COMPARATIVE EFFECT OF ONE SYNTHETIC BIOSTIMULANTS AND MICROBIAL BIOSTIMULANT (Azospirillum lipoferum) ON YIELD AND QUALITY OF WASHINGTON NAVEl ORANGE FRUITS.

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ABSTRACT

Foliar sprays with synthetic biostimulants or microbial biostimulants PGPR (plant growth promoting rhizobacteria) were used. They contain amino acids, macro and micro elements, humic acid and vitamins. Also its direct effect in release stimulants, nutrients, antibiotics, biosides and sidrofores or activation of these microorganisms in plant rhizosphere in activation and improving plant growth. This study was carried out during 2013 and 2014 seasons on 10 years old Washington navel orange (Citrus sinensis Osbeck) trees budded on sour orange (Citrus aurantium L.) rootstock, grown in a private orchard located at Motobus, Kafr El Sheikh Governorate, to study the effect of synthetic stimulants (Furdose) and microbial biostimulant (Azospirillum lipoferum) on fruit set, dropping, yield and fruit quality. Furdose as a commercial synthetic biostimulant and microbial biostimulant Azospirillum lipoferum were used as foliar application alone or in combination at two stages, before flowering (first mach) or after fruit set (first may) or before flowering and after fruit set. The obtained results revealed that, fruit set and drop percentages, yield and fruit quality were significantly affected by Furdose and Azospirillum lipoferum treatments alone or in combination in both seasons. The data cleared that, both stimulators enhanced fruit set percentage, yield and fruit quality of Washington navel orange trees. Azospirillum lipoferum alone or combined with Furdose was more effective on improving the productivity and fruit quality. The T6 (foliar spray of A. lipoferum after fruit set), T7 ((foliar spray of A. lipoferum before flowering and after fruit set) and T10 (foliar spray of Furdose plus A. lipoferum before flowering and after fruit set) were the most effective treatments on yield and fruit quality. It increased fruit set, yield and fruit quality in terms of fruit number, fruit kg/tree, fruit firmness, soluble solids content, reducing and total sugars and vitamin C. Fruit drop was decreased without significant differences among them in both seasons. Thus spraying with Azospirillum lipoferum after fruit set T6 (foliar spray of A. lipoferum after fruit set) gave 112.4 and 115.7 kg/tree compared with T7 (foliar spray with Azospirillum lipoferum before flowering and after fruit set) 108.7 and 121.4 kg/tree and T10 (foliar spray the combination of them before flowering and after fruit set) 114.7 and 130.3 kg/tree during both seasons, respectively. The use of (Azospirillum lipoferum) is recommended for increasing fruit yield and quality such as firmness, SSC, V.C and total sugars which may be increase the fruit ability to handling stages and longest shelf life, and gave the highest of net return per feddan and the increase in net return over control when used alone or with synthetic biostemulants (Furdose) compared with the use of synthetic biostemulants (Furdose) alone.
INTRODUCTION

Washington navel orange (Citrus sinensis L.) is an important cultivar in Egypt; due to its vigorous growth and good productivity with high quality fruits. It is considered as the best for local and exporting markets. In order to improve productivity with excellent fruit quality for high exportation potential, the farmers should be tended to the use of agricultural biostimulants practices. Uses of plant biostimulants which include diverse substances (humic substances, seaweed extracts, free amino acids and other N-containing) and microorganisms (free living bacteria, fungi and arbuscular mycorrhizal fungi) are known to improve plant growth, yield and fruit quality (Calvo et al., 2014). Azospirillum spp. are considered to be an important plant growth promotive rhizobacteria (PGPR) for many reasons: Azospirillum brasilense and Azospirillum lipoferum stimulate growth and increase yield in apple, citrus, olive, pomegranate, cherry, strawberry and apricot (Aslantas et al., 2007, Abbas et al., 2013, Mohamed et al., 2009, Hafez et al., 2013, Esitken et al., 2010 and Abd Ella, 2006). In this respect, Malik et al. (2002) found that Azospirillum brasilense and Azospirillum lipoferum contributed between 7–12% of the total nitrogen content by using N\textsuperscript{15} tracer techniques on wheat. Also, Boddey et al., (1991) noticed that, about 60 – 80 % of total nitrogen came from nitrogen fixation by Azospirillum diazotrophicus on sugarcane plants. The foliar spray with PGPR bacteria had been proved efficiency for enhancing plant growth and yield of different fruit crops (Esitken et al., 2004 on apricot, Esitken et al., 2009 on apple and Nour El-Din et al., 2012 on Anna apple). Moreover, phytohormones, like auxins, cytokinins, gibberellins and ethylene, can be synthesized by beneficial microorganisms (Esitken et al., 2006). These plant hormones regulate multiple physiological processes. For example, gibberellins are mainly involved in regulating plant cell division and elongation and hence, they influence almost all stages of plant growth, including seed germination, stem and leaf growth, floral induction, and fruit growth (Spaepen et al., 2009). PGPR was found also to modify the plant hormones statue (Dodd et al., 2010). Azospirillum brasilense and Azospirillum lipoferum produce different GAs specially GA\textsubscript{1} and GA\textsubscript{3} that are responsible for plant growth promotion that occurs upon inoculation onto plants (Cassan et al., (2001, Mehnaz and Lazarovits, 2006 and Ekine et al., 2014). The use of plant growth promotive rhizobacteria (PGPR) as foliar application mean for producing maximum yield and improving fruit quality like fruit size, fruit firmness, total soluble solids, acidity and vitamin C (El-Shazly and Mustafa, 2013 on Washington navel orange, Esitken, et al., 2002 on apricot, Akea and Ercisli, 2010 on sweet cherry and Arikan et al., 2013 on Quince).

Therefore, the objective of this investigation was to study the effect of synthetic biostimulants Furdose and microbial biostimulant Azospirillum lipoferum on fruit set, dropping, yield and fruit quality of Washington navel orange trees.
MATERIALS AND METHODS

The present study was carried out during 2013 and 2014 seasons on 15 years old Washington navel orange (Citrus sinensis Osbeck) trees budded on sour orange (Citrus aurantium L.) rootstock, spaced a 6×6 meters, grown in a private orchard located at Motobus, Kafr El Sheikh Governorate and subjected to cultural practices usually done in this area. The soil texture was clay (51.91% clay, 39.82% silt and 8.27% sand), 3% total carbonate content, 3.12 ds m⁻¹ an electrical conductivity and a pH of 8.15. Thirty trees uniform in vigour were selected to study the effect of synthetic stimulants (Furdo) and microbial biostimulant (Azospirillum lipoferum) on fruit set, dropping, yield and fruit quality. The experiment consist of ten treatments arranged in a randomized complete block design, with three replicates for each treatment, one tree in each replicate. Azospirillum lipoferum was grown in the semi solid Dobereiner medium (Dobereiner et al., 1976), each liter of distilled water contained 5.0g Malic acid, 0.4g KH₂PO₄, 0.1g K₂HPO₄, 0.2g MgSO₄, 0.1g NaCl, 0.02g CaCl₂,7H₂O, 0.01g FeCl₃,6H₂O, 0.002g NaMoO₄.2H₂O and 1.75g Agar. Solution spray was prepared as 100 ml/100 liter water. Other material Furdo is a commercial synthetic stimulant contained 22% humic and fulvic acids, 40% natural and organic substances, 14.6% free amino acids, 4.5% N, 3.8% P, 5%K, 0.4% Ca,0.4% Mg, 0.1% Fe, 15ppm Mn, 20ppm Zn and 15ppm Cu, and the concentration of solution spray was 5%.

Tween-20 (0.1%) as surfactant was added to the solution then the foliar application was applied directly to trees with a handheld sprayer until runoff in the early morning. The following treatments were applied:

- T₁ Control, trees sprayed with tap water only.
- T₂ Foliar spray of Furdo before flowering (at the beginning of March).
- T₃ Foliar spray of Furdo after fruit set (at the beginning of May).
- T₄ Foliar spray of Furdo before flowering and after fruit set.
- T₅ Foliar spray of A. lipoferum before flowering (at the beginning of March).
- T₆ Foliar spray of A. lipoferum after fruit set (at the beginning of May).
- T₇ Foliar spray of A. lipoferum before flowering and after fruit set.
- T₈ Foliar spray of Furdo plus A. lipoferum before flowering.
- T₉ Foliar spray of Furdo plus A. lipoferum after fruit set.
- T₁₀ Foliar spray of Furdo plus A. lipoferum before flowering and after fruit set.

Four main branches as 2.5 inch in diameter of each tree in different directions were labeled and the following parameters were determined:

1. Final fruit set and preharvest fruit drop percentages:

- **Final fruit set %**: was calculated by dividing the number of fruits before harvesting by the total number of flowers.

  \[
  \text{Final fruit set %} = \frac{\text{No. of fruit set}}{\text{Total No. of flowers}} \times 100.
  \]

- **Preharvest drop percentage %**: was calculated by recording fruits from August to December. The percentage of preharvest drop was calculated to the equation:

  \[
  \text{Preharvest fruit drop %} = \frac{\text{No. of dropping fruits}}{\text{No. of fruits at August}} \times 100
  \]
2. Yield:
Yield of each tree was determined as number and weight (kg) /tree.

3. Fruit quality:
To determine fruit quality, 20 fruits were taken at random from each tree at harvest time (first January) SSC between (12-16 % ) of both seasons and prepared for determination of physical and chemical fruit characteristics.

Physical character:
Fruit weight (gm) and fruit volume (cm$^3$) were determined. Fruit firmness (g/cm2) was recorded by using Lfra Texture analyzer instrument. The results were expressed as resistance force of the fruit to the penetrating tester according to Harold (1985).

Chemical character:
Soluble solids content ( SSC), Acidity %, SSC/Acid ratio and vitamin C:
Juice samples were prepared for determining, soluble solids content percentage by a hand refractometer, total acidity percentage as citric acid according to (A. O. A. C 1990), ascorbic acid as mg/100 ml/juice by using 2, 6 dichlorophenol indophenol and SSC/acid ratio was estimated.

Sugar contents (Reducing, non reducing and total sugars):
Sugar contents (reducing, non-reducing and total sugars) were extracted from 5 grams of mixed flesh of both fruits sample by using distilled water (Loomis and Stull, 1937). The reducing sugars content were determined as (Shaffer and Hartman, 1921), sugar contents were expressed as gm per 100 gm fresh weight of fruit flesh.

The obtained data were subjected to analysis of variance according to Snedecor and Cochran (1990). Duncan’s multiple range test (Duncan, 1955) at 5% level was used to compare the mean values.

RESULTS AND DISCUSSION

Final fruit set and preharvest fruit drop percentages:
Data presented in Table 1 revealed that, final fruit set and preharvest fruit drop percentages were significantly affected by foliar application of Furdo and Azospirillum lipof erum as biostimulants treatment alone or combined with the other in both seasons. As for final fruit set percentage, it is clear that all treatments significantly increased final fruit set percentage in both seasons as compared with the control (T1). The treatments of T5, T7 and T10 gave higher final fruit set percentage than other treatments in both seasons. The difference among T5, T7 and T10 were not significant in both seasons. On the other hand, the least final fruit set% was found on trees sprayed with tap water(control). The data also cleared that, both stimulants enhanced final fruit set of Washington navel orange trees, but Azospirillum lipof erum alone or combined with Furdo was more improved final fruit set as compared with other treatments Table 1. These results are in harmony with those obtained by Esitken et al., (2002) on apricot, Pirlak et al., (2007) and Aslantas et al., (2007) on apple. In this respect, Karakurt et al., (2011)
concluded that the combined treatments of four *Azospirillum* spp. bacteria caused highest fruit set rate of sour cherry.

Concerning preharvest fruit drop percentage, data in Table 1 indicated that fruit drop percentage was significantly affected by treatments as compared with control in both seasons. T1 had the highest preharvest fruit drop followed by T2 and T8 respectively in both seasons. The treatments of T8, T7 and T10 had the lowest values of preharvest fruit drop percentage without significant difference among them in both seasons Table 1. Microbial stimulators (*Azospirillum lipoferum*) decreased preharvest fruit drop% when spray before flowering only or before flowering and after fruit set as compared with the other treatments in the two growing seasons. These findings are confirmed by the results obtained by Omer et al., (2012) on Washington navel orange trees and Abbas et al., (2013) on Kinnow mandarin. In this respect, Taha and Eid (2011) concluded that polyamines contained in biostimulants regulate many growth processes, differentiation, setting and ripening of fruits.

**Yield:**

**Yield as fruit number per tree.**

The reading of Table 1 showed that, both of biostimulants alone or combined to other significantly increased fruit number/tree as compared with the T1 (control) in both seasons. T7, T10 and T8 had the highest significant values of fruit number/tree during the two seasons, respectively compared with control and other treatments. These values were 459.3, 475.6 and 466.0 number fruit/tree and 510.0, 500.3 and 470.0 number fruit/tree compared with 343.0 and 393.6 number fruit/tree for the control during the two seasons, respectively. These results are in agreement with those obtained by El-Shazly and Mustafa (2013) on Washington navel orange. Also, Shamseldin et al., (2010) reported that inoculation of Washington navel orange trees with *Pseudomonas fluorescense* and *Azospirillum brasilense* resulted in significant increase of the number of fruit per tree. In this line Eissa (2003) who reported that spray with EM (effective microorganisms) resulted in an increase in number of Kelsey plum fruits/tree. Also, Eissa et al., (2007) indicated that the spray of pear trees with *Saccharomyces cervecia* had a stimulated effect and increased number of fruits, Iqbal et al., (2011) with bacterial biostimulants which increased fruit number, Nour El-Din et al., (2012) mentioned, that *Azospirillum brasilense* recorded the highest number fruit/tree than the other treatments during two seasons, Gabr and Nour El-Din (2012) found that, the spray of *Azospirillum* isolates increased fruit number on apple trees.

**Yield as kg/tree.**

Data in Table 1 cleared that, all sprayed treatments with biostimulants increased yield as kg/tree during the two seasons compared with the control treatment. The highest increment in this respect was found in treatments of T10, T7 and T6 with 114.7, 114.6 and 112.4 kg/tree in the first season but, treatments of T10, T7 and T9 had 130.3, 128.8 and 121.4 kg/tree in the second season, respectively compared with 92.6 and 97.7kg/tree in control treatment during the two seasons, respectively.
Table 1. Effect of plant biostimulators (Furdose and *Azospirillum lipoferum*) on fruit set %, preharvest fruit drop %, fruit number/tree and yield kg/tree of Washington navel orange fruits in 2013 and 2014 seasons

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Final fruit set %</th>
<th>Preharvest fruit drop %</th>
<th>Yield Number fruit/tree</th>
<th>Kg/tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>6.03e</td>
<td>5.99f</td>
<td>12.05a</td>
<td>11.82a</td>
</tr>
<tr>
<td>T2</td>
<td>7.83bc</td>
<td>7.97bc</td>
<td>10.10b</td>
<td>9.77b</td>
</tr>
<tr>
<td>T3</td>
<td>6.84de</td>
<td>6.17ef</td>
<td>7.63e</td>
<td>7.43de</td>
</tr>
<tr>
<td>T4</td>
<td>7.89bc</td>
<td>7.47cd</td>
<td>6.79fg</td>
<td>6.45f</td>
</tr>
<tr>
<td>T5</td>
<td>9.17a</td>
<td>9.39a</td>
<td>8.18d</td>
<td>7.80d</td>
</tr>
<tr>
<td>T6</td>
<td>6.61de</td>
<td>6.91de</td>
<td>6.12h</td>
<td>5.79g</td>
</tr>
<tr>
<td>T7</td>
<td>9.30a</td>
<td>9.28a</td>
<td>6.28h</td>
<td>5.78g</td>
</tr>
<tr>
<td>T8</td>
<td>8.48ab</td>
<td>8.55ab</td>
<td>9.40c</td>
<td>8.89c</td>
</tr>
<tr>
<td>T9</td>
<td>7.29cd</td>
<td>6.15ef</td>
<td>7.19ef</td>
<td>7.04e</td>
</tr>
<tr>
<td>T10</td>
<td>9.33a</td>
<td>8.78ab</td>
<td>6.44gh</td>
<td>6.32f</td>
</tr>
</tbody>
</table>

Means followed by different letter are significantly different within columns by Duncan’s multiple range test, P ≤ 0.05.

These results agree with Eissa, (2003) who found that, foliar sprays of PGPR increased fruit yield as reflected by promoting of flowering process and fruit setting; Esitken et al., (2004) reported that, spray of apricot with *Bacillus OSU-142* increased fruit yield, Abd El-Migeed et al., (2007) noted that inoculation of Washington navel orange trees with *Azospirillum lipoferum* as a source of biofertilizer improved fruit yield (kg/tree), Esitken (2009) showed that, spraying of PGPR bacteria enhanced plant growth and fruit yield of apple trees, Shamseldin et al., (2010) reported that, inoculation of Washington navel orange trees with *Pseudomonas fluorescence* and *Azospirillum brasiiliense* resulted in significant increase in number of fruit and weight per tree. Similar results were reported by Spinelli et al (2010) who showed that, treated strawberry with Actiwave as a product derived from the algae *Ascophyllum modosum* enhanced the yield and had significant effect on reducing the native effect of alternative bearing. The PGPR had multi-mechanism for enhancing yield and quality which reflected by producing antibiotics (Esitken 2011). Gabr and Nour El-Din (2012) cleared that, the spray of *Azospirillum* isolates increased fruit weight (kg/tree) of apple during two seasons . Nour El-Din et al., (2012) mentioned that Furdose stimulated the growth and increased fruit yield but the spray with bacterial biostimulants *Azospirillum brasiiliense* had a strong influence than the synthetic biostimulants in this concern.

**Fruit quality:**

**Physical characters:**

The results presented in Table 2 showed the effect of Furdose and *Azospirillum lipoferum* as biostimulants treatments on weight, volume and firmness of Washington navel orange fruits. The results cleared an increase in fruit weight and volume in untreated control in the two seasons.
respectively and T<sub>9</sub> on weight and T<sub>10</sub> on volume in the second season. There were significant differences between the control and all treatments. The lowest values of fruit weight was noticed with T<sub>7</sub> and T<sub>4</sub> in the first season and T<sub>2</sub> and T<sub>5</sub> in the second season compared with the other treatments.

The lowest values of fruit volume on the data recorded in Table 2 was found with T<sub>1</sub> and T<sub>6</sub> in the first season and T<sub>2</sub> and T<sub>3</sub> in the second season. Similar effects were mentioned by Esitken et al., (2002) on apricot, Akea and Ercisli (2010) on Quince and El-Shazly and Mustafa (2013) on Washington navel orange. Also, Eissa (2003) reported that, the spray with EM (effective microorganisms) resulted in an increase in weight of Kelsey plum fruits/tree, Eissa et al., (2007) noticed that, Saccharomyces cerevisiae had an increase in weight of pear fruits and had stimulate effect. Iqbal et al., (2011) noticed that, bacterial biostimulants increased size of plant cells due to the function of plant phytohormones like IAA, cytokinins and gibberellins.

Also, data in Table 2 indicated that, fruit firmness was significantly increased by all treatments compared with the untreated treatment during the two seasons, respectively. The highest values of fruit firmness was recorded by T<sub>9</sub> and T<sub>10</sub> compared to the control and the other treatments in both seasons. On the other hand trees sprayed with tap water (control) had the lower fruit firmness than the other treatments in both seasons. Similar results were obtained by Pirlak and Kose (2009) who found that, the spray with synthetic or bacterial biostimulants lead to increase fruit firmness , Abd El-Razek and Saleh (2012) on Florida prince peach and Arikan et al., (2013) on Quince. The data cleared that Azospirillum lipoferum alone or combined with Furdose improved firmness , in harmony with the results obtained by Yolcu et al., (2011) and Mosa et al., (2014).

The increase of fruit firmness on T<sub>9</sub> and T<sub>10</sub> compared with the control and the other treatments may be due to the effect of biostemulators on inducing high potentialataly of fruit rind resist to pathogens Van Loon , L.C. (2007; so harmful microbes and modify the plant hormones status which retarded cell senescence. PGPR regulate plant ethylene level and produce antibiotics Govindaasamy et al.(2008) which are reflected on fruit quality as firmness.
Table 2. Effect of plant biostimulators (Furdose and Azospirillum lipoferum) on weight, volume and firmness of Washington navel orange fruits in 2013 and 2014 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fruit weight (g)</th>
<th>Fruit volume (cm³)</th>
<th>Fruit firmness (g/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>270.15a</td>
<td>261.32a</td>
<td>285.66a</td>
</tr>
<tr>
<td>T₂</td>
<td>256.48b</td>
<td>240.44d</td>
<td>272.33a</td>
</tr>
<tr>
<td>T₃</td>
<td>244.21cde</td>
<td>246.23cde</td>
<td>260.66bc</td>
</tr>
<tr>
<td>T₄</td>
<td>238.70de</td>
<td>258.63ab</td>
<td>265.66bc</td>
</tr>
<tr>
<td>T₅</td>
<td>240.86cde</td>
<td>258.00bc</td>
<td>271.33bc</td>
</tr>
<tr>
<td>T₆</td>
<td>241.25cde</td>
<td>250.09c</td>
<td>257.33c</td>
</tr>
<tr>
<td>T₇</td>
<td>234.34e</td>
<td>252.68bc</td>
<td>267.66bc</td>
</tr>
<tr>
<td>T₈</td>
<td>250.98bc</td>
<td>252.44bc</td>
<td>266.33bc</td>
</tr>
<tr>
<td>T₉</td>
<td>247.58bcd</td>
<td>261.10a</td>
<td>264.66bc</td>
</tr>
<tr>
<td>T₁₀</td>
<td>240.47cde</td>
<td>260.47a</td>
<td>269.00bc</td>
</tr>
</tbody>
</table>

Means followed by different letter are significantly different within columns by Duncan’s multiple range test, P ≤ 0.05.

Chemical characters:
Soluble solids content (SSC), Acidity, SSC/Acid ratio and vitamin C content:

Data in Table 3 present the effect of biostimulants treatments on soluble solids content %, acidity %, SSC/acid ratio and vitamin C content of Washington navel orange fruits. Concerning soluble solids content %, all treatments significantly affected them in both seasons. T₆, T₇ and T₉ recorded the highest values of soluble solids content % in the first season, but in the second season the highest values came with T₆, T₁₀ and T₃. The T₆ and T₁ (control) gave the lowest soluble solids content % in the first season while T₁ (trees sprayed with tap water only) had the lowest value in the second season. The differences between the highest values and control were highly significant.

Also, the same trend was noticed about acidity that the lowest values belonged with T₁ (Control) during the two seasons. Anyhow, T₇ and T₆ gave the highest values of acidity in both seasons, respectively. There were high significant differences between the control values and all treatment values especially with T₇ in both seasons. Similar results were obtained by Abd Ella (2006) on Arabi pomegranate. Pirlak and Kose (2009) claimed that spray of PGPR bacteria increased SSC and acidity of strawberry fruits, Shamseldin et al. (2010) on Washington navel orange. Nour El-Din et al (2012) noticed that, SSC % of Anna apple fruits were generally lowered due to spraying with stimulants whether were synthetic or biological through two studying seasons, but differences did not usually reach to significance. In general acidity of fruits increased by the spray treatments especially with bacterial biostimulants in the two seasons.

Data in Table 3 showed that, SSC/acid ratio was significantly affected by all treatments in both seasons, but these effects varied from season to other and among treatments in this variable. On the other words, T₁ gave
the highest value of SSC/acid ratio in the first season, while $T_{10}$ recorded the highest value of SSC/acid ratio during the second season. $T_7$ showed the lowest SSC/acid ratio in both seasons, respectively. However, there was a clear constant trend on the different treatments on SSC/acid ratio in both seasons. These results are in harmony with those reported by Mohamed et al., (2009) on Balady mandarin and Karakurt et al., (2011) on sour cherry.

Reading in Table 3 indicated that, vitamin C content of Washington navel fruits was significantly affected by all treatments as compared with control in both seasons. There was a high significant difference among the control and all treatments during the two seasons. Results showed that $T_6$, $T_7$ plus $T_{10}$ had the highest values of vitamin C without significant differences among them in both seasons. These values were 57.89, 57.48 and 57.47 mg/100 ml juice and 58.03, 57.70 and 57.66 mg/100 ml juice compared with 52.59 and 53.24 mg/100 ml juice in the control during the two seasons respectively. Control treatments showed the lowest vitamin C content in both seasons compared to the other treatments. Stimulators ($Azospirillum lipoferum$) increased vitamin C when sprayed only or combined with Furdose after fruit set or before flowering and after fruit set as compared with the other treatments in both the two studying seasons. These results are in agreement with those obtained by Akea and Ercisli (2010) on Sweet cherry, Arikan et al., (2013) Quince and El-Shazly and Mustafa (2013) on Washington navel orange.

PGPR was more effective on enhancing plant nutrition uptake of mineral and many of these stimulants contains amino acids, vitamins, humycacids, plant phytohormones and sometimes micro elements which improving fruit quality and its contents of SSC and vitamin C .

Table3. Effect of plant biostimulators (Furdose and $Azospirillum lipoferum$) on SSC %, Acidity %, SSC/acid ratio and vitamin C of Washington navel orange fruits in 2013 and 2014 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SSC %</th>
<th>Acidity %</th>
<th>SSC/acid ratio</th>
<th>Vitamin C mg/100 ml juice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2014</td>
<td>2013</td>
<td>2014</td>
</tr>
<tr>
<td>$T_1$</td>
<td>12.27d</td>
<td>11.93g</td>
<td>0.99d</td>
<td>0.99f</td>
</tr>
<tr>
<td>$T_2$</td>
<td>12.40d</td>
<td>12.07f</td>
<td>1.08c</td>
<td>1.01e</td>
</tr>
<tr>
<td>$T_3$</td>
<td>13.67ab</td>
<td>12.93c</td>
<td>1.10c</td>
<td>1.11b</td>
</tr>
<tr>
<td>$T_4$</td>
<td>13.47ab</td>
<td>13.07c</td>
<td>1.09c</td>
<td>1.11b</td>
</tr>
<tr>
<td>$T_5$</td>
<td>12.40d</td>
<td>12.60d</td>
<td>1.02d</td>
<td>1.04d</td>
</tr>
<tr>
<td>$T_6$</td>
<td>13.73a</td>
<td>13.93a</td>
<td>1.17b</td>
<td>1.12b</td>
</tr>
<tr>
<td>$T_7$</td>
<td>13.67ab</td>
<td>13.47b</td>
<td>1.26a</td>
<td>1.18a</td>
</tr>
<tr>
<td>$T_8$</td>
<td>12.07d</td>
<td>12.33e</td>
<td>1.00d</td>
<td>1.03d</td>
</tr>
<tr>
<td>$T_9$</td>
<td>12.53c</td>
<td>13.47b</td>
<td>1.10c</td>
<td>1.09c</td>
</tr>
<tr>
<td>$T_{10}$</td>
<td>13.27b</td>
<td>13.80a</td>
<td>1.21b</td>
<td>1.08c</td>
</tr>
</tbody>
</table>

Means followed by different letter are significantly different within columns by Duncan’s multiple range test, $P \leq 0.05$
Reducing, non reducing and total sugars content:

Carefully considering readings of Table 4 showed that, reducing and total sugars were significantly affected by all spraying biostimulants treatments as compared with control during the two seasons. T6, T10 and T7 and T10, T7 and T6 recorded the highest values of reducing sugars during the two seasons as 4.85, 4.80 and 4.61 gm/100 gm fresh weight in the first season and 5.06, 5.02 and 5.01 gm/100 gm fresh weight in the second season, respectively. The control treatment gave the lowest value of reducing sugars as 3.43 and 3.86 gm/100 gm fresh weight during the two seasons, respectively with significant differences between it and the other treatments in both seasons. This trend was found with total sugars thus T10 and T7 cleared the highest values in the two seasons, it recorded 8.63 and 8.56 gm/100 gm and 8.90 and 8.91 gm/100 gm with the two seasons respectively while the control treatment recorded the lowest values 7.21 and 7.56 gm/100 gm fresh weight in the both seasons, respectively with a high significant differences among the above treatments. Microbial stimulators (Azospirillum lipoferum) alone or combined with Furdoce increased reducing sugars and total sugars when sprayed before flowering only or before flowering and after fruit set as compared with the other treatments in the two study seasons. There were no clear trend effect for the stimulators on non reducing sugars. The non reducing sugars values varied between the control and all treatments during the study seasons. These results were not significant in most cases. These findings are confirmed by the results obtained by Omer et al., (2012) on Washington navel orange trees and Abbas et al., (2013) on Kinnow mandarin. In this line, El-Shazly and Mustafa (2013) reported that, biostimulants like yeast extract and potassium humate markedly increased total sugars.

Table 4. Effect of plant biostimulators (Furdoce and Azospirillum lipoferum) on reducing, non reducing and total sugars of Washington navel orange fruits in 2013 and 2014 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Reducing sugar</th>
<th>Non reducing sugar</th>
<th>Total sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>3.43e</td>
<td>3.86f</td>
<td>3.78abc</td>
</tr>
<tr>
<td>T2</td>
<td>3.98d</td>
<td>4.15e</td>
<td>3.43cd</td>
</tr>
<tr>
<td>T3</td>
<td>4.33c</td>
<td>4.55c</td>
<td>3.20d</td>
</tr>
<tr>
<td>T4</td>
<td>4.41bc</td>
<td>4.57c</td>
<td>3.47bcd</td>
</tr>
<tr>
<td>T5</td>
<td>4.06d</td>
<td>4.37d</td>
<td>3.72abc</td>
</tr>
<tr>
<td>T6</td>
<td>4.85a</td>
<td>5.01a</td>
<td>3.21d</td>
</tr>
<tr>
<td>T7</td>
<td>4.61ab</td>
<td>5.02a</td>
<td>3.95ab</td>
</tr>
<tr>
<td>T8</td>
<td>4.03d</td>
<td>4.67bc</td>
<td>3.99a</td>
</tr>
<tr>
<td>T9</td>
<td>4.52bc</td>
<td>4.83b</td>
<td>3.81abc</td>
</tr>
<tr>
<td>T10</td>
<td>4.80a</td>
<td>5.06a</td>
<td>3.83abc</td>
</tr>
</tbody>
</table>

Means followed by different letter are significantly different within columns by Duncan’s multiple range test, P ≤ 0.05
Data of Table (5) clearly showed the economical evaluation as total productivity/ fed. of Washington navel fruits, total costs of yield, total return, net return/fed. and the increase in return than control. The fixed costs include (land rent, labors, fertilizers, pruning, hoeing, pesticides and harvest ) which reached about 4500 LE/fed. according to the region. Changed costs include synthetic or biological biostemulators, rent of spray machine and spray labor which varied according to the treatment. The price of navel fruits evaluated about 1000 LE according to the region and season.

Calculation of economic evaluation showed that, all treatments gave a high increase in the net return per feddan over control. The application of *Azospirillum lipoferum* alone or in combination with furdose attained net return much higher than furdose biostemulator. The highest obtained increase in productivity and net return /fed. was recorded by the above two treatments that gave 3181, 3207 LE /fed. These biostemulators as shown increased fruit yield, net return /fed. Increased return than control without a notable increase in costs because of the lower price of these compounds. Thus, the net return /fed was positive. Therefore, it is recommended to spray of Washington navel with *Azospirillum lipoferum* alone or plus Furdoe twice before flowering and after fruit set at the rate of 20 L per feddan which gave the highest effect on increase net return per feddan and the increase return over control than the other synthetic biostemulants.

Table 7: Washington navel orange crop economics resulting from spraying with (Furdose and *Azospirillum lipoferum*) in 2014 season

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fixed costs (LE/fed.)</th>
<th>Changed costs (LE/fed.)</th>
<th>Total costs (LE/fed.)</th>
<th>Total yield (Ton/fed.)</th>
<th>Cop value (LE/fed.)</th>
<th>Net return (LE/fed.)</th>
<th>Increase in return over control(LE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>4500</td>
<td>0</td>
<td>4500</td>
<td>11.333</td>
<td>11333</td>
<td>6833</td>
<td>--------</td>
</tr>
<tr>
<td>Furdoe B</td>
<td>4500</td>
<td>200</td>
<td>4700</td>
<td>11.600</td>
<td>11600</td>
<td>6900</td>
<td>67</td>
</tr>
<tr>
<td>Furdoe A</td>
<td>4500</td>
<td>200</td>
<td>4700</td>
<td>12.040</td>
<td>12040</td>
<td>7340</td>
<td>507</td>
</tr>
<tr>
<td>Furdoe B and A</td>
<td>4500</td>
<td>400</td>
<td>4900</td>
<td>13.769</td>
<td>13769</td>
<td>8869</td>
<td>2036</td>
</tr>
<tr>
<td><em>Azospirillum lipoferum</em> B</td>
<td>4500</td>
<td>200</td>
<td>4700</td>
<td>12.829</td>
<td>12829</td>
<td>8129</td>
<td>1096</td>
</tr>
<tr>
<td><em>Azospirillum lipoferum</em> A</td>
<td>4500</td>
<td>200</td>
<td>4700</td>
<td>13.421</td>
<td>13421</td>
<td>8721</td>
<td>1888</td>
</tr>
<tr>
<td><em>Azospirillum lipoferum</em> B and A</td>
<td>4500</td>
<td>400</td>
<td>4900</td>
<td>14.940</td>
<td>14940</td>
<td>10040</td>
<td>3207</td>
</tr>
<tr>
<td>Furdose and <em>Azospirillum lipoferum</em> B</td>
<td>4500</td>
<td>300</td>
<td>4800</td>
<td>13.270</td>
<td>13270</td>
<td>8470</td>
<td>1637</td>
</tr>
<tr>
<td>Furdose and *Azospirillum A</td>
<td>4500</td>
<td>300</td>
<td>4800</td>
<td>14.082</td>
<td>14082</td>
<td>9282</td>
<td>2449</td>
</tr>
<tr>
<td>Furdose and *Azospirillum B and A</td>
<td>4500</td>
<td>600</td>
<td>5100</td>
<td>15.114</td>
<td>15114</td>
<td>10014</td>
<td>3181</td>
</tr>
</tbody>
</table>

A: after fruit set     B: before flowering
Fu : Furdose         Azo : *Azospirillum lipoferum*
CONCLUSION

The spray of Washington navel orange trees with microbial biostimulants (Azospirillum lipoferum) was more effective on enhancing fruit yield and quality as firmness, V. C., SSC and total sugars which may be increase the fruit ability to handling stages and prolonged its shelf life when used alone or with synthetic biostimulants (Furdose) compared with the use of synthetic biostimulants (Furdose) alone for inducing plant growth and productivity and gave the highest of net return per feddan and the increase in net return over control.

REFERENCES


Cassan, F.; R. Bottini; G. Schneider and P. Piccoli (2001). *Azospirillum brasilense* and *Azospirillum lipoferum* hydrolyze conjugates of GA\textsubscript{20} and metabolize the resultant aglycones to GA\textsubscript{1} in seedlings of rice. Plant Physiology 125: 2053 – 2058.


A. Zaghloul, H. A. Ennab


1874


التأثير المقارن لأحد المنشطات الحيوية الصناعية والمنشط الحيوي الميكروبي
إزاريبسيميل ليوبريم على أنتاجية وجودة ثمار البرتقال أبو سره.
على السيد زغلول و حسن أبو الفتح عتاب

قسم بحوث تدبأ ثمار الفاكهة

قسم بحوث الموائل

معهد بحوث البستاتي - مركز البحوث الزراعية، الجزيرة، مصر

لماضي الفعال والمسال محاذية للماضي الصناعي والمملكة المحاذية وقائدة هذه المكروبات على تخزين ملفتة الزيزفون وتشميف نمو النباتات.

اجرت هذه الدراسة خلال موسم 2013 و 2014 على أشجار البرتقال أبو سره عبر ست سنين بمرازة خاصة بمنطقة مطوي محافظة كفر الشيخ لدراسة تأثير المنشط الحيوي الميكروبي الفوسفور والمضخ الحيوي الميكروبي أزاريبسيميل ليوبريم بألوث المنفرد لكل منهم أو رشهما مع ذلك في مرحلة ما قبل الأزهر أو ما بعد العقد.

منفرد أو مرحلة ما قبل الأزهر و بعد العقد معا.

وقد أظهرت النتائج أن نسبة العقد و نسبة التساقط و الحاجز جودة ثمار قد ظهرت معنوية بالزيرالودوس أو الزيزفون منفرد أو مجمون مع خالق موسمي الدراسة. هذا أظهرت المعدلات (رقم 6 للزيرالودوس الفوسفور و اساعدة معدل) ووالعملة 7 (الزيرالودوس الفوسفور قبل الأزهر و بعد العقد) زائدة في نسبة العقد و المعدل و جودة الثمار مثاثا في عدد الثمار و المحمول كمافةة جودة الصلبية و نسبة المواد الصلبية النانذية و فاينامين G و نسبة السكريات المختزلة و الكليا التي يمكن أن تساهم نسبة تساقط الثمار خلال موسمي الدراسة و ذلك دون اختلاف معنوي بين المعدلات الثلاث.

ظهرت النتائج أيضا أن الزيرالودوس أو الزيزفون منفرد أو مع الفوسفور مجمون كان أكثر تأثيرا في زيادة الحاجز و جودة ثمار البرتقال أبو سره و لكن الزيرالودوس الفوسفور أسواء مع الفوسفور مجمون كان الأكثر تأثيرا في زيادة الحاجز و جودة ثمار. هذا أظهرت النتائج في المعدلات 12 (الزيرالودوس الفوسفور مدمج مع الفوسفور و بعد العقد) و 115 1/2 كجم/جرة و ذلك مقارنة بالمعالجة رقم 7 (الزيرالودوس الفوسفور قبل الأزهر و بعد العقد) و 114 1/2 كجم/جرة و ذلك مقارنة بالمعالجة رقم 6 (الزيرالودوس الفوسفور و الفوسفور مع الفوسفور و قبل الأزهر و بعد العقد) و 118 1/2 كجم/جرة و ذلك مقابلة مع مركب الفودوس الفوسفور و ذلك من أجل زيادة الحاجز وجودة ثمار الانتشار في الصلاة و المواد الصلبية النانذية الكبيرة و فيتامين C و السكريات الكبيرة و التي ربما تزيد من زيادة سرعة الثمار على تحسين مراحل التداول المتطرفة وإثالة القطرة=$((اليا) لها و ذلك مقارنة باستخدام مركب الحيوي الصناعي الفودوس منفرد.

كما أن المعلجة بالمركبة الحيوي إزاريبسيميل سواء منفرد أو مع مركب الحيوي الفودوس رشأن تأثير على قيمة نسبة سواء لإنتاج الفاكهة أو العائد مقارنة بالكامل.