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Effect of Salicylic Acid Spray in Seedling Stage on Yield and Yield Components of Tomato

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ABSTRACT

Background: Salicylic acid (SA) plays a critical role in plant development and defense responses to biotic and a biotic stresses. Objective In other to study the effects of salicylic acid on some quality characters of tomato different concentration of salicylic acid (10-2, 10-4, 10 -6, 10-8 molar and control) was done in seedling stage as foliar replication. Measured characters was including (number of panicle in a bush, yield, fruit number in panicle, fruit number in bush, fruit weight and fruit diameter). Results: Obtained results of this study show that salicylic acid significantly affected number of panicle in a bush, yield, fruit number in panicle, fruit number in bush, fruit weight and fruit diameter. Among foliar application, the highest rate of tomato yield with mean of 3059.5 g obtained in SA3 (SA at 10-6 M), highest numbers of panicle in tomato bushes with mean of 31.25 measured in SA1 (SA at 10-2 M). Highest fruit number in panicle and highest fruit number in bush obtained by mean of 3.5 and 66.75 in SA1 (SA at 10-2 M), respectively and minimum amount of all this characters was recorded in control treatment and the highest amount of fruit weight and also fruit diameter was measured in control treatment with mean of 61.50 g and 51.75 mm, respectively.

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INTRODUCTION

Tomato (*Lycopersicon esculentum*, Mill) is an important vegetable crop, not only because of its economic importance, but also for the nutritional value of its fruits, which is an excellent source of natural colors and antioxidant compounds, like vitamin C and carotenoids. In early 1960s, it was suggested that salicylic acid is synthesized in plants from cinnamic acid by two possible pathways. One pathway involves the decarboxylation of the side chain of cinnamic acid to form benzoic acid, which in turn undergoes a 2-hydroxylation to form salicylic acid. Such biosynthetic pathway of salicylic acid has been reported in tobacco (Yalpani *et al*, 1993) and in rice (Silverman *et al*, 1995). Salicylic acid (SA) is an endogenous growth regulator of phenolic nature, which participates in the regulation of physiological processes in plants (Raskin, 1992). SA, for example, is postulated to play a role as a natural inductor of thermogenesis in Arum lily, to induce flowering in a range of plants, to control ion uptake by roots and stomatal conductivity (Raskin, 1992). Moreover SA might serve as a regulator of gravitropism (Medvedev and Markova, 1991), inhibition of fruit ripening (Srivastava and Dwivedi, 2000) and of other processes. SA application may cause a temporary and low level of oxidative stress in plants, which acts as a hardening process, improving the antioxidative capacity of plants and helping to induce the synthesis of protective compounds and, therefore, the acclimation to stress (Janda *et al*, 2007). In addition to its role in the elicitation of plant defense mechanisms, SA also functions in various physiological and biochemical processes, including plant growth, thermogenesis, flower induction, nutrient uptake, ethylene biosynthesis and stomatal movements (Hayat *et al*, 2010). In particular, the effects of SA on photosynthesis and respiration have been well described (Fariduddin *et al*, 2003; Hayat *et al*, 2005). Moreover, proteomic studies have revealed that exogenous application of SA can up- or down-regulate some proteins and enzymes involved in plant carbohydrate/energy metabolism (Chan *et al*, 2007; Tarchevsky *et al*, 2010). All of these known effects indicate that SA may have a dramatic effect on sugars metabolism in plants. In recent years, there have been an increasing number of reports on the protective effect of exogenously applied SA on abiotic stresses, such as water stress (Singh and Usha, 2003), cold (Tasgín *et al*, 2003), high temperature (He *et al*, 2005; Wang and Li, 2006), heavy metals (Yang *et al*, 2003), UV-B irradiation (Evin *et al*, 2004) and salinity stresses (Khodary, 2004; EI-Tayeb, 2005; Szepesi *et*

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al, 2009). Exogenous application of SA increases resistance to fungal pathogen in sweet cherry (Yao and Tian, 2005) and grape berries (Derckel *et al*, 1998). Such an increased resistance was found to be correlated with enhanced expression or/and activities of glucanase and chitinase (Yao and Tian, 2005; Derckel *et al*, 1998. Enhanced germination and seedling growth were recorded in wheat, when the grains were subjected to pre-sowing seed-soaking treatment in salicylic acid (Shakirova, 2007). Some researches show SA and its close analogues enhanced the leaf area and dry mass production in corn and soybean (Khan *et al*, 2003). Fariduddin *et al*. (2003) reported that the dry matter accumulation was significantly enhanced in *Brassica juncea*, when lower concentrations of SA were sprayed. In another research Khodary (2004) observed a significant increase in growth characteristics, pigment contents and photosynthetic rate in maize, sprayed with SA. The experiment was design to investigate whether there is a relationship between foliar application of salicylic acid on yield and yield component of tomato in Shirvan region.

Methodology:

This experiment was designed to observe the effect of salicylic acid (SA) on yield, quality of tomato, in Shirvan region. This experiment was conducted in 2011 cropping at Shirvan Department of Agriculture Research Center. The site lies at longitude 57º54, and latitude 37º27 and the altitude of the area is 1047 m above sea level. This experiment was done as a complete randomized block design in 4 replications. Treatments were including T_1: 10^{-2} M SA, T_2: 10^{-4} M T_3: 10^{-6} M SA, T_4: 10^{-8} M salicylic acid and T_5: control. Foliar application of salicylic acid was done in seedling stage in green house. At first the seeds of cultivars were transplant from green house in December, and after preparing the field, transplants were moved to the main field in May. Before performing experiment according to soil chemical analysis results, Nitrogen at a rate of 250 kg/ha was applied, in the form of urea, Phosphate at a rate of 200 kg/ha was applied, in the form of triple super phosphate and Potassium at a rate of 150 kg/ha was applied, in the form of potassium sulfate. Nitrogen fertilizer was incorporated to soil in three stages (1/3 before sowing 1/3 in stage 4 leaves and 1/3 in stage 8 leaves) and phosphate and potassium fertilizers were incorporated in soil before planting. The method of cultivation was as rows, and each plot were including 5 rows in 150 cm area between rows and 40 cm between 2 bushes from each other. After reaching to the stage of 4-6 leaves, bushes were transplanted out of nursery on the farm. After 20 days, and foliar application of salicylic acid was done at 6 stages once every 15 days. Finally at the stage of complete ripping, all of characters were measured which was including: number of panicle in a bush, yield, fruit number in panicle, fruit number in bush, fruit weight and fruit diameter.

1. The data were analyzed using MSTATC software; mean comparison was done using Duncan Multiple Comparison at 5% probability level (Babaeian *et al*, 2011).

RESULTS AND DISCUSSION

Tomato yield:

The results of data variance analyzing showed that tomato yield significantly affected by foliar application of S (P < 0/01). The results of mean comprising of data showed that among foliar application, the highest rate of tomato yield obtained in (S_3) SA at 10^{-6} M with the average of 3059.5 and the lowest amount of it was in (S_4) SA at 10^{-2}treatment with the average of 2220.8g in a bush. There weren't any significant difference between treatments of S_2 (SA at 10^{-4} M), S_4 (SA at 10^{-8}) and S_5 (control) in amounts of 2965.8, 2467.8 and 2268.5 respectively. As shown in the table 1, the reduction of SA concentration from SA at 10^{-2} M to SA at 10^{-6} M has been resulted to increasing of tomato yield, but by reduction of concentration from SA at 10^{-6} to SA at10^{-8} reduced tomato yield. Hayat *et al*. (2005) illustrated that leaf number, fresh and dry mass per plant of wheat seedlings raised from the grains soaked in lower concentration (10^{-5} M) of salicylic acid, increased significantly. Fariduddin *et al*. (2003) reported that the dry matter accumulation was significantly enhanced in *Brassica juncea*, when lower concentrations of SA were sprayed. These results showed that foliar application of salicylic acid by concentration of SA at 10^{-6} M caused to increase the yield, and tomato yield reduced in more and less concentration of salicylic acid.

The number of panicle in a bush:

Foliar application of SA has a significant effect on the number of tomato panicle (Table 1). recorded results which has obtained from the mean comparison of data at Table 2 showed that the highest numbers of panicle in tomato bushes obtained from the treatment of S_1 (SA at 10^{-2} M) by average of 31.25 panicle in a bush, and the lowest of it was considered on the average of 16.25 panicle in a bush in the control treatment. In this section ,Gained results showed that all foliar application treatments of salicylic acid in comparison to control caused to increasing the number of panicle in a bush, and as it was mentioned the highest number of panicle in a bush was obtained in treatment of Sa 10^{-2} and after that by increasing the concentration of salicylic acid to SA at 10^{-8} M was reduced from the number of panicles, as the number of panicles which was 24.75 in S_2 (SA at 10^{-4} M) and 22.25 in S_3 (SA at 10^{-6} M) treatment and in S_4 (SA at 10^{-8M}) was 19 panicle in a bush. Therefore, use of low concentration for foliar application of salicylic acid caused to increase the number of tomato branches and after that increasing of SA concentration caused to reduce the number of bush panicles in tomato. Khan *et al*. (2003) reported that SA enhanced the leaf area and dry mass production in corn and soybean.

Table 1: Analysis of variance for yield and yield components of tomato plants under salicylic acid treatments.

S.O.V	df	Tomato yield	number of panicle in a bush	Fruit number in panicle	fruit number in the bush	Dry weight of fruit g	Fruit weight g	fruit diameter mm
Replication	3	571071.51^{ns}	14.73^{ns}	0.18^{ns}	135.26^{ns}	3.98^{ns}	37.25^{ns}	62^{ns}
Treatment	4	616063.17^{ns}	132.80^{**}	1.37^{*}	753.50^{**}	147.61^{**}	480.05^{**}	150.55^{*}
Error	12	286247.64	6.23	0.30	53.26	1.88	38.75	45.91
CV%		20.60	10.99	20.19	13.39	12.21	12.58	15.33
*, ** significantly at the 5% and 1% levels of probability respectively and ns (non significant)								

Table 2: Mean comparison of the effects of salicylic acid on yield and yield components tomato.

Treatment	Tomato yield	number of panicle in a bush	Fruit number in panicle	fruit number in the bush	Dry weight of fruit g	Fruit weight g	fruit diameter mm
10^{-2}	2220.8b	31.25a	3.5a	66.75a	10.90c	33.25c	38c
10^{-4}	2965.8ab	24.75b	3.25ab	62.25a	15.62b	47.50b	40.25bc
10^{-6}	3059.5a	22.25bc	2.25c	64a	18.92a	47.50b	49.75ab
10^{-8}	2467.8ab	19cd	2.5bc	42.75b	5.57d	57.50a	41.25bc
Control	2268.5ab	16.25d	2.25c	36.75b	5.15d	61.50a	51.75a
Mean fallowed by similar letters in each column, are not significantly at the 5% level of probability							

Fruit number in panicle and fruit number in the bush:

Foliar application of SA significantly caused to increase fruit number in panicle and also fruit number in a bush as shown in table1. The results of mean comparison showed that the highest fruit number in panicle and highest fruit number in bush obtained by mean of 3.5 and 66.75 in S_1 (SA at 10^{-2} M) respectively. obtained results showed that by reduction of SA concentration till SA at 10^{-8} M, the fruit number in panicle and also fruit number in a bush gradually reduced, as in concentration of Sa10^{-4}, Fruit number in panicle is 3.25 and fruit number in a bush is 62.25, fruit number in panicle is 2.25 on SA at 10^{-6} M concentration, and the fruit number is 64 in a bush. These results showed that all foliar application treatments of salicylic acid caused to increase the fruit number in the bush in comparison to control. The rate of fruit numbers in panicle and fruit numbers in the bush reduced by reduction of concentration from SA at 10^{-2} M to SA at 10^{-8} M among foliar application treatments. Also in this section recorded results showed that there is a relation between panicle numbers with fruit numbers in panicle and fruit number in the bush, as every factor caused to increase panicle numbers and fruit numbers directly caused to increase fruit numbers in the bush. This result corroborated the earlier findings of Senaratna *et al*. (2000).

Dry weight of fruit:

The foliar application of SA had significant effect on dry weight of fruit as shown in Table 1. Obtained results Table 2 showed that the foliar application treatments in comparison to control caused to increase amount of dry weight of fruit. As the highest amount of this factor obtained from S_3 treatment (SA at 10^{-6} M) by average of 18.92 g, and lowest amount obtained from S_5 (control) treatment.

Fruit weight and fruit diameter:

Both of two factors, fruit weight and also fruit diameter has been affected significantly with foliar application of salicylic acid, (Table 1). The obtained results showed that highest amount of fruit weight and also fruit diameter was measured in control treatment with mean of 61.50 g and 51.75 mm, respectively. In this section results showed that the SA caused to reduce amount of tomato weight and diameter, as the lowest amount of fruit weight and fruit diameter, were 33.25 g and 38 mm, respectively war recoded in S_1 (SA at 10^{-2} M) treatment, which have the highest amount of SA concentrations among foliar application treatments, and reducing salicylic acid concentration cause to increasing the amount of weight and also fruit diameter. As regards to this fact, there is an adverse relation between fruit number and fruit size. So increasing in fruit numbers caused to reduction of fruit size, weight and diameter. Therefore, every factor caused to increase fruit numbers of tomato in a bush, cause to reduce the weight and diameter of tomato in the bush.

Conclusion:

This study confirms the role of salicylic acid (SA) in increasing growth and grain yield of tomato. Salicylic acid, an important plant hormone, has been recognized as a critical signal in local defenses and in systemic acquired resistance (SAR).

- It may be concluded from the above discussion that SA acts as a potent plan growth regulator that can effectively modulate various plant growth responses
- Exogenous application of SA enhances the growth and productivity of tomato.
- Exogenous application of SA induces the SAR in plants, thereby provides a considerable protection against various biotic stress.
- Exogenous application of the lower concentrations of SA proved to be beneficial in enhancing the photosynthesis growth and various other physiological characteristics of plants.

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