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EFFECT OF SALICYLIC ACID IN GROWTH AND FLOWERING OF BULBS (REVIEW ARTICLE)

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Abstract

Salicylic acid is one of the internal growth regulators derived from phenols with multiple functions, this acid was found in *Salix* spp. (willow tree) and extracted naturally since 1928 by the scientist John Buchner, it's produced from the amino acid phenylalanine. Salix plant contain the salicin compound by 9-11%. It's plays an important role in the growth and development of the plant for physiological effect such as increasing the plant's response to stress conditions (biotic and abiotic). salicylic acid also involved in many bio processes including growth, photosynthesis, cellular metabolism, protein synthesis, stomatal closure and gas exchange, as well as strengthening the defense system protects the plant against various diseases and increases the effectiveness of antioxidants and enzymes. It's also work as stimulating the flowering, ion absorption, nutrient transfer within the plant. Numerous experiments have indicated that spraying or soaking many bulbs with salicylic acid gave the best results for vegetative and flowering growth, as well as giving the best diameter and size of the bulbs formed for many plants such as gladiolus, tuberose, amaranth, lilium, tulipa, narcissus and lycoris.

Keywords: Salicylic acid, Growth, Bulbs.

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Introduction

Plants are one of world's richest sources of natural medicine, until the 19th century when the salicylates, including salicylic acid (SA), methyl salicylates were isolated from extracts of different plants like willow [1]. Plants have specific mechanisms to resist various environmental stresses, which include the activation of antioxidant enzymes and non-enzymatic antioxidants such as carotenoids, ascorbic and salicylic acid, SA is a phenolic compound that inhibits ethylene production, the inhibitory actions of SA most closely resembled with that of dinitro phenol, a known inhibitor of ethylene forming enzymes, and the starting compound for salicylic acid for its production inside plants is cinnamic acid [2]. It was found throughout the plant kingdom and has been traced historically, it was used by the Greek physician Hippocrates in 400 BC, for its medicinal virtues, he prescribed it as a decoction of Salix to treat patients [3] [4]. Since 1859 Kolbe & Schmitt discovered the Kolb-Schmitt reaction to chemically synthesize SA from phenol, allowing for it to be produced on a large commercial scale, then in 1893 Felix Hoffman was the 1st to synthesise pure derivative acetylsalicylic acid (known as asprin) which produces less gastrointestinal irritation yet has similar medicinal properties [5]. SA was extracted naturally since 1928 by the scientist John Buchner from the Salix (Latin name for the willow tree which the name was derived), and produced from the amino acid phenylalanine via Coumaric and benzoic acid [6].

SA was classified as an endogenous plant hormone because of its physiological roles in plant such as induction of flowering, regulating ions absorption, nutrient transfer, increasing the representation of CO_2 gas, protein synthesis, hormonal balance and stomatal movement, it also plays a role in regulating the response of plants to environmental stress condition and provides protection against them, such as abiotic stress (salt, heat, drought, chilling) and stress resulting from minerals, as well as biotic stress factor especially to Fusarium, SA affects the biosynthesis of ethylene and has an opposite role to the growth inhibitor "Abscisic acid " [1][7].

The importance of using salicylic acid in plant's tolerance to abiotic stresses, especially drought, is due to its multiple roles in regulating plant metabolism [8]. It plays a role in protecting the plant from frost, drought, and salinity by resisting the formation of active free oxygen radicals (ROS), which destroy cell membranes by oxidizing unsaturated fatty acids and changing the effectiveness of antioxidant-resistant enzymes [9].

Several researchers have determined that salicylic acid causes an increase in vegetative activity and the positive effect of SA on growth and productivity may be attributed to its direct effect on other plant hormones, as it affects the rates of auxin and cytokinin, as well as its role to increase flowering rates by increasing the number of flower buds in comparison with vegetative buds [10]. It's also work to accelerate the formation of chlorophyl, carotene and anthocyanin, photosynthesis by stimulation the formation of grana plates, development of chlorophylase and inhibiting the action of the chlorophyllase enzymes which naturally has a positive effect on the photosynthesis, enzyme activity and it has a role in the process of thermoregulation in some plant, as well as increasing the resistance of plant to diseases and insects [4] [11]. In addition, SA was participated in increasing of metabolic rates which contributes to the energy of the plant through alternative pathways accompanied by a change in the level of nucleic and amino acids within the plant, SA has the ability to bind conjugate with some amino acids such as proline and arginine, which increase the plant's effectiveness in resisting environment stresses [12].

SA compound may also contribute in signal regulation process during the practical of gene expression of leaf senescence in Arabidopsis plants [13]. So many studies have proven that spraying plants with salicylic acid gives a signal to the plant that it's under conditions of tension and stress, so this is what prompts the plant to increase its production of antioxidant enzymes and the most important of them catalase, peroxidase and super oxide dismutase (SOD), these enzymes were the first lines of defense for the plant cell, they also limit damage resulting

from stress and encourage the plant to re-growth [14] [15]. Catalase converts hydrogen peroxide into oxygen and water, the SOD is the plant cells defender against free radicals, peroxidase contributes to reducing oxidation reactions [16]. During recent years, this compound has gained the attention of researchers due to its ability to induce systemic acquired resistance (SAR) in plants when attacked by many pathogens, as this leads to the production of defense proteins [17].

The relationship between salicylic acid and the growth, development of plants was revealed by [18] on Gladiolus, [19] on Tuberose, [20] on Red amaranth, [21] on Lilium. Salicylic acid is an aromatic carboxylic acid of a phenolic nature, a low molecular weight and is colorless, dissolves in water and polar organic Solvents, it's formed by the process of removing the carboxyl group from Trans-cinnamic acid to form benzoic acid and by the action of the enzyme (Benzoic acid 2-hydrxylase), salicylic acid was produced, and its chemical formula is $C_6H_6O_3$ [22]. The effectiveness of salicylic acid used to spray the plants depends on the type of plant, the time of addition, and the concentration used, in this regard,[23] has been noted that when treatment of *Polianthus tuberosa* with salicylic acid by foliar spraying every 20 day at concentration of 0,50, 100 and 200 ppm, it led to recording the maximum duration of flowering the second floret, longest length of flower stalk, number of leaves per plant, the chlorophyll content, number of florets and it's diameter, vase life at concentration of 200 ppm. The bulbs of *Tulipa* sp. were soaked with SA at a levels (0, 250, 500, 1000) ppm and then planted in (green house, outdoor) conditions, the results indicated that the bulbs were grown in the green house had given the first emergence, lowest number of days for flowering moreover the flower length, flower stalk length, flower life was significantly superior with those grown outdoor when treated with SA at a level 1000 ppm [24].

[25] mentioned that the lower concentration of SA 150 ppm had a longer vase life of *Narcissus tazetta* L. than 300 ppm which had more effective in increasing fresh weight of cut flowers and water uptake is due to stress-relieving and acidifying properties of salicylic acid. [26] indicated that spraying of three cultivars of *Gladiolus hortulanus* L. with SA at 250 ppm had a significant effect of showing the highest values for the weight, diameter and volume of the corms from the red variety and more plant height, leaf area, dry weight of leaves, number and diameter of florets, length of inflorescence, duration of flowering as well as the diameter and their dry weight and total sugars accumulated in the corms, total chlorophyll content of leaves and the percentage of dry matter when sprayed with SA at four concentration (0, 50, 100, 150) ppm and it's significantly of 150 ppm to give the best characteristics, comparison with the two varieties of white and purple flowers. These results are illustrative that SA may be involved in many processes i.e. morphogenetic like the formation of flowers and tubers, photosynthesis process result, more dry total sugars accumulated in the corms [27]. More dry matter productively, according to [28] examined the effect of SA in delaying the dissolution of plant organs, especially (leaves and flowers), which automatically helps the site of photosynthesis remain effective for a longer period, it prevents the risk of falling flowers and immature fruits, which leads to increased yield. [29] concluded in a study evaluating the development of *Lycoris radiata* and its carbohydrate content and enzyme activity when treated with three growth regulators, including SA sprayed on the shoots at different concentration, the result showed that SA was a stimulant the growth and development of the bulbs, increasing the carbohydrate content, enzyme activity and bulb's size, in addition to the role of the β-amylase enzyme in starch metabolism in bulbs. In a study on the response of Gladiolus corms to soaking with two levels of salicylic acid (100, 150) ppm for 24 hours, there was a significant superiority at the concentration150 ppm in the time for emergence of 50% of the corms, largest number of branches per plant, longest period for the inflorescences to remain in good coordination, and the largest (number, diameter, length) of the inflorescence as well as vase life [30].

Also spraying this hormone at 200 ppm leads to a significant increase in plant height, leaves per plant, leaf area, total chlorophyll as well as days to appearance flower buds, days to colour visibility in bud and also increase the stalk length, days for sprouting of *Lilium asiatic* hybrid tresor [31]. [32] who reported better seedling growth with SA application on the trait of day to flowering was highly significant and occurred earlier in SA 2% comparison with control treated had a few days' delay in flowering of *Crocus sativus* L.

Conclusion

Salicylic acid plays a role in improving most of the characteristics of vegetative, flowering growth and bulbs, due to its effect increasing the level of cell division within the apical tissues responsible for increasing growth, including plant height, number of branches, and leaf area. It also works to prevent the oxidation of internal hormones through its direct effect in encouraging and stimulating auxins for the purpose of stimulating meristematic cell division from the beginning of root growth with increasing the number of root hairs and their percentage, thus improving the characteristics system, which reflects positively on increasing vegetative growth rate. In addition to the role of hormonal acid in the accumulation of dry matter and increasing the dry weight of the plant and the activity of β_glucosidase enzyme. SA affects the acceleration of the formation of Photosynthetic pigments (chlorophyll) which increases the efficiency of photosynthesis and this is reflected positively in increasing the activity of biological processes.

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تأثير حامض السالسيليك في نمو وازهار الأبصال (مقالة مراجعة)

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الخلاصة

حامض السالسيليك هو أحد منظمات النمو الداخلية المشتق من الفينولات ذات الوظائف المتعددة، يتواجد هذا الحامض في شجرة الصفصاف *Salix* spp. واستخلص طبيعيا منذ عام 1928 على يد العالم جون بوشنر وتم إنتاجه من الحامض الأميني فينيل ألانين. يحتوي نبات الصفصاف على مركب السالسين بنسبة 9-11%. يلعب حامض السالسيليك دوراً هاماً في نمو وتطور النبات لتأثيره الفسيولوجي في زيادة استجابة النبات لظروف الإجهاد (الاحيائية واللااحيائية). كما يشارك حامض السالسيليك في العديد من العمليات الحيوية منها النمو والتمثيل الضوئي والتمثيل الغذائي الخلوي وتخليق البروتينات، واغلاق الثغور وتبادل الغازات،كما أنه يقوي نظام الدفاع ويحمي النبات من الأمراض المختلفة ويزيد من فعالية مضادات الأكسدة والإنزيمات. ويعمل ايضاً على تحفيز التزهير وامتصاص الأيونات ونقل العناصر الغذائية داخل النبات. لقد اشارت التجارب الى ان رش أو نقع العديد من الأبصال بحامض السالسيليك قد اعطى أفضل النتائج للنمو الخضري والزهري، كما أعطى أفضل قطر وحجم للأبصال المتكونة للعديد من النباتات مثل الكلاديولس ومسك الروم والقطيفة الدموية والليليم والتوليب والنرجس وزنبق العنكبوت الاحمر.

الكلمات المفتاحية: حامض السالسيليك، النمو، الأبصال.