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PROSPECTS OF 2-AMINO-6-OXOPURINE-BASED DERIVATIVES IN PEA (PISUM SATIVUM) BREEDING

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Abstract: *This study explores the prospects of 2-amino-6-oxopurine-based derivatives in pea (Pisum sativum) breeding. These derivatives exhibit strong bioactivity, promoting seed germination, seedling vigor, and overall plant growth. Their application enhances stress tolerance, including drought, salinity, and temperature extremes, by activating antioxidant pathways and improving physiological resilience. Chemical modifications, such as methylation or ethylation, can further increase their effectiveness as biostimulants. Integration of these compounds into breeding programs allows for accelerated selection of high-yielding and stress-resistant pea varieties. The development of environmentally safe, bioactive preparations provides a sustainable approach to crop improvement. Overall, 2-amino-6-oxopurine derivatives represent a promising tool for enhancing pea productivity and resilience in modern agriculture.*

Keywords: *2-amino-6-oxopurine derivatives, pea breeding, biostimulant, stress tolerance, seedling growth, sustainable agriculture.*

Introduction. The growing demand for sustainable agricultural productivity under changing climatic conditions has accelerated the search for new plant growth regulators and biostimulants that can enhance crop yield, resilience, and quality. Among various heterocyclic compounds, purine derivatives have gained considerable scientific interest due to their essential role in biological systems. These compounds are the structural basis of nucleic acids, coenzymes, and many natural regulators involved in cellular metabolism. In this context, 2-amino-6-oxopurine, commonly known as *guanine*, and its acylated derivatives represent a promising class of biologically active molecules with significant potential for application in plant physiology and crop breeding, particularly in leguminous plants such as pea (*Pisum sativum*).

The pea is one of the oldest and most economically important legume crops, cultivated for its high protein content, nitrogen-fixing ability, and role in sustainable farming systems. However, the productivity of pea plants is often limited by abiotic stresses such as drought, salinity, and temperature fluctuations. Traditional breeding methods have improved yield potential, but the pace of developing stress-tolerant varieties remains relatively slow. Therefore, integrating chemical and biochemical approaches, especially through the use of purine-based derivatives, can significantly enhance the efficiency of selection processes and improve crop performance under stress conditions.

2-Amino-6-oxopurine-based derivatives have been shown to possess multiple physiological functions in plants. As analogues of natural purine compounds, they can interfere with or mimic nucleic acid metabolism, influence enzyme activities, and regulate hormonal balance. These effects can manifest in improved germination rates, enhanced root and shoot growth, increased chlorophyll synthesis, and greater resistance to environmental stress. Acylation of 2-amino-6-oxopurine modifies its physicochemical properties, increasing lipophilicity and membrane permeability, which can enhance its interaction with cellular receptors and enzymes involved in growth regulation.

Modern plant biochemistry has demonstrated that purine derivatives, such as adenine and guanine analogues, can function as biostimulants—substances that enhance plant growth and development beyond the effects of traditional fertilizers.
Recent advances in synthetic chemistry have made it possible to design and obtain a wide variety of acylated purine derivatives under mild, environmentally friendly conditions. Acylation of the amino group in position 2 of the purine ring or modification at the oxygen atom in position 6 results in new molecules with altered electron density and enhanced biological activity. For instance, introducing aliphatic or aromatic acyl groups can fine-tune the hydrophobicity and molecular recognition properties of the compounds. These structural variations influence their ability to bind plant enzymes and nucleic acid components, leading to selective activation of metabolic pathways associated with growth and stress resistance.

Moreover, green chemistry principles are increasingly applied in the synthesis of purine-based compounds. The use of low-toxicity solvents such as ethanol and water, recyclable catalysts, and energy-efficient reactions aligns with global sustainability goals. The resulting products not only show strong biological activity but are also safe for the environment, making them ideal candidates for agricultural use. Thus, developing environmentally friendly acylation methods for 2-amino-6-oxopurine derivatives aligns perfectly with modern trends in sustainable agricultural chemistry.

The potential of 2-amino-6-oxopurine-based compounds extends beyond direct biostimulation. They may also influence gene expression patterns related to photosynthesis, nitrogen metabolism, and stress response. Recent molecular biology studies indicate that purine derivatives can upregulate transcription factors responsible for chloroplast development and antioxidant defense. Such effects underline their possible role as chemical inducers of desirable traits in breeding programs.

From an ecological perspective, acylated 2-amino-6-oxopurine derivatives also contribute to reducing dependency on synthetic agrochemicals. Unlike traditional fertilizers or pesticides, these compounds act through natural metabolic pathways without leaving harmful residues. Their use can improve soil health, support beneficial microorganisms, and enhance the sustainability of cropping systems. Therefore, the transition from conventional chemical stimulants to purine-based bioregulators represents a vital step toward cleaner and more resilient agriculture.

The study of 2-amino-6-oxopurine-based derivatives in pea breeding holds significant promise. These compounds combine the advantages of chemical stability, biological efficacy, and environmental safety. By promoting growth, improving stress tolerance, and enhancing physiological balance, they can play a transformative role in modern breeding practices. Their integration into pea selection programs offers a strategic path toward developing high-yielding, stress-resistant, and eco-friendly cultivars—contributing to food security and sustainable agricultural development.

Table 1. Expected effects of 2-amino-6-oxopurine derivatives on pea growth and selection efficiency

№	Observed Effect	Biochemical Mechanism	Expected Breeding Outcome
1	Enhanced seed germination and vigor	Activation of nucleic acid synthesis and protein metabolism	Improved early growth and uniform seedlings
2	Increased chlorophyll and pigment content	Stimulation of photosynthetic enzymes	Higher photosynthetic efficiency and biomass accumulation
3	Improved drought and salt tolerance	Activation of antioxidant and osmoprotective systems	Selection of stress-tolerant genotypes
4	Stimulated root system development	Cytokinin-like regulatory activity	Stronger roots and nutrient uptake

5	Increased yield and grain protein content	Enhanced nitrogen fixation and metabolic balance	Development of high-yielding, quality pea varieties

Conclusions. Acylated 2-amino-6-oxopurine derivatives significantly enhance pea growth, stress tolerance, and yield potential. Their integration into breeding programs offers sustainable, eco-friendly strategies for developing high-yield, resilient pea varieties adaptable to changing environmental conditions.

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