



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(7): 1123-1128
Received: 02-05-2026
Accepted: 06-06-2026

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Studies on effect of light spectrum and photoperiod interaction on accelerated flowering and growth performance of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) lines under indoor vertical system

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i7n.6068>

Abstract

An indoor experiment entitled as “Studies on effect of light spectrum and photoperiod interaction on accelerated flowering and growth performance of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) lines under indoor vertical system” conducted during 2025-2026. The experimental setup consisting of two cherry tomato lines (UK1 and UK2) exposed to two different combinations of LED light spectrum (2R:1B and 1R:2B) with two different light duration (16h and 14h) under controlled indoor system. Growth parameters which include plant height and number of branches per plant were measured at 15, 30 and 45 Days after transplanting (DAT) and flowering parameters such as days to first flower initiation, days to 50% flowering and number of flower clusters per plant. Among the treatment combinations, UK2 line grown under 2R:1B light with 16-hour photoperiod (T₉) which performed superior performance like plant height, number of branches and number of flower clusters whereas UK1 line grown under 2R:1B light with 16-hour photoperiod (T₄) which show accelerated flowering require minimum number of days to first flower initiation and days to 50% flowering. The study which indicates that 2R:1B LED light spectrum combined with 16-hour photoperiod leads to favourable conditions for better growth and early flowering for cherry tomato lines under indoor vertical system.

Keywords: Cherry tomato, indoor vertical cultivation, LED light spectrum, photoperiod, accelerated flowering, growth performance

Introduction

Cherry tomato is one of the most important high-value crops which belongs to the Solanaceae family. It is widely cultivated across the world which is adapted to wide range of climatic conditions and optimum temperature for cherry tomato growth ranges from 20 to 25° C. The crop is highly valued for its attractive appearance, pleasant flavour, good nutritional value and high market demand. Cherry tomatoes are low-calorie fruits which is rich in essential nutrients such as vitamin A and C, Potassium and antioxidants like lycopene and β -carotene (Almubarak *et al.*, 2026) [1]. These compounds possess antioxidant, antibacterial and anti-inflammatory properties which contribute to health benefits like prevention of intestinal infections, reducing the risk of cancer, cardiovascular diseases and supports the good eye health. The increasing adoption of indoor vertical farming and controlled-environment agriculture has generated opportunities for year-round food production with efficient usage of resources. Vertical farming delivers economic advantages by increasing the yield and minimising the expenses for transportation or storage (Van Gerrewey *et al.*, 2022) [7]. Farmers will get profit from reduced crop losses, better yields and more secure supply chains along with reduced environmental impact and enhanced sustainability in agriculture. Among the environmental factors, light spectrum and photoperiod plays major role in regulating photosynthesis, vegetative growth, flowering and fruit production. LED systems play an important role in controlling morphological, genetic, physiological, chemical properties, increasing the synthesis of a variety of beneficial secondary metabolites and optobiological interactions of plants (Malabadi *et al.*, 2024) [4].

Based on the characteristics of LEDs, numerous studies have been conducted to understand the effect of different light compositions, intensities and photoperiods on crops grown in indoor vertical farming, including far-red, red, green, blue and UV light, respectively, and in the combination of different light spectrum (Wong *et al.*, 2020) [8]. The red and blue light is essential for maximizing the photosynthesis process, biomass accumulation and metabolite production. The present study aims to evaluate the effects of different LED light spectra and photoperiod

combinations on growth, fast flowering and performance on cherry tomato lines grown under an indoor vertical system.

Materials and Methods

The research work was conducted in indoor vertical farm located at Urban Kisaan private limited, Gundla-pochampally, Hyderabad during 2025-2026. The experimental materials and methodologies adopted for the investigation are presented in the following sections.

Table 1: Treatment details for factors of lines and Light spectrum x photoperiod interaction and treatment combinations (T₁ to T₁₀)

Treatment details	C ₁ (UK1 line)	C ₂ (UK2 line)
P1(1R:2B+14h photoperiod)	T ₁ -UK1+1R:2B+14hour	T ₆ - UK2+1R:2B+14hour
P2(1R:2B+16h photoperiod)	T ₂ -UK1+1R:2B+16hour	T ₇ - UK2+1R:2B + 16hour
P3(2R:1B+14h photoperiod)	T ₃ -UK1+2R:1B +14hour	T ₈ - UK2+2R:1B + 14hour
P4 (2R:1B+16h photoperiod)	T ₄ -UK1+2R:1B+16hour	T ₉ - UK2+2R:1B + 16hour
P5 (control)	T ₅ -UK1+Control	T ₁₀ -UK2+Control

Experimental design

The experiment was conducted in pots under indoor vertical layers using a factorial completely randomized design (FCRD) comprising two factors. The first factor consists of two cherry tomato lines namely UK1 (C₁) and UK2 (C₂). The second factor consists of five light spectrum-photoperiod treatments (P₁ to P₅)

involving red: blue LED light ratios of 2R:1B and 1R:2B under 14-hour and 16-hour photoperiods. The combinations of two lines and five light treatments resulted in ten treatment combinations (T₁ to T₁₀) each replicated with three times and the experiment mainly to evaluate the effects of growth and flowering response towards the light treatments under indoor vertical system.



Fig 1: Speed breeding container



Fig 2: Cherry tomato growth under lights

Results and Discussion

a. Plant height (cm)

Table 2: Effect of lines, light treatments and their interaction on plant height at 15, 30 and 45 DAT

Treatments	15 days after transplanting			30 days after transplanting			45 days after transplanting		
	UK1	UK2	Mean	UK1	UK2	Mean	UK1	UK2	Mean
1R:2B+14hr	8.37	8.83	8.60	14.61	15.69	15.15	21.07	22.41	21.74
1R:2B+16hr	9.85	10.55	10.20	15.98	16.69	16.33	22.61	22.91	22.76
2R:1B+14hr	10.61	11.02	10.81	16.83	17.33	17.08	23.48	23.75	23.62
2R:1B+16hr	11.03	11.14	11.09	18.68	20.28	19.48	26.62	29.81	28.21
Control	5.48	6.27	5.88	10.91	11.78	11.35	16.57	17.77	17.17
Mean	9.07	9.56		15.14	16.35		22.07	23.33	
	SEm±		CD (p=0.05)	SEm±		CD (p=0.05)	SEm±		CD (p=0.05)
Lines (C)	0.141		0.418	0.231		0.681	0.317		0.934
Light (P)	0.223		0.661	0.365		1.077	0.500		1.476
(C x P)	0.315		0.929	0.516		1.524	0.708		2.088

Plant height is one of the most fundamental growth characteristics which indicates that cumulative effect of physiological and metabolic processes which occurs within the plant. Plant height was measured at different stages of growth at 15, 30 and 45 DAT presented in the Table 2 revealed that maximum plant height was observed in UK2 line compared to UK1 line. Among the treatment combination, the greater plant height observed under the T₉ (UK2 line + 2R:1B spectrum with 16-hour photoperiod)

recorded as 11.14cm, 20.28cm and 30.21cm at 15, 30 and 45 DAT and shortest plant height under control treatment (T₅) recorded as 5.48cm, 10.91cm and 20.33cm at 15, 30 and 45 DAT growth stages. Similar findings were observed by Son *et al.*, (2018) [6] who revealed highest plant height and stem growth in tomato cultivars under more red dominant light with less blue light ratios with 16-hour photoperiod.

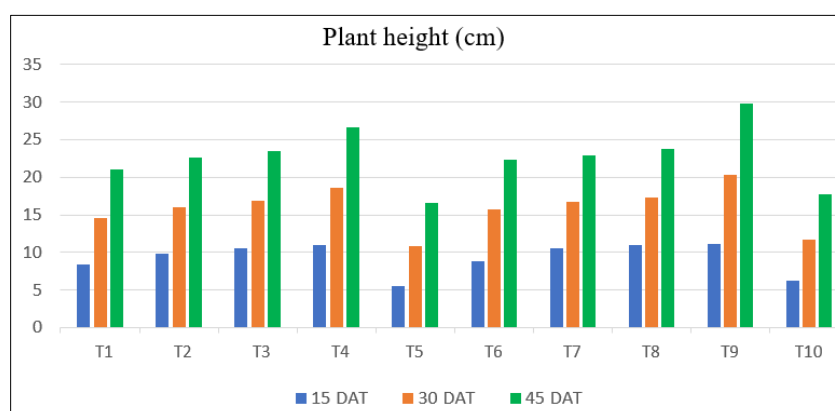


Fig 3: Graphical illustration of plant height measured at 15, 30, 45 DAT

b. Number of branches per plant

Table 3: Effect of lines, light treatments and their interaction on number of branches per plant at 15, 30 and 45 DAT

Treatments	15 days after transplanting			30 days after transplanting			45 days after transplanting		
	UK1	UK2	Mean	UK1	UK2	Mean	UK1	UK2	Mean
1R:2B+14hr	7.6	7.8	7.7	9.67	9.88	9.77	11.9	12.2	12.05
1R:2B+16hr	8.0	8.2	8.1	9.89	10.33	10.11	12.5	12.8	12.65
2R:1B+14hr	8.4	8.6	8.5	10.44	10.78	10.61	13.1	13.4	13.25
2R:1B+16hr	8.8	9.0	8.9	11.33	11.44	11.39	13.7	14.0	13.85
Control	7.0	7.3	7.15	9.11	9.22	9.17	11.0	11.5	11.25
Mean	7.96	8.18		10.09	10.33		12.4	12.78	
	SEm±		CD (p=0.05)	SEm±		CD (p=0.05)	SEm±		CD (p=0.05)
Lines (C)	0.09		0.266	0.308		0.915	0.135		0.398
Light (P)	0.142		0.420	0.487		1.447	0.214		0.630
(C x P)	0.201		0.594	0.689		2.045	0.302		0.891

Number of branches per plant is a notable vegetative parameter which indicates canopy development of the plant. The data recorded at 15, 30 and 45 DAT presented in Table 3 revealed that maximum number of branches observed in T₉ (UK2 line + 2R:1B spectrum with 16-hour photoperiod) which recorded at 15, 30 and 45 DAT as 9, 11.44 and 14.0 branches and minimum number of branches recorded under control treatment (T₅) as 7, 9.11 and 11

branches at 15, 30 and 45 DAT. The highest number of branches observed under 2R:1B light spectrum with 16-hour photoperiod in an indoor condition. The present findings consistent with Gao *et al.*, (2022) [3] who reported the highest number of branches observed in the coriander plant grown under 3R:1B treatment and lowest number branches observed under 1R:3B treatment with 16-hour photoperiod.

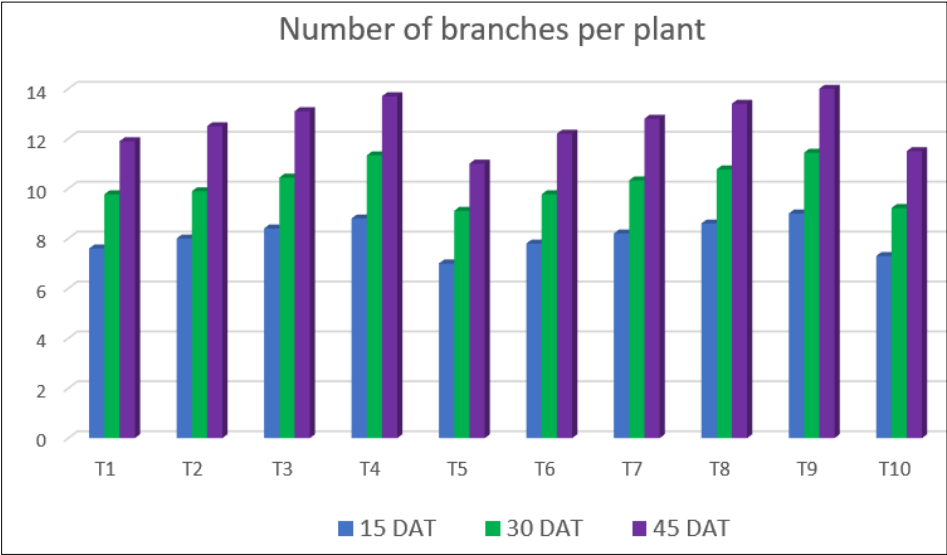


Fig 4: Graphical illustration of number of branches per plant recorded at 15, 30 and 45 DAT

c. Days to first flower initiation

Table 4: Effect of lines, light treatments and their interaction on days to first flower initiation

Treatments	Days to first flower initiation		
	UK1 (C ₁)	UK2 (C ₂)	Mean
1R:2B+14hr (P ₁)	36.76	38.18	37.47
1R:2B+16hr (P ₂)	33.60	35.17	34.39
2R:1B+14hr (P ₃)	29.34	30.28	29.81
2R:1B+16hr (P ₄)	28.17	29.12	28.65
Control (P ₅)	41.56	43.30	42.43
Mean	33.89	35.21	
	SEm±		CD (p=0.05)
Lines (C)	0.171		0.507
Light (P)	0.27		0.802
(C x P)	0.382		1.126

Days to first flower initiation is an important phenological parameter and represents the initiation of reproductive phase leads to earliness of crop development. The observations recorded during the experiment revealed significance differences among the lines and light treatments. Among the combination of treatments, T₄ (UK2 line + 2R:1B spectrum with 16-hour photoperiod) recorded minimum number of days to first flower

initiation as 28.17 days and maximum number days to first flower initiation recorded as 43.30 days observed under control treatment (T₁₀). The similar experimental findings reported by Zhang *et al.*, (2023)^[9] who recorded earlier flowering in micro-tomato variety under 16-hour photoperiod indicates rapid reproductive growth due to extended photoperiod.

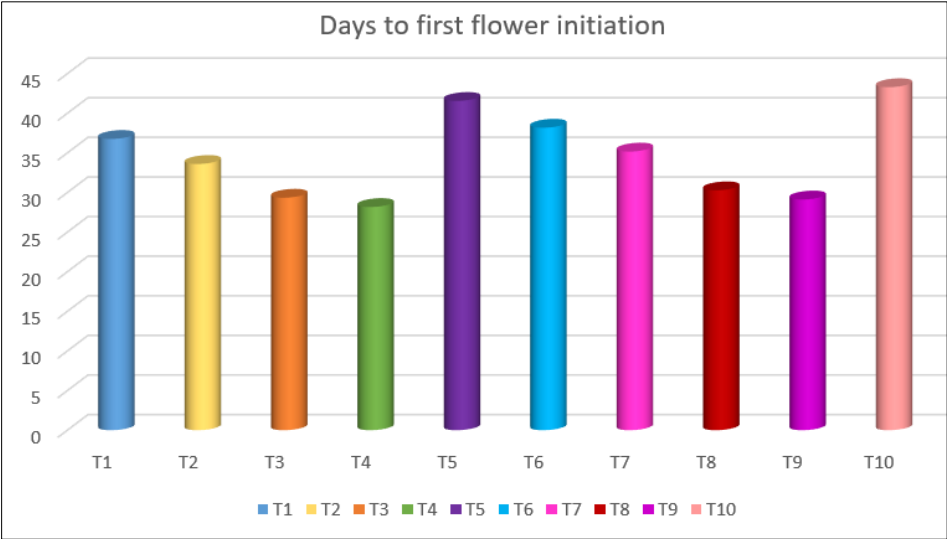


Fig 4: Graphical illustration of Days to first flower initiation

d. Days to 50% flowering

Table 5: Effect of lines, light treatments and their interaction on days to 50% flowering

Treatments	Days to 50% flowering		
	UK1 (C ₁)	UK2 (C ₂)	Mean
1R:2B+14hr (P ₁)	42.67	45.97	44.32
1R:2B+16hr (P ₂)	39.33	41.11	40.22
2R:1B+14hr (P ₃)	36.22	38.01	37.12
2R:1B+16hr (P ₄)	32.38	34.10	33.24
Control (P ₅)	50.67	55.67	53.17
Mean	40.25	42.97	
	SEm±		CD (p=0.05)
Lines (C)	0.395		1.173
Light (P)	0.624		1.854
(C x P)	0.883		2.604

Days to 50% flowering is major developmental parameter which indicates the transition from vegetative phase to reproductive phase. The observations of the experimental data presented in the Table 5 revealed that T₄ (UK2 line + 2R:1B spectrum with 16-hour photoperiod) recorded minimum number of days to 50% flowering as 32.38 days and maximum number days to 50% flowering observed under control treatment (T₅) as 55.67 days. Earlier onset of 50% flowering may be due to enhanced more photosynthetic activity, increased assimilation production and most efficient utilization of resources under 2R:1B light spectrum with 16 hours photoperiod leads to accelerate the transition from vegetative to reproductive growth. The present findings which reported by Argade *et al.*, (2018) ^[2] who observed cherry tomato plants reached 50% flowering earlier (45 days) under 35% shade intensity in greenhouse conditions.

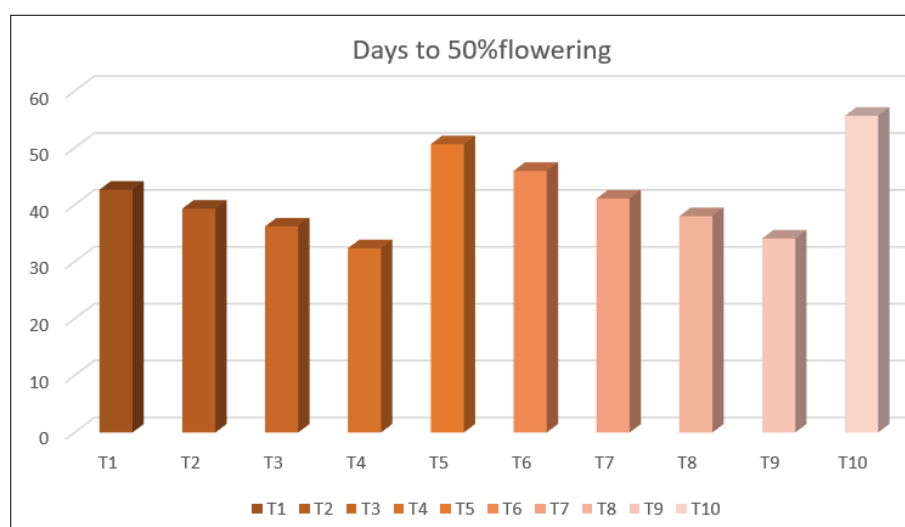


Fig 4: Graphical illustration of Days to 50% flowering

e. Number of flower clusters per plant

Table 6: Effect of lines, light treatments and their interaction on number of flower clusters per plant

Treatments	Number of flower clusters per plant		
	UK1 (C ₁)	UK2 (C ₂)	Mean
1R:2B+14hr (P ₁)	7.97	8.57	8.27
1R:2B+16hr (P ₂)	9.07	9.80	9.43
2R:1B+14hr (P ₃)	10.67	11.87	11.27
2R:1B+16hr (P ₄)	12.03	12.67	12.35
Control (P ₅)	6.60	7.20	6.90
Mean	9.27	10.02	
	SEm±		CD (p=0.05)
Lines (C)	0.118		0.349
Light (P)	0.186		0.552
(C x P)	0.263		0.776

Number of flower clusters per plant is prominent reproductive parameter which indicates flowering potential and yield capacity of the plant. The experimental data on the number of flower clusters per plant revealed the highest number of flower clusters per plant was recorded under the T₉ (UK2 line + 2R:1B spectrum with 16-hour photoperiod) as 12.67 flower clusters and lowest number of flower clusters per plant recorded as 6.60 observed

under control treatment (T₅). The increase in flower truss (flower clusters) production observed in the present study is consistent with the findings of Palmitessa *et al.*, (2020) ^[5] suggesting the prolonged LED illumination of red and blue light promotes reproductive growth and inflorescence development in tomato plant.

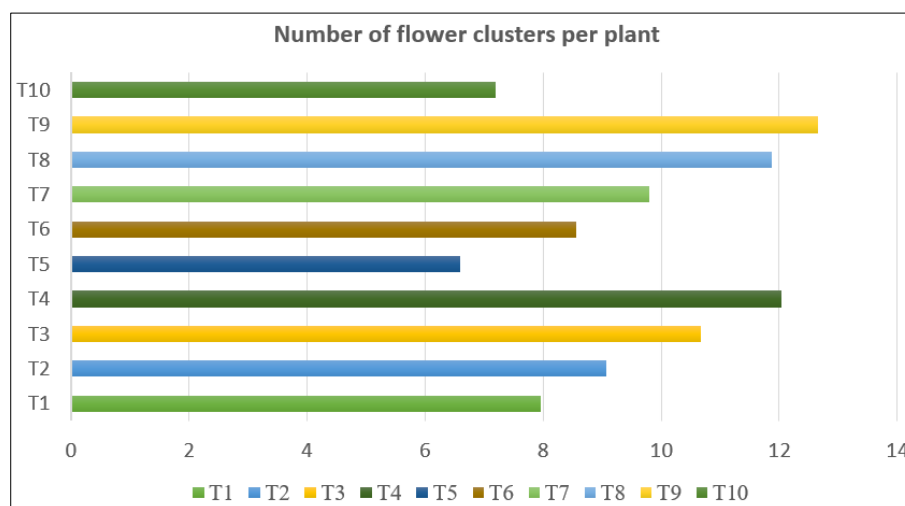


Fig 4: Graphical illustration of number of flower clusters per plant

Conclusion

The findings of this research revealed that light spectrum and photoperiod significantly influenced on the growth and flowering performance of cherry tomato lines under indoor vertical farming conditions. Among the evaluated treatments, UK2 line grown under 2R:1B LED spectrum with 16 hours exhibited superior performance to parameters such as plant height, number of branches and number of flower clusters per plant whereas UK1 line exhibited best performance in earlier flowering and days of 50% flowering due to genetic difference in flowering responses under light conditions. The superior performance recorded under red dominant LED spectrum (2R:1B) along with 16-hour photoperiod proved most effective which promotes the enhanced plant growth, accelerated flowering and increasing flower cluster production. The two cherry tomato lines exhibited distinct responses towards light treatments. However, both lines show good responses under the LED conditions having the minimal variation towards the light. The improved plant performance observed under the 2R:1B light treatment with 16-hour photoperiod suggests that both red and blue light wavelengths perform together with extended photoperiod leads to enhance photosynthetic activity, biomass accumulation and reproductive development in cherry tomato plant. Meanwhile, plant grown under the control treatment exhibit poor performance compared to the all treatments.

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