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Influence of Organic and Inorganic Inputs on Vegetative, Flowering and Yield Attributes of Marigold cv. Pusa Narangi Gainda

E. Manigandan [a++*], Sunil Kumar [a#], A.S. Mailappa [b†] and K.C. Momin [a‡]

[a] Department of Floriculture and Landscape Architecture, College of Horticulture and Forestry (CAU), Pasighat, Arunachal Pradesh, India.
[b] Department of Natural Resource Management, College of Horticulture and Forestry (CAU), Pasighat, Arunachal Pradesh, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out on "Influence of organic and inorganic inputs on vegetative, flowering and yield attributes of marigold cv. Pusa NarangiGainda" at instructional farm, Department of Floriculture and Landscape Architecture, College of Horticulture and Forestry,

[++] PG Scholar;
[#] Professor and Head;
[†] Associate Professor;
[‡] Assistant Professor
**Corresponding author: E-mail: manimelongena@gmail.com;*

Pasighat, Arunachal Pradesh during the year 2021-22. A field experiment was laid out in Randomized Block Design (RBD) with 13 treatments in three replications. Findings revealed significant ($p<0.05$) influence of organic and inorganic inputs on vegetative, flowering and yield characters of the marigold. Maximum plant height (130.70 cm), number of primary branches (11.20), number of secondary branches (14.40), leaf area (56.57 cm^2), East-Westplant spread (49.25 cm), and North-South plant spread (46.50 cm) were associated with treatments T_{12}-FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$. Treatment T_{12} also had earlier bud initiation (44.10 days), maximum number of flowers per plant (20.23), and flower yield (159.73 q). However, the maximum flower diameter (62.19 mm) was recorded in the treatment T_{10} - FYM @ 25 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$. The study demonstrates that combination of organic inputs significantly enhances the vegetative, flowering and yield attributes in marigold that could be exploited for increased productivity of the crop.

Keywords: Marigold; mustard oilcakes; FYM; vermicompost; NPK; yield attributes; marigold cultivation; essential nutrients; mustard oil.

1. INTRODUCTION

Floriculture has become a productive and vibrant industry, paving way for exploring the potential market globally. In India, area under marigold cultivation was around 73.99 thousand hectares with the production of 760.96 thousand tonnes of loose flowers and 19.15 thousand tonnes of cut flower during the year 2020-21 [1]. Marigold belongs to the family Asteraceae and genus *Tagetes*. *Tagetes* consists of 33 species, among these the most commonly cultivated species are African marigold (*T. erecta*) and French marigold (*T. patula*). Marigold was introduced by a Portuguese in India [2]. It was cultivated in Tamil Nadu, Karnataka, Gujarat, Haryana and Madhya Pradesh. Loose flowers are extensively used for making garland, flower baskets, floral decorations and religious gifts. In landscaping, marigold is useful in flower beds, shrubbery border and potted plants. Marigold petals have the highest concentration of xanthophylls and lutein (80-90%). Lutein, the primary constituent of xanthophyll, is used to colour food and marigold flower extract is used to treat eye disease and ulcers. Marigold essential oil contains anti-inflammatory and insect-repellent properties [2,3,4]. Marigold carotenoid pigment is used in chicken feed as supplement to improve the yellow colour of egg yolks and broiler skin Kumar and Sharma [5].

Despite its enormous importance, indiscriminate use of inorganic fertilizers in the production of the crop has negative impact on the soil microbial population, organic carbon content and availability of essential nutrients. In contrast, organic manures enhance organic matter in the soil and it promotes the growth of plants by providing all the essential macro and micro nutrients [6,7]. Incorporation of farm yard manure (FYM) enhanced the proliferation of micro-flora, predominantly *Azotobacter* Gupta et al. [8]. *Azotobacter* is a nitrogen-fixing bacterium which may be used in various non-leguminous crops Kumari et al. [9]. Vermicompost is a rich source of micronutrients and also it acts as chelating agents, regulating the availability of metabolic micronutrients in the plants. It enhances plant growth and productivity by supplying nutrients in the most accessible forms Panwar et al. [10]. Mustard oil cake is widely used as organic manure for the cultivation of flower crops due to its rich nutrient content, especially, nitrogen.

2. MATERIALS AND METHODS

The experiment was carried out at the instructional farm, Department of Floriculture and Landscape Architecture, College of Horticulture and Forestry, Pasighat, Arunachal Pradesh (28.07ºN Latitude and 95.32ºE Longitude), India during 2021-22 cropping season. The soil of the experiment site was sandy loam in texture with initial pH 5.2, and available NPK (313.6 $kg.ha^{-1}$ N, 313.6 $kg.ha^{-1}$ P and 202.2 $kg.ha^{-1}$ K). Marigold seedlings cv. Pusa Narangi Gainda of 10-15 cm in height was transplanted on the raised beds of uniform size 3 × 3 m at a spacing of 30 × 30 cm. The standard inter cultural practices were undertaken as per need during the entire investigation. The field experiment was laid out in Randomized Block Design (RBD) with 13 treatment combinations such as T_0 - Control, T_1 - RDF @ 120:80:60 NPK $kg.ha^{-1}$, T_2 - RDF @ 120:80:60 NPK $kg.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$, T_3 - FYM @ 25 $t.ha^{-1}$, T_4 - Vermicompost @ 5 $t.ha^{-1}$, T_5 - Mustard oil cake @ 5 $t.ha^{-1}$, T_6 - FYM

@ 25 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_7 - Vermicompost @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_8 - Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_9 - FYM @ 25 t.ha^{-1} + Vermicompost @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_{10} - FYM @ 25 t.ha^{-1} + Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_{11} - Vermicompost @ 5 t.ha^{-1} + Mustard oil cake @ 5t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}, T_{12} - FYM @ 25 t.ha^{-1} + Vermicompost @ 5 t.ha^{-1} + Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1} in three replications. Observation on vegetative parameters *viz*., plant height (cm), number of primary branches, number of secondary branches, leaf area (cm^2), East-West plant spread (cm), North-South plant spread (cm); flowering characteristics such as days taken to bud initiation, number of flowers per plant, flower diameter (mm) and flower yield (q/ha) were recorded. Data was analysed statistically as suggested by Gomez and Gomez [11].

3. RESULTS AND DISCUSSION

3.1 Effect of Organic and Inorganic Inputs on Vegetative Parameters of Marigold

The organic and inorganic inputs significantly affected the vegetative parameters in marigold as presented in Table 1.

3.2 Plant Height (cm)

The maximum plant height (130.70 cm) was associated with application of T_{12} (FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha) which was followed by T_7 (Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha) [113.50 cm]. However, the minimum plant height (86.22 cm) was recorded in T_0 (Control). This could be attributed to the absorption of micronutrients and macronutrients that were made available at optimal levels by the use of various organic inputs such as FYM, vermicompost and mustard oil cake. Vermicompost comprises 9.15 to 17.98% organic carbon on average, macro as well as micronutrients like nitrogen, phosphorus, potassium, zinc, sulphur, sodium, calcium, magnesium and iron [12]. The addition of FYM to the soil improves the physical, chemical, and biological properties of the soil, resulting in increased root growth and development and hence absorption of nutrients and water from a larger soil volume, leading to improved plant growth. This is in corroboration with the findings of Kumar and Sharma [10] in marigold, Premkumar et al. [13] in chrysanthemum, Kumar et al. [14] in chrysanthemum and Kumar et al. [15] in rose.

3.3 Number of Primary Branches

The more number of primary branches (11.20) was observed in T_{12} (FYM @ 25 t.ha^{-1} + Vermicompost @ 5 t.ha^{-1} + Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha$^{-1)}$ which was followed by T_9 (FYM @ 25 t.ha^{-1} + Vermicompost @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}) (9.70). Moreover, the minimum number of branches (5.20) was observed in T_0 (Control). Accelerated cell division and elongation in cells and enhanced metabolic activity in plants might be due to the application of FYM, which provides a higher level of nutrients to crops. Furthermore, it may lead to the breakdown of apical dominance and hence the emergence of axillary buds, leading to an increased number of primary branches per plant. Similar findings have also been reported by Premkumar et al. [13] in chrysanthemum, Swathi et al. [16] in marigold, Kumar et al. [14] in chrysanthemum.

3.4 Number of Secondary Branches

The highest number of secondary branches (14.40) was noticed in T_{12} (FYM @ 25 t.ha^{-1} + Vermicompost @ 5 t.ha^{-1} + Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}) in comparison to other treatments including control (4.83) and it was followed by T_{10} (FYM @ 25 t.ha^{-1} + Mustard oil cake @ 5 t.ha^{-1} + Dolomite @ 222 kg.ha^{-1}) produced 12.40 number of secondary branches. The application of vermicompost led to an increased number of secondary branches which is considered as homogeneous in nature and has desirable properties, a relatively low level of contaminates, plant growth promoting hormones, increased levels of soil enzymes, a greater microbial population, and retains more nutrients for quite a longer period of time without negatively impacting the environment. The foregoing findings are in consistent with that of Khan et al. [17] and Kumar et al. [14] in chrysanthemum.

3.5 Leaf Area (cm^2)

Increased leaf area was noticed in the treatment combinations T_{12} (FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha) [56.57 cm^2] and it was statistically on par with T_9 and T_{11}. However,

Control (T_0) showed the minimum leaf area (32.09 cm^2)**.** The probable reason might be due to the enhanced soil fertility and moisture retention capacity through the added vermicompost or FYM, which ultimately increased the leaf area. These findings are close agreements with the Sharma et al. [18] in marigold, Chawla et al. [19] and Madhuri et al. [20] in tuberose.

3.6 Plant Spread (cm)

Among the different treatments, the highest east-west plant spread (49.25 cm) was recorded in the T_{12} (FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$) and observed to be superior over control (26.50 cm), which was followed by the treatment T_2 (RDF @ 120:80:60 NPK $kg.ha^{-1}$ + Dolomite @ 222 $Kg.ha^{-1}$) exhibited the east-west plant spread of 41.21 cm. In addition to that, the maximum north- south plant spread (46.50 cm) was noticed in the T_{12} (FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1)}$ which was followed by the treatment T_1 (RDF @ 120:80:60 NPK $kg.ha^{-1)}$ recorded the north-south plant spread of 40.60 cm. However, the lowest east- west plant spread (28.50 cm) was observed in T_0 (Control). This is possibly attributed to the fact that the efficient decomposition and mineralization of organic inputs such as FYM, vermicompost, and mustard oil cake, leads to the release of the micro and macro nutrients which are readily accessible to plants, aiding the growth of plants. Besides the above, the fixed forms of nutrients also might have been solubilized through the organic acids secreted during the decomposition of added organic inputs. The increased plant spread could also be ascribed to the development of an increased number of leaves, which ultimately increased the photosynthesis activity and photosynthetic translocation to various parts of the plants, and in turn increased plant spread. These findings are in consistent with those of Swathi et al. [16] in marigold, Chander et al. [121] in marigold.

3.7 Effect of Organic and Inorganic Inputs on Flowering and Yield Attributes of Marigold

The organic and inorganic inputs significantly affected the flowering and yield attributes in marigold as shown in Table 2.

3.8 Number of Days Taken to Bud Initiation (days)

Earlier bud initiation (44.10 days) was noticed in the treatment T_{12} (FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$). However, the number of days taken to bud initiation was found to a maximum in T_0 (Control) [63.20 days]. The probable reason might be that the gibberellins present in vermicompost and FYM, helped in regulating the flowering that leads to cause an early flowering in marigold. These results are consistent with those of Kumar et al. [14] in chrysanthemum and Koley and Khan [22] in marigold.

3.9 Number of Flowers Per Plant

The number of flowers per plant was significantly varied with the application of different organic and inorganic treatments. Among the various treatments, treatment T_{12} (FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$) produced the highest number of flowers (20.23) and it was statistically at par with the treatments T_{10} and $T_{11.}$ However, least number of flowers (10.47) was recorded in T_0 (Control). The maximum of flowers/plant might due to the fact that the vermicompost containing essential macro and micro nutrients, growth accelerating hormones, enzymes, exerted a positive and significant impact on micro flora, which resulted in increased number of flowers. These findings are consistent with those of Chaitra and Patil [23] in China aster, Idan et al. [4] Chauhan et al. [21] and Priyadarshini et al. [22] in Marigold.

3.10 Flower Diameter (mm)

The diameter of flower was significantly influenced by various organic and inorganic treatments. Among the different treatment combinations, T_{10} (FYM @ 25 $t.ha^{-1}$) + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$) showed maximum diameter (62.19 mm) which was followed by T_8 (Mustard oil cake @ 5 $t.ha^{-1}$+ Dolomite @ 222 $kg.ha^{-1}$) [53.40 mm]. However, T_0 (Control) produced the flowers with minimum diameter (37.30 mm) in comparison to other treatments. The increased marigold flower size might be attributed to the enhanced vegetative growth, facilitated by the improved nutritional condition of the soil through the added organic inputs. These findings of Dash et al. [24] Swathi et al. [5,16] in marigold are in line with the present findings.

Table 1. Effect of organic and inorganic inputs on vegetative parameters of Marigold

Treatments	Plant height (cm)	Number of primary branches	Number of secondary branches	Leaf area (cm^2)	East-West Plant spread (cm)	North- South Plant spread (cm)
T_0 Control	86.22	5.20	4.83	32.09	26.50	28.50
T_1 RDF @120:80:60 NPK kg/ha	120.34	8.30	9.80	45.30	40.40	40.60
T_2 RDF @ 120:80:60 NPK kg/ha + Dolomite @ 222 kg/ha	122.43	8.70	10.77	46.10	41.21	43.20
T_3-FYM @ 25 t/ha	111.10	7.30	8.70	44.27	36.31	32.90
T_4 Vermicompost @ 5 t/ha	117.90	7.60	8.40	48.02	34.63	37.40
T_5 Mustard oil cake @ 5 t/ha	119.73	7.90	8.20	47.19	39.27	40.40
T_6 FYM @ 25 t/ha + Dolomite @ 222 kg/ha	118.70	9.02	9.40	43.27	40.85	38.50
T_7 Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha	113.50	8.40	9.20	45.24	39.72	36.40
T_8 Mustard oil cake @ 5 t/ha + Dolomite @222 kg/ha	120.30	8.70	10.10	49.30	39.81	41.75
T_9 FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha	123.45	9.70	13.39	51.91	43.47	43.11
T_{10} FYM @ 25 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	128.45	9.34	12.40	48.11	46.20	44.70
T_{11} Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	127.83	8.20	11.60	52.23	45.31	42.87
T_{12} FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	130.70	11.20	14.40	56.57	49.25	46.50
SE(d)	**7.25**	**0.64**	**0.75**	**3.15**	**3.15**	**2.47**
C.D at 5%	**14.98**	**1.32**	**1.56**	**6.50**	**6.51**	**5.10**
C.V (%)	**7.50**	**9.29**	**9.14**	**8.22**	**9.60**	**7.62**

Table 2. Effect of organic and inorganic inputs on flowering and yield attributes of marigold

Treatments	Number of days taken to bud initiation (days)	Number of flowers/plant	Flower diameter (mm)	Flower yield (q/ha)
T_0 Control	63.20	10.47	37.30	39.83
T_1 RDF @120:80:60 NPK kg/ha	51.66	16.13	47.79	95.01
T_2 RDF @ 120:80:60 NPK kg/ha + Dolomite @ 222 kg/ha	50.37	17.17	49.45	102.28
T_3 FYM @ 25 t/ha	53.70	14.07	44.67	79.65
T_4 Vermicompost @ 5 t/ha	52.03	13.63	46.73	75.75
T_5 Mustard oil cake @ 5 t/ha	51.83	15.14	48.60	81.34
T_6 FYM @ 25 t/ha + Dolomite @ 222 kg/ha	50.50	16.25	49.40	94.05
T_7 Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha	49.87	15.60	51.33	90.79
T_8 Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	50.85	16.20	53.40	91.34
T_9 FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha	47.40	17.07	56.68	125.58
T_{10} FYM @ 25 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	48.50	19.33	62.19	137.30
T_{11} Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha	49.40	18.14	58.38	123.91
T_{12} FYM @ 25 t/ha + Vermicompost @ 5t/ha + Mustard oil cake @ 5t/ha + Dolomite @ 222 kg/ha	44.10	20.23	59.16	159.73
SE(d)	**2.95**	**1.30**	**3.17**	**6.63**
C.D at 5%	**6.09**	**2.69**	**6.54**	**13.69**
C.V (%)	**7.09**	**9.89**	**7.58**	**8.14**

3.11 Flower Yield (q/ha)

The treatments had a significant and positive influence on flower yield. The treatment T_{12} (FYM @ 25 $t.ha^{-1}$ + Vermicompost @ 5 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$ + Dolomite @ 222 $kg.ha^{-1}$) recorded maximum flower yield (159.73 q/ha) which was followed by T_{10} (FYM @ 25 $t.ha^{-1}$ + Mustard oil cake @ 5 $t.ha^{-1}$+ Dolomite @ 222 $kg.ha^{-1}$) [137.30 q/ha] in comparison to control T_0 (39.83 q/ha). The increase in flower production might be attributed to the use of organic inputs, which improved the soil productivity and fertility through increased supply of both macro and micro nutrients and enhanced physical and biological conditions. [5,16] However, the flower yield recorded in the present investigation was comparatively less than the recorded in findings of others. This might be due to the extreme weather conditions (rainfall) prevailed during the reproductive stage in the experimental location. According to Devi et al. [25], the prolonged precipitation delayed the opening of flower buds. Heavy rainfall combined with limited sun shine hours may have accelerated vegetative growth over flowering, resulting in fewer flower buds and a lower flower yield/plant Prakash et al.2016 [26].

4. CONCLUSION

The present experiment revealed that the incorporation of organic manures such as FYM, vermicompost and mustard oil cake significantly impacted the vegetative, flowering and yield attributes in marigold. Thus, it is apparent from entire experiment that treatments T_{12} - FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha, T_{10} - FYM @ 25 t/ha + Mustard oil cake @ 5 t/ha + Dolomite @ 222 kg/ha and T_9 - FYM @ 25 t/ha + Vermicompost @ 5 t/ha + Dolomite @ 222 kg/ha significantly associated with enhanced vegetative growth, flowering and quality attributes in marigold. Thus, these treatments are recommended for enhancing productivity of marigold as well as promoting the soil health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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