University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

The effect of treatment with gibberellic acid and Disper Chlorophyll on some growth characteristics of lettuce crop under hydroponic conditions

Shifaa Abdul Ridha Armash, Mohammed J Mohammed

1 Agriculture Diroctorate of Thi Qar

2 Department of horticulture and landscape design, College of Agriculture and Marshes, University of Thi-Qar, Thi-Qar, 64001, Iraq

Corresponding author, email: Shafaa.post2025@utq.edu.iq, muhamed@utq.edu.iq,

Abstract

The experiment was carried out at the Hydroponic Station, Department of Horticulture and Landscape Engineering, University of Thi Qar, to evaluate the effects of gibberellic acid (GA_3) at 0, 10, 20, and 30 $mg·L^{-1}$, Disper Chlorophyll (DC) at 0, 2, and 4 $g·L^{-1}$, and their interactions on lettuce growth (Lactuca sativa L. cv. Wissam) under hydroponic conditions. Treatment means were compared using the Least Significant Difference (LSD) test at a 0.05 probability level.The results showed that GA_3 at 20 $mg·L^{-1}$ increased the number of leaves, averaging 56.22 leaves·plant^{-1}, while the control was 51.66 leaves·plant^{-1}. Disper chlorophyll alone also had a strong effect when applied at 4 $g·L^{-1}$, leaf number reached 55.66. Chlorophyll percentage was also highest when DC alone was used at 4 $g·L^{-1}$, reaching 8.916. Similarly, plant height increased with GA_3 at 20 $mg·L^{-1}$, averaging 31.95 cm, but DC by itself at 4 $g·L^{-1}$ also gave 29.57 cm. Leaf area was biggest when GA_3 was 30 $mg·L^{-1}$ and DC was $g·L^{-1}$, reaching 60.43 cm^2, but again, DC alone also played a role. Both GA_3 and DC on their own had important effects, and together they influenced all traits. The combination of GA_3 at 20 $mg·L^{-1}$ and DC at 4 $g·L^{-1}$ gave the best results in all measurements.

Key words:gibberellic acid, Hydroponic, Disper Chlorophyll, lettuce.

University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

Introduction

Lettuce (Lactuca sativa L.) is one of the most important crops belonging to the Asteraceae (Composite) family, and it is cultivated as one of the most prominent winter leafy vegetable crops. Its production is widespread in Iraq and various countries worldwide due to its nutritional value and health benefits, making it a widely consumed crop across diverse diets, where it is used in salads, sandwiches, and many other dishes. The importance of lettuce stems from its richness in vitamins and minerals, in addition to its rapid growth rate, distinctive taste, and versatile culinary uses. It is believed that its origin traces back to the Mediterranean basin, Europe, and Asia, and humans have known its cultivation for thousands of years (Mitsigiorgi et al., 2024). According to the Food and Agriculture Organization of the United Nations (FAO) and global statistical platforms, the global yield of lettuce ranges between $25\text{–}30 \text{ tons ha}^{-1}$, and lettuce production in Iraq in 2022 reached approximately 36.3 thousand tons (FAO, 2023).

Plant growth regulators, particularly Gibberellic Acid (GA_3), play a crucial role in the physiology of lettuce growth. Gibberellic acid (GA_3) is considered one of the most essential plant hormones regulating growth and development processes in higher plants. It belongs to the gibberellins group, which comprises more than 130 known compounds; however, GA_3 is the most effective and widely utilized in agricultural research and field applications. Physiologically, gibberellic acid plays a fundamental role in stimulating plant cell elongation by influencing the cell wall and increasing its plasticity. It activates enzymes responsible for degrading cell wall components, such as cellulose and hemicellulose, thereby allowing cell expansion and increasing internode length (Taiz et al., 2015). Applied studies have shown that foliar spraying of plants with gibberellic acid leads to a significant increase in vegetative characteristics, such as plant height, internode length, and leaf area, especially in vegetable and herbaceous crops (Rademacher, 2016).

Amino acids are effective means for preventing and treating nutrient deficiencies when applied via foliar spraying, due to their small molecular size, which facilitates their absorption through plant stomata. They also contribute to increasing cell membrane permeability, which aids the transport of nutrients within plant cells and ensures they reach the sites where deficiency symptoms appear to remedy them. In addition, amino acids play a vital role in protein synthesis, enhancing plant resistance to unfavorable environmental conditions, influencing stomatal behavior, hormone synthesis, and improving pollination and fruit set (Suleiman, 2017). Amino acids are simple organic compounds containing two essential chemical groups: the carboxyl group ($-COOH$) and the amine group ($-NH_2$). They are the primary building blocks of proteins, with about 20 amino acids participating in their formation. The importance of proteins lies in their multiple vital roles, as they contribute to stimulating plant growth, regulating metabolic processes, transporting various substances within the plant, and serving as a reservoir for amino acids in plant tissues (Galili et al., 2016; Al-Sarawi, 2017).

With the global expansion in adopting intensive production techniques and moving toward clean agriculture, the need has grown to develop agricultural systems capable of achieving high yields while reducing resource consumption. Consequently, Hydroponics has emerged as one of the most crucial modern agricultural techniques. It allows precise control over the root environment and nutrient management, in addition to its superior water-use efficiency, which is a critical factor in arid and semi-arid environments (Taiz, Zeiger, et al., 2018). Hydroponics offers numerous advantages, as plants can be grown densely due to the continuous availability of water and nutrients, accompanied by a significant reduction in agricultural operations such as plowing and weed control, while saving up to 80% of the water used in traditional agriculture (Savvas et al., 2006; Bo et al., 2018).

University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

Materials and Methods

This study was conducted at the Aquaponics Station, College of Agriculture and Marshes, University of Dhi Qar, during the period ($2025\text{–}2026$). The objective was to determine the effect of Gibberellic Acid (GA_3) and Disper Chlorophyl on the vegetative and chemical growth of lettuce (Lactuca sativa L.) under hydroponic conditions.

A factorial experiment was carried out following a Completely Randomized Design (CRD) with three replicates, involving two factors:

1. First factor: Gibberellic acid at four concentrations ($0, 10, 20, 30$).
2. Second factor: Disper Chlorophyl at three concentrations ($0, 2, 4$).

The total number of experimental units was 36 ($4 \times 3 \times 3$), with four plants in each experimental unit, making the total number of seedlings 144.

Note:

Seeds of the cultivar 'Wesam' (of Dutch origin) were sown in disposable plastic cups filled with Jiffy-7 pellets, which were used as a germination medium. A single seed was placed in each cup to ensure uniform growth and minimize competition among seedlings. The planting process was carried out on October 27, 2025, and the cups were maintained under optimal environmental conditions regarding temperature, humidity, and light intensity. The seeds were irrigated regularly and with appropriate amounts to maintain medium moisture without saturation, ensuring optimal conditions for germination and early plant development.

After developing a robust root system, the seedlings were transferred to a lath house (wooden shade) to complete their growth under suitable conditions. When the plants reached the four-true-leaf stage, 144 uniform seedlings were selected, transplanted into 7 cm diameter hydroponic pots, and placed into the pipes of the hydroponic system on December 14, 2025.

Studied Traits:

1. Number of Leaves (leaves plant^{-1}):

The number of leaves per head was recorded by counting all leaves, excluding exceptionally small ones.

2. Plant Height (cm):

Plant height was measured from the surface level of the growth medium to the highest tip of the plant.

3. Leaf Area ($\text{cm}^2\text{ plant}^{-1}$):

Leaf area was measured using a computerized method. This method relied on taking random leaf samples from three plants per experimental unit and placing them on an automated scanner, according to the device's

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

capacity for the sampled leaf volume. The scans were then converted into high-resolution images readable by the computer, and analyzed using Image J software.

4. Total Leaf Chlorophyll Content:

Leaf chlorophyll pigments (chlorophyll a, chlorophyll b, and total chlorophyll) were estimated according to the method described by Arnon (1949).

Results and Discussion

Table (1) shows a significant effect of gibberellin spray treatments, Disper Chlorophyll treatments, and their interaction on the number of leaves. The gibberellin treatment at a concentration of 20 mg L^{-1} produced the highest mean, reaching 56.22 leaves $plant^{-1}$, compared with the control treatment, which recorded 51.66 leaves $plant^{-1}$.

Similarly, Disper Chlorophyll at a concentration of 2 g L^{-1} significantly outperformed the control treatment, producing the highest mean of 55.66 leaves $plant^{-1}$, whereas the control treatment recorded 50.58 leaves $plant^{-1}$. Regarding the interaction effect, the treatment GA10 + DH2 recorded the highest value of 61.00 leaves $plant^{-1}$, while the treatments GA10 + DH0 and GA30 + DH4 recorded the lowest value of 48.00 leaves $plant^{-1}$.

Table (1). Effect of foliar application of gibberellic acid and Disper Chlorophyll on the number of leaves (leaves $plant^{-1}$).

Mean of gibberellic	Disper Chlorophyll spray treatments (g L^{-1})			Gibberellic acid spray treatments (mg L^{-1})
	4	2	0	
51.66	55.33	55.00	44.66	0
54.66	55.55	61.00	48.00	10
56.22	55.00	57.66	56.00	20
50.22	48.00	49.00	53.66	30
	53.33	55.66	50.58	Mean of Disper
LSD 0.05				
DC*GA=0.8802	DC=0.4401		GA=0.5082	

Table (2) shows a significant effect of gibberellic acid, Disper Chlorophyll, and their interaction on plant height. The gibberellic acid treatment at a concentration of 20 mg L^{-1} produced the highest mean plant height (31.95 cm) compared with the control treatment, which recorded 27.00 cm.

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

Disper Chlorophyll at a concentration of 4 g L^{-1} recorded the highest mean plant height (29.63 cm) compared with the control treatment, which recorded 28.97 cm.

Regarding the interaction effect, the treatment GA20 + DH0 produced the highest value (32.33 cm), whereas the treatment GA30 + DH4 recorded the lowest value (26.33 cm), which did not differ significantly from the control treatment.

The increase in plant height following gibberellic acid application may be attributed to its well-known role in stimulating cell division and elongation, particularly in stem tissues, resulting in enhanced vegetative growth. The positive response to Disper Chlorophyll may be associated with improved photosynthetic activity and greater production of assimilates required for growth. The variation observed among interaction treatments suggests that the response of plant height to gibberellic acid depends on the concentration of Disper Chlorophyll applied, indicating a complex interaction between the two growth-promoting substances.

Table (2). Effect of foliar application of gibberellic acid and Disper Chlorophyll on plant height (cm).

Mean of gibberellic	Disper Chlorophyll spray treatments (g L^{-1})			Gibberellic acid spray treatments (mg L^{-1})
	4	2	0	
27.00	28.02	27.59	25.40	0
30.31	30.10	30.44	30.39	10
31.95	31.46	32.05	32.33	20
28.31	26.33	28.22	30.40	30
	28.97	29.57	29.63	Mean of Disper
LSD 0.05				
DC*GA=0.5962	DC=0.2981		GA=0.3442	

Table (3) shows a significant effect of gibberellic acid spray treatments, Disper Chlorophyll treatments, and their interaction on leaf area. The gibberellic acid treatment at a concentration of 30 mg L^{-1} produced the highest mean leaf area (56.84 cm^2 $leaf^{-1}$) compared with the control treatment, which recorded 48.42 cm^2 $leaf^{-1}$.

Similarly, Disper Chlorophyll at a concentration of 2 g L^{-1} resulted in the highest mean leaf area (50.59 cm^2 $leaf^{-1}$) compared with the control treatment, which recorded 48.42 cm^2 $leaf^{-1}$.Regarding the interaction effect, the treatment GA30 + DH0 achieved the highest value (60.43 cm^2 $leaf^{-1}$), whereas the treatment GA0 + DH0 recorded the lowest value (33.71 cm^2 $leaf^{-1}$).

The increase in leaf area observed with gibberellic acid application may be attributed to its role in promoting cell division and elongation, leading to greater leaf expansion and enhanced vegetative growth. The positive effect of Disper Chlorophyll may be associated with improved chlorophyll synthesis and photosynthetic efficiency, which provide additional assimilates for leaf development. The superior performance of the interaction treatment GA30 + DH0 indicates that gibberellic acid played a major role in stimulating leaf expansion under the conditions of this experiment.

Table (3). Effect of foliar application of gibberellic acid and Disper Chlorophyll on leaf area (cm^2 $leaf^{-1}$).

Mean of gibberellic	Disper Chlorophyll spray treatments (g L^{-1})			Gibberellic acid spray treatments (mg L^{-1})
	4	2	0	
42.05	48.92	43.54	33.71	0
47.51	47.85	47.79	46.90	10
52.95	53.46	52.77	52.64	20
56.84	51.80	58.29	60.43	30
	50.50	50.59	48.42	Mean of Disper
LSD 0.05				
DC*GA=0.8501	DC=0.4250		GA=0.4908	

Table (4) shows a significant effect of gibberellic acid spray treatments, Disper Chlorophyll treatments, and their interaction on chlorophyll content. The gibberellic acid treatment at a concentration of 20 mg L^{-1} recorded a mean value of 8.024, compared with 8.916 for the control treatment, while the mean decreased to 2.746 at the concentration of 10 mg L^{-1}.

Disper Chlorophyll at a concentration of 4 g L^{-1} produced the highest value (6.23), which did not differ significantly from the control treatment.

University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

Regarding the interaction effect, the treatment GA0 + DH4 recorded the highest value (10.94), whereas the treatment GA10 + DH0 recorded the lowest value (1.53).

The variation in chlorophyll content among treatments may be attributed to the influence of gibberellic acid and Disper Chlorophyll on chloroplast development, chlorophyll biosynthesis, and photosynthetic activity. The increase observed in some treatments could be associated with enhanced metabolic activity and improved nutrient utilization, while the decline observed in other treatments may reflect differential physiological responses to the applied concentrations.

Table (4). Effect of foliar application of gibberellic acid and Disper Chlorophyll on chlorophyll content.

Mean of gibberellic	Disper Chlorophyll spray treatments (g L^{-1})			Gibberellic acid spray treatments (mg L^{-1})
	4	2	0	
8.916	10.940	8.443	7.365	0
2.746	4.848	1.859	1.531	10
8.024	5.660	7.496	10.917	20
5.329	3.502	3.068	9.417	30
	6.237	5.217	7.308	Mean of Disper
LSD 0.05				
DC*GA=0.2344	DC=0.1172			GA=0.1353

Reference

productivity and quality indicators of two strawberry cultivars (Fragaria × ananassa Duch.). Karbala Journal of Agricultural Sciences, 5(3), 13–30.

Al-Rawi, K. M., & Khalaf Allah, A. K. (2000). Design and Analysis of Agricultural Experiments (2nd ed.). University of Mosul, Ministry of Higher Education and Scientific Research, Republic of Iraq, 488 pp.

AI-Sarawi, S. (2017). The role of amino acids in plant. National Research Center, Department of Fruit Research, Pomology, pp. 1–5.

Bo, L. E. I., Bian, Z. H., Yang, Q. C., Wang, J., Cheng, R. F., Li, K., Liu, W. K., Zhang, Y., Fang, H., & Tong, Y. X. (2018). The positive function of selenium supplementation on reducing nitrate accumulation in hydroponic lettuce (Lactuca sativa L.). Journal of Integrative Agriculture, 17(4), 837–846.

ISSN Onlin:2708 -9347, ISSN Print: 2708 -9339 Volume 15, Issue 1 (2026)

https://iasj.rdd.edu.iq/journals/journal/issue/20226 https://doi.org/10.54174/utjagr.v13ii 40.

FAO. (2023). World food and agriculture: Statistical yearbook 2023. Rome, Italy: Food and Agriculture Organization of the United Nations.

Galili, G., Amir, R., & Fernie, A. R. (2016). The regulation of essential amino acid synthesis and accumulation in plants. Annual Review of Plant Biology.

Mitsigiorgi, K., Boskou, D., & Fasseas, C. (2024). Lettuce (Lactuca sativa L.) cultures and the bioactivity of extracts. Plants, 13(3), 680.

Rademacher, W. (2016). Chemical regulators of gibberellin status and their application in plant production. Annual Plant Reviews, 49, 359–403.

Savvas, D., Passam, H. C., Olympios, C., Nasi, E., Moustaka, E., Mantzos, N., & Barouchas, P. (2006). Effects of ammonium nitrogen on lettuce grown on pumice in a closed hydroponic system. HortScience, 41(7), 1667–1673.

Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). Plant physiology and development (6th ed.). Sinauer Associates.

Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant physiology and development (6th ed.). Oxford University Press.