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

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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.

Key words: **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 *Azotobacter 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 and 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 Page. *et al*. (1982) and Black (1965). The soil was created for plants cultivation by ploughing, smoothing and settling, and then divided into three Blocks in each block seven main plots and divided each plot into three sub- plots (experimental units) with dimensions (2×3) and an area of 6 m^2 and left a distance of 1 m between the experimental units and 2 m between blocks, The total number of experimental units became 63, and 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 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 biofertilizer with a liter 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 was applied at two weeks after the emergence of seedling. The second applied at the elongation phase. The phosphate fertilizer was added at sowing and at the rate of 100 kg ha^{-1} in the form DAP fertilizer ($P_2O_5$46%). The potash fertilizer was added twice at a rate of 120 kg^{-1} in the potassium sulfate form 52% K_2O, the first half after the emergence stage and the second half at the elongation stage (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.

Parameters Studied

Physiological parameters: The physiological parameters studied were taken randomly from an area of 30 x 30 cm from each experimental unit in the period 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).

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	
	Sandy loam	sandy loam	

1-Flag leaf area (cm ^{2}): The leaf area was calculated as a mean of ten plants selected randomly in the flowering phase and 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 in 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) it 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}).

Statistically analyzing data for all attributes using SPSS Statistical program version 20 and comparing arithmetic averages 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 showed the significant effect of bio-fertilization on the FLA for two seasons. B2 treatment led 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% compared with 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 and 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 indicate 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%.compare with Genzania, which record the lowest area of flag leaf (20.45) cm2. Genzania genotype showed a reverse effect in the second season compared with first season which recorded highest area of flag leaf (24.14) cm^2 with an increase of 6.06% for the Carlup type (22.76 cm2). The difference 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 two seasons consequently with increase of 90.9 and 49.72% compare with two cultivar (Shaffa *B0) in season one and (Carloup *B5) in season two which recorded (14.92,19.06) cm^2 respectively (Fig. 1). The variation in species response to biofertilizer 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

The results illustrated in table (2) that the treatment B2 and both seasons gave higher LAD (138.00 and 124.90) days for two seasons respectively with (18.5% and 16.5%) increase as compared with control that 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 1s leads 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 ant it is 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 indicate 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 in between species in LAD due to the variation of genetic factors which control the physiological phenomena.

The results of Fig. (2) showed the superiority of Genzania in treatment B2, 139.17 days in the first season, and Carlup in treatment B2 in the second season recorded highest LAD 130.40 days, while the combination 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)showed that treatments B1,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 an increase 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 & Nasrolahzadeh (2016) and Nooni (2018).

The results of two seasons showed that Shaffa gave the highest LAI in the first season (5.56) while the Genzania gave highest LAI in the second season produced the highest LAI of 6.41, with an increase of 5.85 and 5.13% respectively compare with Carlup which produced the lowest LAI 5.25 and 6.10 for the two seasons. The difference in the varieties in train 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) they 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 Biofertilizer and the cultivars was significant in terms of the LAI in two seasons. In the first season, Genzania × B6 was given the highest average of 6.16. The rate of increase was 59.94% 3.86 (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) indicate 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 compare with control treatment which gave the lowest average CGR was 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 the difference in the varieties affected the 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 increase by 30.19 and 10.8% compare with Genzania, which gave the lowest 6.95 and 8.22 gm. day -1 m -2 for two seasons, and this is consistent with Bilal *et al.* (2017); Verma *et al.* (2017) and Alrubaiee (2019), who 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) showed that Shaffa was 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 was the lowest average of CGR 3.61 gm. day $^{-1}$ m -2, whereas in the second season the Carlup *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) showed 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 difference in the accumulation of dry matter and differences in the genetic that led to different growth rates (Al-Bayati et al., 2013 and 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 superior at B2 treatment 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 (Fig. 6).

7- Plant height (cm)

The results of table (2) showed 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 and Kafel (2018) and Mahmoud (2019).

The results of Table (2) showed the significant effect of varieties on plant height during the two seasons. In the first season Shaffa ,Genzania in the second season showed the highest plant height 77.36 and 88.99 cm respectively with an increase of 6.8 and 9.36% for Carlup which gave the lowest 72.43 and 81.37cm respectively. This is due to the genetic variability of 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) and Alrubaiee (2019)., Fig. (7) indicates the superiority of the Shaffa with B1 gave the highest height 83.66 cm in the first season with an increase of 23% compared with Shaffa, which gave the lowest 67.47 cm, in the Second season, Genzania was higher with B1 (96.28 cm) with an increase 24.47% with 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 24.42% increase compare with. Genzania which gave 447.23 tiller m^{-2}. This is consistent with Al-Hajooj (2018) and Alrubaiee (2019). The interaction was also observed during the two seasons (Fig. 8) In the first season, Shaffa with B4treatment gave the highest 617.11 tiller m$^{-,}$ In the second season B4 with Genzania gave 842.50 tiller m^{-2} with an increase of 85.37 and 59.01%, for the Genzania 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 of 189.96 and 197.3% compared with control treatment which gave the lowest 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 in the 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. due to the increase in the FLA, LAD, LAI, RGR, and the number of tillers M^{-2} All these led to an increase in NAR and storage in cereals. This result confirm the importance of the use of Biofertilizer 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-ton ha^{-1} with control .

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	535.15	6.035
	B_4	23.53	132.87	5.82	8.40	1.790	9.77	72.08	537.86	5.927
	B_5	21.39	131.43	5.16	9.15	1.702	12.61	75.75	537.98	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	Genzania	20.57	130.62	5.37	6.95	1.411	10.92	74.92	447.23	5.534
	Shaffaa	25.60	132.24	5.56	9.05	1.710	11.06	77.36	556.43	5.772
	Carloup	20.69	130.88	5.25	8.10	1.560	12.18	72.43	570.75	5.730
LSD		0.71	1.247	0.181	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	534.31	3.889
	B_1	26.19	116.37	6.34	9.19	1.454	16.51	85.53	711.73	7.594
	B_2	27.15	124.90	6.97	10.04	1.533	20.17	87.16	806.79	11.562
	B_3	22.50	111.92	6.00	8.25	1.379	14.44	89.18	716.12	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	703.28	7.551

	B_6	22.72	111.95	6.05	7.35	1.307	15.34	85.34	706.17	7.274
LSD		1.97	7.295	.346	0.311	0.389	0.648	2.258	31.87	0.65
ultivars	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	709.59	7.156
LSD		1.03	N.S	0.17	0.198	0.25	N.S	1.88	N.S	0.33

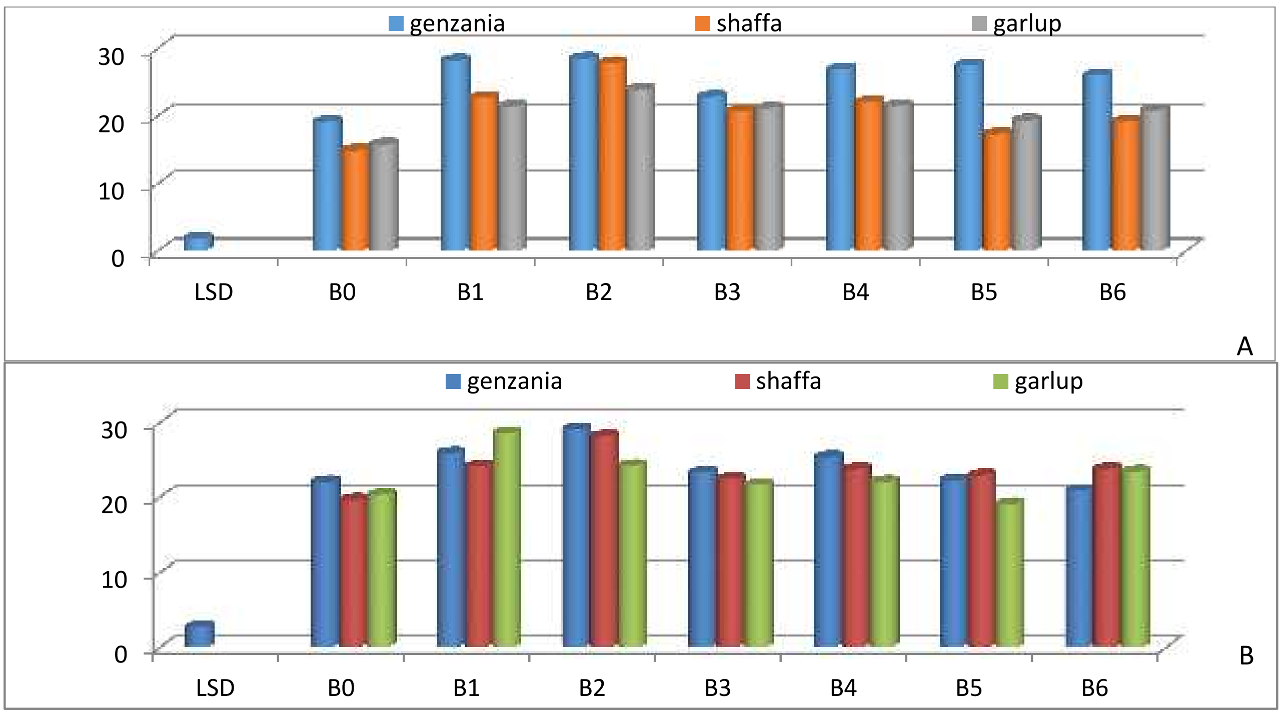

Fig. (1): Effect of interference between Biofertilizer and cultivars in the FLA (cm^2). A-Season1 B-season II.

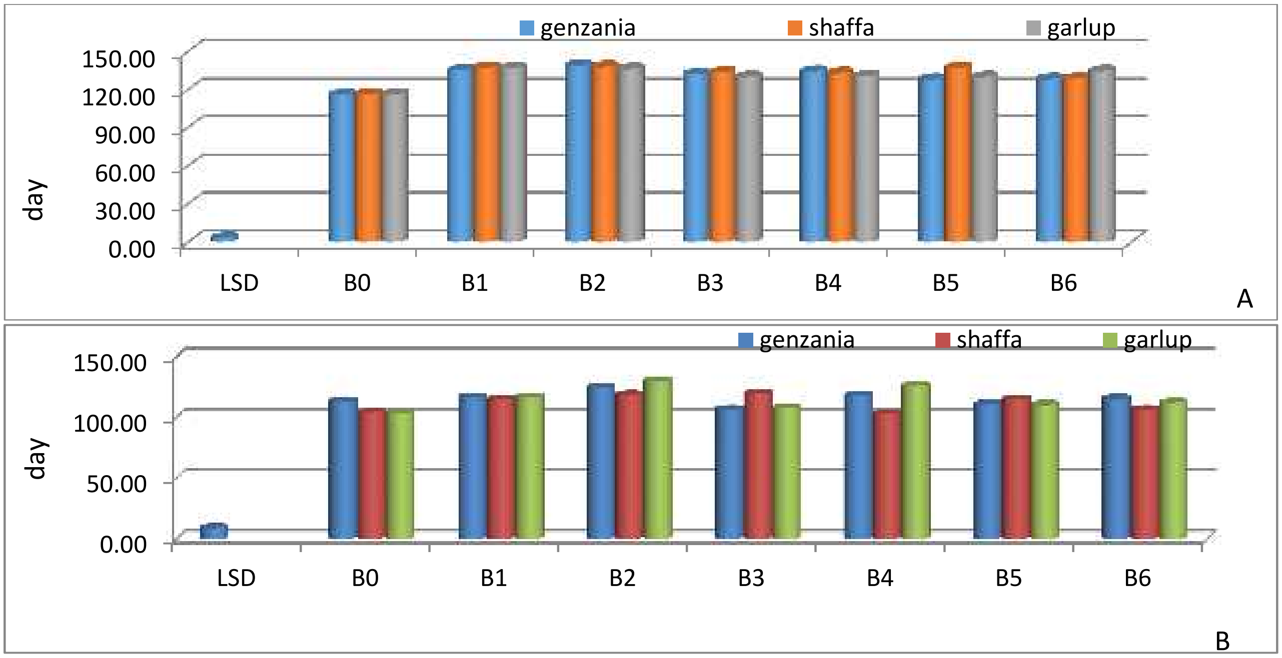

Fig. (2): Effect of interference between Biofertilizer and cultivars in the L A D (day): A-Season1, B-season II.

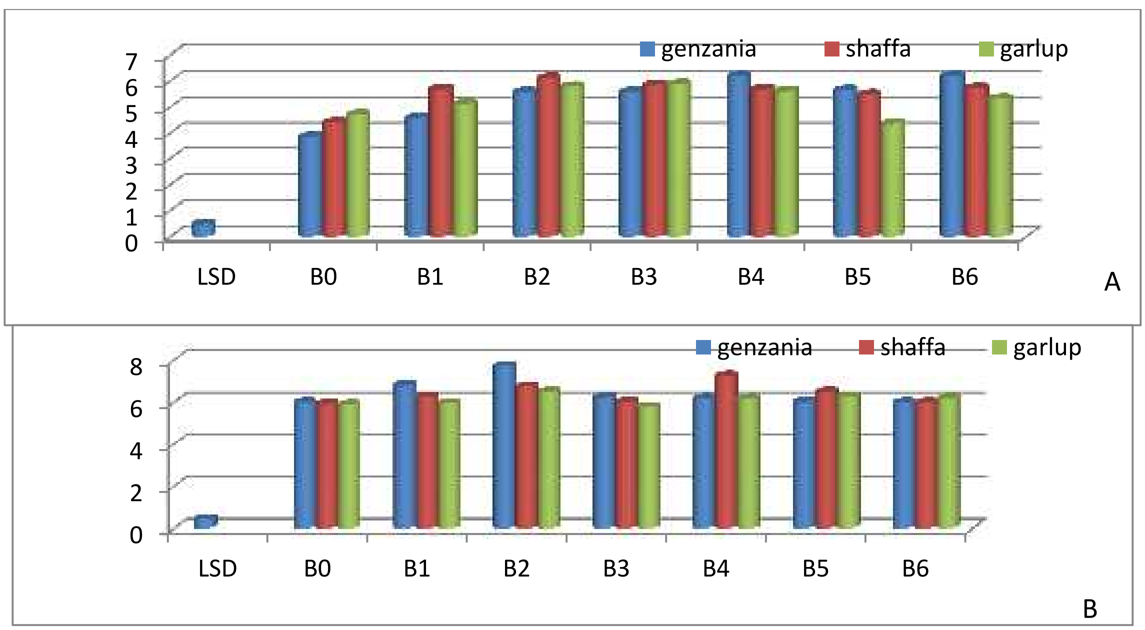

Fig. (3): Effect of interference between Biofertilizer and cultivars in the LAI: A–Season1 B-season II.

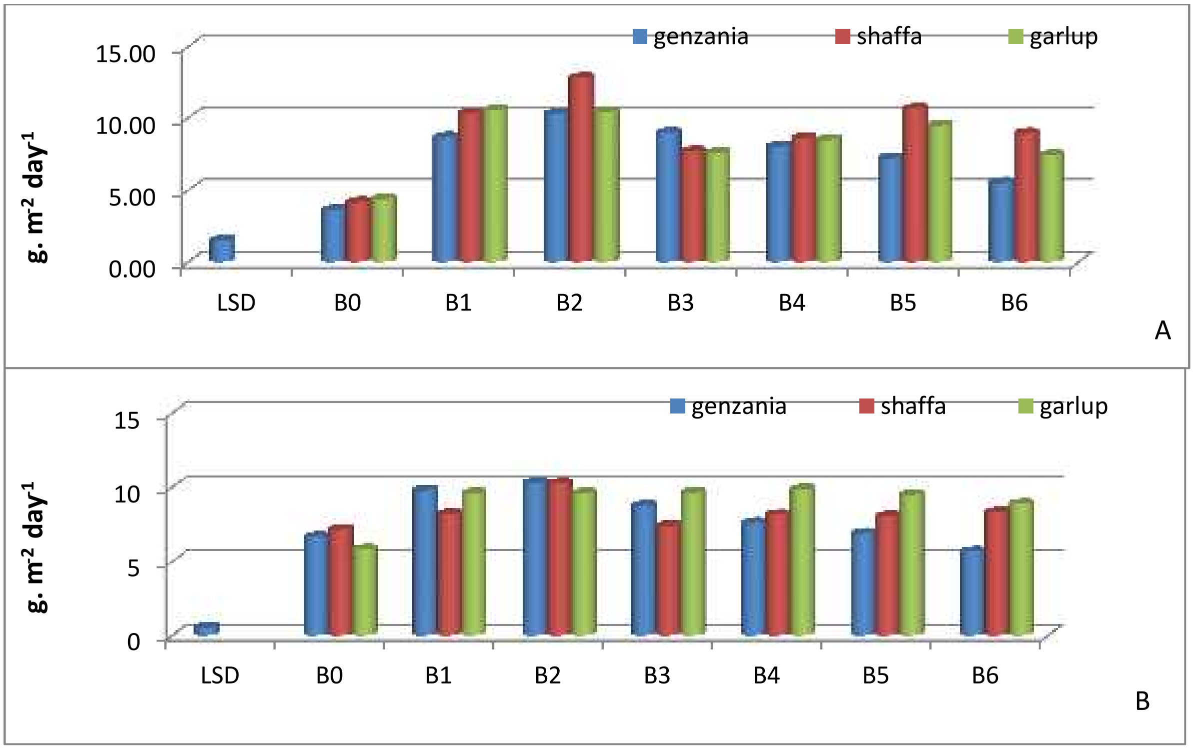

Fig. (4): Effect of interference between Biofertilizer and cultivars in the CGR (g. m^{-2} day^{-1}).

A–Season1 B-season II

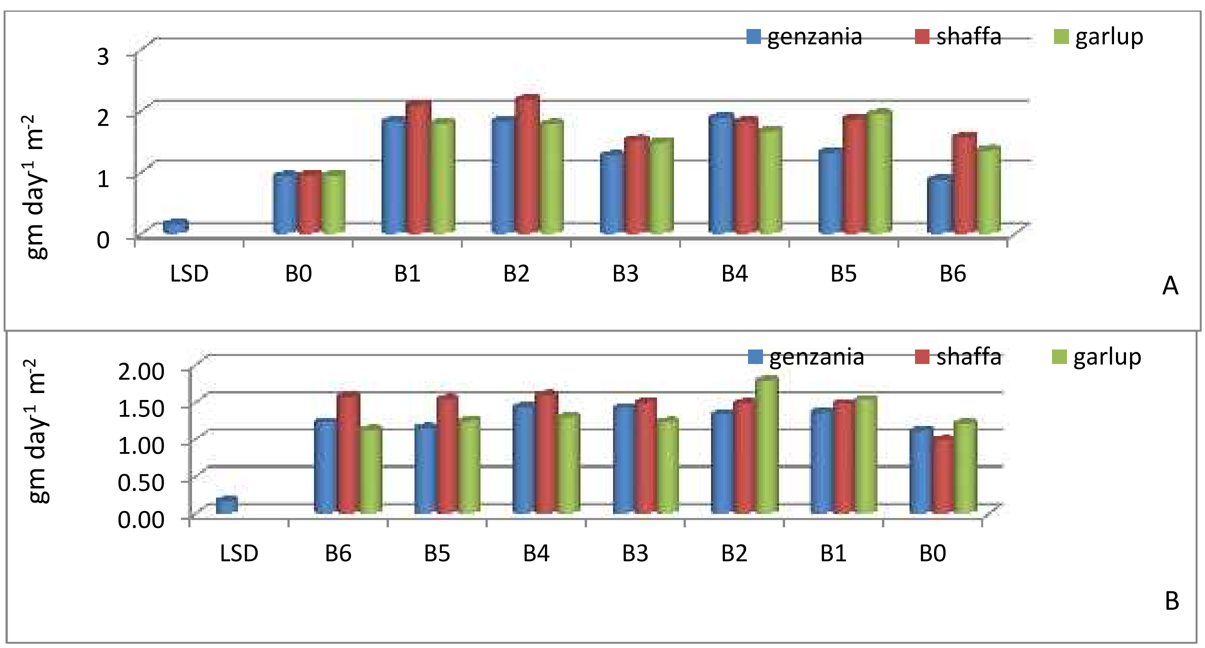

Fig. (5): Effect of interference between Biofertilizer and cultivars in the NAR (gm. Day^{-1} m^{-2}): A-Season1, B-Season II.

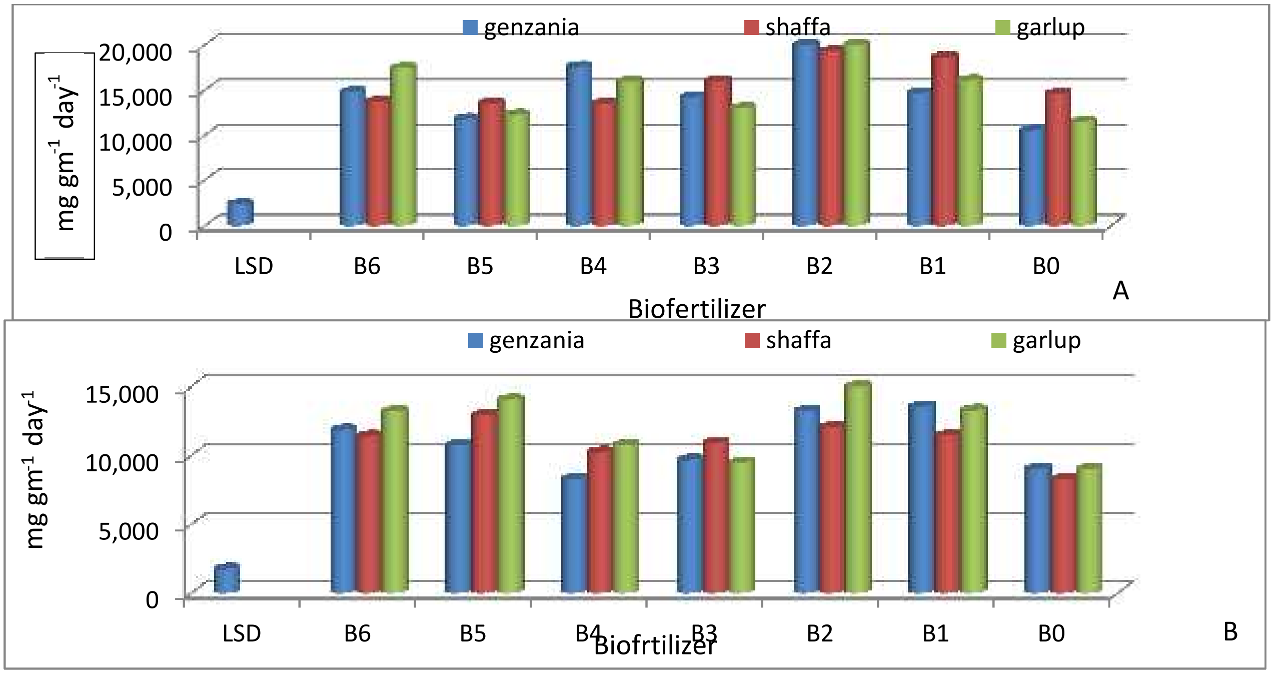

Fig. (6): Effect of interference between Biofertilizer and cultivars in the RGR (mg gm^{-1}. Day^{-1}) A–Season1 B-season II.

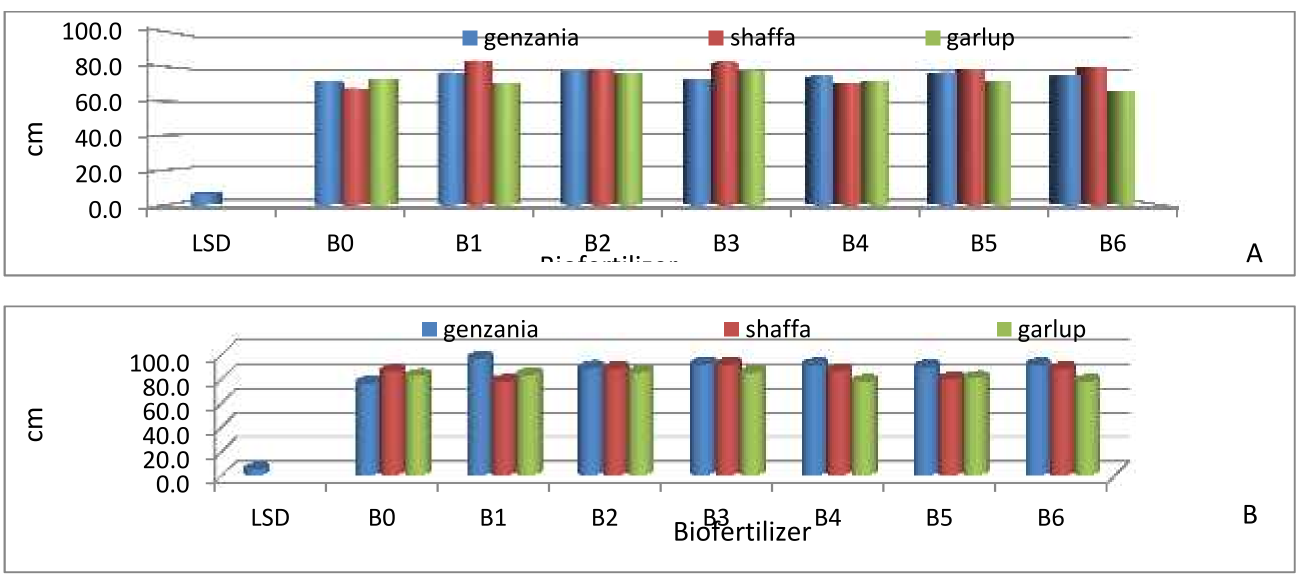

Fig (7): Effect of interference between Biofertilizer and cultivars in the plant high (cm).

A–Season1 B-season II.

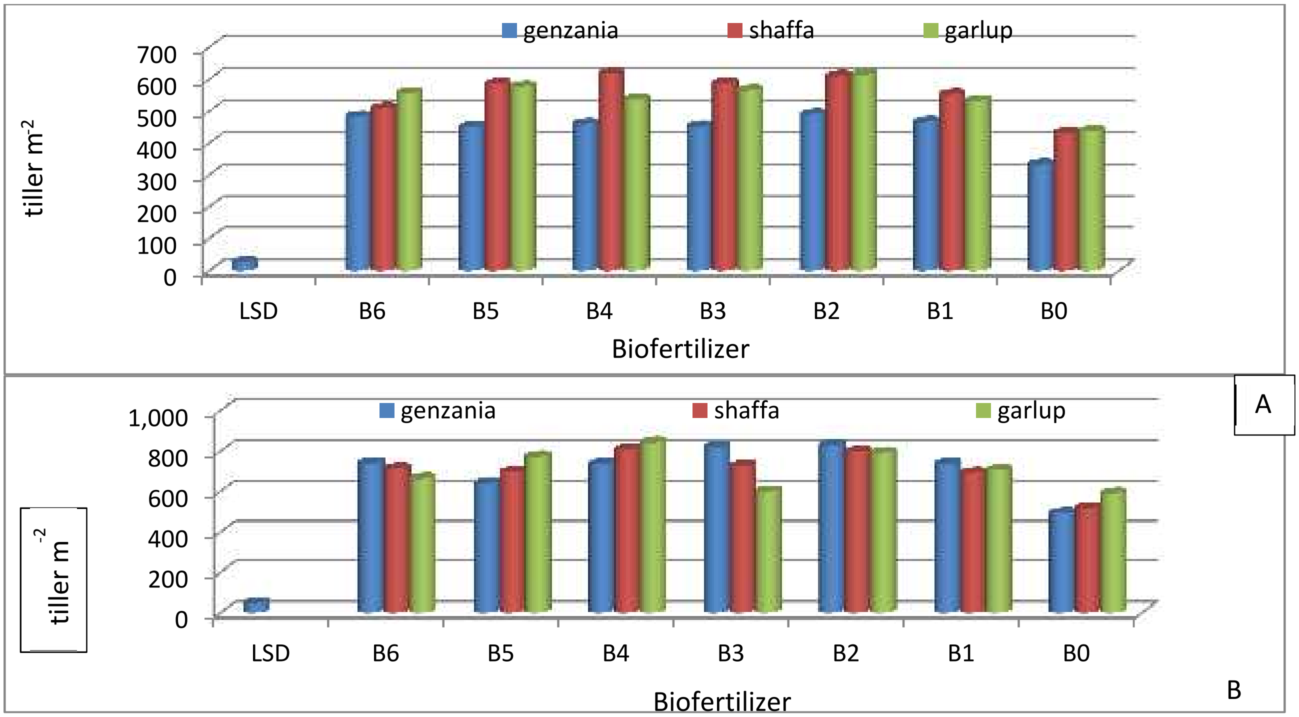

Fig (8): Effect of interference between Biofertilizer and cultivars in the No of Tiller (m^{-2}) A–Season1 B-season II

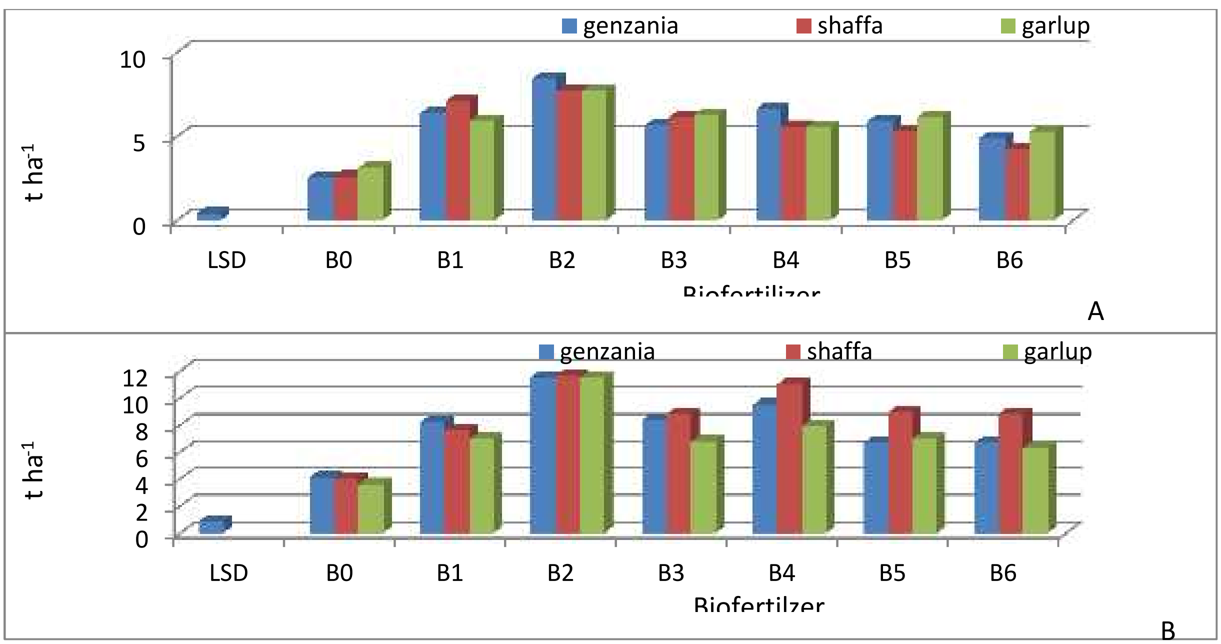

Fig. (9): Effect of interference between Biofertilizer and cultivars in the grain yield (t h^{-1})

A–Season1, B-season II

Conclusion

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

Acknowledgements

I would like to thank Dr. Mahdi Salih Al-Zirkani from Department of Plant Production, College of Agriculture, University of Al-Muthanna, Iraq, for his valuable assistance with this research.

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