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IMPACT OF WHEAT PLANTING METHODS, IRRIGATION WATER QUALITY AND LEVELS ON NUTRIENTS UPTAKE AND WATER USE EFFICIENCY.

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ABSTRACT

Two field experiments were carried out during the two successive winter seasons of 2009/2010 and 2010/2011 at EL Karada, Water Requirements Research Station, Kafr El-Sheikh Governorate- Water Management and Irrigation System Research Institute, National Water Research Center to study the effect of wheat planting methods, water quality and water stress on nutrients NPK uptake and water use efficiency. The experimental design was strip split plot design with three replicates. The main plots were planting methods, (Broadcast, drilling and transplanting), sub plots were (fresh irrigation water, fresh irrigation water alternated drainage irrigation water and drainage irrigation water), and sub sub plots were arranged with three water regime treatments (25, 50 and 75 %) depletion of available soil moisture.

Data showed that the nitrogen uptake by the grain and straw of wheat was significantly affected by planting methods and water quality while it was not affected significantly by water stress, The uptake of phosphorus in the grain and straw of wheat was significantly affected by planting methods, water quality and water depletion. The uptake of phosphorus by grain and straw of wheat was not significantly affected by water depletion. Also, data showed that the uptake of potassium in straw of wheat was not significantly affected by planting methods, water quality and water stress. The planting method and water quality had significant effect on uptake of potassium in grains but no significant with water depletion.

The grain yield was significantly affected by the planting methods, water quality and water depletion except for water depletion in 2009/2010 which had no significant effect on grain yield.

The highest value of crop water use efficiency was obtained with transplanting method and the lowest value was recorded with broadcast method. Concerning the water quality, the irrigation by fresh water recorded the highest value, while the lowest value was achieved with drainage water in the first and second seasons respectively, since the increase of available water resulted in an increase of crop water use efficiency. It can be concluded that the N-uptake by grain and straw of wheat plants decreased with transplanting method, increasing water salinity and water stress, whereas P-uptake by grain and straw of wheat plants decreased with increasing water salinity. It can be concluded that K uptake by grain and straw of wheat plants significantly decrease as water salinity increase.

The objective of this investigation is to study the impact of wheat planting methods, irrigation water quality and levels on nutrients NPK uptake by wheat and water use efficiency.

INTRODUCTION

Water is fast becoming an economically scarce resource in many areas of the world, especially in arid and semi arid regions. In Egypt, there are many plans for increasing cultivable land and agricultural production to overcome problems of the food security. Wheat is a major strategic food and feed grain crop successfully grown under limited water conditions, therefore its growth and high productivity depend mainly on the proper water management.

Transplanting is a good technique which has positive benefits such as saving water and seeds, managing plant population, controlling weeds, solving the problems of sowing date, harvest time and germination of seeds. El- Hadidi et al, (1986) pointed that irrigation at 25% depletion of available soil moisture gave significantly higher grain and straw yield than when irrigation at 50%. According to transplanting and direct seeding of wheat on different planting and transplanting dates using G164 cultivar. Results of this study showed that transplanting methods as well as early planting dates were significantly surpassed direct seeding and late planting dates, respectively, Concerning height of plant, number of spikelet's/spike, number of grains/spike and grain yield ardab/fed, straw and biological yields were increased by early time of planting or transplanting (Tantawy, 1999). Hussien et al. (2000) indicate that soil moisture levels affected on the grain and the straw yield in the two growing seasons. The greatest yield value was achieved under A1 (45% depletion) which increased income by 51.72 L.E per 1000 m^3 irrigation water while the lowest value obtained under A3 (75 % depletion) which decreased income by 54.81 L-E per 1000 m^3 irrigation water. Chaudhry et al., (2004) indicates that, maximum wheat grain yield of 3652 kg ha–1 was obtained with canal water irrigation followed by canal water during spring and drainage water during autumn seasons (2972 kg ha^{-1}). These yields were fairly higher than the rest of the treatments. Abo-Baker., (2009) pointed out that irrigation water salinity affected all wheat growth and yield parameters. Abd El Hafez et al., (1999) reported that at 75% depletion of the available soil moisture resulted in significantly the highest values of water use efficiency (WUE) in comparison to 90 % and 50%. Chhipa and Lal (1985) noticed that, K content of grain and straw of wheat plant decreased with increasing level of salinity. Seedlings of 3 wheat cultivars differing in their salt tolerance were subjected to NaCl stress of 0.6 and 12 dS/m, salinity produced greater decreased in K content in leaves of sensitive culivars, while it was not affected in the salt tolerant cultivars. Abo-Soliman, et al, (1991) studied the effect of salinity namely (0, 0.4, 3 and 6 dS/m), four sources of nitrogen and 3 levels of amended doses on wheat and maize plant. The main results for both crops showed that there was a gradual significant decrease in N-uptake due to increasing irrigation water salinity. They also showed that there was a significant increase in N-uptake due to increasing the N levels. Singh et al., (1992) found that the uptake of nitrogen and phosphorus in wheat plants significantly decrease with increasing salinity levels from 0 to 20 dS/m. Khalifa et al. (1995) studied the effect of two water

stress levels, five levels of N, two rates of K on water relation and uptake of some macro nutrients by wheat under salt affected soil conditions. Data showed that a gradual increase in the uptake of N, P and K by wheat crop with increasing the level of N was noticed, but, a decrease in the uptake of the previous elements was observed under water limiting conditions. Also, Atwa (2005) pointed out that N-uptake by straw significantly decreased as water salinity increased. Atwa (2005) found that P-uptake by grain yield of wheat plants decreased with increasing water salinity. Therefore, the objective of the present study study is focusing on inducing planting methods, water quality and level of irrigation on N P K and water use efficiency of wheat crop.

MATERIALS AND METHODS

Location of the experiments

Two field experiments were carried out during the two successive winter seasons of 2009/2010 and 2010/2011 at El Karada Water Requirements Research Station, Kafr El Sheikh Governorate-Water Management and Irrigation System Research Institute, National Water Research Center.

Basic Treatments:-

Planting methods (main plots)(P): (A_1: Broadcast), (**A_2**: drilling) and **A_3**: (Transplanting).

Irrigation water quality (sub plots Q): (B_1: Fresh irrigation water from (Meet yazeed), (**B_2**: Fresh irrigation water alternated by one drainage irrigation water from field drainage) and (**B_3**: Drainage irrigation water).

Irrigation levels (sub sub plots (D): C_1: Irrigation at 25% depletion from available soil moisture , (**C_2**: Irrigation at 50% depletion from available soil moisture) and (**C_3**: Irrigation at the depletion of 75% from available soil moisture). Data were subjected to the combined analysis as described by **Snedecor and Chochran (1980).** The treatment means were compared according to Duncan"s multiple range test **(Duncan**, **1955).**

Table (1): Dates of sowing and harvesting operation during the two growing seasons,

Operation	2009/2010	2010/2011
Sowing	Nov.24	Nov.20
Harvesting	April,30	April,30

Cultural practices: The recommended N Fertilizer rate was (60kg N/Fed), which applied for all treatments in form of ammonium nitrate (33.5 % N), while phosphorus was applied before cultivation during soil preparation, in the form of calcium super phosphate at the rate of 15.5% (P_2O_5). Other cultural practices were done as recommended in the area.

Some physical and chemical properties of the experimental soil before soil preparation were analyzed according to the procedures outlined by Jackson (1967) are shown in Table (3).

Table (2): Some physical and chemical analysis of the experimentel soils.

Soil properties		Values
Particle size Distribution (%)	Sand	20.2
	Silt	26
	Clay	53.8
	Soil texture	Clayey
Bulk density (g cm^{-3})		1.11
Available water		20.67
Field Capacity (F.C %)		45.17
Saturation percentage		90.34%
Permanent Wilting Point%		24.5
EC (dSm^{-1})		0.517
pH (Soil paste)		7.6
Calcium carbonate (%)		3.8
Organic matter %		1.7
Soluble cations (meq L^{-1})	Ca^{++}	1.4
	Mg^{++}	3.10
	Na^{+}	3.70
	K^{+}	0.14
Soluble anions (meq L^{-1})	CO_3^{--}	0
	HCO_3^{-}	2.3
	Cl^{-}	2.70
	SO_4^{--}	3.34
Available nutrients (mg Kg^{-1})	Nitrogen	38
	Phosphorus	11
	Potassium	327

Nutritional analysis:

Soil analysis

Mechanical analysis: Particle size distribution was carried out using the pipette method as described by Dewis and Fertias (1970).

Field Capacity (F.C %): It was determined by field methods according **to** Black, (1965).

Soil pH and EC were determined in the soil paste and soil paste extract, respectively according to Jackson (1967).

Soil organic matter content was determined by using Walkley & Black method as described by Hesse (1971).

Total carbonate content was estimated gasometrically using Collins Calcimeter and calculated as calcium carbonate according to Dewis and Fertias (1970).

Soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) and anions ($CO_3^{=}$, HCO_3^{-}, and Cl^{-}) were determined in the saturated soil paste extract by the methods described by Hesse (1971).

Soluble Ca^{++} and Mg^{++} were determined by titration with standardized versenate solution.

Soluble Na^{+} and K^{+} ions were determined by using flame photometer.

Soluble $CO3^{=}$ and $HCO3^{-}$ ions were determined by titration with standardized H_2SO_4 solution.

Soluble Cl^- ions were determined by titration with standardized silver nitrate solution. Sulphate ($SO4^{=}$) was calculated as the difference between total cations and anions.

Available nitrogen in the soil was extracted using 2.0 M KCl and determined by using macro-Kjelahl according to Hesse (1971).

Available phosphorus in the soil was extracted with 0.5 M $NaHCO_3$ at pH 8.5 and determined color metrically after treating with ammonium molybedate and stannous chloride at a wavelength 725 nm, according to Hesee (1971).

Available potassium was determined by extracting soil with 1.0 N ammonium acetate at pH 7.0 as described by Hesee (1971).

Cation exchangeable capacity CEC: It was determined by using sodium and ammonium acetate as described by Gohar (1954).

Available water (A. W): It was calculated by the difference between the F.C and P. W. P. as shown in table (2).

Plant analysis:

At harvest the plant were harvested after maturity. Plant materials were carefully washed with top water followed by distilled water, oven dried at 70 ^{0}C for 48 hours and separated to grains and straw. Then 0.2g was wet digested in 5 ml of H_2SO_4 and $HCLO_4$ in a conical flask as described by Chapman and pratt (1961).

Total nitrogen, phosphorus and potassium were determined in the digested dry sample according to Cottenie et al., (1982).

Total nitrogen was determined using micro- kjeldahl method. Potassium was estimated using flame photometer. Phosphorus was determined colorimetrically using chlorostannous reduced molybdophosphric blue color method in sulphoric acid system as described by Jackson (1967).

$$\text{NPK Uptake} = \frac{\%\text{NPK} \times \text{Plant dry matter yield (g)}}{100}$$

Table (3): Some characteristics of irrigation water

Month	Treatments	PH*	Ec** ds/m	Cations meq/l				Anions Meq/L				SAR	Do mg/L
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3	Hco_3	Cl^{-}	So_4		
	Fresh water	7.51	0.42	2.60	1.80	1.5	0.20	0	2.60	0.65	2.90	**1.013**	**8.50**
Nov	Drainage Water	7.50	0.66	1.85	1.56	4.00	0.25	0	1.65	1.7	3.35	**3.06**	**7.50**
Doc	Drainage water	7.57	0.780	1.90	1.57	4.1	0.26	0	1.70	1.80	4.33	**3.11**	**4.30**
Jan	Drainage water	7.66	1.10	3	2.80	5	0.30	0	2.0	2.50	6.60	**2.94**	**3.50**
Feb	Drainage water	7.80	1.50	4.30	2.60	8.70	0.30	0	4.0	3.60	7.60	**4.68**	**3.30**
Mar	Drainage water	7.90	1.60	4.50	2.50	8.00	0.30	0	4.50	3.80	7.10	**4.28**	**4.20**
April	Drainage water	7.70	1.55	4.30	2.60	8.70	0.30	0	4.00	3.70	8.20	**4.68**	**4.59**
May	Drainage water	7.70	1.20	4.35	2.50	6.20	0.30	0	4.00	4.00	5.35	**3.35**	**5.53**

Crop water use efficiency:

Is the weight of marketable crop produced per the volume) unit of water computed by plants or the evapotranspiration quantity. The crop water use efficiency was commuted for the different treatments by divding the yield (Kg) on units of evaportanspiration expressed as cubic meters of water (Abd El Rasool et al, (1971). I t was calculated by the following formula:

$$\text{C.W.U.E.} = \frac{\text{Yield (Kg/fed)}}{\text{Water consumptive use (m}^3\text{/ Fed)}}$$

RESULTS AND DISCUSSION

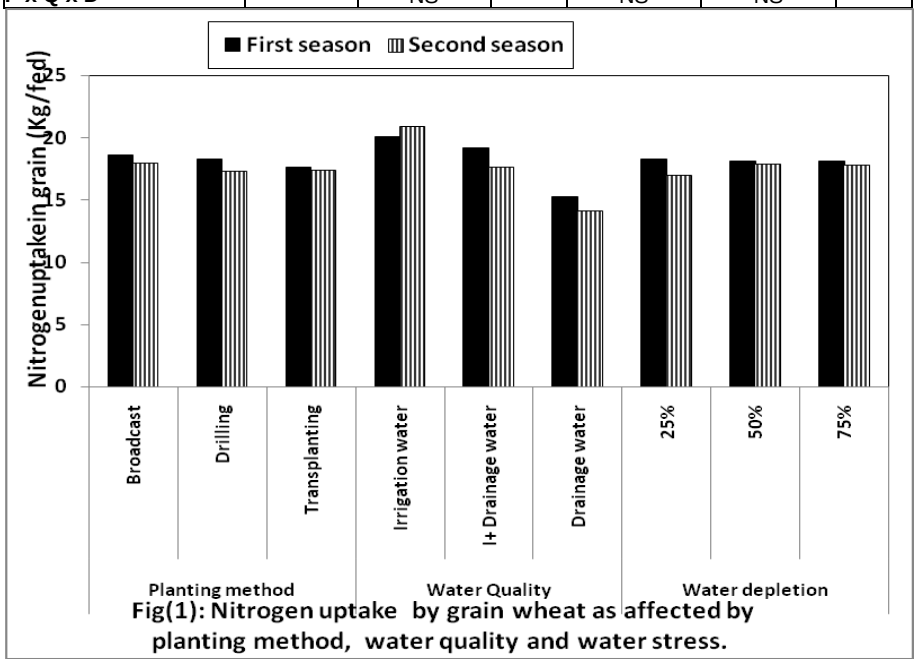
1-The uptake of nitrogen by grain and straw of wheat as affected by planting method, water quality and water stress. The results in Table (4) and Fig. (1) showed that, nitrogen uptake by the grain and straw of wheat was significantly affected by planting method and water quality while it was not significantly affected by water stress. The highest nitrogen uptake by grain and straw of wheat were (18.64 and 17.91) kg/fed and (12.15 and 12.06) kg/fed were obtained with planting method (broadcast). While the highest value under water quality the nitrogen uptake by grain was obtained by irrigation with fresh water (20.11 and 20.89) kg/fed in the first and second seasons respectively. While uptake by straw was obtained with fresh water alternative drainage water (13.27 and 12.99) in 2009/2010 and 2010/2011 respectively.

The interaction effect between different studied factors showed that no significant in all treatments except the interaction between water quality and water depletion and the interaction effect between planting method, water quality and water stress on uptake nitrogen by grain in the first season were significant.

It can be concluded that the N- uptake by grain and straw of wheat plant decreased with transplanting method, increasing water salinity and water stress. These results are similar with those obtained by Abo-Soliman et al (1991), Singh et al. (1992), Khalifa et al (1995) , Atwa (2005) ,Nofal-Fatma and Mobarak (2003)and Nofal-Fatma et al (2005).

Table (4): The uptake of nitrogen by grain and straw yields of wheat cv. Giza 168 as affected by planting method, water quality and water regime and their interactions in 2009/10 and 2010/11 seasons.

Factor	Uptake of nitrogen by grain (kg/fed^{-1})		Mean	Uptake of nitrogen by straw (kg/fed^{-1})		Mean
	2009/10	2010/11		2009/10	2010/11	
Planting method (P):						
Broadcast A1	18.64 a	17.91a	18.28	12.15a	12.06a	12.11
DrillingA2	18.26 b	17.29a	17.78	12.07a	11.62ab	11.85
TransplantingA3	17.68 c	17.36a	17.52	11.74a	11.68a	11.71
F-test	**	NS		NS	NS	
Water quality (Q):						
Irrigation water(I) B1	20.11 a	20.89 a	20.50	12.16 b	11.92 b	12.04
I+ Drainage waterB2	19.20 b	17.58 b	18.39	13.27 a	12.99 a	13.13
Drainage water B3	15.27 c	14.09 c	14.68	10.53 c	10.47 c	10.5
F-test	**	**		**	**	
Water depletion % D):						
25(C1)	18.29	16.95	17.62	11.85a	11.87b	11.86
50 (C2)	18.15	17.81	17.98	11.91a	11.72a	11.82
75 (C3)	18.14	17.80	17.97	12.2b	11.79a	120
F-test	NS	NS		NS	NS	
Interaction:						
P x Q	NS	NS		NS	NS	
P x D	NS	NS		NS	NS	
Q x D	**	NS		NS	NS	
P x Q x D	**	NS		NS	NS	



Fig(1): Nitrogen uptake by grain wheat as affected by planting method, water quality and water stress.

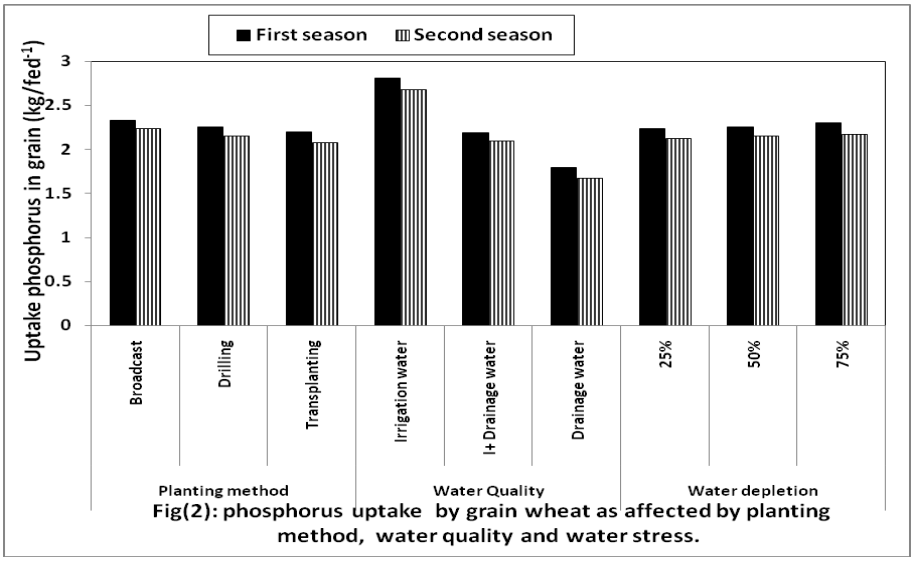
2-The uptake of phosphorus by grain and straw of wheat as affected by planting method, water quality and water depletion.The results in Table (5) and Fig. (2) showed that, the highest phosphorus uptake by grain and straw of wheat (2.33 and 2.23) and (1.73 and 1.63) kg/fed .were obtained with planting method (Broadcast) in the first and second seasons respectively. While the highest values were (2.81 and 2.68) and (2.28 and 2.18) kg/ fed with water quality (fresh water) by grain and straw in the first and second seasons respectively. On the other hand, It can be conclude that the uptake of phosphorus by grain and straw of wheat was not significantly affected by water depletion. It is also cleared that the highest value was obtained by grain and straw (2.30 and 2.17) and ((1.69 and 1.59) kg/ fed at 75% depletion in the first and second seasons respectively.

The interaction between different studied factors showed that no significant to all treatments except the interaction between planting method and water depletion in the second season was significant.

It can be concluded that P-uptake by grain and straw of wheat plants decreased with increasing water salinity. These results are in agreement with those obtained by Atwa (2005).

Table (5): The uptake of phosphorus by Straw and grain yields of wheat cv. Giza 168 as affected by planting method, water quality and water regime and their interactions in 2009/10 and 2010/11 seasons.

Factor	Uptake of Phosphorus by grain kg/fed^{-1}		Mean	Uptake of Phosphorus by straw kg/fed^{-1}		Mean
	2009/10	2010/11		2009/10	2010/11	
Planting method (P):						
Broadcast(A1)	2.33 a	2.23 a	2.28	1.73 a	1.63 a	1.68
Drilling(A2)	2.26 ab	2.15 ab	2.21	1.66 b	1.56 b	1.61
Transplanting (A3)	2.20 b	2.07 b	2.14	1.60 b	1.48 c	1.54
F-test	**	**		**	**	
Water quality (Q):						
Irrigation water(I) (B1) Fresh	2.81 a	2.68 a	2.75	2.28 a	2.18 a	2.23
I+ Drainage water(B2)	2.19 b	2.09 b	2.14	1.49 b	1.38 b	1.44
Drainage water(B3)	1.80 c	1.67 c	1.74	1.22 c	1.11 c	1.17
F-test	**	**		**	**	
Water depletion % (D):						
25 (c1)	2.24 a	2.12 a	2.18	1.63 a	1.53 c	1.85
50 (C2)	2.26 a	2.15 a	2.21	1.69 a	1.59 b	1.64
75 (C3)	2.30 a	2.17 a	2.24	1.66a	1.56 a	1.61
F-test	**	**			**	
Interaction:						
P x Q	NS	NS		NS	NS	
P x D	NS	NS		NS	**	
Q x D	NS	NS		NS	NS	
P x Q x D	NS	NS		NS	NS	



Fig(2): phosphorus uptake by grain wheat as affected by planting method, water quality and water stress.

3- The uptake of potassium by grain and straw of wheat as affected by planting method, water quality and water stress. The data in Table (6) showed that the uptake of potassium in straw of wheat was no significantly affected by planting method, water quality and water stress except in the second season was significant under water stress. The highest value of potassium uptake was obtained with 25% at depletion and the lowest value was obtained under at depletion 75% .While the potassium uptake in grain was significant with planting method and water quality but no significant with water depletion. The highest value uptake by grain of wheat was obtained with broadcast (4.64 and 4.38) kg/fed in the first and second seasons respectively. On the other hand under water quality the average values were (5.30, 4.40 and 3.350) kg/fed was obtained with fresh water, fresh water + drainage and drainage water in the first and second seasons respectively. The highest value was obtained with fresh water, while the lowest value was recorded with fresh water + drainage water.

No interaction effect on potassium between all treatments, by grain and straw except planting method and water quality by straw, and interaction effect between water quality and water depletion. Also the interaction effect between planting method, water quality and water depletion were significant on potassium uptake by straw in the second season.

It can be concluded that K uptake by grain and straw of wheat plant significantly decreased as water salinity increase. Similar results were obtained by Atwa (2005) and El-Hadidi, et al. (2011).

Table (6): The uptake of potassium by grain and straw yields of wheat cv. Giza 168 as affected by planting method, water quality and water regime and their interactions in 2009/10 and 2010/11 seasons.

Factor	Uptake of potassium by Grain (kg/fed^{-1})		Mean	Uptake of potassium by Straw (kg/fed^{-1})		Mean
	2009/10	2010/11		2009/10	2010/11	
Planting method (P):						
Broadcast (A1)	4.64a	4.38a	4.51	34.12	36.24	35.18
Drilling (A2)	4.52b	4.21b	4.37	35.99	35.59	35.79
Transplanting (A3)	4.46b	4.17 b	4.32	36.27	35.48	35.88
F-test	*	**		NS	NS	
Water quality (Q):						
Irrigation water(I) (B1) Fresh	5.41 a	5.18a	5.30	36.21	35.81	36.01
I+ Drainage water(B2)	4.57b	4.22 b	4.40	36.25	36.07	36.16
Drainage water(B3)	3.64 c	3.35 c	3.50	33.88	35.43	34.66
F-test	*	**		NS	NS	
Water depletion % (D):						
25 (c1)	4.56	4.25	4.41	35.01	35.81 a	35.41
50 (C2)	4.53	4.25	4.39	34.82	35.75 b	35.29
75 (C3)	4.53	4.24	4.39	36.5	35.74 b	36.12
F-test	NS	NS		NS	**	
Interaction:						
P x Q	NS	NS		NS	*	
P x D	NS	NS		NS	NS	
Q x D	NS	NS		NS	*	
P x Q x D	NS	NS		NS	**	

The yield and yield components:

4- Grain and straw yield of wheat :

Grain of yield

Data tabulated in Table (7) showed the effect of planting method, water quality and soil moisture depletion levels on grain yield. It can noticed that the grain yield was significantly affected by the planting methods, water quality and water depletion except of water depletion in 2009/2010 was not significant. Results indicated that mean values of grain yield in two growing seasons were (16.12, 16.14 and 15.34) ardab/ fed. under broadcast, drilling and transplanting method respectively. It can be concluded that the highest value was obtained with broadcast method, While the lowest values was obtained with transplanting method. Under water quality, the mean values were 16.27, 16.97 and 15.62 ardab/fed under fresh water, fresh water + drainage water and drainage water respectively. The highest value was obtained with fresh water, while the lowest value was obtained with drainage water.

Under water stress the grain yield was not significant in the first season and significant in the second season. The average values were 15.83, 15.87 and 15.91 ardab/fed. Under 25%, 50% and 75% respectively. The highest value was achieved under 75% and the lowest value was obtained under soil moisture depletion at 25%.

These results are in accordance with those reported by Singh et al (1980), El hadidi et al (1986) and Saied (1986) and Saied (1989).

The interaction between all treatments was not significant in the first and second seasons, but it was significant only between water quality and water depletion in the second season.

Straw yield of wheat:

Data presented in table (7) illustrated the effect of planting method, water quality and water stress on straw yield. The straw yield highly significantly affected by the planting method, water quality and no significant with water stress. Results indicated that the average values of straw yield in two growing seasons as affected by planting methods were 3.51, 3.37 and 3.17 ton/fed under broadcast, drilling and transplanting methods respectively. It can be concluded that the highest value was obtained with broadcast, while the lowest value was recorded under transplanting in the first and second seasons respectively.

Under water quality, the average values were (3.35, 3.52 and 3.19) ton fed^{-1} with fresh water, fresh water + drainage water and drainage water respectively. The highest value was obtained with (fresh water+ drainage water) 3.52 ton /fed. While the lowest value was obtained with (drainage water 3.19 ton/fed in the first and second seasons respectively.

Under water stress it was found that no significant effect in the first and second seasons respectively.The interaction between different studied factor showed that there was no significant effect. Concerning straw yield, data show there are significant effect between planting method and water quality in the first season, and interaction between water quality and water depletion in the second season.

Crop water use efficiency:

Data presented in Table (8) showed the effect of planting method, water quality and water stress treatments on crop water use efficiency during the two seasons. The average values of crop water use efficiency, were (1.17, 1.22 and 2.14) and (1.20, 1.24 and 2.03) Kg/ m^3 in the first and second seasons under Broadcast, drilling and transplanting. It can be concluded that the highest value was obtained with transplanting method and the lowest value was recorded with broadcast method. Concerning the water quality (B) the average values was (1.57, 1.41 and1.49) Kg/m^3 and (1.54, 1.50 and1.48) Kg/m^3 with fresh, fresh + drainage water, drainage water treatments in the first and second seasons respectively. It can be concluded that the irrigation by fresh water recorded the highest value, while the lowest value was achieved with drainage water in the first and second seasons respectively.

Table (7): Grain and straw yields of wheat cv. 168 as affected by planting method, water quality and water depletion and their interactions in 2009/10 and 2010/11 seasons.

Factor	Grain yield (ardab/fed.)		Mean	Straw yield (ton/fed)		Mean
	2009/10	2010/11		2009/10	2010/11	
Planting method (P):						
Broadcast (A1)	16.03 a	16.20 a	16.12	3.52a	3.50a	3.51
Drilling (A2)	16.07 a	16.22 b	16.15	3.39b	3.34b	3.37
Transplanting (A3)	15.24 b	15.44 b	15.34	3.18c	3.16c	3.17
F-test	*	*		**	**	
Water quality (Q):	16.21 a	16.32 a	16. 27	3.39b	3.30b	3.35
Irrigation Fresh water(I) (B1)	15.62 ab	16.80 a	16.97	3.544a	3.49a	3.52
I+ Drainage water (B2)	15.51 b	15.72 b	15.62	3.16c	3.22c	3.19
Drainage water(B3)	**	*		**	**	
F-test						
Water depletion % (D):	16.10	15.21 b	15.87	3.37	3.30	3.34
25 (c1)	16.24	15.88 c	15.91	3.40	3.35	3.38
50 (C2)	NS	**		NS	NS	
75 (C3)						
F-test	NS	NS		**	NS	
Interaction:	NS	**		NS	**	
P x Q x D	NS	NS		NS	NS	

Finally the effect of water stress on the crop water use efficiency was (1.27, 1.48 and 1.70) kg/ m^3 and (1.26, 1.47 and 1.79) kg/ m^3 with 25%, 50% and 75% of available water treatments in the first and second seasons respectively. The data revealed that the increase of available water resulted in an increase of crop water use efficiency. Regarding to the effect of the interaction between the studied tree factors data showed that the maximum values of crop water use efficiency was obtained from A_3 (transplanting) under both B1 (fresh water) and C3 treatment (75% of available water), while the lowest value was A1 (broadcast) under both B3 (drainage water) and C1 treatment (25% of available water) in both seasons. The present results are in line with those reported by Meleha et al., (2004) who mentioned that the efficiency of water use was decreased as the soil moisture was high maintained by the frequent irrigation.

Table (8): Values of grainl yield (Kg/fed) of wheat plant, and water consumptive use (m^3/fed) and crop water use efficiency (Kg/m^3) as affected by interaction between all treatment in 2009/2010and 2010/2011seasons.

Treatments	2009/2010			2010/2011		
	Total yield (Kg/fed)	Water Consumptive Use (m^3/fed)	Crop water use efficiency (Kg/fed)	Total yield (Kg/fed)	Water Cosumptive Use (m^3/fed)	crop water use efficiency(Kg/ fed)
A1B1C1	2521.5	2405	1.048	2522.5	2415	1.044
A1B1C2	2542.5	1970	1.29	2362.5	1990	1.28
A1B1C3	2353.5	1700	1.19	2362.5	1715	1.38
Mean			1.18			1.24
A1B2C1	2434.5	24151	1.00	2455	2430	1.01
A1B2C2	2487	2055	1.21	2505	2060	1.21
A1B2C3	2302.5	1720	1.34	2385	1725	1.38
Mean			1.18			1.20
A1B3C1	2367	2490	0.95	2400	2500	0.96
A1B3C2	2386.5	2020	1.18	2395	2030	1.18
A1B3C3	2221.5	1705	1.30	2255	1710	1.32
Mean			1.14			1.15
A2B1C1	2539.5	2365	1.07	2547.5	2375	1.072
A2B1C2	2490	1999	1.24	2495	2005	1.244
A3B1C3	2385	1644	1.45	2412.5	1659	1.45
Mean			1.25			1.26
A2B2C1	2484	2295	1.04	2510	2310	1.09
A2B2C2	2370	2000	1.19	2400	2010	1.19
A2B2C3	2190	1665	1.3	2232.5	1680	1.33
			1.70			1.20
A2B3C1	2461.5	2310	1.065	2512.5	2320	1.08
A2B33C2	2467.5	1994	1.24	2480	2010	1.23
A2B3C3	2347.5	1630	144	2372.5	1642	1.44
Mean			1.25			1.25
A3B1C1	2325	1310	1.77	2372.5	1320	1.80
A3B1C2	2385	1180	2.02	2437.5	1190	2.048
A3B1C3	2340	840	2.79	2360	860	2.74
Mean			2.19			2.20
A3B2C1	2266.5	1325	1.71	2295	1340	1.71
A3B2C2	2302.5	1130	2.03	2325	1142	2.035
A3B2C3	2253	820	2.74	2280	830	1.72
Mean			2.16			1.82
A3B3C1	2241	1320	1.70	2282.5	1325	1.72
A3B3C2	2265	1160	1.95	2295	1166	1.96
A3B3C3	2182.5	860	2.53	2232.5	872	2.56
Mean			2.06			2.08

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تـأثير طـرق زراعـة القمـح ونوعيـة ميـاه الـرى ومسـتوياته علـى امتصـاص العنلصـر وكفاءة استخدام المياه.

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أجريت تجربة حقليه خلال الموسمين الشتويين المتتاليين ٢٠٠٩/٢٠١٠& ٢٠١٠/ ٢٠١١ بمحطة بحوث القرضا- بكفر الشيخ التابعه لمعهد بحوث ادارة المياه ودلك بهدف دراسة تأثير طرق زراعة القمح ونوعية مياه الرى ومستوياته على امتصاص العناصر (النيتروجين والفوسفور والبوتاسيوم) وكفاءة استخدام المياه وقد أستخدم التحليل الاحصائي الشرائح المتعامدة مرتين بثلاث مكررات وتم توزيع المعاملات كالأتى :

- المعاملات الرئسية وهي طريقة الزراعة (بدار- تسطير- شتل).
- المعاملات الشقيه وهي ونوعية مياه الرى (الري بمياه عذبه & ا لري بمياه عدبه بالتبادل بمياه الصرف طوال الموسم & ا لري بمياه الصرف طوال الموسم)
- المعاملات التحت شقيه وكان الرى عند مستويات مختلفة من الماء الميسر (٢٥& ٥٠ & ٧٥ %) وأوضحت النتائج المتحصل عليها الأتي:
- تأثر امتصاص الحبوب والقش للنيتروجين بطريقة الزراعة ونوعية المياه ولم يؤثر الاجهاد المائي عليهما.
- تأثر امتصاص الحبوب والقش للفسفور بطريقة الزراعة ونوعية المياه و ولم يؤثر الإجهاد المائي عليهما.
- أوضحت البيانات أن امتصاص قش القمح للبوتاسيوم لم يتأثر معنويا بطريقة الزراعة ونوعية المياه وايضا الإجهاد المائي بينما تأثر أيضا امتصاص الحبوب للبوتاسيوم بطريقة الزراعة ونوعية المياه لم يكن للإجهاد المائى أي تاثيرعليها.
- كان لطريقة الزراعة ونوعية المياه تأثيرا معنويا علي انتاجية القمح لمحصول الحبوب بنما الموسم الثاني لم يكن للأجهاد المائى تاثيرا عليه .
- تم الحصول علي أعلى قيمه لكفاءة استخدام المحصول للمياه من طريقة الزراعه بالشتل بينما سجلت المعاملة بدار أقل القيم وبالتركيز علي نوعية المياه سجلت أعلي القيم بالري بالمياه العدبه بينما أعطي الرى بمياه الصرف أقل القيم وذلك في الموسم الاول والثانى علي التوالى. ووجد أن زيادة كفاءة استخدام المحصول للمياه تزيد بزياده الماء الميسر.
- مماسبق يستخلص أن تطبيق أفضل أسلوب للري مع إستنفاد ٥٠% من الماء الميسرالأمر الدى أدي للحصول علي أعلى إنتاجية وكذلك أعلي معدلات لكفاءة الإنتفاع بالوحدة المائية مع اتباع أسلوب الري بالمياه العذبه مع إستخدام طريقة الزراعة بالشتل.
- توصي الدراسة بإستخدام طريقة زراعة القمح بالشتل حيث كان لها تأثير معنوي علي إمتصاص العناص ورفع كفاءة إستخدام المياه للمحصول مع إستخدام الري بالمياه العذبه عند الوصول إلي المستوي الرطوبي 50% إستنفادا من الماء الميسر للتربة.

قام بتحكيم البحث

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