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# SALICYLIC ACID IN PLANT IMMUNITY WITH SPECIAL REFERENCE TO XANTHOMONAS CAMPESTRIS PV. VESICATORIA- A REVIEW

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**Abstract :**The small phenolic compound salicylic acid (SA) plays an important regulatory role in multiple physiological processes including plant immune response. The plant recognizes the bacterial pathogen and activates structural and biochemical defences to protect itself. Pathogen infection and recognition occurs in a series of responses. First, plants utilize pattern recognition receptors to recognize pathogen associated molecular patterns (PAMPs) such as flagellin and lipopolysaccharides. In PAMP triggered immunity (PTI), a signal cascade involves reactive oxygen species (ROS) production, activation of mitogen activated protein-kinases, cell wall fortification and pathogen response (PR) gene transcription.

However, pathogens can attenuate the PTI responses by injecting effector proteins into the plant cells to inhibit the basal defense response. In recognition of these effector proteins, plants have evolved to express resistance genes encoding R proteins, which are able to recognize effector proteins and signal a hypersensitive response (HR) and pathogen resistance gene expression. This defense response is called effector triggered immunity (ETI), characteristic of an incompatible response. Plants that do not recognize effector proteins are susceptible and have a compatible reaction with the infecting pathogen.

Compatible interaction is characterized by increased bacterial growth, increased levels of hormones such as ethylene and jasmonic acid (JA), and necrotic cell death. Incompatible reaction are characterized by HR involving a decrease in bacterial growth, programmed cell death, an increase in salicylic acid (SA) used to induce PR proteins and systemic acquired resistance(SAR) response.

SA is a secondary metabolite produced by a wide range of prokaryotes and eukaryotes including plants. During the past two decades, significant progress has been made in understanding SA metabolism, signalling, and its interaction with other defense mechanisms, especially hormones. SA is predominantly associated with resistance against biotrophic and hemibiotrophic pathogens, and triggering SAR.

Exogeneous application of SA induces SAR in plants, resulting in resistance to certain pathogens. Conversely, plants expressing the bacterial NahG (encoding salicylate hydroxylase) , which converts SA to catechol , are more susceptible to several pathogens. Direct evidence for the role of SA in plant defense comes from the identification and characterization of an Arabidopsis isochorismate synthase (ICS) mutant that is defective in SA biosynthesis. There are several studies suggesting that endogeneous SA in plants plays a critical role in pathogenesis by its direct effects on the pathogen. This review focuses on effect of salicylic acid on the pathogenesis of *Xanthomonas campestris* and its role in inducing SAR responses in the host plants

Key Words- Salicylic Acid, *Xanthomonas campestris* pv. *vesicatoria*, exogenous application

## INTRODUCTION

Plants are challenged by a variety of abiotic and biotic stresses. The oxidative state of plants has been found to play an important role against these kind of stresses. The defense against these stresses is mediated by various signalling pathways which produce many defensive proteins and non-protein compounds. Plant phytohormones such as abscisic acid, jasmonic acid, ethylene and salicylic acid (SA) are important components of different signaling pathways involved in plant defense. Unlike animals, plants lack specialized immune cells and immunological memory. However, each plant has developed the capability of sensing pathogens and corresponding immune responses. The basal resistance involves recognition of pathogen –associated molecular patterns (PAMPs) such as flagellin and lipopolysaccharides and give immune responses through PAMP triggered immunity(PTI). However pathogens have evolved effectors to dampen PTI. In turn plants have evolved resistance(R) proteins to detect effectors and induce effector triggered immunity (ETI). These signalling pathways (PTI and ETI) results in the generation of a mobile signal(s) that moves from localised infected tissue to a distal tissue, inducing systemic acquired resistance (SAR), which is a form of long lasting immunity to broad spectrum of pathogens.

**ROLE OF SA IN SYSTEMIC ACQUIRED RESISTANCE (SAR)**

Salicylic acid (SA), a plant hormone plays an important role in induction of plant defense against a variety of biotic and abiotic stresses. For thousands of years, humankind has extracted SA from willow tree bark to alleviate minor pain, fever, and inflammation. In plants SA was recognised as an endogeneuos regulator which triggers a dramatic increase in the production of metabolic heat and insect-attracting chemicals in the thermogenic inflorescences of *Arum* lilies (Raskin et al.,1987, 1989). Numerous studies suggest that SA is a vital component of the plant signal transduction pathways causing disease and pathogen resistance (Maleck and Dietrich, 1999).

Plants can activate separate defense pathways depending on the type of pathogen encountered. Jasmonic acid (JA) and ethylene dependent pathways seem to be initiated by necrotrophs, whereas salicylic acid dependent pathway is activated by biotrophic pathogens. The mechanisms responsible for this differential recognition and response may involve crosstalk among these three different signal transduction pathways:JA,ethylene(ET) ,and SA. SA mediates the phenylpropanoid pathway,while JA mediates octadecanoid pathway. Exogeneous application of SA and JA manipulates various physiological, biochemical and molecular processes in plants including antioxidative enzyme activities. SA regulates the activities of various enzymes such as, peroxidase (POD), polyphenol oxidase(PPO), superoxide dismutase(SOD), phenylalanine ammonia (PAL) etc., which are the major components against biotic and abiotic stresses.Plant phenolic compounds are the most abundant important group of defensive compounds that mediate plant defense. SA also activates the generation of reactive oxygen species (ROS) and other defensive processes such as hypersensensitive response and cell death. Consistently, application of exogeneous SA and its functional analogs , such as Aspirin, 2,6-dichloroisonicotinic acid (INA) ,and benzothiadiazole S-methyl ester (BTH), activates expression of PR genes and resistance against viral, bacterial and fungal pathogens in a variety of dicotyledonous and monocotyledonous plants.(Shah and Klessig 1999; Pasquer et al.2005; Makander et al.2006). Alternatively, blocking SA accumulation through expression of a bacterial salicylate hydroxylase, which converts SA to catechol, in transgenic tobacco and Arabidopsis compromises HR and abolishes SAR(Gaffeney et al. 1993; Delaney et al.1994)

***XANTHOMONAS CAMPESTRIS* PV. *VESICATORIA***

Bacterial spot , caused by *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, remains a constant threat to tomato (*Lycopersicon esculentum*, Mill.) commercial production. It can be destructive and can result in total crop loss in warm and humid areas due to persistence of the causal bacterium and weather conditions favourable to the disease. The bacterial spot pathogen may be carried as a contaminant on tomato seed. It is also capable of overwintering on plant debris in the soil and on volunteer host plant in abandoned field. Because the bacteria have a limited survival period of days to weeks in the soil, contaminated seed is a common source of primary infection in nursery and home gardens. In commercial fields, volunteer host plants are the main source of initial inoculum because the bacterial pathogen survives in lesions on these plants.

Bacteria enter through stomata on the leaf surfaces and through wounds on the leaves and fruit caused by abrasion from sand particles and/or wind. Prolonged periods of high relative humidity favour infection and disease development.

Symptoms can be found on all aboveground parts of tomato plants. Initially, spots appear as small, water-soaked, light to dark green areas on the young infected leaves and stems.

**SA AS CONTROL METHOD FOR BACTERIAL SPOT**

The current control strategies are based on a combination of practices such as use of pathogen- free seed and transplants, elimination of volunteer tomato plants, resistant cultivars, and frequent application of copper- or streptomycin-based bactericides (Kucharek, T. 1994).

No currently available bactericides are curative to bacterial cells when they reside and multiply inside the plant. Initial or subsequent infections may be prevented through chemical control. During the growing season, a series of copper-based chemicals are commercially available and commonly used to reduce disease incidence (Sun Xiaoan et al.,2002)

One of the potential plant disease management strategies is the use of systemic acquired resistance (SAR) to activate host defense mechanisms (Ryals et al.,1994). Chemical activation of disease resistnce in plants represents an additional option growers to protect their crop losses due to plant diseases. Salicylic acid is one of the most commonly used chemical inducers, which appears to be a central signalling molecule in SAR (Yalpani et.al.,1991: Vallad and Goodman ,2004). The SA dependent defense pathway can be activated by treatment of plants with chemical inducers such as benzo (1,2,3)-thiadiazole-7-carbothioic acid-S-methyl ester (acibenzolar-S-methyl, ASM or BTH). BTH is a chemical analogue of SA and has been used successfully to induce resistance to a wide range of diseases on field crops.

The experiments of Mohammed A. AL- Saleh of King Saud Univrsity (2011) has shown that various concentration of SA (0.5, 1.0, 1.5 ppm) were found to have inhibitory effects against *X.campestris* pv.*vesicatoria*. The inhibition zone increased with increasing concentrations. Also the foliar treatment of SA was found to be more effective than seedling treatment. Palva et. Al(1994) suggested that SA could directly affect bacteria as a chelating agent.

**CONCLUSION**

The use of chemical inducers or elicitors in crop protection and pest management is still in the very early stages of use as a new control method, and thus the current experiences come from experimental trials, and not yet from large scale agricultural use. But it can provide advantages over chemical control like reduced environmental hazards as these affect directly the crop plant. They can be used as protective agrochemicals and can be applied with the current spraying technology. Chemical induder treated plants bear lower ecological risks than GM plants.

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