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ROLE OF WATE STRESS AND NITROGEN FERTILIZER SOURCES ON SOME NUTRIENTS AND GRAINS QUALITY OF MAIZE.

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ABSTRACT

Two field experiments were conducted at Soil Department Greenhouse, of Agriculture Faculty, Mansoura University, during 2007 and 2008 summer seasons using maize plant to investigate the effect of water stress and nitrogen fertilizer sources on growth, yield and yield components of maize plants. Twenty-four treatments were arranged in strip split split design which were the simple possible combination between two treatments of irrigation (Normal irrigation 100% of field capacity and stress irrigation 60% of field capacity), three treatments of mineral nitrogen fertilizer at rates of (0,50,100% from the recommended doses), two treatments of organic nitrogen as farmyard manure (with and without FYM) and two treatments of nitrogen biofertilizer (inoculated with *Azotobacter chroococcum* and uninoculated one).

The obtained results indicated that:

Water stress significantly decreased maize plant dry weight, straw and grains. While, those parameter increased by increasing mineral nitrogen. Also, they increased by adding FYM and inoculation of maize grains by Azotobacter in both seasons.

The interaction among the water stress and nitrogen sources showed insignificantly effect on maize plant dry weight, straw and grains.

Water stress significantly decreased N, P, K, Ca and Mg leaf content of maize plants but Na leaf content was increased .Increasing nitrogen fertilizer rates increased N, P, K, Na, Ca and Mg leaf content of maize plants. Also, FYM application and inoculation by biofertilizers increased N, P, K, Na, Ca and Mg leaf content of maize plants.

There are no interaction effects among the four studied factors on the N, P, K, Na, Ca and Mg leaf content.

The N, P, K, Ca and Mg maize grains content decreased by water stress but Na increased ,on the other hand these characters increased by either increasing nitrogen fertilizer rates or by FYM additions and with inoculation by biofertilizers .

The interactions among the four studied factors had insignificantly effect on nutrient grains content.

Water stress significantly decreased maize grains protein and NO_3^{-1} but increased grains carbohydrates content. Increasing application of mineral nitrogen rates, addition of organic and biofertilizers in the two seasons significantly increased the protein, NO_3^{-1} and carbohydrates percentages in maize grains.

The interaction among the water stress and nitrogen sources showed insignificantly effect on maize grains protein percentage. While, it had significantly effect on maize grains NO_3^{-1} and carbohydrates percentages in the two seasons.

Thus, it could be concluded that the nitrogen fertilization at the rates of 100% (260.87 Kg urea fed^{-1} of recommended doses) and adding FYM at 25m^{3}fed^{-1} with inoculation of maize grains by Azotobacter under normal irrigation are considered as most suitable treatment for obtaining the highest yield of maize under these experimental conditions. In addition, the organic and biofertilizer had an important role in reduce the negative effect of water stress on maize plants and helping for reducing both the pollution factors and the economical maize production costs.

INTRODUCTION

Maize is a major source for human and animal feeding. Recently, maize flour is mixed with wheat at a rate of about 20% for making bread. Such mixture will save the import of about 2.4 million tons of wheat grains yearly farther more the grain is a key industrial row material for very diverse purposes such as oil and starch extraction. Maize grains give a good type of edible oil and plays an important role in solving the shortage of edible oil.

Drought is one of the major abiotic stresses affecting yield of dryland crops. Drought occurs when moisture around the roots is so reduced that a plant is not able to absorb enough water, or in other words with transpiration of water absorption Benjamin, (2007). Abdelmula and Ebrahim-sabile (2007) drought stress at reproductive stage had the most decreasing effect on maize yield so that the grain yield was 4310 kg ha^{-1} under optimum irrigation while it was 3060 $kgha^{-1}$ under drought stress at reproductive stage. In addition to drought stress, the changes in soil stored N can also affect plant growth and development, too. Sajedi, (2010) water deficit stress decreased grain yield of maize plants. The highest grain number per ear, 1000-grain weight and grain yield of maize were obtained under optimum irrigation treatment, and water deficit decreased grain yield and grain number ear^{-1} Moosavi, (2012). Ali et al., (2008) water stress reduced the concentration of mineral nutrients K^{+}, Ca^{2+}

The application of mineral N with organic manure in combination resulted in increased yield and yield components, 50% FYM and 50 % N resulted in maximum rows ear^{-1} and grain row^{-1}. It was concluded that organic and inorganic N application had beneficial effect on yield and yield components of maize Ali, et al. (2012). Farboodi et al., (2011) Azotobacter increased growth characteristics values in maize as stem diameter and plant height and yield of maize and increased chlorophyll content, higher protein content of maize plants. Kizilog et al., (2010) inoculation of seeds with *Azotobacter chroococcum* increased carbohydrate and protein content of corn.

The aim of this investigation is to:

*Study the role of water stress on maize growth, yield components and chemical characteristics.

*Replacement of partial N-mineral fertilizer by organic and biological fertilizer.

*Study the role of nitrogen fertilization sources: mineral, organic and biological on maize growth, yield, yield components and chemical characteristics to produce both high maize yield and its quality.

MATERIALS AND METHODS

Two field experiments were conducted at green house of Soil Department, of Agriculture Faculty, Mansoura University on clay loam soil during two consecutive summer growing seasons of 2007and 2008 in the same soil with using maize plants *(Zea mays l.)* C. V. (TWC 324, Three Way Cross 324). The physical and chemical characteristics of the studied soil before planting are shown in Table (1). Twenty-four treatments were arranged in strip split split design which were the simple possible combination between two treatments of irrigation (Normal irrigation 100% of field capacity and stress irrigation 60% of field capacity), three treatments of mineral nitrogen fertilizer at rates of (0,50,100% from the recommended doses by the instruction laid down by the ministry of Agriculture for maize plants) , two treatments of organic nitrogen fertilizer (farmyard manure (with and without FYM)and two treatments of nitrogen biofertilizer (inoculated with *Azotobacter chroococcum* and uninoculated one).

N and P in the shoots and roots of maize. Sandhya, et al., (2010) inoculated maize plants showed higher levels of proline, sugars, free amino acids under drought stress. However protein and starch content was reduced under drought stress conditions. Ali and Ashraf, (2011) water stress reduced the kernel sugar, oil, protein, moisture contents and most of the seed micro- and macro-nutrients analyzed of both maize cultivars, but it increased the contents of seed fiber and ash contents for maize plants.

Nitrogen is essential for plant growth as it is constituent of all proteins and nucleic acids and hence of all protoplasm. Nitrogen is likely to be in short supply for crop production unless supplemented by legume crop residues or by the application of fertilizers, manures, or other high nitrogen materials. Nitrogen fixing microbes replenish soil nitrogen by converting the relatively inert nitrogen of the atmosphere into a form that can be used by living organisms. Since biological fixation of nitrogen is not usually sufficient to meet the needs of intensive crop production, however, additional sources may be needed. Sepat and Kumar, (2007) higher nitrogen levels improved the growth, yield, water use efficiency and residual organic carbon and available nutrient contents as compared with lower nitrogen levels in maize.

Table (1): Some physical and chemical properties of experimental soil:

Properties	2007	2008	Properties		2007	2008
Sand %	36.58	36.58	Available	N mg kg^{-1}	37.20	42.50
Silt %	29.90	29.90		P mg kg^{-1}	11.87	12.60
Clay %	33.52	33.52		K mg kg^{-1}	400	298
Texture	Clay loam		Ca meq/ L		0.6	0.65
$CaCO_3$ %	1.6	2.4	Mg meq/ L		0.4	0.50
Real density g cm^{-3}	2.40	2.40	Na meq/ L		0.9	1.05
Bulk density g cm^{-3}	1.18	1.20	K meq/ L		0.2	0.50
Porosity %	50.49	49.86	HCO_3^- meq/ L		0.3	0.6
SP	61.00	60.5	Cl^- meq/ L		1.0	1.2
Field capacity	30.5	30.3	SO_4^{--} meq/ L		0.8	0.9
Organic matter	1.04	1.10	E.C dSm^{-1} (soil paste)		0.42	0.83
			pH (soil paste)		8.13	8.00

The plot area was 10.5m^2 which contained 2rows, 7m length and 1.5m width. The normal cultural practices for maize production were followed according to the instruction laid down by the ministry of agriculture. The recommended P fertilizer rate was 200 kg fed^{-1}(500g/plot) applied for all treatments in the form of calcium super phosphate (6.76%P) before cultivation. K fertilizer was applied in a rate of 50 Kg Fed^{-1} (125g/plot) potassium sulphate (40%K) at life irrigation. N fertilizer was applied as urea (46%N) at a rate of 130.43 Kg fed^{-1} (326.07g/plot) (50% from recommended dose), 260.87 Kg fed^{-1} (652.17g/plot) (100% from recommended dose) at two doses at life irrigation and at second irrigation .The quantity of FYM of each plot was incorporate with the soil before sowing (14days) at a rate of $25m^3fed^{-1}$.Some chemical properties of FYM are shown in Table (2).

Table (2): Some chemical properties of FYM used:

Source	EC*	pH*	Total N%	Total C%	C:N	Total P%	Total K%	Ca%	Mg%	Ash%
FYM1	1	8	1.5	28	18.6:1	0.445	1.5	4.70	1.86	>40%
FYM2	1.11	8.1	1.2	22	18.3:1	0.227	1.2	3.65	1.36	>40%

***soil extract (1:10)**

Half the grains of maize cultivars were inoculated with biofertilizers (*Azotobacter chroococcum*) and mixed well then air dried for adhesion and sown at its treatments and the other half grains were sown at its treatments. The grains were sown at the rate of 15 Kg Fed^{-1} on ridges with plant spacing of 25cm. Planting the experimental field was done in May 2007and 2008 .Plant sampling were taken at (harvest stage after 110days) by taking three plants randomly.

Methods of Analysis:-

1- Soil Analysis:-

* Soil texture, physical and chemical analyses were determined using the methods described by Piper (1950), Hesse (1971) and Hillel (1972).

2- Plant Analysis:-

The plant analysis was determined as described by Doubios et al, (1956), cottenie et al., (1982) and Singh (1988).

Appropriate analysis of variance was performed using SAS software .The significant differences among the mean of various treatments were established by the New Least Significant Differences method (NLSD) according to Gomez and Gomez (1984).

RESULTS and DISSCUSSION

1-Role of water stress, nitrogen sources and their interactions on dry weight of whole plant, straw and grains of maize:

The obtained results in Table 3, show that maize plant dry weight at harvesting stage were significantly reduced under water stress and ranged from 20.24% in 1st season and 21.30% in 2nd season .Also, water stress at harvesting stage gave a significant reduction for straw and grains weight of maize while reached to (24.08and10.21%) in 1st season and (23.90and14.85%) in 2nd season respectively. This result is confirmed with those obtained by (Sajedi, 2010) who illustrated that water stress decreased grains yield of maize plants.

Data shown also that maize plant dry weight, straw and grains were significantly increased by increasing mineral nitrogen fertilizer rates. The highest significant increase was recorded (28.61, 23.61 and 41.76%) in 1st season and (31.94, 28.05 and 41.63%) in 2nd season for the weight of plant dry, straw and grains of maize, respectively.

Data in same Table show that the application of organic nitrogen fertilizer have significant effect on maize plant dry weight, straw and grains. It increased by 7.47, 6.46 and 9.96% in 1st season and 7.70, 6.70 and 10.11% in 2nd season. These results are in harmony with those obtained by Ali, et al. (2012).

Also, data illustrated that maize plant dry weight, straw and grains were significantly increased by inoculation with Azotobacter. This increase reached to (2.71, 2.24 and 3.87%) in 1st season and (3.23, 2.75 and 4.37%) in 2nd season. This result is confirmed with those obtained by Farboodi et al., (2011).

Table3: Role of water stress, mineral nitrogen, FYM and biofertilizer on maize crop at harvesting stage:

Treatments	1st season(2007)			2nd season(2008)		
	Plant dry weight ton fed^{-1}	Straw weight ton fed^{-1}	Grains weight ton fed^{-1}	Plant dry weight ton fed^{-1}	Straw weight ton fed^{-1}	Grains weight ton fed^{-1}
Irrigation						
I_1	12.05	8.72	3.33	10.56	7.53	3.03
I_2	9.61	6.62	2.99	8.31	5.73	2.58
LSD 5%	0.0416	0.0219	0.0197	0.0417	0.0239	0.0178
F. test	**	**	**	**	**	**
N_1	9.47	6.86	2.61	8.14	5.81	2.33
N_2	10.82	7.66	3.16	9.42	6.63	2.79
N_3	12.18	8.48	3.70	10.74	7.44	3.30
LSD 5%	0.0509	0.0268	0.0241	0.0243	0.0025	0.0218
F. test	**	**	**	**	**	**
FMY_1	10.44	7.43	3.01	9.08	6.41	2.67
FMY_2	11.22	7.91	3.31	9.78	6.84	2.94
LSD 5%	0.0416	0.0219	0.0197	0.0417	0.0239	0.0178
F. test	**	**	**	**	**	**
Bio_1	10.68	7.58	3.10	9.28	6.54	2.74
Bio_2	10.97	7.75	3.22	9.58	6.72	2.86
LSD 5%	0.0416	0.0219	0.0197	0.0417	0.0239	0.0178
F. test	**	**	**	**	**	**

Data in Table 4 illustrated that the interactions among the four factors had insignificant effect on maize plant dry weight, straw and grains. In the two seasons ,maize plants fertilized with (260.87Kg fed^{-1})of mineral nitrogen, FYM and inoculated with Azotobacter under normal irrigation gave the highest plant dry, straw and grains weights was 13.93 ton fed^{-1}, 9.85 and 4.08 ton fed^{-1} in 1st season and 12.34,8.57 and 3.77 ton fed^{-1} in 2nd season. On the other hand, the unfertilized plants under water stress conditions gave the lowest values of maize plant dry, straw and grains. In addition to, organic and biofertilizer had an important role in reduce the negative effect of water stress on maize plants. This might be due to the increment effect of both the organic manure and biofertilizer on the soil characters and accordingly their reflections on the soil fertility.

Table4: Interactions effect between water stress, mineral nitrogen, FYM and biofertilizer on nutrient at harvesting stage of maize:

Treatments				1st season(2007)			2nd season(2008)		
				Plant weight Kg fed^{-1}	Straw weight ton fed^{-1}	Grains weight ton fed^{-1}	Plant weight Kg fed^{-1}	Straw weight ton fed^{-1}	Grains weight ton fed^{-1}
I_1	N_1	FYM_1	Bio_1	10.20	7.61	2.59	8.08	6.44	2.36
			Bio_2	10.52	7.80	2.72	9.10	6.63	2.47
		FYM_2	Bio_1	11.01	8.12	2.89	9.46	6.86	2.60
			Bio_2	11.25	8.26	2.99	9.75	7.05	2.70
	N_2	FYM_1	Bio_1	11.51	8.40	3.11	10.08	7.26	2.82
			Bio_2	11.79	8.56	3.23	10.37	7.44	2.93
		FYM_2	Bio_1	12.24	8.85	3.39	10.76	7.67	3.09
			Bio_2	12.51	8.99	3.52	11.04	7.83	3.21
	N_3	FYM_1	Bio_1	12.82	9.16	3.66	11.33	8.01	3.32
			Bio_2	13.12	9.34	3.78	11.63	8.21	3.42
		FYM_2	Bio_1	13.64	9.69	3.95	12.05	8.43	3.62
			Bio_2	13.93	9.85	4.08	12.34	8.57	3.77
I_2	N_1	FYM_1	Bio_1	7.60	5.43	2.17	6.50	4.56	1.94
			Bio_2	7.94	5.64	2.30	6.83	4.77	2.06
		FYM_2	Bio_1	8.47	5.95	2.52	7.20	5.01	2.19
			Bio_2	8.81	6.11	2.70	7.50	5.20	2.30
	N_2	FYM_1	Bio_1	9.13	6.30	2.83	7.78	5.38	2.40
			Bio_2	9.42	6.48	2.94	8.05	5.56	2.49
		FYM_2	Bio_1	9.85	6.77	3.08	8.47	5.86	2.61
			Bio_2	10.14	6.95	3.19	8.80	6.07	2.73
	N_3	FYM_1	Bio_1	10.45	7.12	3.33	9.11	6.27	2.84
			Bio_2	10.77	7.30	3.47	9.42	6.46	2.96
		FYM_2	Bio_1	11.24	7.62	3.62	9.85	6.70	3.15
			Bio_2	11.49	7.76	3.73	10.22	6.89	3.33
LSD 5%				--	--	--	--	--	--
F. test				N.S	N.S	N.S	N.S	N.S	N.S

2-Role of water stress, nitrogen sources and their interactions on nutrient content of maize leaves.

It is evident from Table 5 that leaf contents of N, P, K, Ca and Mg were negatively affected by water stress .The reduction in Ca and Mg concentration due to water stress were the highest then K ,N and P in the two seasons. But Na concentration increased in the two seasons. This is consistent with the results of Ali et al., (2008).

Data presented in same Table indicated that increasing nitrogen fertilizer rate as compared to the control treatment increased the average values of N, P, K, Ca, Mg and Na in the leaves during both seasons. Mg and N were the most increasing to nitrogen rate (74.19, 64.37 %) in 1st season (95.45, 69.11%) in 2nd season. The lowest increasing was in Na (7.25 and 6.54%) in the two seasons respectively.

Concerning the effect of FYM, data at Table 5 show that, Adding FYM in the two seasons increased the content of the nutrients in maize leaves and ranged from(18.46, 54.01 ,18.53,12.05 ,74.35and 68.75%)for N, P, K, Na, Ca and Mg in the 1st season to (20.95, 61.30 ,27.03 ,9.32 ,84.61 and 82.60%)in the 2nd season.

It could be observed same trend with, inoculation maize grains where N, P, K, Na, Ca and Mg% increased in leaves in both seasons.

Data in Table 6 also reveal that nutrient contents of maize leaves in both seasons were insignificantly affected by the interactions among water stress and nitrogen sources. In addition to, organic and biofertilizer had an important role in reduce the negative effect of water stress on maize plants.

This result is confirmed with the work of Tisdal et al., (1993). They reported that water is a key factor in nutrient uptake by root interception, mass flow, and diffusion. Roots intercept more nutrients, especially Ca and Mg, when growing in a moist soil than in a drier one because growth is more extensive. Mass flow of soil water to supply the transpiration stream transports most of the nitrate, sulphate, calcium and magnesium. Nutrients slowly diffuse from areas of high concentration to areas of low concentration but at short distance. They added that nutrient absorption is affected directly by the level of soil moisture, as well as indirectly by the effect of water stress on the metabolic activity of the plant, soil aeration, and the salt concentration of the soil solution.

Table5: Role of water stress, mineral nitrogen, FYM and biofertilizer on nutrient contents of maize leaves at harvesting stage:

Treatments	1st season(2007)						2nd season(2008)					
	N%	P%	K%	Na%	Ca%	Mg%	N%	P%	K%	Na%	Ca%	Mg%
Irrigation												
I_1	2.27	0.293	3.07	0.377	0.67	0.50	1.96	0.272	2.77	0.648	0.43	0.36
I_2	1.99	0.276	2.59	0.397	0.41	0.36	1.74	0.241	2.52	0.654	0.32	0.29
LSD 5%	0.0218	0.0013	0.0108	0.001	0.011	0.0099	0.0271	0.0012	0.0106	0.0011	0.0113	0.0093
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Nitrogen rates												
N_1	1.60	0.264	2.51	0.372	0.43	0.31	1.36	0.240	2.22	0.626	0.27	0.22
N_2	2.15	0.286	3.06	0.390	0.56	0.44	1.88	0.261	2.81	0.659	0.38	0.34
N_3	2.63	0.303	2.92	0.399	0.62	0.54	2.30	0.280	2.90	0.667	0.46	0.43
LSD 5%	0.0267	0.0016	0.0132	0.0012	0.0135	0.0121	0.0332	0.0015	0.013	0.0013	0.0138	0.0114
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Organic fertilizer												
FMY_1	1.95	0.224	2.59	0.365	0.39	0.32	1.67	0.199	2.33	0.622	0.26	0.23
FMY_2	2.31	0.345	3.07	0.409	0.68	0.54	2.02	0.321	2.96	0.680	0.48	0.42
LSD 5%	0.0218	0.0013	0.0108	0.001	0.011	0.0099	0.0271	0.0012	0.0106	0.0011	0.0113	0.0093
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Biofertilizer												
Bio_1	2.09	0.281	2.81	0.385	0.52	0.42	1.81	0.257	2.62	0.649	0.36	0.32
Bio_2	2.17	0.288	2.85	0.389	0.55	0.44	1.89	0.263	2.67	0.653	0.38	0.34
LSD 5%	0.0218	0.0013	0.0108	0.001	0.011	0.0099	0.0271	0.0012	0.0106	0.0011	0.0113	0.0093
F. test	**	**	**	**	**	**	**	**	**	**	**	**

Table 6: Interactions effect between water stress, nitrogen, FYM and biofertilizer on nutrient contents of maize leaves at harvesting stage:

Treatments				1st season(2007)						2nd season(2008)					
				N%	P%	K%	Na%	Ca%	Mg%	N%	P%	K%	Na%	Ca%	Mg%
I_1	N_1	FYM_1	Bio_1	1.42	0.213	2.20	0.336	0.35	0.24	1.19	0.187	1.89	0.60	0.21	0.12
			Bio_2	1.56	0.220	2.25	0.341	0.37	0.28	1.28	0.193	1.93	0.60	0.23	0.14
		FYM_2	Bio_1	1.98	0.329	3.07	0.383	0.70	0.47	1.68	0.309	2.75	0.65	0.43	0.33
			Bio_2	2.03	0.334	3.12	0.387	0.73	0.49	1.75	0.315	2.79	0.66	0.45	0.35
	N_2	FYM_1	Bio_1	2.12	0.229	2.90	0.358	0.52	0.40	1.82	0.209	2.63	0.63	0.34	0.27
			Bio_2	2.19	0.236	2.95	0.363	0.56	0.42	1.89	0.214	2.68	0.63	0.36	0.29
		FYM_2	Bio_1	2.40	0.350	3.48	0.398	0.84	0.62	2.10	0.326	3.20	0.67	0.54	0.46
			Bio_2	2.47	0.359	3.53	0.402	0.89	0.64	2.17	0.333	3.25	0.67	0.57	0.50
	N_3	FYM_1	Bio_1	2.59	0.245	3.02	0.370	0.59	0.49	2.24	0.223	2.70	0.63	0.40	0.36
			Bio_2	2.66	0.251	3.08	0.374	0.61	0.53	2.33	0.230	2.74	0.64	0.42	0.38
		FYM_2	Bio_1	2.87	0.373	3.60	0.407	0.93	0.70	2.52	0.351	3.32	0.67	0.63	0.59
			Bio_2	2.96	0.380	3.64	0.411	0.96	0.73	2.59	0.359	3.37	0.68	0.65	0.60
I_2	N_1	FYM_1	Bio_1	1.16	0.194	1.91	0.355	0.20	0.15	0.98	0.167	1.67	0.59	0.14	0.09
			Bio_2	1.26	0.199	1.95	0.360	0.22	0.17	1.05	0.174	1.70	0.59	0.15	0.12
		FYM_2	Bio_1	1.68	0.311	2.79	0.406	0.45	0.36	1.47	0.285	2.50	0.64	0.28	0.29
			Bio_2	1.75	0.316	2.81	0.410	0.47	0.38	1.54	0.292	2.55	0.65	0.30	0.30
	N_2	FYM_1	Bio_1	1.84	0.215	2.66	0.376	0.28	0.24	1.58	0.188	2.43	0.62	0.18	0.21
			Bio_2	1.91	0.223	2.70	0.380	0.31	0.26	1.68	0.195	2.48	0.62	0.20	0.23
		FYM_2	Bio_1	2.12	0.337	3.13	0.421	0.53	0.48	1.89	0.310	2.87	0.70	0.43	0.37
			Bio_2	2.19	0.342	3.18	0.424	0.55	0.50	1.96	0.316	2.93	0.70	0.45	0.40
	N_3	FYM_1	Bio_1	2.33	0.231	2.75	0.385	0.35	0.33	2.00	0.204	2.54	0.63	0.27	0.29
			Bio_2	2.40	0.239	2.79	0.388	0.37	0.36	2.07	0.212	2.58	0.63	0.30	0.31
		FYM_2	Bio_1	2.61	0.353	2.24	0.430	0.60	0.58	2.28	0.328	2.97	0.71	0.53	0.45
			Bio_2	2.68	0.359	2.27	0.433	0.62	0.60	2.36	0.334	3.02	0.71	0.55	0.48
LSD 5%				--	--	--	--	--	--	--	--	--	--	--	--
F. test				**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**	**N.S**

3-Role of water stress and nitrogen sources and their interactions on nutrients content of maize grains:

The nutrients content of grains were significantly decreased under water stress as shown in Table 7. The reduction varied from 38.88, 24.32, 16.46, 12.54 and 7.94 % for Ca, Mg, K, N and P in the 1st season and 22.97, 18.51, 15.86, 13.48 and 9.96 % in the 2nd season. On the other hand, Na concentration in grains increased.

Listed data presented in Table 7 show that nutrients content of grains were significantly increased by increasing nitrogen fertilizer application as compared to the unfertilized treatment.

Data in Table 7 illustrated that using farmyard manure significantly increased the average values of nutrients content of grains than those obtained from the untreated. Also, the nutrients content of grains were significantly increased by inoculation maize grains with Azotobacter compare with the un-inoculated. The rate of increases over the un-inoculated for N , P , K , Na , Ca and Mg were accounted to be 3.01 , 2.16 , 2.70 , 0.97 , 7.14 and 6.45 % in 1st season and 3.26 , 1.02 , 3.81 , 0.44 , 10.52 and 8.33 % in 2nd season but P was insignificant in 2nd season. Data in Table 8 show that nutrients content of maize grains were insignificantly affected by the interactions among water stress and nitrogen sources in both seasons. However organic and biofertilizer had an important role in reduce the negative effect of water stress on maize plants. The enhancement effect of both organic manure and biofertilizer is previously mentioned.

Table 7: Role of water stress, mineral nitrogen, FYM and biofertilizer on nutrient contents of maize grains at harvesting stage:

Treatments	1st season(2007)						2nd season(2008)					
	N%	P%	K%	Na%	Ca%	Mg%	N%	P%	K%	Na%	Ca%	Mg%
Irrigation												
I_1	2.87	0.340	1.64	0.409	0.36	0.37	2.67	0.311	1.45	0.676	0.235	0.27
I_2	2.51	0.313	1.37	0.414	0.22	0.28	2.31	0.280	1.22	0.687	0.181	0.22
LSD 5%	0.0253	0.0013	0.0091	0.001	0.0122	0.0112	0.025	0.0055	0.0093	0.0009	0.0088	0.0094
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Nitrogen rates												
N_1	2.11	0.306	1.12	0.391	0.22	0.23	1.96	0.280	0.96	0.663	0.150	0.15
N_2	2.74	0.327	1.64	0.418	0.29	0.33	2.54	0.296	1.48	0.685	0.214	0.26
N_3	3.22	0.347	1.75	0.427	0.36	0.41	2.97	0.312	1.57	0.696	0.259	0.33
LSD 5%	0.031	0.0015	0.0112	0.0012	0.015	0.0137	0.0307	0.0068	0.0114	0.0012	0.0108	0.0115
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Organic fertilizer												
FMY_1	2.50	0.263	1.20	0.385	0.18	0.26	2.31	0.236	1.05	0.659	0.115	0.17
FMY_2	2.88	0.390	1.81	0.438	0.40	0.39	2.67	0.355	1.62	0.703	0.300	0.32
LSD 5%	0.0253	0.0013	0.0091	0.001	0.0122	0.0112	0.025	0.0055	0.0093	0.0009	0.0088	0.0094
F. test	**	**	**	**	**	**	**	**	**	**	**	**
Biofertilizer												
Bio_1	2.65	0.323	1.48	0.410	0.28	0.31	2.45	0.294	1.31	0.680	0.197	0.24
Bio_2	2.73	0.330	1.52	0.414	0.30	0.33	2.53	0.297	1.36	0.683	0.218	0.26
LSD 5%	0.0253	0.0013	0.0091	0.001	0.0122	0.0112	0.025	--	0.0093	0.0009	0.0088	0.0094
F. test	**	**	**	**	**	**	**	N.S	**	**	**	**

Table 8: Interactions effect between water stress, mineral nitrogen, FYM and biofertilizer on nutrients content of maize grains at harvesting stage:

Treatments				1st season(2007)						2nd season(2008)					
				N%	P%	K%	Na%	Ca%	Mg%	N%	P%	K%	Na%	Ca%	Mg%
I_1	N_1	FYM_1	Bio_1	1.91	0.251	0.81	0.362	0.15	0.20	1.77	0.226	0.62	0.632	0.08	0.07
			Bio_2	2.05	0.258	0.85	0.367	0.18	0.22	1.89	0.232	0.68	0.635	0.10	0.10
		FYM_2	Bio_1	2.45	0.383	1.61	0.417	0.40	0.33	2.33	0.360	1.46	0.680	0.24	0.25
			Bio_2	2.54	0.388	1.66	0.423	0.43	0.35	2.40	0.363	1.50	0.684	0.26	0.27
	N_2	FYM_1	Bio_1	2.71	0.271	1.54	0.385	0.22	0.30	2.57	0.245	1.34	0.659	0.12	0.20
			Bio_2	2.80	0.279	1.59	0.388	0.24	0.34	2.64	0.250	1.39	0.662	0.14	0.22
		FYM_2	Bio_1	3.04	0.399	2.00	0.439	0.48	0.43	2.85	0.368	1.81	0.700	0.34	0.36
			Bio_2	3.13	0.407	2.04	0.445	0.51	0.45	2.92	0.375	1.86	0.705	0.37	0.39
	N_3	FYM_1	Bio_1	3.25	0.292	1.66	0.392	0.30	0.38	3.01	0.260	1.45	0.668	0.16	0.28
			Bio_2	3.32	0.300	1.70	0.396	0.32	0.40	3.04	0.267	1.48	0.670	0.17	0.30
		FYM_2	Bio_1	3.57	0.424	2.10	0.450	0.56	0.51	3.27	0.391	1.92	0.710	0.40	0.43
			Bio_2	3.69	0.433	2.13	0.454	0.59	0.55	3.36	0.401	1.95	0.713	0.42	0.45
I_2	N_1	FYM_1	Bio_1	1.65	0.233	0.60	0.370	0.07	0.11	1.54	0.205	0.47	0.643	0.05	0.05
			Bio_2	1.72	0.239	0.65	0.375	0.09	0.13	1.61	0.211	0.51	0.647	0.07	0.07
		FYM_2	Bio_1	2.24	0.348	1.37	0.407	0.23	0.25	2.03	0.319	1.20	0.692	0.19	0.20
			Bio_2	2.31	0.355	1.42	0.411	0.26	0.27	2.10	0.324	1.25	0.695	0.21	0.24
	N_2	FYM_1	Bio_1	2.40	0.248	1.20	0.389	0.14	0.21	2.19	0.226	1.13	0.668	0.08	0.15
			Bio_2	2.47	0.254	1.23	0.394	0.16	0.23	2.24	0.232	1.17	0.671	0.11	0.18
		FYM_2	Bio_1	2.66	0.376	1.78	0.448	0.30	0.34	2.45	0.333	1.54	0.710	0.26	0.29
			Bio_2	2.73	0.382	1.80	0.452	0.30	0.36	2.52	0.341	1.60	0.712	0.28	0.32
	N_3	FYM_1	Bio_1	2.82	0.265	1.31	0.401	0.19	0.29	2.59	0.238	1.20	0.679	0.14	0.22
			Bio_2	2.89	0.273	1.34	0.406	0.21	0.31	2.68	0.244	1.24	0.683	0.15	0.25
		FYM_2	Bio_1	3.08	0.392	1.89	0.457	0.36	0.42	2.87	0.361	1.66	0.721	0.30	0.36
			Bio_2	3.15	0.400	1.93	0.461	0.38	0.44	2.94	0.332	1.70	0.725	0.32	0.38
LSD 5%				--	--	--	--	--	--	--	--	--	--	--	--
F. test				N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

4- Quality grains of maize water stress and nitrogen sources and their interactions:-

As shown in Table 9 it can be observed that protein and No_3^- percentages were significantly reduced by water stress .While, carbohydrates percentage increased significantly .The reduction rate was 12.63and19.96% in 1st season 13.51and25.92% in 2nd season. This result agrees with the results of Ali and Ashraf, (2011).

Table 9: Role of water stress, mineral nitrogen, FYM and biofertilizer on grains quality at harvesting stage:

Treatments	1st season(2007)			2nd season(2008)		
	%Protein	% No_3^-	%Carbohydrate	%Protein	% No_3^-	%Carbohydrate
Irrigation						
I_1	16.38	16.73	29.45	15.24	14.58	30.41
I_2	14.31	13.39	32.91	13.18	10.80	33.92
LSD 5%	0.1442	0.0116	0.1602	0.1426	0.0545	0.15
F. test	**	**	**	**	**	**
Nitrogen rates						
N_1	12.03	11.38	29.33	11.17	8.91	30.30
N_2	15.64	15.53	31.23	14.53	13.23	32.16
N_3	18.37	18.27	32.97	16.94	15.91	34.03
LSD 5%	0.1766	0.0142	0.1962	0.1747	0.0667	0.1838
F. test	**	**	**	**	**	**
Organic fertilizer						
FMY_1	14.26	11.82	29.50	13.20	9.48	30.63
FMY_2	16.43	18.30	32.85	15.23	15.90	33.70
LSD 5%	0.1442	0.0116	0.1602	0.1426	0.0545	0.15
F. test	**	**	**	**	**	**
Biofertilizer						
Bio_1	15.10	14.33	30.58	14.01	11.65	31.61
Bio_2	15.59	15.79	31.78	14.42	13.73	32.73
LSD 5%	0.1442	0.0116	0.1602	0.1426	0.0545	0.15
F. test	**	**	**	**	**	**

Data in same Table indicated that increasing nitrogen rate significantly increased Protein, No_3^- and Carbohydrates percentages the highest increases were (52.70, 60.54 and 12.41%) in 1st season and (51.65, 78.56 and 12.31 %) in 2nd season.

FYM addition increased Protein, No_3^- and Carbohydrates percentages where the rate of increases were 15.21, 54.82 and 11.35 % in 1st season and 15.37, 67.72 and 10.02% in 2nd season (Table 9).

It is clearly in same Table that inoculation of maize grains with Azotobacter increased the value of Protein, No_3^- and Carbohydrates percentages by 3.24, 10.18 and 3.92 % for 1st season and 2.92, 17.85 and 3.54 % for 2nd season. However organic and biofertilizer had an important role in reduce the negative effect of water stress on maize plants. This result consistent with the results of others such as (Farboodi et al., (2011) and Kizilog et al., (2010)) who indicated that inoculation of seeds with *Azotobacter chroococcum* increased carbohydrates and protein content of corn.

Table 10 showed that protein percentage was insignificantly affected by the interactions among water stress and nitrogen sources. Whereas, No_3^-

and Carbohydrates percentages were significantly affected by the interactions among water stress and nitrogen sources in both seasons. The enhancement effect of both organic manure and biofertilizer is previously mentioned.

Finally, it could be concluded that ,for obtaining a high, good quality and economically maize yield and at the same time saving soil from hazards of high doses of mineral fertilizers, we recommended that maize plants should be irrigated at field capacity and fertilized with mineral nitrogen fertilizer in conjunction with Azotobacter and with addition of FYM under the same conditions of the study .Also, in case of deficit of water at the end of canals we must adding FYM at (20-30)Ton/Fed and biofertilizers with NPK fertilizers to obtaining a high and economically maize yield .

Table 10: Interactions effect between water stress, mineral nitrogen, FYM and biofertilizer on grains quality at harvesting stage:

Treatments				1st season(2007)			2nd season(2008)		
				%Protein	% No_3^-	%Carbohydrate	%Protein	% No_3^-	%Carbohydrate
I_1	N_1	FYM_1	Bio_1	10.90	8.45	25.24	10.11	6.30	26.28
			Bio_2	11.70	10.71	27.61	10.77	8.20	27.89
		FYM_2	Bio_1	13.96	15.13	28.41	13.30	13.24	29.35
			Bio_2	14.49	17.06	28.59	13.70	14.49	30.05
	N_2	FYM_1	Bio_1	15.46	13.26	26.86	14.65	10.75	27.63
			Bio_2	15.99	14.50	28.72	15.06	13.92	29.29
		FYM_2	Bio_1	17.33	19.55	30.57	16.26	16.98	31.53
			Bio_2	17.86	21.44	31.38	16.66	19.57	32.61
	N_3	FYM_1	Bio_1	18.52	15.13	29.82	17.19	12.26	30.74
			Bio_2	18.92	17.10	30.53	17.33	14.43	31.53
		FYM_2	Bio_1	20.38	23.24	32.24	18.66	21.47	33.42
			Bio_2	21.03	25.21	33.40	19.18	23.36	34.58
I_2	N_1	FYM_1	Bio_1	9.44	6.62	28.79	8.78	4.43	29.60
			Bio_2	9.84	7.87	30.22	9.18	5.14	30.56
		FYM_2	Bio_1	12.77	11.98	32.23	11.57	8.83	34.07
			Bio_2	13.17	13.23	33.58	11.97	10.72	34.58
	N_2	FYM_1	Bio_1	13.68	10.41	30.68	12.50	7.38	32.83
			Bio_2	14.10	11.35	31.72	12.77	8.84	33.47
		FYM_2	Bio_1	15.16	16.76	34.42	13.96	12.65	34.42
			Bio_2	15.56	17.01	35.54	14.36	15.80	35.54
	N_3	FYM_1	Bio_1	16.09	12.62	31.39	14.76	9.47	32.99
			Bio_2	16.49	13.87	32.43	15.29	12.64	34.77
		FYM_2	Bio_1	17.56	18.90	36.27	16.36	16.04	36.44
			Bio_2	17.95	20.14	37.65	16.76	17.65	37.82
LSD 5%				--	0.0001	0.0236	--	0.0001	0.0496
F. test				N.S	**	**	N.S	**	**

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دور الإجهاد المائي ومصادر التسميد النيتروجيني علي بعض العناصر وجودة محصول الذرة .

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***قسم الأراضي – كلية الزراعة – جامعة المنصورة .**

****قسم خصوبة التربة وتغذية النبات – معهد الأراضي والمياه والبيئة – مركز البحوث الزراعية**

*****قسم خصوبة التربة وتغذية النبات – المركز القومي للبحوث .**

أجريت تجربتين حقليتين في صوبة قسم الأراضي بكلية الزراعة –جامعة المنصورة خلال الموسمين الصيفيين 2007 و 2008 بإستخدام نبات الذرة لدراسة تأثير الإجهاد المائي ومصادر التسميد النيتروجيني علي نمو ومحصول الذرة ومكوناته . صممت التجربة في 24 معاملة في تصميم قطع منشقة في شرائح متعامدة وهي تمثل كل التفاعلات الممكنة بين معاملتي ري (ري عادي 100% من السعة الحقلية – ري تحت إجهاد 60% من السعة الحقلية) والثلاث معاملات من السماد النيتروجيني المعدني بمعدلات (0 ، 50 ، 100% من الموصي به) ومعاملتي تسميد نيتروجيني عضوي بإستخدام سماد المزرعة (وجود أو عدم وجود سماد المزرعة) ومعاملتي تسميد نيتروجيني حيوي (تلقيح ببكتريا الأزوتوباكتر وعدم التلقيح بها). ا

- وقد أظهرت النتائج أن :-

أدى الإجهاد المائى إلى نقص الوزن الجاف لنبات الذرة ،القش والحبوب بينما زادت هذه الصفات بزيادة التسميد النيتروجينى المعدنى ، كما زادت أيضا بإضافة السماد العضوى وتلقيح حبوب الذرة ببكتريا الأزوتوباكتر فى كلا الموسمين .

أظهر التفاعل الرباعى بين الإجهاد المائى ومصادر التسميد النيتروجينى تأثير غير معنوى على كلا"من الوزن الجاف لنبات الذرة ،القش والحبوب.

أدى الإجهاد المائى إلى نقص محتوى الورقة من العناصر (النيتروجين –الفوسفور- البوتاسيوم – الكالسيوم – الماغنسيوم) بينما زاد محتوى الورقة من الصوديوم .وأدت زيادة معدل التسميد النيتروجينى المعدنى إلى زيادة محتوى الورقة من هذه العناصر كما أدت إضافة المادة العضوية والتلقيح البكتيرى إلى زيادة هذه العناصر .

لا توجد تأثيرات معنوية للتفاعل بين عوامل الدراسة الأربعة علي محتوى ورقة الذرة من العناصر.

كما نقص محتوى الحبوب من العناصر (النيتروجين –الفوسفور- البوتاسيوم – الكالسيوم – الماغنسيوم)نتيجة الإجهاد المائى لكن الصوديوم فإنه زاد، وأدت زيادة معدل التسميد النيتروجينى المعدنى إلى زيادة محتوى الورقة من هذه العناصر كما أدت إضافة المادة العضوية والتلقيح البكتيرى إلى زيادة هذه العناصر .

أظهر التفاعل الرباعى بين الإجهاد المائى ومصادر التسميد النيتروجينى تأثير غير معنوى على محتوى الحبوب من العناصر .

أدى الإجهاد المائى إلى نقص محتوى حبوب الذرة من البروتين والنترات فى حين زيادة محتواها من الكربوهيدرات .كما أدت زيادة معدل التسميد النيتروجينى و إضافة المادة العضوية والتلقيح البكتيرى إلى زيادة محتوى حبوب الذرة من البروتين والنترات والكربوهيدرات فى كلا الموسمين .

أظهر التفاعل الرباعى بين الإجهاد المائى ومصادر التسميد النيتروجينى تأثير غير معنوى على محتوى الحبوب من البروتين بينما أظهر التفاعل الرباعى بين الإجهاد المائى ومصادر التسميد النيتروجينى تأثير معنوى على محتوى الحبوب من النترات والكربوهيدرات فى كلا الموسمين.

وبذلك يمكن استنتاج أن إضافة التسميد النيتروجينى المعدنى بمعدل(260.87 كجم يوريا/ ف)100%من الموصى به مع إضاف سماد المزرعة والتلقيح البكتيرى بالأزوتوباكتر تحت الرى العادى يعتبر المعاملة المثلى للحصول على أعلى محصول للذرة فى مثل ظروف التجربة. بالإضافة إلى أن للتسميد العضوي والحيوي دوره في تقليل التأثير السلبي للإجهاد المائي على نبات الذرة و تقليل كلا من بعض عوامل التلوث و التكلفة الإقتصادية لإنتاج محصول الذرة.

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