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Elicitors: A Boon for Fruit Crop Production

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SUMMARY

Climate change as emerged as a serious environment issue having impact on all forms of life. While, plants are exposed to variety of stress factors. These factors lead to reduction in growth, productivity and quality of fruit crops. There are various options available for the farmers to protect their crop. Some options include resistant cultivars, cultural operations and chemical fertilizers (pesticides/fungicides). Usage of these chemicals at commercial level is uneconomical, toxic and leaves residual effects. Therefore in order to cope up with climate change, stress factors and to reduce the excess use of toxic chemicals. A novel group of signaling molecules that is elicitors can be utilized in fruit production. Elicitors are having the potential to increase growth, productivity and quality of fruit crops and also improve the plant responses and tolerance towards stress conditions by influencing on various processes within the plant.

INTRODUCTION

Elicitors are either molecules or compound which upon application to the plants at minute concentration can promote physiological, biochemical and molecular changes in plant cell by activating an array of mechanisms thereby affect the metabolism within the plants and enhances the level of plant phenolic content, antioxidant activity and secondary metabolites. These molecules may be in the form of bio-regulators, bio-formulations and bio-stimulants or any compounds that trigger or provoke the signaling responses in plants. Thus enhancing growth, yield and quality of fruit crops even under normal and stress conditions.

Classification of Elicitors

Based on the origin -

a. Exogenous elicitors: Originated outside the cell. Ex: glucomannose, glucans, chitosan

b. Endogenous elicitors: synthesized within the plant itself. Ex: Jasmonic acid, methyl jasmonate, and salicylic acid.

2. Based on their host interactions -

a. General Elicitors: They are able to trigger defense both in host and non-host plants. Ex: Carbohydrates and proteins.

b. Specific Elicitors: They induce defense responses leading to disease resistance only in specific host. Ex: avr gene products from fungal, bacterial, viral (or) plant origin

3. Based on the nature -

a. Biotic elicitors: Those of biological origin. Ex: polysaccharides, glycoproteins

b. Abiotic Elicitors: Those of non-biological origin. Ex: growth regulators, mineral elements, metal ions and stress factors.

Why to focus on elicitors or need of elicitors in fruit production?

By application of elicitors:

- Higher yield and quality fruits can be obtained.
- Pre harvest spray can control postharvest losses.
- Increase the phenolic and antioxidant content of fruit.
- Protecting plants and fruits from biotic and abiotic stresses.
- Helps to reduce the excess usage of toxic chemicals
- Non-toxic and environmentally friendly.

Mode of action or mechanism of elicitor in plant cell

During stress condition, ROS produced in plant cell, in which elicitors act as signaling molecule and elicitation starts with the signal perception by elicitor-specific receptors present on the plant cell membrane followed by initiation of signal transduction cascade and which ultimately changes the expression level of

various regulatory transcription factors/genes, defense related genes, signaling molecules and synthesis of secondary metabolites which scavenges the ROS produced in plant cell and avoids cell damage during stress conditions.

Effectiveness of elicitors depends on:

- **Elicitor nature** – biotic or abiotic elicitors.
- **Plant characteristics** – crop, species, cultivars and age.
- **Plant growth stages** – seeds, seedlings, vegetative stage, flowering stage and fruiting stage.
- **Elicitor concentration** – high or low concentration.
- **Mode of application** – seed treatment, soil application and foliar application.
- **Frequency of application** – time and days interval between the applications.

Important Elicitors Used in Fruit Crops

Salicylic acid

- It is also known as Ortho-hydroxybenzoic acid
- It is of phenolic derivative found in all plant kingdom.
- It was first isolated from bark of white willow in 1828 by Johan Buchner
- It plays a crucial role in plants growth and development and also act as a endogenous signalling molecules.
- The biosynthesis of SA, it is known to be produced through the shikimate pathway.

Jasmonic Acid

- Jasmonates are derivatives of fatty acid in which JA is chemical derived from linolenic acid.
- Its role in plant defense was first shown by Farmer and Ryan (1990).
- Its action induces the transcription of many genes involved in plant defense.
- The biosynthesis of JA, it is known to be produced through the octadecanoid pathway.

Chitosan

- Chitosan is a linear biopolymer and polysaccharide, consisting of N-Glucosamine and N-acetyl glucosamine units linked by beta-1,4-glycosidic bonds.
- It is obtained through deacetylation process of purified chitin where acetyl group of chitins is removed and ammonia is added.
- The chemical commonly used for deacetylation process is Ammonia hydroxide.

Seaweed extracts

- Seaweeds are macroscopic, multicellular, marine macroalgae and unexploited resource of nature is rich in bioactive compounds like polysaccharides which forms an integral part of marine coastal ecosystem.
- About 10,000 species of macroalgae broadly classified into three main groups based on their pigmentation

Phaeophyta (Brown)- Most commonly used in agriculture.
Rhodophyta (Red)
Chlorophyta (Green)

Among them, brown seaweed extract is abundant and commonly used in agriculture. Some of species are *Ascophyllum nodosum, Fucus spp., Laminaria spp., Sargassum spp., Ecklonia maxima and Durvillaea spp*. Etc.

β-amino-butyric acid

- It is an isomer of the amino butyric acid
- It has two isomers, gamma-amino-butyric acid and alpha-amino-butyric acid found in plants, where it plays a role in signaling molecule.
- Papavizas and Davey reported its defense role in plants during 1963.
- This has been involved in diverse physiological and signaling processes.

- Enhances the plant growth and development, stress tolerance and disease resistance of many plant species.

Role of Elicitors in Different Fruit Crops
Elicitors enhances the growth and yield in fruit crops

By improving photosynthetic activity, photo-chrome element, carbon assimilation and better partitioning of photosynthates to different parts of the plants. The cultivation of strawberry variety "winter dawn" by foliar application of chitosan at 3grams per litre at 45, 90 and 135 days after planting found better for increasing vegetative growth, yield attributing traits and yield under naturally ventilated polyhouse (Nithin *et al.,* 2020).

Elicitors enhances the quality, antioxidant and phenol content of fruits

Even during harvesting and storage condition thus improving the shelf life of fruit crops. Pre-harvest treatment with salicylates and especially salicylic acid at 10 mM, could be a safe and natural new tool to improve pomegranate fruit quality and their content on phenol/antioxidant compounds with beneficial health effects, at harvest and during storage (Garcia-Pastor *et al.,* 2020).

Alleviates Biotic Stresses

Role in Disease Control – by signaling process *viz.*, local and systemic defense resistance
Localized resistance – Here stress perception, signaling process and defense induction confined to particular tissue or cell.
Systemic resistance – Here stress perception in one part of the tissue leading to distant signaling to uninfected plant parts.

Application of beta amino butyric acid was beneficial in controlling downy mildew of grapes by enhancing defense response within the plants by increasing the PR proteins, antioxidant activity and lignin accumulation (Cohen *et al.,* 2000)

Pest Control through direct and indirect defense.
Direct defense: by changing in volatile and fruit chemical ratios of host plants confuse insects and alter their perception and orientation.
Indirect defense: by attracting natural enemies

Exogenous application of SA on to mango fruit resulted in reduced oviposition, larval growth and adult emergence and also increased in the total flavonoids/ phenols and antioxidative enzymes *viz.,* peroxidase and polyphenoloxidase. Enhanced levels of these plant defense compounds would have affected larval growth and development resulting in poor pupation and adult emergence of *B. dorsalis* (Damodaram *et al.,* 2015)

Alleviates Abiotic Stresses

By drenching of seaweed extracts may be useful tool for improving the drought stress tolerance by enhancing growth and water content of citrus seedling even under stress conditions (Spann *et al.,* 2011).
Alleviates Storage Disorders

It helps in alleviating storage disorders and diseases thus enhancing the quality and also extends the shelf life of fruit crops during storage. Application of jasmonic acid enhances the chilling tolerance in peach fruit by regulating sugar metabolism and also reduced the decline in sugar content during cold storage (Zhao *et al.,* 2021)

CONCLUSION

Elicitors have the potential to increase growth, productivity and quality of fruit crops and also improve the plant responses and tolerance towards stress conditions by influencing on various metabolic processes within the plant. Therefore, elicitors could be one of encouraged way in the future to enhance crop productivity and quality fruits in an environmentally friendly way. Hence, these will be of great boon to farmers and go in favor of bright future in fruit production.

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