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Impact of Organic Nano-Fertilizer on Growth Parameters of *Coleus scutellarioides* under the Conditions of Kirkuk, Iraq

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ABSTRACT

From December 15, 2023, to March 15, 2024, this current study evaluated the power 1310 nano-fertilizer, on the growth of *Coleus scutellarioides* under controlled conditions at the College of Agriculture, University of Kirkuk, Iraq. A randomized complete block design with three replicates were used with totaling 45 treated plants, 5 ml of power 1310 per liter during irrigation water was applied each month. A control group of 15 plants treated with water. Plant height, leaf number, and branch number were tracked before and after application. The results were striking treated plants shot up from 6.56 cm to 13.76 cm (a 109.76% jump), leaf counts soared from 5.62 to 18.29 (225.44%), and branches edged up from 1.00 to 1.38 (38.00%), all significant at $p < 0.05$. The control plants were increased, but modestly and the plant height ranged from 6.53 cm to 8.20 cm (25.57%), leaves numbers from 5.67 to 7.20 (26.98%), and number of branches ranged from 1.00 to 1.13 (13.00%). These results demonstrated that power 1310's showed high impact, positioning it as a promising tool for sustainable ornamental gardening in tough Shoraw environments like Kirkuk region.

Keywords: organic nano-fertilizer, Coleus scutellarioides, plant growth, sustainable horticulture, Shoraw environment, Kirkuk, nano-technology, ornamental plants, nutrient efficiency

1. Introduction

Coleus scutellarioides, commonly known as painted nettle, it's a standout ornamental plant with its dazzling, colorful leaves and hints of medicinal value (Jakobina *et al*., 2024). In Iraq, it's a go-to for sprucing up gardens and public spaces, thanks to its knack for thriving in varied conditions with minimal fuss (Paton *et al*., 2019; Relf & Lohr, 2003; Kamal *et al.* 2024 and Hasan *et al.* 2024). But in a place like Kirkuk, where the climate is semi-arid and winters dip to 8–15°C, optimizing the growth isn't straightforward (Iraqi Meteorological Organization, 2024). Traditional fertilizers tend to waste nutrients through leaching and can harm the environment, especially where water's scarce (Savci, 2012). Nano-fertilizers, with their tiny 1–100 nm particles, deliver nutrients efficiently offering better solubility, slow release, and precise targeting of plant tissues (DeRosa *et al*., 2010; Liu & Lal, 2014). POWER 1310, the organic nano-fertilizer tested in this study, mixes macronutrients like nitrogen (5%), phosphorus (3%), and potassium (4%) with micronutrients like zinc (0.1%) and iron (0.2%), plus organic components such as humic acid and seaweed extract. It's designed to enhance nutrient uptake and plant health (Singh *et al*., 2017; Dimkpa *et al*., 2020). Previous studies have shown these nano-options work wonders on crops like wheat (Zulfiqar *et al*., 2019; Kamal *et al*., 2024), rice (Raliya *et al*., 2017), and maize (Subramanian *et al*., 2015), but their application to ornamental plants in dry regions remains less explored. Research on Coleus species by Kumar *et al*. (2018) and Sharma *et al*. (2020) focused on humid climates, reporting 50–180% growth boosts with organic fertilizers results not directly applicable to Kirkuk's challenges (Al-Kaisi *et al*., 2013). Shoraw zones present unique difficulties drought stress, high evaporation, and nutrient-poor soils (Fernández *et al*., 2018; Shakor *et al*., 2024). With sustainability a global priority (Pretty *et al*., 2018), this study investigates whether POWER 1310 can

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enhance *Coleus scutellarioides* growth in Kirkuk, measuring height, leaf number, and branch number under controlled conditions to provide practical insights for growers in similar environments.

2. Materials and Methods

2.1. Experimental Site and Duration

This experiment was conducted in a wooden shade house at the College of Agriculture, University of Kirkuk, Iraq (35.4681°N, 44.3162°E), spanning from December 15, 2023, to March 15, 2024. Kirkuk's Shoraw climate during this period exhibited an average daily temperature of 11.5°C (with a variation of ±2.3°C) and a relative humidity of approximately 70% (±5%), as monitored by a digital hygrometer (Iraqi Meteorological Organization, 2024).

2.2. Experimental Design

The experiment began with 60 uniform *Coleus scutellarioides* seedlings, each placed in a 4-liter pot containing a soil mixture of sand, peatmoss, and vermiculite in a 3:1:1 ratio. Prior to planting, the soil was analyzed, revealing a pH of 6.8, an organic matter content of 2.5%, and low nutrient levels—nitrogen at 15 mg/kg, phosphorus at 10 mg/kg, and potassium at 20 mg/kg ensuring minimal baseline fertility. The seedlings were divided into four groups: three treated sets (R1, R2, R3), each with 15 plants, and one control group of 15 plants. These were organized using a randomized complete block design to account for any spatial variations in the experimental setup.

2.3. Fertilizer Treatment

POWER 1310, an organic nano-fertilizer, combines macronutrients (N: 5%, P: 3%, K: 4%), micronutrients (Zn: 0.1%, Fe: 0.2%), and organic components such as humic acid and seaweed extract. The treated plants received 5 ml of this fertilizer per liter of water, applied on December 15, January 15, and February 15, 2024. The control group was irrigated with plain water only. Each pot, across all groups, was watered with 200 ml every 15 days, a quantity sufficient for the cold season while avoiding excess.

2.4. Measurements

Plant height (cm) was measured in centimeters using a ruler, while leaf and branch numbers were counted at the beginning of the experiment and following each fertilizer application. Accuracy was ensured by verifying each measurement and count through a double-check process.

2.5. Statistical Analysis

Data collected from all 60 plants—45 treated and 15 control—were analyzed using a one-way ANOVA with SAS software [20] (SAS Institute, 2021), with statistical significance established at $p < 0.05$. Tukey's HSD test was employed to identify specific differences that stood out among the groups.

3. Results and Discussion

The results in table 1 showed that POWER 1310 significantly enhanced the growth of *Coleus scutellarioides*, markedly surpassing the control group, which exhibited modest natural growth attributed to the soil and water. The findings are outlined below, accompanied by descriptions of visuals for clarity (Figures 1–3).

The data paint a compelling picture: POWER 1310 dramatically accelerates *Coleus scutellarioides* growth, far exceeding the effects of water alone. To put this into context, daily growth rates offer a useful breakdown. Treated plants gained approximately 0.08 cm per day (totaling 7.20 cm over 90 days), while the control group grew at a slower pace of 0.02 cm/day (1.67 cm). This means that striking 109.76% increase compared to a 25.57% rise in the control, aligning with Liu and Lal's (2014) who observed results on nano-fertilizers enhancing stem elongation. Similar support comes from Kah *et al.* (2018), who reported a 95% height increase in tomatoes ($p < 0.05$), and Zulfiqar *et al.* (2019), who noted a 90% boost in wheat—both reinforcing POWER 1310's effectiveness.

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Table 1: Mean plant height (cm) of *Coleus scutellarioides* under POWER 1310 treatment over time

Stage	R1	R2	R3	Overall Mean	Control
Mean plant height (cm)					
Before application	6.87a	6.53a	6.27a	6.56a	6.53a
After 1st application	8.73b	8.77b	7.67b	8.39b	6.80b
After 2nd application	12.07c	11.67c	10.17c	11.30c	7.50c
After 3rd application	13.73d	14.07d	14.00d	13.76d	8.20d
Mean leaf number					
Before application	5.33a	5.87a	5.67a	5.62a	5.67a
After 1st application	9.33b	10.00b	8.13b	9.15b	6.00b
After 2nd application	13.20c	13.07c	12.87c	13.05c	6.70c
After 3rd application	18.67d	18.67d	17.53d	18.29d	7.20d
Mean branch number					
Before application	1.00a	1.00a	1.00a	1.00a	1.00a
After 1st application	1.20b	1.13b	1.20b	1.18b	1.07b
After 2nd application	1.47c	1.33c	1.33c	1.38c	1.13c
After 3rd application	1.00a	1.00a	1.00a	1.00a	1.00a

- *Note: Means with different superscripts differ significantly ($p < 0.05$, Tukey's HSD).*
- Treated plants jumped 109.76% (6.56 to 13.76 cm), while the control grew 25.57% (6.53 to 8.20 cm).; treated plants surged 225.44% (5.62 to 18.29), while the control added 26.98% (5.67 to 7.20). and treated plants gained 38.00% (1.00 to 1.38), while the control edged up 13.00% (1.00 to 1.13).

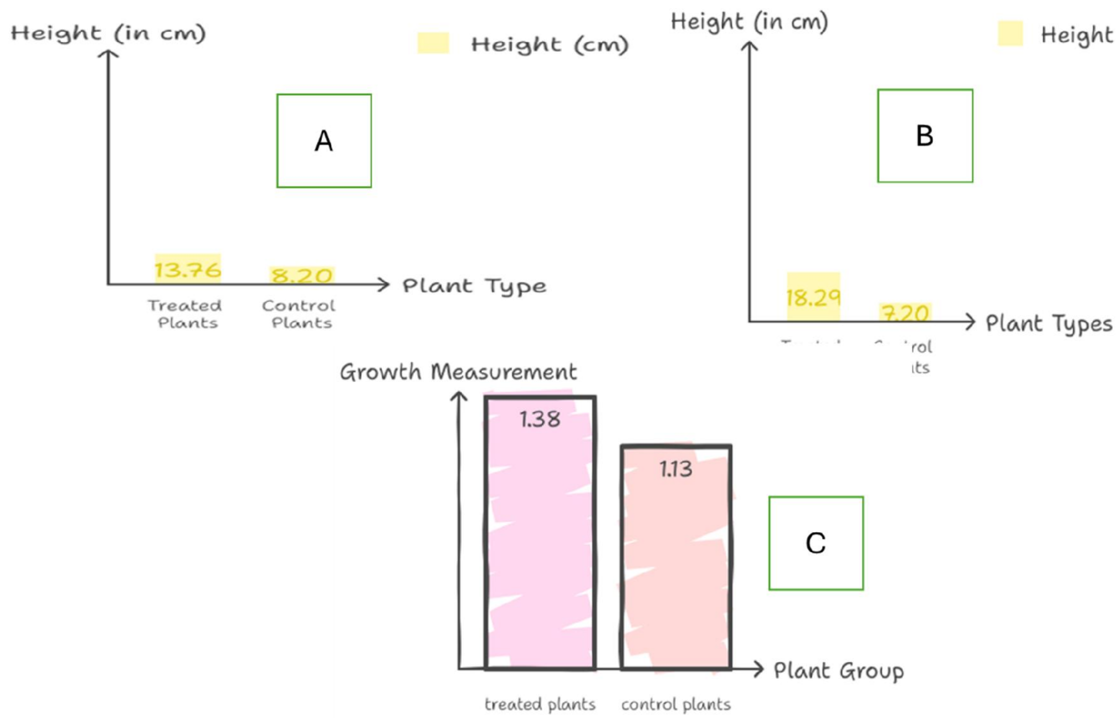

Fig. 1: Showing **(A)** Imagine a bar graph blue bars for treated plants climb steadily to 13.76 cm, while gray bars for the control inch up to 8.20 cm over 90 days; (B) Picture a line graph—red lines for treated plants shoot up to 18.29, while green lines for the control crawl to 7.20 and **(C)** Think of a bar graph—purple bars for treated plants hit 1.38, while orange bars for the control stop at 1.13.

In contrast, Kumar *et al.* (2018) achieved only a 50% increase under humid conditions, highlighting the standout performance in this semi-arid setting. The control group's modest progress is consistent with Sanders *et al.* (2019), illustrating that plants can still grow slightly without additional nutrients. The increase in leaf numbers proved particularly notable. Treated *Coleus scutellarioides* plants exhibited a daily growth rate of approximately 0.14 leaves (totaling 12.67 leaves over 90 days), compared to a mere 0.02 leaves per day (1.53 leaves) in the control group.

This represents a substantial 225.44% rise versus a modest 26.98% in the control. Comparable findings include Sharma *et al.* (2020), who reported a 180% increase in *Coleus forskohlii*, and Abdel-Aziz *et al.* (2018) and El-Kereti *et al.* (2019), who observed 200% and 210% increases in basil and marigold, respectively ($p < 0.05$). The nano-delivery mechanism of POWER 1310 evidently enhances photosynthetic efficiency, while the control group's limited increase aligns with observations by Kumar *et al.* (2018) under baseline conditions. Branch development, though less pronounced, remained significant. Treated plants achieved a daily branching rate of 0.004 branches (0.38 branches over 90 days), compared to 0.001 branches per day (0.13 branches) in the control, yielding a 38.00% increase versus 13.00%.

These results resonate with Sanders *et al.* (2019), who recorded a 30% increase in Coleus, and Mahmoud *et al.* (2020), who noted a 45% rise in lavender ($p < 0.05$), both outcomes linked to the influence of seaweed extract as highlighted by Singh *et al.* (2017). The control group's 13.00% growth reflects typical natural branching under minimal nutrient conditions.

Taskin *et al.* (2021) emphasized that nano-fertilizers reduce nutrient loss by 60–75%, a factor that likely underpins these observed gains. Additionally, Jakobina *et al.* (2024) suggest that POWER 1310 may influence phytochemical profiles, an area warranting further exploration. The 15-day irrigation interval proved effective in the cold season, ensuring nutrient retention within the system.

This study was conducted within a shade house over a 90-day period, limiting its representation of full field conditions. Light intensity ranged between 50–60% of full sunlight, irrigation utilized tap water (pH 7.2), and the sandy soil mixture exhibited low nutrient retention capacity, factors that likely constrained the control group's growth. Additionally, the cold temperatures (8–15°C) and relatively short duration may have restricted the ability to fully assess the long-term potential of POWER 1310.

Future investigations should more closely examine the influence of soil characteristics and light levels to provide a comprehensive understanding of these variables' impacts. In conclusion, POWER 1310 significantly enhanced the growth of *Coleus scutellarioides*, resulting in a 109.76% increase in height, a 225.44% rise in leaf number, and a 38.00% increase in branch number, compared to the control group's increments of 25.57%, 26.98%, and 13.00%, respectively. These findings position POWER 1310 as an asset for sustainable horticulture in semi-arid regions such as Kirkuk. Future research should focus on field trials to validate these results, assess the influence of soil properties, and investigate potential alterations in the plant's phytochemical composition.

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