Plant Archives Vol. 25, No. 2, 2025 pp. 2147-2153 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.308

OPTIMIZATION OF NPK FERTILIZER LEVELS FOR GROWTH AND PRODUCTIVITY TRAITS IN VEGETATIVELY PROPAGATED HYBRID CHERRY TOMATO

Yogesh M.[1]*, Nangsol Dolma Bhutia[1], Easton Lourembam[1], Teju C. M.[1] and Kishorkumar G. K.[2]
[1]Department of Vegetable Science, Central Agricultural University, Imphal 795004, India
[2]Department of Vegetable Science, University of Horticultural Sciences, Bagalkot, Karnataka, India
*Corresponding author email: ymr.horti@gmail.com
(Date of Receiving : 10-08-2025; Date of Acceptance : 13-10-2025)

ABSTRACT

Vegetatively propagated hybrid cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) provides a sustainable approach to maintain heterosis and uniformity without recurrent hybrid seed production. Unlike seedlings, which develop a prominent taproot, cuttings form fibrous root systems with limited penetration but enhanced lateral spread, affecting nutrient absorption and response to fertilizer. This study evaluated the growth, yield and quality of hybrid plants propagated through side shoot cuttings under five NPK levels (50%, 75%, 100%, 125% of recommended dose and unfertilized control) in a randomized block design under polyhouse conditions. Increasing NPK levels significantly enhanced vegetative growth, early flowering and fruiting, with maximum performance at 125% RDF. Fruit attributes, including weight, length, girth, cluster number and total yield, improved progressively with nutrient enrichment, reaching 2.76 kg/plant and 61.33 t/ha at 125% RDF. Quality traits like total soluble solids, ascorbic acid, lycopene and chlorophyll content were also highest under this treatment. The findings highlight that, due to the distinct fibrous root system of cuttings, vegetatively propagated cherry tomato plants require optimized nutrient management for efficient uptake, balanced growth and superior yield and fruit quality. Application of 125% RDF is recommended to achieve optimal performance in protected cultivation systems.
Keywords **:** Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*), vegetative propagation.

Introduction

Hybrid vigour, or heterosis, refers to the increased growth, biomass and reproductive potential observed in the F_1 generation when genetically diverse parents are crossed, resulting in progeny superior to either parent (Birchler *et al.*, 2006). This phenomenon, achieved through the combination of complementary alleles from two homozygous lines, enhances both quantitative and qualitative traits of a crop. However, the benefits of heterosis are transient, as hybrid seeds cannot be reused in subsequent seasons due to genetic segregation and recombination, which dismantle the uniform genetic constitution of the F_1 hybrid (Richharia, 1962). The continuous renewal of hybrid seeds, along with the maintenance of parental lines, demands significant economic and labour inputs, limiting accessibility for smallholder farmers.

Vegetative propagation offers a viable alternative to overcome this constraint by maintaining the heterozygosity of hybrids without genetic segregation. Propagating hybrids through cuttings ensures genetic uniformity and preservation of hybrid vigour, thereby reducing dependence on commercial hybrid seeds.

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) is a high-value, export-oriented vegetable crop prized for its attractive appearance, high nutritional content and consumer appeal in fresh and processed markets. Rich in lycopene, ascorbic acid and antioxidants, it plays a key role in human nutrition by contributing to dietary health and disease prevention. The indeterminate growth habit of hybrid cultivars makes them particularly suitable for protected cultivation, where the controlled environment ensures high productivity and extended harvesting. In

indeterminate cherry tomato cultivation, routine pruning of side shoots is a common practice to enhance canopy management, yield and fruit quality. These pruned side shoots, when treated with suitable root-promoting agents and planted in optimal rooting media, can serve as a cost-effective and sustainable source of true-to-type planting material for round-the-year production of hybrid plants with retained vigour.

Balanced nutrient management, particularly of nitrogen (N), phosphorus (P) and potassium (K), is vital for optimizing growth, yield and fruit quality in tomato. Nitrogen promotes vegetative growth by stimulating meristematic activity, chlorophyll formation and protein synthesis (Singh and Kumar, 1969). Phosphorus facilitates root development and energy transfer, playing an essential role in nutrient absorption and reproductive development (Gould, 1983). Potassium regulates several physiological processes, including enzyme activation, translocation of assimilates, stomatal regulation and water balance, all of which directly affect fruit development and quality. Deficiency or imbalance of these macronutrients often leads to reduced photosynthetic efficiency, delayed flowering, poor fruit set and lower yield and quality.

Nutrient requirements of vegetatively propagated plants often differ from those of seed-raised plants due to distinct root system architecture. While seedlings develop a prominent taproot, cuttings form fibrous root systems with comparatively limited penetration but enhanced lateral spread. This morphological difference influences nutrient absorption dynamics and may alter the plant's response to fertilizer levels. Therefore, optimizing NPK levels specifically for vegetatively propagated cherry tomato plants is essential to ensure efficient nutrient uptake, maximize growth and yield potential and maintain fruit quality under protected cultivation.

Considering these aspects, the present investigation was undertaken to evaluate the effect of different NPK fertilizer levels on the growth, yield and quality of vegetatively propagated hybrid cherry tomato plants, aiming to establish suitable nutrient management standards for maximizing performance under protected conditions.

Materials and Method

Experimental site

The experiment was conducted under controlled polyhouse conditions at the Department of Vegetable Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India. The site is characterized by a humid subtropical climate with moderate temperature and relative humidity conducive to tomato cultivation. The soil of the experimental site was sandy loam, well-drained and moderately fertile. The polyhouse environment ensured uniform temperature and humidity, minimizing external environmental fluctuations and favoring optimal plant growth and development.

Experimental treatment details

The study was laid out in a Randomized Block Design (RBD) comprising five nutrient levels and four replications with ten plants per treatment. The treatments included five levels of NPK fertilizers based on the Recommended Dose of Fertilizers (RDF): T_1 (50% RDF; N:P:K = 37.5:30:30 kg/ha), T_2 (75% RDF; N:P:K = 56.25:45:45 kg/ha), T_3 (100% RDF; N:P:K = 75:60:60 kg/ha), T_4 (125% RDF; N:P:K = 93.75:75:75 kg/ha) and T_5 (control, no fertilizer application). Each plot measured 3.0 m × 1.0 m with raised beds of 20 cm height. Farmyard manure (FYM) at 1 kg/m² was incorporated into the soil during bed preparation and a black polyethylene mulch (30 µm thickness) was used to suppress weeds and conserve soil moisture. The basal application included the full dose of phosphorus and potassium along with half of the nitrogen, while the remaining nitrogen was top-dressed in two equal splits at 30 and 60 days after transplanting.

Plant material

The experimental material consisted of a vegetatively propagated F_1 hybrid cherry tomato (G_2 × G_7) developed by the Department of Vegetable Science. This hybrid exhibited an indeterminate growth habit with red fruits and uniform cluster ripening, suitable for extended harvesting under protected conditions. Side shoots measuring 12–15 cm were collected from healthy stock plants and treated with Indole-3-butyric acid (IBA) at 150 ppm to induce rooting. The treated cuttings were planted in a rooting medium consisting of soil and FYM (1:1) and maintained under mist conditions. Successfully rooted cuttings were transplanted 28 days after planting. The plants were trained using a four-stem system by retaining two primary and two secondary shoots per plant, supported with overhead wires to prevent lodging and ensure balanced canopy growth.

Data Collection

Observations were recorded on growth, yield and quality parameters. Plant height was measured from the base to the apex of the main shoot at 30, 60, 90 and 120 days after transplanting. Earliness parameters such as days to first flowering, days to first fruit maturity

and days to first harvest were also recorded. Yield-contributing parameters including average fruit weight, fruit length and fruit girth were measured using a digital vernier caliper from five randomly selected fruits per plant. The number of clusters per plant and fruits per cluster were counted and yield was expressed as kilograms per plant, kilograms per plot and tonnes per hectare based on the cumulative harvest.

Biochemical and quality parameters were estimated from fully ripened fruits. Total soluble solids (TSS) were determined using a hand-held refractometer (0–32 °Brix). Ascorbic acid content was estimated following the method of Jagota and Dani (1982) using Folin–Ciocalteu reagent and expressed as mg/100 g of fresh weight. Lycopene content was quantified spectrophotometrically at 503 nm following Ranganna (1976) and expressed as mg/100 g fresh weight. Chlorophyll content was measured using Arnon's (1949) method, wherein leaf pigments were extracted in 80% acetone and absorbance was read at 645 and 663 nm using a spectrophotometer.

Data Analysis

Data recorded for all parameters were subjected to analysis of variance (ANOVA) following the method of Gomez and Gomez (1984) for a Randomized Block Design. Statistical analysis was performed using Microsoft Excel. The F-ratio was used to determine the significance of treatment effects and means were compared using the Critical Difference (CD) test at a 5% level of significance. Standard errors of means were calculated for all quantitative parameters to ensure statistical validity and reproducibility of results.

Result and Discussion

Growth Parameters

Different levels of NPK significantly influenced all vegetative growth attributes of cherry tomato plants propagated through side shoot cuttings. Plant height increased progressively with higher nutrient application at all stages of growth (30, 60, 90 and 120 DAT). The maximum plant height was recorded in plants supplied with 125% RDF (T_4) (1.16 m, 2.09 m, 2.71 m and 3.11 m, respectively), followed by those receiving 100% RDF (T_3), whereas the minimum height was observed in the control (T_5). The steady increase in height with increasing NPK levels indicates the synergistic effect of nitrogen, phosphorus and potassium on plant metabolism. Nitrogen stimulates meristematic activity, chlorophyll synthesis and leaf expansion, phosphorus supports energy transfer and root activity and potassium enhances photosynthetic efficiency and water regulation (Marschner, 1995; Ortas, 2013). The abundant supply of these macronutrients under T_4 likely improved nutrient uptake and photosynthate translocation, resulting in vigorous biomass accumulation and overall plant vigor.

Interestingly, although T_5 received the highest level of NPK, it did not produce superior growth. This could be attributed to the excessive nutrient concentration beyond the plant's physiological requirement, which may have led to ionic imbalance, osmotic stress and reduced nutrient uptake efficiency (Gill *et al.*, 2018).

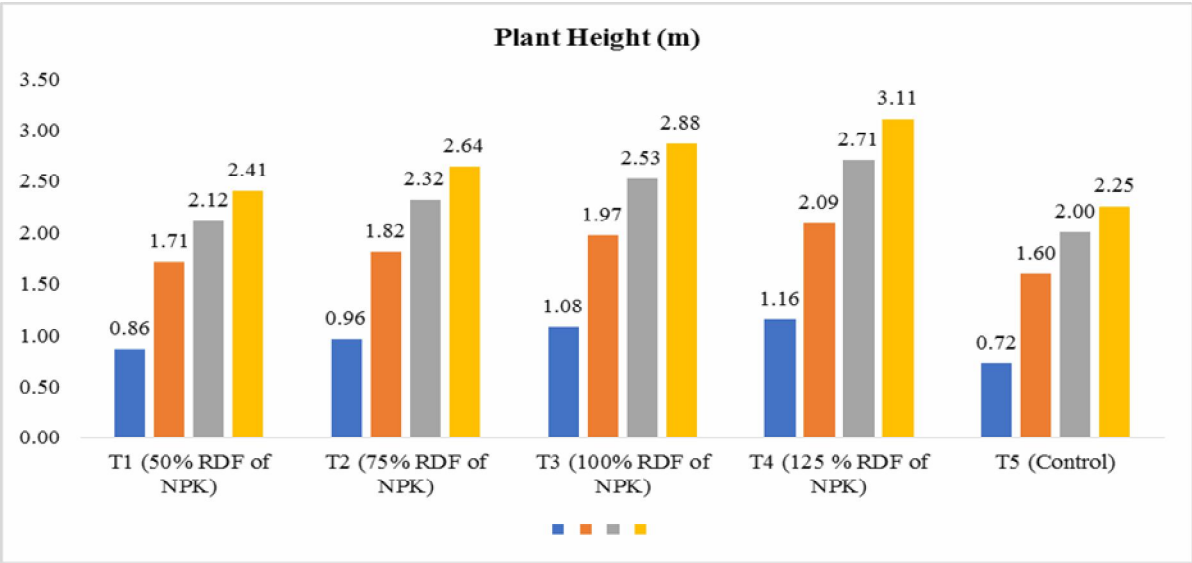

Fig. 1 : Effect of levels of NPK on plant height (m) of cherry tomato at different stages of growth

Earliness Parameters

Nutrient levels had a marked influence on the earliness parameters recorded in this study. Plants treated with 125% RDF (T_4) initiated flowering earliest (18.75 days after transplanting) and reached fruit maturity in the shortest duration (23.25 days after flowering), followed by plants under 100% RDF (T_3). Conversely, delayed flowering (29.00 days) and late fruit maturity (36.50 days) were observed in the control (T_5). Similarly, the earliest fruit harvest was recorded in T_4 (66.13 days after transplanting), followed by T_3 (68.63 days after transplanting), while the control required 84.38 days after transplanting to reach the first harvest. The early transition from vegetative to reproductive stage under higher NPK supply may be attributed to enhanced carbohydrate synthesis and hormonal balance facilitating floral induction and fruit set (Savvas *et al.*, 2008; Damulira *et al.*, 2019). Adequate nutrient availability promotes rapid vegetative growth and accumulation of photo assimilates, which accelerates flowering and fruit development, thus contributing to early yield realization.

Table 1 : Effect of levels of NPK on reproductive parameters of cherry tomato plant

Treatments	Days to first flowering (DAT)	Days to first fruit maturity (DAF)	Days to first fruit harvest	Number of clusters per plant
T_1 (50% RDF of NPK)	24.63	32.63	78.88	18.75
T_2 (75% RDF of NPK)	23.63	29.38	74.88	20.63
T_3 (100% RDF of NPK)	20.63	26.25	68.63	21.50
T_4 (125 % RDF of NPK)	18.75	23.25	66.13	23.25
T_5 (Control)	29.00	36.50	84.38	17.25
$SE_M \pm$	**0.33**	**0.47**	**0.40**	**0.24**
C.D. 5%	**1.19**	**1.71**	**1.45**	**0.86**
C.V. (%)	**2.82**	**3.19**	**1.07**	**2.34**

Yield attributing Parameters

Fruit development characteristics such as fruit weight, fruit length and fruit girth were significantly affected by the levels of NPK. The maximum fruit weight (12.10 g), fruit length (23.62 mm) and fruit girth (22.27 mm) were recorded under T_4, followed by T_3 (11.52 g, 22.10 mm and 20.17 mm, respectively). The smallest fruits were observed in the control (T_5). These results demonstrate that an increased nutrient supply enhances vegetative vigour, which in turn improves the synthesis and translocation of carbohydrates toward developing fruits, leading to superior fruit size and weight (Karcomarczyk *et al.*, 1999). Potassium plays a vital role in improving fruit filling by regulating osmotic balance and carbohydrate transport, thereby enhancing fruit growth and quality.

Table 2 : Effect of levels of NPK on fruit development parameters of cherry tomato

Treatment	Fruit length (mm)	Fruit girth (mm)	Fruit weight $X10^3$ (mg)
T_1 (50% RDF of NPK)	17.57	16.38	9.31
T_2 (75% RDF of NPK)	19.49	17.11	10.10
T_3 (100% RDF of NPK)	22.10	20.17	11.52
T_4 (125 % RDF of NPK)	23.62	22.27	12.10
T_5 (Control)	16.48	15.84	9.05
$SE_M \pm$	**0.27**	**0.14**	**0.44**
C.D. 5%	**0.98**	**0.50**	**1.58**
C.V. (%)	**2.73**	**1.50**	**0.84**

The number of clusters per plant, fruits per cluster and yield per plant were also significantly influenced by NPK levels. The highest number of clusters (23.25) and fruits per cluster (9.75) were recorded in T_4, which consequently produced the maximum yield of 2.76 kg per plant, 27.60 kg per plot and 61.33 t/ha. These were followed by T_3 (2.32 kg per plant and 51.48 t/ha). The lowest yield (1.30 kg per plant, 28.89 t/ha) was observed in the control. The increase in yield under T_4 may be ascribed to improved nutrient uptake efficiency, higher photosynthetic activity and enhanced assimilate partitioning to reproductive sinks (Rasool *et al.*, 2007). The results clearly indicate that moderate enrichment of nutrient supply beyond the

recommended level (125% RDF) supports the vigorous growth and productive potential of vegetatively propagated hybrid cherry tomato plants.

Even though T_5 had the highest NPK concentration, yield declined compared to T_4. This reduction may be due to nutrient antagonism and physiological imbalance, particularly reduced uptake of calcium and magnesium in the presence of excess potassium and nitrogen. High nutrient levels may also increase vegetative growth at the cost of fruit set and retention, resulting in fewer harvestable fruits. Similar findings were reported by Rasool *et al.* (2007), who noted that excessive fertilization often lowers yield efficiency despite high nutrient availability.

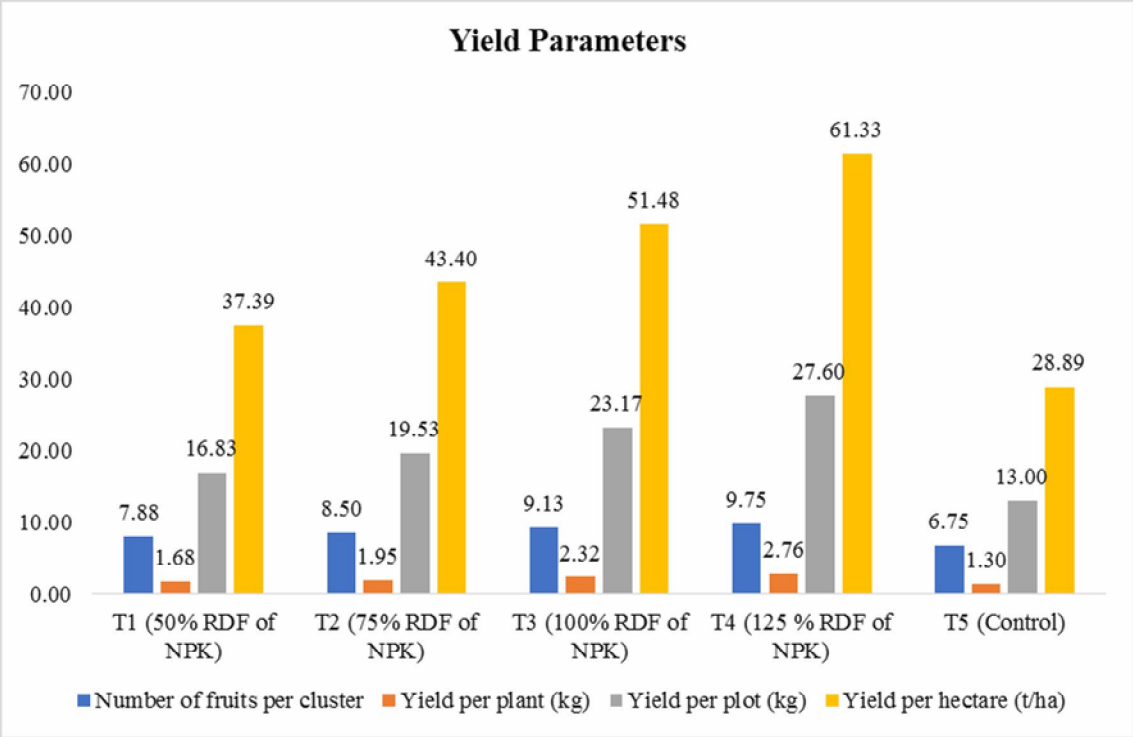

Fig. 2 : Effect of levels of NPK on yield parameters of cherry tomato

Quality Parameters

Fruit quality attributes such as total soluble solids (TSS), ascorbic acid, lycopene and chlorophyll content were significantly affected by NPK levels. The maximum TSS (8.79 °Brix) was obtained under 125% RDF (T_4), followed by 100% RDF (T_3) (8.55 °Brix). Potassium plays an essential role in carbohydrate metabolism and sugar translocation, leading to enhanced sweetness and improved flavor in fruits (Gill *et al.*, 2018). Similarly, ascorbic acid content was highest in T_4 (56.04 mg/100 g), followed by T_3 (54.49 mg/100 g). Adequate macronutrient availability enhances carbohydrate assimilation, which supports ascorbic acid synthesis and antioxidant activity (Duraisami and Mani, 2002).

Table 3 : Effect of levels of NPK on quality parameters of cherry tomato

Treatment	Lycopene (mg/100g)	TSS (°Brix)	Ascorbic acid (mg/100g)
T_1 (50% RDF of NPK)	5.62	7.69	49.54
T_2 (75% RDF of NPK)	6.12	8.21	51.66
T_3 (100% RDF of NPK)	6.30	8.55	54.49
T_4 (125 % RDF of NPK)	6.68	8.79	56.04
T_5 (Control)	4.82	7.35	45.91
$SE_M \pm$	**0.04**	**0.06**	**0.43**
C.D. 5%	**0.13**	**0.20**	**1.57**
C.V. (%)	**1.25**	**1.38**	**1.68**

Lycopene content also increased significantly with nutrient enrichment, with the highest value observed in T_4 (6.68 mg/100 g), followed by T_3 (6.30 mg/100 g). Nitrogen facilitates the synthesis of enzymes involved in the isoprenoid pathway, while potassium enhances pigment biosynthesis and accumulation (De Pascale *et al.*, 2008; Fanasca *et al.*, 2006). Likewise, chlorophyll a (2.70 mg/g), chlorophyll b (2.03 mg/g) and total chlorophyll (4.73 mg/g) were highest under T_4, followed by T_3. Enhanced chlorophyll biosynthesis with higher nutrient levels may be due to nitrogen's role as a constituent of the chlorophyll molecule and phosphorus's involvement in energy transfer during photosynthesis (Nassar *et al.*, 2005). Higher chlorophyll levels ensure efficient light interception and photosynthetic activity, contributing to overall plant productivity.

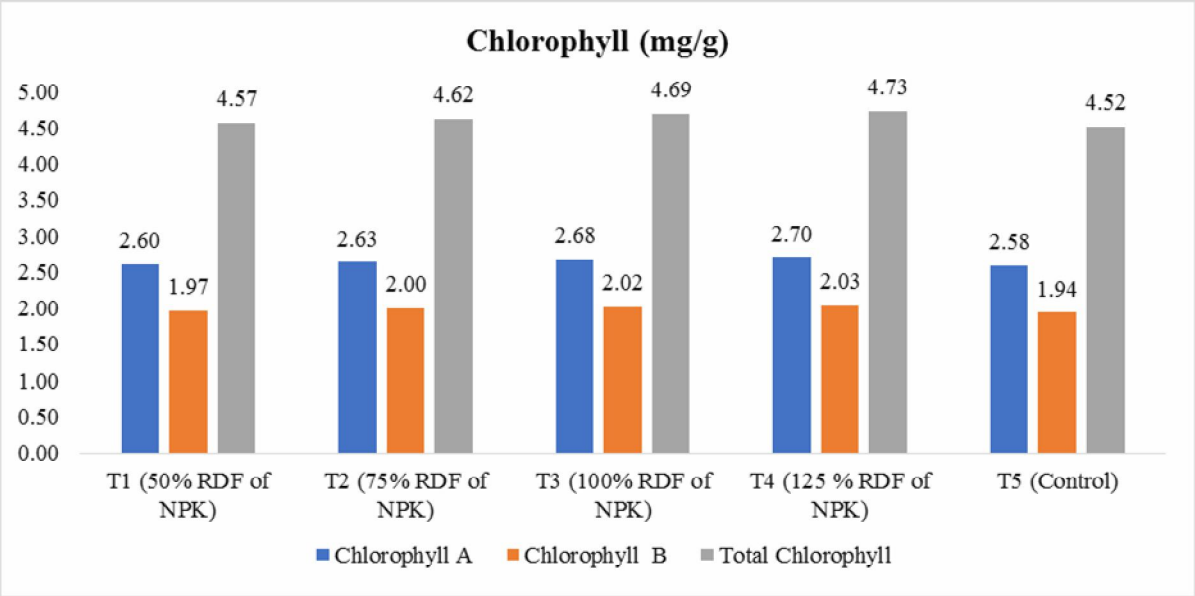

Fig. 3 : Effect of levels of NPK on chlorophyll content of vegetatively propagated cherry tomato leaves

Conclusion

The study demonstrated that vegetatively propagated hybrid cherry tomato plants responded positively to higher NPK levels, showing significant improvements in vegetative growth, earliness, yield and fruit quality. The application of 125% RDF (T_4) produced the most favourable results across all parameters, reflecting the higher nutrient demand of clonally propagated hybrid plants due to their vigorous growth nature. This treatment ensured balanced vegetative and reproductive growth, early flowering and harvest and enhanced fruit quality through improved biochemical composition. Thus, applying 125% of the recommended dose of NPK can be advocated for optimal performance and higher profitability in vegetatively propagated hybrid cherry tomato cultivation.

References

Arnon, D. (1949). Copper enzymes isolated chloroplasts, polyphenol oxidase in *Beta vulgaris*. *Plant Phy*., **24**, 1-15.

Birchler, J.A., Yao, H. and Chudalayandi, S. (2006). Unraveling the genetic basis of hybrid vigor. *Proc. Natl. Acad. Sci.*, **103**(35), 12957-12958

Damulira, G., Idd, R., Namazzi, S., Kalali, F., Mundingotto, J., and Maphosa, M. (2019). Nitrogen and potassium fertilizers increase cherry tomato height and yield. *J. Agric. Sci.*, **11**(13), 48 – 55.

De Pascale, S., Tamburrino, R., Maggio, A., Barbieri, G., Fogliano, V. and Pernice R. (2008). Effects of nitrogen fertilization on the nutritional value of organically and conventionally grown tomatoes. *Acta Hortic.*, **700**, 107-110.

Duraisami, V. P. and Mani, A. K. (2002). Effects of major nutrients on yield and fruit quality of tomato under rainfed condition in Entisol. *South Indian Hortic.*, **50**(1-3), 56-60.

Fanasca, S., Colla, G., Maiani, G., Venneria, E., Rouphael, Y., Azzini, E. and Saccardo, F. (2006). Changes in antioxidant content of tomato fruits in response to cultivar and nutrient solution composition. *J. Agric. Food Chem.*, **54**, 4319-4325.

Gill, N. S., Verma, M. L. and Sharma, J. C. (2018). Response of NPK fertilization on yield and quality of cherry tomato. *Int. J. Chem. Stud.*, **6**(3), 2047-2051

Gomez, A.K. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd Edn. Wiley India Private Limited, New Delhi, 134-138.

Gould, W. (1983). Tomato juice manufacture. In Tomato Production, Processing and Quality Evaluation, 2nd edn. *AVl Pub. Co., Inc*., Westport, CT. p. 150.

Jagota, S. K. and Dani, H. M. A. (1982). New Colorimetric Techniques for the Estimation of Vitamin C using Folin Phenol reagent. *Anal Biochem.*, **127**, 178-182.

Karcomarczyk, S., Rakowski, D., Koszonski, Z. and Podsiado, C. (1999). Activity of some physiological processes and yield of spring wheat and trilicale as effect of supplemental irrigation and fertilization. *Folia. Univ. Agric. Stetin.*, **73**, 53-64.

Nassar, K. E, El-Rasoul, A. S. M. and El-Shebiny, G. M. (2005). Effect of foliar spraying with phosphorus and potassium on faba bean plant under calcareous soil conditions. *Menufiya J. Agric. Res.*, **30**, 1625-1637.

Ranganna, S. (1976). Handbook of analysis and quality control for fruits and vegetable products. 2nd Edn. Tata Mc. Graw Hill Pulishing Co. Ltd. New Delhi. pp. 545.

Rasool, R., Kukal, S. S. and Hira, G. S. (2007). Soil physical fertility and crop performance as affected by long term application of FYM and inorganic fertilizers in rice–wheat system. *Soil Tillage Res*., **96**, 64-72.

Richharia, R. (1962) Clonal Propagation as a Practical Means of Exploiting Hybrid Vigour in Rice. *Nature*, **194**, 598.

Savvas, D., Ntatsi, G. and Passam, H. C. (2008). Plant Nutrition and Physiological Disorders in Greenhouse-Grown Tomato, Pepper, and Egg plant. *Eur. J. Plant Sci. Biotechnol.*, **2**, 45-61.

Singh, K. and Kumar, S. (1969). Effect of nitrogen and phosphorous fertilization on the growth and yield of onion (*Allium cepa* L). *J. Res. Ludhiana*, **6**, 764-768.