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Effect of different nutrient concentration of N, P and K on growth, yield and quality of Lettuce (*Lactuca sativa*) in Nutrient film technique (NFT) of Hydroponic System

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Abstract

The present experiment was carried out during November, 2019 to January, 2020 in Shade net, Research Field, Department of Horticulture, SHUATS, Prayagraj. The experiment was conducted in Randomized Block Design (RBD), with eight treatments, replicated thrice with nutrient film technique hydroponics system and variety Lallo rosa of Lettuce, the treatments were T₁ (NPK 6.25 ml/plant), T₂ (NPK 8.33 ml/plant), T₃ (NPK 10.41 ml/plant), T₄ (NPK 12.5 ml/plant), T₅ (NPK 14.58 ml/plant), T₆ (NPK 16.66 ml/plant), T₇ (NPK 18.75 ml/plant) and T₀ (NPK 0 ml/plant). From the present experimental findings it is found that structure with treatment T₅ was found best in terms of Growth and yield parameters of lettuce in NFT hydroponic system followed by structure with T₄ and T₆. Maximum gross return (2736.00 Rs) and net return (1511.16 Rs) was recorded in structure with treatment T₅ and maximum cost benefit ratio 2.23 was observed in structure with treatment T₅.

Keywords: Lettuce, nutrient film techniques, hydroponic and NPK

Introduction

Lettuce (*Lactuca sativa*) is one of the most commonly grown hydroponic vegetables. Hydroponics is a method of growing plants without soil. Plants may be grown in a nutrient solution only (liquid culture) or they may be supported by an inert medium (aggregate culture). In both systems, all of the plants' nutritional needs are supplied through the irrigation water. Hydroponics is a highly exacting and demanding system that requires a greater amount of production knowledge, experience, technical skill and financial investment than many other greenhouse systems.

A grower must be committed to meeting the daily demands of production to be successful. While there are a number of different hydroponic systems that have been commercially successful for lettuce production, this profile will focus on the nutrient film technique and the floating raft method. Prospective growers should obtain as much information as they can about hydroponic production before entering into this type of enterprise.

The aim of this research was to evaluate the effect of the flow rate of the nutrient solution and the CE concentration (measured through the ionic strength of the solution) over the accumulation of fresh mass of the aboveground part and roots in cultivar of hydroponic lettuce.

It is however necessary to evaluate the real potential of soil less cultivation techniques for the Lettuce, in relation to yield and to crop management, adapting techniques of hydroponic cultivation to tropical and subtropical conditions.

Hydroponics plays an important role in Lettuce production, as recorded the production was high in hydroponically planted Lettuce as compared to those planted in field in open atmospheric conditions. Hydroponics also allows the farmers to grow it all round the year. There for keeping the above facts in view the present study entitled "Production of Lettuce in Nutrient film technique (NFT) of hydroponic systems" was conducted in Department of Horticulture, SHUATS, Prayagraj.

Materials and Methods

The present Experiment was conducted in Randomized Block Design (RBD), with eight treatments, of NPK replicated thrice with Lettuce variety (Lallo rosa), in the Shade net, Research field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during November, 2019 to January, 2020. Total number of treatments were eight viz. T₁ (NPK 6.25 ml/Plant), T₂ (NPK 8.33 ml/Plant), T₃ (NPK 10.41 ml/Plant), T₄ (NPK 12.5 ml/Plant), T₅ (NPK 14.58 ml/Plant), T₆ (NPK 16.66 ml/Plant), T₇ (NPK 18.75 ml/Plant) and T₀ (Control (NPK 0 ml/Plant)).

Climatic condition in the experimental site

The area of Prayagraj district comes under subtropical belt in the south east of Utter Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 °C- 48 °C and seldom falls as low as 4 °C- 5 °C. The relative humidity ranges between 20 to 94%. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

Results and Discussion

The present investigation entitled "Effect of different concentration of N, P and K on growth, yield and quality of Lettuce (*Lactuca sativa*) in nutrient film technique (NFT) of hydroponic system" was carried out during November, 2019 to January, 2020 in Shade net, Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India. The results of the present investigation, regarding the effect of different concentration of NPK on growth, yield and quality of Lettuce in (NFT) hydroponic system, have been discussed and interpreted in the light of previous research work done in India and abroad. The experiment was conducted in Randomized block design with 8 treatments, and three replications.

The results of the experiment are summarized below.

Growth Parameters

In terms of Plant Height, Maximum Plant height 6.77, 11.56, 16.98, 22.91 and 29.21 cm at 15, 30, 45, 60 and 75 DAP was recorded in T₇ (NPK 18.75 ml/plant) followed by T₆ (NPK 16.66 ml/plant) with 6.10, 10.57, 15.69, 20.76 and 25.99 cm, minimum 3.14, 7.12, 10.32, 12.63 and 14.30 cm, was recorded in Control. Significantly maximum plant height was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, which might be due to higher levels of N, P & K, which found suitable for lettuce in hydroponic system helpful in cell elongation of leaves use to development of cell and rapid cell division and cell elongation in meristematic region of plant due to production of plant growth substance and this may be due to abundant supply of plant nutrients and water which led in the growth of lettuce. This finding correlates the findings of Tumbare *et al.*, (2002)^[11] in Chilli, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Plant spread. Maximum 5.30, 8.80, 16.92, 24.88 and 31.31 cm at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₆ (NPK 16.66 ml/plant) with 4.74, 7.50, 15.02, 22.62 and 27.98 cm, minimum 2.61, 4.82, 10.64, 14.67 and 17.55 cm, was recorded in Control. Significantly maximum plant spread was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, which might be due to higher levels of N, P & K, which found suitable for

lettuce in hydroponic system resulted 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 Tumbare *et al.*, (2002)^[11] in Chilli, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Number of leaves/plant, Maximum 5.20, 7.29, 9.17, 11.03 and 12.94 leaves/plant at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₆ (NPK 16.66 ml/plant) with 4.96, 6.85, 8.69, 10.54 and 12.32 leaves/plant and minimum 3.33, 4.81, 6.35, 7.67 and 8.83 leaves/plant was recorded in Control. Significantly maximum Number of leaves per plant was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, which might be due to higher levels of N, P & K, which found suitable for lettuce in hydroponic system resulted 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 Tumbare *et al.*, (2002)^[11] in Chilli, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Leaf length, Maximum 6.31, 7.85, 10.87, 16.19 and 24.70 cm, at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₆ (NPK 16.66 ml/plant) with 5.34, 6.87, 9.89, 14.97 and 23.41 cm, and minimum 3.16, 4.29, 6.83, 10.75 and 14.63 cm, was recorded in Control. Significantly maximum Leaf length was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, which might be due to higher levels of N, P & K, which found suitable for lettuce in hydroponic system and 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 Tumbare *et al.*, (2002)^[11] in Chilli, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Leaf width, Maximum 4.09, 5.87, 8.01, 10.73 and 14.11 cm, at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₆ (NPK 16.66 ml/plant) with 3.35, 5.04, 7.07, 9.84 and 13.06 cm, and minimum 1.49, 2.51, 4.05, 6.19 and 7.76 cm, was recorded in Control. Significantly maximum Leaf width was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, which might be due to higher levels of N, P & K, which found suitable for lettuce in hydroponic system and 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 Tumbare *et al.*, (2002)^[11] in Chilli, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Root length, Maximum 8.34, 20.31, 38.24, 59.93 and 83.19 cm, at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₄ (NPK 12.50 ml/plant) with 7.52, 18.47, 32.21, 51.89 and 69.76 cm, and minimum 4.89, 12.23, 24.52, 37.29 and 50.54 cm, was recorded in Control. Significantly maximum Root length was recorded in T₅ at 15, 30, 45, 60 and 75 DAP, this may be due to large amount of nutrients directly available to the plants roots, which led in the higher water uptake of plants and ultimately growth of roots of lettuce. This finding correlates the findings of Oztekin *et al.*, (2018)^[8] in Spinach, Sundar *et al.*, (2019)^[10] in Lettuce.

In terms of Water used, Maximum 7.25, 11.07, 13.69, 16.81 and 18.29 litre, at 15, 30, 45, 60 and 75 DAP was recorded in T₅ (NPK 14.58 ml/plant) followed by T₄ (NPK 12.50 ml/plant) with 6.70, 9.58, 12.21, 14.75, and 16.17 litre, and minimum 3.26, 5.39, 7.18, 8.96 and 10.92 litre, was recorded in Control. This might be due higher dose of N, P and K in NFT hydroponic system in which plant growth, yield, and

water consumption vary depending on the concentration of nutrient solution as well as the temperature during the growing season. When the temperature and nutrient concentration increased plant growth and water consumption also increased. This finding correlates the findings of Oztekin *et al.*, (2018)^[8] in Spinach.

Yield parameters

In Average weight of plants, Maximum Average weight (95.50 g) were recorded in T₅ (NPK 14.58 ml) after application of NPK, followed by T₄ (NPK 12.50 ml) with (72.96 g) whereas minimum weight (54.25 g) was recorded in T₀ (Control). This might be due to N, P, and K application might be attributed to enhanced photosynthesis, accumulation of carbohydrates and favourable effect on vegetative growth which also increase the weight and size of plants. This finding correlates the findings of Akanbi *et al.*, (2007)^[11] in pepper.

In Yield/structure (kg), Maximum Yield/plot (2.28 kg) were recorded in T₅ (NPK 14.58 ml) after application of NPK, followed by T₄ (NPK 12.50 ml) with (1.74 kg) whereas minimum yield (1.30 kg) was recorded in T₀ (Control). This might be due to the plant growth and final yield depends on

the continued 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 Oztekin *et al.*, (2018)^[8] in Spinach.

Economics

In terms of economics, maximum cost of production (Rs. 1425.00) was observed in T₇ (NPK 18.75 ml/plant) followed by T₆ (NPK 16.66 ml/plant) (Rs. 1324.70), minimum cost of cultivation (Rs. 525.00) was observed in Control. In Gross return (Rs. 2736.00) is recorded in T₅ (NPK 14.58 ml/plant) followed by T₄ (NPK 12.50 ml/plant) (Rs. 2088.00), minimum Gross return (Rs.1040.00) was recorded in T₀ (Control). In Net return (Rs. 1511.20) is found in T₅ (NPK 14.58 ml/plant) followed by T₄ (NPK 12.50 ml/plant) (Rs. 2088.00), minimum Net return (Rs. 359.00) was found in T₁ (NPK 6.25 ml/plant). I Cost – benefit ratio (2.23) is observed in T₅ (NPK 14.58 ml/plant) followed by T₂ (NPK 8.33 ml/plant) (1.98), minimum B:C ratio (1.25) was observed in T₁ (NPK 6.25 ml/plant).

Table 1: Performance of Lettuce for growth parameters in NFT hydroponic system

Treatment	Plant Height (cm)					Plant Spread (cm)					Number of Leaves/plant				
	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP
T ₁	4.11	8.67	13.33	18.21	22.67	3.49	5.96	12.62	19.40	24.20	3.77	5.58	7.29	8.50	9.92
T ₂	4.42	9.52	14.30	19.28	23.72	4.41	6.90	13.59	20.43	25.26	3.65	5.46	7.19	8.43	9.85
T ₃	4.29	8.76	13.67	18.49	23.22	4.74	7.20	14.45	21.50	26.94	4.63	6.36	8.25	9.92	11.43
T ₄	4.87	9.68	14.79	19.85	24.69	3.70	6.09	13.47	20.48	25.74	4.66	6.42	8.34	9.98	11.48
T ₅	6.77	11.56	16.98	22.91	29.21	5.30	8.80	16.92	24.88	31.31	5.20	7.29	9.17	11.03	12.94
T ₆	5.76	10.24	15.36	19.92	25.22	4.74	7.50	15.02	22.62	27.98	4.96	6.85	8.69	10.54	12.32
T ₇	6.10	10.57	15.69	20.76	25.99	4.55	7.29	14.54	21.96	26.20	4.50	6.68	8.50	9.90	11.34
T ₀	3.14	7.12	10.32	12.63	14.30	2.61	4.82	10.64	14.67	17.55	3.33	4.81	6.35	7.67	8.83
F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.291	0.415	0.452	0.694	0.691	0.158	0.237	0.295	0.383	0.483	0.231	0.283	0.296	0.343	0.333
C.V	7.221	5.347	3.866	4.470	3.584	4.624	4.260	2.596	2.261	2.307	6.532	5.605	4.543	4.427	3.702
C.D. at 5%	0.630	0.900	0.978	1.502	1.497	0.343	0.514	0.638	0.829	1.046	0.501	0.613	0.640	0.743	0.721

Table 2: Performance of Lettuce for growth parameters in NFT hydroponic system

Treatment	Leaf Length (cm)					Leaf width (cm)					Root length (cm)				
	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP
T ₁	3.97	5.24	7.96	11.45	18.93	2.15	3.35	5.12	7.33	10.18	6.22	13.86	27.16	44.48	60.50
T ₂	4.30	5.61	8.29	12.52	19.96	2.47	3.66	5.39	7.64	10.52	6.83	15.50	28.88	46.19	62.43
T ₃	4.30	5.75	8.57	13.34	21.57	2.48	3.75	5.47	8.19	11.28	7.22	16.87	29.71	49.55	66.90
T ₄	4.89	6.34	9.13	13.88	22.20	3.01	4.83	6.69	9.43	12.36	7.52	18.47	32.21	51.89	69.76
T ₅	6.31	7.85	10.87	16.19	24.70	4.09	5.87	8.01	10.73	14.11	8.34	20.31	38.24	59.93	83.19
T ₆	5.34	6.87	9.89	14.97	23.41	3.35	5.04	7.07	9.84	13.06	7.39	17.74	29.30	48.02	67.16
T ₇	5.20	6.52	9.27	13.79	20.93	3.18	4.61	6.35	8.26	11.13	7.07	15.95	29.17	47.51	65.88
T ₀	3.16	4.29	6.83	10.75	14.63	1.49	2.51	4.05	6.19	7.76	4.89	12.23	24.52	37.29	50.54
F-Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.232	0.236	0.260	0.338	0.394	0.163	0.260	0.272	0.291	0.314	0.143	0.497	1.105	1.235	1.370
C.V	6.068	4.768	3.593	3.096	2.320	7.176	7.564	5.543	4.217	3.405	2.530	3.720	4.527	3.144	2.550
C.D. at 5%	0.503	0.511	0.562	0.731	0.853	0.352	0.562	0.590	0.630	0.680	0.310	1.076	2.393	2.674	2.966

Table 3: Performance of Lettuce for water used, Weight and yield parameters in NFT hydroponic system

Treatment Symbol	Water used (liter)						Avg. weight of plant (g)	Yield/structure (kg)
	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	Total		
T ₁	4.43	6.71	8.99	10.83	12.34	43.30	62.13	1.48
T ₂	5.20	7.58	10.10	12.22	13.98	49.08	64.07	1.53
T ₃	6.32	9.12	11.70	14.16	15.48	56.78	66.41	1.58
T ₄	6.70	9.58	12.21	14.75	16.17	59.41	72.96	1.74
T ₅	7.25	11.07	13.69	16.81	18.29	67.11	95.50	2.28
T ₆	6.35	8.88	10.96	13.21	14.87	54.27	69.76	1.67
T ₇	6.13	8.60	10.36	12.39	13.86	51.34	65.83	1.57
T ₀	3.26	5.39	7.18	8.96	10.92	35.71	54.25	1.30

F-Test	S	S	S	S	S	S	S	S
SE(d)	0.108	0.320	0.261	0.299	0.292	1.128	2.487	0.057
C.V	2.323	4.681	2.998	2.832	2.469	2.651	4.424	4.281
C.D. at 5%	0.234	0.692	0.565	0.647	0.633	2.443	5.387	0.124

Table 4: Performance of lettuce for Dry matter, Organoleptic evaluation (Accessed with Hedonic scale) and B:C ratio

Treatment	Dry matter	Organoleptic Evaluation				B:C Ratio
		Score for colour and appearance	Score for texture	Score for Flavour and Taste	Score for Over all acceptability	
T ₁	17.17	6.91	7.80	7.52	7.41	1.25
T ₂	18.25	7.89	7.98	7.91	7.92	1.98
T ₃	19.04	7.41	7.45	7.38	7.41	1.85
T ₄	19.39	8.42	8.57	8.62	8.53	1.85
T ₅	20.56	7.21	7.32	7.43	7.32	2.23
T ₆	18.74	7.61	7.58	7.78	7.65	1.51
T ₇	18.28	6.63	7.02	7.35	6.99	1.32
T ₀	16.50	6.58	6.63	6.64	6.61	1.98
F-Test	S	S	S	S	S	
SE(d)	0.246	0.187	0.147	0.176	0.120	
C.V	1.629	3.122	2.389	2.850	1.961	
C.D. at 5%	0.533	0.405	0.319	0.382	0.259	

Conclusion

From the present investigation it is concluded that treatment T₅ found best in terms of Growth and yield parameters of lettuce in NFT hydroponic system followed by T₄ and T₆. Minimum growth and yield was recorded in T₀. Maximum gross return and net return was recorded in T₅ and maximum cost benefit ratio 2.23 was observed in treatment T₅ minimum gross and net return recorded in T₁ and cost benefit ratio in T₇.

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