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IMPACT OF IRRIGATION AND DRAINAGE ON MAIZE (*Zea mays*) YIELD, SOME WATER RELATIONS AND NITROGEN FERTILIZER LOSSES IN THE NORTH MIDDLE NILE DELTA.

Moursi, E.A.; A.A.S. Gendy and M.M. Kassab
Soils, Water and Environment Research Institute Agric. Res. Center

ABSTRACT

A field trail was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, during the two successive growing seasons 2008 and 2009 to study the effect of number of irrigations on maize yield, its components and some water relationships. Moreover, to investigate the effect of irrigation treatments on nitrogen fertilizer losses such as NH^+_4 and NO^-_3 in drainage water. The experimental design was randamized complete block with three replicates. The irrigation treatments were randomly assigned as main treatments which are, 1- Iirrigation as local farmers irrigating, their fields in the studied area (traditional, or control treatment A), 2- Withholding one irrigation through the growing season (treatment, B), 3-Withholding two irrigations through the growing season (treatment, C) and 4- Withholding three irrigations through the growing season (treatment, D).

The obtained results can be summarized as follows :-

- The highest values of water applied and water consumptive use were recorded under control treatment (irrigation without any stress during the growing season, treatment, A).On the contrary, the lowest values were recorded under treatment, D (skipping three irrigations during the growing season).
- The mean values of both water utilization and water use efficiencies were increased under stressed plants comparing with control treatment,A. The highest mean values were recorded under treatment,D but the lowest mean values were recorded under control treatment,A (traditional irrigation).
- The mean values for yield and its components of maize were decreased under water stressed treatments B,C and D compared with the non-stressed one (traditional irrigation). The mean values for all studied parameters can be decreased in order A › B › C › D.
- Data also showed that the differences between A and B treatments was extremely slight for all studied parameters. So, the researchers might be recommended to skipping one irrigation during the growing season instead of the traditional irrigation, without any loss of yield.
- The losses for both NH^+_4 and NO^-_3 was increased under control treatment comparing with other stress irrigation treatments B,C, and D which exposed to different stress treatments during the two growing seasons. Also, data showed that the losses of NO^-_3 ion was higher than NH^+_4 losses. Increasing losses of NH^+_4 and NO^-_3 due to application of fertilizers as one dose, so, application of fertilizers should be splitted into several doses.
- According to rate of water table drawdown in the two growing seasons, the rate was decreased with increasing time following irrigation event. The highest value of water table drawdown was found after one day from irrigation. On the other hand, the lowest value was found before the next irrigation. The highest values of discharge rate were found in the first day after irrigation, while the lowest values were found before the next irrigation.

INTRODUCTION

Maize grain is an important agricultural production in Egypt. The majority of farmers are still using maize grains for baking. Also, maize grains give a good type of edible oil. Therefore, this crop plays an important role in solving the shortage of edible oil which may be reached more than 90%.Maize is also utilized for animal feeding. The average national productivity of maize is about 30 ardab/Fed.(ardab=150 kg).So, maize productivity should be increased to face the need for people and animals. Increasing productivity of maize grain can be happened either by cultivation high productivity verities and the proper technical packages. Regarding cultivation activities among these irrigation management is an important tool. So, irrigation process should be controlled from the beginning of the growing season till the end of it.

Besides giving careness to irrigation we should do our best to care with drainage system in the studied area. This could be reduced the level of water table and decreasing the fertilizers losses particularly the nitrogenous 1 which polluted the drainage water and that hindrances re-using of it again and that needs a great treatment to become available for using again .Besides interests with irrigation and drainage that help to grow healthy plants which give high yield.

Agricultural production in Egypt, almost entirely depends on irrigation with water from the Nile River, as rainfall amount is negligible. Approximately all the national cultivation area of 8 million feddan (3.36 million ha.)is irrigated. The Egyptian water budget is limited to the country's share of the Nile which is fixed according to international agreements.

The main proplem which faces Egyptian agriculture is the limitation of irrigation water because of scarcity of water resources and fixed of Egyptian water budget which is 55.5 milliard cubic metre.Agricultural sector requires more than 85% from this amount. So, under conditions of limited water supply, particularly those of good qualities, the studies of the actual water requirements of crops become essential. The cultivable maize area is about 2 million feddan (1 fed.= 0.42 ha). Therefore, the accurate knowledge of the amount of water required to produce the highest economical grain yield of maize is essential. Also, in planning for irrigation of maize it becomes necessary to know about the quantity of water consumed in growing this crop and the efficiency of the applied water.

The main objectives for this study were to:

* studying some water relations for maize in the studied area.
* Identification of the best water regime which is suitable for maize.
* Decreasing the pressure on the drainage network in the studied area.
* Decreasing the fertilizer losses as well as decreasing pollution of drainage water.

MATERIALS AND METHODS

To achieve the main target of role of irrigation and drainage on maize and its water relations, a field experiment was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate in the North Middle Nile Delta region during the two growing seasons 2008/2009.The soil texture of this experimental site is clayey.

Experimental layout:

Maize as a summer crop was planted on 1st July and 18th June in the first and second growing seasons, respectively. Harvesting was preformed on 20th and 30th October in the first and second growing seasons, respectively. Maize cultivar was single white hybrid 123.

*** Soil chemical and physical properties of the studied site:**

Soil chemical properties were determined according to black *et al.*(1965). Physical properties such as field capacity (F.C.) was determined at the site. Permanent wilting point (P.W.P) was determined according to James(1988) and soil bulk density was determined according to Vomacil (1957). The particle size distribution was determined according to the international method of (Klute, 1962). The soil is clayey in texture and the soil profile is uniform without distinct change in texture. Available water was determined according to James(1988).

Table (1): The mean values of some soil chemical properties of the experimental site before cultivation in the two growing seasons.

Soil depth (cm)	EC dsm^{-1}	pH	Soluble cations MeqL^{-1}				Soluble anions MeqL^{-1}			
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Co^{2-}_3	Hco^{-}_3	Cl^{-}	So^{2-}_4
0-15	1.5	8.15	0.30	0.10	0.76	0.02	-	0.55	0.21	0.42
15-30	1.57	8.00	0.31	0.10	0.79	0.02	-	0.57	0.22	0.43
30-45	1.65	8.00	0.34	0.10	0.89	0.02	-	0.65	0.23	0.47
45-60	2.78	7.90	0.84	0.27	1.25	0.03	-	0.45	0.23	1.71

Table (2): The mean values of some soil Physical properties and some water constants of the experimental site before cultivation in the two growing seasons.

Soil Depth cm.	Particle size distribution%			Texture class	F.C %	P.W.P %	Available Water%	Bulk density Kg/m^3
	Sand	Silt	Clay					
0-15	16.0	18.0	66.0	Clay	47.0	25.3	21.7	1.19
15-30	19.0	13.0	68.0	Clay	39.0	21.8	17.2	1.16
30-45	16.5	16.0	67.5	Clay	38.0	21.9	16.1	1.30
45-60	17.5	15.5	67.0	Clay	38.5	20.8	17.7	1.20

Statistical analysis: -

Data collected were subjected to the statisticaly analysis according to Snedecor and Cochran (1967).

The experimental design was randomized completely block with three replicates. the irrigation treatments were randomly assigned where they were:

1. Treatment A, Control traditional irrigation like local farmers irrigating their fields in the studied area without water stress

2. Treatment, Bwithholding one irrigation through the growing season,
3. Treatment, C withholding two irrigations through the growing season and
4. Treatment, D withholding three irrigations through the growing season.

The area of each irrigation plot was $72m^2$(3m width*24m length).all cultivated practices were executed as recommended for the crop in the studied area except the investigated parameters.

Data collection:

1. Applied irrigation water.

The irrigation flow rate per plot was calculated according to Isrealsen and Hansen equation (1962)

$$q = 0.0226\ D^2 h^{0.5}$$

Where:
q =irrigation flow rate cm^3/sec,
h=average effective head, and
D=inside diameter of the pipe,cm.The amount of water applied for each plot was calculated by using formula

$$a = q*T$$

Where :
a=water volume /plot m^3
q= irrigation flow rate cm^3 and
T=total recorded time for each plot, minute

2. Water utilization efficiency (W.Ut.E)

(W.Ut.E) was calculated according to Michael (1978)

(W.Ut.E)=Y/Wa

Where:
W.Ut.E= water utilization efficiency (kg/m^3)
Y=Marketable yield, kg/fed. and
Wa=Water applied, m^3/fed.

3. Water use efficiency (W.U.E.)

The water use efficiency as a measure to clarify variations in yield due to irrigation water consumed, which was calculated according to Michael (1978) as Follows

$$W.U.E = Y/CU$$

Where
W.U.E= water use efficiency ,kg/m^3
Y= Marketable yield kg/fed. and
CU= water consumed,m^3/Fed.

4. Water consumptive use (C.U.)

Water consumptive use by growing plants was calculated based on soil moisture depletion (SMD) according to Hansen *et al.*(1979)

$$Cu = SMD = \sum_{i=1}^{i=4} \frac{\Theta 2 - \Theta 1}{100} * Dbi * Di$$

Where
Cu= water consumptive use (cm) in the effective root zone (60cm).
Θ_2= Gravimetric soil moisture percentage after irrigation
Θ_1= Gravimetric soil moisture percentage before irrigation

Dbi=Soil bulk density (kg/m^3) for depth
Di= soil layer depth (15cm.)
I= number of soil layers (1-4)

5-Losses ammonium and nitrate in drainage and soil water:

Total soluble nitrogen (ammonium nitrogen+ nitrate nitrogen).Total soluble nitrogen determined using devardas alloy powder (a).Ammonium nitrogen determined without devards alloy powder (b).
Nitrate nitrogen = a-b

Yield and yield components

- Grain yield (ardab/fed.
- Weight of 100grains(g)
- Ear diameter (cm.).
- Number of lines/ear.
- Number of grains/line.
- Plant height at harvesting (cm.)
- Ear height (cm.).
- Stem diameter (cm.).

RESULTS AND DISCUSSION

Water applied for maize m^3/fed.

Tabulated data in Table (3) clearly illustrated that the values of irrigation water applied for maize are greatly affected by irrigation regime. The values of water applied were the highest under control treatment (Trt., A, without holding any irrigation through the growing season) comparing with other stressed treatments. Water applied for treatment (A) are 4037.66 and 3943.8 m^3/fed. in the first and second growing seasons, respectively. The values of irrigation water applied in the two growing seasons can be descended in this order A> B>C >D. On the contrary, the lowest values of 2461.73 and 2577.88m^3/fed., were recorded under the condition of (Trt.D, with skipping three waterings) in the two growing seasons, respectively. Increasing the values of irrigation water applied under the condition of (Trt, A) is due to increasing number of irrigations .These results are in a great harmony with those obtained by El arquan and Abdel Kariem (1982), Ibrahim *et al.*(2005) and Awad *et al.* (2009)

Table (3): Effect of irrigation water regime on maize water applied in the two growing seasons

Irrigation treatment	Water applied (m^3/fed.)	
	1st season	2nd season
A	4037.66	3943.80
B	3672.91	3712.97
C	3102.70	3161.97
D	2461.78	2577.88

Where : A: traditional irrigation (without skipping irrigation)
B: Skipping one irrigations during the growing seasons
C: Skipping two irrigations during the growing seasons
D: Skipping three irrigation during the growing seasons

Water consumptive use for maize, m^3/fed:

Presented data in Table (4) showed that the values of consumptive use for maize are affected by irrigation treatments where the highest values were recoreded under control treatment (A),which practiced by local farmers . The values are 2753.2 and 2706.6m^3/fed. in the first and second growing seasons, respectively. on the contrary, the lowest values were recorded under treatment D(Skipping three irrigations during the growing season) and the corresponding values are 1807.7 and 1557.0m^3/fed., respectively. The values of consumptive use for maize in the studied area can be descended in order A>B>C>D in the two growing seasons. Increasing the values of consumptive use for maize under control treatment might be attributed due to the enough available water .Therefore, the values of consumptive use increased under such condition comparing with other irrigation treatments. Generally, seasonal water consumptive use decreased as soil available water amount decreased. The results are in a great agreement with those obtained by EL arquan and Abd el-Kariem (1982), Faizy *et al.* (1986) who indicated that the values of maize consumptive use were increased by decreasing irrigation interval from 28 days to 14 days. Also, results are in the same line with those obtained by Ashoub *et al.* (1996), Horder *et al.*(1982), Ibrahim *et al.* (2005) and Awad *et al.* (2009).

Table (4): Effect of irrigation water regime on maize consumptive use in the two growing seasons.

Irrigation treatment	consumptive use			
	1st season		2nd season	
	m^3/fed.	cm	m^3/fed.	cm
A	2753.20	65.54	2706.58	64.44
B	2534.35	60.33	2568.08	61.13
C	2192.22	52.20	2237.48	53.27
D	1807.67	43.04	1557.03	44.92

Water utilization and use efficiencies (kg/m^3.)

Data in Table (5) showed that the values of both water utilization and use efficiencies were increased under increasing water stress conditions. The highest values were recorded under (Trt. D) in the two growing seasons. The values of both two crop water efficiencies can be descended in the order D>C>B>A. These results are in a great harmony with those obtained by Faizy *et al.*(1986),Ibrahim *et al.*(2005) and Awad *et al.* (2009).

Table (5): Effect of irrigation water regime on maize water efficiencies in the two growing seasons.

Irrigation treatment	Water utilization efficiency (kg/m^3)		Water use efficiency (kg/m^3)	
	1st season	2nd season	1st season	2nd season
A	1.09	1.12	1.60	1.63
B	1.15	1.18	1.67	1.70
C	1.23	1.26	1.74	1.78
D	1.35	1.38	1.83	2.28

Yield and yield components :

Presented data in Table (6) clearly showed that the mean values of both yield and yield components are affected by the studied irrigation treatments in the two growing seasons. The mean values of both yield and its components of maize were decreased under water stressed conditions of B,C, and D compared with the non-stressed treatment which gave the highest mean values for the studied parameters in the two growing seasons. The mean values for all for the studied parameters can be descended in order A>B>C>D. Where the lowest mean values were recorded under treatment D which exposed to strict water stress, skipping or missing three irrigations during the season. The results showed that the reduction in yield between (Trt.A and B) for all yield and yield components in the two growing seasons were very slight.

Table (6): Effect of irrigation regime on yield and yield components of maize in the two growing seasons

Yield	Seasons	Irrigation treatment				$F_{test.}$	$LSD_{5\%}$	$LSD_{1\%}$
		A	B	C	D			
Grain yield (ardb/Fed)	1st	29.443	28.243	25.387	22.093	**	1.55	2.84
	2nd	29.393	29.097	26.520	23.660	**	2.06	3.78
100 grain weight (g)	1st	39.34	38.29	36.11	35.04	**	2.15	3.95
	2nd	38.58	37.65	36.01	34.68	**	1.91	3.51
Ear diameter(cm)	1st	17.27	16.87	16.47	16.07	**	1.18	2.05
	2nd	16.86	16.47	16.07	16.07	**	0.83	1.53
Ear length (cm)	1st	20.08	20.47	20.23	20.03	**	0.67	1.24
	2nd	20.40	20.20	20.23	20.13	**	0.67	1.23
Number of rows in ear	1st	14.67	14.27	14.00	13.77	**	0.73	1.34
	2nd	14.53	14.20	14.17	14.07	**	0.656	1.20
Number of grains in row	1st	48.5	47.8	46.77	46.37	**	1.05	1.93
	2nd	49.13	48.76	46.66	46.00	**	1.32	2.79
Plant height (cm)	1st	296.67	295.0	226.33	165.0	**	26.61	48.84
	2nd	300.0	298.0	242.0	172.2	**	25.28	46.41
Ear height (cm)	1st	138.0	137.0	129.30	93.0	**	21.89	40.19
	2nd	138.0	137.3	128.0	91.0	**	13.62	25.00
Stem diameter cm	1st	9.3	9.0	8.6	7.3	**	3.182	5.841
	2nd	9.0	8.3	7.6	6.6	**	3.181	5.841

Increasing yield and yield components under control treatment in the two growing seasons might be due to increasing amount of available nutrients and hence increasing amount of nutrients uptake so, forming strong plants with good vegetative growth were reflected on yield and yield components. Therefore, increasing yield and its components was obtained under treatment (A) comparing with other irrigation treatments which exposed to water stress.These results are in a great harmony with those obtained by Elarquan and Abdel Kariem(1982) who indicated that both yield and yield components for 20% soil moisture deficit treatment exceeded that of 50% and 80% of soil moisture deficit.From data obtained the authors can be recommended under the conditions of the studied area which suffer from limitation of irrigation water resources maize can be exposed to water stress

by missing or skipping one irrigation during the growing period without any drastic effect on yield and yield components because the difference between treatments A and B is slight. Under limitation of irrigation water resources maize can be skipped one irrigation through its growing period without any bad effect on yield and yield components .This skipping irrigation saves a large amount of irrigation water on the national level, such amount of water saving can be used in irrigating other crops in the same crop rotation or others.These results are in a great harmony with those obtained by Harder *et al.*(1982) Who showed that grain yield of maize was reduced by 33% due to the severity and duration of soil moisture stress. Also, these results are in a great agreement with those obtained by Ibrahim *et al.*(2005).and Awad, *et al.* (2009))

NH^{+}_{4} and NO^{-}_{3} losses in groundwater:

Presented data in Table (7) clearly showed that the losses of both NO^{-}_{3} and NH^{+}_{4} were affected by days after irrigation where the meanvalues were decreased by elongation days after irrigation. The highest mean values were recorded in the first day after irrigation comparing with the other days which gave the low values for NO^{-}_{3} and NH^{+}_{4}. Also data in the same table illustrated that the mean values of NO^{-}_{3} were higher than values of NH^{+}_{4} in the two growing seasons. This might be due to that on the first day after irrigation the amount of drainage water is high. So, the leaching rate also is high and consequently the content of NO^{-}_{3} and NH^{+}_{4} were higher in groundwater in the first day after irrigation comparing with other days.

Table (7): Effect of irrigation regime on losses of NH^{+}_{4} and NO^{-3} in groundwater in the two growing seasons

Days after irrigation	Observation well	NH^{+}_{4}	NO^{-}_{3}
1	P1	70.0	70.0
	P2	49.0	49.0
	P3	21.0	108.0
	P4	10.5	136.5
2	P1	21.0	91.0
	P2	35.0	526.0
	P3	49.0	959.0
	P4	17.5	290.5
3	P1	10.5	115.0
	P2	28.0	140.0
	P3	7.0	112.0
	P4	14.0	143.0
4	P1	7.0	197.0
	P2	17.0	73.5
	P3	7.0	133.0
	P4	10.5	108.5
5	P1	10.5	94.5
	P2	14.0	616.0
	P3	7.0	504.0
	P4	17.0	270.0

Increasing the values of NO^{-}_{3} ion in groundwater comparing with NH^{+}_{4} because of increasing leaching rate of NO^{-}_{3} comparing with NH^{+}_{4} which adsorbed on clay particles in comparison with NO^{-}_{3} which has a high solubility rate. So, its content in drainage water is high comparing with NH^{+}_{4}

ion. The amount of NO^-_3 and NH^+_4 losses at the end of growing season is 7.3kg/Fed. But the losses through the growing season is 29.0kg/Fed. Because the fertilization is applied as one dose. Data also in the same table indicated that the amount of NO^-_3 and NH^+_4 loses through observation well (1)which installed in control treatment (irrigated during fixed period through the whole growing season without any stress) is very high comparing with other observation wells which put in other irrigation treatments which exposed to stress during the growing season. Increasing losses of NO^-_3 and NH^+_4 might be due to application of fertilizers as one dose comparing with application it in different doses (3 doses instead of one dose) which leads to decreasing rate of losses .These results are in a great harmony with those obtained S.A.Ramadan *et al.*(2004 and 2009)

Rate of water table drawdown:

As shown in Fig. (1 and 2) and table 8 the calculated rate of drawdawn in both studied seasons was decreased with increasing interval after irrigation. The highest values of drawdown were found a after one day following irrigation event. While the lowest values were found before the next irrigation. This may be due to the improvement of tile drainage which in return gave the top soil chance to dry and permitted for shrinkage and formation of water passage ways and allowed a rather easier movement of water into drain pipes. These results are in a great harmony with those obtained by S.A. Ramadan *et al.* (2009)

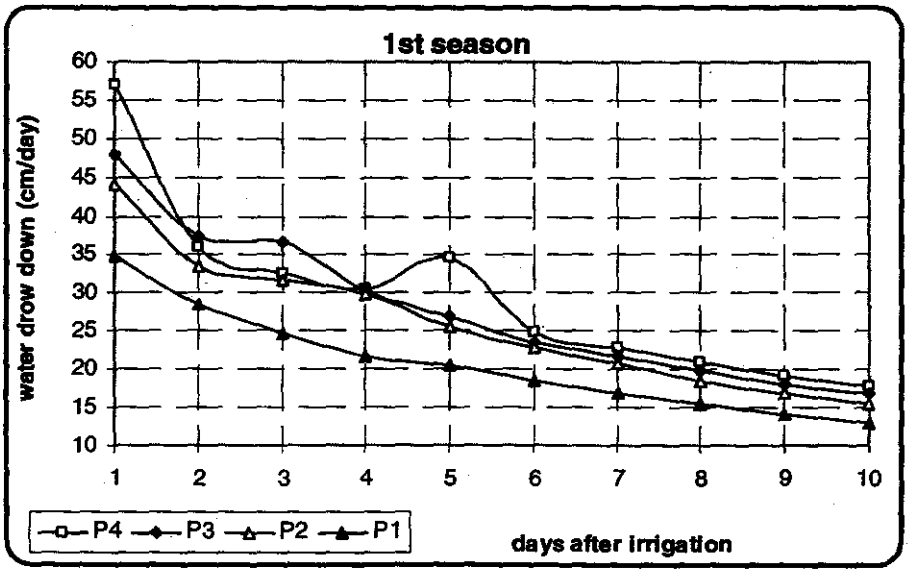

Fig.(1): Average watertable drawdown rate under maize (*Zea mays*) crop in 2008 season

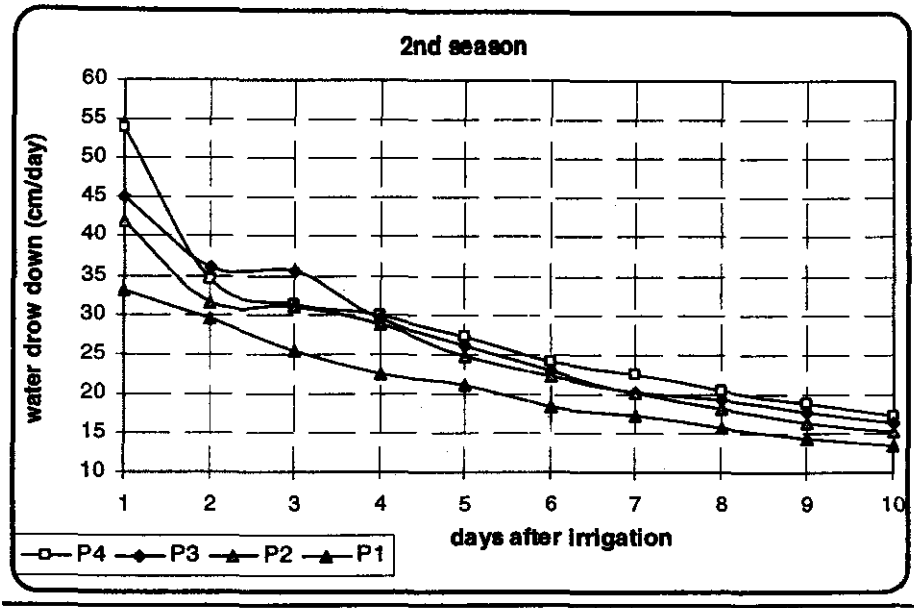

Fig. (2): Average watertable drawdown rate under maize (*Zea mays*) crop in 2009 season

Table (8): Effect of irrigation regime on water table drawdown rate (cm) in the two growing seasons.

Days after irrigation	Water table draw down rate, cm day							
	1st season				2nd season			
	P1	P2	P3	P4	P1	P2	P3	P4
1	35.0	44.0	48.0	57.0	33.0	42.00	45.00	54.00
2	28.5	33.5	37.5	36.0	29.50	31.50	36.00	34.50
3	24.67	31.67	36.67	32.67	25.33	31.0	35.67	31.33
4	21.75	29.75	30.25	30.50	22.50	28.75	29.50	30.00
5	20.6	25.60	26.8	34.75	21.00	24.80	26.00	27.20
6	18.5	22.83	23.5	24.83	18.33	22.33	22.83	24.00
7	16.86	20.71	21.71	22.86	17.29	20.29	20.29	22.43
8	15.50	18.5	19.75	20.88	15.75	18.25	19.38	20.50
9	14.11	16.76	18.0	19.11	14.22	16.44	17.67	18.89
10	13.00	15.5	16.90	17.80	13.5	15.20	16.40	17.20

Drain discharge rate :

The highest values of drainage discharge rate found in the first day after irrigation, while the lowest values are found before the next irrigation. In general, values of drainage discharge rate for all conditions under the first growing season were higher comparing with second season. The mean values of discharge rate in the first season were 5.88 mm/day while in the second season were 4.58 mm/day, respectively. While, the discharge rate was low in the treatments which exposed to stress and this plays an important role for relief the press on the drainage system S.A.Ramadan *et al.* (2009)

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تأثير الري والصرف على محصول الذرة الشامية وبعض العلاقات المائيـــة وفقـــد بعض الأسمدة النتروجينية بمنطقة شمال دلتا النيل

السيد ابوالفتوح مرسي ، الجندي عبدالرازق سليمان جندي و ماهر محمد كساب
معهد بحوث الاراضي والمياه والبيئه- مركز البحوث الزراعية

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا-محافظة كفرالشيخ خلال موسمي الدراسة ٢٠٠٨/٢٠٠٩بهدف دراسة تأثير عدد الريات على محصول الذرة الشامية ومكوناته وبعض العلاقات المائية وكذلك دراسة اثر معاملات الري على فقد الأسمدة النتراتية والأمونيومية في مياه الصرف بالاضافة الى معدل إنخفاض مستوى الماء الارضي وكذا معدل الصرف.وكان التصميم الأحصائى كان قطاعات كاملة العشوائية في ثلاث مكررات- ووزعت معاملات الري بطريقة عشوائية وكانت:

١-ري عادى (معاملة الكنترول ا)
٢-حرمان ريه خلال موسم النمو (معاملة ب)
٣-حرمان ريتين خلال موسم النمو (معاملة ج)
٤-حرمان ٣ريات خلال موسم النمو (معاملة د)

أهم النتائج المتحصل عليها:

- سجلت أعلى القيم بالنسبة للماء المضاف وكذلك الاستهلاك المائي تحت معاملة الكنترول(ري بدون حرمان طول الموسم معاملة ا) وعلى العكس من ذلك سجلت اقل القيم تحت المعاملة د حرمان ٣ ريات خلال الموسم
- بالنسبة لقيم كفاءة استخدام واستعمال المياه سجلت تحت المعاملات التي حدث بها حرمان مقارنة بالكنترول(بدون حرمان) حيث سجلت أعلى القيم تحت المعاملة (د) حرمان ٣ ريات طوال الموسم ولكن اقل القيم سجلت تحت المعاملة ا (ري بدون حرمان طول الموسم ري عادى)
- بالنسبة لقيم المحصول ومكوناته تناقصت تحت المعاملات التي حدث بها حرمان ب،ج ، د مقارنة بمعاملة الكنترول(ا) والتي أعطت أعلى القيم بالنسبة للمحصول ومكوناته،ويمكن ترتيب متوسطات القيم بالنسبة للمقاييس المدروسة ترتيبا تنازليا ا ، ب ، ج ، د وأوضحت النتائج أن الفروق بين اب ليست معنوية.
- بالنسبة لفقد الأسمدة (النترات والأمونيوم)زاد تحت المعاملة ا (ري عادى طول الموسم) مقارنة بالمعاملات ب،ج،ء والتي تعرضت لعمليات شد مختلفة ،و اوضحت النتائج كذلك أن فقد النترات أعلى من فقد الأمونيوم.
- بالنسبة لمستوى الماء الأرضي معدل الانخفاض تناقص مع زيادة الوقت بعد الري) حيث سجلت أعلى القيم في حالة يوم واحد بعد الري وعلى الجانب الأخر اقل القيم سجلت قبل الرية التالية.
- أعلى القيم بالنسبة لمعدل التصرف كان في اليوم الأول بعد الري بينما اقل القيم سجلت قبل الرية التالية.

قام بتحكيم البحث

أ.د / السيد محمود فوزي الحديدي — كلية الزراعة – جامعة المنصورة
أ.د / محمد عبد الفتاح محمد إبراهيم — مركز البحوث الزراعية