



Plant Archives

Journal homepage: <http://www.plantarchives.org>DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.367>

EFFECT OF BIOCHAR IN COMBINATION WITH LIQUID BIOFERTILIZERS ON GROWTH AND FLOWERING OF FRENCH MARIGOLD (*TAGETES PATULA* L.) VAR. CGFM-1

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(Date of Receiving-26-07-2025; Date of Acceptance- 29-09-2025)

ABSTRACT

A study was conducted to evaluate the effect of biochar in combination with liquid biofertilizers on growth and flowering of French marigold at Centre of Excellence, Mulugu during summer season from march to may of 2025. The results revealed that in growth parameters maximum plant height (46.73 cm), plant spread (E-W) (38.66 cm), plant spread (N-S) (38.33 cm), number of branches per plant (15.07), stem diameter (1.23 cm) was recorded in the treatment T₇ {Soil + Vermicompost + 3% Biochar enriched with liquid biofertilizers (Azotobacter+PSB+KSB)}. Similarly in flowering parameters minimum days taken for first flower bud initiation (50.73), flower bud to full bloom (6.96), 50% flowering after transplanting (53.73), maximum average flower weight (2.54 g) and highest number of flowers (12.33) were recorded in the treatment T₇ {Soil + Vermicompost + 3% Biochar enriched with liquid biofertilizers (Azotobacter+PSB+KSB)}.

Key words: Biochar, liquid biofertilizers, French marigold, growth and flowering parameters.

Introduction

French marigold (*Tagetes patula*) plants produce the vibrant orange, yellow, and red blooms in a compact bushy form, making them ideal for borders, containers, and mass plantings. They attract bees and butterflies, enhancing garden biodiversity. Their strong scent has volatile compounds like limonene is known to repel pests such as aphids and whiteflies in home gardens. Rice production generates several by-products, including rice husk, rice straw, and rice bran. Rice husk is produced during the initial stage of milling when the outer layer of paddy rice is removed. Similar to other plant residues, rice husk can be transformed into biochar. Rice husk biochar (RHB) makes up about 20% of the rice's weight and is composed of roughly 50% cellulose, 25–30% lignin, 15–20% silica, and 10–15% moisture. Converting rice husk into RHB and applying it back to paddy fields as a soil amendment

offers an efficient approach to managing rice waste. The yield of biochar from rice husk is around 35% of the original feedstock. The combination of biochar and liquid biofertilizers offers a sustainable solution for improving soil health and crop productivity. Biochar enhances soil structure, retains moisture, and provides a stable habitat for beneficial microbes in liquid biofertilizers, boosting their effectiveness. This synergy promotes better nutrient uptake, stronger plant growth, and higher yields while reducing the need for chemical fertilizers. Additionally, biochar contributes to long-term carbon sequestration, making this approach environmentally friendly and ideal for sustainable agriculture.

Material and Methods

The present investigation was carried out in a pot culture experiment at Centre of Excellence located in the premises of the Post Graduate Institute of Horticulture

Sciences, Mulugu, Siddipet, Sri Konda Laxman Telangana Horticultural university, Telangana. The site is geographically positioned at a latitude of 17°43'02" N and a longitude of 78°37'34" E. French marigold seeds of *var.* CGFM-1 were used as experimental material procured from Floricultural Research Station, Rajendranagar, Hyderabad. The experiment was laid out in completely randomized design (CRD) with seven treatments and three replications. The treatments consist of T₁ {Soil + Vermicompost (1:1)}, T₂ {Soil + Vermicompost + 1% Rice husk Biochar}, T₃ {Soil + Vermicompost + 2% Rice husk Biochar}, T₄ {Soil + Vermicompost + 3% Rice husk Biochar}, T₅ {Soil + Vermicompost + 1% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)}, T₆ {Soil + Vermicompost + 2% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)}, T₇ {Soil + Vermicompost + 3% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)}. The data was collected for five plants in each treatment and replications. The data on plant height (cm), plant spread (E-W) (cm), plant spread (N-S) (cm), number of branches per plant, stem diameter (cm), number of days taken for first flower bud initiation (days), number of days taken from flower bud to full bloom (days), number of days taken to 50 (%) flowering after transplanting (days), number of flowers per plant. The data collected from the plants were averaged across three replications and analyzed using Analysis of Variance (ANOVA) as described by Panse and Sukhatme (1954). The Standard Error of Mean (SEm) and Critical Difference (CD) at the 5% significance level were computed to assess statistical significance.

Results and Discussion

Plant height (cm)

The effect of biochar in combination with liquid biofertilizers on plant height has no significant variation and highest was recorded in treatment T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (46.73) and remaining all treatments T₆ {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (46.06), T₅ {Soil + Vermicompost + 1% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (46.03), T₄ (Soil + Vermicompost + 3% Rice husk Biochar) (45.33), T₃ (Soil + Vermicompost + 2% Rice husk Biochar) (44.67), T₂ (Soil + Vermicompost + 1% Rice husk Biochar) (45.41), T₁ (Soil + Vermicompost) (43.33) were found to be on par with each other. Biochar can adsorb nutrients and reduce

Table 1: Effect of biochar with liquid biofertilizers on growth parameters of French marigold.

Treatments	PH	PS-EW	PS-NS	NBPP	SD
T ₁	43.33 ^a	37.23 ^a	37.53 ^a	12.60 ^d	1.04 ^c
T ₂	45.41 ^a	37.53 ^a	37.66 ^a	13.26 ^{cd}	1.08 ^{bc}
T ₃	44.67 ^a	37.93 ^a	37.53 ^a	13.93 ^{bc}	1.06 ^{bc}
T ₄	45.33 ^a	38.40 ^a	35.68 ^b	13.62 ^{cd}	1.07 ^{bc}
T ₅	46.03 ^a	37.60 ^a	38.14 ^a	13.80 ^{bc}	1.11 ^{bc}
T ₆	46.06 ^a	38.46 ^a	36.73 ^{ab}	14.85 ^{ab}	1.12 ^b
T ₇	46.73 ^a	38.66 ^a	38.33 ^a	15.07 ^a	1.23 ^a
SE(m)±	1.27	0.70	0.56	0.45	0.02
CD@5%	3.81	2.10	1.68	1.38	0.07
PH: Plant height(cm); PS(EW): Plant spread (E-W) (cm); PS(NS): Plant spread (N-S) (cm); SD: Stem diameter(cm) NBPP: Number of branches per plant;					

leaching, slowly releasing them over time. This helps liquid biofertilizers remain in the root zone longer, ensuring steady nutrient availability aid in increasing plant height. Similar results were observed by Shikarwar *et al.*, (2025) in African marigold.

Plant spread (E-W) (cm)

The effect of biochar in combination with liquid biofertilizers on plant spread in E-W direction does not show any significant differences and highest was observed in T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (38.66) and remaining all treatments T₆ {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (38.46), T₅ {Soil + Vermicompost + 1% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (37.60), T₄ (Soil + Vermicompost + 3% Rice husk Biochar) (38.40), T₃ (Soil + Vermicompost + 2% Rice husk Biochar) (37.93), T₂ (Soil + Vermicompost + 1% Rice husk Biochar) (37.53), T₁ (Soil + Vermicompost) (37.23) were found to be on par with each other.

Plant spread (N-S) (cm)

The effect of biochar in combination with liquid biofertilizers on plant spread in N-S direction does not show any significant differences and highest was observed in T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (38.33) and remaining all treatments T₆ {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (36.73), T₅ {Soil + Vermicompost + 1% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (38.14), T₄ (Soil + Vermicompost + 3% Rice husk Biochar) (35.68), T₃ (Soil + Vermicompost + 2% Rice husk Biochar) (37.53), T₂ (Soil + Vermicompost + 1% Rice husk Biochar) (37.66),

Table 2: Effect of biochar with liquid biofertilizers on flowering parameters of French marigold.

Treatments	NFI	NFB	NFT	AFW	NFP
T ₁	57.60 ^a	10.60 ^a	60.07 ^a	1.78 ^a	7.46 ^c
T ₂	56.40 ^{ab}	9.60 ^b	58.50 ^{ab}	1.90 ^a	8.41 ^c
T ₃	56.33 ^{ab}	9.80 ^b	59.10 ^a	1.98 ^a	8.36 ^c
T ₄	55.47 ^{abc}	9.20 ^b	58.57 ^{ab}	2.07 ^a	8.46 ^c
T ₅	53.73 ^{bcd}	9.60 ^b	56.73 ^{bc}	2.24 ^a	10.93 ^{cb}
T ₆	52.73 ^{cd}	8.20 ^c	55.70 ^{cd}	1.94 ^a	10.73 ^b
T ₇	50.73 ^d	6.96 ^d	53.73 ^d	2.54 ^a	12.33 ^a
SE(m) ±	0.92	0.23	0.66	0.31	0.39
CD@5%	2.82	0.71	2.04	0.93	1.00

NFI: Number of days taken for first flower bud initiation (days); **NFB:** Number of days taken for first flower bud to full bloom (days); **NFT:** Number of days taken to 50 (%) flowering after transplanting (days); **AFW:** Average flower weight (g); **NFP:** Number of flowers per plant

T₁ (Soil + Vermicompost) (37.53) were found to be on par with each other. Biochar provides a stable habitat for these microbes, helping them to survive and colonize the rhizosphere more effectively. These microbes enhance hormone production (e.g., auxins), which promotes both vertical and lateral plant growth. Similar results were observed by Shikarwar *et al.*, (2025) in African marigold.

Number of branches per plant

All the treatments differed significantly with respect to number of branches per plant. Among the treatment combinations T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has recorded highest number of branches (15.07) which was on par with T₆ {Soil + Vermicompost + 2% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (14.8) and lowest was recorded in T₁ (Soil + Vermicompost) (12.6). The number of branches per plant exhibited significant variation under the influence of biochar and liquid biofertilizer treatments. These microbes likely stimulated hormonal activity, particularly cytokinins, which are known to promote lateral bud development and branching. Similar results were observed by Kanaby *et al.*, (2022) in African marigold and Alwan *et al.*, (2023) in carnation.

Stem diameter (cm)

Significant differences were observed among the treatment combinations for stem diameter (cm). The treatment T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has recorded maximum (1.23 cm) and lowest was recorded in T₁ (Soil + Vermicompost) (1.04). The combination of biochar and biofertilizers likely resulted in synergistic effects biochar provides a habitat for beneficial

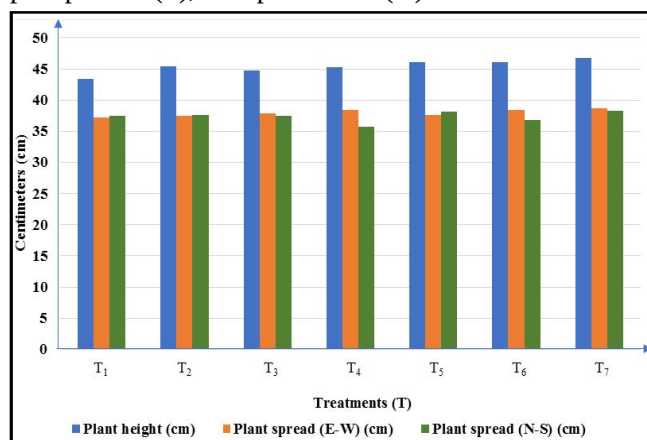
microbes, enhancing the survival and efficacy of the biofertilizers. Similar results were observed by Ali and Mjeed (2017) garland chrysanthemum.

Number of days taken for first flower bud initiation (days)

The number of days taken for first bud initiation has notable significant difference among the treatment combinations. The treatment T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has taken minimum days (50.73) followed by T₆ {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (52.73) and lowest was recorded in T₁ (Soil + Vermicompost) (57.60). The plant growth-promoting rhizobacteria in biofertilizers can induce early flowering via production of auxins and gibberellins. They reduced plant stress, improved water and nutrient availability helps plants avoid stress, which typically delays flowering. They enhanced nutrient use efficiency especially nitrogen and phosphorus, which are crucial for early flower development. Similar results were reported by Shikarwar *et al.*, (2025) in African marigold.

Number of days taken from flower bud to full bloom (days)

The mean number of days taken from bud to full bloom was found to be significant among the treatment combinations. The treatment T₇ {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has taken minimum days (6.96 days) followed by T₆ {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (8.20) and lowest was recorded in T₁ (Soil + Vermicompost) (10.60). Biochar improves cation exchange capacity (CEC), which increases the soil ability to hold and gradually release nutrients like nitrogen (N), phosphorus (P), and potassium (K) essential for flower

**Fig. 1:** Effect of biochar with liquid biofertilizers on Plant height, Plant spread (E-W) and Plant spread (N-S).

development. The liquid biofertilizers contain PGPR (plant growth-promoting rhizobacteria), which can fix nitrogen, solubilize phosphorus, mobilize potassium and micronutrients. Together, they ensure a steady supply of nutrients during the critical reproductive phase, accelerating bud growth, petal expansion, and blooming.

Number of days taken to 50% flowering after transplanting (Days)

The number of days taken to 50% flowering after transplanting varied significantly among the treatment combinations. The treatment T_7 {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has taken minimum days (53.73 days) followed by T_6 {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (55.70) and lowest was recorded in T_1 (Soil + Vermicompost) (60.07). Microbes in liquid biofertilizers produce plant growth regulators like indole acetic acid (IAA) and cytokinins. These hormones can accelerate bud formation and floral organ elongation. Similar results were observed by Shikarwar *et al.*, (2025) in African marigold.

Average flower weight (g)

The effect of biochar in combination with liquid biofertilizers on average flower weight does not show any significant variation among the treatments highest was observed in T_7 {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (2.54 g) and remaining all treatments T_6 {Soil + Vermicompost + 2% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (1.94 g), T_5 {Soil + Vermicompost + 1% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (2.24 g), T_4 (Soil + Vermicompost + 3% Rice husk Biochar) (2.07 g), T_3 (Soil + Vermicompost + 2% Rice husk Biochar) (1.98 g), T_2 (Soil + Vermicompost + 1% Rice husk Biochar) (1.90 g), T_1 (Soil + Vermicompost) (1.78 g) were found to be on par with each other. Biochar provides a stable habitat for PGPR, enhancing their colonization and long-term function. It also improves soil moisture retention, reducing drought stress that can limit flower development. This leads to consistent nutrient and water supply during flower formation, which is critical for achieving higher flower weight.

Number of flowers per plant

The number of flowers per plant was found to be significant among the treatment combinations T_7 {Soil + Vermicompost + 3% biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} has recorded highest (12.33) followed by T_6 {Soil + Vermicompost +

2% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (10.73), T_5 {Soil + Vermicompost + 1% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} (10.93) and lowest was recorded in T_1 (Soil + Vermicompost) (7.46). The liquid biofertilizers, rich in PGPR (plant growth promoting rhizobacteria), stimulate production of plant hormones like auxins and cytokinins which can promote more lateral branching, formation of more flowering sites (axillary buds) which increases number of flowers. Similar results were noticed by Shikarwar *et al.*, (2025) in African marigold.

Conclusion

Based on the current study it can be concluded that the treatment T_7 {Soil + Vermicompost + 3% Biochar enriched with liquid biofertilizers (Azotobacter + PSB + KSB)} had a beneficial impact on growth and flowering parameters of French marigold.

References

- Agarwal, H., Kashyap V.H., Mishra A., Bordoloi S., Singh P.K and Joshi N.C. (2022). Biochar-based fertilizers and their applications in plant growth promotion and protection. *Biotech.* **12(6)**, 136.
- Ali, M.A. and Mjeed A.J. (2017). Biochar and nitrogen fertilizers effects on growth and flowering of garland chrysanthemum (*Chrysanthemum coronarium* L.) plant. *Kurdistan Journal of Applied Research.* **2(1)**, 8-14.
- Alwan, S.H., Owen M.A., Omar O.A. and Salih Z.K. (2023 April). Effect of Biochar Application and Foliar Application of Gibberellin and Cytokinin on Growth and Flowering of Chinese Carnations *Dianthus chinensis*. In *IOP Conference Series: Earth and Environmental Science*. IOP Publishing.
- Kanaby, P.N. and Saeed S.M. (2022). Influence of Bamboo Biochar and Gibberellic Acid on Vegetative and Flower Production of *Tagetes erecta* L. *Zanco Journal of Pure and Applied Sciences.* **34(6)**, 97-106.
- Panse, V.G. and Sukhatme P.V. (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.
- Sharma, A.K., Chaudhary S.V.S. and Bhatia R.S. (2012). Effect of spacing and pinching on regulation of flowering in African Marigold (*Tagetes erecta* L.) under sub montane low hills conditions of Himachal Pradesh. *Progressive Agriculture.* **12**, 331-36.
- Sikarwar, P.S. and Prasad V.M. (2025). Influence of Animal Manure Combined with Biochar on Plant Growth and Yield in Pinched Seedling of African Marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. *Journal of Experimental Agriculture International.* **47(3)**, 242-254.
- Singh, B. (2018). Rice husk ash. In Waste and supplementary cementitious materials in concrete. *Woodhead Publishing.* 417-4.