ORIGINAL ARTICLES

Enhancement Yield, Fruit Quality and Nutritional Status of Washington Navel Orange Trees by Application of biostimulants

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ABSTRACT

The effect of some biostimulants [potassium humate, yeast extract and amino green II (amino acids mixture)] on yield, fruit quality and nutritional status of Washington Navel orange trees were evaluated. Potassium humate was applied at 10 and 20g/tree as soil application. In addition, yeast extract at 0.2 and 0.4% and amino green II at 0.25 and 0.5% were applied as foliar application. The obtained results revealed that all biostimulants increased total yield. Fruit weight, fruit juice %, total soluble solids (TSS), total sugars and V.C. contents markedly increased with biostimulants treatments compared to control. In addition, high values of such characters were obtained with trees treated with potassium humate at 20g/tree and active dry yeast at 0.4%. Biostimulants treatments enhanced leaf chlorophyll content and leaf mineral contents of N, P, K, Ca and Mg. Generally, it can be concluded that biostimulants treatments had a promotional effect on yield, fruit quality and nutritional status of Washington Navel orange trees. In this respect, potassium humate at 20g/tree and active dry yeast at 0.4% were considered the promising treatments.

Key words: Orange trees biostimulants, potassium humate, yeast extract, amino acids, yield, fruit quality

Introduction

Citrus nearly is the main fruit crop in the world, and it is considered the first economic fruit crop in Egypt. Fertilization is one of the important tools in increasing crop yield. Mineral fertilizers and other chemical commonly used in agricultural production not only have harmful effects on the environment, but also, they can alter the composition of fruit, vegetable and root crops and decrease their content of vitamins, minerals and other useful compounds. There is a very danger that harmful residue may remain in fruits (Bogatyre, 2000). Therefore, a great attention was realized to use some organic and bio sources as an additional application with mineral fertilization (El-Haddad et al., 1993).

Biostimulants are organic compounds that cause or accelerate biochemical activity within the treated plants and increase the efficiency of plant or any of its parts for uptake necessary nutrients. Application of biostimulants to soil or plant foliage enhances chemical changes in living cells by which energy is provided for vital processes and activities. Biostimulants are very safe for humans, animals and environment, thus their use decreases the pollution caused by chemical fertilizers (Russo and Berlyn, 1990).

There are many types of Biostimulants like; humic substances, yeast extract and amino acids. Humic substances namely potassium humate, fulvic acid and humic acid act as conditioners for soil, so they improve soil structure and increase root development. Benefits of humic substances are due to the addition of organic matter to organically deficient soils which increase root vitality, improve nutrient uptake, increase chlorophyll synthesis, fertilizer retention, stimulate beneficial microbial activity, produce healthier plants and improve yield (Davis and Ghabbour, 1998 and Kabeel et al., 2008). Fathi et al., (2002) mentioned that biostimulant treatments applied with inorganic source of N considerably increased peach fruit weight, size and fruit dimensions as compared to the control.

The general positive effects of applying active dry yeast to plants were attributed to its content of different nutrients as N, P and K and some common amino acids (Abou-Zaid, 1984). Also, yeast contains some natural growth regulators like auxin and cytokinins (Moor, 1979 and Ferguson et al., 1987). In addition, application of active dry yeast is very effective in releasing CO2 which improves net photosynthesis (Attala et al., 2000 and Abd El-Moniem et al., 2002). Yeast extract contains higher values of proteins and large amount of vitamin B which plays a key role in improving growth and controlling the incidence of fungi diseases (Idso et al., 1995). Likewise, Ismaeil et al., (2003) found an increment in Thompson seedless yield and yield components as a result of spraying yeast extract.
Amino acids are considered a growth stimulator and it is involved in many commercial organic and bio fertilizers. Aberg (1961) indicated that amino acids can act as growth factors of higher plants since they are the build blocks of protein synthesis, which could be enzymes important for metabolic activities. Gamal El-Din et al., (1997) found an increase in vegetative growth of lemon grass as a result of ornithine and phenylalanine treatments. Also, Karima and Abd Elwahed (2005) showed that treatments of some amino acids (ornithine, proline and phenylalanine) led to significant increases in the plant height, number of branches, number of flowers per plant, fresh weight and dry weight of herb and flowers of Chamomile plants.

The present study was aimed to evaluate the effect of different bio-stimulants; (Potassium humate, yeast extract and amino acid mixture “commercial product” on yield, fruit quality and nutritional status of Washington Navel orange trees.

Materials and Methods

This study was carried out during (2010-2011) seasons on healthy and almost uniform Washington Navel orange trees 20 years old cultivated in a private farm located in Behaira governorate, northwest of Cairo, Egypt. The texture of the soil is heavy loam soil and well drained with water table not less than 120 cm deep. The trees were annually fertilized with organic manure at the rate of 48m³ha⁻¹ in winter. In addition, each tree received 1kg calcium super phosphate (6.77% P) at mid January plus 1.5 Kg potassium sulphate (38.5% K) into equal doses in mid February and mid April plus 2Kg ammonium nitrate (33.5% N) through three equal doses during March, May and July. The investigation was designed to throw some light on the effect of some biostimulants (Potassium humate, yeast extract and amino green II (amino acids mixture) on yield, fruit quality and nutritional status of Washington Navel orange trees.

The experiment consists of seven treatments arranged in a randomized complete block design. Five replicates were chosen for each treatment with one tree in each replicate. Least significant differences (L.S.D) at 0.05 (Steel and Torrie, 1984) were used for comparison between the control and the other experimental treatments for the following parameters; yield, fruit quality and leaf mineral composition.

Treatments were applied monthly (from March to October) as follows:-

1- Control
2- Yeast extract as foliar application at 0.2%.
3- Yeast extract as foliar application at 0.4%.
4- Amino green II as foliar application at 0.25%.
5- Amino green II as foliar application at 0.5%.
6- Potassium humate as soil application at 10g/tree.
7- Potassium humate as soil application at 20g/tree.

Potassium humate was added as soil application in a small hole under the periphery of the tree. Meanwhile yeast extract and amino green II were applied adhesive as foliar spray using a hand pressure sprayer. This was done along with Triton B emulsifier at a rate of 0.2 % as a surfactant was used with each spray solution as wetting agent.

At harvest (20 November) the total fruit yield was determined and expressed as kg/tree. A random sample of ten mature fruits was taken from each replicate. The average fruit weight and juice % were determined. The percentage of fruit total soluble solids (TSS) and vitamin C content (expressed as mg V.C. / 100 ml juice were determined as outlined by Association of Official Agriculture Chemists (A.O.A.C.) 1980. Total sugars were determined according to Malik and Singh (1980).

In the spring of each season, 20 non-fruitering shoots of spring cycle were tagged at constant height and at all directions of each tree. In November, leaf samples (about 50 leaves /tree) were taken and washed with distilled water, in a portion of fresh leaf material total chlorophyll was determined according to method described by (Yadava 1986) using a Minolta SPAD chlorophyll meter model. The results were expressed as SPAD unites. The remaining leaf samples were oven dried at 65°C to a constant weight and then ground. To determine leaf mineral contents, 0.3 g of ground material of each sample was digested with H₂SO₄ and H₂O₂ according to Wolf (1982). In the digested material, total nitrogen and phosphorus were determined colorimetrically according to Evenhuis and De waard (1976) and Murphy and Riley (1962), respectively. Potassium was determined by flame photometer as described by Cheng and Bray (1951). Calcium and magnesium leaf contents were determined by atomic absorption according to Carter (1993).

Results and Discussion

The effect of biostimulant treatments on yield and fruit quality of Washington Navel orange are presented in Table1. Generally it can be observed that all biostimulants significantly increased total yield as Kg/tree compared to control. Moreover, the effect of biostimulants in increasing yield can be arranged as follows potassium humate, active dry yeast and amino acids in descending order. Generally, the highest concentration of
each biostimulants markedly increased yield compared to the lowest concentration. Potassium humate at 20 g/tree (the best treatment) increased the yield by about 53.2% compared to control. Regarding average fruit weight, the data revealed that potassium humate at 20gm/tree significantly increased average fruit weight; meanwhile other biostimulants caused an insignificant increase compared to control. Moreover, there were no significant differences between kind and concentrations of biostimulants. Fruit juice percentage significantly increased with application of potassium humate at 10 and 20gm/tree and active dry yeast at 0.4%. In addition potassium humate had a superior effect compared to the other biostimulants. All biostimulants except amino acids at 0.25% markedly increased fruit TSS compared to control. In addition, potassium humate at 20g/tree and active dry yeast at 0.4% caused a significant increase in total sugars and vitamin C contents of fruits.

Regarding leaf chlorophyll and mineral contents the data in table 2 indicated that, all biostimulants significantly increased leaf P, K, Ca, and Mg contents, and the highest values were obtained with potassium humate at 20gm/tree, meanwhile leaf chlorophyll and nitrogen contents were not significantly affected with biostimulant treatments.

The positive effect of potassium humate in increasing yield and fruit quality and enhancing leaf mineral composition could be attributed to its effect in increasing root vitality, improving nutrient uptake, increasing chlorophyll synthesis, enhancing fertilizer retention and stimulating beneficial microbial activity. In this respect Stevenson (1982) reported that the positive action of humic substances on plant growth and fruiting is attributed to the following reasons; increase water holding capacity, enhance aeration of soil, increase drought resistance, chelate nutrients and so increase their availability, possesses high ion-exchange capacity, increase percentage of total N in soil and increase buffering properties of soil.

Enhancement of yield, fruit quality and leaf mineral contents as a result of applying active dry yeast to plants were attributed to its content of different nutrients as N, P and K and some common amino acids (Abou-Zaid, 1984). Also, yeast contains some natural growth regulators; i.e., auxin (Kihlbery, 1972). The constructive effect of spraying yeast could be also attributed to the enhancement of photosynthesis processes and increasing the promoter hormones as cytokinins. (Kamelia et al., 2000b and Abd El-Galil et al., 2003). Yeast is considerable as a natural source of Bs vitamins and most of the essential elements (Nagadawithana, 1991). B-Vitamins practicable in plant growth and development indirectly by enhancing endogenous levels of various growth factors such as cytokinins and gibberellins (Kodandaranalah and Rao, 1985).

The beneficial effect of amino acids application may be due to that amino acids are considered a growth stimulator and it is involved in many commercial organic and bio fertilizers. Aberg (1961) indicated that amino acids can act as growth factors of higher plants since they are the build blocks of protein synthesis, which could be enzymes important for metabolic activities.

Generally, our results are in line with those obtained by Barakat et al. (2012) who showed that, organic fertilization plus humic acid enhanced vegetative growth of old Newhall Navel orange trees by increasing trunk circumference, tree canopy volume, leaf area and total leaf chlorophyll content. Also, they added that organic fertilization plus humic acid significantly improved leaves nutritional status through increasing their contents of nitrogen, phosphorus and potassium compared to the chemical fertilizers alone. In this concern, Saeed et al., (2009) reported that liquid humic acid having pH 5.9 was applied at 40, 60 and 80 ml tree⁻¹ to 12 year old Kinnow mandarin plants in single, two and three equal splits as well. The humic acid significantly increased the yield of Kinnow mandarin and also improved fruit taste and quality and enhanced leaf chlorophyll content through enhancing photosynthetic rate, transpiration rate and stomatal conductance. Khafagy et al. (2010) showed that single or combined application of either yeast or zinc were very effective in stimulating yield of Navel orange trees as well as physical and chemical characters of fruits rather than control. Spraying trees with 4.0% yeast extract combined with 1.0% zinc sulphate was more effective in improving total yield and fruit numbers besides increasing fruit weight, length and volume. Also, the highest values of fruit quality resembled by increasing total soluble solids, ascorbic acid and decreasing fruit acidity were noticed with such treatment.

Karima and Abdel Wahed (2005) reported that foliar application of different concentrations (0, 50, 100, 150 mg/ 100 ml) of three amino acids (ornithine, proline and phenylalanine) significantly increased oil %, yield, plant height, number of branches, number of flowers per plant, fresh weight and dry weight of herb and flowers of Chamomile plants.

Table 1: Effect of some biostimulants on yield and fruit quality of Washington Navel orange trees (average of two seasons).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield (Kg/tree)</th>
<th>Av.Fruit Weight (g)</th>
<th>Fruit Juice (%)</th>
<th>TSS (%)</th>
<th>Total Sugars (%)</th>
<th>V. C. mg/100 ml juice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>81.20</td>
<td>204.33</td>
<td>24.33</td>
<td>10.73</td>
<td>7.18</td>
<td>55.10</td>
</tr>
<tr>
<td>Yeast extract (0.2%)</td>
<td>89.30</td>
<td>241.67</td>
<td>29.17</td>
<td>11.93</td>
<td>8.11</td>
<td>58.43</td>
</tr>
<tr>
<td>Yeast extract (0.4%)</td>
<td>105.33</td>
<td>259.00</td>
<td>30.67</td>
<td>12.53</td>
<td>8.26</td>
<td>61.07</td>
</tr>
<tr>
<td>Amino green II (0.25%)</td>
<td>87.20</td>
<td>239.00</td>
<td>24.67</td>
<td>11.46</td>
<td>7.73</td>
<td>56.63</td>
</tr>
<tr>
<td>Amino green II (0.5%)</td>
<td>96.33</td>
<td>241.00</td>
<td>26.67</td>
<td>11.73</td>
<td>7.53</td>
<td>57.37</td>
</tr>
<tr>
<td>Potassium Humate (10gm)</td>
<td>117.67</td>
<td>250.00</td>
<td>32.33</td>
<td>12.07</td>
<td>8.18</td>
<td>60.70</td>
</tr>
<tr>
<td>Potassium Humate (20gm)</td>
<td>124.43</td>
<td>266.67</td>
<td>34.00</td>
<td>12.60</td>
<td>8.44</td>
<td>63.56</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>3.219</td>
<td>54.893</td>
<td>5.242</td>
<td>0.993</td>
<td>1.050</td>
<td>5.661</td>
</tr>
</tbody>
</table>
Table 2: Effect of some biostimulants on leaf mineral and chlorophyll contents of Washington Navel orange trees (average of two seasons).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>N (%)</th>
<th>P (%)</th>
<th>K (%)</th>
<th>Ca (%)</th>
<th>Mg (%)</th>
<th>Chlorophyll (SPAD units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.07</td>
<td>0.16</td>
<td>1.01</td>
<td>3.29</td>
<td>0.39</td>
<td>77.16</td>
</tr>
<tr>
<td>Yeast extract (0.2%)</td>
<td>2.36</td>
<td>0.20</td>
<td>1.29</td>
<td>3.40</td>
<td>0.45</td>
<td>78.35</td>
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<tr>
<td>Yeast extract (0.4%)</td>
<td>2.41</td>
<td>0.22</td>
<td>1.34</td>
<td>3.55</td>
<td>0.49</td>
<td>80.49</td>
</tr>
<tr>
<td>Amino green II (0.25%)</td>
<td>2.33</td>
<td>0.19</td>
<td>1.31</td>
<td>3.36</td>
<td>0.42</td>
<td>75.83</td>
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<tr>
<td>Amino green II (0.5%)</td>
<td>2.38</td>
<td>0.19</td>
<td>1.33</td>
<td>3.39</td>
<td>0.45</td>
<td>77.31</td>
</tr>
<tr>
<td>Potassium Humate (10gm)</td>
<td>2.51</td>
<td>0.22</td>
<td>1.41</td>
<td>3.61</td>
<td>0.50</td>
<td>77.95</td>
</tr>
<tr>
<td>Potassium Humate (20gm)</td>
<td>2.56</td>
<td>0.24</td>
<td>1.52</td>
<td>3.77</td>
<td>0.51</td>
<td>81.64</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>0.617</td>
<td>0.028</td>
<td>0.046</td>
<td>0.041</td>
<td>0.043</td>
<td>6.219</td>
</tr>
</tbody>
</table>

Conclusion:

From the above mentioned results, generally it can be concluded that biostimulants treatments had a promotional effect on yield, fruit quality and nutritional status of Washington Navel orange trees. In this respect, potassium humate at 20g/ tree and active dry yeast at 0.4% were considered the promising treatments.

References


