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BIOSTIMULANTS- A POSSIBLE ROLE IN PLANT VITALITY

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Climate change that has been happening around the world in the past decade is posing severe threats to the agricultural sector in terms of crop productivity as well as increased vulnerability to various biotic and abiotic stresses. To adapt to these stresses, not all species have the ability to evolve their plastic responses and grow in such harsh environments. Immune-stimulation of plants, which is postulated to be an adaptive and low-cost defensive measure, is a result of interactions of plants with beneficial microbes, chemical compounds and environmental cues. Several technical advancements have been suggested during the past three decades to improve the sustainability of agricultural production systems. Biostimulant application is one such technique.

Biostimulants are agronomic tools that have been gaining importance in the reduction of fertilizer applications. They can improve the yield of cropping systems or prevent crop yield losses under abiotic stresses. Biostimulants can be composed of organic and inorganic materials and most of the components are still unknown. The application of biostimulants has been considered a potentially novel approach to stimulate plant growth and crop productivity under both stress and control conditions, representing a significant breakthrough towards sustainably safeguarding future food production (Rai *et al*., 2021).

Biostimulants and its Potential Role

A 'bio-stimulant' means a substance or micro-organisms or a combination of both whose primary function when applied to plants, seeds or rhizosphere is to stimulate physiological processes in plants and to enhance its nutrient uptake, growth, yield, nutrition efficiency, crop quality and tolerance to stress, regardless of its nutrient content, but does not include pesticides or plant growth regulators which are regulated under the Insecticides Act,

1968. In short, biostimulants are chemical compounds that encourage and control plant development organically. They stimulate plant growth and increase crop yield in a sustainable way (Kumari *et al.*, 2022).

Several types of biostimulants are being widely used. Humic substances (HS) are formed by chemical and biological transformations of plant and animal matter through microbial metabolism and represent the major pool of organic carbon at the earth's surface. Protein hydrosylates are mainly produced by chemical (with strong acids or alkalis) and/or enzymatic hydrolysis of proteins contained in agro-industrial by-products from animal (i.e., leather, viscera, feathers, blood) or plant origin (i.e., vegetable by-products) and in biomass of dedicated legume crops (i.e., seeds, hay). Seaweed extracts, even at low concentrations, are capable of inducing an array of physiological, plant responses, such as promotion of plant growth, improvement of flowering and yield and also enhanced quality of products, improved nutritional content of edible product as well as shelf life. Silicon brings about anatomical changes in plant tissues due to deposition of phytoliths which provide rigidity and modulate nutrient and water mobility inside the plants, enhancement of the antioxidant defense systems in plants, immobilization of toxic metals through complexation or co-precipitation with Si in plant tissues and soil and modulation of gene expression and signaling through phytohormones. Chitosan is the deacetylated form of chitin, a biopolymer that occurs naturally as a component of fungal cell walls, insect exoskeletons and crustacean shells. The physiological and biochemical responses of chitosan have been investigated and it has been found to act as a stimulator of plant defense responses. Microbial biostimulants are composed of microorganisms such as plant growth-promoting rhizobacteria (PGPR) and/or microbes which stimulate nutrient uptake, produce secondary metabolites, siderophores, hormones and organic acids, participate in nitrogen fixation, imparts stress tolerance, enhance crop quality and yield when applied to the plants.

S.No	Biostimulants	Beneficial effect
1.	Humic and Fulvic acid	Improves fertility status in soils by increasing macronutrients, micronutrients and beneficial microorganisms thus increase soil health. It improves water holding capacity of soils because it acts as organic manure. encourages growth and reproduction of beneficial soil microorganisms
2.	Protein hydrolysates	Alteration of assimilation and uptake of Nitrogen, improvement of overall fertility of soil and enhancement of activity and biomass of soil microbial population
3.	Seaweed	Increase plant growth, nutrient uptake and grain yield as a result of

	extracts	phytohormones within the product, mitigation of stresses and/or upregulation of plant metabolism
4.	Chitosan	Generation of active oxygen species, cellular responses like ion flux variations and membrane depolarization, cytosol acidification and changes in protein phosphorylation
6.	Megafol- by Syngenta (Amino acid based biostimulant)	Promotes balanced vegetative development and productivity, preserves the quality and quantity of the yields by overcoming stress situation
7.	Ambition- by Bayer (Amino acid and fulvic acid)	Stimulate plant growth on new shoot, flowering, fruit formation and harvest. Quickly recover plants from biotic/abiotic-induced stress and better nutrient absorption.
8.	Biplantol universal by BNG (Macro-and microelements, germanium, uronic acids, medicinal herb)	Strengthens plants and supports their vigour by stimulating the microflora of the soil, by releasing blockages in the plant and thus initiating the sap flow. Through increased root growth, the plant can absorb nutrients in a better way and transport them to every single cell. This results in a healthy and vital plant which is more robust and less susceptible to disease and pest infestation.
9.	SPICem Power-G - by SPIC (Humic acid, amino acid and fulvic acid)	Promotes photosynthesis, helps in the thickening of the epidermis in fruits, hence shelf life is prolonged. It improves the physical, chemical and biological activities of the plant, so as to produce high yield and quality produce. Improves the physical appearance and nutritional value of the produce.

(Madende and Hayes, 2020)

Conclusion

The majority of research on biostimulants has generally concentrated on agronomic and phenotypic qualities; however, the cellular and molecular processes that constitute these agronomically observed benefits are not well understood. A product's legitimate status as a biostimulant, which ensures a certain level of efficacy and effectiveness in all circumstances, cannot be determined by such agronomic descriptions or characterizations. Therefore, there is a rising demand for a solid scientific foundation to lay the groundwork for a theoretical framework that would help in the development of biostimulant products with credible scientific descriptions.

Different techniques, including in vitro bioassays, micro-phenotyping, high-throughput phenotyping have been established and replaced traditional time consuming screening methods. Omics approach such as transcriptomics, proteomics and metabolomics

have also been widely used to determine the mode of action of several biostimulants and its potential role in agriculture practices. Combined approach using biology, chemistry and omics might pave way for developing highly advantageous biostimulants to improve the resilience of plants against abiotic stresses and stimulate the synthesis of beneficial metabolites contributing to functional food production.

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