



## Bioregulators as a Tool to Enhance Nutrient Uptake in Crops: What Farmers Should Know

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Open Access

### Article History

Received: 03. 05.2025

Revised: 07. 05.2025

Accepted: 12. 05.2025

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### INTRODUCTION

Efficient nutrient uptake by crops is a fundamental factor that directly influences their growth, yield, and overall quality. Nutrients such as nitrogen, phosphorus, potassium, sulfur, and essential micronutrients are critical for plant metabolic functions, including photosynthesis, protein synthesis, and stress resistance. Even when farmers apply recommended doses of fertilizers, crops may not absorb nutrients effectively due to several challenges. These include adverse environmental conditions like drought, high soil salinity, and temperature extremes, which can impair root function and nutrient mobility in soil. Additionally, poor soil health caused by nutrient imbalances, compaction, low organic matter, or microbial inactivity limits nutrient availability and uptake by plants. Crop-specific physiological inefficiencies can also affect how nutrients are absorbed and utilized. To address these challenges, the agricultural sector is increasingly focusing on bioregulators, naturally occurring or synthetic compounds that regulate and enhance plant physiological processes. In recent years, bioregulators—natural or synthetic substances that influence plant physiological processes—have emerged as promising tools to improve nutrient uptake and enhance crop productivity sustainably. This article aims to inform farmers about bioregulators and how they can help maximize nutrient use efficiency in crops.

### What Are Bioregulators?

Bioregulators are compounds that regulate various physiological processes in plants such as growth, development, stress tolerance, and metabolism. They include natural substances like plant hormones (auxins, cytokinins, gibberellins), seaweed extracts, humic acids, amino acids, and newer synthetic or microbial-based products. Unlike fertilizers that supply nutrients directly, bioregulators stimulate the plant's own mechanisms to absorb and utilize nutrients more effectively.

## Why Is Nutrient Uptake Enhancement Important?

Efficient nutrient uptake is the backbone of productive and sustainable farming. Even with correct fertilizer application, crops often fail to reach their full potential because the nutrients applied are not absorbed effectively by the plant. Enhancing nutrient uptake through improved agronomic practices and the use of bioregulators is vital for several key reasons:

1. **Soil Nutrient Imbalance:** Over time, soil nutrients can become imbalanced or locked in unavailable forms.
2. **Environmental Stress:** Abiotic stresses such as drought, high temperatures, and salinity are increasingly affecting crop growth and nutrient absorption. Under stress conditions, root growth is restricted, the uptake of water and nutrients slows down, and the plant's internal transport system is impaired. Bioregulators can help plants overcome these challenges by improving root architecture, enhancing membrane permeability, and activating stress-resistance pathways, ultimately facilitating better nutrient absorption even under adverse conditions.
3. **Cost and Resource Efficiency:** Fertilizers represent a significant input cost for farmers. However, studies have shown that in many cases, only 30–50% of the applied nitrogen and other nutrients are actually absorbed by crops, with the rest lost to leaching, volatilization, or fixation in the soil. This not only leads to financial loss but also contributes to groundwater contamination, eutrophication of water bodies, and greenhouse gas emissions. Enhancing nutrient uptake helps improve the return on investment in fertilizers while reducing environmental impact, aligning with both economic and ecological goals.
4. **Improved Yield and Quality:** Crops that efficiently absorb and utilize nutrients tend to exhibit better vegetative growth, stronger

root systems, and more vigorous flowering and fruiting. This directly translates to higher yields and improved crop quality. In a market-driven agricultural economy, producing higher-quality crops can also lead to better market prices and farmer profitability.

## How Do Bioregulators Enhance Nutrient Uptake?

- **Stimulating Root Growth:** Many bioregulators promote root proliferation and root hair development, increasing the soil volume explored for nutrients.
- **Activating Nutrient Transporters:** Bioregulators can induce expression of nutrient transporter proteins in roots, enhancing uptake of nitrogen, phosphorus, potassium, and micronutrients.
- **Improving Soil Microbial Activity:** Some bioregulators support beneficial microbes in the rhizosphere, which assist in nutrient solubilization and availability.
- **Reducing Abiotic Stress Impact:** By enhancing antioxidant activity and stress resilience, bioregulators help maintain nutrient uptake processes under drought, heat, or salinity stress.
- **Optimizing Hormonal Balance:** Hormones like cytokinins regulate nutrient mobilization within plants, ensuring efficient distribution to growing tissues.

## Common Bioregulators Used for Nutrient Uptake Enhancement

1. **Seaweed Extracts:** Rich in growth hormones and micronutrients, they improve root architecture and nutrient absorption.
2. **Humic and Fulvic Acids:** Enhance soil nutrient availability and root permeability.
3. **Amino Acids:** Act as chelators and growth stimulators, improving nutrient transport inside plants.
4. **Acetic Acid:** Recent research shows low concentrations can improve drought tolerance and nutrient uptake.
5. **Microbial Bioregulators:** Beneficial bacteria and fungi (like mycorrhizae) help solubilize nutrients and facilitate uptake.

### Practical Tips for Farmers

- **Choose the Right Bioregulator:** Select products suited to your crop and soil conditions, preferably those tested under local conditions.
- **Timing and Dosage:** Apply bioregulators during key growth stages (e.g., early vegetative phase, flowering) for maximum impact.
- **Combine with Good Fertilizer Practices:** Bioregulators complement but do not replace fertilizers; ensure balanced nutrient supply.
- **Follow Label Instructions:** Overuse or misuse can reduce effectiveness or cause phytotoxicity.
- **Monitor Crop Response:** Observe changes in growth, leaf color, and yield to assess benefits.
- **Consult Experts:** Agricultural extension officers or crop specialists can guide appropriate bioregulator use.

### Benefits for Farmers

- **Increased Yield:** Better nutrient uptake translates to healthier plants and higher productivity.
- **Cost Savings:** Improved nutrient efficiency means less fertilizer wastage and reduced input costs.
- **Environmental Protection:** Reduces nutrient runoff and pollution risks.
- **Stress Resilience:** Enhanced tolerance to drought and heat improves crop reliability.

### CONCLUSION

Bioregulators represent an innovative and eco-friendly approach to enhancing nutrient uptake in crops. By stimulating plant physiological processes, they help farmers achieve higher yields and better quality produce while optimizing fertilizer use. For sustainable and profitable farming, integrating bioregulators with sound nutrient and irrigation management is key. Farmers are encouraged to explore these tools, start with small trials, and adopt best practices suited to their local agro-climatic conditions.