Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL
Volume 7, Issue 1, 2024, Pages 1–25

Available online at https://aasj.journals.ekb.eg

DOI: https://dx.doi.org/10.21608/aasj.2024.340606

Rationalizing the use of nitrogen mineral fertilizers by using biological and organic alternatives on cucumber crop under arid region of Egypt

Abd-El-Shafy A. N., Abd-El-Raheem G. H., Azab M. A.*

Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt

Abstract

The current study aims to rationalize the use of nitrogen fertilizer by using alternatives of biological and organic fertilizers and their interactions on cucumber crop productivity and quality. The experimental design was split split plot design with three replicates. Cucumber plants was tested under two bio-fertilizations (with and without), four types of compost (without, plant, animal and mixed compost) as well as three rates of mineral-N i.e., (25, 50, and 75 kg/feddan) (feddan = 4200 m^2). The main effect of biological, organic and N fertilization compared to non-fertilized showed a significant increase in cucumber yield, all crop components, and the percentage of TSS in cucumber fruits, in both seasons. Results indicated that the increase in cucumber crop productivity was estimated at (13.04%, 11.42%), (17.89%, 38.04%) and (43.83%, 55.69%) as a result of biological, organic and nitrogen fertilization in both seasons, respectively. Despite the superiority of the intervention treatment containing 4 ton/feddan, (mixed compost) + (mixed bio) + Mineral-N at a rate of 75 kg/feddan. Statistical analysis proved to apply 4 ton/feddan of (mixed compost) + (mixed bio) + Mineral-N at a rate of 50 kg/feddan, because there is no significant difference with mineral-N fertilization treatment.

Keywords: cucumber, organic fertilizer, compost, bio-fertilizer, nitrogen fertilizer.

*Corresponding author: Azab M. A.,
E-mail address: mmazab999@gmail.com

1. Introduction

Cucumber (*cucumis sativus* L.) represents the most important fresh consumed vegetables. According to FAO (2020) the cucumber area in Egypt amounted 16,104 ha with a total production of 364,571 tons and with an average productivity of 226,385 kg/ha in the year of 2019. Cucumber fruits are rich in conventional antioxidants, vitamins, minerals, and other phytonutrients that are vital for human health. Excessive use of nitrogen fertilizers on vegetable crops has negative effects on human health. There is an urgent need to rationalize and reduce nitrogen consumption in cultivated plants, especially after its high price. Cucumber, like any vegetable crop needs fertile soils rich in organic matter. However, usually, there is a need for external input such fertilizers. Cucumber plants are needed either bio, organic and chemical fertilizers. Nowadays, biofertilizers take great attention in fertilization. Also, the combination of organic, bio- and inorganic fertilizers were investigated in various experiments (Hana, *et al*. 2005; Marliah *et al*. 2019). Moreover, Jilani *et al*. (2009) indicated that application of NPK fertilizer (100-50-50 kg/ha) showed the best performance in almost all the parameters studied, as it took the least days to flowering (39.33), fruit setting (11.55), maturity (7.88), maximum fruit per plant (35.5), maximum fruit length (18.36 cm), maximum fruit weight (136.03 g) and yield per hectare (60.02 ton). Application of NPK fertilizers 120-60-60 kg ha^{-1} also showed some beneficial effect on some parameters including fruit weight (150.69 g) and vine length (3.85 m). Also, Mohammed *et al*. (2011) indicated that chemical fertilizer gave the highest total yield (22.55 ton/ha) in fall and 31.77 ton/ha) in spring season and total yield of same variety. Many investigations presented the effect of chemical fertilizers on grown cucumber (Eifediyi and Remison, 2010; Jilani *et al***.** 2009). Additionally, the utilization of biofertilizers in a wide scale in the Egyptian agriculture field leads to fixing atmospheric nitrogen, whether symbiotically or non-symbiotically, and provides 25% of nitrogen fertilizers. Abu El-Fotoh *et al.* (2000) reported that bio-fertilizers produced organic acids and excretion growth regulators like IAA and GA3. Raeisi *et al.* (2013) reported that the best treatment was containing humifrote at concentration of 4000 ppm, that leads to most yields per bush and yield per m^2. Much research papers reported that bio-fertilizers impact on different crops; Ismail and Helmy (2018) on sugar bean, Gomaa *et al.* (2021) on maize plants, Hassan (2020) on sweet potato plants, and Soltan and Osman (2021) on carrot plants. Abd Allah *et al.* (2002) indicated that increasing organic fertilizer rates improved vegetative growth of tomato characteristics, flowers, and fruit numbers, as well as fruit acidity and ascorbic acid contents; however, average fruit weight was increased. Moral *et al.* (2005) reported that organic fertilizers (cattle manure and poultry manure) were as good as inorganic fertilizer for cucumber production. Aiyelaagbe (2007) showed that organic fertilizers (manure) (20 and 30 ton ha^{-1}) increase the fruit weight of each sample and the fruit weight of cucumber plant. Various organic fertilizers were studied by some investigators; Law-Ogbomo *et al*. (2018) used cattle and poultry manure, Moral *et al*. (2005) used cattle manure and poultry manure, Natsheh and Mousa (2014) and Al-Magrebi (2015) used compost. The application of bio, organic and chemical N combinations on cucumber plants were investigated by several research workers. Gaber *et al*. (2007) recorded that the interaction effects of biofertilizer types and nitrogen levels 60 and 90 kg N feddan^{-1}) together, gave the highest mean values of most studied characters. Aiyelaagbe (2007) indicated that the combination of organic fertilizer (manure at a rate of 20 ton ha^{-1} and inorganic NPK + Micro Fertilizer results in the best fruit weight each plant of cucumber. Moreover, Saeed *et al*. (2015) indicated that the combined treatment between bio-fertilizer and chemical fertilizer had significant effect and increased the yield and growth traits of cucumber. According to this study, the use of bio-fertilizers led to a significant increase in the yield and yield component of cucumber. Bindiya *et al*. (2014) revealed that, application of Vermi-compost 2 ton ha^{-1} + 50% recommended dose of fertilizers (50:30:30 NPK kg ha^{-1}) + bio-fertilizers (Azotobacter and phosphate solubilizing bacteria each 5 kg ha^{-1}) resulted in maximum growth, yield and yield attributes with good quality cucumber. Al-Azzawi and Al-Ibadi (2017) showed superiority of the treatment of interaction (NPK 100% + 10 kg ha^{-1} nutrient organic) in total production (42.51 and 30.50) tons for two seasons, spring and autumn respectively. Sayed-Ahmed *et al*. (2016) concluded that the application of the mixture of (Microbeen + Rhizobacterin + Phosphorien) as biofertilizers and adding 120 kg N feddan^{-1}, as a mineral fertilization for maximizing sugar beet productivity under the environmental conditions. El-Hamdi *et al*. (2017) concluded that the integrated treatment of compost application at 10 ton feddan^{-1} alongside with (Microbien + Phosphorien + EM bio-fertilization) is recommended to produce the highest productivity and quality indices of cucumber yield grown on a sandy soil condition. Ahmed *et al.* (2017) concluded that, the combination among (Microbein + 25% NPK of recommended fertilization +10 m^3 feddan^{-1} of chicken manure or among Microbein + 50 % NPK of recommended fertilization +10 m^3 feddan^{-1}) gave the highest mean values of vegetative growth characters, yield and its components and fruit quality of cucumber plants. Dash *et al*. (2018) found that the application of (half rec. NPK + FYM 10 ton ha^{-1} + Vermi-compost 2 ton ha^{-1} + bio-fertilizer (4.0 kg Azotobacter ha^{-1} + 4.0 kg PSB ha^{-1}) recorded average fruit weight of 174.84 g, 180.45 g and 171.40 g during 2014, 2015 and 2016 respectively. Al-Fehaid *et al.* (2022) indicated that chemical fertilization treatments (NPK 13: 13: 13) and (organic at a rate of 2.5% + bacteria "Bacillus") showed the highest values in all studied characteristics of cucumber plant (*Cucumis sativus* L.) grown under greenhouse conditions. Mohamed *et al.* (2023) recommended that application of combined fertilizers (organic + inorganic) gave the best practice for tomato and cucumber under greenhouse conditions than any of the two fertilizers alone.

2. Materials and methods

2.1 Experimental site and treatments description

Two field experiments were carried out during the summer seasons of 2021 and 2022 at a private farm, in East Oweinat, New Valley governorate, Egypt. Field experiments were designed to evaluate the effect of using bio-and organic fertilizers to rationalize chemical fertilizers on the productivity of cucumber (*Cucumis sativus* L.). The experiments were laid out in a split-split plot design in three replicates. The main plots were assigned for 2 bio- fertilizers (with and without), meanwhile, sub-plots were assigned for 4 organic-fertilizers type (control, plant, animal and mixed compost) and sub-sub-plots were assigned for 3 nitrogen fertilizer rates (25, 50 and 75 kg N feddan^{-1}. The experiment consists of 2 bio-fertilizer x 3 organic fertilizers × 4 nitrogen rates =24 treatment with 3 replicates for each treatment. The unit plot size was (3.5 × 3.0 m = 1/400 feddan) and the total number of plots was 72 experimental units. The applied bio-fertilizers were bought from the Agriculture Research Centre (ARC) and included mixture of 3 types of micro-organisms under commercial names (Rhizobactien, Microbien and Potassien). The biofertilizers mixture was prepared at a rate of 1 kg feddan^{-1}, (1 kg of each biofertilizer), where the quantity was dissolved in 10 litres of water and added to the irrigation water during the cultivation. Organic fertilizers (plant and animal compost) were prepared at a ratio of 50% of each plant and animal compost. Organic fertilizers were applied during soil preparation at a rate of 10 kg/plot^{-1} = 4 ton/feddan^{-1}. The physical and chemical analyses of experimental soil used during the two seasons (2021 and 2022) were demonstrated as follows: The soil textural class was sandy loam, slightly alkaline and low in total nitrogen (20 and 22.5 ppm), phosphorus (20 and 31ppm), and potassium (120 and 151ppm) in both seasons, respectively. Agronomic practices were followed as usually done for the cucumber crop in the East Oweinat region. Phosphorus and potassium fertilizers were applied before land preparation at the rate of 30 kg P_2O_5 feddan^{-1} and 24 kg K_2O in the form of super phosphate (15.5% P_2O_5) and potassium sulfate (48% K_2O), respectively. Seeds of cucumber hybrids (Rahaf) were sown on the 28th of August and harvested on the 6th of October in both seasons, respectively. Floating irrigation was followed in both seasons. Chemical analysis showed that animal compost (C1) and mixed compost (C3) were neutral (7.30 and 7.50), respectively. While vegetable compost (C2) was alkaline (8.50). Mixed compost (C3) had the highest organic carbon content (30.41%). The results also show that all the compost used contained moderate content of total nitrogen (0.646, 0.904 and 1.040) phosphorus (0.34, 0.36 and 0.37%) and potassium (0.45, 0.20 and 0.28%) in both seasons, respectively that can support cucumber production.

2.2 Data recorded

Four plants from each treatment in each replication were randomly selected and tagged for records on yield components and total yield as well as fruit quality parameters. All the following characters were determined after 75 days of transplant.

2.2.1 Some yield characters

Cucumber fruits at marketable stage were harvested twice weekly. At harvest time, number of fruits plant^{-1}, fruit set, fruit weight plant$^{-1,}$ fruit length, fruit diameter and yield (kg plant^{-1}), yield and early yield ton feddan^{-1}.

2.2.2 Total soluble solids (TSS)

Measured using a digital refractometer and pH meter, respectively (AOAC, 1999).

2.3 Analytical methodology

2.3.1 Soil analysis

The physical and chemical analyses of experimental soil were determined according to Piper (1950) and Klute (1986).

2.3.2 Compost analysis

All characters were determined according to Jackson (1973) and Page *et al*. (1982).

2.4 Statistical analyses

All obtained data were subjected to statistical analysis of variance and treatment means were compared for significant differences using the LSD at p = 0.05. The MSTAT-C computer program was used to perform all the analysis of variance with the procedure outlined by Steel and Torrie (1982).

3. Results and Discussion

3.1 Effects on some yield characters

3.1.1 Number of fruit/plant

The results of the study in Table (1) showed that bio-fertilization treatment (B1) gave the highest number of fruitplant^{-1} (17.40 and 19.50) in comparison to the treatment without biofertilization in the 1st and 2nd seasons, respectively. Also, the percentage increase in number of fruits/plant was (16.77 and11.42%) in the bio-fertilization treatment compared to the treatment without biofertilization in the 1st and 2nd seasons. Gashash *et al*. (2022) found that combined use of *B. subtilis* and *B. amyloliquefaciens* increased the number of fruit plant^{-1} (by 76% compared to the control in the first season. Results found that mixed organic fertilization (C3) gave the highest number of fruit/plant (18.30 and 21.80) with increasing percentages (31.65 % and 43.42 %) compared to the other treatments in the 1st and 2nd season, respectively. The increase in the number of fruit plant^{-1} may be due to the organic fertilization advantage as the slow release and high cation exchange capacity exceed the ability of sandy soil to retain nutrients absorbed by the plants, increasing the minerals content of cucumber plants (Ahmad *et al*., 2008; Fiorentino and Fagnano, 2011). Also, Alkharpotly *et al*. (2019) found that the highest rates of chicken manure (20 m^3 feddan^{-1}) achieved the highest average values for number of fruits/plant. The obtained results indicated that there were no significant differences between N50 (18.60 and 21.00) and N75 (19.70 and 22.50) treatments in number of fruitplant^{-1}. Both were significantly superior to the N25 (9.70 and 11.70) treatment in both seasons, respectively.

Table (1): Effect of bio and compost fertilizers substituted by mineral-N on No of fruit/ plant under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer (B)	Compost (C)	2021			Mean	2022			Mean
		N1 (25)	N2 (50)	N3 (75)		N1 (25)	N2 (50)	N3 (75)	
Without (B0)	C0	6.85	14.91	16.16	12.60	8.75	16.53	17.76	14.30
	C1	8.91	16.53	17.15	14.20	10.85	19.06	20.96	17.00
	C2	9.15	18.11	19.96	15.70	11.51	21.36	22.28	18.40
	C3	11.55	19.85	20.11	17.20	13.16	23.07	24.91	20.40
	Mean	9.10	17.40	18.30	14.90	11.10	20.00	21.50	17.50
With (B1)	C0	8.13	17.80	19.33	15.10	10.46	18.33	19.53	16.10
	C1	10.00	18.67	20.67	16.40	11.26	20.19	21.8	17.80
	C2	11.67	21.85	22.67	18.70	12.88	24.56	25.73	21.10
	C3	12.33	22.67	23.33	19.40	15.66	26.07	27.67	23.10
	Mean	10.50	20.20	21.50	17.40	12.60	22.30	23.70	19.50
Main effects	C0	7.50	16.40	17.70	13.90	9.60	17.40	18.60	15.20
	C1	9.50	17.60	18.90	15.30	11.10	19.60	21.40	17.40
	C2	10.40	20.00	21.30	17.20	12.20	23.00	24.00	19.70
	C3	11.90	21.30	21.70	18.30	14.40	24.60	26.30	21.80
	Mean	9.70	18.60	19.70		11.70	21.00	22.50	
F-test A (Bo.)			**				**		
L.S.D 0.05 B (Co.)			1.13				1.32		
AB			1.62				1.72		
C (N)			1.78				1.81		
AC			1.82				1.86		
BC			1.87				1.89		
ABC			1.93				1.94		

Where B = Biofertilization treatments, B0 = treatment without biofertilization, B1 = Biofertilization treatment, C = Compost, C0= without compost, C1 = Plant compost, C2 = Animal compost, C3 = Mixed compost, N = Nitrogen rate, N1 = 25 kg feddan^{-1}, N2 = 50 kg feddan^{-1}, N3 = 75 kg feddan^{-1}.

Increasing nitrogen mineral fertilizer from 25 to 50 kg N feddan^{-1}, significantly increased the number of fruit/plant by (91.95% and 79.48%) in both seasons. This finding may be attributed to the critical part of the applied N, which plays a great role in nucleic acids, co-enzymes, and proteins- phosphorus Alkharpotly, *et al*. (2019) found that the highest rates of NPK (150:50:110 kg feddan^{-1}) produced the highest significant average values for number of fruits/plant. The observation in (Table 1) showed that the interaction (B1 × C3), (B1 × N3) and (B1 × C3 × N75) significantly gave the highest number of fruit/plant (19.40 and 23.10), (21.50 and 23.70) and (21.70 and 26.30) in the 1st and 2nd season, respectively. However, observation showed insignificant effect between N50 and N75 on number of fruit/plant. Mohan *et al*. (2016) revealed that 60 percent of each of recommended fertilizer and vermicompost along with *Azotobacter*, *Trichoderma* and PSB were found to be superior among all the combinations of organic, inorganic and bio-fertilizer sources. The results recorded in Table (1) indicate that there are no significant differences between the two treatments (B1 × C3 × N3) and (B1 × C3 × N2). The biological fertilization and the organic type mixed with 75 and 50 kg N feddan^{-1} recorded the best number of fruit/plant (23.33, 27.67), (22.67 and 26.07) in both seasons, respectively. Both of them are significantly superior to the treatment (B1 × C3 × N1).

3.1.2 Fruit length (cm)

Demonstrated results in Table (2) indicated that soil treated by Bio-fertilizers (B) gave the longest fruit (12.54 and 13.10 cm) as compared with the untreated one compared to the untreated plots in both seasons, respectively. The increase percentage in fruit length due to the soil applied bio fertilizer compared to the untreated one recorded (20.11 and 16.75%). Gashash *et al*. (2022) proved that combined use of *B. subtilis* and *B. amyloliquefaciens* significantly increased fruit height by 50% relative to the control, in the first season. The positive effect of fruit length due to bio-fertilizers addition may be attributed to the improved plant growth (Cimrin and Yilmaz, 2005). Concerning the main effect of applied compost, results recorded soils treated by mixed fertilizer (C3) gave the highest fruit length (12.24 and 12.94 cm) with increasing percentage (14.28 and 16.78 %) in comparison to the untreated plots in both seasons, respectively. This may be due to the importance of added organic materials which contained suitable amount of organic carbon containing as a reservoir of plant nutrients considered as slow fertilizers among mineralization, which led to increase growth and development of the crop plants (Moral *et al*., 2005). This is in agreement with Law-Ogbomo *et al*. (2018) who indicated that Fruit length values observed with plots fertilized with 5, 10 and 15t ha-1 were statistically comparable ($P>0.05$) but significantly ($P<0.05$) than 0 ton ha^{-1} (unfertilized plots). In relation to the main effect of nitrogen fertilizer rates (N) on fruit length (cm), Results observation indicated that fruit length increased with increase mineral rate application, but there are no-significant differences between N at a rate of 50 and 75 kg/feddan, in both seasons. Application nitrogen fertilizer at the rate of 50 kg

N/feddan recorded increase percentage in fruit length due to 50 kg N/feddan over 25 kg N/feddan was (12.93 and 13.33%) in the 1st and 2nd season, respectively. This finding owing to considering nitrogen as a structural element of chlorophyll and protein molecules, thereby affects the formation of chloroplasts and accumulation within or inside them (Tucker, 2004). Results recorded in Table (2) indicate that the interaction effect, between bio- and compost fertilization (B × C) was significant for fruit length in two seasons. The highest fruit length (13.32 and 14.03 cm) was obtained as a result from the interaction between (B1 × C3) in the 1st and 2nd season, respectively. Mohan *et al*. (2016) revealed that 60 per cent each of RDF and vermicompost along with *Azotobacter*, *Trichoderma* and PSB were found to be superior among all the combinations of organic, inorganic and bio-fertilizer sources of nutrients for characters, namely minimum number of days to 50 per cent. Data presented in Table (2) expressed that all the second combinations significantly affected fruit length in both seasons. (B1 × C3) recorded the highest fruit length (13.32 and 14.03 cm), while (B1 × N50) gave the significant fruit length (13.93 and 19.33 cm), as well as (C3 × N50) gave the longest fruit length (13.21 and 13.96 cm) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively.

Table (2): Effect of bio and compost fertilizers substituted by mineral-N on fruit length under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer (B)	Compost (C)	2021			Mean	2022			Mean
		N1 (25)	N2 (50)	N3 (75)		N1 (50)	N2 (75)	N3 (25)	
Without (B0)	C0	8.16	9.73	10.86	9.58	9.3	10.86	10.91	10.36
	C1	9.17	10.53	11.01	10.24	9.36	11.93	12.21	11.17
	C2	9.86	10.96	11.47	10.76	9.94	12.11	12.47	11.51
	C3	10.16	11.36	11.96	11.16	10.2	12.57	12.83	11.87
	Mean	9.34	10.65	11.33	10.44	9.70	11.87	12.11	11.22
With (B1)	C0	9.83	12.73	12.96	11.84	10.6	12.23	12.60	11.81
	C1	10.94	12.83	12.91	12.23	11.09	13.67	13.90	12.89
	C2	12.23	12.93	13.13	12.76	12.31	14.17	14.60	13.69
	C3	12.63	13.48	13.85	13.32	12.87	14.43	14.73	14.01
	Mean	11.41	12.99	13.21	12.54	11.72	13.63	13.96	13.10
Main effects	C0	9.00	11.23	11.91	10.71	9.95	11.55	11.76	11.08
	C1	10.06	11.68	11.96	11.23	10.23	12.80	13.06	12.03
	C2	11.05	11.95	12.30	11.76	11.13	13.14	13.54	12.60
	C3	11.40	12.42	12.91	12.24	11.54	13.50	13.78	12.94
	Mean	10.26	11.69	12.16		10.60	12.65	12.93	
F-test A(Bo.)		**					**		
L.S.D 0.05 B (Co.)		0.09					0.11		
AB		0.12					0.13		
C (N)		0.19					0.17		
AC		0.22					0.23		
BC		0.25					0.27		
ABC		0.28					0.31		

Where B = Biofertilization treatments, B0 = treatment without biofertilization, B1 = Biofertilization treatment, C = Compost, C0= without compost, C1 = Plant compost, C2 = Animal compost, C3 = Mixed compost, N = Nitrogen rate, N1 = 25 kg feddan^{-1}, N2 = 50 kg feddan^{-1}, N3 = 75 kg feddan^{-1}.

Results observations showed that there are no differences between applying N50 and N75 in both seasons. Bhavini Patel *et al*. (2022) found that (75% RDF + 10 ton/ha FYM + 1.5 ton/ha Neem cake + 3 kg/ha biofertilizer) gave maximum fruit length (19.68 cm). This results in agreement with Kumar *et al*. (2018) who indicated that combined application of organic and chemical fertilizers improved average fruit length, in cucumber cv. Swarna Ageti. Further, the third interaction (B × C × N) was significant on fruit length in both seasons. Also, soils treated by bio-fertilizers and mixed with mixed compost fertilizer combined with 75 kg N/feddan (B1 × C3 × N75) recorded the maximum fruit length (13.85 and 14.73 cm) in the 1st and 2nd season, respectively. However, there are no significant differences between (B1 × C3 × N50) interactions on fruit length in both seasons. These results lead to reduce mineral-N fertilizer. This might be due to integrated use of biofertilizers, organic manures and chemical fertilizers increased the yield attributes due to the fact that increasing major elements particular N level through biofertilizers and organic manures might have accelerated the synthesis of chlorophyll and amino acids. Similar findings are quoted from the experimental trial conducted by Prabhu *et al*. (2006) and Narayanamma *et al*. (2010) in cucumber. Also, present findings are in conformity with the reports of Choudhari and More (2002) on cucumber.

3.1.3 Fruit diameter (cm)

Average of fruit diameter (cm) of cucumber (Table 3) was significantly affected by all factories under the study in both seasons. Results in Table (3) showed that soil treated by Bio- fertilizers (B) gave the longest fruit diameter (2.839 and 2.915 cm) as compared with the untreated one with increasing percentage (0.96 and 1.10%) compared to the untreated one recorded in both seasons. In this respect, Gashash *et al*. (2022) found that combined use of *B. subtilis* and *B. amyloliquefaciens* significantly increased fruit diameter by 50% relative to the control, in the first season. In relation to the main effect of organic compost, Results recorded in Table (3) that compost fertilizers (C) significantly affected fruit diameter (cm) in both seasons. Soils treated by mixed fertilizer (C3) gave the highest fruit length (2.844 and 2.921 cm) with increasing percentage (1.6 and 1.6%) in comparison to the untreated one in both seasons, respectively. This might be attributed to available nutrients which released among mixed compost degradation in the soils which absorbed by plants, as reported by Ahmad *et al.* (2008), and Fiorentino and Fagnano (2011).

Table (3): Effect of bio and compost fertilizers substituted by mineral-N on fruit diameter under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer	Compost	N25		N50		N75		Mean	
		S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)
Without	C0	2.676	2.751	2.831	2.904	2.836	2.912	2.781	2.856
	C1	2.706	2.782	2.862	2.923	2.868	2.943	2.812	2.883
	C2	2.712	2.767	2.873	2.947	2.879	2.954	2.821	2.889
	C3	2.732	2.813	2.881	2.953	2.887	2.963	2.833	2.910
	Mean	2.707	2.778	2.862	2.932	2.868	2.943	2.812	2.884
With	C0	2.689	2.764	2.881	2.957	2.884	2.961	2.818	2.894
	C1	2.741	2.816	2.886	2.961	2.891	2.968	2.839	2.915
	C2	2.747	2.819	2.889	2.965	2.893	2.973	2.843	2.919
	C3	2.765	2.839	2.897	2.976	2.903	2.981	2.855	2.932
	Mean	2.736	2.810	2.888	2.965	2.893	2.971	2.839	2.915
Main effects	C0	2.683	2.758	2.856	2.931	2.860	2.937	2.800	2.875
	C1	2.724	2.799	2.874	2.942	2.880	2.956	2.826	2.899
	C2	2.730	2.793	2.881	2.956	2.886	2.964	2.832	2.904
	C3	2.749	2.826	2.889	2.965	2.895	2.972	2.844	2.921
	Mean	2.719	2.792	2.874	2.946	2.879	2.955		
L.S.D 0.05		**	**						
		0.061	0.026						
		0.042	0.033						
		0.064	0.057						
		0.071	0.066						
		0.076	0.068						
		0.092	0.086						

Results demonstrated that fruit diameter (cm) increased with increase mineral rate application, application nitrogen fertilizer at the rate of 75 kg N/feddan gave the highest fruit diameter (cm) (2.879 and 2.955 cm) with increasing percentage (5.90 and 5.80%) in comparison to untreated plots in both seasons, respectively. Similar results were obtained by Waseem *et al*. (2008) who indicated that application of NPK fertilizer (100-50-50) showed the best performance in almost all the parameters studied. Interaction effects in Table (3) recorded the highest fruit length (2.855 and 2.932 cm), (2.893 and 2.971 cm) and (2.893 and 2.971 cm) was obtained as a result from the interaction between (B 1 × C3), (B1 × N75) and (C3 × N75) in the 1st and 2nd season, respectively. Also, in spite of the maximum fruit diameter (cm) as a result of the interaction (B1 × N75), Soils treated with bio-fertilizers and applied Mineral N fertilizer rate of 50 (B1 × N50) gave similar values of fruit diameter (cm) (2.893 and 2.971 cm) in the 1st and 2nd season, respectively. Al-fehaid *et al*. (2022) indicated that chemical fertilization treatments (NPK 13: 13: 13) and (organic at a rate of 2.5% + bacteria "*Bacillus*") showed the highest values in all studied characteristics of cucumber plant (*Cucumis sativus* L.). Results recorded in Table (3) indicated that the third interaction between bio, organic and applied nitrogen fertilizer rates (B × C ×

N) was significant on fruit diameter (cm) in both seasons. Also, soils treated by bio-fertilizers and mixed compost combined with 75 kg N/feddan (B1 × C3 × N75) recorded the maximum fruit diameter (cm) (2.903 and 2.981 cm) in the 1st and 2nd season, respectively. However, there are no significant differences between (B1 × C3 × N50) interactions on fruit diameter (cm) in both seasons. These results could lead to reduce mineral-N fertilizer.

3.1.4 Fruit weight/plant (kg)

The data in the Table (4) showed that Bio fertilization (B) gave the highest fruit weight/plant (1.315 and 1.495) compared to the untreated plots in the 1st and 2nd season, respectively. Also, the increase in fruit weight/plant exceeds un-fertilized soils in fruit weight/plant by (15.96 and 10.22) in the 1st season and 2nd season, respectively. This might be due to the treatment of NPK fertilizer and NPK + micro fertilizers provide phosphorus and potassium nutrients that are appropriate to the needs of cucumber plants for fruit formation (Novizan, 2002). Similar results reported by Marliah *et al.* (2019) who found that fruit weight showed the same significant responses than without NPK. Results presented in Table (4) show that Organic fertilization with mixed compost (O3) gave the highest fruit weight/plant (1.488 and 1.675) with increasing percentages (51.68 and 51.72%) in the 1st and 2nd season, respectively. Similar results reported by (Abd Allah *et al*., 2001; Aiyelaagbe, 2007; Moral *et al*. 2005). Results presented in Table (4) show clearly that application of nitrogen fertilizer at the rate of 50 kg N/feddan, gave the highest fruit weight/plant (1.451 and 1.643) as compared with all other nitrogen levels in both seasons, respectively. Increasing Mineral N-fertilizer, from 25 to 50 kg N/feddan, significantly increased fruit weight/plant by (78.29 and 63.26%) in both seasons. Waseem *et al*. (2008) indicated that application of NPK fertilizer (100-50-50) showed the best performance in almost all the parameters studied. Results recorded in Table (4) indicate that bio-fertilization combined with mixed compost (B1 × C3), (B1 × N3) and (C3 × N3) gave the highest fruit weight/plant. The recorded values of fruit weight/plant were (1.579 and 1.760), (1.775 and1.941) and (1.734 and 1.890) as a result of these interactions as compared with other interaction treatments in 2021 and 2022 seasons, respectively. Similar results were obtained by Dash *et al*. (2018) and Kumar *et al*. (2018). Relating to the third interactions, results revealed that no significant dereference between N50 and N75 rates on fruit length/plant. So, the 3rd interaction (B1 × C3 × N50) gave the 2nd highest fruit weight/ plant (1.844 and 1.967) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively.

Table (4): Effect of bio and compost fertilizers substituted by mineral-N on fruit weight (g)/plant under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer	Compost	N25		N50		N75		Mean	
		S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)
Without	C0	0.624	0.722	0.991	1.128	1.051	1.177	0.889	1.009
	C1	0.691	0.845	1.179	1.394	1.192	1.457	1.021	1.232
	C2	0.788	0.971	1.425	1.654	1.482	1.722	1.232	1.449
	C3	0.913	1.068	1.624	1.812	1.653	1.892	1.397	1.591
	Mean	0.754	0.902	1.305	1.497	1.345	1.562	1.134	1.320
With	C0	0.701	0.815	1.239	1.377	1.278	1.403	1.073	1.198
	C1	0.748	0.936	1.408	1.569	1.469	1.648	1.208	1.384
	C2	0.875	1.135	1.634	1.838	1.689	1.935	1.399	1.636
	C3	0.996	1.323	1.844	1.967	1.896	1.99	1.579	1.760
	Mean	0.830	1.052	1.531	1.688	1.583	1.744	1.315	1.495
Main effects	C0	0.663	0.769	1.115	1.253	1.165	1.290	0.981	1.104
	C1	0.720	0.891	1.294	1.482	1.331	1.553	1.115	1.308
	C2	0.832	1.053	1.530	1.746	1.586	1.829	1.316	1.543
	C3	0.955	1.196	1.775	1.890	1.775	1.941	1.488	1.675
	Mean	0.788	0.969	1.405	1.582	1.451	1.643		
L.S.D 0.05		**	**						
		0.165	0.126						
		0.173	0.158						
		0.179	0.172						
		0.181	0.185						
		0.183	0.201						
		0.199	0.226						

3.1.5 Fruit weight (g)

The influence of Bio-fertilization (B) gave the highest fruit weight (65.40 and 69.30) compared to the un-fertilized one in the 1st and 2nd season, respectively. Fruit weight increased due to bio-fertilization (B) compared to unfertilized treatment which recorded (7.38 and 5.81%) in the 1st season and 2nd season, respectively. Also, Gashash *et al*. (2022) proved that combined use of *B. subtilis* and *B. amyloliquefaciens* significantly increased fruit weight by 33% relative to the control, in the first season. Also, bio-fertilizer had major role in increase cucumber yield and its components (Faranak and Hossein, 2012; Gharib, 2001; Hana *et al*., 2005; Kamil *et al*., 2015). Results presented in Table (5) show clearly that mixed compost (C3) gave the highest fruit weight (68.60 and 73.90) in the 1st and 2nd season, respectively. On the other hand, un-treated plots gave lowest fruit weight (56.70 and 60.10) in the 1st and 2nd season, respectively. Also, mixed compost exceeds (C3) control treatment (C0) in fruit weight by (20.98 and 22.96%) in the 1st and 2nd season, respectively. The simulative effect of organic-fertilizers in the present of mineral-N may be due to the enhancement of cell division and cell enlargement. These results are in conformity with the findings of Khalil *et al*. (2011), Soliman (2011) and Hamail *et al*. (2014) on cucumber.

Table (5): Effect of bio and compost fertilizers substituted by mineral-N on fruit weight (g) under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer	Compost	N25		N50		N75		Mean	
		S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)
Without	C0	32.18	36.28	64.83	67.19	66.64	71.71	54.60	58.40
	C1	36.00	44.81	69.98	71.81	72.15	73.81	59.40	63.50
	C2	41.76	48.86	73.52	76.33	75.47	78.67	63.60	68.00
	C3	43.65	51.31	76.63	81.53	78.45	83.90	66.20	72.20
	Mean	38.40	45.30	71.20	74.20	73.20	77.00	60.90	65.50
With	C0	36.33	39.77	68.60	71.91	71.36	73.82	58.80	61.80
	C1	38.00	46.67	76.00	76.27	78.43	78.73	64.10	67.20
	C2	43.80	56.18	78.67	79.82	80.48	81.85	67.70	72.60
	C3	47.51	57.91	82.00	83.73	83.30	84.76	70.90	75.50
	Mean	41.40	50.10	76.30	77.90	78.40	79.80	65.40	69.30
Main effects	C0	34.30	38.00	66.70	69.60	69.00	72.80	56.70	60.10
	C1	37.00	45.70	73.00	74.00	75.30	76.30	61.80	65.40
	C2	42.80	52.50	76.10	78.10	78.00	80.30	65.60	70.30
	C3	45.60	54.60	79.30	82.60	80.90	84.30	68.60	73.90
	Mean	39.70	47.50	73.50	75.90	75.50	78.30		
L.S.D 0.05		**	**						
		1.37	1.29						
		1.43	1.37						
		1.67	1.58						
		1.72	1.65						
		1.78	1.69						
		1.96	1.83						

Results presented in Table (5) show clearly that increasing mineral N-fertilizer significantly increased gradually fruit weight. Meanwhile, the deference between N50 and N75 were insignificant in both seasons. Applied nitrogen fertilizer at the rate of 50 kg N/feddan gave the second rank of fruit weight (73.50 and 75.90) in the 1st and 2nd season, respectively. The increase percentages due to N50 in comparison to N25 reached (85.13 and 59.78%) in both seasons. Results recorded in Table (5) indicate that the interaction effect, between bio-fertilization (B × C), (B × N) and (C × N) was significant on fruit weight in two seasons. Treating plots with the interactions gave the highest fruit weight (70.90 and 75.50), (78.40 and 79.80) and (80.90 and 84.30) as a result of (B1 × C3), (B1 × N2) and (C3 × N2) compared with all interactions under the study in both seasons, respectively. The results are in the same line with several studies have been conducted on the effect of organic and bio-fertilizers on yield and productivity of cucumbers (El-Nemr *et al*., 2012; Halime *et al*., 2011; Kazemi, 2012). Saeed *et al*. (2015) found that the maximum total fruit weight of cucumber was recorded in biofertilizers, ½ chemical fertilizers. Results recorded in Table (5) indicate that treating plots with bio-and mixed compost combined with 75 kg N fertilizer gave the highest fruit weight (83.30 and 84.76) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively. Also, data indicated that mineral N could be reduced to 50 kg/feddan, combined with bio1 and mixed compost as in the third interaction (B1 × C3 × N75) which recorded (82.00 and 83.73) in both seasons.

3.2 Effects on yield

3.2.1 Cucumber yield (ton/feddan)

Demonstrated results in Table (6) show that bio-fertilization gave the highest cucumber yield/feddan, (10.40 and 11.70 ton/feddan) in the 1st and 2nd season, respectively. On the other hand, un-fertilized cucumber plants (B0) gave the lowest cucumber yield/feddan, (9.20 and 10.50 ton/feddan) in the 1st and 2nd season, respectively. Also, bio-fertilization (B1) exceeds un-fertilized plants (B0) in cucumber yield/ fed., by (13.04 and 11.42%) in the 1st and 2nd season, respectively. Gashash *et al.* (2022) proved that combined use of *B. subtilis* and *B. amyloliquefaciens* had a positive impact on tomato yield, increasing fruit yield relative to the control, in the first season. This mixed biofertilizers contain effective microorganisms, which are able to improve soil quality indices. In this respect, several reports reported about the impact of biofertilization on improving cucumber productivity (El-Hamdi *et al*., 2017; Moemenpour and Karami, 2015; Saeed *et al*., 2015). Obtained results presented in Table (6) showed that application mixed organic fertilizer (C3) gave the highest cucumber yield/feddan, (11.20 and 12.701 ton/feddan) as compared with all other organic fertilizers in both seasons, respectively. On the other hand, un-applied organic fertilizer (C0) gave the lowest cucumber yield/feddan (9.50 and 9.20) in the 1st and 2nd season, respectively. Mixed organic -fertilizer significantly increased cucumber yield/feddan, by 17.89 and 38.04% in both seasons. The highly positive effect of mixed compost in increasing cucumber yield might be due its physical and chemical properties on soil and may be due to its lower C/N ratio (16.29), improves soil drainage, and maximizing water and nutrient supply potentials of soil, thus, maintain cucumber productivity (El-Hamdi *et al*., 2017). Several investigators in agreement with those (Abou-El-Hassan *et al*., 2014; Fahmy, 2012; Nair and Ngouajio, 2010). Similar results were obtained by Al-Azzawi and Al-Abdi (2017) who indicated that cucumber yield due to organic fertilizer recorded (22.27 and 13.01 ton) compared to control treatment (18.99 and 26.20 ton) with increasing percentages (17.27 and 18.44%). Results presented in Table (6) indicated that there was a significant effect of nitrogen fertilizer levels (N) on grain yield/feddan, in 2021 and 2022 seasons. Application nitrogen fertilizer at the rate of 75 kg N/feddan gave the highest cucumber yield/feddan (11.40 and 13.00 ton/feddan) as compared with all other nitrogen levels in both seasons, respectively. On the other hand, applied nitrogen fertilizer at the rate of 25 kg N/feddan gave the lowest cucumber yield/feddan (7.30 & 7.90) in the 1st and

2nd season, respectively. Results observation show that no significant differences in cucumber yield between adding 50 and 75 kg of nitrogen /feddan in both seasons. So, Increasing Mineral N-fertilizer from 25 to 50 kg/feddan significantly increased grain yield/feddan by 43.83 and 55.69%, in both seasons. Al-Azzawi and Al-Abdi (2017) found that cucumber yield due to Chemical fertilizer increased (41.17 and 28.62 ton) compared to control treatment (14.61 and 19.26 ton) with increasing percentages (95.89 and 113.76%). Concerning the second interaction effects on cucumber yields, results recorded in Table (6) that the interaction between bio- and organic fertilizer type (B1 × C3) was significant on cucumber yield/feddan, in two seasons. Fertilization with Bio- and mixed compost (C3) gave the highest cucumber yield/ fed., (11.90 and 13.40 ton/feddan) in the 1st and 2nd season, respectively. This increase might be attributed to this interaction which led to increase the permeability of plant membranes, promote the uptake of nutrients, reduce impacts of disease and stimulate plant growth all of this led to increase yield of fruits. This observation agrees with the report of Karuppaiah and Manivannan (2005) and Tei *et al.* (2006) on cucumber. In relation to the interaction between (B × N), the results shown that there are no significant differences in cucumber yield between the rates of nitrogen added (50 or 75 kg/feddan). Also, bio-fertilization combined with mineral N fertilizer at a rate of 50 kg/feddan can be utilized in cucumber fertilization from economically view. These results ravelled to the role of bio fertilizer in reducing mineral N fertilizers of various vegetable crops. In this respect, Kusagur *et al*. (2022) indicated that the highest fruit yield (11.50 ton/ha) was recorded with 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* (T6). Mohan *et al*. (2016) revealed that 60 percent each of RDF and vermicompost along with Azotobacter, Trichoderma and PSB were found to be superior among all the combinations of organic, inorganic and bio-fertilizer sources of nutrients for characters. Also, obtained results in Table (6) show that interaction between organic-fertilization and nitrogen fertilizer levels (C × N) was significant in both seasons. Mixed compost combined with N-fertilizer at a rate of 75 kg and 50 kg /feddan, (C3 × N3) significantly gave the highest cucumber yield/feddan in comparison to cucumber plants treated without organic fertilization in (O 0) in both seasons. The insignificant differences between N-fertilizer at a rate of 75 kg and 50 kg kg/feddan on cucumber yield tended to reducing N fertilization to 50 kg/feddan. Thess results proved that the role of organic fertilizers in rationalizing mineral N in different crop fertilization. In this respect, Kumar *et al*. (2018) indicated that combined application of organic fertilizers improved edible fruit yield per hectare in cucumber cv. Swarna Ageti. Also, Similar results in agreement with El-Shabrawy *et al*. (2010), and Al-Azzawi and Al-Ibadi

(2017). Results recorded in Table (6) indicate that the third interaction (bio × C × N) was significant on cucumber yield/feddan, in both seasons. Treating cucumber plants with bio- and mixed compost combined with N-fertilization at a rate of 50 kg gave the most significant cucumber yield/feddan by (12.64 and 15.22 ton/feddan) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively. These results showed importance of bio and compost fertilizers in reducing chemical fertilizers. Several reports have been published about the improvements of crops especially cucumber yields due to the mixed bio-fertilizers and organic compost, combined with mineral-N which might be suitable to microbial development, increase water holding capacity, increase availability of plant nutrients, as well as soil fertility. Majeed, (2021) who found that all the organic type treatments significantly growth and yield of cucumber plants grown in the soils amended with the leonardite.

Table (6): Effect of bio and compost fertilizers substituted by mineral-N on cucumber yield (ton/feddan) under open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer	Compost	N25		N50		N75		Mean	
		S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)
Without	C0	5.56	6.12	8.59	9.67	9.95	10.44	8.00	8.70
	C1	6.31	6.89	9.51	11.06	10.33	12.15	8.70	10.00
	C2	6.84	7.97	10.61	12.55	11.19	13.26	9.50	11.30
	C3	7.77	9.26	11.26	13.28	12.15	13.82	10.4	12.10
	Mean	6.60	7.60	10.00	11.60	10.90	12.40	9.20	10.50
With	C0	6.46	6.90	9.36	10.73	10.92	11.48	8.90	9.70
	C1	7.28	7.32	10.97	12.66	11.52	13.43	9.90	11.10
	C2	9.26	9.14	11.18	14.28	12.34	14.82	10.90	12.70
	C3	9.36	10.09	12.73	14.81	13.64	15.22	11.90	13.40
	Mean	8.10	8.40	11.10	13.10	12.10	13.70	10.40	11.70
Main effects	C0	6.00	6.50	9.00	10.20	10.40	11.00	8.50	9.20
	C1	6.80	7.10	10.20	11.90	10.90	12.80	9.30	10.60
	C2	8.10	8.60	10.90	13.40	11.80	14.00	10.20	12.00
	C3	8.60	9.70	12.00	14.00	12.90	14.50	11.20	12.70
	Mean	7.30	7.90	10.50	12.30	11.40	13.00		
L.S.D 0.05		**	**						
		0.85	0.81						
		0.96	0.94						
		1.90	1.88						
		1.95	1.91						
		1.36	1.88						
		1.74							

3.3 Effects on some quality content

3.3.1 Total soluble solids (TSS)

Results presented in Table (7) show clearly that there was a significant effect of bio- fertilizer on TSS (%) in 2021 and 2022 seasons. Average of TSS (%) were significantly affected by bio-fertilizers (B1) in the 1st and 2nd season, Bio-fertilization (B1) gave the highest TSS

(3.454 and 3.496%) in the 1st and 2nd season, respectively. On the other hand, un-fertilization (B0) gave the lowest protein (3.368 and 3.426) in the 1st and 2nd season, respectively. Also, bio-fertilization exceeds non-fertilization in TSS (%) by (2.60 and 2.00%) in the 1st and 2nd season, respectively.

Table (7): Effect of bio and compost fertilizers substituted by mineral-N on Total Soluble Solids (TSS %) open field conditions in summer seasons of 2021 and 2022.

Bio-fertilizer	Compost	N25		N50		N75		Mean	
		S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)	S1 (2021)	S2 (2022)
Without	C0	2.720	2.812	3.290	3.321	3.310	3.346	3.107	3.160
	C1	2.790	2.831	3.340	3.372	3.360	3.397	3.163	3.200
	C2	2.910	2.986	3.860	3.926	3.910	3.972	3.560	3.628
	C3	2.940	3.016	3.970	4.051	4.010	4.086	3.640	3.718
	Mean	2.840	2.911	3.615	3.668	3.648	3.700	3.368	3.426
With	C0	2.840	2.846	3.615	3.412	3.648	3.432	3.368	3.230
	C1	2.770	2.863	3.380	3.462	3.410	3.486	3.187	3.270
	C2	2.830	3.021	3.440	3.972	3.470	4.016	3.247	3.670
	C3	2.970	3.086	3.930	4.162	3.970	4.193	3.623	3.814
	Mean	2.890	2.954	3.718	3.752	3.755	3.782	3.454	3.496
Main effects	C0	2.745	2.829	3.335	3.367	3.360	3.389	3.147	3.195
	C1	2.810	2.847	3.390	3.417	3.415	3.442	3.205	3.235
	C2	2.940	3.004	3.895	3.949	3.940	3.994	3.592	3.649
	C3	2.965	3.051	4.045	4.107	4.090	4.140	3.700	3.766
	Mean	2.862	2.930	3.661	3.705	3.695	3.736		
L.S.D 0.05		**	**						
		0.037	0.019						
		0.042	0.027						
		0.057	0.038						
		0.062	0.045						
		0.076	0.059						
		0.091	0.073						

Similar results were obtained by Ebtesam A. Gashash *et al*. (2022) whom proved that combined use of *B. subtilis* and *B. amyloliquefaciens* significantly increased total soluble solids (TSS) by 26% relative to the control, in the first season. Das *et al*. (2015) in their study reported that quality character like total soluble solid (TSS) was increased by application of biofertilizers. The increase in TSS may be due to the role of bio-fertilizers in chelation and absorption of micronutrients which contributes to a number of biochemical processes and so synthesis of many vitamins and bioactive substances (Kumar *et al*., 2018). Average TSS were significantly affected by the type of compost fertilizers in the 1st and 2nd season, mixed compost (C3) gave the highest TSS (3.70 and 3.766%) in the 1st and 2nd season, respectively. On the other hand, control treatment (without organic fertilizer) (C0) gave the lowest TSS (3.370 & 3.195) in the 1st and 2nd season, respectively. Also, mixed compost exceeds control treatment in TSS (%) by (17.60 and 17.90%) in the 1st season and 2nd season, respectively. Moreover, Kanaujia and Daniel (2016) reported that Vitamin C content and TSS content increased by application of 50% NPK + 5 ton per feddan Vermicompost and biofertilizers. Mohammed (2017) reported significant interaction between bio-fertilizer to increase the concentration of (TSS) and chlorophyll. Results presented in Table (7) show that application nitrogen fertilizer at the rate of 75 kg N/feddan gave the highest TSS (3.695 and 3.736) as compared with all other nitrogen levels in both seasons, respectively. On the other hand, applied nitrogen fertilizer at the rate of 25 kg N/feddan gave the lowest TSS percentage (2.862 and 2.930) in the 1st and 2nd season, respectively. Increasing Mineral N-fertilizer significantly increased TSS percentage by (29.10 and 27.50%). Results observation revealed that no significant differences between the application of 50 and 75 kg N/feddan on TSS%. Results recorded in Table (7) indicate that Bio-fertilization combined with mixed compost (B1 × C3) gave the highest TSS (3.760 and 3.736) in the 1st and 2nd season, respectively. Fertilization cucumber plots with 75 kg (B1 × N3) gave the highest TSS by (3.755 and 3.782) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively. Also, results show that mixed compost combined with 75 kg (C3 × N3) gave the highest TSS percentage (4.090 and 4.140%) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively. The reason for the increase in the percentage of dissolved solids may also be attributed to the addition of fertilizers organic fertilizers because they contain nitrogen, which has a role in increasing the products of photosynthesis and their transfer to the fruits, which leads to an increase in the percentage of dissolved solids, and they also contain organic potassium Al-Magrebi (2015) who found that the treatments of adding organic fertilizer to the soil, resulting in a significant increase in the percentage of soluble solids (TSS) and thus increasing the weight of the fruit as well as the plant yield for zucchini fruits (ElSahookie, 2006). Results recorded in (table, 7) indicate that the third interaction (bio × O × N) between Bio- and organic fertilization and nitrogen fertilizer rates was significant on TSS (%) in both seasons. Bio- and organic fertilization with mixed compost combined with mineral N- fertilizer at a rate 75 kg N/feddan, gave the highest TSS values (4.170 and 4.193) in both seasons as compared with other interaction treatments in 2021 and 2022 seasons, respectively. From the previous discussion, it could be concluded that, the combination between soil bio-fertilization and mixed compost combined by 75 kg N/feddan, had the highest values of TSS under East Oweinat conditions.

References

Abd-Allah, A. M., Adam, S. M., and Abou-Hadid, A. F. (2002), "Response of some tomato hybrids to the organic fertilizer under newly reclaimed soil conditions", *Egyptian Journal of Horticulture,* Vol. 29 No. 1, pp. 25–36.

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*, Vol. 10 No. 2, pp. 162–169.

Abu El-Fotoh, H. G., Abd El-Magid, A. A. and Knany, R. E. (2000), *Effect of biofertilization on sugar beet yield, quality and optimization of the chemical fertilizers*, In Proceedings of the 9th Conference of Agronomy, Minufiya University, Egypt, pp. 1–2.

Ahmad, R., Khalid, M., Naveed, M., Shahzad, S. M., Zahir, Z. A., and Khokhar, S. N. (2008), "Comparative efficiency of auxin and its precursor applied through compost for improving growth and yield of maize", *Pakistan Journal of Botany*, Vol. 40 No. 4, pp. 1703–1710.

Ahmed, A. A. A, Gabal, A.A.A., Alkharpotly, A. A., Radwan1, F. I. and Abido, A.I. (2017), "Effect of mineral, organic and bio-fertilization on cucumber (*Cucumis sativus* L.) grown under plastic houses conditions", *Journal of The Advances in Agricultural Researches*, Vol. 22 No. 2, pp. 374–400.

Aiyelaagbe, I. O. O., Adegbite, I. A. and Adedokun, T. A. (2007), *Response of cucumber to composted city refuse in south-western Nigeria*, In 8th African Crop Science Society Conference, El-Minia, Egypt, pp. 333–337.

Al-Azzawi, A. A. and Al-Ibad, M. (2017), "Effect organic nutrient humic and compound chemical fertilizer in leaves content from elements and total yield cucumber", *Iraqi Journal of Agricultural Sciences*, Vol. 48 No. 3, pp.727–728.

Al-fehaid, S., Abdelmageed, A. H. A. and Abd-Elmoniem, E. M. (2022), "Effect of chemical, organic and bio fertilizers on growth, yield and quality of cucumber plant (*Cucumis sativus* L.) grown under greenhouse conditions", *Journal of Sohag Agriscience*, Vol. 7 No. 1, pp. 28–40.

Alkharpotly, A. A., Shehata, M. N. and Abd El Rasheed, K. G. (2019), "The performance of cucumber plants (*Cucumis sativus* L.) as affected by organic and NPK mineral fertilization under plastic houses conditions at Arid region", *Journal of Plant Production*, Vol. 10 No. 7, pp. 551–558.

Al-Magrebi, N. M. H. (2015), "Effect of organic fertilizer application to the soil or spraying plant in qualitative characteristics and mineral content of squash", *Alexandria Journal for Scientific Exchange*, Vol. 36 No. 2, pp. 245–257.

Al-Mharib, M. Z., Al-Sahaf, F. H. and Jawad, F. M. (2011), "Response of cucumber hybrids to chemical and organic fertilizers", *Iraqi Journal of Agricultural Sciences*, Vol. 42 No. 4, pp. 655–664.

Bindiya, Y., Reddy, I. P. and Srihari, D. (2014), "Response of cucumber to combined application of organic manures, biofertilizers and chemical fertilizers", *Vegetable Science*, Vol. 41 No. 1, pp. 12–15.

Choudhari, S. M. and More, T. A. (2001), "Fertigation, fertilizer and spacing requirement of tropical gynoecious cucumber hybrids", *II International Symposium on Cucurbits*, Vol. 588, pp. 233–240.

Cimrin, K. M. and Yilmaz, I. (2005), "Humic acid applications to lettuce do not improve yield but do improve phosphorus availability", *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science*, Vol. 55 No. 1, pp. 58–63.

Das, R., Mandal, A. R., Priya, A., Das, S. P. and Kabiraj, J. (2015), "Evaluation of integrated nutrient management on the performance of bottle gourd [*Lagenaria siceraria* (Molina) Standl.]", *Journal of Applied and Natural Science*, Vol. 7 No. 1, pp. 18–25.

Dash, S. K., Sahu, G. S., Das, S., Sarkar, S., Tripathy, L., Pradhan, S. R., and Patnaik, A. (2018), "Yield improvement in cucumber through integrated nutrient management practices in Coastal Plain Zone of Odisha, India", *International Journal of Current Microbiology and Applied Sciences*, Vol. 7 No. 2, pp. 2480–2488.

Eifediyi, E. K., and Remison, S. U. (2010), "The effects of inorganic fertilizer on the yield of two varieties of cucumber (*Cucumis sativus* L.)", *Report and Opinion*, Vol. 2 No. 11, pp. 1–5

El-Hamdi, K., Mosa, A., EL-Shazly, M., and Hashish, N. (2017), "Response of Cucumber (*Cucumis sativus* L.) to various organic and bio fertilization treatments under an Organic Farming System", *Journal of Soil Sciences and Agricultural Engineering*, Vol. 8 No. 5, pp. 189–194.

El-Nemr, M. A., El-Desuki, M., El-Bassiony, A. M. and Fawzy, Z. F. (2012), "Response of growth and yield of cucumber plants (*Cucumis sativus* L.) to different foliar applications of humic acid and bio-stimulators", *Australian Journal of Basic and Applied Sciences*, Vol. 6 No. 3, pp. 630–637.

Elsahookie, M. M. (2006), "Genetic-physiologic and genetic-morphologic components in soybean", *Iraqi Journal of Agricultural Sciences*, Vol. 37 No. 2, pp.63–68.

El-Shabrawy, R. A., Ramadan, A. Y. and. El-Kady, Sh. M (2010), "Use of humic acid and some biofertilizers to reduce nitrogen rates on cucumber (*Cucumis sativus* L.) in relation to vegetative growth, yield and chemical composition", *Journal of*

Plant Production, Vol. 1 No. 8, pp. 1041–1051.

Fahmy, M. A. M. (2012), *Effect of some treatments on growth, yield and fruit chemical composition of melon and cucumber crops under sandy soils conditions*, M.Sc. Thesis, Faculty of Agriculture, Cairo University, Cairo, Egypt.

FAO (2020), "Agricultural production statistics 2000–2021 FAOSTAT Analytical Brief 60", *FAOSTAT*, 60, No. 1.

Fiorentino, N. and Fagnano, M. (2011), "Soil fertilization with composted solid waste: short term effects on lettuce production and mineral N availability", *Geophysical Research Abstracts*, Vol. 13, Article ID 10520.

Gabr, S. M., Elkhatib, H. A. and El-Keriawy, A. M. (2007), "Effect of different biofertilizer types and nitrogen fertilizer levels on growth, yield and chemical contents of pea plants (*Pisum sativum* L.)", *Journal of Agricultural & Environmental Sciences*, Vol. 6 No. 2, pp. 192–218.

Gashash, E. A., Osman, N. A., Alsahli, A. A., Hewait, H. M., Ashmawi, A. E., Alshallash, K. S. and Ibrahim, M. F. (2022), "Effects of plant growth promoting rhizobacteria (PGPR) and cyanobacteria on botanical characteristics of tomato (*Solanum lycopersicon* L.) plants", *Plants*, Vol. 11 No. 20, Article ID 2732.

Gharib, M. G. (2001), *Response of two cucumber cultivars to biofertilization under plastic house condition*, M.Sc. Thesis, Faculty of Agriculture, Cairo University, Cairo, Egypt.

Halime, O. U., Unlu H., Karakurt Y. and Padem, H. (2011), "Changes in fruit yield and quality in response to foliar and soil humic acid application in cucumber", *Scientific Research and Essays*, Vol. 6 No. 13, pp. 2800–2803.

Hamail, A. F., Hamada, M. S., Tartoura, E. A. and El-Hady, A. (2014), "Effect of n-forms and bio-stimulants on productivity of cucumber: 2-flowering characters, yield and its components", *Journal of Plant Production*, Vol. 5 No. 4, pp. 573–583.

Hana, M. M., Kabeel, S. and Darwesh, F. (2005), "Effect of organic and biofertilizers on growth, yield and fruit quality of cucumber (*Cucumis sativus*, L.) grown under clear polyethylene low tunnels", *Journal of Plant Production*, Vol. 30 No. 5, 2827–2841.

Hassan, S. (2020), "Effect of potassium fertilizer, feldspar rock and potassium releasing bacterium (*Bacillus circulans*) on sweet potato plant under sandy soil conditions", *Scientific Journal of Agricultural Sciences*, Vol. 2 No. 2, pp. 56–63.

Jilani, M. S., Afzaal, M. F. and Waseem, K. (2009), "Effect of different nitrogen levels on growth and yield of brinjal", *Journal of Agricultural*

Researches, Vol. 46, pp. 245–251.

Kanaujia, S. P. and Daniel, M. L. (2016), "Integrated nutrient management for quality production and economics of cucumber on acid alfisol of Nagaland", *Annals of Plant and Soil Research*, Vol. 18 No. 4, pp. 375–380.

Karuppaiah, P. and Manivannan, K. (2005), "Effect of humic acid and other amendments on the performance of cucumber in lignite mine spoil", *Journal of Ecobiology*, Vol. 17 No. 5, Article ID 415.

Kazemi, M. (2013), "Effect of foliar application of humic acid and potassium nitrate on cucumber growth", *Bulletin of Environment, Pharmacology and Life Sciences*, Vol. 11, pp. 3–6.

Khalil, H. M., Ali, L. K. and Mahmoud, A. A. (2011), "Impact of applied humic and fulvic acids on the soil physic-chemical properties and cucumber productivity under protected cultivation conditions", *Journal of Soil Sciences and Agricultural Engineering*, Vol. 2 No. 2, pp. 183–201.

Klute, A. (1986), *Methods of soil analysis. Part-1. Physical and mineralogical methods*, 2nd Edition, American Society of Agronomy, Madison, Wisconsin, USA.

Kumar, M., Chaudhary, V., Naresh, R. K., Maurya, O. P. and Pal, S. L. (2018), "Does integrated sources of nutrients enhance growth, yield and quality and soil fertility of vegetable crops", *International Journal of Current Microbiology and Applied Science*, Vol. 7 No. 6, pp. 125–155.

Kumar, M., Kathayat, K., Singh, S. K., Singh, L. and Singh, T. (2018), "Influence of bio-fertilizers application on growth, yield and quality attributes of cucumber (*Cucumis sativus* L.): A review", *Plant Archives*, Vol. 18 No. 2, pp. 2329–2334.

Kusagur, N., Manjunatha, B., Chandru Patil and Maruthesh, A. M. (2022), "A studies on impact of chemical and bio-fertilizers in cucumber (*Cucumis sativus* L.) production under Zone number 7 of Karnataka", *The Pharma Innovation Journal*, Vol. 11 No. 7, pp. 3068–3071.

Law-Ogbomo, K. E. and Osaigbovo, A. U. (2018), "Productivity of cucumber (*Cucumis sativus* L) and post-harvest soil chemical properties in response to organic fertilizer types and rates in an ultisols", *Tropical and Subtropical Agroecosystems*, Vol. 21 No. 3, pp. 513–520.

Majeed, A. J. (2021), "Cucumber (*Cucumis sativus* L.) growth and nutrient content response to applications of leonardite and phosphorus fertilizer", *Agricultural Science*, Vol. 5 No. 1, pp. 1–12.

Marliah, A., Anhar, A. and Hayati, E. (2020), "Combine organic and inorganic fertilizer increases yield of cucumber (*Cucumis sativus* L.)", *IOP Conference Series: Earth and Environmental Science*, Vol. 425, No. 1, p. 012075.

Moemenpour, F. and Karami, E. (2015), "Effects of methanol foliar spray and bio-fertilizers application on fruit yield of greenhouse cucumbers", *International Journal of Agricultural Policy and Research*, Vol. 3 No. 10, pp. 382–387.

Mohamed, R. E., Mohamed, L. M. M. and Abdelmalik, E. M. (2023), "Comparative study on organic and inorganic fertilizers and their effects on growth and yield of tomato and cucumber under greenhouse conditions", *Biological and Natural Resources Engineering Journal*, Vol. 7 No. 1, pp. 91–99.

Mohammed, W. F. H. I. (2017), "Effect of bio-organic fertilization in some nutrients availability, growth and yield of cucumber (*Cucumis sativus* L.)", *IOSR Journal of Agriculture and Veterinary Science*, Vol. 10 No. 10, pp. 13–17.

Mohan, L., Singh, B. K., Singh, A. K., Moharana, D. P., Kumar, H. and Mahapatra, A. S. (2016), "Effect of integrated nutrient management on growth and yield attributes of cucumber (*Cucumis sativus* L.) cv. Swarna Ageti under polyhouse conditions", *The Bioscan*, Vol. 12 No. 1, pp. 305–308.

Moral, R., Moreno-Caselles, J., Perez-Murcia, M. D., Perez-Espinosa, A., Paredes, C. and Sosa, F. (2005), "The influence of fresh and composted solid fractions of swine manure slurry on yield of cucumber (*Cucumis sativus* L.)", *Communications in Soil Science and Plant Analysis*, Vol. 36 No. (4-6), pp. 517–524.

Nair, A. and Ngouajio, M. (2010), "Integrating row covers and soil amendments for organic cucumber production: Implications on crop growth, yield, and microclimate", *HortScience*, Vol. 45 No. 4, pp. 566–574.

Narayanamma, M., Chiranjeevis, C. H., Ahmed, R. and Chaturvedi, A. (2010), "Influence of integrated nutrient management on the yield, nutrient status and quality of cucumber (*Cucumis sativus* L.)", *Vegetable Science*, Vol. 37 No. 1, pp. 61–63.

Natsheh, B. and S. Mousa (2014), "Effect of organic and inorganic fertilizers application on soil and organic and biofertilizers application", *Journal of Agricultural Sciences*, Vol. 31 No. 2, pp. 951–962.

Page, A. L., Miller, R. H. and Keeney, D. R. (1982), *Methods of Soil Analysis. Π Chemical and Microbiological Properties*, American Society of Agronomy Inc., Madison, Wisconsin, USA.

Patel, B. B., Patel, K. D., Vasava H. V. and Senjaliya, H. J. (2022), "Influence of integrated nutrient management and split application of fertilizers on yield of cucumber (*Cucumis sativus* L.) under protected condition", *The Pharma Innovation Journal*, Vol. 11 No. 10, pp. 840–842.

Piper, C. S. (1950), *Soil and Plant Analysis*, 1st Ed., InterScience Publishers Inc, New York, USA, pp. 30–229.

Prabhu, T., Narwadkar, P. R. and Sujindranath, M. R. (2006), "Integrated nutrient management in Okra", *South Indian Horticlture*, Vol. 50 No. 4-6, pp. 550–553.

Raeisi, M., Palashi, M. and Babaie, Z. (2013), "A study of the effect of biofertilizers containing amino acid on the yield and growth traits of cucumber (*Cucumis sativus*) var. Royal", *International Journal of Farming and Allied Sciences*, Vol. 2 No. 20, pp. 857–860.

Saeed, K. S., Ahmed S. A., Hassan I. A. and Ahmed P. H. (2015), "Effect of Bio-fertilizer and chemical fertilizer on growth and yield in cucumber (*Cucumis sativus*) in green house condition", *Pakistan Journal of Biological Sciences*, Vol. 18 No. 3, pp.129–134 ·

Saeed, K. S., Ahmed, S. A., Hassan, I. A. and Ahmed, P. H. (2015), "Effect of bio-fertilizer and chemical fertilizer on growth and yield in cucumber (*Cucumis sativus*) in green house condition", *Pakistan Journal Biological Sciences*, Vol. 18 No. 3, pp. 129–134.

Sayed-Ahmed I. F., Abdel Aziz Ranya M. and Rashed, Sahar H. (2016), "Effect of bio and mineral fertilization on yield and quality of sugar beet in newly reclaimed lands in Egypt", *International Journal of Current Microbiology and Applied Sciences*, Vol. 5 No. 10, pp. 980–991.

Soliman, M. A. (2011), *Optimizing of using the sea weeds and organic acids on cucumber production under drip irrigation system*, Ph.D. Thesis, Faculty of Agriculture, Mansoura University, Egypt.

Soltan, H. A. and Osman, S. (2021), "Efficiency of potassium solubilizing bacteria inoculants to improve yield of carrot and their potential cytotoxicity on root tip cells", *Egyptian Journal of Horticulture*, Vol. 48 No. 2, pp. 165–180.

Steel, R. G. D. and Torrie, J. H. (1982), *Principles and procedures of statistics. A biometrical approach*, 2nd Edition, McGraw-Hill Book Company, New York, USA.

Tei, F., Benincasa, P. and Guiducci, M. (2006), "Effect of organic and mineral fertilisation on yield and quality of zucchini", *Acta Horticulturae*, Vol. 700, pp. 125–128.

Tucker, M. (2004), "Primary nutrients and plant growth", In: *Essential Plant Nutrients*, North Carolina Department of Agriculture, pp. 126.

Waseem, K., Kamran, Q. M. and Jilani, M. S. (2008), "Effect of different nitrogen levels on growth and yield of cucumber (*Cucumis sativus* L.)", *Journal of Agricultural Research*, Vol. 46 No. 3, pp. 259–266.