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# *Impatiens balsamina* L. and *Celosia argentea* L. as model ornamentals for assessing the growth-promoting efficacy of termite mound soil

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## Abstract
The rising demand for sustainable and eco-friendly agricultural practices has promoted interest in bio-based soil amendments as alternatives to chemical fertilizers. Termite mound soil is widely accepted for its unique physical, chemical, and biological properties, which may augment plant growth and soil fertility. The work reported here evaluated the effectiveness of termite mound soil as a sustainable fertilizer for the cultivation of two ornamental plants, *Impatiens balsamina* and *Celosia argentea*. An experiment was conducted using termite mound soil as the growth medium and compared with regular garden soil under similar environmental conditions. Plant growth and flowering parameters, including plant height, number of leaves, flowering time, number of flowers, leaf length was recorded. Plants grown under the addition of termite mound soil exhibited large variation in growth and flowering performance when compared to control setup. Enhanced vegetative growth, increased flower production, and elevated plant vigor indicated that termite mound soil provided favorable conditions for plant development. The findings suggest that termite mound soil can serve as a promising soil enrichment material and sustainable planting medium for ornamental horticulture, reducing dependence on synthetic fertilizers while improving plant productivity.

**Keywords:** Termite mound soil, biofertilizer, floriculture, plant growth, sustainable horticulture

## Introduction
Termites are eusocial insects. Out of the 3000known species of termites approximately 75% are classified as soil-feeding insects (Sarcinelli *et al*., 2009) [20]**.** They have Powerful influence on soil properties including redistribution of soil particles with nutrient and minerals, nest building, repacking and cementing, feeding activity, interaction with the organism, organic matter (OM) decomposition, nutrient recycling, foraging behaviour and decaying.

Termite activities cause noticeable physicochemical modifications in tropical and sub-tropical soil environments. They construct mounds of different sizes and structural complexity that function as long-term soil engineering features and are widely recognized as major biological determinants of soil physicochemical modification. Through biological soil reworking, organic residue breakdown, and biogeochemical cycling, termites contribute directly to soil formation and ecosystem performance. These activities accelerate the exude of plant-available nutrients from organic and mineral sources (Kathbaruah *et al*., 2024) [10].

Termites' mounds serve as an alternative source of environmentally sustainable soil amendment for plant growth (Sunitha *et al*., 2026) [21]. Termite mounds were discovered to be accumulating nutrients that are needed for plant growth and development, which are deficient in the surrounding soil (I. P. *et al*., 2025) [6]**.**

Balsam (*Impatiens balsamina*) is an annual herbaceous plant belonging to the family Balsaminaceae. They are predominantly distributed in warm climates and commonly known as rose balsam or garden balsam. It is native to southern Asia, especially in India and Myanmar, and is now widely cultivated in subtropical parts of the world. The blooms appear in about 60-70 days and colours include shades of white, pink, rose, violet, and red (Baloch *et al*., 2018) [4]. *Impatiens balsamina* is widely grown for both ornamental and medicinal purposes (Minh Sang *et al*., 2026) [14]**.**

*Celosia argentea* L. is an herbaceous plant which belongs to the family Amaranthacaceae. The leaves are eaten as vegetable in West Tropical Africa where it is considered an excellent pot herb and slightly bitter spinach alternate, rich in protein and vitamins. *C. argentea* has garnered attention as better source of a natural pigment (Klanrit *et al*., 2025) [11]. The stems and leaves bruised and applied as poultice is used for infected sores, wounds and skin eruptions. Poultice of leaves, smeared in honey, is used as cooling application to inflamed areas and painful affections such as buboes and abscesses. Leave concussions are used to relieve gastrointestinal disorders and are antipyretic in nature (Kanu *et al*., n.d.) [8].

Considering all the positive attributes of termite mound soil, the aim of the present investigation is to analyze the influence of termite mound soil on the growth and flowering of floriculture plants like *Impatiens balsamina* and *Celosia argentea.*

## Materials and Methods
### Experimental location
The experiment was conducted at the Department of Botany, University of Kerala, Kariavattom, Thiruvananthapuram during the year 2025 to 2026. The experiment was carried out under open field conditions. The average temperature ranged from 31 to 37 °C, relative humidity from 70 to 85%, and photoperiod was approximately 11 h day$^{-1}$.

### Plant species and seed procurement
Seeds of *Impatiens balsamina* and *Celosia argentea* were obtained from College of Agriculture, Kerala Agricultural UniversityVellayani, Thiruvananthapuram, Kerala. Healthy

and uniform seedlings were raised in grow bags containing both termite mound soil and normal soil. Seedlings with 3–4 true leaves were selected for transplanting.

### Collection and Preparation of Termite Mound Soil

Termite mound soil was collected from mature, inactive termite mounds located in south campus of our university. Soil was collected from the outer and middle portions of the mound after removing surface debris. Garden soil was collected from the experimental farm at a depth of 0–20 cm. Both soils were air-dried under shade, crushed gently, and passed through a 2-mm sieve to remove stones, roots, and other debris before preparing the potting mixtures.

### Physicochemical characterization of soil

Representative samples of termite mound soil and garden soil were analyzed before planting.
The soil samples were analyzed for physicochemical parameters including pH (Bachha *et al*., 2022) [2], electrical conductivity was recorded in deionized water at a soil : water ratio of 1:5, Electrical conductivity (EC) was measured in 1:5 soil-water extract by means of a conductivity meter, sand, silt, organic carbon (Nelson & Sommers, 1996) [16] organic matter, available nitrogen (Robert Okalebo *et al*., n.d.) [19]**,** phosphorus (Kruse *et al*., 2015) [13]potassium was determined by the flame photometer method ,zinc, copper, iron, magnesium and water holding capacity by Keen’s cup method as outlined by (Okweche *et al*., 2024) [17].

### Experimental Design and Treatments

Experimental pot was prepared by adding 450g of termite mound soil in a grow bag and after germination the seedlings were transferred into the experimental plot. Seedlings of both experimental and control were sown at a uniform depth. The experiment was maintained under natural environmental conditions. During the growth phase, 250g of termite soil was added as amendment to the experimental setup in two occasions, with onemonth interval between applications. Irrigation was provided regularly to maintain adequate soil moisture, and no chemical fertilizers or growth regulators were applied during the experimental period.

### Transplanting and Crop Management

Seedlings of balsam and celosia were transplanted individually into the soil. All experimental units received identical management practices throughout the study. Irrigation was applied as required to maintain adequate soil moisture. No fertilizers were applied. Weeding was carried out manually. Pest and disease incidencewas monitored regularly, and appropriate control measures were adopted whenever necessary.

### Growth Observations

Growth observations were recorded at regular interval after transplanting. The following parameters were measured: Plant height (cm), Number of leaves per plant, leaf length (cm).

### Flowering Observations

Flowering characteristics were recorded throughout the flowering period. The observations included: Number of flowers per plant, flowering time (weeks).

### Statistical Analysis

The experimental data were analyzed using one-way analysis of variance (ANOVA) and the data were evaluated at $p \leq 0.05$ level of significance. All treatments were conducted with six replicates, and results are presented as mean ± standard error.

## Results and Discussion

### Physicochemical Properties of the Soils

The analysis revealed notable differences between the two soil types. pH was slightly neutral to alkaline (6.3) which is favorable for nutrient availability. The availability of nutrients by plant is directly influenced by pH. When the pH is between 6.0 and 6.5, macronutrients like nitrogen, potassium, calcium, magnesium, and sulphur are readily available, whereas micronutrients are less readily available at higher, alkaline pHs (pH > 7.0) (Ferrarezi *et al*., 2022) [5]. These enhanced soil properties may be attributed to termite activity, which incorporates organic matter and improves soil structure.
The termite mound soil exhibited higher nitrogen, phosphorus, and potassium levels. Nitrogen, phosphorus, and potassium are important elements in plant metabolic processes and are included in plant macronutrients. Nitrogen is an important macronutrient that gives plants a dark green color, is a component of chlorophyll, nucleic acid, protein, and protoplasm and can boost the vegetative growth of cultivated plants. Phosphorus is essential for photosynthesis and cell division process. Phosphorus deficiency can inhibit plant growth. Meanwhile, potassium plays an important role in nutrient absorption and nutrient transportation, water absorption, and plant growth (Bachtiar *et al*., 2023) [3]**.**
According to (Kathbaruah *et al*., 2025) [9]**,** macronutrients like phosphorus and potassium were high in termite soil compared to normal soil but nitrogen was lesser in quantity. Whereas in our study, available nitrogen (313.60kg/ha), phosphorus (40.5kg/ha) and potassium (221.90kg/ha) were high in termite mound soil than normal soil (Table 1).

**Table 1:** Comparison of the physicochemical properties of termite mound soil

| Sl. No: | Parameters | Termite Mound Soil | Normal Soil |
|---|---|---|---|
| 1 | pH | 6.30 | 4.60 |
| 2 | Clay% | 55.80 | 22.60 |
| 3 | Sand% | 10.10 | 74.50 |
| 4 | Silt% | 34.14 | 2.90 |
| 5 | Water holding capacity (%) | 36.25 | 27.38 |
| 6 | Electrical Conductivity | 0.19 | 0.17 |
| 7 | Organic carbon (%) | 0.6 | 0.85 |
| 8 | Organic matter | 1.34 | 1.46 |
| 9 | Available Nitrogen (kg/ha) | 313.60 | 220.40 |
| 10 | Available Phosphorous (kg/ha) | 40.5 | 20.1 |
| 11 | Available potassium (Kg/ha) | 221.90 | 32.58 |
| 12 | Zinc (ppm) | 4.30 | 1.40 |
| 13 | Copper(ppm) | 5.20 | 1.10 |
| 14 | Iron (ppm) | 96.90 | 51.90 |
| 15 | Magnesium (ppm) | 393.40 | 150.10 |

(Sunitha *et al*., 2026) [21] reported a higher plant growth in chilli and red amaranth grown in termite mound soil compared to normal soil. Similar results were observed by (Kathbaruah *et al*., 2025) [9]**.** Likewisein the present study, *Impatiens balsamina* and *Celosia argentea* which are Ornamental flowering plants displayed an enhanced growth performance unlike the one grown in normal soil. This increased growth may be due to improved nutrient availability and better water-holding capacity of termite mound soil.

### Growth Performance of *Impatiens balsamina* and *Celosia argentea*

The development of *Impatiens balsamina* and *Celosia argentea* was evaluated by measuring plant height, number of leaves, leaf length, and flower production in plants grown in control soil and termite mound soil.

As shown in Figure (1) the *Impatiens balsamina* plants grown in termite mound soil obtained significantly greater plant height (28.2 ± 16.13 cm) compared with those grown in the normal soil (23 ± 9.81 cm). Likewise, the total number of leaves increased from 8.79 ± 1.74 in the control to 30.75 ± 14.32 in the termite mound soil treatment. Leaf length was also significantly higher in plants established in termite mound soil (9.11 ± 2.81cm) than in the control (3.21 ± 1.35cm). Flower production per plant was also high in termite mound soil (2.83 ± 2.74) compared with flowers per plant in the control (1.44 ± 1.97).

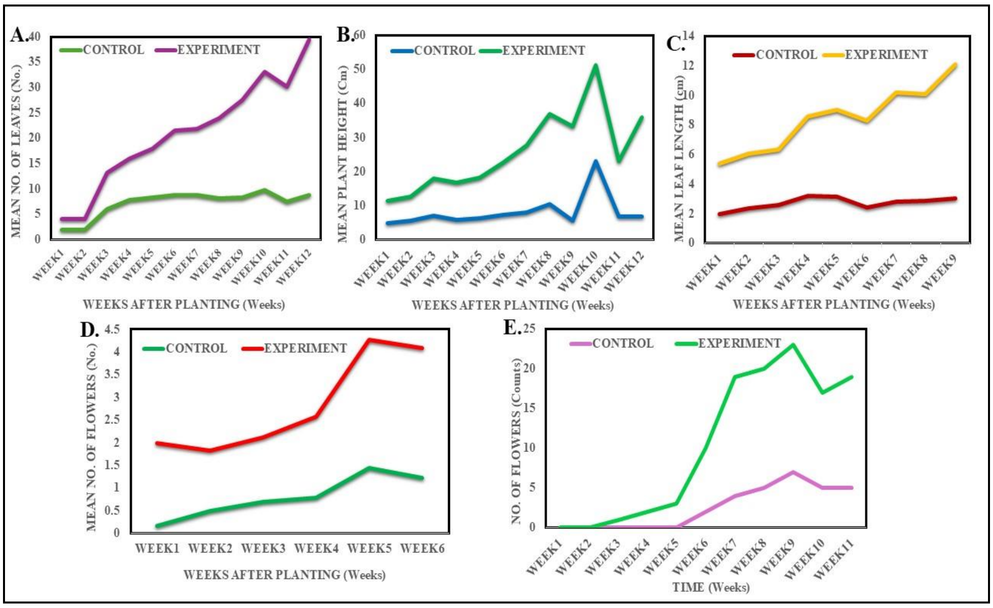



**Fig 1:** Growth performance of *Impatiens balsamina* under control and experimental conditions. (A) Number of leaves, (B) Plant height, (C) Leaf length, (D) Number of flowers, and (E) Time to first

A similar result was observed in *Celosia argentea* **(**Figure 2). Plants grown in termite mound soil recorded a significantly increased plant height (23 ± 13.14 cm) than those grown in normal soil (5.18 ± 7.82 cm). The leaves number increased from 7.714 ± 9.34 in the control treatment to 24.80 ± 10. 51 in the termite mound soil treatment, while the length of the leaf increased from 4.55 ± 1.90 cm to 6.96 ± 2.38 cm. Flower production was also significantly enhanced in plants grown in termite mound soil (3.09 ± 4.36 flowers plant$^{-1}$) compared with the control (0.85 ± 1.27 flowers plant$^{-1}$)

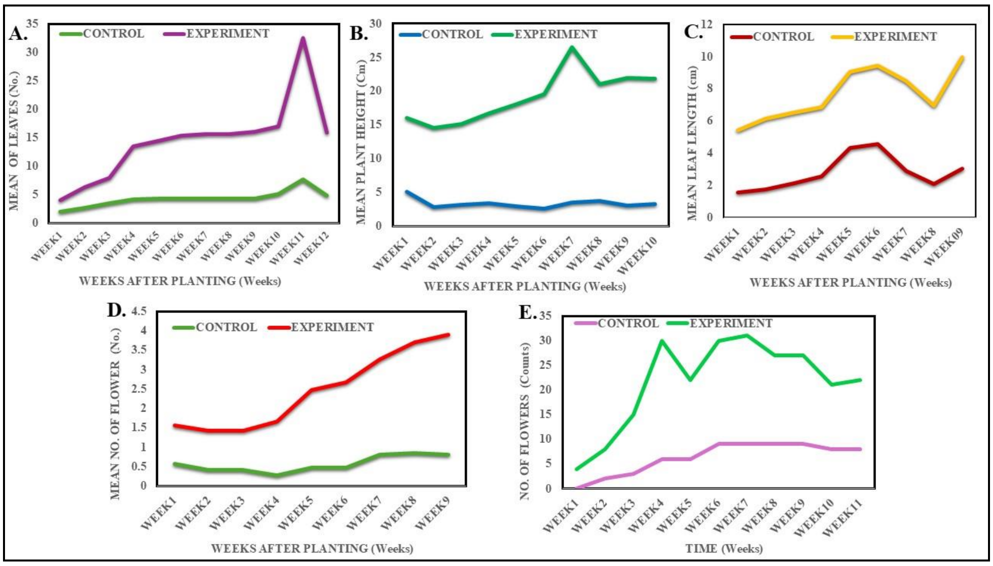


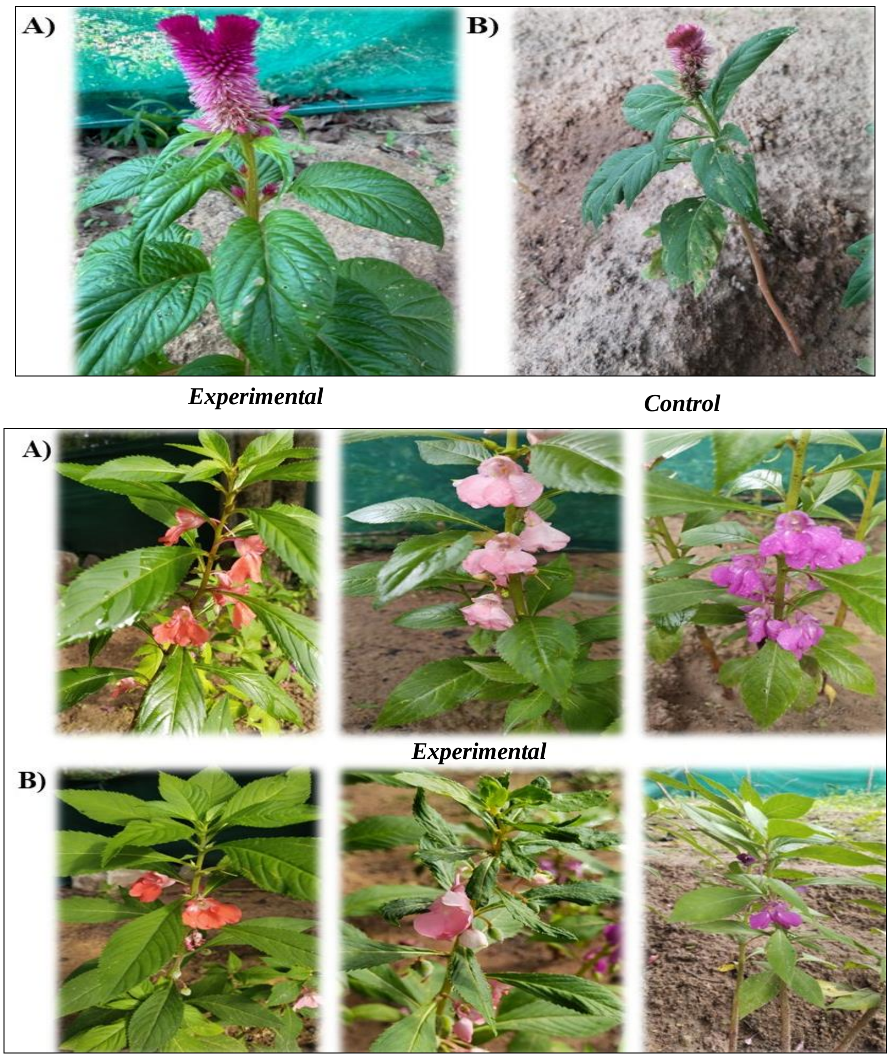

**Fig 2:** Growth performance of *Celosia argentea* under control and experimental conditions. (A) Number of leaves, (B) Plant height, (C) Leaf length, (D) Number of flowers, and (E) Time to first flowering (weeks).

The elevated vegetative and reproductive growth recorded in both ornamental species may be connected to the improved fertility and physicochemical properties of termite mound soil. Previous analysis of the experimental soil confirmed higher nutrient availability and improved soil properties, which are known to enhance nutrient uptake, and overall plant development. Increased plant height and leaf production indicate improved vegetative growth, while the higher number of flowers revealed the superior reproductive performance resulting from improved nutritional status.

These findings are consistent with those of (Jouquet *et al*., 2011) [7], who reported that the improved fertility of termite mound soil is due to its turbation of soil particles thus accumulating nutrients and organic matter which in turn enhance plant productivity. Similarly, (Apori *et al*., 2020) [1] described termites as ecosystem engineers that modify soil structure and nutrient dynamics through the accumulation of macronutrients needed for plant growth, creating favourable conditions for their development. (Muvengwi *et al*., 2016) [15] has discussed the diverse modification that happens to soil during the termite's mound building activity which have a great impact on the temporospatial aspects of vegetation.

As described by the Law of Diminishing Returns, the continuous input of fertilizers or other growth enhancers do not always lead to increased yield improvements and may even decrease beyond the point of maximum efficiency (Riski Nurfadillah *et al*., 2025) [18]**.** The need is to optimize the correct amount of nutrient's needed for plants. Here the addition of termite mound soil into the plant species in two cycles of 250g each and 450g during the germination phase shows improved vegetative and generative growth. Further the studies of (Konyak *et al*., 2025) [12] have revealed that termitarium based biofertilizers shows promising yield in both ornamental and food crops.

The increased leaf number and leaf length observed in the present study may have enhanced the photosynthetic ability of both species, that supported plant growth and flowering. Adequate availability of macronutrients like phosphorus and potassium in termite mound soil may have further contributed to improved floral initiation and development, as these nutrients play important roles in reproductive growth. Similar observations have been reported by (Tilahun *et al*., 2012) [22], who mentioned that the nutrient-rich environment of termite mounds aids in vegetation growth compared with surrounding soils. The comparative analysis of flowering in experimental and control plants is shown in figure 3. Overall, the current findings pave a way to the sustainable and scientific use of termite mound soil as vegetative and reproductive growth promoter of *Impatiens balsamina* and *Celosia argentea*, highlighting its potential as a natural fertilizer for ornamental and horticultural use.




***Control***

**Fig 3:** Comparison of flowering in termite mound soil-amended and control plants of (A) *Celosia argentea* and (B) *Impatiens balsamina* at the end of the experimental period

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