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Effect of Mineral -Biofertilizer on Physiological Parameters and Yield of Three Varieties of Oat (*Avena sativa* L.)

Lamiaa M. Al-Freeh*, Sundus A. Alabdulla & Kadhim H. Huthily

Department of Field Crop, College of Agriculture, University of Basrah, Iraq

***Corresponding author e-mail: lamiaa.mahmood@yahoo.com**

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Abstract: To study the effect of biofertilizers on physiological parameters and yield of three varieties of Oat (*Avena sativa* L.), field experiments were conducted during winter seasons 2016-2017 and 2017-2018 at Al- Zubair district (20 km. West of Basrah province) in sandy loam soils. A split plot arrangement, using RCBD with three replicates, the main plots contained varieties: V_1 (Genzania), V_2 (Shaffaa), V_3 (Carloup), Biofertilizer, treatments were at the sub plots: B_0 (control), B_1 (NPK mineral fertilizer as recommended), B_2 (biofertilizers NPK), B_3 (mineral fertilizer PK+ biofertilizers N), B_4 (mineral fertilizer K+ biofertilizers NP), B_5 (mineral fertilizer P + biofertilizers NK), B_6 (mineral fertilizer N + biofertilizers PK). Data were collected on Flag leaf area FLA, Leaf area duration LAD, Leaf area index LAI, Crop growth rate CGR, Relative growth rate RGR, Net assimilation rate NAR, Plant high Tillers number m^2 and grain yield t ha^{-1}. The results showed that the adding of biofertilizers NPK (B_2) led to a significant increase in the studied traits (FLA, LAD, LAI, CGR, RGR, NAR, and grain yield). The grain yield were increased about 189.96 and 197.3% as compared with control in each seasons respectively. Cultivar Genzania resulted in highest grain yield among studied varieties in the first season (5.774 t ha^{-1}), while cultivar Shaffa gave the highest grain yield in the second season (8.691 t ha^{-1}). The interaction between Ganzania and B_2 treatment recorded the highest seed yield (8.429 tan ha-1) in the first season. While, in the second season all varieties that interacted with B2 treatment produced the highest seed yield.

Keywords: Oat, *Avena sativa,* Biofertilizer, Basrah, Iraq.

Introduction

Oat (*Avena sativa* L.) is a cereal forage crop which belongs to Poaceae family. It contains large amount of digestible crude protein, vitamin B1, minerals, fats and antioxidants (Brtnikowska *et al*., 2000), and contains soluble fiber, which is B-glucan (Anttila *et al.,* 2004). Oat has been named the medical plant in 2017 because of it is used as a cure for many diseases (Mayer, 2017). Increasing oat yield per unit area can be achieved by high yielding varieties and applying the optimum cultural practices, the use of biofertilizer was recommended to improve plant nutrient and production in sustainable way (Han *et al.*, 2006).

Basically, biofertilizer is a substance which contains microorganisms that colonizes the rhizosphere or the zone that surrounds the roots of plants (Shen, 1997). These microorganisms have ability to convert nutritionally important elements such as nitrogen, phosphorus and potassium (NPK) from unavailable to available form through biological processes. Different microorganisms used to supply different kind of nutrients in the soil. For examples, N-fixer microorganisms such as *Azotobactor chroococcum* can supply nitrogen by fixing the nitrogen from atmosphere and convert the nitrogen into ammonium ion for plants uptake, *Basillus megaterium* is one of the phosphorus solubilizer that apply in biofertilizer to solubilize phosphorus soil and rock in form of phosphate ion, then, KSB for instance *Basillus mucilaginosus* is function to solubilize potassium rock and can stimulate plant growth through synthesis of growth promoting substance. (Kawalekar *et al*., 2013), and induced resistance to environmental stress factors and direct or indirect suppression of plant pathogens (Malhotra & Srivastava, 2009).

The role and importance of biofertilizers in sustainable crop production has been reviewed by several authors. Santa *et.al.* (2004) studied that using of Azospirillum on wheat has an increased in grain yield (14.64 g plant $^{-1}$) as compared to the control plant (3.94 g plant^{-1}). It has also been increased wheat yield up to 30% inoculation with phosphate solubilizing bacteria (*Pseudomonas*) (Afzal & Bano, 2008).

Sivasakthi *et.al.* (2014) revealed that inoculation of *B. phosphaticum* as phosphate solubilizing bacteria and *B .mucilaginosus* as potassium solubilizing bacteria increased plant growth, nutrient uptake (NPK) then crop growth rate and rate of photosynthesis. Therefore, the study was designed to find most suitable biofertilizer combinations to improve the physiological characteristic and yield of three varieties of Oat .

Materials & Methods

Two field experiments were conducted during the agricultural season 2016-2017 and 2017-2018 in Zubair district (20 km west of Basrah Governorate Centre). The aim is to study the response of three varieties of oats (Genzania, Shaffaa and Carloup) to biofertilizer and mineral fertilizer. experimental design was, split plots according to Random Complete Block Design (R.C.B.D.) with three replicates. A composite sample was taken in both seasons to evaluate some chemical and physical analysis (table 1) at the Central laboratory, College of Agriculture, University of Basrah, according to the methods mentioned in Black (1965) and Page. *et al.* (1982).

The soil was created for plants cultivation by plowing, smoothing, settling, and then the soil divided into three blocks. Each block divided into seven main plots and each main plots divided into three sub- plots (experimental units) with dimensions 2×3 m^2 . A distance of 1 m between the experimental units and 2 m between blocks have been left. The total number of experimental units became 63.

The experiment consisted of two factors: bio-fertilization and varieties. A- Bio and mineral fertilization combinations are as follows: B0 = no addition, B1 = NPK mineral fertilizer, B2 = Bio-Fertilizer NPK, B3 = Bio N + mineral PK, B4 = Bio NP + K mineral, B5 = Bio NK + mineral P, B6 = Bio PK + N mineral. Three types of Bio-fertilizer were used: (1)- nitrogen bio-fertilizer is a free nitrogen-fixing bacteria of the type *Azotobacter chroococcum.* (2)- a mixture of two types of phosphorus solubilizing bacteria which are *Pseudomonas putida* and *Pantoea agglomerans.* (3)- A mixture of two types of potassium are: *Bacillus subtits* and *Bacillus mucilaginosus*.

B- Varieties are as follows: Genzania, Shaffaa and Carloup.

Each experimental unit consisted of 11 rows of 3m long and a 20 cm distance between one row and another. The sowing was carried out on 12/11/2016 and 15/11/2017 for the two season respectively at a rate of 120 kg^{-1} seed. ha^{-1} (Mohammad, 2017). The seeds were inoculated according to the recommendations of the producing company by mixing 50 g of bio-fertilizer with a litre of water, well mixed and sprayed on the seeds directly before planting. After spraying seeds with a sugar solution (glucose + water) to ensure adhesion and encourage bacteria compost to grow. Mineral fertilizers used were urea fertilizer (46% N) at a rate of 120 $kg.ha^{-1}$ were used in two times. The first time was applied after two weeks from seedling emergence. The second time applied at elongation phase. The phosphate fertilizer was added at sowing at rate of 100 $kg.ha^{-1}$ in form of DAP fertilizer ($P_2O_5$46%). The potas fertilizer was added twice, the first half after the emergence stage and the second half at the elongation stage at a rate of 120 kg^{-1} in the potassium sulfate form 52% K_2O (Al-Abide, 2011; Mohammad, 2017). The irrigation process was carried out immediately after planting. The harvest applied when 50-75% of plants reached full maturity.

Table (1): Some of the chemical and physical qualities of the experimental soil before sowing for two seasons.

Character	value		Unit
	Season 1	Season 2	-
pH (irrigation water)	7.44	7.30	-
pH (soil)	8.00	7.80	-
Electrical conductivity E.C (irrigation water)	3.30	3.50	des. m^{-1}
Electrical conductivity E.C (soil).	4.30	4.70	
Available N: (NH4 + + $NO3^{-1}$)	84.00	80.00	mg Kg^{-1} soil
Available Phosphorus	3.50	2.90	
Available Potassium	0.127	0.150	$meq.l^{-1}$
Clay	20.53	20.13	
Silt	21.44	21.54	%
Sand	58.03	58.33	
Soil texture	Sandy loam	Sandy loam	

Parameters Studied

Physiological parameters: In order to study some of physiological traits, plant samples were taken randomly from an area of 30 x 30 cm^2 during the period started from in between the elongation and flowering stage, where the period of rapid growth according to the growth analysis curve (Sigmoid), except the characteristic of leaf area duration which was taken at the stage of flowering and maturity as reported by Hunt *et. al*. (1982).

1-Flag leaf area (cm^2):

The leaf area was calculated as a mean of ten plants selected randomly in the flowering phase according to the following equation:

Flag leaf area= leaf length × maximum width x 0.75 (Thomas, 1975).

2- Leaf Area Duration (L.A.D) day

The following law it was calculated from:

L.A.D = (LAI1 + LAI2) × (T2-T1)/2

LAI1 = Leaf Area Index in the flowering phase.

LAI2 = Leaf Area Index at the physiological maturation stage.

T1 = number of days until the flowering.

T2 = number of days until physiological maturation stage.

3- Leaf Area Index (LAI)

By the total area of foliage divided by the area occupied by the plant (30 × 30) cm^2.

4- Crop Growth Rate (C.G.R.) gm. $days^{-1}$ m^{-2}:

C.G.R. = (1/A) × (W2-W1)/ (T2-T1)

A = Land area; W2 = dry weight in flowering phase; W1 = dry weight in elongation phase;

T2 = Number of days until the flowering of; T1 = Number of days until elongation

5- Net Assimilation Rate (N.A.R.) gm. m^{-2} $days^{-1}$:

N.A.R = (W2-W1/T2-T1)×(log LA2-Log LA1/LA2-LA1)

W2 = Dry weight at flowering phase, W1 = dry weight in elongation phase

T2 = Number of days up to flowering T1 = number of days until elongation

LA1 = L.A. in elongation phase, LA2 = L. A. in flowering phase

6- Relative Growth Rate (R.G.R) mg^{-1} gm^{-1} day^{-1}:

R.G.R. = (LnW2-LnW1)/t_2-t_1

LnW2 = Inverted natural logarithm of dry weight in flowering phase

LnW1 = Inverted logarithm of dry weight in elongation phase

7- Plant height (cm)

Plant height was measured at the flowering stage as mean of ten plants randomly selected from each experimental unit.

8- Number of Tillers:

They were calculated from of an area (60 × 200) cm^2 then converted to square meters.

9. Seed yield (ton ha^{-1}):

Data were statistically analyzed using SPSS statistical program version 20 and the arithmetic averages compared using a less significant difference method (L.S.D) at the probability level of 0.05 (Al-Rawi & Khalaf-Allah, 2000).

Results & Discussion:

1-Flag Leaf Area (FLA)

The results of table (2) explained the significant effect of bio-fertilization on the FLA for two seasons. B2 treatment lead to increase the area of the flag leaf and gave

26.76 and 27.15 cm^2 with an increase of 65.21 and 31.15% respectively compared to the control (16.594 and 20.65 cm^2). The reason of increasing FLA is due to the effect of biofertilizer in nitrogen fixation by the *A. chroococcum* bacteria that secrete the nitrogenase enzyme which increased the soil content of the nitrogen and thus increases the fertility of the soil, that reflected on the growth of the plant (Al-Rashedi & Taj Al-Din, 1988), increasing the density and efficiency of microorganisms around the roots led to raise the level of nutrients in the plant that effect on increasing the cells division and that led to expand the flag leaf (Javid & Suhab, 2010). This is consistent with Al-Hassan (2017) and Mahmoud (2019).

The results indicated that there is a significant differences between the cultivars in FLA at the two seasons. Shaffa gave the highest area of flag leaf in the first season (25.60 cm^2), with an increase of 24.45% compared with Genzania, which recorded the lowest area of flag leaf (20.45 cm^2). Genzania genotype revealed a reverse effect in the second season compared with first season which recorded highest area of flag leaf area (24.14 cm^2) with an increase of 6.06% for the Carlup type (22.76 cm2). The differences between the two varieties can be attributed to their genetic differences, photosynthesis efficiency, and the effectiveness of compounds formed and enzymes attributed to increasing cells division including flag leaf cells that led to increase the area (Mania & Kadeem, 2014). This is consistent with Al-Jubouri *et al.* (2017), Al-Hajooj (2018) and Alrubaiee (2019).

Significant interaction occurred between Biofertilizer and cultivars on the FLA during the two seasons. Genzania with treatment B2 gave the highest FLA of 28.48 and 29.09 cm^2 for the two seasons consequently with an increase of 90.9 and 49.72% compared with the two cultivar Shaffa under B0 in season one and Carloup underB5 in season two which they recorded 14.92 and 19.06 cm^2 respectively (Fig. 1). The variation in species response to bio-fertilizer may be because the varieties differ in their ability to benefit from the contents of compost depending on their genetic features.

2- Leaf area duration (LAD).day^{-1}

The results illustrated in table (2) displayed that the treatment B2 in both seasons gave higher LAD 138.00 and 124.90 days respectively with 18.5% and 16.5% increase as compared with control which gave the lowest duration 116.49 and 107.23 days respectively, furthermore nitrogen has a role in building. The porphyrin ring which is part of chlorophyll molecule structure and continuously fixed it through the leaves evolution and developing contributing in delay leaves aging and extent leaves duration (Mengel & Kirkby, 1987), In addition, phosphorus plays a role in increasing the root mass, which lead to increased elements uptake which causes the reduction and delay leaves aging. Potassium plays a role through the balancing between the effect of nitrogen and phosphorus on maturity of the plant, which increases nitrogen absorption and synthesis where it increases nitrogen absorption, synthesis and increase the plant absorb phosphorus (Al-Alwi, 2011) and this is confirmed by the correlation values between the LAD and FLA (r =**0.665 and r = ** 0.391) and the LAI (r = ** 0.639 and r=** 0 .280) and CGR (r = ** 0.752 and r = ** 0.122) for the seasons respectively.

The results indicated that there is a significant differences between the cultivars in FLA for the two seasons. Shafaa gave high

LAD (132.24 days), while the two genotypes Genzania and Carluop gave lowest LAD and (130.62 and 130.88) days for the two species sequentially and did not differ significantly. This is consistent with Azarpour *et al.* (2014), Hisir *et al.* (2014) and Al-Jabouri *et al.* (2017), which they are referred to the differences between species in LAD due to the variation of genetic factors which control the physiological phenomena.

The results of Fig. (2) exhibited that the superiority of Genzania under treatment B2, 139.17 days in the first season, and Carlup under the treatment B2 in the second season which recorded highest LAD 130.40 days, while the combination of B0 × Genzania for the first season was 116.26 days and Shaffa was recorded in the second season treatment B4, the minimum LAD was 102.96 days.

3- Leaf Area Index LAI

The results of table (2) revealed that both treatments B1 and B2 in first season and B2 in second season gave 5.82, 5.82 and 6.97 respectively, with an increase of 34.67 and 17.44 % compared with a control which refer lowest LAI in two the seasons (4.32 and 5.93) respectively. The interaction of different microorganisms led to early increased in the nitrogen fixation and solubility of both phosphorus and potassium in early stage of plant growth, so plant was encouraged to produce plant hormones, as well as to protect the plant in the rhizosphere against pathogenic fungal species, roots are increased through lateral capillary growths and increased roots surface area which led to increase water and nutrients absorption from the soil, reflected on the plant increase the number and size of the formed leaves, which has led to an increase LAI (Sivasakthi *et al.*, 2014) and this is consistent with Shirkhani and & Nasrolahzadeh (2016) and Nooni (2018).

The results of two seasons displayed that Shaffa gave the highest LAI in the first season (5.56) while the Genzania gave highest LAI in the second season 6.41, with an increase of 5.85 and 5.13% respectively compared with Carlup which produced the lowest LAI 5.25 and 6.10 for the two seasons respectively. The differences in between varieties in trait of leaf area index reflects the difference in the ability of the varieties on tillers formation. This is reflected in the difference in the number of leaves as well as the area of the total leaves area/plant. This is consistent with the findings of Hisir *et al.* (2012) which pointed to the differences of verities in LAI due to the varieties ability and their nature in the formation of highest LAI.

The effect of interaction between Bio-fertilizer and the cultivars was significant in terms of the LAI in two seasons. In the first season, Genzania × B6 was given the highest average LAD (6.16). The rate of increase was 59.94% (Fig. 3). In the second season, Genzania was superior in B2 treatment and gave LAI of 7.69 with an increase of 33.27% compare with Carloup, which gave lowest LAI in B3 treatment (5.77).

4- Crop Growth Rate gm. day $^{-1}$ m $^{-2}$ (CGR)

The results of table (2) indicated the superiority of treatment B_2 and gave 11.19 and 10.04 gm. day^{-1}.m^{-2}, with an increase of 177.4 and 58.45% for two seasons compared with control treatment which gave the lowest average of CGR that reached to 4.04 and 6.53 g day $^{-1}$.m $^{-2}$ for the two seasons sequentially, and this is consistent with Bilal *et al.* (2017).

The results indicated that there is a differences in between the varieties in CGR, Shaffa gave the highest averages (9.05 gm. day $^{-1}$.m $^{-2}$) in the first season, while Carlup gave 9.11 gm. day. $^{-1}$.m $^{-2}$ in the second season with an increasing reached to 30.19 and 10.8% compared to Genzania, which gave the lowest CGR 6.95 and 8.22 gm. day^{-1}.m^{-2} for two seasons respectively, and this is consistent with Bilal *et al.* (2017); Verma *et al.* (2017; Alrubaiee (2019), who they found that the difference in oats due to different genetic composition and different ability to improve the qualities of growth.

The results of fig. (4) indicated that Shaffa was the superior in treatment B_2 in the first season and gave 12.81 gm. day^{-1} m^{-2}, while Genzania was higher with B_2 in the second season 10.28 g day^{-1} m^{-2}. In the first season the control treatment was the lowest average of CGR 3.61 gm. day^{-1} m^{-2}, whereas in the second season the interaction of Carlup x B6 treatment gave 5.67 gm. day $^{-1}$ m $^{-2}$. This is consistent with the findings of Bilal *et al.* (2017).

5- Net Assimilation Rate NAR gm. m^{-2} day^{-1}

The results of table (2) indicated that B2 treatment gave the highest value of NAR in two seasons 1.926 and 1.53 gm. m $^{-2}$.day $^{-1}$ by increasing 106.65 and 48.45% compared with control which gave 0.93 and 1.10 gm. m $^{-2}$ day $^{-1}$ respectively, this can be explained by the early nutrient availability at the early stage of plant growth increasing the efficiency of photosynthesis Which led to an increase of accumulation of dry matter (Yao *et al*., 1990). This was confirmed by the correlation values of NAR with growth characteristics, including the FLA, LAI and CGR. The correlation coefficient was r=** 0.596 r =** 0.420 r =** 0.848 in the first season., while in the second season were r =** 0.263 r =** 0.302 r =** 0.262.respectively, Shaffa variety gave 1.710 and 1.424 gm. m $^{-2}$ .day $^{-1}$ for two seasons respectively, while Genzania recorded the lowest value of 1.411 and 1.282 gm. m $^{-2}$.day $^{-1}$ of the seasons respectively. The different varieties in NAR reflects its different morphological characteristics, leaf area and leaves (Hisir *et al.*, 2012). These results were agreed with Azarpour *et al.* (2014)) and Al-Jabouri *et al.* (2018), who reported that the different types of NAR were due to their genetic diversity.

In fig. (5) at the first season, Shaffa with B2 treatment gave the highest value of NAR 2.176 gm.m^{-2}.day $^{-1}$, while Genzania with B6 gave the lowest 0.867 gm.m^{-2}.day $^{-1}$, in the second season, Carlup B2 gave 1.786 gm. m^{-2} .days^{-1}, while Shaffa with control gave the lowest 0.987 gm. m^{-2}.day^{-1}.

6-Relative Growth Rate mg.gm^{-1}day^{-1} (RGR)

The results of table (2) presented that Biofertilizer B2 treatment was higher rate of RGR (13.57 and 20.17 mg.gm^{-1}.day^{-1}) for two seasons respectively, with an increase of 54.75% and 64.83 compared with control (B0) which gave 8.77 and 12.24 mg. gm^{-1}.day^{-1} of two seasons. The difference between varieties in RGR was clearly in the first season only. Carlup was the highest with 12.18 mg^{-1}.day^{-1}, with an increase of 11.42% for Genzania, which gave the lowest 10.93 mg.gm^{-1}.day^{-1}, The variability of varieties in RGR due to the differences in the accumulation of dry matter and the differences in the genetic performance that led to different growth rates (Al-Bayati *et al.*, 2013; Azarpour *et al.*, 2014). The correlation between the CGR and the RGR was determined. The correlation coefficient was r = ** 0.679 and r = ** 0.290 for the two seasons respectively. This result was agreed with Al-Jubouri *et al.* (2017), Verma *et al.* (2017) and Alrubaiee (2019). Carlup was the superior at B2 treatment and gave 15.38 and 21.06 mg. $gm^{-1}.day^{-1}$ respectively for two seasons, Genzania with B4 in the first season gave 8.27 $mg^{-1}.day^{-1}$, while Genzania with control gave 10.53 $mg^{-1}.day^{-1}$ in the second season (see fig. 6).

7- Plant height (cm)

The results of table (2) revealed that the treatment of biofertilizer B3 was significantly effected in plant height and gave 77.79 and 89.18 cm respectively increasing by 10.14 and 9.84% compared with control which gave the lowest 70.63 and 81.19 cm respectively. The reason for this can be attributed to the adding of Biofertilizer of all kinds had an effect on the efficiency of *A. chroococcum*. In the nitrogen fixation on the other hand stimulated root growth as well as the secretion of some plant hormones (IAA and Gaberlin and cytokinein) affecting the division and expansion of cells and increase the absorption of essential nutrients, (Khalifaa, 2016). Phosphorus also affects plant height through a cycle of high-energy compounds (ATP), which act as co-factors of enzymes in the plant. It also strengthens plant roots and their branches, helping to increase nutrients uptake of soil solution (Al-Tamimi, 2005). Potassium also has a positive effect on increasing the plant height of the biochemical cycle by stimulating the photosynthesis process, activating the cell division and elongation by an ideal extension in the cellular wall which is necessary for the split process (Sivasakthi *et al*., 2014). This is consistent with Bilal *et al.* (2017); Mahato & Kafel (2018) and Mahmoud (2019).

The results of table (2) indicated a significant effect of varieties on plant height during the two seasons. In the first season Shaffa, while Genzania in the second season showed the highest plant height which reached to 77.36 and 88.99 cm respectively with an increase of 6.8 and 9.36% as compared to Carlup that gave the lowest plant high 72.43 and 81.37cm for the two seasons respectively. This is due to the genetic variability in between the varieties, as well as the difference due to the difference in content of hormones of Oxines and Gaberlin responsible for elongation and expansion of cells (Zamir, 2010). This is consistent with Al-Zirkani, (2017), Al-Hajooj (2018) Alrubaiee (2019). Fig. (7) indicates the superiority of Shaffa with B1 which gave the highest plant height 83.66 cm in the first season with an increase reached to 23% compared to Shaffa, that gave the lowest plant high 67.47 cm, in the second season, Genzania produced the higher plant high with B1treatment (96.28 cm) with an increase reached to 24.47% as compared to Genzania with B0 (75.86 cm). This is consistent with (Saleem *et al*., 2015).

8- Number of Tillers

The results of table (2) showed that B_2 gave the largest number of tillers 571.24 and 806.79 $tiller.m^{-2}$ for the two seasons, with an increase of 44.77 and 44.86% for the two seasons compared with control which gave the lowest 399.59 and 534.31 $tiller.m^{-2}$. The increase in the number of tiller may be due to the effectiveness of *Azotobacter*, *Pseudomonas* and *Bacillus* in the supply of sufficient amounts of nitrogen, phosphorus and potassium, as well as production of growth regulator by bacteria, which leads to increase roots system growth, increases the absorption of water and soil nutrients (Akbari *et al*., 2007) This is consistent with Bilal *et al.* (2017), Mahato & Kafele (2018) and Mahmoud (2019). Carloup gave the highest number of tillers 570.75 $tiller.m^{-2}$, with

Table (2): Growth traits and grain yield of oat as influenced by Biofertilizer and varieties for two seasons.

character factors		FLA m^2	LAD day	LAI	CGR gm. day^{-1} m^{-2}	NAR gm. m^{-2} day^{-1}	RGR mg gm^{-1} day^{-1}	Plant High cm	No of Tillers (m^{-2})	Grain Yield ton h^{-1}
		First season								
Bioferliser	B_0	16.59	116.49	4.32	4.04	0.932	8.77	70.63	399.59	2.739
	B_1	24.16	136.73	5.13	9.21	1.918	12.80	77.04	517.23	6.468
	B_2	26.76	138.00	5.82	11.19	1.926	13.57	77.36	571.24	7.942
	B_3	21.60	130.66	5.76	7.93	1.411	10.04	77.79	5535.1	6.035
	B_4	23.53	132.87	5.82	8.40	1.790	9.77	72.08	6537.8	5.927
	B_5	21.39	131.43	5.16	9.15	1.702	12.61	75.75	8537.9	5.825
	B_6	21.00	132.07	5.74	7.31	1.256	12.18	73.66	516.85	4.812
LSD		1.35	2.28	0.39	1.036	0.21	0.438	5.55	13.355	0.188
cultivars	**Genzani**	20.57	130.62	5.37	6.95	1.411	10.92	74.92	3447.2	4535.
	Shaffaa	25.60	132.24	5.56	9.05	1.710	11.06	77.36	556.43	2775.
	Carloup	20.69	130.88	5.25	8.10	1.560	12.18	72.43	570.75	5.730
LSD		0.71	1.247	0.18	0.567	0.13	0.66	5.55	10.245	0.15
		Second season								
Bioferliser	B_0	20.65	107.23	5.93	6.53	1.100	12.24	81.19	34.315	3.889
	B_1	26.19	116.37	6.34	9.19	1.454	16.51	85.53	3711.7	7.594
	B_2	27.15	124.90	6.97	10.04	1.533	20.17	87.16	06.798	11.562
	B_3	22.50	111.92	6.00	8.25	1.379	14.44	89.18	216.17	7.992
	B_4	23.75	115.96	6.52	8.52	1.440	15.72	84.75	796.27	9.472
	B_5	21.44	112.49	6.24	8.13	1.311	12.57	82.90	803.27	7.551
	B_6	22.72	111.95	6.05	7.35	1.307	15.34	85.34	7706.1	7.274
LSD		1.97	7.295	460.	0.311	0.389	0.648	2.258	31.87	0.65
cultiva	**Genzania**	24.14	115.56	6.41	8.22	1.282	14.85	88.99	714.09	7.869
	Shaffaa	23.56	112.00	6.37	8.50	1.424	15.64	85.09	708.35	8.691
	Carloup	22.76	115.64	6.10	9.11	1.339	15.36	81.37	09.597	7.156
LSD		1.03	S.N	0.17	0.198	0.25	N.S	1.88	N.S	0.33

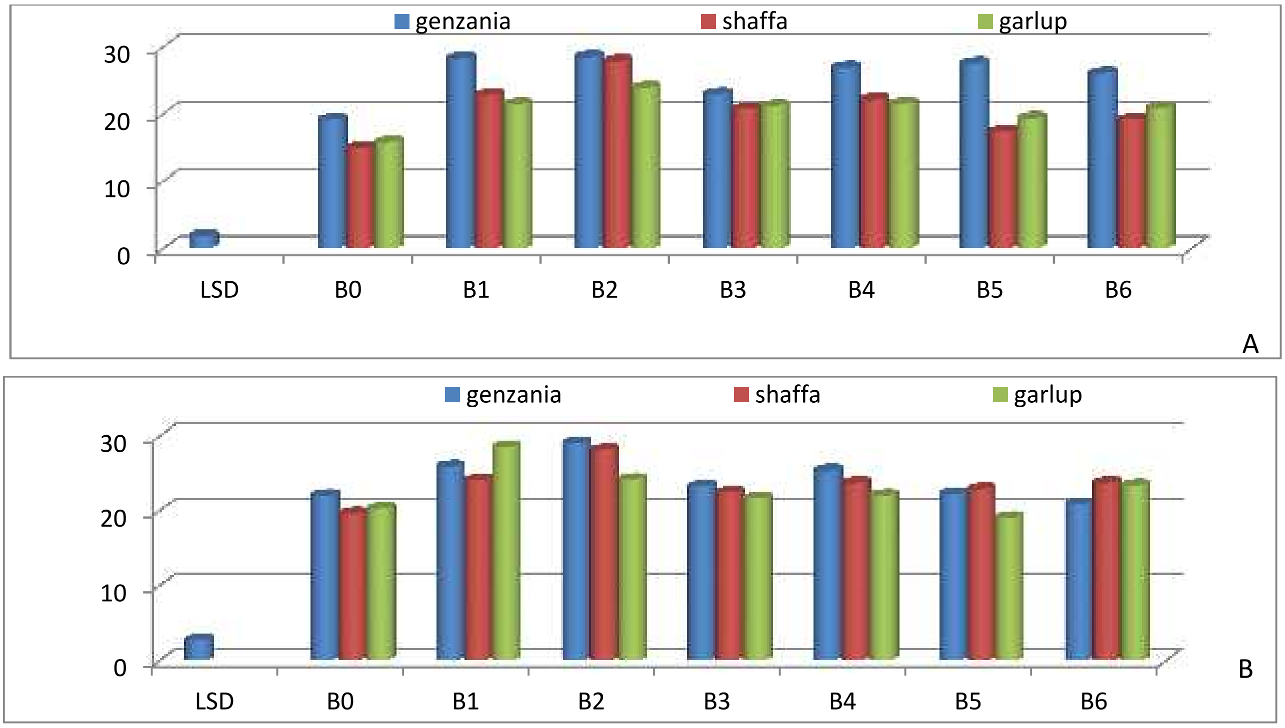


Fig. (1): Effect of interference between Biofertilizer and cultivars in the FLA (cm^2). A-Season I, B-season II.

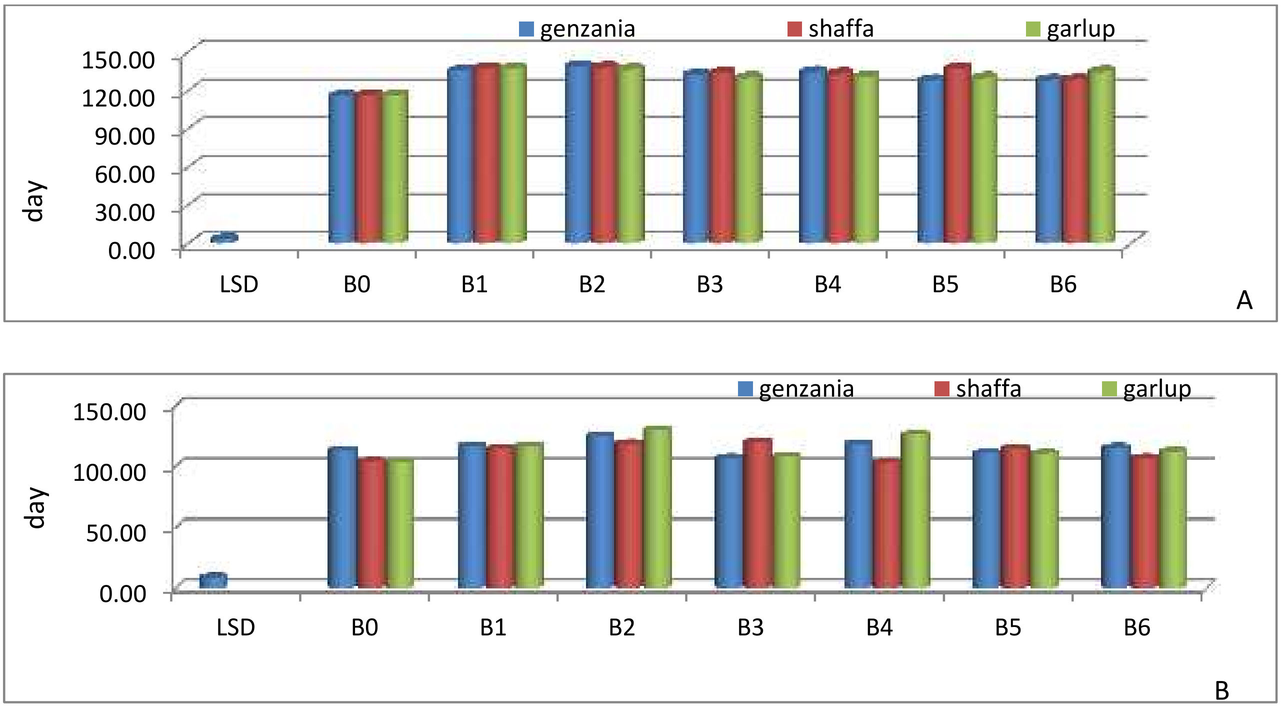


Fig. (2): Effect of interference between Biofertilizer and cultivars in the L A D (day): A-Season I, B- Season II.

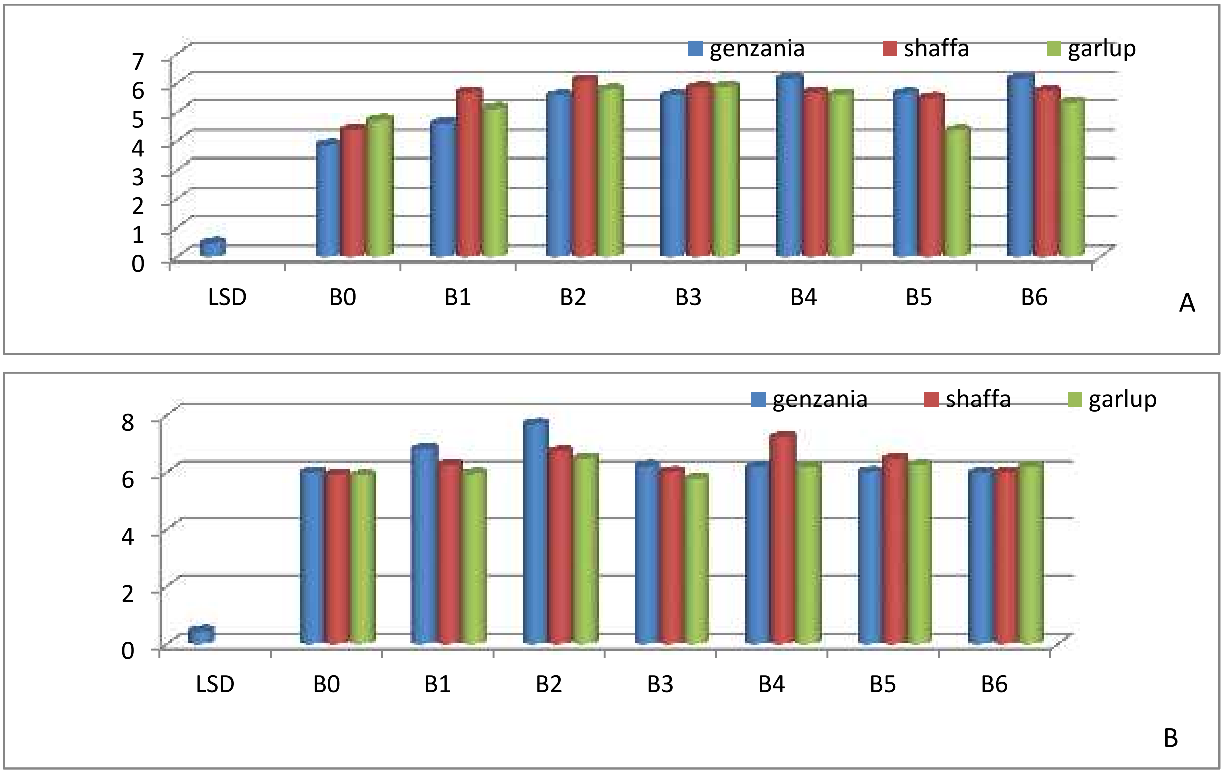


Fig. (3): Effect of interference between Biofertilizer and cultivars in the LAI: A–Season I, B-season II.

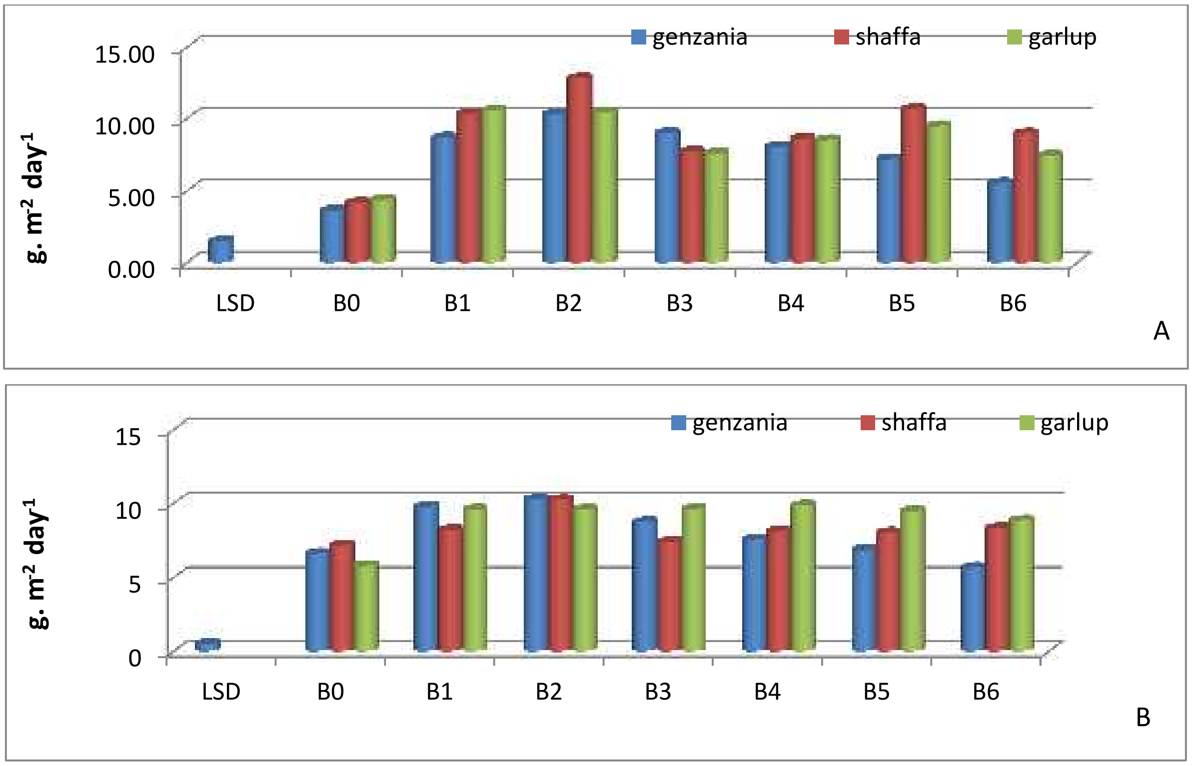


Fig. (4): Effect of interference between Biofertilizer and cultivars in the CGR (g. m^{-2} day^{-1}). A-Season I, B-season II.

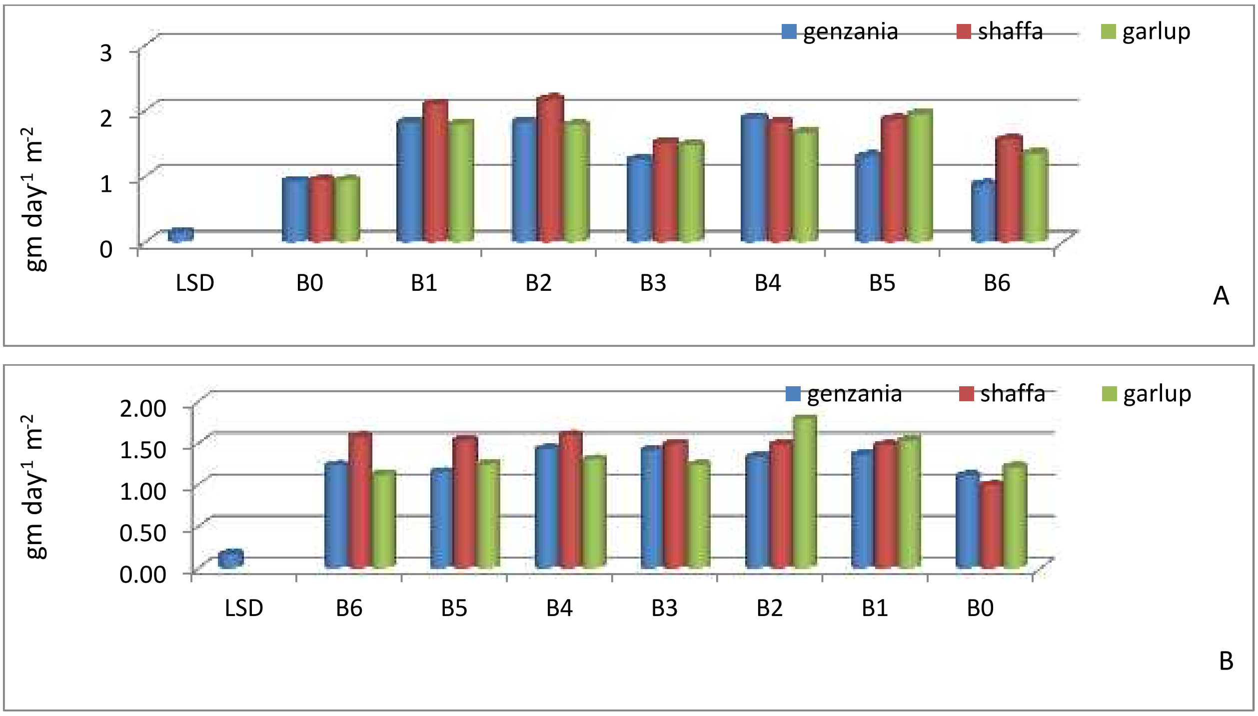


Fig. (5): Effect of interference between Bio-fertilizer and cultivars in the NAR (gm. Day^{-1} m^{-2}): A-Season I, B-Season II.

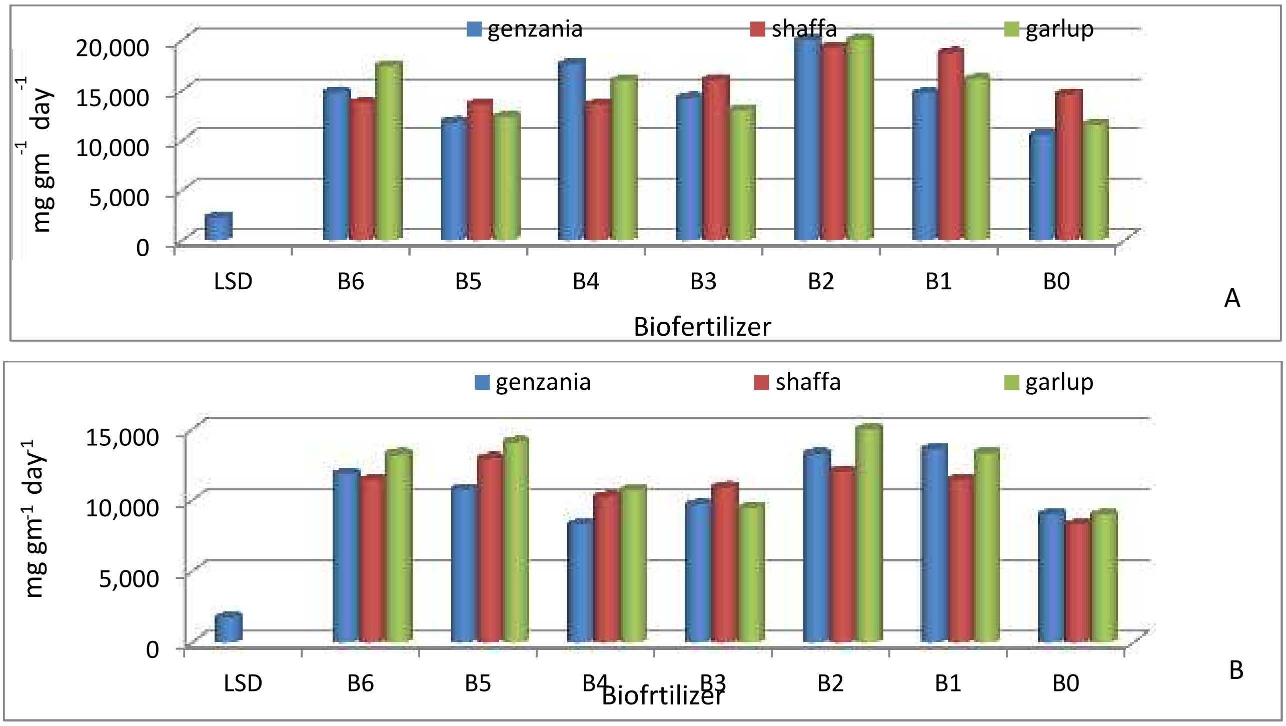


Fig. (6): Effect of interference between Bio-fertilizer and cultivars in the RGR (mg gm^{-1}. Day^{-1}) A–Season I, B-season II.

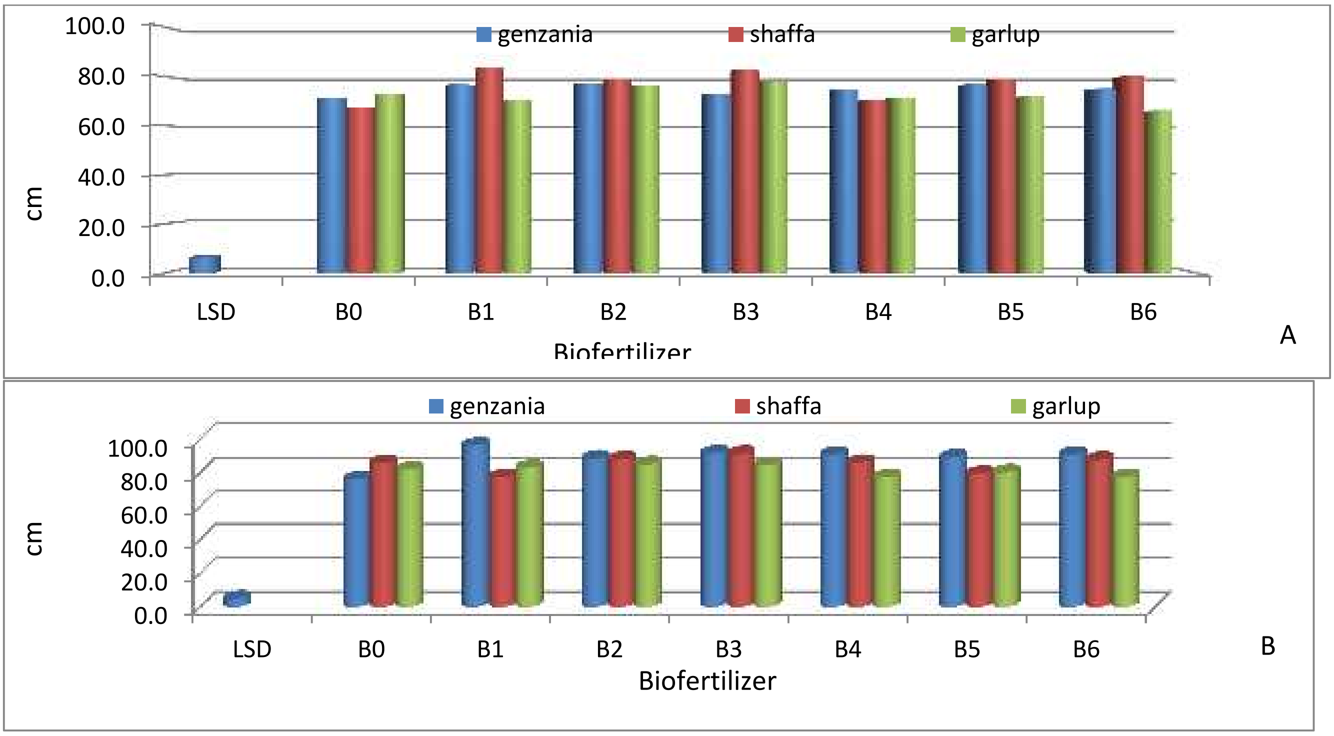


Fig (7): Effect of interference between Bio-fertilizer and cultivars in plant high (cm). A–Season I, B-season II.

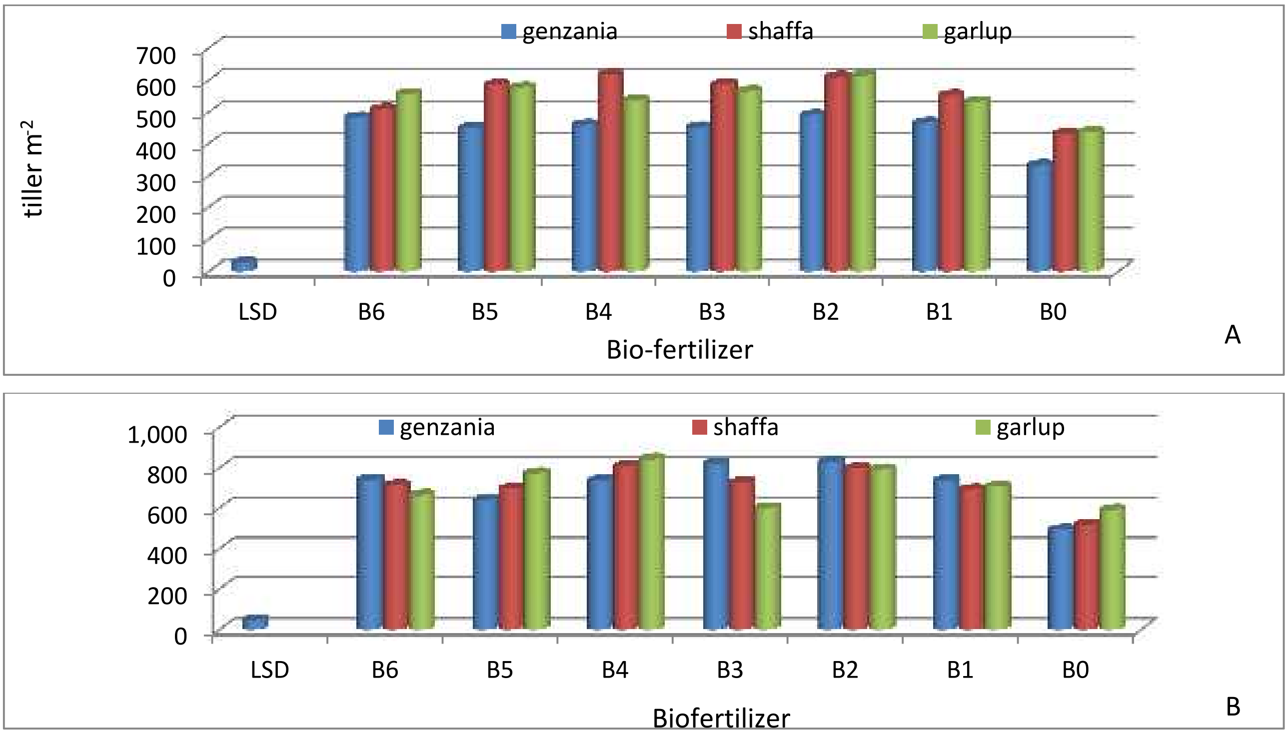
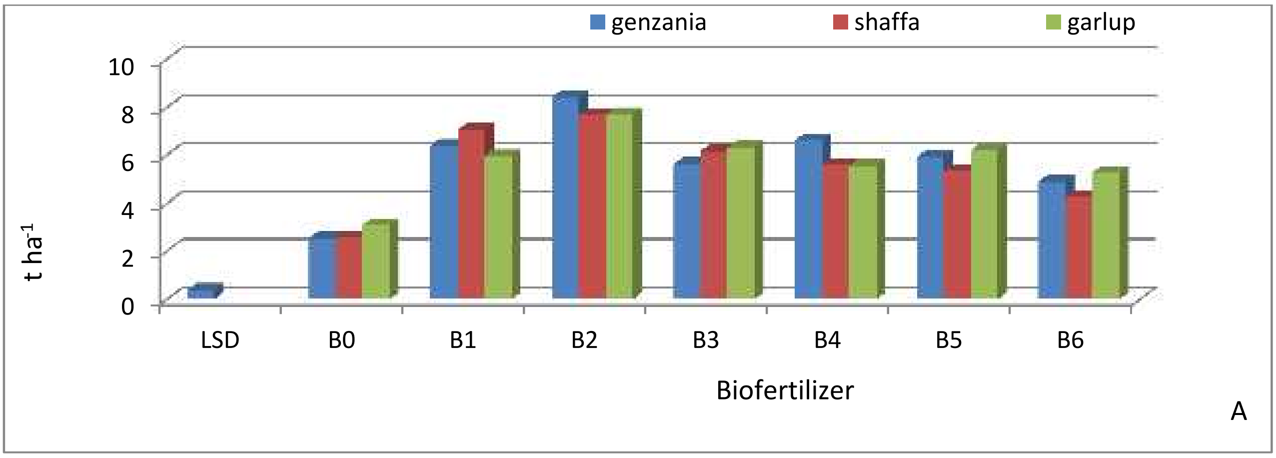


Fig. (8): Effect of interference between Bio-fertilizer and cultivars in the No of Tiller (m^{-2}): A–Season I, B-season II.



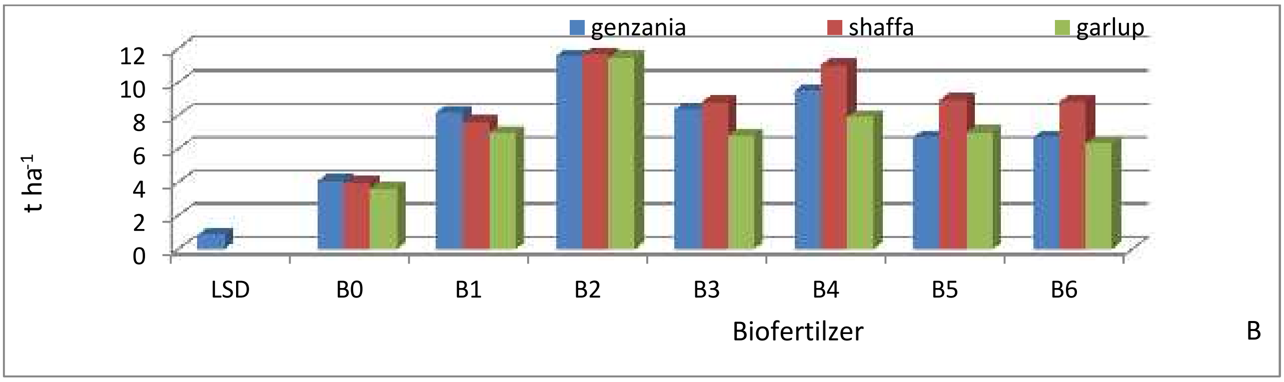


Fig. (9): Effect of interference between Biofertilizer and cultivars in the grain yield (t h^{-1}): A–Season I, B-season II.

24.42% increase compared with Genzania which was gave 447.23 tiller.m^{-2}. This is consistent with Al-Hajooj (2018) and Alrubaiee (2019). Significant interaction was also observed during the two seasons (Fig. 8). In the first season, Shaffa with B4 treatment gave the highest 617.11 tiller.m^{-1}. In the second season B4 with Genzania gave 842.50 tiller. m^{-2} with an increase of 85.37 and 59.01%, as compared with Genzania in control treatment which gave lowest number was 332.90, 492.59, tiller.m^{-2} in two seasons, this is consistent with Saleem *et al.* (2015).

9 - Grain yield (ten ha^{-1})

The results of table (2) showed that B_2 treatment gave the highest grain yield 7.942 and 11.562 t.ha^{-1} for two seasons respectively, with an increase reached 189.96 and 197.3% compared with control treatment that gave the lowest grain yield 2.739 and 3.889 t. ha^{-1} for the two seasons respectively, with an increase of 52.27% 24.18–% compared with B2 treatment. The superiority of the B2 treatment due to the availability of the nutrients necessary for growth from different varieties of microorganisms, which led to an increase in the quantity of elements available during the growth stages. This is due to the increase in the FLA, LAD, LAI, RGR, and the number of tillers. m^{-2}. All these led to increase in NAR and storage in cereals. This result confirm the importance of the use of Bio-fertilizer by increasing plant growth and productivity, which is consistent with Bilal *et al.* (2017) and Mahmoud (2019). Genzania gave the highest yield 5.774, While Shaffa gave the lowest 5.532 t. ha^{-1} while Shaffa at the second seasons gave the highest 8.691 t ha^{-1} while Carlup gave the lowest (7.156 t. ha^{-}

[1]), this result agreed with Al-Hajooj (2018) and Alrubaiee (2019). Genzania was superior with B2 gave the highest yield 8.429 t. ha^{-1}, while Genzania with control treatment of the lowest amount of 2.546 t. ha^{-1} (Fig. 9). In the second season, Shaffa with B_2 gave the highest yield 11.645 t. ha^{-1}, with no significant difference from the other cultivars at the same treatment,. while Carloup 3.627 t. ha^{-1} with control.

Conclusion

The results indicate that oats can be grown in Basrah, particularly in the western areas with light soils, and can be used for bio-fertilization, reducing economic losses and pollution hazards from chemical fertilizers.

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