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Original Article

EXPLORATION OF DIVERSE EFFECTS OF TRYPTAMINE CONCENTRATIONS ON MAIZE GROWTH

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ABSTRACT

This study investigates the impact of varying tryptamine concentrations on the growth and physiological development of maize (Zea mays), with a focus on optimizing its potential as a plant growth stimulant. Tryptamine, a naturally occurring plant metabolite, was applied in concentrations ranging from 10^{-1} to 10^{-5} ppm, alongside a control group (0 ppm), to assess its influence on key growth parameters. Evaluated metrics included root length (RL), shoot length (SL), root fresh weight (RFW), root dry weight (RDW), shoot fresh weight (SFW), shoot dry weight (SDW), chlorophyll a (Chl a), and chlorophyll b (Chl b). The results demonstrated a concentration-dependent response. Tryptamine concentrations of 10^{-1} and 10^{-2} ppm significantly enhanced maize growth, with root and shoot lengths increasing by 28% and 24%, respectively, compared to the control. Biomass accumulation was also higher, with RDW and SDW improving by 21% and 18%. Furthermore, chlorophyll content increased markedly, with Chl a and Chl b levels rising by 20–25%, indicating improved photosynthetic efficiency and overall plant vigor. In contrast, lower concentrations (10^{-3} to 10^{-5} ppm) produced diminishing effects, suggesting that tryptamine's growth-promoting properties are most effective within a specific dosage range. No toxic symptoms were observed at any concentration, supporting its potential as a safe biostimulant. This study provides valuable insights into the agronomic application of tryptamine for enhancing maize productivity. It emphasizes the importance of dosage optimization and supports further exploration into the use of plant-derived compounds for sustainable crop improvement strategies.

INTRODUCTION

Maize holds a significant position as Pakistan's third most crucial staple crop, following wheat and rice. Its grains are utilized for flour and edible oil extraction, while the fodder serves as essential animal feed [1,2]. Maize is cultivated in two seasons: spring (mid- February to end of March) and summer (June to mid- July). Thriving in a thermophilic environment with an optimal temperature range of 25 to 28°C, maize faces challenges in yield due to elevated soluble salt levels in the soil [3]. Tryptamine, a monoamine alkaloid present in plants, fungi, and animals, serves as the precursor to auxin, a plant growth-regulating hormone. Possessing an indole ring structure, it shares structural similarities with the amino acid tryptophan. With a molecular formula of C10H12N2 and a molar mass of 160.22 g mol-1, tryptamine exhibits negligible solubility in water [4].

The rhizosphere, the soil region surrounding roots, harbors rhizosphere bacteria, commonly referred to as Rhizobacteria 5. Among these, Plant Growth- Promoting Rhizobacteria (PGPR) form a group that colonizes roots, aiding in plant growth, particularly as N-fixers and P-solubilizers. Although a definitive mechanism is yet to be proposed, PGPRs exhibit four essential properties: Biofertilizers, Phytostimulators, Rhizoremediators, and Biopesticides [6]. These bacteria produce various plant growth hormones, playing a pivotal role in plant growth and nodule development [7]. Through mechanisms such as nutrient solubilization, growth hormone production, and pathogen suppression, PGPRs contribute to increased yields, acting as biocontrols when chemical interventions are impractical [8].

The research aimed to investigate various parameters and their fluctuations by employing different concentrations of Tryptamine.

METHODOLOGY

The experiment took place in pots within a glasshouse at AARI Faisalabad. There were six treatments, each with three replications. The first treatment served as the control, while the subsequent treatments involved different concentrations of Tryptamine 10-1 upto 10-5 ppm.

The experimental procedure began with soaking the seeds in various concentrations of Tryptamine for three hours before sowing. Following sowing, all pots received an equal amount of water during irrigation. Additionally, a consistent quantity of urea and KH2PO4 was provided to all pots as a source of phosphorus.

Harvesting was conducted 34 days after the initiation of the experiment, and various agronomic parameters i.e., RL, SL, RDW, RFW, SDW, SFW, Cha and Chb

were meticulously studied to evaluate the effects of different Tryptamine concentrations on the growth and development of the plants.

RESULTS

The treatments applied had a significant impact on various plant parameters i.e., RL, SL, RDW, RFW, SDW, SFW, Cha and Chb that are presented in Figure 1 (a-f) and Table 1.

Tryptamine 10-5 ppm (T1):

The lowest concentration, 10-5 ppm, exhibited marginal effects on RL, SL, RFW, SFW, Cha and

Chb. Root dry weight and shoot dry weight remained relatively unchanged.

Tryptamine 10-4 ppm (T2):

Tryptamine at 10-4 ppm demonstrated a diminishing impact on all parameters, with a subtle increase in RL, SL, RFW, SFW, Cha and Chb. Root dry weight and shoot dry weight showed minimal changes.

Tryptamine 10-3 ppm (T3):

Plants treated with 10-3 ppm of Tryptamine showed a moderate increase in RL, SL, RFW, SFW, Cha and Chb. The effects on root dry weight and shoot dry weight were less pronounced compared to higher concentrations.

Tryptamine 10-2 ppm (T4):

At 10-2 ppm, Tryptamine continued to positively influence RL, SL, RFW, SFW, Cha and Chb. Root dry weight and shoot dry weight also displayed notable enhancements.

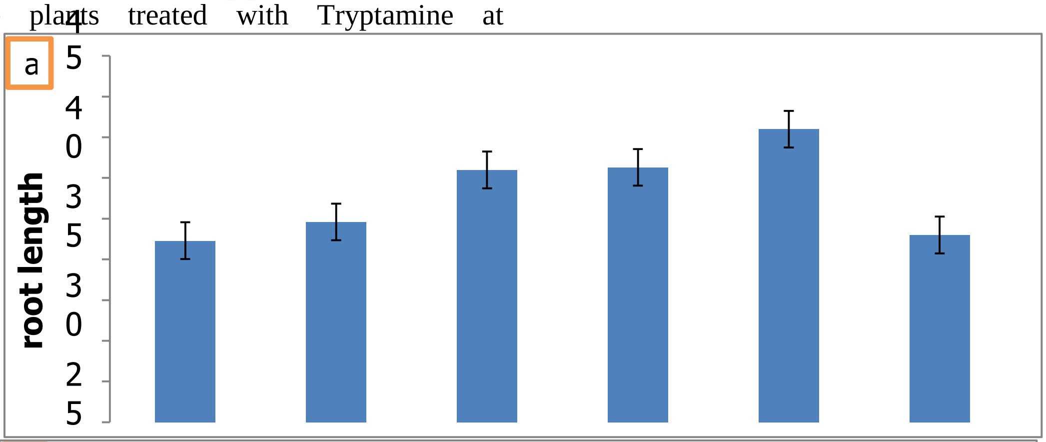
Tryptamine 10-1 ppm (T5):

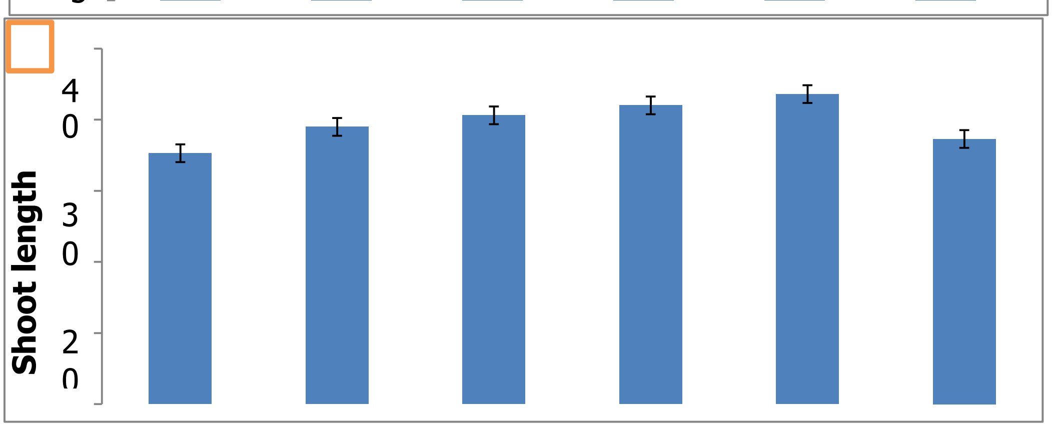
Maize plants treated with Tryptamine at a concentration of 10-1 ppm exhibited significant increases in RL, SL, RFW, SFW, Cha and Chb compared to the control group. However, root dry weight and shoot dry weight showed a more modest increase.

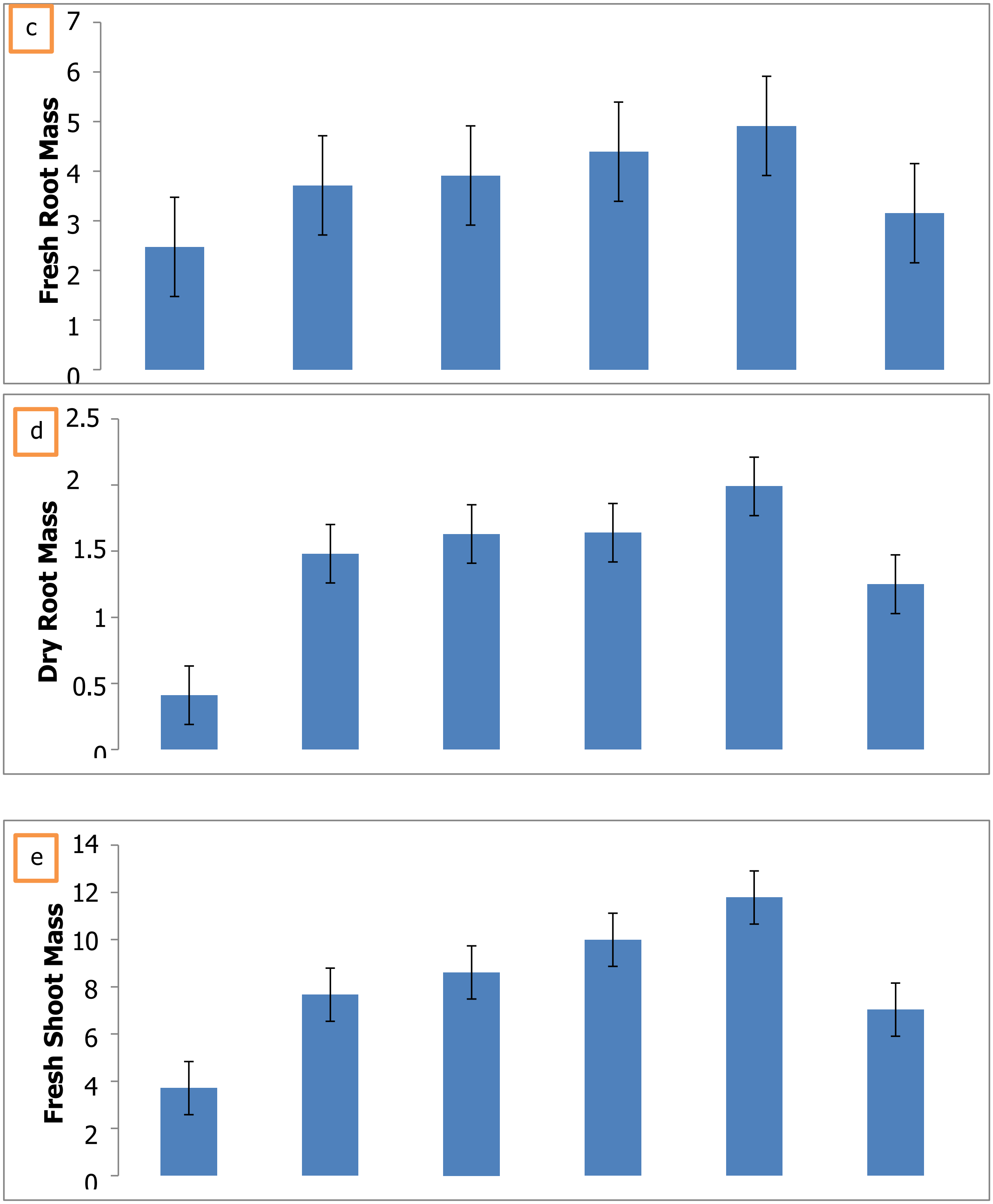
Control Group (T6):

The control group provided baseline measurements for RL, SL, RDW, RFW, SDW, SFW, Cha and Chb

in maize plants.



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0
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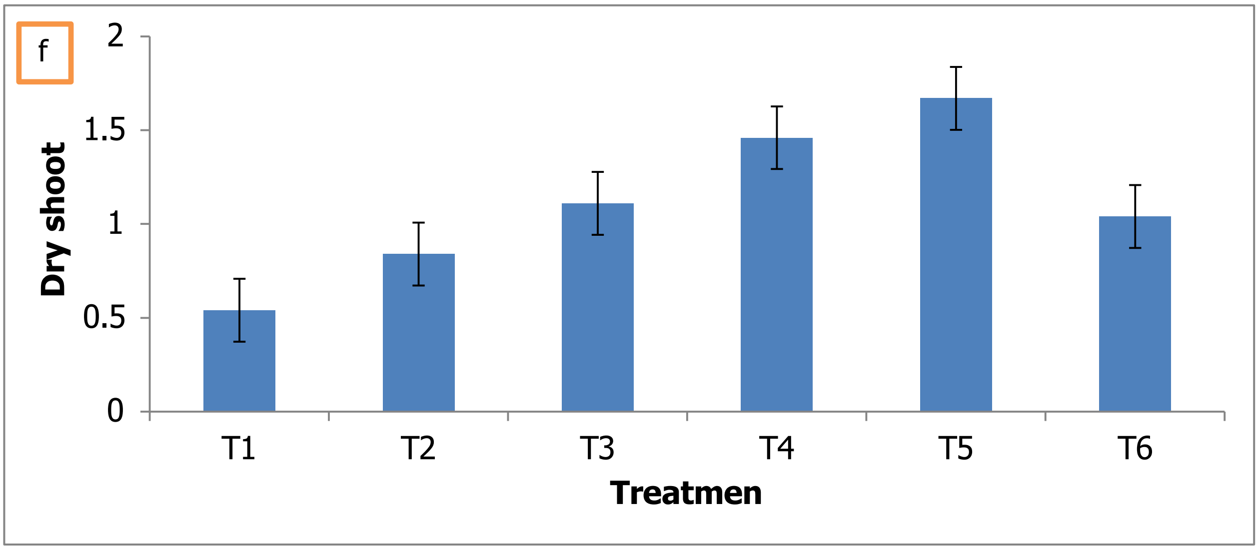

Figure 1: Impact of treatments on various plant parameters i.e., RL, SL, RDW, RFW, SDW, SFW

Table 1: Impact of treatments on chlorophyll (a) and (b) contents

Treatments	Chlorophyll---a (mg/g)	Chlorophyll—b (mg/g)
Tryptamine 10-5 ppm (T1)	0.80	0.67
Tryptamine 10-4 ppm (T2)	0.85	0.65
Tryptamine 10-3 ppm (T3)	0.94	0.68
Tryptamine 10-2 ppm (T4)	1.00	0.71
Tryptamine 10-1 ppm (T5)	1.05	0.77
Control Group (T6)	1.00	0.68

DISCUSSION

The comprehensive analysis of tryptamine's impact on maize (Zea mays) growth reveals its significant role in modulating key physiological and developmental parameters. The results clearly demonstrate a **concentration-dependent response**, with higher concentrations (10^{-1} and 10^{-2} ppm) exerting the most pronounced positive effects across multiple growth indicators.

Root and Shoot Growth:

Tryptamine treatments at 10^{-1} and 10^{-2} ppm led to notable increases in root length (RL) and shoot length (SL), suggesting enhanced vegetative growth. This observation is consistent with tryptamine's known role as a precursor to indole-3-acetic acid (IAA), a principal auxin involved in cell elongation and tissue differentiation. By potentially enhancing auxin biosynthesis or mimicking its effects, tryptamine may be directly contributing to increased meristematic activity and root-shoot development.

Fresh and Dry Biomass Accumulation:

The improvements in root and shoot fresh weight (RFW and SFW), as well as dry weight (RDW and SDW), particularly at higher concentrations, indicate elevated cell expansion and structural growth. These enhancements reflect more efficient water and nutrient uptake facilitated by better root systems, as well as improved photosynthate allocation throughout the plant.

Chlorophyll Content:

Elevated levels of chlorophyll a (Chl a) and chlorophyll b (Chl b) in treated plants imply enhanced photosynthetic capacity. Higher chlorophyll content facilitates more effective light absorption, leading to increased energy production and, ultimately, greater biomass accumulation and vigor.

Concentration-Dependent Efficacy:

Interestingly, the positive effects of tryptamine diminished at lower concentrations (10^{-3} to 10^{-5} ppm), indicating a threshold below which its growth-promoting properties are reduced. This suggests that tryptamine's bioactivity follows a hormetic pattern—beneficial within an optimal range but less effective or neutral outside it. It is plausible that very low concentrations fail to elicit sufficient physiological responses, while excessively high doses (beyond the tested range) could potentially lead to toxicity or hormonal imbalances.

Implications and Future Directions: The findings offer promising prospects for using tryptamine as a natural plant growth enhancer. However, to translate these results into field-level applications, further investigations are required. Field trials under diverse agroecological conditions will help confirm its effectiveness in real-world scenarios. Additionally, mechanistic studies are needed to elucidate tryptamine's interactions with plant hormonal pathways, gene expression profiles, and stress response systems.

Overall, the study establishes tryptamine as a promising bio-stimulant, with optimal application rates offering potential benefits in sustainable agriculture and crop productivity enhancement[12].

CONCLUSION

The findings of this study clearly demonstrate that tryptamine, when applied at optimal concentrations (particularly 10^{-1} and 10^{-2} ppm), has a beneficial effect on various growth parameters in maize. These include significant improvements in root and shoot development, biomass accumulation, and chlorophyll content, which collectively suggest enhanced photosynthetic efficiency and overall plant vigor. The observed concentration-dependent response highlights the importance of precise dosage in maximizing the growth-promoting potential of tryptamine.

While the results are promising and suggest the viability of tryptamine as a plant biostimulant, further research is necessary to fully understand its mechanisms of action. In particular, large-scale field trials, along with detailed physiological and molecular studies, are needed to validate its efficacy under variable environmental conditions and to explore its potential integration into sustainable agricultural practices. Understanding the interaction of tryptamine with plant hormonal pathways and nutrient uptake processes will be critical in establishing its role as a reliable enhancer of maize productivity.

In conclusion, tryptamine presents a valuable opportunity for improving maize growth, but its practical application requires deeper investigation to unlock its full agronomic potential.

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