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Chitosan: A Bio-stimulant's Role in Ornamental Crops

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Natural compounds or microorganisms known as bio-stimulants are known to enhance several natural processes, including nutrient uptake, nutrient usage efficiency, tolerance to abiotic and biotic stresses, and crop quality and production. Bio-stimulants, in contrast to fertilizers and insecticides, are not highly nutrient-rich or possess a defensive nature against infections. Some of the bio-stimulants are humic and fulvic acids, protein hydrolysates, seaweed extracts, chitosan, inorganic compounds, beneficial fungi and bacteria. Chitosan is a polycationic polymer that is produced through the deacetylation of chitin and is frequently gathered by the exoskeletons of crustaceans, especially shrimp and crabs, as well as the cell walls of fungi, yeast, and diatoms. The principal applications for chitosan include food preservation, coating films, biopesticides, degradable mulching, and plant growth regulators.

Applications of chitosan

* **Plant growth and development**: By modifying the osmotic pressure within the cells, chitosan increases the uptake and availability of water and other essential nutrients, hence promoting plant development. It assisted in triggering the hydrolytic enzymes required for the breakdown and mobilization of dietary reserves, such as protein and starch. By triggering plant hormones like auxin and cytokinin, it can encourage the proliferation of root cells, which in turn increases food uptake. Its actions that promote plant growth are intimately related to effects on physiological processes in plants, such as food uptake, cell division, cell elongation, enzyme activation, and protein synthesis.
* **Induce seed germination**: Increased seed germination, improved seedling growth and development, and the activation of antioxidant enzymes to stop potential harm from reactive oxygen species during seed germination. It has the ability to create a semi-permeable layer on the surface of seeds, which helps to keep moisture in the seed and draw in more moisture from the soil to encourage germination.
* **Uptake of plant nutrient**: It have a positive effect on rhizobacteria growth, where it possesses a symbiotic relationship with growth-promoting rhizobacteria, thus triggering germination rate and improving plant nutrient uptake. It increases the activity of plant symbiotic microbes, altering rhizosphere microbial equilibrium and deterring plant pathogens. The application of chitosan coating on fertilizer increases the efficiency of plant fertilizer uptake.
* **Abiotic stress tolerance**: Plants that have been exposed to chitosan treatment less susceptible to stress caused by unfavourable circumstances including salt, drought, low or high temperatures. When applied topically, chitosan improves stomatal conductance, raises the concentration of abscisic acid (ABA), and decreases transpiration in plants without changing their biomass, height, leaf area, or root height. By inducing ABA activity, chitosan gets degraded enzymatically without affecting the soil-borne beneficial rhizosphere biota at low concentrations.

* **Antifungal properties**: Numerous harmful fungi, including *Alternaria alternata*, *Botrytis cinerea*, *Penicillium digitatum*, *Colletotrichum gleosporoides*, *Rhizopus stolonifera*, etc., are inhibited from growing in vitro by it. Various stages of pathogen development, such as hyphal growth, spore formation, spore viability, germination, and fungal virulence factor production, were observed to exhibit suppression. The ability to make and employ chitosan to enhance its antifungal activity as a natural antifungal agent in nanoparticles and many other forms is the main benefit of using it.
* **Antibacterial properties**: Chitosan has strong in vitro and in vivo antibacterial activities towards different plant pathogenic bacteria, like *Xanthomonas spp.*, *Pseudomonas spp.*, *Streptomyces scabies*, *Burkholderia seminalis*, *Acidovorax spp.*, *Ralstonia solanacearum* and *Staphylococcus aureus*.
* **Antiviral and nematicidal properties**: Chitosan inhibits the systemic proliferation of viroids and viruses across the plant and enhances the host's hypersensitive reactions to infection. Application of chitosan in soil promotes the multiplication of chitinolytic microorganisms that degrade chitin containing the organ of plant parasitic nematodes, and reduces egg hatching and the viability of larvae and adults belonging to *Meloidogyne javanica*, *Meloidogyne arenaria* and *Heterodera schachtii.*
* **Bioremediation**: Chitosan contains active groups that can be altered to improve its ability to absorb heavy metal ions. Examples of these materials include humic acids, carbon nanotubes, and the algae Ulva lactuca.
* Chitosan has a wide range of uses outside of agriculture, including the culinary, cosmetic, textile, and biomedical sectors.

Role of chitosan in ornamental crops

Sl. No.	Crop	Effect
1.	Chrysanthemum	Protected against *Oidium chrysanthemi* and *Puccinia horiana*.
2.	Gladiolus	Accelerated corm emergence, increased number of flowers extended vase life and increased number of cormlets.
3.	Lisianthus	Enhanced growth, shortened flowering time increased number and weight of flowers.
4.	Rose	Protection against *Sphaerotheca pannosa* var. *rosae*, *Peronospora sparsa* and *Diplocarpon rosae*.
5.	Gloxinia	Promoted seedling growth and induced earlier flowering.
6.	African marigold	Improved plant height
7.	Freesia	Increased plant height, relative chlorophyll content, Increased corm weight and number, Induced early flowering, Increased number of inflorescence shoots
8.	*Begonia* x *hiemalis*	Promoted seedling growth Induced earlier flowering
9.	*Dendrobium* orchid	Induced early flowering Increased accumulative inflorescence number, Improved protocorm growth
10.	Wishbone flower	Promoted seedling growth. Induced earlier flowering

Future perspectives

Even though chitosan's use in agriculture has been widely documented, there is still more to be done. Field trials are required because the majority of these investigations are still conducted in labs or greenhouses. It is especially necessary to assess how these molecules affect the soil and ambient biomes. To protect crops from nematode-borne diseases, apply chitosan to the root zone, and reduce the use of synthetic fertilizers, more research is required. Further research is required to fully understand the intricacy of how plants perceive and react to chitosan activities.

Conclusion

We may conclude that the use of bio-stimulants can boost the output of different flower crops in both a qualitative and quantitative way. In comparison to synthetic fertilizers, chitosan bio-fertilizer and fertilizer coated in chitosan stimulate plant development more. Additionally, chitosan and its derivatives are a strong source of antifungal and nematocidal activity without upsetting the beneficial bacteria in the soil, making them a viable green method of sterilizing soil. Therefore, bio-stimulants are important for sustainable floral production.