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Improvement of productivity and quality of Cape gooseberry (*Physalis peruviana* L.) by foliar application of some chemical substances

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ABSTRACT

Cape gooseberry (*Physalis peruviana* L.) is one of the important vegetable crops that have high nutritional value and potential health benefits. However, its high prices both in the local and international markets make it profitable for growers and promising for exportation. The present study aimed to investigate the responses of Cape gooseberry plants to foliar application of Gibberllic acid (GA 3), putrescine and zinc under arid land conditions in Nubaria region (West of Nile Delta of Egypt). Several measurements were recorded including vegetative growth measurements (plant length, number of branches and plant fresh weight), yield, fruit diameter, total chlorophyll content of leaves, total soluble solids of fruits (T.S.S.) and N, P, K contents of leaves. The results revealed that vegetative growth of Cape gooseberry responded positively to foliar application of GA 3, putrescine and zinc especially at the higher levels. The higher levels of GA 3, putrescine and zinc significantly increased all vegetative growth parameters, yield, T.S.S. of fruits, and total chlorophyll content of leaves. The results indicated that under arid land conditions, the treatments had pronounced effects on growth, yield and quality of fruits of Cape gooseberry.

Key words: Chlorophyll, yield, quality, sandy soils

Introduction

Cape gooseberry (*Physalis peruviana* L.) is a vegetable fruit showing increased marketing potential in Egypt as its price is relatively high compared to other vegetables and this may improve the profits of Cape gooseberry growers. In addition, Cape gooseberry is becoming promising for exportation.

Plants belong to Physalis spp. is a group of annuals and perennials, which are grown for their fruits and for decoration and belongs to the family of Solanaceae. The berries (fruits) of some species of Physalis are edible, have the size of a cherry tomato and the fruits are produced inside of a papery husk and they often are called husk tomatoes. *Physalis peruviana* is also commonly known as Cape gooseberry, Poha, goldenberry, ground-cherry. Cape gooseberry is considered as an important vegetable crop because of its high nutritional value, flavor, and potential health benefits and the fruits are eaten fresh or can be prepared as a jam or canned in heavy sugar syrup. However, plants grown under arid conditions usually suffer from several unfavorable environmental conditions which markedly inhibit their growth and productivity. Growth and yield of plants grown under such conditions could be enhanced by the application of some promoting substances. Previous investigations indicated that putrescine is known to improve plant growth and development due to its effects on cell division and differentiation. However, these findings were confirmed in bean plants (Altman et al., 1982). Putrescine (as one of the polyamine group) has a regulatory role in promoting productivity of many plants such as sweet pepper (Talaat, 2003), tomato (Cohen et al., 1982) and pea plants (Gharib and Hanafy, 2005). El-Tohamy et al. (2008) found that foliar application of putrescine resulted in a significant increment of vegetative growth (including plant height, number of leaves, number of branches and fresh weight of plants) and yield of eggplant compared to control plants. It was reported that GA 3 application resulted in an increase in plant height, number of leaves and fresh and dry weight in plants such as spinach plants (Abou-Sedra 1981). GA 3 significantly increased plant height and improved quality of spinach plants (Shehata et al. 2001). Under sandy soil conditions, foliar application with Zn could be of great importance to plants because most of sandy soils suffer from nutrient deficiency including microelements such as zinc. Moreover, sandy soils in many semiarid regions are known to limit mobility and availability of soil-Zn to plant roots (Marschner, 1993). Gobarah, et al.(2006) found that the foliar application with zinc levels had a significant effect on groundnut growth, yield and its components as well as seed quality under sandy soil conditions. On bean plants, Karaman et al. (1999) showed that dry matter production increased with increasing Zn concentrations applied to the plants. Also, another study indicated that foliar application of either Fe and Zn alone or urea in combination with Zn or Cu on
mungbean gave the tallest plants and the application of urea or Zn increased the number of branches per plant (Abd-El-Lateef et al. 1998). The present study was conducted to investigate the effects of foliar application of GA₃, putrescine and zinc on Cape gooseberry plants grown under arid land conditions.

Materials and Methods

The experiments were conducted under sandy soil conditions in new-reclaimed lands at the experimental station of the National Research Center located in Nubaria region (West of Nile Delta of Egypt). The soil of the experimental site was deep and well-drained with 85.5% sand, 11.7% silt and 2.8% clay, an alkaline pH of 8.2, an EC of 0.85 dS m⁻¹, and with 1.5% CaCO₃. The average available N, P and K in the top soil was 0.2 and 17 mg kg⁻¹ soil, respectively. The experiments were carried out for two successive seasons of 2009 and 2010. The seeds of *P. peruviana* L. cv.“Balady” (which is the local variety in Egypt) were sown in the 2nd week of March in both years. 40 days after the sowing, the seedlings were transplanted in the field. The distances between hills were 60 cm apart and 1 m between ridges. A drip irrigation system was used for this experiment. Plants were sprayed twice with the following treatments at 15 days interval beginning after 40 days from transplanting:

1. GA₃ (100 ppm)
2. GA₃ (200 ppm)
3. Putrescine (25 ppm)
4. Putrescine (50 ppm)
5. Zn as chelated form (0.3 g/L)
6. Zn as chelated form (0.5 g/L)
7. Control: (sprayed with only water)

The following measurements were recorded:

1. Vegetative growth and yield measurements: Five plants from each treatment were taken for growth and yield measurements. Plant height, number of branches and plant fresh weight were recorded 90 days from transplanting. Fruits were collected at harvest stage in a weekly basis and total number of fruits, fresh weight of fruits and fruit diameter were recorded.

2. Total soluble solids (T.S.S.) of fruits: measured by refractometer.

3. Chemical analysis: Plant samples of leaf tissues were collected at harvest, dried at 70°C, weighed and ground to pass through 0.5 mm screen size. Total nitrogen of leaves was measured by the modified -Kjeldahl method (Bremner and Mulvaney, 1982). The powdered leaf samples were digested in a 1:3 perchloric-nitric acid mixture for total P and K analysis. Phosphorus (vanadomolybdate) and potassium (flame photometry) were determined following the method described by Jackson (1973). Total chlorophyll content in third fully expanded leaves was measured as SPAD units using Minolta SPAD-501 chlorophyll Meter (Minolta Co. Ltd., Japan).

Statistical analysis:

The experiments were established as complete randomized block design with 4 replicates and analysis of variance was calculated according to Snedecor and Cochran (1967). Least significant difference (L.S.D.) at 5% was used to compare between means.

Results and Discussion

Growth, productivity and quality of Cape gooseberry plants:

As mentioned previously, the fruits of some species of *Physalis* are edible and produced inside of a papery husk (Figure 1 shows the vegetative growth and fruits of Cape gooseberry (*Physalis peruviana* L.) grown in Nubaria region under the experimental conditions). The influence of GA₃, putrescine and zinc on growth and yield is presented in Table (1). The results revealed that all treatments enhanced growth and yield of Cape gooseberry as they significantly increased plant height, number of branches, fresh weight of plants, number of fruits and fresh weight of fruits especially at the higher levels of each of the substances compared to control plants. However, fruit diameter was not significantly affected by treatments although treated plants had higher values than the control. The highest values of vegetative growth parameters and yield were obtained by the high level of GA₃. El-Tohamy et al. (2008) found that spraying eggplant with putrescine resulted in a significant increase of plant height, number of leaves, number of branches, fresh weight of plants and yield compared to control plants. This is related to the mode of action of putrescine as it is known to improve plant growth and development due to its effects on cell division and differentiation. Similar results were obtained in other plants such as bean plants (Altman et al., 1982). It is also indicated that putrescine (as one of the polyamine group) exhibits a regulatory role in promoting productivity of many plants including sweet pepper (Talaat, 2003), tomato (Cohen et al., 1982) and pea plants (Gharib and Hanafy, 2005). Moreover, putrescine significantly
enhanced plant height, number of branches, shoot fresh and dry weights/plant during vegetative and flowering stages of chamomile plants as indicated by Abd El-Wahed et al. (2005). The results of GA3 agree with those obtained by Abou-Sedra (1981) who reported that GA3 application resulted in an increase in plant height, number of leaves and fresh and dry weight in spinach plants. Also, Shehata et al. (2001) found that GA3 significantly increased plant height and improved quality of spinach plants. Wanyama et al. (2006) found that the application of GA3 increased branching, flower bud formation and fruiting of Cape gooseberry plants. The higher the concentration the greater was the growth and yield. However, they indicated that applying GA3 at 100ppm one week after transplanting the seedlings resulted in plants producing significantly largest number of fruits (303 fruits per plant), number of branches (20 branches per plant), and plant height (112.4 cm). Concerning the positive effects of Zn on Cape gooseberry plants, the application of Zn may compensate the lack of Zn and avoid Zn deficiency in plants as sandy soils are poor in micronutrients. Marschner (1993) reported that sandy soils in many semi-arid regions are known to limit mobility and availability of soil-Zn. The results agree with Gobarah, et al. (2006) who indicated that the foliar application with zinc significantly increased groundnut growth, yield and its components under sandy soil conditions. Karaman et al. (1999) found that increasing Zn concentrations applied to bean plants resulted in an increase in dry matter production. Abd-El-Lateef et al. (1998) found that foliar application of Zn alone gave the tallest mungbean plants and increased the number of branches.

Fig. 1: Fruits and vegetative growth of the local Egyptian variety of Cape gooseberry (Physalis peruviana L.) grown in Nubaria region (West of Nile delta of Egypt). The fruits are produced in a papery husk and they are small (usually the diameter is in the range of 1-2 cm).

Table 1: Effects of GA3, putrescine and zinc on growth and yield of Cape gooseberry (means of two seasons).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Number of branches/plant</th>
<th>Number of fruits/plant</th>
<th>Fresh weight of fruits(g/plant)</th>
<th>Plant fresh weight (g)</th>
<th>Fruit diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA3 (100 ppm)</td>
<td>87,33</td>
<td>14,00</td>
<td>54,33</td>
<td>80,87</td>
<td>516,47</td>
<td>1,63</td>
</tr>
<tr>
<td>GA3 (200 ppm)</td>
<td>109,33</td>
<td>21,33</td>
<td>133,00</td>
<td>212,27</td>
<td>1207,67</td>
<td>2,10</td>
</tr>
<tr>
<td>Putrescine (25 ppm)</td>
<td>84,10</td>
<td>16,33</td>
<td>56,33</td>
<td>72,83</td>
<td>512,00</td>
<td>1,80</td>
</tr>
<tr>
<td>Putrescine (50 ppm)</td>
<td>93,33</td>
<td>18,33</td>
<td>76,67</td>
<td>81,00</td>
<td>875,33</td>
<td>1,97</td>
</tr>
<tr>
<td>Zn (0,3 g/l)</td>
<td>79,53</td>
<td>18,00</td>
<td>53,67</td>
<td>83,67</td>
<td>618,00</td>
<td>1,77</td>
</tr>
<tr>
<td>Zn (0,5 g/l)</td>
<td>83,00</td>
<td>19,00</td>
<td>74,33</td>
<td>92,67</td>
<td>907,67</td>
<td>1,97</td>
</tr>
<tr>
<td>Control</td>
<td>62,67</td>
<td>16,00</td>
<td>49,00</td>
<td>62,00</td>
<td>422,80</td>
<td>1,43</td>
</tr>
<tr>
<td>L.S.D. 5%</td>
<td>7,85</td>
<td>2,68</td>
<td>4,99</td>
<td>7,15</td>
<td>12,66</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

Similar results under sandy soil conditions were obtained by El-Tohamy and El-Greadly (2007) who found that foliar application of Zn treatments significantly improved vegetative growth and yield of bean plants compared to control plants especially at the higher concentrations. Moreover, El-Tohamy et al. (2009) indicated that essential oil, growth and yield of onion plants significantly increased by the application of Fe, Zn and Mn compared to control plants.

**Total chlorophyll content of leaves, total soluble solids (T.S.S.) of fruits and N, P, and K contents of leaves:**

As shown in Figure (2), Cape gooseberry plants sprayed with GA3, putrescine and zinc had significantly higher total chlorophyll content compared to control plants. The higher levels of treatments gained the highest values of chlorophyll content. Similar results were obtained with total soluble solids of fruits (Figure 3), the high level of GA3 had the best effects in this respect indicating that the treatments improved the quality of Cape gooseberry fruits and these effects may be due to the fact that the treatments promoted the vegetative growth resulting in high amounts of assimilates which in turn played an important role in improving fruit quality and
yield. El-Tohamy and El-Greadly (2007) found foliar application of Zn resulted in a higher total chlorophyll content in bean plants and improved fruit quality expressed as high total carbohydrate and low fiber content compared to control. On the other hand, putrescine improves plant growth and development through its effects on cell division and differentiation and such role was evident in bean plants (Altman et al., 1982). Also, Shehata et al. (2001) found that GA3 significantly increased plant height and improved quality of spinach plants. Concerning N, P and K contents of leaves, the results indicated that the treatments had no significant effects although they had higher values compared to control (Table 2).

**Fig. 2:** Effects of GA3, putrescine and zinc on total chlorophyll content of Cape gooseberry leaves (means of two seasons).

**Fig. 3:** Effects of GA3, putrescine and zinc on total soluble solids (T.S.S.) of fruits (means of two seasons).

**Table 2:** Effects of GA3, putrescine and zinc on N, P and K contents of leaves (means of two seasons).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N%</th>
<th>P%</th>
<th>K%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA3 (100 ppm)</td>
<td>3.32</td>
<td>0.23</td>
<td>2.27</td>
</tr>
<tr>
<td>GA3 (200 ppm)</td>
<td>3.51</td>
<td>0.28</td>
<td>2.34</td>
</tr>
<tr>
<td>Putrescine (25 ppm)</td>
<td>3.22</td>
<td>0.22</td>
<td>2.32</td>
</tr>
<tr>
<td>Putrescine (50 ppm)</td>
<td>3.35</td>
<td>0.24</td>
<td>2.36</td>
</tr>
<tr>
<td>Zn (0.3 g/l)</td>
<td>3.26</td>
<td>0.24</td>
<td>2.28</td>
</tr>
<tr>
<td>Zn (0.5 g/l)</td>
<td>3.29</td>
<td>0.27</td>
<td>2.32</td>
</tr>
<tr>
<td>Control</td>
<td>3.19</td>
<td>0.19</td>
<td>2.22</td>
</tr>
<tr>
<td>L.S.D. 5%</td>
<td>N.S.</td>
<td>N.S.</td>
<td>N.S.</td>
</tr>
</tbody>
</table>
Our results suggest the possibility of using GA3, putrescine and zinc to improve growth, yield and quality of Cape gooseberry plants grown under arid land conditions.

References


