Effect of Pre-sowing Salicylic Acid Seed Treatment on Seed Germination and Growth of Greenhouse Sweet Pepper Plants

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Abstract

This experiment was carried out to determine the effect of pre-sowing treatment of Salicylic acid (SA) on seed germination and growth of greenhouse sweet pepper, Cadia cultivar. In this research, pre-sowing seed treatment of Salicylic acid at three different concentrations (0.0, 0.1 and 0.5 mM) was applied during 120 days of growth, and the higher concentration led to a better germination percentage and faster growth rate. Randomized Complete Block Design (RCBD) with three replications was applied for statistical analysis and factors such as seedling growth rate as well as some qualitative and quantitative characters of fruit were assayed. Results showed that 0.5 mM SA as a pre-sowing seed treatment had a significant effect on all of the measured growth factors and germination rate. In addition, 0.5 mM SA had the highest values of in fruit diameter, fruit length, fruit weight, fruit number per plant, stem diameter, plant height, total fruit yield per plant and fruit titrable acidity (TA). However, pre-sowing treatment of SA in different concentrations had no significant effect on leaf and fruit dry mass and vitamin C. The results of this research can be of use for greenhouse owners to increase the growth rate and also fruit yield of pepper plants.

Keywords: Pre-sowing treatment, Relative Growth rate, Quantitative character, Qualitative character

1. Introduction

Nowadays, by increasing the population of the whole world and not enough agricultural space in the environment, humans are trying to provide their first needs which are health and food. This has led to some debates on high quality production of fruit and vegetables (Bosland and Votava, 1999). Vegetable production under greenhouse conditions has become of importance and this is because of its controlled environmental conditions which allows higher and better producing of fresh products. Bell Peppers (*Capsicum annuum* L.) are consumed fresh, dried and are also used in some processed products. Bell Pepper is one of the important vegetable crops in international and national markets and its importance is because of its nutritional values. This fruit is a rich source of natural colors and antioxidant compounds i.e. vitamin C and carotenoids. (Howard et al., 2000; Navarro et al., 2006; Russo and Howard, 2002). Germination rate and seedling growth in pepper plants are slow (Korkmaz, A. and Y. Korkmaz, 2009; O'Sullivan et al., 1984), and different pre-treatments have been investigated on improving the germination rate (Bradford et al., 1990; Ilyas, 1993; Wien, 1997). Application of exogenouse Salicylic acid (SA) as a natural phytohormone (Raskin, 1992) at non-toxic concentrations has been shown to be effective in some of the qualitative and quantitative characters of pepper plants (Elwan and El-Hamahmy, 2009) as well as the germination percentage and growth rate in wheat (Hayat et al, 2005) and barley (Pancheva et al., 1996). Sweet pepper is an important crop in Iran, however, no data has been gathered on its responses to pre-sowing treatment of SA. In response, the present study aim to analyze if pre-sowing treatment of SA improves germination percentage, seedling growth rate as well as some of the qualitative and quantitative characters.

2. Materials and Methods

The experiment was conducted in a well-equipped greenhouse in Karaj, Iran during 2010 and 2011.

2.1 Seeds and Solutions

Bell pepper cv Cadia , F1 seeds were obtained from Enza Zaden company. They were soaked in three different concentrations of salicylic acid for 24 hours before sowing. Firstly SA was dissolved in few drops of dimethylsulfoxide and desired concentrations (0.0, 0.1 and 0.5 mM) were prepared, then pH was adjusted to 7 using NaOH 0.1 M. Triton 0.01 % was added as surfactant.

2.2 Medium and pots

Cocopeat, perlite and gravel were mixed in a ratio of 7:3:3 and considered as the medium to keep the moisture in a steady rate. Plastic pots were used to sow the seeds. They had the diameter of 8 and height of 10 cm. Pots were distributed according to randomized complete block design, 70 pots in each experimental unit with 3 treatments and 3 replications. Emergence of cotyledon leaves on the medium was considered as a germinated pot. The germinated pots were counted until 70 % of them were germinated (Onofri et al., 2010). Since seedlings had small primordial of a leaf, three pots were randomly selected from each experimental unit and destroyed for 6 times at 7 days intervals during 42 days of growth to be able to calculate the relative growth rate.

After 45 days, seedlings were transplanted to the greenhouse and other characteristics were measured during 120 days of growth in the greenhouse. Soil texture was loamy-sandy (65 % sand, 20% silt and 15 % clay) with pH 7.27 and EC 0.214 dS/m. Temperature, relative humidity and light density were fluctuated between 22-27 ° C, 50-80 % and 23- 43 KLUX, respectively. Training and irrigation of plants were carried out as normal agricultural practices.

3. Measurements and Observations

Total fresh and dry weights were measured using gravimetric method. Dry weight was determined after drying in an oven at 80 °C for 72 hours up to constant weight. Relative growth rate was measured according to its common equation for the plants:

RGR (mg/g/day) = (LnW2-LnW1)/ (T2-T1)

W1, W2 : Dry weights at T1 and T2.

T1, T2: Times of measurements.

At the end of the season and after harvesting of the fruit, stem diameter, stem height were recorded by caliper and meter respectively. 15 fruit from each experimental unit were randomly selected and weight, length and diameter of each fruit were measured. Fresh and dry weights of the plants were measured at the end of the season by selecting 3 plants from each experimental unit randomly. Samples were dried in an oven at 70 °C until constant weights were obtained. Leaf dry mass was measured by weighing the fresh leaves and drying them in an oven at 80 °C for 72 hours. Fruit dry mass was measured by randomly selection of 15 fruit from each experimental unit. Digital refractometer (Ceti-Belgium) was used to determine total soluble solids at 24 °C. Titrable acidity was measured based on Citric acid. 10 cc of fruit juice was diluted with 90 cc of distilled water and then was titrated by adding NaOH 0.1 N until pH of 8.2 (Iglesias et al., 2002; Janisiewicz et al., 2003). Vitamin C (ascorbic acid) was determined by the oxidation-reduction method based on the reduction of indophenols dye by an acid extract of the ascorbic acid (Kolawole et al, 2010). SPSS and EXCEL were used for statistical analysis and Duncan ANOVA test for analysis of the variance.

4. Results and Discussion

4.1 Germination percentage and relative growth rate

Pre-sowing treatment of SA had a significant effect on germination percentage. 0.5 mM SA resulted in the highest germination (Table 1). Relative growth rate between the first and the last destruction was also different (Table 1). 0.5 mM treatment showed an increasing and faster trend (Fig. 1). Pre-sowing salicylic acid treatment effect on other quantitative and qualitative characters are shown in Table 1.

Fig 1 *The effect of different concentrations of pre-sowing Salicylic acid treatment on Relative Growth Rate*

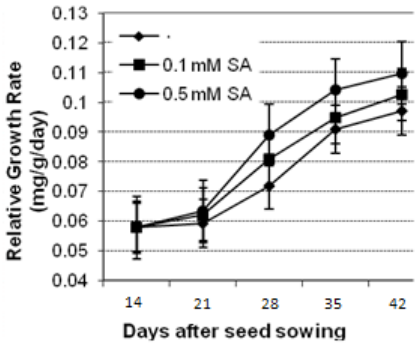

Table 1. Pre-sowing SA treatment effect on quantitative and qualitative characteristics of sweet pepper.

Stem diameter (cm)	Plant height (m)	Total fruit weight per plant (g)	Fruit number per plant	Fruit diameter (cm)	Fruit length (cm)	Fruit weight (g)	Relative growth rate (mg/g/day)	Germination percentage (%)	Treatment (mM)
2.10 b	2.12 b	890.5 b	8.09 b	67.9 c	73.5 b	110.0 b	0.06 b	77.4 b	Control
2.18 b	2.19 ab	928.5 b	8.31 b	69.3 b	74.8 b	110.6 b	0.064 b	79.2 b	SA 0.1mM
2.32 a	2.29 a	1098.9 a	9.48 a	71.7 a	77.5 a	115.4 a	0.080 a	89.5 a	SA 0.5 mM

Vitamin C (mg/100g FW)	TA (%)	TSS (%)	Fruit dry mass (%)	Leaf dry mass (%)	Foliage dry weight (g)	Treatment (mM)
152.6 a	1.40 b	4.44 a	30.29 a	22.51 a	215.2 b	Control
153.3 a	1.42 b	4.34 b	30.04 a	22.13 a	224.2 b	SA 0.1mM
155.3 a	1.49 a	4.29 b	29.30 a	21.47 a	251.9 a	SA 0.5 mM

SA= Salicylic acid

The means with the same letters are non-significantly different using DMRT test. Pre-sowing salicylic acid treatment at 0.5 mM caused a significant increase in germination percentage and relative growth rate and this approves previous study on wheat seeds. In that study, seeds were soaked at 0.05 mM SA and it led to better and faster germination percentage and growth rate of the seedlings (Shakivora et al., 2003). This effect was further observed in the field with measuring factors such as total yield.

Pre-sowing SA treatment increased yield and number of wheat seeds per plant (Hayat and Ahmad, 2007). Phytohormones such as SA play an important role in regulating the growth. Germination of pre-treated seeds with SA is accompanied by abrupt hormonal changes in the plant due to accumulation of IAA and ABA (Hayat and Ahmad, 2007). Thus, increasing in growth rate is probably because of increasing in amount of IAA. It should be mentioned that according to previous reports ABA has no inhibitory effect on the growth of the seedlings (Hayat and Ahmad, 2007). IAA is a natural Auxin that exists in all plant dynasties and accelerates the growth rate (Arteca, 1996). As it can be seen in **Fig 1**, the growth rate is increasing slowly until 28 days after germination of the seeds. It can be assumed that root emergence and its growth has caused the further differences in the growth rate which is because of the stimulating effect of SA on root growth (Gutierrez-Coronado and Larque-Saavedra, 1998; Sandoval-Yapiz, 2004).

4.2 Fruit size, number and weight

Increased root growth ameliorates the absorption of nutrients and minerals from soil, so plant grows better and produces more leaves and foliage which leads to an increase in the amount of photosynthesis. Faster growth rate at 0.5 mM pre-sowing SA treatment made an increase in fruit size, number and weight. Fruit weight and number of fruit per plant have increased, therefore total fruit weight per plant also increased. This approves other studies in relation to the effect of SA in increasing of the yield and growth of wheat plants (Dhaliwal et al., 1997).

4.3 Plant height, stem diameter and dry weight

Application of 0.5 mM pre-sowing treatment of SA caused significant effects. In this treatment, higher plants, thicker stems and also an increase in dry weight were observed (**Table 1**). Increased growth rate is related to increased photosynthesis and this is due to production of more photosynthetic organs like leaves. It had been proved that SA treatment increased leaf area and dry weight in maize and soya bean (Khan et al., 2003). In another study thickest stem was observed at 0.5 mM (Yildirim and Dursan, 2009) which approves the findings of this experiment.

4.4 Leaf and fruit dry mass

At 0.5 mM better growth rate and therefore the most leaf area were observed. So leaf and fruit dry mass must be at the highest rate at this treatment, whereas they are not. This is different from previous studies (Elwan and El-Hamahmy, 2009). This difference might be due to higher concentrations in this study in comparison to theirs.

4.5 Fruit total soluble solids, titrable acidity and Vitamin C

SA treatment has a significant effect in fruit weight and size. Bigger fruit has more amount of water inside its cells, so TSS decreases. This result is different from an experiment that was carried out on Tomato plants in which TSS increased (Yildirim and Dursan, 2009). TA increased at 0.5 mM treatment of this study. In this study TSS/TA decreases which can be favored by some people who like sour-sweet taste. Elwan and El-Hamahmy (2009) investigated that foliar treatment of SA increased the amount of vitamin C in pepper fruit, however, it had no significant effect in this study which might be because of higher concentrations in comparison to theirs.

5. Conclusion Remarks

It can be concluded that SA application to the seeds of sweet pepper before sowing under greenhouse conditions induced positive effects on the germination percentage, plant growth rate as well as some quantitative characters such as fruit yield. It also caused a sour-sweet taste which might be pleasant to some people. High yield and better germination rate and faster relative growth rate in greenhouse sweet pepper are desirable in greenhouses where time and field are valuable and expensive.

All in all, pre-sowing treatment of SA seems to be beneficial economically due to higher production of yield and also a new taste in greenhouse sweet pepper.

6. References

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