POTENTIALITY OF BIO-STIMULANTS IN AGRICULTURE: AN INNOVATIVE APPROACH

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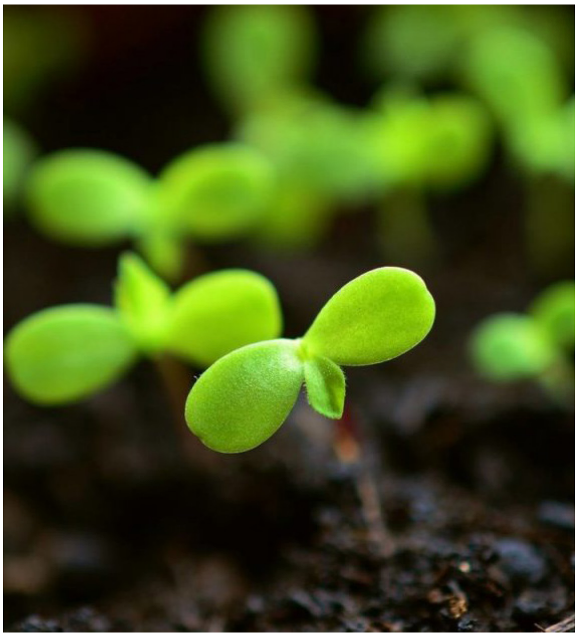
INTRODUCTION

Small-scale applications of bio stimulants improve plant physiological processes, producing high-quality product. For bio stimulants, the phrase "metabolic enhancers" has been employed. They improve the plant's enzymatic and metabolic functions, particularly in the early stages of growth. Additionally, they improve nutrient absorption, which increases stress tolerance and productivity in the plants. As a result, these compounds are crucial to the structural mechanisms that enhance plant development, increase plant tolerance to biotic and abiotic stress, and boost product output and quality. This was a historic occasion to bring bio stimulants in agriculture to the notice of several stakeholders. Furthermore, bio stimulants are increasingly being used in production systems to alter plant physiological processes to maximize productivity. Bio stimulants and biologically derived compounds are becoming more and more important in agriculture these days since sustainable production demands higher-quality products, increased yields, and environmentally friendly growing environments.

TYPES OF BIO-STIMULANTS:

1. Seaweed and algal extracts:

In agriculture, seaweed and algal extracts are widely used as organic matter and fertilizers. These include the micro- and macronutrients found in carrageenan, sterols, and N-containing compounds, as well as polysaccharides like laminarin and alginates. The algae species are members of the Fucus, Laminaria, and Ascophyllum genera. They are sprayed foliarly and used as a hydroponic solution in the soil. Plants are better able to withstand extreme cold and heat when seaweed extracts are used. Algae extracts help with soil remediation, water retention, cation exchange, and plant growth and development. They also enhance basic nutrition. Plants treated with algal extracts had much higher levels of antioxidants and total chlorophyll.



2. Humic and fulvic substances:

Humic substances are diverse molecules that are divided into humins, humic acids, and fulvic acids based on their molecular weights and solubility. Because of the breakdown of leftovers from plants, animals, and microbes, they are organic. As a result, their components are natural and mostly needed to increase soil cation exchange capacity, aid in enhancing root nourishment, and improve soil fertility. The precipitation of calcium phosphate makes them more phosphorus-available and aids in the intake of nutrients. Extracts of humic acid have been shown to enhance endogenous proline levels, decrease membrane leakage, and improve stress tolerance for salt. Additionally, they improve the activity of enzymes that scavenge reactive oxygen species and antioxidants, which prevents plants under abiotic stress from producing harmful free oxygen radicals.

3. Protein hydrolysates and N-containing compounds:

N-containing chemical combinations and protein hydrolysates improve growth and basic nutrition. Plant development is aided by a combination of amino acids and peptides derived from plant and animal sources. Glycine betaine keeps plants' osmotic potential intact and possesses anti-stress qualities. Plants become resistant to abiotic stressors when glycine betaine builds up in their bodies. Porcine haemoglobin is hydrolysed enzymatically, which lessens the impact of heat and cold stress on plants. The detrimental effects of rising temperatures on plant development are mitigated by porcine haemoglobin.

4. Chitosan and other biopolymers:

The polymer chitin undergoes deacetylation to yield chitosan. The use of chitosan improves quality attributes associated with primary and secondary metabolism and aids in the development of resistance to abiotic stress and fungal infections. Chitosan oligomers can attach to a variety of biological components, including as DNA, components of the plasma membrane and cell walls, and to certain receptors that are involved in the activation of defense genes. Chitosan-induced stomatal closure offered defence against environmental stress. Because chitosan binds to receptors in cells, physiological changes resulting from the accumulation of hydrogen peroxide and Ca2+ leakage into the cell are critical for signalling stress responses and control.

5. Inorganic compound:

Many beneficial elements are reported to enhance growth, quality of produce, and tolerance to abiotic stress in plants. Such beneficial effects include cell-wall rigidification, osmoregulation, transpiration reduction by crystal deposits, thermal regulation by radiation reflection, activities of enzymes, antioxidant protection, plant nutrition, protection against heavy metals toxicity, hormones synthesis and signalling, interactions with symbionts, pathogens, and herbivore response. Inorganic elements, namely chlorides, silicates, phosphates, phosphites and carbonates, are used as fungicides. Silica deposition during pathogen attack and osmotic stress in grass are enhanced by applying inorganic elements and amorphous silica ($SiO_2 . nH_2O$). This might be due to the influence of hormone signalling enzymes involved in stress response and redox homeostasis, pH, osmotic pressure, nutrient efficiency, plant growth and tolerance toc stress. It has been reported that NaCl salt concentration increases seed germination of parsley, leek, tomato, onion, celery, lettuce, basil and radish.

6. Beneficial fungi:

By interacting with plants' roots and developing a symbiotic connection, beneficial fungi are crucial in improving tolerance against both biotic and abiotic stress. Additionally, the relationship with plant roots might be parasitic. Fungi and plants had coevolved over their terrestrial evolutionary history. A relevant notion to characterize the wide variety of interactions that emerged throughout the course of evolution is the mutualism-parasitism continuum. In more than 90% of plant species, mycorrhizal fungi are beneficial to plant growth and development. AMF, often referred to as endo-mycorrhiza, are extensively dispersed and connected to a variety of agricultural plants. To improve nutrition and water usage efficiency, tolerance to biotic and abiotic stress, and crop production and quality, the hyphae of AMF develop arbuscules, a unique structure that penetrates the cortical cells of roots and forms a symbiotic connection with the plants. To improve nutrient intake to their host and increase tolerance to biotic and abiotic challenges, several other fungus species, including Trichoderma and Sebacinales, have also developed a strong endophytic connection with plants. The use of AMF, other advantageous fungi, and algae as the starting points for bioactive ingredients increased plant tolerance to salt by promoting improved seed germination, root and shoot development, productivity, and crop quality.

7. Beneficial bacteria:

As bio stimulants, beneficial bacterial species are crucial. As PGPRs like Pseudomonas species or endosymbionts like Rhizobium species, they are connected to the plants. Species of Rhizobium are utilized as biofertilizers. In the agroecosystems, PGPRs have an impact on interactions with other species, morphogenesis and development, reaction to biotic and abiotic stress, and nutrition and growth. The thermotolerant Pseudomonas putida strain AKMP7 dramatically enhanced plant biomass, shoot and root length, heat tolerance, and seed size in wheat.

8. Plant hormones:

Low quantities of plant hormones such as auxin, gibberellic acid, cytokinin, and kinetin improved nutrient efficiency, crop quality attributes, and resistance to abiotic stress. Auxin is a crucial hormone that controls the growth and development of plants by causing blooming, senescence, apical dominance, abscission, and cell division and differentiation. The processes of seed germination, endosperm mobilization, protease and alpha amylase activity, dormancy breaking, stem elongation, cell division, and growth are all significantly impacted by gibberellic acid. Applying cytokinin and indole-butyric acid was found to promote seedling emergence, growth, and leaf size. Kinenectin and calcium application decreased cellular electrolytes and maintained relative water content.

CONCLUSION

Given the current state of agriculture, bio stimulants offer enormous promise for development and use. To improve growth and yield, they alter the plants' physiological processes. Bio stimulants should be made more widely used in agriculture to satisfy the growing demand for high-quality goods, an environmentally friendly atmosphere, and sustainable nutrient and water management. The creation and application of bio stimulants have received more attention lately. Nonetheless, there are two main issues with bio stimulants that the sectors must deal with. The first has to do with the challenges associated with determining the main mechanism of action since the compositions of bio stimulants are exceedingly complicated and incompletely understood. The second is the regulatory classification of bio stimulants, which is mostly focused on the source rather than the biological mechanism of action.