



Effect of Different Levels of Nutrients on Plant Growth, Yield and Quality of Lettuce (*Lactuca sativa*) in NFT (Nutrient Film Technique) Vertical System of Hydroponics under Shade Net Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was carried out under the Shade net, Research Field, Department of Horticulture, SHUATS, Prayagraj during the month of November 2021 to February 2022. Experiment was laid out in Randomized Block Design (RBD), with eight treatments, replicated thrice with nutrient film technique hydroponics system and lettuce variety Grand Rapids. The treatments were T₁ (NPK 2.8ml/Plant), T₂ (NPK 4.2ml/Plant), T₃ (NPK 5.71ml/Plant), T₄ (NPK 7.14ml/Plant), T₅ (NPK 8.57ml/Plant), T₆ (NPK 10ml/Plant), T₇ (NPK 11.43ml/Plant) and T₈ (NPK12.86ml/Plant). From the observations T₅ was found to be the best relating to growth and yield parameters followed by T₆ and T₇. In gross return, net return and B.C maximum values were also recorded in T₅.

Keywords: Lettuce; nutrient film techniques; NPK; growth; yield and quality.

1. INTRODUCTION

“Lettuce (*Lactuca sativa* L.) is an important member of the Asteraceae family, with very successful and diverse group of plants having global distribution. It is a major fresh vegetable and its leaves are commonly found in salad mixtures and sandwiches. Lettuce is a rich source of vitamin K and vitamin A, and a moderate source of folate and iron. Growing hydroponics lettuce is one of the easiest and the best ways to start hydroponic gardening. Lettuce hydroponics will typically look after themselves and do not need a lot of nutrients as other heavy feeding plants like tomatoes. Hydroponic agriculture in urban areas is one of urban farming, an agricultural system without using soil media that uses narrow land in urban areas and is free from the use of synthetic pesticides”. [1].

Lettuce being a leafy vegetable crop, needs proper nitrogenous as well as potassium fertilization schedule. Kumar *et al.* [2] stated that “proper nutrient management in diversified cropping system can improve the soil health as well as crop yield in both field and protected condition”. Pramanick *et al.* [3], Dey *et al.* [4], Garai *et al.* [5] also showed “foliar nutrition schedule is very important for crop production”.

“As stated, hydroponic lettuce is extremely easy to grow, once established into system. It mostly come down to providing adequate light (which varies depending on if we’re growing outdoors or indoors), maintaining air temperature, and adjusting the nutrient levels to ensure the best results. In terms of autotoxin secretion reduction efficiency and yield performance of lettuce, 8R1B light regime is recommended for practical use” [6].

However, according to Santos *et al.*[7], “the hydroponic cultivation of lettuce has economic

viability when the crop is grown with mineral solutions, but there is no formulation considered as ideal, because it involves a large number of variables and their interactions” [8]. The solution of Furlani [9] is the most used and little is known about the utilization of organomineral solutions.

2. MATERIALS AND METHODS

The experiment was conducted at Vegetable Research Farm under shade net condition, Department of Horticulture, Naini Agricultural Institute, Sam Higgin bottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during winter season that is from November 2021 to February 2022 in Randomized block design with 8 treatments, and three replications of Lettuce in NFT (Nutrient Film Technique) horizontal system of hydroponics. Plants per treatment/system were 21, total number of plants 168 and distance per treatment/system 30 cm. The treatments were T₁ (NPK 2.8ml/Plant), T₂ (NPK 4.2ml/Plant), T₃ (NPK 5.71ml/Plant), T₄ (NPK 7.14ml/Plant), T₅ (NPK 8.57ml/Plant), T₆ (NPK 10ml/Plant), T₇ (NPK 11.43ml/Plant) and T₈ (NPK12.86ml/Plant). Coco peat were used for its medium.

The treatment combinations were given as per the given table 1. The nutrient solutions were changed every 15 days interval and fresh new solutions were made.

The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (ANOVA) as outlined by Panse and Sukhatme, (1985). The data recorded were on growth parameters (plant height, plant spread, number of leaves/plant, leaf length, leaf width, water used), quality parameters (T.S.S, vitamin C, chlorophyll content) and yield parameters (avg. weight, yield/structure, yield/29.02 m²).

Table 1. Treatment combinations

Treatments Symbol	Treatment combinations N, P and K ml/20 liter water			
	Initial	15 DAP	30 DAP	Total
T ₁	10	20	30	60
T ₂	20	30	40	90
T ₃	30	40	50	120
T ₄	40	50	60	150
T ₅	50	60	70	180
T ₆	60	70	80	210
T ₇	70	80	90	240
T ₈	80	90	100	270

Note: Equal amount of N, P and K was used to prepare one treatment i. e. (3.33 + 3.33 + 3.33ml = 10 ml)

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Plant height:

Maximum plant height 21.18 cm was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 20.98 cm, minimum 16.89 cm, was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Which can be due to higher levels of N, P & K, which is found suitable for lettuce in hydroponic system in cell elongation of leaves used in development of cell, rapid cell division and cell elongation in meristematic region of plant due to production of plant growth substance, this might be due to abundant supply of plant nutrients and water which led in the growth of lettuce. This finding correlates the findings of Tumbareet *et al.*, [10], Sundar *et al.*, (2019).

Plant spread:

Maximum plant spread 22.02 cm was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) 21.91 cm minimum 18.36 cm was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Lettuce in hydroponic system result enhanced photosynthetic and other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation. This finding correlates the findings of Tumbareet *et al.*, [10], Sundar *et al.*, (2019), Dey *et al.*, [11].

Number of leaves/plant:

Maximum number of leaves/plant 11.21 was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) 11.81 leaves/plant and minimum 8.12 leaves/plant was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Poorly balanced nutrient solution composition led to improper growth and hence less number of leaves also components of water, nutrients and dissolved oxygen must be available proportionally. This finding correlates the findings of Ahmed *et al.*, [12], Suyantohadi *et al.*, [13], Frassetta *et al.*, [14], Singh *et al.*, [15].

Leaf length:

Maximum leaf length 20.38 cm, was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57

ml/plant) with 20.11 cm, and minimum 16.34 cm, was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Components of water, nutrients and dissolved oxygen must be available proportionally which increases the plant growth leading to increase in leaf length. This finding correlates the findings of Suyantohadi *et al.*, [13].

Leaf width:

Maximum leaf width 12.58 cm, was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 12.23 cm, and minimum 10.26 cm, was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Which can be due to higher suitable levels of N, P & K, enhanced photosynthetic, other metabolic activities which lead to increase in various plant metabolites responsible for cell division and elongation. This finding correlates the findings of Tumbareet *et al.*, [10], Sundar *et al.*, (2019) Das *et al.* [16].

Water used:

Maximum water used 12.21 liter, was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 11.92 liter, and minimum 12.34 liter, was recorded in T₁ (NPK 2.8 ml/plant) (Table 2). Water consumption depends upon the temperature, plant growth on nutrient concentration and also the temperature during the growing season as these factors contribute to the water consumption. This finding correlates the findings of Pramanick *et al.* [3], Laiket *et al.* [17], Oztekin *et al.*, [18].

The statistically analyzed data on growth parameters of lettuce are presented in Table 2. It is clear that there is significant difference.

3.2 Quality and Yield Parameters

T.S.S:

Maximum T.S.S content 4.59 was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 4.34 and minimum 2.91 was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to increasing the rate of NPK application resulting in the percentage of T.S.S content and significantly reduced with increasing salt concentration. This finding correlates the findings of Ahamed *et al.*, [12] and Franquera *et al.*, [19].

Table 2. Growth parameters of Lettuce like plant height, plant spread, number of leaves/plant, leaf length, leaf width, water used

Treatments	Plant height (cm)	Plant spread (cm)	Number of leaves/plant	Leaf length (cm)	Leaf width (cm)	Water used (liter)
T ₁	17.4	18.82	8.51	16.83	10.61	12.34
T ₂	17.69	18.85	8.58	16.92	10.88	13.35
T ₃	17.99	19.18	9.81	17	11.2	14.11
T ₄	18.48	19.59	9.99	17.68	11.03	14.87
T ₅	20.65	21.57	10.85	19.89	12.21	15.78
T ₆	20.52	21.47	10.43	19.68	11.92	15.67
T ₇	20.44	21.26	10.37	19.63	11.87	15.45
T ₈	19.03	20.03	10.27	18.04	11.77	15.23
T-test	S	S	S	S	S	S
SE(d)	0.44	0.44	0.36	0.43	0.35	0.22
C.D. at 5%	0.95	0.95	0.77	0.93	0.75	0.46
C.V.	2.83	2.70	4.44	2.91	3.73	1.79

Vitamin C:

Maximum vitamin C content 3.48 was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 3.25 and minimum 2.08 was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to the climatic conditions during crop growth and development which have a greater overall effect on vitamin C content. It is shown that excessive use of nitrogen decreases the vitamin C content. This finding correlates the findings of Song *et al.*, [20].

Chlorophyll content:

Maximum chlorophyll content 20.05 was recorded in T₅ (NPK 10 ml/plant) followed by T₆ (NPK 8.57 ml/plant) with 18.98 and minimum 11.03 was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to amount of chlorophyll in leaf tissue influenced by nutrient availability and environmental stress such as salinity cold heat etc. Application of higher dosage of N also increase the chlorophyll content. This finding correlates the findings of Coronel *et al.*, [21] and Hokmalipour *et al.*, [22].

Average weight:

Maximum average weight (32.53 g) were recorded in T₅ (NPK 10 ml), followed by T₆ (NPK 8.57 ml) with (31.01 g) whereas minimum weight (19.36 g) was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to application of N, P, and K which attributed to enhanced photosynthesis, accumulation of carbohydrates

and favorable effect on vegetative growth which also increase the weight and size of plants. This finding correlates the findings of Akanbi *et al.*, [23].

Total yield/structure:

Maximum total yield/structure (683.13 g) was recorded in T₅ (NPK 10 ml), followed by T₆ (NPK 8.57 ml) with (651.14 g) whereas minimum yield (406.63 g) was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to availability of water, oxygen and optimum nutrients sufficient to increase plant vegetative growth which leads to weight and size of plant. This finding correlates the findings of Frasetya *et al.*, [14] and Akanbi *et al.*, [23].

Yield Kg/29.02 m²:

Maximum yield kg/29.02 m² (5.46 kg) were recorded in T₅ (NPK 10 ml) after application of NPK, followed by T₆ (NPK 8.57 ml) with (5.20 kg) whereas minimum yield (3.25 kg) was recorded in T₁ (NPK 2.8 ml/plant) (Table 3). Which can be due to plant growth and final yield depending on the continues supply of food material and water. Since N, P and K help in the absorption of water and carbohydrates metabolism, its deficiency may cause poor growth and yield of plants. This finding correlates the findings of Akanbi *et al.*, [23].

The statistically analyzed data on quality and yield parameters of lettuce are presented in Table 2. It is clear that there is significant difference.

Table 3. Quality parameters of Lettuce like chlorophyll content, T.S.S, vitamin C and yield parameters like average plant weight, yield per plot, yield (kg/29.02m²)

Treatments	Chlorophyll content	T.S.S	Vitamin C	Average plant weight (g)	Yield per plot (g)	Yield (kg/29.02m ²)
T ₁	11.63	3.1	2.08	19.36	406.63	13.55
T ₂	11.93	3.11	2.31	21.35	448.28	14.94
T ₃	13.27	3.33	2.51	22.98	482.51	16.08
T ₄	15.8	3.75	2.65	27.82	584.15	19.47
T ₅	19.7	4.49	3.48	32.53	683.13	22.77
T ₆	18.7	4.11	3.25	31.01	651.14	21.7
T ₇	18.35	3.99	2.75	30.19	634.06	21.13
T ₈	16.2	3.97	2.71	29.18	612.85	20.42
T-test	S	S	S	S	S	S
SE(d)	0.68	0.17	0.10	0.53	4.72	0.10
C.D. at 5%	1.46	0.37	0.20	1.13	10.13	0.21
C.V.	5.30	5.66	4.29	2.41	3.08	0.63

4. CONCLUSION

From the present investigation it is concluded that treatment T₅ (NPK 8.57ml/Plant) was found best in terms of following parameters of lettuce in NFT (nutrient film technique) hydroponic system, average plant height (20.65 cm), average plant spread (21.57 cm), average number of leaves/plant (10.85), average leaf length (19.89 cm), average leaf width (12.21 cm), water uptake(15.78 L), yield (22.77 kg/29.02 m²), average T.S.S (4.49), average vitamin C (3.48) and average chlorophyll content (19.7). Maximum B:C ratio (1.75) were also obtain in treatment T₅.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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