American-Eurasian J. Agric. & Environ. Sci., 15 (3): 353-358, 2015
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2015.15.3.12514

Effect of Bio-Fertilizer and Chemical Fertilizer on Growth and Yield in Cucumber (*Cucumis sativus* L.) 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 cucumber plant (*Cucumis sativus* L.). An experiment was conducted in randomized completely blocks design (RCBD) with four replicates. The treatment 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 Azoto barwar1 and chemical fertilizer was Urea (46% N). The results indicated that there were significant difference between the application bio-fertilizer and chemical fertilizer for yield and yield component traits. This study indicated that a combination treatment of bio-fertilizer and chemical fertilizer had significant effect and increased the yield and growth traits of cucumber. Correlation analysis showed that the strongest positive relationship between fruit yield and total fruit weight per plant (r = 0.89). The results of regression analysis by stepwise method for fruit yield in cucumber indicated that individual fruit Weigh can justify 50.9 percent of the fruit yield variation. According to this study using bio-fertilizers has increased yield and yield component of cucumber significantly.

Key words: Bio-fertilizers · Chemical fertilizers · Compare Means · Correlation · Cucumber · Regression Analysis

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a widely cultivated plant in the gourd family Cucurbitaceae is an agricultural crop that is has demanded all around the year [1]. Cucumber, (*Cucumis sativus* L.) is one of the most important vegetable crops in Kurdistan and Iraq, it is a warm season crop with required growing conditions of 26 to 30°C and plenty of sunlight has been commonly cultivated in Iraq during the summer and fall as well as in low tunnels and plastic and green houses[2]. In the last century, chemical fertilizers were used in agriculture. Farmers were happy of getting increased yield in agriculture in the beginning. Biofertilizers is a large population of a specific or a group of beneficial microorganisms for enhancing the productivity of soil. In recent decades the use of chemical fertilizers has been a common practice, whereas bio-fertilizers were neglected but nowadays by reason of irregular application of chemical fertilizers and their detrimental effects on human and soil health a lot of emphasis is being paid and organisms to provide nutrition requirement of plants [3]. A lot of emphasis is being paid to biofertilizers and it has emerged as one of the alternatives to application of chemical inputs for needs of fertilizers. Their use in agriculture in preference to chemical fertilizers offers economic and ecological benefits by improving soil health and fertility. Nitrogen is required for cellular synthesis of

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enzymes, proteins, chlorophyll, DNA and RNA and is therefore required for plant growth and production of food and feed. Inadequate supply of available N frequently results in plants that have slow growth, depressed protein levels, poor yield of low quality and inefficient water use [4]. When the chemical fertilizers were first introduced into the agriculture field, most of the problems faced by farmers to increase yield of their plantation have been solved. However, chemical fertilizers slowly started to show their side effect on human and environment [5]. Bio-fertilizers will be the best solution to replace chemical fertilizers. Bio-fertilizers are the carrier-based preparations containing mainly effective strains of microorganisms in sufficient number, which are useful for nitrogen fixation. Bio-fertilizers have several advantages over chemical fertilizers, they are non pollutant, in-expensive, utilize renewable resources. In addition to their ability of using free available solar energy, atmospheric nitrogen and water. Amongst biofertilizers, *Azotobacter* strains play a key role in harnessing the atmospheric nitrogen through its fixation in the roots. They have been shown also to improve fertility condition of the soil [6]. Use of *Azotobacter* biofertilizer as shown from the result that the bio-fertilizer in all parameter was higher than the control, this indicated that bio-fertilizer helped plant growth and has been able to provide the plant with nitrogen, which is one of the most needed nutrients for plant growth, But the lack of other nutrients such as potassium and phosphorus make growth less than that of the growth of plants with a chemical fertilizer [7]. Chemical fertilizers have several negative impacts on environment and sustainable agriculture. Therefore, biofertilizers are recommended in these conditions and growth prompting bacteria have been used as a replacement of chemical fertilizers [8]. Growth promoting bacteria induced increasing plant yield as clone in plants root [9]. Growth prompting bacteria include *Azotobacter*, *Azospirillum* and *Pseudomonas* [10,11,12]. 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 [13]. 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 solubilisation, 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 [14]. 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. Biofertilizers can symbiotically associate with plant root. Involved microorganisms could readily and safely convert complex organic material to simple compounds, so that plant could easily utilize them. Microorganism improve soil fertility. It maintains the natural habitat of the soil. Has been shown that it increases crop yield by 20-30%, replace chemical nitrogen and phosphorus by 25% in addition to stimulating plant growth. Finally it could provide protection against drought and some soil borne diseases. Biofertilizers in comparison with chemical fertilizers have enormous economic and environmental advantages. Biological fertilizers has been shown to have a special importance as appropriate replacement for chemical fertilizers, through to improving of soil fertility and providing nutrition requirement of plant [15].

The purpose of this study was to compare different levels of chemical and biofertilizer on growth and yield of cucumber, also evaluate the relationship between quantitative traits of cucumber. One of the goals was to examine morphological traits effects on fruit yield using multivariate analysis and to investigate the improvement of cucumber 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 ANDMETHODS

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,

Table 1: Soil physical and chemical properties

Properties	1. Soil texture	2. %Sand	3. %Silt	4. %Clay	5. EC	6. pH	7. %N	8. Available P(ppm)	9. Soluble K^+ Meq/L	10. Soluble Na^+ Meq/L	11. Soluble Ca^{2+} Meq/L	12. Soluble Mg^{2+} Meq/L	13. Cl Meq/L	14. %OM	15. 16. 17.	18. $\%CaCO_3$	19. HCO_3 Meq/L	20. CO_3^{2-}
21. Sample value	22. Clay	23. 12.17	24. 45.72	25. 42.11	26. 0.36	27. 7	28. 0.12	29. 56.97	30. 0.24	31. 0.22	32. 12.3	33. 3.3	34. 2.5	35. 2.06		36. 22.5	37. 2.5	38. zero

Prepared by Agricultural Research Center of Bakrajo - Sulaymania

Sulaymania, Iraq during 2014. The material consisted of one cucumber sayfe species. Is the biofertilizer used azoto barwar1. The seeds sown in the spring season and cucumber 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 per plant, 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 is presented in Table 1.

Chemical Component of Plants: [16], 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 [17]. For determination of total nitrogen Kjeldahl digestion was used [18], 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.

RESULTS AND DISCUSSION

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

Compare means for studied traits in cucumber conducted by Duncan method. The results indicated that bio-fertilizer and ½ chemical fertilizer treatments had significant difference for yield and growth traits and the highest yield and growth traits of cucumber was obtained with this treatment (Table 3). The best treatment was bio-fertilizer and ½ chemical fertilizers that has the highest led to individual and total fruit weight and fruit yield per green house.

Plant Height: The data presented in Table 3 showed that plant height was 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, while the maximum plant height was recorded in chemical fertilizers.

Individual Fruit Weight: The data presented in Table 3 showed that individual fruit weight was increased across the treatments, there were significant differences in the individual fruit weight. The minimum individual fruit weight was recorded in the bio-fertilizer, while the maximum individual fruit weight was recorded in bio-fertilizer, ½ chemical fertilizers.

Total Fruit Weight: The results of mean comparing of traits are shown in Table 3 between all treatments significant difference exist. The data presented in Table 3 showed that the total fruit weight was increased across the treatments, there were significant differences in the total fruit weight. The minimum total fruit weight was recorded in the control, while the maximum total fruit weight was recorded in bio-fertilizer, ½ chemical fertilizers.

Fruit Size: The data presented 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 control and the maximum fruit size was recorded in bio-fertilizer.

Potassium Content[BE3]: The data presented in Table 3 showed that potassium content increased across the treatments, there were some significant differences in the potassium content. The minimum potassium content was recorded in the control, while the maximum potassium content was recorded in bio-fertilizer.

Table 2: Analysis of variance (RCBD) for studied traits

		MS								
S.O.V	df	Plant height	Number of fruits per plant	Individual fruit weight per plant/gm	Total fruit weight per plant/g	Fruit size	%N	%P	%K	Fruit yield per green house
Replication	3	20.242	.677	4.983	488.258	14.229	.212	.001	.012	19.630
Treatment	3	306.47*	8.125	32.102**	281834.61**	205.896**	.336	.001	.046*	11274.2**
Error	9	78.650	3.006	3.974	1193.264	11.562	.621	.001	.012	47.661

Table 3: Compare means in traits cucumber

	Traits Name								
Treatment	Plant height	Number of fruit per plant	Individual fruit Weight per plant/ gm	Total fruit Weight per plant / gm	Size fruit	%N	%P	%K	Fruit yield per green house/kg
Control	271.32b	30.05a	76.54b	2149.1c	75.5a	2.86a	0.206ab	1.13a	4298.3c
Bio-fertilizer	265.12ab	32.29ab	73.33a	2170.3b	92.7 c	3a	0.231b	1.7b	4340.6b
Chemical	273.25a	31.94ab	77.67bc	2193.6a	87b	2.72a	0.203ab	1.51ab	4387.2a
Bio-fertilizer, ½ Chemical	253.82b	33.49b	80.16c	2671.7d	85.5b	2.4a	0.19a	1.36ab	5343.4d

Table 4: Correlation analysis of studied traits in cucumber

Traits name	Plant heigh	Number of fruit per plant	Individual fruit Weight per plant	Total fruit Weight per plant	Size fruit	%N	%P	%K	Fruit yield per green house
Plant height	1								
Number of fruit per plant	-0.206	1							
individual fruit weightper plant	-.217	.388	1						
total fruit weight per plant	-.507*	.197	.509*	1					
fruit size	-.341	.339	-.193	-.446	1				
%N	-.148	.328	-.191	-.397	.172	1			
%P	.378	.159	-.306	-.348	.252	.382	1		
%K	.251	.271	-.183	-.439	.484	.275	.469	1	
Fruit yield per green house	-.508*	.197	.508*	.89**	.446	.397	.348	.439	1

Fruit Yield Per Green House: The data presented in Table 3 showed that fruit yield per green house wsa increased across the treatments, there were significant differences in the fruit yield per green house. The minimum total fruit yield per green house was recorded in the control, while the maximum fruit yield per green house was recorded in bio-fertilizer, ½ chemical fertilizers. The fruit yield in cucumber has been significantly influenced by the application of bio fertilizer with ½ chemical at all stages of plant growth. The treatment receiving bio-fertilizer 100 g/ha barwar1 *Azetobacter* and chemical fertilizer Urea 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 the strongest relation with total fruit weight per plant (r = 0.89). Also it was found strong association between individual fruit weight per plant. After this traits the fruit size (r = 0.446) and potassium content (r = 0.439) showed the most correlation with fruit yield (Table 4). Significantly positive correlations were also observed for individual fruit weight per plant and total fruit weight per plant. 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. The results are in agreement with those obtained by [19] who reported a positive and significant correlation between Fruit number per plant and branches number per plant, fruits number per node had negative and significant correlation with branch number per plant and Shoot diameter, however a positive correlation with vigor of plant was found. [20] reported that most correlations between yield components and components and fruit yield were weak and strong correlations varied between populations, seasons and yield components. Selection weakened many strong correlations between yield components and between yield and components. [21] reported a positive and significant correlation (r = 0.7*) between number of branches per plant with total yield.

Table 5: Regression Analysis of studied traits in cucumber

Traits name	Regression Coefficient	T Test	Significant Level	Cofficient of determination component	Cofficient of comulative determination
Intercept	2/36	3.742	0.006		
Individual fruit Weight/ gm	0.194	1.01	.003	50.9	50.9
Fruit size	0.779	3.494	.004	27.8	78.7
Potassium content	0.092	0.672	.008	11.34	90.04

Correlations between fruit number per node and branches per plant and shoot diameter revealed that an increase in fruits number per node resulted in a decrease in branches number per plant and shoot diameter and an increase in vigor of plant. Although correlation between fruit yield and branches number per plant was weak in this study, however, [22] showed that among vegetative traits, number of nodes/branch and branches/plant was correlated with early yield, indicating that early yield was higher when the plants were able to grow longer branches and having more nodes.

Regression Analysis: The results of regression analysis by stepwise method for fruit yield in cucumber (Table 5) indicated that individual fruit weigh can justify 50.9 percent of the fruit yield variation. So it might this was be seen that traits the most important component of fruit yield in cucumber. Fruit size and potassium content made 90.04 percent of the fruit yield variation. Presence of high significance and the positive correlation, between individual fruit weight and fruit size with fruit yield indicate that the results of the stepwise regression were in harmony with the correlation results. Stepwise regression analysis showed that improvement of fruit weight per plant and fruit size 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 fruit yield (5343.4 kg), individual fruit weight and total fruit weight and fruit size biofertilizer was the highest. It can be concluded that barwar1 *Azotobacter* with Urea treatment had the most yield [23] 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 preferred over obtaining higher amount of non-healthy products with more environmental disturbances.

CONCLUSION

According to this study using biofertilizers has increased yield and yield component of cucumber significantly. In other words, presence of these bacteria have increased cucumber growth factors. Result from the present study indicated that yield and growth of cucumber, have been affected by the inoculation with *Azotobacter chroococcum*, because these biofertilizers can fix the atmospheric nitrogen in soil. Seeds inoclutated with *Azotobacter chroococcum* had beneficiary response on growth and yield of cucumber by 5 - 30%. 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 and ½ chemical fertilizer treatments maximum fruit yield was recorded.

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