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The Impact of Biological Inoculation on Zea Mays L. growth, Protein Content, and Iron Availability Under Different Levels of Water Stress

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Abstract. This study aims to investigate the effect of biological inoculation with Azotobacter chrococcum and Glomus mosseae on the growth and yield of Zea mays L., the variety of Baghdad 3 under different levels of water stress. A field experiment was carried out in the fall season of 2020 in a private farm in the Diwaniyah Governorate-Afak district. According to the Randomized Complete Block Design R.C.B.D, the experiment was designed with three replications, and the treatment was distributed randomly. Three levels of irrigation were used in the experiment (I4 irrigation every four days, I7 irrigation every seven days, I10 irrigation every ten days) and the levels of inoculation (B1 inoculation with A-chrococcum and B0 not inoculating with bacteria) and (F1 inoculating with G-mosseae and F0 non-inoculation) and (B1F1 interaction between fungus and bacteria). The means were compared using the L.S.D. Test at a 5% significance level. The results present that the treatments inoculated with fungi or bacteria or both, and for a seven-day irrigation period, significantly increased the values of the traits (plant height, dry weight of the vegetative part, length of corn cob, protein percentage, soil content of available iron during the flowering and end of season periods). They had the highest values 358, 85.71, 25.63, 12.23, 0.5423, and 0.4873 cm plant-1, respectively, compared to the treatments (control + irrigation every ten days) as they resulted in 165, 32.87, 9.07, 6.75, 0.3133, and 0.2823 cm plant-1, respectively.

Keywords. Maize, Azotobacter chrococcum, Glomus mosseae, Bio-fertilizers, Iron availability.

I. INTRODUCTION

Zea mays. L is a globally economically curtail field crop. Its region of origin is in North America because there are many variations, [1]. Maize is important because all its grains and vegetative portions are utilized as food and fodder for animals. Additionally, it is used in the manufacture of paper and the extraction of different oils from its seeds and starch. It is a concentrated feed because it contains carbohydrates, proteins, and oil (81, 10.6, and 2) %. It is cultivated in two seasons globally and is known for its flexibility in various climatic situations. It occupies third place in productivity after wheat and barley, [2]. The cultivated area in the world for the year 2012 is (182) million hectares, with a grain yield of (824) million/tons. The production is (4527.50) $kg.ha^{-1}$, (2012, F.A.O). The cultivated area in Iraq of the crop is (125,000) hectares in 2012, [3].

Biological inoculations are one of the essential agricultural fertilizers used in agro-systems. Organic fertilizers include several microorganisms that may offer the plant with required components and nutrients in an easily accessible form. Thus, it results in the reduction or avoidance of chemical fertilizers, which decreases pollution and reduces or avoids mineral fertilizers and chemical pesticides, which results in reduced agricultural expenses [4]. *Azotobacter* is one of the necessary inoculation used in agriculture. This bacterium is a member of the Azotobactereacea family, including free-living, compulsive, heterotrophic, and found in neutral basalt soils in numbers that seldom surpass (10^4,10^5) cells [4]. *A-chrococcum* bacteria use some organic acids, sugars, and alcohol derivatives as a carbon source: glucose, sucrose, fructose, methyl, and formate. These bacteria are found in soil, water, and on plant root surfaces, where they benefit from carbohydrates, amino acids, and vitamins secreted by the roots [5]. The German researcher Frank used the word microscopic (mushroom + root) for the first time in 1885 to describe the symbiotic relationship between mushrooms and roots.

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Mycorrhizae coexist with the roots of the majority of plants in Symbiosis. Except for the cruciferous family, over 90% of recognized families belong to aquatic, brackish, or desert plants. The mycorrhizal fungus affects cluster formation due to its symbiotic relationship with the root, which results in significant alterations in the root, where the fungus grows a mycelium of stretched threads that increases soil aggregation and stability. Mycorrhizae fungus increases the amounts of the growth regulators released in the growth medium (cytokinin, gibberellin, and auxin), which have an active role in the growth of root hairs [6]. The relationship between the fungus and the plant is symbiotic because it benefits the fungus and the plant and the fungus's role in preparing the plant with major and minor elements. It also plays a role in protecting the plant from pathogens present in the soil and its role in increasing plants' ability to withstand stress and drought conditions [7]. Several studies have indicated that water stress leads to many phenotypic and physiological changes in plants. It operates by reducing the height and leaf area of the plant, as well as the chlorophyll content of the leaves and their relative content, which results in a decrease in photosynthesis rates and the buildup of dry matter in the plant[8].

Irrigation periods are critical for plant development and production, and their effects are reflected in-field plant traits, altering yield components. The literature indicates that the blooming phase and the end of the season are subject to water stress owing to a drop in photosynthetic production, which impacts the development and formation of arbors owing to a portion of them being directed toward the male and female inflorescence, [9,10]. In the same line, a shortage of water directly affects the efficiency of hormones and enzymes in the ovaries, and when fertilization lowers the number of grains, the ultimate grain production decreases [11].

This study aimed to:

- Investigate the effect of *Azotobacter chrococcum* on the growth and yield of maize.
- Investigate the effect of *Glomeas mosseae* on drought resistance and growth and yield of maize.
- Investigate the effect of irrigation periods on the growth and yield of maize.
- Investigate the overlap between *Glomus mosseae* and *Azotobacter chrococcum* and the irrigation periods on maize growth and yield.

II. Methods and materials

In the autumn of 2020, in the Ali-Qadisiyah Governorate/Afak district, a field experiment was carried out to produce the yellow maize crop *Zea mays. L* of the cultivar Baghdad 3 in a loam sandy soil. Samples were randomly obtained from the soil's surface horizon at many locations in the field. The physical, chemical, and biological characteristics of the soil before planting were evaluated. The soil was allowed to dry naturally and then filtered through a sieve with a diameter of 2 mm hole.

- **Preparation and inoculation of the seeds**

In the experimental field, maize seeds Zea mays. L (Baghdad 3) was cultivated. The *Mycorrhizae* inoculation consisting of (spores, infected roots, and dry soil) was used. *Glomus mosseae* was received from the Agricultural Research Service, Ministry of Science and Technology, Zafarania. *Azotobacter chromium* inoculation was also used. The seeds were inoculated with the bacterial inoculation *A_chrococcum* after seeds surface sterilization with mercury chloride and 95% alcohol. To remove alcohol and suspended particles from the seeds, they were rinsed several times with distilled water. They were air-dried and then dipped in prepared gum arabic in a ratio of 1:10 gum-water for eight minutes to ensure the adhesion of the bacterial inoculum to the washed seeds. Inoculated with previously prepared bacterial inoculum by mixing 50% of the liquid culture *A_chrococcum* and left for (15) minutes to achieve seed inoculation [12]. The uninoculated seeds were sowed first, in the shade, away from the sun to prevent contamination. As a control, seeds were left uninoculated. Preparation of the fungal inoculation: *Glomus_mossea* (spores, infected roots, and dry soil) was applied by applying it to the seedbed before planting.

- **Experimental design**

The current study was designed following the Randomized Complete Block Design (R.C.B.D) with three replications. The experimental treatments were: treatment of mycorrhiza inoculation G, treatment of inoculation with *A. azotobacter*, treatment of the interaction between fungi and bacteria A + G, comparison treatment for C_0, with three irrigation periods of 4, 7, and 10 days. They were randomly distributed on the experimental units. Each experimental unit occupies 4 x 4 = 16 m^2, with a space between 1.5 m and 2 m between each replicate and another to control the irrigation process. Each plot had five lines. The distance among lines is 75 cm and within a line is 25 cm. *Mycorrhizae* inoculation was applied and distributed under the seeds, 5 cm wide and 5 cm thick, with the seeds being inoculated with the *Azotobacter bacteria* an hour before planting to ensure the adhesion most significant number of bacterial cells to the seeds. The plantation was done on the 29th of July 2020. Three seeds were grafted onto a single seedbed a week after planting to compensate for the loss. Crop service and manual weeding were performed to eliminate the bushes when needed.

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- **The studied plant traits**

Plant height (cm $plant^{-1}$): Five plants were randomly chosen from each plot and measured their height with a tape measure from the plant's site with the soil surface to the plant's highest top.

The vegetative total dry weight ($g.plant^{-1}$): The plants were harvested at the end of the season. The vegetative part was separated from the roots and dried in an electric oven at a temperature of 60˚ until the weight stabilized. Subsequently, for each experimental unit, the dry weight of the vegetative total was determined.

Corn cob length: It was measured using a measurement tape.

Protein percentage (%): 2 gm of dried and ground sample was taken from the seeds and digested according to the method of Cresser and Parsons [13]. The percentage of nitrogen was estimated using the Micro Kjeldahl device, and the percentage of protein was calculated according to the following equation:

$$\text{Protein\%} = \text{Nitrogen\%} \times 6.25$$

*The atomic absorption spectroscopy estimated soil iron content for flowering and end-of-season periods (*mg F L^{-1}*)* according to [14].

TABLE 1. Chemical and physical characteristics of the field soil before planting.

Trait	Value	Unit	References
PH	7.71	-------------------	[15]
EC	3.24	$DesiSmens.M^{-1}$	[16]
CEC	10.17	Cml.charge.kg^{-1}.soil	[17]
Soil texture		Sandy Loam	
Sand	765.6		[16]
Clay	34.7		
Silt	199.7	g.kg-^{1}Soil	
Organic matter O.M	8.7		[18, 19]
N	40.18		[20]
P	20.37	Mg.kg^{-1} Soil	[54]
K	224.45		
Ca	1200		
mg	697.84		[16]
CO_3	0		
HCO_3	0.492	$Cmol_c$. L -^{1}	
SO_4	4.739		[22]
Fe	0.2900	Mg Fe^{-1} litter	[14]
Zn	0.2500	Zn mg^{-1} litter	[14]
Total bacteria	2.90×10^{6}	CFU gm dry $soil^{-1}$	[23]
Total fungi	1.81×10^{3}	CFU gm dry $soil^{-1}$	[24]

III. RESULTS AND DISCUSSION

- **Effect of A.chrococcum and G.mosseae application and irrigation periods on dry weight on the part of the shoot (g $plant^{-1}$)**

Table 2 presents the positive effect of inoculation with *A.chrococcum* on the dry weight of the vegetative part of maize plants. The inoculated treatment yielded a averaged of 66.12 g $plant^{-1}$ compared to the comparison treatment, resulting in the least value of the mean 51.61 g $plant^{-1}$. This increase is due to the positive role of inoculation with the bacteria, as it can improve the properties that enhance plant growth, [15-25]. The inoculation with *G.mosseae* resulted in a significant increase in the dry weight trait of the shoots of yellow corn plants. The inoculation treatment yielded 62.97 g $plant^{-1}$ compared to the comparison treatment that made 54.76 g $plant^{-1}$. This is due to the role of the fungus in increasing the dry matter accumulation of the shoots, as well as its ability to absorb essential nutrients and improve water relations as well as increase the surface area of the root.

The effect of irrigation periods was significant on the dry weight trait of the shoots. The irrigation period every seven days produced 71.62 g plant^{-1} compared to the irrigation period every four days, which gave 63.54 g plant^{-1}, and the irrigation period every ten days, which made 41.14 g plant^{-1}. This is because the lack of water leads to a decrease in the growth of the roots, which results in a decrease in the shoots of maize plants and for all varieties, and this has been explained before [12].

The two-way interaction between irrigation periods and biological inoculation was significant in the dry weight of the shoots. Treatment B1I7 produced the highest value of interference, 82.97 g plant$^{-1,}$ compared to the comparison treatment B0I10, which had the lowest value of interaction 35.60 g plant^{-1}. The reason is attributed to the fact that biological inoculation leads to an increase in the processing capacity of the necessary nutrients, which leads to an increase in the synthesis of carbohydrates and amino acids. Thus, increasing the demand for nitrogen, which helps in the synthesis of proteins necessary for the growth of new cells, as well as the secretion of the bacteria to hormones that encourage and contribute to the continuity of the generation of new cells of the root, as well as the ability of the bacteria to free fixation of atmospheric nitrogen and thus increase the weight of the dry matter of the plant or increase the growth of the vegetative part. These are consistent with the findings of [27] with barley.

The triple overlap between the study factors was also significant in the dry weight of the shoots. The treatment B1F1I7 produced the highest value of interaction, 85.71 g plant$^{-1,}$ compared to the comparison treatment B0F0I10, which gave the lowest value of interference 32.87 g plant^{-1}.

TABLE 2. Effect of *A. chrococcum* and *G.mosseae* application and irrigation periods on the dry weight of shoots (g plant^{-1}).

Bacteria B	**Fungi F**	**Irrigation periods I day** I_4	I_7	I_{10}	**Mean of Binary interaction F x B**
B_0	F_0	56.67	47.80	32.87	45.78
	F_1	60.07	73.93	38.33	57.44
B_1	F_0	66.20	80.23	44.80	63.74
	F_1	71.23	85.71	48.57	68.50
LSD .05			4.98		2.88
		Binary interaction I x B			
Bacteria B		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
B_0		58.37	60.87	35.60	51.61
B_1		68.72	82.97	46.68	66.12
LSD .05			3.52		2.04
		Binary interaction O x F			
Fungi F		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
F_0		61.43	64.02	38.83	54.76
F_1		65.65	79.82	43.45	62.97
LSD .05			3.52		2.04
means		63.54	71.92	41.14	
LSD .05			2.49		

- **Effect of A. chrococcum and G.mosseae application and irrigation periods on length of corn cob (cm)**

Table 3 indicated the significant effect of inoculation with *A.chrococcum* on the elongation trait of the corn cob. The inoculation treatment yielded 19.48 cm than the comparison treatment, which gave a lower value of 15.53 cm. Inoculation with the fungus *G.mosseae* made a significant increase in this trait 19.30 cm compared to the comparison treatment, which gave a lower value of 15.71 cm. The reason is attributed to the fact that plant growth depends on the leaf area and the elongation of the cells, and this depends on the provision of the necessary nutrients prepared by the fungi.

The effect of irrigation intervals was also significant in the trait of the length of corn cob, as the irrigation period, every seven days gave the highest 21.28 cm compared to the four-day irrigation period 18.68 cm, and the irrigation period every ten days, which gave the lowest value 12.54 cm. The reason for the decrease in the height of the corn cob is attributed to the fact that water stress during the period of male and female flowering leads to the formation of tiny spiders, and thus the decrease in the height of the cob when the plant is subjected to stress for ten days or more.

As for the bilateral interaction between the biological inoculation and irrigation, periods were significant in this trait. The treatment B1I7 resulted in the highest value of interaction, 24.67 cm, compared to the comparison treatment B0I10, which made the lowest value 10.69 cm. The reason is attributed to the positive interaction between bacteria and fungi, the increase in plant growth rates, and the increase in the availability of absorption of elements during the different growth stages, and these are in agreement with [29].

As for the triple overlap between the study factors, it was significant in the traits of the height of the corn cob, so that the treatment B1F1I7 gave the highest value of the interaction 25.63 cm compared to the comparison treatment B0F0I10, which gave the lowest value of the interference 9.07 cm.

TABLE 3. Effect of *A. chrococcum* and *G.mosseae* and irrigation periods on length of corn cob (cm).

Bacteria B	Fungi F	Irrigation periods I day I_4	I_7	I_{10}	Mean of Binary interaction F x B
B_0	F_0	16.07	13.77	9.07	12.97
	F_1	19.93	21.03	12.30	18.09
B_1	F_0	18.33	23.50	13.50	18.44
	F_1	20.40	25.63	15.30	20.51
LSD .05			1.82		1.05
		Binary interaction I x B			
Bacteria B		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
B_0		18.00	17.90	10.69	15.53
B_1		19.37	24.67	14.40	19.48
LSD .05			1.29		0.74
		Binary interaction O x F			
Fungi F		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
F_0		17.20	18.63	11.28	15.71
F_1		20.17	23.93	13.80	19.30
LSD .05			1.29		0.74
I mean		18.68	21.28	12.54	
LSD .05			0.91		

- **Effect of A.chrococcum and G.mosseae application and irrigation periods on protein percentage (%)**

Table 4 showed the significant effect of *A.chrococcum* inoculation on the protein content of grains. The inoculation treatment yielded a value of 10.44 % compared to the comparison treatment (non-inoculation), which gave the lowest value, 8.91 %. The reason is attributed to the fact that the addition of bacteria causes an increase in the percentage of protein in the seeds because of their efficiency in fixing nitrogen. This result agrees with [30] on the crop of mung bean. The effect of pollination with *G.mosseae* was significant on the protein content of grains, as the inoculated treatment gave a value of 10.16 % compared to the comparison treatment of 9.20%. The reason is attributed to the role of the fungus in the roots, which is reflected in the increase in nitrogen in the plant parts, thus increasing the protein content in the grains, and to the role of the positive relationship between the fungus and the nitrogen-fixing organisms, as the protein concentration in the seeds increases with the increase in the rate of nitrogen fixation [31].

The overlap between irrigation periods was also significant in the protein content of grains. The irrigation period every seven days gave the highest value, 10.68%, compared to the four-day irrigation period 10.63% and the irrigation period every ten days, which gave the lowest value 7.72%. The decrease in the percentage of protein during ten days is due to water stress that caused the decrease in the percentage of protein.

The bilateral interaction between the bio-inoculum and the irrigation periods was significant, as the treatment B1I7 resulted in 11.95% compared to the comparison treatment B0I10 7.22%. This is due to the role of the bio-fertilizer, as they provide many nutrients, especially potassium and nitrogen, and their essential role in the manufacture of protein and increase its percentage in grains, as they enter into the composition of amino acids that are essential in building protein, which is positively reflected in the increase in the percentage of protein [28].

The triple interaction between study factors was significant in the protein content of grains, as the interaction treatment B1F1I10 resulted in the highest value, 12.23%, compared to the comparison treatment B0F0I10, which had the lowest value 6.75%.

TABLE 4. Effect of *A. chrococcum* and *G.mosseae* and irrigation periods on protein percentage (%).

Bacteria B	**Fungi F**	**Irrigation periods I day** I_4	I_7	I_{10}	**Mean of Binary interaction F x B**
B_0	F_0	9.68	8.22	6.75	8.22
	F_1	10.50	10.62	7.69	9.60
B_1	F_0	10.82	11.66	8.05	10.18
	F_1	11.53	12.23	8.36	10.71
LSD .05			0.70		0.40
		Binary interaction I x B			
Bacteria B		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
B_0		10.09	9.42	7.22	8.91
B_1		11.18	11.95	8.21	10.44
LSD .05			0.49		0.28
		Binary interaction O x F			
Fungi F		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
F_0		10.25	9.94	7.40	9.20
F_1		11.02	11.42	8.03	10.16
LSD .05			0.49		0.28
I mean		10.63	10.68	7.72	
LSD .05			0.35		

- **Effect of A. chrococcum and G.mosseae and irrigation periods on the iron element during the flowering period (mg Fe L^{-1})**

Table 5 presents a significant effect of inoculation with *A.chrococcum* on the soil's iron content during the flowering period, as the inoculation treatment achieved the highest value, 0.4612 mg F $L^{-1,}$ compared to the comparison treatment that gave the lowest value 0.3972 mg F L^{-1}. This increase is due to the ability of the bacteria to produce iron-chelating compounds that are dissolved complexes with iron, cedroforce - iron, which is an available form of iron [32]. The Table results showed the significant effect of the fungus *G.mosseae* on the soil content of available iron and for the flowering period, as the highest value was 0.4514 mg F L^{-1} compared to the comparison treatment 0.4071 mg F L^{-1}. The reason for this increase is due to the ability of the fungus to increase the availability of iron from the ferric oxide compound by converting it to the chelating form and reducing the unprepared ferric ion to the ferrous ion availablity for absorption by the plant, and this is consistent with [33].

As for the irrigation periods, the significant effect was on the soil content of iron availability during the flowering period, as the irrigation period every seven days resulted in the highest value 0.4753 mg F L^{-1} compared to the irrigation period every four days, 0.4605 mg F L^{-1} and the lowest value with the ten-day irrigation period was 0.3519 mg F L^{-1}. This is due to the decrease in the essential elements needed for the plant due to water stress. This is in agreement with [32], who stated that the decrease in nutrients was significant in the wheat plants when exposed to stress.

The two-way interaction between irrigation periods and biological inoculation was significant in soil content of available iron during the flowering period, and treatment B1I7 produced the highest value, 0.5288 mg F L^{-1} compared to comparison treatment B0I10, which had the lowest value 0.3292 mg F L^{-1}. The reason is due to the positive interaction between bacteria and fungi, as the bacteria secrete some growth regulators, amino acids, and some chelating substances for trace elements such as iron [34] and agree with [35].

The triple overlap between study parameters was significant, as the treatment B1F1I7 gave a value of 0.5423 mg F L^{-1} compared to the comparison treatment that made the lowest value of interaction 0.3133 mg F L^{-1}.

TABLE 5. Effect of *A. chrococcum* and *G.mosseae* and irrigation periods on the iron element during the flowering period (mg F L^{-1}).

Bacteria B	Fungi F	Irrigation periods I day I_4	I_7	I_{10}	Mean of Binary interaction F x B
B_0	F_0	0.4130	0.3697	0.3133	0.3653
	F_1	0.4687	0.4737	0.3450	0.4291
B_1	F_0	0.4707	0.5153	0.3603	0.4488
	F_1	0.4897	0.5423	0.3890	0.4737
LSD .05			0.0267		0.0154
		Binary interaction I x B			
Bacteria B		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
B_0		0.4408	0.4217	0.3292	0.3972
B_1		0.4802	0.5288	0.3747	0.4612
LSD .05			0.0189		0.0109
		Binary interaction O x F			
Fungi F		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
F_0		0.4418	0.4425	0.3368	0.4071
F_1		0.4792	0.5080	0.3670	0.4514
LSD .05			0.0189		0.0133
I mean		0.4605	0.4753	0.3519	
LSD .05			0.0133		

- **Effect of A. chrococcum and G.mosseae and irrigation periods on iron at the end of the season (mg F L^{-1})**

The results of Table 6 showed the significant effect of *A.chrococcum* inoculation on soil iron content and for the end of season period, as the inoculation treatment resulted in the highest value 0.4206 mg F L^{-1} compared to the control 0.3586 mg F L^{-1}. The reason is due to the efficiency of bacteria in producing growth stimulants that release nutrients from soil complexes, and this result is consistent with [36]. The Table results showed the significant effect of *G.mosseae* application on the soil content of available iron for the end-of-season period, and the highest value was 0.4107 mg F L^{-1} compared to the control 0.3684 mg F L^{-1}. This is due to the ability of the fungus to secrete glomalin, which works to hold soil particles and form large agglomerations, which improves the ability of the soil to retain water and nutrients and increase its concentration in the area of root depletion, [37].

As for the irrigation periods, the significant effect was on the soil content of available iron during the end of the season, as the irrigation period every four days produced the highest value 0.4259 mg F L^{-1} compared to the irrigation period every seven days 0.4227 mg F L^{-1}. The value was for the ten-day irrigation period was 0.3201 mg F L^{-1}. This is since water stress reduces and dissolves the movement of nutrients, and thus the plant's ability to absorb them decreases.

The double overlap between irrigation and biological inoculation periods was significant in the soil content of the available iron form during the end of the season. Treatment B1I7 produced the highest value of interaction, 0.4725 mg F $L^{-1,}$ compared to comparison treatment B0I10, which produced the lowest value 0.3007 mg F L^{-1}. The reason is due to the fungal and bacterial biological inoculum's ability to supply micro and macro elements and increase the intent tolerance to water stress and improve soil construction (Mahdi et al., 2010). The triple overlap between study factors was significant, as the treatment B1F1I7 resulted in a value of 0.4873 mg F L^{-1} compared to the comparison treatment that produced the lowest value of interaction 0.2823 mg F L^{-1}.

TABLE 6. Effect of *A. chrococcum* and *G.mosseae* and irrigation periods on iron at the end of the season period (mg F L^{-1})

Bacteria B	**Fungi F**	**Irrigation periods I day** I_4	I_7	I_{10}	**Mean of Binary interaction F x B**
B_0	F_0	0.3830	0.3203	0.2823	0.3286
	F_1	0.4213	0.4257	0.3190	0.3887
B_1	F_0	0.4340	0.4577	0.3333	0.4083
	F_1	0.4653	0.4873	0.3457	0.4328
LSD .05			0.0276		0.0160
		Binary interaction I x B			
Bacteria B		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
B_0		0.4022	0.3730	0.3007	0.3586
B_1		0.4497	0.4725	0.3395	0.4206
LSD .05			0.0195		0.0113
		Binary interaction O x F			
Fungi F		Irrigation periods I day I_4	I_7	I_{10}	(B) Mean
F_0		0.4085	0.3890	0.3078	0.3684
F_1		0.4433	0.4565	0.3323	0.4107
LSD .05			0.0195		0.0113
I mean		0.4259	0.4227	0.3201	
LSD .05			0.0138		

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