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Effect of Chemical, Organic and Bio Fertilizers on Growth, Yield and Quality of Cucumber Plant (*Cucumis sativus* L.) grown under Greenhouse Conditions

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Abstract

This study was carried out at the Experimental Farm, College of Agriculture and Veterinary Medicine, Qassim University, Qassim Region, Kingdom of Saudi Arabia during the period 2019-2020 under greenhouse conditions to investigate the effect of chemical, organic and bio- fertilizers on growth, yield and quality of cucumber crop. Five treatments of fertilization (chemical "inorganic") as a control – (organic) – (organic + Biochar) – (organic + fungus “VA-mycorrhiza”) – (organic + bacteria “Bacillus”) were used in this study. Results revealed that there were significant differences between the fertilization treatments in all studied characteristics except leaf fresh weight (g), fruit length (cm), number of fruits plant^{-1} and total soluble solids (%). The results showed that the organic with bio fertilizers gave the best results in all studied characteristics and were not significantly different from chemical (inorganic) fertilization. Fertilization treatment (organic + bacteria) was the best in yield and quality characteristics. Fertilization treatment (organic + fungus) was the best in some vegetative growth traits such as relative growth rate (g g^{-1} day^{-1}) and net assimilation rate (g m^{-2} day^{-1}). Therefore, the study recommends the use of organic fertilizers with bio fertilizers, especially (organic + bacteria) to obtain the highest yield and quality of cucumber fruits. Thus, it is possible to preserve the soil, ground water and air from pollution by fertilizer residues, which achieves the main objective of the study, which is to preserve the environment from pollution, as well as to obtain safe healthy food. The study also recommends conducting more studies on the use of this type of fertilizer in different quantities and for other cultivars and on other crops under greenhouse conditions. As well as the use of this type of fertilizer with different mixtures of other organic fertilizers.

Keywords
Cucumber, Inorganic fertilization, Organic Fertilization, Biochar, Bacillus, VA-mycorrhiza, Fruit Yield, Fruit Quality, Greenhouse.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a vegetable crop belonging to the *Cucurbitaceae* family. It is an annual, cross-pollinated, dicotyledonous crop. It is a warm season vegetable. It is a very sensitive crop to low temperatures, and exposure to these conditions may lead to a decrease in both growth rate and yield (Hassan, 1991). It is a very sensitive crop to the lack of nitrogen element, and soil salinity, and exposure to these conditions can change the shape of the fruit (Hassan, 2001). It is cultivated for its fruits that can be eaten fresh or pickled. (Matlub *et al*., 1989). Cucumber fruits in the consumer maturity stage contain about 4-6% dry matter consisting of carbohydrates, proteins, fibers and fats, in addition to some mineral salts, such as potassium salts. It contains a number of enzymes that help digest and assimilate fatty and protein substances. Its mineral salts are alkaline in effect, thus helping to adjust the acidity of the blood fluid, dissolving stones in the kidneys, and increasing urine output. It is believed to be highly beneficial for treating both high and low blood pressure (Kashif *et al*., 2008). The use of various chemical fertilizers certainly has an impact on increasing productivity. Despite the high efficiency of these fertilizers, recent trends, especially after the nineties, focused on the need to limit their use because of their negative impact that causes environmental and health problems as well as their negative impact on microorganisms in the soil, soil properties and groundwater pollution (Al-Redhaiman, 2003). One of the most important purposes of organic agriculture is to produce plants that are free from the toxic effects of chemicals (Al-Redhaiman, 2004; Al-Redhaiman and Al-Shenawy, 2005). Attempting to find natural alternatives to chemical fertilizers is characterized by the ability to increase nutrients in the soil and improve its chemical, physical properties, and have a good impact on the environment, is one of the most important modern trends to increase the production of vegetable crops and obtaining a product free of chemical fertilizer (Al-Sahaf, 1989). The cucumber crop is considered one of the vegetable crops stressing the soil, which needs a high percentage of chemical fertilizer, to obtain good growth and high production (Al-Sahaf, 1989). To avoid the damages of chemical fertilizer and reduce their high cost, which increases the cost of production, the use of organic and bio fertilizer is an ideal solution because it is low-cost and a solution to the problems that result from the use of industrial chemical fertilizer (Al-Redhaiman and AL-Shenawy, 2005; Al-Sahaf, 1989). Striving to increase productivity of the area unit is required to meet the growing needs of the population through various types of services, including fertilization (Gerges, 2006). The doubling of production using chemical fertilizer was not without compensation, as many problems emerged, including environmental damage and its effects on human health due to the extensive and irrational use of those chemical fertilizers (Bayoumi and Hafiz, 2006). Which called those concerned with environmental safety to what is known as sustainable agricultural development, i.e. stay away from everything that is industrial in plant nutrition and return to feeding with natural organic fertilizers as well as the use of natural organic fertilizers has a much better effect than inorganic fertilizers for increasing fruit quality (Yousif, 2011; Aly, 2002). El-Shaikh and Mohamed, (2009) and El-Shaikh *et al*., (2018), mentioned some of the benefits of adding VA-mycorrhiza fungi to the soil, facilitating the phosphorous component through the secretion of phosphatase enzyme, the hyphae of the VA-mycorrhiza fungi absorb phosphorous by 60 times more than the roots of the normal plant, as the fungi extend in the soil to great depths that may reach to 10 meters and act as absorbers to collect and absorb nutrients and water from far depths and the roots of plants treated with VA-mycorrhiza live for long periods, active in the absorption and in a young state. The benefit of adding Bacillus bacteria to the soil is secreting the phytohormones such as indole acetic acid and cytokinin, which encourage increased growth and yield. It also secretes organic acids, which lead to a change in the pH, and facilitate the micro-elements such as (iron - zinc - manganese - boron - copper). In addition, facilitating phosphorous from the major elements through the secretion of the phosphatase enzyme, which breaks the phosphate bond fixed to it as a result of the alkalinity of the soil and transforms it into an easy form for absorption by the plant (El-Shaikh and Mohamed, 2009 and El-Shaikh *et al*., 2018). The benefits of adding biochar to sandy lands include improving soil properties and then increasing productivity in plants, as well as reducing pollution, carbon storage, and energy production (Kim *et al*., 2014 and Li *et al*., 2021). Moreover, Li *et al*. (2021) showed that the effect of adding biochar to sandy lands led to an increase in the land's ability to retain water and resist drought due to the increase in the specific surface area of biochar.

Therefore, the objective of this study was to investigate the effect of using chemical, organic and bio fertilizers on growth, yield and quality of cucumber crop grown in greenhouse under the arid conditions of Kingdom of Saudi Arabia.

MATERIAL AND METHODS

The present study was conducted during the during the period of 2019-2020 at the Experimental Farm of the College of Agriculture and Veterinary Medicine, Qassim University, Al-Qassim region (latitude 26-27 N, longitude 44-45 E, altitude 725 m above sea level), Kingdom of Saudi Arabia, to investigate the effect of chemical, organic and bio fertilizers on growth, yield and quality of cucumber plant. Soil and water samples were collected prior to planting at 0-20 cm depth and their properties were given in Table (1).

Five treatments of fertilization were used in this study: (1) Chemical (inorganic) fertilizers (NPK 13: 13: 13 as a control was added at a rate of 2 g l^{-1}. It was purchased from SABIC). (2) Organic fertilizers as processed cow manure was added at a rate of 2.5%. It was purchased from Al Reef Factories Company for Organic Fertilizers. (3) Organic fertilizers + Biochar, (Biochar was added to the soil before planting at a rate of 30 g pot^{-1} or $plant^{-1}$). It was obtained from one of the farmers in the area as a gift. (4) Organic fertilizers + fungi "VA-mycorrhiza", (VA-mycorrhiza were added 10 days before planting at a rate of 3 g $plant^{-1}$. It was obtained from Abdul Rahman Al-Haqbani Agricultural Corporation. (5) Organic fertilizers + bacteria "Bacillus", (Bacteria was added 8 days before planting at a concentration of 4/500 and after planting at a concentration of 1/1000 every week (the addition was mixed with water). It was obtained from Abdul Rahman Al-Haqbani Agricultural Corporation. Cucumber seeds were sown under greenhouse in seedling foam trays (84 eyes) filled with a mixture of Peat moss: Vermiculite (1:1 v/v), supplemented with 300 g Ammonium Sulphate (20.5% N), 400 g Calcium Superphosphate (15% P_2O_5), 150 g Potassium Sulphate (48% K_2O), 50 g micronutrient and 50 g of a fungicide (thiophanate-methyl) for each 50 kg of the mixture. After one-month seedlings were transplanted in the conditioned greenhouse on December, 25, 2020 at 50 cm apart and 1 m width of ridge. The experimental plot consisted of one ridge with 15 m long and 1 m width making an area of 15 m^2. All missing transplants were replaced by other ones of the same age, one week later after transplanting.

The greenhouse was 60 m long and 9 m width making a total area 540 m^2, 50 cm from both sides of the greenhouses arch near from fiberglass and 30 cm from beginning (entrance) and end (exit or out) of the greenhouse were left without planting. So, the total number of plants $greenhouse^{-1}$ were about 1200 plants (2.22 plants m^{-2}). Plots were arranged in a randomized complete block design, with four replicates. Each plot has an area of 15 m^2 and contains 33.33 plants. The plants were planted on both sides of the line in pots, each pot had one plant and the distance between plants on the same row is 50 cm in the shape of the leg of a crow on ridge.

Zahran cucumber hybrid was used in this study. Its seeds were purchased from the Astra Agricultural Company.

Average day and night temperatures in greenhouses were 25 ^oC and 18 ^oC. These temperatures are considered optimal for most common crops grown under greenhouse conditions according to Johnson (1980) and Maynard and Hochmuth (2007) who reported that the optimum temperature for cucumber growth lies between 18-24 ^oC.

Table (1). Physical and Chemical Properties of Soil and Water used for the Study

Properties	Value	
	Soil	Water
Physical properties		
Sand (%)	94.1	-
Silt (%)	3.6	-
Clay (%)	2.3	-
Texture	Sandy	-
Chemical properties		
[1]pH	7.84	7.13
[2]EC (dS m^{-1})	0.508	2.8
[3]Nutrient (ppm)		
Total N	168	-
Available P	0.450	-
Available K	45.0	40.0
[4]Dissolved Ions (meq l^{-1})		
1- Dissolved Anions (meq l^{-1})		
Cl^-	1.0	12.0
$HCO_3^{-1} + CO_3^{-2}$	3.0	3.0
2- Dissolved Cations (meq l^{-1})		
Na^+	1.3	11.9
Ca^{++}	3.0	4.0
Mg^{++}	1.0	3.0
[5]Organic Matter (%)	0.34	-

1- pH was measured in the soil aqueous extract (soil: water) at a ratio of (1: 2.5) using a pH meter type (Jenway, model 3310) according to what was mentioned in the method (Black, 1965).
2- EC (dS m^{-1}) was measured in the saturated soil paste extract was estimated using an EC-meter type (ELE, model 470) according to the method recommended in Jackson, 1973).
3- Total N was determined by Kjeldahal method; P was extracted using Olsen method; K by 1 N NH_4OAc at pH 7.
4- The dissolved salts (cations + anions) were measured in the extract of saturated soil paste. and determined using EDTA solution titration method for calcium, magnesium, carbonate and bicarbonate by titration with hydrochloric acid, and chloride by titration with silver nitrate, while, sodium was determined using a Flame photometer according to the method mentioned by Jackson (1973).
5- Organic matter (%) was determined in soil by modified Walkly-Black method according to Sahrawat, 1982.

Five plants form each treatment in each replication were randomly selected and tagged for records on vegetative growth, fruit yield as well fruit quality parameters.

1. **Vegetative growth traits**

the following Vegetative growth traits were determined:

1-1.Plant height (cm), was measured after 120 days of transplant from the base of the plant to the terminal growing point of tagged plants using a meter scale of each plant of the measured experimental unit.

1-2.Number of leaves plant^{-1}, were counted after 120 days of transplant.

1-3.Leaf area (cm^2), the leaf area at the fifth fruit picking (the physiological peak of the plant's activity) was calculated by taking 30 discs with a known area of five leaves from each plant of the experimental unit, the discs were dried and the rest of the leaves were separately. Then the leaf area of the plant was calculated by multiplying the leaf area of the tablets by the dry weight of the plant leaves divided by the dry weight of the tablets according to Dvornic (1974).

1-4.Chlorophyll content in leaf (SPAD Units), the chlorophyll content in cucumber leaf was measured by taking three leaves of the plant for each replicate in each experimental unit using the SPAD-502 chlorophyll meter (Minolta, Japan).

1-5. Relative growth rate (g g^{-1} day^{-1}), it is the increase in dry weight in certain periods of the plant's life and its relationship to the initial weight of the plant, and it is calculated from the following equation (according to Evans, 1972).

$$RGR = \frac{\text{Ln W2} - \text{Ln W1}}{\text{T2} - \text{T1}} \quad (g\ g^{-1}\ day^{-1})$$

Whereas,

Ln: logarithm of the natural base, W2: dry weight of the plant at the beginning of the period T2, W1: dry weight of the plant at the beginning of the period T1.

1-6. Net assimilation rate (g m^{-2} day^{-1}), it is the increase in net products of photosynthesis per unit area of leaves during the time after subtracting the losses due to respiration and is calculated from the following equation according to Sudhakar *et al.* (2016).

$$NAR = \frac{W2 - W1}{T2 - T1} \times \frac{Ln\,LA2 - Ln\,LA}{LA2 - LA1}\ (g\ m^{-2}\ day^{-1})$$

Whereas,
W2: Dry weight of the plant at the beginning of the period T2, W1: dry weight of the plant at the beginning of the period T1, LA2: leaf area of the plant at the beginning of the period T2, LA1: leaf area of the plant at the beginning of the period T2, Ln: logarithm of the natural base.

1-7. Leaf fresh weight (g), the leaf fresh weight at the fifth fruit picking by taking three leaves from 5 plants from each experimental unit chosen randomly and then weighed using a Balance Sensitive scale (Mettler pc 4000) and the results were recorded.

1-8. Leaf dry weight (g), after weighing three fresh leaves from 5 plants from each experimental unit using a Balance Sensitive scale (Mettler pc 4000), and recording their fresh weight. These leaves were placed in an electric oven at a temperature of 70°C for 72 hours until the weight was stable according to, Al-Sahaf, (1989) and their dry weight was recorded.

2. Fruit yield Characteristics

2-1. Fruit length (cm), the average length of the fruit was measured using a ruler for a representative sample (20 fruits) selected randomly and for three picks (early, middle, and late) for each experimental unit. The length of the fruit was calculated by dividing the sum of the lengths of the fruits by their number.

2-2. Fruit diameter (cm), the average diameter of the fruit was measured by Vernier for a representative sample (20 fruits) selected randomly and for three picks (early, middle, and late) for each experimental unit. The diameter of the fruit was calculated for each by dividing the sum of the diameters by their number.

2-3. Number of fruits plant^{-1}, it was calculated by counting the fruits of the experimental unit cumulatively from the beginning of the harvest until the end of the growing season and divided by the number of plants of the experimental unit.

2-4. Fruit fresh weight (g), the fresh weight of the fruit was measured by a Balance Sensitive scale (Mettler Pc 4000) and the fresh fruit weight was calculated by dividing the weight of the experimental unit yield (Kg) by the number of fruits of the experimental unit.

2-5. Fruit dry weight (g), the dry weight of the fruit was estimated by taking 10 fruits from each randomly selected experimental unit, then they were placed in an electric oven at a temperature of 105 °C for 72 hours until the weight was stable.

2-6. Fruit yield square meter^{-1} (kg m^{-2}), the average fruit yield of square meter was measured by the weight of the cumulative fruit yield of one square meter plants from the beginning of harvest to the last harvest and divided by the one square meter plants.

2-7. Fruit yield experimental unit^{-1} (kg 15 m^{-2}), the average yield of the experimental unit was calculated by the weight of the cumulative yield of the plants of the experimental unit from the beginning of harvest to the last harvest and divided by the experimental unit plants

2-8. Fruit yield greenhouse^{-1} (ton 540 m^{-2}), the average total weight of fruits in the greenhouse was calculated from the yield of the experimental unit by weighing the yield of plants in the experimental unit and multiplying it by the ratio between the total greenhouse area 540 m^2 and the area of the experimental unit 15 m2.

3- Fruit quality parameters

3-1. Fruit firmness (Lbs. inch^{-2}), the firmness of the fruit was measured by a hardness measuring device on fruits taken from the fifth fruit picking to ensure homogeneity (Ali *et al.,* 2012) at a rate of 5 fruits replicate-1.

2-2. Fruit acidity (%), the acidity of the fruit was measured using a pH meter on fruits taken from the fifth fruit picking, at a rate of 5 fruits for each plot

3-2. Total soluble solids (TSS %), it was measured in the fruit by a Hand Refractometer on fruits taken from the fifth fruit picking, at a rate of 5 fruits for each plot.

All recorded data were statistically analyzed and (Tuckey's Test) was used to compare the means at the level of significance ($P \leq 0.05$) using the SAS statistical analysis program according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

A. Effect of chemical, organic and bio fertilizers treatments on some vegetative growth traits in cucumber plants grown in a conditioned greenhouse

It is noted from the vegetative growth traits such as [(Plant length (cm), Number of leaves plant^{-1}, Leaf area (cm^2) and Chlorophyll content in the leaf SPAD)] as shown in Table (1 A, B, C, D) and Fig. (1 A, B, C, D), and [(Relative growth rate (g g^{-1} day^{-1}), Net assimilation rate (g m^{-2} day^{-1}), Leaf fresh weight (g) and Leaf dry weight (g)] as shown in Table (2 A, B, C, D) and Fig. (2 A, B, C, D) that there are significant differences among the fertilization treatments in all vegetative growth traits except Leaf fresh weight (g). Fertilization treatments (organic + biochar) and (organic + fungi) gave the highest values for Plant height (215, 213.3 cm), respectively, while the fertilization treatment (organic + bacteria) gave the lowest value (176.1 cm) for this trait (Table 1. A, Fig.1. A). Fertilization treatments (chemical), (organic) and (organic + fungi) recorded the highest values for number of leaves plant^{-1} (19.3, 18.3, 18.3), respectively, while the fertilization treatment (organic + bacteria) recorded the lowest value (16.6) for this trait (Table 1. B, Fig.1. B). Fertilization treatments (chemical) and (organic + bacteria) gave the highest values for leaf area (189.4, 172.6 cm^2), respectively, while the fertilization treatment (organic + fungi) gave the lowest value (151.9 cm^2) for this trait (Table 1.C, Fig.1. C). Fertilization treatment (chemical) gave the highest values of chlorophyll content in leaf (33.6 SPAD), while the fertilization treatment (organic + fungi) gave the lowest values (26.3 SPAD) for this trait (Table 1.D, Fig.1. D). Fertilization treatment (organic + fungi) recorded the highest values (0.19 g g^{-1}day^{-1}, and 0.55 g m^{-2} day^{-1}) for relative growth rate and net assimilation rate, respectively. While the fertilization treatment (organic) recorded the lowest values (0.10 g g^{-1} day^{-1}, 0.31 g m^{-2} day^{-1}) for these traits, respectively, (Table 2 A and B, Fig. 2 A and B). Fertilization treatments (chemical), (organic + biochar) and (organic) gave the highest values for leaf dry weight (3.69, 3.16, 3.11 g), respectively. While the fertilization treatment (organic + bacteria) and (organic + fungi) gave the lowest values for this trait (2.81 and 2.84 g), respectively (Table 2 D, Fig. 2 D). The results of this study seem consistent with what was found by Eifediyi and Remison (2009) who found that increasing the rates of inorganic fertilizers leads to increased growth in the cucumber crop. On the other hand, many researchers such as Mahmoud *et al*. (2009), Al-Bayati (2012), Isfahani and Besharati (2012), Abou-El-Hassan *et al*. (2014), and Tahir *et al*. (2019) studied the effect of adding different types of organic and bio fertilizers separated or combined in different crops and found a significant increment in vegetative growth traits. The reason for the increase in the traits of vegetative growth when treated with organic and/or organic with bio fertilizers may be attributed to increasing soil fertility and thus increasing the absorption of nutrients such as nitrogen, phosphorous, potassium, and others by the plant, which have a significant role in many vital processes leading to the division of cells forming meristem tissues and increase the size of cells. It also contains some other substances such as hormones, vitamins, proteins, and some amino acids such as alanine and glycine. These fertilizers also improve the structure and porosity of the soil, which leads to a balance between moisture and aeration in the soil (Genchev *et al*., 1979; Al-Sahaf, 1989; Al-Nuaimi, 1999). The increase in relative growth rate and net assimilation rate in the fertilization treatment (organic + fungi) may be due to the benefits of adding VA-mycorrhiza to the soil as mentioned by El-Shaikh and Mohamed, (2009) and El-Shaikh *et al*., (2018).

B.Effect of chemical, organic and bio fertilizers treatments on some fruit yield characteristics in cucumber plants grown in a conditioned greenhouse

Regarding fruit characteristics such as [(Fruit length (cm), Fruit diameter (cm), Number of fruits plant^{-1}, and Fruit fresh weight (kg)] as shown in Table (3 A, B, C, D) and Fig. (3 A, B, C, D), and characteristics [(Fruit dry weight (g), Fruit yield square meter^{-1} (kg m^{-2}) Fruit yield experimental unit^{-1} (kg 15 m^{-2}) and Fruit yield greenhouse^{-1} (Ton 540 m^{-2})] as shown in Table (4 A, B, C, D) and Fig. (4 A, B, C, D) that there are significant differences among the fertilization treatments in all fruit yield characteristics except Fruit length (cm) and Number of fruits plant^{-1} (Table 3 A and C, Fig. 3 A and C)

Table (1) Effect of chemical, organic and bio fertilizers treatments on some vegetative growth traits [A-Plant height (cm), B-No. of leaves plant^{-1}, C-Leaf area (cm^{2}) and D-Chlorophyll content in leaf (SPAD)] in cucumber plants grown in a conditioned greenhouse.

Fertilization Treatments	A- Plant height (cm)	B- No. of leaves plant^{-1}	C- Leaf area (cm^{2})	D- Chlorophyll content in leaf (SPAD)
Chemical	204.9^{ab}	19.3^{a}	189.4^{a}	33.6^{a}
Organic	184.5^{bc}	18.3^{ab}	165.1^{bc}	28.1b^{c}
Organic + Biochar	215^{a}	17.3^{ab}	164.5^{bc}	29.3^{b}
Organic + Fungi	213.3^{a}	18.3^{ab}	151.9^{c}	26.3^{c}
Organic + Bacteria	176.1^{c}	16.6^{b}	172.6^{ab}	27.3b^{c}

Means followed by different letter are significantly different at 5% level of significance

Table (2) Effect of chemical, organic and bio fertilizers treatments on some vegetative growth traits [A-Relative growth rate (g g^{-1} day^{-1}), B-Net assimilation rate (g m^{-2} day^{-1}), C-Leaf fresh weight (g) and D-Leaf dry weight (g)] in cucumber plants grown in a conditioned greenhouse.

Fertilization Treatments	A-Relative growth rate (g g^{-1} day^{-1})	B-Net assimilation rate (g m^{-2} day^{-1})	C-Leaf fresh weight (g)	D-Leaf dry weight (g)
Chemical	0.13^{bc}	0.51^{a}	20.1^{a}	3.69^{a}
Organic	0.10^{c}	0.31^{b}	17^{a}	3.11^{ab}
Organic + Biochar	0.12^{c}	0.40^{b}	18.5^{a}	3.16^{ab}
Organic + Fungi	0.19^{a}	0.55^{a}	18^{a}	2.84^{b}
Organic + Bacteria	0.16^{ab}	0.38^{b}	16.8^{a}	2.81^{b}

Means followed by different letter are significantly different at 5% level of significance

Table (3) Effect of chemical, organic and bio fertilizers treatments on some fruit growth characteristics [A-Fruit length (cm), B-Fruit diameter (cm), C-No. of fruit plant^{-1} and D-Fruit fresh weight (Kg)] in cucumber plants grown in a conditioned greenhouse

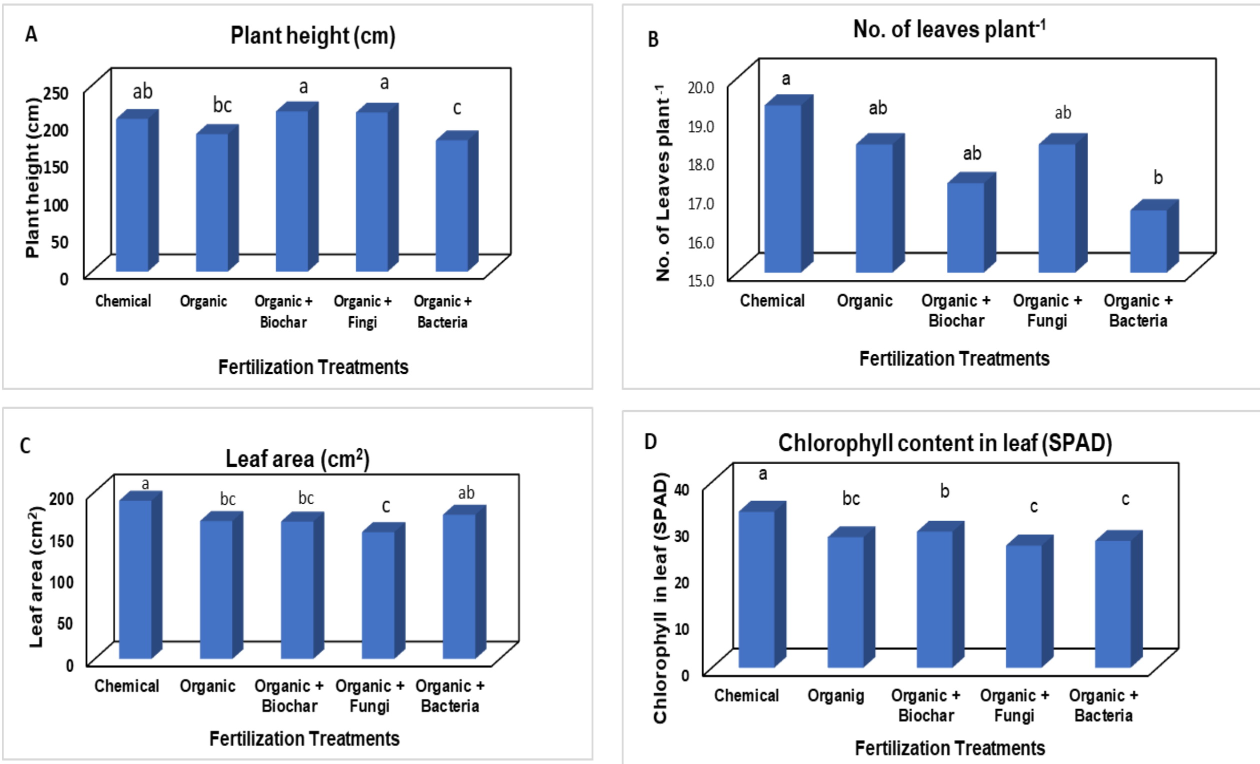
Fertilization Treatments	A- Fruit length (cm)	B- Fruit diameter (cm)	C- No. of fruit plant^{-1}	D- Fruit fresh weight (Kg)
Chemical	19.03^{a}	3.05^{a}	68.94^{a}	6.25^{a}
Organic	18.10^{a}	2.70^{b}	65.97^{a}	4.60^{b}
Organic + Biochar	18.26^{a}	2.84^{ab}	65.97^{a}	4.74^{b}
Organic + Fungi	17.10^{a}	2.69^{b}	63.00^{a}	4.41^{b}
Organic + Bacteria	17.76^{a}	2.90^{ab}	65.97^{a}	5.59^{a}

Means followed by different letter are significantly different at 5% level of significance

Table (4) Effect of chemical, organic and bio fertilizer treatments on some fruit yield characteristics [A-Fruit dry weight (g), B-Fruit yield square meter^{-1} (kg m^{-2}), C-Fruit yield experimental unit^{-1} (Kg 15m^{-2} and D-Fruit yield greenhous^{-1} (ton 540m^{-2})] in cucumber plants grown in a conditioned greenhouse.

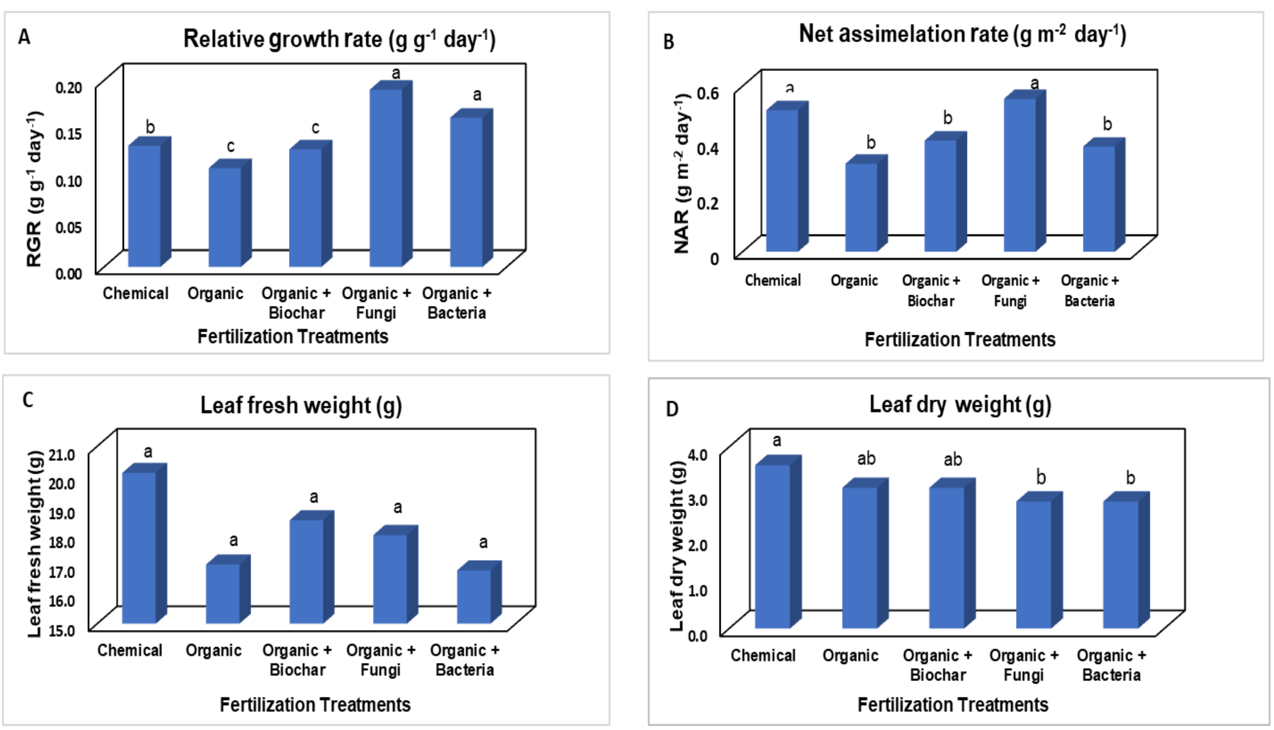
Fertilization Treatments	A- Fruit dry weight (g)	B- Fruit yield square meter^{-1} (kg m^{-2})	C- Fruit yield experimental unit^{-1} (kg 15 m^{-2})	D- Fruit yield greenhous^{-1} (ton 540m^{-2})
Chemical	21.785^{a}	13.875^{a}	208.13^{a}	7.49^{a}
Organic	15.899^{bc}	10.212^{b}	153.18^{b}	5.52^{b}
Organic + Biochar	16.756^{bc}	10.523^{b}	157.84^{b}	5.68^{b}
Organic + Fungi	14.805^{c}	9.790^{b}	146.85^{b}	5.29^{b}
Organic + Bacteria	19.065^{ab}	12.410^{a}	186.15^{a}	6.70^{a}

Means followed by different letter are significantly different at 5% level of significance



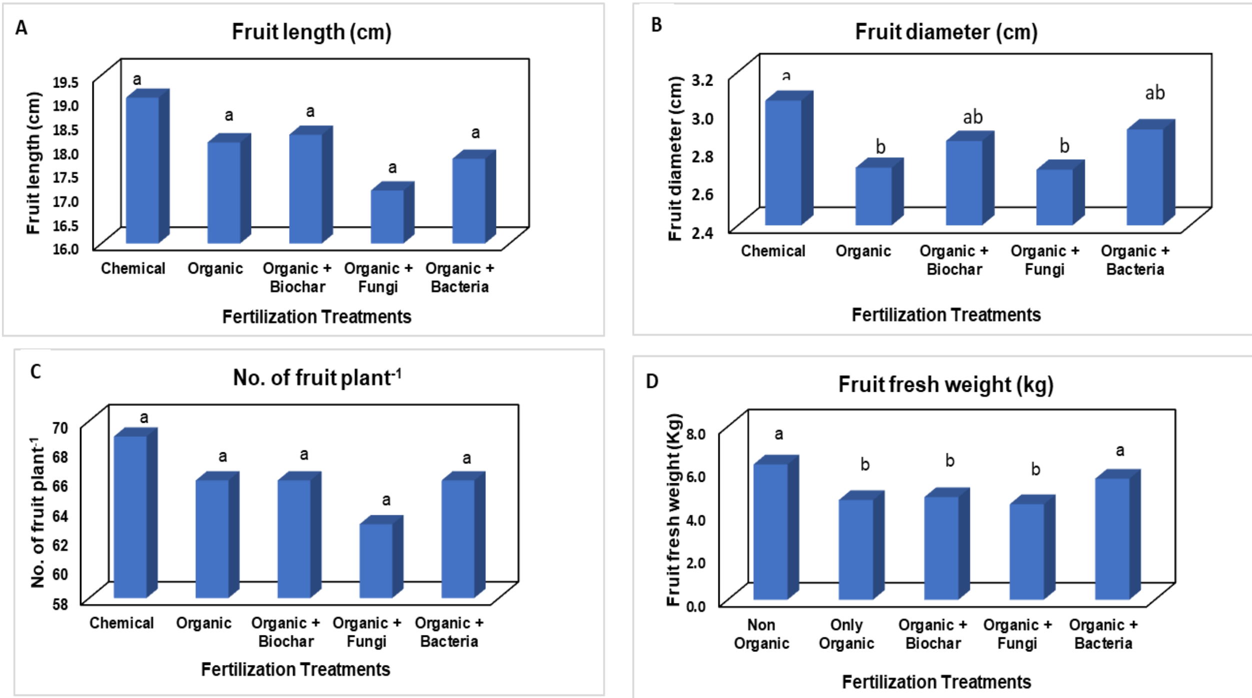
Means followed by different letter are significantly different at 5% level of significance

Figure (1) Effect of chemical, organic and bio fertilizers treatments on some vegetative growth traits [A- Plant height (cm), B- No. of leaf plant^{-1}, C- Leaf area (cm^2) and D- Chlorophyll content in leaves (SPAD)] in cucumber plants grown in a greenhouse.



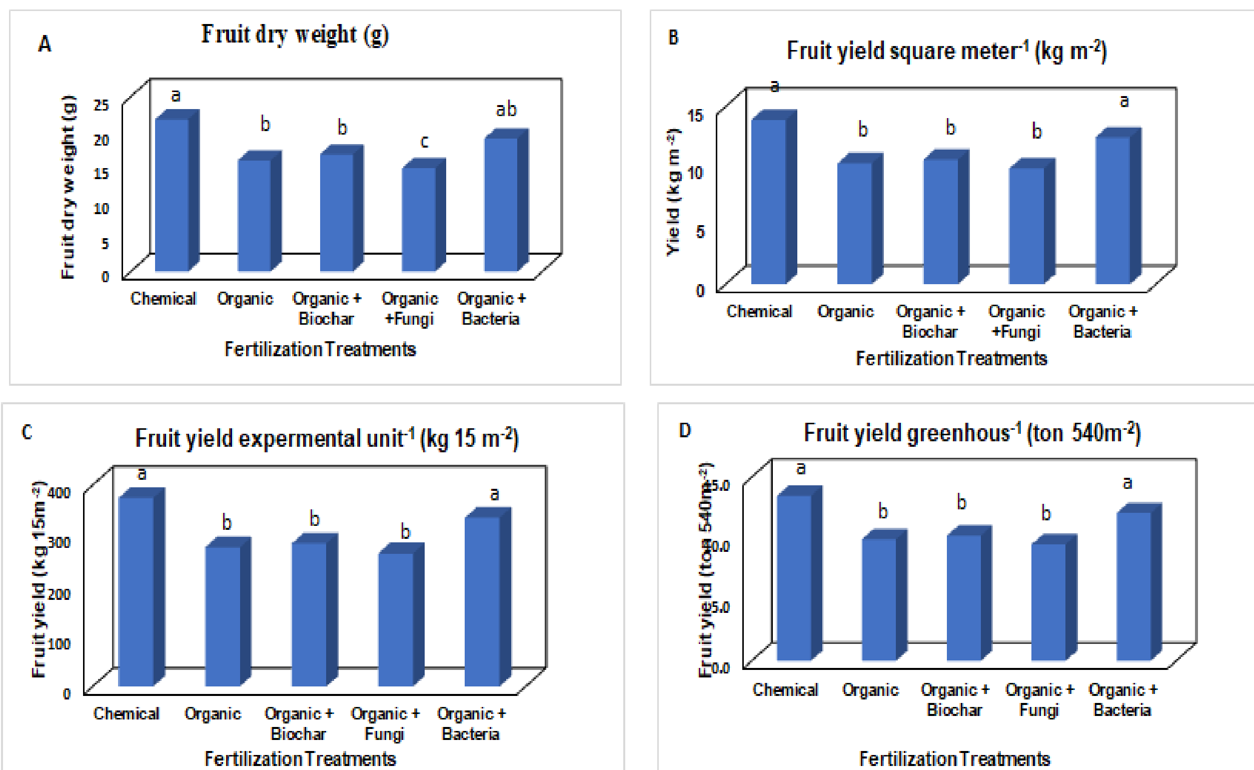
Means followed by different letter are significantly different at 5% level of significance

Figure (2) Effect of chemical, organic and bio fertilizers treatments on some vegetative growth traits [A- Relative growth rate (g g^{-1} day^{-1}), B- Net assimilation rate (g m^{-2} day^{-1}), C- Leaf fresh weight (g) and D- Leaf dry weight (g)] in cucumber plants grown in a greenhouse.



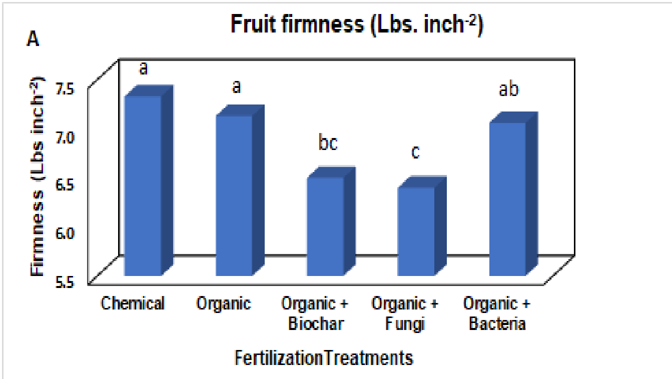
Means followed by different letter are significantly different at 5% level of significance

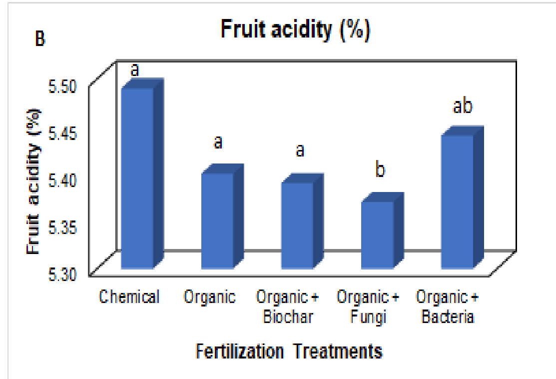
Figure (3) Effect of chemical, organic and bio fertilizers treatments on some fruit yield characteristics [A- Fruit length (cm), B- Fruit diameter (cm), C- No. of fruit plant^{-1} and D- Fruit fresh weight (kg)] in cucumber plants grown in a Greenhouse.

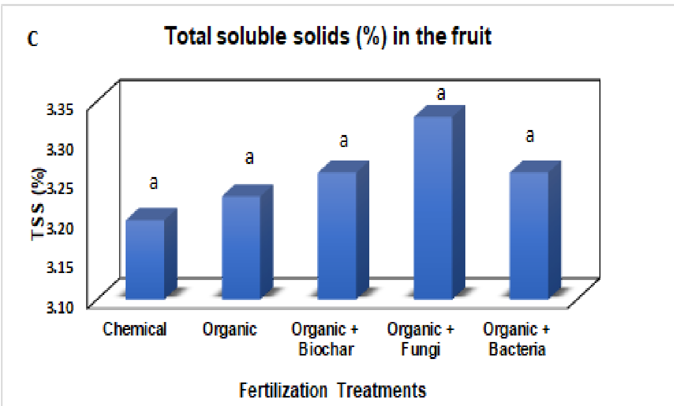


Means followed by different letter are significantly different at 5% level of significance

Figure (4) Effect of chemical, organic and bio fertilizers treatments on some fruit yield Characteristics [A- Fruit dry weight (g), B- Fruit yield square meter^{-1} (kg m^{-2}), C- Fruit yield experimental unit^{-1} (kg 15m^{-2}) and D- Fruit yield greenhouse^{-1} (ton 540m^{-2})] in cucumber plants grown in a Greenhouse.







Means followed by different letter are significantly different at 5% level of significance

Figure (5) Effect of chemical, organic and bio fertilizers treatments on some fruit quality parameters [A- Fruit firmness (Lbs. inch^{-2}), B- Fruit acidity (%) and C-Total soluble solids (%)] in cucumber plants grown in a greenhouse.

Fertilization treatments (chemical) and (organic + bacteria) showed the highest values in all studied characteristics and there was no significant difference between them. While the fertilization treatments (organic + fungi) showed the lowest values in all studied characteristics (Table 3 B and D, Fig. 3 B and D) and (Table 4 A, B, C and D, Fig 4 A, B, C and D).

The results of this study seem consistent with what was found by (Mahmoud *et al*., 2009; El-Shabrawy *et al*., 2010; Nair and Ngoajio, 2010; Al-Bayati, 2012; Isfahani and Besharati, 2012; Abou-El-Hassan *et al*., 2014 and Tahir *et al*., 2019) who studied the effect of adding different types of organic and bio fertilizers separated or combined in different crops and found a significant increment in the most fruit yield characteristics. Eifediyi and Remison (2009), indicated that increasing the rates of inorganic fertilizers leads to high fruit yield in the cucumber crop.

The increase in all characteristics related to the fruit yield in the fertilization treatment (organic + bacteria) may be due to the multiple benefits of adding bacteria to the soil as mentioned by El-Shaikh and Mohamed, (2009) and El-Shaikh *et al*., (2018).

C. Effect of chemical, organic and biological fertilizers treatments on some fruit quality parameters in cucumber plants grown in a conditioned greenhouse

It is noted from the parameters related to the quality of the fruit [(Fruit firmness (Lbs. inch^{-2}), Fruit acidity (%) and Total soluble solids (%)], that there are significant differences among the fertilization treatments in all studied traits except total soluble solids (%) (Table 5A, B, C and Fig. 5A, B, C). The fertilization treatments, (chemical), (organic) and (organic + bacteria) gave the highest values (7.33, 7.13, 7.06 lbs. inch^{-2}), (5.49, 5.40, 5.44 %) in the Fruit firmness and Fruit acidity, respectively. Whereas, the fertilization treatments (organic + fungi) gave the lowest values (6.40 Lbs. inch^{-2}, 5.37 %) for these two parameters, respectively, (Table 5A, B and Fig. 5A, B).

Results of this study appear to be in agreement with (Azarmi *et al*. (2009); Al-Bayati, 2012; and Abou-El-Hassan *et al*., 2014) who studied the effect of adding different types of organic and bio fertilizers separated or combined on cucumber crop and found a significant increase in the fruit quality parameters. As well as the combination of organic and inorganic fertilizers can increase fruit quality and soil fertility (Mahmoud *et al*., (2009) and Singh *et al*., 2020).

Table (5): Effect of chemical, organic and bio fertilizer treatments on some Fruit Quality Characteristics [A-Fruit firmness (Lbs. inch^{-2}), B-Fruit acidity (%) and C-Total soluble solids (%)] in cucumber plants grown in a conditioned greenhouse

Fertilization Treatments	A- Fruit firmness (Lbs. inch^{-2})	B- Fruit acidity (%)	C- Total soluble solids (%)
Chemical	7.33^{a}	5.49^{a}	3.2^{a}
Organic	7.13^{a}	5.40^{ab}	3.23^{a}
Organic + Biochar	6.50^{bc}	5.39^{ab}	3.26^{a}
Organic + Fungi	6.40^{c}	5.37^{b}	3.33^{a}
Organic + Bacteria	7.06^{ab}	5.44^{ab}	3.26^{a}

Means followed by different letter are significantly different at 5% level of significance

CONCLUSIONS AND RECOMMENDATIONS

From the results of this study, it can be concluded that: (1) Fertilization treatments organic with bio fertilizers gave the best results in all studied characteristics and were not significantly different from chemical (inorganic) fertilization. (2) Fertilization treatment (organic + bacteria) was the best in all fruit yield and quality characteristics. (3) Fertilization treatment (organic + fungi) was the best in some vegetative growth traits such as relative growth rate and net assimilation rate. Therefore, it is possible to use organic fertilizers with bio fertilizers as an alternative to inorganic fertilization, and this will certainly preserve the environment and human health without negatively affecting the growth, yield and quality of cucumber plants.

REFERENCES

Abou-El-Hassan, S., Abdrabbo, M.A.A. and Desoky, A.H. (2014). Enhancing organic production of cucumber by using plant growth promoting rhizobacteria and compost tea under sandy soil condition. *Research Journal of Agriculture and Biological Sciences*, 10(2): 162-169.

Al-Bayati, H. J. M., Al-Habbar, M. T. A. and Al-Laila, W. B. (2012). Effect of organic fertilization on the growth and yield of female hybrid cucumbers, cultivar Grass F1, grown under unheated greenhouses. *Kufa Journal of Agricultural Sciences* 4 (2) 327 – 336.

Ali, J. Y., Kamil, Ashjan, N., Abas, A., J. and Salih, Z. K (2012). Effect of treatment with Cyanobacteria and Seaweed extract on growth, flowering and yield of Cucumber *Cucumis sativus* L. *Journal of Tikrit University of Agricultural Sciences*, 12(4): 101-107.

Al-Nuaimi, S. N. A. (1999). Fertilizers and soil fertility. The 2nd Ed, Dar Al-Kutub for Printing and Publishing, University of Mosul, Iraq.

Al-Redhaiman, K. N. (2003). Nitrates and their effect on the environment, Alexandria Journal for Scientific Exchange, 3 (24): 357-372.

Al-Redhaiman, K. N. (2004). *An Introduction to Organic Agriculture*. The Agricultural Journal - Volume 35, Issue Two. Ministry of Agriculture - Kingdom of Saudi Arabia.

Al-Redhaiman, K. N. and AL-Shenawy, M.Z., (2005). *Introduction in organic agriculture*. Series of scientific sources of Saudi society for agricultural science .8th source .5th year. Kingdom of Saudia Arabia.

Al-Sahaf, F. H. (1989). *Applied plant nutrition*. Baghdad University. Ministry of Higher Education and Scientific Research, Iraq. 260 pp

Aly, H.H. (2002). Studies on Keeping quality and storage ability of cucumber fruits under organic farming system in greenhouses. *M.Sc. Thesis Fac. Agric. Cairo Univ. Egypt*.

Azarmi, R., Mousa, T.G. and Bahzad, H. (2009). The effect of sheep manure vermicompost on quantitative and qualitative properties of cucumber (*Cucumis sativus* L.) grown in greenhouse. *Africa J. Biotech.*, 8 (19): 453-457.

Bayoumi, Y.A. and Hafez, Y.M. (2006). Effect of organic fertilizer combined with benzo (1,2,3) thiadiazole -7-carbothioic acid S-methy ester (BTH) on the cucumber powdery mildew and the Yield production. *Acta Biologica Szegediensis*, 50 (3-4):131-136.

Black, C.A. (1965). *Methods of soil analysis*. Part I, American Society of Agronomy. Madison, Wisconsin, USA. 1572 p.

Eifediyi, E.K. and Remison, S.U. (2009). The Effect of Inorganic Fertilizer on the Yield of Two Varieties of Cucumber (*Cucumis sativus* L.). *Report and Opinion*, 1(5): 74-80.

EL-Shabrawy, R.A., Ramadan, A.Y. and El-Kady, S.M. (2010). Use of Humic Acid and some Biofertilizer to reduce Nitrogen rates on cucumber (*Cucumis sativus* L.) in relation to vegetative growth, yield and chemical composition. *J. plant production, Mansoura University* 1(8): 1041-1051.

El-Shaikh, K.A.A and Mohammed, M. S. (2009). Enhancing fresh and seed yield of okra and reducing chemical phosphorus fertilizer via using VA-mycorrhizal inoculants. *World Journal of Agricultural Sciences*, 5(5): 810-818

El-Shaikh, K.A.A., Mohammed, M.S. and Hamadly, K.S.H. (2018). Effect of Bio-and Mineral Fertilization and number of pickings on seed production of okra (*Aelmoschus esculentus* L. Moench). *Journal of Shohag Agriscience*, (2): 23-36.

Genchev, S., Drev, T. K., Georgieva, V., Rankov, V. and Dimitrov, G. (1979). Changes in the plastidpigments content of tomatoes as affected by different nutrient elements ratios. Fiziologiyana Rasteniya, (4): 67- 74. Plovdiv, Bulgaria. (C.F. Hort. Abst. Vol. 51: 1968).

Gerges, M. M. (2006). IPM applications of real cucumber to lay the foundations for sustainable agriculture. Published article. *Iraqi Journal of Agriculture, Ministry of Agriculture*, 3: 37-38.

Hassan, A. A. (1991) *Vegetable Crop Production*. First Edition - Arab House for Publishing and Distribution - Cairo - 711 pages.

Hassan, A. A. (2001). *Cucurbits*. First Edition - Arab House for Publishing and Distribution, Cairo University - Arab Republic of Egypt - 497 pages.

Isfahani, F.M. and Besharati, H. (2012). Effect of biofertilizers on yield and yield components of cucumber. *J. Biol Earth Sci*., 2(2), 83–92.

Jackson, M.L. (1973). *Soil Chemical Analysis*. Prentice Hall of India Pvt., Ltd., New Delhi, 498.

Johnson, J. (1980). *Greenhouse vegetable production*. General information and bibliography. Division of Agricultural University of California. Extension leaflet 2667. Riverside California, USA

Kashif, W., Kamran, Q. and Jilani, M., (2008). Effect of Different Nitrogen Levels on Growth and Yield of Cucumber (*Cucumis sativus* L.). *J. Agric. Res*., 46(3): 259-266.

Kim, P., Hensley, D. and Labbe, N. (2014) Nutrient release from switchgrass derived biochar pellets embedded with fertilizers. *Geoderma*, (232–234): 341–351.

Li, L., Zhang, Y., Novak, A., Yang, Y. and Wang, J. (2021). Role of Biochar in Improving Sandy Soil Water Retention and Resilience to Drought. *Water*, 13 (407): 1-11.

Mahmoud, E., Abd El-Kader, N., Robin, P., Akkal-Corfini, N. and Abd El-Rahman, L. (2009). Effects of different organic and inorganic fertilizers on Cucumber Yield and Some Soil Properties. *World J. Agric. Sci*., 5(4): 408-414.

Matlub, A.N., Ez-Aldeen, S.M. and Kream. S.A. (1989). *Production of vegetables*. 2nd part .2nd printing. Dar AL-Kutub broad of printing. Mosul University. Ministry of Higher Education and Scientific Research. Iraq.

Maynard, D.N. and Hochmuth, G.J. (2007). *Knott's Handbook for Vegetable Growers*. 5th Ed. John Wiley and Sons, INC, 621 pp.

Nair, A. and Ngouajio, M. (2010). Integrating row covers and soil Amendments for organic cucumber production: implications on crop growth, yield, and microclimate. *Hort. Sci*., 45(4):1-9.

Sahrawat, K. L. (1982). Simple modification of the Walkley-Black method for simultaneous determination of organic carbon and potentially mineralizable nitrogen in tropical rice soil. *Plant and Soil*, 69: 73 77.

Singh, J., Singh, M. K., Kumar, M., Gupta, A. and Singh, K.P. (2020). Growth, Yield and Quality Parameters of Cucumber (*Cucumis sativus* L.) as Influenced by Integrated Nutrient Management Application. *Int. J. Curr. Microbiol. App. Sci*., 9(10): 1455-1462.

Snedecor, G.W. & Cochran, W.G. (1980). *Statistical Methods*. 7th Ed., Iowa State Univ. Press, Ames, Iowa, USA

Tahir, S.M., Kabir, A.M., Ibrahim, H. and Sufiyanu, S. (2019). Studies on the Performance of Organic and Inorganic Fertilizer on the Growth and Yield of Cucumber (*Cucumis Sativus* L.). *Science World Journal* 14(1):156-163.

Yousif, K.H. (2011). Effect of humic acids, biofertilizer (EM-1) and application methods on growth, flowering and yield of cucumber. A Thesis Submitted, College of Agriculture, University of Duhok, Iraq.

الملخص العربى

تأثير التسميد الكيماوى والعضوى والحيوى على النمو والمحصول والجودة لنبات الخيار النامى تحت ظروف البيوت المحمية

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أجريت هذه الدراسة في المزرعة التجريبية، كلية الزراعة والطب البيطري ، جامعة القصيم ، منطقة القصيم، (خط عرض 26-27 شمالاً، خط طول 44-45 شرقاً، إرتفاع 725 م فوق سطح البحر)، المملكة العربية السعودية خلال الفترة 2019-2020 تحت ظروف البيوت المحمية لدراسة تأثير الأسمدة الكيماوية والعضوية والحيوية على نمو ومحصول وجودة محصول الخيار. استخدم في هذه الدراسة خمسة معاملات من التسميد هى - التسميد الكيماوى (غير عضوي) ككنترول – التسميد العضوى – التسميد العضوي + الفحم (الفحم الحيوي) – التسميد العضوي + الفطرى (فطر – (VA-mycorrhiza) التسميد العضوي + البكتيرى (بكتيريا .(Bacillus أوضحت النتائج وجود فروق معنوية بين معاملات التسميد في جميع الصفات المدروسة ماعدا صفة وزن الورقة الطازجة (جم)، طول الثمرة (سم)، عدد الثمار على النبات، نسبة المواد الصلبة الذائبة الكلية (٪). أظهرت النتائج أن الأسمدة العضوية مع الأسمدة الحيوية أعطت أفضل النتائج في جميع الصفات المدروسة ولم تختلف معنوياً عن التسميد الكيميائي (غير العضوي). معاملة التسميد (العضوي + البكتيرى) كانت الأفضل في صفات المحصول والجودة. فى حين معاملة التسميد (العضوي + الفطرى) كانت الأفضل في بعض الصفات الخضرية مثل معدل النمو النسبي (جم/ جم/ يوم) وصافى معدل التمثيل (جم/م2/يوم). لذلك توصي الدراسة باستخدام الأسمدة العضوية مع الأسمدة الحيوية وخاصة البكتيرية منها للحصول على أعلى محصول وجودة من ثمار الخيار. ومن هنا تنبع اهمية استخدام الاسمدة العضوية والحيوية منفردة او معاً كبديل للاستخدام المكثف للاسمدة الكيميائية للحفاظ على التربة والبيئة وصحة الانسان.