

Growth and biochemical response of basil to foliar-applied garlic extract

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Abstract

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This study sought to evaluate the efficacy of garlic extract as a growth promoter in potted basil plants. To this end, four extract concentrations (14, 16, 18, and 20 g/l) were prepared and administered via foliar spray once on growing basil plants. Various plant growth and biochemical parameters were documented after five months of cultivation to assess the effectiveness of garlic extract. The results demonstrated that the administered extracts, especially at higher concentrations, resulted in increased plant height, number of leaves per plant, and leaf area relative to control samples. Moreover, these treatments resulted in an increase in chlorophyll and total soluble solids content. No discrepancies in protein content were noted between the treated plants and the control group. These findings highlight the importance of garlic extracts as a substitute for chemical plant growth promoters in home gardening and small-scale organic farming.

1. Introduction

The application of chemicals in agriculture has undoubtedly enhanced food production during the past century. Nonetheless, the pervasive application of chemicals over the last several decades has resulted in numerous significant environmental, health, and production challenges. In light of this fact, there has been a movement advocating for the resuscitation of traditional agricultural techniques and the exploration of new economic and organic methods within the framework of sustainable agricultural production. Among these methodologies, the application of compost and organic fertilizers [1], biocontrol agents [2], and plant extracts as promoters of plant growth and production [3][4].

Basil (*Ocimum basilicum* L.) is a prominent herb in Mediterranean cuisine and traditional medicine, recognized for its distinctive perfume, exceptional flavor, and several health benefits, primarily attributed to its primary components, linalool and eugenol [5]. Basil is typically grown as a houseplant or commercially in open fields in protected tunnels. Research indicates that organically cultivated basil possesses a superior essential oil concentration and enhanced attributes relative to basil cultivated in tunnels [6]. The efficacy of diverse organic methods was evaluated within the organic production framework of basil. Garlic and aloe vera extract enhanced plant height, branch quantity, dry weight of basil, and oil output in comparison to the control group [7]. Seaweed extract alleviated salinity-induced stress in basil plants, leading to increased plant height, shoot length, branch count per plant, chlorophyll content, and carotenoid levels compared to control plants [8].

Garlic (*Allium sativum* L.) is a recognized plant renowned for its several bioactive components, including allicin, alliin, diallyl sulfide, diallyl disulfide, diallyl trisulfide, ajoene, and S-allyl-cysteine [9]. These chemicals establish garlic as a significant element in the human diet for combating seasonal and chronic diseases [10][11]. Conversely, garlic extracts have demonstrated efficacy in organic agriculture by augmenting productivity in both quality and quantity [12], as well as improving plant responses and resilience to abiotic and biotic stresses [13].

This article aims to evaluate the effects of garlic extract on various growth and biochemical parameters of organically cultivated basil.



2. Material and Methods

2.1. Basil plants

Basil (*Ocimum basilicum* L.) seeds were sourced from a local supplier. Pots measuring 20 cm in diameter were filled with equal weights of sterilized homogenized soil sourced from a nursery located in Misrata City. The pots were relocated to the greenhouse, where three basil seeds were sown in each pot. The pots were irrigated with standard tap water, maintaining the soil moisture content near field capacity until the seedlings attained an appropriate size. The seedlings were subsequently thinned to achieve one plant per pot two weeks after sowing. This study examined a growth period spanning five months, specifically from May to September 2023. No fertilizers or pest control agents were utilized on the basil plants during the duration of the study. The pots received regular irrigation with tap water, and the growing conditions remained unchanged, apart from routine aeration during periods of elevated temperatures.

2.2. Garlic extracts preparation

Garlic cloves were sourced from a local market in Misrata, peeled and washed thoroughly. Following the cleaning process, garlic cloves were ground using a food processor. Amounts of pulverized cloves weighing 14, 16, 18, and 20 grams were soaked in sterilized water (1 L) overnight to create garlic extracts. Following the immersion process, the extracts were subjected to filtration using filter paper and stored at 4 °C until needed for application.

2.3. Foliar spray

The prepared extracts (14, 16, 18, and 20 g/l) were placed into a hand sprayer, and the basil plants were treated with the spray in the early morning hours. Alongside the garlic extract treatments, the control plants were sprayed with sterilized water. Foliar spray was administered a single time, one-month post-germination, coinciding with the development of two sets of true leaves.

2.4. Study parameters

At the end of the experiment (September 2023) various plant measurements were recorded. Plant height from soil surface was measured with a ruler. Number of leaves per plant was counted. Leaf area was measured as an average of three fully grown leaves per plant by processing leaves images against a reference length using ImageJ software [14].

Chlorophyll content in leaves was estimated using Chlorophyll Meter SPAD-502Plus (Konica Minolta – Japan) and the average chlorophyll content in each plant was presented as the average of three readings. Total soluble solids (TSS) content in leaves was estimated using a hand-held refractometer. Protein content in leaves was estimated using bovine serum albumin as a standard [15].

2.5. Experimental design and statistical analysis

The experiment was conducted in a completely randomized block design, using four replications and three pots per replication. Analysis of variance (ANOVA) followed by Fisher's least significant difference (LSD) test was carried out using SPSS 2019 software to compare the obtained means at a significance level of 0.05.

3. Results and Discussion

3.1. Basil growth parameters

A notable enhancement in the height of basil plants was recorded in those subjected to foliar spray with garlic extract at concentrations of 16, 18, and 20 g/l, in comparison to the control group and plants treated with 14 g/l extract. The tallest plants were recorded in the group treated with 16 g/l, measuring 79.36 cm, whereas the control group exhibited the shortest height at 31.44 cm. (Fig. 1)

In a similar manner, the application of garlic extract treatments resulted in a significant increase in the number of leaves per plant, with the 20 g/l treatment yielding an average of 86.1 leaves per plant, in contrast to the control group, which exhibited only 44.3 leaves per plant. The treatment at 14 g/l did not result in a notable increase in the total leaf count per plant when compared to the control group (Fig. 1).

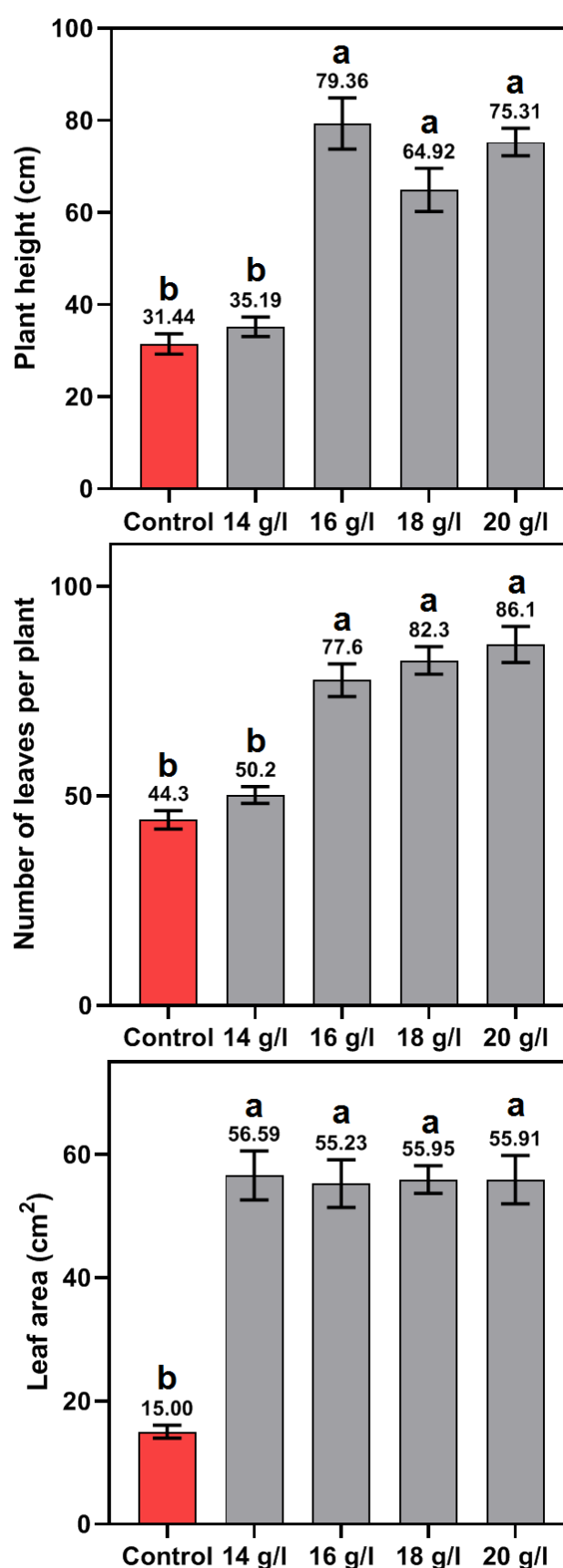
Regarding leaf area, it was observed that all plants treated with garlic extract exhibited larger leaves in comparison to the control group, with no significant differences noted among the four concentrations. Nonetheless, the treatment at 14 g/l resulted in the most extensive leaf surface area, measuring 56.59 cm². Conversely, the untreated plant exhibited an average leaf area of 15 cm² (Fig. 1).

Numerous studies have documented the beneficial effects of garlic extract on the vegetative growth of several plant species, such as tomato [16], eggplant, pepper [12], snap bean [17], and chickpea [18]. The identified beneficial effect in this study can be attributed to the augmentation of leaf area and the overall leaf count per plant during the growth phase. The hormonal research indicated that garlic extracts contain substantial levels of several phytohormones, including salicylates, auxins, and gibberellins [16]. These growth regulators are acknowledged for their critical roles in cell division, expansion, and elongation. This action may have contributed to the observed augmentation in leaf size and the quantity of leaves per plant, hence affecting plant height, especially in those subjected to elevated concentrations of garlic extract (16-20 g/l).

3.1. Basil biochemical parameters

Basil plants subjected to garlic extract at dosages of 18 and 20 g/l exhibited a substantial enhancement in chlorophyll content relative to other treatments, including the control group. The maximum chlorophyll content was 36.67 mg Kg⁻¹, seen in plants subjected to the highest tested concentration (20 g/l). The minimal content, conversely, was recorded with the 16 g/l treatment (25.38 mg Kg⁻¹) (Fig. 2).

Figure 1. The effect of foliar application of garlic extracts (at 14, 16, 18, and 20 g/l) on basil plant height, number of leaves per plant, and leaf area. Values are expressed as Mean±SD, and columns with distinct annotations indicate significant differences between treatments based on Fisher's LSD test ($p<0.05$).



Total soluble solids (TSS) seem to have risen with garlic extract treatments in comparison to the control group. The rise was substantial solely in the 16-20 g/l treatments, with the 20 g/l treatment achieving the greatest total soluble solids concentration of 4.35 °Brix. The minimum total soluble solids (TSS) was recorded in the control treatment at 2.19 °Brix.

No significant variations in protein content were identified among the treatments, including the control. Nevertheless, the control treatment exhibited the highest protein concentration among all plants (17.14 mg g⁻¹) (Fig. 2).

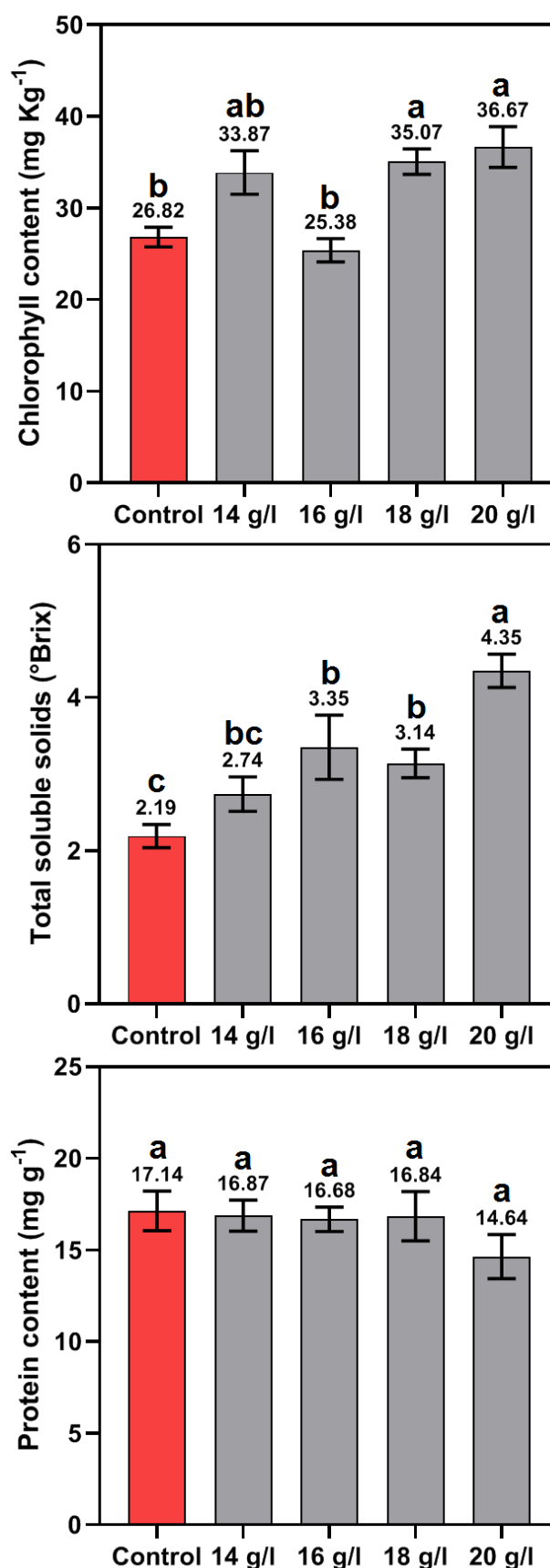
The elevated chlorophyll levels in treated plants may have facilitated the significant growth observed, as enhanced chlorophyll content likely promotes more efficient photosynthesis [12], leading to increased carbohydrate and soluble solid accumulation consistent with current findings.

Among all evaluated treatments, the 18 and 20 g/l treatments demonstrated superior efficacy in converting enhanced photosynthetic activity into vegetative growth, as evidenced by the increased leaf area and number of leaves per plant. The increase was also accompanied by a rise in TSS content, which may be regarded as a direct indicator of enhanced leaf quality. These treatments may be recommended for home and small-scale organic basil growers as an alternative to chemical products, particularly as only one application was necessary to attain the reported outcomes. Nonetheless, the implementation of garlic extracts on a broader scale necessitates further research under field conditions and a comprehensive economic evaluation of its profitability.

4. Conclusion

The current research shown that the application of garlic extract to basil plants, particularly at doses of 18 and 19 g/l, resulted in enhanced plant height, number of leaves per plant, leaf area, chlorophyll content, and total soluble solids in comparison to the untreated control group. These findings underscore the potential of utilizing garlic extract in domestic and small-scale organic basil cultivation as an alternative to chemical plant growth promoters.

Figure 2. The effect of foliar application of garlic extracts (at 14, 16, 18, and 20 g/l) on chlorophyll, total soluble solids, and protein contents in basil leaves based on fresh weight. Values are expressed as Mean±SD, and columns with distinct annotations indicate significant differences between treatments based on Fisher's LSD test ($p < 0.05$).



Conflict of interest statement

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Data availability statement

The authors declared that data used in the preparation of this manuscript will be available upon reasonable request.

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