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Performance of advanced breeding lines of tomato (*Solanum lycopersicum* L.) under protected condition

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Abstract
The present investigation was undertaken during 2024-2025 to evaluate the performance of twenty advanced breeding lines of tomato (*Solanum lycopersicum* L.) for growth, yield and quality characters. The study was conducted at College of Horticulture, Mudigere. The evaluation of advanced breeding lines of tomato experiment was laid out in a Randomized Complete Block Design (RCBD) with three replication, standard check varieties namely, Arka Vikas and Pusa Ruby were included for comparison. Among the advanced lines, CHMT-1 exhibited superior performance in most of the traits like plant height (226.20 cm), number of branches (8.69), average fruit weight (100.79 g), number of fruits per plant (27.00), fruit yield per plant (2.33 kg) total chlorophyll (4.17 mg/g) and shelf life (18.37 days).When compared to standard checks *i.e*., Arka Vikas and Pusa Ruby. Overall performance of the advanced lines identified CHMT-1 as promising lines for growth, yield and quality characters. This line is recommended for inclusion in future tomato crop improvement programme.

Keywords: Tomato, breeding lines, growth, yield, quality, evaluation

Introduction

The world's population is expected to outreach 9.6 billion by 2050, posing a major challenge for global food production. To meet this growing demand, food production must increase by 70% compared to current levels. This is not just about producing abundant food but also ensuring it is nutritious, affordable, and sustainable. Achieving this goal will require advancements in farming techniques, efficient resource management, and better food distribution. At the same time, challenges like climate change, shortages of water and soil degradation must be addressed to secure long term food supplies (Shubham *et al*., 2022) [2]. One of the most effective ways to boost agricultural growth is by developing improved crop varieties and increasing cropping intensity. In India, vegetables are cultivated on 10.86 million hectares, producing around 200.45 million tonnes annually. Among these, tomatoes (*Solanum lycopersicum* L.) are among one of the most widely consumed vegetables. They are highly nutritious, rich in vitamins A and C and valued for their taste and colour making them an important cash crop globally (Ughade *et al*., 2016) [1]. Indeterminate tomato varieties are highly suitable for protected cultivation as the growth continues and harvest vertical space of polyhouse and increases productivity. Hence, there is a continuous need to strengthen the crop improvement programmes in tomato and ultimately developing new varieties/hybrids suitable for protected cultivation to fulfill off-season demand and satisfying to the present day needs of farmers and consumers as well. Growing tomatoes in green house can further increase the yield and improve the quality. In addition to the quantum jump in yield and superior quality, substantial reduction in use of pesticides makes it an eco-friendly proposition to grow tomato in naturally ventilated greenhouse throughout year. Keeping the above aspects in view and importance of the crop, the present study has been planned with the following objectives to know the performance of advanced breeding lines for growth, yield and quality.

Materials and Methods

The experiment was carried out in the naturally ventilated polyhouse at the Department of Vegetable Science, College of Horticulture, Mudigere which is situated in the Western Ghats and represents the typical hill zone (Zone-9 and Region-V) of Karnataka and lies at 13° 25'

North latitude and 75° 25' East longitude with an altitude of 980 m above mean sea level (MSL).The naturally ventilated polyhouse of 500 m² area is oriented in North-South direction. The framework is made up of galvanized iron pipe (class B) with a central height of 6 meters and covered with UV-stabilized 200-micron Low Density Polyethylene (LDPE) film. An area of 500 m² with 6 beds of 25m length and 1.2 m breadth was used for the experimental purpose. Twenty genotypes were evaluated which were laid out in randomized complete block design (RCBD) which was replicated thrice with two check Arka Vikas and Pusa Ruby. The following observations were recorded on various growth, flowering and yield related characters plant height at 90 DAT, stem girth at 90 DAT, number of brances, number of fruits per cluster, number of fruits per plant, average fruit weight, fruit yield per plant, total chlorophyll, lycopene and shelf life.

Results

The line CHMT-1 recorded maximum plant height (226.20 cm), which is followed by CHMT-4 (225.00 cm), followed by Pusa Ruby (224.20 cm). The range of stem girth at 90 DAT in advanced breeding tomato lines varied from 5.12 to 4.57 centimeters, with an average of 4.79 centimeters. The line CHMT-4 recorded maximum stem girth of (5.12 cm), which is followed by CHMT-1 (5.07 cm), followed by CHMT-8 (5.03 cm).The range of the number of branches at 90 DAT in tomato lines varied from 3.29 to 8.69, with an average of 5.89 (Table 5). The line CHMT-1 recorded the maximum number of branches of (8.69), which is followed by CHMT-20 (8.52), followed by CHMT-4 (8.16). The number of fruits per cluster varied from 3.00 to 4.47, with a general mean of 3.84. Among the different advanced breeding lines, the lines CHMT-1 and CHMT-4 recorded the maximum number of fruits per cluster of 4.47, which is followed by CHMT-20 (4.40), followed by CHMT-14 (4.27). The number of fruits per plant ranged from 18.73 to 24.00 with an overall mean of 21.00. The maximum number of fruits per plant was found in CHMT-1 (24.00), which is followed by CHMT-4 (23.78), followed by CHMT-20 with a value of 23.62. The average fruit weight varied from 57.98 to 94.38 grams, with an average of 69.09 grams. Among the different lines, the highest average fruit weight was observed in CHMT-1 (94.38 g), which is followed by CHMT-4 (92.99 g), followed by CHMT-20 (78.28 g). Fruit yield per plant in advanced breeding lines of tomato ranged from 1.09 to 2.27 kilograms, with an average of 1.46 kilograms. Among the different lines, the line CHMT-1 had a maximum yield per plant of 2.27 kilograms, which is followed by CHMT-4 (2.21 kg), followed by CHMT-20 (1.85 kg. Total chlorophyll in advanced breeding of tomato varied from 2.62 to 4.17 milligrams per gram, with an average of 3.35. The highest amount of total chlorophyll amongst the lines was observed in CHMT-1 (4.17 mg/g), which is followed by CHMT-4 (3.92 mg/g), followed by CHMT-8 (3.89 mg/g). Lycopene content amongst the tomato lines varied from 3.96 to 6.70, with a mean of 5.23. The highest lycopene content was recorded in CHMT-3 (6.70 mg/100 g), which is followed by CHMT-13 (6.36 mg/100 g), followed by Pusa Ruby (6.24 mg/100 g). Shelf life varied from 9.31 to 18.37 days, with a mean of 13.83 days. Among the advanced breeding lines of tomato, the line CHMT-1 (18.37 days) had the maximum shelf life, which is followed by CHMT-3 (17.91 days), followed by CHMT-13 (17.48 days).

Discussion

It is clear from the experimental results that significant variations were recorded among the advanced breeding lines of tomato for growth yield and biochemical parameters. Taller genotypes, such as CHMT-1 and CHMT-4, may have better light interception and canopy development, potentially leading to improved photosynthesis and yield similar findings have been reported by Meena *et al*. (2018) [3] and Shastri (2024) [4] who also observed significant variation in plant height among tomato genotypes. The variation in stem girth among the different lines could be attributed to differences in cambial activity, which affects the secondary growth of the stem and also to the efficiency of nutrient uptake and assimilation. Singh, 2017 and Maurya *et al*. (2022) [6] emphasized the role of stem girth in plant sturdiness and stress tolerance, particularly under variable agro-climatic conditions. A higher number of branches often correlates with increased flowering sites, which can lead to greater fruit production. Singh, 2017 and Anyaoha *et al*. (2023) [7] emphasized the utility of this trait in varietal selection and breeding for yield improvement. The number of fruits per cluster is an important yield contributing trait in tomato, as it directly affects the total number of fruits produced per plant and ultimately, the marketable yield. The results of the present study are in agreement with the findings of Bhandari *et al*. (2017) [8], Meena *et al*. (2018) [3] and Shastri (2024) [4], who all reported significant genotypic differences for this trait.The higher fruit count was observed in CHMT-1 reflects its superior yield potential, which can be attributed to efficient flowering, fruit set and assimilate partitioning toward reproductive growth. Furthermore, Sindhya *et al*. (2014) [9] and Anyaoha *et al*. (2023) [7] emphasized that fruit number is a heritable trait that can be improved through effective selection in advanced breeding lines. The enhanced yield performance of CHMT-1 can be attributed to a combination of factors, including a higher number of fruits per plant, greater fruit volume and better pericarp development. Srivastava *et al*. (2023) who also noted that yield in tomato is significantly influenced by its component traits and can be improved through selection based on high-performing genotypes. The highest average fruit weight was recorded in CHMT-1, reflecting its superior capacity for fruit development and sink strength. The findings of the present study are in agreement with earlier reports by Sadat *et al*. (2023) [10]. genotypes with higher chlorophyll levels, such as CHMT-1 may exhibit superior photosynthetic capacity and yield potential under optimal agronomic conditions similar findings was observed by Behera *et al*. (2020) [11]. In the current study, the highest lycopene content was recorded in CHMT-3, indicating its superiority in pigment accumulation as reported by Sadat *et al*. (2023) [10]. The extended shelf life in CHMT-1 can be attributed to factors such as lower respiration rate, delayed ripening and a firmer pericarp, which collectively contribute to slower deterioration. This is in agreement with findings by Reddy *et al*. (2013) [12].

Table 1: Performance of advanced breeding lines of tomato for morphological characters

Genotypes	Plant height @ 90 DAT	Stem girth @ 90 DAT	Number of branches @ 90 DAT
CHMT-1	226.20	5.07	8.69
CHMT-2	211.93	4.78	6.41
CHMT-3	203.73	4.67	4.22
CHMT-4	225.00	5.12	8.16
CHMT-5	208.33	4.76	5.09
CHMT-6	197.07	4.59	3.29
CHMT-7	210.40	4.78	5.62
CHMT-8	219.13	5.03	7.54
CHMT-9	200.00	4.57	3.55
CHMT-10	206.80	4.72	4.61
CHMT-11	201.93	4.64	3.86
CHMT-12	217.20	4.82	6.79
CHMT-13	210.73	4.78	5.88
CHMT-14	220.47	4.92	7.80
CHMT-15	200.20	4.61	3.82
CHMT-16	209.53	4.78	5.26
CHMT-17	215.27	4.80	6.55
CHMT-18	206.47	4.67	4.54
CHMT-19	207.33	4.75	4.99
CHMT-20	218.73	4.89	8.52
Arka Vikas	218.73	4.86	7.10
Pusa Ruby	224.20	4.89	7.22
Mean	211.79	4.79	5.89
S.Em±	6.21	0.11	0.18
CD @ 5%	17.73	0.31	0.52

Table 2: Performance of advanced breeding lines of tomato for yield parameters

Genotypes (Breeding lines)	Number of fruits per cluster	Number of fruits per plant	Average fruit weight (g)	Fruit yield per plant (kg)
CHMT-1	4.47	24.00	94.38	2.27
CHMT-2	4.00	20.11	66.17	1.33
CHMT-3	3.47	19.34	63.43	1.23
CHMT-4	4.47	23.78	92.99	2.21
CHMT-5	3.60	22.10	64.53	1.43
CHMT-6	3.00	18.73	57.98	1.09
CHMT-7	3.87	19.93	65.27	1.30
CHMT-8	4.20	23.45	74.82	1.75
CHMT-9	3.33	18.86	62.62	1.18
CHMT-10	3.53	22.00	64.00	1.41
CHMT-11	3.47	19.22	63.13	1.21
CHMT-12	4.07	20.52	66.94	1.37
CHMT-13	3.87	20.01	65.61	1.31
CHMT-14	4.27	23.50	75.77	1.78
CHMT-15	3.33	19.08	62.93	1.20
CHMT-16	3.67	19.82	64.91	1.29
CHMT-17	4.00	20.41	66.71	1.36
CHMT-18	3.47	19.43	63.65	1.24
CHMT-19	3.60	19.75	64.31	1.27
CHMT-20	4.40	23.62	78.28	1.85
Arka Vikas	4.13	20.88	67.98	1.42
Pusa Ruby	4.20	23.38	73.63	1.72
Mean	3.84	21.00	69.09	1.46
S.Em±	0.12	0.93	3.14	0.06
CD @ 5%	0.35	2.66	8.98	0.19

Table 3: Performance of advanced breeding line for quality parameter

Genotypes (Breeding lines)	Total chlorophyll (mg/g)	Lycopene (mg/100 g)	Shelf life (days)
CHMT-1	4.17	6.12	18.37
CHMT-2	3.39	5.40	12.32
CHMT-3	3.04	6.70	17.91
CHMT-4	3.92	3.96	10.60
CHMT-5	3.26	5.88	15.33
CHMT-6	2.62	4.44	14.04
CHMT-7	3.83	4.32	9.31
CHMT-8	3.89	4.08	10.17
CHMT-9	2.93	4.56	11.03
CHMT-10	3.05	6.00	14.90
CHMT-11	3.41	4.80	9.74
CHMT-12	3.53	4.20	13.18
CHMT-13	2.89	6.36	17.48
CHMT-14	3.36	5.16	11.89
CHMT-15	3.24	4.68	14.47
CHMT-16	3.48	5.64	16.62
CHMT-17	3.45	4.92	12.75
CHMT-18	2.88	5.28	11.46
CHMT-19	2.80	5.52	17.05
CHMT-20	3.31	5.04	13.61
Arka Vikas	3.64	5.76	15.76
Pusa Ruby	3.58	6.24	16.19
Mean	3.35	5.23	13.83
S.Em±	0.10	0.17	0.45
CD @ 5%	0.30	0.49	1.30

Conclusion
The present study on twenty advanced breeding lines of tomato revealed significant variability for growth, yield, and quality traits. Among the evaluated lines, CHMT-1 exhibited superior performance in plant height, number of branches, fruit yield per plant, total chlorophyll, and shelf life, indicating its potential for high productivity and better post-harvest quality. CHMT-4 and CHMT-20 also showed promising results for several traits. The observed variability among lines suggests ample scope for genetic improvement through selection and hybridization. Overall, CHMT-1 emerged as the most promising line, suitable for inclusion in future tomato breeding programs aimed at enhancing yield potential and fruit quality under similar agro-climatic conditions.

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