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IMPACT OF DIFFERENT ORGANIC NUTRIENT SOURCES ON FLOWER QUALITY IN MARIGOLD CV. PUSA ARPITA

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ABSTRACT

Marigold (*Tagetes patula* L.) is a commercially significant ornamental flower in India due to its ease of cultivation, adaptability, prolonged flowering period, and excellent shelf life. Organic manures, such as farmyard manure (FYM) and vermicompost, improve soil structure and microbial activity, while bio-fertilizers like Azotobacter enhance nutrient availability. Integrating organic and inorganic fertilizers promotes sustainable agriculture, reducing environmental pollution and fertilizer costs while maintaining soil health. A field experiment was conducted at the Horticulture Research Field, Department of Horticulture, C.C.R. P.G. College, Muzaffarnagar, from September 2021 to April 2022, using the 'Pusa Arpita' variety. The study followed a Randomized Block Design (RBD) with 11 treatments and three replications. The study demonstrated that integrated nutrient management significantly enhanced the quality parameters of marigold. Among all treatments, the combined application of ½ RDF + ½ PSB + ½ Vermicompost (T11) consistently outperformed others. It resulted in the earliest flowering (39.57 days), maximum flower circumference (22.51 cm), highest number of florets per flower (136.55), longest flower stalk (6.44 cm), and extended vase life (7.47 days). These improvements were attributed to the synergistic effects of chemical fertilizers, organic manure, and biofertilizers, which collectively enhanced nutrient availability, soil microbial activity, and plant physiological responses. While daily water uptake and physiological weight loss did not differ significantly, their trends supported the overall superiority of integrated treatments. The results emphasize that partial substitution of chemical fertilizers with eco-friendly alternatives like PSB and vermicompost leads to improved flower quality and sustainability. Therefore, integrated nutrient management is a viable strategy for enhancing marigold yield, quality, and postharvest performance while maintaining soil health. This approach not only ensures profitable and eco-conscious cultivation but also aligns with sustainable horticultural practices for long-term agricultural productivity.
***Keywords*: Marigold, Organic manure, Bio fertilizers, Quality, Vase life**

Introduction

Marigold (*Tagetes patula* L.), a widely cultivated ornamental flower in India, is favored for its adaptability to various soils and climates, long flowering duration, and excellent keeping quality. Originating from Central and South America, particularly Mexico (Datta *et al.,* 2008), marigold was introduced to India by the Portuguese between 1502 and 1550 A.D. The two most commercially grown species are *Tagetes erecta* (African marigold) and

Tagetes patula (French marigold). These flowers are extensively used for religious, social, and decorative purposes and are known by various names worldwide, such as "friendship flower" in the U.S. and "Shayapatri" in Nepal.

Beyond aesthetics, marigold has significant medicinal, industrial, and agricultural applications. Its flowers are used for pigment extraction, particularly lutein, which is important in the poultry industry for coloring egg yolks and chicken skin. Marigold oil, especially from *T. patula*, is used as a fly repellent, while essential oils from other species are utilized in perfumes and medicines (Bose & Yadav, 1993). Traditional uses include treating fever, skin ailments, liver issues, and wounds (Rhama & Madhawan, 2011). Additionally, marigold acts as a natural nematicide, reducing populations of harmful soil nematodes like *Meloidogyne* spp (Husain *et al.,* 2019).

The overuse of chemical fertilizers has led to soil degradation, pollution, and reduced crop productivity (Savci, 2012; Song *et al.,* 2017). Thus, balanced nutrient management has become essential for sustainable flower cultivation. The integration of organic manures such as farmyard manure and vermicompost, with biofertilizers like *Azotobacter*, enhances soil fertility, improves plant growth parameters, and increases flower yield and quality. These eco-friendly practices also mitigate environmental pollution and improve the physico-chemical properties of soil.

Integrated Nutrient Management (INM) combines organic, inorganic, and biofertilizer inputs to optimize crop production sustainably. INM in marigold cultivation not only boosts productivity and profitability but also maintains ecological balance. The combined use of farmyard manure, vermicompost, and biofertilizers like *Azotobacter* enhances microbial activity, nutrient availability, and overall plant health, making it a viable approach for sustainable, commercial-scale floriculture.

Materials and Methods

The experiment was laid out at the Horticulture research field, Department of Horticulture at C.C.R. P.G. College, Muzaffarnagar from September 2021 to April 2022. 'Pusa Arpita' variety of marigold (*Tagetes patuala* L.) was used in the experiment. The experiment design was laid out in Randomized Block Design (RBD) with 11 treatments and 3 replications. Treatment details are as follows,

S. No.	Notation	Treatment Combination
1.	T1	Control
2.	T2	RDF@ 150:60:60 kg/ha (N:P:K)
3.	T3	FYM @ 30t/ha
4.	T4	Vermicompost @10 q/ha
5.	T5	*Azotobacter* @700 ml/ha
6.	T6	PSB @ 500 ml/ha
7.	T7	½ RDF + ½ FYM
8.	T8	½ RDF + ½ Vermicompost
9.	T9	½ RDF + ½ *Azotobacter*
10.	T10	½ RDF + ½ PSB
11.	T11	½ RDF + ½ PSB + ½ Vermicompost

Observations Recorded

Quality Parameters

Flowering duration (in days): Duration of flowering was taken from first flower opening to the day of senescence of last flower expressed in number of days.

Circumference of flower (cm): The size of flowers was measured by Vernier callipers and average determined. The size of flower was scientifically measured in the form of surface area of a flower and circumference of a flower.

Number of florets per flower: Number of florets counted from 10 flowers randomly selected tagged plant and average was determined.

Flower stalk length (cm): The length of flower stalk was measured in centimetres after emergence of stalk at the time of 15 days interval with the help of meter scale.

Vase life of flowers: Keeping quality was calculated by harvesting the flowers at fully open stage and keeping at room temperature. The number of days was counted when petals lost turgidity and changed the colour.

Statistical Analysis

Data recorded on growth, floral and yield a character was subjected to (1997) statistically analysis randomized block design (RBD) as advocated by Fisher (1950). Analysis of variance was calculated and critical difference (C.D.) at 5% level of significance was tested through 'F' test.

Results and Discussion

Flowering Duration (Days)

The results (Table 1) indicated that all nutrient treatments significantly reduced the flowering duration compared to the control (T1). The earliest flowering (39.57 days) was observed in treatment T11 (½ RDF + ½ PSB + ½ Vermicompost), followed by T10 (43.58 days), T9 (45.80 days), and T8 (48.48 days). In contrast, the control (T1) showed the longest flowering duration (60.66 days). These results suggest that the combined application of chemical fertilizers with biofertilizers and organic manures accelerates plant development by enhancing nutrient availability and microbial activity in the rhizosphere, thereby promoting early floral initiation. The enhanced biological processes might have improved root growth, hormonal balance, and nutrient uptake, leading to earlier flowering. Similar trends have been reported where integrated nutrient management practices hasten plant maturity and reduce vegetative phase duration. These findings are conformity with Singh and Rao (2005) and Chadha *et al.* (2002) in marigold.

Circumference of Flower (cm)

Application of integrated nutrient sources significantly influenced flower size (Table 1). The maximum flower circumference was recorded in T11 (22.51 cm), which was followed by T10 (20.73 cm), T8 (18.84 cm), and T9 (18.47 cm). The minimum circumference was observed in the control treatment (T1: 9.92 cm). These improvements may be due to better plant nutrition under integrated nutrient treatments, resulting in more vigorous floral organ development. Organic amendments and biofertilizers enhance nutrient availability and water retention, while PSB (Phosphate Solubilizing Bacteria) likely facilitated phosphorus uptake, which is crucial for flower development. The increase in flower size is also supported by improved soil structure and enhanced microbial activity, which collectively improve root function and nutrient acquisition. These findings are the close confirm with Chadha *et al.* (2002) and Garge *et al.* (2020) in marigold.

Table 1: Effect of nutrient sources on flowering duration, circumference of flower and number of florets per flower

Notation	Treatment	Flowering duration (days)	Circumference of flower (cm)	Number of florets per flower
T1	Control	60.66	9.92	56.88
T2	RDF-150:60:60 kg/ha N:P:K	58.41	12.21	78.69
T3	FYM @ 30t/ha	57.55	13.48	89.15
T4	Vermicompost @ 10Q/ha	56.74	14.83	97.52
T5	*Azotobacter*@ 700 ml/ha	55.76	15.34	109.50
T6	PSB @ 500 ml/ha	53.40	15.62	112.72
T7	½ RDF + ½ FYM	52.65	15.98	124.68
T8	½ RDF + ½ Vermicompost	48.48	18.84	126.65
T9	½ RDF + ½ *Azotobacter*	45.80	18.47	121.42
T10	½ RDF + ½ PSB	43.58	20.73	122.46
T11	½ RDF + ½ PSB + ½ Vermicompost	39.57	22.51	136.55
	S.E.(m)±	0.25	0.39	0.49
	C D at 5%	0.77	1.16	1.46

Number of Florets per Flower

Significant differences were observed in the number of florets per flower across treatments (Table 1). T11 showed the highest number of florets (136.55), followed closely by T8 (126.65), T7 (124.68), and T10 (122.46). The lowest number of florets was noted under the control treatment (T1: 56.88 florets). These findings emphasize the importance of balanced and integrated nutrient supply in supporting reproductive development. The combination of organic and inorganic nutrients supports steady and prolonged nutrient availability, particularly during critical growth stages. PSB and Azotobacter not only enhance nutrient uptake but also produce growth-promoting substances (such as IAA), which may stimulate floret differentiation and development. This parameter strongly reflects the plant's vigor and metabolic health under different nutrient regimes. The results obtained were similar to finding of Shashikanth (2005) and Garge *et al.* (2020) in marigold.

Length of Flower Stalk (cm)

There was a significant increase in flower stalk length with nutrient application (Fig. 1). T11 recorded the longest stalk (6.44 cm), followed by T8 (5.53 cm), T9 (5.41 cm), and T10 (5.30 cm), whereas T1 (control) produced the shortest stalk (3.40 cm). Longer flower stalks enhance the marketability of cut flowers and are often associated with better nutrient management. The effect of integrated nutrients likely enhanced cell division and elongation in floral tissues. Improved photosynthesis due to a more robust plant canopy under these treatments may also have contributed to increased assimilate supply to growing stalk tissues. The improvement in physical soil conditions by vermicompost and microbial enhancement by PSB and Azotobacter positively influenced the growth of stalks. The findings are in similarity with the reports of Hussain *et al.* (2019) in marigold.

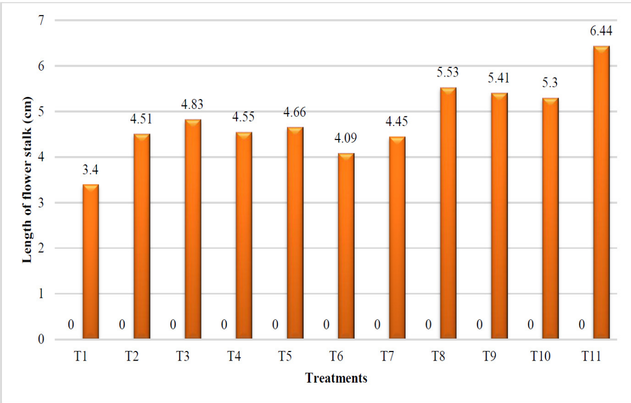

Fig. 1: Effect of nutrient sources on length of flower stalk (cm)

Vase Life of Cut Flowers (Days)

The vase life was significantly affected by nutrient management (Table 2). The longest vase life (7.47 days) was recorded in T11, followed by T10 (6.82 days), T9 (6.54 days), T8 (6.44 days), and T5 (6.33 days). The shortest vase life was observed in the control (3.60 days). The extended vase life can be attributed to improved nutrient status and plant health, resulting in better tissue integrity, lower senescence rates, and slower degradation of pigments and water content. Higher carbohydrate reserves from efficient photosynthesis also prolong freshness. In addition, biofertilizers may have indirectly enhanced the structural stability of floral tissues, reducing microbial clogging in the stem during vase storage.

Daily Physiological Weight Loss (g)

While the differences were not statistically significant, a trend was observed (Table 2). The highest physiological weight loss was noted in T10 (7.74 g), followed by T11 (7.56 g), while the lowest loss was seen in T1 (4.27 g). Despite this increase in weight loss in the nutrient-rich treatments, these same treatments exhibited longer vase life, indicating that weight loss alone isn't the sole factor determining postharvest longevity. The higher initial fresh weight in nutrient-rich flowers may contribute to this result. The role of nutrient-enhanced cellular turgidity and metabolic activity should also be considered in interpreting this trait.

Daily Water Uptake per Five Flowers (ml)

Although not statistically significant (Table 2), T11 recorded the highest water uptake (39.68 ml), followed by T10 (38.84 ml), indicating better vascular conductance and water transport capacity. The lowest uptake was seen in T1 (25.65 ml). Higher water uptake is generally associated with lower microbial blockage and healthier xylem tissue, both of which were likely influenced by improved plant nutrition. These results are consistent with the observed improvement in vase life and floral quality, supporting the importance of nutrient balance in postharvest water relations.

Table 2: Effect of nutrient sources on fresh weight of flowers, daily physiological weight loss and daily water uptake of flowers

Notation	Treatment	Fresh wt. of five flowers (g)	Daily physiological Weight loss (g)	Daily water uptake per five flowers (ml)
T1	Control	28.42	4.27	25.65
T2	RDF-150:60:60 kg/ha N:P:K	26.09	4.91	30.52
T3	FYM @ 30t/ha	28.02	4.73	28.69
T4	Vermicompost @ 10Q/ha	32.02	5.10	32.72
T5	*Azotobacter*@ 700 ml/ha	34.76	5.32	33.78
T6	PSB @ 500 ml/ha	36.46	5.22	35.28
T7	½ RDF + ½ FYM	34.42	5.53	33.87
T8	½ RDF + ½ Vermicompost	36.68	6.47	36.39
T9	½ RDF + ½ *Azotobacter*	36.20	6.87	35.43
T10	½ RDF + ½ PSB	37.83	7.74	38.84
T11	½ RDF + ½ PSB + ½ Vermicompost	39.74	7.56	39.68
	S.E.(m)±	0.99	0.40	0.54
	C D at 5%	2.95	1.19	1.61

Conclusion

The study clearly demonstrates that the integrated application of half recommended doses of chemical fertilizers with PSB and vermicompost (T11) was most effective in improving all measured parameters of marigold quality. The synergy among organic, chemical, and bio inputs not only enhances growth and floral traits but also extends vase life and improves marketability. This highlights the potential of integrated nutrient management (INM) in promoting sustainable, high-quality marigold cultivation.

Plate 1: View of experimental plot in flowering stage of the crop.

Competing interests

"Authors have declared that no competing interests exist."

Authors' Contributions

- **Mahima Sharma -** designed and conducted the study, Data collection, analysis and interpretation of results.
- **Prof. Vijai Kumar -** facilitated the resources required and provided technical guidance.
- **Karthik, D.R. -** wrote the manuscript and sourced the journal for publication.
- **Jaspreet Kaur -** Assisted in conduct of experiment.
- **Harshit Vimal -** Assisted in conduct of experiment.
- **Atul Kumar Mishra** - Assisted in conduct of experiment.
- All authors read and approved the final manuscript.

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