

Optimizing Growth Dynamics and Vase Life Extension of Daffodil (*Narcissus Tazetta L. Var. Orientalis 'Double Roman'*) Through High-Dose Compost and GA₃ Pre-Treatment

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ABSTRACT: To promote the growth of the crop and floral quality, sustainable floriculture is based on environment friendly agronomic management, including the use of organic substrates for soil preparation and bulb priming with phytohormones. The effect of individual and combined application of organic compost incorporation and gibberellic acid (GA₃) bulb priming on morpho-physiological traits, phenology and post-harvest flowering longevity of daffodil (*Narcissus tazetta L. var. Orientalis 'Double Roman'*) was evaluated. A pot experiment was designed to assess the contribution of the two factors in a two-factor factorial Scheme (3 × 3) with a Completely Randomized Design (CRD) with three replications. Three compost rates (0%, 20%, and 40% w/w) and three concentrations of GA₃ (0, 100, and 200 mg L⁻¹) were used in the experimental treatments. Analysis of variance showed statistically significant main and interaction effects ($P \leq 0.05$) for all the parameters evaluated. The substrate enrichment with 40% compost (C₄₀) showed the significant better performance than the lower rates and produced the highest mean values for the plant height (40.13 cm), the number of leaves (4.98 leaves plant⁻¹), the length of the leaves (53.83 cm), the width of the leaves (2.35 cm), the emergence time (9.28 days) and the flowering period (15.12 days). In the same way, the mean values of plant height (39.20 cm), plant leaves (5.00 leaves plant⁻¹), leaf length (55.50 cm), leaf width (2.38 cm), emergence duration (9.50 days) and flowering longevity (13.17 days) were the highest with bulb priming by 200 mg L⁻¹ GA₃ (G₂₀₀). The synergistic effect of 40% compost incorporation with 200 mg L⁻¹ GA₃ priming (C₄₀ × G₂₀₀) resulted in highest overall performance for all traits investigated such as plant height (45.80 cm), leaf number (5.72 leaves plant⁻¹), leaf length (62.50 cm), leaf width (2.62 cm), emergence duration (11.20 days) and flowering longevity (15.35 days) compared to dual control (C₀ × G₀). The results presented here show that incorporating 40% organic compost and bulb priming with 200 mg L⁻¹ GA₃ offers an important, sustainable agronomic solution for better commercial daffodil production, cut flower vase life and the reduction in reliance on inorganic synthetic fertilizers for the commercial production of daffodils.

KEYWORDS: *Narcissus tazetta var. Orientalis*, Phyto-priming, Gibberellic acid (GA₃), Flowering longevity, Vegetative architecture, and Compost made from Palm fronds.

INTRODUCTION

The floriculture is one of the most dynamic and profitable sectors in modern horticulture which is one of the most important sectors for enhancing agricultural economy and rural livelihoods worldwide (Adebayo et al., 2020). Hurrell (2016) states that high quality cut flowers are a large export commodity in the international market. Faust and Dole (2021) have extensively detailed the global trade structure and important market distribution hubs within countries like the Netherlands, France, Belgium, and Greece. *Narcissus* is a genus of geophytes with high cultural, historical and symbolic value in different societies, among the various ornamental geophytes, (Liu and Liao, 2025). It is a valuable plant greatly used for ornamental purposes and floral displays within the Amaryllidaceae family (Maryam and Gul, 2025). In addition to its ornamental use, *Narcissus* can be used as a valuable source of aromatic extracts and essential oils, used in many cosmetics, perfumes, and pharmaceutical preparations (Breiterová et al., 2020).

Groom (2012) performed phytochemical analysis of daffodil tissues, revealing the production of a variety of active chemicals: cinnamyl derivatives, eugenol and alcohols. Boshra et al. (2022) further profiled these extracts and were able to detect benzoic acid and functional benzaldehydes. Interestingly, the benzaldehydes found in *Narcissus* have shown exceptional anti-cancer activity (Mazumder et al., 2020), and significant anti-tumor bioactivities (Ibrahim et al., 2022). Although it is well known to be a commercial crop, propagation and field production of *Narcissus* is often limited by physiological constraints, such as its extended bulb endodormancy (Lee and Elston, 2023).

The developmental drawbacks experienced can be solved by applying exogenous (synthetic) plant growth regulators (PGRs) which are common agronomic practice to boost metabolism (Al-Khafaji, 2014). The effectiveness of PGRs in improving the germination dynamics was highlighted by Farman et al. (2019); and Carlos et al. (2021) reported the ability of PGR to promote the speed of the first establishment of seedlings. Of these regulators, gibberellic acid (GA₃) is one of the main phytohormones which play a key role in controlling cell division, metabolism and morphogenesis (Shah et al., 2023). GA₃ treatment has been shown to enhance leaf area growth and biomass production (Muniandi et al., 2018), stimulate stem elongation, ion movement, and germination potential (Lupepsa et al., 2024). The effects of these physiological changes are mostly mediated by the GA₃-induced cell wall loosening and activation of α -amylase (Asami and Nakagawa, 2018) and by the improvement of specific

carboxylase hydrolytic activities (Kosakivska and Vasyuk, 2021). Moreover, GA₃ pre-treatment is also known to break seed dormancy (Situma et al., 2015) and has been shown to be effective in breaking dormancy in ornamental geophytes' bulbs (Jokar and Asil, 2021).

At the same time, modern floriculture has to face the environmental problems of the overuse of synthetic fertilizers (Tagkas et al., 2024), as well as the related problems of human health (Jote, 2023). Sustainable inorganic N fertilization results in high soil nitrogen mineralization rate, which causes nitrate build-up in agricultural soils and creates serious health problems, including renal failure and carcinogenesis (Kesarwani et al., 2024). This highlights the need for sustainable soil amendments especially compost. The use of compost enriches the soil and results in improved soil physical architecture than inorganic chemical fertilizer (Chaudhari et al., 2021) and hence better overall plant growth potential than inorganic chemical fertilizer (Bamdad et al., 2022).

While the individual physiological advantages of GA₃ bulb priming and compost fertilization are well established, their interactive, integrated effects on *Narcissus tazetta* require further quantification. Building upon our earlier findings (Abood et al., 2026), which demonstrated the positive baseline effects of 30% organic compost and 100 mg L⁻¹ GA₃ bulb priming on daffodil growth and flowering, the present study expands this research line by evaluating higher application thresholds (up to 40% compost and 200 mg L⁻¹ GA₃). The objective is to evaluate maximum growth responsiveness, potential synergistic saturation points, and extended post-harvest flowering longevity in *Narcissus tazetta* L. var. *Orientalis* 'Double Roman', thereby identifying an optimized sustainable protocol for commercial daffodil production.

MATERIALS AND METHODS

Experimental Site and Plant Material

This pot experiment was carried out in the fall 2023 and spring 2024 seasons at Al Mussaib Technical College, Department of Plant Production Techniques, Babil Governorate, Iraq. Healthy and uniform bulbs of daffodil (*Narcissus tazetta* var. *orientalis* 'Double Roman') were provided from certified commercial growers in Mersin, Turkey. *N. tazetta* plants were investigated for their growth, phenological development, and quality of flowers with different levels of organic compost amendments and phytohormonal bulb priming.

Experimental Design and Treatment Combinations

The study was arranged in a two-factor factorial scheme (3 × 3) using a Completely Randomized Design (CRD) with three replications. The experimental factors consisted of:

1. Organic Compost Incorporation Levels (C): Palm frond compost was incorporated into the base potting mix at three weight-based proportions (w/w):

- C₀: 0% compost (unamended base medium)
- C₂₀: 20% compost (w/w)
- C₄₀: 40% compost (w/w)

2. Gibberellic Acid (GA₃) Bulb Priming (G): Bulbs were pre-soaked for 24 hours prior to planting in aqueous GA₃ solutions at three concentration levels:

- G₀: 0 mg L⁻¹ (distilled water control)
- G₁₀₀: 100 mg L⁻¹ GA₃
- G₂₀₀: 200 mg L⁻¹ GA₃

Combining three compost rates with three GA₃ priming levels yielded 9 distinct treatment combinations (3 × 3 factorial layout).

Table 1. Chemical and Physicochemical Characterization of the Formulated Palm Frond Compost Substrate

Parameter	Unit	Value
Electrical Conductivity (EC _{1:10})	dS m ⁻¹	4.65
pH (1:10)	—	7.35
Total Nitrogen (Total N)	%	2.24
Available Potassium (K)	mg kg ⁻¹	235.00
Organic Matter (O.M.)	%	75.80
Organic Carbon (C)	%	43.95
Carbon-to-Nitrogen Ratio (C/N)	—	19.6:1

Table 2. Physicochemical Properties of the Growth Substrate

Parameter	Value	Unit
Electrical Conductivity (EC _e)	2.85	dS m ⁻¹
pH	7.25	—
Available Nitrogen (N)	18.50	mg kg ⁻¹
Available Phosphorus (P)	12.10	mg kg ⁻¹
Available Potassium (K)	170.20	mg kg ⁻¹
Organic Matter (O.M.)	9.80	%
Sand	60.00	%
Silt	25.00	%
Clay	15.00	%
Soil Texture Class	Sandy loam	—

Planting and Crop Management

The primed bulbs were planted one by one in plastic pots (24 × 23 cm) containing 7 kg of growing substrate on November 10, 2023. Bulbs were planted at the same planting depth and covered with the substrate and watered as necessary to keep the soil moisture at optimum levels. Weeding was done on a regular basis by hand. A balanced NPK foliar fertilizer (Brusol) was applied in uniform, every two weeks, to avoid any nutrient deficiency.

The chemical properties of palm frond compost and physical and chemical properties of the base substrate are presented in Tables 1 and 2, respectively.

Morpho-Phenological Data Collection

-Emergence Duration (Days): Recorded as the total days from planting (November 10, 2023) to visible shoot emergence above the substrate surface.

-Plant Height (cm): Measured vertically from the substrate surface to the top of the floral apex.

-Leaf Number per Plant: Total functional green leaves counted manually at full vegetative maturation.

-Leaf Length (cm) and Width (cm): Evaluated using a metric scale and ruler on fully expanded leaves.

-Flowering Longevity (Days): Determined by harvesting two representative inflorescences per unit at early morning anthesis, placing cut stems in vessels containing 100 mL distilled water under room temperature (27°C), and recording display validity days following Hassan.(2005)

Statistical Analysis

The two-way Analysis of Variance (ANOVA) under the CRD framework was used to analyze data. The Least Significant Difference (LSD) at $P \leq 0.05$ (Al-Sahuki and Waheeb, 1990) was used for the treatment means comparison.

RESULTS

Plant Height (cm) Dynamics

The analysis of variance showed significant individual and interactive effects ($P \leq 0.05$) of organic compost application and gibberellic acid (GA_3) bulb priming on the average plant height of daffodil plants (Table 3).

As far as the main effect of compost fertilization, the higher rate of compost incorporation in the substrate the greater increase in plant height. The mean plant height was the highest under 40% compost (C_{40}) with the least height in the unamended control (C_0) (30.62 cm).

In the same way, a pre-soaking of the bulbs with GA_3 strongly promoted growth in the vertical direction in a concentration-dependent way. The bulbs primed with 200 mg L⁻¹ GA_3 had the highest plant height with an average of 39.20 cm whereas the bulbs primed with 100 mg L⁻¹ GA_3 had an average of 35.53 cm and the un-primed control (G_0) had the minimum plant height of 30.52 cm.

The combined effect of 40% compost incorporation and 200 mg L⁻¹ GA_3 bulb priming ($C_{40} \times G_{200}$) showed a synergistic effect and gave the maximum plant height (45.80 cm). The dual-control treatment ($C_0 \times G_0$) gave the smallest average height of plant (26.85 cm) (Table 3).

Table 3. Mean Plant Height (cm) of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA_3 Bulb Priming, and Their Interaction

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	26.85	31.40	33.60	30.62
20	30.20	35.10	38.20	34.50
40	34.50	40.10	45.80	40.13
Average	30.52	35.53	39.20	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	1.15	1.15	1.98	

Average Leaf Count per Plant

The main and interaction effects of the organic compost amendments and the gibberellic acid (GA_3) bulb priming on the average number of leaves per plant were significant ($P \leq 0.05$) according to statistical analysis (Table 4).

As for the main effect of the organic fertilization, the leaf count was significantly highest (4.98 leaves plant⁻¹) in the 40% compost (C_{40}) than that of the unamended control (C_0 ; 4.35 leaves plant⁻¹).

In terms of phytohormonal priming, the foliar initiation was greatly enhanced by GA_3 in a concentration-dependent manner. The 200 mg L⁻¹ GA_3 (G_{200}) resulted in the maximum mean leaf count (5.00 leaves plant⁻¹) compared to 100 mg L⁻¹ GA_3 (4.55 leaves plant⁻¹) and un-primed (G_0 ; 4.28 leaves plant⁻¹).

For the interaction effect ($C \times G$), the combined treatment of 40% compost incorporation and 200 mg L⁻¹ GA_3 bulb priming ($C_{40} \times G_{200}$) significantly outperformed all other treatments, yielding the maximum leaf number (5.72 leaves plant⁻¹). Conversely, the dual control ($C_0 \times G_0$) resulted in the lowest leaf number per plant (4.19 leaves plant⁻¹) (Table 4).

Table 4. Mean Number of Leaves per Plant of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA₃ Bulb Priming, and Their Interaction

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	4.19	4.35	4.52	4.35
20	4.28	4.45	4.75	4.49
40	4.38	4.85	5.72	4.98
Average	4.28	4.55	5.00	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	0.11	0.11	0.19	

Effect of Treatments on Average Emergence Duration (Days)

It is found from the results presented in Table 5 that both experimental factors (separately and in combination) had a statistically significant effect ($P \leq 0.05$) on the time for shoot emergence in daffodil bulbs.

Concerning the major effect of organic fertilization, the C₄₀ (40% Compost) treatment showed the longest mean emergence time (9.28 d) while the unamended control treatment (C₀) had the shortest mean emergence time (7.76 d).

Pre-soaking with gibberellic acid (GA₃) also had a significant effect on the emergence kinetics with respect to phytohormonal bulb priming. The average number of days needed for a shoot to emerge from the bulbs was 9.50 days for G₂₀₀, 100 mg L⁻¹ GA₃ (8.12 days) and un-primed control (G₀) (7.80 days).

The treatment of 40% compost and 200 mg L⁻¹ GA₃ bulb priming (C₄₀ × G₂₀₀) had the longest emergence duration with an average of 11.20 days for the interaction effect (C × G). In contrast, dual control treatment (C₀ × G₀) had the earliest shoot emergence, with just 7.29 days (Table 5).

Table 5. Mean Shoot Emergence Duration (Days) of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA₃ Bulb Priming, and Their Interactive Effects

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	7.29	7.60	8.40	7.76
20	7.95	8.25	8.90	8.37
40	8.15	8.50	11.20	9.28
Average	7.80	8.12	9.50	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	0.26	0.26	0.45	

Mean Leaf Length (cm)

The results of the statistical analyses showed significant interactive and individual effects of organic compost application and gibberellic acid (GA₃) bulb priming on the average leaf length of daffodil plants (Table 6).

Concerning the main effect of compost fertilization, leaf elongation of 40% compost (C₄₀) produced the maximum average leaf length (53.83 cm) with the shortest leaf length obtained from unamended control treatment (C₀) (46.26 cm).

In terms of phytohormonal bulb priming, pre-soaking with GA₃ had a significant effect on stimulating foliar longitudinal growth, with a concentration-dependent effect. The G₂₀₀ treatment (200 mg L⁻¹ GA₃) gave maximum mean leaf length (55.50 cm), followed by 100 mg L⁻¹ GA₃ (49.70 cm) and then the un-primed control (G₀) (44.40 cm).

The interaction effect (C × G) showed a significant synergistic effect with the combined effect of 40% compost incorporation and 200 mg L⁻¹ GA₃ bulb priming (C₄₀ × G₂₀₀) that resulted in the longest leaf length (62.50 cm). On the contrary, the dual-control treatment (C₀ × G₀) yielded the shortest average leaf length of 42.19 cm (Table 6).

Table 6. Mean Leaf Length (cm) of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA₃ Bulb Priming, and Their Interaction

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	42.19	46.50	50.10	46.26
20	44.80	49.80	53.90	49.50
40	46.20	52.80	62.50	53.83
Average	44.40	49.70	55.50	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	1.75	1.75	3.03	

Average Leaf Width (cm)

The results of the statistical evaluation showed that organic compost fertilization and gibberellic acid (GA₃) bulb priming had significant individual and interactive effect ($P \leq 0.05$) on the mean leaf width of daffodil plants (Table 7).

As to the main effect of the application of compost substrate, the treatment with C₄₀, 40% compost, significantly increased the width of leaf blade, with the highest average value of 2.35 cm, compared to the unamended control (C₀), which had the narrowest leaf blade (2.03 cm).

From the point of view of phytohormonal priming, lateral leaf development was strongly stimulated by a GA₃ pre-soaking which was concentration dependent. Bulbs treated with 200 mg L⁻¹ GA₃ (G₂₀₀) gave the highest mean leaf width (2.38 cm) significantly higher than 100 mg L⁻¹ (2.18 cm) and un-primed control (G₀) which gave the lowest mean leaf width of 1.97 cm.

When both 40% compost incorporation and 200 mg L⁻¹ GA₃ bulb priming were evaluated, 40% C and 200 mg L⁻¹ GA₃ (C₄₀ × G₂₀₀) showed a significant synergistic effect with the maximum leaf width being produced (2.62 cm). The dual control treatment (C₀ × G₀) on the other hand, had the lowest mean leaf width of 1.83 cm (Table 7).

Table 7. Mean Leaf Width (cm) of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA₃ Bulb Priming, and Their Interaction

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	1.83	2.08	2.18	2.03
20	1.95	2.16	2.33	2.15
40	2.12	2.30	2.62	2.35
Average	1.97	2.18	2.38	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	0.06	0.06	0.11	

Mean Flowering Age and Pre-Anthesis Period (Days)

The use of organic compost fertilization and gibberellic acid (GA₃) bulb priming significantly affected the average flowering age (longevity) of daffodil flowers both individually and interactively ($P \leq 0.05$) (Table 8).

The main effect of compost application revealed that the substrate enriched with 40% compost (C₄₀) had the longest floral display longevity with an average of 15.12 days while the unamended (C₀) had the shortest floral display longevity (11.31 days).

In terms of phytohormonal bulb priming, pre-soaking using GA₃ in a concentration-dependent manner had a positive effect on the floral longevity. The flowering duration was the longest with the 200 mg L⁻¹ GA₃ treatment (13.17 days) compared to the 100 mg L⁻¹ GA₃ treatment (12.92 days) and the un-primed bulb (G₀) which had the lowest average flowering duration (12.81 days).

The interaction effect (C × G) showed that the combination of 40% compost incorporation and 200 mg L⁻¹ GA₃ bulb priming (C₄₀ × G₂₀₀) had a clear synergic effect, increasing the flowering age up to 15.35 days. Dual control treatment (C₀ × G₀) had the shortest flowering age of 10.78 days (Table 8).

Table 8. Mean Time to Flowering (Days) of *Narcissus tazetta* L. var. *Orientalis* 'Double Roman' as Influenced by Substrate Compost Incorporation, GA₃ Bulb Priming, and Their Interactive Effects

Compost (%)	Gibberellin (mg L ⁻¹)			Average
	0	100	200	
0	10.78	11.40	11.75	11.31
20	12.80	12.20	12.40	12.47
40	14.85	15.15	15.35	15.12
Average	12.81	12.92	13.17	
LSD _{0.05}	Compost	Gibberellin	Interaction	
	0.06	0.06	0.11	

DISCUSSION

In recent years, sustainable floriculture is increasingly based on eco-friendly agronomic practices such as soil conditioning by organic compost amendments, and metabolic priming by exogenous phytohormones, particularly gibberellic acid (GA₃), for optimizing the growth, developmental kinetics, and post-harvest quality of high-value geophytes (Adedayo et al., 2022; Jokar and Asil, 2021). The results of this investigation reveal that treatments of palm frond compost (0, 20 and 40%) and GA₃ bulb priming (0, 100 and 200 mg L⁻¹) significantly improved the morpho-physiological parameters, phenological development and display lifespan of *Narcissus tazetta* L. variety.

1. Physiological Mechanisms of Compost Fertilization

Palm frond compost incorporation significantly increased all the vegetative and reproductive parameters with the highest values observed at 40% (C₄₀). The comprehensive improvements of compost on the physicochemical and biological architecture of growing mediums can be credited for this promotional effect (Verma et al., 2024; Mooleki et al., 2004). Organic matter yields a better soil structure with the increase in cation exchange capacity (CEC), soil aggregation, porosity, and moisture holding capacity, which provides an optimum condition to rhizosphere for root development and absorption of nutrients (Ahmed et al., 2009; Chaudhari et al., 2021).

In addition, the mineralization in the compost is a continuous process and gradually provides macro and micronutrients, especially nitrogen (N), phosphorus (P) and potassium (K), throughout the life of the plant (Bamdad et al., 2022). Nitrogen is a key element in promoting vegetative vigor. N is an integral part of amino acids, proteins, nucleoproteins and nucleic acids and excess N availability directly increases cell division and apical meristematic activity (Hou et al., 2021; Brahimi, 2011). Nitrogen also stimulates the production of endogenous auxin in a synergistic manner with respect to cell wall expansion and stem elongation (Brahimi, 2011). Proper N levels stimulate the synthesis of the photosynthetic pigments in the photosynthetic apparatus and increase the efficiency of light harvesting, carbon assimilation and metabolic energy production (ATP and NADPH) needed for tissue maintenance and growth, as stated by Taiz et al., (2021).

2 .Biochemical Pathways of GA₃ Bulb Priming

Gibberellic acid pre-soaking greatly stimulated all growth criteria and was optimal at 200 mg L⁻¹ (G₂₀₀). In geophytes, gibberellic acid (GA) is a critical hormone involved in breaking dormancy and triggering the mobilization of storage carbohydrates in the bulb scales (Situma et al., 2015; Lupepsa et al., 2024). The activity of gene expression and the synthesis of hydrolytic enzymes, among which the hydrolysis of starch is performed by α -amylase, proteases and phosphatases, are induced by GA₃ priming, which breaks down the starch reserves in the form of insoluble granules into soluble mono- and disaccharides (Asami and Nakagawa, 2018; Lupepsa et al., 2024).

Emerging tissues have lower osmotic potential based on the accumulation of soluble sugars which promotes turgor-mediated cell extension and rapid structural elongation (Kosakivska and Vasyuk, 2021). The molecular mechanisms of GA₃ activity include the upregulation of cell wall loosening enzymes (CWLEs) including xyloglucan endotransglucosylase/hydrolases and expansins, activation of cellular division in sub-apical meristems, RNA and DNA replication and increased metabolism of nitrogen and protein assembly in expanding leaves (Shah et al., 2023; Kurve et al., 2018). The significantly higher values of plant height, leaf number, leaf length and leaf width in response to increasing levels of GA₃ can be explained by these sequential biochemical changes.

3 .Synergistic Interaction (C × G) on Vegetative Architecture

The combination of 40% compost amendment and 200 mg L⁻¹ GA₃ priming (C₄₀ × G₂₀₀) resulted in the highest overall values for plant height (45.80 cm), number of leaves (5.72 leaves plant⁻¹), leaf length (62.50 cm), and leaf width (2.62 cm). This interactive synergy shows how the two different systems of hormonal signaling and nutritional supply work hand in hand. The exogenous GA₃ supplies the metabolic components (energy) for cell division, tissue elongation and creation of sink strength while the enriched compost substrate supplies the structural components (N, P, K) and water needed for maintaining high photosynthetic output and high structural biomass accumulation. In addition, lacking of nutrition in the substrate may also reduce the hormonal stimulation. In contrast, high soil nutrient levels need hormone signals for the optimal uptake and structural allocation.

4 .Phenological Progression and Floral Longevity

The experimental treatments had a significant effect on phenological timing and floral senescence dynamics. The time to shoot emergence was increased at the highest rates (C₄₀ × G₂₀₀ = 11.20 days vs. 7.29 days for the control). The observed change in emergence kinetics in relation to the high level of organic and hormonal inputs may be due to altered relationship between sources and sinks and/or metamorphosis reconfiguration during the early bud differentiation period. Increased release of GA₃ and nutrients stimulate initial formation of organs and growth of underground tissues in the bulb before the onset of strong shoot elongation from the substrate surface (Jokar and Asil, 2021; Shah et al., 2023).

In terms of post-harvest performance, the treatment of 200 mg L⁻¹ GA₃ + 40 % compost resulted in highest vase life (C₄₀ × G₂₀₀ = 15.35 days) of cut flower compared to unamended control (C₀ = 10.78 days). The factors that control the floral longevity in cut geophytes include carbohydrate availability, osmotic balance and/or integrity of the membrane during anthesis (Hassan, 2005). Pre-harvest accumulation of soluble carbohydrates and mineral ions (K⁺ and Ca²⁺) occurs in floral scapes as a result of substrate compost incorporation, which regulate cellular osmotic potential, inhibit membrane lipid peroxidation, and minimize ethylene sensitivity during post-harvest phase (Ahmed et al., 2009; Tagkas et al., 2024). At the same time, GA₃ priming slows down the degradation of chlorophyll, stabilizes protein complexes, and prevents the loss of the homeostasis of hydrolytic enzymes in petal tissue (Breiterová et al., 2020; Lupepsa et al., 2024).

5 .Alignment with Literature and Broader Implications

The results of this research are consistent with and directly extend our previous findings (Abood et al., 2026), which established that baseline applications of 30% compost and 100 mg L⁻¹ GA₃ significantly improved N. tazetta growth metrics. The present findings demonstrate that elevating treatment levels to 40% compost and 200 mg L⁻¹ GA₃ further amplifies both vegetative performance (e.g., maximum leaf length reaching 62.50 cm compared to baseline levels) and post-harvest longevity (extending flower display to 15.35 days). These outcomes are also in line with broader literature on ornamental geophytes and cut flower species, including reports by Nasir (2017), Jokar and Asil (2021), El-Attar et al. (2023), who confirmed the synergistic efficiency of organic amendments combined with GA₃ priming in optimizing growth and post-harvest quality in Narcissus and related monocotyledonous cultivars. The combination of organic palm frond compost (40%) and the bulb priming with GA₃ (200 mg L⁻¹) is a practical and environmentally-friendly management protocol that benefits the production of commercial Narcissus tazetta and thereby lowers the reliance on synthetic inorganic fertilizers.

CONCLUSION

According to the results of the present study, the use of organic palm frond compost (OPC) as a growing medium and pre-soaking the bulbs with gibberellic acid (GA₃) led to significant effects on vegetative growth architecture, phenological dynamics and floral longevity of Narcissus tazetta L. var. Orientalis 'Double Roman'. The most significant improvements were achieved in all the measured morpho-physiological traits such as plant height, leaf number per plant, leaf length, leaf width, emergence duration, and post-harvest flowering longevity with the application of 40 compost (C₄₀) and 200 mg L⁻¹ GA₃ (G₂₀₀) on their own. Moreover, the effect of combined application of 40% compost incorporation and 200 mg L⁻¹ GA₃ pre-soaking (C₄₀ times G₂₀₀) was found to be very synergistic, leading to maximum structural vegetative development and cut flower vase life of 15.35days, as compared to 10.78 days in the unamended control. The findings suggest that organic waste recycling, when combined with hormonal

bulb priming, is an effective and sustainable agronomic approach to improve the commercial daffodil production, minimize the use of synthetic inorganic fertilizers and promote eco-friendly floricultural production.

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