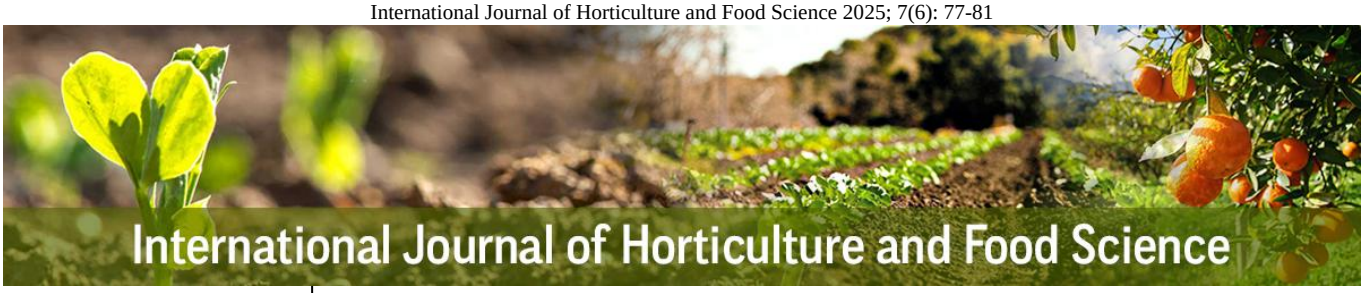

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Effect of integrated nutrient management on growth, flowering and yield of African marigold (*Tagetes erecta* L.)

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Abstract
An experiment was entitled "Effect of Integrated Nutrient Management on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.)" was carried out during *rabi*, 2024-25 at Instructional Farm, School of Agricultural Sciences, Dabok, Udaipur. The experiment comprised of ten treatments *viz*., T_1 (Control), T_2 (100% RDF), T_3 (75% RDF + FYM 10 t ha^{-1}), T_4 (75% RDF + Vermicompost 5 t ha^{-1}), T_5 (75% RDF + FYM 10 t ha + Bio fertilizer (Liquid consortia)), T_6 (75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)), T_7 (50% RDF + FYM 10 t ha^{-1}), T_8 (50% RDF + Vermicompost 5 t h^{-1}), T_9 (50% RDF + FYM 10 t h^{-1} + Bio fertilizer (Liquid consortia) and T_{10} 50% RDF + Vermi compost 5 t h^{-1} + Bio fertilizer (Liquid consortia) with replicated three in Randomized Block Design. Marigold variety Yellow-307 was used as a test crop.
The results reveled that during experiment use of different nutrient on growth, flowering and yield its effect among all treatments T_6 (75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia) was found to significantly increase growth, flowering, yield parameters, yield as well as economic of African marigold. It was found that maximum value of growth parameters *viz*., The maximum plant height (35.68 and 68.65 cm) at 60 DAT and 90 DAT, number of primary branches $plant^{-1}$ **(**14.71), number of secondary branches $plant^{-1}$ (26.55), and stem girth (1.47 cm), flowering parameters *viz*., minimum days taken to bud initiation (35.63 days), minimum days to 50% flowering (50.63), maximum duration of flowering (54.23), highest flower diameter (5.38 cm), The maximum number of flowers $plant^{-1}$ (51.11), yield parameters and yield *viz*., the highest flower yield $plant^{-1}$ (285.45 g)., maximum flower yield $plot^{-1}$ (5.14 kg), maximum flowers yield ha^{-1} (21.15 t ha^{-1}), economic parameters *viz*., maximum net return of (₹ 282981 ha^{-1}) was found under T_6 (75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)] and maximum B-C ratio (2.91) was found under T_2 (100% RDF).

Keywords: African marigold, integrated nutrient management on growth, flowering and yield

Introduction
One of the commercially grown flower crops in the genus Tagetes and family Asteraceae is marigold.. The genus Tagetes has 33 species, the two of which most commonly grown in India *viz*., African marigold (*Tagetes erecta* L., 2n = 24) and French marigold (*Tagetes patula* L., 2n = 48) (Rydberg, 1945; Kumar *et al*. 2015) [15, 9]. African marigold is hardy, about 90 cm tall, erect and branched. The flowers are large to medium sized with globular heads and come in a variety of shades. It is indigenous to South and Central America, particularly Mexico. Marigold was brought to India by the Portuguese, and it swiftly gained popularity and expanded because to its ease of cultivation and tolerance to diverse soil and climatic conditions.
The application of a balanced dose of inorganic fertilizer plays a significant role in increasing flower production because nitrogen is a key component of amino acids, which is essential for the synthesis of proteins. Nitrogen bases like pyrimidines and purines as well as numerous co-enzymes also need nitrogen for their synthesis. Additionally, nitrogen is a component of cytochrome and chlorophyll, both of which are essential for the process of photosynthesis. On the other hand, phosphorus serves as an energy source in the form of ATP and ADP and influences cell division. It is also a component of many enzymes, co-enzymes, nucleic acids and phospholipids.

Whereas, potassium acts as a catalyst for various enzymes and co-enzymes and plays a major role in the synthesis of starch. Furthermore, potassium is responsible for processes such as photorespiration, translocation of metabolites and transpiration (Bhardwaj *et al*. 2012) [3].

The elements NO_3, PO_4, Ca, K, Mg, S, and micronutrients found in vermicompost, which is mostly composed of C, H, and O, have comparable effects on plant development and yield to those found in inorganic soil fertilisers. (Shashikant 2005) [17]. Liquid consortia can be used on marigolds. Liquid consortia are biofertilizers that can help improve soil health and increase crop yield. Here are some benefits of using liquid consortia, Improves soil health. It can boost the soil's ability to retain water and nutrients while also improving its physical and chemical characteristics. It can increase crop yield and quality by 20-30% reduces disease infestation. In order to assess the effects of integrated nutrient management on African marigold (*Tagetes erecta* L.) development, flowering, and yield as well as the physico-chemical characteristics of soil, the current study was conducted.

Materials and Methods

The field experiment was conducted during October, 2024 to May, 2025 Horticulture farm, Department of Horticulture, School of Agricultural Sciences, Dabok, Udaipur. Geographically, Udaipur is located at 24° 34' N latitude and 73° 42' E longitude at an elevation of 582.17 meters above mean sea level (MSL). This particular part of India falls under agro climatic zone IV a *i.e.* "Sub-Humid Southern Plain and Aravalli Hills" of Rajasthan state. The geography of the experimental site was fairly levelled with an ample surface drainage and the field soil was having clay loam texture. In experiment conducted ten treatments in RBD Design with trice replications. In study, cultivar Yellow-307 was used. The 0.5 m x 1.5 m seed beds were made by excavating the soil, adding 50 kg of well-rotted FYM each bed, and levelling the beds to a height of around 15 cm. The seeds of marigold were sown on 5th October 2024.

Results and Discussion

Effect of Integrated nutrient management on growth attributes

Data examine in Table 1 indicate that application of integrated nutrient management brought about a significant variation in growth parameters as *viz*., plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1} and stem girth. The maximum plant height (35.68 and 68.65 cm) was recorded at 60 DAT and 90 DAT, maximum number of primary branches plant^{-1} (14.71) maximum number of secondary branches plant^{-1} (26.55), maximum stem diameter (1.47 cm) was recorded under T_6 [75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)] as compared to control. Plant height may have increased because there was more organic carbon available for microorganisms to multiply, which improved soil N and P availability by fixing atmospheric nitrogen and dissolving soil-bound and inaccessible phosphorus. These nutrients enter the plants, promoting their growth and stimulating auxiliary buds, which increases the height of the plants. The combined effect of vermicompost and inorganic fertilisers may have increased nutrient availability, improved root and shoot growth, and eventually led to the proliferation of more branches per plant. Similar findings were also reported by Sunitha *et al*. (2007) [22] in marigold, Vermicompost is an excellent source of micronutrients and a variety of enzymes in addition to nitrogen, phosphorus, and potash. The vermicompost's aforementioned ingredients may have contributed to crop plants' efficient access to plant nutrients, which would have increased plant height and spread. reported by Chanani *et al*. (2008) in Petunia. It is also said that vermicompost act as miracle growth promoter and protector reported by Shasidhara *et al*. (2002) in Calendula. Additionally, vermicompost increases the marigold plant's photosynthetic efficiency, which results in an increase in leaf area.

Nitrogen, an important component of nucleic acid that is crucial for fostering plant development, may be the cause of a rise in stem diameter. This confirms the finding of Mandloi *et al*. (2008) [10] in onion and Singh and Singh (2003) [8] in rose. Phosphorus is clearly a component of chlorophyll and has a role in a variety of physiological functions, such as cell division, meristematic tissue formation, photosynthesis, and the metabolism of proteins, lipids, and carbohydrates. When compared to other organic manures and fertilisers, vermicompost greatly increased the plants' development. Similar results have also been reported by Prakash *et al*. (2002) [13], Rafi *et al*. (2002) [12] in tomato, Barman *et al*. (2003) [2] in tuberose and Acharya and Dashara (2004) [1] in African marigold.

Table 1: Effect of integrated nutrient management on plant height, number of branches plant^{-1} and stem diameter of African marigold

Treatments	Treatments combination	Plant height (cm)		Number of branches plant^{-1}		Stem diameter (cm)
		At 60 DAT	At 90 DAT	Primary	Secondary	
T_1	Control	26.65	50.60	7.65	15.76	1.32
T_2	100% RDF	34.12	64.25	12.45	24.70	1.42
T_3	75% RDF + FYM 10 t ha-1	32.54	62.47	11.25	24.35	1.39
T_4	75% RDF + Vermicompost 5 t ha-1	33.44	63.47	12.18	24.55	1.40
T_5	75% RDF + FYM 10 t ha + Bio fertilizer (Liquid consortia)	34.25	65.68	13.15	25.13	1.45
T_6	75% RDF + Vermicompost 10 t ha-1 + Bio fertilizer (Liquid consortia)	35.62	68.65	14.71	26.55	1.47
T_7	50% RDF + FYM 10 t ha-1	28.68	56.84	9.26	22.58	1.34
T_8	50% RDF + Vermicompost 5 t h-1	29.68	58.68	9.56	22.65	1.35
T_9	50% RDF + FYM 10 t h-1 + Bio fertilizer (Liquid consortia)	30.14	60.45	10.26	23.12	1.37
T_{10}	50% RDF + Vermicompost 5 t h-1 + Bio fertilizer (Liquid consortia)	31.25	62.14	11.15	24.21	1.38
	S.Em.±	0.45	1.01	0.15	0.27	0.06
	C.D. (P=0.05)	1.35	3.01	0.46	0.80	NS

Flowering Parameters

Different floral characters Table 2 *viz*, days to 50% flowering, days to first flower bud appearance and days to first harvest were significantly influenced by different treatments. Minimum days taken to bud initiation (35.63 days) minimum days to 50% flowering (50.63), maximum duration of flowering (54.23), the highest flower diameter (5.47 cm). The maximum number of flowers plant^{-1} (51.11) was recorded under T_6 [75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)], which were recorded significantly higher over rest of the treatments. According to Sreekanth *et al*. (2008) [21], this occurs in African marigold because of the rapid halt of vegetative development, which forces the plants to blossom early. Additionally, he noted that applying more nitrogen boosted vegetative growth and postponed the initiation of buds and the subsequent 50% flowering. This could be because there is a greater supply of major plant nutrients, which are needed in greater amounts for plant growth and development. Growth and reproductive stages are accelerated when nitrogen is applied at the ideal level. Moreover, higher content of nitrogen might have accelerated protein synthesis, thus promoting earlier flower primordial development. Thus, results are in confirmation with Acharya and Dashora (2004) [1] in African marigold.

This might be due apical dominance may have been broken as a result of the auxiliary buds' facile reception of nutrients and concurrent transfer of chemicals that promote growth. In the end, this may have produced a superior sink for quicker photosynthetic mobilisation and an earlier transition of plant components from the vegetative to the reproductive phases. The favourable effect of vermicompost also caused the earliest flowering which lead to earliest harvesting by enhancing soil fertility and moisture retention capacity of the soil. These results are reported by Jadhav *et al*. (2002) [7] marigold and Sehrawat *et al*. (2003) [16] in marigold. Analogous results were also obtained by Gayathri *et al*. (2004) [6] in limonium and Jayamma *et al*. (2008) [8] in jasmine.

Table 2: Effect of integrated nutrient management on flowering parameters of African marigold

Treatments	Treatments combination	Days taken to bud initiation	Days to 50% flowering	Duration of flowering	Flower diameter (cm)	Number of flowers plant^{-1}
T_1	Control	42.66	57.66	42.57	3.12	29.54
T_2	100% RDF	37.65	52.14	52.85	5.06	49.30
T_3	75% RDF + FYM 10 t ha^{-1}	38.65	53.26	51.36	4.23	43.65
T_4	75% RDF + Vermicompost 5 t ha^{-1}	38.45	52.36	52.53	4.45	45.65
T_5	75% RDF + FYM 10 t ha + Bio fertilizer (Liquid consortia)	37.32	51.23	53.12	5.18	49.38
T_6	75% RDF + Vermicompost 10 t ha-1 + Bio fertilizer (Liquid consortia)	35.65	50.63	54.23	5.38	51.11
T_7	50% RDF + FYM 10 t ha^{-1}	41.23	56.85	45.62	3.77	32.65
T_8	50% RDF + Vermicompost 5 t h^{-1}	40.45	55.92	47.98	3.86	36.54
T_9	50% RDF + FYM 10 t h-1 + Bio fertilizer (Liquid consortia)	40.23	54.68	49.65	4.11	40.36
T_{10}	50% RDF + Vermicompost 5 t h-1 + Bio fertilizer (Liquid consortia)	39.65	53.45	50.65	4.18	42.85
	S.Em.±	0.46	0.84	0.55	0.14	0.89
	C.D. (P=0.05)	1.36	2.49	1.63	0.41	2.65

Yield attributes and yield

A glance of the data represented in Table 3 that there was significant effect of integrated nutrient management on flower yield plant^{-1} African marigold.the highest flower yield plant^{-1} **(**285.45 g). Maximum flower yield plot^{-1} (5.14kg). The maximum flowers yield ha^{-1} (21.15 t ha^{-1}) was recorded under T_6 [75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)], The abundant supply of nutrients, enzymes, biofertilizer, and the positive effects of microflora may have contributed to the production of more flowers, which in turn led to more blooms per plant, a maximum yield, and more flowers per square metr.. These findings are in accordance with those of Sunitha *et al*. (2007) [22] in marigold, This may be because the phytohormones that vermicompost produces increase the microbial enzymatic activity in the soil, which in turn promotes root development and morphological changes in the roots, which improves nutrient absorption. This boosting effect may also result from enhanced yield and a greater buildup of carbohydrates in flower heads when inorganic fertilisers are added. Similar results were recorded by Gaur *et al*., (2008) [5] in marigold. Vermicompost's simple, balanced nutrient availability to plants for improved root proliferation may be the cause of the rise in yield metrics brought about by the integrated nutrients of inorganic fertilisers with biofertizer. increased activity of microorganisms Increased absorption of NPK as a result of enhanced photosynthetic activity and better biological traits. This results in improved protein and carbohydrate absorption, which improves the plant's vegetative growth and helps it produce the most blooms possible per plant by using photosynthesis to improve bud and flower development.. Also, the availability of organic and inorganic nitrogen and other essential nutrients for longer period at optimum level resulting in more number of flowers per plant which increased the yield of flowers per plant yield of flowers per plot. Mittal *et al*. (2010) [11] in African marigold and Choudhary *et al*. (2020) [4] in marigold and Prasad *et al*. (2018) [14] in dahlia

Table 3: Effect of integrated nutrient management on yield of African marigold

Treatments	Treatments combination	Flower yield plant^{-1} (g)	Flower yield plot^{-1} (kg)	Flower yield ha^{-1} (t)
T_1	Control	115.25	2.07	8.54
T_2	100% RDF	215.35	3.88	15.95
T_3	75% RDF + FYM 10 t ha^{-1}	210.35	3.79	15.58
T_4	75% RDF + Vermicompost 5 t ha^{-1}	212.65	3.83	15.75
T_5	75% RDF + FYM 10 t ha + Bio fertilizer (Liquid consortia)	225.32	4.06	16.69
T_6	75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)	285.45	5.14	21.15
T_7	50% RDF + FYM 10 t ha^{-1}	182.65	3.29	13.53
T_8	50% RDF + Vermicompost 5 t h^{-1}	195.65	3.52	14.49
T_9	50% RDF + FYM 10 t h^{-1} + Bio fertilizer (Liquid consortia)	205.36	3.70	15.21
T_{10}	50% RDF + Vermicompost 5 t h^{-1} + Bio fertilizer (Liquid consortia)	207.35	3.73	15.36
	S.Em.±	23.67	1.29	2.40
	C.D. (P=0.05)	71.02	3.85	5.40

Economics

The use of integrated nutrient management strategies in taro had a substantial impact on net return and the B-C ratio, according to the data (Table 4). Treatment T_6 [75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)] produced the maximum net return of ₹ 282981 ha^{-1} and maximum B-C ratio (2.91) was found under T_2 (100% RDF) which was superior than rest of treatments. It might be because this treatment produced the most high-quality flowers, which sold for a higher price and increased gross return when compared to other treatments. It could also be because of the high returns and average cultivation cost when compared to other treatments. Similar results was obtained by Singh *et al*. (2015) [19] in marigold, Tandel *et al*. (2021) [24] in African marigold and Tiwari *et al*. (2010) [23] in marigold.

Table 4: Effect of integrated nutrient management on net return and B-C ratio of African marigold

Treatments	Treatments combination	Net return (₹ ha^{-1})	B-C ratio
T_1	Control	96731	1.31
T_2	100% RDF	237372	2.91
T_3	75% RDF + FYM 10 t ha^{-1}	206877	1.98
T_4	75% RDF + Vermicompost 5 t ha^{-1}	205285	1.87
T_5	75% RDF + FYM 10 t ha + Bio fertilizer (Liquid consortia)	228916	2.18
T_6	75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)	282981	2.02
T_7	50% RDF + FYM 10 t ha^{-1}	167755	1.63
T_8	50% RDF + Vermicompost 5 t h^{-1}	182013	1.69
T_9	50% RDF + FYM 10 t h^{-1} + Bio fertilizer (Liquid consortia)	201247	1.95
T_{10}	50% RDF + Vermicompost 5 t h^{-1} + Bio fertilizer (Liquid consortia)	199195	1.84

Conclusion

On the basis of results procured from present investigation entitled "Effect of Integrated Nutrient Management on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.)" conducted during *Rabi* 2024-25, it may be concluded that under prevailing agro-climatic zone IV of Rajasthan, a significant increase in growth, yield attributes as well as net returns of marigold were found under application of T_6 (75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia). The maximum yield and net return were obtained with T_6 [75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia)]. Therefore, application 75% RDF + Vermicompost 10 t ha^{-1} + Bio fertilizer (Liquid consortia may be recommended for taro to obtain higher yield and net returns. However, these are one-year results and need further experimentation for final recommendation.

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