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Research Article

Relative Efficiency of Different Concentrations of Tryptamine for the Growth Promotion of Maize (*Zea mays* L.)

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Abstract

Balanced use of agrochemical helps in the sustainable crop production. The objective of the study was to examine the effect of Tryptamine on the production of Indole Acetic Acid (IAA), Auxin Biosynthesis, Total Chlorophyll content and the increase of root-shoot length and root-shoot mass. This study was carried out at Soil Bacteriology Section, Ayub Agricultural Research Institute, Faisalabad. This study was conducted to check the efficiency of Tryptamine on the growth and yield of maize (*Zea mays* L.) Treatments were control and different concentration of Tryptamine. Results revealed that there was significant effect of 10-5 M concentration of Tryptamine on the calculated parameters i.e. auxin biosynthesis, total chlorophyll content, root-shoot length, fresh and dry root-shoot mass. This study suggest that Tryptamine may be a dynamic precursor to boost the yield of maize and other agricultural crops.

Keywords: Tryptamine; Indole Acetic Acid (IAA); Auxin Biosynthesis; Concentration; Total Chlorophyll Content

Introduction

Maize is the 3rd most grown crop in the world. The area of maize is more than 118 million hectares and annual production is about 600 million metric tons. In Pakistan, maize is the 4th largest grown crop after wheat, cotton and rice whose grain are used as floor and edible oil extraction. Whereas, its fodder is used as animal food [1]. There are two seasons of maize sowing: spring season (mid Feb to end March) and summer season. Tryptamine is mono-amine alkaloid found in plants, fungi and animals. Tryptamine is basically precursor of auxin (Plant Growth Regulating Hormone). Tryptamine consists of indole ring structure and is structurally similar to amino acid tryptophan (Jones., *et al.* 1982). Its molecular formula is $C_{10}H_{12}N_2$ and molar mass is 160.22 $gmol^{-1}$. Its solubility in water is negligible. Rhizosphere is soil portion near roots which is richest of rhizosphere bacteria commonly known as Rhizobacteria (Anton and Prevost, 2006). PGPR (Plant Growth Promoting Rhizobacteria) are group of bacteria that colonize in roots and help in plant growth, especially N-fixer and P-solubilized [2]. A proper mechanism of it is not proposed yet. However, following four properties of PGPR given as: Biofertilizer, Phyto stimulators, Phytoremediators and Bio pesticides [3]. They produce different plants growth hormones play vital role in plant growth and nodule development [4]. They help several known and unknown mechanism in plant growth i.e. nutrient solubilisation, growth hormone production and suppression of pathogens, hence, significant increase yield has been reported [5] which act as biocontrol when chemical control is not practical. Plant Growth Promoting Rhizobacteria (PGPR) that resides in the rhizosphere of plants, increase growth by direct and indirect mechanism like nitrogen fixation, solubilisation of nutrients (P, K and Zn) and siderophores production etc. Alternatively, PGPR supplement the role of chemical fertilizers, pesticides and other inputs. Although nitrogen and phosphorus are fundamental nutrients but P is more frequently required for the completion of plant`s life cycle. Different phosphate solubilizing micro-organisms (PSMs) are reported which transform the insoluble P to soluble P by the releasing of organic acids and producing protons through acidification. Present study was conducted to access the different levels of tryptamine on the growth promotion of maize.

Materials and Methods

A pot experiment was carried out in the glass house of the Soil Bacteriology Section, Ayub Agriculture Research Institute (AARI) Faisalabad, Pakistan. This Study was conducted to investigate the best concentration of Tryptamine solution for the exogenous ap-

plication in order to promote the growth of maize plant. Six treatments were applied i.e. one is control and five are the different concentration of Tryptamine. These are given below;

- Control (No application of Tryptamine)
- Tryptamine @ 10^{-2} M
- Tryptamine @ 10^{-3} M
- Tryptamine @ 10^{-4} M
- Tryptamine @ 10^{-5} M
- Tryptamine @ 10^{-6} M

Each treatment was repeated three times. All pots arranged in completely randomized design (CRD). Every pot contained 1kg soil. Seeds of maize were soaked for two hours with Tryptamine solution of different concentration. After soaking the seeds were sown in the pots with respective to their treatments. Irrigation was done manually as per need of pots. Recommended doses of fertilizer @ 100-60 N P kg/ha were applied.

After one-month pots were harvested and following data were recorded

- Root length (cm)
- Shoot length (cm)
- Fresh and dry root mass (g)
- Fresh and dry shoot mass (g)
- Auxin biosynthesis of potential of maize plant after 10 days (μg/ml)
- Chlorophyll content (mg/g)

Field trials

Pot trials on maize were studied at the Soil Bacteriology Field Station of Ayub Agriculture Research Institute (AARI), Faisalabad, Pakistan. Composite soil samples were prepared by mixing individual samples collected before the experiment and analysed for various physical and chemical characteristics. The soil was sandy clay loam having pH, 7.6; ECe, 1.85 dS m^{-1}; organic matter, 0.72%; total N, 0.047%; available P, 8.50 mg kg^{-1} and extractable K, 130 mg kg^{-1} soil. The hybrid variety (Corn-786) of maize was sown in the pots keeping row to row distance 75 cm and plant to plant distance 25 cm with a plot size of 12 m^2. The experiments were laid out in complete randomized design with four replications. Whole dose of P and K fertilizers was applied at the time of seed bed preparation as a basal dose in all blocks, while N was applied according to the treatments in two split doses. First dose of N (urea) was applied after germination with a drill along with organic-/bio-fertilizer while second dose of N was applied before tasselling along the plant rows. The organic- and bio-fertilizers were applied @0.5 g/pot as a band placement with a drill and supplemented with either no N or with 0.15g N. Good quality canal water [electrical conductivity, 0.05 dS m^{-1}; sodium adsorption ratio, 0.1 (mmol l^{-1}) ½ and residual sodium carbonates, 0.02 me l^{-1}] meeting the irrigation quality criteria for crops in the area [6] was used for irrigation in both trials. The data regarding plant height, cob weight, total biomass, grain yield and 1000-grain was recorded at maturity. Grain and shoot samples of maize plants were analysed for N, P and K concentrations [7] and their total uptake in maize plants were determined.

Chlorophyll Determination

Procedure

- Took the 1 g of leaf part from each sample
- Homogenized it with 80% acetone
- Filtered the homogenate through the filter paper
- Chlorophyll a and b determined by absorbance of liquid in spectrophotometer at 663 nm and 645 nm.

Auxin determination

Media preparation

- General purpose media prepared to determine the IAA equivalent.
- General purpose media prepared by dissolving 1.5 g glucose, 0.5 g peptone, 0.5g K_2HPO_4, 0.1g $MgSO_4$. 7H20, $FeSO_4$ in traces and 0.5g $(NH_4)_2SO_4$ in 1 litre of distilled water.

Salkowski Reagent

Salkowski reagent prepared by mixing 98 ml of 35% of per chloric acid with 2 ml of 0.5 M ferric chloride.

Procedure

- Prepared the General-Purpose Media
- Washed the test tubes and air dried them
- Filled each test tube with 10 ml of GPM
- Autoclave the filled test tube at 1210C and 15 psi pres sure for 45 minutes
- Weighed the I g of soil, shoot and root of each sample
- Root, shoot and soil inoculated separately to test tubes containing sterilized GPM
- The tubes allowed to stand for 8 days while shaking well thrice in a day
- After the 8 days, centrifuged the tubes @ 1000 rpm for 20 minutes

- Took 3 ml of supernatant solution in test tubes and add 2 ml of salkowiski reagent and wait for 40 minutes
- Prepared stock solution of 100 ppm in 100 ml flask.
- Then, prepared the standards of 2 ppm, 4 ppm, 6 ppm, 8 ppm and 10 ppm in 100 ml flask.
- Run the standards first in spectrophotometer and then sam ple at 535 nm wavelength to measure the IAA equivalent.

Results and Discussion

Statistical analysis

Complete Randomized Design (CRD) with 18 replicates was used in the assessment of the results to improve accuracy and minimize error. All data and variables were statistically analysed using the SPSS statistical package. Values were presented as mean ± SE. One-way ANOVA and multiple ranges were carried out on all data using Duncan's multiple range test (DMRT) at $p < 0.05$.

Treatments	Dry-root mass (g)	Dry-shoot mass (g)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll
Control	1.3	2.07	1.13	0.66	1.79
Tryptamine @ 10^{-2} M	1.45	2.37	1.24	0.69	1.93
Tryptamine @ 10^{-3} M	1.42	2.28	1.27	0.73	2.00
Tryptamine @ 10^{-4} M	1.58	2.59	1.31	0.76	2.07
Tryptamine @ 10^{-5} M	1.66	2.88	1.32	0.77	2.09
Tryptamine @ 10^{-6} M	1.33	2.09	1.11	0.75	1.86

Table a

Figure a

Different treatments have different values of root mass, shoot mass, chlorophyll (a, b).

Control treatment with no application of Tryptamine has 1.3g of dry root mass, 2.07g dry of shoot mass, 1.13 mg/g chlorophyll a, 0.66 mg/g chlorophyll b and total count of chlorophyll is 1.79.

- Treatment with application of 10-2 M has 1.45 g of dry root mass, 2.37g dry of shoot mass, 1.24 mg/g chlorophyll a, 0.69 mg/g chlorophyll b and total count of chlorophyll is 1.93.
- Treatment with application of 10-3 M has 1.42 g of dry root mass, 2.28 g dry of shoot mass, 1.27 mg/g chlorophyll a, 0.73 mg/g chlorophyll b and total count of chlorophyll is 2.00.

Treatments		IAA Equivalents (µg mL^{-1}) in soil	IAA Equivalents (µg mL^{-1}) in root	IAA Equivalents (µg mL^{-1}) in shoot
Control	1.35	1.043	1.012	1.630
Tryptamine @ 10^{-2} M	1.38	1.185	1.198	1.846
Tryptamine @ 10^{-3} M	1.39	1.247	1.444	2.062
Tryptamine @ 10^{-4} M	1.40	1.309	1.568	2.185
Tryptamine @ 10^{-5} M	1.44	1.290	1.630	2.247
Tryptamine @ 10^{-6} M	1.42	1.265	1.383	2.000

Table b

- Treatment with application of 10-4 M has 1.58 g of dry root mass, 2.59g dry of shoot mass, 1.31 mg/g chlorophyll a, 0.76 mg/g chlorophyll b and total count of chlorophyll is 2.07.
- Treatment with application of 10-5 M has 1.66 g of dry root mass, 2.88g dry of shoot mass, 1.32 mg/g chlorophyll a, 0.77 mg/g chlorophyll b and total count of chlorophyll is 2.09.
- Treatment with application of 10-6 M has 1.33 g of dry root mass, 2.09g dry of shoot mass, 1.11 mg/g chlorophyll a, 0.75 mg/g chlorophyll b and total count of chlorophyll is 1.86.

Figure b

Different treatments have different values of Indole Acetic Acid (IAA) in soil, root and shoot.

Control treatment with no application of tryptamine has 1.043 IAA Equivalents (μg mL^{-1}) in soil, 1.012 IAA Equivalents (μg mL^{-1}) in root, 1.630 IAA Equivalents (μg mL^{-1}) in soil.

- Treatment with application of Tryptamine 10^{-2} M has 1.185 IAA Equivalents (μg mL^{-1}) in soil, 1.198 IAA Equivalents (μg mL^{-1}) in root, 1.846 IAA Equivalents (μg mL^{-1}) in soil.
- Treatment with application of Tryptamine 10^{-3} M has 1.247 IAA Equivalents (μg mL^{-1}) in soil, 1.444 IAA Equivalents (μg mL^{-1}) in root, 2.062 IAA Equivalents (μg mL^{-1}) in soil.
- Treatment with application of Tryptamine 10^{-4} M has 1.309 IAA Equivalents (μg mL^{-1}) in soil, 1.630 IAA Equivalents (μg mL^{-1}) in root, 2.185 IAA Equivalents (μg mL^{-1}) in soil.
- Treatment with application of Tryptamine 10^{-5} M has 1.290 IAA Equivalents (μg mL^{-1}) in soil, 1.630 IAA Equivalents (μg mL^{-1}) in root, 2.247 IAA Equivalents (μg mL^{-1}) in soil.
- Treatment with application of Tryptamine 10^{-6} M has 1.265 IAA Equivalents (μg mL^{-1}) in soil, 1.383 IAA Equivalents (μg mL^{-1}) in root, 2.000 IAA Equivalents (μg mL^{-1}) in soil.

Conclusion

The results clearly showed that the application of Tryptamine has a considerably effect on the maize plant growth. The 10^{-5} M concentration of Tryptamine have a maximum effect on the studied parameter i.e. root length, shoot length, fresh and dry root mass, fresh and dry shoot mass, auxin biosynthesis and total chlorophyll content.

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