

Effect of plant growth regulators and organic manures on growth and yield of African marigold var Pusa Basanti Gainda (*Tagetes erecta* L.)

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ABSTRACT

A factorial experiment with three different growth regulators and organic manures was conducted during the *Zaid* season at the Nalanda College of Agriculture (Affiliated to Tamil Nadu Agricultural University), Trichy to find out their influence on the growth and yield parameters of African marigold var. 'Pusa Basanti Gainda'. The study has revealed that the growth regulators and organic manures had significant impact on the growth and yield parameters of African marigold var. "Pusa Basanti Gainda". The plants in the control plot had much lower growth and yield parameters than the plants in the treatment plots. Among the treatments, T₆ (100 PPM NAA + 50% goat manure) was found to be the best treatment with mean values of 37.2 cm plant height, 17.33 leaves per plant, 26.5 cm² leaf area, 14.33 laterals per plant, 13 flowers per plant, 8.57cm flower diameter and 11.73g flower weight. The growth regulators had significant impact on both the growth and yield parameters, while the organic manures had significant impact only on the yield parameters. The interaction between growth regulators and organic manures had significant impact on most of the parameters (Number of leaves per plant, leaf area, number of laterals per plant, flower diameter, and individual flower weight). Among the growth regulators, 100 PPM NAA and among the organic manures, 50% vermicompost had significant impact on all the growth and yield parameters of marigold.

Key words: Growth regulators, marigold, organic manures, 100 PPM NAA + 50% goat manure.

INTRODUCTION

The most commonly cultivated marigold is the African Marigold, scientifically known as *Tagetes erecta* L. The name *Tagetes* is believed to be originated from the name of the Etruscan

Tages. It belongs to the family *Asteraceae* (Kar and Patra, 2022). The family is one of the largest families of dicotyledonous angiosperms with over 1,600 genera and 25,000 species worldwide. It includes a variety of species such as chicory, sunflower, lettuce, coreopsis, dahlias,

daisy, and marigold, as well as a variety of plants with medical significance, such as wormwood, chamomile and dandelion (Herman and Swelankomo, 2011). The plants are herbaceous majorly, with a significant number of shrubs, vines, or tress, with worldwide distribution from polar regions to the tropics, and colonizing a wide variety of habitats, most common in the arid and semi-arid regions of subtropical and lower temperate latitudes. The leaves are basally rosette, and sessile or petiolate and with absence of stipules. The flowers are perfect. Corolla are tri or penta-merous. Stamens are four or five. The ovary is inferior and single loculed. The fruit is an achene. Seeds are endosperm scanty and embryo straight. (Xu *et al.*, 2017). The word 'Tagetes' was named after a demigod, known for her beauty. Marigold is known as 'friendship flower' in the Unites States. Marigold is a native of Central and South America, especially Mexico. There are around 33 cultivated species in the genus *Tagetes*, out of which only 2 species are being cultivated in the large scale. They are *T. erecta* (African Marigold) and *T. patula* (French Marigold). The African Marigold are diploid species with $2n=24$, while the French ones are tetraploid with $4n=48$. The plants grow up to height of 1-4 metres. It is cultivated extensively in Asia, especially in India and China. It requires temperature ranging from 20-30°C. The marigold production at the global level stands at 6,00,000 tonnes, of which 75-80% is contributed by India. About 80% of its production is consumed by India. The Indian Marigold is considered the best in the world. Marigold is exported to countries like Japan, Iran, Sri Lanka, United States of America, and United Kingdom. At the national level, production is dominated by Uttar Pradesh, followed by Tamil Nadu. The maximum area under marigold cultivation is dominated by Andhra Pradesh, followed by Maharashtra,

Tamil Nadu, Orissa, Karnataka, Uttar Pradesh and Kerala. *Tagetes erecta* is the main species of commerce and is distributed in India, China, Sri Lanka, Indonesia, Jamaica and Peru. In Tamil Nadu, Erode is the largest producer in India and the most important trading centre. (Singh *et al.*, 2020). The African Marigold, *Tagetes erecta* is hardy about 90-100 cm tall, erect and branched with pinnately divided leaves and lanceolate and serrate leaflets. Flowers are single to fully double with colors varying from lemon yellow to golden yellow or orange with diameter of more than 15 cm. The flower yield is around 11-18 t/ha. The leaves and flowers are equally important in terms of medicinal properties. The oil yield is around 0.02-0.08% giving 8-15 kg oil/ha/year. The roots of marigold are known to supress soil nematode population. The essential oil of nematode is used in the perfume industry (Dikr and Belete, 2017). Based on the study conducted by Singh *et al.* (2022), the major constraints in marigold production includes unfavourable weather conditions, non-availability of HYV seeds and inadequate knowledge of recommended packages and practices. From this study, we can infer that there has not been much importance given to marigold research. The cost of seeds, manures, and fertilisers are also high leading to constraints in marigold production. (Verma *et al.*, 2013). Based on the above interventions, the study focussed on the effect of growth regulators and organic manures on growth and yield of African Marigold.

MATERIALS AND METHODS

The study was conducted in the research farm belonging to the Department of Horticulture, Nalanda College of Agriculture (Affiliated to Tamil Nadu Agricultural University), Trichy, Tamil Nadu (Latitude 11°02'42.6"N, longitude

78°47'16.2"E and altitude 85 m above msl). The mean maximum temperature is around 37.2° and mean minimum is 27.3°. The mean annual rainfall is 526.4 mm. The soil is clay loam with pH 7.9, 39% water holding capacity, 0.21g OC, 109.76 kg/ha N, 42.56 kg/ha P, and 79.52 kg/ha K.

The material comprised of marigold variety Pusa Basanti Gaiinda acquired from a nearby private nursery. The experiment was laid out in Two-factor Randomised Complete Block Design (RCBD) with 3 replications. The treatments details are given in Table 1. The growth regulators were sprayed at 25 DAT, while the organic manures were basally applied at the time of transplanting. The plants were transplanted in the plots of size 3 × 2 m² with 60 × 45 cm² spacing. All the good packages of practices were properly adopted.

Data were collected in each treatment on growth parameters such as plant height (cm), no. of leaves per plant, no. of laterals per plant, and

Table 1: Treatment details.

Treatment	Description
T ₀ (Control)	No treatment
T ₁ (G ₁ M ₁)	GA ₃ (150 PPM) + FYM (50%)
T ₂ (G ₁ M ₂)	GA ₃ (150 PPM) + Vermicompost (50%)
T ₃ (G ₁ M ₃)	GA ₃ (150 PPM) + Goat Manure (50%)
T ₄ (G ₂ M ₁)	NAA (100 PPM) + FYM (50%)
T ₅ (G ₂ M ₂)	NAA (100 PPM) + Vermicompost (50%)
T ₆ (G ₂ M ₃)	NAA (100 PPM) + Goat Manure (50%)
T ₇ (G ₃ M ₁)	Ethrel (400 PPM) + FYM (50%)
T ₈ (G ₃ M ₂)	Ethrel (400 PPM) + Vermicompost (50%)
T ₉ (G ₃ M ₃)	Ethrel (400 PPM) + Goat Manure (50%)

leaf area (cm²) and yield parameters such as no. of flowers per plant, flower diameter (cm), and individual flower weight (g) at their appropriate time of observation as suggested by marigold descriptors (45 DAT, 60 DAT or 90 DAT).

The data were statistically analysed by agricolae (de Mendiburu, 2023) and Doebioresearch (Popat and Banakara, 2020) packages in R-studio (v4.3.2; R Core Team, 2023).

Table 2: Mean, Coefficient of Variation (CV) and Critical Difference (CD) (At 5% level of significance) of growth and yield parameters of marigold under combined effects of the treatments.

Treatment	Plant Height (cm)	No. of Leaves per Plant	Leaf Area (cm ²)	No. of Laterals per Plant	No. of Flowers per Plant	Flower Diameter (cm)	Individual Flower Weight (g)
T ₀	29.53 ^e	10.00 ^d	20.40 ^c	06.67 ^d	04.67 ^e	5.63 ^d	07.13 ^{ef}
T ₁	34.13 ^{cd}	12.36 ^c	26.77 ^a	10.33 ^c	08.17 ^d	5.50 ^d	06.75 ^f
T ₂	35.80 ^{abc}	14.33 ^c	22.63 ^b	09.67 ^c	10.33 ^b	8.17 ^{ab}	11.87 ^a
T ₃	34.87 ^{bcd}	13.33 ^c	21.43 ^{bc}	10.00 ^c	11.00 ^b	8.42 ^{ab}	11.07 ^b
T ₄	36.97 ^a	16.00 ^c	21.27 ^{bc}	08.67 ^c	08.33 ^{cd}	8.12 ^{ab}	07.42 ^e
T ₅	36.00 ^{ab}	12.33 ^b	25.33 ^a	12.00 ^b	10.67 ^b	7.63 ^b	10.20 ^c
T ₆	37.20 ^a	17.33 ^a	26.50 ^a	14.33 ^a	13.00 ^a	8.57 ^a	11.73 ^a
T ₇	33.33 ^d	16.00 ^c	21.57 ^{bc}	09.00 ^c	08.33 ^{cd}	6.70 ^c	09.86 ^c
T ₈	34.83 ^{bcd}	15.67 ^c	21.10 ^{bc}	10.00 ^c	09.67 ^{bc}	8.23 ^{ab}	08.68 ^d
T ₉	33.40 ^d	13.67 ^c	21.47 ^{bc}	10.00 ^c	10.00 ^{bc}	6.67 ^c	07.68 ^e
Mean	34.61	14.10	22.85	10.00	09.33	7.26	09.24
CV (%)	3.088%	7.066%	3.893%	9.813%	10.655%	6.941%	3.686%
CD (At 5%)	1.833	1.709	1.561	1.683	1.706	0.877	0.584

Means followed by the same letter do not statistically differ at 5% level of significance.

RESULTS AND DISCUSSION

The result of the current study indicated that the growth regulators and organic manures had significant individual effects and combined effects on the growth and yield of marigold variety Pusa Basanti Gaiinda. The mean, CV and CD at 5% level of significance of growth and yield parameters of marigold under the combined effects of growth regulators organic manures is tabulated in Table 2. Comparing all the treatments, control is found to be having much lower values. On comparing all the treatments, the T₆ (100 PPM NAA + 50% goat manure) was found to be the best treatment for improving the growth and yield of marigold.

Maximum plant height was observed in T₆ (37.20 cm) and was minimum in control T₀ (29.53 cm) followed by T₇ (33.33 cm) (Figure 1). The overall

mean of plant height was found to be 34.61 cm and it had low CV (3.088%). Maximum number of leaves per plant was observed in T₆ (17.33) and was minimum in control T₀ (10). Among the treatments, minimum number of leaves per plant was observed in T₅ (12.33), followed by T₁ (12.36) (Figure 2). The marigold plants had 14.1 mean leaves per plant with low CV (7.066%).

Leaf area was found to be maximum in T₁ (26.77 cm²) and minimum in control T₀ (20.4 cm²). Among the treatments, leaf area was lowest in T₈ (21.4 cm²), followed by T₃ (21.43 cm²) (Figure 3). The leaf area had a mean value of 22.85 cm², with a low CV (3.893%). Mean number of laterals per plant was found to be highest in T₆ (14.33) and lowest in control T₀ (6.67) and in T₄ (8.67), among the treatments (Figure 4). Number of laterals per plant had a mean value of 10 with low CV (9.813%).

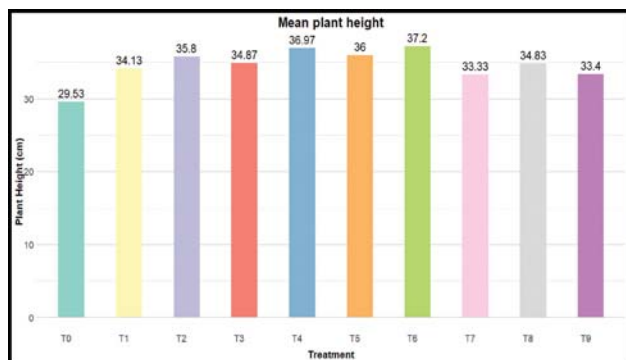


Fig. 1: Mean plant height (cm).

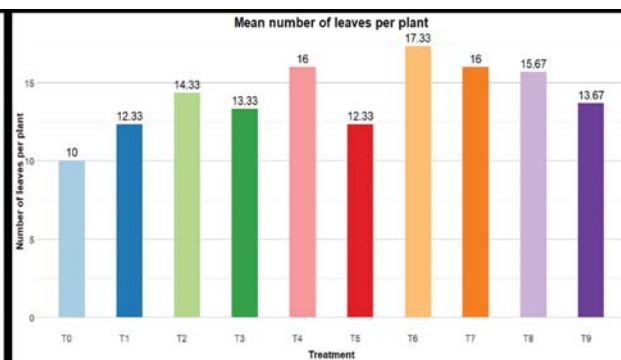


Fig. 2: Mean number of leaves per plant.

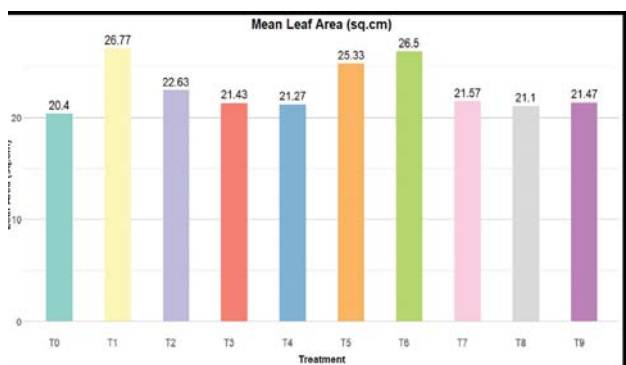


Fig. 3: Mean leaf area (cm²).

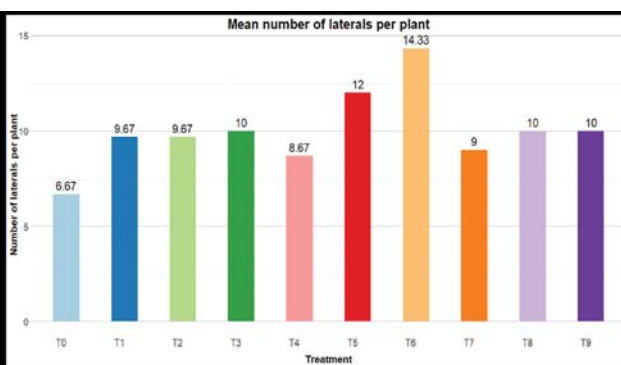


Fig. 4: Mean number of laterals per plant.

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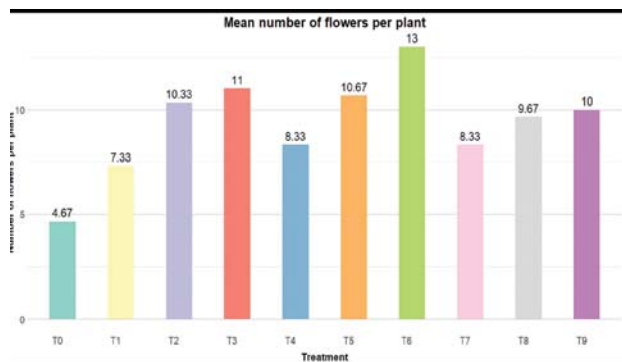


Fig. 5: Mean number of flowers per plant.

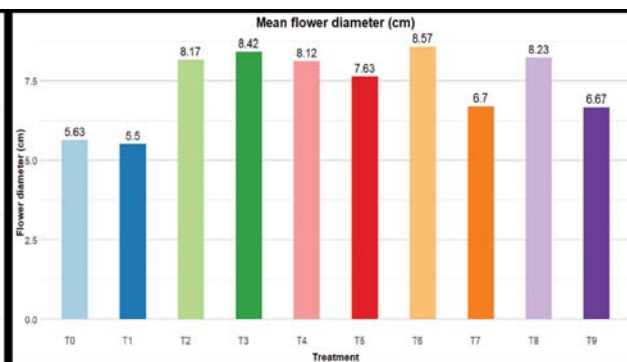


Fig. 6: Mean flower diameter (cm).

Mean number of flowers per plant was found to be maximum in T₆ (13) and minimum in control T₀ (4.67) and in T₁ (8.17) (Figure 5). The mean number of flowers per plant was calculated to be 9.33 with a CV of 10.655% (High). Flower diameter was found to be highest in T₆ (8.57 cm), while it was lowest in T₁ (5.50 cm) (Figure 6). The mean flower diameter was found to be 7.26 cm with a CV of 6.941%. Individual flower weight was found to be more in T₂ (11.87 g) followed by T₆ (11.73 g) and lowest in T₁ (6.75 g) (Figure 7). The weight of a flower was estimated to be 7.26 cm with a CV of 3.686%.

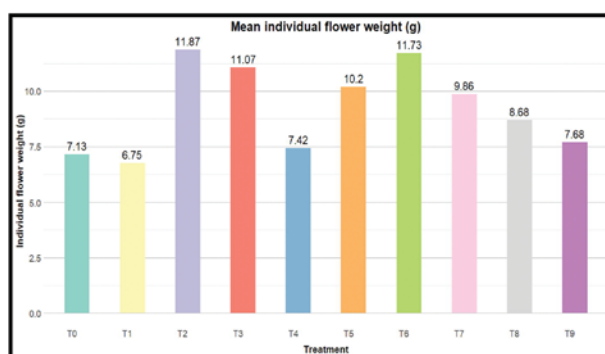


Fig. 7: Mean individual flower weight (g).

ANOVA for the effect of growth regulators and organic manures on the growth and yield parameters of marigold had been tabulated (Table 3). The block effects were non-significant for all of the parameters, indicating there was minimum

variation due to environment among the blocks and the experimental layout has successfully mitigated the field variability. Growth regulators significantly influenced all the parameters under study. It is evident by the high MSS values and their significance at 1%. The highest MSS for the growth regulators was observed in plant

Table 3: ANOVA of two-factor RCBD.

Sources of Variation	Plant Height (cm)	No. of Leaves per Plant	Leaf Area (cm ²)	No. of Laterals per Plant	No. of Flowers per Plant	Flower Diameter (cm)	Individual Flower Weight (g)
Block	0.044	0.4	0.129	0.00	0.43	0.345	0.074
Growth Regulators	41.178***	25.419***	21.143***	19.926***	27.259***	4.726***	7.359***
Organic Manures	2.423	1.333	0.072	12.482***	25.936***	4.179***	14.502***
Growth Regulators:							
Organic Manures	8.5901	13.278***	23.118***	6.482**	2.093	3.359***	13.076***
Residuals	1.1142	0.993	0.828	0.963	0.989	0.2613	0.116
R-squared value	0.867	0.881	0.913	0.865	0.889	0.886	0.980

**** - Significant at 0.1%, *** - Significant at 1%.

height (41.178), followed by number of flowers per plant (27.259). Meanwhile, organic manures had a significant impact only on the yield parameters under study. The highest MSS was observed in number of flowers per plant (25.936), followed by individual flower weight (14.502). The interaction between growth regulator and organic manure had significant impact on most of the parameters under study (No. of leaves per plant, leaf area, no. of laterals per plant, flower diameter and individual flower weight) The highest MSS for interaction was observed in leaf area (23.118). The MSS of residuals were not statistically significant, indicating that the models with high R^2 value, captured most of the variability in the experiment.

The single effect of growth regulators on growth and yield parameters of marigold had been given in Table 4. Comparing the treatment means of growth regulators, the control mean is found to be significantly low. Comparing all the growth regulators, the G_2 (100PPM NAA) is found to

be the best growth regulator for increasing the growth and yield of marigold.

The single effect of organic manures on growth and yield parameters of marigold had been given in Table 5. Comparing the treatment means of organic manures, the control mean is found to be significantly low. Comparing all the organic manures, the G_2 (50% vermicompost) is found to be the best organic manure for increasing the growth and yield of marigold.

CONCLUSION

The growth regulators and organic manures had a significant impact on the growth and yield parameters of marigold. Single effect of 100 PPM NAA had significantly improved the growth and yield of marigold, while 50% vermicompost had significant impact on yield of marigold. Combinedly, 100 PPM NAA and 50% goat manure was found to be best treatment to increase the growth and yield of marigold.

Table 4: Single effect of Growth Regulators on Growth and Yield Parameters of Marigold.

Growth Regulator Treatments	Plant Height (cm)	No. of Leaves per Plant	Leaf Area (LA) (cm ²)	No. of Laterals per Plant	No. of Flowers per Plant	Flower Diameter (cm)	Individual Flower Weight (g)
Control	29.53 ^d	10.00 ^c	20.40 ^b	6.67 ^c	4.67 ^c	5.63 ^c	7.13 ^c
G_1	34.93 ^b	13.33 ^b	23.61 ^a	9.78 ^b	9.56 ^b	7.36 ^b	9.89 ^a
G_2	36.72 ^a	15.22 ^a	24.37 ^a	11.67 ^a	10.67 ^a	8.11 ^a	9.78 ^a
G_3	33.86 ^c	15.11 ^a	21.38 ^b	9.67 ^b	9.33 ^b	7.20 ^b	8.74 ^b

Means followed by the same letter do not statistically differ at 5% level of significance.

Table 5: Single effect of Organic Manures on Growth and Yield Parameters of Marigold.

Organic Manure Treatments	Plant Height (cm)	No. of Leaves per Plant	Leaf Area (LA) (cm ²)	No. of Laterals per Plant	No. of Flowers per Plant	Flower Diameter (cm)	Individual Flower Weight (g)
Control	29.53 ^b	10.00 ^b	20.40 ^b	6.67 ^c	4.67 ^d	5.63 ^c	7.13 ^c
G_1	34.81 ^a	14.78 ^a	23.20 ^a	9.11 ^b	8.00 ^c	6.77 ^b	8.01 ^b
G_2	35.54 ^a	14.11 ^a	23.02 ^a	10.56 ^a	10.22 ^b	8.01 ^a	10.25 ^a
G_3	35.16 ^a	14.78 ^a	23.13 ^a	11.44 ^a	11.33 ^a	7.88 ^a	10.16 ^a

Means followed by the same letter do not statistically differ at 5% level of significance.

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