

**RESEARCH ARTICLE :**

# Effect of inorganic fertilizers, vermicompost and bio-fertilizers on floral characters of African Marigold (*Tagetes erecta* L.) Cv. Pusa Narangi

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**SUMMARY :** The present experiment was carried out for two consecutive winter seasons (2012-13 and 2013-14) at the horticulture nursery, College of Agriculture, Gwalior. The topography of the experimental area was uniform with adequate irrigation and drainage facilities. In this trial 12 treatments of inorganic and organic was observed and analyzed in Randomized Block Design (RBD) with three replications. An examination of the data recorded for the various aspects of flower characters viz., days taken to flower bud initiation, days taken to flowering, duration of the flowering (days), days to 50% flowering, number of flowers/plant, flower diameter (cm), fresh and dry weight of flower (g), flower yield hectare (q) basis, days to flower senescence in plant were significantly affected by different treatment combinations.

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**KEY WORDS:**

Inorganic fertilizers,  
Vermicompost, Bio-fertilizers, Flowering, Marigold

## **BACKGROUND AND OBJECTIVES**

Marigold becomes one of the most popular flowers in our country on account of its easy culture, wider adaptability to varying soil and climatic conditions and lucrative returns. Its habit of free flowering, short duration to product marketable flowers, and wide range of colours, shape, size and good keeping quality attracted the attention of flower growers. In India, it is in great demand as loose flower throughout year. Globular shaped flower with long stalks are used for cut-flower purposes. In gardens, marigold

provides beautification of beds and borders. Marigold is grown for cut flowers, making garlands, decoration during pooja and several religious and social functions, besides its use in landscape gardening. Marigold is a heavy feeder of nutrients specially nitrogen and phosphorus (Nalwadi, 1982). At present, these nutrients are supplied through chemical fertilizers. The indiscriminate and continuous use of chemical fertilizers has lead to an imbalance of nutrients in soil which has an adversely effected the soil fertility and productivity.

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The use of organic manures and bio-fertilizers along with the balanced use of chemical fertilizers is known to improve physico-chemical and biological properties of soil, besides improving the efficiency of applied fertilizers, affecting the yield and quality of the product. Due to the rising cost of fertilizers, environmental pollution problems it has become imperative to arrive at an integrated nutrient management practice for marigold to achieve the target yield at economical use of plant nutrients. Hence, an attempt is made to reduce the amount of nitrogenous and phosphatic fertilizers by substituting with organic manures and bio-fertilizers.

## RESOURCES AND METHODS

The present experiment was carried out for two consecutive winter seasons (2012-13 and 2013-14) at the horticulture nursery, College of Agriculture, Gwalior. The topography of the experimental area was uniform with adequate irrigation and drainage facilities. In this trial 12 treatments of inorganic and organic were observed and analyzed in Randomized Block Design (RBD) with three replications. T<sub>1</sub> Control, T<sub>2</sub> - 150% RDF, T<sub>3</sub> - 100% RDF (120 : 80 : 80 kg NPK/ha), T<sub>4</sub> - Azotobacter (2 kg/ha) + PSB (4 kg/ha), T<sub>5</sub> - Vermicompost (5 t/ha), T<sub>6</sub> - Vermicompost + Azotobacter + PSB, T<sub>7</sub> - 75% RDF + Azotobacter + PSB, T<sub>8</sub> - 100% RDF + Azotobacter + PSB, T<sub>9</sub> - 75% RDF + Vermicompost, T<sub>10</sub> - 100% RDF + Vermicompost, T<sub>11</sub> - 75% RDF + Vermicompost + Azotobacter + PSB and T<sub>12</sub> - 100% RDF + Vermicompost + Azotobacter + PSB.

## OBSERVATIONS AND ANALYSIS

The maximum days taken to first flowering *i.e.*, for flower bud initiation to full bloom of flower (42.73 days) was recorded with T<sub>2</sub> (150% RDF) followed by T<sub>11</sub>, T<sub>9</sub>, T<sub>12</sub> and T<sub>10</sub>, while, the minimum days taken to first flowering (38.49 days) was recorded under T<sub>1</sub> (control). Reason of the maximum days required for flower bud initiation to full bloom of flower may be due to higher levels of NPK which increased vegetative growth along with flower growth. Similar results have been reported by Pushkar *et al.* (2008) in African marigold.

The maximum duration of flowering (92.96 days) was noticed with T<sub>2</sub> (150% RDF) followed by T<sub>10</sub>, T<sub>12</sub>, T<sub>11</sub> and T<sub>3</sub> while the minimum duration of the flowering (83.22 days) were observed in T<sub>1</sub> (control), it was

effective significantly when applied in combination of 100% RDF + vermicompost, 100% RDF + vermicompost + Bio-fertilizer, 75% RDF + vermicompost + Bio-fertilizer and 100% RDF. Maximum duration of flowering may be due to integration of chemical fertilizers, vermicompost and Bio-fertilizers. It is in close conformity with the findings of Gaikwad *et al.* (2004), Jamkhande *et al.* (2004) and Mohit *et al.* (2008) in China aster.

The maximum number of days (75.99 days) required to 50% flowering in the plant was noticed with T<sub>2</sub> (150% RDF) followed by T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) (75.10 days) while, the minimum days to 50% flowering (66.71 days) was found in T<sub>1</sub> (control). This may be due to increased supply of major plant nutrients which are required in larger quantities for the growth and development of plants. The application of nitrogen at optimum level attributed to acceleration in development of growth and reproductive phases. 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) who reported that flowering and yield characters significantly influenced with higher level of nitrogen application in African marigold.

The maximum number of flowers per plant (61.32) was observed with T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) followed by T<sub>2</sub> (60.62) and T<sub>12</sub> which indicates that the integrated use of NPK along with vermicompost and Bio-fertilizers increased the number of flowers per plant. Number of flowers per plant increased might be due to the presence of growth substance (NAA) in vermicompost and INM. This increase in number of flowers per plant may be due to the integration of nutrient which enhances the vigorous of plant growth like primary and secondary branches. Similar results have been obtained by Rao and Reddy (2006), Sunitha *et al.* (2007), and Pushkar *et al.* (2008).

The maximum flower diameter (8.54 cm) was recorded in T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) followed by T<sub>2</sub> (8.28 cm) and T<sub>12</sub> on pooled basis. This may be assigned to early breaking of apical dominance followed by easy and better translocation of nutrients to the flowers brought about by inoculation with beneficial microbial inoculants like *Azotobacter* and PSB. This may be due to *Azotobacter* which provides more amounts of nitrogen by fixing it

through atmosphere. Similarly, PSB helped in increasing phosphorus availability by releasing enzymes. Phosphate in soil which helps the plant in healthy growing condition resulting into the production of flower having more diameters. Reason of higher diameter of flower may be due to higher level of P and presence of growth substances in vermicompost. The positive effect of vermicompost on flower diameter has been reported in marigold by Kumar (2002).

The maximum fresh weight of flower (10.43 g) was noticed in T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) followed by T<sub>2</sub> and T<sub>12</sub>, which indicates that the integrated use of NPK along with vermicompost and Bio-fertilizers increased the fresh weight of flowers. Reason of maximum fresh weight of flowers may be due to INM. During the present investigation on pooled basis, on an average 1.25 g fresh weight of flower was increased with the application of Bio-fertilizers in different treatment combinations. It was also observed that application of Bio-fertilizers was more effective when applied with 75% NPK + vermicompost. Kumar *et al.* (2006) also reported Bio-fertilizers to be effective in increasing the average weight of flowers in marigold. It was observed that application of vermicompost increased the fresh weight of flowers in the range of 0.11 to 3.91 g with different treatment combinations. Rathore *et al.* (2002) in gaillardia and Mittal *et al.* (2010) in marigold also reported higher fresh weight of flowers with integrated nutrient management.

The maximum dry weight of flowers (7.17 g) was

recorded with T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) followed by T<sub>10</sub>, while the minimum dry weight of flowers (0.88 g) was observed in T<sub>1</sub> (control) on pooled basis. It indicates that the integrated use of NPK along with vermicompost and Bio-fertilizers increased the dry weight of flowers. These findings are in conformity with the findings of Gayathri *et al.* (2004) and Mittal *et al.* (2010).

The maximum days to flower senescence in plant was noticed with T<sub>3</sub> (100% RDF) followed by T<sub>12</sub>, T<sub>2</sub>, T<sub>8</sub> and T<sub>9</sub>, while the minimum duration of the flowering were observed in T<sub>7</sub> (75% RDF + Azotobacter + PSB), whereas, it was effective significantly when applied in combination of 100% RDF + vermicompost, 100% RDF + vermicompost + Bio-fertilizer. The slight variation between vermicompost, bio-fertilizers and NPK might be due to variation in soil fertility. These findings were similar to that of Mishra (1998) and Singotkar *et al.* (1995) in gaillardia. It was observed that the application of Bio-fertilizers or vermicompost alone or Bio-fertilizers + vermicompost were not effective significantly in duration of flowering in the plant, whereas it was effective significantly when applied in combination of 75% RDF and 100% RDF. Similar findings were reported by Angadi (2010). It can be explained that the anti-correlation exist between higher dose of nitrogen and days to flower senescence in plant.

The maximum flower yield of marigold per hectare (312.004 q) basis was recorded in T<sub>11</sub> (75% RDF + Vermicompost + Azotobacter + PSB) followed T<sub>2</sub> and

**Table 1: Effect of inorganic fertilizers, vermicompost and bio-fertilizers on flower characters of marigold flowers.**

Treatments	Days taken to first flowering	Duration of flowering (Days)	Days to 50% flowering	Number of flowers /plant	Flower diameter (cm)	Fresh weight of flower (g)	Dry weight of flower (g)	Days to flower senescence in plant	Flower yield (q/ha)
T <sub>1</sub>	38.49	83.22	66.71	39.71	6.25	6.95	0.88	17.63	160.640
T <sub>2</sub>	42.73	92.96	75.99	60.62	8.28	10.12	1.11	20.64	295.660
T <sub>3</sub>	41.17	91.33	73.27	54.58	7.48	8.96	1.08	20.95	260.317
T <sub>4</sub>	38.63	84.20	67.96	42.76	6.51	7.20	1.01	18.18	197.569
T <sub>5</sub>	38.67	84.99	67.84	43.05	6.43	7.47	0.98	17.53	192.857
T <sub>6</sub>	39.04	86.07	70.12	46.51	6.98	7.42	0.99	17.27	230.506
T <sub>7</sub>	40.93	87.56	70.50	49.10	6.85	8.09	1.03	16.88	224.950
T <sub>8</sub>	40.32	89.92	71.80	50.30	7.63	8.66	1.05	20.05	231.647
T <sub>9</sub>	42.07	89.84	71.73	53.73	7.03	8.15	1.04	18.94	281.324
T <sub>10</sub>	41.82	92.72	73.97	56.51	7.88	9.07	1.14	17.68	291.220
T <sub>11</sub>	42.22	92.41	75.10	61.32	8.54	10.43	1.17	18.34	312.004
T <sub>12</sub>	41.85	92.42	73.79	59.71	8.01	9.89	1.09	20.88	286.756
S.E. ±	0.39	0.59	0.67	1.08	0.20	0.29	0.02	0.80	7.153
C.D. (P=0.05)	1.14	1.74	1.98	3.16	0.59	0.85	0.05	2.34	20.978

T<sub>10</sub>, while the minimum yield of marigold flowers per hectare (160.640 q) basis were observed in T<sub>1</sub> (control) on pooled basis, which indicates that the integrated use of NPK along with vermicompost and bio-fertilizers increased the flower yield of marigold. These significantly increased in flowers yield might be due to application of 75% RDF along with vermicompost with the use and combined effect of Bio-fertilizers. These sources releases higher amount of nutrients and make them available to the plant which might be a reason to increase the yield attributes up to maximum level. The beneficial effect of combination of organic, inorganic fertilizers on the flower yield was attributed to the increased in number of flowers per plant. These findings are in accordance with the findings of Gupta *et al.* (1999), Kumar *et al.* (2006), Rao and Reddy (2006), Pushkar *et al.* (2008).

Bio-fertilizers are microbial inoculants which are capable in nitrogen fixation, phosphorus solubilizing and decomposing organic matter at faster rate and they help in improving the soil fertility and boosting crop productivity. The increase in number of flowers and flowers yield may be due to the possible role of *Azotobacter* through atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water, higher leaf number and area. More photosynthesis enhanced food accumulation which might have resulted in better plant growth and subsequently higher number of flowers per plant and, hence, more number of flowers yield/ha. Besides this, increase in flower yield may be attributed to increased availability of phosphorous and its greater uptake (Kundu and Gaur, 1980).

The mechanisms by which PSB augment plant growth is through phosphate dissolution and in the biosynthesis of auxin (Sattar and Gaur, 1987) and IAA (Bareae *et al.* 1976). Also by providing protection against the non-parasitic root pathogens and transforming unavailable mineral and organic compounds into available forms in plants. Any of these effects would have lead to increase in plant growth and flowers yield. Similarly, Narsimharaju and Haripriya (2001) reported higher flower yield in crossandra with the combination of bio-fertilizers with 100% NPK, Chandrikapure *et al.* (1999) had similar results in marigold.

Vermicompost, being the rich source of macro and micro nutrients like Fe and Zn, enzymes, growth hormones and beneficial effects of micro flora might have played a secondary role in increasing the flower yield.

The positive effect of vermicompost on plant growth and higher flower yield due to application of vermicompost has been reported by Sreenivas *et al.* (1999) in China aster, Kusuma (2001) in Golden Rod and Gangadharan and Gopinath (2000) in gladiolus. These results suggest that the combined application of inorganics, bio fertilizers and vermicompost was superior over individual application for better flower yield.

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