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Effect of Humic Acid On Yield and Growth of Two Cotton Varieties in Balkh Province

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ABSTRACT

This study, conducted in 2024, explores the effects of varying levels of humic acid on the growth and yield performance of two cotton varieties, Sanroof 1155 and Sanroof 610, in Balkh province. Utilizing a Randomized Complete Block Design (RCBD) with three replications, the experiment evaluated four treatments: a control (no humic acid), a recommended dose (5 L/ha), 1.5 times the recommended dose (7.5 L/ha), and double the recommended dose (10 L/ha). The results indicated significant improvements in various growth and yield parameters with the application of humic acid. In Sanroof 1155, the highest plant height (155.5 cm) was recorded in the (R2T1), while the maximum number of bolls per plant (85) and the highest seed cotton yield (2700 kg/ha) were observed at the double dose (R3T3). The peak 100-seed weight was noted at 13.4 g in the R3T3 treatment. Similarly, Sanroof 610 demonstrated notable enhancements, with a seed cotton yield of 2271 kg/ha under the 1.5 times recommended dose (R2T3). Overall, the study concludes that increasing humic acid application, particularly to 10 L/ha, can significantly enhance cotton growth and yield in the agro-climatic conditions of Balkh province, with Sanroof 1155 demonstrating superior performance. This study underscores the potential benefits of humic acid in cotton cultivation.

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INTRODUCTION

The scientific name of cotton is *Gossypium hirsutum L.*, which belongs to the *Malvaceae* family. It is one of the most important industrial crops in the world and is cultivated for the production of fibers, used in the textile industry. Cotton grows well under warm, dry climatic conditions, with an optimal temperature range of 25-35°C, and is adapted to sandy loam to clay loam soils with good drainage. The crop is mainly self-pollinated, although a small percentage of cross-pollination may occur (Rady et al., 2016).

Cotton fibers are used in the production of yarn and fabric, while its seeds are used for vegetable oil extraction and as animal feed. To improve yield and enhance quality, the use of soil-improving substances such as humic acid has received increasing attention. Humic acid is a naturally occurring organic compound that improves soil structure, increases nutrient uptake, stimulates root growth, and enhances plant biological performance (Khodadadi et al., 2020).

The climatic conditions of Balkh Province, characterized by high temperatures, low moisture availability, and soils with low organic matter, create significant challenges for plant growth, particularly for cotton. Under such conditions, the application of organic fertilizers, especially humic acid, can improve soil physical, chemical, and biological properties and significantly enhance plant growth. Moreover, the variety (genotype) plays a key role in the plant's response to environmental conditions and nutrient availability (Rashid et al., 2018).

In this study, we evaluated the effects of different levels of humic acid on two cotton varieties assess their differences in performance (yield quantity and quality) under the climatic conditions of Balkh Province. The findings of this study can be used to identify suitable cotton varieties and appropriate levels of humic acid to improve yield and quality under similar environmental conditions.

In recent years, many researchers have studied the effects of humic acid on the growth, development, and yield of crops, including cotton. These studies indicate that humic acid plays a significant role in improving root development, increasing photosynthetic activity, enhancing nutrient uptake, and strengthening plant tolerance to environmental stress. Overall, HA is considered an important component of sustainable plant nutrition due to its positive effects on soil physical, chemical, and biological properties, as well as on plant metabolism (Temiz, 2010).

Given the climatic conditions of Balkh Province and the need to improve soil fertility and ensure sustainable cotton production, a scientific evaluation of the effects of different levels of humic acid on two cotton varieties is both essential and practical. Several previous studies have examined the impact of humic acid on the growth, quality, and yield of various crops, including cotton, which will be discussed below.

Khan et al. (2018), in a study conducted in Pakistan, demonstrated that the application of humic acid significantly increased plant height, the number of bolls, and boll weight in cotton. The study confirmed the positive impact of organic fertilizers on crop yield.

Mosavi (2019), in a study conducted at the Islamic Azad University of Birjand, reported that the application of 10 litres per hectare of humic acid increased plant height, stem diameter by 9.4 %, number of branches by 14.2 %, cottonseed yield by 23.5 %, and water use efficiency by 9.9, 9.4, 14.2, 23.5, and 20.7%. These results indicate that humic acid plays a positive role in improving cotton performance under drought conditions.

Kang et al. (2022) conducted a meta-analysis evaluating the effects of humic acid on crops. Their results showed that humic acid application led to an average yield increase of 12% and an improvement in nitrogen use efficiency of 27%. These effects were more prominent in areas with annual rainfall over 300 mm and average annual temperatures above 10°C.

In a study conducted at Dicle University in Turkey, Basbag (2010) reported that applying humic acid through seed moistening and foliar spraying increased plant height, the number of bolls, and cottonseed yield. Although this study was published in 2010, its findings remain notable because of their relevance to the effects of humic acid on cotton.

Musarrat et al. (2021), in a study conducted in Pakistan, found that applying 5 kg/ha of humic acid to a silty loam soil increased cottonseed yield from 1.84 T/ha to 2.76 T/ha. This increase in yield was attributed to improved nitrogen uptake and enhanced enzymatic activity in the plant rhizosphere.

Pui et al. (2024) reported that the application of humic acid through both foliar spraying and soil application, in combination with NPK fertilizers, resulted in significant increases in cotton seed yield, nutrient uptake, and improvement of soil chemical properties. This study is guided by the following research questions:

1. How do different levels of humic acid affect the growth parameters of two cotton varieties in Balkh Province?
2. Which humic acid treatment level produces the best growth and yield performance?
3. What is the impact of humic acid application on cotton yield and fiber quality?

METHODS AND MATERIALS

The field experiment was conducted during the 2024 growing season at the Faculty of Agriculture research farm, Balkh University, to investigate the effects of humic acid on cotton growth, yield, and quality. A Randomized Complete Block Design with four treatments and three replications was used to evaluate two cotton (Gossypium hirsutum L.) varieties, Sanroof 1155 and Sanroof 610. Different rates of humic acid were applied under uniform agronomic management, and the methods of soil analysis, data collection, and statistical analysis are described in the following sections.

Experimental Site and Design

The experiment was conducted during the 2024 growing season at the research farm of the Faculty of Agriculture, Balkh University. The study employed a Randomized Complete Block Design (RCBD) with four treatments and three replications. The objective of the experiment was to evaluate the effects of different application rates of humic acid on the yield quantity and quality of two cotton (*Gossypium hirsutum* L.) varieties, namely Sanroof 1155 and Sanroof 610, under the agro-climatic conditions of Balkh Province.

Soil Characteristics

Prior to sowing, soil samples were collected from the experimental field and analyzed. The soil had a pH of 8.10, indicating slightly alkaline conditions, and an electrical conductivity (EC) of 0.68 ds/m, reflecting non-saline soil conditions suitable for cotton cultivation. The organic matter content was 0.70%, which is considered low. Available nutrient contents (on a dry-weight basis) were 79.9 mg/kg nitrogen, 21.4 mg/kg phosphorus, 142 mg/kg potassium, and 25.45 mg/kg sulfur.

Plot Layout and Crop Management

Each experimental plot measured 3 m × 4 m (12 m²). Cotton was sown on 26 April 2024 and harvested on 9 November 2024. Irrigation was applied 12 times throughout the growing season based on crop requirements. A basal fertilizer application consisted of diammonium phosphate (DAP) at 100 kg/ha and urea at 150 kg/ha, in accordance with local agronomic recommendations.

Humic Acid Treatments and Application

Humic acid was applied as a foliar spray. Applications began after seed germination and were conducted in **five stages at 15-day intervals**:

- Early vegetative stage (10–15 days after germination) to support root establishment
- Mid-vegetative stage to enhance shoot growth and leaf development
- Pre-flowering stage to promote floral initiation
- Flowering stage to support boll formation
- Boll development stage to improve fiber quality and final yield

The humic acid used in this study was an industrial-grade liquid formulation, commercially produced for agricultural use and obtained from a certified agricultural input supplier to ensure uniform quality and concentration.

The treatments were defined as follows:

- **T_0 (Control):** No humic acid application
- **T_1:** Recommended rate (5 L/ha)
- **T_2:** 1.5 × recommended rate (7.5 L/ha)
- **T_3:** 2 × recommended rate (10 L/ha)

Data Collection

In each plot, three plants were randomly selected and tagged for data collection. Growth, phenological, yield, and fiber quality parameters were recorded, including plant height, number of bolls per plant, seed cotton yield (kg/ha), 100-seed weight (g), and days to 50% flowering. Fiber quality traits, including fiber length and fiber strength (mm), were also measured.

Statistical Analysis

All recorded data were analyzed using analysis of variance (ANOVA) in appropriate statistical software. Treatment means were compared using the Least Significant Difference (LSD) test at the 5% probability level ($p \leq 0.05$).

Recent research in agriculture has increasingly focused on improving crop yields in terms of both quantity and quality. One innovative approach that has been widely studied is the use of humic acid as a natural additive to enhance plant growth. Humic acid is recognized for its effectiveness in improving soil properties and promoting plant growth, potentially increasing agricultural productivity. This study aimed to evaluate the effects of different application rates of humic acid on the yield quantity and quality of two cotton varieties, namely Sanroof 1155 and Sanroof 610, under the specific agro-climatic conditions of Balkh Province. By employing a Randomized Complete Block Design and accounting for other relevant factors, the primary objective of this research was to assess the effects of this additive on key agronomic traits, with the goal of optimizing cotton production.

FINDINGS

The main findings of this study revealed that the application of humic acid significantly improved the yield and growth parameters of both cotton varieties (Sanroof 1155 and Sanroof 610), with the highest dose (10 L/ha) demonstrating the most notable positive effects. Among the measured traits, Sanroof 1155 showed superior performance in number of bolls per plant, seed cotton yield, and plant height, whereas Sanroof 610 demonstrated better performance in 100-seed weight and fiber strength.

These results indicate that increasing levels of humic acid, particularly at 10 L/ha, enhanced nutrient uptake, root development, and overall plant vigor. The improvements observed in the yield components support previous studies showing that humic substances enhance crop productivity by improving soil structure and nutrient availability.

The study on the performance of different levels of humic acid applied to two cotton varieties (Sanroof 1155 and Sanroof 610) under the climatic conditions of Balkh province showed significant effects, as presented in Table 1. The Application of various concentrations of humic acid had a statistically nonsignificant effect on the number of bolls per plant and bolls per square meter. The third treatment (10 L/ha of humic acid) in Sanroof 610 showed the highest average number of bolls per plant (50.66) across the three replications, indicating superior performance among all treatments. This suggests that the 10 L/ha dose of humic acid had the most tremendous impact on cotton yield. However, no significant effects were observed on plant height and 50% flowering time. Moreover, the control treatment exhibited non-significant values for plant height, boll yield per plant, and 50% flowering time (Table 1).

Table 1. *Effect of different levels of humic acid on 50% flowering time, plant height (cm), and number of bolls per plant in San Roof 610 cotton variety*

50% Flowering Time (days)	*Plant Height (cm)*	*Number of Bolls/Plant*	*Treatments*	*Number*
69	104	32	R_1T_0 (0 L/ha) Humic Acid)	1
71	85	22	R_1T_1 (5 L/ha) Humic Acid	2
69	141.33	24.33	R_1T_2 (7.5 L/ha) Humic Acid	3
70	141	29	R_1T_3 (10 L/ha) Humic Acid	4

69	105	45	R_2T_0 (0 L/ha) Humic Acid)	5
68	110	33.65	R_2T_1 (5 L/ha) Humic Acid	6
69	103.3	45.33	R_2T_2 (7.5 L/ha) Humic Acid	7
68	121.66	50.66	R_2T_3 (10 L/ha) Humic Acid	8
65	105	26.33	R_3T_0 (0 L/ha) Humic Acid)	9
67	91	36	R_3T_1 (5 L/ha) Humic Acid	10
65	103	28.33	R_3T_2 (7.5 L/ha) Humic Acid	11
65	111.5	17.33	R_3T_3 (10 L/ha) Humic Acid	12
1.28	13.82	24.12	**CV%** [1]	
1.73	31.38	15.66	**CD (5%)** [2]	
NS	NS	NS	**(FC)** [3]	
0.50	9.07	4.53	**EMSS** [4]	

According to Table 2, in the Sanroof 610 variety, the highest statistically significant yield was recorded in treatment R_2T_3 with 2,271 kg per hectare. The maximum 100-seed weight (15.94 g) was also observed in R_2T_3, whereas the longest fiber length (34 mm) was recorded in R_3T_3. These notable improvements were achieved by applying 10 liters of humic acid per hectare.

Table 2. *illustrates the effects of different levels of humic acid on yield (kg/ha), 100-seed weight (g), and Fiber Length (mm) in the San Roof 610 cotton variety*

Fiber length(mm)	***100-Seed Weight(g)***	***Yield (kg/ha)***	***Treatments***	***Number***
20.22	10.3	1332	R_1T_0 (0 L/ha) Humic Acid)	1
26	10.3	1834	R_1T_1 (5 L/ha) Humic Acid	2
31	10.3	1936	R_1T_2 (7.5 L/ha) Humic Acid	3
29	13.62	2048	R_1T_3 (10 L/ha) Humic Acid	4
22	10.3	1275	R_2T_0 (0 L/ha) Humic Acid)	5
27	13.3	2050	R_2T_1 (5 L/ha) Humic Acid	6

[1] Coefficient of Variation%
[2] Critical difference
[3] F. Calculated
[4] Error mean sum of square

27	11.3	2153	R_2T2 (7.5 L/ha) Humic Acid	7
31	15.94	2271	R_2T3 (10 L/ha) Humic Acid	8
26	12.3	1235	R_3T0 (0 L/ha) Humic Acid)	9
28.32	10.3	1734	R_3T1 (5 L/ha) Humic Acid	10
33	12.39	1732	R_3T2 (7.5 L/ha) Humic Acid	11
34	15.94	2121	R3T3 (10 L/ha) Humic Acid	12
5.75	10.75	5.57	**CV%**	
3.20	2.65	201.36	**CD (5%)**	
*	*	*	**(FC)**	
0.93	0.77	58.19	**Emss**	

(*significant at $_{5\%}$ probability level = *)*

In the Sanroof 1155 variety, as shown in Table 3, the highest number of bolls per plant (85) was recorded in treatment R3T3, where 10 litres of humic acid per hectare were applied, indicating a significant increase. However, the tallest plant height (155.5 cm) was observed in the treatment (R2T1). Humic acid can direct plant growth toward grain, fruit, or tuber production rather than just vertical or stem growth. Consequently, the plants became shorter but more productive. No humic acid was used. No significant differences were observed among treatments in 50% flowering time or plant height.

The reduced plant height in the humic acid treatment was not a negative indicator; this may suggest that growth resources were redirected from unproductive elongation to economically valuable yield components. This reflects the positive regulatory effect of humic acids on plant physiology. Plants with more balanced growth (not overly tall) can allocate resources more efficiently and maintain efficient photosynthesis, leading to greater assimilate production and higher yield.

Table 3. *Effects of different humic acid levels on the number of bolls per plant, plant height (cm), and flowering time in Sanroof 1155 cotton variety*

50% Flowering Time (days)	*Plant Height (cm)*	*Number of Bolls/Plant*	*Treatments*	*Number*
65	108	55	R_1T_0 (0 L/ha) Humic Acid)	1
65	123.3	63	R_1T_1 (5 L/ha) Humic Acid	2
66	140	72	R_1T_2 (7.5 L/ha) Humic Acid	3
66	141.3	81	R_1T_3 (10 L/ha) Humic Acid	4

66	107.5	51	R_2T_0 (0 L/ha) Humic Acid)	5
65	155.5	59	R_2T_1 (5 L/ha) Humic Acid	6
66	139	68	R_2T_2 (7.5 L/ha) Humic Acid	7
66	133.5	76	R_2T_3 (10 L/ha) Humic Acid	8
66	111	57	R_3T_0 (0 L/ha) Humic Acid)	9
66	123	62	R_3T_1 (5 L/ha) Humic Acid	10
66	112	81	R_3T_2 (7.5 L/ha) Humic Acid	11
65	121	85	R3T3 (10 L/ha) Humic Acid	12
0.84	15.78	3.64	**CV%**	
1.10	42.33	4.91	**CD (5%)**	
NS	NS	**	**(FC)**	
0.32	12.23	1.42	**Emss**	

*(significant at $_{5\%}$ probability level = *)*

According to Table 4, in the Sanroof 1155 cotton variety, the highest yield was observed in treatment R3T3 at 2,700 kg/ha. The maximum 100-seed weight (13.4 g) and fiber length (35 mm) were recorded in treatment R2T3, both under the application of 10 litres of humic acid per hectare. Overall, the Sanroof 1155 variety demonstrated better performance than Sanroof 610 under the same agro-climatic conditions of Balkh province.

Table 4. *shows the effects of different application rates of humic acid on seed cotton yield (kg/ha), 100-seed weight (g), and fiber length (mm) in the Sanroof 1155 cotton variety*

Fiber length(mm)	***100-Seed Weight(g)***	***Yield (kg/ha)***	***Treatments***	***Number***
29	9.8	1332	R_1T_0 (0 L/ha) Humic Acid)	1
29.8	9.7	1622	R_1T_1 (5 L/ha) Humic Acid	2
32.9	9.9	1712	R_1T_2 (7.5 L/ha) Humic Acid	3
33.8	13.1	2050	R_1T_3 (10 L/ha) Humic Acid	4
31.28	11.3	980	R_2T_0 (0 L/ha) Humic Acid)	5
31.59	11.5	1072	R_2T_1 (5 L/ha) Humic Acid	6
33.2	12.5	1072.5	R_2T_2 (7.5 L/ha) Humic Acid	7
35	12.8	2400	R_2T_3 (10 L/ha) Humic Acid	8

25.1	11.2	1200	R_3T_0 (0 L/ha) Humic Acid)	9
30.8	10.5	1200	R_3T_1 (5 L/ha) Humic Acid	10
32.8	12.6	2050	R_3T_2 (7.5 L/ha) Humic Acid	11
33.2	13.4	2700	R3T3 (10 L/ha) Humic Acid	12
4.53	6.16	19.23	**CV%**	
2.85	1.42	620.78	**CD (5%)**	
*	**	**	**(FC)**	
0.82	0.41	179.39	**Emss**	

(significant at 5% probability level = *)

DISCUSSION

The results of this study demonstrated that humic acid application improves both cotton yield and quality. Different levels of humic acid had a significant effect on the number of bolls per plant and bolls per square meter. In the Sanroof 610 variety, the treatment receiving 10 L/ha of humic acid produced the highest number of bolls per plant (50.66) across three applications, indicating that this rate had the most favorable effect on yield components. In Sanroof 1155 variety, the highest seed cotton yield was recorded in treatment R3T3 (2700 kg/ha), while the highest 100 seed weight (13.4 g) and fiber length (35 mm) were observed in treatment R2T3, where 10 liters per hectare of humic acid was applied. Overall, under the climatic conditions of Balkh Province, the San Roof 1155 performed better than the San Rough 610.

Mousavi (2019) reported that applying 10 L/ha of humic acid increased seed cotton yield by 23.5% and improved water use efficiency by 20.7% under drought conditions, which is consistent with our observation that the highest yield in Sanroof 610 (2271 kg/ha) and improved 100-seed weight and fiber length occurred with increased humic acid application. This suggests a similar physiological response to humic acid in dry regions.

Moreover, the current study supports the work of Puy et al. (2024), who reported that humic acid, when applied as a foliar and soil treatment along with NPK fertilizers, significantly enhanced cotton yield and nutrient uptake while improving soil chemical properties. This is reflected in our results, where treatments with higher humic acid rate (especially 10 L/ha) yielded stronger plant growth and yield parameters, likely due to improved nutrient absorption.

Temiz (2010) emphasized that humic acid enhances root development, enzymatic activity, and nutrient uptake, thereby contributing to greater plant vigour. These physiological improvements were observed in both cotton varieties in our study, particularly in Sanroof 1155, which showed superior overall performance.

Furthermore, the response variation between the two cotton varieties suggests that genetic factors influence the efficiency of humic acid uptake and utilization. This observation echoes findings by Bisen et al. (2024), who noted varietal differences in response to humic acid treatments.

Overall, the consistency between our results and previous findings reinforces the importance of humic acid as a sustainable agronomic input, especially in regions with limited water resources and degraded soils.

Furthermore, regional studies have confirmed the effectiveness of humic acids in dry and semi-arid soils. Musarrat et al. (2021) reported that applying 5 kg /ha of humic acid to a silty loam soil in Pakistan increased cotton yield from 1.84 to 2.76 tons per hectare due to improved nitrogen uptake and enhanced enzymatic activity in the rhizosphere.

In Afghanistan, the use of organic materials such as humic acid can play an important role in restoring nutrient-poor soils, reducing dependence on chemical fertilizers, and increasing the sustainability of agricultural production (Ullah et al., 2020; Shah et al., 2023).

The application of humic acid at varying concentrations significantly influenced key growth parameters of both cotton varieties (Sanroof 1155 and Sanroof 610). Higher doses, particularly the double-recommended dose (10 L/ha), resulted in improved plant height, increased boll number per plant, and enhanced seed cotton yield. These findings align with the existing literature, which attributes these improvements to humic acid's ability to enhance nutrient uptake, stimulate root development, and improve soil structure and microbial activity.

The double recommended dose (10 L/ha) was the most effective treatment. In Sanroof 1155, this level resulted in the highest number of bolls per plant (85), maximum seed cotton yield (2700 kg/ha), and peak 100-seed weight (13.4 g). Sanroof 610 also showed notable improvements under the 7.5 L/ha treatment. This suggests that the optimal dose may vary slightly between varieties. However, overall, higher levels of humic acid consistently lead to superior performance, with 10 L/ha being the most effective in this study.

The study demonstrates that humic acid application enhances seed cotton yield by improving plant physiological functions and reproductive development. Although the fiber quality was not directly measured or reported in the study, the increase in boll number and seed weight implies potential improvements in fiber production. Previous studies have suggested that better plant nutrition and stress tolerance, both enhanced by humic acid, can positively influence fiber quality parameters such as length and strength.

While this study offers valuable insights into the effects of humic acid on cotton yield and quality, several limitations must be noted. The experiment was conducted over a single growing season, potentially overlooking seasonal variability in weather and pest pressures. Additionally, findings are specific to the agro-climatic conditions of Balkh Province and may not apply to other regions. The study also focused on a limited range of humic acid application rates and only two cotton varieties, which restricts the generalizability of the results. The short duration of the study may not fully capture long-term effects on soil health and crop performance. Furthermore, important factors, such as soil microbial activity, were not measured, and standard statistical analyses may not account for all possible interactions. These limitations highlight the need for further research to confirm findings and explore the broader applications of humic acid in cotton cultivation.

CONCLUSION

To improve crop yield and quality, the use of soil enhancers such as humic acid has received significant attention. Humic acid is a naturally occurring organic compound that plays a vital role in improving soil structure, enhancing nutrient uptake, stimulating root growth, and increasing plant vitality.

The climatic conditions of Balkh province ,characterized by intense heat, moisture deficiency, and low soil organic matter, pose serious challenges to plant growth, particularly cotton. Under these conditions, the use of organic fertilizers, especially humic acid, can significantly improve soil physical, chemical, and biological properties, thereby enhancing plant growth. Furthermore, this study examined the effects of different rates of humic acid on two cotton varieties to evaluate their quantitative and qualitative performance under the climatic conditions of Balkh. These findings can guide the selection of appropriate cotton varieties and the optimal amount of humic acid to increase yield and improve fiber quality in similar environments. The application of humic acid at certain levels can enhance cotton yield and quality under Balkh's conditions. The variety Sanroof 1155 showed a better response to humic acid than Sanroof 610.

- It is recommended to use humic acid at the recommended rates in cotton cultivation.
- Further research is needed to study the effects of humic acid on other cotton varieties under different climatic conditions.
- Application during soil preparation: Apply humic acid to the soil during land preparation or with initial irrigation. This improves soil structure, enhances water-holding capacity, and increases nutrient availability.
- Foliar spray during early growth stages (emergence): Spraying humic acid during seedling emergence and early vegetative growth stimulates root development and boosts nutrient uptake.
- Combination with macronutrient fertilizers: Use humic acid in combination with nitrogen-based fertilizers such as urea. This reduces nitrogen volatilization and increases nutrient-use efficiency.
- Use during the heading stage: Applying humic acid during the heading or flowering stage improves photosynthesis, enhances stress tolerance (e.g., drought), and increases grain weight and yield.
- Application in poor or saline soils: In saline or nutrient-deficient soils, humic acid acts as a soil conditioner, helping plants absorb nutrients more effectively and reducing the toxicity of heavy metals and salts.

AUTHORS CONTRIBUTIONS

All authors contributed to the study conception, design, data analysis, and manuscript preparation. All authors have read and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

If there are no competing interests in their submitted manuscripts, authors should state so explicitly: "The authors declare that they have no conflicts of interest. If conflicts exist (e.g., financial, personal, or professional relationships that could bias the work), disclose them clearly, such as: "Author A has received funding from Company X, which may influence the study outcomes."

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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