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Chitosan: A Godsend Biopolymer

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SUMMARY

Chitosan is a polysaccharide derived from chitin. Chitin is the second most abundant polysaccharide found in the world, after cellulose. Chitosan is biocompatible, biodegradable and non-toxic and hence it can be used in various fields such as Agriculture, Medical and Pharma industries and Waste Water Management and so on. (Ibrahim and Zairy, 2015). Now a days to meet the increasing demand of food for population is getting more difficult. The application of conventional inputs to mitigate this gap has observed to be less effective. These naturally occurring compounds have great physiological potential. These biopolymers with stimulating physiological potential has been receiving more attention in recent years. Hence, the use of Chitosan compounds can play pivotal role in increasing agricultural production quantitatively and qualitatively as well.

INTRODUCTION

Chitosan is a linear polysaccharide, made by treating the chitin shells of shrimp and other crustaceans with an alkaline substance, such as sodium hydroxide. Chitosan, deacetylated chitin, is currently obtained from the outer shell of crustaceans such as crabs, krills and shrimps (Sandford and Hutchings, 1987; Sandford 1989). It is composed of randomly distributed β-(1→4)-linked with D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine. Chitosan has gained much attention from various fields due to its excellent biocompatibility, biodegradability and bioactivity. As it improves physiology of crop, therefore its potential application in agriculture is increasing day by day. It can be applied in both pre harvest as well as post-harvest. In agriculture, chitosan is typically used as a natural seed treatment and plant growth enhancer, and as an eco-friendly bio-pesticide substance that boosts the innate ability of plants to defend themselves against fungal infections (Linden *et al*, 2000). Chitosan enhanced the efficacy of plant to reduce the deleterious effects of unfavorable conditions like disease infection, pest attack and post-harvest losses. Along with these benefits, chitosan has been found responsible for better plant growth ultimately getting increased crop yield. Foliar and Soil application of Chitosan compounds reduce the occurrence of plant pathogens *viz*., fungal, bacterial, viral and nematodes (Bautista-Baños *et al*, 2005).

Role of Chitosan compounds in Plant Growth

Chitosan promotes plant growth by improvising vital physiological processes of plants. It acts as PGR, bio-stimulant for varied crops. Chitosan compounds stimulates nutrient uptake, increases sprouting and germination percentage, develop vigor of plant. Degraded molecules of chitosan compounds exist in soil and water naturally. As it emerged as biomolecule compound, it can be used as an organic input. Plants nurtured with Chitosan gives higher yield with zero residues as that of conventionally nurtured plants. In addition to production of higher quality produce, the cost of cultivation also gets minimized up to certain extent. Hence, the application of chitosan in regular crop practices proved to be advantageous.

Role of Chitosan compounds in Plant Protection

Chitosan compounds act as an elicitor for plants. In agriculture, chitosan compounds are typically used as biocontrol agent for various biotic stresses. These compounds are having ability to inhibit the fungal, bacterial and viral growth. Derived compounds of chitosan are known to have eliciting activities leading to a variety of defense responses in host plants in response to microbial infections, including the accumulation of phytoalexins, pathogen related (PR) proteins and proteinase inhibitors, lignin synthesis, and callose formation (Hadrami *et al.* 2010). Oligomeric chitosans (pentamers and heptamers) have been reported to exhibit a better antifungal activity as compared to regular fungicides (Rabea *et al.*, 2003). Chitosan compounds applied at the rate of 1mg-ml gives better results against fungus (Allan and Hadwiger, 1979). Chitosan restrict the systemic propagation of viruses and viroids throughout the plant and enhance the host's defense mechanism against infection (Pospieszny *et al.*, 1991, Faoro *et al*., 2001, Chirkov, 2002). The ability to suppress the viral infection varies with molecular weight of different chitosan compounds (Kulikov *et al*., 2006). These compounds observed to be beneficial against potato virus X, tobacco mosaic and necrosis viruses, alfalfa mosaic virus, peanut stunt virus and cucumber mosaic virus (Pospieszny *et al*., 1991, Chirkov, 2002, Pospieszny *et al*., 1996, Pospieszny 1997, Struszczyk 2002). Chitosan checks the multiplication of a wide range of bacteria (Muzzarelli *et al*., 1990). The rate of application may vary within 10–1,000 ppm for different bacterial species (Hadrami *et al*. 2010). These compounds perform well against various bacterial species such as *E. coli*, *Staphylococcus aureus* and some strains of *Bacillus* species (Kim *et al*., 1997).

Role of Chitosan compounds in Post-Harvest Management

Along with pre-harvest, Chitosan compounds found beneficial for post-harvest management in agriculture. It forms a semipermeable film that regulates the gas exchange and reduces transpiration loses and fruit ripening is slowed down. Thus it plays a significant role in extending shelf life of fruits and vegetables. These compounds have shown positive effect for numerous horticultural commodities such as tomatoes, strawberries, longan, apples, mangoes, bananas, bell peppers and so on (El Ghaouth *et al*., 1991a, 1992e; Du *et al*., 1997, 1998; Jiang and Li, 2001; Kittur *et al*., 2001). Chitosan treated fruits and vegetables retain their firmness for longer duration as compared to untreated commodities.

CONCLUSION

Chitosan and its derivatives has been presented multidisciplinary approaches in agriculture and food industry. It promotes plant growth. Being an elicitor, it controls pathogenic microorganisms and their activities by initiating defense mechanism in host plant. Along with this it can be applicable in maintaining post-harvest life of produce by extending its shelf life. And hence it may conclude that the beneficial effects of chitosan might be extended from the field through to the storage of numerous horticultural commodities.

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