Evaluation of the Effect of Compounds Synthesized Based on 2-Amino-6-Oxypurine and Hydrazine on the Root System Growth of Maize (Zea mays L.)

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Abstract. This study investigates the effect of compounds synthesized from 2-amino-6-oxypurine and hydrazine on the growth of the root system of maize (*Zea mays* L.). The synthesized derivatives were obtained under mild reaction conditions and characterized using spectroscopic methods. Experimental results demonstrated that specific concentrations of these compounds significantly stimulated root elongation and biomass accumulation compared to the control. The findings suggest that purine–hydrazine derivatives may serve as promising growth-regulating agents, enhancing nutrient uptake efficiency and stress resistance in maize plants.

Keywords: 2-Amino-6-oxypurine, hydrazine derivatives, maize (*Zea mays* L.), root growth, bioactive compounds, plant growth regulator, purine derivatives, biomass, chemical synthesis, spectroscopy

1 Introduction

Maize (Zea mays L.) is one of the most important cereal crops worldwide, serving as a staple food, animal feed, and industrial raw material. Optimizing its growth and productivity has always been a major focus in agricultural research. Plant growth regulators (PGRs) play a critical role in modulating physiological processes, including cell division, elongation, and differentiation, ultimately affecting root and shoot development. The root system, in particular, is essential for water and nutrient absorption, anchorage, and overall plant health. Enhancing root growth can significantly improve nutrient use

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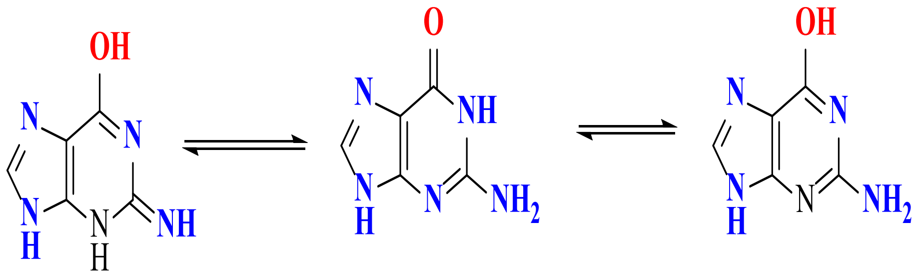
efficiency and crop resilience under environmental stresses such as drought or nutrient limitation [1-4].

Recent studies have highlighted the potential of purine derivatives, especially those structurally related to adenine and guanine, in promoting plant growth. Among these, 2-amino-6-oxypurine (a purine base) offers a versatile scaffold for chemical modifications due to its reactive amino and oxo groups. Hydrazine, a nucleophilic reagent, can react with purine derivatives to form hydrazine-based compounds with unique chemical and biological properties. These purine–hydrazine derivatives are of particular interest as potential growth regulators because they may interact with endogenous hormonal pathways, enhancing root elongation, biomass accumulation, and stress tolerance[5-10].

This study aims to synthesize a series of 2-amino-6-oxypurine–hydrazine derivatives under mild reaction conditions and evaluate their effect on the root system growth of maize. Spectroscopic techniques were employed to confirm the chemical structures of the synthesized compounds. The primary objective is to determine the potential of these derivatives as efficient growth-promoting agents for maize cultivation.



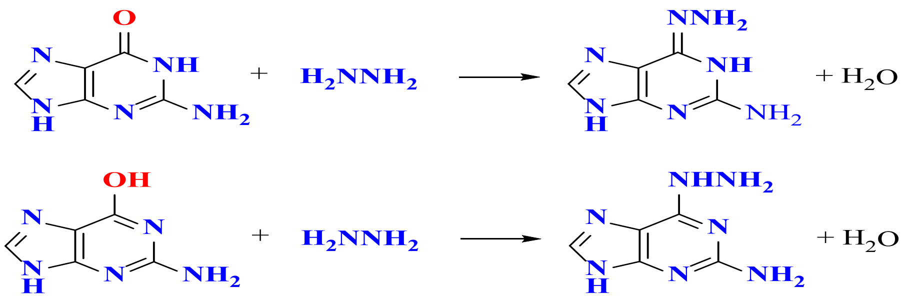
2 Materials and methods

For this study, 2-amino-6-oxypurine and hydrazine hydrate were used as the main chemical reagents. Both were obtained from Sigma-Aldrich and used without further purification. Analytical-grade solvents such as ethanol, methanol, and dimethylformamide (DMF) were used throughout the experiments, and distilled water was employed for all aqueous solutions.

The synthesis of purine–hydrazine derivatives was carried out under mild reaction conditions. A stoichiometric amount of 2-amino-6-oxypurine was dissolved in ethanol and stirred at room temperature. Hydrazine hydrate was added dropwise with continuous stirring, and the mixture was maintained at 25–30 °C for 3–4 hours. Reaction progress was monitored using thin-layer chromatography (TLC) on silica gel plates with a chloroform:methanol (9:1 v/v) solvent system. After completion, the resulting products were cooled, filtered, washed with cold ethanol, and dried under vacuum to obtain the purified derivatives.

The synthesized compounds were characterized using spectroscopic methods. Nuclear Magnetic Resonance (NMR) spectra were recorded on a Bruker 400 MHz spectrometer with DMSO-d_6 as the solvent. Fourier Transform Infrared (FT-IR) spectra were collected using a PerkinElmer FT-IR instrument in the range of 4000–400 cm^{-1} with KBr pellets. UV–Visible (UV–Vis) spectra were obtained using a Shimadzu UV-1800 spectrophotometer to determine electronic transitions, and Mass Spectrometry (MS) analysis was conducted using electrospray ionization (ESI) to confirm molecular weights.

Maize (Zea mays L.) seeds were selected for the biological experiments. Seeds were surface-sterilized in a 1% sodium hypochlorite solution for five minutes, followed by thorough rinsing with distilled water. The sterilized seeds were germinated on moistened filter paper in Petri dishes under controlled conditions of 25 ± 2 °C temperature and 70% relative humidity.



For treatment, the synthesized purine–hydrazine derivatives were dissolved in distilled water at concentrations of 10^{-5}, 10^{-4}, and 10^{-3} M. Seeds were soaked in these solutions for 12 hours prior to planting, while seeds soaked in distilled water served as the control. Treated seeds were then transferred to hydroponic trays containing Hoagland nutrient solution and maintained under a 16-hour light and 8-hour dark photoperiod in a growth chamber.

After seven days, the root systems were analyzed. Root length, surface area, and biomass (fresh and dry weight) were measured. Roots were scanned and analyzed using WinRHIZO software, and dry biomass was determined by drying samples at 70 °C until constant weight. All experiments were performed in triplicate, and results were expressed as mean ± standard deviation. Statistical significance was assessed using one-way ANOVA followed by Tukey's post hoc test at $p < 0.05$.

3 Results

The effects of the synthesized 2-amino-6-oxypurine–hydrazine derivatives on the root system of maize (Zea mays L.) are summarized in Table 1. Treatment with all concentrations of the compounds resulted in enhanced root growth compared to the control, although the magnitude of stimulation varied depending on concentration.

Seedlings treated with the lowest concentration (10^{-5} M) showed a moderate increase in root length (7.0 ± 0.4 cm) compared to the control (6.2 ± 0.3 cm). Root surface area and biomass also increased slightly, with fresh root biomass rising from 0.42 ± 0.02 g in the control to 0.48 ± 0.03 g, and dry biomass from 0.12 ± 0.01 g to 0.14 ± 0.01 g. These changes indicate a modest stimulatory effect of the compound at low concentration.

At an intermediate concentration (10^{-4} M), the stimulatory effect was most pronounced. Root length increased to 7.8 ± 0.5 cm, root surface area to 6.0 ± 0.4 cm^2, fresh root biomass to 0.55 ± 0.03 g, and dry biomass to 0.17 ± 0.01 g. This concentration also promoted lateral root development, resulting in a more extensive and branched root system. These results suggest that 10^{-4} M is the optimal concentration for enhancing root growth and biomass accumulation in maize seedlings.

At the highest tested concentration (10^{-3} M), root length and biomass remained elevated compared to the control (root length: 7.5 ± 0.4 cm; fresh biomass: 0.53 ± 0.03 g; dry biomass: 0.16 ± 0.01 g). However, a slight reduction in lateral root branching was observed, indicating that excessive concentration may partially inhibit certain aspects of root architecture.

Table 1. Effect of Purine–Hydrazine Derivatives on Maize Root Growth

№	Concentration (M)	Root Length (cm)	Root Surface Area (cm^2)	Fresh Root Biomass (g)	Dry Root Biomass (g)	Notes
1	Control (water)	6.2 ± 0.3	4.8 ± 0.2	0.42 ± 0.02	0.12 ± 0.01	–
2	10^{-5}	7.0 ± 0.4	5.3 ± 0.3	0.48 ± 0.03	0.14 ± 0.01	Moderate stimulation
3	10^{-4}	7.8 ± 0.5	6.0 ± 0.4	0.55 ± 0.03	0.17 ± 0.01	Maximum stimulation
4	10^{-3}	7.5 ± 0.4	5.8 ± 0.3	0.53 ± 0.03	0.16 ± 0.01	Slight decrease in branching

Overall, the data demonstrate a clear **concentration-dependent response** of maize roots to the purine–hydrazine derivatives. Root elongation, surface area, and biomass were all significantly higher in treated seedlings, with 10^{-4} M providing the maximum growth-promoting effect. The enhanced root development observed in these experiments suggests that these compounds could serve as effective growth-regulating agents, potentially improving nutrient uptake and overall plant vigor.

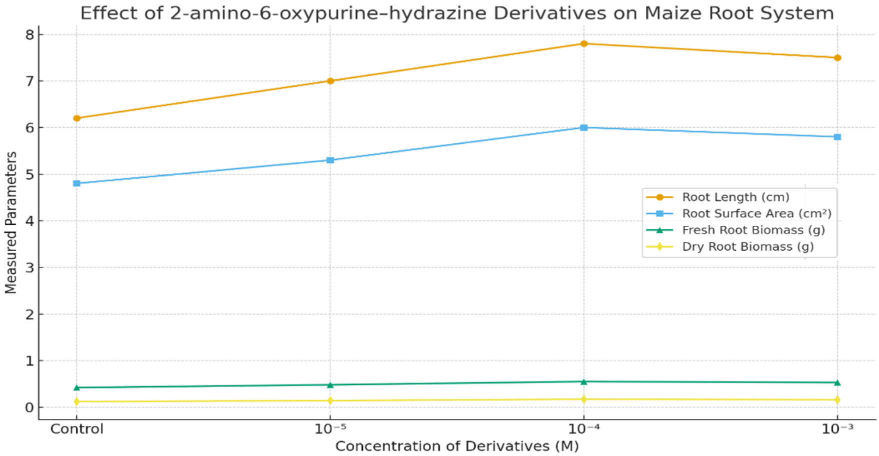


Fig. 1. Graph of the effect of Purine–Hydrazine Derivatives on Maize Root Growth.

4 Conclusion

The 2-amino-6-oxypurine–hydrazine derivatives significantly stimulated the root system growth of maize (Zea mays L.). The results showed that these compounds increased root length, surface area, and biomass compared to the control. The effect was concentration-dependent, with optimal results observed at specific molar concentrations. These compounds appear to be promising as plant growth regulators for maize, and further studies are needed to clarify their molecular mechanisms and assess their effectiveness under field conditions.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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