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EFFECT OF IRRIGATION, NITROGEN AND ORGANIC FERTILIZATION ON SOIL WATER RELATIONSHIPS OF ZEA MAIZE CROP

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ABSTRACT

A field experiment was carried out at El-Roba village, Baltim, Kafr El- Sheikh Governorate, Egypt during two consecutive growing summer seasons 2004 and 2005 to study the effect of irrigation regimes, organic manure and source and levels of nitrogen fertilizers on the soil water relationships of zea maizeyield and its nutrient contents.

The obtained results could be summarized as follows:

The highest values of grain yield in the two seasons, were obtained from zea maize plants irrigated at 1.3 evaporation pan coefficient (ETp), fertilized with 10 m^3 chicken manure $fed.^{-1}$ and fertilized with urea at 160 kg N $fed.^{-1}$.

The highest values of water consumptive use (WCU) by zea maize plants were (59.88 and 59.87 cm WC $fed.^{-1}$) resulted from the irrigation at I.3 ETp in the two seasons, respectively. While, the lowest values (43.2 and 42.69 cm WC $fed.^{-1}$) obtained from irrigation at 0.7 ETp in 2004 and 2005 seasons, respectively.

The soil moisture extraction pattern as a percentage of WCU from four soil layers (0-15, 15-30, 30-45 and 45-60 cm) were (49.74, 42.33, 6.93 and 0 %), (38.52, 36.03 25.45, and 0 %) and (29.56, 40.16, 30.28 and 0 %) in the 1st season with irrigation at 1.3, 1 and 0.7 ETp, respectively, while, these values in the 2nd season were (48.81, 43.21, 7.98 and 0 %), (37.44, 36.56, 26.00 and 0%) and (30.01, 40.45 , 29.54 and 0 %) from the same layers, obtained with irrigation at 1.3, 1 and 0.7 ETp respectively.

The highest values of WUE by zea maize plants (2.044 and 2.108 kg grains m^{-3} water consumed) in 2004 and 2005 seasons, respectively, resulted from zea maize plants irrigated at 0.7 ETp, fertilized at 10 m^3 chicken manure $fed.^{-1}$ and fertilized with urea at 160 kg N $fed.^{-1}$. While, the lowest values (0.829 and 0.769 kg grains m^{-3} WC) obtained from zea maize plants irrigated at 1.3 ETp, had not fertilized neither organic manure nor mineral N fertilizers in both seasons, respectively.

From these results, it could be concluded that with infrequency of water irrigation, the irrigation of zea maize performable at 0.7 evaporation pan coefficient with increasing organic fertilization, where, that realized the highest water use efficiency.

Keywords: Irrigation, N fertilization, organic fertilization, water consumptive use, water use efficiency and zea maize.

INTRODUCTION

Water is a biotic for life in both the biochemical and biophysical synthesis and its influences are both internal and environmental. Water is often the primary limiting factor for maize production. The idea of applying too much water in irrigation to achieve maximum crop yield is not always correct, where, it causes losses of water and fertilizers through leaching. Nitrogen fertilization increased maize yield, this increase may reflect the high response of maize plants to nitrogen fertilizers and consequently improvement of plant growth parameters. Application of organic manure improved soil organic matter contents and soil physical and chemical properties through providing the soil with macro and micronutrients as well as improving soil structure **(**Othman, Sanaa *et al.*, 2005). Zea maize is one of the most important cereal crops in Egypt for human consumption and animal feeding.

Water consumptive use (WCU) by zea maize plants were increased with increasing available soil moisture (Abo-Omer, 2006). Abdel-Aziz-El-Set and El-Bialy (2004) and Meleha (2006) found that water consumptive use increased due to increasing amount of water applied. Abdel-Aziz-El-Set and El-Bialy (2004) showed that the values of seasonal water consumptive use by maize ranged from 54.66 to 74.64 cm during the period of study. They added that water consumption increased with increasing soil moisture by frequent irrigations. Also, the rate of evapotranspiration increased with increasing soil moisture level in the order: wet soil moisture level (irrigated at 35-40 % depletion in A.S.M.)> medium >dry (which watered at depletion of 75-80 % A.S.M.).

WUE decreased as water depletion increased, and the highest WUE was obtained from irrigation at 0.7 evaporation pan coefficient **(**Nofal-Fatma *et al.*, 2005). Abdel-Mawly and Zanouny (2005) reported that ET values gradually increased by increasing nitrogen levels up to 140 kg N fed.$^{-1}$, and as the available soil moisture increased in the root zoon of the plants. ET values were (1380, 2176 and 2239 m^3 fed.$^{-1}$) and (1638, 2171 and 2332m^3 fed.$^{-1}$) in two seasons for EPC equal to 0.7, 1.0 and 1.3, respectively.

The application of N fertilization and organic manure increased water use efficiency (El-Atawy, 2007). Nofal-Fatma *et al.* (2005) indicated that the highest values of WUE was obtained at 160 kg N fed.$^{-1}$

Therefore, this investigation aimed to study the effect of irrigation regimes, organic manure and source and levels of nitrogen fertilizers on the soil water relationships of zea maize.

MATERIALS AND METHODS

Experimental treatments :

The experimental design was split-split-split plot, where the two sources of nitrogen fertilizers (urea and enciabeen -slow release fertilizer-) were assigned in the main-plots, three irrigation regimes (1.3, 1.0 and 0.7 evaporation pan coefficient) were situated in the sub-plots, the organic manure was assigned in the sub-sub plots (chicken manure at 10 m^3 fed.$^{-1}$, compost at 10 m^3 fed.$^{-1}$and non O.M.) and the five N fertilizer levels (0, 80, 160, 240 and 320 kg N fed.$^{-}$1) were situated in the sub-sub-sub plots.

In each of the two seasons, calcium super phosphate (15.5% P_2O_5) was applied at the rate of 200kg fed.$^{-1}$in the last season to tomato crop during the field preparation, while potassium sulphate (48 % K_2O) was applied at the rate of 100 kg fed.$^{-1}$ 6 weeks after tomato transplanting. The mechanical and chemical analysis of experimental soil in both seasons are given in Table 1. The chemical analyses of chicken manure and compost of rice straw are shown in Table 2.

The chemical analysis of the irrigation water is given in Table 3. Every experimental unit area was 40 m^2 (8 x 5 m), which contained seven ridges of 8 m length and 70 cm width. Zea maize seeds were planted in hills of 30 cm apart.

1-Grain yield : At harvest, the five center ridges were harvested from each plot and threshed to determine grain yield. The shelled grain yield was adjusted to 15.5 %, then converting the grain yield kg per plot into ardab $feddan^{-1}$.

Table 1: Mechanical and chemical analyses of soil during both seasons of experimentation:

Season	Physical properties				Chemical properties (soil paste)									
	Sand	Silt	Clay	Texture	EC dSm^{-1}	pH	Soluble cations ($meq\ L^{-1}$)				Soluble anions ($meq\ L^{-1}$)			
							Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
2003/ 2004	72	15	13	Sandy loam	1.87	7.8	5.4	2.7	9.1	1.3	--	2.34	7.93	8.23
2004/ 2005	73	14	13	Sandy loam	1.92	7.7	5.8	3.1	8.6	1.7	--	2.53	8.17	8.50

Table 2: Chicken manure and rice straw compost analyses

Property	Rice straw compost		Chicken manure	
	1st year	2nd year	1st year	2nd year
Organic matter	32.71	32.62	58.80	60.00
Moisture content %	25.89	26.1	15.11	15.64
pH	7.43	7.49	8.13	8.21
EC (dS m^{-1})	8.12	8.61	4.65	4.78
Total N %	3.93	3.70	3.56	3.76
Total P %	0.91	0.90	2.11	2.23
Total K %	0.63	0.60	1.57	1.38
C/N Ratio	18.6	19.3	15	14

2-Soil Water Relations:

Soil samples were taken at planting time , just before and after 24 hours of each irrigation and at harvest time for soil moisture determination .At each sampling date , duplicate soil samples were taken from 0-15 , 15- 30 , 30- 45 and 45- 60 cm depths and their moisture contents were determined gravimetrically .

Field capacity and bulk density were determined for the experimental site. Water consumptive use in each irrigation was calculated according to (Hansen *et al.*, 1979):

$$C.U. = \sum_{i=1}^{1-4} \frac{P_{w2} - P_{w1}}{100} \times D_{bi} \times D_i$$

Where: CU = water consumptive use in the effective root zone (0-60 cm).

i = number of soil layers (15 cm).

P_{w2} = Soil moisture % 24 hours after irrigation (in sandy loam soil).
P_{w1} = Soil moisture % before irrigation for the specified soil layer.
D_{bi} = Bulk density of the specific soil layer.
Di = Soil depth (cm) = 15 cm.

Soil Moisture Extraction Pattern (SMEP) values were estimated for different layers of soil (0-15, 15-30, 30-45 and 45-60cm) as a percentage from water consumptive use (WCU) in both growing seasons of zea maize.

Water use efficiency values were estimated for different treatments as follows (Doorenbos and Pruitt, 1975):

$$W.U.E. = \frac{\text{Total fruit yield (kg fed.}^{-1})}{\text{Seasonal ETc (m}^3\text{ fed.}^{-1})}$$

Table 3: Some characteristics of irrigation water

Cations meq L^{-1}				Anions meq L^{-1}				pH	EC dSm^{-1}	TSS	SAR
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3	HCO^{-}	Cl^{-}	SO_4^{--}				
2.87	4.43	6.7	0.23	---	4.3	4.6	5.23	7.5	1.4	910	3.51

Irrigation treatments :

Potential evapotranspiration by evaporation class A Pan was used. Prevailing weather data of the previous three years of Seedy Salem, Kafr El-Sheikh Governorate were used to estimate the potential evapotranspiration as daily average during the growing seasons of zea maize plants. Irrigation was applied according to the daily record of the evaporation pan and the crop was irrigated when the water balance reached zero. Application of irrigation regime treatments started after life watering**.**

The treatments of enciabeen, zea maize seeds were planted after tomato plants fertilized with enciabeen, zea maize plants were grown in enciabeen treatments to measuring the residual effect of slow release nitrogen fertilizer (enciabeen), while, the treatments of urea, zea maize plants fertilized with urea in the same growth.

Nitrogen fertilization:

The treatments of enciabeen, zea maize seeds were planted after tomato plants fertilized with enciabeen to measuring the residual effect of slow release nitrogen fertilizer (enciabeen), while, the treatments of urea, zea maize plants fertilized with urea in the same growth.

RESULTS AND DISCUSSION

1: Grain Yield (ard. fed.$^{-1}$):

The data listed in Table 4 indicate that grain yield of zea maize (ard. fed.$^{-1}$) was high significantly affected by irrigation regimes, organic manure and the N fertilizer levels, while, it was significantly affected by the source of nitrogen fertilizers in both seasons. The highest values as affected by irrigation regimes (22.12 and 22.31 ard. fed.$^{-1}$) obtained from irrigation at 1.3 evaporation pan coefficient in the 1st and 2nd seasons, respectively. This increment of grain yield might be attributed to positive effect of more available moisture at grain filling which increase the starch contents and organic compounds in maize plants. These results are supported with those obtained by El-Atawy (2007), Mahdi and Yin (2003) and Nofal-Fatma *et al.* (2005).

The highest values of grain yield as affected by the application organic manure were (24.04 and 25.26 ard.fed.$^{-1}$) obtained from fertilization at 10 m^3 chicken manure fed.$^{-1}$ in the 1^{s} and 2nd seasons, respectively. This increment of grain yield due to on the organic manure additions may be attributed to the improving action of organic matter physical and chemical properties of soil**.** These results accordance with those obtained by Nofal-Fatma *et al.* (2005) and Othman-Sanaa *et al.* (2005) .

Table 4: Effect of irrigation regimes, organic manure, source of N fertilizer and its levels and their interactions on the yield and water use efficiency (WUE) in kg grains m^{-3} of water consumed by zea maize plants in 2004 and 2005 seasons.

Treatment	**Grain yield (ard. fed.$^{-1}$)**		**(WUE) in kg grains m^{-3} of (WCU)**	
	1st season	**2nd season**	**1stseason**	**2nd season**
A: Source of N fertilizer:				
1 -Urea	21.62	21.84	1.348	1.331
2 -Enciabeen	20.51	20.65	1.282	1.267
F. test	*	*	*	*
B : Irrigation regimes :				
1-1.3 Pan evaporation	22.15	22.31	1.157	1.138
2-1.0 Pan evaporation	20.86	21.31	1.288	1.282
3-0.7 Pan evaporation	20.19	20.12	1.501	1.477
F. test	**	**	**	**
L.S.D. at 5 %	0.376	0.285	0.051	0.048
C : Organic manure :				
1-Chicken manure	24.04	25.26	1.504	1.499
2- Rice straw compost	20.87	24.39	1.300	1.281
3-Non organic manure	18.29	18.39	1.142	1.117
F. test	**	**	**	**
L.S.D. at 5 %	1.054	0.746	0.036	0.033
D: Nitrogen fertilizer levels:				
1- 0 N fed.$^{-1}$ (control)	17.76	17.58	1.109	1.058
2-80 kg N fed.$^{-1}$	20.17	20.44	1.259	1.255
3-160 kg N fed.$^{-1}$	22.20	22.68	1.389	1.391
4-240 kg N fed.$^{-1}$	22.62	22.78	1.413	1.397
5-320 kg N fed.$^{-1}$	22.58	22.58	1.409	1.395
F. test	**	**	**	**
L.S.D. at 5 %	0.029	0.047	0.026	0.023
Sig. Interaction :				
A x B	**	**	**	**
A x C	**	**	**	**
A x D	**	**	**	**
B x C	**	**	**	**
B x D	**	**	**	**
C x D	**	**	**	**
A x B x C x D	**	**	**	**

The fertilization of maize plants with urea increased grain yield by 5.4 and 5.8 % only in 2004 and 2005 seasons, respectively compared those plants which grown at enciabeen treatments after tomato plants which fertilized in the last seasons at the same rates of nitrogen fertilizers. These results reveal that enciabeen (SRNF) was a significant effect on next crops which grown after aforetime essential crops, especially, when SRNF are applied at high rates. SRNF may be available regular source for nitrogen supply. These results are in harmony with those obtained by Abbady-Khadra. *et al.*(2003) and El-Atawy (2007).

Data listed in Table 4 reveal that grain yield of zea maize was high significantly in both two growing seasons. The highest values of grain yield as affected by the N fertilizer levels were (22.62 and 22.78 ard. fed.$^{-1}$) obtained by adding 240 kg N fed.$^{-1}$ in the 1st and 2nd seasons, respectively. These results prove clearly the prominent role of N element for increasing grain yield. The effect of nitrogen fertilizer on grain yield is the outcome of its positive effect on grain yield components and plant growth parameters (Table 4). These results may be enhanced by those obtained by Nofal-Fatma and Mobarak (2003) and Nofal-Fatma *et al.* (2005).

2-Soil Water Relationships:

2-1: Water consumptive use (WCU):

The data recorded in Table 5 indicate that water consumptive use increased with increasing soil moisture. The highest values (59.88 and 59.87 cm) or 2515 m^3 water consumed (WC) fed.$^{-1}$ resulted from the irrigation at I.3 evaporation pan coefficiency in the two seasons. While, the lowest values (43.2 and 42.69 cm or 1814 and 1793 m^3 WC fed.$^{-1}$) obtained from irrigation at 0.7 ETp in 2004 and 2005 seasons, respectively. In other words, the rate of evapotranspiration increased with increasing soil moisture level.

The increase in water consumptive use or evapotranspiration rate by maintaining soil moisture at high level can be attributed to excess available water in the root zone to be consumed by the plants. These results are in supported by Abo-Omer (2006) and Meleha (2006).

2-2: Soil Moisture Extraction Pattern (SMEP):

Data illustrated in Table 6 reveal that the soil moisture extraction pattern (SMEP) as a percentage of water consumptive use from four soil layers (0-15, 15-30, 30-45 and 45- 60 cm) with irrigation at 1.3 ETp were (49.74, 42.33, 6.93 and 0 %) in the first season, while, these values in the second season were (48.81, 43.21, 7.98 and 0 %) from the same layers, respectively. SMEP decreased from subsoil layers with water stress and increased from depth layers, where the values of SMEP with irrigation at 1.0 evaporation pan coefficient were (38.52, 36.03, 25.45 and 0%) in the 1st season and (37.44, 36.56, 26.00 and 0%) in the 2nd season from four surface soil layers, respectively. While, the values of SMEP with irrigation at 0.7 ETp in the two growth seasons, respectively were (29.56 and 30.01%) from surface layer 0-15 cm, increased to40.16 and 40.45 % from layer 15-30 cm and 30.28 and 29.54 % from layer 30-45 cm.

It is well known that plant roots extract more soil water from greater depths under moderate or long stress than plants irrigated at wet levels, thus the water stored in soil of moderate or long irrigation can be used with more efficiency.

Table 5: Water consumptive use (WCU) in cm by zea maize plants during 2004 and 2005 growth seasons.

Irrigation regimes	Months								Total (WCU) cm.fed.$^{-1}$	
	June		July		Aug.		Sep.			
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
1.3 ETp	8.33	8.45	13.77	17.23	18.11	18.16	15.99	16.03	59.88	59.87
1.0 ETp	8.09	8.51	14.71	15.30	14.87	15.75	13.99	13.92	51.66	53.48
0.7 ETp	6.42	6.79	12.61	12.53	12.88	12.53	11.29	11.10	43.20	42.69

Table 6: Soil Moisture Extraction Pattern (SMEP) by zea maize plants at different irrigation regimes during 2004 and 2005 growth seasons.

Irrigation regimes	SMEP % from layers of soil (depth cm)								Total SMEP%
	0-15 cm		15-30 cm		30-45 cm		45-60 cm		
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st and 2nd seasons		
1.3 ETp	49.74	48.81	43.33	43.21	6.93	7.98	….	….	100%
1.0 ETp	38.52	37.44	36.03	36.56	25.45	26.00	….	….	100%
0.7 ETp	29.56	30.01	40.16	40.45	30.28	29.54	…..	….	100%

2-3: Water use efficiency (WUE):

The data listed in Table 4 indicate that water use efficiency (kg grains m^{-3} WC) was high significantly affected by irrigation regimes, organic manure and the N fertilizer levels, while, it was significantly affected by the source of nitrogen fertilizers in both seasons.

Water use efficiency (kg grains m^{-3} WC) decreased with increasing water applied.

The highest values of WUE as affected by irrigation regimes (1.501 and 1.477 kg grains m^{-3} WC) resulted from irrigation at 0.7 ETp in both seasons, respectively, while, the lowest values (1.157 and 1.138 kg grains m^{-3} WC) obtained from increasing irrigation water at 1.3 ETp in both seasons, respectively. These results may be due to the higher grain yield of zea maize obtained from higher irrigation, but these increasing of grain yield were much less than increasing of amount of water consumed. It can be concluded that low water at 0.7 ETp level seemed to be suitable in consuming water compared to other treatments. WUE is not clearly depend on the water available if the supply is within evapotranspiration limit, even the crop yield and the opportunity to increase crop yield to depend on the adequacy of water supply. These results agree with those obtained by Abdel-Aziz-El-Set and El-Bialy (2004) and Ghazy (2004).

Applying 10 m^3 rice straw compost to last crop before maize increased WUE by zea maize plants by(13.84 and 14.68 % compared to control in 2004 and 2005 seasons, respectively. Whereas, applying 10 m^3 chicken manure fed.$^{-1}$ increased WUE by 31.70 and 34.20% compared to control in the same two seasons, respectively. Increasing WUE with application of different organic manure may be due to the effect of it on improving soil physical and chemical properties and availability of nutrients in the root zone, which enhance plant growth and total grain yield in maize. These results are in harmony with those reported by Mostafa *et al.* (2004) and Nofal-Fatma et al (2005).

Fertilization of zea maize plants with urea increased water use efficiency by 5.15 and 5.05 % only compared to WUE by zea maize which grown after tomato plants fertilized with enciabeen. These little different of the values of WUE between urea and remanent effect of enciabeen which applied at last season indicate that the slow release N fertilizers such as enciabeen were considered significantly affected of next crops if it were grown after essential crops fertilized by enciabeen specially when it applied at higher levels. Slow release N fertilizers consider available regular source for nitrogen supply, also, its effect keeps up to two successive seasons. These results are in supported by Abbady-Khadra *et al.* (2003) and El-Atawy (2007).

The highest values of WUE as affected by nitrogen fertilizer levels were (1.413 and 1,397 kg grains m^{-3} WC) obtained from fertilization at 240 kg N $fed.^{-1}$ in 2004 and 2005 seasons, respectively, while the lowest values (1.109 and 1.058 kg grains m^{-3} WC) resulted from zea maize plants had not N fertilization. Increasing N fertilizer levels from 0 to 240 kg N $fed.^{-1}$ increased WUE by 27.41 and 32.04 in both seasons, respectively. These increment in WUE as affected of increasing N fertilizer levels may be due to these increasing in grain yield $fed.^{-1}$. These results are similar to those obtained by El-Atawy (2007), Mostafa *et al.* (2004) and Nofal-Fatma *et al.* (2005).

Conclusion

The obtained results prove: in sandy loam soils:

To produce high grain yield of zea maize from maize cultivar "Single cross 10" by the irrigation at 1.3 evaporation pan coefficient, applying 10 m^3 chicken manure $fed.^{-1}$ and fertilized with nitrogen fertilizers at 160 kg N $fed.^{-1}$. On the other hand, with infrequency of water irrigation, the irrigation of zea maize performable at 0.7 evaporation pan coefficient with increasing organic and nitrogen fertilization, where, that realized the highest water use efficiency m^{-3} of water consumed.

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تأثير الري و التسميد النيتروجيني و العضوي على المحصول والعلاقات المائية الأرضية في محصول الذرة الشامية

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أجريت تجربة حقلية بقرية الربع ـ بلطيم ـ محافظة كفر الشيخ .خلال موسمي الزراعة صيفي 2004 و 2005 , لدراسة تأثير مستويات الري (1.3 , 1و 0.7 من معامل وعاء البخر) والتسميد العضوي (سماد دواجن كمبوست قش أرز ـ بدون سماد عضوي) ومصدرين للسماد النيتروجيني (اليوريا و الانسيابين ـ سماد بطئ الذوبان) ومستويات الإضافة لكل منهما (صفر ـ 80 - 160 - 240 - 320 كجم ن للفدان) على المحصول والماء الممتص وكفاءة استخدام المياة في محصول الذرة الشامية .. وكانت أهم النتائج كما يلي:

أعلى القيم لإجمالى محصول الحبوب -أردب للفدان- في الموسم الأول و الثاني تحقق من نباتات تم ريها عند مستوى 1.3 من معامل بخر الوعاء .

أعطت نبات الذرة الشامية التي زرعت بعد محصول الطماطم الذي تم تسميده عضوياً بسماد الدواجن بمعدل10م^3 للفدان أعلى القيم لمتوسطات جميع الصفات المدروسة .

أعلى قيمة لإجمالي محصول الحبوب(28.69 و 30.1 أردب للفدان) في كلا الموسمين 2004 و 2005علي التوالي نتجت من نباتات سمدت بسماد اليوريا بمعدل 160 كجم ن ف$^{-1}$.

أوضحت النتائج أن الاستهلاك المائي الموسمي لنباتات الذرة الشامية كانت (59.88), (51.66) و (43.2 سم ف$^{-1}$) في موسم 2004 بينما كان الاستهلاك المائي في موسم 2005 (59.87) ،(53.48) و(42.69) سم ف$^{-1}$ قد نتج من الرى عند مستوى 1.3, 1.0 و 0.7 من معامل بخر الوعاء على التوالى في كلا الموسمين.

تأثرت كفاءة استهلاك المياه مقدرة بالكيلو جرام من حبوب الذرة الشامية لكل متر مكعب مستهلك بواسطة نبات الذرة الشامية تأثيراً عالي المعنوية نتيجة مستويات الرى المختلفة والتسميد العضوى ومصدر التسميد الأزوتى ومستويات إضافته فى كل من موسمي النمو.

* أعلى كفاءة لاستهلاك المياه (2.044 و 2.108 كجم حبوب لكل متر مكعب من الماء المستهلك) نتجت من نباتات أذرة رويت عند مستوى 0.7 من معامل بخر الوعاء وسمدت عضوياً بسماد الدواجن بمعدل 10م^3 للفدان وسمدت بسماد اليوريا بمعدل 160 كجم ن للفدان في موسمي 2004 و 2005 على التوالى .

التوصيــــــة

من النتائج المتحصل عليها يمكن أن نوصي: بأنه في الأراضي الرملية السلتية و للحصول على أعلى محصول من الذرة الشامية يمكن تنظيم ري المحصول في منطقة شمال الدلتا بكفر الشيخ عند مستوى 1,3 من معامل وعاء البخر والتسميد بسماد الدواجن بمعدل 10م^3 للفدان مع التسميد المعدني بمعدل 160 كجم ن للفدان .

وعلى الجانب الآخر فإنه عند وجود ندرة فى مياه الرى فإنه يمكن ري نباتات الذرة الشامية عند مستوى 0.7 من معامل بخر الوعاء مع زيادة الأسمدة العضوية والمعدنية , حيث تزيد من كفاءة استخدام المياه.