Productivity of Snap Bean plants by spraying of some antioxidants materials under sandy soil conditions in plastic house.

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ABSTRACT

Two field experiments were carried out during two successive seasons of 2011 and 2012 at the experimental station of National Research Centre at Nubaria, Behira Governorate, Egypt to assess the response of snap bean plants (Phaseolus vulgaris L.) cv. Paulista to some antioxidants treatments on growth characters, total green pods yield as well as total seeds yield and seeds quality. Aqueous solutions of the antioxidants as foliar spray i.e Salicylic acid at 50 and 100 ppm, Vitamin E at 75 and 150 ppm and control. Obtained results reflected that plant growth characters expressed as (plant length, number of leaves and branches, dry weight of leaves and branches, total green pods yield and its components and seeds quality were significantly affected by treating snap bean plants with both antioxidants materials. Whereas, increasing rates of the application of both antioxidants caused an increment these characters. Moreover, foliar application of vitamin E especially at high concentration (150 ppm) exceeded salicylic acid at both concentrations and control.

Key words: Snap bean plants- Salicylic acid- Vitamin E- growth- pods green yield- seeds quality.

Introduction

Snap bean (Phaseolus vulgaris L.) is one of the most important vegetable crops grown in Egypt for both local consumption and exportation. As they are very rich in protein content which is essential for human nutrition rather than the role of such crops in improving soil fertility.

The majority of the antioxidant capacity of fruits or vegetables may be from some compounds such as falvonoids, isofalvonoids, flavones, anthocyanins, catechins, vitamin C, E or β carotene (Kahkonen et al., 1999). Salicylic acid is widely present in plants and functions as a hormonal mediator of the systemic acquired resistance response. Thus, it is present in a large scale of fruits, vegetables, herbs and spices of dietary relevance. The recognized effect of consuming fruits and vegetables on lowering risk of colon cancer may be partly attributable to salicylates in plant-based foods (Paterson et al., 2006). Application of salicylic acid at 20 ppm on pea plants enhanced plant growth as indicated by plant height, number of leaves, fresh and dry weights in both seasons (El-Shraiy and Hegazi 2009). Foliar spray with salicylic acid increased the fresh and dry weight of plant, pod setting and total proteins of leaves and fruits (Jas, 2001). Salicylic acid retarded the growth and green pod yield and its components as well as weight of dry seed of common bean (Amer, 2004). Using 150 ppm of salicylic acid as a foliar application gave the highest increment in number of branches, fresh weight and dry weight and total protein. As well as number of pods, pods setting and green pods yield of snap bean (Kmal et al., 2006). Also spraying tomato plants with salicylic acid at 100 ppm increased vegetative growth, dry weight, yield and its components and NPK content as well as total protein (Ali et al., 2009). 1.5 mM concentration of salicylic acid had a stimulating effect on the growth, dry weight and protein of pepper as compared with other concentrations 5 and 10 mM (Canakci 2011). In general, adding salicylic acid significantly relieved the harsh effects of drought on okra germination and growth parameters and it seems that salicylic acid were able to enhance the tolerant ability of the plant to drought stress (Baghizadeh and Hajmohammadrezaei, 2011). In the same respect, Nour et al. (2012) found that, plant growth, yield and its components and chemical constituents of pods were significantly affected by treating snap bean plants with different antioxidants materials. However, Magda, et al. (2013) reported that all concentrations of salicylic acid (25, 50, 75 and 100 mg/l) was significant on growth characters, yield and its components (except crop index and migration coefficient) and photosynthetic pigments content.

Tocopherols are a group of compounds synthesized also occurs is response to variety of a biotic stresses including high light, drought, salt and cold and may provide on additional line of protection from oxidative damage. Vitamin E is considered as highly antioxidant at the membrane site (Hess, 1983) which is a highly effective antioxidant at the membrane site. And has a positive effect on chlorophyll content of bean plants (Schmitz and Noga, 1998). Foliar application of Vitamin E at 0.1 ml/l and 0.3 ml/l significantly improved vegetative growth and yield of bean plants compared to control plants especially at the higher concentrations.
(El-Tohamy and El-Greedy, 2007). However, El-Bassiouny et al (2005) reported that foliar spray with – 
–tocopherol (vitamin E) on bean plants induced increments in growth parameters, yield components, chlorophyll 
a, b and carotenoids content. In the same respect, Nour et al (2012) found that, plant growth, yield and its 
components and chemical constituents of pods were significantly affected by treating snap bean plants with 
different antioxidants materials.

This investigation aimed to assess the response of snap bean plants (Phaseolus vulgaris L.) cv. Paulista 
under plastic house grown on sandy soil conditions to some antioxidants materials to improve the growth, yield 
and chemical constituents of snap bean plants.

MATERIAL AND METHODS

The present work was carried out under plastic house during two successive winter seasons of 2011 and 
2012 at the Experimental Station of National Research Centre in Nubaria region, North Egypt. The physical and 
chemical properties of the soil are presented in Table (1).

Table 1: physical and chemical properties of the experimental soil.

<table>
<thead>
<tr>
<th>Physical properties</th>
<th>Sand</th>
<th>Clay</th>
<th>Silt</th>
<th>Texture</th>
<th>f.c. %</th>
<th>w.p. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.08</td>
<td>9.26</td>
<td>0.66</td>
<td></td>
<td>Sandy</td>
<td>16.57</td>
<td>5.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical analysis</th>
<th>E.c.</th>
<th>pH</th>
<th>Meq/L</th>
<th>Ca</th>
<th>Mg</th>
<th>Na</th>
<th>K</th>
<th>Hco3</th>
<th>Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>7.02</td>
<td>0.527</td>
<td>0.982</td>
<td>0.31</td>
<td>1.3</td>
<td>0.566</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This experiment included 5 treatments, as follows: -
1- Control (untreated).
2- Salicylic acid (SA) at 50 ppm.
3- Salicylic acid (SA) at 100 ppm.
4- Vitamin E at 75 ppm.
5- Vitamin E at 150 ppm.

Treatments were arranged in a complete randomized block design with three replicates. Seeds of snap bean 
cv. Paulista were obtained from Horticultural Research Institute, Agriculture Research Center, Egypt and sown 
on December 24th and 21st in 2011 and 2012, respectively. The area of experimental plot was 10.5 m². Every 
plot consisted of 5 dripper lines 3m in length and 0.7m in width. Seeds were sown in hills 20 cm apart on one 
side of dripper lines and two seeds per hill. The first two rows of each treatment were harvested for green snap 
bean characters. The other three rows of each treatment were harvested for the determination of the seed yield 
and its components. The normal agriculture practices of snap bean under drip irrigation system were followed 
according to the recommendations of Agriculture Ministry. The foliar application treatments were sprayed twice 
during the growth period of plant at 30 and 45 days after sowing. The untreated plants (control) were sprayed 
with tap water.

Data recorded:

Growth Characters:

A random sample of three plants was taken from every plot at 60 days after sowing in both seasons of study 
for measuring the growth characters of snap bean plants expressed as follows: plant height (cm), number of both 
leaves and branches / plant, total dry weight (leaves + branches) / plant (g), (the samples were dried in an 
electric oven at 70°C till constant weight).

Yield and Its Components:

At harvesting stage (aged 70 days for both seasons), 15 bean plants from each treatment were randomly 
taken to study the yield and its components Including: - numbers of pods/plant, weight of green pods/plant (g), 
average pod weight (g) and dry matter of pod (%).

Seeds quality:

At seed maturity stage, dry pods were harvested continuously whenever it would be dry till the end of 
experiment for determined dry seeds weight (g/plant), number of dry seeds/pod and total yield of dry seeds/m² 
in (kg). In a representative sample of dry seeds of each plot the weight of 100 seeds (g), germination % and
germination rate index (GRI) were measured. Total crude protein (%) was determined according to methods described by (A.O.A.C., 1980).

\[
GRI = \frac{a + (a + b) + (a + b + c) + \ldots}{n (a + b + c + \ldots)}
\]

\[a = \text{number of germinated seeds at the first count.}\]
\[b = \ldots = \text{second count.}\]
\[n = \text{number of counts.}\]

The obtained data of experiments were subjected to the statistically analysis of variance procedure and means were compared using the LSD method at 5% level of significance according to Gomez and Gomez (1984).

**RESULTS AND DISCUSSION**

**Plant growth characters:**

Data recorded in Table (1) shows clearly that all both concentrations of Salicylic acid (SA) and Vitamin E (VE) significantly increased snap bean plant growth characters expressed as (number of branches, dry weight of leaves and branches) compared to untreated (control). However, the highest plant growth characters were determined by foliar spraying of high concentrations (100ppm of Salicylic acid (SA) and 150ppm of Vitamin E (VE). On the other hand, the low concentration of both antioxidant materials 50ppm of (SA) and 75ppm of (VE) significantly increased the dry weight of leaves and branches compared to control treatment. Moreover, the maximum significantly values for all plant growth characters (plant length cm, number of leaves and branches as well as dry weight of leaves and branches) were obtained by foliar spraying of high concentration of VE (150ppm) and followed in descending order by snap bean plants were sprayed with high concentration of SA (100ppm) and followed low concentration of VE (75ppm) and followed low concentration of SA (50ppm) followed as control treatment. these results may be due to the role of antioxidants in enhancing some physiological and biochemical aspects(Maiti and Bera 2009) or increasing N,P,K and Ca content, activity in antioxidant enzymes and glutathione content (Khan et al 2009) on pea plant. It be concluded that, many of these phytochemicals may help to protect cells against oxidative damage caused by free radicals (Wada and Ou, 2002). Antioxidants intercept free radicals and protect cells from the oxidative damage that leads to aging and disease (Karadeniz et al., 2005). Active oxygen scavengers (antioxidants) could be beneficial in the protection of the structure and function of the photosystems against excess light (Rajagopal et al., 2005). Antioxidants play role in the reduction or prevention of enzymatic browning by inhibiting polyphenol oxidase (Maurice et al., 2000). These results were in agreement with these which obtained by foliar spraying of SA (Kmal et al., 2006; Paterson et al 2006; Ali et al., 2009; El-Shraiy and Hegazi 2009; Canakci 2011; Nour et al 2012 and Magda, et al 2013) and foliar spraying of VE (El-Bassiouny et al 2006; Abd El-Hakim 2006; El-Tohamy and El-Gready, 2007, Matringe et al 2008 Al-Qubaie 2012 and Shafeek et al 2013).

**Table 1:** Effect of foliar spraying of different levels of Salicylic acid and Vitamin E on growth characters of snap bean plants (average of two seasons).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant length (cm)</th>
<th>Number of Leaves</th>
<th>Number of Branches</th>
<th>Dry weight leaves (g)</th>
<th>Dry weight branches (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>51.07</td>
<td>20.44</td>
<td>5.17</td>
<td>9.00</td>
<td>8.83</td>
</tr>
<tr>
<td>50ppm Salicylic acid</td>
<td>55.59</td>
<td>23.28</td>
<td>6.67**</td>
<td>10.73*</td>
<td>11.03*</td>
</tr>
<tr>
<td>100ppm Salicylic acid</td>
<td>63.31*</td>
<td>29.59***</td>
<td>7.17**</td>
<td>11.33*</td>
<td>12.25*</td>
</tr>
<tr>
<td>75ppm Vitamin E</td>
<td>57.72*</td>
<td>23.99</td>
<td>5.33</td>
<td>10.33*</td>
<td>10.33*</td>
</tr>
<tr>
<td>150ppm Vitamin E</td>
<td>64.11**</td>
<td>30.70***</td>
<td>7.29**</td>
<td>11.57**</td>
<td>12.55**</td>
</tr>
<tr>
<td>LSD at 5%</td>
<td>5.82</td>
<td>4.30</td>
<td>1.11</td>
<td>1.05</td>
<td>1.45</td>
</tr>
</tbody>
</table>
Pods yield and quality:

The resulted data of Table (2) show that all concentrations of antioxidants treatments (SA or VE) had a significant effect on total yield and pods quality of snap bean. The application of vitamin E at high concentration (150ppm) induced a highly significant increase in total yield and its components expressed as (number of pods/plant, weight of pods/plant and the percentage of dry matter content of pods) and followed in descending order by snap bean plants were sprayed with high concentration of SA (100ppm) and followed low concentration of VE (75ppm) and followed low concentration of SA (50ppm) followed as control. In the same respect, foliar application of high concentration of both antioxidant materials significantly increased number of pods/plant, weight of pods/plant (g) and dry matter of pods % compared to low concentration ( 50ppm of SA and 75ppm of VE). However, increasing the concentration of vitamin E up to 150ppm caused an increased number of pods/plant, weight of pods/plant (g) and dry matter of pods % amounted by 34.68 %, 21.02 % and 17.38 % respectively compared to the control treatment. It could be concluded that the heaviest number and weight of pods / plant which resulted may be attributed to the best vigor of plant growth characters which obtained by foliar spraying of high concentration of antioxidants treatments (Table 1).The promotive effect of SA could be attributed to its bioregulator effect on physiological and biochemical in plants such as ion uptake, cell elongation, cell division, cell differentiation, sink and source regulation, enzymatic activities, protein synthesis and photosynthetic activity, as well as, increase in antioxidant capacity of plant (Paskin, 1992, Blokhina et al., 2003 and El-Tayeb, 2005).The trends of obtained results are in good accordance of the previous investigators by foliar spraying of SA such as Ali et al., 2009; El-Shraiy and Hegazi 2009; Canakci 2011; Nour et al 2012 and Magda, et al, 2013 and by foliar spraying of VE (El-Bassiouny et al 2005; Abd EI-Hakim 2006; El-Tohamy and El-Grealy, 2007, Matringe et al 2008 Al-Qubaie 2012 and Shafeek et al 2013).

Table 2: Effect of foliar spraying of different levels of Salicylic acid and Vitamin E on yield and its components of snap bean pods (average of two seasons).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of pods/plant</th>
<th>Weight of pods/plant (g)</th>
<th>Average pod weight (g)</th>
<th>Pod length (cm)</th>
<th>Dry matter of pods (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>11.300</td>
<td>43.457</td>
<td>3.064</td>
<td>11.77</td>
<td>6.370</td>
</tr>
<tr>
<td>50ppm Salicylicacid</td>
<td>14.700*</td>
<td>60.700</td>
<td>3.690</td>
<td>12.41</td>
<td>6.740*</td>
</tr>
<tr>
<td>100ppm Salicylicacid</td>
<td>16.300**</td>
<td>65.627**</td>
<td>3.720</td>
<td>13.02</td>
<td>7.023**</td>
</tr>
<tr>
<td>75ppm Vitamin E</td>
<td>16.700**</td>
<td>62.330**</td>
<td>3.740</td>
<td>12.74</td>
<td>6.817**</td>
</tr>
<tr>
<td>150ppm Vitamin E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17.300***</td>
<td>67.683***</td>
<td>3.923</td>
<td>12.75</td>
<td>7.710***</td>
</tr>
<tr>
<td>LSD at 5%</td>
<td>0.13</td>
<td>0.423</td>
<td>N.S.</td>
<td>N.S.</td>
<td>0.056</td>
</tr>
</tbody>
</table>

Total seeds yield and quality:

The application of the concentration of both antioxidant materials (SA or VE) had a great effect on the seeds yield and its components of snap bean seeds tissues. Whereas, increasing rates of the application of both antioxidants caused an increment in seeds weight (g/plant), total yield of seeds/m² (kg) and crude protein %. However, the application of vitamin E at high concentration (150pppm) resulted the highest values of the percentage of crude protein in dry seeds tissues. Also, obtained data showed that these treatment significantly increased seeds weight (g/plant) and total yield of seeds/m² (kg) compared other treatments and control. These increase of total yield of seeds/ m² amounted by 13.65 % compared to untreated control. On the other hand, the statistical analysis of the obtained data show that the differences within different the antioxidant treatments were not great to reach the 5% leve of significantly of number of dry seeds/pod, weight of 100 seeds (g), germination % and germination rate index (GRI). It could be concluded that, The positive effect of SA could be attributed to its bioregulator effects on physiological and biochemical processes in plants such as ion uptake, cell elongation, cell division, cell differentiation, sink and source regulation, enzymatic activities, protein synthesis and photosynthetic activity; as well as; increase the antioxidant capacity of plant (Blokhina et al., 2003 and El-Tayeb, 2005). Salicylic acid as anti-stress substance may enhance the plant tolerance to environmental stresses (Sreenivasulu et al., 2000).
Table 3: Effect of foliar spraying of different levels of Salicylic acid and Vitamin E on seeds quality of snap bean pods (average of two seasons).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Seeds weight (g/plant)</th>
<th>Number of dry seeds/pod</th>
<th>Total yield of seeds/m²(kg)</th>
<th>Weight of 100 seeds (g)</th>
<th>Germination %</th>
<th>GRI</th>
<th>Protein %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>30.522</td>
<td>3.910</td>
<td>1.397</td>
<td>41.73</td>
<td>87.640</td>
<td>0.55</td>
<td>19.56</td>
</tr>
<tr>
<td>50ppm Salicylic acid</td>
<td>33.527*</td>
<td>4.363</td>
<td>1.462*</td>
<td>43.05</td>
<td>88.780</td>
<td>0.58</td>
<td>21.51*</td>
</tr>
<tr>
<td>100ppm Salicylic acid</td>
<td>35.617**</td>
<td>4.573</td>
<td>1.453*</td>
<td>43.33</td>
<td>89.090</td>
<td>0.57</td>
<td>21.87*</td>
</tr>
<tr>
<td>75ppm Vitamin E</td>
<td>33.277*</td>
<td>4.564</td>
<td>1.482*</td>
<td>43.57</td>
<td>88.793</td>
<td>0.58</td>
<td>21.91*</td>
</tr>
<tr>
<td>150ppm Vitamin E</td>
<td>36.120***</td>
<td>4.616</td>
<td>1.502***</td>
<td>43.30</td>
<td>88.867</td>
<td>0.57</td>
<td>21.62*</td>
</tr>
<tr>
<td>LSD at 5%</td>
<td>0.989</td>
<td>N.S.</td>
<td>0.030</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
<td>0.94</td>
</tr>
</tbody>
</table>

GRI = Germination rate index

References


