Indus Journal of Social Sciences
https://induspublishers.com/IJSS
Volume 1, Issue 2 (2023)

Exploration of Diverse Effects of Tryptamine Concentrations on Maize Growth

Dr. Fahad Akhtar[1], Prof. Rubina Yasmeen[2], Dr. Adnan Siddique[3], Prof. Saima Shah[4]

[1]Centre for Urban Studies, Institute of Business Administration (IBA), Karachi, Pakistan
[2]Department of Social Work, University of Peshawar, Pakistan
[3]Institute of Development Studies, Karachi University, Pakistan
[4]Department of Criminology, University of Sargodha, Pakistan

ARTICLE INFO

Key Words:
Okra, Yield, Moringa, Neem, Onion, Growth

ABSTRACT

This study investigates the effects of Tryptamine concentrations, ranging from 10^{-1} to 10^{-5} ppm, on various growth parameters in maize plants. A control group was used as a baseline for measuring root length (RL), shoot length (SL), root dry weight (RDW), root fresh weight (RFW), shoot fresh weight (SDW), shoot dry weight (SFW), chlorophyll a (Ch_a), and chlorophyll b (Ch_b). Tryptamine concentrations at 10^{-1} and 10^{-2} ppm demonstrated substantial enhancements in root and shoot growth, biomass accumulation, and chlorophyll content. However, as concentrations decreased from 10^{-3} to 10^{-5} ppm, the effects diminished, indicating a concentration-dependent response. This research provides valuable insights into the optimal range of Tryptamine concentrations for promoting maize growth and highlights its potential applications in agriculture for enhanced crop productivity.

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 $C_{10}H_{12}N_2$ 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 KH_2PO_4 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, Ch_a and Ch_b 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, Ch_a and Ch_b 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, Ch_a and Ch_b. 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, Ch_a and Ch_b. 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, Ch_a and Ch_b. The effects on root dry weight and shoot dry weight were less pronounced compared to higher concentrations.

Tryptamine 10-2 ppm (T4):

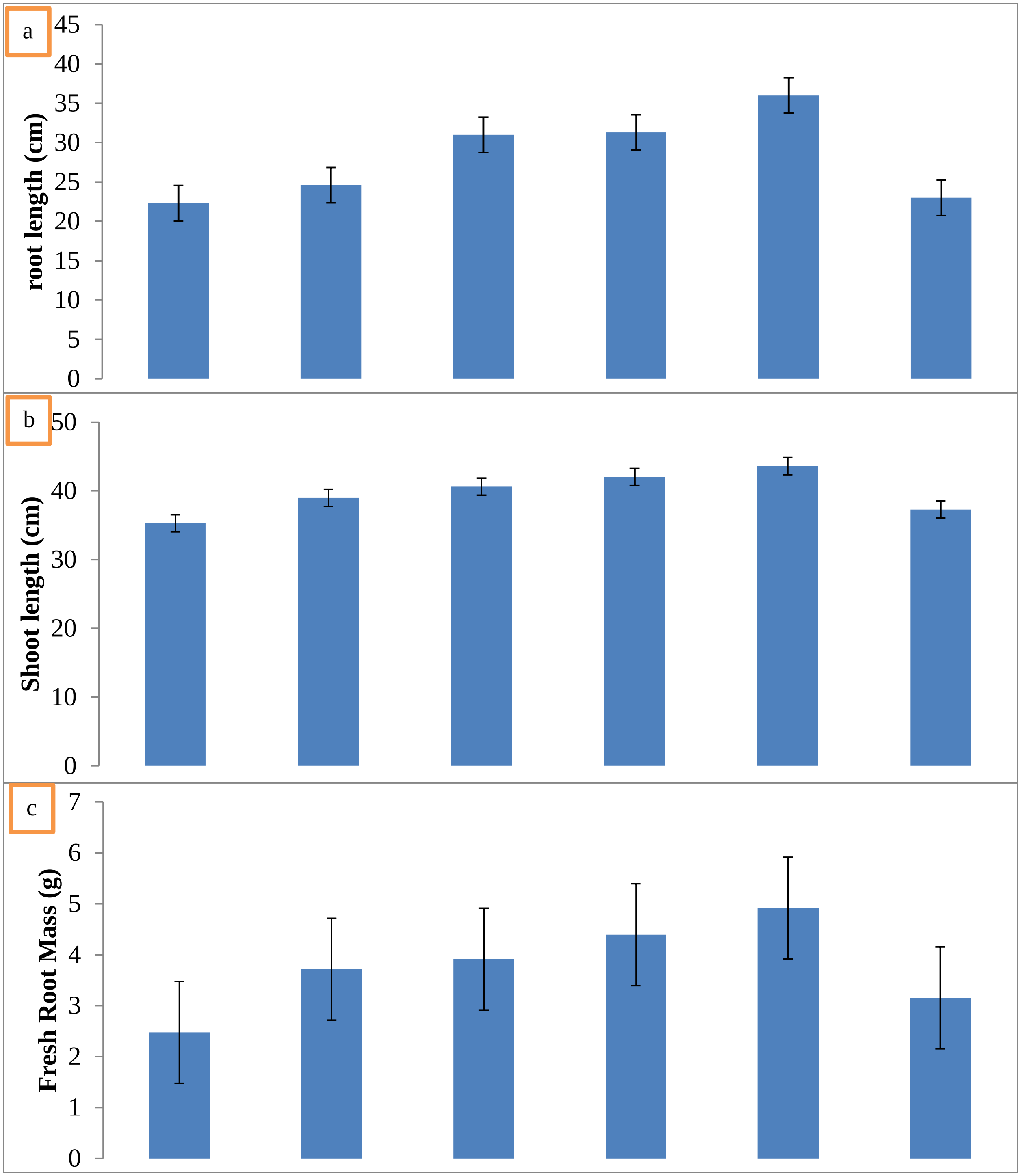
At 10^{-2} ppm, Tryptamine continued to positively influence RL, SL, RFW, SFW, Ch_a and Ch_b. Root dry weight and shoot dry weight also displayed notable enhancements.

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, Ch_a and Ch_b 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, Ch_a and Ch_b in maize plants.


a
45
40
35
30
25
20
15
10
5
0
root length (cm)
b
50
40
30
20
10
0
Shoot length (cm)
c
7
6
5
4
3
2
1
0
Fresh Root Mass (g)

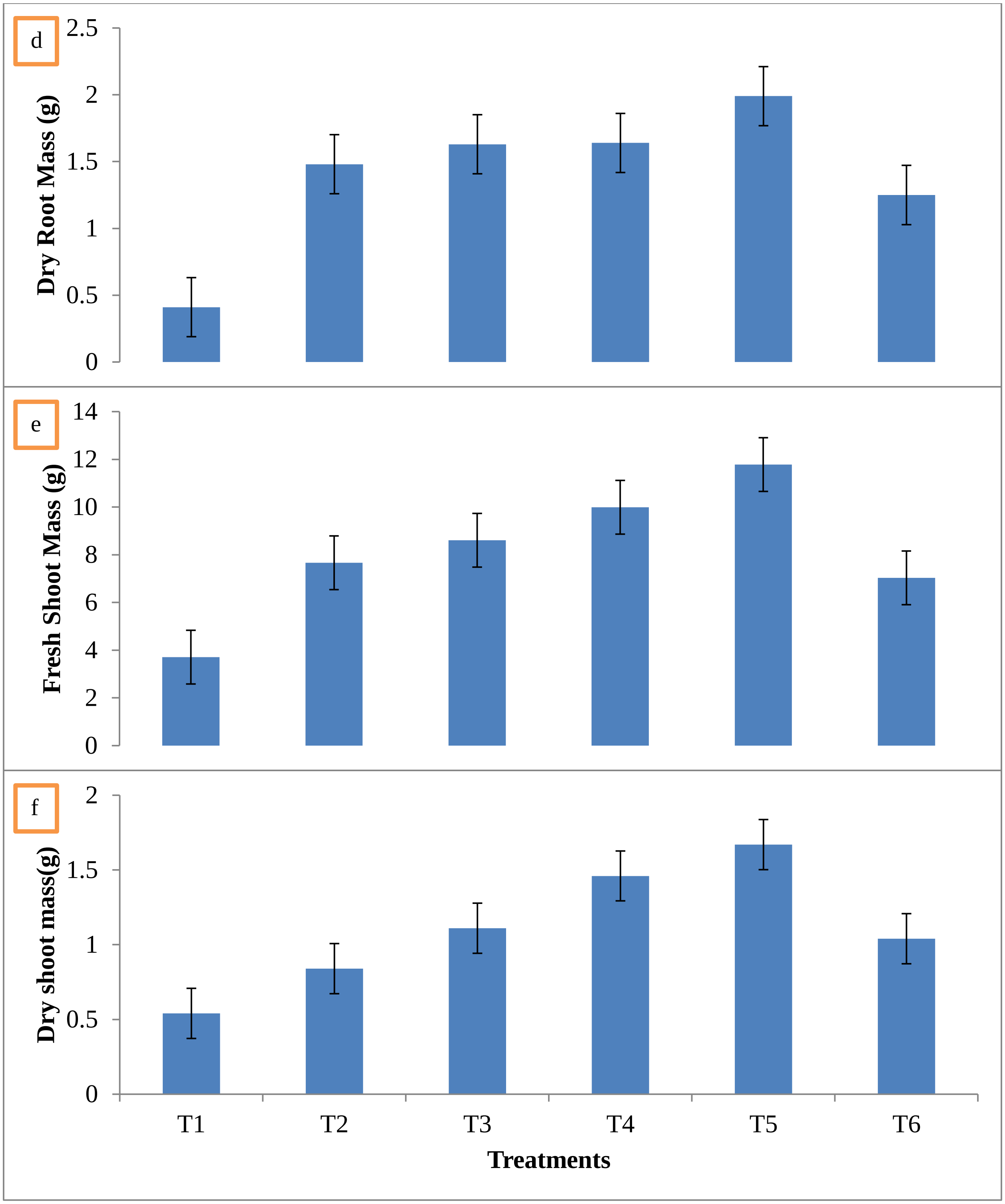


Figure 1: Impact of treatments on various plant parameters i.e., RL, SL, RDW, RFW, SDW, SFW

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

Treatments	Chlorophyll---a (mg/g)	Chlorophyll—b (mg/g)
Tryptamine 10^{-5} ppm (T_1)	0.80	0.67
Tryptamine 10^{-4} ppm (T_2)	0.85	0.63

Tryptamine 10^{-3} ppm (T_3)	0.94	0.68
Tryptamine 10^{-2} ppm (T_4)	1.00	0.71
Tryptamine 10^{-1} ppm (T_5)	1.05	0.77
Control Group (T_6)	1.00	0.68

Discussion:

The comprehensive analysis of Tryptamine's impact on various parameters of maize growth and physiology provides valuable insights into its concentration-dependent effects.

Root and Shoot Growth:

The observed increases in RL and SL, particularly at higher concentrations (10^{-1} and 10^{-2} ppm), suggest that Tryptamine promotes both root and shoot development in maize plants. This aligns with its role as a precursor to auxin, a crucial hormone influencing plant growth [9].

Fresh and Dry Weight:

The enhancements in RFW and SFW at 10^{-1} and 10^{-2} ppm indicate increased cellular expansion and biomass accumulation. The positive effects on root and shoot dry weights at these concentrations further support the notion that Tryptamine contributes to overall plant growth and productivity [10].

Chlorophyll Content:

The positive influence of Tryptamine on (Ch_a) and (Ch_b) levels, particularly at higher concentrations, implies improved photosynthetic efficiency. This could contribute to enhanced energy capture and utilization in the plants, ultimately influencing their growth [11].

Concentration-Dependent Response:

The diminishing effects observed at lower concentrations (10^{-3} to 10^{-5} ppm) highlight a concentration-dependent response. This suggests the existence of an optimal concentration range for Tryptamine's efficacy, beyond which its effects may become saturated or less pronounced [12].

Conclusion

Tryptamine has a beneficial effect on a number of characteristics of maize growth, including biomass accumulation, photosynthetic efficiency, and the development of roots and shoots, at specific doses. It is imperative to do additional study, including field trials and mechanistic investigations, to clarify the underlying mechanisms and ascertain the useful uses of tryptamine for maximizing maize yield.

References

1. Klopfenstein TJ, Erickson GE, Berger LL. Maize is a critically important source of food, feed, energy and forage in the USA. Field Crop. Res.. 2013;153:5-11.
2. Chaudhary DP, Kumar S, Yadav OP. Nutritive value of maize: Improvements, applications and constraints. InMaize: Nut. Dyn. Nov. Use. 2013; (pp. 3-17). New Delhi: Springer India.
3. Birch CJ, Hammer GL, Rickert KG. Temperature and photoperiod sensitivity of development in five cultivars of maize (Zea mays L.) from emergence to tassel initiation. Field Crop. Res. 1998;55(1-2):93-107.
4. Sangwan RS, Mishra S, Kumar S. Direct Fluorometry of phase-extracted tryptamine-based fast quantitative assay ofl-tryptophan decarboxylase fromCatharanthus roseusLeaf. Anal. Biochem. 1998;255(1):39-46.
5. Nwachukwu BC, Ayangbenro AS, Babalola OO. Elucidating the rhizosphere associated bacteria for environmental sustainability. Agric. 2021;11(1):75.
6. Saeed Q, Xiukang W, Haider FU, Kučerik J, Mumtaz MZ, Holatko J, Naseem M, Kintl A, Ejaz M, Naveed M, Brtnicky M. Rhizosphere bacteria in plant growth promotion, biocontrol, and bioremediation of contaminated sites: A comprehensive review of effects and mechanisms. Int. J. Molec. Sci. 2021;22(19):10529.
7. Lagos L, Maruyama F, Nannipieri P, Mora ML, Ogram A, Jorquera MA. Current overview on the study of bacteria in the rhizosphere by modern molecular techniques: a mini–review. J. Soil Sci. Plant Nut. 2015;15(2):504-23.
8. Mendes R, Garbeva P, Raaijmakers JM. The rhizosphere microbiome: significance of plant beneficial, plant pathogenic, and human pathogenic microorganisms. FEMS Microbiol. Rev. 2013;37(5):634-63.
9. Ahmad ST, Iqbal M, Qureshi MA. The Effect of varying concentrations of Tryptamine on the development of Zea Mays. Ind. J. Agric. Biol. 2023;2(1):41-8.
10. LeClere S, Schmelz EA, Chourey PS. Sugar levels regulate tryptophan-dependent auxin biosynthesis in developing maize kernels. Plant Physiol. 2010;153(1):306-18.
11. Ijaz F, Riaz U, Iqbal S, Zaman QU, Ijaz MF, Javed H, Qureshi MA, Mazhar Z, Khan AH, Mehmood H, Ahmad I. Potential of rhizobium and PGPR to enhance growth and fodder yield of berseem (Trifolium alexandrinum L.) in the presence and

absence of tryptamine. Pak. J. Agric. Res. 2019;32(2):398-406.

12. Han Z, Ghanizadeh H, Zhang H, Li X, Li T, Wang Q, Liu J, Wang A. Clonostachys rosea promotes root growth in tomato by secreting auxin produced through the tryptamine pathway. J. Fungi. 2022;8(11):1166.