

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

P Chirukuri^{a#}, UC Singh^b, G Khangarakpam^c, B Nandigam^d and Herojit Singh Athokpam^e



Summary

According to the result of the current study, plant height, canopy, stem girth, number of primary branches and total dry matter of the plant at 30 DAT, 60 DAT, 90 DAT were recorded maximum with the application of 100% RDF. The maximum yield parameters, such as a number of flowers per plant, yield/plant, yield/plot and yield/ha., flowering parameters, such as minimum days to first flower bud appearance, 50% flowering, first harvest and maximum flowering duration, i.e., the highest gross return/ha and the net return/ha were recorded highest by the application of 75% RDF + Vermicompost (1.25t/ha).

JAE 2023, Vol 15

Received: 02 March 2023

Accepted: 09 May 2023

Published: 30 June 2023

<https://doi.org/10.58628/JAE-2315-111>

Associated Editor: Dr. RK Meena

Copyright © 2023 The Author(s). Published by Society for Agriculture and Arid Ecology Research (SAAER). This is an Open Access article under the Creative Commons Attribution License 4.0 (CC BY-NC-SA).



Keywords: African Marigold, *Tagetes erecta* L., Vermicompost, FYM and flower, bud, yield

Introduction

Marigold belongs to the family Asteraceae and genus *Tagetes*. Marigold (*Tagetes erecta* L.) is an immensely popular annual flower crop widely grown worldwide and in India as well, accounting for more than half of the nation's loose flower production. It is grown in flower beds, borders, and even as potted plants in landscaping architecture. In India, Marigold rank first among the loose flowers, followed by chrysanthemum, jasmine, tuberose and crossandra. In India loose flowers are grown in an area of 266.62 thousand ha with an annual production of 2095.16 thousand MT [NHB Database (2021-22)]. The estimated area under marigold cultivation in India is about 73.15 thousand ha producing 728.53 thousand MT. Major marigold-producing states are Madhya Pradesh (224.62 thousand MT), Karnataka (121.93 thousand MT), Gujarat (83.28 thousand MT), Andhra Pradesh (76.42 thousand MT), West Bengal (63.44 thousand MT), Chhattisgarh (36.84 thousand MT), Odisha (30.47 thousand MT) and Haryana (23.73 thousand MT) [NHB Database (2021-22)]. It is one of the dominating flowers which fetches high price in the local market.

The uses of marigold are many folds, often referred to as 'versatile crop with golden harvest'. Flowers of marigold are extensively used for making garlands, baskets, veni, wreaths for religious offerings as well as decorative purpose. Marigold is gaining industrial importance due to its huge potential in value addition. A wide array of value-added products are prepared from marigold-like pigments, meals, food colorant of essential

oils. Marigold is also grown as a trap crop for the Management of *Helicoverpa armigera* (Hubber) in crop like tomato and tobacco and used as an eco-friendly component of IPM.

The use of chemical fertilizers is an essential ingredient for maintaining the sustainability of yield, but it poses problems to soil health in the long span of time. Therefore, it is necessary to restrict the use of chemical fertilizers to a certain limit (Gotmare et al. 2007; Anusuya et al. 2018; Meena et al. 2018). The basic concept underlying INM is maintenance and possible improvement in soil fertility for sustainable productivity on a long-term basis by use of chemical fertilizers with matching addition of organic manures and with or without biofertilizers. Keeping in view the importance of integrated nutrient management (INM) the present investigation on 'Effect of integrated nutrient management on growth, flowering and yield of African Marigold (*Tagetes erecta* L.) cv. 'Pusa Basanti Gaiinda' was undertaken with the following objectives to identify the best integrated nutrient management treatment for maximizing growth, flowering and yield in African marigold cv. Pusa Basanti Gaiinda and to be analyzed the economics of the crop production.

Materials and Methods

The present experiment was carried out at the experimental field of the Department of Horticulture, College of Agriculture, Central Agricultural University, Imphal from 2021 to 2022. The experiment was carried out in Randomized Block Design (RBD) constituting 7 treatments replicated three times with 30 plants per plot spaced at 40 cm × 30 cm. The treatments included 100% recommended dose of inorganic fertilizer (RDF) (T₁), 75% RDF + FYM (7.5 t/ha) (T₂), 75% RDF + Neem cake (0.63 t/ha) (T₃), 75% RDF + Vermicompost (1.25 t/ha) (T₄), 50% RDF + FYM (15 t/ha) (T₅), 50% RDF + Neem cake (1.3 t/ha) (T₆), 50% RDF + Vermicompost (2.5 t/ha) (T₇). Well rotten FYM, neem cake and vermicompost were applied

^{a,b,c,d}Department of Horticulture, College of Agriculture, Central Agricultural University, Imphal -795004, Manipur.

^eDepartment of soil science and agricultural chemistry, College of Agriculture, Central Agricultural University, Imphal-795004, Manipur.

[#]Corresponding author: P Chirukuri, E-mail: chirukuriprasanthi@gmail.com

as per the treatment combinations to the experimental plots 15 days before transplanting, after layout and land preparation of the field. The recommended dose of nitrogen, phosphorus and potassium for Manipur condition was 250, 100 and 50 kg per hectare (Chokhoni 2015) was applied in two splits i.e., 50 per cent N and K and full dose of P at the time of transplanting and remaining 50 per cent N and K was applied 40 days after transplanting as top dressing in the form of urea, super phosphate and muriate of potash, respectively. During the experiment, various parameters such as growth parameters, flowering parameters, yield and yield contributing parameters, postharvest parameters were recorded and the economics of the crop production using different integrated nutrient management treatments were also analyzed.

Results and Discussions

Growth parameters

The effect of integrated nutrient management was found significant in respect to plant growth data presented in table 1. The maximum plant height (37.46 cm, 59.16 cm, 77.74 cm), canopy spread north to south and east to west at 30 DAT (13.90 cm, 13.80 cm), 60 DAT (18.87 cm, 18.70 cm) and 90 DAT (31.43 & 31.50 cm), stem girth (0.44 cm, 0.87 cm, 1.02 cm), number of primary branches (4.43, 12.41, 14.04), total dry matter of plant (6.81

g, 14.98 g and 23.34 g respectively) at 30 DAT, 60 DAT, 90 DAT were recorded with the application of 100 per cent (RDF) recommended dose of inorganic fertilizer (RDF) (T₁). This might be due to nitrogen as an essential part of nucleic acid this plays vital role in promoting the plant growth by initiation of meristematic activity of plants and acceleration of cell division and cell enlargement. Thus, the growth of plant by and large depends on nitrogen. It is obvious that phosphorus is a constituent of chlorophyll and is involved in many physiological processes including cell division, meristematic tissue development, photosynthesis, carbohydrates metabolism, fats and proteins etc. Potassium has also been reported to be involved in the synthesis of peptide bond, and protein and carbohydrate metabolism, and also participates in rapid cell division and differentiation. Similar results had also been reported by (Kishan et al. 2007) in plant height, canopy spread and number of branches, (Ahirwar et al. 2012) in plant height, plant canopy and a number of branches, stem girth and number of branches (crop) and Dikr and Belete (2017) in plant height, plant spread, stem girth and number of branches (crop). Sahu et al. (2021) reported the same in chrysanthemum in plant height and number of branches.

Table 1. Effect of integrated nutrient management on morphometric characteristics and total dry weight per plant of African marigold

Treatment	Plant height (cm)			Plant spread (cm)						No. of primary branches/plant			Stem girth (cm)			Total dry weight per plant (g)		
	30	60	90	30 DAT		60 DAT		90 DAT		30	60	90	30	60	90	30	60	90
	DA	DA	DA	N-S	E-W	N-S	E-W	N-S	E-W	DA	DA	DA	DA	DA	DA	DA	DA	DA
T ₁ : 100% recommended dose of inorganic fertilizer (RDF)	37.46	59.17	77.70	13.90	13.80	18.87	18.70	31.43	31.50	4.43	12.41	14.04	0.44	0.87	1.02	6.81	14.98	23.34
T ₂ : 75% RDF + FYM (7.5t/ha)	35.07	55.30	74.11	12.67	12.63	17.70	17.96	28.93	28.10	4.33	11.70	13.79	0.41	0.82	0.94	5.80	13.23	22.55
T ₃ : 75% RDF + Neem cake (0.63t/ha)	28.60	48.63	62.77	12.33	12.03	17.37	17.43	26.13	26.63	3.07	9.47	10.81	0.41	0.80	0.91	4.50	11.83	21.29
T ₄ : 75% RDF + Vermicompost (1.25t/ha)	36.73	57.97	75.83	13.60	13.43	18.57	18.33	30.00	30.37	4.40	12.08	13.98	0.42	0.85	0.97	6.17	14.02	22.90
T ₅ : 50% RDF + FYM (15t/ha)	31.53	50.53	69.17	12.43	12.33	17.53	17.50	27.23	27.03	4.10	10.77	12.80	0.39	0.77	0.88	5.38	12.75	21.85
T ₆ : 50% RDF + Neem cake (1.3t/ha)	29.40	49.40	65.23	12.17	11.87	17.10	17.33	25.73	25.67	3.40	10.13	11.78	0.37	0.73	0.83	4.16	11.02	20.44

T ₇ : 50% RDF + Vermicompost (2.5t/ha)	33.17	52.31	71.53	12.47	12.45	17.50	17.77	27.30	27.63	4.20	11.14	13.10	0.40	0.79	0.90	5.23	13.11	22.38
S.Ed(±)	0.97	1.12	0.83	0.38	0.48	0.36	0.36	0.75	0.79	0.26	0.34	0.19	0.01	0.02	0.04	0.16	0.16	0.21
CD (p=0.05)	2.11	2.43	1.80	0.84	1.04	0.79	0.78	1.63	1.73	0.56	0.74	0.42	0.03	0.04	0.09	0.35	0.34	0.46

Flowering parameters

Data presented in Table 2 on flowering parameters showed significant response to different treatments of integrated nutrient management. Different flowering parameters viz., minimum days to flower bud appearance (54.27days), minimum days to 50% flowering (81.33 days), minimum days to first harvest (75.23 days) and maximum flowering duration (53.07 days) was observed with the treatment application of 75% RDF + Vermicompost (1.25 t/ha) [T₄]. It may be because nutrients are taken in more readily and growth-promoting agents are sent simultaneously to auxiliary buds, breaking apical dominance. In the end, this may have produced a superior sink for the earlier transition of plant

parts out from vegetative to reproductive phase, as well as for the quicker mobilization of photosynthates. The application of vermicompost in combination of inorganic fertilizer provide optimum availability of nitrogen and other essential nutrients for longer period at optimum level. The same results for minimum **days taken to first flower bud appearance** were observed by Sudhagar *et al.* (2019) and Kaushik and Singh, (2020) in marigold. Similar findings on earliest first harvest by Priyadarshini *et al.* (2018) in marigold and Priyanka *et al.* (2018) in crossandra. For longest duration of flowering similar results is reported by Singh *et al.* (2015) in marigold Pusa basanti gainda.

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

Treatment	Days taken to flower bud initiation	Flowering duration (days)	Days taken to first harvest	Days to 50% flowering	No. of flowers per plant	Yield / plant (grams)	Yield of flower/ plot (kg)	Yield of flower/ha (t)
T ₁ : 100% Recommended dose of inorganic fertilizer (RDF)	59.27	52.47	90.57	95.33	58.93	372.93	3.08	8.55
T ₂ : 75% RDF + FYM (7.5t/ha)	55.67	52.23	78.33	83.00	58.07	379.23	3.13	8.69
T ₃ : 75% RDF + Neem cake (0.63t/ha)	61.33	46.17	95.63	100.00	40.10	243.13	2.20	6.11
T ₄ : 75% RDF + Vermicompost (1.25t/ha)	54.27	53.07	75.23	81.33	60.87	388.20	3.27	9.10
T ₅ : 50% RDF + FYM (15t/ha)	57.43	50.77	85.53	94.00	49.67	330.93	2.84	7.90
T ₆ : 50% RDF + Neem cake (1.3t/ha)	61.80	46.80	96.40	102.00	43.87	274.97	2.51	6.97
T ₇ : 50% RDF + Vermicompost (2.5t/ha)	58.97	49.00	86.13	95.00	50.50	339.36	2.88	8.01
S.Ed(±)	1.72	1.44	0.46	0.84	3.94	21.14	0.12	0.35
CD (p=0.05)	3.74	3.13	1.00	1.83	8.58	46.06	0.27	0.75

Yield parameters

A close examination of data given in Table 2 revealed that the number of flowers per plant, yield/plant, yield/plot and yield/ha was significantly influenced by integrated nutrient management. It was revealed that the maximum number of flowers (60.87), flower yield per plant (388.20 g), flower yield per plot (3.27 kg), flower yield per hectare (9.10 t) were observed in the treatment application of T₄ [75% RDF + Vermicompost (1.25 t/ha)]. The increase in yield parameters due to integrated approach of vermicompost with inorganic fertilizers, might be due to easy balanced availability of nutrients to plants by vermicompost for better root proliferation enhanced microbial activity excellent uptake of NPK due to improved biological characteristics, enhancement of photosynthetic activity. This leads to better assimilation of carbohydrate and protein resulting in better vegetative growth of plant and helped the plant to produce maximum number of flowers per plant involving in

photosynthesis for better development of bud and flower. 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) and Choudhary *et al.* (2020) in marigold and Prasad *et al.* (2018) in dahlia.

Nutrient content in plant

A keen observation of the data shown in from Table 3 it was found that there was significant difference among treatments with respect to Nitrogen, Phosphorus, Potassium per cent in leaf at flower bud initiation stage of marigold. Among the treatments T₁ (1.57 %) was recorded maximum for N per cent and T₄ (0.35 %) for P per cent, T₇ (1.26 %) for K per cent recorded maximum in leaf and T₆ (1.43 %, 0.21 % respectively) recorded minimum for N per cent and P per cent, T₃ (1.20 %) recorded minimum for K per cent in leaf. The application of inorganic fertilizers has easy and ready availability of

nitrogen to plants. The application of both organic and inorganic manures together may have improved the soil's condition and increased the number of phosphorus-solubilizing microorganisms in the soil, therefore increased P availability and the addition of N and P₂O₅ considerably raised the amount of K in the plant. This might be as a result of the fact that P₂O₅ and N both boost K nutrition and plant uptake. At the beginning of the flower bud, there was one peak rate of uptake for N, P, and K. The positive effect of vermicompost on the nutrient content can be supported by the findings of Ichancha et al. (2019) in marigold and Sharukhkhani (2019) in chrysanthemum.

Economics

Table 3. Nitrogen content (%), Phosphorus content (%), Potassium content (%) in leaf and economics of African Marigold as influenced by integrated nutrient management

Treatments	N %	P %	K %	Total cost of cultivation (Rs/ha)	Yield (kg/ha)	Gross return (Rs/ha)	Net returns (Rs/ha)	B: C
T ₁ : 100% Recommended dose of inorganic fertilizer (RDF)	1.57	0.29	1.22	1,08,899	8550.93	4,27,546	3,18,647	2.93
T ₂ : 75% RDF + FYM (7.5t/ha)	1.46	0.26	1.21	1,96,838	8693.98	4,34,699	2,37,861	1.21
T ₃ : 75% RDF + Neem cake (0.63t/ha)	1.44	0.23	1.20	1,69,051	6114.54	3,05,727	1,36,676	0.81
T ₄ : 75% RDF + Vermicompost (1.25t/ha)	1.54	0.35	1.24	1,29,942	9095.42	4,54,771	3,24,829	2.50
T ₅ : 50% RDF + FYM (15t/ha)	1.45	0.25	1.23	2,83,509	7902.62	3,95,131	1,11,622	0.39
T ₆ : 50% RDF + Neem cake (1.3t/ha)	1.43	0.21	1.21	2,32,808	6965.41	3,48,270	1,15,462	0.50
T ₇ : 50% RDF + Vermicompost (2.5t/ha)	1.47	0.28	1.26	1,50,475	8012.04	4,00,602	2,50,127	1.66
S.E.d(±)	0.03	0.01	0.0054					
CD (p=0.05)	0.06	0.02	0.0118					

Conclusion

From the current study, it can be inferred that, the application of 75% RDF + Vermicompost (1.25 t/ha) (T₄) could give the best result for the flowering, xanthophyll content, yield, net returns and gross returns, while the postharvest characteristics of African marigold flowers were most noticeable under treatment T₇ [50% RDF + Vermicompost (2.5 t/ha)]. Vermicompost and inorganic fertilizers may combine well to boost African marigolds' sustainable growth and flower production, according to the current study's findings.

Acknowledgments

The authors are grateful to the Dean, College of Agriculture, Central Agricultural University, Imphal for providing all the facilities.

Declarations of interests

All authors of this manuscript declare that they have no conflict of interest.

Data sharing

All relevant data are within the manuscript.

References

- Ahirwar M K, Ahirwar K & Shukla M. 2012. Effect of plant densities, nitrogen and phosphorus levels on growth, yield and quality of African Marigold. *Annals of Plant and Soil Research*, 14(2): 153-155.
- Annual report 2021-22. First Advance Estimates of Area and Production of Horticulture Crops. *National Horticulture Board*. (nhb.gov.in).<https://agricoop.nic.in/sites/default/files/2021-22-First-Advance-Estimates-29-0.pdf>.
- Anusuya R, Vijayakumar RM, Srividhya S & Sivakumar R. 2018. Comparison of physiological and flowering parameters of main and off season by using different plant nutrients and growth hormone in mango (*Mangifera indica* L.) cv. Bangalora. *Journal of Agriculture and Ecology*, 5: 76-82. Retrieved from <https://journals.saaer.org.in/index.php/jae/article/view/152>.
- Chokhoni K, 2015. Effect of nitrogen and phosphorus on growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. M.Sc. dissertation, Central Agricultural University, Imphal.
- Choudhury S, Sarangi D & Mishra. 2020. Response of integrated nutrient management on plant growth, flower yield and shelf life of African Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. *International Journal of Chemical Studies*, 8(3): 2453-2456. DOI:<https://doi.org/10.22271/chemi.2020.v8.i3ai.9577>.
- Dikr W & Belete K. 2017. Review on the Effect of organic fertilizers, bio-fertilizers 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.
- Gotmare P T, Damke M M, Gonge V S & Snehal D. 2007. Influence of integrated nutrient management on vegetative growth parameters of marigold (*Tagetes erecta* L.). *The Asian Journal of Horticulture*, 2(2): 33-36.

8. Ichancha M, Singh UC, Singh AH & Devi RS. 2019. Effect of different sources of nitrogen on the growth, flowering and yield of African marigold (*Tagetes erecta* L.) cv. summersugat. *The Pharma Innovation*, 8(7): 283-286.
9. Kaushik H & Singh J P. 2020. Impact of integrated nutrient management (INM) on plant growth and flower yield of African marigold (*Tagetes erecta* L.). *Journal of Pharmacognosy and Phytochemistry*, (4): 1481-1484.
10. Kishan S, Raju DVS & Singh, KP 2007. Effect of nitrogen and phosphorus on growth, flowering and seed yield of African marigold, variety Pusa Narangi Gaiinda (*Tagetes erecta* L.). *Orissa Journal of Horticulture*, 35(2): 15-20.
11. Meena CL, Meena RK, Sarolia DK, Dashora LK & Singh D. 2018. Effect of integrated nutrient management on fruit quality of pomegranate cv. Ganesh. *Journal of Agriculture and Ecology*, 5: 67–75. Retrieved from <https://journals.saaer.org.in/index.php/jae/article/view/151>.
12. Mittal R, Patel HC, Nayee DD & Sitapara HH. 2010. Effect of integrated nutrient management on flowering, yield and vase life of African marigold (*Tagetes erecta* L.) cv. Local under middle Gujarat agroclimatic conditions. *Asian Sciences*, 5(1): 22-24.
13. 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.
14. Priyadarshini A, Palai SK & Nath MR. 2018. Effect of source of nitrogen on growth and yield of African marigold (*Tagetes erecta* L.). *The Pharma Innovation Journal*, 7(7): 917-921.
15. Priyanka TK, Kamble BS, Subiya RK, Anuradha RW & Gasti VD. 2018. Interactive study of spacing and different levels of nutrients on flowering and yield attributes of crossandra (*Crossandra undulaefolia* Salisb.). *Journal of Pharmacognosy and Phytochemistry*, 7(1): 487-490.
16. Sahu NP, Sharma G & Jaiswal AK. 2019. Effect of bio-organic and inorganic nutrient sources on the growth and flower yield of marigold. *International Journal of Chemical Studies*, SP6: 18-21.
17. Sharukh Khan, 2019. Influence of Vermicompost in combination with microbial consortium on growth, yield and quality of Chrysanthemum (*Dendranthema grandiflora* L.) cv. Marigold. MSc dissertation, University Of Agricultural Sciences, GKVK, Bengaluru.
18. Singh L, Gurjar PKS, Barholia AK, Haldar A & Shrivastava A. 2015. Effect of organic manures and inorganic fertilizers on growth and flower yield of Marigold (*Tagetes erecta* L.) var. Pusa narangi gaiinda. *Plant Archive*, 15(2): 779-783.
19. Singh P, Prakash S, Kumar M, Kumar S & Singh M K. 2015. Effect of integrated nutrient management (INM) on growth, flowering and yield in marigold (*Tagetes erecta* L.) cv. Pusa Basanti. *Annals of Horticulture*, 8(1): 73-80.
20. 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.