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RESEARCH ARTICLE

Morpho-quality response of tomato (*Solanum lycopersicum* L.) fruits to preharvest iodine applications

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Abstract

Tomato is a nutritionally rich vegetable crop and is valued for its economic importance. It is one of the most widely cultivated vegetable crops globally after the potato. Despite its importance, tomato yield and quality are frequently constrained by hidden micronutrient deficiencies, as reported under diverse soil and agro-climatic conditions. The present investigation was conducted for two consecutive years to evaluate iodine application using two sources, potassium iodide (KI) and potassium iodate (KIO_3), through soil, foliar spray, seed priming, and their combinations. The experiment comprised nine treatments laid out in a randomized complete block design (RCBD) with three replications. Key parameters related to fruit morphology and quality attributes were measured to determine the efficacy. Integrated and foliar applications of KI, particularly T_8 (SP+SA+FA) and T_4 (FA), significantly enhanced fruit size (polar diameter up to 6.15 cm) and fruit weight per plant (1.89 kg). Quality traits, such as ascorbic acid content (29.40 mg/100 mL), TSS (5.51°Brix) and dry matter content (6.63%) were also markedly improved. Correlation analysis showed strong positive linkages between fruit size traits (polar and equatorial diameter, average fruit weight), yield and key quality attributes (ascorbic acid, TSS and dry matter), with PCA identifying these traits as major contributors to treatment variability. Although structural traits such as locules and seed number showed weaker correlations, the overall findings support the use of foliar KI @ 0.5 mg/l as an efficient, economical and practical approach for improving tomato fruit quality and physiological performance in North-Indian conditions.

Keywords: Ascorbic acid; Foliar application; Iodine; Tomato; Total soluble solids; Yield traits.

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Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most widely grown solanaceous vegetables worldwide, second only to potato in area and production. It holds significant economic and nutritional importance, being a rich source of vitamins (A and C), minerals and health-promoting phytochemicals such as lycopene, beta-carotene and other carotenoids that help prevent cancer and degenerative disorders (Collins et al., 2022; Kiferle et al., 2013). In India, tomato is cultivated on 852.54 thousand hectares, producing 21.55 million tonnes with an average productivity of 25.28 MT/ha. In Punjab, tomato is cultivated on 11.17 thousand hectares with a total production of 293.92 thousand tonnes and productivity of 26.32 MT/ha. However, despite its widespread cultivation and market potential, tomato productivity and fruit quality are often compromised due to suboptimal nutrient management and environmental challenges (Indiastat, 2025).

Among emerging micronutrient interventions, iodine has attracted research interest due to its multifaceted role in plant growth and its critical importance in human nutrition. Iodine is not officially classified as an essential element for plants, yet it is considered beneficial because of its regulatory effects on physiological and reproductive processes, including antioxidant enzyme activation, flowering stimulation, and biomass accumulation in various crops (Kiferle et al., 2021). More importantly, iodine deficiency remains a major public health concern, particularly in developing countries such as India, where an estimated 200 million people are at risk of iodine deficiency disorders (IDDs) and 71 million individuals suffer from clinical manifestations including goitre, impaired neuro-development and reduced cognitive performance (Riyazuddin et al., 2023; Kaur et al., 2017). Recognizing iodine's dual relevance agronomically for plant response and nutritionally for its societal importance, this study was designed to evaluate its influence on tomato crop performance (Medrano-Macías et al., 2016; Zhang et al., 2023). Potassium iodide (KI) and potassium iodate (KIO_3), the two major sources of iodine, can be delivered via diverse methods such as soil application, foliar spray, and seed priming (Gonzali et al., 2017; Ikram et al., 2025; Nakachew et al., 2024). These delivery modes differ in efficiency, plant uptake pathways and cost-effectiveness. While earlier studies have explored iodine's impact on vegetative growth or stress physiology, there is limited systematic research on its effects on tomato fruit morphology, yield attributes and quality parameters under Indian agro-climatic conditions (Smith et al., 2018).

Therefore, the present investigation was undertaken over two consecutive years to evaluate the role of iodine in tomato performance. A two-year investigation was conducted using potassium iodide (KI) and potassium iodate (KIO_3) through varied application strategies since your study emphasizes fruit morphological, structural and quality traits in tomato.

Material and Methods

The experiment consisted tomato variety «Punjab Ratta» applied with nine treatments involving two iodine sources, potassium iodide (KI) and potassium iodate (KIO_3), applied through different methods and concentrations as shown in Table 1. Seed priming was done by soaking tomato seeds in a 0.5 mg/l solution of the respective iodine salt for 12 hours, followed by drying to the original moisture content before sowing. Soil applications were given at transplanting by broadcasting the respective salt at 1 Kg/acre. Foliar sprays (0.1 g/l) were applied twice at 30 and 45 days after transplanting (DAT). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications across two consecutive years, 2022-23 and 2023-24.

Yield attributes

Polar and equatorial diameters of fruit were measured using five healthy, mature and ripe fruits from plants of each replication with a vernier caliper. Polar diameter was recorded from the base (calyx end) to the fruit apex, while equatorial diameter was measured across the widest portion of the same fruit. Measurements were replicated for five fruits per plant to derive an average value. The number of locules was determined by transversely slicing mature fruits at the equatorial region and counting the distinct seed-containing chambers. Pericarp thickness was measured on transverse sectioning using a vernier caliper at multiple points around the pericarp. The number of seeds per fruit was recorded by careful extraction, cleaning, drying and manual counting. Average fruit weight was recorded by weighing five randomly selected fruits per treatment individually and calculating the mean. The number of fruits per plant was recorded by counting all matured fruits harvested from five selected plants in each plot. Fruit weight per plant was determined by harvesting and weighing all mature fruits from five selected plants and the mean values were used for statistical analysis.

Quality attributes

Quality attributes of tomato fruits were analyzed using standardized analytical methods. Ascorbic acid (mg/100 mL) was quantified following the AOAC protocol as outlined by U'stiin Ozgiir & Sungur, 1995, using a dye titration method. Titrable acidity (%) was measured by a titrimetric method using standardized sodium hydroxide with phenolphthalein as an indicator according to Srivastava & Srivastava (2015) and expressed as anhydrous citric acid. Total soluble solids (°Brix) were assessed at the red ripe stage from randomly selected fruits using a hand refractometer under ambient conditions. Dry matter content (%) was estimated by the oven-drying method as described by Srivastava & Srivastava (2015).

Statistical analysis

The data were subjected to Analysis of Variance (ANOVA) using R software. Treatment means were compared using least significant difference (LSD) at 5% level of significance.

Table 1: Details of iodine treatments with different sources, doses and method of application in tomato

Treatment	*Source*	*Dose*	*Method of application*
T_1	Control	--	----
T_2	KI	1 kg /acre	Soil application (SA)
T_3	KIO_3	1 kg /acre	Soil application (SA)
T_4	KI	0.1 g/l	Foliar application (FA)
T_5	KIO_3	0.1 g/l	Foliar application (FA)
T_6	KI	0.5 mg/l	Seed priming (SP)
T_7	KIO_3	0.5 mg/l	Seed priming (SP)
T_8	$T_2+T_4+T_6$ (KI)	1 kg/acre + 0.1 g/l + 0.5 mg/l	SA+FA+SP
T_9	$T_3+T_5+T_7$ (KIO_3)	1 kg/acre + 0.1 g/l + 0.5 mg/l	SA+FA+SP

Where, KI is Potassium Iodate and KIO_3 is Potassium Iodide

Table 2: Effect of iodine treatments on fruit morphological traits (mean values across 2022–23 and 2023–24)

S. No.	*Polar diameter (cm)*	*Equatorial diameter (cm)*	*Number of locules*	*Number of seeds/fruit*
T_1	4.52 ± 0.14^{c}	3.27 ± 0.07^{d}	2.67 ± 0.17^{a}	96.42 ± 2.47^{a}
T_2	4.96 ± 0.22^{bc}	3.54 ± 0.06^{c}	2.50 ± 0.58^{a}	109.15 ± 6.93^{a}
T_3	4.98 ± 0.18^{bc}	3.58 ± 0.06^{c}	2.17 ± 0.17^{a}	102.45 ± 6.10^{a}
T_4	6.10 ± 0.11^{a}	4.13 ± 0.05^{ab}	2.67 ± 0.44^{a}	111.73 ± 9.95^{a}
T_5	6.06 ± 0.06^{a}	4.10 ± 0.04^{b}	2.33 ± 0.17^{a}	101.98 ± 6.49^{a}
T_6	5.03 ± 0.32^{bc}	3.61 ± 0.09^{c}	2.33 ± 0.33^{a}	97.65 ± 6.80^{a}
T_7	5.01 ± 0.04^{bc}	3.60 ± 0.17^{c}	3.00 ± 0.00^{a}	99.12 ± 10.16^{a}
T_8	6.15 ± 0.10^{a}	4.13 ± 0.09^{ab}	2.50 ± 0.00^{a}	102.29 ± 11.00^{a}
T_9	5.39 ± 0.34^{b}	4.35 ± 0.14^{a}	2.33 ± 0.17^{a}	105.45 ± 8.10^{a}
LSD ($p \leq 0.05$)	0.59	0.24	NS	NS
CV (%)	6.32	3.64	13.83	11.76

Results

Fruit morphology

Polar diameter (cm)

As presented in Table 2, the pooled data revealed that T_8 (KI, SP+SA+FA) recorded the maximum polar diameter (6.15 cm), followed by T_4 at 6.10 cm and T_5 (KIO_3, FA) at 6.06 cm. These treatments were statistically at par with each other, indicating a strong effect of foliar and combined iodine applications in enhancing fruit elongation. The control (T_1) exhibited the lowest value (4.52 cm), significantly lower than all treatments at the 5% level of significance.

Equatorial diameter (cm)

The highest equatorial diameter was observed in T_9 (KIO_3, SP+SA+FA) at 4.35 cm, followed by T_4 (KI, FA) and T_8 (KI, SP+SA+FA), both around 4.13 cm (Table 2). These values were statistically similar and suggest that foliar and integrated approaches enhanced lateral fruit expansion. The control (T_1) consistently remained the lowest (3.27 cm), showing the positive role of iodine treatments.

Number of locules

Variation in locule number was minimal across treatments with no significant differences (Table 2). However, numerically T_7 (KIO_3, SP) recorded the highest locules (3.00), whereas T_3 (KIO_3, SA) showed the lowest (2.17), suggesting developmental influence rather than a treatment effect.

Number of seeds per fruit

Although the differences were not statistically significant, the number of seeds per fruit exhibited notable trends withT_4 (KI, FA) recording the highest value (111.73) and the control (T_1) recording the lowest value (111.73) and the control. Foliar treatments, particularly with KI, appeared to enhance seed set during both years.

Yield traits

Fruit weight per plant (kg)

As evident from Table 3, the highest fruit weight per plant was observed in T_8 (KI, SP+SA+FA) at 1.89 kg, followed by T_9 (KIO_3, SP+SA+FA) and T_4 (KI, FA). These increases were substantial, with T_8 showing a 12.5% gain over the control. However, statistical differences among treatments were non-significant, reflecting uniform performance across iodine treatments. The temporal trend was consistent during both years.

Average fruit weight (g)

T_8 (KI, SP+SA+FA) again outperformed all other treatments recorded with the highest average fruit weight of 78.62 g. In contrast, T_1 (Control) recorded the lowest (71.81 g), as shown in Table 3. Though the difference was statistically at par, the

Table 3: Effect of iodine treatments on fruit production metrices per plant in tomato (mean values across 2022–23 and 2023–24)

S. No.	*Fruit weight/ plant (kg)*	*Number of fruits/ plant*	*Average fruit weight (g)*
T_1	1.68 ± 0.01^{a}	20.52 ± 1.02^{c}	71.81 ± 2.25^{a}
T_2	1.70 ± 0.05^{a}	24.20 ± 0.58^{b}	73.07 ± 1.44^{a}
T_3	1.71 ± 0.02^{a}	24.73 ± 0.48^{ab}	73.38 ± 4.48^{a}
T_4	1.81 ± 0.03^{a}	24.54 ± 0.43^{ab}	77.31 ± 1.69^{a}
T_5	1.76 ± 0.03^{a}	24.11 ± 0.21^{b}	75.28 ± 5.03^{a}
T_6	1.70 ± 0.05^{a}	25.01 ± 0.24^{ab}	74.29 ± 3.60^{a}
T_7	1.69 ± 0.04^{a}	24.88 ± 0.68^{ab}	74.02 ± 1.85^{a}
T_8	1.89 ± 0.08^{a}	25.71 ± 0.65^{a}	78.62 ± 3.40^{a}
T_9	1.86 ± 0.05^{a}	25.35 ± 0.09^{ab}	78.16 ± 3.17^{a}
LSD ($p \leq 0.05$)	NS	1.69	NS
CV (%)	4.57	3.45	7.25

trend emphasizes the cumulative benefit of foliar application of iodine alone in improving fruit size.

Number of fruits per plant

A clear and consistent trend emerged from the pooled data where T_8 (KI, SP+SA+FA) showed the highest number of fruits per plant (25.71) followed by T_9 (KIO_3, SP+SA+FA), T_6 (KI, SP), T_7 (KIO_3, SP), T_3 (KIO_3, SA) and T_4 (KI, FA) represented in Table 3. All these treatments were significantly better than the control (T_1, 20.52), highlighting the positive impact of foliar strategies of iodine application on fruit set. Variations in the magnitude of fruit number reflect seasonal environmental influences, while the consistent treatment ranking confirms the stability of iodine treatment effects.

Quality traits

Ascorbic acid (mg/100 mL juice)

Table 4 shows that T_8 (KI, SP+SA+FA) recorded the highest ascorbic acid content (29.40 mg/100 mL), which was significantly higher than all of the other treatments except T_4 (KI, FA) (28.51 mg/100 mL). The control (T_1) was the lowest at 20.94 mg/100 mL. These results underline the synergistic benefit of foliar application of iodine alone on antioxidant accumulation.

Titrable acidity (%)

Treatment T_8 (0.87%) and T_9 (0.86%) exhibited the highest acidity, followed by T4 (0.84%) (Table 4). These treatments were statistically at par with each other and significantly higher than T_1 (0.65%). The results suggest a positive modulation of organic acid metabolism through iodine application, especially in foliar application alone and in combined forms.

Total soluble solids (°Brix)

TSS values showed an increasing trend with iodine treatments. T_8 (KI, SP+SA+FA) recorded the maximum °Brix value (5.51), followed by T_4 (5.44) and T_5 (5.39), all significantly superior to the control (4.86 °Brix) (Table 4). This suggests enhanced sugar synthesis and accumulation under KI treatments, particularly when applied as a foliar spray or in combination.

Pericarp thickness (mm)

Interestingly, the control (T_1) had the thickest pericarp (6.92 mm), significantly higher than all other iodine-treated plants (Table 4). This inverse trend may indicate a dilution effect due to higher fruit expansion or possible structural changes under iodine treatments.

Dry matter content (%)

The highest dry matter was observed in T_8 (KI, SP+SA+FA) (6.63%), followed by T_9 (KIO_3, SP+SA+FA) (6.20%) (Table 4). These were statistically at par with each other but significantly higher than the control (T_1, 5.41%) and T_2 (KI, SA, 5.53%). The integrated application strategy (T_8) thus proved most effective in enhancing dry matter accumulation.

Correlation matrix highlights trait synergies and quality trade-offs in iodine-treated tomato

The correlation matrix, as shown in Figure 1 revealed that strong positive associations among fruit size traits, polar diameter, equatorial diameter and average fruit weight, with coefficients ranging from 0.97 to 0.99 (***), indicating that these parameters increase in tandem. This coordinated increase reflects synchronized cell expansion and enhanced sink strength during fruit development (Bertin and Génard, 2018). These traits also showed significant positive correlations with the number of fruits per plant and fruit weight per plant (r = 0.79–1.00 ***), highlighting their collective contribution to yield. Ascorbic acid, titrable acidity, TSS and dry matter showed strong correlations with fruit as well as other quality traits (r = 0.97-0.99 ***), suggesting improved fruit quality alongside growth. This relationship

Table 4: Effect of iodine treatments on biochemical and physical quality traits of fruit in tomato (mean values across 2022–23 and 2023–24)

S. No.	*Ascorbic acid (mg/100 ml juice)*	*Titrable acidity (%)*	*TSS (°Brix)*	*Pericarp thickness (mm)*	*Dry matter (%)*
T_1	20.94 ± 0.35^{e}	0.65 ± 0.01^{f}	4.86 ± 0.01^{c}	6.92 ± 0.05^{a}	5.41 ± 0.65^{bc}
T_2	25.37 ± 0.06^{c}	0.72 ± 0.01^{e}	4.96 ± 0.20^{c}	5.99 ± 0.33^{b}	5.53 ± 0.22^{bc}
T_3	25.96 ± 0.45^{c}	0.75 ± 0.00^{cd}	4.98 ± 0.04^{c}	5.92 ± 0.33^{b}	5.62 ± 0.55^{abc}
T_4	28.51 ± 0.50^{ab}	0.84 ± 0.01^{a}	5.44 ± 0.01^{ab}	5.47 ± 0.09^{b}	6.57 ± 0.31^{ab}
T_5	27.48 ± 0.60^{b}	0.78 ± 0.01^{b}	5.39 ± 0.02^{ab}	5.53 ± 0.35^{b}	6.45 ± 0.55^{ab}
T_6	25.01 ± 0.04^{cd}	0.77 ± 0.01^{bc}	5.06 ± 0.03^{c}	5.85 ± 0.06^{b}	5.73 ± 0.34^{abc}
T_7	24.17 ± 0.08^{d}	0.73 ± 0.00^{de}	5.01 ± 0.03^{c}	5.91 ± 0.34^{b}	5.64 ± 0.47^{abc}
T_8	29.40 ± 0.63^{a}	0.87 ± 0.01^{a}	5.51 ± 0.13^{a}	5.41 ± 0.41^{b}	6.63 ± 0.41^{a}
T_9	27.48 ± 0.33^{b}	0.86 ± 0.00^{a}	5.07 ± 0.01^{c}	5.69 ± 0.11^{b}	6.20 ± 0.19^{ab}
LSD ($p \leq 0.05$)	1.40	0.04	0.25	0.78	1.05
CV (%)	2.00	1.46	2.16	5.21	6.08

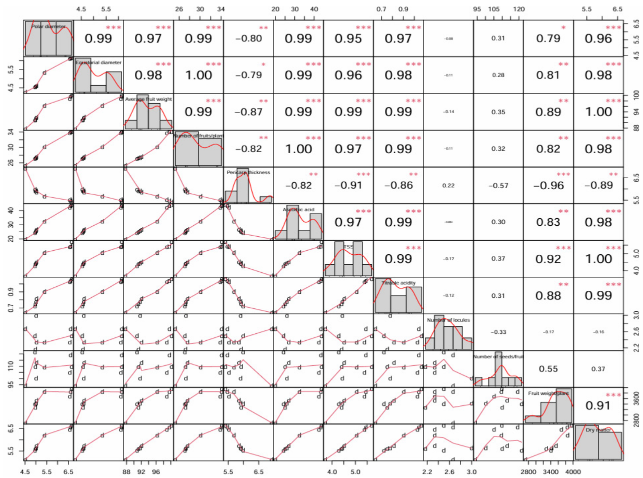


Figure 1: Pearson correlation matrix of growth, yield and phenological traits in tomato under different treatment

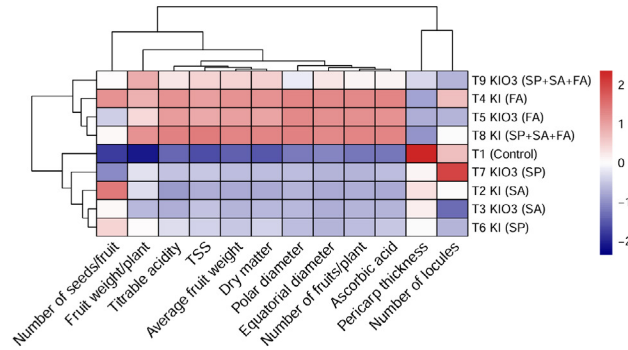


Figure 2: Heatmap of growth and yield traits in tomato across different treatments

indicates enhanced metabolic activity, carbohydrate accumulation and organic acid biosynthesis accompanying fruit enlargement.

In contrast, the number of locules, pericarp thickness and number of seeds per fruit showed weak or negative correlations with major traits, indicating an inverse trend. These negative associations may reflect a trade-off between internal structural traits and fruit enlargement, where greater compartmentalization or seed load limits resource allocation toward pericarp expansion and quality metabolite accumulation (Dariva et al., 2021). The effect of different treatments on various traits is also depicted through a colour gradient in a heat map (Figure 2)

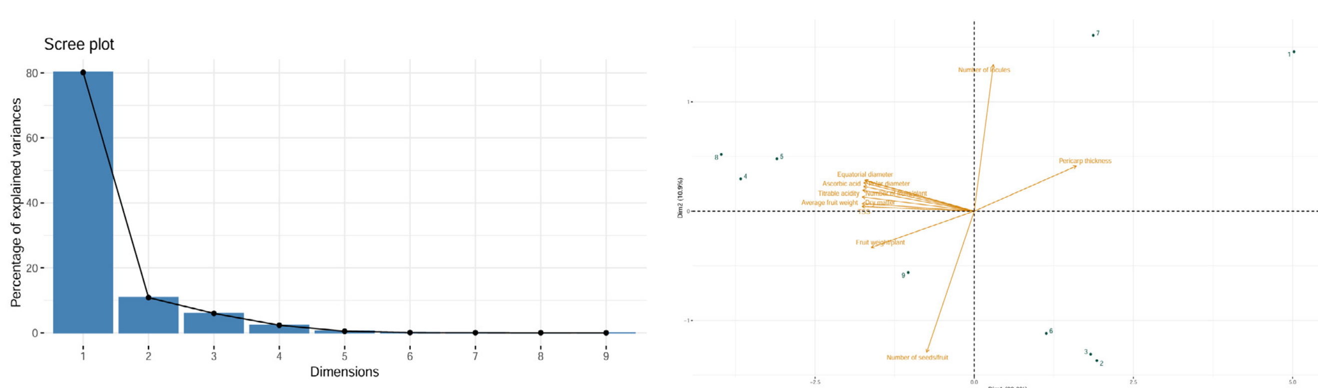
PCA reveals major trait contributors to variance in tomato under iodine treatments

The PCA biplot showed that PC1 and PC2 together explain 91.1% of the total variance, with PC1 (80.2%) capturing most of the variability (Figure 3). Prior to PCA, all variables were standardized (mean-centered and scaled to unit variance) to account for differences in measurement units. Traits like polar diameter, equatorial diameter, average fruit weight, ascorbic acid and titrable acidity strongly load on PC1 (loading values > 0.70). This indicates a close association with fruit size and quality. Pericarp thickness and number of locules show moderate alignment (0.40–0.70) with these traits, while fruit weight per plant and number of seeds per fruit are more closely associated with PC2, showing their diverse influence on yield-related variability. We can conclude that fruit morphology and quality traits govern treatment variation, contributing independently.

Discussion

Fruit morphology

Increase in polar and equatorial diameters under foliar and combined iodine treatments may be due to iodine helps in cell expansion and hormonal regulation (Kiferle et al., 2021). Iodine is reported to influence auxin and gibberellin pathways, which are crucial in ovary development and fruit enlargement (Jong et al., 2009). Moreover, improved nutrient translocation and better photosynthates accumulation under iodine treatments further support fruit filling stages. The increase in the number of seeds per fruit could be a result of improved floral organ development and fertilization



Scree plot PCA biplot

Figure 3: Principal component analysis of growth and yield attributes in tomato: Scree plot and biplot

efficiency under balanced iodine nutrition (Chu et al., 2019). Similar results of iodine on reproductive growth and fruit structural parameters have been reported by Blasco et al. (2008) and Smolen et al. (2019), who observed enhancement in tomato fruit set and morphological characters with iodine fertilization. Landini et al. (2011) also emphasized the significance of iodine in promoting organ differentiation in higher plants.

Fruit traits

Fruit-related parameters such as fruit weight per plant, number of fruits per plant and average fruit weight showed marked improvement with respect to foliar and integrated iodine treatments. This may be attributed to enhanced carbon assimilation and improved source-sink dynamics resulting from iodine-induced photosynthetic activity (Lawson et al. 2015). Iodine may promote better flower retention and fruit development through modulation of oxidative stress and hormone levels. These physiological mechanisms have been supported by Halka et al. (2018); Somma et al. (2024). Moreover, the synergistic effect observed under integrated application (soil + foliar + seed priming) might reflect the combined action of enhanced photosynthetic carbon assimilation and improved oxidative stress regulation.

Fruit quality

Quality traits, including ascorbic acid content, titrable acidity, TSS, pericarp thickness and dry matter content, also showed a positive aspect towards iodine treatments. Increased ascorbic acid levels can be linked to iodine in relation to antioxidant metabolism, as previously reported by Blasco et al. (2008) and Ortega-Ramirez et al. (2025), who found elevated vitamin C levels in iodine-enriched tomato. Higher TSS and acidity may result from upregulation of sugar metabolism and organic acid biosynthesis under iodine treatments due to mild metabolic stress, which enhances flavour-related compounds. The reduction in pericarp thickness under certain treatments could be attributed to the fruit expansion, resulting in a dilution effect in the outer wall (Lindstrom et al., 2007). Meanwhile, higher dry matter content under integrated and foliar treatments suggests improved photosynthetic carbon assimilation and improved source-sink portioning, which results in greater accumulation of carbohydrates and nutrients in fruits. In addition, iodine-mediated redox balance may reduce stress-related respiratory losses, thereby promoting more efficient retention of assimilates and improved fruit quality (Halka et al. 2018; Kiferle et al. 2021; Smolen et al. 2019).

Conclusion

The present study clearly demonstrated that iodine application, particularly through integrated (SP+SA+FA) and foliar application using potassium iodide (KI), significantly enhanced tomato fruit morphology, yield contributing and quality parameters under North-Indian conditions characterized by sandy loam soils. Treatments such as T8 (KI, SP+SA+FA) and T4 (KI, FA) consistently showed marked improvements across most traits as compared to the control. These further suggest that iodine positively influences not only fruit development (polar and equatorial diameter, average fruit weight) but also biochemical composition (ascorbic acid, titratable acidity, TSS and dry matter) and marketable quality of tomato. While some traits, like locule number and seed count, exhibited non-significant variation. This shows the overall consistent enhancement across most parameters underscores the beneficial role of iodine in tomato cultivation. However, KI also stood out as a cost-effective and practical approach for farmers and offering ease of adoption. Therefore, it may be suggested as a viable iodine application practice in tomato cultivation under diverse growing conditions. Future research should focus on optimizing iodine application across different soil types and climatic conditions, assessing long-term impacts on soil health and evaluating the bioavailability of iodine in fruits to strengthen recommendations for sustainable iodine biofortification.

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सारांश

टमाटर (*Solanum lycopersicum L.*) एक पोषण-समृद्ध एवं आर्थिक दृष्टि से महत्वपूर्ण सब्जी फसल है, जो आलू के बाद विश्व में सर्वाधिक उगाई जाने वाली सब्जी फसलों में से एक है तथा वर्ष 2023 में इसका वैश्विक उत्पादन लगभग 190 मिलियन टन दर्ज किया गया है। अपने महत्व के बावजूद, विभिन्न मृदा एवं कृषि-जलवायु परिस्थितियों में सूक्ष्म पोषक तत्वों की छिपी हुई कमी के कारण टमाटर की उपज एवं गुणवत्ता प्रायः प्रभावित होती है। इसी परिप्रेक्ष्य में प्रस्तुत अध्ययन दो लगातार वर्षों तक किया गया, जिसमें आयोडीन के दो स्रोतों— पोटैशियम आयोडाइड (KI) एवं पोटैशियम आयोडेट (KIO_3)—का मृदा अनुप्रयोग, पर्णीय छिड़काव, बीज प्राइमिंग तथा इनके संयोजनों के माध्यम से टमाटर पर प्रभाव का मूल्यांकन किया गया। प्रयोग में कुल नौ उपचारों को यादृच्छिक पूर्ण खण्ड अभिकल्प (RCBD) में तीन पुनरावृत्तियों के साथ व्यवस्थित किया गया। उपचारों की प्रभावशीलता का आकलन करने हेतु फलों की आकृतिक विशेषताओं एवं गुणवत्ता संबंधी मापदण्डों का अध्ययन किया गया। परिणामों से यह स्पष्ट हुआ कि KI के एकीकृत तथा पर्णीय अनुप्रयोग, विशेषकर T_8 (बीज प्राइमिंग + मृदा अनुप्रयोग + पर्णीय छिड़काव) एवं T_4 (केवल पर्णीय छिड़काव), ने फलों के आकार (ध्रुवीय व्यास अधिकतम 6.15 सेमी) एवं प्रति पौधा फल भार (1.89 किग्रा) में उल्लेखनीय वृद्धि की। इसी प्रकार, गुणवत्ता लक्षणों जैसे एस्कॉर्बिक अम्ल की मात्रा (29.40 मि.ग्रा./100 मि.ली.), कुल घुलनशील ठोस (5.51°ब्रिक्स) एवं शुष्क पदार्थ प्रतिशत (6.63%) में भी इन उपचारों के अंतर्गत स्पष्ट सुधार दर्ज किया गया। सहसंबंध विश्लेषण से यह ज्ञात हुआ कि फल आकार से संबंधित लक्षण (ध्रुवीय एवं भूमध्य व्यास, औसत फल भार), उपज तथा प्रमुख गुणवत्ता गुणों (एस्कॉर्बिक अम्ल, TSS एवं शुष्क पदार्थ) के मध्य सशक्त धनात्मक संबंध विद्यमान था, जबकि प्रमुख अवयव विश्लेषण (PCA) ने इन लक्षणों को उपचारों के बीच भिन्नता के प्रमुख निर्धारक के रूप में पुष्टि की। यद्यपि संरचनात्मक लक्षण जैसे लोक्यूल संख्या एवं बीज संख्या का सहसंबंध अपेक्षाकृत कमजोर पाया गया, तथापि समग्र निष्कर्ष यह संकेत करते हैं कि 0.5 मि.ग्रा./ली. की दर से KI का पर्णीय अनुप्रयोग उत्तर भारतीय परिस्थितियों में टमाटर की फल गुणवत्ता एवं शारीरिक प्रदर्शन में सुधार हेतु एक प्रभावी, किफायती एवं व्यावहारिक रणनीति है।