***Original Research Article***

**Influence of Biochar, Goat Manure, Sheep Manure and Camel Manure on plant growth and yield in pinched seedling plants of African marigold (*Tagetes erecta* L*.*) cv. Pusa Narangi Gainda.**

**Abstract**

**Aims:**The present experiment investigated the effects of different doses of Biochar, Goat Manure, Sheep Manure and Camel Manure on the growth and flower yield of African marigold (Tagetes erecta L.) cv. Pusa Narangi Gainda

**Study design:** Randomized block design.

**Place and Duration of Study: The field** experiment was conducted during 2013-14 at the Horticultural Experimental Field, Department of Horticulture, SHUATS, Prayagraj (U.P.) India.

**Methodology:**

Nine treatments were evaluated, including Biochar at 2 t/h, 2.5 t/h and 3 t/h, combined with Goat, Sheep and Camel Manure at rates of 1 t/h, 2 t/h and 3 t/h. The treatments significantly improved plant growth parameters such as plant height, number of branches, leaf area, plant spread, stem diameter, stalk length, flower diameter and flower yield, while reducing the time to first flower bud emergence.

**Results:**Among the treatments, T3 (Biochar 3 t/h + Goat Manure 3 t/h) demonstrated the most pronounced effects, achieving the highest values for plant height (66.07 cm), number of branches (27.80), leaf area (1582.15 cm²), plant spread (47.83 cm), stem diameter (1.90 cm), stalk length (8.23 cm), flower diameter (11.24 cm), total flowers per plant (49.15), flower weight (8.38 g), flower yield per plant (412.78 g), flower yield per plot (12.38 kg) and total flower yield (20.37 t/ha), along with the shortest bud initiation period (30.96 days).

**Conclusion:** The results indicate that T3 is the most effective treatment for enhancing both vegetative and reproductive growth in pinched seedling plants of African marigold.

***Key words:*** *Biochar, Camel Manure, Goat Manure, Sheep Manure, Pinched seedling.*

1. **INTRODUCTION**

Floriculture, the cultivation of plants for ornamental purposes, represents the aesthetic dimension of horticulture. Flowers, often regarded as nature’s most exquisite creations, symbolize purity, beauty, peace, love and passion. Beyond their visual and emotional appeal, flowers contribute to environmental well-being by providing fresh air and fragrance. Historically, flowers have held cultural and religious significance, as evidenced in ancient literature and scriptures, though their economic value was initially limited. However, with evolving lifestyles and increasing commercialization, floriculture has emerged as a significant agricultural sector. In India, flower cultivation has deep-rooted traditions, primarily driven by religious practices, the perfume industry and landscaping. Today, the sector is undergoing a transformative phase, fueled by rising demand, technological advancements, policy reforms, environmental considerations and a growing preference for high-quality flowers (Singh *et al.*, 2001).

India's floriculture industry spans approximately 249 thousand hectares, producing 1,659 thousand tonnes of loose flowers and 484 thousand tonnes of cut flowers. States such as Tamil Nadu (20%), Karnataka (13.5%) and West Bengal (12.2%) lead in production, followed by Madhya Pradesh, Mizoram, Gujarat, Andhra Pradesh, Odisha, Jharkhand, Haryana, Assam and Chhattisgarh. The industry has also made significant strides in exports, with floriculture products worth Rs. 571.38 crores (approximately $81.94 million) exported in 2018-19 to countries like the United States, the Netherlands, the United Kingdom, Germany and the United Arab Emirates. With over 300 export-oriented units, predominantly located in Karnataka, Andhra Pradesh and Tamil Nadu and supported by technical collaborations with foreign companies, India is poised to expand its share in the global floriculture trade (NHB, 2019).

Biochar, a carbon-rich product derived from biomass pyrolysis, offers significant benefits for flower production in India. Its application enhances soil structure, increases nutrient retention and promotes beneficial microbial activity, leading to healthier crops. Biochar also improves water retention, reducing irrigation needs a crucial advantage in water-scarce regions. Additionally, it aids in carbon sequestration, contributing to climate change mitigation. Incorporating biochar into soil has been shown to suppress plant pathogens, reducing the reliance on chemical fungicides.

Organic manure plays a critical role in enhancing flower production by improving soil fertility, structure and water retention. It provides essential nutrients such as nitrogen, phosphorus and potassium, which are vital for robust plant growth and high-quality blooms. Organic fertilizers like goat, sheep and camel manure are particularly beneficial, offering a balanced nutrient profile that promotes healthy flowering and overall plant vigor. Both goat and sheep manure are valuable organic fertilizers that significantly benefit flower production in India. They are rich in essential nutrients, containing approximately 3% nitrogen (N), 1% phosphorus (P₂O₅) and 2% potassium (K₂O). For instance, camel manure contains approximately 1.35 % of nitrogen, 0.63% of phosphorus and 0.84 % of potassium, making it an excellent choice for sustainable flower cultivation.

African marigold (Tagetes erecta L.) is a versatile crop widely cultivated for its ornamental, medicinal and industrial applications. Known for its profuse flowering, short growth cycle and vibrant colors, marigold is used in bedding plants, loose flowers, perfumes, natural dyes and even poultry feed supplements. It also possesses medicinal properties, including anti-inflammatory, analgesic and digestive benefits. African marigolds, characterized by their tall, erect growth and large globe-shaped flowers, are particularly popular in the floriculture industry.

Recent studies have explored techniques like pinching and the use of balanced organic manure to enhance desirable traits such as compact growth, increased branching and improved flower quality (Rathi *et al.*, 2005). These practices are especially relevant for varieties like Pusa Narangi Gainda, where manual pinching has been studied to optimize production.

1. **MATERIALS AND METHODS**

The field experiment, titled “Influence of different doses of Biochar, Goat Manure, Sheep Manure and Camel Manure on the growth and flower yield of African marigold (Tagetes erecta L.) cv. Pusa Narangi Gainda,” was conducted at the Horticultural Experimental Field, Department of Horticulture, SHUATS, Prayagraj (U.P.), India. The experiment was laid out in a randomized block design (RBD) with nine treatments. These treatments included Biochar applied at three doses (2 t/h, 2.5 t/h and 3 t/h) in combination with Goat Manure, Sheep Manure and Camel Manure, each applied at three rates (1 t/h, 2 t/h and 3 t/h). Seeds of the African marigold cultivar ‘Pusa Narangi Gainda’ were procured from the Department of Horticulture, SHUATS, Prayagraj. The seeds were sown on raised nursery beds measuring 1.0 x 15 m. Standard cultural practices, including regular watering, weeding and pinching (performed 30 days after sowing), were followed during the nursery phase. The experimental field was plowed one month prior to transplanting the seedlings. This was followed by three harrowings to achieve a fine tilth. The field was leveled using a spade and flat beds measuring 3 x 2 m were prepared. Biochar and well-decomposed Goat Manure, Sheep Manure and Camel Manure were applied 20 days before transplanting, according to the specified treatment combinations. The amendments were thoroughly mixed into the soil. Two days before transplanting, the plots were irrigated to ensure adequate soil moisture. Marigold seedlings were transplanted into the main field at the 3-5 true leaf stage (55 days after sowing) with a spacing of 45 x 45 cm. During transplanting, the soil was firmly pressed around the seedlings to minimize disturbance from irrigation. Gap filling was performed as needed during the first two weeks after transplanting. Regular weeding was carried out to keep the plots weed-free, with the first weeding conducted 30 days after planting and subsequent weedings as required. A light irrigation was applied immediately after transplanting, followed by subsequent irrigations based on soil moisture requirements. The total number of irrigations during the growth period is detailed in the cost of cultivation table. Initial observations indicated signs of plant dryness and the presence of red termites in the soil. To control termites, Chlorpyrifos was applied at 0.2% of the recommended dose, three times during the experiment. A mild incidence of Alternaria leaf spot was observed, which was managed by spraying Dithane M-45 at 0.2% at 15-day intervals. The experiment evaluated various growth and yield parameters, including plant height, number of branches per plant, leaf area, plant spread, stem diameter, days to first flower bud emergence, stalk length, flower diameter, total number of flowers per plant, flower weight, flower yield per plant, flower yield per plot and overall flower yield. Data were recorded and analyzed to assess the impact of the different treatments on the growth and yield of African marigold.

1. **RESULT AND DISCUSSION**

The present study investigated the influence of different doses of Biochar, Goat Manure, Sheep Manure and Camel Manure on the growth and flower yield of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda. The results highlight the significant impact of these organic amendments on plant growth parameters, particularly plant height and flower yield. The findings are discussed under the following headings.

**Plant Height (cm)**

The plant height was significantly influenced by the application of Biochar, Goat Manure, Sheep Manure and Camel Manure. The maximum plant height of 66.07 cm was recorded in treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h), followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h) with a plant height of 64.45 cm. In contrast, the minimum plant height of 53.86 cm was observed in treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h). These results indicate that the combination of Biochar and Goat Manure at higher doses (T3 and T2) significantly enhanced plant growth compared to other treatments. This can be attributed to the synergistic effect of Biochar and Goat Manure, which likely improved soil fertility, nutrient availability and water retention, thereby promoting better plant growth.

The superior performance of T3 and T2 treatments suggests that the optimal combination of Biochar and Goat Manure plays a crucial role in enhancing plant height. These findings are consistent with previous studies. For instance, Nagaich *et al.* (2003) reported similar results for marigold, while Acharya and Dashora (2004) observed comparable outcomes in Gladiolus. Additionally, Dubey (2005) and Das and Mishra (2005) also reported enhanced growth in marigold, respectively, with the application of organic amendments. Bhat *et al.* (2010) further supported these findings, emphasizing the positive impact of organic manures on marigold growth.

**Number of branches per plant**

The data presented in Table 1 demonstrate the significant impact of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on the number of branches per plant. The treatment **T3**, which consisted of **Biochar 3 t/h + Goat Manure @ 3.0 t/h**, resulted in the highest number of branches per plant (**27.80**). This was closely followed by **T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h**), which produced **24.57** branches per plant. In contrast, the treatment **T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h**) exhibited the lowest number of branches per plant (**11.74**).

The superior performance of **T3** and **T2** can be attributed to the optimal combination of Biochar and Goat Manure, which likely provided essential nutrients and improved soil conditions, thereby promoting vigorous plant growth. The higher dosage of organic amendments in these treatments may have enhanced nutrient availability, root development and overall plant health, leading to increased branching. On the other hand, the lower performance of **T7** suggests that insufficient levels of Camel Manure, combined with a lower Biochar application rate, may have limited nutrient supply and hindered plant growth.

These findings are consistent with previous studies conducted by Kumar *et al.* (2003), Nagaich *et al.* (2003), Acharya and Dashora (2004), Das and Mishra (2005) and Ahmad *et al.* (2010), all of whom reported similar results in their experiments with Marigold. These studies collectively highlight the importance of balanced organic amendments in enhancing plant growth and branching. The results underscore the critical role of Camel Manure and organic waste compost in optimizing plant development, particularly when applied in appropriate combinations and dosages.

**Leaf area (cm2)**

The leaf area (cm²) of plants treated with varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure demonstrated significant differences across treatments, as presented in Table 1. The highest leaf area of 1582.15 cm² was recorded in treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h), followed closely by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h) with a leaf area of 1517.29 cm². In contrast, the lowest leaf area of 1129.65 cm² was observed in treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h). These findings indicate that the application of Camel Manure and organic waste compost significantly influenced leaf area, with the combination of biochar and goat manure proving to be particularly effective.

The superior performance of treatment T3 can be attributed to the optimal balance of nutrients provided by the combination of biochar and goat manure, which likely enhanced nutrient availability and uptake, leading to improved plant growth and leaf expansion. Treatment T2 also showed promising results, suggesting that even at a slightly lower application rate of goat manure, the synergistic effect of biochar and organic amendments can still significantly benefit plant growth. Conversely, the reduced leaf area in treatment T7 may be due to the lower application rates of biochar and Camel Manure, which might have provided insufficient nutrients to support optimal leaf development.

These results align with previous studies that have highlighted the positive effects of organic amendments on plant growth. For instance, Nagaich *et al.* (2003) reported similar enhancements in leaf area in Marigold plants treated with organic manures. Dubey (2005) also observed comparable effects in Gladiolus, while Javed *et al.* (2005) and Ahamd *et al.* (2010) documented analogous outcomes in Zinnia and Marigold, respectively. These consistent findings across different plant species underscore the importance of organic amendments in promoting vegetative growth and leaf expansion.

**Plant spread (cm)**

The results of the study on plant spread (cm) as influenced by varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure are presented in Table 1. The data reveal significant differences in plant spread across the treatments, highlighting the impact of biochar and organic waste compost on plant growth. The highest plant spread of 47.83 cm was recorded in treatment T3, which consisted of Biochar 3 t/h + Goat Manure @ 3.0 t/h. This was closely followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h), which exhibited a plant spread of 45.39 cm. In contrast, the lowest plant spread of 40.79 cm was observed in treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h). These findings clearly demonstrate that the type and quantity of organic waste compost, in combination with biochar, significantly influence plant spread.

The superior performance of treatment T3 can be attributed to the optimal combination of biochar and goat manure, which likely provided an ideal balance of nutrients and improved soil structure, promoting enhanced plant growth. Treatment T2 also showed notable growth, further supporting the effectiveness of biochar and goat manure in combination. The lower plant spread observed in treatment T7 may be due to the lower application rates of biochar and camel manure, which might not have provided sufficient nutrients or soil conditioning effects to support robust plant growth.

These results align with the findings of Sharma *et al.* (2017) and Ganesh and Jawaharlal (2019), who reported similar positive effects of biochar and organic amendments on plant growth in marigold.

**Stem diameter (cm)**

The impact of different levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on stem diameter (cm) was evaluated and the results are presented in Table 1. The study revealed significant variations in stem diameter across the treatments, highlighting the influence of organic amendments on plant growth. The highest stem diameter of 1.90 cm was recorded in treatment T3, which involved the application of Biochar at 3 t/h combined with Goat Manure at 3.0 t/h. This was closely followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h), which resulted in a stem diameter of 1.87 cm. In contrast, the lowest stem diameter of 1.73 cm was observed in treatment T7, where Biochar at 2 t/h was combined with Camel Manure at 1.0 t/h.

The superior performance of treatment T3 can be attributed to the optimal combination of biochar and goat manure, which likely provided a balanced nutrient supply and improved soil conditions, thereby promoting robust plant growth. Treatment T2 also demonstrated commendable results, further supporting the importance of balanced nutrient management in enhancing stem diameter. The lower stem diameter observed in treatment T7 suggests that suboptimal levels of Camel Manure, in combination with lower biochar application, may not provide sufficient nutrients or soil conditioning to support maximum plant growth.

These findings align with previous studies, such as those by Sangwan *et al.* (2010) in marigold and Airadevi (2014) in garland chrysanthemum, which also reported improved plant growth parameters with the application of organic amendments.

**Number of days required for first flower bud emergence from transplanting**

The number of days required for the first flower bud emergence from transplanting was significantly influenced by the application of different levels of Biochar, Goat Manure, Sheep Manure and Camel Manure, as detailed in Table 1. Among the treatments, **T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h)** demonstrated the most efficient bud initiation, with the shortest duration of **30.96 days**. This was closely followed by **T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h)**, which recorded **33.58 days** for bud emergence. In contrast, **T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h)** exhibited the longest duration for bud initiation, taking **48.03 days**.

The results highlight the significant role of Camel Manure and organic waste compost levels in influencing the timing of bud formation. The superior performance of **T3** and **T2** can be attributed to the optimal dosage of nutrients provided by the combination of biochar and goat manure, which likely enhanced vegetative growth and accelerated the transition to the reproductive phase. These treatments provided a balanced nutrient supply, particularly nitrogen, which is critical for early vegetative growth and subsequent bud initiation.

On the other hand, the delayed bud initiation observed in **T7** is likely due to insufficient nitrogen availability, resulting in limited vegetative growth and a prolonged duration for the plants to reach the bud formation stage. This finding is consistent with the study by Ahamd *et al.* (2010) on Marigold, which also reported that inadequate nitrogen levels delay flowering. The results underscore the importance of optimizing nutrient management, particularly nitrogen, through appropriate combinations of organic amendments to promote timely and efficient bud initiation.

**Flower stalk length (cm)**

The flower stalk length (cm) was significantly influenced by the application of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure, as detailed in Table 2. Among the treatments, **Treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h)** resulted in the maximum flower stalk length of **8.23 cm**, closely followed by **Treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h)** with a stalk length of **8.15 cm**. In contrast, the minimum flower stalk length of **6.77 cm** was recorded in **Treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h)**. These findings highlight the significant role of camel manure and organic waste compost in enhancing flower stalk growth.

The superior performance of **Treatment T3** and **Treatment T2** can be attributed to the optimal combination of biochar, goat manure and camel manure, which likely provided a balanced nutrient supply and improved soil conditions, thereby promoting vigorous plant growth. The results align with previous studies, such as those by **Ahamd *et al.* (2010), Palagani *et al.* (2013)** and **Singh *et al.* (2015)**, who reported similar positive effects of organic fertilizers on marigold growth. Additionally, **Pandey *et al.* (2018)** observed comparable outcomes in chrysanthemum, further supporting the efficacy of organic amendments in enhancing floral attributes.

**Diameter of flower (cm)**

The diameter of flowers was measured to evaluate the effects of different levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on plant growth. The results revealed significant variations in flower diameter across the treatments. The largest flower diameter of 11.24 cm was recorded in treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h), followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h) with a diameter of 10.10 cm. In contrast, the smallest flower diameter of 8.59 cm was observed in treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h). These results underscore the substantial impact of camel manure and organic waste compost on flower size, with higher doses of organic amendments promoting larger flower diameters.

The superior performance of treatments T3 and T2 can be attributed to the optimal combination of biochar and goat manure, which likely enhanced soil fertility, nutrient availability and water retention, thereby supporting robust plant growth and flower development. The smaller flower diameter in treatment T7 suggests that lower doses of camel manure, combined with reduced biochar application, may not provide sufficient nutrients or soil conditioning to achieve maximum flower size.

These findings align with previous studies, such as those by Acharya and Dashora (2004), who reported similar effects of organic fertilizers on marigold growth. Additionally, Gaikwad *et al.* (2004) observed comparable results in China aster and Singh *et al.* (2008) documented a similar trend in lily, further supporting the positive influence of organic amendments on flower diameter.

**Total number of flowers per plant**

The data presented in Table 2 highlights the influence of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on the total number of flowers per plant. The results demonstrate significant variability in flower production across different treatments, with treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h) yielding the highest number of flowers per plant at 49.15. This was closely followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h), which produced 49.08 flowers per plant. In contrast, treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h) resulted in the lowest flower count, with only 37.72 flowers per plant. These findings underscore the significant impact of camel manure and organic waste compost on flower production.

The superior performance of treatments T3 and T2 can be attributed to the optimal nutrient supply provided by the well-balanced combination of biochar and goat manure. Biochar is known to enhance soil fertility by improving nutrient retention and availability, while goat manure contributes essential organic matter and nutrients that promote plant growth. The synergistic effect of these components likely created an ideal growing environment, leading to increased flower production. Conversely, the lower flower count observed in treatment T7 may be due to the suboptimal combination of biochar and camel manure, which might not have provided sufficient nutrients or soil conditioning to support robust flower development.

These results are consistent with previous studies. Gaikwad *et al.* (2004) reported similar findings in China aster, where the application of organic fertilizers significantly enhanced flower production. Additionally, Javed *et al.* (2005) and Kumawat *et al.* (2017) observed comparable outcomes in marigold, further supporting the effectiveness of organic amendments in improving floral yield. The alignment of our results with these studies reinforces the importance of organic fertilizers in horticultural practices, particularly for enhancing flower production.

**Weight of flower (g)**

The results presented in Table 2 demonstrate the influence of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on the weight of flowers. Treatment T3, which consisted of Biochar 3 t/h + Goat Manure @ 3.0 t/h, yielded the highest flower weight at 8.38 g. This was closely followed by treatment T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h), which produced a flower weight of 8.32 g. In contrast, the lowest flower weight of 8.03 g was recorded in treatment T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h). These findings highlight the significant role of camel manure and organic waste compost in enhancing flower weight.

The superior performance of treatments T3 and T2 can be attributed to the optimal combination of biochar and goat manure, which likely provided an adequate supply of nutrients and improved soil conditions, thereby promoting better plant growth and flower development. The higher flower weights observed in these treatments suggest that the application of biochar at 3 t/h combined with goat manure at 2.0–3.0 t/h creates a favorable environment for nutrient uptake and plant health. Conversely, the lower flower weight in treatment T7 may be due to the suboptimal dosage of camel manure and biochar, which could have limited nutrient availability or soil conditioning effects.

These results align with previous studies, such as those by Niedziela *et al.* (2008), who reported similar improvements in flower weight in lilies with the application of organic fertilizers. Additionally, the findings are consistent with the work of Ahamd *et al.* (2010) and Shadanpour *et al.* (2011), who observed enhanced growth and flower weight in marigolds following the application of organic amendments.

**Flower yield per plant (g)**

The data presented in Table 2 highlights the significant influence of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on flower yield per plant (g). Among the treatments, **T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h)**demonstrated the highest flower yield per plant, recording **412.78 g**, followed closely by **T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h)** with **408.45 g**. In contrast, **T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h)**yielded the lowest flower production, with only **302.90 g**per plant. These results clearly indicate that the application of camel manure, in combination with biochar and goat manure, significantly enhances flower yield, with the optimal combination being observed in T3 and T2.

The superior performance of T3 and T2 can be attributed to the balanced nutrient supply and improved soil conditions facilitated by the synergistic effects of biochar and goat manure. Biochar is known to enhance soil fertility by improving water retention, nutrient availability and microbial activity, while goat manure provides essential macro- and micronutrients required for plant growth. The combination of these organic amendments likely created an optimal growing environment, leading to increased flower yield. Conversely, the lower yield observed in T7 may be due to the suboptimal dosage of camel manure and biochar, which might have been insufficient to meet the nutrient demands of the plants.

These findings are consistent with previous studies, such as those by **Kumar *et al.* (2009)**on marigold and **Parolekar *et al.* (2012)**on tuberose, which also reported enhanced flower yields with the application of organic fertilizers. The results underscore the importance of selecting appropriate organic amendments and their optimal dosages to maximize flower production.

**Flower yield per plot (kg)**

The data presented in Table 2 highlights the significant influence of varying levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on flower yield per plot (kg). Among the treatments evaluated, **T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h)**demonstrated the highest flower yield per plot, recording **12.38 kg**, closely followed by **T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h)** with **12.25 kg**. In contrast, **T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h)** yielded the lowest flower production at **9.09 kg**. These findings emphasize the critical role of organic amendments, particularly the combination of Biochar and Goat Manure, in enhancing flower yield. The superior performance of treatments T3 and T2 can be attributed to the optimal integration of Biochar and Goat Manure, which likely improved soil fertility, nutrient availability and water retention capacity. Biochar, known for its porous structure and ability to enhance soil microbial activity, combined with the nutrient-rich composition of Goat Manure, likely created a synergistic effect that promoted plant growth and flower production. Conversely, the lower yield observed in T7 may be due to the suboptimal combination of Biochar and Camel Manure, which might not have provided the necessary nutrient balance or soil conditioning required for maximizing flower yield.

These results align with previous studies by **Pushkar *et al.* (2008)**and **Dikr and Belete (2017)**, who also reported significant improvements in marigold yield with the application of organic amendments. The findings underscore the importance of selecting appropriate organic fertilizers and their combinations to achieve optimal flower production. The use of Biochar and Goat Manure, in particular, appears to be a promising strategy for enhancing flower yield, as evidenced by the superior performance of T3 and T2.

**Flower yield (t ha-1)**

The study investigated the impact of different levels of Biochar, Goat Manure, Sheep Manure and Camel Manure on flower yield (t ha⁻¹), as detailed in Table 2. The results revealed significant variations in flower yield across the treatments, highlighting the influence of organic amendments on plant productivity. The highest flower yield of **20.37 t ha⁻¹** was recorded in treatment **T3 (Biochar 3 t/h + Goat Manure @ 3.0 t/h)**, followed closely by **T2 (Biochar 3 t/h + Goat Manure @ 2.0 t/h)** with a yield of **20.16 t ha⁻¹**. In contrast, the lowest flower yield of **14.96 t ha⁻¹** was observed in treatment **T7 (Biochar 2 t/h + Camel Manure @ 1.0 t/h)**. These findings underscore the significant role of Camel Manure and organic waste compost in enhancing flower yield.

The superior performance of treatments T3 and T2 can be attributed to the optimal combination of biochar and goat manure, which likely improved soil fertility, nutrient availability and water retention capacity. The synergistic effect of these organic amendments provided an ideal growth environment for the plants, leading to higher flower yields. Conversely, the lower yield in T7 may be due to the suboptimal application rate of Camel Manure, which might have been insufficient to meet the nutrient demands of the plants.

These results align with previous studies by Pal and Ghosh (2010), Kumari *et al.* (2019) and Kumar *et al.* (2013), who also reported enhanced flower yields in marigold crops with the application of organic fertilizers. The consistency of these findings across studies reinforces the importance of organic amendments in sustainable agriculture, particularly for improving flower yield in ornamental crops.

1. **CONCLUSION**

Based on the current investigation, it can be affirmed that treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0t/h) significantly influenced the growth, floral attributes and overall yield of the African marigold plants. This treatment yielded the highest values for various parameters including plant height (66.07cm), branches per plant (27.80), leaf area (1582.15cm2), plant spread (47.83cm), stem diameter (1.90 cm), stalk length (8.23 cm), flower diameter (11.24cm), total flowers per plant (49.15), flower weight (8.38g), flower yield per plant (412.78g), flower yield per plot (12.38 kg) and overall flower yield (20.37 t/ha) demonstrated the shortest duration for bud initiation at 30.96 days. Consequently, Treatment T3 (Biochar 3 t/h + Goat Manure @ 3.0t/h) emerged as the most efficient approach for stimulating both vegetative and reproductive growth in pinched seedling African marigold plants during the *rabi* season.

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment No.** | **Growth parameters on pinched seedling plants of African marigold (Mean)** | | | | | |
| **Plant height (cm)** | **Number of branches per plant** | **Leaf area (cm2)** | **Plant spread (cm)** | **Stem diameter (cm)** | **Number of days required for first flower bud emergence** |
| **T1 – Biochar 3 t/h + Goat Manure @ 1.0t/h** | 62.13 | 21.99 | 1430.52 | 43.15 | 1.85 | 36.20 |
| **T2 – Biochar 3 t/h + Goat Manure @ 2.0t/h** | 64.45 | 24.57 | 1517.29 | 45.39 | 1.87 | 33.58 |
| **T3 – Biochar 3 t/h + Goat Manure @ 3.0t/h** | 66.07 | 27.80 | 1582.15 | 47.83 | 1.90 | 30.96 |
| **T4 – Biochar 2.5 t/h + Sheep Manure @ 1.0t/h** | 59.41 | 15.52 | 1245.30 | 42.01 | 1.81 | 41.22 |
| **T5 – Biochar 2.5 t/h + Sheep Manure @ 2.0t/h** | 60.22 | 17.28 | 1296.84 | 42.90 | 1.83 | 38.17 |
| **T6 - Biochar 2.5 t/h + Sheep Manure @ 3.0t/h** | 61.03 | 19.43 | 1314.57 | 43.86 | 1.86 | 34.35 |
| **T7 – Biochar 2 t/h + Camel Manure @ 1.0t/h** | 53.86 | 11.74 | 1129.65 | 40.79 | 1.73 | 48.03 |
| **T8 – Biochar 2 t/h + Camel Manure @ 2.0t/h** | 55.67 | 13.63 | 1158.43 | 41.60 | 1.77 | 45.31 |
| **T9 – Biochar 2 t/h + Camel Manure @ 3.0t/h** | 58.19 | 15.25 | 1193.05 | 41.94 | 1.80 | 41.79 |
| **F - test** | **S** | **S** | **S** | **S** | **S** | **S** |
| **S. Ed. (±)** | **0.19** | **0.24** | **0.60** | **0.30** | **0.03** | **0.67** |
| **C. D. (P = 0.05)** | **0.39** | **0.50** | **1.22** | **0.61** | **0.06** | **1.35** |

**Table No. 1: Impact of Biochar, Goat Manure, Sheep Manure and Camel Manure on growth and floral characters on pinched seedling plants of African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda.**

**Table No. 2: Impact of Biochar, Goat Manure, Sheep Manure and Camel Manure on yield parameters on pinched seedling plants of African marigold (*Tagetes erecta* L*.*) cv. Pusa Narangi Gainda.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment No.** | **Yield parameters on pinched seedling plants of African marigold (Mean)** | | | | | | |
| **Flower Stalk length (cm)** | **Diameter of flower (cm)** | **Total number of flowers per plant** | **Fresh Weight of flowers ( g)** | **Flower yield per plant (g)** | **Flower yield per plot (g)** | **Flower yield (t/ha)** |
| **T1 – Biochar 3 t/h + Goat Manure @ 1.0t/h** | 8.07 | 10.02 | 48.32 | 8.25 | 398.64 | 11.96 | 19.68 |
| **T2 – Biochar 3 t/h + Goat Manure @ 2.0t/h** | 8.15 | 10.10 | 49.08 | 8.32 | 408.45 | 12.25 | 20.16 |
| **T3 – Biochar 3 t/h + Goat Manure @ 3.0t/h** | 8.23 | 11.24 | 49.15 | 8.38 | 412.78 | 12.38 | 20.37 |
| **T4 – Biochar 2.5 t/h + Sheep Manure @ 1.0t/h** | 7.41 | 9.31 | 41.98 | 8.09 | 339.75 | 10.19 | 16.79 |
| **T5 – Biochar 2.5 t/h + Sheep Manure @ 2.0t/h** | 7.73 | 9.67 | 46.46 | 8.16 | 379.25 | 11.38 | 18.73 |
| **T6 - Biochar 2.5 t/h + Sheep Manure @ 3.0t/h** | 8.00 | 10.85 | 49.11 | 8.24 | 405.24 | 12.16 | 20.02 |
| **T7 – Biochar 2 t/h + Camel Manure @ 1.0t/h** | 6.77 | 8.59 | 37.72 | 8.03 | 302.90 | 9.09 | 14.96 |
| **T8 – Biochar 2 t/h + Camel Manure @ 2.0t/h** | 6.81 | 8.92 | 40.45 | 8.07 | 326.45 | 9.79 | 16.12 |
| **T9 – Biochar 2 t/h + Camel Manure @ 3.0t/h** | 7.16 | 9.13 | 43.27 | 8.11 | 350.97 | 10.53 | 17.32 |
| **F - test** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **S. Ed. (±)** | **0.06** | **0.07** | **0.61** | **0.06** | **5.11** | **30.14** | **3.02** |
| **C. D. (P = 0.05)** | **0.14** | **0.15** | **1.32** | **0.12** | **10.23** | **60.30** | **6.05** |