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Influence of Integrated Nutrient Management on Yield and Economic Returns of Flower and Tuber Production in Dahlia (*Dahlia variabilis* L.) cv. Zail Singh

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ABSTRACT

This study evaluates the "Influence of Integrated Nutrient Management (INM) on Yield and Economic Returns of Flower and Tuber Production in Dahlia (Dahlia variabilis L.) cv. Zail Singh", conducted during the winter seasons of 2022–2023 and 2023–2024 at the Horticultural Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, UP. The experiment employed a Randomized Complete Block Design (RCBD) with 19 INM treatments replicated three times, integrating varying levels of chemical fertilizers, organic amendments, and bio-inoculants. Treatment T_{12} significantly enhanced flower production, achieving 20.33 and 25.00 flowers per plant, 241.75 and 243.17 flowers per plot, and 1,007,290 and 1,220,931 flowers per hectare. Corresponding flower yields were 696.79 g and 724.07 g per plant, 8.19 kg and 8.36 kg per plot, and 34.84 tons and 34.14 tons per hectare across the two seasons. Treatment T_{16} recorded superior tuber yields, with tuber weights of 900.00 g and 877.50 g per plant, 10.80 kg and 10.53 kg per plot, and 45.00 ton and 43.88 ton per hectare, alongside tuber diameters of 65.30 cm^2 and 68.98 cm^2. Treatment T_{17} achieved the highest cost-benefit ratios (4.47 and 4.26), with 9.83 and 12.17 tubers per plant and 116.08 and 146.00 tubers per plot. In contrast, 100% inorganic fertilizer (T_1) had a negligible impact on flower and tuber production. The study faced several challenges, including variability in soil nutrient content, climate fluctuations, and the complexity of effectively integrating different nutrient management practices. It highlights the effectiveness of combining organic and microbial inputs with reduced chemical fertilizers to improve yield and economic viability in dahlia cultivation.

Keywords: *Dahlia, Farmyard manure, Flowers, Integrated nutrient management, Poultry manure, Recommended dose of fertilizer, Vermicompost, Zail Singh*

1. Introduction

Dahlias, prized for their stunning blossoms and landscaping potential, are half-hardy, tuberous-rooted perennials. Native to Mexico, where they are the national flower, dahlias belong to the Asteraceae family. Known as the "king of flowers," [1], they symbolize optimism, confidence, and flamboyance [2]. The octoploid *D. variabilis* (n=64) is thought to have originated from tetraploid species with 32 chromosomes [3]. The Netherlands is a leading producer of tuberous-rooted dahlias [4], supplying 50 million tubers annually to global markets. The Dutch floriculture market is projected to reach 4.89 billion USD (United States dollars) by 2024 [5], with a compound annual growth rate (CAGR) of 4.70% during the forecast period. People use dahlias for both trimmed and loose blooms. Only specific countries have exploited the trade appreciation of the dahlia crop [6]. The Netherlands is a significant producer of tuberous-rooted dahlias, supplying 50 million tubers to international markets annually [7] [8]. Dahlias are cultivated for ornamental purposes because of their aesthetic qualities, essential for the ornamental industry.

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To enhance the quality of these aspects, it is necessary to ensure adequate rooting and vegetative growth, as well as to provide water, gas exchange, nutrient supply, and plant support [9].

Various factors, including environmental conditions and nutrient management, influence successful dahlia cultivation [10]. Integrated Nutrient Management (INM) is a sophisticated approach that addresses the complex nutritional needs of crops [11]. INM integrates crop residues, organic manures, inorganic fertilizers, and bio-fertilizers to establish a sustainable nutrient supply, enhancing both crop yield and soil health [12]. Organic manures, such as FYM (Farm yard manure), poultry manure, and vermicompost, improve soil structure, while inorganic fertilizers provide immediate nutrients [13]. Bio-fertilizers, including nitrogen-fixing bacteria, play a role in long-term nutrient management [14]. However, excessive use of inorganic fertilizers may harm soil and water quality by leaching into groundwater and waterways [15] [16]. Studies show that INM improves plant growth, flowering, tuber development, chlorophyll content, photosynthetic rate, nutrient uptake, and soil structure [17–20] as well as shown better growth and flowering of several flower crops like gladiolus [21-23], chrysanthemums [24], marigolds [25] [26], dahlia [27] and tuberoses [28].

However, earlier one study highlighted the effect of INM on the growth and flowering of dahlia [9] but failed to discuss the cost-benefit ratio for the economic production of dahlia under Western Uttar Pradesh, India conditions.

Because of the above facts, the present study was carried out to assess the impact of INM on the growth, flowering, and economic cultivation of dahlia.

2. Materials and methods

The current experiment was conducted in the Horticulture Research Centre at the Sardar Vallabhbhai Patel University of Agriculture and Technology in Meerut from 2022-2023 and 2023 to 2024. We acquired cuttings of Dahlia "*D. variabilis* L. cv. Zail Singh" from a local plant nursery in Kolkata in November. We employed various sources of macro- and micronutrients such as FYM, vermicompost, poultry manure, *Azotobacter*, *Azospirillium*, VAM (Vesicular Arbuscular Mycorrhiza), urea (46% N), SSP (Single Super Phosphate) (18% P), and MOP (Murat of Potash) (46% K). We retrieved these materials from the storage facility of the College of Horticulture at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. We calculated and administered a variety of inorganic fertilizer concentrations to dahlia plants at varying intervals. There were 19 treatments comprising T_1 Control (100% RDF), T_2 (75% RDF+2.5 ton/ha FYM+2 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_3 (75% RDF+2.5 ton/ha FYM+2 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_4 (75% RDF+0.83 ton/ha Vermicompost+2 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_5 (75% RDF+0.83 ton/ha Vermicompost+2 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_6 (75% RDF+0.41 ton/ha Poultry manure+ 2 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_7 (75% RDF+0.41 ton/ha Poultry manure +2 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_8 (50% RDF+5 ton/ha FYM+4 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_9 (50% RDF+5 ton/ha FYM+4 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_{10} (50% RDF+1.6 ton/ha Vermicompost+4 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_{11} (50% RDF+1.6 ton/ha Vermicompost+4 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_{12} (50% RDF+0.82 ton/ha Poultry manure+4 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_{13} (50% RDF+0.82 ton/ha Poultry manure+4 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_{14} (25% RDF+7.5 ton/ha FYM+6 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_{15} (25% RDF+7.5 ton/ha FYM+6 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_{16} (25% RDF+2.5 ton/ha Vermicompost+6 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_{17} (25% RDF+2.5ton/ha Vermicompost+6 Kg/ha *Azospirillium*+4.50 L/ha VAM), T_{18} (25% RDF+1.23 ton/ha Poultry manure+6 Kg/ha *Azotobacter*+4.50 L/ha VAM), T_{19} (25% RDF+1.23 ton/ha Poultry manure+6 Kg/ha *Azospirillium*+4.50 L/ha VAM). The experiment was arranged in an RCBD with three replications and nineteen treatments, resulting in a total population of 285 plants. We employed Analysis of Variances (ANOVA) to evaluate any discrepancies between the means of the collected data for soil health, flowering, and growth attributes [29]. We used Tukey's Honestly Significant Difference Test (HSD) test to compare significant means at a 5% probability level [30].

3. Results and Discussion

3.1. Effect of integrated nutrient management on flower yield of dahlia

The application of different combinations of organic, inorganic, and bio-fertilizers significantly influenced the flowering parameters of dahlia (*D. variabilis* L.) examined in the present study (Table 1 and Table 2). Treatment T_{12} (50% RDF+0.82 ton/ha Poultry manure+4 Kg/ha *Azotobacter*+4.50 L/ha VAM) was surpass other treatments in number of flowers per plant (20.33 and 25.00), number of flowers per plot (241.75 and 243.17), number of flowers per ha (1007290.06 and 1220931.00 lakh/ha), flower yield per plant (696.79 and 724.07gm/plant), flower yield per plot (8.19 and 8.36 kg/plot) and flower yield per hectare (34.84 and 34.14 ton/ha) in both of the year 2022-2023 and 2023-2024, respectively. However, treatment T_1 (100% RDF) was observed lower in term of number of flowers per plant (12.42 and 16.00), number of flowers per plot (150.58 and 150.83), number of flowers per ha (627429.55 and 804231.00 lakh/ha), flower yield per plant (310.12 and 322.23 gm/plant), flower yield per plot (3.60 and 3.72 kg/plot) and flower yield per hectare (15.51 and 15.01 ton/ha) in both of the years 2022-2023 and 2023-2024, respectively.

The combined treatment provides adequate nutrients, promoting growth through VAM and *Azotobacter*, and macronutrients via the half-dose of inorganic fertilizers. This enhances cell division, carbohydrate accumulation [31], flower production, and size [32] [19]. Adequate nitrogen, delivered through this integrated form, promotes early bud formation, faster protein synthesis, and accelerates floral development [33] [32]. The study also found that higher nitrogen and phosphorus levels boost flower size and number. Bio-fertilizers like *Azotobacter* and VAM convert nutrients such as nitrogen and phosphorus into available forms via processes like nitrogen fixation and rock phosphate solubilization [34]. Poultry manure, rich in nutrients such as nitrogen, phosphorus, potassium, and micronutrients, improves chlorophyll content, photosynthesis, soil fertility, aeration, water retention, nutrient absorption, and microbial activity [35–37]. Combining poultry manure with 50% RDF, *Azotobacter*, and VAM enhances flower initiation and quantity by facilitating nutrient uptake and cytokine transport to axillary buds. This breaks apical dominance, accelerating photosynthesis and transitioning the plant to the reproductive phase [38] [39]. In contrast, the T_1 treatment (100% RDF) resulted in fewer flowers and lower yields, likely due to insufficient macro and micronutrient supply. The current study is comparable with the experimental findings of the Asiatic lily [40] [41] in dahlia and [42] in marigold crop. Moreover, Binas et al. [43], Nada et al. [44], and Rajaselvam et al. [20] also revealed that the flower yield per hectare was significantly affected by poultry manure and inorganic fertilizer combinations in anthurium, calendula, and tuberose, respectively.

3.2. Effect of integrated nutrient management on tuber growth and yield of dahlia

The study evaluated the effect of various combinations of organic, inorganic, and bio-fertilizers on dahlia (*D. variabilis* L.) cv. Zail Singh. All applied treatments significantly affected the tuber growth and yield as compared to the plants, which were treated with control (100% RDF). Results in Table 3. exposed that fertilization of soil with treatment T_{17} (25% RDF+2.5 ton/ha Vermicompost+6 Kg/ha *Azospirillium*+4.50 L/ha VAM) was found best in the number of tubers per plant (9.83 and 12.17), number of tubers per plot (116.08 and 146.00) in both of the years 2022-2023 and 2023-2024, respectively. Moreover, Treatment T_{16} (25% RDF+2.5 ton/ha Vermicompost+6 Kg/ha *Azotobacter*+4.50 L/ha VAM) was examined best in weight of tuber per plant (900.00 and 877.50 gm/plant), the weight of tuber per plot (10.80 and 10.53 kg/plot), the weight of tuber per hectare (45.00 and 43.88 ton/ha), and tuber diameter (65.30 and 68.98 cm^2) in both of the years 2022-2023 and 2023-2024, respectively. But in term of fresh weight of tuber (90.19 gm and 95.32 gm), treatment T_{19} (25% RDF+1.23 ton/ha Poultry manure+6 Kg/ha *Azospirillium*+4.50 L/ha VAM) was recorded best in 2022-2023 and treatment T_{18} (25% RDF+1.23 ton/ha Poultry manure +6 Kg/ha *Azotobacter*+4.50 L/ha VAM) best in 2023-2024, respectively. However, treatment T_1 (100% RDF) was found to minimize in number of tubers per plant (8.00 and 8.58), weight of tuber per plant (365.71 and 367.66 gm/plant), weight of tuber per plot (4.39 and 4.41 kg/plot), weight of tuber per hectare (18.29 and 18.38 ton/ha), tuber diameter (43.10 and 45.86 cm^2), and fresh weight of tuber (48.14 and 50.74 gm) same in both of the years, respectively. Moreover, treatment T_{10} (50% RDF+1.6 ton/ha Vermicompost+4K g/ha *Azotobacter*+4.50 L/ha VAM) was recorded lower in number of tubers per plot (96.00 and 100.00) in both the years respectively.

The application of 25% RDF with 2.5 tons/ha vermicompost and bio-fertilizers (6 kg/ha *Azotobacter*, 6 kg/ha *Azospirillium*, and 4.50 L/ha VAM) in treatments T_{16} and T_{17} increased tuber weight, diameter, number, and yield. This integrated approach improved nutrient availability, root development, and photosynthesis, particularly phosphorus for better growth before tuber initiation [45] [46]. VAM symbiosis enhanced photosynthesis, increasing storage and export [47]. Phosphorus significantly influenced tuber yield, supporting cell division, enlargement, and photosynthesis [48] [49]. Vermicompost, *Azospirillium*, and VAM boost nutrient uptake, photosynthesis, and productivity, while insufficient phosphorus reduces bulb yield [50] [51]. Similar results were reported by Pandey et al*.* [45] in dahlia in terms of weight of tubers, number of tubers per plant, tuber yield per plant, and tuber yield per hectare.

3.3. Effect of integrated nutrient management on economic returns of flower and tuber production in dahlia

Results demonstrated that the different combination of organic manure and bio-fertilizer with different levels of inorganic fertilizers significantly affects the economic returns of dahlia flower and tuber production (Table 4 and Table 5). Treatment T_{17} (25% RDF+2.5 ton/ha Vermicompost+6 Kg/ha *Azospirillium*+4.50 L/ha VAM) was found best in cost-benefit ratio (4.47 and 4.26) in flower and tuber production in dahlia, in both of the years 2022-2023 and 2023-2024, respectively. However, treatment T_1 (100% RDF) recorded minimum cost-benefit returns (3.57 and 3.42) in both of the years 2022-2023 and 2023-2024, respectively. Similar results were found by Singh [52], Wararkar et al. [10], and Badgujar et al. [53] in the dahlia crop.

4. Conclusion

The study concludes that INM improves vegetative development and blooming of Dahlia (*D. variabilis* L.). Treatment T_{12} performed best in flower production was among its strengths. Treatment T_{17}, which had 25% RDF, vermicompost, *Azospirillium*, and VAM, had the maximum number of tuber production per plant number of tuber production per plot, and cost-benefit ratio. On the other hand, Treatment T_{16} promotes tuber growth and yield such as weight of tuber per plant, weight of tuber per plot, weight of tuber per hectare, and tuber diameter. However, Treating T_1 with 100% inorganic fertilizers failed to improve most metrics, highlighting the drawbacks of chemical fertilizers.

This study shows that organic amendments, bio-inoculants, and reduced chemical inputs improve flower and tuber production, and the cost-benefit ratio, making floriculture more sustainable, and balanced and doubling farmer's income.

Future Scope of the Study

This study further explores the long-term impacts of different nutrient management strategies on soil health and sustainability. Additionally, this could contribute to more sustainable farming and improved economic outcomes for Dahlia growers globally.

Conflict of Interest Statement

The authors state that none of the work described in this study could have been influenced by any known competing financial interests or personal relationships.

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Author's Contributions

Krishna Kaushik conceptualized and conducted the study, designed the methodology, analyzed data, and drafted the manuscript. Mukesh Kumar assisted in the research, contributing to writing, editing, and revising the manuscript. Kedar Mahadev Gheware supported data analysis, provided technical help, and contributed to the literature review and manuscript accuracy. Ravi Kumar assisted in research and manuscript revisions. Rohan Tomar, Devanshu Shukla, and Mahima Sharma coordinated research activities, managed logistics, provided statistical support, and contributed to manuscript preparation. All authors approved the final manuscript and are accountable for the work.

Table 1 Effect of INM on flower yield parameters

Treatment	NoFPP		No.FPPl		No.FPHa		FYPP	
	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024
T_1	12.42 ± 0.52	16.00 ± 1.89 c	150.58 ± 6.69	150.83 ± 10.26 c	627429.55 ± 27879.54	804231.00 ± 95477.96 b	310.12 ± 9.98	322.23 ± 28.23 f
T_2	15.83 ± 0.14 ghi	20.42 ± 0.76 abc	187.50 ± 0.25 fg	190.00 ± 22.78 bc	781248.75 ± 1041.67 fg	987579.00 ± 21652.37 ab	472.03 ± 9.15 efgh	477.48 ± 36.39 cde
T_3	17.42 ± 0.52 bcdefg	20.83 ± 1.66 abc	208.50 ± 5.58 bcde	212.25 ± 8.53 ab	868748.61 ± 23269.03 bcde	1041750.00 ± 83235.76 ab	535.07 ± 7.66 cd	531.01 ± 61.36 bc
T_4	16.67 ± 0.38 defgh	20.50 ± 2.05 abc	199.33 ± 3.88 def	202.67 ± 23.57 ab	830554.23 ± 16182.17 def	1029249.00 ± 104091.63 ab	448.77 ± 22.56 ghi	476.86 ± 17.59 cde
T_5	16.92 ± 0.14 cdefgh	20.25 ± 0.87 abc	202.42 ± 3.47 cdef	203.08 ± 23.96 ab	843401.43 ± 14446.26 cdef	1016748.00 ± 28869.82 ab	489.27 ± 15.63 defg	478.80 ± 51.40 cde
T_6	16.75 ± 0.66 defgh	20.42 ± 1.53 abc	202.58 ± 5.51 cdef	205.83 ± 19.03 ab	844095.87 ± 22971.81 cdef	1025082.00 ± 78068.72 ab	475.88 ± 13.04 efgh	473.07 ± 20.55 cde
T_7	16.00 ± 0.66 fghi	19.58 ± 1.42 bc	191.92 ± 5.97 efg	188.17 ± 7.35 bc	799651.50 ± 24854.86 efg	979245.00 ± 71083.70 ab	499.05 ± 9.37 defg	498.97 ± 53.16 cde
T_8	17.50 ± 0.50 bcdef	21.00 ± 1.73 abc	210.00 ± 7.63 bcd	206.08 ± 15.84 ab	874998.60 ± 31783.58 bcd	1050084.00 ± 87507.00 ab	467.06 ± 7.75 fgh	460.41 ± 9.05 cde
T_9	14.67 ± 0.63 i	19.75 ± 0.66 bc	174.50 ± 7.63 g	179.67 ± 3.99 bc	727082.17 ± 31783.59 g	975078.00 ± 33074.54 ab	382.36 ± 24.36 j	401.37 ± 12.83 def
T_{10}	17.92 ± 0.14 bcd	21.58 ± 2.57 ab	214.25 ± 0.00 bcd	216.50 ± 21.39 ab	892706.91 ± 0.00 bcd	1083420.00 ± 133669.15 ab	558.89 ± 2.52 c	558.20 ± 20.13 bc
T_{11}	18.00 ± 0.00 bcd	21.83 ± 2.40 ab	214.92 ± 2.98 bcd	220.58 ± 12.07 ab	895484.68 ± 12427.43 bcd	1091754.00 ± 120122.40 a	506.77 ± 4.87 def	504.35 ± 35.13 cde
T_{12}	20.33 ± 0.38 a	25.00 ± 0.90 a	241.75 ± 3.12 a	243.17 ± 19.07 a	1007290.06 ± 13010.39 a	1220931.00 ± 109219.92 a	696.79 ± 21.55 a	724.08 ± 37.97 a
T_{13}	18.58 ± 0.76 b	23.50 ± 1.56 ab	226.25 ± 8.36 ab	219.67 ± 10.54 ab	942706.83 ± 34814.06 ab	1104255.00 ± 104091.63 a	636.87 ± 12.46 b	650.68 ± 78.38 ab
T_{14}	16.17 ± 0.72 efghi	21.25 ± 1.80 ab	190.92 ± 7.49 efg	201.83 ± 5.69 ab	795484.84 ± 31203.62 efg	1062585.00 ± 90145.99 ab	402.38 ± 23.31 ij	378.18 ± 44.01 ef
T_{15}	15.67 ± 0.63 hi	21.17 ± 2.18 abc	186.17 ± 8.01 fg	195.92 ± 3.74 bc	775693.21 ± 33371.24 fg	1058418.00 ± 109219.92 ab	425.06 ± 20.68 hij	444.98 ± 39.38 cdef
T_{16}	18.42 ± 0.29 bc	23.25 ± 2.22 ab	219.42 ± 1.28 bc	223.33 ± 8.22 ab	914234.65 ± 5345.41 bc	1162593.00 ± 111111.32 a	519.45 ± 17.06 cde	506.98 ± 41.13 cd
T_{17}	16.08 ± 0.14 efghi	21.25 ± 1.98 ab	190.83 ± 0.14 efg	194.25 ± 15.98 bc	795137.62 ± 601.40 efg	1062585.00 ± 102325.10 ab	472.10 ± 11.06 efgh	466.19 ± 28.65 cde
T_{18}	17.33 ± 0.38 bcdefg	21.83 ± 1.42 ab	206.00 ± 4.99 cde	207.75 ± 8.11 ab	858331.96 ± 20807.24 cde	1091754.00 ± 83235.76 a	504.74 ± 25.47 def	501.96 ± 44.01 cde
T_{19}	17.67 ± 0.80 bcde	22.58 ± 1.42 ab	211.75 ± 8.77 bcd	221.92 ± 17.51 ab	882290.26 ± 36547.45 bcd	1133424.00 ± 73249.18 a	473.05 ± 21.57 efgh	455.51 ± 27.25 cde

No.FPP, Number of flowers per plant; No.FPPl, Number of flowers per plot; No.FPHa, Number of flowers per Ha; FYPP, Flower yield per plant.

Table 2 Effect of INM on flower yield parameters

Treatment	FYPPl		FYPHa		FWST		TD	
	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024
T_1	3.72 ± 0.12	3.60 ± 0.25 h	15.50 ± 0.50	15.01 ± 1.02 h	48.15 ± 1.48	50.74 ± 1.38 g	43.10 ± 0.68 i	45.86 ± 3.75 f
T_2	5.66 ± 0.11 efgh	5.75 ± 0.14 cdef	23.60 ± 0.46 efgh	23.98 ± 0.57 cdef	74.52 ± 2.54 cdef	75.48 ± 8.10 bcdef	53.10 ± 1.72 cde	53.69 ± 5.99 cdef
T_3	6.42 ± 0.09 cd	6.39 ± 0.19 cd	26.75 ± 0.38 cd	26.64 ± 0.79 cd	82.27 ± 3.48 abc	85.32 ± 5.18 abcd	54.80 ± 2.42 c	58.92 ± 4.64 abcde
T_4	5.39 ± 0.27 ghi	5.22 ± 0.16 efg	22.44 ± 1.13 ghi	21.72 ± 0.66 efg	72.91 ± 4.07 def	71.58 ± 8.22 def	47.80 ± 1.85 fgh	48.36 ± 2.69 ef
T_5	5.87 ± 0.18 defg	5.81 ± 0.31 cdef	24.47 ± 0.78 defg	24.20 ± 1.31 cdef	80.31 ± 3.60 bcd	81.81 ± 1.87 abcdef	46.90 ± 1.81 fghi	49.11 ± 1.17 def
T_6	5.71 ± 0.16 efg	5.59 ± 0.24 def	23.79 ± 0.65 efgh	23.30 ± 0.97 def	75.91 ± 2.73 cde	75.53 ± 2.85 bcdef	48.90 ± 1.63 fgh	49.34 ± 2.27 def
T_7	5.99 ± 0.11 defg	6.12 ± 0.25 cde	24.95 ± 0.47 defg	25.49 ± 1.05 cde	62.83 ± 0.93 g	65.88 ± 1.51 fg	49.50 ± 0.31 def	52.55 ± 3.92 cdef
T_8	5.61 ± 0.09 fgh	5.66 ± 0.37 cdef	23.36 ± 0.39 fgh	23.59 ± 1.55 cdef	82.62 ± 2.43 abc	83.57 ± 5.41 abcde	44.80 ± 0.28 hi	46.86 ± 3.80 ef
T_9	4.59 ± 0.29 j	4.26 ± 0.29 gh	19.12 ± 1.21 j	17.73 ± 1.24 gh	88.31 ± 3.09 ab	87.89 ± 2.38 abcd	45.10 ± 1.34 ghi	48.37 ± 3.89 ef
T_{10}	6.71 ± 0.03 c	6.72 ± 0.70 bc	27.94 ± 0.13 c	27.99 ± 2.94 bc	68.27 ± 3.25 efg	71.60 ± 3.40 def	43.20 ± 0.43 i	44.94 ± 3.79 f
T_{11}	6.08 ± 0.06 def	6.15 ± 0.33 cde	25.34 ± 0.25 def	25.60 ± 1.39 cde	73.94 ± 4.29 cdef	74.15 ± 5.59 cdef	53.30 ± 0.77 cd	55.82 ± 4.39 bcdef
T_{12}	8.36 ± 0.26 a	8.19 ± 0.40 a	34.84 ± 1.08 a	34.14 ± 1.65 a	89.86 ± 3.51 a	88.90 ± 2.33 abc	59.70 ± 0.91 b	61.19 ± 5.41 abcd
T_{13}	7.64 ± 0.15 b	7.67 ± 0.24 ab	31.84 ± 0.62 b	31.97 ± 1.00 ab	65.74 ± 3.29 fg	71.89 ± 1.59 def	60.40 ± 1.79 b	64.99 ± 3.09 abc
T_{14}	4.83 ± 0.28 ij	5.01 ± 0.09 fg	20.12 ± 1.17 ij	20.85 ± 0.36 fg	66.53 ± 1.58 fg	68.32 ± 4.03 ef	49.60 ± 0.20 def	52.25 ± 2.31 def
T_{15}	5.10 ± 0.25 hij	4.83 ± 0.13 fg	21.25 ± 1.03 hij	20.11 ± 0.56 fg	70.93 ± 2.79 efg	73.88 ± 2.66 cdef	49.00 ± 0.40 efg	52.09 ± 4.26 def
T_{16}	6.23 ± 0.20 cde	6.20 ± 0.73 cde	25.97 ± 0.86 cde	25.82 ± 3.03 cde	88.26 ± 3.63 ab	88.88 ± 6.63 abc	65.30 ± 1.17 a	68.98 ± 2.88 a
T_{17}	5.66 ± 0.13 efgh	5.63 ± 0.24 def	23.60 ± 0.56 efgh	23.47 ± 1.00 def	86.81 ± 2.80 ab	92.17 ± 5.74 ab	64.80 ± 1.28 a	66.68 ± 6.12 ab
T_{18}	6.06 ± 0.31 def	6.39 ± 0.23 cd	25.24 ± 1.27 def	26.65 ± 0.94 cd	89.89 ± 2.93 a	95.32 ± 10.86 a	47.80 ± 1.85 fgh	50.29 ± 3.71 def
T_{19}	5.68 ± 0.26 efgh	5.65 ± 0.35 cdef	23.65 ± 1.08 efgh	23.56 ± 1.43 cdef	90.19 ± 1.54 a	92.66 ± 7.67 a	48.30 ± 1.22 fgh	49.84 ± 5.47 def

FYPPl, Flower yield per plot; FYPHa, Flower yield per hectare; FWST, Fresh weight of single tuber; TD, Tuber diameter.

Table 3 Effect of INM on tuber parameters

Treatment	NoTPP		No.TPPl		WTPP		WTPPl		WTPHa	
	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024	2022-2023	2023-2024
T_1	8.00 ± 0.25 c	8.58 ± 0.52 de	96.25 ± 3.03 b	103.08 ± 6.29 de	365.71 ± 2.34	367.66 ± 14.82 e	4.39 ± 0.03	4.41 ± 0.18 e	18.29 ± 0.12	18.38 ± 0.74 e
T_2	9.25 ± 0.75 ab	10.50 ± 0.43 abcde	111.00 ± 9.00 ab	126.00 ± 4.98 abcde	722.50 ± 16.28 bc	728.62 ± 88.96 abcd	8.67 ± 0.20 bc	8.74 ± 1.07 abcd	36.13 ± 0.81 bc	36.44 ± 4.45 abcd
T_3	8.92 ± 0.29 abc	9.50 ± 0.66 bcde	106.92 ± 3.54 ab	114.00 ± 8.17 bcde	715.60 ± 26.45 bc	724.14 ± 71.80 abcd	8.59 ± 0.31 bc	8.69 ± 0.86 abcd	35.78 ± 1.32 bc	36.21 ± 3.59 abcd
T_4	9.42 ± 0.38 ab	9.75 ± 0.43 bcde	112.83 ± 4.45 ab	117.08 ± 5.05 bcde	670.00 ± 18.72 cd	666.01 ± 48.03 bcd	8.04 ± 0.23 cd	7.99 ± 0.58 bcd	33.50 ± 0.94 cd	33.30 ± 2.40 bcd
T_5	8.00 ± 0.25 c	8.58 ± 0.52 de	96.00 ± 3.25 b	103.08 ± 6.29 de	650.00 ± 12.89 de	654.38 ± 76.68 bcd	7.80 ± 0.15 de	7.85 ± 0.92 bcd	32.50 ± 0.64 de	32.72 ± 3.83 bcd
T_6	8.75 ± 0.25 abc	9.42 ± 1.28 bcde	105.00 ± 3.00 ab	113.08 ± 15.43 bcde	682.60 ± 1.23 cd	684.87 ± 53.32 abcd	8.19 ± 0.02 cd	8.22 ± 0.64 abcd	34.13 ± 0.06 cd	34.25 ± 2.67 abcd
T_7	9.08 ± 0.14 abc	11.08 ± 0.88 abc	108.92 ± 1.81 ab	133.00 ± 10.54 abc	596.75 ± 9.14 efg	606.16 ± 25.83 cd	7.16 ± 0.11 efg	7.27 ± 0.31 cd	29.84 ± 0.46 efg	30.31 ± 1.29 cd
T_8	8.50 ± 0.25 bc	9.50 ± 0.66 bcde	102.08 ± 3.13 ab	114.08 ± 7.99 bcde	710.25 ± 16.64 bc	725.50 ± 87.99 abcd	8.52 ± 0.20 bc	8.71 ± 1.06 abcd	35.51 ± 0.83 bc	36.28 ± 4.40 abcd
T_9	8.50 ± 0.50 bc	9.75 ± 0.66 bcde	102.00 ± 6.00 ab	116.92 ± 8.08 bcde	750.00 ± 2.03 b	752.56 ± 82.02 abcd	9.00 ± 0.03 b	9.03 ± 0.98 abcd	37.50 ± 0.10 b	37.63 ± 4.10 abcd
T_{10}	8.00 ± 0.43 c	8.33 ± 0.38 e	96.00 ± 5.41 b	100.00 ± 4.58 e	545.60 ± 14.75 g	563.17 ± 57.23 de	6.55 ± 0.17 g	6.76 ± 0.69 de	27.28 ± 0.74 g	28.16 ± 2.86 de
T_{11}	8.58 ± 0.52 bc	8.92 ± 0.14 cde	103.42 ± 5.79 ab	107.17 ± 1.66 cde	605.80 ± 23.48 ef	600.69 ± 64.97 cd	7.27 ± 0.28 ef	7.21 ± 0.78 cd	30.29 ± 1.17 ef	30.04 ± 3.25 cd
T_{12}	8.42 ± 0.38 bc	9.17 ± 0.52 cde	101.08 ± 4.61 ab	110.25 ± 6.25 cde	710.00 ± 30.72 bc	677.52 ± 49.97 abcd	8.52 ± 0.37 bc	8.13 ± 0.60 abcd	35.50 ± 1.54 bc	33.88 ± 2.50 abcd
T_{13}	8.92 ± 0.29 abc	10.58 ± 1.28 abcd	107.08 ± 3.39 ab	127.00 ± 15.39 abcd	610.50 ± 6.60 ef	617.69 ± 73.90 cd	7.33 ± 0.08 ef	7.41 ± 0.89 cd	30.53 ± 0.33 ef	30.89 ± 3.69 cd
T_{14}	8.67 ± 0.29 abc	10.08 ± 1.01 abcde	105.00 ± 3.00 ab	120.83 ± 12.15 abcde	585.35 ± 7.02 fg	581.31 ± 12.39 d	7.02 ± 0.09 fg	6.98 ± 0.15 d	29.27 ± 0.35 fg	29.07 ± 0.62 d
T_{15}	8.42 ± 0.52 bc	10.25 ± 0.75 abcde	102.08 ± 6.00 ab	123.00 ± 9.00 abcde	595.50 ± 15.57 efg	610.75 ± 55.55 cd	7.15 ± 0.19 efg	7.33 ± 0.67 cd	29.78 ± 0.78 efg	30.54 ± 2.78 cd
T_{16}	9.58 ± 0.58 ab	11.58 ± 0.52 ab	110.92 ± 12.25 ab	139.00 ± 6.25 ab	900.00 ± 29.21 a	877.50 ± 102.82 a	10.80 ± 0.35 a	10.53 ± 1.23 a	45.00 ± 1.46 a	43.88 ± 5.15 a
T_{17}	9.83 ± 0.38 a	12.17 ± 0.14 a	116.08 ± 6.21 a	146.00 ± 1.73 a	850.00 ± 7.66 a	843.90 ± 17.98 ab	10.20 ± 0.09 a	10.13 ± 0.22 ab	42.50 ± 0.38 a	42.20 ± 0.90 ab
T_{18}	8.58 ± 0.14 bc	10.25 ± 0.50 abcde	107.00 ± 8.66 ab	123.08 ± 5.88 abcde	764.20 ± 31.00 b	792.09 ± 87.62 abc	9.17 ± 0.37 b	9.51 ± 1.05 abc	38.21 ± 1.55 b	39.61 ± 4.38 abc
T_{19}	7.92 ± 0.14 c	9.75 ± 0.66 bcde	98.00 ± 6.25 b	117.08 ± 7.80 bcde	748.56 ± 14.84 b	746.44 ± 37.31 abcd	8.98 ± 0.18 b	8.96 ± 0.45 abcd	37.43 ± 0.74 b	37.33 ± 1.86 abcd

No.TPP, Number of tubers per plant; No.TPPl, Number of Tubers per plot; WTPP, Weight of tubers per plant; WTPPl, Weight of tubers per plot; WTPHa, Weight of tubers per Ha.

Table 4 Economic cost of benefit ratio of Dahlia crop 2022-2023

Treatments	Cost of Treatment	Total Cost of Cultivation	Common Cost of Cultivation	Flower yield /ha (No.)	Returns from flower (Rs/ha)	Bulb yield per ha (ton/ha)	Returns from bulbs (Rs/ha)	Post-Harvest Losses (10%)	Gross Return Income (Rs./ha)	Net return (Rs/ha)	B:C Ratio
T_1	7720.96	195079.08	42076.32	627429.55	132930.00	18.29	640150.00	77308.00	695771.99	500692.92	3.57
T_2	12867.24	297234.21	42076.32	781248.75	165518.80	36.12	1264200.00	142971.88	1286746.92	989512.71	4.33
T_3	12867.24	304197.74	42076.32	868748.61	184056.90	35.78	1252300.00	143635.69	1292721.22	988523.48	4.25
T_4	12852.24	289972.40	42076.32	830554.23	175964.90	33.50	1172500.00	134846.49	1213618.39	923645.99	4.19
T_5	12852.24	286624.46	42076.32	843401.43	178686.70	32.50	1137500.00	131618.67	1184568.07	897943.61	4.13
T_6	12807.24	294145.14	42076.32	844095.87	178833.90	34.13	1194550.00	137338.39	1236045.48	941900.34	4.20
T_7	12807.24	270079.70	42076.32	799651.50	169417.70	29.84	1044400.00	121381.77	1092435.92	822356.22	4.04
T_8	15576.95	306274.56	42076.32	874998.60	185381.10	35.51	1242850.00	142823.11	1285407.95	979133.40	4.20
T_9	15576.95	301012.97	42076.32	727082.17	154042.80	37.50	1312500.00	146654.28	1319888.55	1018875.58	4.38
T_{10}	15276.95	269842.37	42076.32	892706.91	189132.80	27.28	954800.00	114393.28	1029539.54	759697.17	3.82
T_{11}	15276.95	283959.08	42076.32	895484.68	189721.30	30.29	1060150.00	124987.13	1124884.20	840925.12	3.96
T_{12}	15456.95	319001.37	42076.32	1007290.06	213408.90	35.50	1242500.00	145590.89	1310318.02	991316.65	4.11
T_{13}	15456.95	289799.24	42076.32	942706.83	199726.00	30.52	1068200.00	126792.60	1141133.42	851334.18	3.94
T_{14}	18286.66	272531.04	42076.32	795484.84	168534.90	29.27	1024450.00	119298.49	1073686.43	801155.39	3.94
T_{15}	18286.66	272902.20	42076.32	775693.20	164341.80	29.77	1041950.00	120629.18	1085662.60	812760.40	3.98
T_{16}	18286.66	356462.12	42076.32	914234.65	193693.80	45.00	1575000.00	176869.38	1591824.40	1235362.28	4.47
T_{17}	18286.66	333355.21	42076.32	795137.62	168461.40	42.50	1487500.00	165596.14	1490365.22	1157010.02	4.47
T_{18}	18106.66	319599.98	42076.32	858331.96	181850.00	38.21	1337350.00	151920.00	1367279.99	1047680.02	4.28
T_{19}	18106.66	318346.90	42076.32	882290.26	186925.90	37.43	1310050.00	149697.59	1347278.31	1028931.42	4.23

Table 5 Economic cost of benefit ratio of Dahlia 2023-2024

Treatments	Total Cost of Cultivation	Cost of Treatment	Common Cost of Cultivation	Flower yield /ha (No.)	Returns from flower (Rs/ha)	Bulb yield per ha (No.)	Returns from bulbs (Rs/ha)	Post-Harvest Losses (10%)	Gross Return Income (Rs./ha)	Net return (Rs/ha)	B:C Ratio
T_1	214256.68	7720.96	43609.28	804231.00	170387.92	18.38	643300	81368.79	732319.13	518062.45	3.42
T_2	320321.63	12887.24	43609.28	987579.00	209232.84	36.43	1275050	148428.28	1335854.56	1015532.93	4.17
T_3	324589.00	12887.24	43609.28	1041750.00	220709.75	36.21	1267350	148805.97	1339253.77	1014664.77	4.13
T_4	309969.69	12872.24	43609.28	1029249.00	218061.23	33.30	1165500	138356.12	1245205.11	935235.42	4.02
T_5	306083.37	12872.24	43609.28	1016748.00	215412.71	32.72	1145200	136061.27	1224551.44	918468.07	4.00
T_6	313888.58	12827.24	43609.28	1025082.00	217178.39	34.25	1198750	141592.84	1274335.55	960446.97	4.06
T_7	291297.41	12827.24	43609.28	979245.00	207467.16	30.31	1060850	126831.72	1141485.44	850188.03	3.92
T_8	328432.92	15596.95	43609.28	1050084.00	222475.42	36.28	1269800	149227.54	1343047.88	1014614.96	4.09
T_9	327333.02	15596.95	43609.28	975078.00	206584.32	37.63	1317050	152363.43	1371270.89	1043937.87	4.19
T_{10}	294029.77	15296.95	43609.28	1083420.00	229538.14	28.16	985600	121513.81	1093624.32	799594.55	3.72
T_{11}	303489.98	15296.95	43609.28	1091754.00	231303.81	30.04	1051400	128270.38	1154433.43	850943.45	3.80
T_{12}	333923.27	15476.95	43609.28	1220931.00	258671.82	33.88	1185800	144447.18	1300024.64	966101.37	3.89
T_{13}	308798.30	15476.95	43609.28	1104255.00	233952.33	30.89	1081150	131510.23	1183592.10	874793.80	3.83
T_{14}	299194.95	18306.66	43609.28	1062585.00	225123.94	29.07	1017450	124257.39	1118316.55	819121.59	3.74
T_{15}	305550.85	18306.66	43609.28	1058418.00	224241.10	30.54	1068900	129314.11	1163826.99	858276.14	3.81
T_{16}	377067.50	18306.66	43609.28	1162593.00	246312.08	43.88	1535800	178211.21	1603900.87	1226833.37	4.25
T_{17}	359592.95	18306.66	43609.28	1062585.00	225123.94	42.20	1477000	170212.39	1531911.55	1172318.59	4.26
T_{18}	350341.69	18126.66	43609.28	1091754.00	231303.81	39.61	1386350	161765.38	1455888.43	1105546.74	4.16
T_{19}	343914.75	18126.66	43609.28	1133424.00	240132.20	37.33	1306550	154668.22	1392013.98	1048099.23	4.05

References

1. Baddiyavar R, Belakud B (2017). Dahlia. p 51-53 In: Glimpses of floriculture and landscaping. Agro India Publication. Uttar Pradesh. India. ISBN No. 978-81-929086-8-7.

2. Menon GR (2019) Flower-16-the delightful dahlia. https://www.poemhunter.com/poem/flower-16-the-delightful-dahlia/ [accessed July 13, 2024].

3. Darlington CD (1973) Chromosome botany and the origin of cultivated plant. George Allen and Unwin, London. 231 p. ISBN: 0045810117.

4. Bhattacharjee SK, Vinayananda S and De L (2019) In: Advances in Ornamental Horticulture. Pointer Publishers, Jaipur, Rajasthan. https://www.researchgate.net/publication/337324233.

5. Dutch Flower Industry Report (2023) Holland's Annual Dahlia Tuber Exports. http://dutchflowercouncil.org/reports/2023. [accessed 12 July 2024].

6. Milian, C (2024) LatinX genesis: On the origins of a mongrel species. Cultural Dynamics 36(1-2): 87-107.

7. Singh S, Dhatt KK, Bodla, PK (2023) Exploring genetic diversity of Dahlia (*Dahlia variabilis* Desf.) germplasm using multivariate statistics. Journal of Horticultural Sciences 18(1): 67-76.

8. Kumar M, Thakur P, Kashyap B, Kumar P, Sharma A, Bhardwaj R, Shah AH (2024a). Effect of Different Planting Dates on Tuber Production in Dahlia (*Dahlia variabilis* L.) in Low Hill Conditions of Himachal Pradesh, India. Plant Cell Biotechnology and Molecular Biology 25(7-8): 71-78.

9. Shukla U, Kumar M, Pal V, Kumari N, Kumar M, Chaudhary V (2023). Performance of different bio-stimulants on vegetative, floral, tuber yield and prolonging vase life quality parameters of Dahlia (*Dahlia variabilis* L.). International Journal of Agricultural & Statistical Sciences 19(1).

10. Wararkar SM, Sarvanan S, Prasad VM (2020). Effect of integrated nutrient management on growth, flowering, and yield of dahlia (*Dahlia variabilis* L.). Cv. Kenya white. Plant Archives 20(1): 3292-3296.

11. Kushwah N, Billore V, Sharma OP, Singh D, Chauhan APS (2024). Integrated Nutrient management for optimal plant health and crop yield. Plant Science Archives 8(02): 10-12.

12. Wu W, Ma B (2015). Integrated nutrient management (INM) for sustaining crop productivity and reducing environmental impact: A review. Science of the Total Environment 512: 415-427.

13. Tripathi S, Srivastava P, Devi RS, Bhadouria R (2020). Influence of synthetic fertilizers and pesticides on soil health and soil microbiology. In Agrochemicals detection, treatment and remediation 25-54.

14. Tiemann T, Douxchamps S (2023). Opportunities and challenges for integrated smallholder farming systems to improve soil nutrient management in Southeast Asia. World Development Sustainability 100080.

15. Tiwari AK, Pal DB (2022). Nutrients contamination and eutrophication in the river ecosystem. In Ecological Significance of River Ecosystems 203-216.

16. Samad MA, Sikder RK, Karim MT, Iqbal M, Sumon MM, Imtiaz AA, Touhidujjaman M (2024). Integrated Nutrient Management Strategies: Unraveling the Impact of Bio-Fertilizers and Traditional Fertilizers on Soybean (*Glycine max*) Productivity. European Journal of Nutrition and Food Safety 16(1): 60-65.

17. Sudhagar R, Alexander R, Elisheba BP, Kamalakannan S (2019). Effect of integrated nutrient management on the growth of African marigold (*Tagetes erecta* L.) CV. local orange. Journal of Pharmacognosy and Phytochemistry 8(3): 3669-3671.

18. Kaushik H, Singh, JP (2020). Impact of integrated nutrient management (INM) on plant growth and flower yield of African marigold (*Tagetes erecta* L.). Journal of Pharmacognosy and Phytochemistry 9(4): 1481-1484.

19. Singh H, Ahirwar GK (2024). Assessment of Different Organic Manures on Morphological and Floral Attributes of Marigold (*Tagetes erecta* L.). Journal of Scientific Research and Reports 30(8): 936-941.

20. Rajaselvam M, Sudhagar R, Kumaresan M (2024). Determining the Effect of Integrated Nutrient Management (INM) on Growth and Flower Yield of Tuberose (*Polianthes tuberosa* L.) cv. Prajwal. International Journal of Plant and Soil Science 36(6): 1-9.

21. Kumar M, Malik S, Singh MK, Pal V (2012). Impact of spacing, doses of vermi-compost and foliar application of salicylic acid on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) cv."White prosperity". Annals of Horticulture 5(2): 272-279.

22. Motla R, Malik S, Kumar M, Kumar S, Kumar D, Gangwar V, Pratap A (2022). Integrated effect of bio-fertilizers, organic and inorganic fertilizers on flowering, corms and cormel yield attributes of gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux. International Journal of Environment and Climate Change 12(11): 1914-1920.

23. Kaur Y, Malik S, Kumar M, Kumar S, Singh SP, Gangwar R, Shukla D (2023). Effect of integrated nutrient management and foliar application of micronutrients on vegetative and quality attributes of gladiolus (*Gladiolus hybridus* Hort.) cv. White Prosperity. Int. J. Agricult. Stat. Sci 19(1): 959-966.

24. Kumar S, Momin BC, Niki Dewan ND (2015). Response of nutrition on growth and flowering of Dendrobium orchids under eastern Himalayan region 214-219.

25. Singh P, Prakash S, Kumar M, Malik S, Singh MK, Kumar A (2015). Effect of Integrated Nutrient Management (INM) on growth, flowering and yield in marigold (*Tagetus erecta* L.) cv." Pusa basanti". Annals of Horticulture 8(1): 73-80.

26. Garge VC, Malik S, Kumar M, Singh MK, Prakesh S, Kumar S, Singh SP (2020). Effect of organic and integrated sources of nutrıent on growth and flowering of French marigold (*Tagetes patula* L.) under North Western Plain Zone of Utter Pradesh. Journal of Plant Development Sciences 12(11): 671-674.

27. Kumar N, Prasad VM, Yadav NP (2019). Effect of chemical fertilizers and bio fertilizers on flower yield, tuberous root yield and quality parameter on dahlia (*Dahlia variabilis* L.) cv. Kenya orange. Journal of Pharmacognosy and Phytochemistry 8(4): 2265-2267.

28. Tomar R, Malik S, Kumar M, Kumar S, Singh SP, Singh B, Kaushik K (2024). Determining the Effect of Integrated Nutrient Management (INM) on the Growth of Tuberose (*Polianthes tuberosa* L.) cv. Rajat Rekha. Journal of Advances in Biology & Biotechnology 27(10): 669-675.

29. Gomez KA (1984). Statistical procedures for agricultural research. John NewYork: Wiley and Sons.

30. Nanda A, Mohapatra BB, Mahapatra APK (2021). Multiple comparison test by Tukey's honestly significant difference (HSD): Do the confident level control type I error. International Journal of Statistics and Applied Mathematics 6(1): 59-65.

31. El-Araby SM, Ghoneim IM, Shehata AI, Mohamed RA (2003). Effects of nitrogen, organic manure and biofertilizer applications on strawberry plants. I-vegetative growth, flowering and chemical constituents of leaves. J. Agric. and Env. Sci. Alex. Univ., Egypt 2(2): 36-62.

32. Dikr W, Belete K (2017). Review on the effect of organic fertilizers, biofertilizers and inorganic fertilizers (NPK) on growth and flower yield of marigold (*Tagetes erecta* L.). Academic Research Journal of Agricultural Science and Research 5(3): 192-204.

33. Acharya MM, Dashora LK (2004). Response of graded levels of nitrogen and phosphorus on vegetative growth and flowering in African marigold (*Tagetes erecta* Linn.). Journal of Ornamental Horticulture 7(2): 179-183.

34. Kızılkaya R (2008). Yield response and nitrogen concentrations of spring wheat (*Triticum aestivum*) inoculated with *Azotobacter* chroococcum strains. Ecological Engineering 33(2): 150-156.

35. Khandaker MM, Rohani F, Dalorima T, Mat N (2017). Effects of different organic fertilizers on growth, yield and quality of *Capsicum annuum* L. Var. Kulai (Red Chilli Kulai). Biosciences Biotechnology Research Asia 14(1): 185-192.

36. Owoeye AO, Opadokun WO, Olorunmaiye KS (2024). Influence of poultry manure on the performance of bell pepper (*Capsicum annum* L). Bulgarian Journal of Crop Science 61(1): 87-92.

37. Tama NY, Adesoji AG, Sanusi J (2024). Growth Performance of Tomato Varieties as Influenced by Rates and Time of Poultry Manure Application in the Savanna Zone of Nigeria. Nigeria Agricultural Journal 55(1): 286-294.

38. Kumar M (2015). Impact of different sources of nutrients on growth and flowering in chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv Yellow Gold. Journal of Plant Development Sciences 7(1): 49-53.

39. Soni S, Kanawjia A, Chaurasiya R, Chauhan PS, Kumar R (2018). Effect of organic manure and biofertilizers on growth, yield and quality of strawberry (*Fragaria X ananassa* Duch) cv. Sweet Charlie. Journal of Pharmacognosy and Phytochemistry 7(2S): 128-132.

40. Prasad L, SS, Lall D, Singh VK (2017). Effect of organic manure and inorganic fertilizer on plant growth and flower yield of Asiatic lily (*Lilium longiflorum*) sp. Zephyranthes. Environment and Ecology 35(2A): 929-932.

41. Prasad DSH, Prasad VM, Goutham SK, Bose SC (2018). Effect of integrated nutrient management on flowering and flower yield of dahlia (*Dahlia variabilis* L) cv. Kenya Orange. Plant Archives 18(1): 795-798.

42. Himaja R, Prasad VM, Bahadur V (2021). Effect of organic manures on growth, flowering, yield and quality of African marigold (*Tagetes erecta* L.) in Prayagraj agro climatic conditions Cv. Pusa Narangi. The Pharma Innovation 10(8): 1486-1488.

43. Binas JrEE, Lumentac GV, Mocadam AA (2023). Performance of Anthurium (*Anthurium andraeanum* Lind.) as influenced by different organic manures and inorganic fertilizers. Journal of Ornamental Plants 13(1): 31-39.

44. Nada RS, Soliman MN, Zarad MM, Sheta MH, Ullah S, Abdel-Gawad AI, Elateeq AA (2024). Effect of Organic Fertilizer and Plant Growth-Promoting Microbes on Growth, Flowering, and Oleanolic Acid Content in Calendula officinalis under Greenhouse Conditions. Egyptian Journal of Soil Science 64(3): 815-831.

45. Pandey SK, Kumari S, Singh D, Singh VK, Prasad VM (2017). Effect of biofertilizers and organic manures on plant growth, flowering and tuber production of dahlia (*Dahlia variabilis* L.) Cv. SP Kamala. International Journal of Pure and Applied Bioscience 5(2): 549-555.

46. Kumar M, Malik S, Singh MK, Singh SP, Chaudhary V, Sharma VR (2019). Optimization of spacing, doses of Vermicompost and foliar application of salicylic acid on growth, flowering and soil health of Chrysanthemum (*Dendranthema grandiflora* Tzvelev) cv."Guldasta". International Journal of Agriculture, Environment and Biotechnology 12(3): 213-224.

47. Kalaiyarasan C, Sriramachandrasekharan MV, Jawahar S, Suseendran K, Ramesh R, Ramesh S, Kanagarajan R (2019). Growth and yield of sunflower as influenced by VAM and phosphorus application. Journal of Pharmacognosy and Phytochemistry 8(2): 836-839.

48. Sadozai GU, Farhad M, Khan MA, Khan EA, Niamatullah M, Baloch MS, Wasim K (2013). Effect of different phosphorous levels on growth, yield and quality of spring planted sunflower. Pakistan Journal of Nutrition 12(12): 1070.

49. Kumar M, Kasera S, Mishra S, Singh NV, Singh D (2018). Effect of organic manure and inorganic fertilizer on growth and yield traits of gladiolus (*Gladiolus grandiflora* L.) Cv. Plumtart. International Journal of Current Microbiology and Applied Sciences 7(1): 1430-1435.

50. Kumari S, Chowdhuri TK, Mandal T (2018). Effect of bio-fertilizers on growth and flowering of Dendrobium var. Sonia. Journal of Crop and Weed 14(2): 85-88.

51. Chhabra S, Vishwakarma G (2019). Effect of integrated nutrient management on growth, yield and quality of onion (*Allium cepa* L.) cv. Palam Lohit. Journal of Pharmacognosy and Phytochemistry 8(4S): 73-77.

52. Singh J, Sharma MK, Singh SP, Bano R, Mahawar AK (2018). Effect of organic and inorganic sources of NPK and bio-fertilizer on enhancement of growth attributes and chlorophyll content of sweet potato. International Journal of Current Microbiological Applied Science 7(9): 3659-3667.

53. Badgujar S, Topno SE, Kerketta A (2023). Effect of Seaweed Extracts on the Growth, Flower Yield and Quality of Dahlia (*Dahlia variabilis*) cv. Aditya Birla. International Journal of Environment and Climate Change 13(10): 2882-2889.