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GROWTH REGULATOR-INDUCED CHANGES IN MORPHO-PHYSIOLOGICAL TRAITS AND FLOWERING BEHAVIOUR OF *GOMPHRENA GLOBOSA* L.

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ABSTRACT

The current study on Gomphrena was conducted at Floriculture block of Dr. Y. S. R. Horticultural University- College of Horticulture, Anantharajupeta, Annamaya district, Andhra Pradesh in 2024. The experiment was aimed to assess the effects of growth regulators, including Gibberellin, Naphthalene Acetic Acid, Benzyl Adenine, Paclobutrazol, Cycocel and control imposed at 30 days after transplanting (DAT) using Randomized Block Design (RBD). The results revealed that, the vegetative attributes like number of leaves per plant (62.60), leaf length (10.52 cm), leaf width (4.04 cm) and stem girth (36.67 mm) and also the physiological attributes like photosynthetic rate, transpiration rate, stomatal conductance and chlorophyll content (48.03) registered the maximum effect with foliar application of Gibberellin @ 200 ppm (T₂). Flowering characteristics like maximum stalk length was recorded in Gibberellin @ 200 ppm T₂ (18.39 cm), fresh (7.39 g) and dry weight of the flowers and duration of flowering (47.67 days) were recorded in cycocel @ 1000 ppm (T₁₃) and earliest flowering was observed in Gibberellin @ 200 ppm. Flower yield was recorded maximum in the plants sprayed with (T₁₂) Paclobutrazol @ 80 ppm (143.91 g plant⁻¹).

Key words: Gomphrena, vegetative, physiological, gibberellin and flower yield.

Introduction

Gomphrena (*Gomphrena globosa* L.) or “Globe Amaranth,” is an edible plant from the Amaranthaceae family, native to the America, Myanmar and India. It was known for its vibrant, long-lasting dried flowers, it ranks seventh in India’s floral market and is primarily cultivated in Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. This hardy plant thrives in tropical climates and is popular in floral decorations, urban gardens and traditional medicine. Its antioxidant-rich flowers are used to treat ailments such as coughs, diabetes and respiratory issues, while its stems and leaves have anti-inflammatory properties. Additionally, in China, Gomphrena is used as a green organic sulfur fertilizer to improve soil health

(Wang *et al.*, 2009). Gomphrena plants can be grown in pots, garden beds, borders, and rockeries. Besides using a single color, mass planting can create eye-catching color combinations, such as magenta and white or pink and white. Potted Gomphrena is an excellent option for urban dwellers living in flats without traditional gardens and is also ideal for indoor decoration.

Plant growth regulators (PGRs) like GA₃, NAA, BA, paclobutrazol and cycocel are known to enhance ornamental traits by promoting growth, flowering, and longevity (Singh *et al.*, 2013; Yadav *et al.*, 2005). Limited research exists on the impact of PGRs on Gomphrena, so this experiment aims to assess their effects on its growth, flower yield and physiological attributes.

Materials and Methods

This study was conducted at the Floriculture block of Dr. YSRHU - College of Horticulture, Anantharajupeta, Annamayya district, Andhra Pradesh, in 2024, to evaluate the performance of the Gomphrena cultivar 'Vemagiri Local.' The experiment followed a Randomized Block Design (RBD) with sixteen treatments with three replications. These treatments were applied at 30 days after transplanting (DAT). Healthy and uniform 30 days-old seedlings were transplanted into polybags. The observations were recorded at different crop growth stages *viz.*, 30, 60 and 90 days after transplanting.

Vegetative and physiological attributes

Vegetative characters like number of leaves plant⁻¹, leaf length (cm), leaf width (cm), stem girth (mm) and physiological parameters like photosynthetic rate ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), stomatal conductance ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$), transpiration rate ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$) and total chlorophyll content (SPAD readings) were measured.

Flowering attributes

Flowering traits, such as days taken for 50% flowering (days) was recorded from the date of transplanting, duration of flowering (days) was recorded by counting the number of days taken from the first flowering to the last flowering, stalk length (cm) and flower yield (g plant^{-1}) at each harvest were recorded. For the fresh weight of flower, five fully opened flowers from each treatment were harvested and weighed on an electronic balance. The average weight was calculated and recorded in grams. The dry weight of flower was measured by collecting five fully opened fresh flowers from each treatment and placed in a hot air oven at 70°C for six hours and expressed in grams.

Results and Discussion

Vegetative and Physiological attributes

The data related to vegetative attributes like number

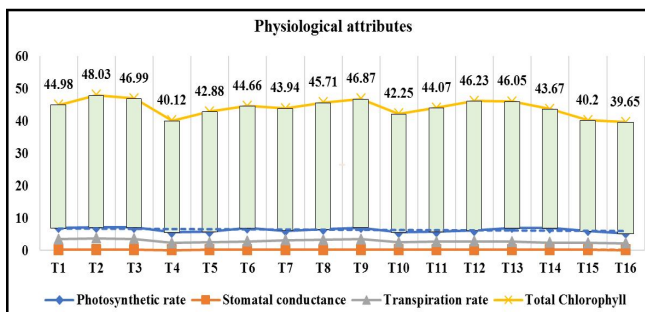


Fig. 1: Photosynthetic rate, stomatal conductance, transpiration rate and total chlorophyll content (SPAD values) of gomphrena as influenced by different growth regulators at 90 DAT.

Table 1: Number of leaves plant⁻¹, leaf length (cm), leaf width (cm) and stem girth (mm) of gomphrena as influenced by different growth regulators at 90 DAT.

Treatments	Number of leaves plant ⁻¹	Leaf length (cm)	Leaf width (cm)	Stem girth (mm)
T ₁	58.33	10.08	3.51	35.73
T ₂	62.60	10.52	4.04	36.67
T ₃	60.44	10.23	3.70	36.33
T ₄	51.56	9.76	3.27	32.51
T ₅	52.44	9.82	3.34	32.97
T ₆	53.67	9.96	3.40	33.17
T ₇	54.11	9.56	3.25	34.44
T ₈	54.67	9.61	3.28	34.66
T ₉	55.44	9.67	3.32	34.87
T ₁₀	56.56	9.12	3.20	32.39
T ₁₁	57.45	9.03	3.18	31.80
T ₁₂	57.78	8.89	3.15	31.44
T ₁₃	56.33	9.43	3.25	34.01
T ₁₄	56.00	9.31	3.22	33.81
T ₁₅	55.89	9.22	3.20	33.37
T ₁₆	50.00	8.84	3.14	30.74
S. Em±	2.07	0.16	0.14	0.72
CD @ 5%	5.99	0.46	0.42	2.07

of leaves plant⁻¹, leaf length (cm), leaf width (cm) and stem girth (mm) was indicated in (Table 1). Physiological attributes like photosynthetic rate, stomatal conductance, transpiration rate and total chlorophyll content were expressed in (Fig. 1.).

Number of leaves plant⁻¹

At 90 DAT, T₂ (62.60) showed the maximum number of leaves plant⁻¹, which was comparable to T₃ (60.44), T₁ (58.33), T₁₂ (57.78) and T₁₁ (57.45) followed by T₁₀ (56.56), while the minimum number of leaves plant⁻¹ was registered in T₁₆ (50.00). The rise in leaf count per plant is attributed to the optimal application of GA₃, which enhances protein and carbohydrate biosynthesis, stimulating leaf primordia development from the shoot apical meristem (Aparna *et al.*, 2018). This promotes vegetative growth, as seen in gladiolus (Sable *et al.*, 2016), calendula (Khudus *et al.*, 2017), chrysanthemum (Choudhari *et al.*, 2018) and in marigold (Maurya *et al.*, 2023).

Leaf length and width (cm)

The longest leaf length was recorded in T₂ (10.52 cm), which was similar to T₃ and T₁ (10.23 cm and 10.08 cm, respectively) followed by T₆ (9.96 cm), while the shortest leaf length was noticed in T₁₆ (8.84 cm) at 90 DAT. At 90 DAT, leaf width was found to be maximum in T₂ (4.04 cm), which was on par with T₃ (3.70 cm)

followed by T_1 (3.51 cm), whereas T_{16} (3.14 cm) showed the minimum leaf width.

The observed increase in leaf width with GA_3 application aligns with findings (Singh *et al.*, 2013) in gladiolus and chrysanthemum (Sharifuzzaman *et al.*, 2011). It enhances leaf length and width by promoting cell elongation and division. Additionally, reported that GA_3 application in China Aster (Maurya and Singh, 2018) likely expanded leaf area due to the development of thicker mesophyll tissues. This increase in tissue thickness was linked to higher chlorophyll content, enabling the leaves to remain photosynthetically active for a prolonged period.

Stem girth (mm)

The maximum stem girth was noticed in T_2 (36.67 mm), which was statistically on par with T_3 , T_1 , T_9 and T_8 (36.33 mm, 35.73 mm, 34.87 mm and 34.66 mm, respectively) followed by T_7 (34.44 mm), while T_{16} showed minimum stem girth (30.74 mm) at 90 DAT. The application of GA_3 increases stem girth by promoting cell elongation and division, especially in the vascular cambium, resulting in thicker stems. This stimulation supports the formation and activity of the vascular cambium, which produces secondary xylem and phloem tissues. Additionally, increased lignin deposition strengthens the stem, enhancing its structural integrity. Similar results were found by Kumar *et al.*, (2012) in cut roses, Sethy *et al.*, (2016) in ornamental sunflower and Maurya *et al.*, (2023) in marigold.

Physiological attributes

At 90 DAT, T_2 documented a maximum photosynthetic rate ($7.20 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), which was at par with T_3 , T_9 , T_1 and T_{13} (7.16 , 7.08 , 7.06 and $7.05 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$), whereas the minimum was registered in T_{16} ($5.31 \mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$). The treatment T_2 ($0.24 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$) registered maximum stomatal



Fig. 2: Stalk length (cm) of gomphrena as influenced by different growth regulators.

Table 2: Days taken for 50% flowering (days), duration of flowering (days), fresh weight of flower (g), dry weight of flower (g) and flower yield (g plant⁻¹).

Treatments	DIF	DF	FWF	DWF	FF
T_1	45.67	38.00	5.97	2.25	100.15
T_2	44.33	41.89	7.06	2.69	126.06
T_3	45.33	39.22	6.53	2.34	114.89
T_4	47.67	41.22	5.11	1.78	75.91
T_5	47.00	42.33	5.27	1.84	89.04
T_6	46.33	44.00	5.68	2.02	95.87
T_7	49.00	38.44	4.99	1.59	80.69
T_8	48.67	40.22	5.08	1.67	85.09
T_9	48.41	41.78	5.63	2.13	99.36
T_{10}	48.00	37.78	6.20	2.16	119.74
T_{11}	48.33	39.00	6.71	2.42	124.30
T_{12}	48.40	40.89	7.32	2.75	143.91
T_{13}	46.67	47.67	7.39	3.08	137.09
T_{14}	47.00	46.00	6.62	2.44	120.39
T_{15}	48.33	44.56	5.93	2.18	106.38
T_{16}	49.33	36.00	4.62	1.52	72.47
S. Em±	0.41	0.19	0.15	0.11	1.94
CD @ 5%	1.18	0.56	0.43	0.31	5.62

DTF: Days taken for 50% flowering (days); DF: Duration of flowering (days); FWF: Fresh weight of flower (g); DWF: Dry weight of flower (g); FF: Flower yield (g plant⁻¹)

conductance, which was comparable to T_3 and T_9 (0.23 and $0.23 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$, respectively), whereas the minimum stomatal conductance was recorded in T_{16} ($0.16 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$) at 90 DAT.

At 90 DAT, transpiration rate was registered maximum in T_2 ($3.81 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$), which was similar to T_3 , T_1 , T_9 and T_8 (3.64 , 3.53 , 3.47 and $3.31 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$) followed by T_7 (BA @ 100 ppm) ($3.22 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$), whereas the minimum transpiration rate was recorded in T_{16} ($2.27 \text{ mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$).

Photosynthesis relies on CO_2 assimilation, stomatal conductance, chlorophyll content, and transpiration rate (Chandel *et al.*, 2023). GA_3 enhances chlorophyll content and carbohydrate levels, boosting photosynthetic efficiency and assimilate redistribution in calla lily. It also increases ribose and alpha-amylase activity, strengthening source-sink dynamics. GA_3 promotes potassium and glucose accumulation in guard cells, improving stomatal function and conductance. Similar effects were observed in lettuce (Miceli *et al.*, 2019), spinach (Gong *et al.*, 2021) and gerbera and lily (Othman *et al.*, 2021).

GA_3 -treated plants show increased transpiration and water use due to higher stomatal conductance, enhancing CO_2 assimilation, dry matter production and water use efficiency (Miceli *et al.*, 2019) in lettuce. Similar results were noted in strawberry (Sekhar *et al.*, 2021) and

mustard (Iqbal *et al.*, 2022). GA₃ also boosts chlorophyll content by delaying degradation, promoting biosynthesis, and stabilizing thylakoid membranes. It improves membrane stability, slowing senescence and protecting chloroplasts.

Total chlorophyll content (SPAD Chlorophyll Meter Readings)

At 90 days after transplanting, T₂ showed the highest chlorophyll content (48.03), which was statistically comparable to T₃ (46.99) and T₉ (46.87), with T₁₂ following closely at 46.23. The lowest chlorophyll content was observed in the control treatment T₁₆ (39.65). Enhanced root permeability aids nutrient uptake and assimilate transport, supporting chlorophyll formation and protein synthesis (Aparna *et al.*, 2018) in Chrysanthemum. Similar findings are reported by Taheri-Shiva *et al.*, (2014) in oriental hybrid lily, Choudhari *et al.*, (2018) in chrysanthemum and Patel *et al.*, (2020) in hibiscus.

Flowering and yield attributes

The data corresponding to flowering and yield attributes as influenced by different growth regulators was represented in (Table 2).

Days taken for 50% flowering (days)

T₂ took the shortest time to attain 50% flowering (44.33 days), which was comparable to T₃ (45.33 days), followed by T₁ (45.67 days). T₁₆ exhibited the longest time to reach 50% blooming (49.33 days). GA₃ application led to 50% earlier flowering, likely due to enhanced nutrient transfer and improved CO₂ fixation supporting floral bud development (Shirsat *et al.*, 2021) in gaillardia.

Duration of flowering (days)

T₁₃ exhibited the longest flowering period (47.67 days), which was much longer than the other treatments, followed by T₁₄ (46.00 days) and T₁₅ (44.56 days), which was similar to T₆ (44.00 days). The shortest flowering period was reported in T₁₆ (36.00 days). Cycocel prolongs flowering duration by inhibiting gibberellin synthesis, which reduces stem elongation and overall vegetative growth. This results in a compact plant form and extends the reproductive phase. Delayed flowering and an extended flowering period due to cycocel application have been reported in chrysanthemum (Badge *et al.*, 2017), Nerium (Kumar *et al.*, 2019).

Stalk length (cm)

Stalk length was documented maximum in T₂ (18.39 cm), which was on par with T₃, T₁ and T₆ (17.87 cm, 16.50 cm and 15.42 cm, respectively) followed by T₅ (14.81 cm), whereas T₁₂ resulted in minimum stalk length (11.04 cm) as represented in Fig. 2. The longer flower

stalk may be attributed to rapid internode elongation, higher cell division and increased cell elongation in the intercalary meristem (Ara *et al.*, 2022) in chrysanthemum. The application of GA₃ could lead to increased stalk length by shifting photosynthesis to the flower due to higher sink demand, along with promoting faster cell proliferation and elongation (Singh *et al.*, 2022) in China Aster. Similar findings were reported by Mounika *et al.*, (2019) in Chrysanthemum and Kousika *et al.*, (2021) in Marigold.

Fresh weight and dry weight of flower (g)

The data revealed that T₁₃ produced the highest fresh weight of the flowers (7.39 g), which was comparable to T₁₂ (7.32 g), T₂ (7.06 g) followed by T₁₁ (6.71 g). T₁₆ showed the lowest fresh flower weight (4.62 g). The highest dry weight of the flowers was recorded in T₁₃ (3.08 g), followed by T₁₂ (2.75 g) and it was comparable to T₂ and T₁₄ (2.69 g and 2.44 g, respectively). T₁₆ recorded the lowest dry weight of the flowers (1.52 g).

Cycocel application in chrysanthemum enhances floral weight by promoting metabolite accumulation and reserve food availability for reproductive growth (Vaghasia & Polara, 2016). It also stimulates secondary branching, aiding carbohydrate buildup for flower bud induction (Soliman *et al.*, 2022). Comparable results are reported by Majeed *et al.*, (2017) and Sikarwar and Vikram (2017) in marigold, Ghatas (2016) in chrysanthemum and Sharma and Collis (2017) in petunia. Similar findings related to dry weight of the flower have been observed by Dhanasekaran (2018) in jasmine.

Flower yield (g plant⁻¹)

In comparison to other treatments, T₁₂ documented the highest flower yield (143.91 g plant⁻¹), followed by T₁₃ (137.09 g plant⁻¹), T₂ (126.06 g plant⁻¹), and T₁₁ (124.30 g plant⁻¹). T₁₆ registered the lowest flower yield (72.47 g plant⁻¹). Paclobutrazol improves flower production by redirecting energy from vegetative to reproductive growth, enhancing bud formation and stress tolerance. Both growth regulators significantly increased flower yield compared to control (Rajyalakshmi and Rajasekhar, 2014).

Conclusion

Foliar application of GA₃ at 200 ppm significantly enhanced vegetative growth and physiological traits in *Gomphrena globosa* L. Cycocel at 1000 ppm improved flower weight and longevity, while paclobutrazol at 80 ppm maximized flower yield by promoting greater plant spread, branching, and flower production. These findings highlight the potential of specific growth regulators in

optimizing growth and floral traits.

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