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Influence of Bio-Fertilizers and Addition Methods on Growth, Yield and Quality of Sweet Pepper Under Green House

S. M. Ahmed[1] A. J. Abdulsada N. S. Deiab G.K. Abbas R. S. Ibrahim

Ministry of Science and Technology, Agricultural Research Directorate, Iraq – Baghdad. Plant Breeding & improvement center

[1]Corresponding Author: Samaf-88@hotmail.com

Abstract

The effect of some biofertilizers and addition methods on growth, yield, and quality of sweet pepper were studied under greenhouse conditions. This research was conducted at AL-Latifia Research Station(Located 35 km south of Baghdad), Agricultural Research Directorate, Baghdad- Iraq, during season 2016. The factors were methods of adding bio-fertilizers (A) included added to seeds (A_1) and added to transplants (A_2) and bio-fertilizers (T) included without adding any biofertilizers as control(T_0), *Pseudomonas fluorescenc*e (T_1), *Azospirillim brasilense* (T_2), *Bacillus subtillus* (T_3) and *Azotobactor chroococcum* (T_4). Results showed a significant increase in plant height for treatment of *Azotobacter chroococcum* which recorded (79.00 cm) compared with (65.00 cm) in the control treatment. There is no significant influence of biofertilizers treatments in leaf area dcm^2. Moreover, the treatment of *Azotobacter chroococcum* showed a significant increase for plant yield and total yield which recorded (1344.00 gm $plant^{-1}$ and 1512.00 kg green $house^{-1}$) respectively in comparison with the control treatment which recorded(880.00 gm $plant^{-1}$ and 989.00 kg green $house^{-1)}$ respectively.

Keywords: Biofertilizers, Sweet Pepper, Growth, Yield.

Introduction

Sweet pepper (*Capsicum annuum* L.*)* is a major vegetable crop in Iraq, tropical, subtropical, and all parts of the world because of its economic and nutritional value for human health (Matlob *et al*, 1989). Othman (2007) indicated to an increase in the rates of chemical fertilizers use when planting vegetable compared with other crops because they were planted more than once in one season, although chemical fertilizers have important role in crop production excessive use it appeared many problems and caused harmful effects on health and the environment pollution. Has been to use of biofertilizers a significant impact on obtaining crops that are highly productive and free from chemical pollutants due to its ability to inhibit and stop the growth of pathogenic microorganisms and its ability to stimulate and increase root and vegetative growth and increase the absorption of nutrients essential for growth and increase the plant's ability to resist unsuitable environmental conditions (Al-Shahat, 2007). Al-Dulaimi *et al* (2003) explained that the use of the *Pseudomonas fluorescence* has increased the growth of tomato plants under Greenhouse conditions. Shams (2003) showed that when using Nitropin (contains three different nitrogen fixers of the *Azotobacter*, *Azosprillium*, and *Bacillus*) and phosphorin (Biofertilizer containing a bacterial strain of *Bacillus megatherium* var phosphaticum , It has the ability to convert Tricalcium phosphate) with different levels of

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nitrogen and phosphorus, gave an increasing in plant length, stem thickness, number of leaves, leaf area, dry plant weight and the highest content of chlorophyll a, b and total chlorophyll. Al-Samarrai and Rahi (2006) reported that the inoculated tomato seeds, Hofuf variety by *Azotobacter chroococcum* and *Azospirillium brasilense*, caused increasing in the germination rate of inoculated seeds and root lengths of the plants. Fawzy *et al* (2012) also indicated that the use of *Azotobacter* with Ascorbic Acid with a concentration of 400 $mg.L^{-1}$ spraying on pepper plant achieved a significant increase in plant height, number of branches, number of fruits, and yield. El-Hifny and El-Sayed (2011) found that inoculated of sweet pepper plants with the microbin (Biofertilizers containing *Azotobacter* and *Azospirillium*) resulted in a significant increase in the length and diameter of the fruit and the total yield and the content leaves of the chlorophyll a, total chlorophyll and the fruit content of the vitamin C . Zehra *et al* (2012) indicated that inoculated of hot pepper plants with biological nitrogen stabilizers individually or in combination with the addition of different levels of mineral nitrogen led to significant differences in the growth and yield characteristics. Alwan (2016) found that the addition of biofertilizers on soil gave increasing in chlorophyll content, dry weight of vegetative and the total yield compared with control treatment of beans plant. In another study, using *Azospirillium* with 25% FYM (Farm Yard Manure) gave increasing in plant yield and total yield compared with control treatment (Meena *et al*, 2017). Therefore, this study aimed to evaluate the effect of some biofertilizers and addition methods on the growth, yield, and quality of sweet pepper under Greenhouse conditions.

Materials and Methods

This research was conducted at AL-Latifia research station(Located 35 km south of Baghdad. E 44.16° and N 33.03°), Agricultural Research Directorate, Ministry of Science and Technology Baghdad - Iraq during season 2016, using the Olympic sweet pepper cultivar.

Prepare seeds and transplants

1 - Treatment of seeds

Pepper seeds were treated with biofertilizer by coating them with the bacterial suspension for 10 minutes and then let to dry for 15 minutes (a gram of bacterial incoula contains 80-100 x 103 cfu / gm incoula). The treated and untreated seeds were planted on 7/10/2016 in transplanting trays which contain peat moss and the trays were kept inside the greenhouse for germination before transferring to the permanent place (Deiab, 2012).

2 - Treatment of transplants

Pepper seeds were sown in transplanting trays that contain peat moss on 7/10/2016. Biofertilizers were added to pepper transplants when real leaf appeared on 31/10/ 2016 at a rate of 5 ml of the bacterial suspension for each transplant (a gram of bacterial incoula contains 80-100 x 103 cfu / gm incoula). The trays were placed in the Greenhouse until transferring to the permanent place (Deiab, 2012).

Preparing the Greenhouse

The plastic house was prepared with a distance of 9 x 50 m and solar sterilization was applied from 15 June until 1 September 2016 and then divided into five blocks with a length of 50 m and width of 0.80 m and a distance between raw and other 0.80 m with 1 m left on each side. Each block was divided into 9 sections of 5 m each experimental unit, pepper transplants were planted with a distance of 0.40 m between plants on 12/11/2016.

Chemical fertilizer was added as KNO_3 potassium nitrate at a rate of 142 kg and 190 kg .ha $^{-1}$ in four times during the growing season, Two weeks after transferring the seedlings to the plastic house, pre-flowering, flowering stage, and after fruits set (Shams,2003). The Greenhouse soil has been characterized physically and chemically as shown in Table (1). The temperature and humidity were measured with a Thermo hygro graph, the temperature was ranged between 35-37 during the day and 10-midnight, and the humidity was between 80-85%. The factorial experiment was laid out in Randomized Complete Block Design (R.C.B.D) with three replicates. Means of traits were compared by L.S.D. at level 5% (Al-Sahuki and Wahib, 1990). The data were analyzed using Statistical Analysis System GenStat ed [12] (Glaser and Biggs, 2010)

Table 1. Physical and Chemical properties of Greenhouse Soil

properties		Standard unit	value
pH $_{1:1}$		---	7.8
EC $_{1:1}$		dSm^{-1}	4.2
Organic matter		gkg^{-1}	0.70
HCO_3		gkg^{-1}	2.45
Available Nitrogen		$mgkg^{-1}$	46.20
Available Phosphorus		$mgkg^{-1}$	20.83
Available potassium		$mgkg^{-1}$	189.0
Ions soluble	Mg^{+2}	mgL^{-1}	33.96
	Ca^{+2}	mgL^{-1}	110.2
silt		gkg^{-1}	490
clay		gkg^{-1}	140
sand		gkg^{-1}	370
Soil texture		Loam	

Prepare biofertilizers

Biofertilizers were obtained from the Center of Biotechnology / Agricultural Research Directorate. Ministry of Science &Technology, Baghdad, Iraq.

Treatments

Treatments included:

1- Methods of Addition inocula (A)

A_1: Add the inocula to seeds

A_2: Add the inocula to the transplants

2. The biofertilizers (T) included

T_0: control (without biofertilizers)

T_1: *Pseudomonas fluorescence*

T_2: *Azospirillum brasilense*

T_3: *Bacillus subtilis*

T_4: *Azotobacter chroococcum*

Parameters of vegetative growth and yield

Parameters were studied by randomly selected 5 plants in each treatment. The vegetative growth measurements were recorded after 55 days from planting and included the plant height (cm), stem diameter (mm) and several branches per plant, fresh weight of root and shoot, the relative content of chlorophyll was measured by Chlorophyll meter SPAD – 502 according (Minnotti et al, 1994), leaf area (dcm^2) measured by the Portable Leaf Area Meter according to (Tekalign and Hammes, 2005), The yield characteristics were recorded weekly after 30 days from plantings and included an average number of fruits (fruit per plant), average fruit weight (gm), fruit size (cm^3) and an average yield of one plant (kg) were taken. As for calculating the yield on basis of the Green house, it was done on basis that the house contains 625 plants (the distance between the plant and another is 0.40 m and the length of the planting line is 50 m). Therefore, the yield of plant for each treatment multiplied by 625 plants equals total yields of Greenhouse, length, and diameter of fruit were taken to measure per plant.

Results and Discussions

Effect of biofertilizers on the growth of pepper

The results of Table 2 showed the effect of methods of inocula addition was significant differences in plant height (cm). Transplants treatment (A_2) gave the highest significant differences ($P<0.05$) in plant height (78.70 cm) compared with (A_1) seed treatment which reached (68.70 cm). Biofertilizer treatments, results showed that T_4 treatment (*A. Chroococcum*) was significantly higher than (79.00 cm) and followed by T2 treatment (*A brasilense*) was (77.50 cm) compared with T_0 treatment (without Bio-fertilizer) which gave (65.00cm). Interaction between addition methods (A) and biofertilizer treatments (T) had a significant effect A_2T_4 (transplants + *A. Chroococcum*) treatment gave (85.70 cm), while A1T0 treatment addition methods of biofertilizers to seeds + without adding biofertilizers gave (61.70 cm). The same table showed also significant differences in the diameter of stem between the method of additional treatments, transplant treatment (A_2) there was significantly superior 16.80 mm compared with seeds treatment (A_1) which gave 15.47 mm. The results showed significant differences in the effect of biofertilizer treatments on stem diameter where *A. Chroococcum* treatment (T_4) was significantly superior which reached (17.00 mm) and reduced significantly without adding biofertilizer treatment (T_0) which reached14.50 mm. The interaction between the methods of inocula addition and biofertilizers treatments had a significant effect the highest stem diameter was in A_2T_4 and A_2T_1 treatments which gave(18.00 mm), while the least stem diameter was in the method of adding biofertilizers to the seeds + without adding biofertilizers treatment (A_1T_0) which gave 14.33mm (Table 2)

Table 2. Effect of Biofertilizers and Addition Methods on Plant Height (cm) and Stem Diameter (mm) of Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	Plant Height (cm)			Stem Diameter (mm)		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	61.70	68.30	65.00	14.33	14.67	14.50
T_1	68.30	80.00	74.20	15.33	18.00	16.67
T_2	76.70	78.30	77.50	15.67	17.00	16.33
T_3	64.70	81.30	73.00	16.00	16.33	16.17
T_4	72.30	85.70	79.00	16.00	18.00	17.00
Mean of a method of addition	68.70	78.70		15.47	16.80	
L.S.D 0.05	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
	5.81	9.19	12.99	1.14	1.81	2.56

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

Data of Table 3 showed no significant differences between addition methods of bio-fertilizers (A) in several branches per plant. Biofertilizer treatments gave the highest rate of branches per plant in T_4 treatment which reached (6.50 branches per plant) compared with 4.33 branches per plant for treatment T_0. Interaction between methods of inocula addition and biofertilizer treatments showed significant effect between treatments A_2T_4 treatment gave the highest number of branches (7.00) while the lowest number of branches was recorded with A_1T_0 treatment which reached (4.00).

Moreover, the results of Table 3 showed a significant effect between the method of incoula addition biofertilizers in fresh weight of shoot the treatment of transplants (A_2) had the highest fresh weight of shoot (233.70 gm) compared with the treatment of seeds A1 which gave (137.10 gm). For biofertilizers treatments, a significant effect on shoot weight was found in T_4 treatment which recorded the highest shoot weight (205.90 g) while T_0 treatment gave the lowest shoot weight (133.60 gm). Interaction between methods of incoula addition biofertilizers and biofertilizer showed significant effect the best treatments were A_2T_1 which gave (303.30 gm shoot fresh weight), while the lowest shoot fresh weight was in (A_1T_0) treatment which gave (130.50 g shoot fresh weight).

Table 3. Effect of Biofertilizers and Addition Methods on the Number of Branches and Fresh Weight of Shoot (g) of the Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	No. of Branches $plant^{-1}$			Fresh Weight of Shoot (g) $plant^{-1}$		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	4.00	4.67	4.33	136.7	130.5	133.6
T_1	5.33	6.33	5.83	140.8	303.3	222.1
T_2	5.67	6.67	6.17	142.2	230.2	186.2
T_3	5.33	5.00	5.17	129.2	228.9	179.1
T_4	6.00	7.00	6.50	136.4	275.4	205.9
Mean of a method of addition	5.27	5.93		137.1	233.7	
	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
L.S.D 0.05	N.S	1.25	1.78	33.90	53.60	75.81

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The results of Table 4 showed no significant differences in fresh weight of roots between methods of inocula addition, among biofertilizers treatments and the interaction between them. The results of the same table also indicated no significant differences in chlorophyll content in leaves between the two methods of inocula addition there were significant differences among biofertilizers treatments on chlorophyll content where T_4 treatment was significantly superior which reached (49.07 SPAD units) and reduced significantly in T_0 treatment (40.40 SPAD units). The interaction between the methods of inocula addition and biofertilizer treatments had a significant effect A_2T_4 treatment (transplants + *A. Chroococcum*) gave the highest amount of chlorophyll (50.97 SPAD units), while A_1T_0 treatment gave (40.30 SPAD units).

Table 4. Effect of Biofertilizers and Addition Methods on the Weight Roots of the Plant and the Percentage of Chlorophyll of the Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	Fresh Weight of Root (g) plant^{-1}			Relative Chlorophyll Content		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	28.80	26.00	27.40	40.30	40.50	40.40
T_1	31.40	37.10	34.20	46.83	46.27	46.55
T_2	34.60	36.40	35.50	46.23	49.27	47.75
T_3	28.40	32.70	30.50	44.50	47.53	46.02
T_4	32.30	38.00	35.10	47.17	50.97	49.07
Mean of a method of addition	31.10	34.00		45.01	46.91	
L.S.D 0.05	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
	N.S	N.S	N.S	N.S	6.25	8.84

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The results of Table 5 showed no significant differences between addition methods among biofertilizers treatments and interaction between them on leaf area(dcm^2).

Table 5. Effect of Biofertilizers and Addition Methods on Leaf Area dcm^2 of Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	Leaf Area dcm^2 plant^{-1}		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers

T_0	31.30	38.30	34.80
T_1	33.90	48.40	41.20
T_2	38.10	46.30	42.20
T_3	35.40	42.50	39.00
T_4	46.60	34.90	40.70
Mean of a method of addition	37.10	42.10	
L.S.D 0.05	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
	N.S	N.S	N.S

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The increase in most shoot characteristics of plants with biofertilizers inoculation (*Azotobacter* and *Azospirillum*) attributed to the role of biofertilizers in the availability, absorption, and concentration of nutrients such as nitrogen and phosphorus. Biofertilizers also play a role in stimulating the production of growth regulators, which are positively reflected in the increased division, elongation, and expansion of cells, which reflected on shoot growth (Mirzakhan et al, 2009; Salhia, 2010; Allawi, 2013; Shash et al, 2018), and availability of elements in leaves lead to increase management and activity of photosynthesis, which leads to increase CO_2 in the leaves, which is the basic unit for building carbohydrates, amino acids and proteins structure and therefore increasing vegetative growth (Latitha et al, 2004; Jark et al, 2010; Taiz and Zeiger, 2010). The results of the present study were in agreement with many papers (Fawzy et al, 2012; Dharmendra, 2014; Saeed et al, 2014; Meena et al, 2017).

Effect of biofertilizers on yield of pepper

Table 6 indicated that the methods of inocula addition gave a significant difference in the number of fruits per plant. A significantly higher number of fruits per plant was recorded in transplants treatment A_2 was (24.40 fruit Plant^{-1}) while the seed treatment A_1 gave (21.67 fruit Plant^{-1}). Biofertilizer application T_2 and T_4 treatments recorded higher fruits and reached (24.67and 24.33fruits. Plant^{-1}) respectively, compared with the T_0 treatment (without biofertilizers) which gave (20.50 fruit. Plant^{-1}).

Interaction between the methods of inocula addition and biofertilizers application showed a significant effect A_2T_4 and A_2T_2 treatments gave (27.33 and 26.00 fruits. Plant^{-1}) respectively, while A_1T_0 treatment gave (20.33) fruits. The same table showed a significant effect in the fruit weight of Greenhouse according to the methods of inocula addition which reached 53.90 gm in treatment of transplants (A_2) compared with the treatment of seeds (A_1) which gave (46.30 gm). Biofertilizer treatments T_4 was superior in fruit weight which recorded (54.70 gm) compared with others and T_0 treatment gave the lowest value (43.00 gm). Interaction between the methods of inocula addition and biofertilizer treatments found significant differences among treatments the highest value recorded for treatments A_2T_4 and A_2T_3 were (58.00 gm) for both of them while the lowest yield was recorded by A_1T_0 treatment which reached (41.70 gm).

Table 6. Effect of Biofertilizers and Addition Methods on Number of Fruits and Fruit Weight of Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	No.of Fruits plant^{-1}			Fruit Weight(gm)		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	20.33	20.67	20.50	41.70	44.30	43.00
T_1	22.33	24.33	23.33	43.70	52.70	48.20
T_2	23.33	26.00	24.67	48.30	56.70	52.50
T_3	22.33	23.67	23.00	47.30	58.00	52.70
T_4	21.33	27.33	24.33	51.30	58.00	54.70
Mean of a method of addition	21.93	24.40		46.50	53.90	
L.S.D 0.05	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
	1.44	2.29	3.23	4.69	7.42	10.49

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The methods of inocula addition showed significant differences in plant yield (Table 7). The highest value of plant yield was obtained from inocula treatments of transplant (A_2) which was (1324.00 gm plant^{-1}) while (A_1) treatment gave (1015.00 gm plant^{-1}). Concerning biofertilizers treatments, the results showed that T_4 treatment (*A. Chroococcum*) was significantly higher than other treatments in fruit weight per plant which reached (1344.00 gm plant^{-1}) while the lowest value was for the control treatment (T_0) which reached (880.00 gm plant^{-1}). Interaction between the methods of inocula addition and biofertilizer treatments was significant, the highest value for treatment A_2T_4 was (1588.00 gm plant^{-1}) and the lowest plant yield of fruit was recorded for A_1T_0 treatments which recorded (847.00gm plant^{-1}).

Moreover, the results of Table 7 showed a significant effect in total yield of the plastic house according to methods of inocula addition which reached (1489.00 Kg) in the treatment of transplants (A_2) compared with the treatment of seeds (A_1) which gave (1142.00 Kg). In addition, significant differences were found among treatments for plant yield, T_4 treatment (*A. Chroococcum*) gave the highest value (1512.00 Kg) compared with other and T_0 treatment (without biofertilizers) gave the lowest yield compared with others (989.00 Kg).Interaction between the methods of inocula addition and biofertilizer treatments found to be significant with the highest value recorded for treatment A_2T_4 which gave (1787.00 Kg) while the lowest yield was recorded by A_1T_0 treatment which reached (951.00 Kg).

Table 7. Effect of Biofertilizers and Addition Methods on Yield of Plant (gm) and Total yield of House (Kg) of Sweet Pepper under Greenhouse Conditions

Method of Addition A / Biofertilizers T	The yield of Plant (gm)			Total Yield of House (Kg)		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	847.00	913.00	880.00	951.00	1028.00	989.00
T_1	976.00	1271.00	1123.00	1098.00	1430.00	1264.00
T_2	1100.00	1475.00	1288.00	1237.00	1659.00	1448.00
T_3	1055.00	1371.00	1213.00	1187.00	1542.00	1365.00
T_4	1099.00	1588.00	1344.00	1237.00	1787.00	1512.00
Mean of a method of addition	1015.00	1324.00		1142.00	1489.00	
L.S.D 0.05	Method of Addition 107.40	Biofertilizers 169.80	Method of Addition X Biofertilizers 240.10	Method of Addition 120.90	Biofertilizers 191.10	Method of Addition X Biofertilizers 270.30

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The results of Table 8 showed significant differences in length of fruit by methods of inocula addition wherein transplants treatment (A_2) reached (4.88 cm) compared with the seed treatment (A_1) which gave (4.28 cm). Significant effect among bio-fertilizer had been found the highest rate of fruit length was in (T_2) treatment (4.66cm) and the lowest fruit length was in (T_0) treatment(4.20 cm). Interaction between the methods of inocula addition and biofertilizer treatments showed significant effect A_2T_2 treatment gave (5.43 cm) fruit length while reduced to (4.20

cm) in A_1T_0 and A_2T_0 treatments. The diameter of fruit in Table (8) was significantly different depending on the methods of inocula addition, transplants treatment (A_2) recorded (53.50 mm) compared with seeds treatment (A_1) which gave (40.10 mm). Also, bio-fertilizers treatments showed a significant effect on fruit diameter and the results showed that T_4 treatment (*A. Chroococcum*) was the highest value (50.40 mm), while the lowest fruit diameter was in the control treatment (38.80 mm). Interaction between the methods of inocula addition and biofertilizer treatments showed a significant effect on fruit diameter A_2T_2 treatment gave the highest value (60.10 mm) while the lowest value was in A_1T_0 treatment (37.40 mm).

Table 8. Effect of Biofertilizers and Addition Methods on Length (cm) and Diameter of Fruit (mm) of Sweet Pepper under the Greenhouse Conditions

Method of Addition A / Biofertilizers T	Length of Fruit(cm)			Diameter of Fruit(mm)		
	Seeds A_1	Transplant A_2	Mean of Biofertilizers	Seeds A_1	Transplant A_2	Mean of Biofertilizers
T_0	4.20	4.20	4.20	37.40	40.30	38.80
T_1	3.73	5.26	4.50	40.70	58.00	49.40
T_2	4.66	5.43	5.05	35.40	60.10	47.70
T_3	4.30	4.80	4.55	41.70	54.00	47.80
T_4	4.50	4.70	4.60	45.40	55.40	50.40
Mean of a method of Addition	4.28	4.88		40.10	53.50	
L.S.D 0.05	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers	Method of Addition	Biofertilizers	Method of Addition X Biofertilizers
	0.31	0.49	0.69	4.69	7.41	10.48

T0 control T1 *Pseudomonas fluorescence*
T2 *Azospirillum brasilense* T3 *Bacillus subtilis* T4 *Azotobacter chroococcum*

The inoculation of sweet pepper with biofertilizers leads to encouragement and increase of growth indicators through the strategies which are used in this biological system, especially the availability of nutrients through phosphorus soluble and nitrogen fixation in soil and increase the resistance of plants to biotic and abiotic stresses and production of different growth regulators like IAA and GA_3. All these factors contributed to increasing lengths and diameters of fruits, the number of fruits, and weight of fruit, which lead to increased plant growth and total yield (Saharan and Nehra, 2011; Dharmendra, 2014; Saeed, 2015; Tosi et al, 2016; Shashi et al, 2018).

The growth regulators also contribute to increasing shoot and root growth due to the division and elongation of cells and tissues.

Conclusions

In this study, bio-fertilizers showed a significant effect on most traits, *Azotobacter* and *Azospirillum* applications showed positive results in increasing the fruit yield of Sweet Pepper. Also, results revealed that treatments of transplants with biofertilizers were superior on most traits compared with treatments of seeds coating with biofertilizers.

Conflict of interests

The authors declare no conflict of interest.

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