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Effect of Salicyclic Acid and Indole Acetic Acid on Tomato Crop under Induced Salinity and Cadmium Stressed Environment: A Review

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Tomato is one of the common garden fruits in India and is cultivated worldwide because of its edible fruits that are rich in antioxidants, such as lycopene and carotenoid etc. Although densities of ascorbic acid and B-carotene in tomato are modest compared to some other vegetables, tomato ranks high as a source of vitamins A and C in human diets because of high consumption in many countries of the world. Cadmium (Cd) is probably one of the most toxic heavy metals, particularly at high concentrations, inhibiting plant growth and development, whereas at low concentrations Cadmium may also stimulate growth depending on the plant species. Cadmium can also negatively interfere with important plant processes such as water transport, oxidative phosphorylation in mitochondria, photosynthesis and chlorophyll contents. Salinity reduces plant productivity first by reducing plant growth during the phase of osmotic stress and subsequently by inducing leaf senescence during the phase of toxicity. Salicyclic Acid (SA) and Indole acetic acid (IAA) are

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involved in the protection of plants against multiple stresses, Such as salinity, water stress, drought stress, and herbicides. Indeed, this may be also reported that Salicyclic acid and Indole acetic acide can ameliorate the injurious effects of heavy metals on plants.

Keywords: Indole acetic acid; salicyclic acid; salinity and cadmium.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the common garden fruits in India and is cultivated worldwide because of its edible fruits that are rich in antioxidants, such as lycopene the consumption of tomato is believed to benefit the heart, among other cure and is world's most important vegetable crop in economic terms [1]. In an attempt to explain the scientific basis for the medicinal and nutritional benefits of lycopersicum esculentum (tomato), the phytochemical contents, anti-oxidant, anti-bacteria and anti-inflammatory activity were assessed [2]. The fruit contains lycopene, one of the most powerful natural antioxidants which are able to fight singlet oxygen and peroxy radicals otherwise both are responsible for damaging DNA in the process that leads to the origin of cancer. Similarly ascorbic acid and b-carotene also act as antioxidant against reactive oxygen species (ROS) and protect the living system from their damaging effect [3]. Tomato plant is warm-season perennial, that typically grows into a shrub, although often grows as an annual. And one of the crops that have recently been added to the list of the world's major food. Tomato is considered a significant vegetable crop that play notable role in human health due to variety of vitamins, carotenoids, beneficial acids, sugar and minerals. Tomato is consumed in diverse way as raw or culinary processes [4]. Tomatoes are also an excellent source of free radical-scavenging vitamin C and vitamin A as well as bone-healthy vitamin K. They are a very good source of enzyme-promoting molybdenum; heart-healthy potassium, vitamin B_6, folate, and dietary fiber; blood sugar-balancing manganese. In addition, tomatoes are a good source of heart-healthy magnesium, niacin, and vitamin E; energy-producing iron, vitamin B_1, and phosphorus; muscle-building protein, and bone-healthy copper [5].

Salinity: Salinity is a limiting environmental factor for plant production, and is becoming more prevalent as the intensity of agriculture increases. Around the world, 100 million ha, or 5% of arable land, adversely affected by high salt concentrations, which reduce crop growth and yield [6]. Salt stress is major environmental constraint most limiting plant productivity. Seeking salt-tolerant crops requires an examination of the behaviour of the plant development including seed germination stage [7]. Tomato cultivar PKM 1 was subjected to 25, 50, 100, 150 and 200 mM NaCl stress and response of tomato plant to salt stress were determined by assessing the variability of different biochemical parameters**,** in tomato plants the applications of NaCl caused increase in Na+ content, while K+ content and K+/Na+ ratio decreased with increase in salt stress [8]. Salinity is one of the major environmental factors limiting plant growth and productivity [9]. High salt concentration in particular Na+ which deposits in the soil, can alter the basic texture of the soil, thereby causing decreased soil porosity, and consequently leading to reduced soil aeration and water conductance. Soil salinity alters root and shoot hormone relations, e.g. it decreases cytokinins and gibberellins and increases abscisic acid contents [10]. Salinity disrupts plant morpho-physiological processes due to osmotic disturbance and ionic stress [11]. Salt stress can restrict photosynthesis by decreasing green pigments 12 suppressing rubisco activity [13] and reducing stomatal conductance, thus affecting internal CO_2 availability [14]. Salt stress can reduce activity of various enzymes involved innnitrogen metabolism thus reducing plant nitrogen status [15]. General symptoms of damage by salt stress are growth inhibition, accelerated development and senescence and death during prolonged exposure. Growth inhibition is the primary injury that leads to other symptoms although programmed cell death may also occur under severe salinity shock. Salt stress induces the synthesis of abscisic acid which closes stomata when transported to guard cells. As a result of stomatal closure, photosynthesis declines and photoinhibition and oxidative stress occur [16]. The review investigates the effect of salicyclic acid and indole acetic acid on tomato crop under induced salinity and cadmium stressed environment.

Cadmium: Cadmium (Cd) is a toxic heavy metal, which can cause severe damage to plant development roots of the tomato hormonal mutants, when analysed by light microscopy, exhibited alterations in root diameter and disintegration of the epidermis and the external layers of the cortex. A comparative analysis has allowed the identification of specific Cd-induced ultrastructural changes in wild-type tomato, the pattern of which was not always exhibited by the mutants [17]. Contamination of the soil by toxic elements such as heavy metals is a major environmental concern [18]. Cadmium (Cd) is probably one of the most toxic heavy metals, particularly at high concentrations, inhibiting plant growth and development, whereas at low concentrations Cd may also stimulate growth depending on the plant species [19]. Cadmium (Cd) is generally known as the most toxic pollutants in the environment. Furthermore, this heavy metal has a high mobility in soil and is easily absorbed by plant roots [20]. Cadmium preferentially accumulates in the chloroplasts and disrupts chloroplast function by damaging the membrane and inhibiting the biosynthesis of chlorophyll and the CO_2 fixation activity [21]. Cadmium toxicity is known to decrease nodulation and the activity of nitrogen-metabolizing enzymes, thereby decreasing the ability of the plants to fix nitrogen [22].

The toxicity of heavy metals in different plants is varied commensurate with factors such as the availability of metals in soils, metal uptake by plants and the amount of its displacement in plant parts. This toxicity occurs when the related metal can enter to system of plant root from the soil [23]. Usually soils contaminated with cadmium possess other polluting elements such as lead and thus further threaten the health of organisms [24]. It has been reported that the delay in the growth of plants is one of the symptoms of toxicity with cadmium [25]. Studies have shown that cadmium affects the cell division and growth, the overall growth of plant, cell division in meristematic region and the regulation of the growth and development of plants [26]. This dangerous toxic element can disrupt the metabolism of carbohydrates [27]. Cadmium also shows diverse effect on growth and yield parameters of vegetable crops [28]. Heavy metals like Cadmium etc on soil profile may prove harmful not only to plants, but also to consumers of the harvested crops [29].

Salicyclic acid (SA) against Salinity and Cadmium stress: A specific experiment has been carried out by Salicylic acid (SA) on tomato, results revealed that the maximum leaf area, number of clusters and number of fruits per plant, sucrose, fructose, glucose, total soluble solid (TSS), vitamin C and lycopene. Consequently, foliar applications of SA in growth duration lead to biomass accumulation which guide to enhance of carbohydrates, TSS, vitamin C and lycopene under salt stress [30]. Acetyl salicylic acid enhanceroot activity and improve root morphological features in tomato plants under heat stress [31]. Salicylic acid (SA) plays an important role in abiotic stress tolerance, and considerable interests have focused on SA due to its ability to induce a protective effect on plants under stress. Many studies support the SA-induced increases in the resistance salinity [32] and osmotic stress [33] and of rice on heavy metal stress [43]. Salicylic acid (SA) is an endogenous plant growth regulator that acts as a signal in the induction of specific plant responses to biotic and abiotic stresses. SA is involved in the protection of plants against multiple stresses, including freezing, salinity, ozone, ultra-violet radiation, water stress, drought stress [35]. As seed treatment with H_2O_2 it had an alleviating effect on the oxidative damage caused by salt stress in wheat plants [36], it seems possible that SA may exert its protective effect partially through the transiently increased level of H_2O_2. Root drenching with 0.1 mM SA protected tomato (Lycopersicon esculentum) plants against 200 mM NaCl stress [37]. It increased the growth and photosynthetic rate of the plants, as well as the transpiration rate. The application of salicylic acid at varying concentrations of 100 and 200 ppm can lead to overcome salinity situations upto a certain extent [38].

Seeds with SA have been reported to ameliorate the effects of Cd-induced heavy metal toxicity via enhanced activities of reactive oxygen species (ROS)-scavenging enzymes [39]. Indeed, there are many reports that show that SA can ameliorate the injurious effects of heavy metals on plants [40]. SA-induced protection of plants from oxidative injury caused by metals including Cd is mainly linked to enhanced accumulation of antioxidant enzymes [41].

Indole acetic acid (IAA) against Salinity and Cadmium stress: The exogenous applications of IAA under salt stress improve the root and shoot length through raising the absorption of water and mineral. These results were similar with the effects of [42]. Of the various plant growth regulators which regulate growth under normal or stress conditions, indoleacetic acid (IAA) plays a vital role in maintaining plant growth under stress conditions including salt stress [43]. Foliar-applied IAA (15 mg l-1) considerably ameliorated the adverse effects of salt on these plants 44. It has also been reported that the exogenous application of IAA showed high stimulatory effects on the root and shoot growth of wheat seedling in saline condition [45]. IAA exogenous application provides an attractive approach to counter the stress conditions [46]. The hypotheses of this study were that the growth-promoting phytohormone auxin (indole-3 acetic acid, IAA) can alleviate toxic effects of metals on plants [47]. In particular IAA increased root and sometimes also shoot growth of plants that were stressed by salinity or heavy metals and IAA alleviated drought stress and suggested that exogenously applied IAA may serve in mediating morphological reactions of plants in response to stresses, in particular by increasing root growth [48].

2. CONCLUSION

It can be concluded that stress like salt or heavy metal shown the negative impacts on growth, yield, physiological and biochemical parameters of plants. But the applications of SA and IAA can ameliorate the injurious effects of heavy metals and salt stress from plants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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