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Influence of organic manures on the growth, flowering, yield and quality of African marigold (*Tagetes erecta* L.) (cv. Pusa Narangi)

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Abstract
The present investigation, titled "Influence of Organic Manures on The Growth, Flowering, Yield and Quality of African Marigold (*Tagetes erecta* L.) (cv. Pusa Narangi)" was conducted during the agricultural year 2020-2021 at the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh. This study was rigorously prepared and carried out utilizing a Randomized Block Design (RBD), allowing for a thorough evaluation of the influence of various organic manures on African marigold. The experiment was repeated three times to ensure the results' repeatability and robustness, and it included nine separate treatment groups. Studies showed that, a significant effect by poultry manure Plant height (32.4 cm), Number of leaves (284.33), Number of branches (20.42), Plant Spread (43.03 cm), Number of buds per plant (44.17), Days to first flower emergence (71.67), Flower diameter (93.00 mm), Fresh flower weight (25.33 g) Flower weight per plant (67.33 g), Fresh weight of plant (417.00 g), Dry weight of plant (114.00 g), Shelf life of plant (8.88 days).

Keywords: Flower, marigold, organic manure, flower production, flower quality

Introduction
The African Marigold, scientifically known as *Tagetes erecta* L., belongs to the Asteraceae family and is widely cultivated for its vibrant loose flowers, commonly used in various religious and social events (Panwar *et al.*, 2020) [16]. Within the Asteraceae family, comprising 1,600 genera and 23,000 species including herbs, shrubs, climbers, and medicinal plants, the African Marigold stands out for its extended retention of appealing colors, making it a popular choice for decorations, especially when cut. Indigenous to Central and South America, particularly Mexico, Marigolds were initially domesticated for ornamental purposes before being introduced to Europe and South Asia, notably India. The genus name, *Tagetes* is derived from "*Tages*" the name of the Etruscan God known for beauty, as applied by the French and later adopted by others (Pal *et al.*, 2016) [3]. Commercially grown in India for cut flowers, *Tagetes erecta* and *Tagetes patula* have distinct characteristics, with *Tagetes erecta* commanding higher prices, showcasing variations in plant height, spread, flower size, quality, and yield (Ali, 2016) [2]. The flowers exhibit various color hues ranging from light yellow to creamy yellow, bright yellow, cadmium orange, deep orange, Sulphur yellow, to white, with a chromosomal number of 2n = 24 for African marigolds.
Marigold is not only valued for its aesthetic appeal but also serves various purposes in traditional medicine and gardening. Its deep root system aids in mineral absorption from the soil, enhancing soil structure and fertility (Uteau *et al.*, 2013) [18]. After completing its growth cycle, the plant's leaves and stems can be incorporated into the soil as green manure, enriching the organic matter content. This biofertilization process contributes essential nutrients like nitrogen, phosphate, and potassium, benefiting other plants in the vicinity. Recognized for its weed-reducing and pest-repelling properties, Marigold is an ideal companion plant for crops such as tomatoes, eggplants, and peppers. Overall, Marigold stands out as an environmentally beneficial and easily cultivable plant, celebrated for its striking blooms and contributions to soil health.

Materials and Methods

The present investigation was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj from December 2020 to March 2021.

Experimental Design

A field experiment entitled "Influence of Organic Manures on The Growth, Flowering, Yield and Quality of African Marigold (*Tagetes erecta* L.) (cv. Pusa Narangi)". The experiment was laid out in Randomized Block Design with nine treatments and replicated thrice times.

Experimental Treatment Details

T_1-Control, T_2-Farmyard manure @ 1000 g, T_3-Farmyard manure @ 500 g, T_4-Vermi compost @ 1000 g, T_5-Vermi compost @ 500 g, T_6-Poultry manure @ 1000 g, T_7-Poultry manure @ 500 g, T_8-Goat manure @ 1000 g, T_9-Goat manure @ 500 g

Result and Discussion

Plant Height (cm): The plant height exhibited notable variations across different treatments. T_6 poultry manure recorded the highest plant height (32.4 cm). These results indicate a significant positive impact of poultry manure on Marigold plant growth. As indicated in some previous works carried out by researchers in India, poultry manure has been seen to greatly benefit crops like Marigold, with its rich nutrients (Rahman *et al.*, 2016; Sharma *et al.*, 2017) [10, 14], thereby encouraging the strong growth of plants.

Number of leaves per plant: In the number of leaves per plant treatment differed significantly with respect. The maximum number of leaves per plant was recorded in T_6 Poultry manure (284.33). Overall, these studies suggest that the application of organic manures such as poultry manure can significantly increase the number of leaves per plant in marigold. The study investigates the role of organic fertilizers in promoting sustainable farming. It has been observed that one can note a significant increase in marigold leaf count through poultry manure (Sharma & Sharma, 2018) [13].

Number of branches per plant: The number of branches varied significantly among the different treatments. T_6 Poultry manure (20.42) is having maximum number of branches. It is important to note that the effect of organic manures on growth and yield may vary depending on various factors such as soil type, climatic conditions, and plant species. The study highlights organic fertilizers importance for sustainable agriculture. It examined different organic manures impact on marigold growth. While farmyard, vermicompost, and goat manure increased branch count, poultry manure proved most efficient (Kumar *et al.*, 2014) [4].

Plant Spread (cm): Plant spread varied significantly among the different treatments. T_6 Poultry manure (43.03 cm) is having maximum plant spread with the application of all the organic manures viz., FYM, vermicompost and poultry manure in different levels with sand, the plant height increased significantly. In marigold, Kumar *et al.* (2014) [4] also reported that the addition of Poultry manure, increased plant spread significantly in comparison to other treatments. In other research of Pandey *et al.* (2015) [8] application of poultry manure with chemical fertilizers resulted in significantly superior growth of Plant in marigold as compared to other treatments.

Number of buds per plant: The number of buds per plant varied significantly among treatment groups in our study, with the highest number reported in T_6 (Poultry manure) at 44.17. In comparison, the control group T_1 had the fewest buds per plant, registering 32.70. Kuppuswamy *et al.* (1992) [5] supported the benefits of organic manures for early blooming. Organic fertilizers like farm yard waste, poultry manure, and vermicompost enhance vegetative growth, aiding bud transition into flowers, potentially influencing blossoming dates, vital for flower production.

Days to first flower emergence: The number of days required for the first blossom to appear varied significantly between treatment groups in our study. T_6 (Poultry manure) had the shortest time to first bloom emergence at 71.67 days, whereas T_9 (Goat manure) had the longest at 84.00 days. These findings highlight the significance of organic fertilizer selection in determining floral emergence timing. In comparison to goat manure, poultry manure hastened the process, demonstrating its potential to promote early flowering. This knowledge aids flower producers in optimizing bloom production timing and crop management. Poultry manure showed the most beneficial effects on both flowering and yield characteristics, as supported by Vieira *et al.* (1999) [19] and Shelke *et al.* (2000) [15].

Flower diameter (mm): We found significant differences in blossom diameter among treatment groups in our study. T_6 (Poultry manure) had the largest bloom diameter at 93.00 mm, followed by T_9 (Goat manure) at 67.23 mm. The T_1 control group, on the other hand, had the smallest flower diameter at 57.40 mm. These findings underscore the importance of organic fertilizers in fostering greater blossom diameters, with poultry manure showing to be the most beneficial. This research suggests that organic fertilizers, notably poultry manure, impact both bloom productivity and aesthetic aspects in flower cultivation. Poultry dung showed significant benefits, enhancing blooming and production characteristics, supported by Vieira *et al.* (1999) [19].

Fresh flower weight (g): That the Fresh flower weight was recorded T_6 (Poultry manure) (25.33 g) followed by T_5 (Vermicompost) (19.67 g). Whereas minimum fresh flower weight was T_1 (Control) (6.77 g) recorded. These findings are consistent with prior studies, as Pooja *et al.* (2012) [9] showed comparable results in marigold and Rajanna, (2001) [11] in china aster, both of which demonstrated increased flower weight with organic fertilizer treatment. Furthermore, our findings are congruent with those of Bhat *et al.* (2010) [1], Tyagi and Kumar (2006) [17], and Mukesh *et al.* (2007) [6], who all showed similar patterns in marigold, highlighting the persistent favorable impact of organic fertilizers on flower weight across diverse flower crops. This body of studies emphasizes the value of organic fertilizers, notably poultry manure, vermicompost, and goat dung, in increasing flower production in horticulture practices.

Flower weight per plant (g): The maximum Flower yield per plant was recorded T_6 (Poultry manure) (67.33 g) followed by T_7 (Poultry manure) (57.67 g) whereas minimum Flower yield per plant was T_1 (Control) (24.33 g) recorded. These findings are consistent with earlier research findings, indicating that organic fertilizers have a positive impact on flower yield across a variety of flower crops. The consistency and reproducibility of our findings with Munikrishnappa *et al.*, (2004) [7] in tuberose, Mukesh *et al.*, (2007) [6], Shadanpour *et al.*, (2011) [12], Pooja *et al.*, (2012) [9], and Bhat *et al.*, (2010) [1] in marigold is highlighted. This emphasizes the need of using organic fertilizers, notably poultry and goat manure, as well as vermicompost, to increase flower production per plant in horticulture practices, offering useful information for flower producers and gardeners.

Fresh weight of plant (g): The fresh weight of plants varied significantly between treatment groups in our study, with T_6 (Poultry manure) having the greatest fresh weight at 417.0 g, closely followed by T_3 (Farm Yard Manure-FYM) at 330.67 g. The control group T_1 had the smallest fresh weight of plants, measuring 148.33 g. These findings highlight the importance of organic fertilizers, specifically poultry manure and FYM, in fostering robust plant development and boosting overall fresh plant weight. This information is useful for horticulturists and farmers because it highlights the potential of certain organic fertilizers to improve overall plant health and size, which may have significant consequences for crop output and quality in both commercial and home gardens. Pooja *et al.* (2012) [9], and Bhat *et al.* (2010) [1].

Dry weight of plant (g): In our study, we found that the dry weight of plants varied significantly between treatment groups, with T_6 (Poultry manure) having the greatest dry weight at 114.0 g, followed by T_3 (Farm Yard Manure-FYM) at 75.33 g. In contrast, the control group T_1 had the smallest dry weight of plants, measuring 37.0 g. These findings emphasize the vital role of chicken manure in enhancing plant development and biomass accumulation, valuable for agriculture and horticulture. Vieira *et al.* (1999) [19] demonstrated maximum fresh and dry matter yields in marigold flowers and plants with chicken litter, without extra phosphorus.

Shelf life of plant: In our study, we observed differences in plant shelf life across treatment groups, with T_6 and T_7 (Poultry manure) having the longest shelf life at 8.88 days, followed by T_3 (Farm Yard Manure-FYM) at 7.93 days, and T_1 (control group) having the shortest shelf life at 7.33 days. These findings imply that the use of organic fertilizers, particularly poultry manure and FYM, can improve plant shelf life, possibly owing to better overall plant health and vitality as a result of increased nutrient availability. This discovery has practical consequences for growers and farmers, emphasizing the possible benefits of employing certain organic fertilizers to lengthen plant shelf life, which may be especially useful for marketing and shipping.

Table 1: The influence of different organic manures on vegetative and flowering traits.

Treatments	Plant Height (cm)	Number Leaves Per Plant	Number of Branches Per Plant	Plant Spread (cm)	Number of buds per plant	Days to first flower emergence	Flower diameter (mm)	Fresh flower weight (g)	Flower weight per plant (g)	Fresh weight of plant (g)	Dry weight of plant (g)	Shelf life of plant (days)
T_1	26.7	204.66	11.09	29.38	32.70	85.00	57.40	6.77	24.33	148.33	37.00	7.33
T_2	26.56	236	10.50	27.96	39.13	78.67	64.13	8.00	33.50	267.00	74.33	7.66
T_3	27.1	236	9.83	27.99	41.53	83.00	58.47	9.43	33.07	330.67	75.33	7.93
T_4	24.1	249.33	8.67	26.21	38.33	82.00	62.17	11.00	34.63	230.00	53.00	7.55
T_5	26.63	245	10.50	28.99	40.13	80.00	56.87	19.67	37.93	187.33	36.67	7.60
T_6	32.4	284.33	20.42	43.03	44.17	71.67	93.00	25.33	67.33	417.00	114.00	8.88
T_7	28.4	268.33	14.92	28.55	42.53	76.67	60.40	22.33	57.67	328.33	65.00	8.88
T_8	27.5	242.66	10.50	30.35	31.03	84.00	63.27	11.33	39.47	152.33	35.33	7.63
T_9	28.5	254.33	13.67	32.58	39.20	84.00	67.23	11.00	50.23	203.67	46.67	7.44
S.Ed. (±)	0.47	4.63	0.24	0.64	0.93	1.57	1.30	0.32	0.63	7.11	1.19	0.21
C.D. at 5%	1.00	9.90	0.51	1.38	1.99	3.37	2.78	0.69	1.35	15.22	2.54	0.45

*T_1-Control, T_2-Farm yard manure @ 1000 g, T_3-Farm yard manure @ 500 g, T_4-Vermi compost @ 1000 g, T_5-Vermi compost @ 500 g, T_6-Poultry manure @ 1000 g, T_7-Poultry manure @ 500 g, T_8-Goat manure @ 1000 g, T_9-Goat manure @ 500 g

Conclusion

Based on the findings of this study, it is clear that Poultry manure is the most beneficial organic substance in terms of vegetative characteristics, blooming attributes, and yield aspects in marigold production. T_6, which included Poultry manure, consistently produced the most favourable results across all growth criteria, followed by vermicomposting and goat dung. In conclusion, the findings clearly show that applying Poultry manure at a greater rate is the best organic material for boosting the growth and development of marigold plants. Nonetheless, it is critical to emphasise the need for more study to confirm these findings and fully examine the long-term effects of using diverse organic materials on plant development and soil health.

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