GROWTH AND PRODUCTIVITY OF EGGPLANT AS AFFECTED BY PINK PIGMENTED FACULTATIVE METHYLOTROPHIC BACTERIA

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ABSTRACT

The present study was suggested as an attempt to investigate the effects of Pink Pigmented Facultative Methylorophic Bacteria (PPFM) dipping and foliar spray on vegetative growth and yield of eggplant (\textit{Solanum melongena} L.). Field experiments were carried out during the summer seasons of 2014 and 2015 at the Experimental Farm, Faculty of Agriculture, Ain Shams University. The vegetative growth of eggplant responded positively to dipping seedlings in PPFM which gave the highest values of growth parameters, i.e. number of leaves per plant, leaf area, nitrogen & potassium concentration in leaf and total protein in fruit, in the two seasons as compared with control (dipping in water). The application of PPFM as foliar spray, increased significantly plant growth (plant length, leaf number, potassium concentration in leaf, vitamin "C" in fruit and total yield per plant) in the two seasons as compared with the other studied foliar application treatments. The interaction between dipping seedlings in PPFM and PPFM foliar spray with all concentrations gave synergistic effects on growth parameters and yield components of eggplant, during the two growing seasons as compared with either individual foliar application or control plants.

Keywords: Eggplant, PPFM, Foliar spray, Dipping, Growth, Yield

INTRODUCTION

In Egypt, eggplant is considered as one of the most important crops grown in the summer season. The varieties of \textit{Solanum melongena} L. show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped; and from white, yellow, green through degrees of purple pigmentation to almost black. Eggplant fruits contain a considerable amount of carbohydrates, proteins and some minerals and it's known for being low in calories and having a mineral composition beneficial for human health. They are also a rich source of potassium, magnesium, calcium and iron. The hybrids of eggplant have many advantages compared with open-pollinated cultivars in terms of yield and disease resistance. The yield depends upon several production factors. Among these proper, balanced nutrition plays a significant role.

Pink pigmented facultative methylotrophic bacteria (PPFM), ubiquitous in nature and frequently reported on various plant species, are a substantial part of the aerobic, heterotrophic microflora of the surfaces of young leaves (Meena \textit{et al} 2012). They are capable of growing on C\textsubscript{1} compounds such as formate, formaldehyde and methanol in addition to C\textsubscript{2}-C\textsubscript{4} compounds (Lidstrom, 2001 and Iguchi \textit{et al} 2015).

Moreover, they are able to produce plant growth regulators such as cytokinins and auxins (Omer \textit{et al} 2004 and Nadali \textit{et al} 2010) which affect plant growth and different physiological processes. The PPFM can also, induce systemic re-
istance against diseases (Madhaiyan et al 2004) and degrade a widely range of highly toxic compounds and tolerate heavy metals (Jahan et al 2013). Methanol is considered a natural product of plant metabolism, all plant tissues emit methanol (Gout et al 2000) especially during early stages of leaf expansion (Fall, and Benson, 1996). Some of this methanol is rapidly oxidized in the presence of light to water and CO2 (Galbally and Kirstine, 2002). Generation of CO2 from methanol can also occur by PPFM (Lee et al 2006 and McTaggart, et al 2015). Increasing CO2 concentration inside stomata led to accelerate the rate of photosynthesis and decrease the rate of photorespiration in C3 plants (Ramirez et al 2006) because the competition between CO2 and O2 for RuBisco enzyme (the enzyme responsible for reducing CO2 and synthesis of carbohydrates during photosynthesis in C3 plants).

Therefore, the objective of this study was to investigate the effect of foliar spray with PPFM and dipping PPFM on vegetative growth, yield and quality of eggplant.

MATERIALS AND METHODS

Field experiments were carried out during the summer seasons of 2014 and 2015 under open field conditions in the silt soil, at the Experimental Farm, Faculty of Agriculture, Ain Shams University, to study the effect of Pink Pigmented Facultative Methylotrophic Bacteria (PPFM) as dipping seedlings or as foliar spray on vegetative growth, yield and quality of eggplant (Solanum melongena L.).

The experimental design and treatments

Seeds of eggplant cultivar Soma are produced by Syngenta; 35 days old seedlings were sown on 14 of May during 2014 and 2015 seasons. The area of the experimental is divided into three plots, the dimensions of each plot were 19.5 meters in length, 3 meters in width, each plot was 58.5 m² consisted of 26 rows; each row was 3 m length. The plant distance was 0.6 m apart on one side of ridge. Thus, each plot had 130 plants.

The experiment layout

This experiment was laid out in a split plot design with three replicates. Dipping seedlings applications were assigned in the main plots, whereas foliar spray treatments was distributed in the sub plots.

The experiment included five treatments as follows

1. Inoculation the Rhizosphere
   i. Untreated control; without addition (T1).
   ii. PPFM dipping; The PPFMs vaccine is added with eggplant seedlings immediately before planting and repeated after 30 days of planting the seedlings around the crown area (20 liters /fed). (T2)

2. Foliar spray
   i. Untreated control; (spraying with tap water). (T3)
   ii. Sprayed PPFM Media on the eggplant /canes without a cell-free vaccine (after centrifugation). (T4)
   iii. Sprayed PPFMs. (T5)

Sprinkling after 30, 60, 90 days of planting seedlings (20 liters / fed). Preparation of the bacterial vaccine in the Unit of Biological Fertilization - Faculty of Agriculture - Ain Shams University.

Agricultural practices

Agricultural management, disease and pest control programs were followed according to the recommendations of the Egyptian Ministry of Agriculture and Land reclamation.

Studied characteristics

Vegetative growth characteristics

Representative samples of nine plants from each experimental plot were randomly chosen after 45, 75 and 105 days from transplanting in the two seasons and the following data were recorded: plant length, stem diameter, number of branches per plant, leaf area per plant, number of leaves per plant, leaf and stem fresh and dry weight (A.O.A.C., 2000). Leaf chlorophyll reading (SPAD) was determined using, Minolta SPAD-502, (Minolta Company, Japan), the recently full expanded fourth leaf from the plant top as relation between unit area and leaf fresh weight (Koller, 1972).

Leaf area (cm²) = \[
\frac{\text{Disk area} \times \text{No.Disks} \times \text{Leaf f.w.}}{\text{Disk f.w.}}
\]
Chemical characteristics

Total nitrogen, phosphorus and potassium were determined in the digested dry matter of plant foliage according to the methods described by Brown and Lilliland (1946), respectively.

Total protein (g/100g DW) in fruit was calculated by using the conversion factor (N x 6.25) as described by Pregl (1945).

Total carbohydrates in fruit was determined colorimetrically according to method described by James (1995).

L ascorbic acid (V.C.) in fruit was determined by using 2, 6-dichlorophenol indophenols titration method as described by A.O.A.C (2000).

Yield characteristics

Eggplant fruits were harvested every 4 days. Total yield per plant and feddan were recorded.

Statistical analysis

Data of the two seasons were arranged and statistically analyzed using M static (M.S.). The comparison among means of the different treatments was determined, as illustrated by Snedecor and Cochran (1982) and means were compared by Duncan multiple range test (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

Vegetative characteristics

Data presented in Table (1) show the influence of dipping seedlings in PPFM and foliar spray on vegetative characteristics (plant length, leaf area per plant, number of leaves per plant and leaf chlorophyll content) of eggplant in the two seasons (2014 and 2015).

Plant length

Dipping the seedlings in PPFM generally, gave the tallest plants as compared with the control (not dipping) in the first season and there was no significant change in the second season. This result may be attributed to the importance of PPFM for growth.

Table 1. Effect of pink pigmented facultative methylotrophic (PPFM) bacteria on plant length, leaf area per plant, number of leaves per plant and leaf chlorophyll content of eggplant, in the two seasons (2014 and 2015)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st season</td>
<td></td>
<td></td>
<td>2nd season</td>
</tr>
<tr>
<td>Plant length (cm)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>62.85 b</td>
<td>60.11 bc</td>
<td>61.48 B</td>
<td>73.56 a</td>
<td>68.04 b</td>
<td>70.8 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>58.35 cd</td>
<td>62.1 b</td>
<td>60.23 B</td>
<td>70.56 ab</td>
<td>65.5 b</td>
<td>68.03 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>55.73 d</td>
<td>74.57 a</td>
<td>65.15 A</td>
<td>74.81 a</td>
<td>75 a</td>
<td>74.9 A</td>
</tr>
<tr>
<td>Mean</td>
<td>58.98 B</td>
<td>65.59 A</td>
<td>72.97 A</td>
<td>69.51 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf area per plant (cm²)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Control</td>
<td>36.78 b</td>
<td>37.86 b</td>
<td>37.32 B</td>
<td>38.92 b</td>
<td>43.77 ab</td>
<td>41.34 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>33 b</td>
<td>35.18 B</td>
<td>37.29 b</td>
<td>47.65 a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>33.92 b</td>
<td>66.16 a</td>
<td>50.04 A</td>
<td>40.04</td>
<td>40.58 ab</td>
<td>40.31 A</td>
</tr>
<tr>
<td>Mean</td>
<td>34.57 B</td>
<td>47.13 A</td>
<td>38.75 B</td>
<td>44 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of leaves per plant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>92.67 b</td>
<td>63.33 d</td>
<td>78 B</td>
<td>87 b</td>
<td>81.33 bc</td>
<td>84.17 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>81.67 c</td>
<td>89.67 b</td>
<td>85.67 A</td>
<td>70.56 c</td>
<td>75 c</td>
<td>72.78 C</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>68.33 d</td>
<td>104 a</td>
<td>86.17 A</td>
<td>109.33a</td>
<td>111.11 a</td>
<td>110.22 A</td>
</tr>
<tr>
<td>Mean</td>
<td>80.89 B</td>
<td>85.67 A</td>
<td>83.3 B</td>
<td>92.48 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf chlorophyll reading (SPAD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>46.6 b</td>
<td>49.48 ab</td>
<td>48.04 B</td>
<td>57.64 a</td>
<td>58.26 a</td>
<td>57.95 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>49.27 ab</td>
<td>48.72 ab</td>
<td>48.99 AB</td>
<td>56.92 a</td>
<td>58.52 a</td>
<td>57.72 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>52.19 a</td>
<td>51.12 ab</td>
<td>51.65 A</td>
<td>58.03 a</td>
<td>57.89 a</td>
<td>57.96 A</td>
</tr>
<tr>
<td>Mean</td>
<td>49.35 A</td>
<td>49.77 A</td>
<td>57.53 A</td>
<td>58.22 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at P ≤ 0.5 level; Duncan’s multiple range test.

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Regarding the effect of foliar spray, the plant tested varied significantly in plant length, PPFM foliar spray induced highest values of plant length compared with PPFM media foliar spray in both seasons.

The interaction between dipping seedlings in PPFM and PPFM foliar spray produced the highest plant length compared to other combination treatments in both seasons.

These increments may be necessary to improve the vegetative growth of plants because malondyaldehyde (MDA) was concentrated in the meristematic cells and concomitant to cell division (Mène-Saffrané et al 2007 and Schmid-Siegert et al 2012).

Leaf area per plant

Dipping seedlings in PPFM generally, gave the highest leaf area as compared with the control (not dipping) in the first season and there was no significant change in both seasons.

The effect of foliar spray on the tested plants varied significantly in leaf area, PPFM foliar spray gave the highest values of leaf area compared with the other studied foliar spray in first season but insignificant effect was induced by all foliar spray tested treatments in second season.

The interaction between dipping seedlings with PPFM and PPFM foliar spray caused the highest leaf area than the other combination treatments in both seasons. In the current study, this effect could be explained by that, PPFM have the ability to produce some growth regulators including auxins and cytokinins (Lee et al 2006 and Nadali et al 2010).

Leaf chlorophyll content

Dipping the seedlings in PPFM generally caused insignificant effect with all tested treatments in both seasons.

Regarding the effect of foliar spray, the various tested varied significantly in leaf chlorophyll content, PPFM foliar spray gave the highest values of total chlorophyll content of leaf compared with the other studied foliar spray in first season but insignificant effect was observed with all foliar spray tested treatments in second season.

The interaction between control (not dipping seedlings with PPFM) and PPFM foliar spray produced the highest values of leaf chlorophyll reading than the other combination treatments in first season but the interaction with tested treatments in the second season is insignificant.

Leaf Chemical Components

Data presented in Table (2) show the influence of dipping seedlings with PPFM and foliar spray on chemical characteristics (nitrogen, phosphorus and potassium concentration) in leaf of eggplant in the two seasons (2014 and 2015).

Nitrogen concentration in leaf

Dipping the seedlings with PPFM generally, gave the highest nitrogen concentration as compared with the control (not dipping).

The effect of foliar spray and the interaction with all tested treatments on nitrogen concentration was found to be insignificant.

Phosphorus concentration in leaf

Dipping the seedlings with PPFM generally has insignificant effect with all tested treatments. In addition, the effect of foliar spray and the interaction with all tested treatments on phosphorus concentration were shown to be insignificant.
Table 2. Effect of pink pigmented facultative methylotrophic (PPFM) bacteria on nitrogen, phosphorus and potassium % in leaf of eggplant, in two seasons (2014/2015)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st season</td>
<td>2nd season</td>
<td></td>
<td>1st season</td>
<td>2nd season</td>
<td></td>
</tr>
<tr>
<td>Nitrogen %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>5.502 a</td>
<td>5.400 a</td>
<td>5.451 A</td>
<td>5.251 a</td>
<td>5.190 a</td>
<td>5.221 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>4.687 a</td>
<td>5.100 a</td>
<td>4.894 A</td>
<td>5.140 a</td>
<td>5.339 a</td>
<td>5.239 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>5.460 a</td>
<td>4.571 a</td>
<td>5.016 A</td>
<td>5.150 a</td>
<td>5.108 a</td>
<td>5.129 A</td>
</tr>
<tr>
<td>Mean</td>
<td>5.216 A</td>
<td>5.024 A</td>
<td>5.180 B</td>
<td>5.212 A</td>
<td>5.212 A</td>
<td>5.180 B</td>
</tr>
<tr>
<td>Phosphorus %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.360 a</td>
<td>0.290 a</td>
<td>0.325 A</td>
<td>0.322 a</td>
<td>0.267 a</td>
<td>0.295 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>0.315 a</td>
<td>0.345 a</td>
<td>0.330 A</td>
<td>0.323 a</td>
<td>0.326 a</td>
<td>0.325 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>0.341 a</td>
<td>0.362 a</td>
<td>0.352 A</td>
<td>0.304 a</td>
<td>0.319 a</td>
<td>0.311 A</td>
</tr>
<tr>
<td>Mean</td>
<td>0.339 A</td>
<td>0.332 A</td>
<td>0.317 A</td>
<td>0.304 A</td>
<td>0.304 A</td>
<td>0.311 A</td>
</tr>
<tr>
<td>Potassium %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.636 a</td>
<td>1.661 a</td>
<td>1.649 A</td>
<td>1.658 ab</td>
<td>1.587 ab</td>
<td>1.622 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>1.550 a</td>
<td>1.673 a</td>
<td>1.612 A</td>
<td>1.558 b</td>
<td>1.692 ab</td>
<td>1.625 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>1.611 a</td>
<td>1.501 a</td>
<td>1.556 A</td>
<td>1.573 b</td>
<td>1.833 a</td>
<td>1.703 A</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at P≤ 0.5 level; Duncan's multiple range test.

**Potassium concentration in leaf**

Dipping the seedlings with PPFM gave the highest potassium concentration as compared with non-dipping ones.

Regarding the effect of foliar spray, the various tested plants varied significantly in potassium concentration, PPFM foliar spray gave the highest values of potassium concentration compared with the other studied foliar spray.

The interaction between dipping seedlings with PPFM and PPFM foliar spray induced the highest values of potassium concentration than the other combination treatments.

**Fruit Chemical Components**

Data presented in Table (3) show the influence of dipping seedlings in PPFM and foliar spray on chemical characteristics (total protein, total carbohydrates and ascorbic acid content) in fruit of eggplant in the two seasons (2014 and 2015).

**Total protein in fruit**

Dipping the seedlings in PPFM generally, gave the highest total protein as compared with the non-dipping control.

As for the effect of foliar spray on total protein in fruit, the various tested plants varied insignificantly with all tested treatments.

The interaction between dipping seedlings with PPFM and PPFM media foliar spray showed the higher values of total protein in fruit than the other combination treatments.

**Total carbohydrates in fruit**

Dipping the seedlings in PPFM insignificantly affecting all other tested treatments. Also, the effect of foliar spray and the interaction with all tested treatments on total carbohydrates in fruit were insignificant.

**Ascorbic acid content in fruit**

Dipping the seedlings in PPFM has insignificant effect with all tested treatments.

Regarding the effect of foliar spray, the various tested plants varied significantly in Vitamin "C" content, PPFM foliar spray gave the highest values of vitamin C compared with the other studied foliar spray treatments.

The interaction with all tested treatments on Vitamin "C" content was insignificant.

**Yield and its Components**

Data presented in Tables (4 & 5) show the influence of dipping seedlings with PPFM and foliar spray on yield characteristics (fruit length, fruit diameter, fruit number per plant, yield per plant and total yield) of eggplant in the two seasons (2014 and 2015).
Table 3. Effect of pink pigmented facultative methylotrophic (PPFM) bacteria on total protein, total carbohydrates and vitamin C in fruit of eggplant, in the two seasons (2014/2015)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st season</td>
<td></td>
<td></td>
<td>2nd season</td>
</tr>
<tr>
<td><strong>Total protein (g/100g DW)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>18.637 a</td>
<td>16.012 a</td>
<td>17.325 A</td>
<td>19.629 ab</td>
<td>18.725 b</td>
<td>19.177 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>22.138 a</td>
<td>24.675 a</td>
<td>23.406 A</td>
<td>20.096 ab</td>
<td>24.062 a</td>
<td>22.079 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>18.987 a</td>
<td>19.075 a</td>
<td>19.031 A</td>
<td>19.629 ab</td>
<td>20.767ab</td>
<td>20.198 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>19.921 A</td>
<td>19.921 A</td>
<td>---------</td>
<td>19.785 B</td>
<td>21.185 A</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Total carbohydrates (g/100g DW)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>3.200 a</td>
<td>0.960 a</td>
<td>2.080 A</td>
<td>2.627 a</td>
<td>1.133 a</td>
<td>1.880 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>2.540 a</td>
<td>2.020 a</td>
<td>2.280 A</td>
<td>2.960 a</td>
<td>2.280 a</td>
<td>2.620 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>1.820 a</td>
<td>3.620 a</td>
<td>2.720 A</td>
<td>2.000 a</td>
<td>2.147 a</td>
<td>2.073 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>2.520 A</td>
<td>2.200 A</td>
<td>---------</td>
<td>2.529 A</td>
<td>1.853 A</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Vitamin C (g/100ml)</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.200 a</td>
<td>0.100 a</td>
<td>0.150 A</td>
<td>0.167 a</td>
<td>0.100 a</td>
<td>0.133 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>0.200 a</td>
<td>0.100 a</td>
<td>0.150 A</td>
<td>0.167 a</td>
<td>0.100 a</td>
<td>0.117 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>0.100 a</td>
<td>0.200 a</td>
<td>0.150 A</td>
<td>0.167 a</td>
<td>0.133 a</td>
<td>0.150 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.167 A</td>
<td>0.133 A</td>
<td>---------</td>
<td>0.156 A</td>
<td>0.111 A</td>
<td>---------</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at P≤ 0.5 level; Duncan’s multiple range test.

Table 4. Effect of pink pigmented facultative methylotrophic (PPFM) bacteria on fruit length, fruit diameter, fruit number per plant, yield per plant and total yield of eggplant, in the two seasons (2014 and 2015)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1st season</td>
<td></td>
<td></td>
<td>2nd season</td>
</tr>
<tr>
<td><strong>Fruit length (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>15.4 ab</td>
<td>14.38 bc</td>
<td>14.89 A</td>
<td>15.02 ab</td>
<td>14.62 c</td>
<td>14.82 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>14.14 c</td>
<td>15 abc</td>
<td>14.57 A</td>
<td>14.49 c</td>
<td>14.56 c</td>
<td>14.52 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>14.27 c</td>
<td>15.69 a</td>
<td>14.98 A</td>
<td>14.69 bc</td>
<td>15.08 a</td>
<td>14.89 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>14.6 A</td>
<td>15.02 A</td>
<td>---------</td>
<td>14.73 A</td>
<td>14.75 A</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Fruit diameter (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>29.47 ab</td>
<td>28.94 b</td>
<td>29.21 A</td>
<td>30.36 ab</td>
<td>30.01 b</td>
<td>30.19 A</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>29.46 ab</td>
<td>30.36 a</td>
<td>29.91 A</td>
<td>29.7 b</td>
<td>29.82 b</td>
<td>29.76 A</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>30.34 a</td>
<td>30.53 a</td>
<td>30.43 A</td>
<td>30.44 ab</td>
<td>31.26 a</td>
<td>30.85 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>29.76 A</td>
<td>29.94 A</td>
<td>---------</td>
<td>30.17 A</td>
<td>30.36 A</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Fruit number per plant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>27.21 b</td>
<td>25.89 b</td>
<td>26.05 B</td>
<td>25.97 C</td>
<td>26.86 ab</td>
<td>26.42 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>29.1 b</td>
<td>30.36 b</td>
<td>29.73 B</td>
<td>29.64 ab</td>
<td>27.12 b</td>
<td>28.88 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>31.28 b</td>
<td>34.83 a</td>
<td>33.06 A</td>
<td>28.76 b</td>
<td>31.85 a</td>
<td>30.3 A</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>28.86 B</td>
<td>31.36 A</td>
<td>---------</td>
<td>28.12 A</td>
<td>28.94 A</td>
<td>---------</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at P≤ 0.5 level; Duncan’s multiple range test.
Table 5. Effect of pink pigmented facultative methylotrophic (PPFM) bacteria on yield per plant and total yield of eggplant, in the two seasons (2014 and 2015)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
<th>Control</th>
<th>PPFM dipping</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>--------------</td>
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<td>---------</td>
<td>--------------</td>
<td>------</td>
</tr>
<tr>
<td><strong>Yield per plant (kg)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>3.99 b</td>
<td>3.95 b</td>
<td>3.97 B</td>
<td>4.1 b</td>
<td>3.97 b</td>
<td>4.03 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>3.88 b</td>
<td>4.13 b</td>
<td>4.05 B</td>
<td>4.13 b</td>
<td>4.16 b</td>
<td>4.14 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>4.23 b</td>
<td>4.65 a</td>
<td>4.44 A</td>
<td>4.245 b</td>
<td>4.63 a</td>
<td>4.44 A</td>
</tr>
<tr>
<td>Mean</td>
<td>4.07 A</td>
<td>4.24 A</td>
<td>------</td>
<td>4.16 A</td>
<td>4.25 A</td>
<td>------</td>
</tr>
<tr>
<td><strong>Total yield (ton/fed)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>34.21 b</td>
<td>33.89 b</td>
<td>34.05 B</td>
<td>35.15 b</td>
<td>34.02 b</td>
<td>34.58 B</td>
</tr>
<tr>
<td>PPFM Media foliar</td>
<td>34.1 b</td>
<td>35.36 b</td>
<td>34.73 B</td>
<td>35.38 b</td>
<td>35.62 b</td>
<td>35.5 B</td>
</tr>
<tr>
<td>PPFM foliar</td>
<td>36.28 b</td>
<td>38.83 a</td>
<td>38.066 A</td>
<td>36.39 b</td>
<td>38.7 a</td>
<td>38.05 A</td>
</tr>
<tr>
<td>Mean</td>
<td>34.86 B</td>
<td>36.36 A</td>
<td>------</td>
<td>35.64 A</td>
<td>36.45 A</td>
<td>------</td>
</tr>
</tbody>
</table>

Means followed by different letters are significantly different at P≤ 0.05 level; Duncan's multiple range test.

Fruit length

Dipping the seedlings in PPFM generally has insignificant effect with all tested treatments in both seasons.

The effect of foliar spray, the various tested plants varied insignificantly with all tested treatments on fruit length in both seasons.

The interaction between dipping seedlings with PPFM and PPFM foliar spray showed the highest fruit length as compared with that of the other combination treatments in both seasons.

Fruit diameter

Dipping the seedlings in PPFM has insignificant effect with all tested treatments in both seasons.

Regarding the effect of foliar spray, the various tested plants varied insignificantly with all tested treatments on fruit diameter in both seasons.

The interaction between dipping seedlings with PPFM and PPFM foliar spray induced the highest fruit diameter than the other combination treatments in both seasons.

Fruit number per plant

Dipping the seedlings in PPFM gave the highest fruit number as compared with the other combination treatments in both seasons.

Yield per plant

Dipping the seedlings in PPFM caused insignificant effect with all tested treatments in both seasons.

Regarding the effect of foliar spray, the different tested plants varied significantly in yield per plant, PPFM foliar spray gave the highest value of yield per plant compared with the other studied treatments in both seasons.

The interaction between dipping seedlings in PPFM and PPFM foliar spray showed the highest yield per plant than the other combination treatments in both seasons. These results are in harmony with those obtained by Verginer et al (2010).

Total yield

Dipping the seedlings in PPFM gave the highest total yield as compared with the non-dipping control in the first season while non-significant effect was observed in the second season.

The various tested plants varied significantly in total yield, PPFM foliar spray gave the highest value of total yield compared with the other studied foliar sprays in both seasons.

The interaction between dipping seedlings in PPFM and PPFM foliar spray showed the highest total yield than the other combination treatments in both seasons.

These results could be attributed to the stimulating effect of PPFM on the vegetative growth (Table 1). Also, PPFM can accelerate the rate of
photosynthesis and decrease the rate of photorespiration (Lee et al. 2006). These responses explain the biochemical changes in fruit composition because they affected all physiological and biochemical pathways which related to quality of pods.

CONCLUSIONS

It can be recommended to add PPFMs vaccine with eggplant seedlings Soma cultivars immediately before planting and repeated after 30 days of planting the seedlings around the crown area (20 liters /fed) and spraying PPFMs after 30, 60, 90 days of planting (20 liters / fed) to obtain the best yield and quality of eggplant in the field.

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of foliar and root applications of methanol on the growth of Arabidopsis, tobacco and tomato plants. Journal of Plant Growth Regulation, 25, 30-44.


تأثير نمو وانتاجية البانجان بالبكتيريا الفرمونية ميلثيلية التشغيلية اختبارياً

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مجلد (27)، عدد (1)، عدد خاص مارس، 595-604، 2019

Website: http://strategy-plan.asu.edu.eg/AUJASCI/

الموجز

أجريت هذه الدراسة في المزرعة التجريبية بكلية الزراعة- جامعة عين شمس وتم إجراء التجربة خلال موسمي الصيف لعامي 2014 و 2015 بهدف دراسة تأثير تلفيف منطقة الزيزوفر بالزراعة وكذلك البك

تيريا الفرمونية ميلثيلية التشغيلية اختبارياً أثناء مراحل النمو المختلفة على كل من النمو الخضري والزهرى في الباانجوان الهجين "سوما". وكذلك إنتاجية جودة الثمار. أوضحت النتائج أن النمو الخضري للبانجان استجاب بشكل إيجابي لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs لغرس الشتلات بـ PPFMs حيث أنه أعلى على غير PPFMs Lغرس الشتلات بالبكتيريا الفرمونية ميلثيلية التشغيلية اختبارياً، النمو، وانتاجية البانجان.

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التمارين، محصول البذور والمحصول الكل (كلي)

ثانياً، تقابل بين عمس الشتلات ب-
PPFMs ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورقي و/or PPFMs، ورش الورق...