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Review on the Role of Salicylic Acid in Plants

Ali S. Hassoon and Inas Abdulsattar Abduljabbar

Abstract

Salicylic acid and its derivatives as one of the plant hormones produced by the plant naturally belong to the group of phenolic acids and consist of a ring linked to the group of hydroxyl and carboxyl group, and the starting ingredient to form the cinnamic acid. It is mainly manufactured within the plant in cytoplasmic cell. This acid was first discovered in *Salix* spp., which contains the Salicin compound by 9.5–11% and is present in the plant in the form of free phenolic acids or associated with amino compounds. Symbolized by the symbol SA called chemical ortho hydroxyl benzoic acid chemical formula is $C_7H_6O_3$.

Keywords: salicylic acid, plants

1. Introduction

Salicylic acid and its derivatives as one of the plant hormones produced by the plant naturally belongs to the group of phenolic acids and consists of a ring linked to the group of hydroxyl and carboxyl group, and the starting ingredient to form is the cinnamic acid (**Figure 1**). It is mainly manufactured within the plant in cytoplasmic cell. This acid was first discovered in *Salix* spp., which contains the salicin compound by 9.5–11% and is present in the plant in the form of free phenolic acids or associated with amino compounds [1]. Symbolized by the symbol SA called chemical ortho hydroxyl benzoic acid chemical formula is $C_7H_6O_3$ [2].

Salicylic acid plays an important role in the growth and development of the plant for important physiological roles such as increasing the plant's response to stress conditions (biotic and abiotic) by increasing the resistance of the plant to System Acquired Resistance (SAR) by stimulating or changing the internal paper dissection endogenous signaling to withstand a large number of stresses. Salicylic acid acts as a stimulant or transmitter of the cell to withstand environmental stress conditions such as dryness, coldness, heat, stress of heavy elements, and conditions of ammonia tension and also increases the plant's ability to withstand salt stress salt particularly harmful sodium chloride compound NaCl [3].

It also has the ability to bind conjugate with some amino acids such as proline and arginine, which increase the plant's effectiveness in resisting environmental stresses and at the same time maintain systemic acquired resistance [4].

The most important effects of salicylic acid are to stimulate the production of antioxidants. Antioxidant against the effect of free radicals from the group Reactive Oxygen species (ROS) when exposed to heat stress and stress Drought stress and prevents the oxidation of algebraic and oxytin and cytokinein and also has a role at

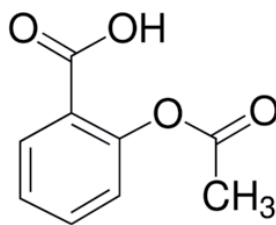


Figure 1.
Chemical structure of SA acid.

the genetic level. It stimulates the genes of antioxidant enzymes such as manganese superoxide dismutase (Masud) [5].

Salicylic acid increases the plant's response to tolerance and resistance to various diseases affecting plants as it is found that increasing its internal concentration activates the protective role of pathogenic pathogens [6]. The SA also has many important physiological roles, such as stimulating the flowering, ion absorption, nutrient transfer, increasing the representation of CO₂ gas, controlling the movement of stomata, photo materials, gas exchange, and protein synthesis. It also contributes to increasing the percentage of nucleic acids and amino acids and the accumulation of dry matter and speeds up the formation of various plant dyes and increasing their levels such as chlorophyll and carotene and prevents the representation of ethylene gas, and it is contrary to the work of ABA responsible for the fall of leaves. It also plays an important role in increasing metabolic rates, which contributes to the energy saving of the plant through alternative pathways accompanied by a change in the level of nucleic and amino acids within the plant [7].

2. Effect of salicylic acid in growth and yield

De Kock et al. [8] were the first to talk about the role of salicylic acid as a growth regulator during the past two decades, after which the interest in this compound has increased, and many studies have been conducted that showed a relationship between salicylic acid and the growth and development of plants. Among these studies is the finding of the cotton plant *Gossypium hirsutum* L., which belongs to the Malvaceae family in three levels of salicylic acid (50, 100, and 150) mg/l had it. The highest rate of the studied traits was the plant height (143.80) cm, the number of branches (34.28 branches), and the total cotton yield (3371.9) kg/Ha in relation to other concentrations used [9].

Najafian [10] concluded that *Rosmarinus officinalis* L. spraying with three levels of salicylic acid (450, 300, and 150) mg/l resulted in a significant increase in growth rates and photosynthesis compared to untreated plants. The increase was more pronounced when spraying plants with a concentration of 300 Mg.

Najafian [11] found that spraying SA acid at three levels (150, 300, and 450) mMol on *Thymus vulgaris* L. had a significant effect on the studied traits. Spraying at a concentration of 150 mM gave an increase in the dry weight of the vegetative total and photosynthesis and increased plant tolerance for salt stress conditions.

In a study on the response of the Indian mustard *Brassica juncea* L. to spraying with two levels of salicylic acid (35 and 70 mg), there was a significant superiority in all vegetative traits studied (plant height, number of branches, and leaf area). In addition, there was a significant increase in all the parameters of the crop (the weight of one mustard, the total yield of the seed, and the seed yield), when spraying the plants at a concentration of 70 mg/l in comparison with the concentration of 35 mg/l and spraying with distilled water only [12].

In a study conducted in Pakistan on the *Abelmoschus esculentus* L., which belongs to the marsh family, [13] found that salicylic acid spraying with concentrations of 50 and 75 mg/l had a significant effect on most studied traits. The effect of spraying was 50 mg/l is more pronounced in increasing vegetative growth rates and leaf content than chlorophyll.

Abbas and Ibrahim reported [14] that the growth regulator SA was sprayed on *Niggella sativa* L. at several levels (50, 100, and 200) mg/l with significant effect on the studied traits. And 200 mg/l. Spraying at a concentration of 50 mg/l was the best in increasing growth, yield, and oil ratio indices.

Al-Mohammadi and Al-Rawi also [15] observed a study on the effect of spraying on some of the growth catalysts on *Datura stramonium* L. The spraying with acetylsalicylic acid at 200 ppm gave the highest rate of all vegetative and studied traits (plant height, dry and vegetative content of the leaves, nitrogen and potassium, number of fruits, plant and the total yield kg/hectare) compared to non-treated plants.

3. Effect of salicylic acid in qualitative and medical qualities

The significant phylogenetic effects reflected by the salicylic acid act towards the growth and development of the plant and the improvement of its health made it a popular vehicle for those interested in agricultural production. This has already been shown to improve the qualities of many plants that occupy a high economic position. It also activates the roles of many enzymes and also has an important action towards syphilis and the bio-synthesis of ethylene gas (the maturation hormone and aging) and the movement of stomata and contributes to plant metabolism and transfer of ions [16, 17].

Through research and studies on the effect of salicylic acid treatment on the specific qualities of plants, Gharib [18] noted that the spray of the basil plants *Ocimum basilicum* L. and the *Majorana hortensi* L. were planted in a 40 cm pot with three concentrations of salicylic acid [10^{-3} , 10^{-4} , 10^{-5}] mole resulted in a significant increase in the ratio of the active ingredient of both plants compared to the comparison treatment. The spraying of two varieties of *Cymbopogon flexuosus* L. with a concentration of 5–10 m of salicylic acid developing in the plants gave a significant increase in the specific qualities and active substances of plants and antioxidants compared to non-treated plants [19].

Khandaker et al. showed [20] that spray of red *Amaranthus tricolor* L. plants with three concentrations of salicylic acid (10^{-3} , 10^{-4} , and 10^{-5} mm) had the most significant effect on plant active compounds compared to untreated plants and significant increase in properties (total phenols, antioxidant, and plant pigments). Salicylic acid spraying with concentrations (25 and 50 mg/l) on the vegetative group of *Cumin cyminum* L. resulted in a significant increase in the percentage of plant pigments at a concentration of 50 mg/l compared to comparison plants [21].

The addition of salicylic acid with three concentrations (30, 60, and 90 mg/l) resulted in a significant increase in the production of some plant antioxidants from blackwheat leaves when treated with concentrations of 60 and 90 mg/l compared with non-treated plants [22].

Majoul showed [23] a significant increase in the percentage of nutrients P, N, and the leaf content of chlorophyll when spraying the okra plants were measured at two levels of salicylic acid (78 and 155 mg/l) and in two steps compared to the comparison treatment.

The medicinal seeds of the *Digitalis trojanaivanina* collected from the Turkish Aida mountains with three concentrations of salicylic acid resulted in significant superiority in the studied active substances (pigment content, total phenols, phenols, and flavonoids) compared to non-treated plants [24].

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References

- [1] Janda M, Ruelland E. Magical mystery tour: Salicylic acid signaling. Environmental and Experimental Botany. 2014. In Press
- [2] Pál M, Szalai G, Kovács VG, Janda OK. Salicylic acid-mediated abiotic stress tolerance. In: Hayat S, Ahmad A, Alyemeni MN, editors. Salicylic Acid. Netherlands: Springer; 2013. pp. 183-247
- [3] Simaei M, Khavari-Nejad RA, Bernard F. Exogenous application of salicylic acid and nitric oxide on the ionic contents and enzymatic activities in NaCl-stressed soybean plants. American Journal of Plant Sciences. 2012;3:1495-1503
- [4] Baghizadeh A, Hajmohammadrezaei M. Effect of drought stress and its interaction with ascorbate and salicylic acid on okra (*Hibiscus esculents* L.) ruination and seedling growth. Journal of Stress Physiology & Biochemistry. 2011;7(1):55-65
- [5] Horvath E, Szalai G, Janda T. Induction of a biotic stress tolerance by salicylic acid signaling. Journal of Plant Growth Regulation. 2007;26(3):290-300
- [6] Kumar D. Salicylic acid signaling in disease resistance. Plant Science. 2014;228:127-134
- [7] Davies PJ. The plant hormones: Their nature, occurrence and function. In: Davies PJ, editor. Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd ed. Dordrecht: Kluwer Academic Publishers; 2004. pp. 1-15
- [8] De Kock PC, Grabowsky FB, Innes AM. The effect of salicylic acid on the growth of *Lemna gibba* L. Annals of Botany. 1974;38:903-908
- [9] Al-Rawi ANT, Al-Ani MH, Al-Saad TM. Response of cotton *Gossypium hirsutum* L. for different irrigation periods and salicylic acid. Anbar Journal of Agricultural Sciences. 2014;12(2):283. The Republic of Iraq
- [10] Najafian S, Khoshkhui M, Vahid T. Effect of salicylic acid and salinity in rosemary (*Rosmarinus officinalis* L.): Investigation on changes in gas exchange, water relations, and membrane stabilization. Advances in Environmental Biology. 2009;3(3):322-328. Iran
- [11] Najafian S, Khoshkhui M, Tavallali V, Saharkhiz MJ. Effect of salicylic acid and salinity in thyme (*Thymus vulgaris* L.): Investigation on changes in gas exchange, water relations, and membrane stabilization and biomass accumulation. Australian Journal of Basic and Applied Sciences. 2009;3(3):2620-2626
- [12] Dugogi EH, Mahdi NK, Matroud SAK. Response of Indian mustard (*Brassica juncea* L.) to the distance of planting and spraying with salicylic acid and their effect on growth, seed yield and hard oil. In: Second Scientific Conference of the Faculty of Agriculture, University of Karbala; 2012. pp. 173-181. The Republic of Iraq
- [13] Raza SH, Shafiq F, Khan I. Seed invigoration with water, ascorbic and salicylic acid stimulates development and biochemical characters of okra (*Ablemoschus esculentus*) under normal and saline conditions. International Journal of Agriculture and Biology. Faisalabad University. 2013;15:486-492. Pakistan
- [14] Abbas J, Ibrahim BA. Effect of salicylic acid in some vegetative and fruit traits of the black bean. Iraqi Journal of Agricultural Sciences. 2014;45(8):845-853. (Special number) The Republic of Iraq

- [15] Al-Mohammadi AN, Al-Rawi AR. Effect of planting date, growth promoters, type of organic manure on growth and yield, and active ingredient of *Datura stramonium* L. Tikrit Journal for Agricultural Sciences. 2016;**16**(2):26-50. The Republic of Iraq
- [16] Krasavina MS. Effect of Salicylic Acid on Solute Transport in Plants. Timiryazev Institute of Plant Physiology. Moscow, Russia: Springer; 2007. pp. 25-68
- [17] Hayat S, Ali B, Ahmed A. Salicylic acid: Biosynthesis, metabolism and physiological role in plants. In: Salicylic Acid—A Plant Hormone. Netherlands: Springer; 2007. pp. 1-14
- [18] Gharib FAE. Effect of salicylic acid on the growth metabolic, activities and oil content bail and major. International Journal of Agriculture and Biology. 2006;**8**(4):485-492
- [19] Idrees MM, Khan MA, Aftab T, Naeem M, Hashmi N. Salicylic acid-induced physiological and biochemical changes in lemongrass varieties under water stress. Journal of Plant Interactions. Aligarh Muslim University. 2010;**5**(4):293-303. India
- [20] Khandaker L, Akond AS, Oba S. Foliar application of salicylic acid improved the growth, yield and leaf's bioactive compounds in red amaranth (*Amaranthus tricolor* L.). Vegetable Crops Research Bulletin. 2011;**74**:77-86. Japan
- [21] Shouaily MS. A physiological study of the effect of planting method, the number of plants in Joura and the spraying of salicylic acid concentrations and their interactions in the vegetative and syphilis growth of *Cuminum cyminum* L. Basrah Journal of Agricultural Sciences. 2012;**25**(2):37-46. The Republic of Iraq
- [22] Nasrallah AY, Saadallah HSE, Ne'ma SI. Effect of some plant growth regulators on field properties and antioxidant production of blackwheat leaves. Iraqi Journal of Agricultural Sciences. 2015;**46**(5):682-694. The Republic of Iraq
- [23] Majoul AK. Effect of salicylic acid and boron in the growth and yield of the plant *Abameoschus esculentus* L. Btira. Al-Furat Journal of Agricultural Sciences. 2015;**7**(3):27-35. The Republic of Iraq
- [24] Cingoz GS, Ekrem G. Effect of salicylic acid on thermo tolerance and cardenolide accumulation under high temperature stress in *Digitalis trojana* Ivanina. Journal of Plant Physiology and Biochemistry. Abnat Izzet Baysal University. 2016;**105**:145-149. Turkey