

Effect of different levels of nutrients on plant growth, yield and quality of Lettuce (*Lactuca sativa*) in NFT (Nutrient Film Technique) system of hydroponics under shade net condition.

Comment [M1]: The article needs a general review and should be more complete.

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), eight different treatments with three replications with nutrient field technique in vertical 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. Minimum growth parameters were recorded in T₁. In gross return, net return and B.C ratio (1.75) maximum values were recorded in T₅.

Comment [M2]: It is better to mention the problem briefly in the first part of the abstract.

Keywords: Lettuce, NFT vertical system, Hydroponic and NPK.

Comment [M3]: It is better not to choose keywords from the title and to use synonymous or related words.

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. (Nurlaili *et al.*, 2020). 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. (Zhou *et al.*, 2020)

MATERIALS AND METHODS

The experiment was conducted 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 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).

Comment [M4]: Introduction and materials and methods need to be reviewed, the content presented in the introduction is very brief and with little reference. The materials and methods section is also very brief and provided with a reference that should be more complete.

RESULTS AND DISCUSSION

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). 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., (2002), 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). 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., (2002), Sundar et al., (2019)**.

Number of leaves/plant:

Maximum 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). Which can be due to higher suitable levels of N, P & K, 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., (2002), Sundar et al., (2019)**.

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). Which can be due to higher suitable levels of N, P & K, 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., (2002), Sundar et al., (2019)**.

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). 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., (2002), Sundar et al., (2019)**.

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). Water consumption depends upon the temperature, plant growth on nutrient concentration and also the temperature during the growing season as this factors contribute to the water consumption. This finding correlates the findings of **Oztekin et al., (2018)**.

Comment [M5]: The content used in the analysis section is very brief and quantitative sources are used.

Table 1: 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

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). 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.*, (2019)** and **Franquera *et al.*, (2015)**.

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). 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.*, (2020)**.

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). 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.*, (2009)** and **Hokmalipour *et al.*, (2012)**.

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). 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.*, (2007)**.

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). 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.*, (2007)**.

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). 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., (2007)*.

Table 2: 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

CONCLUSION

From the present investigation it is concluded that treatment T₅ was found best in terms of growth (plant height, plant spread, number of leaves/plant, leaf length, leaf width, water uptake) yield and quality (T.S.S, vitamin C, chlorophyll content) parameters of lettuce in NFT hydroponic system. Maximum B:C ratio (1.75) were observed in treatment T₅.

Comment [M6]: The conclusion is very brief and it is better to be more complete and have a final interpretation and analysis.

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