

Response of the Growth and Yield of Cherry Tomato to Growing Medium Type and Foliar Application of K.P.N Fertilizer under Unheated Greenhouse Conditions.

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Abstract

The experiment was conducted at the Research Station of the College of Agriculture, University of Kufa, Najaf Al-Ashraf Governorate, during the 2025 growing season to investigate the effect of the type of growing medium, which included four growing media: sand (control treatment) (C₁), a mixture of Peat moss and Perlite (1:1) (C₂), a mixture of Peat moss and Perlite (2:1) (C₃), and a mixture of Peat moss and Perlite (1:2) (C₄), and foliar application of NPK fertilizer at concentrations of 0, 3, and 4 g L⁻¹ on the yield and the chemical and qualitative characteristics of cherry tomato plants. The experiment was conducted as a Split Plot Design according to a Randomized Complete Block Design (RCBD) with three replications. The growing media were assigned to the main plots, whereas the NPK fertilizer concentrations were assigned to the sub-plots. Treatment means were compared using the Least Significant Difference (LSD) test at the 0.05 probability level. The results showed that treatment C₂ was significantly superior to all other treatments in early yield per unit area. Treatment C₃

was superior to all other treatments in fruit vitamin C content and was also significantly superior in leaf nitrogen, phosphorus, and potassium contents, as well as shoot dry weight. No significant differences were observed among the growing media treatments in fruit anthocyanin content. Regarding the effect of foliar application of NPK fertilizer, no significant differences were found among fertilizer concentrations in fruit anthocyanin content. However, the 3 and 4 g L⁻¹ concentrations were significantly superior to the control treatment in early yield per unit area (24.15 Mg ha⁻¹). The 4 g L⁻¹ concentration was superior to the other two concentrations in fruit vitamin C content and leaf phosphorus content, whereas the 3 g L⁻¹ concentration was superior in leaf nitrogen content and shoot dry weight. No significant differences were observed among fertilizer concentrations in leaf potassium content. The interaction between the two study factors showed a significant superiority in all studied traits except fruit anthocyanin content.

Keywords: Vegetative growth; Soilless culture; Fruit quality; Protected cultivation; Nutrient management.

Introduction

One of the most important challenges facing agricultural production in Iraq is soil-related problems, which have contributed to the deterioration of the agricultural production of all important economic and strategic crops, including tomato. Soil salinity is one of the major

problems that has led to the deterioration of the agricultural sector in Iraq. The impact of

increasing soil salinity is not limited to the loss of agricultural land; it also results in reduced land productivity.

Reports have indicated that 60–70% of the land in central and southern Iraq has been affected by salinity and has become unsuitable for agricultural exploitation [1].

Water availability is directly affected by climate change, which is reflected in agricultural production and food supply. Water scarcity threatens food security and agricultural economic development by affecting production volume and the composition of agricultural products. Furthermore, recent drought waves have reduced the quantities of water allocated for agricultural irrigation, resulting in a decline in total agricultural production and exports, with consequent negative impacts on food security and economic development [2]. Therefore, it has become necessary to adopt agricultural production systems that overcome soil-related problems such as salinity, improve the management of water scarcity, and control disease-causing agents. Among the advantages of soilless cultivation are balanced and regular irrigation and fertilization, optimum utilization of water and fertilizers, a disease-free growing environment, the use of an appropriate growing medium, and consequently increased productivity and improved product quality [3].

The use of growing media as alternatives to soil protects plants from many soil-related problems, particularly those associated with the availability of nutrients in the root zone. One of these media is agricultural perlite, which is characterized by its high water absorption capacity. It improves aeration and drainage of the growing medium, thereby enhancing root aeration. It also has a high capacity for retaining water and fertilizers for extended periods, increasing the interval between irrigations and consequently reducing water and fertilizer consumption. Perlite possesses a high cation exchange capacity and has a nearly neutral pH (5.6–5.7),

thereby providing a balanced growing environment for plants. It is a sterile medium free of weed seeds and pathogens. As an inorganic material, it is resistant to decomposition and can therefore be reused for several growing seasons. In addition, it reduces the harmful effects of high temperatures on plants and protects plant roots from severe temperature reduction. It is clean, odorless, and lightweight [4,5]. Peat moss is widely used in horticulture and agriculture because of its excellent water-holding capacity, favorable aeration properties, low pH, low bulk density, low nutrient content, beneficial cation exchange capacity, and its ability to improve soil structure [6,7] in their study on the effect of three growing media mixtures, namely sand manure (80%:20%), sand moss (50%:25%:25%), and Peat moss (50%:50%), on eggplant (*Solanum melongena* L.) during the 2023 and 2024 growing seasons, reported that the sand moss (50%:25%:25%) and Peat moss (50%:50%) media were significantly superior to the sand manure (80%:20%) medium in leaf chlorophyll content during both seasons. Furthermore, the Peat moss (50%:50%) medium was significantly superior in leaf nitrogen, phosphorus, and potassium contents compared with the other two media.

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) is one of the important strategic crops that can be cultivated under soilless culture to increase productivity. It is recognized for its high economic value, excellent nutritional quality, and increasing consumer demand. It is also an important crop in protected cultivation because of its high nutritional value, providing essential vitamins (A, C, and K), minerals (potassium, calcium, phosphorus, and folic acid), and antioxidants such as carotenoids (β -carotene and lycopene) [8,9]. Supplying this crop with essential macronutrients is important for increasing productivity and

achieving high economic returns. Among these fertilizers, NPK fertilizer is considered essential because nitrogen (N), phosphorus (P), and potassium (K) are indispensable nutrients required for proper vegetative growth, flowering, and fruit development of tomato plants [10,9,11], in a study evaluating the effect of four concentrations of NPK fertilizer (0, 1, 2, and 4 g L⁻¹) on three cherry tomato hybrids, found that the concentration of 4 g L⁻¹ significantly increased leaf potassium content, total chlorophyll, carbohydrate

Material and Methods

The field experiment on cherry tomato was conducted during the 2025–2026 growing season at the Research Station of the College of Agriculture, University of Kufa, Najaf Al-Ashraf Governorate, located at longitude 44° and latitude 32°, approximately 70 m above sea level. The experimental field was divided into three blocks, each block containing 12 treatments (experimental units). Each treatment consisted of four plants, and the plants were arranged in longitudinal rows.

Cherry tomato seeds were sown in special seedling trays for seedling production. The seedlings were then transplanted to the field and grown in pots. All standard cultural practices required for plant growth were carried out throughout the experimental period.

The experiment was conducted as a Split Plot Design according to a Randomized Complete Block Design (RCBD) with three replications. The experiment included two factors. The first factor consisted of four growing media, which were assigned to the main plots: sand (control treatment) (C1), a mixture of peat moss and Perlite (1:1) (C2), a mixture of Peat moss and Perlite (2:1) (C3), and a mixture of Peat moss and Perlite (1:2) (C4). The second factor consisted of foliar application of NPK fertilizer at concentrations of 0, 3, and 4 g L⁻¹, which

content, fruit vitamin C content, total soluble solids, and anthocyanin content compared with the other concentrations. However, no significant differences were observed in leaf nitrogen and phosphorus contents or in fruit lycopene and β -carotene contents. Therefore, the present study aimed to determine the role of organic growing media in improving plant growth, productivity, and the chemical and qualitative characteristics of cherry tomato.

were assigned to the sub-plots. Treatment means were compared using the Least Significant Difference (LSD) test at the 0.05 probability level.

The experimental measurements were recorded using four randomly selected plants from each experimental unit. The studied parameters included fruit anthocyanin content (mg 100 g⁻¹ fresh weight), determined according to the method of [12]; fruit vitamin C content, determined according to the method of [13]; early yield (Mg ha⁻¹); shoot dry weight (g); leaf nitrogen content (%), determined according to the method of [14] using a spectrophotometer; leaf phosphorus content (%), determined by the ammonium molybdate and ascorbic acid method according to [15]; and leaf potassium content (%), determined according to the method of [16] using a Flame Photometer.

Results and Discussion

The results presented in Table 1 showed that both experimental factors had a significant effect on fruit vitamin C content (mg 100 g⁻¹ fresh weight). The growing medium treatment C3 was significantly superior to all other treatments and produced the highest mean value of 40.00 mg 100 g⁻¹ fresh weight. Both C3 and G4 were superior to the G1 medium treatment

(sand only), which recorded the lowest mean value of $21.44 \text{ mg } 100 \text{ g}^{-1}$ fresh weight. Regarding fruit anthocyanin content, neither the two experimental factors nor their interaction produced any significant differences in fruit anthocyanin content. The C2 growing medium treatment was significantly superior to all other treatments in early yield and produced the highest mean of 24.15 Mg ha^{-1} , whereas both C3 and C4 were superior to the G1 medium treatment (sand only), which recorded the lowest early yield of 9.62 Mg ha^{-1} .

With respect to foliar application of NPK fertilizer, the concentration of 4 g L^{-1} was significantly superior to the control treatment in fruit vitamin C content, recording a mean value of $34.33 \text{ mg } 100 \text{ g}^{-1}$ fresh weight, whereas the control treatment recorded the lowest mean value of $28.00 \text{ mg } 100 \text{ g}^{-1}$ fresh weight. Concerning early yield, foliar application of NPK fertilizer at 3 and 4 g L^{-1} (which did not differ significantly from each other) was significantly superior to the control treatment, recording mean values of 17.71 and 17.94 Mg ha^{-1} , respectively, whereas the control treatment produced an early yield of 14.88 Mg ha^{-1} . Regarding the interaction between the two factors, the interaction treatment (C3 $\times$ 4 g L^{-1} NPK) was significantly superior to all other interaction treatments in fruit vitamin C content and produced the highest mean value of $52.00 \text{ mg } 100 \text{ g}^{-1}$ fresh weight, whereas the lowest mean value ($17.33 \text{ mg } 100 \text{ g}^{-1}$ fresh weight) was recorded by the interaction treatment (C1 $\times$ 0 g L^{-1} NPK). The interaction treatment (C2 $\times$ 4 g L^{-1} NPK) was significantly superior to all other interaction treatments in early yield, producing the highest mean value of 28.76 Mg ha^{-1} , whereas the lowest mean value (7.78 Mg ha^{-1}) was recorded by the interaction treatment (C1 $\times$ 0 g L^{-1} NPK).

The results presented in Table 2 showed that the growing medium treatment G3 was superior to all other treatments in leaf nitrogen, phosphorus, and potassium contents, recording mean values of 3.28%, 1.57%, and 3.01%, respectively. The lowest mean values were obtained from the control treatment, amounting to 1.99%, 0.47%, and 2.57%, respectively. The C3 growing medium treatment was also superior to all other treatments in shoot dry weight, producing the highest mean value of $51.44 \text{ g plant}^{-1}$, whereas the C4 treatment recorded the lowest mean value of $45.30 \text{ g plant}^{-1}$.

Regarding foliar application of NPK fertilizer, the 3 and 4 g L^{-1} concentrations were significantly superior to the control treatment in leaf nitrogen content, producing the highest mean values of 2.56% and 2.50%, respectively, compared with the control treatment, which recorded the lowest value (2.18%). For leaf phosphorus content, the 4 g L^{-1} concentration was significantly superior to the other two concentrations, recording the highest mean value of 1.08%. No significant differences were observed among fertilizer concentrations in leaf potassium content. The 3 and 4 g L^{-1} concentrations were also significantly superior to the control treatment in shoot dry weight, producing the highest mean values of 51.00 and $49.84 \text{ g plant}^{-1}$, respectively, whereas the control treatment recorded the lowest mean value of $44.26 \text{ g plant}^{-1}$. Regarding the interaction between the two factors, the interaction treatment (C3 $\times$ 3 g L^{-1} NPK) was superior to all other interaction treatments in leaf nitrogen content, producing the highest mean value of 3.80%, whereas the lowest mean value (1.91%) was recorded by the interaction treatment (C1 $\times$ control fertilizer treatment). The interaction treatments (C3 $\times$ 3 g L^{-1} NPK) and (C3 $\times$ 4 g L^{-1} NPK) were significantly superior to all other interaction treatments in leaf phosphorus

content, producing the highest mean values of 1.63% and 1.65%, respectively, whereas the lowest mean value (0.28%) was recorded by the interaction treatment (G1 × control fertilizer treatment). Regarding leaf potassium content, the interaction treatments (C3 × 3 g L⁻¹ NPK) and (C3 × 4 g L⁻¹ NPK) were significantly superior to all other interaction treatments, producing the highest mean values of 3.03% and 3.05%, respectively, whereas

the lowest mean value (2.52%) was recorded by the interaction treatment (C1 × 4 g L⁻¹ NPK). The interaction treatment (C3 × 4 g L⁻¹ NPK) was significantly superior to all other interaction treatments in shoot dry weight, producing the highest mean value of 55.06 g plant⁻¹, whereas the lowest mean value (40.16 g plant⁻¹) was recorded by the interaction treatment (C2 × 0 g L⁻¹ NPK).

Table 1. Effect of culture media levels and NPK Concentrations on some chemical and early yield traits of cherry tomatoes under protected farming conditions.

<i>Early Yield (kg ha⁻¹)</i>	<i>Anthocyanin (mg.100 g⁻¹)</i>	<i>Vit C (mg.100 g⁻¹)</i>	<i>Treatments</i>	
Effect of Culture Media Levels				
9.62	47.72	21.44	C1	C4
24.15	49.09	31.78	C2	
17.72	46.41	40.00	C3	
15.89	48.00	27.89		
2.22	N.S.	0.94	LSD 0.05	
NPK Concentrations				
14.88	48.52	28.00	NPK 1	C1
17.71	47.54	28.50	NPK 2	
17.94	47.35	34.33	NPK 3	
1.41	N.S.	0.61	LSD 0.05	
Effect of the Interaction				
7.78	48.77	17.33	NPK 1	C1
9.89	47.95	23.33	NPK 2	
11.20	46.45	23.67	NPK 3	
18.81	49.32	34.00	NPK 1	C2
24.86	48.63	30.67	NPK 2	
28.76	49.32	30.67	NPK 3	
19.73	46.41	32.33	NPK 1	C3
17.39	45.90	35.67	NPK 2	
16.03	46.93	52.00	NPK 3	
13.20	49.59	28.33	NPK 1	C4
18.70	47.68	24.33	NPK 2	
15.78	46.72	31.00	NPK 3	
2.83	N.S.	1.22	LSD 0.05	

N.S. indicates a non-significant effect at p>0.05.

C1: Control, C2: Perlite + Peat moss (1:1), C3: Perlite + Peat moss (2:1), C4: : Perlite + Peat moss (1:2)

Table 2. Effect of culture media levels and NPK Concentrations on some nutritional and shoot dry weight traits of cherry tomatoes under protected farming conditions.

Shoot Weight (g)	Dry Potassium (%)	Phosphorus (%)	Nitrogen (%)	Treatments	
Effect of Growing Media Levels					
46.74	2.57	0.47	1.99	C1	C4
50.00	2.84	1.19	2.24	C2	
51.44	3.01	1.57	3.28	C3	
45.30	2.77	0.75	2.15		
0.54	0.04	0.08	0.07	LSD 0.05	
NPK Concentrations					
44.26	2.79	0.96	2.18	NPK 1	C4
51.00	2.79	0.94	2.56	NPK 2	
49.84	2.80	1.08	2.50	NPK 3	
0.62	N.S.	0.05	0.06	LSD 0.05	
Effect of the Interaction					
40.46	2.57	0.28	1.91	NPK 1	C1
49.20	2.62	0.55	2.10	NPK 2	
50.55	2.52	0.57	1.95	NPK 3	
40.16	2.87	1.36	2.30	NPK 1	C2
59.32	2.82	0.95	2.20	NPK 2	
50.51	2.82	1.25	2.22	NPK 3	
49.98	2.94	1.44	2.36	NPK 1	C3
49.28	3.03	1.63	3.80	NPK 2	
55.06	3.05	1.65	3.68	NPK 3	
46.44	2.79	0.76	2.16	NPK 1	C4
46.19	2.71	0.63	2.14	NPK 2	
43.26	2.80	0.86	2.16	NPK 3	
1.24	0.08	0.10	0.12	LSD 0.05	

N.S. indicates a non-significant effect at $p > 0.05$.

C1: Control, C2: Perlite + Peat moss (1:1), C3: Perlite + Peat moss (2:1), C4: : Perlite + Peat moss (1:2).

Discussion

The significant superiority resulting from the use of different mixtures of peat moss and perlite as growing media, particularly for the traits that showed significant improvement compared with sand, including fruit vitamin C content, early yield, shoot dry weight (g), and leaf

nitrogen, phosphorus, and potassium contents, can be attributed to the role of these media in promoting plant growth. Soilless culture is extensively used in protected cultivation to improve control over the plant-growing environment and to avoid problems associated with soil water status and nutrient availability [17]. Such regulation of water and nutrient supply

within the root hair zone enables plants to absorb them more efficiently, which is reflected in improved plant growth and increased productivity. As reported by [18], peat moss is an organic growing medium containing a large number of micropores, giving it a high water-holding capacity, as it can retain an amount of water equivalent to approximately ten times its dry weight [19,20]. Perlite improves aeration and drainage, provides optimum moisture retention and better nutrient availability, and produces a lightweight growing medium characterized by high porosity [21,22]. In addition, it has a high capacity for water absorption, improves drainage and root aeration, retains water and fertilizers for long periods, increases the interval between irrigations, thereby reducing water and fertilizer consumption, and possesses a high cation exchange capacity [23,5]. These common characteristics of peat moss and perlite improve vegetative growth and stimulate photosynthesis, thereby increasing yield, shoot dry weight, and the chemical and quality characteristics of leaves and fruits. This agrees with the findings of [24], who reported that the quality and quantity of tomato fruits produced in organic growing media were superior to those produced in inorganic media.

The significant effect of NPK fertilizer on fruit vitamin C content, early yield, shoot dry weight (g), and leaf nitrogen and

phosphorus contents can be explained by the findings of [25], who reported that an adequate supply of the three major nutrients (nitrogen, phosphorus, and potassium) positively regulates plant physiological functions and morphological responses. Furthermore, all plants require relatively large amounts of N, P, and K fertilizers to achieve optimum growth and productivity, which explains the significant increase in early yield following NPK application. This effect is also attributed to the physiological functions of NPK nutrients. Nitrogen and phosphorus are structural components of many important organic compounds involved in vital plant processes, including nucleic acids, amino acids, and coenzymes such as NADH₂ and NADPH₂, which play essential roles in oxidation-reduction reactions associated with photosynthesis, respiration, carbohydrate metabolism, and fatty acid synthesis [17]. In addition, potassium performs several essential physiological functions, including enzyme activation, protein synthesis, photosynthesis, osmotic regulation, stomatal movement, energy transfer, phloem transport, cation-anion balance, and stress tolerance [26]. Therefore, the stimulation of these physiological processes is reflected in an increase in the chemical composition and quality characteristics of the plants. Moreover, the direct application of fertilizer enhanced nutrient accumulation in the leaves.

Conclusion

Eliminating soil-related problems such as drought, nutrient retention limitations, and plant pathogenic microorganisms through the use of organic growing media such as perlite and peat moss plays an important role in promoting tomato plant growth and increasing yield. Plant nutrition with NPK

fertilizer significantly improved the chemical composition, quality characteristics, and early yield of the plants. The perlite and peat moss mixture at a ratio of 1:2 produced a significant increase in early yield per unit area, while the 3 and 4 g L⁻¹ concentrations of NPK fertilizer were significantly superior in achieving the highest early yield.

Acknowledgment:

The researcher and her supervisor would like to thank the faculty of Agriculture, Al-Kufa University, for providing the facilities and academic support that helped in the successful completion of this research. They would also like to thank the staff of the faculty and laboratory for their cooperation and help in the study.

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