality, indicating that varietal differences in leaf greenness may reflect differences in crop quality.

Table 3. Mean leaf greenness index of lettuce at different AB Mix concentrations and varieties under a Nutrient Film Technique (NFT) hydroponic system (SPAD units)

Plant Age (DAT)	Concentration (K) (ppm)	Variety (V)			Mean
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)	
42	k1 (560)	27.42	17.70	23.63	22.92 c
	k2 (840)	30.44	23.47	26.88	26.93 b
	k3 (1000)	35.21	28.10	31.76	31.60 a
	Mean	31.02 a	23.09 c	27.42 b	27.18

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level

The interaction between AB Mix concentration and variety did not significantly affect the leaf greenness index, as indicated in Table 3. This result suggests that the response of each variety to changes in nutrient concentration was relatively similar. That leaf greenness was influenced more by the main effects of concentration and variety than by their combination. A similar result was reported by Wulandari and Ayu (2023), who found that treatment combinations in lettuce physiology under the NFT system did not always produce a significant interaction effect.

Leaf Area

Leaf area at 42 DAT was highly significantly affected by AB Mix concentration, variety, and their interaction. These results indicate that leaf area was influenced not only by the main effects of nutrient concentration and varietal differences, but also by the specific response of each variety to each concentration level. The mean leaf area values under different treatment combinations are presented in Table 4.

Table 4. Mean leaf area of lettuce under different AB Mix concentrations and varieties in a Nutrient Film Technique (NFT) hydroponic system (cm²)

Plant Age (DAT))	Konsentrasi (K) (ppm)	Variety (V)		
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)
42	k1 (560)	20.15 g	69.63 bc	39.04 e
	k2 (840)	64.79 c	30.32 f	20.35 g
	k3 (1000)	94.51 a	46.75 d	75.75 b

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level

As shown in Table 4, the highest leaf area was obtained from the combination of 1000 ppm AB Mix and Batavia Caipira (94.51 cm²). This result indicates that leaf expansion in lettuce was strongly affected by the compatibility between nutrient concentration and varietal characteristics. Batavia Caipira responded more favorably to the 1000 ppm treatment than the other tested varieties, suggesting differences in nutrient requirement, nutrient uptake efficiency, and physiological response among varieties. Pertamasari *et al.* (2023) stated that differences in varietal response to nutrient treatment reflect the role of genetic factors in nutrient utilization. In addition, Suharjo (2024) reported that increasing nutrient concentration can enhance lettuce leaf area by providing more adequate nutrients to support vegetative growth. Bestari *et al.* (2018) also explained that larger leaf area increases light interception and supports photosynthesis, thereby promoting better plant growth. Therefore, leaf area formation in this study was determined by the interaction between nutrient concentration and varietal adaptability under the NFT hydroponic system.

Root Length

Root length at 42 DAT was significantly affected by AB Mix concentration. As shown in Table 5, the 1000 ppm treatment produced the highest mean root length (21.72 cm), indicating that this concentration better supported root development under the NFT hydroponic system. This response was likely related to a more adequate nutrient supply for root formation and elongation. Krestiani *et al.* (2022) reported that higher AB Mix.

Concentrations can provide nutrients more optimally, thereby promoting better lettuce root growth. A similar result was also reported by Sholeh and Wahyuni (2023), who found that AB Mix concentration affected root length at several observation times. In addition, Hendra and Andoko (2014) explained that sufficient phosphorus availability can stimulate root formation and elongation, while Ramadanis and Migusnawati (2024) stated that AB Mix contains essential nutrients, including phosphate, required to support root growth.

In contrast, variety and the interaction between AB Mix concentration and variety did not significantly affect root length, as indicated in Table 5. This result suggests that root growth responded similarly across the tested varieties at all nutrient concentrations.

This result indicates that root length was influenced more by nutrient concentration than by varietal differences or their combination. A similar finding was reported by Nita *et al.* (2023), who found that varietal differences did not significantly affect lettuce root length, while Meriaty *et al.* (2021) reported that treatment interactions in hydroponic lettuce cultivation do not always produce significant effects on root-related parameters.

Table 5. Mean root length of lettuce under different AB Mix concentrations and varieties in a Nutrient Film Technique (NFT) hydroponic system (cm)

Plant Age (DAT)	Concentration (K) (ppm)	Variety (V)			
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)	Mean
42	k1 (560)	13.00	21.33	14.17	16.17 ab
	k2 (840)	10.33	12.00	11.67	11.33 b
	k3 (1000)	22.17	22.33	20.67	21.72 a
	Mean	15.17	18.56	15.50	16.41

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level.

Shoot Fresh Weight

Shoot fresh weight at 42 DAT was highly significantly affected by both AB Mix concentration and variety. As shown in Table 6, the 1000 ppm treatment produced the highest mean shoot fresh weight (135.67 g), indicating that this concentration better supported shoot biomass accumulation. This response was likely associated with a more adequate nutrient supply for vegetative growth, which increased cell division, tissue expansion, and biomass formation. Krestiani and Supriyo (2022) reported that higher AB Mix concentrations increased lettuce shoot fresh weight because plants received sufficient nutrients to support vegetative development. Similarly, Salsabila *et al.* (2023) stated that higher AB Mix concentrations increased lettuce fresh weight, whereas lower concentrations were insufficient to optimize overall plant growth.

Variety also had a highly significant effect on shoot fresh weight, with Batavia Caipira showing the highest mean value (111.17 g), as presented in Table 6. This result indicates that Batavia Caipira had a better capacity to accumulate shoot biomass than the other tested varieties. Such differences may be related to genetic characteristics and to each variety's ability to absorb water and utilize nutrients for vegetative growth. Suseno and Widyawati (2020) explained that biomass accumulation increases with greater water and nutrient uptake, thereby promoting organ development. Better photosynthetic performance may also contribute to higher fresh biomass because photosynthates are used for growth and the formation of new tissues.

Table 6. Mean shoot fresh weight of lettuce under different AB Mix concentrations and varieties in a Nutrient Film Technique (NFT) hydroponic system (g)

Plant Age (DAT)	Concentration (K) (ppm)	Variety (V)			
		v1 (Batavia Caipira)	v2 (Grand Rapids)	v3 (Sementel)	Mean
42	k1 (560)	77.33	48.00	49.00	58.11 b
	k2 (840)	86.00	43.67	61.83	63.83 b
	k3 (1000)	170.17	144.83	92.00	135.67 a
	Mean	111.17 a	78.83 b	67.61 b	85.87

Note: Mean values followed by the same letter within the same row or column are not significantly different according to Duncan's Multiple Range Test (DMRT) at the 5% level.



Figure 1. Representative lettuce plants at 42 days after transplanting (DAT) under 1000 ppm AB Mix concentration (k3) based on variety and replication: (a) k3v1 R1, (b) k3v2 R1, (c) k3v3 R1, (d) k3v1 R2, (e) k3v2 R2, (f) k3v3 R2, (g) k3v1 R3, (h) k3v2 R3, and (i) k3v3 R3.

Note: v1 = Batavia Caipira, v2 = Grand Rapids, v3 = Sementel, and R = replication.

The interaction between AB Mix concentration and variety did not significantly affect shoot fresh weight, as indicated in Table 6. This result suggests that the response of shoot biomass accumulation to nutrient concentration was relatively similar among the tested varieties, and that shoot fresh weight was influenced more by the main effects of concentration and variety than by their combination. A similar finding was reported by Suwardi *et al.* (2022), who found that the interaction between AB Mix concentration and other treatment factors in NFT lettuce cultivation did not significantly affect shoot fresh weight.

CONCLUSION AND RECOMMENDATIONS

Based on the results of this study, it can be concluded that AB Mix at a concentration of 1000 ppm produced the best growth and yield response of lettuce under the NFT hydroponic system, as reflected by plant height at 28 DAT (18.17 cm) and 35 DAT (22.74 cm), number of leaves at 35 DAT (12.89 leaves) and 42 DAT (19.09 leaves), leaf greenness index at

42 DAT (31.60 SPAD units), root length at 42 DAT (21.72 cm), and shoot fresh weight at 42 DAT (135.67 g). Among the tested varieties, Grand Rapids showed the best performance in plant height, with a mean value of 40.16 cm at 42 DAT. In contrast, Batavia Caipira produced the highest number of leaves (19.28 leaves), leaf greenness index (31.02 SPAD units), and shoot fresh weight (111.17 g). A highly significant interaction between AB Mix concentration and variety was observed only for leaf area, with the combination of 1000 ppm AB Mix and Batavia Caipira producing the highest value (94.51 cm^2). Therefore, the application of 1000 ppm AB Mix and the use of Batavia Caipira are recommended for lettuce cultivation under an NFT hydroponic system. Further research is needed to evaluate additional quality parameters, including dry weight, visual leaf quality, bitterness level, and postharvest shelf life, to provide a more comprehensive understanding of lettuce responses to nutrient concentration and varietal differences.

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