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

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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

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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]. Biofertilizer is a natural product carrying living microorganisms derived from the root or cultivated soil. So they don't have any ill effect on soil health and environment. Besides their role in atmospheric nitrogen fixation and phosphorous solubilization, these also help in stimulating the plant growth hormones providing better nutrient uptake and increased tolerance towards drought and moisture stress. A small dose of biofertilizer is sufficient to produce desirable results because each gram of carrier of biofertilizers contains at least 10 million viable cells of a specific strain [12]. Biofertilizer' is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers add nutrients through the natural processes of Nitrogen fixation, solubilizing phosphorus and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizer and pesticides. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Benefits of using Biofertilizers As it is living thing, it can symbiotically associate with plant root. Involved microorganisms could readily and safely convert complex organic material in simple compound, so that plant easily taken up. Microorganism function is in long duration causing improvement of the soil fertility. It maintains the natural habitat of the soil. It increases crop yield by 20-30%. Replace chemical nitrogen and phosphorus by 25% in addition to stimulating of the plant growth. Finally it can provide protection against drought and some soil borne diseases.

The purpose of this study was to compare different levels of chemical and biofertilizer on growth and yield of tomato, also evaluate the relationship between 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 t 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 HNO_3 and $HClO_4$ 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.

Table 1: Soil physical and chemical properties

Properties	Soil texture	% Sand	% Silt	% Clay	EC	PH	% N	Available P(ppm)	Soluble K^+Meq/L	Soluble Na^+Meq/L	Soluble Ca^{2+} Meq/L	Soluble Mg^{2+}Meq/L	Cl^-Meq/L	%o.m	%$CaCO_3$	HCO_3 Meq/L	CO_3^{2-}
Sample value	Clay	12.17	45.72	42.11	0.36	7	0.12	56.97	0.24	0.22	12.3	3.3	2.5	2.06	22.5	2.5	zero

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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 percentageat 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 controland 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

		MS								
S.O.V	df	Plant heigh	Number of fruits per plant	Individual fruit weight per plant/g	Total fruits weight per plant/g	Fruit size	%N	%P	%K	Fruit yield per green house
Replication	3	143.67	13.750*	8.588	94961.705	42.682	.128	.001	.010	380019.62
Treatment	3	1685.69**	16.750**	20.52*	495414.1**	770.4**	.264	.001	.231*	1980923.3**
Error	9	203.83	2.028	7.346	67761.696	73.356	.162	.000	.074	270963.31

Table 3: Mean comparing in tomato for studied treatment

	Traits name								
Treatment	Plant heigh	Number of fruits per plant	Individual fruit weight per plant/ gm	Total fruit weight per plant / gm	Fruit size	% N	%P	%K	Fruit yield per green house/kg
Control	183.06b	14.75a	74.19a	4334.4a	117.81a	2.35a	.195ab	2.56a	8670a
Bio-fertilizer	174.12b	18.5b	78.12ab	6577.5b	107.12a	2.5a	.21b	2.7b	13154.9b
Chemical	184.93b	17.75ab	79.44b	5644.8b	140b	2.2a	.194ab	1.25ab	11289.9b
Bio-fertilizer , ½ Chemical	140.75a	14.5a	78.05ab	6555.6b	117.12a	1.9a	.175a	1.1ab	13110b

Table 4:Correlation analysis of studied traits in tomato

	Traits name								
Treatment	Plant heigh	Number of fruits per plant	Individual fruit weight per plant/ gm	Total fruit weight per plant / gm	Fruit size	% N	%P	%K	Fruit yield per green house/kg
plant height	1								
Number of fruit per plant	0.27	1							
individual fruit Weight/ gm	-.190	-.096	1						
total fruit Weight/ gm	-.442	.311	.449	1					
size fruit	.227	.083	.357	-.104	1				
N	.179	.379	.525*	.517*	.84	1			
P	.281	.545*	. 110	.145	.049	.469	1		
K	.140	.383	-.044	.087	-.075	.275	.382	1	
Fruit yield per green house	-.442	.412	.529*	.780**	-.104	.489	.145	.187	1

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 weigh 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

Traits name	Regression Coefficient	T Test	Significant Level	Coefficient of determination component	Coefficient of cumulative determination
Intercept	.561	.604	.369		
Total fruit Weight per plant	1	7.74	.000	65.3	65.3
individual fruit Weight per plant	.048	2.701	.018	23.36	88.63
%P	0.024	0.78	.0024	4..6	93.23

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.

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