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PRODUCTIVITY OF MAIZE UNDER WATER STRESS CONDITIONS AND BIOLOGICAL FERTILIZATION IN CALCAREOUS SOILS

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Two field experiments were conducted in 2003 and 2004 summer seasons at Desert Research Center Experimental Station at Maruyt to investigate the response of maize cv. 30B9 to different bio-fertilization treatments (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) and (*Azospirillum lipoferum* + *Bacillus megatherium var. phosphaticum* + *Bacillus sabtilis)* accompanied with two mineral NPK levels (full and half dosages) , under four water regime treatments; which missed one irrigation (the second, the third, or the fourth) beside the normal irrigation treatment as a control.

Results proved that water is a limiting production factor of maize plants; meanwhile maize plants can tolerate water scarcity at the vegetative growth period (60 days). Missing the fourth followed by the third irrigation seemed to be the worst treatments compared with the other treatments, while missing the second irrigation treatment seemed to be the best after the control one.

The application of the bio-fertilization treatments help the plants to overcome the bad effects of water stress at any growth period. The first bio-fertilizer (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) seemed to be more successive under water stress conditions compared with the other treatment (*Azospirillum lipoferum* + *B. megatherium var. phosphaticum* + *B. sabtilis)*. Under the normal irrigation conditions, the full dosage of the mineral NPK fertilizers seems to be the best followed by both first and the second bio fertilizers accompanied with the half dosage of the mineral NPK .When taking into consideration the environmental expenses , using the half dosage of the mineral NPK + the bio fertilizers will be more logic.

Results indicated that under normal irrigation, the full dosage of mineral NPK fertilizers followed by the combination of both the first then the second bio-fertilizer and half dosage of mineral NPK increased significantly the plant growth parameters (plant height, plant fresh , dry weights, and leaf area), in addition it increased significantly pigments accumulation, total chlorophyll content, N, P and K. These results increased significantly ear weight, number of grains per ear, 100 grain weight, consequently biological and grain yield.

Keywords: maize, biological fertilization, *Azotobacter crococcum*, mycorrhiza, *Pseudomonas* spp, *Azospirillum lipoferum*, *Bacillus megatherium var. phosphaticum*, *Bacillus sabtilis*, growth characters, total pigments, total chlorophyll, N, P, K, yield parameters, biological and grain yield.

The critical period of plant growth usually starts at the time when reproductive organs are formed, and pollination and fertilization take place. Therefore, each unit of water should be used effectively and equitably. Hence, the development of such important crops as maize with high and stable yield under low moisture is an important priority for today's needs on both national and international levels.

Maize is known for its numerous industrial uses like corn bread, corn chips, paper, insulator, card board, pipes, chemicals, plastics, methanol, tar, green corn, baby corn, starch, glucose and oil, besides human and animal consumption.

When taking into consideration the comparative importance of water, maize plant is considered as a very sensitive crop to water stress especially at the reproductive phase. Plants can tolerate the water stress in the vegetative growth period compared with the other growth periods, in other words, the total sensitive period to water stress equals the last 55 days of plant growth (Wenmead and Shaw, 1960; Norwood and Dumler, 2001 and Nathan *et al.* 2005).

In Egypt, maize plant is considered one of the main grain crops, and during the last period it became one of the most important goals of the Egyptian government to increase the maize production in order to face the human and animal essential needs. In this respect, continuous extension efforts had been done at both horizontal and vertical levels.

Many challenges faced all efforts made in this target, the challenges concentrated in irrigation water scarcity associated with inapplicable fertilization treatments, and the pollution made by the fertilizers itself particularly under new reclaimed soil conditions (Reiad *et al.*, 1987 and Todd and Larry, 2005).

Maize plant is considered as a greedy plant to fertilization, particularly to nitrogen when irrigation water is available (Nour El-Din *et al.* 1975; Yakout *et al.*, 1980 and Reiad *et al.*, 1987), but when there is a scarcity in irrigation water, fertilization is not an acceptable risk. Therefore, biological fertilizers may supply maize plant with all nutrients needed for plant metabolism and growth without all hazards occurred when applying chemical fertilizers under water stress conditions.

Many reports declared the associations of N_2 fixing bacteria, phosphate bacteria, and mycorrhiza with plant root system (Neyra and Doberiener, 1978, and Van Berkum and Bohlool, 1980; Schroeder and Janos, 2005). Other investigators reported that under water stress, the bio-fertilizers helped the plants to overcome the bad effects of water stress, and increased significantly all growth characters, chemical composition, hence yield and its attributes (Goicoechea *et al.*, 1997; Schweigera and Jakobsenb,1999; Mozafara *et al.*, 2000; Egamberdiyeva *et al.*, 2002 and El Hawary *et al.*, 2002).

The present study evaluate maize growth, chemical composition and productivity under the effect of two bio-fertilizers (NPK) associated with either 0 %, 50% or 100 % of chemical NPK fertilizers under different water regime treatments during the vegetative growth period.

MATERIALS AND METHODS

Two field experiments were conducted in 2003 and 2004 summer seasons at Desert Research Center Experimental Station at Maruyt to investigate the response of maize plant (*Zea mays* L. var. pioneer 30B9) to different bio-fertilization treatments (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) and (*Azospirillum lipoferum*+ *B. megatherium var. phosphaticum* +*B. sabtilis)* accompanied with two mineral NPK levels {full (100 %) and half (50%) dosages}, under four water regime treatments; which included missed one irrigation treatment after El-mohayah irrigation 10 days after germination, {the 2nd irrigation (25 days after germination), the 3rd irrigation (40 days after germination), or the 4th irrigation (55 days after germination) }beside the normal irrigation treatment as a control.

Inoculants used consisted of three strains of every microorganism to protect bacteriofage in the rhizosphere. These strains were kindly provided from microbial research center (Cairo MIRCEN), The Unit of Biofertilizers, Faculty of Agriculture, Ain Shams University, Cairo.

The inoculated maize plant received 3 ml of inocula / hill just before the first irrigation (El-mohayah). Bacterial cultures used for inocula normally had a cell density of 10 with 10^6 /plant , where Mycorrhiza was 60 spore /plant. They were grown in a liquid medium containing 1 g NH_4Cl/liter (Okon *et al.*, 1976), consequently, spores of Mycorrhiza were isolated from the soil by the wet sieving and decanting method (Gerdemann and Nicolson, 1963).

Compost (complete fermented organic materials) was added into the soil during soil preparation in the dosage 20 kg/ fed accompanied with phosphorous as calcium super phosphate 16% P_2O_5 in the rate 15 and 30 kg P_2O/ fed following the treatments scheme.

The other chemical fertilizers were added as complete and half of the recommended dosage i.e., nitrogen as ammonium nitrate 33.5% N in the rate 60 and 120 kg N/ fed., while potassium was added as potassium sulfate 40% K_2O in the rate 12 and 24 kg K_2O/fed in two equal dosage added just before the first and second irrigation.

Spilt split plot design in four replicates was used in this experiment, where irrigation treatments occupied the main plots, chemical fertilizers in the sub-main, and bio-fertilizers in the sub-sub main plots.

The experimental plot area was 14.20 m^2 with four rows of 4 m in length and 71 cm in width. Two grains per hill were sown in the first of June in both seasons at distance of 20 cm. Plants were thinned after 25 days from sowing to one plant/hill.

Samples were taken one week after applying the fourth irrigation for studying some growth characters i.e. plant height (cm/plant), number of leaves/ plant, fresh and dry weights (g/plant), third leaf area (cm^2) (using "Li-3000A" portable leaf area meter) and chemical composition i.e. total nitrogen percentage following the method described by Paech and Tracey (1956), potassium percentage referring to (Johnson and Ulrich, 1961) method, phosphorous percentage following the method described by John (1970) and total pigments using SPDA-502 leaf chlorophyll meter, then converted into total chlorophyll (a+b) as μ mole m^{-2} referring to the equation published by John *et al.* (1988). Similarly, yield and its components were evaluated at harvest time i.e., ear weight/ cm , number of grains/ ear, seed index (as 100 grain weight /g), biological and grain yield (ton/fed).

Data obtained was exposed to the proper method of statistical analysis of variance (ANOVA) as described by Steal and Torrie (1960) and Duncan's new multiple range test was used to differentiate between means as described by Duncan (1955).

RESULTS

Effect of Irrigation Treatments

Results (Table 1) indicated that there were significant differences between irrigation treatments i.e. normal irrigation treatment (without missing any irrigation) seemed to be the superior irrigation treatment to enhance all growth characters i.e. plant height, fresh and dry weights, number of leaves and leaf area, followed by the other treatments including (missing either the second, the third or the fourth irrigation) respectively.

Similarly, table (1) water stress reduced significantly the absorption of nitrogen, phosphorous and potassium by plant, hence total pigments and total chlorophyll accumulation. Plants under missing the fourth irrigation had the lowest growth characters and chemical composition if compared gradually with missing the third, the second or the normal irrigation treatment as a best one. These results can clarify the unfavorable obtained growth characters as a result of low plant nutrition.

As indicated in table (1), water stress affected negatively ear weight, number of grains per ear, 100 grain weight, hence, both biological and grain yield. It could be concluded that the more advanced growth stage is the more sensitive to water stress in maize plants. Meanwhile, when there is a scarcity of water irrigation missing the second irrigation at 25 days may produce appreciated grain yield (2.7 ton/fed.) compared with missing the third (2.3 ton/fed) and the fourth irrigation (1.8 ton/fed).

Effect of Bio-fertilization Treatments

Results in table (2) indicated that using the bio-fertilizer-1 which consist of (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) was more superior if compared with the bio-fertilizer -2 which consist of *Azospirillum lipoferum + B. megatherium var. phosphaticum +B. sabtilis*. Bio-fertilizert-1 enhanced all studied growth characters i.e. plant height, fresh and dry weights, number of leaves per plant and leaf area. Nevertheless, it led to enhance NPK absorption by plants; as a result plant total pigments and total chlorophyll content were significantly increased. Accordingly using biofertilizer-1 increased significantly all studied yield components, hence biological and grain yield ton/fed.

Effect of NPK Fertilization Treatments

When study the chemical fertilization effects, results in table (3) clarify that the usage of chemical NPK fertilization increased significantly all studied growth characters, which led to significant increase in all studied plant chemical composition. Both growth and chemical composition observations in table (3) escorted the high yield components, biological and grain yield obtained in table (3). Mineral fertilization may seems to be more applicable to get an appreciated yield if compared with bio-fertilizers application from commercial sight of view, as a result of highly response of maize plants to fertilization particularly to nitrogen. But when calculate the environmental costs which include the water, air and soil pollution, chemical fertilization bill will have high environmentally costs if compared with the bio-fertilizers application, especially when an appreciated yield is obtained and particularly if there is no significant differences in both biological yield and grain yield were observed. This was noticed by applying bio-fertilizer-1 as compared with 100 % NPK chemical fertilizers as presented in table (3).

Effect of Bio-fertilization Treatments Under Different NPK Levels

When the two bio-fertilizers efficiency studied under different mineral NPK levels, Bio-fertilizer-1 seemed to be more successive under 50% of the recommended NPK dosage comparing with the Bio-fertilizer-2. Both bio-fertilizers treatments increased significantly all studied maize plants growth characters and chemical composition which significantly increases in all studied yield components, biological and grain yield as well as indicated in table (4).

When 100% of the recommended NPK chemical fertilizer dosage was applied together with bio-fertilizer 1 or 2, significant decrease obtained in each of all studied growth characters, chemical composition, yield and its components of maize plants as presented in table (4) respectively as compared with the combination included 50% of mineral NPK application and either bio-fertilizer 1 or 2.

Effect of Bio-fertilization Treatments Under Different Irrigation Treatments

Consequently, when study the behavior of the two bio-fertilizers under different irrigation treatments, bio-fertilizer-1 seems to be superior when compared with bio-fertilizer-2, especially when water stress is existed. Under the severe water stress conditions as the fourth irrigation is escaped due to irrigation water deficit, bio-fertilizer 1 then 2 remained capable to increase all yield components in addition to biological and grain yield as a result of enhancing significantly all studied plant chemical composition, thus all studied growth characters table (5).

Similarly, when missing either 2nd or 3rd irrigation, water stress may not be as much of missing the 4th irrigation, though each of bio-fertilizer 1 then 2 could easily encourage significantly all studied growth characters as a result of increasing significantly plant chemical composition thus, yield and its attributes table (5).

When irrigation water is adequate enough to provide maize with its water requirements, although the dosage 100% of NPK is highly recommended for maize production because it is greedy to fertilizers particularly to nitrogen, but it is highly environmentally costing at the same time. So that, bio-fertilizer-1 was superior to encourage all studied plant growth characters, chemical compositions, and therefore yield and its attributes compared with either bio-fertilizer-2 or the dosage 50% of NPK.

Effect of NPK Fertilization Treatments Under Different Irrigation Treatments

Under normal irrigation treatment, 100% of NPK was the recommended treatment to enhance all studied growth characters, chemical composition, yield and its components when comparing with 50% of NPK as indicated in table (6).

TABLE (1). Effect of irrigation treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																			
Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2
240 A	17.6 A	845.2 A	158.6 A	510.7 A	212.7 B	15.3 B	608.4 B	112.4 B	435.2 B	197.1 C	14 C	510 C	90 C	381 C	160.1 D	12.4 D	388.3 D	65.2 D	299.3 D
Chemical composition																			
Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K
53.4 A	741.5 A	1.73 A	0.95 A	2.88 A	47.7 B	631 B	1.45 B	0.73 B	2.45 B	44.1 C	534.4 C	1.24 C	0.62 C	2.36 C	37.8 D	416.4 D	1.06 D	0.53 D	1.98 D
Yield and its components																			
Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
342.1 A	531.7 A	8.06 A	3.28 A	27.38 A	326.6 B	449.5 B	6.5 B	2.78 B	23.13 B	242.9 C	844.2 C	5.3 C	2.3 C	94.4 C	178.6 D	633 D	4.0 D	1.8 D	14.8 D

Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (2). Effect of bio-fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Bio- Fertilizer 1	Bio- Fertilizer 2	Control
				NPK 100%
Studied Characters				
Growth Characters	Plant height /cm	207.1 A	202.7 B	204 A
	No. leaves /Plant	14.95 B	14.5 B	15.8 A
	Fresh weight g/Plant	600.3 B	583.4 C	658.7 A
	Dry weight g/Plant	109.4 B	101 C	168.3 A
	Leaf Area /cm^2	466.1 A	404.2 B	425.8 A
Chemical Composition	Total Pigments	46.9 A	45.3 B	46.7 A
	Chlorophyll μ mol m^{-2}	597.7 A	581.3 B	601.2 A
	% N	1.41 A	1.39 A	1.38 A
	% P	0.72 AB	0.71 B	0.75 A
	% K	2.40 B	2.40 B	2.93 A
Yield and Its components	Ear Weight /g	292.4 A	264.4 B	276.4 A
	No. Grains /ear	420.8 A	409.5 B	422.8 A
	Bio yield T/fed	6.14 A	5.93 B	6.26 A
	Grain yield T/fed	2.61 A	2.54 B	2.65 A
	100 grain weight/g	21.73 B	21.15 B	22.1 A

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (3). Effect of NPK mineral fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Control	
		NPK 50%	NPK 100%
Studied Characters			
Growth Characters	Plant height /cm	186.6 B	204 A
	No. leaves /Plant	13.9 B	15.8 A
	Fresh weight g/Plant	496.2 B	658.7 A
	Dry weight g/Plant	87.1 B	168.3 A
	Leaf Area /cm^2	365.8 B	425.8 A
Chemical Composition	Total Pigments	42.1 B	46.7 A
	Chlorophyll μ mol m^{-2}	508.4 B	601.2 A
	% N	1.21 B	1.38 A
	% P	0.63 B	0.75 A
	% K	2.87 B	2.93 A
Yield and Its components	Ear Weight /g	233.9 B	276.4 A
	No. Grains /ear	342.3 B	422.8 A
	Bio yield T/fed	5.28 B	6.26 A
	Grain yield T/fed	2.25 B	2.65 A
	100 grain weight/g	18.72 B	22.1 A

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (4): Effect of the interaction between bio-fertilization and NPK fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Bio- Fertilizer 1		Bio- Fertilizer 2		Control
		NPK 50%	NPK 100%	NPK 50%	NPK 100%	NPK 100%
Studied Characters						
Growth Characters	Plant height /cm	216.6 A	206.7C	210.7B	203.1 D	204.1 D
	No. leaves /Plant	15.4 A	14.8 B	15.1 A	14.8 B	15.8 A
	Fresh weight g/Plant	649 A	599 B	629.5A	580.1 B	658.7 A
	Dry weight g/Plant	117.3 A	109.4B	112.9A	105.5 B	118.3 A
	Leaf Area /cm²	438.5 A	415.3B	424.8A	403.5 B	425.8 A
Chemical Composition	Total Pigments	48.2 A	46.9 A	47.6 B	46.1 C	46.7 C
	Chlorophyll µ mol m $^{-2}$	632.1 A	596.8A	619.9A	580.4 B	601.2 A
	% N	1.44 A	1.40 B	1.43 A	1.40 B	1.38 B
	% P	0.77 A	0.71 C	0.74 B	0.70 C	0.75 B
	% K	2.48 A	2.38 B	2.44 B	2.34 B	2.84 A
Yield and Its components	Ear Weight /g	284.2 A	345.4A	276.2C	265.1 C	276.4 C
	No. Grains /ear	445.8 A	418.3A	428.3B	410.7 E	422.8 B
	Bio yield T/fed	6.57 A	6.13 C	6.34 B	5.8 D	6.26 B
	Grain yield T/fed	2.73 A	2.6 C	2.65 B	2.54 C	2.65 B
	100 grain weight/g	22.73 A	21.64C	22.09B	21.21 C	22.1 B

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (5). Effect of the interaction between irrigation and bio-fertilization treatments on some growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation / Fertilization	Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																				
	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height g/cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²
Bio-fertilizer 1	242.7 Ba	17.6 Ba	839.8 Ba	157.1 Ba	489.1 Ba	213.7 Bb	15.3 Bb	613.4 Bb	113.7 Bb	438.7 Bb	200.3 Ab	14 Ac	523 Ac	93.7 Ac	391.4 Ac	171.6 Ad	12.9 Ad	425.2 Ad	73.1 Ad	324 Ad
Bio-fertilizer 2	236 Ca	17 Ca	805 Ca	148.3 Ca	491.5 Ca	211.7 Cb	15.1 Bb	600.4 Cb	110.3 Cb	434 Cb	198.5 Ac	14 Ac	514.7 Bc	91.3 Bc	383.5 Bc	164.5 Bd	12.7 Bd	413.3 Bd	72.3 Bd	307.7 Bd
100 % NPK	261 Aa	21.3 Aa	1123 Aa	214 Aa	618.4 Aa	221 Ab	16 Ab	689 Ab	126.8 Ab	455.6 Ab	190.6 Bc	14 Ac	482 Cc	83.8 Cc	363.2 Cc	143.7 Cd	12 Cd	340.6 Cd	48.7 Cd	266 Cd
Chemical Composition																				
	Pigm-ents	Chlor-ophyll µ mol m⁻²	% N	% P	% K	Pigm-ents	Chlor-ophyll µ mol m⁻²	% N	% P	% K	Pigm-ents	Chlor-ophyll µ mol m⁻²	% N	% P	% K	Pigm-ents	Chlor-ophyll µ mol m⁻²	% N	% P	% K
Bio-fertilizer 1	63.6 Ba	745.2 Ba	1.76 Ba	0.96 Ba	2.64 Ba	49.1 Ab	640.4 Bb	1.46 Bb	0.74 Bb	2.45 Bb	44.9 Ac	550.7 Ac	1.26 Ac	0.63 Ac	2.37 Ac	39.9 Ad	454.5 Ad	1.17 Ad	0.56 Ad	2.15 Ad
Bio-fertilizer 2	52.8 Ca	726.4 Ca	1.70 Ca	0.93 Ba	2.54 Ca	48.3 Bb	622.5 Cb	1.45 Bb	0.72 Cb	2.45 Bb	44.5 Ac	541.9 Bc	1.24 Bc	0.62 Ac	2.37 Ac	39.1 Bd	434.2 Bd	1.16 Bd	0.55 Bd	2.08 Bd
100 % NPK	57.3 Aa	838.6 Aa	1.91 Aa	1.05 Aa	5.0 Aa	50.6 Ab	674.2 Ab	1.50 Ab	0.82 Ab	2.50 Ab	43 Bc	512.1 Cc	1.21 Cc	0.60 Bc	2.32 Bc	35.7 Cd	379.7 Cd	0.89 Cd	0.51 Cd	1.92 Cd
Yield and its components																				
	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
Bio-fertilizer 1	432.1 Ba	529.3 Ba	8.1 Ba	3.3 Ba	27.4 Ba	392.2 Ab	454.8 Bb	6.6 Bb	2.8 Ab	23.3 Ab	252.8 Ac	402.9 Ac	5.5 Ac	2.4 Ac	20.2 Ac	182.4 Ad	296 Ad	4.3 Ad	2.1 Ad	15.93 Ad
Bio-fertilizer 2	331.1 Ca	514.7 Ca	7.8 Ca	3.2 Ca	26.5 Ca	287.5 Cb	447.2 Cb	6.4 Cb	2.8 Ab	23.0 Ab	246.7 Bc	394.1 Bc	5.3 Bc	2.4 Ac	19.7 Bc	192.1 Ad	282 Bd	4.1 Ad	1.8 Bd	15.4 Bd
100 % NPK	410.3 Aa	641.3 Aa	9.6 Aa	3.9 Aa	32.8 Aa	303.7 Bb	470.7 Ab	7.0 Ab	2.9 Ab	24.3 Ab	227.7 Cc	362 Cc	5 Cc	2.2 Bc	18.2 Cc	164 Bd	217 Cd	3.5 Bd	1.6 Cd	13.1 Cd

Means having the same capital letters (in the same column) and same small letters (in the same row)are not significantly differed at $P \geq 0.05$

TABLE (6). Effect of the interaction between irrigation and NPK mineral fertilization treatments on some growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation / Fertilization	Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																				
	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area $/cm^2$	Plant height g/cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area $/cm^2$	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area $/cm^2$	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area $/cm^2$
50 % NPK	223.2 Ba	16 Ba	714 Ba	129.4 Ba	462 Ba	204 Bb	15 Bb	544.6 Bb	101.1 Bb	408 Bb	190 Bc	13.7 Bc	475.7 Bc	81.3 Bc	360 Bc	129 Bd	10.7 Bd	250.3 Bd	36.5 Bd	233 Bd
100 % NPK	261 Aa	21.3 Aa	1123 Aa	214 Aa	618.4 Aa	221 Ab	16 Ab	689 Ab	126.8 Ab	455.6 Ab	190.6 Ac	14 Ac	482 Ac	83.8 Ac	363.2 Ac	143.7 Ad	12 Ad	340.6 Ad	48.7 Ad	266 Ad
Chemical Composition																				
	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K
50 % NPK	50.8 Ba	678.8 Ba	1.58 Ba	0.86 Ba	2.51 Ba	46.6 Bb	585.1 Bb	1.42 Bb	0.67 Bb	2.42 Bb	41.6 Bc	485 Bc	1.20 Bc	0.59 Bc	2.30 Bc	29.4 Bd	285 Bd	0.63 Bd	0.28 Bd	1.26 Bd
100 % NPK	57.3 Aa	838.6 Aa	1.91 Aa	1.05 Aa	5.0 Aa	50.6 Ab	674.2 Ab	1.50 Ab	0.82 Ab	2.50 Ab	43 Ac	512.1 Ac	1.21 Ac	0.60 Ac	2.32 Ac	35.7 Ad	379.7 Ad	0.89 Ad	0.51 Ad	1.92 Ad
Yield and its components																				
	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /car	Bio yield T/fed	Grain yield T/fed	100 grain weight
50 % NPK	307.3 Ba	480 Ba	7.1 Ba	3 Ba	24.6 Ba	269.7 Bb	420 Bb	6.0 Bb	2.6 Bb	21.6 Bb	217.3 Bc	340 Bc	4.9 Bc	2.0 Bc	17.4 Bc	141.3 Bd	129 Bd	3 Bd	1.4 Bd	11.3 Bd
100 % NPK	410.3 Aa	641.3 Aa	9.6 Aa	3.9 Aa	32.8 Aa	303.7 Ab	470.7 Ab	7.0 Ab	2.9 Ab	24.3 Ab	227.7 Ac	362 Ac	5 Ac	2.2 Ac	18.2 Ac	164 Ad	217 Ad	3.5 Ad	1.6 Ad	13.1 Ad

Means having the same capital letters (in the same column) and same small letters (in the same row)are not significantly differed at $P \geq 0.05$

TABLE (7). Effect of the interaction between irrigation, bio-fertilization and NPK mineral fertilization treatments on some growth characters of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio. fertili -zation	Mineral fert.	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height g/cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm²
Bio-fertilizer 1	**0**	230.7 Ea	17 Da	755 EFa	143.3 DEa	481.2 EFa	207.3 CDb	15 Bb	579.3 Bb	108 Db	432.2 BCb	197.3 BCc	14 Ac	492 ABCc	89.7 ABc	376.2 CDc	156.7 Ed	12.7 Ad	385.7 BCd	65.5 BCd	288 Cd
	50%	255.6 Ba	18.7 Ba	941.3 Ba	170 Ba	549.2 Ba	220.3 Ab	16 Ab	657 Ab	121 ABb	445.6 BCb	202.6 Ac	14 Ac	543 Ac	97.8 Ac	404 ABc	188 Ad	13 Ad	454.7 Ad	80.4 Ad	355 Ad
	100%	241.7 Ca	17 Da	823 Da	158.1 BCa	499.8 Da	214 Bb	15 Bb	604 Bb	112.2 Cb	438.4 BCb	201 Ac	14 Ac	534 ABc	93.6 Ac	394 ABc	170 Cd	13 Ad	435.3 ABd	73.5 ABd	329 Bd
Bio-fertilizer 2	**0**	226.7 Fa	16 Ea	741 Fa	134.2 Ea	468 FGa	206.7 CDb	15 Bb	559.3 BCb	105.2 Db	423.3 Cb	195 Cc	14 Ac	490 ABCc	87.4 ABc	368.6 CDc	148.7 Fd	12 Bd	371.6 Cd	57.2 CDd	278 CDd
	50%	244.3 Ca	18 Ca	881.3 Ca	161.8 Ba	518.8 Ca	218.3 Ab	15.3 Bb	657 Ab	116.6 BCb	441.2 BCb	201.3 Ac	14 Ac	535 ABc	94.5 Ac	396 ABc	178.7 Bd	13 Ad	444.7 Ad	78.6 Ad	343 ABd
	100%	237 Da	17 Da	792.7 DEa	148.9 CDa	487.8 DEa	210 Cb	15 Bb	585 Bb	109 CDb	437.6 BCb	199.3 ABc	14 Ac	519 ABCc	92 ABc	386 BCc	166 Dd	13 Ad	423.6 ABd	72 ABd	302 Cd
Control	**50%**	223.3 Fa	16 Ea	714 Fa	129.4 Ea	462 Ga	204 Db	15 Bb	544.6 Cb	101.1 Db	408 Db	190 Dc	13.7 Ac	475.7 BCc	81.3 Bc	360 Dc	129 Hd	10.7 Cd	250.3 Dd	36.5 Ed	233 Dd
	100%	261 Aa	21.3 Aa	1123 Aa	214 Aa	618.4 Aa	221 Ab	16 Ab	689 Ab	126.8 Ab	455.6 ABb	190.6 Dc	14 Ac	482 BCc	83.8 Bc	363.2 Dc	143.7 Gd	12 Bd	340.6 Cd	48.7 Dd	266 Ad

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at P≥0.05

TABLE (8). Effect of the interaction between irrigation, bio-fertilization and NPK mineral fertilization treatments on chemical composition of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio fertilization	Mineral fert	Pigm-ents	Chlorophyll μ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlorophyll μ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlorophyll μ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlorophyll μ mol m $^{-2}$	% N	% P	% K
Bio-fertilizer 1	0	51.5 DEa	690.5 Ea	1.66 Da	0.90 CDa	2.54 Ca	47.9 Deb	613 FGb	1.44 ABb	0.69 Eb	2.43 ABb	44 Dc	530.7 Dc	1.24 ABCc	0.61 Bc	2.34 Ac	38.2 CDd	422.4 CDd	1.14 CDd	0.55 Cd	2.07 Abd
	50%	56.2 Aa	810.3 Ba	1.90 Aa	1.05 Aa	2.8 Ba	50.2 ABb	665.8 BCb	1.48 ABb	0.79 ABb	2.47 ABb	46 ABc	572.4 ABc	1.29 Ac	0.65 ABc	2.41 Ac	41.3 Ad	480 Ad	1.19 Abd	0.58 Abd	2.25 Ad
	100%	53.1 Ca	734.7 Da	1.71 Ca	0.92 Ca	2.58 Ca	49.2 Cb	642.4 Deb	1.45 ABb	0.73 CDb	2.45 ABb	44.8 Cc	549 CDc	1.25 ABCc	0.62 Bc	2.37 Ac	40.3 Abd	461.1 Dd	1.17 Bd	0.56 Bd	2.12 Abd
Bio-fertilizer 2	0	51.1 EFa	685.7 EFa	1.60 Ea	0.88 Da	2.52 Ca	47.1 Deb	596.4 GHb	1.43 Bb	0.69 Eb	2.43 ABb	43.7 Dc	526 Dc	1.22 BCc	0.61 BCc	2.33 Ac	37.3 Dd	406.1 Dd	1.12 Dd	0.52 Cd	1.98 Bd
	50%	54.7 Ba	771.6 Ca	1.81 Ba	1.00 Ba	2.7 BCa	49.5 BCb	649.2 CDb	1.46 ABb	0.76 BCb	2.46 ABb	45.3 BCc	558.8 BCc	1.27 ABc	0.63 BCc	2.41 Ac	40.8 Ad	469.8 Ad	1.18 Abd	0.57 Bd	2.17 Abd
	100%	52.6 CDa	722 Da	1.70 CDa	0.91 Ca	2.45 Ca	48.3 CDb	621.8 EFb	1.45 ABb	0.71 Deb	2.45 ABb	44.4 CDc	540.8 CDc	1.24 ABCc	0.62 Bc	2.36 Ac	39 BCd	436.8 Cd	1.19 Abd	0.56 BCd	2.10 Abd
Control	50%	50.8 Ea	678.8 EFa	1.58 Ea	0.86 Da	2.51 Ca	46.6 EFb	585.1 HIb	1.42 Bb	0.67 Eb	2.42 Bb	41.6 EFc	485 Fc	1.20 Cc	0.59 BCc	2.30 Ac	29.4 Fd	285 Fd	0.63 Fd	0.38 Ed	1.26 Cd
	100%	57.3 Aa	838.6 Aa	1.91 Aa	1.05 Aa	5.0 Aa	50.6 ABb	674.2 ABb	1.50 Ab	0.82 Ab	2.50 ABb	43 DEc	512.1 Ec	1.21 BCc	0.60 BCc	2.32 Ac	35.7 Ed	379.7 Ed	0.89 Ed	0.51 Dd	1.92 Bd

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at $P \geq 0.05$

TABLE (9). Effect of the interaction between irrigation , bio-fertilization and NPK mineral fertilization treatments on yield and yield components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio. fertilization	Mineral fert.	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
Bio-fertilizer 1	**0**	326.3 Ea	497.3 Ea	7.436 Fa	3.132 Ea	26.11 Ea	279.7 CDb	441 Deb	6.328 Eb	2.684 CDb	22.37 CDb	245 Cc	388.7 CDc	5.196 DEc	2.352 Cc	19.6 Cc	139.3 CDd	266 Dd	3.900 Dd	1.817 CDd	15.15 CDd
	50%	361.3 Ba	564.7 Ba	8.768 Ba	3.468 Ba	28.91 Ba	301.7 Ab	468 ABb	6.896 Bb	2.896 Ab	24.13 Ab	262 Ac	419.3 Ac	5.900 Ac	2.515 Ac	20.96 Ac	211.7 Ad	331 Ad	4.720 Ad	2.032 Ad	16.93 Ad
	100%	338.7 CDa	526 CDa	8.108 Da	3.251 CDa	27.1 CDa	595.3 ABb	455.3 CDb	6.512 Db	2.835 ABb	23.63 ABb	251.3 BCc	400.7 BCc	5.488 Cc	2.412 BCc	20.11 BCc	196.3 BCd	291 BCd	4.412 Bd	1.884 BCd	15.71 BCd
Bio-fertilizer 2	**0**	315.3 Fa	490 EFa	7.200 Ga	3.027 Fa	25.23 Fa	275 DEb	431.7 Eb	6.160 Fb	2.640 DEb	22.01 DEb	236 Dc	379.7 Dc	5.080 EFc	2.265 Dc	18.88 Dc	181 Dd	257 Dd	3.744 Ed	1.737 Dd	14.48 Dd
	50%	346 Ca	539.3 Ca	8.428 Ca	3.321 Ca	27.68 Ca	300.3 Ab	462 BCb	6.716 Cb	2.883 Aa	24.03 Ab	255.7 ABc	406.7 ABc	5.636 Bc	2.454 ABc	20.45 ABc	202.7 Bd	305 Bd	4.588 Ad	1.945 Bd	16.21 Bd
	100%	332 DEa	514.7 Da	7.832 Ea	3.187 DEa	26.56 DEa	287.3 BCb	448 Db	6.380 Deb	2.758 BCb	22.99 BCb	248.3 BCc	396 BCc	5.312 Dc	2.384 BCc	19.87 BCc	192.7 Cd	284 Cd	4.092 Cd	1.849 Cd	15.41 Cd
Control	**50%**	307.3 FGa	480 FGa	7.120 GHa	2.950 FGa	24.59 FGa	269.7 Fb	420 EFb	6.020 Gb	2.588 Eb	21.57 Eb	217.3 Ec	340 Fc	4.868 Gc	2.086 Ec	17.39 Ec	141.3 Fd	129 Fd	3.096 Gd	1.356 Fd	11.31 Fd
	100%	410.3 Aa	641.3 Aa	9.584 Aa	3.939 Aa	32.83 A	303.7 Ab	470.7 ABb	6.984 ABb	2.915 Ab	24.29 Ab	227.7 Dc	362 Ec	4.992 FGc	2.185 Dc	18.21 Dc	164 Ed	217 Fd	3.488 Fd	1.574 Ed	13.12 Ed

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at $P \geq 0.05$

Effect of Bio-fertilization Treatments Under Different Irrigation and NPK Fertilization Treatments

The combination of bio-fertilizer-1 with 50% of NPK was the superior in order to encourage significantly all studied characters as indicated in tables (7,8 and 9) respectively.

Under the moderate water stress, when the second irrigation is absent, the combination of bio-fertilizer-1 with 50% NPK was capable to overcome all bad effects obtained from water stress and could significantly encourage all studied growth characters, chemical composition and yield and its components as presented in tables (7,8 and9). The second recommended treatment under these conditions was bio-fertilizer-2 with 50% NPK.

When missing the 3rd or the 4th irrigation, plants will face the challenges of the severe water stress conditions. Only bio-fertilizer-1 with 50% NPK and bio-fertilizer-2 with 50% NPK were able to overcome the unfavorable growth conditions and could significantly improve all studied growth characters, hence chemical composition, yield and its components as presented in tables (7,8 and9).

DISCUSSION

As it is well known, maize plant is a very sensitive crop to water stress especially at the reproductive phase. Plants can tolerate the water stress in the vegetative growth period compared with the other growth periods (Wenmead and Shaw, 1960).

Results indicated that three irrigation treatments out of four were in the vegetative growth, while the fourth one lied between both of the end of the vegetative growth and the beginning of the reproductive growth period. In another word, the first three irrigation treatments were applied in the juvenile period, while the fourth one was in the beginning of maturity.

Many investigators indicated that plants in juvenility can tolerate and overcome the unfavorable growth conditions such as water stress, salinity or even heat stress rather than those in maturity. Plants in juvenile have high concentration of growth promoters such as IAA, GA_3 and CKs. It helps significantly in compensating any decrease may happened in photosynthesis pathway, water and minerals absorption and finally general decay in plant metabolism as a result of producing inhibitors such as ethylene and ABA when stress occurs (Muhammad, 2005; Nathan *et al.*, 2005).

Similarly, at maturity plants generally have high concentrations of the inhibitors comparing with the promoters; the way it encourages assimilates transportation from sources to sinks accompanied with recognizable decay in plant growth and metabolism, to reach early the end of life cycle by producing the fruity parts (Devieln, 1969; Al-Kaisi and Xinhua, 2005). This can clarify the results obtained in this study when taking into consideration the hazard effects of water stress on maize plants growth, chemical composition therefore yield and its components especially at the end of the juvenility compared with the early juvenile growth period.

Several investigators reported that maize plant is considered as one of the greediest crops to use fertilizers particularly to nitrogen. Nitrogen is one of the major elements which encourage assimilates metabolism and transportation, through encouraging plant photosynthesis rate. (Moursi *et al.*, 1970; Ibrahim *et al.*, 1979; Moursi *et al.*, 1983; Reiad *et al.*, 1987). This can simplify the appreciated observations obtained as a result of adding the full dosage of NPK fertilization when compared with the half dosage fertilization or with applying both of the bio-fertilizers under investigation.

The biological fertilization may consider as the only available solution to apply fertilizers when there is irrigation water scarcity. Positive plant growth responses after inoculation with associated N_2 fixing bacteria were found by several investigators under water stress conditions (Nur *et al.*, 1980).

Perhaps the superior results obtained when applying bio-fertilizer-1 rather than bio-fertilizer-2, may be achieved as a consequence of the micro-organisms efficiency in N-fixation, producing organic acids and phyto-hormones as IAA, GA_3 and CKs, which led to increase P and K availability in plants rhizosphere, beside the higher P and K release capability of the micro-organisms in bio-fertilizer-1 if compared with Bio-fertilizer-2 (Ishac, 1989; Schroeder and Janos, 2005). All mentioned factors together led to produce higher yield as a result of incurring plant growth upshot improving plant chemical composition and metabolism.

The superior results obtained from bio-frtilizer-1 either under normal irrigation or water stress conditions, are because of the hyphal development of the mycrrohiza which play a big role in improving the soil mechanical texture out of the nature of fungal growth; in addition it plays as lateral roots exchanging the carbohydrate and the amino acids from the co-operated plant to the fungi, on the other hand, phosphate and other minerals from the fungus to the co-operated plant. Under water stress conditions, the hypha of mycrrohiza plays as an additional lateral root system providing the water from long distances away from the root system to the plants. (Hall and Fish,1979; Trans and Schenck, 1982).

Azotobacter crococcuma, as the second microorganism in the biofertilizer-1, helped in increasing nitrogen soil content through non-symbiotic nitrogen fixation pathway. This was producing plant growth promoting phyto-hormones such as IAA, GA_3 and CKs, which helps in encouraging plant growth, and organic acids therefore reducing soil pH, thus release the unavailable soil nutrients particularly zinc and phosphate especially under calcareous soil conditions. All these factors together led to enhance the photosynthetic pigments accumulation thus increase photosynthesis pathway as well as increased yield and its components (Devieln, 1969; Ishac, 1989 and Schroeder and Janos, 2005).

When NPK soil content is increased through mineral fertilization, the micro-organisms in both bio-fertilizers used the suitable NPK which added directly into soil instead of going through N-fixation. Unavailable P and K release pathway, by the mean of micro-organisms inhibition because of high soil content of NPK (Ishac, 1989; and Schroeder and Janos, 2005). This can illustrate the results observed under all studied water regime conditions. But once discussing the severe water stress conditions when missing 3rd or the 4th irrigation, plants faced complex challenges which seriously defend against implementing plant life cycle. Bio-fertilization remains alone capable to overcome the water stress hazard effects through producing growth promoting phyto-hormones such as IAA, GA_3 and CKS, beside the organic acids. Moreover, activate the enzyme phoshatase which help in releasing P and K in plant rhizosphere. Consequently, encourage the plant metabolism and improve the plant chemical compositions and growth, to be confirmed finally as significant increase in yield and its components (Kumar *et al.*, 2005).

CONCLUSION

Using the biological fertilization technique as an eco-friend source of NPK is urgently needed to save the environment and reduce the running costs of crops production particularly in the new reclaimed areas, and to avoid the inapplicable risks of applying the mineral fertilization under water stress conditions.

Using the biofertilizer-I alone is highly recommended under water stress conditions, while it is permissible accompanied with the half of the recommended dosage of mineral NPK when irrigation water is sufficient enough.

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إنتاجية الذرة الشامية تحت ظروف الإجهاد المائي والتسميد الحيوي بالأراضي الجيرية

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أجريت تجربتان حقليتان في موسمين متتاليين ٢٠٠٣- ٢٠٠٤ بمحطة مركز بحوث الصحراء بمريوط لدراسة إستجابة نباتات الذرة صنف بايونير (٣٠ ب ٩) لمعاملتان من التسميد الحيوي (ن بو فو) ; الأولي(أزوتوباكتر كروكوككم + ميكرهيزا + أنواع من السيدوموناس) والثانية (أزوسبيريللم ليبوفرم + باسيلس ميجاثيرم المتخصص علي الفوسفات + باسيلس سابتيلس) ،كلا المعاملتين مصحوب بمستويين من التسميد المعدني (ن بو فو) الأول معدل سمادي كامل والثاني نصف المعدل السمادي المعتاد ، وذلك تحت أربعة مستويات من الري ، والتي تضمنت بدورها حرمان رية واحدة من إجمالي عدد الريات لكل معاملة كالتالي (حرمان الرية الثانية ، حرمان الرية الثالثة، حرمان الرية الرابعة) بجانب الري الطبيعي كمعاملة مقارنة.

ولقد أثبتت النتائج المتحصل عليها أن الماء من أهم العوامل المحدده لإنتاج الذرة ، في حين يمكن للنباتات أن تقاوم نقص المياه خلال فترة النمو الخضري والتي تمتد إلي ٦٠ يوماً. حيث تأثرت النباتات سلبياً بشدة من جراء حرمانها من الرية الرابعة ثم الثالثة مقارنة بباقي المعاملات، في حين كانت معاملة المقارنة متبوعة بحرمان الرية الثانية من أفضل المعاملات.

ولقد ساعد التسميد الحيوي بوجه عام النباتات في مقاومة التأثير السيئ للإجهاد المائي في كل مراحل النمو المختلفة. ولقد ظهر أن السماد الحيوي الأول (أزوتوباكتر كروكوككم + ميكرهيزا + أنواع من السيدوموناس) أكثر فاعلية تحت ظروف الإجهاد المائي من السماد الحيوي الثاني (أزوسبيريللم ليبوفرم + باسيلس ميجاثيرم المتخصص علي الفوسفات + باسيلس سابتيلس). كما أظهرت النتائج أن الجرعة الكامله المعتادة من السماد المعدني (ن فو بو) كانت أفضل المعاملات السمادية، وتبعها في ذلك تفاعل نصف الجرعة المعتادة من السماد المعدني مع كل من السماد الحيوي الأول ثم الثاني علي الترتيب. ولكن عند الأخذ في الأعتبار التكلفة البيئية فإن تطبيق نصف الجرعة من السماد المعدني مع السماد الحيوي الأول أو الثاني تبدو أكثر واقعية.

ولقد أظهرت النتائج، أنه تحت ظروف الري العادي فإن المعدل الكامل من السماد المعدني، متبوعاً بتفاعل نصف معدل السماد المعدني مع كل من السماد الحيوي الأول ثم الثاني قد أدي إلي زيادة معنوية في جميع قياسات النمو (إرتفاع النبات، الوزن الغض والجاف للنباتات، ومساحة الأوراق)، كما أدت إلي زيادة معنوية في الصبغات الكلية، الكلوروفيل الكلي، محتوي الحبوب من (ن، فو، بو)، وجميعها أدت بدورها إلي زيادة معنوية في وزن الكوز، عدد الحبوب بالكوز، وزن الـ ١٠٠ حبة وبالتالي زيادة المحصول البيولوجي والحبوب معنوياً.