

EFFECT OF DIFFERENT NUTRIENT FORMULATIONS ON GROWTH, YIELD AND QUALITY OF LETTUCE (*LACTUCA SATIVA*) CV. *LOLLO ROSSO* IN A HYDROPONIC SYSTEM

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ABSTRACT

The experiment were undertaken in the shade net of the Department of Horticulture, during the year 2011-2013. The experiment were laid out in Randomized Block Design with 7 treatments, replicated thrice. Thirty days old seedlings of lettuce were transplanted in 25 litre plastic tubs using different formulations constituting important nutrients. The tubs were kept in the shade net of the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (formerly known as Allahabad Agricultural Institute), during Rabi. The Riviora's formulation (0.13%) i.e. T₆ containing (NH₄)₂HPO₄- 5 g, Ca(NO₃)₂- 12.5 g, KNO₃- 5 g, MgSO₄•7H₂O - 2.5 g, FeEDTA- 128 mg, MnSO₄•H₂O-18.25mg, ZnSO₄•5H₂O-1.5 mg, CuSO₄•5H₂O - 1.5 mg, H₃BO₃ - 14.75 mg in 25 L of water, proved better with regards to the minimum number of days to harvesting (50 days), Maximum plant height (29.33cm), more number of leaves (25.60), maximum plant spread (26.43cm), maximum length of roots (20.53 cm), maximum fresh weight of leaves (123.33 g), maximum dry weight of leaves (11.04g/plant), maximum weight of fresh roots per plant (34.50g), maximum dry weight of roots (5.02g/plant), total maximum weight of plants per container (617.33 g) the total dry matter content per plant (16.06 g), T.S.S (5.97 °Brix) and Vitamin-C (1.92 mg/100g). On the basis of organoleptic score the maximum overall acceptability (8.33) were found in T₅ (Dr. Howard Resh formulation) and the maximum benefit cost ratio (1.42) were obtained with T₆ (Riviora's formulation)

Keywords: Lettuce, Nutrient Formulations, Growth Yield and Quality.

INTRODUCTION

Lettuce belonging to (*Lactuca sativa*) is an annual plant of the aster or sunflower family Asteraceae. It is an annual plant native to the Mediterranean area. Lettuce is derived from the French word "laitue" meaning "milk" whereas, "sativa" means grow from seed. Lettuce is most often used for salads, although it is also seen in other kinds of food, such as soups, sandwiches and wraps. One advantage of lettuce is that it provides people with various essential minerals. Lettuce is one of the most important vegetable crops in temperate countries. It is rich in vitamin A and C and minerals like calcium and iron (Aykroyd, 1963). Vitamin C is a powerful natural antioxidant; regular consumption of foods rich in vitamin C helps the body develop resistance against infectious agents and scavenge harmful, pro-inflammatory free radicals. Lettuce is a good source of dietary fiber which is best known for its ability to aid with digestion. Hydroponic vegetable production has caught producers' attention in utilizing an empty greenhouse. The major advantages of hydroponic lettuce include a short production period, availability year round, and consistency of product attributes. The life cycle of hydroponic lettuce is very short compared to traditionally grown lettuce; growers can harvest hydroponic lettuce after 35 to 40 days of production. In greenhouse production, temperature can be controlled year round to provide the optimal level of lettuce. This also means that the growers can supply their lettuce when demand is high.

MATERIALS AND METHODS

The experiment were undertaken in the shade net of the Department of Horticulture, during the year 2012-2013. The

experiment were laid out in Randomized Block Design with 7 treatments, replicated thrice. The seven treatments were T₁- Knop's formulation (5g KNO₃, 20g Ca (NO₃)₂, 5g H₂PO₄, 5g MgSO₄•7H₂O, 2.5g FePO₄), T₂- Trelease (17.1g KNO₃, 1.69g (NH₄)₂SO₄, 8.67g KH₂PO₄, 10.92g CaCl₂, 18.7MgSO₄, 69.5mg FeSO₄), T₃- Arnon and Hoagland formulation (25.5g KNO₃, 12.3g Ca(NO₃)₂, 5.75g NH₄H₂PO₄, 12.25g MgSO₄, 12mg H₃BO₃, 6.25 mg MnSO₄, 0.875mg ZnSO₄, 0.2 mg CuSO₄), T₄- Shive and Robbin's formulation (23.45g Ca(NO₃)₂, 2.31g (NH₄)₂SO₄, 7.82g KH₂PO₄, 14.17g MgSO₄•7H₂O, 0.14mg FeSO₄•7H₂O, 0.02mg H₃BO₃, 0.02mg MnSO₄•4H₂O, 0.02mg ZnSO₄•5H₂O), T₅- Dr Howard Resh formulation (1.76g (NH₄)₂SO₄, 28g Ca(NO₃)₂, 5.55g KNO₃, 11.4g MgSO₄•7H₂O, 6.9g KH₂PO₄, 769.25mg FeEDTA, 38.5mg MnSO₄•H₂O, 7.5mg ZnSO₄•5H₂O, 9.75mg CuSO₄•5H₂O, 71.5mg H₃BO₃, 3.25mg Na₂MoO₄), T₆- Riviora's formulation (5g (NH₄)₂HPO₄, 12.5g Ca(NO₃)₂, 5g KNO₃, 2.5g MgSO₄•7H₂O, 128mg FeEDTA, 18.25mg MnSO₄•H₂O, 1.5mg ZnSO₄•5H₂O, 1.5mg CuSO₄•5H₂O, 14.75mg H₃BO₃), T₇- Piper's formulation (32.5g KNO₃, 7.5g KH₂PO₄, 2.5g NaCl). Thirty days old seedlings of lettuce were transplanted in 25 litres plastic tubs using the seven different formulations constituting important nutrients. The tubs were kept in the shade net of the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology And Sciences, (formerly known as Allahabad Agricultural Institute), during Rabi. The seedlings ready for transplanting were uprooted from the nursery field where root parts of the sampling were thoroughly washed under running tap water. They were carefully inserted through the centre aperture of the cover supported by a cellulose sponge in such a way that their roots could sufficiently reach and immersed by the nutrient solution. Between the rows

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of 20 cm and between the plants of 20 cm spacing were maintained and plants were planted in the evening. After every 10 days interval nutrient solutions were changed according to the treatment in each container. A total five observations at 10, 20, 30, 40 and 50 DAT were recorded during the experiment. The data recorded on each character were analysed by the ANOVA technique.

RESULTS AND DISCUSSION

The maximum plant height (29.33 cm) were recorded in T_6 (Riviora's formulation) followed by 27.47 cm in T_5 (Dr. Howard Resh's fromulation) and 23.33 cm in T_3 (Arnon and Hoagland's formulation) recorded the minimum. Abundant supply of nitrogen significantly increased the plant height as nitrogen is responsible for rapid foliage growth. **Zito *et al.* (1994)** and **Braz *et al.*** reported similar findings.

The maximum plant spread (26.43 cm) were recorded in T_6 (Riviora's formulation) followed by 25.20 cm in T_4 (Shive and Robbin's fromulation) and 24.80 cm in T_5 (Dr. Howard Resh's fromulation) which were found to be at par with each other and 21.73 cm in T_1 (Knop's formulation) recorded the minimum. Abundant supply of calcium significantly increased the plant height as calcium is responsible for shoot and root tips. **Costa *et al.* (1997)** reported similar findings.

The maximum number of leaves (25.60 cm) was recorded in T_6 (Riviora's formulation) followed by 22.53 cm in T_4 (Shive and Robbin's fromulation) and 19.10 cm in T_1 (Knop's formulation) recorded the minimum. This may be due to the abundant nutrients supply and its availability helped the plants to attain more vigour in terms of number of leaves. Supply of phosphorous and diammonium phosphate levels significantly increased the number of leaves because of enough availability of phosphorous and ammonia at growing stages. **Massiha *et al.* (2000)** and **Kim *et al.*, (1996)** reported similar findings.

Maximum length of roots (20.53 cm) was observed in T_6 (Riviora's formula) followed by T_4 (Shive and Robbins) in (18.50 cm). However minimum length of roots (16.97 cm) were noticed

in T_1 (Knop's solution). This may be due to the abundant nutrients supply and its availability helped the plants to attain more vigour in terms of number of leaves. Supply of phosphorous and diammonium phosphate levels significantly increases the length of roots as phosphorous promotes root formation and growth. **Braz *et al.*, (2003)** reported similar findings.

The treatment T_6 (Riviora's formula) showed the best performance in 123.33 g per plant of fresh weight of Lettuce followed by T_5 (Dr. Howard Resh formula) with in g per plant. Abundant supply of nitrogen significantly increases the plant height as nitrogen is responsible for rapid foliage growth. The result is close conformity with the finding of **Lopes *et al.*, (2003)** and **Savvas *et al.*, (2006)**.

The dry weight of the plant were seen to maximum in the treatment T_6 (Riviora's formula) with 11.05 g/plant followed by T_4 (Shive and Robbins) with a weight of 10.06 g/plant. However, the minimum dry weight of the head were observed in T_1 (Knop's solution) with a weight of 9.04g/plant.

The weight of fresh roots per plant were seen maximum in the treatment T_6 (Riviora's formula) with 34.50g/plant which was then followed by T_4 (Shive and Robbins) with a weight of 32.80g/plant. However, the minimum dry weight of the head were observed in T_3 (Arnon and Hoagland formula) with a weight of 28.10g/plant. This may be due to the abundant nutrients supply and its availability helped the plants to attain more vigour in terms of dry weight. **Braz *et al.*, (2003)** reported similar findings.

Maximum dry weight of 5.02g/plant were recorded with T_6 (Riviora's formula) followed by T_4 (Shive and Robbins) with a weight of 3.77 g/plant and 1.73 g/plant in T_1 (Knop's solution) recorded the minimum diameter of dry weight of roots per plant.

The highest weight per plot were recorded in T_6 (Riviora's formula) with 617.33 g/ft² followed by T_5 (Dr. Howard Resh formula) with 583.66 g/ft². The minimum weight per plot were observed in T_1 (Knop's solution) with 502.66 g/ft². Supply of nitrates significantly produced higher yields because of enough availability of nitrogen at growing stages. **Magnani *et al.*, (1997)** and **Schmidt *et al.*, (2001)** reported similar findings.

Table 1: Effect of different nutrient formulations on growth, yield and quality of Lettuce (*Lactuca sativa*) cv. Lollo Rosso in a hydroponic

Treatment	Plant height (cm) 50 DAT	Plant spread (cm) 50 DAT	No. of leaves 50 DAT	Length of roots cm 50 DAT	Fresh shoot per plant (g)	Dry Weight of Lettuce per plant	Fresh Weight of roots per plant (g)	Dry Weight of roots per plant (g)	Edible shoots Weight of lettuce per Container (g)	Total dry matter (g)	Total soluble solids (TSS °Brix)	Ascorbic acid content (mg/100g)
T_1	24.03	21.73	19.1	17.17	100.33	9.04	28.57	1.73	502.66	10.82	1.40	1.42
T_2	24.2	22.60	19.07	17.1	107.66	9.68	28.93	2.37	539.66	12.06	3.73	1.59
T_3	23.33	23.83	18.87	16.87	107.66	9.30	28.10	1.88	542.33	11.18	2.53	1.43
T_4	25.90	25.20	22.53	18.5	109.33	10.06	32.80	3.77	548.66	13.83	5.20	1.64
T_5	27.47	24.80	20.97	17.83	116.33	9.88	30.70	3.18	583.66	13.06	4.97	1.69
T_6	29.33	26.43	25.6	20.53	123.33	11.05	34.50	5.02	617.33	16.06	5.97	1.92
T_7	24.43	24.07	19.37	16.97	112.00	9.32	29.50	1.89	561.00	11.21	1.63	1.40
F-test	S	S	S	S	S	S	S	S	S	S	S	S
S. Ed. (±)	0.535	0.756	0.392	0.57	1.842	0.307	0.690	0.226	16.304	0.408	0.268	0.095
C. D. (0.05)	1.133	1.602	0.832	1.209	3.904	0.650	1.470	0.479	34.565	0.865	0.567	0.201

The total dry matter of (16.06g) were recorded highest in T₆ (Riviora's formula) followed by (13.83g) with T₄ (Shive and Robbin's formula). The minimum value (10.82g) were recorded under T₁ (Knop's solution).

The highest total soluble solids (5.97 °Brix) were recorded in plants treated in T₆ (Riviora's formula) followed by (5.20 °Brix) in T₄ (Shive and Robbins) treated plants. The minimum (1.40 °Brix) TSS content were recorded under T₁ (Knop's solution). This must be due to the accessibility of nitrogen to the plants and must have played positively. **Huett (1989)** reported similar findings.

The maximum value of vitamin C were recorded in T₆ (Riviora's formula) with 1.92 mg/100g followed by T₅ (Dr. Howard Resh) with 1.69mg/100g. However, the minimum value were observed in T₇ (Piper's formula) with 1.40mg/100g. Nitrogen in the ammonium form increased the content L-ascorbic acid. **Borowski et al., (1998)** and **Resende et al., (2010)** reported similar findings.

The maximum gross return of Rs 12,346/100 containers were recorded in T₆ (Riviora's formula) followed by T₅ (Dr. Howard Resh) Rs 11,673/100 containers and the minimum of Rs 10,532/100 containers were found in T₁ (Knop's formulation).

The maximum net return of Rs 3,655/100 containers were recorded in T₆ (Riviora's formula) followed by T₅ (Dr. Howard Resh) Rs 1,576/100 containers and the minimum of Rs 305/100 containers were observed in T₂ (Trelease formulation).

The maximum cost: benefit ratio of 1.42 were found in T₆ (Riviora's formula) followed by T₅ (Dr. Howard Resh) of 1.15 and the minimum of 1.02 were recorded in in T₂ (Trelease formulation).

REFERENCES

- Aykroyd, W.R. (1963).** Composition of dolichas bean green pod. ICMR Special Report Series No.42
- Borowski, E. and Michalek, S. (1998).** Effect of state produced hydrogel addition to peat substrate on yield and quality of lettuce fed with N-NO₃ or N-NH₄. Part II. Content in the leaves of certain organic and mineral substances. Annales Universitatis Mariae Curie-Sklodowska. Sectio EEE, Horticultura., 6:117-128.
- Braz, L. T.; Grilli, G. V. G.; Hamasaki, R. I. and Santos, G. M. (2003).** Production and evaluation of lettuce seedlings and plants in hydroponic floating system. *Acta Horticulturae*, 607, 67-71.
- Cometti, N. N.; Matias, G. C. S.; Zonta, E.; Mary, W. and Fernandes, M. S. (2008).** Effects of the concentration of nutrient solution on lettuce growth in hydroponics-NFT system. *Horticultura Brasileira*, 26(2): 262-267.
- Costa, A. S. V. da; Silva, N. F. da; Martinez, H. E. P.; Fontes, P. C. R. and Pereira, P. R. G. (1997).** Utilization of fertilizers from commercial sources in hydroponic cultivation of lettuce. *Revista Ceres*, 44(252): 169-179.
- Huett, D. O. (1989)** Effect of nitrogen on the yield and quality of vegetables. *Acta Horticultura*, (247):205-209.
- Kim JuHee; Kim HyeJin and Kim YoungShik. (1996).** Effect of ammonium phosphate on nutrient solution using tap water during hydroponic culture of crisp lettuce. *J. the Korean Society for Horti. Sci.*, 37(2): 223-227.
- Lopes, M. C.; Freier, M.; Matte, J. D.; Gartner, M.; Franzener, G.; Casimiro, E. L. N. and Sevigani, A. (2003).** Nutrient accumulation by lettuce cultivars under hydroponic culture in the winter. *Horticultura Brasileira*, 21(2): 211-215.
- Magnani, G. and Oggiano, N. (1997).** Reducing the level of nitrates in hydroponic lettuce. *Colture Protette*, 26(1): 57-61.
- Massiha, S.; Karimaei, M. S. and Moghaddam, M. (2000).** Effects of three nutrient solutions on growth and N, P and K concentrations in lettuce cultivars using hydroponic system. *Seed and Plant*, 15(4): 375-389.
- Resende, G. M. de; Alvarenga, M. A. R.; Yuri, J. E. and Souza, R. J. de. (2010).** Doses of nitrogen and molybdenum effects on yield and micronutrient content of crisphead lettuce plants. *Horticultura Brasileira*, 28(3): 266-270.
- Savvas, D.; Passam, H. C.; Olympios, C.; Nasi, E.; Moustaka, E.; Mantzos, N. and Barouchas, P. (2006).** Effects of ammonium nitrogen on lettuce grown on pumice in a closed hydroponic system. *Hort Science*, 41(7): 1667-1673.
- Schmidt, D.; Santos, O. S.; Bonnacarrere, R. A. G.; Mariani, O. A. and Manfron, P. A. (2001).** Efficiency of nutrient solutions and performance of lettuce cultivars in hydroponics. *Horticultura Brasileira*, 19(2): 122-126.
- Wang Bo; Shen QiRong; Lai Tao; Chen AiQun and Wei Jin. (2007).** Effects of NH₄⁺-N/NO₃⁻-N ratio in nutrient solution on growth of lettuce in hydroponics. *Acta Pedologica Sinica*, 44(3): 561-565.
- Zito, R. K.; Fronza, V.; Martinez, H. E. P.; Pereira, P. R. G. and Fontes, P. C. R. (1994).** Nutrient sources, nitrate:ammonium ratios and molybdenum in lettuce (*Lactuca sativa* L.) produced hydroponically. *Revista Cere*, 41(236): 419-430.