Comparison of Different Levels of Phosphate and Biofertilizer of Growth and Yield on Tomato (Lycopersicum esculentum mill) in Green House Condition

Kamil Sabier Saeed, Sarkawt Abdulla Ahmed, Ismael Ahmaed Hassan and Niyan Jalal Qader

Ornamental Plants Department, Agricultural Technical Institute of Bakrajo, Sulaimania Polytechnic University, Iraq
Industrial Crops Department, Agricultural Technical Institute of Bakrajo, Sulaimania Polytechnic University, Iraq
Protected Agriculture Green House Department, Agricultural Technical Institute of Bakrajo, Sulaimania Polytechnic University, Iraq
Agriculture Engineering in Protected Agriculture Green House, Agricultural Technical Institute of Bakrajo, Sulaimania Polytechnic University, Iraq

Abstract: A comparative study on the effect of chemical fertilizers and bio-fertilizers was done on growth and biochemical parameters in tomato plant (Lycopersicum esculentum Mill.). An experiment was conducted in randomized complete blocks design (RCBD) with four replicates. The treatments were (T1= control, T2= bio-fertilizer, T3= chemical and T4= combination treatment (biofertilizer and ½ chemical)) at Agricultural Technical Institute of Bakrajo, Sulaymania, Iraq during 2014. The bio-fertilizer used in this study was phosphate barwar2 and chemical fertilizer was triple super phosphate. The material consisted of one cultivar of tomato localspecies. The results indicated that there were significant difference between the application bio-fertilizer and chemical fertilizer for yield and yield component traits. Comparison means were conducted by Duncan method. This study indicated that a combination treatment of bio-fertilizer and chemical fertilizer had significant effect and increased the yield and growth traits of tomato. Correlation analysis showed that the strongest positive relationship was between fruit yield and total fruit weight per plant (r = 0.78). The results of regression analysis by stepwise method for fruit yield in tomato indicated that total fruit weigh can justify 65.3 percent of the fruit yield variation. According to this study using bio-fertilizers has increased fruit yield and yield component of tomato significantly.

Key words: Bio-fertilizers • Chemical fertilizers • Compare Means • Correlation • Regression Analysis • Tomato

INTRODUCTION

The tomato (Lycopersicum esculentum Mill.) is an important vegetable crop worldwide. Its cultivation has spread throughout the world occupying an area of 3.5×106 ha with the production of 1×106 tons [1]. Tomatoes, aside from being tasty and nutritious as they are, among other nutrients, a good source of vitamins A and C and lycopene content. Hence, this crop is gaining importance both in developing and developed countries and efforts are being made for the quality and quantity production of this commodity [2]. Nitrogen (N), phosphorus (P) and potassium (K) are considered fertilizer macronutrients because plants require them in a relatively large quantity for maximum growth and may need to be added to the soil annually [3]. Nitrogen (N), phosphorus (P) and potassium (K) are in quantitative terms the most important minerals for the tomato fruit as they account for more than 90% of the mineral content [4]. Phosphorus is absorbed as the H2PO4 - or HPO4 = ion. This complex does not leach readily from the soil and is mobile once in the plant. Phosphorus is rapidly “fixed” with iron, magnesium and aluminum on soil particles, when applied under acidic soil conditions (Flynn, 2002). Phosphorus
helps to initiate root growth of tomato and therefore aids in early establishment of the plant immediately after transplanting or seeding. Starter solution containing high concentration of P is normally applied to tomato plants within few days after transplanting for early root development and establishment in the soil [5]. Chemical fertilizers have several negative impacts on environment and sustainable agriculture. Therefore, biofertilizers are recommended in these conditions and growth prompting bacteria uses as a replacement of chemical fertilizers [6]. Growth promoting bacteria induced increasing plant yield as clone in plants root [7]. Growth prompting bacteria are including Azotobacter, Azospirillum and Pseudomonas [8-10]. Biofertilizers are becoming increasingly popular in many countries and for many crops. They are defined as products containing active or latent strains of soil microorganisms, either bacteria alone or in combination with algae or fungi that increase the plant availability and uptake of mineral nutrients [11]. The purpose of this study was to compare different within few days after transplanting for early root levels of chemical and biofertilizer on growth and yield of development and establishment in the soil [5]. Chemical tomato, also evaluate the relationship between fertilizers have several negative impacts on environment quantitative traits of tomato. One of the goals was to examine morphological traits effects on fruit yield using multivariate analysis and to investigate the improvement of nutrition and improvement of produce of highest yield via application of biofertilizers so if possible to able to recommend this fertilizers as replacement to the chemical fertilizers.

MATERIALS AND METHODS

Morphological Characters: An experiment was conducted in randomized complete blocks design (RCBD) with four replication and four treatment (T1= control, T2= biofertilizer, T3= chemical and T4= biofertilizer, ½ chemical ) at Agricultural Technical Institute of Bakrajo, Sulaymania, Iraq during 2014. The material consisted of one tomato local species. Is the biofertilizer used phosphate barwar2. The seeds sown in the spring season and tomato were grown in four row plots, each plot included two ridges and each ridge was 2.5 m in length and 50 cm apart. Agronomic characteristics included plant height, number of fruit per plant, individual fruit weight per plant, total fruit weight, fruit size and fruit yield per green house. Data were recorded on 4 competitive plants of each plot was calculated for the entire plot. Selected chemical and physical characteristics of experimental the soil are presented in Table 1.

Chemical Component of Plants: Jones and Case [13], reported a block-digestion procedure using a mixture of HNO₃ and HClO₄ for digestion of plant samples. Vanadomolybdophosphoric acid method was used to determine P concentration in plant extraction [14]. For determination of total nitrogen Kjeldahl digestion was used. Bremner [15], reported the use of Kjeldahl method for determination of total N in soils (note: the same method used for N in plant.

Data Analysis: For quantitative characters, data were analyzed for simple statistics using the compare means and correlation analysis and regression analysis with the help of computer software SPSS. Table 1. Soil physical and chemical analysis.
RESULTS AND DISCUSSION

Results of analysis of variance (Table 2) showed that there were significant differences between application of bio- and chemical fertilizers for fruit yield and yield component traits. The data showed high potential of these fertilizers to improve tomato yields. The results indicated that the effect of bio- and chemical fertilizers on characters such as, plant height, number of fruits per plant, total fruits weight, fruit size and fruits yield per green house was significant at 1% probability and individual fruit weight and potassium percentage at 5% probability and effect of bio fertilizer and chemical fertilizer on characters, nitrogen phosphorus and potassium content was not significant (Table 2).

Compare Means: Compare means for studied traits in tomato conducted by Duncan method. The results indicated that bio-fertilizer and ½ chemical fertilizer treatments had significant differences for fruit yield and growth traits and the highest fruit yield and growth traits of tomato was obtained with this treatment (Table 3). The best treatment was bio-fertilizer that has the highest led.

Plant Height: The results of mean comparing of traits are shown in (Table 3). There were a significant differences between the majority of the traits exist. The data in Table 3 showed that plant height increased across the treatments, there were some significant differences in the plant heights. The minimum plant height was recorded in the bio-fertilizer, ½ chemical fertilizers and the maximum plant height was recorded in chemical fertilizers.

Number of Fruits per Plant: The data in Table 3 showed that number of fruit per plant increased across the treatments, there were significant differences in the number of fruit per plant. The minimum number of fruits per plant was recorded in the bio-fertilizer, ½ chemical fertilizers and the maximum number of fruits per plant was recorded in bio-fertilizer.

Potassium Percentage: The data in Table 3 showed that potassium percentage increased across the treatments, there were significant differences in the potassium percentage. The minimum potassium percentage was recorded in the bio-fertilizer, ½ chemical fertilizers and the maximum potassium percentage was recorded in bio-fertilizer.

Individual Fruit Weight: The data in Table 3 showed that individual fruit weight increased across the treatments, there were significant differences in the individual fruit weight. The minimum individual fruit weight was recorded in the control and the maximum individual fruit weight was recorded in chemical fertilizers.

Total Fruits Weight: The results of mean comparing of traits are shown in Table 3 between all treatments significant differences exist. The data recorded in table 3 showed that the total fruit weight increased across the treatments, there were significant differences in the total fruit weight. The minimum total fruit weight was recorded in the control and the maximum total fruit weight was recorded in bio-fertilizer.

Fruit Size: The data in Table 3 showed that fruit size increased across the treatments, there were some significant differences in the fruit size. The minimum fruit size was recorded in the bio-fertilizer and the maximum fruit size was recorded in chemical fertilizers.

Fruits Yield per Green House: The data in Table 3 showed that fruits yield per green house increased across the treatments, there were significant differences in the fruits yield per green house. The minimum total fruits yield per green house was recorded in the control and the maximum fruits yield per green house was recorded in bio-fertilizer. The fruits yield in tomato has been significantly influenced by the application of bio fertilizer at all stages of plant growth. The treatment receiving bio-fertilizer 100 g/ha phosphate barwar2 and chemical fertilizer triple super phosphate recorded the highest fruit yield production increase over control.

Correlation Analysis: Knowledge of the relationship among plant characters is useful while selecting traits for yield improvement. To determine association between studied traits we calculated coefficient of correlation. Data in Table 4 indicated that fruit yield had
Table 2: Analysis of variance (RCBD) for studied traits

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>df</th>
<th>Plant height</th>
<th>Number of fruits per plant</th>
<th>Individual fruit weight per plant/ g</th>
<th>Total fruit weight per plant/ gm</th>
<th>Fruit size</th>
<th>% N</th>
<th>% P</th>
<th>% K</th>
<th>Fruit yield per greenhouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>3</td>
<td>143.67</td>
<td>13.750*</td>
<td>8.588</td>
<td>94961.705</td>
<td>42.682</td>
<td>.128</td>
<td>.001</td>
<td>.010</td>
<td>380019.62</td>
</tr>
<tr>
<td>Treatment</td>
<td>3</td>
<td>1685.69**</td>
<td>16.750**</td>
<td>20.52*</td>
<td>495414.1**</td>
<td>770.4**</td>
<td>.264</td>
<td>.001</td>
<td>.231*</td>
<td>1980923.3**</td>
</tr>
<tr>
<td>Error</td>
<td>9</td>
<td>203.83</td>
<td>2.028</td>
<td>7.346</td>
<td>67761.696</td>
<td>73.356</td>
<td>.162</td>
<td>.000</td>
<td>.074</td>
<td>270963.31</td>
</tr>
</tbody>
</table>

Table 3: Mean comparing in tomato for studied treatment

<table>
<thead>
<tr>
<th>Traits name</th>
<th>Plant height</th>
<th>Number of fruits per plant</th>
<th>Individual fruit weight per plant/ gm</th>
<th>Total fruit weight per plant/ gm</th>
<th>Fruit size</th>
<th>% N</th>
<th>% P</th>
<th>% K</th>
<th>Fruit yield per greenhouse/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>183.06b</td>
<td>14.75a</td>
<td>74.19a</td>
<td>4334.4a</td>
<td>117.81a</td>
<td>2.35a</td>
<td>.195ab</td>
<td>2.56a</td>
<td>8670a</td>
</tr>
<tr>
<td>Bio-fertilizer</td>
<td>174.12b</td>
<td>18.5b</td>
<td>78.12ab</td>
<td>6577.5b</td>
<td>107.12a</td>
<td>2.5a</td>
<td>.21b</td>
<td>2.7b</td>
<td>13154.9b</td>
</tr>
<tr>
<td>Chemical</td>
<td>184.93b</td>
<td>17.75ab</td>
<td>79.44b</td>
<td>5644.8b</td>
<td>140b</td>
<td>2.2a</td>
<td>.194ab</td>
<td>1.25ab</td>
<td>11289.9b</td>
</tr>
<tr>
<td>Bio-fertilizer + 1/2 Chemical</td>
<td>140.75a</td>
<td>14.5a</td>
<td>78.05ab</td>
<td>6555.6b</td>
<td>117.12a</td>
<td>1.9a</td>
<td>.175a</td>
<td>1.1ab</td>
<td>13110b</td>
</tr>
</tbody>
</table>

Table 4: Correlation analysis of studied traits in tomato

<table>
<thead>
<tr>
<th>Traits name</th>
<th>Plant height</th>
<th>Number of fruits per plant</th>
<th>Individual fruit weight per plant/ gm</th>
<th>Total fruit weight per plant/ gm</th>
<th>Fruit size</th>
<th>% N</th>
<th>% P</th>
<th>% K</th>
<th>Fruit yield per greenhouse/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fruit per plant</td>
<td>0.27</td>
<td>1</td>
<td>.190</td>
<td>.442</td>
<td>.227</td>
<td>.179</td>
<td>.281</td>
<td>.140</td>
<td>-.442</td>
</tr>
<tr>
<td>Individual fruit weight/ gm</td>
<td>-0.96</td>
<td>.311</td>
<td>.449</td>
<td>.083</td>
<td>.357</td>
<td>.525*</td>
<td>.517*</td>
<td>.458</td>
<td>.529*</td>
</tr>
<tr>
<td>Total fruit weight/ gm</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Size fruit</td>
<td>.427</td>
<td>.037</td>
<td>.529*</td>
<td>.517*</td>
<td>.84</td>
<td>.469</td>
<td>.145</td>
<td>.049</td>
<td>.489</td>
</tr>
<tr>
<td>N</td>
<td>.281</td>
<td>.545*</td>
<td>.110</td>
<td>.45</td>
<td>.049</td>
<td>.469</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P</td>
<td>.140</td>
<td>.383</td>
<td>-.044</td>
<td>.087</td>
<td>-.075</td>
<td>.275</td>
<td>.382</td>
<td>.187</td>
<td>.187</td>
</tr>
<tr>
<td>K</td>
<td>.042</td>
<td>.412</td>
<td>.529*</td>
<td>.780**</td>
<td>-.104</td>
<td>.489</td>
<td>.145</td>
<td>.187</td>
<td>1</td>
</tr>
</tbody>
</table>

the strongest relation with total fruits weight per plant ($r = 0.78$) also found strong association between individual fruit weight per plant. After this traits the nitrogen percentage ($r = 0.489$) and number of fruit per plant ($r = 0.412$) showed the most correlation with fruit yield (Table 4). Significantly positive correlations were also observed for nitrogen percentage and individual fruit weight per plant with total fruit weight per plant; number of fruit per plant and phosphor percentage. In general a significant positive correlation was observed between some of the traits. However, negative correlation was also found among certain characters in the present study. Fehmida and Ahmad [16] reported similar results for plant height, number of fruits per plant, fruit size and weight of 10 tomatoes. Mohanty [17] had reported positive and significant correlation of number of fruits per plant with fruit size and single fruit weight. More branching accessions of tomato tend to flower and mature late as shown in the negative and significant association of number of branches per plant with days to flower, days to fruit ripening and days to maturity. This may be due to the fact that much time is spent by the plant in growing more vegetative branches, hence extending its lifespan. Therefore, a breeder interested in improvement for early maturity in tomato may select plants with less number of branches.

**Regression Analysis:** The results of regression analysis by stepwise method for fruit yield in tomato (Table 5) indicated that total fruit weight can justify 65.3 percent of the fruit yield variation. So it might this was be seen that traits the most important component of fruit yield in tomato. Individual fruit weight per plant and phosphor percentage made 93.23 percent of the fruit yield variation. Presence of high significance and the positive correlation, between total individual and total fruit weight indicate that the results of the stepwise regression were in harmony with the correlation results. Stepwise regression
Table 5: Regression Analysis of studied traits in tomato

<table>
<thead>
<tr>
<th>Traits name</th>
<th>Regression Coefficient</th>
<th>Significant Level</th>
<th>Coefficient of determination component</th>
<th>Coefficient of cumulative determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.561</td>
<td>.604</td>
<td>.369</td>
<td></td>
</tr>
<tr>
<td>Total fruit Weight per plant</td>
<td>1</td>
<td>7.74</td>
<td>.000</td>
<td>65.3</td>
</tr>
<tr>
<td>individual fruit Weight per plant</td>
<td>.048</td>
<td>2.701</td>
<td>.018</td>
<td>23.36</td>
</tr>
<tr>
<td>%P</td>
<td>0.024</td>
<td>0.78</td>
<td>.0024</td>
<td>4.6</td>
</tr>
</tbody>
</table>

analysis showed that improvement of fruit weight per plant could be a good breeding way for increasing fruit yield. Based on regression analysis, if one had to choose just one trait for predicting fruit grade weights due to lack of resources, total fruit weight with fruit number could be used.

DISCUSSION

Our results in Table (3) showed that combination use of biofertilizers and chemical fertilizers has increased fruits yield (5343.4 kg), individual fruit weight and total fruits weight and fruit size biofertilizer was the highest. It can be concluded that barwar 2 phosphate with triple super phosphate treatment had the most yield. Mahfouz and Sharaf-Eldin [18] have indicated that the use of biofertilizer combined with chemical fertilizers has increased the shoot fresh weight and shoot dry weight of corn. The problem associated with the use of chemical fertilizers is becoming a global one and researchers are working all over the world to find a solution to this problem. Excessive use of chemical fertilizer in agriculture causes environmental problems including soil, physical destruction and nutrient imbalance. The main advantage of bio-fertilizer is that it does not pollute the soil and also does not show any negative effect to environment and human health. And this can be overcome either by adding chemical fertilizers containing nitrogen only for plants which are chemical treated or add other nutrients such as potassium and phosphorus to plant inoculated with bacteria. Finally obtaining less amount of healthy products with less environmental disturbances is proffered over obtaining higher amount of non-healthy products with more environmental disturbances.

CONCLUSION

Results of this study indicated that Barwar 2 Phosphate Biofertilizers (BPB) increased seeds measurement parameters compared with control. From the current results it can be concluded that using biofertilizer with low levels of triple duper phosphate had a positive effect on growth, yield and yield component in tomato. Depending on this conclusion it can be recommended that using this biofertilizer could be used as a suitable fertilizer along with organic and chemical fertilizers to achieve the maximum benefits. In other words, presence of these bacteria have increased tomato growth factors. Result from the present study indicated that yield and growth of tomato, have been affected by the inoculation with barwar2 Phosphate, because these biofertilizers can fix the atmospheric phosphor in soil. As a result, biological fertilizers can be recommended for the sake of achieving the higher quality production. The traits fruit weight and fruit size could be used for the selection of batter yielding lines under kurdistan region. The results compare means indicated that combination of bio-fertilizer treatments maximum fruit yield was recorded.

REFERENCES


