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IMPACT OF BIOFERTILIZERS AND NANO POTASSIUM ON GROWTH AND YIELD OF EGGPLANT (*SOLANUM MELONGENA* L.)

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Abstract

This experiment was carried out at University of Baghdad/college of agricultural engineering sciences / Station A to evaluate the effect of Biofertilizers (*Azotobacter chroococcum, Glomus mosseae*) and Nano potassium fertilizer on growth and yield of Eggplant. Randomized complete block does used with single facter that included three replicates each one were contained 14 experimental units. Results showed that the triple interaction treatment between *Mycorrhizae, Azotobacter chroococcum* and Nano potassium fertilizer ($MBKN_2$) at the 1.5 $gm.L^{-1}$concentration gave the highest values in the vegetative parameters which were Plant height (cm), leaves number ($leaf.plant^{-1}$), leaves area (dm^2), chlorophyll (mg. $100gm^{-1}$), dry weight (gm), leaf content of (N,P,K)%, and (Fe, Zn) mg.kg-1which recorded 93.90, 136.33, 149.76, 326.79, 219.66, 2.98, 0,34, 3.95, 39.93, 218.30 respectively compared with the control treatment which gave 79.46, 83.00, 91.56, 209.31, 124.66, 1.56, 0.21, 2.41, 23.86 and 140.97 for the same characters respectively, And it also gave the highest values in yield parameters which were fruit weight (gm), fruit number ($fruit.plant^{-1}$), plant yield ($kg.plant^{-1}$), total yield ($ton.h^{-1}$), anthocyanin and TSS which were 172.26, 10.60, 1.82, 36.52, 853.77, 8.5 respectively compared to the control treatment which gave the lowest values that were 129.11, 9.13, 1.17, 23.58, 461.40, 6.5 respectively.

***Keywords*:** Eggplant, Bio fertilizer, *Mycorrhizae, Azotobacter chroococcum, Glomus mosseae*, Nano potassium fertilizer

Introduction

Eggplant (*Solanum melongena* L.) belongs to Solanaceae family, is a major crop in tropical and subtropical regions, spread from Africa to all parts of the Middle East and Asia (Weese *et al*., 2010). The world's cultivated area in 2017 was 1,858,253 ha and the total production was 52,309,119 tons (FAO, 2017). Eggplant fruits are characterized by containing minerals, vitamins such as vitamin A and some types of vitamin B and a low proportion of protein, carbohydrates as well as contain high amounts of iron, Eggplant's medical importance lies to it contains low calories contribute to the prevention of obesity and also reduce the arteriosclerosis by hindering the transmission of cholesterol and reduce the body fat, also contain polyphenols that are useful in fighting cancer (Daunay *et al*., 2000).

Recently, Several studies showed the role of *Mycorrhizae* in plant phosphorus absorption, through its high ability to secrete the phosphatase enzyme, which converts organic phosphorus into mineral phosphorus (Nirmalnath, 2010, Dubey and Fulekar, 2011), As well as it produce an organic compounds (Sidrophors) that can chelate iron from the soil (Haselwandter, 2008). Also the *Mycorrhizae* has an important role in improving soil fertility by secrete the Glomalin which increase the soil ability to keep the water (Mahdi *et al*., 2010). Graf and Frej (2013) showed that the fungal hives as flexible strands that can by secrete many proteins Improve the soil cohesion, as well as their importance in increasing the readiness and absorption of certain nutrients, thus it contribute to recover about 50% of the applied fertilizers. Ortas *et al*. (2003) confirmed that *Mycorrhizae* fertilization increases the growth of eggplants, tomatoes and peppers. Vaccination of eggplant with mycorrhiza fungi causes an increase in nutrient uptake due to plant and *Mycorrhizae* symbiosis (Ortas, 2012), Al-Karaki (2017) found that infection of green peppers with *Glomus Mosseae* had significantly increased the *Mycorrhizae* infection as well as the parameters of vegetative growth and yield. The group of bacterial species that vary in their use and mechanisms in promoting plant growth are called Plant Growth Promotion Rhizobacteria (PGPR). They works on stimulating plant growth through several mechanisms, the most is by nitrogen fixation, dissolution of phosphorus, analysis organic matter, producing hormones, plant growth regulators and chelating compounds (Vidakovic-Papic, 2000, Al-shahaat, 2007) Recent studies have indicated that the *Azotobacter* bacteria producing hormones such as Auxins (IAA), Cytokines, Gibberellins as well as stimulate the microorganism in the rhizospheric and improve the nutrients uptake (Jnawali *et al*., 2015). Ramakrishnan and Selvakumar (2012) mentioned that the inoculation of tomato with *Azotobacter chroococcum* has increased the plant height, leaves number, plant yield, fruit content of protein compared with the control treatment. Alladi *et al*. (2017) recorded that the inoculation eggplant with *Azotobacter chroococcum* has significantly increased the plant content of N, P and K. Nandkar and Doifode (2014) recorded that the inoculation of *Azotobacter chroococcum* to eggplant with a half amount of recommended fertilization has increased the vegetative parameters which were plant height, stem diameter, leaves number, wet and dry weight of the vegetative system as well as the yield parameters. Marajan *et al*. (2017) recorded in a study to investigate the effect of biofertilizers with the application of organic fertilizer (Compost) (15 $ton.h^{-1}$) the increase of the plant height and plant dry weight. The Nanotechnology consented a scientific revolution which is not less important than the industrial revolution that took the world to the machine's age, industry and technological revolution that became possible to produce extremely small particles (less than 100 nm) from various elements. This technology has the ability to offer to the humanity what the bulk materials couldn't offer, Their uses spreaded recently in the industrial and agricultural fields in the production of fertilizers because of their effect on the plant's growth and yield as well as to decrease the need to traditional chemical fertilizers (Elwakil, 2013), and the reason behind this is their physical and chemical properties due to their high surface area and their Nano size (Khan *et al*., 2017). The

Nanofertilizers plays an important role in plant nutrition by foliar or soil application, It's slow release contributes in provide plant with nutrients which ensure the maintenance of metabolic processes and improve the yield (Naderi and Abedi, 2012). Al-Juthery *et al*. (2018) mentioned that the foliar application of Potato with Nano fertilizer which contains 11 elements (N 5%, P 4%, K 2%, Mg 1%, Ca 1.5%, Fe 4%, Cu 1%, Zn 5%, Mn 2%, Mo 0.04%, B 0.06%) in the concentration of 400 L. h^{-1} in autumn season 2017 has increased the studied parameters which were leaf content of chlorophyll (Spad unit), total yield megagram.ha^{-1}, Nitrogen in fruit compared with control treatments. As all mentioned above, this study aimed to evaluate the effect of biofertlilzers (*Azotobacter chroccocum, Glomus moseae*) and foliar spraying of Nano potassium and their interaction on growth and yield of Eggplant.

Materials and Methods

An experiment was carried out at Station (A) that belongs to College of Agricultural Engineering Sciences / University of Baghdad Al-Jaderria for the spring season 2018 on Eggplant crop, in order to evaluate the effect of Biofertilizers (*Azotobacter chroccocum, Glomus moseae*) and Nano potassium fertilizer and their interaction on growth and yield of Eggplant. The field has been plowed, softened and settled. Random samples were taken from the field at a depth of 0.30-0 m for the purpose of analysis and knowledge the physical, chemical (Table 1)

Table 1 : some physical and chemical properties of the soil

Value	Unit	Characteristics	
7.85		PH	
3.8	ds.m^{-1}	EC	
0.65	g.k^{-1}	Organic matter	
35.1		$CaCO_3$	
11.21	Meq.L^{-1}	Ca	
15.13		Cl	
2.4	Mg.k^{-1}	Available Nitrogen	
5.18		Available phosphorus	
86.01		Available Potassium	
20.08	%	Clay	Soil separators
30		Silt	
49.2		Sand	
Mixed soil		Soil texture	

The poultry fertilizer (Fertak) (Produced by the Spanish company FERTINAGRO) were added along the terrace and mixed in the soil (6.5 Kg per tap).

A local seeds cultivar produced by the Danish company (Hawars) in 2018/2/20 were planted in corky dished accommodate 209 seeds. The seedlings were transplanted to the field at 2018/3/28 after 4-5 certain leaves were appeared and the distance between plant to other was 0.40m reciprocally on the terrace, the experiment unit contained 10 plants with 2m between each unit. Half recommended fertilization were applied (K_2O 60, P_2O_5 80, N 60) Kg.h^{-1} to all treatments except the treatments (T1, T2) (Al Neaamie,1999). A bacterial farm was prepared which contained a pure *Azotobacter chroococcum* in a density of 1*810 CFU, The bacterial farm were translocated to a plastic container and appended by 100 ml of arabic glue which prepared by 1:10 percent (glue: Water) to ensure the cohesion of the bacterial vaccine to plant's root and to guarantee the vaccination. The treated plants were placed inside the container for 15 minutes considering the immersion of all plant inside the bacterial farm and away from the sunlight, then removed out in the shadow for 10-15 minutes and planted in the field. The *Mycorrhizae* was vaccinated by placing 30 gm of *Glomus mosseae* in a density 51 spore.gm-1 dry soil in the wholes that prepared for the fungal vaccine considering a totally touch between the vaccine and seedling's roots by using (Pad) method(Allawi, 2013).

The experiment was carried out using fertilizing compounds in one factor which contained (42) experiment units randomly distributed in three replicates, each replicate contained (14) experiment units with 10 plants in each unit as following:

T1: the control treatment, Ch: the recommended fertilization (N 120, P_2O_5 160, K_2O 120) Kg.h^{-1} (Al Neaamie,1999), K: high potassium fertilizer treatment (45%) (produced by the Italian company "Valagro"), M: *Glomus mosseae* treatment (The *Mycorrhizae* vaccine), B: *Azotobacter chroococcum* treatment (bacterial vaccine), KN1: the foliar application of Nano potassium 0.75 gm.L^{-1}, KN2: the foliar application of Nano potassium 1.5 gm.L-^{1}, MB: *Glomus mosseae* (The *Mycorrhizae* vaccine)+ *Azotobacter chroococcum* (bacterial vaccine), MKN1: *Glomus mosseae* (The *Mycorrhizae* vaccine) + the foliar application of Nano potassium 0.75 gm.L^{-1}, MKN2: : *Glomus mosseae* (The *Mycorrhizae* vaccine) + the foliar application of Nano potassium 1.5 gm.L^{-1}, BKN1: *Azotobacter chroococcum* (bacterial vaccine) + the foliar application of Nano potassium 0.75 gm.L^{-1}, BKH2: *Azotobacter chroococcum* (bacterial vaccine) + the foliar application of Nano potassium 1.5 gm.L^{-1}, MBKN1: *Glomus mosseae* (The *Mycorrhizae* vaccine) + *Azotobacter chroococcum* (bacterial vaccine) + the foliar application of Nano potassium 0.75 gm.L^{-1}, MBKN2: *Glomus mosseae* (The *Mycorrhizae* vaccine)+ *Azotobacter chroococcum* (bacterial vaccine) + the foliar application of Nano potassium 1.5 gm.L^{-1}.

The Nano potassium fertilizer 35% (by Sepehr Parmis company) treatment was applied four times for each concentration, The first was after 20 days of planting in 2018/4/18 and repeated every 15 days, The high potassium fertilizer 45% (by Valagro) was applied after 20 days of planting date in the concentration 300 gm.L^{-1} and repeated four times. All parameters were measured and subjected to computerized statistical analysis of variance (ANOVA) and means of treatments were compared using L.S.D at 0.5.

Studied parameters: Five plants were randomly chosen from each experiment unit and replicate and symboled to measure the following parameters

Plant height (cm), Total leaves number (leaf.$plant^{-1}$), Leaves area (dsm^2.$plant^{-1}$) :leaf area was measured using Digimizer method by (Sadik, 2011), Plant dry weight (gm. $Plant^{-1}$), Leaf content of chlorophyll (mlg. 100 gm^{-1}) according to Goodwin method (1979).

Yield parameters: Total fruits number (fruit.$plant^{-1}$), Fruit weight (gm), Plant yield (kg.$plant^{-1}$), Total yield (ton.h^{-1}), TSS: measured using Hand reflectometer, Anthocyanin pigment: according to Ranganna (1977), nutrients in plant tissues: the samples were prepared by using 0.2 gm of grinded leaves after being washed and cleaned, then dried in the oven under 70 C̊, then the wet digestion was used according to Cresser and Parson (1979).

Nitrogen N(%): N was measured by Micro-Kjeldahl (Jackson, 1958)

Phosphorus (%): P was measured by Spectrophotometer under 882 mn wavelength(Olsen, 1902)

Potassium (%): K was measured by Flame photometer.

concentration of Fe, Zn in the leaf: Zn and Fe were measured by Atomic absorption spectrophotometer according to A.O.A.C (1980).

Results and Discussions

1- **Plant height (cm):** Results in Table (1) showed that the highest values has given by the treatment MKN2 reached (96.33)cm in increase percent (21.73)cm compared with the control which gave the lowest value (79.46) cm, Also it gave a significant values comparing to K, KN_1 treatment.

2- **Leaves number (leaf. Plant^{-1}):** Results in Table (2) revealed a significant effect for the treatment $MBKN_2$ that gave (136.33) leaf.Plant^{-1} in increase percent (64.25%) compared to the lowest value given by the control treatment (T1) 83.00 leaf. Plant^{-1}

3- **Leaves area (Dcm^2):** Results in Table (2) showed that the treatment MBKN2 has significantly increased the leaves surface that area reached (149.76) Dcm^2, which is not significant to the treatment MBKN1 (145.44) Dcm^2, comparing to T1 which gave the lowest value (91.56) Dcm^2

4- **Leaves content of chlorophyll:** Results in Table (2) refers that the treatments increased the leaves chlorophyll content compared to the treatment T1, and as following MBKN2, MBKN1, MB (326.79, 320.31, 316.67) mg.100g^{-1} fresh weight in increase percent (56.12, 53.03, 51.29) respectively, while the treatment T1 gave the lowest value (209.31) mg.100g^{-1}fresh weight

5- Vegetative dry weight gm.plant^{-1}: Results in Table (1) revealed that the treatment MBKN2 gave the highest value that reached (219.66) gm.plant^{-1} compared to the treatment T1 which gave the lowest value (124.66) gm.plant^{-1}

Table 2 : Effect of Biofertilizers and Nano potassium in vegetative parameters

Vegetative parameters					
Vegetative dry weight gm.plant^{-1}	**Chlorophyll mg.100g^{-1} fresh weight**	**Leaves area Dcm^2**	**Leaves number (leaf.plant^{-1})**	**Plant height (cm)**	**Treatments**
124.66 i	209.31 g	91.56 g	83.00 g	79.46 d	T1
168.23 c	296.57 bc	129.60 cd	99.00 de	92.16 abc	CH
135.90 gh	254.59 f	`109.06 f	96.67 def	87.50 bcd	K
159.46 cd	285.54 cd	121.63 de	102.33 d	88.90 abc	M
134.46 h	290.78 bcd	130.76 bcd	94.00 def	88.40 abcd	B
135.86 gh	262.79 ef	93.10 g	88.00 fg	84.23 cd	KN_1
141.60 fgh	270.03 e	95.76 g	91.67 efg	91.33 abc	KN_2
152.56 de	316.67 a	122.50 de	117.00 c	93.56 ab	MB
145.33 efg	282.16 d	118.26 ef	124.00 bc	90.56 abc	MKN_1
151.10 def	289.71 cd	139.46 abc	130.33 ab	96.73 a	MKN_2
140.10 gh	301.51 b	139.96 abc	126.67 abc	88.36 abcd	BKN_1
152.56 de	296.59 bc	140.50 ab	127.33 ab	91.63 abc	BKN_2
188.73 b	320.31 a	145.33 a	128.67 ab	93.36 ab	$MBKN_1$
219.66 a	326.79 a	149.76 a	136.33 a	93.90 ab	$MBKN_2$
10.03	11.43	10.59	10.26	8.96	$L.S.D_{0.05}$

6- **N leaf content (N%):** Results in table (3) presented that the N leaf content has significantly increased by applying the biofertilizer compounds and Nano potassium MBKN2, MBKN1 that gaves the highest values reached (2.85, 2.98)% respectively, while the treatment T1 gave the lowest value (1.56)%.

7- **P leaf content (%):** Results in table (3) revealed that the treatment MBKN2 has significantly increased the P leaf content which was (0.34)% compared to T1 (0.21)%

8- **K leaf content (%):** Results in Table (3) showed that all the treatments has a significant effect compared to T1, the treatments MBKN2 and BKN2 gave the same value reached (3.95)% in increase percent (63.00), while the treatment T1 gave the lowest value (2.41)%.

9- **Zn leaf content (Zn mg.Kg^{-1} dry weight):** Results in table (3) presented that all treatment gave a significant values, the treatment MBKN2 gave the highest value that reached (39.93) mg.kg^{-1} in increase percent (67.35)% compared to T1 which gave the lowest value (23.86) mg.kg^{-1} .

10- **Fe leaf content (Fe mg.Kg^{-1} dry weight):** Results in table (3) revealed that all treatments gave a significant values compared to T1, the treatment MBKN2 gave the highest value reached that was (218.30) mg.kg^{-1} while the treatment T1 gave the lowest value (140.97) mg.kg^{-1}dry weight.

Table 3 : Effect of biofertilizers and Nano potassium on leaf content of nutrients

Fe, Zn leaf content) mg.kg^{-1}dry wight		Leaf content N,P,K%			Treatments
Fe	Zn	K	P	N	
140.97 f	23.86 g	2.41 h	0.21 g	1.56 f	T1
171.12 cde	30.17 f	3.18 defg	0.24 defg	1.98 d	CH
166.14 def	30.14 f	3.68 abc	0.23 efg	1.71 ef	K
192.89 abc	36.69 abcd	2.91 g	0.29 abcd	1.82 def	M
186.20 bcde	34.54 bcdef	2.97 fg	0.22 fg	1.98 d	B
172.72 cde	31.41 ef	2.96 g	0.21 g	1.69 ef	KN_1
178.11 cde	31.80 def	3.56 abcd	0.25 cdefg	1.80 def	KN_2
161.24 ef	37.73 abc	3.41 cdef	0.31 ab	2.55 c	MB
192.88 abc	35.65 abcde	3.07 efg	0.28 bcde	1.72 def	MKN_1
194.50 abc	38.88 ab	3.43 bcde	0.30 abc	1.84 de	MKN_2
188.99 bcd	31.99 def	3.87 ab	0.28 bcde	2.65 bc	BKN_1
190.84 bcd	33.40 cdef	3.95 a	0.27 bcdef	2.68 bc	BKN_2
206.52 ab	37.86 abc	3.78 abc	0.30 ab	2.85 ab	$MBKN_1$
218.30 a	39.93 a	3.95 a	0.34 a	2.98 a	$MBKN_2$
26.47	5.00	0.44	0.05	0.26	$L.S.D_{0.05}$

The significant effect of the triple interaction between *Mycorrhizae, Azotobacter chroococcum* and Nano potassium fertilizer K_2SO_4 (1.5 gm.L^{-1}) can be due to the positive interaction between the studied factors, it might be due to the mycorrhizae role in increasing the absorption area because that the fungal hyphaes are able to reach areas where roots cannot reach it (Read and Perez-Moreno, 2003), As well as their high ability to secrete the phosphatase enzyme (Fulekar and Dubey, 2011), which increase the phosphorus availability, and also increase the macro-elements absorption. The ability of mycorrhizae in producing Glomalin which improved the soil ability to keep the water and improve soil physical characteristics and increased the roots permeability to farther areas and expansion the absorption area (Mahdi *et al*., 2010) which is reflected on the vegetative growth parameters of plant. The positive relationship between *Mycorrhizae, Azotobectar* might be contributed in increase the nitrogen fixation, Also phosphorus existence considered as an important factor in nitrogen fixation (Wu and Xia, 2006, Antunes *et al*., 2006) Which reflected on increase the chlorophyll production Table (2) and increase the leaves number, leaves area Table (2). The researches mentioned that the vaccination by *Micorrhizae* and *Azotobacter* can increase the P, Zn and Fe absorption (Rajaee *et al*., 2007) Also they increase the carbohydrates and proteins (Kizilog *et al*., 2001) Also the *Azotobacter* production of Thiamine, riboflavin, nicotine, IAA, Gibberellins, as well as Auxins and cytokinins that can stimulate the roots growth (Brakel *et al*., 1965) which increased the roots efficiency to absorb the nutrients which positively reflected on the vegetative growth parameters. The foliar application of Nano potassium fertilizer can be contribute in metabolic activities stimulation and reinforcement (Naderi and Abedi, 2012), The potassium contributes as a stimulator for the enzymes activities that responsible for carbon processes as well as the metabolic activities inside the cells which positively reflected on cells division and increase the leaves area (Tisdale *et al*.,1993 and Havlin *et al*., 2005), And it might be due to the fact that Nano potassium fertilizer has a higher physical and chemical activity than traditional fertilizers because of the high surface area of the Nano fertilizer which reflected on the increasing and improving the metabolic activities and accelerate the enzymatic activities of the photosynthesis as well as the chlorophyll (Morteza *et al*., 2013 and Siddiqui, 2014) Which positively reflected on increase the leaves number, leaves area and dry weight. The increase of vegetative growth parameters may be due to the positive interaction between the study factors that we mentioned.

11- **Fruits number (Friut.plant^{-1}):** Results in table (4) mentioned that the treatment CH has gave the most significant value reached (11.10) Friut.plant^{-1} compared with T1 which gave the lowest value (9.13) Friut.plant^{-1}, Also all treatments gave a significant values comparing to T1.

12- **Fruits weight (gm) :** Results in table (4) showed that the treatment MBKN2 gave the highest value reached (172.26) gm, while the treatment T1 gave the lowest value (129.11) gm, All treatments were gave a significant values compared with T1.

13- **Plant yield (kg.plant^{-1}):** Results in table (4) presented that applying biofertilizers and Nano potassium fertilizer significantly increased all treatments compared to T1 in plant yield parameter, The treatments MBKN2 and CH gave the highest values (1.82, 1.80) kg.plant^{-1} respectively compared to T1 which gave the lowest value (1.17) kg.plant^{-1} .

14- **Total yield (ton.h^{-1}):** Results in table (4) refer to a significant values for the treatments MBKN2, CH that reached (36.52, 35.96) ton.h^{-1} respectively compared to T1 which gave 23.58 ton.h^{-1}.

15- **Fruits Anthocyanin pigment (mlg. 100 gm^{-1} wet weight):** Results in table (5) revealed that the treatment MBKN2 has a significant value reached (852.77) mlg. 100 gm^{-1} wet weight in increase percent 85.03% compared to T1 which recorded the lowest value that was (461.40) mlg. 100 gm^{-1} wet weight, As well as the significant values for all treatments compared with T1.

16- **Fruits Total soluble solids (TSS) %:** The applied biofertilizers and Nano potassium fertilizer were significantly increased the TSS in fruits, the treatment MBKN2 gave the highest value reached (8.50) % compared to T1 which gave (6.50)% as shown in Table (5).

Table 4 : Effect of Biofertilizers and Nono potassium on yield characteristics of Eggplant

Yield parameters				
Total yield (ton.h^{-1})	**Plant yield (kg.plant^{-1})**	**Fruits weight (gm)**	**Fruits number (Friut.plant^{-1})**	**Treatments**
23.58 g	1.17 g	129.11 g	9.13 i	T1
35.96 a	1.80 a	162.06 cde	11.10 a	CH
33.39 cde	1.67 cde	168.66 abc	9.90 fgh	K
32.96 de	1.65 cde	162.20 cde	10.16 def	M
32.01 e	1.60 e	156.20 e	10.24 cde	B
28.36 f	1.42 f	144.90 f	9.78 h	KN_1
31.77 e	1.59 e	161.03 de	9.86 gh	KN_2
33.87 cd	1.69 cd	164.93 bcd	10.26 cde	MB
33.35 cde	1.66 cde	159.53 de	10.45 bc	MKN_1
34.23 bc	1.71 bc	170.44 ab	10.04 efgh	MKN_2
32.36 de	1.61 de	160.13 de	10.10 efg	BKN_1
32.53 de	1.62 de	162.26 cde	10.03 efgh	BKN_2
35.57 ab	1.78 ab	170.66 ab	10.42 bcd	$MBKN_1$
36.52 a	1.82 a	172.26 a	10.60 b	$MBKN_2$
1.63	0.08	6.90	0.26	$L.S.D_{0.05}$

Table 5 : Effect of biofertilizers and nono potassium on qualitative fruits characteristics of Eggplant

Fruits parameters Qualitative		
Total soluble solids (TSS) %	**Anthocyanin pigment (mlg. 100 gm^{-1} wet weight)**	**Treatments**
6.5 c	461.40 h	T1
7.83 ab	612.40 f	CH
7.83 ab	639.93 e	K
7.86 ab	659.30 e	M
7.50 abc	649.80 e	B
7.66 abc	645.20 e	KN_1
6.83 bc	570.87 g	KN_2
8.70 a	736.90 c	MB
7.83 ab	613.97 f	MKN_1
8.16 a	702.70 d	MKN_2
7.50 abc	654.80 e	BKN_1
7.66 abc	796.80 b	BKN_2
7.50 abc	812.10 b	$MBKN_1$
8.50 a	853.77 a	$MBKN_2$
1.27	23.03	$L.S.D_{0.05}$

The increase in yield parameters may be due to raise the absorption area which came from the fungal hyphaes deep permeation which increase the absorption area through the activity of root hairs as well as the hyphaes activity (Huez-Lopez *et al*., 2011) *Mycorrhizae* produces the Siderophores compound that works on chelate macro elements which increase their absorption and their role in metabolic activity which leads to increase the photosynthesis outputs and that's agree with (Karaki, 2017) by the transmission of photosynthesis outputs to the fruits and improve the yield qualities. The high ability of *Mycorrhizae* in producing Phosphatase enzyme which works on transfer the organic phosphorus to mineral phosphorus can be contribute in increase the plant absorption of phosphorus and fungal hyphaes which positively reflected on improve fruits growth and absorption (Smith and Read, 2008) or may be due to that the vaccination by *Azotobacter* increased the leaves area because of their nitrogen fixation and chlorophyll production which affected on the accumulation of photosynthesis productions leaded to increase the yield and that was agreed with (Zena *et al*., 1986). Or it may be due to photosynthesis productions that transferred by potassium which contribute in transfer the outputs from the source(leaves) to the sink (vegetative growth, flowers, fruits), as well as the activation of potassium for many enzymes which responsible for the activities of vegetative growth may contribute to increase the cellular activity and transfer of nutrients to the fruits and thus reflected on the yield (Patrick *et al*., 2001), or it may be due to the effectiveness of Nano-fertilizer to improve the enzymatic and biological reactions and the regularity of hormones (Grover *et al*., 2012), as well as its nutrition role in activating the nutrient movement, which is positively reflected on increase the yield and its components. This is consistent with Al-juthery et al. (2018).

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