

# Biological activity of a quinazolone-phosphite derivative synthesized from benzaldehyde and acetone as a plant growth stimulator

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**Abstract:** The development of biologically active compounds based on heterocyclic structures remains a promising direction in modern agrochemical research. In this study, a quinazolone-phosphite derivative synthesized from benzaldehyde and acetone was evaluated for its plant growth-stimulating activity. The biological effectiveness of the compound was assessed through standard germination and growth assays, including seed germination rate, root elongation, and biomass accumulation. The results demonstrated a significant enhancement in plant growth parameters compared to untreated controls, indicating the stimulatory potential of the synthesized compound. The presence of the phosphite group is assumed to contribute to improved nutrient assimilation and metabolic activation in plants, while the quinazolone moiety may enhance biological activity through its known bioactive properties. The findings suggest that this compound can be considered a promising candidate for application as an eco-friendly plant growth regulator in sustainable agriculture.

**Keywords:** quinazolone derivative, phosphite compounds, plant growth stimulation, bioactive substances, seed germination, agrochemical application, heterocyclic compounds, sustainable agriculture

## INTRODUCTION

The increasing demand for sustainable agricultural practices has stimulated intensive research into biologically active compounds capable of enhancing plant growth and productivity while minimizing environmental impact. Conventional agrochemicals, although effective, often pose ecological risks due to their persistence, toxicity, and accumulation in soil and water systems. Consequently, the development of novel, eco-friendly plant growth regulators based on organic compounds has become a priority in modern agrochemical science.

Heterocyclic compounds, particularly quinazolone derivatives, have attracted considerable attention due to their diverse biological activities, including antimicrobial, antioxidant, and growth-regulating properties. The presence of a quinazolone core structure provides significant pharmacological and biochemical versatility, enabling interaction with various biological targets. These compounds are known to influence enzymatic processes, cellular metabolism, and physiological responses in both microorganisms and higher plants.

Phosphite-containing compounds have emerged as promising agents in agriculture due to their dual role as both nutrient sources and plant defense activators. Phosphites are readily absorbed by plants and can enhance phosphorus metabolism, stimulate root development, and improve resistance to biotic and abiotic stress factors. Their systemic movement within plant tissues allows for efficient distribution and prolonged biological activity.

The combination of quinazolone and phosphite functional groups within a single molecular framework represents a novel approach to designing multifunctional bioactive compounds. Such hybrid structures are expected to exhibit synergistic effects, combining the biological activity of heterocyclic systems with the physiological benefits of phosphite moieties.

The present study focuses on evaluating the plant growth–stimulating activity of a quinazolone–phosphite derivative synthesized from benzaldehyde and acetone. The investigation aims to assess its biological effectiveness through standard growth parameters and to explore its potential application as an environmentally safe growth regulator in sustainable agriculture.

#### MATERIAL AND METHODS

The quinazolone-phosphite derivative investigated in this study was synthesized from benzaldehyde and acetone via a multi-step organic synthesis route followed by phosphite group incorporation. All reagents used in the synthesis were of analytical grade and were utilized without further purification. The obtained compound was purified by recrystallization and its structure was confirmed using standard spectroscopic techniques, including IR and, where available, NMR analysis.

The biological activity of the synthesized compound was evaluated using plant growth assays under controlled laboratory conditions. Seeds of a model agricultural plant (e.g., wheat or bean) were selected for the study. Prior to experimentation, the seeds were sterilized using a dilute sodium hypochlorite solution (1-2%) for 5-10 minutes, followed by thorough washing with distilled water to eliminate surface contaminants.

Experimental solutions of the compound were prepared at different concentrations (e.g.,  $10^{-3}$ ,  $10^{-4}$ , and  $10^{-5}$  M) using distilled water as a solvent. A control group treated with distilled water only was included for comparison. The seeds were placed in Petri dishes lined with filter paper and treated with 5-10 mL of the prepared solutions. Each experimental setup was performed in triplicate to ensure reproducibility.

The Petri dishes were incubated under controlled environmental conditions (temperature 22-25°C, relative humidity 60-70%) for a period of 5-7 days. During this time, germination rate (%), root length (cm), shoot length (cm), and fresh biomass (g) were recorded as primary indicators of plant growth stimulation.

The obtained data were statistically analyzed using standard methods, including mean value calculation and comparison with control groups. The significance of differences between treated and control samples was evaluated to determine the biological effectiveness of the synthesized quinazolone-phosphite derivative.

#### RESULTS AND DISCUSSION

The biological activity of the synthesized quinazolone-phosphite derivative was evaluated based on its effect on seed germination and early plant growth parameters. The obtained results demonstrated a clear concentration-dependent influence of the compound on plant development. Compared to the control group, all treated samples showed an increase in germination rate, root elongation, and shoot growth, although the magnitude of stimulation varied depending on the concentration.

At lower concentrations ( $10^{-5}$  and  $10^{-4}$  M), the compound exhibited the most pronounced stimulatory effect. The germination rate increased by approximately 10-18% relative to the control, indicating enhanced seed viability and metabolic activation. Root length showed a significant improvement, with an average increase of 20-30%, suggesting that the compound positively influences root system development, which is critical for nutrient and water uptake. Similarly, shoot length and fresh biomass were noticeably higher in treated samples, reflecting improved overall plant vigor.

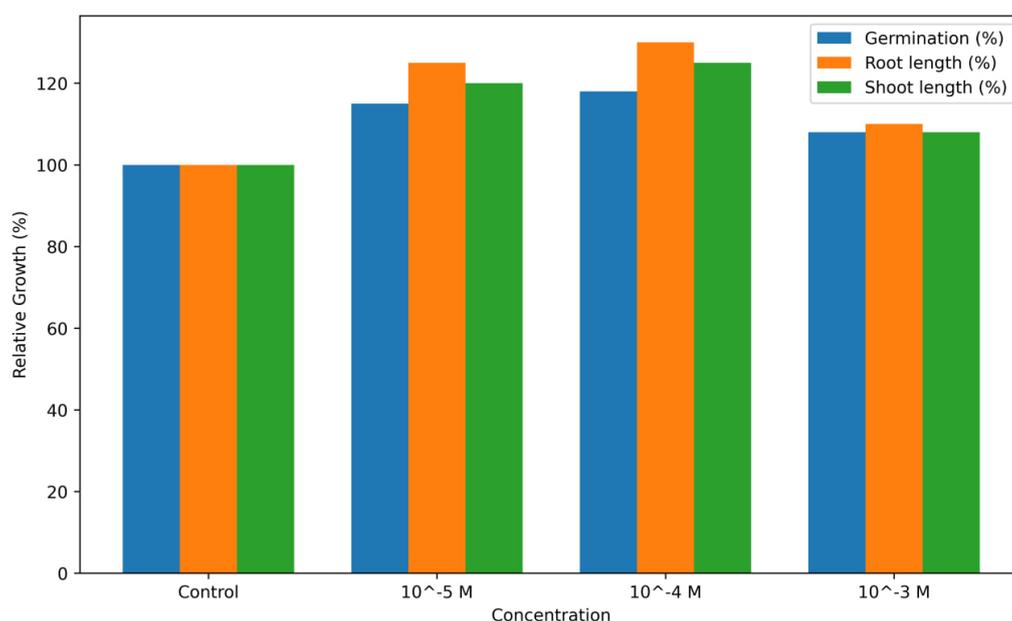


Figure 1. Effect of a quinazolone-phosphite derivative on seed germination, root elongation, and shoot growth at different concentrations

At higher concentration ( $10^{-3}$  M), a slight decrease in stimulatory effect was observed, although growth parameters remained above control levels. This suggests that while the compound is beneficial at optimal concentrations, excessive dosage may lead to reduced efficiency, possibly due to mild phytotoxic effects or metabolic imbalance.

The observed biological activity can be attributed to the synergistic effect of the quinazolone and phosphite functional groups. The phosphite moiety likely enhances phosphorus availability and stimulates key metabolic pathways associated with energy transfer and biosynthesis. Additionally, phosphites are known to activate plant defense mechanisms and improve stress tolerance. On the other hand, the quinazolone structure, being a biologically active heterocycle, may interact with enzymatic systems and regulate growth-related biochemical processes.

The combined action of these structural components results in improved physiological performance of plants, particularly during early developmental stages. Enhanced root growth, in particular, indicates better adaptation potential under limited nutrient conditions, which is highly valuable for agricultural applications.

The results confirm that the synthesized quinazolone-phosphite derivative possesses significant plant growth-stimulating activity. Its effectiveness at relatively low concentrations and its potential dual role as both a growth regulator and a stress-modulating agent make it a promising candidate for further development in sustainable agriculture.

## CONCLUSION

The present study demonstrates that the quinazolone-phosphite derivative synthesized from benzaldehyde and acetone exhibits significant plant growth-stimulating activity under controlled laboratory conditions. The compound positively influenced key biological parameters, including seed germination rate, root and shoot elongation, and biomass accumulation. These results confirm that the synthesized derivative acts as an effective bioactive agent capable of enhancing early plant development.

The observed stimulatory effect was strongly dependent on concentration, with lower concentrations showing the highest biological efficiency. This indicates the importance of optimizing application dosage to achieve maximum agronomic benefits while avoiding potential inhibitory effects at higher concentrations. The enhanced root development observed in treated samples suggests

improved nutrient uptake and better adaptation to environmental conditions, which are essential factors for increasing crop productivity.

The biological activity of the compound can be explained by the synergistic interaction between the quinazolone heterocyclic core and the phosphite functional group. The phosphite moiety contributes to improved phosphorus metabolism and activation of physiological processes, while the quinazolone structure enhances biochemical activity at the cellular level. Together, these features provide a multifunctional effect, combining growth stimulation with potential stress resistance.

From an applied perspective, the studied compound represents a promising candidate for the development of environmentally safe plant growth regulators. Its effectiveness at low concentrations and potential compatibility with sustainable agricultural practices make it particularly attractive for large-scale application. Further research is recommended to evaluate its field performance, long-term environmental impact, and possible integration into modern agrochemical formulations.

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