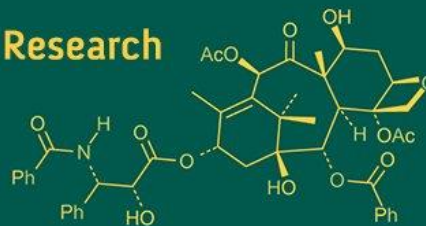


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Performance of different Lettuce (*Lactuca sativa* L.) cultivars in Nutrient Film Technique (NFT) system of hydroponics

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Abstract

Aims: To evaluate quality performance of different lettuce cultivars under NFT hydroponic conditions

Study design: Completely Randomized Design

Place and Duration of Study: Hydroponics unit, RCSM Govt. College of Agriculture, Kolhapur, Maharashtra between December, 2025 and January, 2026.

Methodology: The treatments comprised of T₁: Butterhead Green, T₂: Batavia Green, T₃: Catalogna Green, T₄: Lolo Bionda, T₅: Lolo Rossa, T₆: Red Salad Bowl Oakleaf Red, T₇: Romain Little Gem, T₈: Romain Paris Island Cos, T₉: Green Coral and T₁₀: Phule Padma. Lettuce was transplanted on 10th December, 2025 and Sensory and quality parameters were recorded after harvesting.

Results: The results revealed that lettuce cultivars significantly influenced the sensory and quality attributes under NFT hydroponic conditions. Romain Paris Island Cos recorded the highest overall acceptability (7.90) and crispness (8.71), while Green Coral recorded the highest firmness (8.43). For visual appearance and colour, Lolo Rossa (7.86) and Red Salad Bowl Oakleaf Red (7.71) were superior compared to the other cultivars. Among biochemical parameters, Catalogna Green recorded the highest chlorophyll content (1.29 mg g⁻¹) and total potassium content (2.26%). Similarly, Red Salad Bowl Oakleaf Red recorded the maximum moisture content (95.68%), whereas Romain Little Gem recorded the minimum potassium (1.84%) and moisture (93.66%) content.

Conclusion: Catalogna Green proved to be the most effective cultivar for major biochemical and quality attributes, recording the highest chlorophyll and total potassium contents, while Red Salad Bowl Oakleaf Red recorded the highest moisture content. Romain Paris Island Cos was superior for overall acceptability and crispness, whereas Green Coral recorded the highest firmness. Lolo Rossa and Red Salad Bowl Oakleaf Red were superior for visual appearance and colour. Overall, cultivar selection effectively influenced the sensory and biochemical quality of lettuce under NFT hydroponic conditions.

Keywords: Lettuce, sensory, biochemical, NFT hydroponics

1. Introduction

Lettuce (*Lactuca sativa* L.), a leafy vegetable crop, is widely cultivated because of its high market demand, short growth cycle and suitability for year-round production under protected conditions. It is considered an important vegetable crop due to its nutritional value and consumption as a fresh leafy vegetable (Kim *et al.* 2016) [7]. Lettuce responds exceptionally well to hydroponic cultivation because of its shallow root system and short crop duration, making it suitable for intensive production systems. Hydroponic cultivation also provides opportunities for higher productivity, improved produce quality and efficient utilization of water and fertilizers (Martinez 2016; Khan 2018) [6, 9].

Hydroponics is a soilless production system in which essential macro and micronutrients are supplied directly to the root zone through nutrient solutions. The importance of hydroponics has increased due to rapid urbanization, climate change, shrinking cultivable land and increasing pressure on freshwater resources. It enables efficient water use, higher productivity per unit area, reduced dependence on soil quality and year-round production under protected environments (Delaide *et al.* 2016; Pantoja Neto *et al.* 2016) [2, 11]. Among different hydroponic systems, the Nutrient Film Technique (NFT) is widely adopted for lettuce cultivation, in which a thin film of nutrient solution continuously flows through

channels containing plant roots, ensuring adequate nutrient supply, oxygen availability and moisture around the root zone (Vital *et al.* 2002) ^[20].

Hydroponic lettuce production offers several advantages over conventional cultivation, including reduced incidence of soil-borne diseases, improved yield, enhanced visual quality, longer shelf life and reduced use of water and fertilizers (Khan 2018; Sambo *et al.* 2019) ^[6, 15]. Several studies have demonstrated superior growth rate, early yield, total yield and quality characteristics of lettuce cultivated under NFT systems compared with conventional soil cultivation and other soilless systems (El-Shinawy and Gawish 2006; Kim *et al.* 2016) ^[7, 14]. However, productivity and quality under NFT systems are strongly influenced by nutrient solution composition and management practices.

Despite the growing popularity of NFT systems, identification of cultivars specifically adapted to hydroponic environments remains a major constraint. Cultivar performance under open-field conditions cannot be directly extrapolated to hydroponic systems because environmental conditions and nutrient dynamics differ substantially between production methods. Information regarding the comparative performance of lettuce cultivars under NFT-based hydroponic systems remains limited in India. Therefore, systematic evaluation of available lettuce cultivars is required to identify those best suited for hydroponic production under protected cultivation conditions. The present investigation was undertaken to study the quality performance of different lettuce cultivars under NFT-based hydroponic conditions.

2. Material and Methods

The present investigation was conducted during the winter season from December, 2025 to January, 2026 at the Hydroponics Unit, Instructional-cum-Research Farm of the Horticulture Section, Rajarshree Chhatrapati Shahu Maharaj Government College of Agriculture, Kolhapur, Maharashtra (16°68' N latitude and 74°26' E longitude) situated at an altitude of 546 m above mean sea level. The experimental site falls under the *Sub-montane* zone of Maharashtra, with the temperature inside the hydroponics unit maintained between 26 and 28 °C and relative humidity between 60 and 70 per cent using a sensor-based automatic climate control system. The experiment comprised ten lettuce cultivars with three replications laid out in a Completely Randomized Design (CRD). The cultivars included Butterhead Green, Batavia Green, Catalogna Green, Lolo Bionda, Lolo Rossa, Red Salad Bowl Oakleaf Red, Romain Little Gem, Romain Paris Island Cos, Green Coral and Phule Padma. Healthy seedlings were raised in pro-trays using cocopeat and peat moss in 1:1 ratio and shifted into the NFT system on 10th December 2025 at 30 days after sowing, maintaining a spacing of 15 cm × 20 cm. The NFT channels were supplied with a continuous film of nutrient solution to provide water and essential nutrients directly to the root zone. Growth, yield, sensory and biochemical parameters were recorded at appropriate stages, and the experimental data were statistically analyzed following the procedure described by Panse and Sukhatme (1985) ^[10] under uniform protected environmental and management conditions. antibacterial ^[17, 18] activities.

Table 1: Treatment details

Treatment	Details
T ₁	Butterhead Green
T ₂	Batavia Green
T ₃	Catalogna Green
T ₄	Lolo Bionda
T ₅	Lolo Rossa
T ₆	Red Salad Bowl Oakleaf Red
T ₇	Romain Little Gem
T ₈	Romain Paris Island Cos
T ₉	Green Coral
T ₁₀	Phule Padma

3. Results and Discussion

3.1 Sensory parameters

Sensory evaluation of lettuce cultivars grown under NFT hydroponic system was conducted with the help of a seven-member panel employing the nine-point hedonic scale developed by Amerine *et al.* (1965) ^[1]. The samples were evaluated for important quality attributes viz., firmness, crispness, colour and overall acceptability. The average scores for organoleptic evaluation assigned by the panelists were calculated which indicated that different cultivars had a marked influence on the sensory attributes like firmness, crispness, colour and overall acceptability of the leaves.

3.1.1 Firmness

The data pertaining to firmness at harvest of different lettuce cultivars is presented in the table 2. With respect to firmness, Green Coral obtained the maximum mean score of 8.43, while the sensory evaluation indicated that the remaining cultivars recorded comparatively lower scores. In support of this Pooja Dhikale (2022) and Dhumal (2024) ^[3, 14].

3.1.2 Crispness

The effect of different cultivars on crispness at harvest in detail is given in table 2. Regarding crispness, the highest mean score (8.71) was noted in Romain Paris Island Cos, whereas the remaining cultivars recorded comparatively lower scores. In support of this Pooja Dhikale (2022) and Dhumal (2024) ^[3, 14].

3.1.3 Colour

The influence of different cultivars on colour of lettuce at harvest is presented in table 2. For colour, Lolo Rossa recorded the highest mean score of 7.86, followed by Red Salad Bowl Oakleaf Red (7.71), indicating better visual appeal. Among the cultivars, Lolo Rossa and Red Salad Bowl Oakleaf Red achieved higher scores for visual appearance and colour, reflecting better consumer preference. On the other hand, the remaining cultivars recorded comparatively lower scores. These findings indicate that cultivar selection significantly influenced the visual quality and colour characteristics of lettuce leaves under NFT hydroponic conditions. In support of this Pooja Dhikale (2022) and Dhumal (2024) ^[3, 14].

3.1.4 Overall Acceptability

The influence of different cultivars on overall acceptability of lettuce at harvest is presented in Table 2. For overall acceptability, Romain Paris Island Cos recorded the highest mean score of 7.90, followed by Red Salad Bowl Oakleaf Red (6.71) and Green Coral (6.67), indicating better

consumer preference. Among the cultivars, Romain Paris Island Cos achieved the highest score in terms of overall acceptability, reflecting superior sensory quality and

consumer acceptance. These findings indicate that cultivar selection significantly influenced the overall sensory acceptability of lettuce under NFT hydroponic conditions.

Table 2: Overall Acceptability of different lettuce cultivars under NFT system of hydroponics

Tr. No	Treatments	Firmness	Crispness	Colour	Overall acceptability
T ₁	Butterhead Green	6.14	6.14	5.57	5.95
T ₂	Batavia Green	6.29	6.14	6.14	6.19
T ₃	Catalogna Green	6.71	6.43	6.00	6.33
T ₄	Lolo Bionda	5.57	5.86	5.86	5.62
T ₅	Lolo Rossa	5.57	6.43	7.86	6.57
T ₆	Oakleaf Red	5.71	6.86	7.71	6.71
T ₇	Romain Little Gem	5.29	5.71	6.29	5.76
T ₈	Romain Paris Island Cos	7.29	8.71	7.71	7.90
T ₉	Green Coral	8.43	6.71	7.00	6.67
T ₁₀	Phule Padma	6.71	6.00	6.29	6.24

Biochemical parameters

Biochemical constituents are important quality attributes in lettuce tissues involved in various physiological processes that support normal plant growth and development. The results of the present investigation showed that different lettuce cultivars significantly influenced the biochemical composition, particularly chlorophyll, potassium and moisture content under NFT hydroponic conditions.

Total Potassium Content (%)

The data pertaining to total potassium content among different lettuce cultivars is presented in Table 3. The potassium content among the cultivars varied between 1.84 and 2.26 *per cent*. Among the cultivars, Catalogna Green registered the maximum potassium content of 2.26 per cent and remained statistically comparable with Green Coral (2.20%), Romain Paris Island Cos (2.18%), Phule Padma (2.12%) and Red Salad Bowl Oakleaf Red (2.09%). The minimum potassium content of 1.84 per cent was noticed in Romain Little Gem and was statistically comparable with Lolo Rossa (1.87%), Batavia Green (1.96%) and Lolo Bionda (1.98%). The higher potassium content in Catalogna Green may be attributed to differences in genetic constitution, nutrient absorption, translocation and utilization efficiency under the NFT hydroponic system. In support of this, Pineda *et al.* (2018); Pooja Dhikale (2022); Grzegorzewska *et al.* (2023); Pastor-Arbulú *et al.* (2025) and Dhumal (2025) [3, 5, 12, 13, 14] reported similar variations in potassium content in lettuce.

Total Chlorophyll Content

The data pertaining to total chlorophyll content among

different lettuce cultivars is presented in Table 3. The chlorophyll content among the cultivars varied between 0.61 and 1.29 mg g⁻¹. Among the cultivars, Catalogna Green registered the maximum total chlorophyll content of 1.29 mg g⁻¹, whereas Green Coral recorded the minimum chlorophyll content of 0.61 mg g⁻¹. The higher chlorophyll content in Catalogna Green might be attributed to differences in genetic constitution, pigment synthesis efficiency and adaptability to the environmental conditions maintained under the NFT hydroponic system. Moreover, nutrient availability and root zone conditions might have also influenced chlorophyll biosynthesis and accumulation in the leaves. In support of this, Mampholo *et al.* (2016); Sapkota *et al.* (2019); Santos *et al.* (2021); Thomas *et al.* (2021); Pooja Dhikale (2022); Grzegorzewska *et al.* (2023); Singh *et al.* (2023) and Dhumal (2025) [3, 8, 14, 16, 17, 18, 19] reported similar variations in chlorophyll content in lettuce.

Moisture Content

The data pertaining to moisture content among different lettuce cultivars is presented in Table 3. The moisture content among the cultivars varied from 93.66 to 95.68 *per cent*. However, the effect of different cultivars on moisture content was found to be non-significant. Red Salad Bowl Oakleaf Red recorded the maximum moisture content (95.68%), followed by Lolo Bionda (95.65%) and Butterhead Green (95.59%), whereas Romain Little Gem recorded the minimum moisture content (93.66%). The variation in moisture content may be attributed to differences in cultivar characteristics and water accumulation in leaf tissues under the NFT hydroponic system.

Table 3: Effect different lettuce cultivars on Biochemical characters under NFT system of hydroponics.

Tr. No.	Treatments	Total Potassium (%)	Total Chlorophyll (mg g ⁻¹)	Moisture (%)
T ₁	Butterhead Green	2.05	0.85	95.59
T ₂	Batavia Green	1.96	0.70	95.22
T ₃	Catalogna Green	2.26	1.29	95.15
T ₄	Lolo Bionda	1.98	0.65	95.65
T ₅	Lolo Rossa	1.87	0.64	95.14
T ₆	Oakleaf Red	2.09	0.72	95.68
T ₇	Romain Little Gem	1.84	1.10	93.66
T ₈	Romain Paris Island Cos	2.18	1.03	95.54
T ₉	Green Coral	2.20	0.61	94.89
T ₁₀	Phule Padma	2.12	1.27	94.70
Mean		2.05	0.99	95.12
SEm(±)		0.06	0.01	0.50
CD@5%		0.17	0.03	NS

Conclusion

Different lettuce cultivars significantly influenced the sensory and biochemical quality attributes under NFT hydroponic conditions, with Romain Paris Island Cos (7.91) producing the best overall performance in terms of overall acceptability and crispness, while Green Coral recorded the highest firmness. Additionally, Lolo Rossa and Red Salad Bowl Oakleaf Red were superior for visual appearance and colour, whereas Catalogna Green recorded the highest chlorophyll and total potassium contents. Red Salad Bowl Oakleaf Red recorded the highest moisture content.

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Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Amerine MA, Pangborn RM, Roessler EB. Principles of sensory evaluation of food. New York: Academic Press; 1965.
2. Delaide B, Goddek S, Gott J, Soyeurt H, Jijakli MH. Lettuce (*Lactuca sativa* L. var. Sucrine) growth performance in complemented aquaponic solution outperforms hydroponics. *Water*. 2016;8(10):467.
3. Dhumal S. Performance of different lettuce varieties under deep water culture (DWC) technique of aquaponics [unpublished thesis]. Rahuri: Mahatma Phule Krishi Vidyapeeth; 2025. p. 59.
4. El-Shinawy MZ, Gawish ShM. Effect of commercial organic nutrient solutions on growth and chemical composition of lettuce under agricultural soilless system. *Egyptian Journal of Horticulture*. 2006;33:19-28.
5. Grzegorzewska M, Badelek E, Matysiak B, Kaniszewski S, Dyśko J, Kowalczyk W, et al. Assessment of Romaine lettuce cultivars grown in a vertical hydroponic system at two levels of LED light intensity. *Scientia Horticulturae*. 2023;313:111913.
6. Khan FA. A review on hydroponic greenhouse cultivation for sustainable agriculture. *International Journal of Agriculture Environment and Food Sciences*. 2018;2(2):59-66.
7. Kim MJ, Moon Y, Tou JC, Mou B, Waterland NL. Nutritional value, bioactive compounds and health benefits of lettuce (*Lactuca sativa* L.). *Journal of Food Composition and Analysis*. 2016;49:19-34.
8. Mampholo BM, Maboko MM, Soundy P, Sivakumar D. Phytochemicals and overall quality of leafy lettuce (*Lactuca sativa* L.) varieties grown in closed hydroponic system. *Journal of Food Quality*. 2016;39(6):805-815.
9. Martinez HEP. Manual práctico de hidroponia. 3rd ed. Viçosa: Editora UFV; 2016. p. 286.
10. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. 4th ed. New Delhi: Indian Council of Agricultural Research; 1985. p. 361.
11. Pantoja Neto RA, Martins BS, Palheta IC, Paula MT. Viabilidade econômica da produção de hortaliças em sistema hidropônico em Cametá-PA. *Revista Brasileira de Agropecuária Sustentável*. 2016;6(2):75-80.
12. Pastor-Arbulú P, Rodríguez-Delfín A. Enhancing the growth, yield and physiological response of two lettuce (*Lactuca sativa* L.) cultivars through NFT system optimization. *Frontiers in Plant Science*. 2025;16:1639002.
13. Pineda-Pineda J, Valdez-Zamora A, Miranda-Velázquez I, Rodríguez-Pérez JE, Ramírez Arias JA, Lozano-Toledano A. Yield of two cultivars of lettuce (*Lactuca sativa* L.) in hydroponic and aquaponic systems. *Acta Horticulturae*. 2018;1227:347-354.
14. Dhikale P. Performance of lettuce cultivars in DWC technique of aquaponics using different media [MSc thesis]. Rahuri: Mahatma Phule Krishi Vidyapeeth; 2022. p. 71.
15. Sambo P, Nicoletto C, Giro A, Pii Y, Valentinuzzi F, Mimmo T, et al. Hydroponic solutions for soilless production systems: Issues and opportunities in a smart agriculture perspective. *Frontiers in Plant Science*. 2019;10:923.
16. Santos CP dos, Noboa CS, Martinez M, Cardoso JC, Sala FC. Morphological evaluation of lettuce genotypes grown under hydroponic system. *Horticultura Brasileira*. 2021;39(3):312-318. DOI:10.1590/S0102-0536-20210311.
17. Sapkota S, Sapkota S, Liu Z. Effects of nutrient composition and lettuce cultivar on crop production in hydroponic culture. *Horticulturae*. 2019;5(4):72. DOI:10.3390/horticulturae5040072.
18. Singh H, Dunn BL, Fontanier C, Singh H, Kaur A, Zhang L. Shade nets reduced growth, nutrition, and sugars of hydroponic lettuce and basil. *HortScience*. 2023;58(11):1383-1392.
19. Thomas T, Biradar MS, Chimmad VP, Janagoudar BS. Growth and physiology of lettuce (*Lactuca sativa* L.) cultivars under different growing systems. *Plant Physiology Reports*. 2021;26(3):526-534. DOI:10.1007/s40502-021-00591-3.
20. Vital WM, Teixeira NT, Shigihara R, Ferraro AE, Damaglio EL, Alvero P. Behavior of varieties of lettuce (*Lactuca sativa* L.) cultivated in hydroponics with different nutritious solutions. *Ecosistema*. 2002;27(1-2):59-61.