Minufiya J. Agric. Res. Vol.35 No. 1:267-291 (2010) "http://agri.menofia.edu.eg/megla.html"

THE COMBINED EFFECT OF PHOSPHATE FERTILIZATION AND IRRIGATION WATER SALINITY ON THE CALCAREOUS SOILS PRODUCTIVITY

R.A. Khalil, S.A. Radwan, E.A. Abou Hussien and M.M.Hamad
Soil, Sci. Dept. Fac. Of Agric. Minufiya .Univ. Egypt.

(Received: Nov. 3, 2009)

ABSTRACT: ***This experiment was carried out on five calcareous soils varied in their content of $CaCO_3$ (%) and other soil properties to study the effect of individual and combined applications levels of phosphate fetilization and irrigation water salinity and sodicity on some properties of these soils and its productivity .***

A pot experiment was carried out in split split plot design with three replicates, where the main plots pluts were the used calcareous soils, the sub plots were application rates of P fertilization and the sub sub plots were irrigation water salinity and sodicity levels .The tested P levels were 0, 50, 100 and 200% of recommended dose (RD) for barley(300Kg superphosphate / fed) which used as tested plant. Five irrigation water sources varied in their salinity and sodicity levels were used in this study .

The obtained data show a clear increase of soil content of both total soluble salts and soluble ions with irrigation by the tested saline water and also with the increase of added P.

The obtained dry matter yield of both straw and grains of barley plant were decreased with the increase of irrigation water salinity and sodicity . The decrease associated with the increase of water sodicity levels were higher than that resulted from the increase of water salinity levels . On the other hand , increasing of added P resulted in an increase of obtained dry matter yield . The high dry mater yield was found in the soils irrigated with tap water at P level of 200% of RD . Also , the obtained dry matter yield was greatly affected by the studied calcareous soils properties.

Straw and grains of barley plants content of N, P and K was greatly affected by the studied treatments and soil properties.This content was decreased with the increase of irrigation water salinity or sodicity, where it was varied widely with P fertilization . The significant levels of relationships between the content of these nutrients and soil properties were varied from nutrient to another.

Key words: ***Water quality, Phosphate fertilization, Calcareous soil, Barley, Soil properties and Nutrients content.***

INTRODUCTION

Barley is major cereal crop for human and animal feeding as well as in malt industry. There for more efforts and studies are necessary to improve its productivity.

Ragab *et al* (2008) showed that, soil electrical conductivity increased as a result of increasing salinity levels of irrigation water, it is more pronounced in calcareous soils. This may be due to the great surface area of the fine particles, which adsorb more soluble and exchangeable cations of saline solution. Abou Hussien and Barsoum (2002), found a significant increases in soil EC and also the concentration of soluble Ca^{2+}, Mg^{2+} and Na^{+} in calcareous soil as a result of irrigation with saline solution.

Ragab *et al* (2008) fund that, irrigation water salinity are a significantly effect on affected weight of 100 grains and finally grain and straw yield plant wheat. The magnitude of this decrease depends on salinity level where it increased with the increase of salinity level. This may be due to a possibility that plants grown under saline condition utilize energy for osmotic adjustment process at the expense of growth and the most important factor which is the high soil water potential, hence the water flow from soil to plant is very much limited under saline conditions. The responses of wheat grain and straw yields were negatively and highly correlated with soil salinity and in particular with the mean soil salinity in the top 50 cm .

Khalil (2000) found that, the correlation coefficient and regression analysis showed clearly the positive correlation between available P and each of clay, silt native P, CEC and OM while it were negative with sandy fractions, $CaCO_3$ and EC values. The availability of P in soil decreases as soon as the phosphorus fertilizers added to the soils. Shen et al (2004) found that the dominant P_i (inorganic phosphate) fraction in the calcareous soil at the long-term filed trial with NPK treatments were Ca-P(69-71% of total P_i), Fe-P (11 -12%) , O-P (11-12%), and Al-P (7 -8% of total P_i).

This study was carried out to study the individual and combined effect of irrigation water salinity or/and sodicity and rate of phosphate fertilization on : 1) Some chemical properties of calcareous soils and 2)Growth of barley plants and its chemical composition.

MATERIALS AND METHODS

Soil sampling and irrigation water.

Five surface (0-20 cm) samples of different calcareous soils varied in their content of $CaCO_3$ were selected from different five areas i.e. El-Bostan (Behara Governorate); Terat El-Nasr (Alexandria Governorate); Kilo 52 Cairo-Alexandria Desert way (El-Giza Governorate); El-Nobariya (Behara Governorate); and Borg El-Arab (Alexandria Governorate). The collected soil samples of each area air- dried, good mixed ground to pass through a 2mm sieve and the fine soils (>2mm) were kept and analyzed for some physical and chemical properties (Table 1) as described by (Black 1965; Cottenie *et al* 1982 and Page *et al* 1982).

Table (1): Some physical and chemical properties of the studied calcareous soils.

a-Physical properties

Soil properties	Soil number				
	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
Particle size distribution(%)					
Corse sand	68.8	41.2	55.8	56.8	23.4
Fine sand	25.5	34.4	20	7.7	41.5
Silt	4.2	11.3	21.8	33.1	21.6
Clay	1.5	13.1	2.4	2.4	13.5
Texture class	Sandy	Loam-sandy	Loam sandy	Sandy loam	Sandy loam
Total $CaCO_3$ (%)	3.8	11.4	19.4	29.4	42.2
Active $CaCO_3$ (%)	1	4.6	10	14	18.8
W.H.C (%)	25.7	27.4	30.7	33.4	40.50

a. without $CaCO_3$ removal   b. with $CaCO_3$ removal

b- Chemical properties

Soil properties	Unit	Soil number				
		Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
O.M	%	0.3	0.4	0. 9	1.76	1.87
pH	(1:2.5) soil :water	7.87	7.88	7.92	8.1	8.01
EC	dSm^{-1}	1.61	2.83	12.65	8.2	7.22
Soluble ions (meq/100g)						
CO_3^{2-}		0	0	0	0	0
HCO_3^-		1.56	1.56	2.25	1.3	1.82
Cl^-		6.93	11.88	82.67	60.3	43.46
SO_4^{2-}		7.68	14.85	41.58	20.43	26.99
Ca^{2+}		6.42	10.16	31.27	19.02	23
Mg^{2+}		2.85	6.83	22.9	11.46	19.54
Na^+		6.5	10.4	69.62	50.42	28.43
K^+		0.4	0.9	2.71	1.1	1.3
Available-P(mg/kg)		0.21	0.62	0.72	0.57	0.22

Five irrigation water seurces (Nile or tap water and four of artificial solutions) varied in their salinity and sodicity and also in their content of Na^+, Ca^{2+} and Mg^{2+} were used in this study. The chemical composition of these solution is recorded in Table (2). Also the chemical compostion of tap water is listed in Table (3)

Table (2): Chemical composition of the used artificial irrigation solution.

Solution number	Chemical composition						SAR	TSS* mg/l	Na^+ Concent.
	NaCl		$CaCl_2$		$MgCl_2$				
	mg/l	meq/l	mg/l	meq/l	mg/l	meq/l			
A1B1	660.60	11.39	166.70	3.00	166.70	3.51	6.31	1000	666.60
A1B2	950.00	16.23	25.00	0.45	25.00	0.52	23.26	1000	950.00
A2B1	1660.60	28.48	416.70	7.50	416.70	8.77	9.97	2500	1666.60
A2B1	2375.00	40.52	62. 50	1.12	62.5	1.36	36.75	2500	2375.00

*Total soluble salts mg/l.

Table (3): Chemical analysis of tap water(C_O).

pH	EC dSm^{-1}	Soluble ions (meq/L)								SAR
		Cations				Anions				
		Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	
7.8	0.37	1.14	1.21	1.15	0.20	0.0	1.81	0.94	0.95	1.06

Greenhouse experiment

Plastic pots (300 pot) with 20 cm in diameter and 18 cm in depth were used in this study. The pots were divided into five main groups (60 pot for each group). Each pot of these five main groups was filled by 5 kg of one calcareous soil. The pots of each main group were divided into equal four sub groups. These sub groups were fertilized with superphosphate (15.5% P_2O_5) at application rates of 0, 50, 100 and 200% of recommended dose (300 kg superphosphate/fed.). This rates equal 0, 0.15, 0.30 and 0.60 g superphosphate/Kg soils. After that, the pots of each sub group (15pot) were divided into five sub subgroups (3 pot for each sub subgroup) which represent the treatments of the used irrigation solutions. The pots were arranged in split split design with three replicates. Each plot was sowen with eight seeds of barley and irrigated with tap water at 60% of water holding capacity of each soil. After 15 days from sowen, the plants were thinned to five plants for each pot. Each pot was fertilized with both ammonium nitrate (33.5%N) 0.75 g NH_4NO_3 /pot (equivalent to 50.25 Kg N fed^{-1}), and potassium sulphate (48-50% K_2O) at rate 0.3g K_2SO_4/pot(equivalent to about 29.4 Kg K_2O fed^{-1}). After that, the tested irrigation solutions were used for irrigation of the five sub subgroups for each soil every three days by alteration between artificial solutions and tap water by 2:1. The moisture content of pots must be still at 60% of water holding capacity of each soil. After plants maturity, the plants were harvested above the soil surface and separated the spike from straw. Also, the grains were separated from the spokes. The separated straw and grains were air-dried, oven dried at 70 °C until the weight become content, weighted, ground and kept for chemical analysis. The obtained dry weight for straw and grains were statistically analyzed according to Sendecore and Cochran (1980). 0.2 g sample of the ground oven dry plant samples was digested with 5 ml of concentrated H_2SO_4 on hot plate. Repeatedly small quantities of concentrated $HClO_4$ were added until the digest become clear and uncolored. The digest was diluted to 50 ml with distilled water (Cottenie, 1980). The concentration of NPK were determined in digest solution accerding to the methods of Page et al., (1982). The soils in the pots of unfertilized treatment with P were taken from each pot individually. The soil samples were air –dried , groued , good mixed, sieved throw a 2mm sieve and analyzed for pH, EC and the content of soluble cations and anins as prementioned with orginal soil samples .

RESULTS AND DISCUSSION

Soil pH, EC and content of soluble ions

The presented data in Table (4) show EC values of calcareous soils as affected by salinity and sodicity levels of irrigation water. These values indicates that, increasing irrigation water salinity and sodicity resulted in an increase of calcareous soil EC values , The increases of EC associated with increase of water salinity levels were higher than those resulted from the increase of water sodicity Abou Hussien and Shaban (2008), and Abou Hussien *et al* (2009) obtained similar results, where they reported that, irrigation soils by low quality of irrigation water resulted in a clear increase of soil content of total soluble salts.

Calcareous soils content (meq/100g soil) of soluble cations and anions was clear affected by irrigation water salinity and sodicity (Table 4). The content of soluble Na^+, $Ca^{2+}$and Mg^{2+} and Cl^- were increased clearly with the increase of water salinity but K^+ CO_3^{2-}, HCO_3^- and SO_4^{2-} were weakly affected. Also the content of Na^+, Cl^- and SO_4^{2-} were clearly increased with the increase of water sodicity. In the five soils under study and also with different levels of irrigation water salinity and sodicity, the predominant soluble cation was Na^+ followed by Ca^{2+}, where the predominant soluble anions were Cl^- followed by SO_4^{2-}. These results are in agreement with the chemical composition of the used water, Abou Hussien and Shaban., (2008); Abou Hussien *et al.,* (2009), and Fayed (2009) obtained similar results.

Table (4): Some chemical properties of the studied calcareous soils as affected by saline irrigation water treatments.

Studied soils	irrigation water Treatment	PH 1-2.5	EC dSm^{-1}	Soluble ions ($meql^{-1}$) Cations Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Anions HCO_3^-	Cl^-	SO_4^{2-}
Soil1	Co	7.87	2.31	5.92	5.29	10.59	1.30	1.04	8.08	13.98
	A1B1	7.86	2.34	5.70	5.30	11.90	1.40	1.21	14.31	8.78
	A1B2	7.89	2.51	6.86	2.34	14.48	1.42	1.34	16.85	6.91
	A2B1	7.87	3.07	8.35	5.61	15.23	1.51	1.60	15.63	13.47
	A2B2	7.80	3.80	8.81	2.43	25.16	1.60	1.65	18.22	18.13
Means			2.81	7.13	4.19	15.47	1.45	1.37	14.62	12.25
Soil2	Co	7.88	3.62	9.70	6.53	18.23	1.74	1.66	23.00	11.54
	A1B1	7.88	4.13	12.80	10.19	16.29	2.02	1.77	23.30	16.23
	A1B2	7.90	4.18	12.53	10.40	17.30	1.57	1.84	22.37	17.59
	A2B1	7.88	4.89	18.23	11.32	18.11	1.24	1.86	13.73	33.31
	A2B2	7.91	4.97	21.16	11.27	15.40	1.87	1.94	13.98	33.78
Means			4.36	14.88	9.94	17.07	1.69	1.81	19.28	22.49
Soil3	Co	7.92	7.78	16.80	11.18	48.64	1.18	2.07	27.01	48.72
	A1B1	7.91	8.22	23.17	12.23	44.73	2.07	2.21	45.66	34.33
	A1B2	7.92	8.37	24.76	13.11	43.80	2.03	2.33	41.15	40.22
	A2B1	7.93	10.13	25.20	19.87	54.02	2.21	2.50	47.60	51.20
	A2B2	7.91	10.56	25.92	20.55	56.80	2.33	2.67	49.80	53.13
Means			9.01	23.17	15.39	49.60	1.96	2.36	42.24	45.52
Soil4	Co	8.10	6.09	17.78	4.47	37.00	1.65	2.66	39.66	18.58
	A1B1	8.10	6.61	24.48	9.67	29.80	2.15	2.72	38.25	25.13
	A1B2	8.11	6.70	24.72	9.80	30.23	2.25	3.03	32.21	31.76
	A2B1	8.11	7.83	27.15	9.72	38.88	2.55	3.09	40.21	35.00
	A2B2	8.15	7.92	27.36	12.02	37.50	2.32	3.72	38.29	37.19
Means			7.03	24.30	9.14	34.68	2.18	3.04	37.72	29.53
Soil5	Co	8.01	6.33	18.25	12.42	30.71	1.92	3.64	30.41	29.25
	A1B1	8.01	6.61	22.84	11.65	30.20	1.41	3.67	29.18	33.25
	A1B2	8.02	6.75	22.21	12.23	31.03	2.03	3.71	31.60	32.19
	A2B1	8.01	7.35	28.25	12.42	30.71	2.12	3.86	38.90	30.74
	A2B2	8.05	7.45	29.25	11.31	32.11	1.83	3.92	40.12	30.46
Means			6.90	24.16	12.01	30.95	1.86	3.76	34.04	31.18

Regarding to soil pH as affected by irrigation water salinity and sodicity, the recorded data in Table (4) show, soil pH was increased with the increase of water salinity and sodicity. The increase of soil pH associated with the increase of water salinity was lower than that associated with the increase of water sodicity. So the high values of soil pH were found in the treatments of C2S2, where the lowest values were found with the treatments of tap water (C0). Similar results were found by Abou Hussien *et al.* (1994); and Abou Hussien and Shaban (2008) and Fayed (2009).

Plant growth and dry matter yield.

The presented data in Table (5) show the dry matter yield (g/pot) of straw, and grain of barley plant grown on the studied calcareous soils, as affected by levels of P fertilizer and irrigation water salinity and sodicity. Data show that, the obtained dry matter yield of barley plants (straw and grains) was significantly increased with the increase of added P with different sources of irrigation water. These increases resulted from the important role of P on plant growth and enzymes activity (Mengel and Krikby, 1987). Also these findings were in agreement with those of Zhang *et al* (2006). So the high obtained yield was found at application rate of 0.60 g superphosphate /Kg soil. For example the dry matter yield of straw and grain on soil1 increased from 11.32 to 15.06 and from 3.39, to 6.24 respectively when added P increased from 0.00 to 0.60 g /Kg soil under the treatment of C0. These results are in agreement with the finding of Khalil (2000) and Basak (2006).

Regard to the calculated equations intercepts, recorded in Table, (6) show that the dry weight of, straw and grain were in agreement with the added P level. The regression coefficients (r) for all equations were highly significance. Reddy and Yada (1994); and Khalil (2000) obtained similar relations, where they equation illustrated the effect of P application rates on dry matter yield was highly positive significance.

The obtained relations which recorded in Table (7) show that the dry matter yield of grain and straw was greater affected by the studied soil properties. According to the obtained dry matter yield, the tested soil takes the order: soil1> soil2> soil3> soil4> soil5. This trend was found with different treatments of P fertilization and irrigation water. The obtained variations of barley dry matter yield were attributed to the wide variations among the properties of the studied calcareous soils. Table (7) shows a negative relationships between the dry matter yield of barley plants and calcareous soils content (%) of $CaCO_3$, and silt and soil pH. The negative effect of these properties may be resulted from its reduce effect on nutrients availability Abou Hussien and Barsoum, (2002); and Mohamad and Malakouti, (2008) obtained similar results. Also the other hand, the negative effect of calcareous soil content of total soluble salts may be resulted from its negative effect on plant uptake of some nutrients and also may be resulted from the effect of soluble salts on the uptake of water by plant (Cakmak, 2002 and Mohamad and Malakouti., 2008).

Table (5): Dry matter yield (g/pot) of barley plants (straw,grain and total plant) grown on calcareous soils as affected by soil properties, P-fertilization and irrigation water quality

P-level g/pot	Irrigation	Straw					Means	Grain					Means
		soil 1	soil 2	soil 3	soil 4	soil 5		soil 1	soil 2	soil 3	soil 4	soil 5	
0.00	Co	11.32	10.22	9.28	8.33	7.78	9.39	3.89	3.00	2.78	2.56	2.27	2.90
	A1B1	11.07	10.15	8.95	7.74	7.62	9.11	3.64	2.99	2.69	2.38	2.22	2.78
	A1B2	10.96	10.08	8.86	7.63	7.51	9.01	3.33	2.97	2.66	2.34	2.15	2.69
	A2B1	10.25	8.53	8.01	7.49	7.37	8.33	3.11	2.51	2.41	2.31	2.12	2.49
	A2B2	9.38	8.49	7.98	7.47	7.29	8.12	2.84	2.49	2.40	2.30	2.11	2.43
Means		10.60	9.49	8.61	7.73	7.51	8.79	3.36	2.79	2.59	2.38	2.17	2.66
0.75	Co	13.57	11.26	10.49	9.71	9.37	10.88	4.99	4.01	3.73	3.44	3.09	3.85
	A1B1	13.16	11.11	10.38	9.65	9.03	10.67	4.94	3.95	3.68	3.41	2.98	3.79
	A1B2	12.38	10.50	9.75	8.99	8.77	10.08	4.73	3.74	3.46	3.18	2.89	3.60
	A2B1	11.69	10.10	9.39	8.67	8.62	9.69	4.62	3.61	3.34	3.07	2.85	3.50
	A2B2	11.29	9.45	8.94	8.43	8.43	9.31	4.13	3.36	3.18	2.99	2.78	3.29
Means		12.42	10.48	9.79	9.09	8.84	10.12	4.68	3.73	3.48	3.22	2.92	3.61
1.50	Co	14.53	12.65	11.26	9.87	9.52	11.57	5.71	4.99	4.41	3.82	3.44	4.47
	A1B1	14.26	12.04	10.84	9.64	9.07	11.17	5.55	4.76	4.25	3.74	3.28	4.32
	A1B2	13.57	11.08	10.03	8.97	8.83	10.50	5.27	4.37	3.92	3.47	3.18	4.04
	A2B1	13.08	10.63	9.61	8.58	8.57	10.09	5.01	4.21	3.77	3.32	3.09	3.88
	A2B2	12.11	9.92	9.19	8.45	8.35	9.60	4.76	3.92	3.60	3.27	3.01	3.71
Means		13.51	11.26	10.18	9.10	8.87	10.59	5.26	4.45	3.99	3.52	3.20	4.08
3.00	Co	15.06	13.03	11.70	10.37	9.28	11.89	6.24	5.28	4.64	4.00	3.53	4.74
	A1B1	14.82	12.26	10.97	9.67	8.97	11.34	6.15	4.97	4.42	3.87	3.42	4.57
	A1B2	13.83	11.94	10.56	9.17	8.60	10.82	6.10	4.85	4.27	3.68	3.27	4.43
	A2B1	13.65	11.64	10.30	8.95	8.39	10.59	5.76	4.71	4.15	3.59	3.20	4.28
	A2B2	12.85	11.09	9.89	8.68	7.73	10.05	5.42	4.47	3.98	3.48	2.94	4.06
Means		14.04	11.99	10.68	9.37	8.59	10.94	5.93	4.86	4.29	3.72	3.27	4.42
G.Means		12.64	10.81	9.82	8.82	8.46	10.11	4.81	3.96	3.58	3.21	2.89	3.69

L..S.D.at .05

	Straw	Grains
Soils	0.37	0.14
Irrigation	0.38	0.18
P-levels	0.38	0.12

Table (6): Relationships between straw and grain dry matter yield and added P level.

Soil	Straw		Grains	
number	Equations	r	Equations	r
Soil1	$DW_{S1} = -0.5402P_a^2+2.7628P_a+10.611$	0.99	$DW_{G1}= -0.3072P_a^2+1.7579P_a+3.4096$	0.99
Soil2	$DW_{S2} = -0.2275P_a^2+1.5175P_a+9.4885$	0.99	$DW_{G2}=-0.2712Pa^2+1.5058Pa+2.7825$	0.99
Soil3	$DW_{S3} = -0.2796P_a^2+1.5032P_a+8.6686$	0.98	$DW_{G3}= -0.2527P_a^2+1.3214P_a+2.5965$	0.99
Soil4	$DW_{S4} = -0.3318P_a^2+1.4888P_a+7.8487$	0.94	$DW_{G4} = -0.2343P_a2+1.137P_a+2.4105$	0.99
Soil5	$DW_{S5} = -0.4344P_a^2+1.6197P_a+7.6121$	0.95	$DW_{G5}= -0.2301P_{a2}+1.0453P_a+2.1984$	0.99

P_a = P added (mg/kg) , DWs =Dry weight for straw , DW_G= Dry weight for grain

Table (7): The relationships between some of studied soil properties (X) and dry weight of barley straw and grain (Y)

Soil	Straw		Grains	
properties	Equations	r	Equations	r
Sand %	$Y s= 0.0092x^2-1.3316x +56.218$	0.5195	$YG=0.0044x^2-0.6329x +25.793$	0.5215
Silt & clay	$Y s= 0.0092x^2-0.5123x +15.253$	0.5195	$Y G = 0.0044x^2-0.2374x +6.0177$	0.5215
Total $CaCO_3$	$Y s= 0.0033x^2-0.2559x +13.482$	0.9958	$Y G = 0.0012x^2-0.103x +5.1102$	0.9857
O.M%	$Y s= 9.0738x^2-21.784x +18.184$	0.9496	$Y G = 4.0438x^2-9.6824x +7.2506$	0.9250
pH	$Y s= 20.81x^2-343.04x +1422.1$	0.9850	$Y G = 7.7385x^2-128.17x +533.58$	0.9740
EC	$yS = 0.2279x^2 -3.1972x +20.01$	0.9728	$yG= 0.1031x^2-1.4335x +8.0928$	0.9614
Av-P	$yS = 318.45x^2-339.58x +98.937$	0.9877	$yG= 118.79x^2-124.48x +35.533$	0.9725

Y_s= Straw Y_G= Grains

Also the obtained relations show a positive effect of both soil content of Av-P ($mgkg^{-1}$) on the obtained dry matter yield of barley plants. This positive effect of the soil content of Av-P was resulted from the important role of P on the enzymes activity and enhanced effect on some biochemical processes within plant tissues (Basak, 2006).

The presented data in Table (5) show that , the obtained dry matter yieled of both straw and grains of barley plants and its relative increase (RI,%) were grater negatively affected by irrigation water salinity and sodicity levels . This negative effect was increased with the increase of water salinity and sodicity.

Also this negative effect may be resulted from the negative effect of high salinity levels of irrigation water on water uptake and absorption by plants. Also the increase of water sodicity level resulted in a decrease of some nutrients availability . These results are in agreement with the findings of Nikos *et al.* (2003) and Fayed (2009).This negative effect of irrigation water salinity and sodicity on barley dry matter yield was decreased with the increase of added P . This effect was found in the five calcareous soils understudy .

Chemical composition of barley plants:

-Nitrogen (N)

Grains and straw of barley plants content (%or mg/kg) of N as affected by calcareous soil properties, level of P fertilization and irrigation water salinity and sodicity which recorded in Tables (8 and 9) show that, under the same treatment of irrigation water, N concentration (%) of barley grains and straw was decreased with the increase of added P. On the other hand, N uptake (mg/kg) of barley grain positively affected by the increase P fertilization. So low N uptake was found with zero treatments of P fertilization. The negative effect of P on N concentration was resulted from dilution effect of obtained high dry matter yield associated with high level of added P. The obtained effect of P fertilization on N concentration and its uptake of barley grains and straw was in agreement with that found by El-Sherif (1997) ; Khalil (2000) and El-Shennawi *et al* (2009).

Regarding to the effect of irrigation water salinity and sodicity on barley grains and straw content of N, the recorded data in Tables (8 and 9) show that, increasing the level of irrigation water salinity or sodicity resulted in a decrease of N concentration and its uptake by barley. The found decrease associated with the increase of irrigation water sodicity was higher than that resulted from the increase of irrigation water salinity. This trend was attributed to the negative effect of water salinity or sodicity on plant growth. Thus high N concentration and its uptake of barley grains and

straw were found in the Co treatments. This trend was found with the different soils at all application rates of P fertilizer. These results are in agreement with the findings of Abou Hussien and Barsoum (2002) and Shaban (2005) and Fayed (2009).

Nitrogen concentration and its uptake by grains and straw of barley plants were great affected by the properties of the studied calcareous soils (Table 8 and 9) . In most treatments under study, the arrangement of the used soils according to N concentration and uptake of barley grains and straw was soil number :1>2>5>4>3. This arrangement was in harmony with the soil content of $CaCO_3$ (%). This content have wide variations among the studied soils. These variations may be resulted from the effect of irrigation water salinity and sodicity on soil properties and its effect on the plant response to P fertilization. Similar results were obtained by Salam (1999) and Adhami *et al.* (2006).

Table (8): N concentration (%) and uptake (mg/pot) of barley straw as affected by soil properties, P-fertlization and irrigation water quality.

P-level g/pot	Irrigation water	N concentration %					Means	Nuptake (mglpot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	1.70	1.31	0.81	1.03	1.37	1.24	192.44	133.88	37.10	85.80	106.59	111.16
	A1B1	1.59	1.21	0.64	0.84	1.24	1.10	176.01	122.82	28.48	65.02	94.49	97.36
	A1B2	1.27	1.12	0.60	0.83	1.14	0.99	139.19	112.90	25.92	63.33	85.61	85.39
	A2B1	1.22	0.82	0.50	0.75	1.06	0.87	125.05	69.95	20.35	56.18	78.12	69.93
	A2B2	0.90	0.79	0.39	0.64	0.98	0.74	84.42	67.07	13.69	47.81	71.44	56.89
Mean		1.34	1.05	0.59	0.82	1.16	0.99	143.42	101.32	25.11	63.63	87.25	84.15
0.75	Co	1.54	1.21	0.72	0.86	1.30	1.13	208.98	136.25	54.07	83.51	121.81	120.92
	A1B1	1.25	1.12	0.55	0.79	0.98	0.94	164.50	124.43	39.05	76.24	88.49	98.54
	A1B2	1.15	0.91	0.54	0.75	0.96	0.86	142.37	95.55	29.92	67.43	84.19	83.89
	A2B1	1.02	0.90	0.38	0.72	0.93	0.79	119.24	90.90	19.76	62.42	80.17	74.50
	A2B2	0.91	0.68	0.35	0.70	0.90	0.71	102.74	64.26	16.70	59.01	75.87	63.71
Mean		1.17	0.96	0.51	0.76	1.01	0.88	147.57	102.28	31.90	69.72	90.11	88.31
1.50	Co	1.12	1.15	0.62	0.83	1.13	0.97	162.74	145.48	42.22	81.92	107.58	107.99
	A1B1	1.08	1.10	0.54	0.72	0.92	0.87	154.01	132.44	36.45	69.41	83.44	95.15
	A1B2	1.04	0.88	0.45	0.72	0.90	0.80	141.13	97.50	28.08	64.58	79.47	82.15
	A2B1	0.93	0.78	0.36	0.65	0.88	0.72	121.64	82.91	20.66	55.77	75.42	71.28
	A2B2	0.80	0.72	0.33	0.60	0.78	0.65	96.88	71.42	14.95	50.70	65.13	59.82
Mean		0.99	0.93	0.46	0.70	0.92	0.80	135.28	105.95	28.47	64.48	82.21	83.28
3.00	Co	1.01	1.03	0.50	0.82	1.09	0.89	152.11	134.21	42.65	85.03	101.15	103.03
	A1B1	0.99	0.95	0.38	0.70	0.90	0.78	146.72	116.47	31.88	67.69	80.73	88.70
	A1B2	0.88	0.91	0.36	0.68	0.88	0.74	121.70	108.65	23.90	62.36	75.68	78.46
	A2B1	0.78	0.77	0.30	0.63	0.77	0.65	106.47	89.63	15.33	56.39	64.60	66.48
	A2B2	0.65	0.71	0.21	0.57	0.70	0.57	83.53	78.74	9.51	49.48	54.11	55.07
Mean		0.86	0.87	0.35	0.68	0.87	0.73	122.10	105.54	24.66	64.19	75.26	78.35
G Mean		1.09	0.95	0.48	0.74	0.99	0.85	137.09	103.77	27.53	65.50	83.70	83.52

Table (9): N concentration (%) and uptake (mg/pot)of barley grain as affected by soil properties, P-fertlization and irrigation water quality.

P-level g/pot	Irrigation water	N concentration %					Means	Nuptake (mglpot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	2.34	1.95	1.76	1.95	1.56	1.91	91.03	58.50	24.99	49.92	35.41	51.97
	A1B1	1.95	1.56	1.17	1.95	1.56	1.64	70.98	46.64	16.03	46.41	34.63	42.94
	A1B2	1.95	1.37	0.98	1.56	1.37	1.45	64.94	40.69	13.03	36.50	29.46	36.92
	A2B1	1.95	1.17	0.81	1.56	1.17	1.33	60.65	29.37	10.13	36.04	24.80	32.20
	A2B2	1.56	1.17	0.00	1.37	0.98	1.02	44.30	29.13	0.00	31.51	20.68	25.13
Mean		1.95	1.44	0.94	1.68	1.33	1.47	66.38	40.87	12.84	40.08	29.00	37.83
0.75	Co	1.95	1.76	1.76	1.76	1.56	1.76	97.31	70.58	46.11	60.54	48.20	64.55
	A1B1	1.76	1.56	1.56	1.37	1.37	1.52	86.94	61.62	38.69	46.72	40.83	54.96
	A1B2	1.56	1.37	1.37	1.37	1.37	1.41	73.79	51.24	26.44	43.57	39.59	46.93
	A2B1	1.56	1.37	1.37	1.17	1.37	1.37	72.07	49.46	24.66	35.92	39.05	44.23
	A2B2	1.37	1.17	1.17	1.17	0.98	1.17	56.58	39.31	19.42	34.98	27.24	35.51
Mean		1.64	1.45	1.45	1.37	1.33	1.45	77.34	54.44	31.06	44.35	38.98	49.23
1.50	Co	1.95	1.76	1.56	1.37	1.56	1.64	111.35	87.82	41.96	52.33	53.66	69.43
	A1B1	1.76	1.76	1.37	1.37	1.37	1.53	97.68	83.78	36.03	51.24	44.94	62.73
	A1B2	1.56	1.76	1.17	1.37	1.17	1.41	82.21	76.91	28.43	47.54	37.21	54.46
	A2B1	1.37	1.56	1.17	1.37	0.98	1.29	68.64	65.68	28.31	45.48	30.28	47.68
	A2B2	1.37	1.17	1.17	1.17	0.98	1.17	65.21	45.86	20.48	38.26	29.50	39.86
Mean		1.60	1.60	1.29	1.33	1.21	1.41	85.02	72.01	31.04	46.97	39.12	54.83
3.00	Co	1.95	1.76	1.56	1.17	1.37	1.56	121.68	92.93	51.64	46.80	48.36	72.28
	A1B1	1.56	1.56	1.37	1.17	1.17	1.37	95.94	77.53	38.63	45.28	40.01	59.48
	A1B2	1.56	1.56	1.22	1.17	0.98	1.30	95.16	75.66	32.00	43.06	32.05	55.58
	A2B1	1.37	1.37	1.15	1.17	0.98	1.21	78.91	64.53	29.00	42.00	31.36	49.16
	A2B2	1.17	1.17	0.98	0.78	0.98	1.02	63.41	52.30	23.00	27.14	28.81	38.93
Mean		1.52	1.48	1.26	1.09	1.10	1.29	91.02	72.59	34.85	40.86	36.12	55.09
G Mean		1.68	1.49	1.23	1.37	1.24	1.40	79.94	59.98	27.45	43.06	35.80	49.25

As for the specific relationship between N concentration and uptake with soil properties in Table (10 and 11) indicate significant and positive relation with bulk density and hydraulic conductivity but these relations were negative with $CaCO_3$, with (N)% . But these relations were significant and negative correlations with pH, and the content of soluble cations and anions . On the other hand significant and positive relations correlation were found with the soil content of Av-P, and N concentration (%).

Table (10). Relationship between soil properties (X)and N uptake (mg/kg) (Y).

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	$Y\ sn= 0.0092x^2-1.3316x +56.218$	0.5195	$Y\ Gn= 0.0044x^2-0.6329x +25.793$	0.5215
Silt & clay	$Y\ sn= 0.0092x^2-0.5123x +15.253$	0.5195	$Y\ Gn = 0.0044x^2-0.2374x +6.0177$	0.5215
Total $CaCO_3$	$Y\ sn= 0.0033x^2-0.2559x +13.482$	0.9958	$Y\ Gn = 0.0012x^2-0.103x +5.1102$	0.9857
O.M%	$Y\ sn= 9.0738x^2-21.784x +18.184$	0.9496	$Y\ Gn = 4.0438x^2-9.6824x +7.2506$	0.9250
pH	$Y\ sn= 20.81x^2-343.04x +1422.1$	0.9850	$Y\ Gn = 7.7385x^2-128.17x +533.58$	0.9740
EC	$ySn = 0.2279x^2 -3.1972x +20.01$	0.9728	$yGn= 0.1031x^2-1.4335x +8.0928$	0.9614
Av-P	$ySn = -142.75x^2+2776.5x -13389$	0.7423	$yGn= -81.73x^2+1591.1x -7667.2$	0.6360

Y_{Sn}= Nitrogen in straw Y_{Gn} = Nitrogen in grains

Table (11). Relationship between soil properties and N concentration (%).

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	$Y\ sn= 0.0092x^2-1.3316x +56.218$	0.5195	$Y\ Gn= 0.0044x^2-0.6329x +25.793$	0.5215
Silt & clay	$Y\ sn= 0.0092x^2-0.5123x +15.253$	0.5195	$Y\ Gn = 0.0044x^2-0.2374x +6.0177$	0.5215
Total $CaCO_3$	$Y\ sn= 0.0033x^2-0.2559x +13.482$	0.9958	$Y\ Gn = 0.0012x^2-0.103x +5.1102$	0.9857
O.M%	$Y\ sn= 9.0738x^2-21.784x +18.184$	0.9496	$Y\ Gn = 4.0438x^2-9.6824x +7.2506$	0.9250
pH	$Y\ sn= 20.81x^2-343.04x +1422.1$	0.9850	$Y\ Gn = 7.7385x^2-128.17x +533.58$	0.9740
EC	$ySn = 0.2279x^2 -3.1972x +20.01$	0.9728	$yGn= 0.1031x^2-1.4335x +8.0928$	0.9614
Av-P	$ySn = 108.07x^2-124.82x +36.644$	0.7655	$yGn= 38.857x^2-41.894x +12.575$	0.9883

Y_{Sn}= Nitrogen in straw Y_{Gn} = Nitrogen in grains

Phosphorus (P).

The data of P concentration (%) and uptake (mg/kg) of barley grains and straw affected by P fertilization, calcareous soils properties and irrigation water salinity and sodicity which recorded in Tables (12 and 13) show that, in the soils under study with different treatments of irrigation water increasing levels of P application increased P content of barley grains and straw. These increases were resulted from the increase P availability with the increase of added P. Khalil (2000)., and Mehdi *et al.* (2002) obtained similar results. The same data also show, increasing irrigation water salinity and sodicity resulted in a clear decrease of barley grains and straw content of P. This decrease which associated with the increase of irrigation water sodicity was higher than that found with the increase of irrigation water salinity. This negative effect of irrigation water quality on P content of barley grains and straw decreased with the increase of added P. These results are in agreement with that found by Mehdi *et al.* (2002) and Shaban (2005).

Regarding to the effect of calcareous soils properties on P content of barley grains and straw, the data of Tables (12 and 13) show that, there are a wide range for the grains and straw content of P. This content was depended on these soils properties and their effect on the nutrients availability and plant growth. Under most treatments of P fertilization and irrigation water, according to the grains and straw content of P the studied soils takes the order: soil number: 1 >2> 3> 4> 5. In this respect khalil (2000) and Zhang *et al.* (2006) obtained similar results. As for specific relationship between P uptake (mg/kg) and soil properties, data in Tables (14 and 15) indicated that, there were significant and positive relations with the content of sand(%), where these relations were negative with soil content of silt blus clay , $CaCO_3$,OM, soil pH and soil porosity and the content of soluble cations and anions .

Potassium (K)

Potassium (K) concentration (%) and uptake (mg/kg) of barley grains and straw planted on the used calcareous soils irrigated with water varied in their salinity and sodicity were great affected by application level of P fertilization where the recorded data in Tables (16 and 17) show that, increasing added P resulted in an increase of both k concentration and uptake by barley grains and straw. These results were found in barley plants growing in the five soils under different treatments of irrigation water. Also these results show an increase effect of P on plant growth and K uptake by barley plants. These results are in agreement with those found by Khalil (2000) ., Mostafa (2001) and Rehan *et al.* (2002).

Table (12): P concentration (%) and uptake (mg/pot) of barley straw as affected by soil properties, P-fertilization and irrigation water quality.

P-level g/pot	Irrigation water	P concentration %					Means	P uptake (mg/pot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	0.54	0.30	0.30	0.28	0.13	0.31	61.13	30.66	13.74	23.32	10.11	27.79
	A1B1	0.49	0.26	0.21	0.20	0.10	0.25	54.24	26.39	9.35	15.48	7.62	22.62
	A1B2	0.45	0.26	0.19	0.18	0.08	0.23	49.32	26.21	8.21	13.73	6.01	20.70
	A2B1	0.37	0.18	0.15	0.14	0.06	0.18	37.93	15.35	6.11	10.49	4.42	14.86
	A2B2	0.34	0.16	0.13	0.13	0.05	0.16	31.89	13.58	4.56	9.71	3.65	12.68
Mean		0.44	0.23	0.20	0.19	0.08	0.23	46.90	22.44	8.39	14.55	6.36	19.73
0.75	Co	0.76	0.36	0.39	0.31	0.27	0.42	103.13	40.54	29.29	30.10	25.30	45.67
	A1B1	0.72	0.33	0.29	0.29	0.23	0.37	94.75	36.66	20.59	27.99	20.77	40.15
	A1B2	0.58	0.32	0.28	0.23	0.20	0.32	71.80	33.60	15.51	20.68	17.54	31.83
	A2B1	0.50	0.31	0.23	0.21	0.19	0.29	58.45	31.31	11.96	18.21	16.38	27.26
	A2B2	0.37	0.30	0.18	0.19	0.12	0.23	41.77	28.35	8.59	16.02	10.12	20.97
Mean		0.59	0.32	0.27	0.25	0.20	0.33	73.98	34.09	17.19	22.60	18.02	33.18
1.50	Co	0.87	0.60	0.44	0.32	0.30	0.51	126.41	75.90	29.96	31.58	28.56	58.48
	A1B1	0.79	0.58	0.38	0.30	0.24	0.46	112.65	69.83	25.65	28.92	21.77	51.76
	A1B2	0.75	0.37	0.30	0.28	0.21	0.38	101.78	41.00	18.72	25.12	18.54	41.03
	A2B1	0.62	0.28	0.26	0.24	0.11	0.30	81.10	29.76	14.92	20.59	9.43	31.16
	A2B2	0.61	0.27	0.24	0.09	0.06	0.25	73.87	26.78	10.87	7.61	5.01	24.83
Mean		0.73	0.42	0.32	0.25	0.18	0.38	99.16	48.66	20.03	22.76	16.66	41.45
3.00	Co	0.89	0.71	0.55	0.43	0.32	0.58	134.03	92.51	46.92	44.59	29.70	69.55
	A1B1	0.84	0.42	0.41	0.34	0.25	0.45	124.49	51.49	34.40	32.88	22.43	53.14
	A1B2	0.75	0.41	0.37	0.28	0.22	0.41	103.73	48.95	24.57	25.68	18.92	44.37
	A2B1	0.72	0.36	0.31	0.25	0.20	0.37	98.28	41.90	15.84	22.38	16.78	39.04
	A2B2	0.61	0.30	0.29	0.16	0.06	0.28	78.39	33.27	13.14	13.89	4.64	28.66
Mean		0.76	0.44	0.39	0.29	0.21	0.42	107.78	53.63	26.97	27.88	18.49	46.95
G Mean		0.63	0.35	0.30	0.24	0.17	0.34	81.96	39.70	18.14	21.95	14.88	35.33

Table (13): P concentration (%) of barley grain as affected by soilproperties,P-fertlization and irrigation water quality.

P-level g/pot	Irrigation water	P concentration %					Means	P uptake (mglpot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	0.73	0.62	0.60	0.48	0.43	0.57	28.40	18.60	8.52	12.29	9.76	15.51
	A1B1	0.61	0.60	0.52	0.40	0.39	0.50	22.20	17.94	7.12	9.52	8.66	13.09
	A1B2	0.57	0.56	0.43	0.38	0.32	0.45	18.98	16.63	5.72	8.89	6.88	11.42
	A2B1	0.48	0.41	0.38	0.30	0.28	0.37	14.93	10.29	4.75	6.93	5.94	8.57
	A2B2	0.36	0.36	0.00	0.29	0.22	0.25	10.22	8.96	0.00	6.67	4.64	6.10
Mean		0.55	0.51	0.39	0.37	0.33	0.43	18.95	14.49	5.22	8.86	7.18	10.94
0.75	Co	0.98	0.85	0.65	0.62	0.57	0.73	48.90	34.09	17.03	21.33	17.61	27.79
	A1B1	0.86	0.83	0.61	0.56	0.40	0.65	42.48	32.79	15.13	19.10	11.92	24.28
	A1B2	0.65	0.62	0.59	0.48	0.36	0.54	30.75	23.19	11.39	15.26	10.40	18.20
	A2B1	0.57	0.54	0.49	0.32	0.30	0.44	26.33	19.49	8.82	9.82	8.55	14.60
	A2B2	0.49	0.48	0.48	0.30	0.28	0.41	20.24	16.13	7.97	8.97	7.78	12.22
Mean		0.71	0.66	0.56	0.46	0.38	0.56	33.74	25.14	12.07	14.90	11.25	19.42
1.50	Co	1.54	0.90	0.73	0.73	0.68	0.92	87.93	44.91	19.64	27.89	23.39	40.75
	A1B1	1.38	0.85	0.69	0.69	0.64	0.85	76.59	40.46	18.15	25.81	20.99	36.40
	A1B2	1.14	0.81	0.66	0.64	0.61	0.77	60.08	35.40	16.04	22.21	19.40	30.62
	A2B1	0.90	0.76	0.61	0.55	0.46	0.66	45.09	32.00	14.76	18.26	14.21	24.86
	A2B2	0.76	0.65	0.51	0.48	0.36	0.55	36.18	25.48	8.93	15.70	10.84	19.42
Mean		1.14	0.79	0.64	0.62	0.55	0.75	61.17	35.65	15.50	21.97	17.77	30.41
3.00	Co	1.56	1.38	0.95	0.90	0.81	1.12	97.34	72.86	31.45	36.00	28.59	53.25
	A1B1	1.48	0.93	0.88	0.73	0.73	0.95	91.02	46.22	24.82	28.25	24.97	43.05
	A1B2	1.30	0.82	0.74	0.68	0.62	0.83	79.30	39.77	31.561	25.02	20.27	39.19
	A2B1	1.04	0.73	0.69	0.68	0.50	0.73	59.90	34.38	28.635	24.41	16.00	32.67
	A2B2	0.98	0.69	0.62	0.52	0.49	0.66	53.12	30.84	24.645	18.10	14.41	28.22
Mean		1.27	0.91	0.78	0.70	0.63	0.86	76.14	44.82	28.22	26.36	20.85	39.28
G Mean		0.92	0.72	0.59	0.54	0.47	0.65	47.50	30.02	15.25	18.02	14.26	25.01

Table (14). Relationship between soil properties and(P) uptake(mg/kg).

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	$Y_{sp}= 0.0092x^2-1.3316x +56.218$	0.5195	$Y_{Gp}= 0.0044x^2-0.6329x +25.793$	0.5215
Silt & clay	$Y_{sp}= 0.0092x^2-0.5123x +15.253$	0.5195	$Y_{Gp} = 0.0044x^2-0.2374x +6.0177$	0.5215
Total $CaCO_3$	$Y_{sp}= 0.0033x^2-0.2559x +13.482$	0.9958	$Y_{Gp} = 0.0012x^2-0.103x +5.1102$	0.9857
O.M%	$Y_{sp}= 9.0738x^2-21.784x +18.184$	0.9496	$Y_{Gp} = 4.0438x^2-9.6824x +7.2506$	0.9250
pH	$Y_{sp}= 20.81x^2-343.04x +1422.1$	0.9850	$Y_{Gp} = 7.7385x^2-128.17x +533.58$	0.9740
EC	$y_{Sp} = 0.2279x^2 -3.1972x +20.01$	0.9728	$y_{Gp}= 0.1031x^2-1.4335x +8.0928$	0.9614
Av-P	$y_{Sp}= -142.75x^2+2776.5x -13389$	0.7423	$y_{Gp}= -81.73x^2+1591.1x -7667.2$	0.6360

Y_{Sp}= Phosphorus in straw Y_{Gp} = Phosphorus in grains

Table (15). Relationship between soil properties and P (%)concentration .

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	$Y_{sp}= 0.0092x^2-1.3316x +56.218$	0.5195	$Y_{Gp}= 0.0044x^2-0.6329x +25.793$	0.5215
Silt & clay	$Y_{sp}= 0.0092x^2-0.5123x +15.253$	0.5195	$Y_{Gp}= 0.0044x^2-0.2374x +6.0177$	0.5215
Total $CaCO_3$	$Y_{sp}= 0.0033x^2-0.2559x +13.482$	0.9958	$Y_{Gp} = 0.0012x^2-0.103x +5.1102$	0.9857
O.M%	$Y_{sp}= 9.0738x^2-21.784x +18.184$	0.9496	$Y_{Gp}= 4.0438x^2-9.6824x +7.2506$	0.9250
pH	$Y_{sp}= 20.81x^2-343.04x +1422.1$	0.9850	$Y_{Gp} = 7.7385x^2-128.17x +533.58$	0.9740
EC	$y_{Sp} = 0.2279x^2 -3.1972x +20.01$	0.9728	$y_{Gp}= 0.1031x^2-1.4335x +8.0928$	0.9614
Av-P	$y_{Sp}= 108.07x^2-124.82x +36.644$	0.7655	$y_{Gp}= 38.857x^2-41.894x +12.575$	0.9883

Y_{Sp}= Phosphorus in straw Y_{Gp} = Phosphorus in grains

Data in Table (16 and 17) show that, K content of barley grains and straw varied widely from soil to another. This wide variation was resulted from the presented wide variation among the studied soil properties and their content of available K and other nutrients. The high concentration of K and its uptake of barley grains and straw was found in the barley planted in soil1 followed by that planted in soil 2 where the lowest content was found in the grains of plants grown on soil 5. This trend was found with different treatments of P and irrigation water. Similar results were obtained by El-Sheikh (2000 and 2003) ., Mostafa (2001) and Rehan *et al* (2002)

Table (16): K concentration (%) and uptake (mg/pot) of barley straw as affected by soil properties,P-fertlization and irrigation water quality.

P-level g/pot	Irrigation water	K concentration %					Means	K uptake (mglpot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	1.30	1.74	1.06	0.93	0.61	1.13	147.16	177.83	48.55	77.47	47.46	99.69
	A1B1	1.16	1.35	1.04	0.85	0.60	1.00	128.41	137.03	46.28	65.79	45.72	84.65
	A1B2	1.08	1.25	0.97	0.62	0.53	0.89	118.37	126.00	41.90	47.31	39.80	74.68
	A2B1	1.01	1.24	0.88	0.58	0.51	0.84	103.53	105.77	35.82	43.44	37.59	65.23
	A2B2	0.83	0.92	0.50	0.31	0.30	0.57	77.85	78.11	17.55	23.16	21.87	43.71
Mean		1.08	1.30	0.89	0.66	0.51	0.89	115.06	124.95	38.02	51.43	38.49	73.59
0.75	Co	1.53	1.95	1.12	0.96	0.74	1.26	207.62	219.57	84.11	93.22	69.34	134.77
	A1B1	1.40	1.70	1.06	0.92	0.65	1.15	184.24	188.87	75.26	88.78	58.70	119.17
	A1B2	1.05	1.53	1.03	0.83	0.60	1.01	129.99	160.65	57.06	74.62	52.62	94.99
	A2B1	1.03	1.47	0.94	0.60	0.54	0.92	120.41	148.47	48.88	52.02	46.55	83.27
	A2B2	0.99	1.33	0.56	0.43	0.31	0.72	111.77	125.69	26.71	36.25	26.13	65.31
Mean		1.20	1.60	0.94	0.75	0.57	1.01	150.81	168.65	58.41	68.98	50.67	99.50
1.50	Co	1.76	1.98	1.41	1.09	0.95	1.44	255.73	250.47	96.02	107.58	90.44	160.05
	A1B1	1.22	1.81	1.36	0.94	0.69	1.20	173.97	217.92	91.80	90.62	62.58	127.38
	A1B2	1.18	1.55	1.10	0.77	0.55	1.03	160.13	171.74	68.64	69.07	48.57	103.63
	A2B1	1.12	1.49	0.90	0.69	0.55	0.95	146.50	158.39	51.66	59.20	47.14	92.58
	A2B2	1.06	1.34	0.76	0.57	0.34	0.81	128.37	132.93	34.43	48.17	28.39	74.46
Mean		1.27	1.63	1.11	0.81	0.62	1.09	172.94	186.29	68.51	74.93	55.42	111.62
3.00	Co	1.80	2.23	1.41	1.14	1.00	1.52	271.08	290.57	120.27	118.22	92.80	178.59
	A1B1	1.55	1.92	1.36	0.98	0.70	1.30	229.71	235.39	114.10	94.77	62.79	147.35
	A1B2	1.43	1.78	1.20	0.91	0.64	1.19	197.77	212.53	79.68	83.45	55.04	125.69
	A2B1	1.42	1.75	1.20	0.82	0.58	1.15	193.83	203.70	61.32	73.39	48.66	116.18
	A2B2	0.93	1.58	0.80	0.61	0.45	0.87	119.51	175.22	36.24	52.95	34.79	83.74
Mean		1.43	1.85	1.19	0.89	0.67	1.21	202.38	223.48	82.32	84.55	58.82	130.31
G Mean		1.24	1.60	1.03	0.78	0.59	1.05	160.30	175.84	61.81	69.97	50.85	103.75

Table (17): K concentration (%) and uptake (mg/pot) of barley grain as affected by soil properties, P-fertlization and irrigation water quality.

P-level g/pot	Irrigation water	K concentration %					Means	K uptake (mglpot)					Means
		Soil1	Soil2	Soil3	Soil4	Soil5		Soil1	Soil2	Soil3	Soil4	Soil5	
0.00	Co	0.94	0.70	0.67	0.58	0.58	0.69	36.57	21.00	9.51	14.85	13.17	19.02
	A1B1	0.83	0.58	0.55	0.54	0.54	0.61	30.21	17.34	7.54	12.85	11.99	15.99
	A1B2	0.81	0.58	0.45	0.45	0.44	0.55	26.97	17.23	5.99	10.53	9.46	14.03
	A2B1	0.75	0.54	0.44	0.44	0.43	0.52	23.33	13.55	5.50	10.16	9.12	12.33
	A2B2	0.70	0.47	0.00	0.38	0.32	0.37	19.88	11.70	0.00	8.74	6.75	9.42
Mean		0.81	0.57	0.42	0.48	0.46	0.55	27.39	16.17	5.71	11.43	10.10	14.16
0.75	Co	0.97	0.86	0.83	0.78	0.75	0.84	48.40	34.49	21.75	26.83	23.18	30.93
	A1B1	0.87	0.75	0.70	0.70	0.61	0.73	42.98	29.63	17.36	23.87	18.18	26.40
	A1B2	0.83	0.61	0.67	0.64	0.55	0.66	39.26	22.81	12.93	20.35	15.90	22.25
	A2B1	0.78	0.61	0.55	0.52	0.45	0.58	36.04	22.02	9.90	15.96	12.83	19.35
	A2B2	0.70	0.52	0.38	0.41	0.38	0.48	28.91	17.47	6.31	12.26	10.56	15.10
Mean		0.83	0.67	0.63	0.61	0.55	0.66	39.12	25.28	13.65	19.86	16.13	22.81
1.50	Co	1.08	0.91	0.86	0.81	0.73	0.88	61.67	45.41	23.13	30.94	25.11	37.25
	A1B1	0.97	0.83	0.78	0.70	0.62	0.78	53.84	39.51	20.51	26.18	20.34	32.07
	A1B2	0.83	0.73	0.70	0.61	0.55	0.68	43.74	31.90	17.01	21.17	17.49	26.26
	A2B1	0.78	0.70	0.67	0.58	0.52	0.65	39.08	29.47	16.21	19.26	16.07	24.02
	A2B2	0.70	0.61	0.61	0.48	0.44	0.57	33.32	23.91	10.68	15.70	13.24	19.37
Mean		0.87	0.76	0.72	0.64	0.57	0.71	46.33	34.04	17.51	22.65	18.45	27.80
3.00	Co	1.14	1.11	0.86	0.86	0.78	0.95	71.14	58.61	28.47	34.40	27.53	44.03
	A1B1	1.08	0.86	0.83	0.83	0.64	0.85	66.42	42.74	23.41	32.12	21.89	37.32
	A1B2	0.94	0.81	0.80	0.70	0.55	0.76	57.34	39.29	34.12	25.76	17.99	34.90
	A2B1	0.86	0.75	0.76	0.58	0.54	0.70	49.54	35.33	31.54	20.82	17.28	30.90
	A2B2	0.83	0.73	0.71	0.52	0.48	0.65	44.99	32.63	28.22	18.10	14.11	27.61
Mean		0.97	0.85	0.79	0.70	0.60	0.78	57.88	41.72	29.15	26.24	19.76	34.95
G Mean		0.87	0.71	0.64	0.61	0.55	0.67	42.68	29.30	16.50	20.04	16.11	24.93

As for the specific relationship between K uptake (mg/kg) and concentration (%) of barley straw and grains with some physical and chemical soil properties which recorded in Tables (18 and 19) these data indicate that, these relations were significant and positive with the content of sand%, and the content of Av-P but these relations were negative correlation with soil content of silt (%), total $CaCO_3$, and soil pH. Khalil (2000) obtained similar relationships.

Table (18). Relationship between soil properties and(K) uptake (mg/kg).

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	ySk = -0.1363x2+25.556x-1022.1	0.92	yGk =0.0004x2+0.8302x- 33.477	0.97
Silt&clay	ySk = -0.1363x2 + 1.705x +170.52	0.92	yGk = 0.0004x2 -0.9006x +53.061	0.97
Total $CaCO_3$	ySk =0.0547x2 - 6.0444x+205.86	0.98	yGk = 0.0198x2 -1.6008x +52.277	0.99
OM %	ySk = 41.63x2 - 163.92x +219.82	0.99	yGk= 11.337x2 -38.153x +53.379	0.92
PH	ySk = 430.84x2 - 7206.5x+30182	0.99	yGk = 123.42x2 -2039.2x +8442.6	0.98
EC	ySk =5.9724x2 -86.681x +388.95	0.90	yGk = 1.5461x2 -21.47x +96.662	0.99
Av-P	ySk = -142.75x2+2776.5x -13389	0.7423	yGk= -81.73x2+1591.1x -7667.2	0.6360

Y_{SK}= Potassium in straw Y_{GK} = Potassium in grains

Table (19). Relationship between soil properties and K (%)concentration..

Soil properties	Straw		Grains	
	Equations	r	Equations	r
Sand %	ySk = 0.0004x2 - 0.028x + 0.6918	0.97	yGk = 0.0004x2-0.031x +1.1237	0.99
Silt&clay	ySk = -0.1087x2 - 0.003x + 8.0593	0.87	yGk = 0.8966x2-14.978x +63.177	0.98
Total $CaCO_3$	ySk = 0.0004x2 - 0.028x + 0.6918	0.97	yGk = 0.0004x2- 0.031x +1.1237	0.99
OM %	ySk = 0.016x2 - 0.5231x + 1.5708	0.92	yGk = 0.0733x2-0.2985x +0.9473	0.93
PH	ySk = -0.1087x2 - 0.003x + 8.0593	0.87	yGk = 0.8966x2-14.978x +63.177	0.98
EC	y Sk= 0.0244x2 - 0.3789x + 2.3293	0.65	yGk = 0.0163x2-0.2231x +1.4202	0.97
Av-P	ySk = 108.07x2-124.82x +36.644	0.76	yGk= 38.857x2-41.894x +12.575	0.98

Y_{SK}= Potassium in straw Y_{GK} = Potassium in grains

REFERENCES

Abou Hussien, E. A. and S. W. Barsoum (2002). The combined effect of salinity and nitrogen fertilization on calcareous soil properties and oil crops growth. Zagazig J. Agric. Res.,.29.(1).151-167.

Abou Hussien, E. A. and S. W. Barsoum, B.Y. El-Koumey and S.A.S. Fayed (2009). Sandy soil properties and its productivity as affected by irrigation water quality . Menufiya J. Agric, Res.. 34..5 1945-1958.

Abou Hussien, E. A. and F. S. El-Shafie and N.S. Rizk (1994). Effect of salinity and root-knot nematode on growth and nutrients uptake by broad bean plant. Minufiya . J. Agric. Res. 19(6 part 2): 3375- 3396.

Abou Hussien, E. A. and K.H. A. Shaban (2008). Trace elements status in the saline soils leached by using low quality water . Twenth International water Technology conference, 27 – 30 March (2008) Alexandria, Egypt., 1031- 1043.

Adhami, E. M. M. Maftoun, A.Ronaghi; N. Karimian, J Yasrebi and M. T. Assad (2006). Inorganic phosphorus fraction of highly calcareous soils of Iran. Commun. Soil Sci. and Plant Analysis, 37: 1877 – 1888.

Basak, R.K. (2006). "Fertilizers" Kalyani Pubishers, Ludhiana-New Delhi-Nodia(U.P.), Hyderabad-Chennai-Calcutta-Cuttack.

Black,C.A (ed) (1965) . Methods of soil analysis .Parts 1 and 2 . Agronomy 9:552-559, 900, 1374-1376.Amer Soc. Agron. Madison,Wis.

Cakmak, I. (2002) Plant nutrition research priorties to meet human needs for food in sustainable ways. Plant and Soil 247: 3 – 24

Cottenie, A. (1980). Soil and plant testing as basis of fertilizer recommendations. FAO. Soils Bull., 38/2 FAO, Rome.

Cottenie, A., M. Verloo, L. Kikens, G. Velghe and R. Camerlynck (1982). Analytical Problems and Methods in Chemical Plant and Soil Analysis. Hand book Ed. A. Cottenie, Gent, Belgium (1982).

El-Sheikh, O. M. (2000). Effect of quality of irrigation waters the absorption of some elements. M.Sc., Thesis Fac. of Agric Zagazge Univ., Egypt.

El-Sheikh, O. M. (2003). Salinity problem of soils irrigated with water of low qualities. Ph.D. Thesis Faculty of Agric. Zagazig Univ., Egypt.

El-Shennawi, M.M, F. S. El-Shafee, M.R. Abd El-Hady and M.M.N. Faiyad (2009) Effect of mineral phosphate and organic fertilizers on plant growth and nutrient contents of Faba Bean grown on different soils. Menufiya J. Agric, Res. Vol. 34. No.4 :1737-1757.

Fayed, S.A.S., (2009) Effect of irrigation with sewage and drainage water on properties of some new reclaimed soils and plants growth. M.Sc., Thesis Fac. of Agric. Menufiya. Univ., Egypt.

Hafiz. W. A. (2001). Effect of drainage water on some Egyptian soils and plant. M.Sc. Thesis, Fac. of Agric. Moshtohor, Zagazig Univ. Egypt.

Khalil, H. M. (2000). Influence of soil properties on plant requirements of phosphorus in some soils of Egypt. M.Sc. Thesis Fac. Agric. Minufiya Univ.

Mehdi, S. M., M.J. Ahmed, M. Sarfraz, G. Hassan and M. Sadiq (2002). Comparative effect of different phosphates on chemical composition of wheat under saline conditions. Sarhad – Journal of Agriculture. 18: 4, 393 – 404.

Mengel, K. and E. A. Kirkby (1987). Principles of Plant Nutrition 4th Edition , International Potash Institute Boro Swizer Land.

Mohammad, J. and Malakouti (2008). The effect of micronutrients in ensuring efficient use of macronutrients. Turk.J. Agric. 32:215-220.

Mostafa, M. M. (2001). Nutrition and productivity of broad bean plant as affected by quality and source of irrigation water. Zagazig, J. Agric. Res., 28(3):517-532.

Nikos J. Warrence, and Krista E. Pearson, and James W. Bauder (2003). The basics of salinity and sodicity effects on soil physical properties. Frequently Asked Questions-saline and /or sodic soil and water. The department of Land resources and environmental sciences. Water Quality & Irrigation Management. (MSU BOZEMAN). http://waterquality. Montana.edu/docs/methane/basics_highlight.shtml.

Page, A. L., R. H. Miller and D. R. Keeney (1982). Methods of Soil Analysis. Part2: Chemical and microbiological properties (2nd ed) Amer. Soc. Agron. In Soil Sci.Soc. Amr. Inc. Madison, Wisconsin, USA.

Ragab, A. A. M, F.A. Hellal and M. Abd El-Hady (2008). Water salinity impacts on some soil properties and nutrients uptake by wheat plants in sandy and calcareous soil. Australian J. of Basic Applied Sciences, 2(2):225-233.

Reddy, D.D. and V. Yada (1994). Response of wheat to zinc and phosphorus in a highly calcareous soil. J . Indian .Soci. Soil Sci. ., 42:594-597.

Rehan, M. G. A., A. H. El-Sayed, H. M. M. Syam and M. H. El-Kholy (2002). Response of wheat to K-fertilization under irrigation with drainage water. Egypt Soil Sci. Soc., (ESSS) 6th Nat. Congress, Oct, 29-30, Cairo, Egypt.

Salam, A. (1999). Effect of the increase in contents and fineness of $CaCO_3$ in soil on ryegrass growth and its P and K uptake. Annals Agric. Sci. Moshtohotr, 23:1831-1842.

Sendecore, G.W. and G.W. Cochran (1980). Statisticl Methods 6th Ed. Iowa State Univ. Press; Ames, Iowa, USA

Shaban, K. A. H.(2005). Effect of different irrigation water resources on properties and productivity of salt affected soils. Ph.D. tThesis, Fac. Of Agric. Minufiya Univ., Egypt.

Shen, I., R.L. Zhang, J. Fan, C. Tang and Z. Rengel (2004). Crop yields, soil fertility and phosphorus fractions in response to long-term fertilization under the rice monoculture system on a calcareous soil. Felid Crops Research 86:225-238.

Somaya, A. H., M. A. Abu-Sinna, N. F. Kandil, B. M. El-Nashar and N. M. El-Mowelhi (2002). Environmental assessment of drainage water in Nile Delta for sustainable agricultural development: I-Elements Hazard. Problems of land degradation in Egypt and Africa. Causes, Environment Hazard and conservation, Methods, 23-24 March.

Zhang. Q., G.H. Wang, Y.K. Feng, Q. Z. Sun, C. Witt and D. Obermann (2006). Changes in soil phosphorus fractions in calcareous paddy soil under intensive rice cropping. Plant and Soil, 288:1421-154.

التأثير المشترك للتسميد الفوسفاتي وملوحة مياه الري على إنتاجية الاراضى الجيرية

رفعت أحمد خليل ، صلاح عبد المجيد رضوان ، الحسيني عبد الغفار ابو حسين ، محمد محمد حسن حماد

قسم علوم الاراضى- كلية الزراعة - جامعة المنوفية - مصر

الملخص العربي

أجريت هذه التجربة على خمسة أراضى جيرية تختلف في محتواها من كربونات الكالسيوم وبعض الخواص الأخرى وذلك لدراسة التأثير المشترك لإضافات التسميد الفوسفاتي المختلفة ومستويات ملوحة وقلوية مياه الري على بعض الخواص الكيميائية لهذه الاراضى وإنتاجيتها . تم تصميم تجربة أصص في نظام قطع منشقة فى ثلاث مكررات حيث كانت الاراضى تمثل القطع الرئيسية ومستويات التسميد الفوسفاتي القطع تحت الرئيسية بينما وضعت مصادر مياه الري في القطع تحت الرئيسية وكانت مستويات التسميد الفوسفاتي المختبرة هي صفر؛ ٥٠؛ ١٠٠؛ ٢٠٠ % من الجرعة الموصى بها لنبات الشعير (٣٠٠ كجم سوبر فوسفات / فدان) وكذلك فقد استخدم خمس مصادر لمياه الري والتي تختلف فى مستويات ملوحتها و قلويتها استخدم نبات الشعير كنبات اختبارى.

ولقد اوضحت النتائج وجود زيادة واضحة فى محتوى الارض من الأملاح الكلية الذائبة والايونات الذائبة نتيجة الرى بمياه مالحة وكذلك مع زيادة معدل الإضافة من التسميد الفوسفاتى ولقد حدث نقص فى الوزن الجاف المتحصل علية لكل من القش والحبوب لنبات الشعير مع زيادة ملوحة وقلوية مياه الرى وكان النقص المصاحب لزيادة قلوية المياه اعلى من ذلك الناتج عن زيادة ملوحة مياه الرى .ومن ناحية اخرى ازداد محصول المادة الجافة لكل من القش و الحبوب مع زيادة المضاف من السماد الفوسفاتى . وكان اعلى محصول للمادة الجافة التى تم ريها بماء الصنبور والمسمدة بالفسفور عند معدل إضافة ٢٠٠% من الموصى به ولقد تأثر محصول المادة الجافة المتحصل علية تأثيرا كبيرا بخواص الأرض الجيرية تحت الدراسة .

ولقد تأثر محتوى القش والحبوب لنبات الشعير من كل من النيتروجين والفسفور والبوتاسيوم تأثرا كبيرا بمعاملات الدراسة وخواص الأرض . ولقد تناقص هذا المحتوى مع زيادة مستوى ملوحة أو قلوية مياه الري بينما اختلف هذا المحتوى اختلافا كبيرا نتيجة للتسميد الفوسفاتي وكذلك فقد اختلف مستوى معنوية العلاقة بين المحتوى من هذه المغذيات وخواص الأرض من عنصر إلى آخر.