Short Communication

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Effects of night break light sources on morphology and pigment content in standard chrysanthemum (*Chrysanthemum morifolium*)

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Abstract

This study investigated the effects of incandescent bulbs, compact fluorescent lamps (CFL), and light-emitting diodes (LED) on morphological and pigment traits of ten *Chrysanthemum morifolium* Ramat. Varieties, in a factorial completely randomized design with three replications. The plant height, leaf area index (LAI), flowering time, duration, and pigment content were measured. The LED lighting produced tallest plants (103.35 cm), highest LAI (6.28), and largest flowers (19.58 cm), yielding highest anthocyanin (1.84 mg/g) and carotenoid (96.12 mg/g). Incandescent lighting induced earliest flowering (158.87 days), while LED extended flowering duration to 36.34 days. There was significant influence of night break light sources on growth, flowering, and pigment synthesis, LEDs showing the greatest overall benefit.

Key words: Genotypes, Light sources, LED, Morphological traits, Pigments

Chrysanthemum morifolium Ramat., a member of the Asteraceae family, is widely cultivated for ornamental purposes. In India, it is extensively cultivated for various purposes (Koley and Sarkar, 2013). Light perception in chrysanthemums plays a crucial role in regulating flowering and physiological processes, mediated by the circadian clock (Jackson, 2009). Various light sources are used in horticulture for photoperiodic control, with LEDs emerging as promising alternatives due to their spectral specificity and energy efficiency (Bergstrand and Schussler, 2012). Schamp *et al.* (2012) suggested that LEDs could potentially replace high-pressure sodium lamps in flower production systems. Thakur and Grewal (2018) demonstrated that supplementary light treatments can modulate flowering timing of *C. morifolium.*

Recent studies have highlighted the benefits of LED lighting compared to traditional sources. Wang *et al.* (2023) reported significant height variations among chrysanthemum cultivars under different light treatments, while Li *et al.* (2022) found that specific LED spectra enhanced plant growth. Zhang *et al.* (2021), observed improved plant characteristics under optimized lighting conditions. This study builds upon existing research by evaluating the effects of incandescent bulbs, CFLs, and LEDs on multiple morphological and pigment-related traits of *C. morifolium*. By manipulating photoperiods with various light sources, we aim to address challenges in commercialization within sub-tropical regions and contribute to the optimization of chrysanthemum cultivation practices.

Three light sources (incandescent bulbs, CFL, LED) were tested using a factorial CRD design with three replications and three pots per replication. Plant propagation was achieved through terminal stem cuttings (2-3 cm long) treated with NAA (500 mg/l) for 30 seconds. Cuttings were planted in propagation trays using burnt rice husk as a rooting medium and maintained under high humidity conditions. After two weeks, rooted cuttings were transplanted into 20 cm diameter pots containing a 2:1 mixture of garden soil and well-rotten farmyard manure, supplemented with diammonium phosphate (1 kg/ft^3). Long-day conditions were simulated using night breaks from August 15 to October 31 (consecutive years 2018-19), with the three light sources applied for two hours nightly (22:00-00:00). Plants were subsequently shifted to natural day length on November 1. Standard cultural practices, including pinching and disbudding, were implemented throughout the growth period until flowering.

The leaf area index (LAI) was calculated as total leaf area per plant multiplied by number of plants/m^2, divided by surface area of land (Gardener *et al.*, 2003). Anthocyanin content (mg/g)- Five ml of sample were diluted to 100 ml with ethanolic HCl (85% ethanol, 15% 1.5 N HCl) and kept overnight at 4°C. Filtered through Whatman No.1 and fine Millipore, a 10 ml aliquot was diluted to 20 ml with ethanolic HCl. Absorbance at 535 nm was measured, and anthocyanin content was calculated (Harborne 1967). Carotenoids content (mg/g) were extracted from 100 mg of ray florets with 10 ml acetone. Absorbance at 440 nm was measured, and carotenoid concentration was calculated using Wettstein's formula (Wettstein 1957). Number of stomata per unit area were counted on three 1 mm^2 leaf areas using 100× magnification on an Olympus trinocular microscope, on both abaxial and adaxial surfaces.

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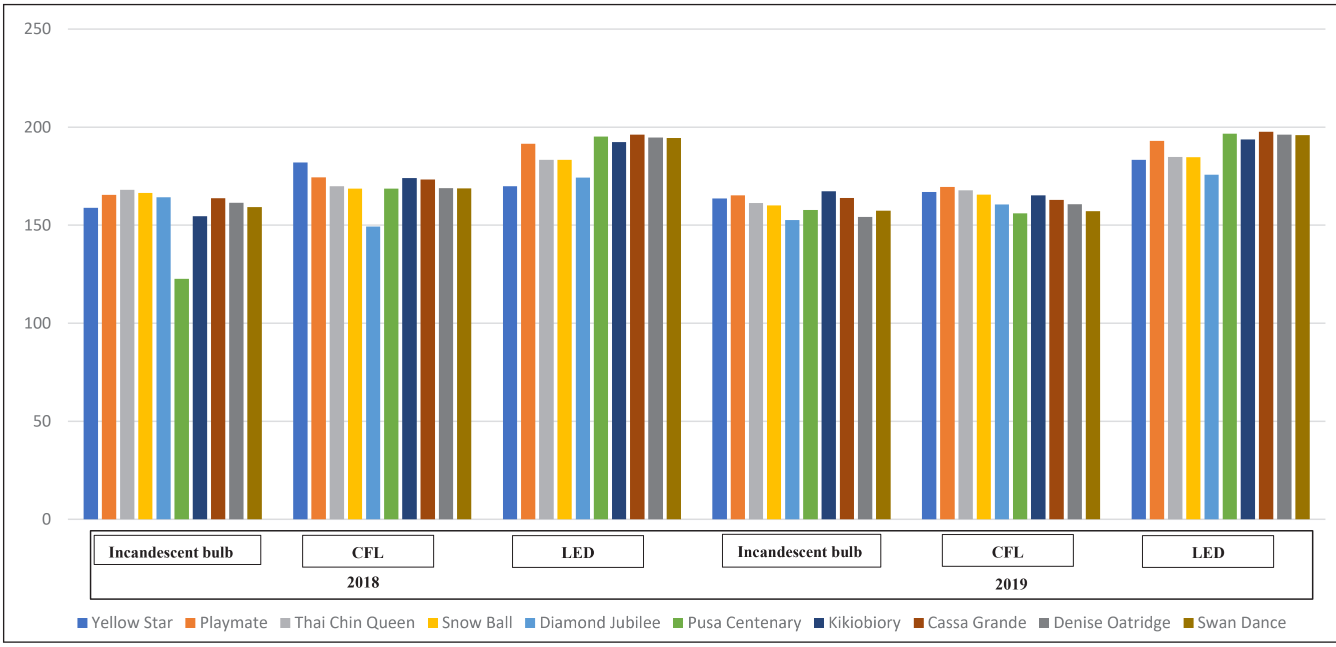

Fig. 1 Effect of different sources of light as night break on days taken for flowering in standard chrysanthemum

Table 1: Effect of different sources of light as night break on flower size in standard chrysanthemum

Genotype	Flower size (cm)							
	2018			Mean	2019			Mean
	Incandescent bulb	CFL	LED		Incandescent bulb	CFL	LED	
Yellow Star	12.32	13.64	15.34	13.77^{h}	13.85	15.07	16.78	15.23^{g}
Playmate	15.90	16.34	17.82	16.69^{d}	17.43	17.77	19.25	18.15^{cd}
Thai Chen Queen	13.50	14.25	16.38	14.71^{g}	15.03	15.68	17.82	16.18^{f}
Snow Ball	17.33	17.27	19.83	18.14^{a}	18.77	18.70	21.26	19.58^{a}
Diamond Jubilee	16.23	16.02	16.27	16.17^{e}	17.67	17.45	17.71	17.61^{d}
Pusa Centenary	15.23	16.34	17.61	16.39^{e}	16.67	17.77	19.04	17.83^{d}
Kikiobiory	17.20	18.03	18.05	17.76^{b}	18.63	19.47	19.49	19.20^{ab}
Cassa Grande	17.24	16.99	17.48	17.24^{c}	18.67	18.43	18.91	18.67^{bc}
Denise Oatridge	12.40	13.35	15.37	13.71^{h}	13.83	14.78	16.81	15.14^{g}
Swan Dance	14.35	15.30	16.39	15.35^{f}	15.78	16.73	17.83	16.78^{e}
Mean	15.17^{c}	15.75^{b}	17.06^{a}		16.63^{c}	17.19^{b}	18.49^{a}	

Mean values in each column with the same letter are not significantly different at $p < 0.05$ according to DMRT. *Significant at $p < 0.05$

Plant height varied among genotypes and light treatments. It was highest in 'Playmate' (101.88-103.35 cm), and shortest (70.23-76.23 cm) in 'Kikiobiory'. LED lighting consistently produced tallest plants (average 95.12 cm), followed by CFL and incandescent bulbs. These results align with Wang *et al.* (2023). The superiority of LED lighting supports Li *et al.* (2022) work showing enhanced growth under specific LED spectra and also concurs with findings by Seif *et al.* (2021) on red light promoting shoot growth in chrysanthemums.

Leaf Area Index (LAI) was highest in 'Yellow Star' (6.86-7.33), while 'Swan Dance' had lowest (4.77-5.19). LED lighting produced highest mean LAI (5.85-6.28), followed by CFL and incandescent bulbs. The superior LAI of 'Yellow Star' supports work by Liu *et al.* (2022) on cultivar-specific leaf traits. LED lighting's efficacy in promoting LAI corroborates Chen *et al.* (2023) findings on spectral effects on chrysanthemum leaf expansion, also aligns with observations recorded by Lim *et al.* (2023) during in vitro culture of Gerbera under varying LED spectra.

The LED lighting resulted in longest flowering times (up to 196.15 days), while incandescent bulbs produced shortest (minimum 122.59 days). The CFLs yielded intermediate results. These findings align with Wang *et al.* (2023) and Zhang *et al.* (2021), supporting the efficacy of LED lighting in extending the vegetative phase and enhancing plant attributes. 'Kikiobiory' had longest flowering period (35.75-36.34 days), while 'Yellow Star' and 'Swan Dance' had shortest. The LED lighting produced longest flowering durations (average 32.5 days), followed by CFL and incandescent bulbs. These findings support recent research by Li *et al.* (2023) and Wang *et al.* (2022) on regulation of flowering time in chrysanthemums and benefits of specific LED spectra.

'Snow Ball' produced largest flowers (18.14-19.58 cm), while 'Yellow Star' and 'Denise Oatridge' had smallest (13.71-15.23 cm). LED lighting consistently produced largest flowers across genotypes (average 17.2 cm), followed by CFL and incandescent bulbs. These findings align with Zhang *et al.* (2023). Genotypic variations reflect genetic diversity in flower development mechanisms noted by Liu *et al.* (2022).

Only 'Thai Chen Queen', 'Playmate' and 'Denise Oatridge' showed detectable anthocyanin levels. 'Thai Chin Queen' exhibited highest content (1.67-1.84 mg/g). LED lighting consistently produced highest anthocyanin levels (average 1.2 mg/g), followed by CFL and incandescent bulbs. These findings align with Li *et al.* (2023). Zhang *et al.* (2022) demonstrated enhanced flavonoid biosynthesis under specific LED spectra. 'Pusa Centenary' exhibited highest carotenoid levels (94.68-96.12 mg/g), while 'Diamond Jubilee' showed lowest (22.57-24.00 mg/g). LED lighting generally produced highest carotenoid levels (average 65.3 mg/g), followed by CFL and incandescent bulbs. These findings align with Liu *et al.* (2023). Chen *et al.* (2023) reported light quality effects on secondary metabolite accumulation in chrysanthemums. LED lighting consistently produced highest stomatal density (mean 55.38-55.39 mm^2). 'Denise Oatridge' exhibited highest density under LED (55.65-55.70 mm^2), while 'Diamond Jubilee' had lowest under incandescent bulbs (51.67-51.87 mm^2). These findings align with Zhang *et al.* (2023), who reported enhanced stomatal development in *C. morifolium* under optimized LED spectra. Results support Wang *et al.*'s (2024) observations on impact of lighting quality on physiological traits.

Thus, LED lighting significantly enhanced various growth parameters and pigment contents in *Chrysanthemum morifolium* compared to CFL and incandescent bulbs. Specifically, LED lighting resulted in taller plants, more leaf area index, and larger flowers, as well as higher levels of anthocyanins and carotenoids (Table 1 and Fig. 1). These findings are consistent with recent studies highlighting the efficacy of LED lighting in improving plant quality and productivity.

REFERENCES

Bergstrand K. and Schussler H. 2012. The benefits of LED lighting in horticulture. *Horticultural Science* and 47(6): 728-33.

Chen H, Zhou R. and Wang M. 2023. Spectral effects of LED on chrysanthemum leaf expansion. *Journal of Experimental Botany* **74**(2): 485-94.

Jackson S.D. 2009. Plant Photoperiodism: Mechanisms and Impacts on Growth. *Plant Science* 177(1): 1-8.

Koley S. and Sarkar A. 2013. Florist's Chrysanthemum: Cultivation and uses. *Indian Journal of Horticulture* and 58(4): 320-25.

Li J. Zhou and Wang Y. 2022. Enhanced plant growth with specific LED spectra. *Plant Physiology and Biochemistry* and 169: 19-25.

Li W, Zhao L. and Huang Y. 2023. Regulation of flowering time in chrysanthemums with LED spectra. *Horticulture Research* 10(2): 78-84.

Lim M, Park S, Lee J, Cui Y, Lee H. 2023. Influence of LED lights on in vitro multiplication of *Gerbera jamesonii*. *Agronomy* **13**(9): 2216. https://doi.org/10.3390/agronomy13092216

Liu S, Zhang Y. and Chen H. 2023. Carotenoid accumulation in chrysanthemum cultivars. *Journal of Plant Biology* 66(3): 312-20.

Liu Y, Wu J. and Zhang X. 2022. Cultivar-specific leaf traits in chrysanthemum. *Journal of Horticultural Science & Biotechnology* and **97**(1): 29-35.

Schamp B.S, Pridgeon J. and Smith R. 2012. LEDs in floriculture: Replacing high-pressure sodium lamps. *Journal of Horticultural Technology* and 18(3): 311-18.

Seif M, Kremer J. Runkle E.S. 2021. Monochromatic red light during plant growth decreases the size and improves the functionality of stomata in chrysanthemum. *Functional Plant Biology* 48(5): 515–528. https://doi.org/10.1071/FP20280

Thakur R. and Grewal H. 2018. Supplementary lighting for flowering in chrysanthemums. *Horticultural Reviews* **46**(1): 75-80.

Wang X, Liu Y. and Chen L. 2024. Impact of lighting quality on physiological traits in chrysanthemum. *Plant and Cell Physiology* **65**(1): 123-34.

Wang X. Chen L. and Zhang Y. 2023. Height variations among chrysanthemum cultivars under different light sources. *Journal of Plant Growth Regulation* and 42(2): 145-55.

Zhang L, Li Q and Wang X. 2021. Improved plant characteristics under optimized lighting conditions. *Journal of Plant Research* and 134(3): 267-75.

Zhang M, He J. and Li Y 2022. Enhanced flavonoid biosynthesis under LED lighting. *Journal of Photochemistry and Photobiology B* and 226: 112345.