JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 8 No. 3 September 2026

DOI :https://doi.org/10.36378/juatika.v8i3.5817
eissn 2656-1727
pissn 2684-785X
pages : 965 – 972

RESEARCH ARTICLE Open Access

Biochemical Quality of Green Lettuce (*Lactuca sativa* L.) NFT Hydroponic in Various Types and Concentrations of Liquid Organic Fertilizer

Irvan Febriel Adham[1], Yusniwati[1], Lily Syukriani[1,*]

Abstract

Green lettuce (*Lactuca sativa* L.) is a highly nutritious vegetable with increasing demand, making hydroponic cultivation using the nutrient film technique (NFT) a strategic option. However, reliance on AB Mix solution may lead to excessive nitrate accumulation, reducing food safety and the plant's biochemical quality. This study aimed to evaluate the effects of liquid organic fertilizer (POC) type and concentration on the chlorophyll, crude fiber, vitamin C, and nitrate content of lettuce grown hydroponically using NFT. The experiment used a split-plot design, with four POC types (Hantu, DI Grow, NASA, and Ribost) as the main-plot factor and four POC concentrations (0, 10, 20, and 30 mL/L) as the subplot factor. The experiment was replicated three times. POC concentration significantly affected chlorophyll content, with the highest value recorded at 30 mL/L (2.24 mg/L). Ribost produced the highest crude fiber content (0.97%), while DI Grow at 30 mL/L produced the highest vitamin C content (23.8 mg/100 g) and reduced nitrate levels from 3,511.0 to 2,782.1 mg/kg, below the European Union's safe threshold of 4,000 mg/kg. DI Grow at 30 mL/L is recommended as a partial substitute for AB Mix for hydroponic growers seeking to produce green lettuce with improved biochemical quality and lower nitrate levels.

Keywords: Fiber Content, Nitrate Accumulation, Nutrient Substitution, Organic Nutrition, Vitamin C

1. Introduction

Demand for green lettuce (*Lactuca sativa* L.) in Indonesia continues to increase. However, productivity has not been able to keep up with demand, resulting in high lettuce imports (Central Statistics Agency, 2023). The *Nutrient Film Technique (NFT)* hydroponic system offers an efficient cultivation solution in terms of land and water utilization and produces healthier products compared to conventional cultivation. However, in the NFT system, nitrogen is supplied directly through the AB Mix solution in the form of nitrate (NO_3^-), which is instant and abundant, so that the rate of nitrate ion absorption by the roots depends entirely on the concentration of the solution in the system (Ali, 2020). Muis *et al* . (2022) compared hydroponic lettuce with conventional lettuce and found that the nitrate content of lettuce in the hydroponic system reached 3,500–4,022 mg/kg fresh weight, far exceeding the results of organic cultivation.

Nitrate accumulation is not just an agronomic problem, but also a threat to food safety. Excessive consumption triggers *methemoglobinemia* and the formation of carcinogenic compounds (Khan *et al*., 2018). The European Union, through Regulation (EU) 2023/915, sets a maximum limit of 4,000 mg NO_3 /kg fresh weight for greenhouse lettuce and 3,000 mg NO_3 /kg for open-field lettuce, with a safe daily intake (ADI) of 3.7 mg/kg body weight per day (European Commission, 2023).

Lettuce quality is also determined by its chlorophyll, fiber, and vitamin C content, which play a vital role in photosynthetic efficiency, digestive health, and antioxidant capacity (Barber *et al* ., 2020; Naim and Askhabun, 2022). However, excessive nitrate supply from AB Mix tends to suppress vitamin C biosynthesis, as carbohydrates from photosynthesis are diverted more to amino acid formation (Yang *et al*., 2017).

The main challenge in this research is to reduce nitrate

*Correspondence: lilysyukriani@agr.unand.ac.id
1) Universitas Andalas - Jl. Dr. Mohammad Hatta, Limau Manis, Kecamatan Pauh, Kota Padang, Sumatera Barat 25163, Indonesia

residues while increasing fiber and vitamin C levels in hydroponically grown green lettuce. Several studies have examined strategies for controlling nitrate accumulation and improving the biochemical quality of hydroponic lettuce, but with different approaches and limited scope. Mampholo *et al*. (2018) examined the effect of varying inorganic nitrogen (*ammonium nitrate*) concentrations on the content of ascorbic acid, phenolic compounds, and nitrate residues in three lettuce varieties in a gravel-film hydroponic system. They found that a lower nitrogen concentration (90 mg L^{-1}) increased the accumulation of vitamin C and bioactive compounds while suppressing nitrate residues. Pedrinho *et al* . (2021) demonstrated that an organic cultivation system produced significantly lower nitrate levels in lettuce than a conventional system, indicating that organic nitrogen sources play a significant role in suppressing nitrate residue accumulation. Wang *et al* . (2023) compared hydroponic and conventional systems and reported significant increases in vitamin C and soluble sugar content in hydroponically grown lettuce, but also recorded higher nitrate accumulation. Ruangrak *et al* . (2023) reported that replacing AB Mix nutrient solution with tap water in the pre-harvest period in an NFT system was able to reduce the nitrate content of lettuce by 61–63%, but this approach simultaneously caused a decrease in vitamin C content by 16–30%, reflecting a trade-off between nitrate reduction and maintaining biochemical quality.

Different from the above studies, this study integrated the foliar application of commercial POC based on organic biostimulants (Hantu, DI Grow, NASA, Ribost) at certain concentrations into an NFT system that was deliberately operated at half the standard AB Mix dose.

Organic fertilizers (POCs) provide complex organic nutrients along with natural growth regulators that can maintain the C/N ratio of plants, stimulate the activity of the Nitrate Reductase enzyme, and suppress the accumulation of nitrate residues (Khan *et al*., 2018). Several POCs such as Ribost ®, DI Grow ®, NASA ®, and Hantu ® have been shown to increase nitrogen uptake, chlorophyll content, vitamin C, and fiber in hydroponic plants (Mohammed *et al* ., 2025; Rasouli *et al* ., 2022). The effectiveness of POCs is also determined by the raw materials, concentration, and cultivation system used, so direct comparisons between commercial POCs with different compositions are important for further study (Saragih *et al*., 2026).

This research aims to improve the biochemical quality of plants, including chlorophyll, crude fiber, and vitamin C, while suppressing the accumulation of nitrate residues through the plant's own internal mechanisms, without post-cultivation intervention.

2. Material and Methods

The research was conducted at *the Green House* Arif Hydrofarm, Pauh District, Padang City, with an altitude of ± 31.56 meters above sea level, located at the geographical coordinates 0°56'28.3"S 100°23'42.6"E, as well as at the Plant Physiology Laboratory and the Plant Product Processing Technology Laboratory, Faculty of Agriculture and Faculty of Agricultural Technology, Andalas University. The research took place in April–May 2026.

The planting materials used were green lettuce seeds of the Grand Rapids variety, rockwool, flannel cloth, and netpots. The basic hydroponic nutrient solution used AB Mix with a concentration of 700 ppm, POC Ribost ®, POC DI Grow ®, POC NASA ®, and POC Hantu, 80% acetone, H_2SO_4 0.255 N and NaOH 0.313 N, 0.1 M iodine solution and 1% starch indicator, 5% salicylic acid and 8% NaOH.

The tools used consist of a hydroponic installation of the *Nutrient Film Technique* (NFT) system with a pump with a capacity of 5,000 L/hour, TDS meter and pH meter, *sprayer*, digital scales and ruler, as well as a spectrophotometer, microscope, filter paper, cuvette, mortar, and measuring cup.

The study was designed using a Split Plot Design (RPT) with two factors. The first factor (main plot) was the type of POC, consisting of four levels: Hantu ®*POC* (A1), DI Grow ®*POC* (A2), NASA ®*POC* (A3), and Ribost ®*POC* (A4). The second factor (subplot) was the concentration of POC, consisting of four levels: 0 mL/L (B0), 10 mL/L (B1), 20 mL/L (B2), and 30 mL/L (B3). Each treatment combination was replicated three times, resulting in 48 experimental units with 8 plants per experimental unit, resulting in a total plant population of 384, with 4 plants per experimental unit used as samples.

The research implementation includes the following stages: (1) Preparation of a 4 m long NFT hydroponic installation with a 5% slope, equipped with a 100 L tank and a 5,000 L/hour pump. (2) Sowing lettuce seeds in rockwool for 7 days until they have 3 leaves, then transferring them to a flannel-lined netpot on the installation pipe. (3) Providing AB Mix solution at a concentration of 700 ppm (half of the recommended dose of 1,400 ppm) and maintaining stability using a TDS meter, with additional nutrients if the concentration drops below 600 ppm. (4) POC application is carried out four times at 1–4 MST with a one-week interval, sprayed evenly on the upper and lower surfaces of the leaves using a calibrated volume in the morning to minimize evaporation. (5) Pest and disease control is carried out mechanically. (6) Harvesting is carried out when 80% of the plant population shows optimal harvest characteristics, namely fully developed leaves, fresh green, not yet *bolting*, and not yet producing white sap (Irawati & Slamet, 2017).

The observed variables were total chlorophyll content, crude fiber content, vitamin C content, and plant nitrate content. Data analysis of green lettuce biochemical variables in the form of nitrate content, crude fiber content,

and vitamin C content was presented descriptively from the composite sample of each treatment. In contrast, the total chlorophyll content data was analyzed by analysis of variance through the F test at a significance level of 5% using the STAR ® application version 2.0.1.

2.1. FLOWCHART IMPLEMENTATION

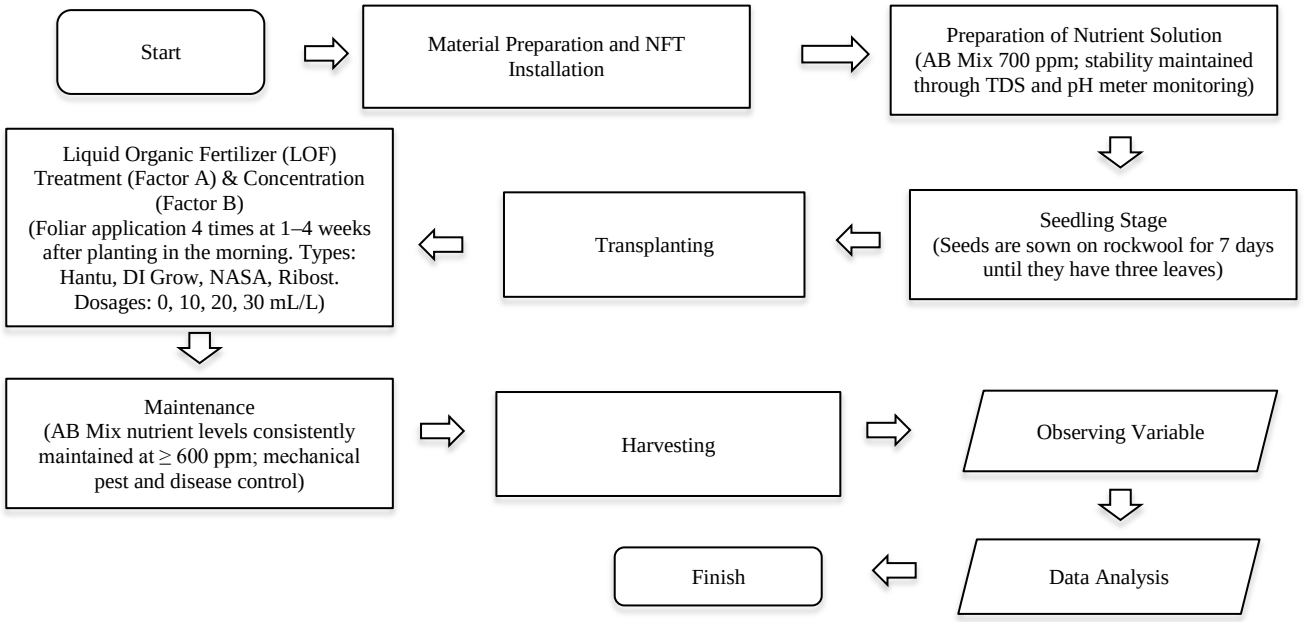


Figure 1. Research flow diagram

3. Results and Discussion

3.1. Total Chlorophyll Content (mg/l)

The results of the analysis of variance at the 5% level showed that there was no significant interaction between the type and concentration of POC on the chlorophyll content of green lettuce leaves at 5 WAP. However, the concentration of POC had a significant effect individually (Table 1).

The chlorophyll content of lettuce in all treatments ranged from 1.11 mg/L to 2.99 mg/L. On average, increasing the POC concentration from 0 to 10 mL/L increased the chlorophyll content by 49.3%**,** while at a concentration of 30 mL/L the increase reached 64.7% compared to the control. However, this increase was no longer significantly different at a concentration of 10 mL/L, indicating a tendency towards saturation.

The stagnation of chlorophyll values in the range of 2.01 to 2.24 mg/l reflects the limited capacity of leaf mesophyll cells to form chloroplasts. This saturation pattern aligns with the findings of Chowdhury & Samarakoon (2024), who reported that lettuce leaf chlorophyll accumulation reached its highest value at relatively low organic fertilizer concentrations.

Table 1 Chlorophyll content of lettuce leaves with several types and concentrations of POC at 5 WAP.

POC Types	**Liquid Organic Fertilizer Concentration (mL/L)**			
	0	**10**	**20**	**30**
		----------mg/l----------		
Ghost	1.53 ± 0.61	2.27 ± 0.48	2.19 ± 0.64	2.34 ± 0.31
DI Grow	1.13 ± 0.24	2.06 ± 0.29	2.17 ± 0.42	2.99 ± 0.48
NASA	1.11 ± 0.13	2.23 ± 0.55	1.64 ± 0.33	2.25 ± 0.35
Ribost	1.64 ± 0.67	1.53 ± 0.57	2.01 ± 0.59	1.35 ± 0.27
Average Concentration	**1.36 ± 0.47 b**	**2.03 ± 0.52 a**	**2.01 ± 0.49 a**	**2.24 ± 0.87 a**
Family A = 35.06% Family B = 27.22%				

Description: Numbers followed by the same letter in the main effect row of concentration are not significantly different according to the DNMRT test at the 5% level.

Foliar supplementation of POC in AB Mix 700 ppm was still able to increase the average chlorophyll content of lettuce plants compared to the control. This is different from the findings of Saragih *et al* . (2026) on oil palm seedlings using the wick system, where a single AB Mix actually produced the highest chlorophyll content compared to the POC treatment.

The large increase of 49.3% at a concentration of 10

mL/L indicates that the need for chlorophyll biosynthesis precursors has been largely met at low doses. This is triggered by the availability of amino acids, primarily glutamic acid, which acts directly as a precursor to δ-*aminolevulinate* (ALA) for chlorophyll formation. These results are supported by research by Colla *et al* . (2017) and Choi *et al* . (2022), which demonstrated that foliar application of amino acid-rich fertilizers significantly stimulates chlorophyll biosynthesis even at low concentrations.

This is reinforced by Hooks *et al* . (2022), who found that lettuce plants receiving organic input had 19% higher chlorophyll retention and value than plants that relied purely on inorganic nutrients.

The application of POC Di Grow at a concentration of 30 mL/L produced 27.8% higher chlorophyll than Hantu, 32.9% higher than NASA, and 121.5% higher than Ribost. This response supports the report of Colla *et al* . (2017) that the application of amino acid-based biostimulants can increase chlorophyll biosynthesis. This result is supported by the content of fulvic and humic acids that increase the mobility of magnesium (Mg^{2+}).

Visually (Figure 2), lettuce plants receiving 20–30 mL/L of POC had wider crowns, greener leaves, and denser canopies than the control. This response was consistent with an average increase in chlorophyll content of 49.3–64.7% in the POC treatment, indicating that increased chlorophyll biosynthesis contributed to plant crown development.



Figure 1. The comparison of the result between treatment of green lettuce

3.2. Crude Fiber Content

The crude fiber content of green lettuce across all treatments ranged from 0.47% to 0.97% (Table 2). This crude fiber content is relatively higher than the range reported by Setiawan et al. (2024), which was 0.45–0.61% in hydroponic lettuce cultivation using liquid organic fertilizer (POC) as the hydroponic nutrient solution. This difference is thought to be related to the use of POC as a foliar application in this study, allowing bioactive compounds to directly interact with leaf tissue and modulate cell wall formation metabolism.

Table 2 Crude fiber content of green lettuce plants (*Lactuca sativa* L.) with several types and concentrations of POC at 5 WAP.

POC Types	POC concentration (mL/L)			
	0	10	20	30
	----------%----------			
Ghost	0.47	0.55	0.63	0.63
DI Grow	0.47	0.63	0.63	0.87
NASA	0.47	0.55	0.55	0.55
Ribost	0.47	0.87	0.97	0.97

Note: Data are the average of the composite sample (5 g plants per treatment).

Compared to the control, the application of POC Ribost at a concentration of 30 mL/L increased crude fiber content by 106.4%**,** while DI Grow increased fiber content by 85.1% at a concentration of 30 mL/L. In contrast, the increase in Hantu only reached 34.0%**, while** NASA only reached 17.0%**.** showed that the fiber formation response was not only influenced by the type of POC used, but also the biostimulant composition of each product. This is similar to the fiber content of hydroponic lettuce reported by Ohse *et al* . (2001), which was 0.73–0.88 g 100 g^{-1} using the Bernardes, Furlani, and Castellane-Araújo nutrient solution.

The fastest response was shown by Ribost, which increased fiber content by 85.1% at a concentration of 10 mL/L and reached 106.4% at 20 mL/L. The high fiber yield in Ribost is driven by the presence of *the bio-enzyme* peroxidase in its formulation. This phenomenon is supported by statements by Shigeto & Tsutsumi (2016) and Chou *et al* . (2018). Peroxidase is a key enzyme that catalyzes lignin polymerization exclusively in the middle lamella and corners of secondary plant cell walls, right in the zone of highest lignin deposition. Therefore, the

peroxidase bio-enzyme from Ribost can be directly integrated into the active lignification zone of the cell wall and catalyze the localized polymerization of monolignols. Increasing the concentration of POC by 50% (20 to 30 mL/L) no longer increases fiber content, so the efficiency of the plant response begins to saturate.

In the Di Grow POC treatment, crude fiber levels stagnated at concentrations of 10 mL/L and 20 mL/L, each of which increased crude fiber levels by 34% compared to the control, then jumped to 85.1% at 30 mL/L. This is thought to occur due to the content of complex polysaccharides based on seaweed extracts, including alginate, laminarin, and carrageenan contained in Di Grow POC, which function as elicitors activating the plant cell wall biosynthesis pathway (Rouphael *et al* ., 2022). The increase in crude fiber levels is in line with Wang *et al* . (2023), who reported that increasing the concentration of the hydroponic nutrient solution *"Hoagland nutrient solution"* (HS) increases *the crude fiber content* in lettuce, especially in the highest nutritional treatment of 1.3 HS compared to 0.7 HS and 1 HS.

The Ghost and Nasa POC treatments produced a relatively low percentage of crude fiber. Ghost POC increased fiber content by 17.0% at a concentration of 10 mL/L and reached 34.0% at 20 mL/L, then did not experience a further increase at 30 mL/L. A similar pattern also occurred with NASA, which only increased fiber content by 17.0% compared to the control and remained constant until the highest concentration. The low fiber content in Ghost POC is likely due to the high nitrogen ratio it contains (12%), which creates a carbon-nitrogen (C/N) imbalance. This is supported by Huang *et al* . (2025), who found that an overly dominant nitrogen supply forces plants to allocate most of the carbon assimilates for protein synthesis and rapid cell division (biomass), so that the availability of carbohydrates to build rigid fiber structures such as lignin and cellulose decreases drastically.

3.3. Vitamin C Levels

The vitamin C content of green lettuce in this study ranged from 5.1 to 23.8 mg/100 g (Table 3). Compared to a concentration of 0 mg/100 g, the application of POC increased vitamin C levels 2.5 to 4.7-fold. In contrast, Mampholo *et al* . (2018) reported that increasing nitrogen concentrations above 90 mg L^{-1} actually reduced vitamin C content in hydroponic lettuce to around 6–10 mg/100 g. This difference suggests that the increase in vitamin C in this study was likely not due to increased nitrogen supply, but rather to the biostimulatory effect of POC, which activates ascorbic acid biosynthesis.

Table 3. Vitamin C levels of green lettuce plants (*Lactuca sativa* L.) with several types and concentrations of POC at 5 WAP.

POC Types	POC concentration (mL/L)			
	0	10	20	30
	----------mg/100 g----------			
Ghost	5.1	16.2	20.6	20.6
DI Grow	5.1	20.6	20.6	23.8
NASA	5.1	16.2	16.2	16.2
Ribost	5.1	12.9	12.9	16.2

Note: Data are the average of the composite sample (10 g plants per treatment).

The highest increase was obtained in the DI Grow 30 mL/L treatment, which produced a vitamin C level of 23.8 mg/100 g or about 4.7 times higher than the control. In contrast, the lowest increase occurred in Ribost 10–20 mL/L with a vitamin C level of 12.9 mg/100 g or about 2.5 times higher than the control. POC Hantu increased vitamin C levels by about 3.2-fold at a concentration of 10 mL/L and reached 4.0-fold at a concentration of 20 mL/L before entering a plateau phase at 30 mL/L. POC DI Grow increased vitamin C levels by about 4.0-fold at a concentration of 10 mL/L, then increased to 4.7-fold at 30 mL/L. In contrast, NASA only reached about 3.2-fold and showed no additional response to increasing doses, while Ribost increased about 2.5-fold at 10–20 mL/L and only reached 3.2-fold at a concentration of 30 mL/L. These differences in response patterns indicate that the effectiveness of increasing vitamin C is determined more by the biostimulant characteristics of each POC than simply by increasing the application dose. The pattern of increasing vitamin C levels as the concentration of POC increases is consistent with the general principle of dose response of organic fertilizers, where the higher the dose given, the greater the yield obtained by the plants, as long as it is still within the optimal concentration limit (Afmerta *et al* ., 2019).

POC DI Grow with a concentration of 30 mL/L produced the highest vitamin C content of 23.8 mg/100g. This result differs from Wang et al. (2023), who reported that increasing the concentration of hydroponic nutrient solution had no significant effect on ascorbic acid content. However, the overall hydroponic system produced approximately 28.05% higher vitamin C than conventional cultivation systems. This difference indicates that the increase in vitamin C in the POC DI Grow treatment was supported by its formulation in the form of seaweed extract that produces an *elicitor effect*. Rasouli *et al* . (2022) explained that foliar application of seaweed extract provides a mild cellular stress signal that forces plants to increase ascorbic acid production as a protective mechanism.

Ghost POC increased vitamin C levels from 5.1 to 16.2 mg/100 g, or approximately 3.2-fold, at a concentration of 10 mL/L, then increased to approximately 4.0-fold at a concentration of 20 mL/L and did not increase further at a concentration of 30 mL/L. This plateau pattern indicates that the plant's physiological needs for cytokinins have likely been met at a concentration of 20 mL/L, so that subsequent dose increases no longer significantly increase ascorbic acid biosynthesis. Natural cytokinins, especially trans-Zeatin, physiologically delay leaf tissue senescence by inhibiting chlorophyll degradation and maintaining cell metabolic activity (Hönig *et al* ., 2018).

POC Ribost produced the lowest vitamin C levels among all treatments, which were about 2.5 times higher than the control at a concentration of 10–20 mL/L and increased to about 3.2 times at a concentration of 30 mL/L. Castro *et al* . (2023) stated that tissue peroxidase activity will consume ascorbic acid as a substrate for the oxidative reaction of lignin formation. As a result of the substrate diversion, the availability of free ascorbic acid (vitamin C) in the leaves is significantly depleted.

Overall, all POC treatments increased vitamin C levels, indicating that the application of POC as a foliar supplement to AB Mix 700 ppm was able to increase leaf ascorbic acid accumulation. This finding complements the results of Wang *et al* . (2023), which showed that increasing the concentration of hydroponic nutrient solution alone was not sufficient to increase vitamin C content significantly. This study indicates that the composition of biostimulants in POC plays a greater role in modulating vitamin C biosynthesis than simply increasing the concentration of macronutrients in the nutrient solution.

3.4. Nitrate Levels

Green lettuce nitrate levels across all treatments ranged from 2,782.1 to 3,511.0 mg/kg fresh weight (Table 4). Compared to the control (3,511.0 mg/kg), POC application reduced nitrate levels by 2.6–20.8%. The largest reduction was achieved with DI Grow 30 mL/L at 20.8%, while the smallest reduction occurred with Ribost 10 mL/L at only 2.6%. All treatments remained below the maximum nitrate limit set in European Union Regulation 2023/915 for greenhouse lettuce, which is 4,000 mg/kg.

Table 4. Nitrate levels of green lettuce plants (*Lactuca sativa* L.) with several types and concentrations of POC at 5 WAP.

POC Types	POC concentration (mL/L)			
	0	10	20	30
	----------*mg/kg*----------			
Ghost	3511.0	3102.6	3100.3	3002.7
DI Grow	3511.0	3102.6	2974.3	2782.1
NASA	3511.0	3102.6	3251.8	3102.6
Ribost	3511.0	3418.6	3102.6	3102.6

Note: Data are the average of the composite sample (3 kg plants per treatment).

The highest value was consistently found in the treatment without POC (0 mL/L), reaching 3,511.0 mg/kg. This condition indicates that plants that only obtain nitrogen from the AB Mix solution tend to accumulate higher nitrate than plants that receive POC supplementation. This indicates that nitrate uptake by the roots is much greater than the plant's capacity to assimilate it. This condition is in line with the findings of Liang and Zhang (2020), who explained that nitrate that has not been broken down by the nitrate reductase (NR) enzyme will continue to accumulate in the leaf cell vacuoles if the plant only relies on inorganic nitrogen sources. Similarly, Yang *et al*. (2017) reported that plants fertilized with organic fertilizers consistently produce lower nitrate levels than inorganic fertilizers at equivalent nitrogen concentrations, because nitrogen release occurs more gradually and synchronized with the plant's metabolic needs.

The application of DI Grow POC showed the best pattern of nitrate reduction. Compared to the control, nitrate levels were reduced by 11.6% at a concentration of 10 mL/L, increasing to 15.3% at 20 mL/L, and reaching 20.8% at 30 mL/L. This reduction occurred because DI Grow supplies organic nitrogen in the form of amino acids that can be directly absorbed by the leaves. These results are in line with research by Wang et al. (2023), which showed that improving the quality of nutrient management in hydroponic systems can improve yield quality by controlling nitrate accumulation. However, increasing nutrient solution concentration is not always followed by a linear change in nitrate levels. In addition, research by Uusitupa et al. (2023) reported that the application of glycinebetaine in NFT systems can reduce nitrate levels by up to 40% while improving the consumption quality of lettuce. This explains that increasing the efficiency of nitrogen metabolism can reduce nitrate accumulation in leaf tissue.

Hantu POC produced a relatively stable reduction in nitrate levels, namely around 11.6% at 10 mL/L, 11.7% at 20 mL/L, and 14.5% at 30 mL/L. This indicates that increasing Hantu concentration only provides a relatively small additional nitrate reduction after a dose of 10 mL/L. In contrast to Hantu, Ribost POC showed a slower response. A concentration of 10 mL /L mL/L only reduced nitrate levels by 2.6%**,** while increasing the concentration to 20 mL/L reduced nitrate levels by 11.6%**,** and did not experience further reduction at 30 mL/L.

In contrast, Nasa POC showed a fluctuating response pattern. At a concentration of 10 mL/L, nitrate levels decreased by 11.6%**,** but its effectiveness decreased at a concentration of 20 mL/L, so that nitrate levels were only reduced by 7.4% compared to the control. The decrease increased again to 11.6% at a concentration of 30 mL/L. This pattern indicates that increasing the dose of Nasa POC is not always followed by an increase in nitrogen assimilation efficiency. This phenomenon is very consistent with the report of Li et al. (2024) that the exponential growth phase of plants stimulated by PGRs often triggers nitrate absorption that exceeds the plant's assimilation capacity, so that the nitrate accumulates temporarily in the vacuole.

4. Conclusion

Based on the research results, POC DI Grow at a concentration of 30 mL/L is the best treatment because it is most effective in suppressing nitrate levels to 2,782.1 mg/kg, chlorophyll content of 2.99 mg/L and vitamin C of 23.8 mg/100g. As for crude fiber content, the highest value was obtained in the application of POC Ribost, namely 0.97% at concentrations of 20 and 30 mL/L. Therefore, the application of POC DI Grow at 30 mL/L is recommended to improve the nutritional quality and consumption safety of hydroponic lettuce. At the same time, POC Ribost can be considered if increasing fiber content is the main goal of cultivation.

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