 Egypt. J. Soil Sci., **Vol. 57,** No.1, pp. 89 - 100 (2017)

Effect of Water Table Level on Soil and Wheat Productivity in Siwa Oasis

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SIWA Oasis, which is included under irrigated lands, considered a part of depressions presents in the western desert. This study aims to show how drainage system, water table level and application of farmyard manure (7 Mg/fed) could influence on some soil physical properties and wheat production for the two years 2014 and 2015 and to evaluate the performance of the existing drainage in Bany Beer. The results showed that, there was a negative significant relationship between drainage execution and organic fertilizer with bulk density besides to the soil salinity, while a positive significant relationship with total porosity, hydraulic conductivity and pore size distribution. Drainage execution led to reduce bulk density by 0.7 % whenever it accompanied by organic fertilizer increased it to reach 1.8 %. So, salinity decreased from 7 and 9 % for the first and second layers while it was 51 and 54 % for the third and fourth layers. Generally, it decreased 21, 14, 52 and 53 % for the 1st, 2nd, 3rd and 4th layers, respectively. Hydraulic conductivity increased 221 % when drainage executed while it was 156 % when drainage accompanied by organic fertilizers applied for improving soil physical properties. There was a highly significant relationship between wheat production and aforementioned treatments when comparing with control. Drainage efficiency increased when spacing between drains was 30 m comparing to 50 m. The yield increased from 18 to 71% for the second year comparing with the first one which increased averagely by 23 to 59%. This might be caused by improving soil chemical and physical properties by decreasing water table level and increasing aeration. So, it is recommended to apply drainage system accompanied by organic fertilizers application in Siwa oasis that suffers from water logging problem.

Keywords: Drainage system, Logged areas, Water table, Flooding irrigation system, Farmyard manure .

Introduction

Water table management has been studied by several author's works. Skaggs (1990) and Madramootoo and Buckland (1990) showed that sub-irrigation and controlled drainage not only increase crop yields, but also combat denitrification. FAO (1997) and Ben-Hur et al. (2001) found that soil salinity (ECe) values at various soil depths at different sites along the experimental field indicated an increase in salinity. It increased downhill and also with soil depth. In addition the salinity in the soil changed with seasons; *i.e.*, after rainfall and irrigation sessions. This change differed between the upper and lower parts of the field. Two main processes can account for such salt distribution patterns in the field. Water percolating below the root zone moves downward to the soil water and may cause the water table to rise. As the water table approaches the soil surface, poor soil aeration and/or high salinity in the root zone reduces crop yields. Consequently, installation of a subsurface drainage system keeps the water table at a given level and allows salt leaching from the specified soil depth. This is highly recommended specifically for long-term production systems (Bresler et al. 1982). The low productivity of crop yields were probably achieved as a result of the relatively high EC values in the upper soil layers (0 – 0.9 m).

Wheat crop is moderately tolerant to soil salinity but the ECe should not exceed 4 dS/m in the upper soil layer during germination. Yield

DOI: 10.21608/EJSS.2017.3603

decrease due to soil salinity as follows 0, 10, 25, 50 and 100 % at different ECe 6.0, 7.4, 9.5, 13 and 20 dS/m, respectively (FAO, 1981). Oosterbaan (1994) found that the average depth to water table that is required for crop production was more than 0.5 m, from the soil surface. This indicates that the fields did not suffer from serious drainage problems and that the critical depth (*i.e.,* the minimum permissible depth) of the water table is 0.5 m or deeper. It could be concluded that the lowest crop yields observed were not due to a shallow water table but to other, unfavorable, agricultural conditions. Davis et al. (2002) reported that soil texture affects on nutrients and soil water retention. Also, clay and organic soils hold nutrients and water much better than sandy soils. Wheat is relatively tolerant to a high groundwater table; for sandy loam to silt loam a depth of groundwater of 0.6 to 0.8 m can usually be tolerated, and for clay 0.8 to 1 m. For short periods the crop can withstand without visible harm a minimum depth of 0.25 m. With a rise of groundwater table to 0.5 m for long periods the yield decrease is 20 to 40 percent (FAO, 1981).

Concerning farmyard manure, soil bulk density can be reduced especially for the addition of 7.5 Mg/fed farmyard manure in hills (EL-Sherbiny, 2007). The desirable increase in total porosity was associated with rate of composing manure and increased the hydraulic conductivity as compared with the control. This effect could be rendered to improve root zone layer by allowing more water to be extracted by cultivated plants. In addition, the crop yield increased by 60 % after the installation of tile drainage. Maamoun and El- Sherbiny (2014) found that the addition of rice straw compost decreased the soil saturated hydraulic conductivity of calcareous saline loamy sand soil and increased the yield and yield component of wheat. Maamoun and El- Sherbiny (2015) showed that residual effect of rice straw compost was able to reduce bulk density. The interaction between residual rice straw compost and N fertilization was able to reduce the large pores of the soil and to increase the medium and small ones compared with the control. Fodder yield was used as an indicator to the improvement of soil properties. Eusufzai and Fujii (2012) concluded that field saturated hydraulic conductivity was higher in organic matter amended soils it increased effective macro- and meso-porosity by (14.7% - 29.2%), respectively. Pores in the amended soils were hydraulically active and water movement was dominated by gravity. In addition, applied organic matter could effectively be used to improve soil quality. Zachary and James (2013) concluded that Hydraulic conductivity was the highest in forest-land and decreased in the order of agricultural land, grassland and wetland. There was significant negative correlation between hydraulic conductivity and bulk density and clay content of the soils. Marinari et al. (2000) stated that the addition of organic fertilizers improved soil physical and biological properties. Wherever the increase in macropores, ranging from 50–500 μm, in soil treated with organic fertilizers was mainly due to an increase in elongated pores, which are considered very important both in soil–water–plant relationships and in maintaining a good soil structure. Organic treatments stimulated soil biological activity probably due to an enrichment of soil organic matter. Mineral fertilizer enhanced soil porosity by increasing regular and irregular pores and caused a priming effect on native soil organic matter.

Therefore, the aim of the study is to evaluate of drainage, water table and organic fertilization on some soil physical properties and wheat production.

Materials and Methods

Siwa Oasis is a closed depression located at 65 km east of the Egyptian-Libyan borders and 300 km South-east of Matrouh city. The depression bottom lies at 21 m blow sea level and bonded by zero contour line between latitudes 29° 06¯ and 29° 24¯ N , and longitudes 25° 16¯ and 26° 12¯ E. with a total area of about 1088 K m2. It is bounded by escarpments rise about 100 m above the depression bed in the north direction. The great sand sea borders from the west and the south with an elevation of 25 to 50 m. Experimental study was conducted in three locations in Bany Beer region. Two locations were associated with water table levels 45 and 90 cm while the drainage works had been executed with two drain spacing as 30 and 50 m as a distance between drains. Furthermore, each location was divided into two parts which one without organic matter addition while the other with 7 ton/fed addition. So that the whole experiment include 24 plots.

Calculation of drain spacing

In case of the steady state conditions, the modifications on Hooghoudt equation by

Wesseling (1980) were used. These equations can be written in the following formula:

$$q = [8\,k\,dh + 4\,k\,h2] / L2$$

or $$q = 8\,k\,\bar{D}\,h/L$$

where

q = drain discharge rate per unit surface area (m /day)

K = hydraulic conductivity of the soil (m/day)

D = the distance between impermeable layer and drain line (m)

d = equivalent depth (m)

L = distance between two drains (drain spacing) (m)

h = water head in the drain above surface of hard pan (m)

$\bar{D}$ = Saturated zone (m)

$k\bar{D}$ = Transmissivity of the aquifer (m^2/day)

Evaluation of the present drainage system

To evaluate the performance of the existing drainage in Bany Beer, data on the hydraulic head and its gradient (drainage coefficient) of water released from each drain are required, according to Ochs and Bishay (1992). Equation could be used and became applicable to the subsequent stages of the falling of water table (Ochs and Bishay, 1992) :

$$at = 2.3 \log\ ho / ht$$

$$a = \{2.3 (\log ho - \log ht)\} / t$$

where :

a = the drainage intensity factor (day-1).

t = length of observation period, during which the water table drops from position ho to ht (time in days),

ho and ht = available hydraulic head at selected observation period from (t = 0) to (t = t).

The experimental fields were irrigated by flood irrigation system. The field plots were 8 × 8 m. in the studied locations. Three replicates were assigned for each experimental treatment. Wheat variety Sakha 93 was the adopted grain crop and sowed at the end of October. Water requirement (ETm) was 550 mm. The fertilizer requirement was applied as 150 kg/feddan ammonium sulphate 50 kg/feddan P and K. Nitrogen fertilizer was divided into three equal doses that were applied after 20, 40, and 90 days from sowing. Calcium supper phosphate was added during soil management as a mixture with soil before sowing wheat grains while K was added at the beginning of yield formation as a mid-season (30-35 days). At the end of each experiment, the biological yield, (*i.e.,* grain, straw, 1000-grain weight, and number and weight of spikes per square meter), were recorded for both two studied years.

Soil physical properties (*i.e.,* bulk density, total porosity, pore size distribution, hydraulic conductivity and electric conductivity) were measured and their relations with crop production for the two years were calculated which determined as outlined by Klute (1986). Table 1 points out that the soil is almost uniform in texture, *i.e.* loamy sand and sandy loam. CaCO3% varies sharply from 3.29 to 35.12 % in the soil surface, while it increased with depth. Farmyard manure was mixed in the soil surface layer (0-30cm) before planting at the rate of 7 Mg fed^{-1} in addition to the control treatment. The initial analyses of the applied manures are presented in Table 2.

Statistical analysis

The analysis of variance (ANOVA) was calculated to verify the significance of applied treatments (Gomez and Gomez, 1984). The least significant difference (LSD) at 5% level of significance was recorded to differentiate every two significant means. This was applied to the different wheat yield parameters (grain and straw).

Results and Discussion

Chemical properties of different soil location

Data in Tables 3(a and b) point out that pH values in the saturated soil paste extraction before cultivation ranges between 7.79 to 8.65, while after cultivation ranged between 7.43 to 8.13 indicating that these soils are slightly alkaline. It is also evident that the values of EC of soil paste extraction reveal that the soil of Bany-Beer (1), (location1) is highly saline. While, the other two locations are non saline soils. This indicated that the values of soil salinity vary from site to another and from layer to another in the same profile. In fact this behavior is generally related to the conditions of water-table depth, site elevation, land use and management as well as the efficiency of drainage. Exceptional being the bottom soil layers of most studied profiles in which salt concentration is high because of saline conditions. This is mainly due to the upward salt movement from the ground water, these result are conferment with Faltas and Naguib (2001).

Ionic composition of the soil solution cleared

TABLE 1. Some chemical and physical properties of the studied soils in Bany Beer area

Soil locations	Depth cm	OM (%)	Sand (%)	Silt (%)	Clay (%)	Texture class	Bulk density t. m^{-3}	Ca CO_3 %	CEC C mole Kg^{-1}
Bany Beer (1)	0-20	1.12	76.05	16.75	7.20	L.S	1.43	3.69	7.81
	20-50	1.15	75.95	15.99	8.06	LS	1.41	28.88	9.33
Bany Beer (2)	0-20	0.96	78.95	20.61	0.44	L.S	1.43	3.29	6.29
	20-50	1.14	76.80	19.88	3.32	L.S	1.41	20.05	10.05
	50-75	1.06	77.45	18.3	4.25	L.S	1.41	30.53	8.57
	75-90	1.13	76.00	16.37	7.63	L.S	1.40	35.12	7.81
Bany Beer (3)	0-20	1.05	77.87	20.24	1.88	S.L	1.32	3.49	11.55
	20-50	1.21	65.77	27.87	6.36	S.L	1.38	12.36	12.36
	50-75	1.16	67.95	22.23	9.82	L.S	1.41	28.17	8.17
	75-120	1.11	70.13	16.60	13.27	L.S	1.35	31.95	11.95

Abbreviations: L.S = loamy sand S.L = sandy loam.

TABLE 2. Organic manure parameters, applied in the field experiment of Bany Beer, Siwa Oasis

Manures	C (%)	N (%)	O.M (%)	C/N ratio	P (PPm)	K (PPm)	pH	EC (dS/m)
Farmyard manure	40.28	2.12	69.28	19	20	135	7.92	5.35

TABLE 3a. Some chemical properties of the studied soils

Site No.	Depth (cm)	PH	EC (dS m^{-1})	Cations (meq / L) Na^+	K^+	Ca^{++}	Mg^{++}	Anions (meq / L) HCO_3^-	Cl^-	$SO_4^=$	E.S.P.
	1st year										
Bany Beer (1)	0-20	7.79	19.39	173.3	2.7	45	30	7	134	110	8.8
	20-50	7.8	19.11	171.14	2.65	44.12	29.37	6.81	130	110.47	8.7
Bany Beer (2)	0-20	8.34	3.75	10.5	3	16	8	3.5	17.5	16.5	11.01
	20-50	8.51	2.63	13.5	0.33	14	1.08	3.57	13	12.34	9.63
	50-75	8.61	4.92	27.74	1.89	15.69	5.06	2.98	24	23.4	11.95
	75-90	8.12	2.95	22.35	0.64	7.31	0.69	2.38	20	8.61	11.91
Bany Beer (3)	0-20	8.02	2.09	12.17	0.92	6.39	4.12	2.38	13	8.22	10.48
	20-50	8.04	1.24	8.78	0.87	3.55	1.45	2.98	7.62	4.05	10.21
	50-75	8	1.17	10.17	0.85	1.67	2.12	2.12	7.0	5.69	10.17
	75-120	8.04	1.16	9.22	0.54	2.66	1.34	2.38	8.0	3.38	9.74
2nd year											
Bany Beer (1)	0-20	7.82	18.84	164.2	2.72	46.23	30.58	6.77	126	111.02	8.73
	20-50	7.43	15.73	116	3.9	40.4	37.1	6.2	107.5	83.7	6.78
Bany Beer (2)	0-20	8.65	6.4	44.6	1.97	17.74	2.7	2.7	42.0	22.31	12.97
	20-50	8.26	3.2	23.57	0.83	6.75	3	2.38	20.0	11.77	12.68
	50-75	7.84	2.53	12.17	0.9	11.1	8.4	2.98	17.59	12	12.48
	75-90	8.07	1.48	10.35	0.87	3.83	1.67	2.98	7.00	6.74	11.78
Bany Beer (3)	0-20	8.13	2.4	14.39	0.43	9.64	2.47	2.47	12.00	12.46	8.8
	20-50	7.97	2.23	14.35	0.49	8.53	2.6	2.6	12.00	11.37	8.11
	50-75	7.9	1.24	8.78	0.87	3.55	1.45	2.98	7.62	4.05	9.77
	75-120	8.06	1.06	6.24	0.76	2.21	1.36	2.11	5.21	3.25	7.97

Bany Beer (1) = without drainage (water table) = 45cm.
Bany Beer (2) = without drainage (water table) = 90cm.
Bany Beer (3) = with drainage (water table) = 120cm.

TABLE 3b. Chemical analysis of irrigation water (well flowing water) in Bany-Beer

Time	pH	EC dS/m	Cations (meq /L)				Anions (meq/L)				S.A.R
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3	HCO_3^-	CL^-	$SO4^{--}$	(%)
1st year	7.84	6.19	17	11	41.91	1.65	0	3.5	37.6	46	11.20
2nd year	7.98	6.12	20	10.5	38.89	1.36	0	4	42	31	9.96

that sodium is the dominant cation followed by calcium and magnesium; meanwhile, chloride is the main anion followed by sulfate. Bicarbonate also found in appreciable concentrations. So the dominant compound is sodium chloride followed by calcium sulfate and magnesium sulfate. ESP values were less than 15 indicating that such soils are non-saline or alkali.

The results in Table 3 indicate generally an obvious effect of drainage and its effect on salinity which decreased with time as a result of the effectiveness of the drainage system. Such values seem to be related to either irrigation or drainage efficiency or both according to Abu-Zahra and Tahboub. (2008).

Effect on soil physical and hydraulic properties

Porosity and Pore size distribution percent

Regarding the porosity and the pore-size distribution of the studied soils, data in Table 4 show that, the mean values of the total porosity varied from 44.19 to 52.03% in Bany-Beer (Table 3a, b; with drainage), meanwhile it differs from 36.54 to 48.10 % in Bany-Beer (1 and 2) (without drainage). In all studied soils, mean values of total porosity in lower layers were higher than those of upper ones due to water table variation in undrained locations. This might be attributed to the relatively finer texture of the subsurface soil layers compared to the top ones, while the subsurface soil layers were lower in drained location. Generally mean values of total porosity was higher in drained location. Total porosity was significantly increased in drained location when applying 7 ton/fed Farmyard manure as reported by Li et al. (2011).

Meso-pores, as a percent, played an important role as conduit water and determine drainage rate, they represent about 41.42 % (without drainage) to 47.10 % (with drainage) of the total pore-space of the soil. This could be taken as a positive indicator for the reclaim ability of such poor drained soils. Macro-pores ranged between 16.90 % (without drainage) to 21.77 % (with drainage) in the surface soil layer of the total pore-space while they were ranged from 13.51% to 19.88% in subsurface soil layer of without and with drainage location respectively. Micro pores percentages were ranged from 33.82 % (un-drained) to 37.24% (drained location) of the total pore-space of the soil in the surface layer while the second layer, percentages were ranged from 35.38% and 41.83 % (without and with drainage respectively in Bany Beer region.

Data illustrated in Table 4 clarified that executed drainage system and adding farmyard manure significantly affected on soil large pores for the two soil layers, found by Maamoun and EL- Sherbiny (2015). Meanwhile, the differences of percentages between maximum and minimum values were 45.22 and 59.54 % for soil layers 0-20, and 20-50cm, in macro pores respectively. Also, data showed that drainage and farmyard manure affected positively significant on medium pores for soil layers 0-20 and 20-50cm. So, the differences of percentages between maximum and minimum values were 20.16 and 11.87% for soil layers 0-20, and 20-50 cm, respectively while they were 19.64 and 17.51% for layers 0-20, and 20-50 cm, in micro pores respectively. Soil small pores values for the two soil layers were affected positively significant. All these improvement in large pores, particularly under clay soil condition is considered of great importance for air exchange, water movement in to the soil, reducing evaporation rate and its reflection on plant growth. These results were in concurrent with Kohnke (1979) and Russel (1989). Large pores (>8.62 μ) took the priority of increase, compared with the other divisions, as the addition of farmyard manure, and execution of the drainage system. The combined effect of drainage system and farmyard manure led to increase medium pores (8.62-0.19 μ). This might attributed to migration of very fine soil particles to fill some of large voids during wetting and drying cycles.

TABLE 4. Effect of drainage execution, depth to water table and farmyard manure on total porosity (%) and soil pore size distribution (%) of Bany Beer, Siwa Oasis

Depth	Without drainage				With drainage			
	Water table at 45 (cm) Bany-Beer (1)		Water table at 90 (cm) Bany-Beer (2)		Water table at 45 (cm) Bany-Beer (3a)		Water table at 90 (cm) Bany-Beer (3b)	
	Farmyard manure (Mg/fed)							
	0	7	0	7	0	7	0	7
Total porosity (%)								
0 – 20	36.54	39.6	42.45	45.82	46.72	52.03	47.08	50.34
20 – 50	37.08	39.82	42.96	48.1	44.97	50.97	44.19	59.78
L.S.D. 0.05	0.51							
Macro pores (> 8.62 µ)								
0 – 20	6.8	7.52	8.52	9.52	9.67	9.98	8.39	8.77
20 – 50	5.5	6.22	7.22	8.22	7.57	8.78	7.29	8.67
LSD 0.05	0.29							
Meso-pores (8.62-0.19 µ)								
0 – 20	16.67	17.81	18.62	19.54	21.83	23.54	20.97	21.77
20 – 50	16.63	17.75	18.6	20.52	19.23	21.61	18.66	21.17
L.S.D. 0.05	0.4							
Micro pores (< 0.19 µ)								
0 – 20	13.61	14.49	15.31	16.76	16.22	18.61	16.32	17.24
20 – 50	14.41	15.63	17.14	19.36	18.17	20.58	18.24	20.5
L.S.D. 0.05	0.16							

Soil total porosity Drainage Water table Farmyard manure
Dr Wt Fm Dr × Wt Dr × Fm wt × Fm Dr × Wt × Fm
Significance *** *** ** * ns *** **

Soil hydraulic conductivity and bulk density

The data of hydraulic conductivity (HC) and bulk density in Table 5 indicate the following :

1-Considerable difference between the two sites (1) and (2) due the depth of water table from 45 to 90 cm as the former confined the water movement so may maintains semi- permeable layer near the surface.

2-The drainage application either by 30 m or 50 m spacing enhance the HC values to be moderately rapid with the former and moderate with the latter one indicating good drainage character which could improve the salinity level of soil as shown in Table 6.

3-Organic application give more enhancement for HC values because of amelioration effect of such soil by aggregation so increasing HC values with the 7 ton/fed O.M. application by 65.8 % with 30m drain spacing and 9.5 % with 50m one. These results are concurrent with Maamoun and EL- Sherbiny (2014).

4-Soil hydraulic conductivity values increased significantly in response to drainage and application of organic fertilization comparing to the undrained soil with high water table level, *i.e.*; 45 and 90 cm.

5-The presence of moderately slow hydraulic conductivity in water table 45 cm may caused by long-lasting of water logging problem. These results were in agreement of (Scott, 2000).

6- Soil bulk density mean values took the same trend that noticed with HC as it enhanced by more water table depth and organic treatment, but soil HC values decreased with the larger drain spacing from 30 to 50m. Soil bulk density mean values were significant decreased for in drained and application of organic fertilization comparing to the undrained soil. These results are in agreement with those obtained by Roy and Kashem (2014).

TABLE 5. Effect of drainage system, water table (cm) and farmyard manure (Mg/fed) on soil hydraulic conductivity (m/day) and soil bulk density (t m^{-3}) of Bany Beer, Siwa Oasis.

Soil physical properties	Without drainage				With drainage			
	Water table at 45 (cm) Bany Beer (1)		Water table at 90 (cm) Bany Beer (2)		Water table at 45 (cm) Bany Beer (3a) drain space 30 m)		Water table at 90 (cm) Bany Beer (3b) (drain space 50 m)	
	Farmyard manure							
	0	7 Ton/fed	0	7 Ton/fed	0	7 Ton/fed	0	7 Ton/fed
H C (k rate (m/day)								
Mean	0.3391	0.6424	0.8274	1.3627	1.6933	2.4197	1.1914	1.8712
Class	**Moderately slow**	**Moderate**				**Moderate rapid**		
LSD 0.05	0.40							
Bulk density (t m^{-3})								
0-20	1.43	1.39	1.33	1.30	1.42	1.37	1.32	1.27
20 - 50	1.41	1.37	1.35	1.28	1.38	1.32	1.31	1.25
LSD 0.05	0.02							

	Dr	Wt	Fm	Dr × Wt	Dr × Fm	wt × Fm	Dr × Wt × Fm
Soil hydraulic conductivity Significance	***	**	**	ns	ns	ns	ns
Soil Bulk density Significance	ns	***	**	ns	*	ns	ns

Soil electric conductivity

Table 6 cleared that salinity values (dS/m) in the first soil layer (0-20) were reduced from 3 to 11 % in the control treatment when drainage application executed. While it decreased from 11 to 31 % when applying both of farmyard manure fertilizer and drainage application together. For the second soil layer (20-50cm); results showed that salinity value decreased from 8 to 9 % when using drainage without organic fertilizer addition and from 10 to 18 % when adding fertilizer. For the third layer; (50-75cm) which characterized by high salinity level which reduced from10-95 % when executing drainage application without adding Farmyard manure. Same salinity value was found in the fourth soil layer (75-100cm); like the third one as well without fertilizers while it decreased from 12 to 96 % when adding 7 ton/fed organic fertilizer accompanying with drainage treatment.

On the other hand, the bottom two soil layers have the most effectiveness on rootzone, the highest salinity reduction deduced when drainage treatment applied. So leaching fraction and irrigation continued beside drainage to the depth of 120 cm decreased salinity with 95%. This showed improvement of hydrological and physical properties and the yield as well. These results were in concurrent with Ben-Hur et al. (2001) and Oosterbaan (1994).

Data also showed that EC mean values decreased significantly by drained location and ranged from 477 to 12537 ppm Moukhtar et al (2003) they found that the same trend in low values of EC with the drainage system. It is worth to mention that drained locations system with adding organic fertilizer (7 Mg/fed) have EC less than 821 ppm in the surface layer. While percentages of EC ranged from 5.83 to 16.71% comparing to the control. Meanwhile percentages were high in undrained location which increased with 2.51 to 9.68% for 0-20 and 20-50 cm soil layer and they were 1.03 to 20 % in the subsurface soil layers 50-75 cm and 75-100 cm. Data showed that EC mean values affected by drainage application, depth of water table and farmyard manure especially in the lower soil layer.

From the statistical analysis, (LSD), it was remarked that :

(1) Soil bulk density, hydraulic conductivity, total porosity and pore size distribution values are significant with the drainage execution, water table levels and farmyard manure quantities.

(2) Soil electric conductivity was significantly with drainage and water table level only.

(3) The combined effect that high significant between soil porosity and pore size distribution with applied treatments (water table levels + farmyard manure quantities) while the tri interaction effect was significantly cleared between total porosity and drainage execution, water table levels and farmyard manure quantities.

TABLE 6. Effect of drainage application, water table (cm) and farmyard manure on electric conductivity (ppm) of Bany Beer Siwa Oasis

Depth	Without drainage				With drainage			
	Water table at 45 (cm)		Water table at 90 (cm)		Water table at 45 (cm) Bany Beer (3a) (drain space 30 m)		Water table at 45 (cm) Bany Beer (3b) (drain space 50 m)	
	Farmyard manure (Mg/fed)							
	0	7	0	7	0	7	0	7
0 - 20	861	945	848	856	764	645	821	762
20 - 50	756	775	774	741	688	632	702	665
50 - 75	**12410**	**12538**	749	681	613	547	685	612
75 -100	**12230**	**12301**	693	588	507	478	614	512
LSD 0.05	54.37							

EC dS/m	Dr	Wt	Fm	Dr × Wt	Dr × Fm	wt × Fm	Dr × Wt × Fm
Significance	***	***	**	*	ns	***	**

Drainage coefficient (Drainage intensity factor" a")

The above mentioned discussion cleared that at a certain time (ta) after cessation of water recharge, relationship between (h) and (q) becomes approximately constant. Therefore, could be used the equation and became applicable to the subsequent stages of the falling of water table (Ochs and Bishay 1992): Data presented in Table 7 cleared that drain coefficient factor "a" with drain spacing 30, and 50 m, after the first (1st) season, it was 0.434 at 30 m drain spacing in Bany beer drain, location (3a). They were 0.442, for the some drains at the end of the second year. The results show increasing the value of drain coefficient "a" with time and it was more in Bany beer drain location (3a) than in Bany Beer location (3b). It is observed that the narrow spacing show higher efficient and increased with time.

TABLE 7. Discharge intensity factor "a" of studied soil at Bany beer location

Items and units	With drainage			
	Location			
	Bany beer (3a)		Bany beer (3b)	
Water table level Between Lateral (m)	0.9		1	
Water table level above drain (m)	1.1		1.2	
Impermeable layer (m)	3.75		3.2	
Drain space (m)	30		50	
Deep of drain (m)	1.2			
Flow direction	North to south			
Time per day (period from t=0 to the end of the =t)	7			
Drainage rate (mm/day)	4	4	5	5
Discharge intensity factor "a"	**h_o/h_t**	**"a"**	**h_o/h_t**	**"a"**
After 1st year	20.914	0.434	12.67	0.362
After 2nd year	38.75	0.522	22.129	0.442

Effect of drainage system on wheat yield parameters

Appling drainage system and water depth led to be more lowered in the soil reflecting an improvement in the physical properties in the form of a drawdown as a result of the establishment of the open ditch drains either narrow-or wide-spaced ones. This led to increase the yield of wheat significantly at both the studied seasons. It could be noticed that, Fig. (2 and 3), and Table (9) shows also that location (3a and 3b) soil with drainage system was significantly high biological, straw and grain yields, 1000-grain weight, and weight and number of spikes, of wheat compared with location (1) soil without drainage by 41, 42, 38, 35, 40 and 14%, respectively these data stood in agreement with that reported by Bouajila and Sanaa (2011). Analogously, at location (2), the soil with narrow spacing drainage system was higher than the soil with wide spacing drainage system by about 28, 31, 21, 23, 16 and 13%, of all the studied parameters, respectively. The data also clear that efficiency of drainage system in Bany Beer soil location 3a was better than in the location (3b). These due to the difference between drainage spacing in each of the two locations. This reflects on yield parameters of wheat.

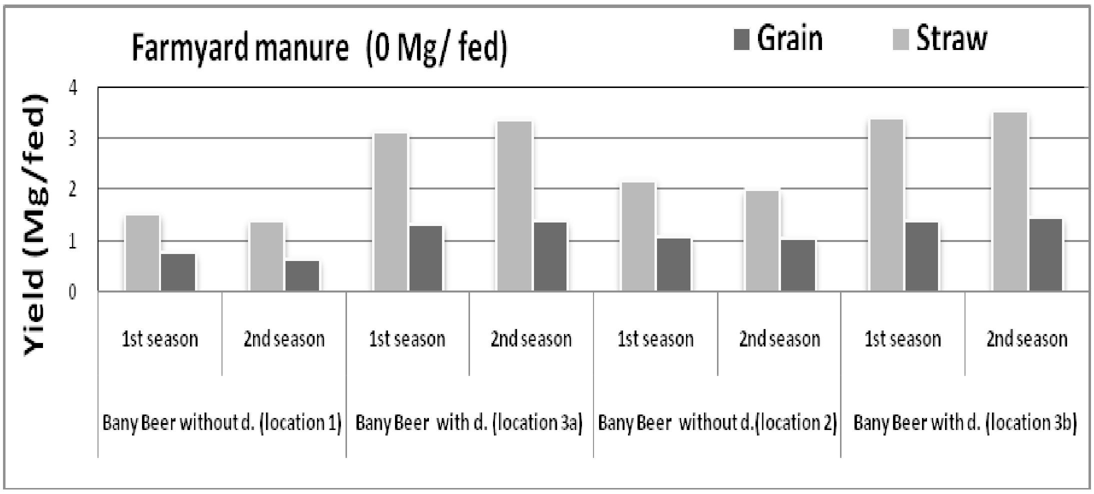

Fig. 1. Effect of the drainage execution on wheat yield at two seasons.

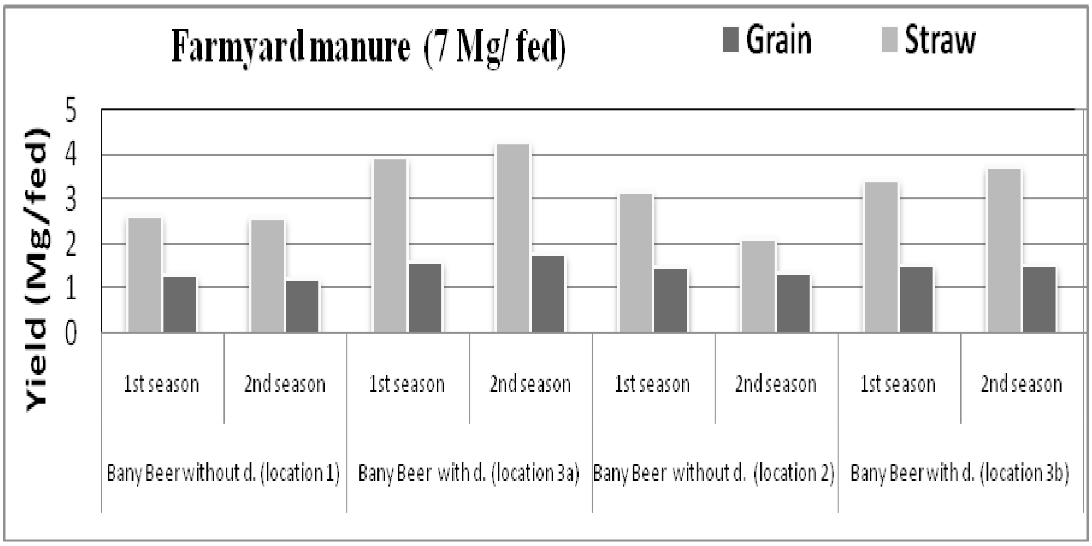

Fig. 2. Effect of the drainage execution and farmyard manure on wheat yield .

TABLE 8. Effect of drainage and farmyard manure on wheat yield parameters through the studied two seasons

Drainage execution	Farmyard manure (Mg fed^{-1})	Yield (Mg fed^{-1})		Weight	Spikes/m^2	
		Grain	Straw	1000 (g)	W.Kg	No.
First season						
Bany Beer location (1)						
Without drainage	0	0.76	1.51	25.9	0.28	194
	7	1.3	2.64	39.8	0.47	225
Bany Beer location (3a)						
With drainage	0	1.32	3.12	43.7	0.52	249
	7	1.62	3.94	46.8	0.59	282
Bany Beer location (2)						
Without drainage	0	1.07	2.18	32.2	0.41	206
	7	1.49	3.18	41.6	0.49	238
Bany Beer location (3b)						
With drainage	0	1.38	3.39	44.6	0.52	249
	7	1.51	3.44	46.8	0.59	276
L.S.D 0.05		0.03	0.03	0.03	0.03	0.04
Second season						
Bany Beer location (1)						
Without drainage	0	0.64	1.38	21.1	0.23	147
	7	1.22	2.6	36.28	0.41	241
Bany Beer location (3a)						
With drainage	0	1.38	3.36	43.4	0.51	256
	7	1.77	4.28	48.5	0.62	311
Bany Beer location (2)						
Without drainage	0	1.04	1.98	30.6	0.38	179
	7	1.35	2.14	39.8	0.44	258
Bany Beer location (3b)						
With drainage	0	1.44	3.51	42.47	0.52	249
	7	1.53	3.74	45.7	0.56	268
L.S.D at 0.05		0.03	0.03	0.03	0.04	0.04

Location (1) = water table (45cm) location (2) =water table (90cm)
Location (3a) = w.t 120cm (at drain spacing 30 m) location (3b) = w.t. 120cm (at drain spacing 50 m)

Grain (Mg fed^{-1})	Dr	Wt	Fm	Dr × Wt	Dr × Fm	wt × Fm	Dr × Wt × Fm
Significance	***	***	***	***	***	***	* **
Straw (Mg fed^{-1})	Dr	Wt	Fm	Dr × Wt	Dr × Fm	wt × Fm	Dr × Wt × Fm
Significance	***	***	***	***	***	***	***

The results of data stood in agreement with the reported by Skaggs (1990) and Oosterbaan (1994) who showed that controlled drainage not only increased crop yields, but also enhanced denitrification (FAO, 2000). Abd EL-Mawgoode (1979) reported that sugar cane yield (ton/fed) increased by 60.2% after tile drainage. EL–Melegy (1990) concluded that production of rice, cotton and maize (kg/fed) where increased by 22%, 20% and 29%; respectively after modifying the layout of drains compared with conventional layout. Data of this study revealed that plants develop better in well drained soil as the root system is able to utilize fertilizers efficiently, stand drought, resist plant disease and compete with weeds. Also for irrigated areas, leaching and other irrigation management are required to reduce or eliminate salinity effects, in agreement with Ali et al (2004).

Conclusions

Application of organic matter with execution drainage system, especially in regions which suffer from water logging enhancement soil physical properties, and improvement water percolation increased wheat productions. On the other hand, reduced water table levels and salinity hazards. So it is recommended to apply open drainage system execution with 120cm depth and spacing between drains as 30m accompanied by addition of farmyard manure with 7Mg/fed in the studied area of Siwa oasis which is suffering from water logging problem.

References

Abu-Zahra,. T.R. and Tahboub A.B. (2008) Effect of Organic Matter Sources on Chemical Properties of the Soil and Yield of Strawberry under Organic Farming Conditions. *World Appl. Sci. J.,* **5** (3); 383-388.

Ali, R., Hatton, T., George, R., Bryne, J., Hodgson, G., and Lambert, T. (2004) Evaluation of the impacts of deep open drains on soil root zone salinity at Narembeen in the wheat belt of Western Australia. in: *Proceedings 1st National Salinity Engineering Conference Engineering Salinity Solutions,"* 9-12 November 2004, Perth, Western Australia: 89-94

Ben-Hur, M. F. H. Keren, Li, R. Ravina, I. and Shalit, G. (2001) Water and Salt Distribution in a Field Irrigated with Marginal Water under High Water Table Conditions, *Soil Sci. Soc. Am. J.* **65,** 191-198

Bouajila,. K. and Sanaa, M. (2011) Effects of organic amendments on soil physico-chemical and biological properties. *J. Mater. Environ. Sci.* **2** (S1) (2011) 485-490

Bresler, E., McNeal, B.L. and Carter.D.L. (1982) *Saline and sodic soils: Principles, dynamic, modeling.* Springer-Verlag, Berlin.

Davis, J.G.; Westfall, D.G.; Mortvedt, J.J. and Shanahan, J.F. (2002) Fertilizing winter wheat. *Soil and Crop Sciences,* Colorado State University.

EL- Sherbiny., W.A. (2007) Fodder beat production from Maryout calcareous soil treated by organic manure. *Egypt. J. of Appl. Sci*., **47,** pp. 419-434.

Eusufzai,. M. and Fujii, K. (2012) "Effect of Organic Matter Amendment on Hydraulic and Pore Characteristics of a Clay Loam Soil," *Open J.of Soil Sci.* **2**, (4), 372-381.

Faltas, R.L. and Naguib, B.H. (2001) Monitoring of soil salinity and alkalinity changes under different tile drain spacing and their effects on the redistribution of soil pores and aggregates , *Egypt. J. Appl. Sci.,* **16** (2), 719-733.

FAO. (1981) International scheme for the co-ordination of Dairy Development and International Meat Development Scheme. Report of a Mission to Ethiopia, 27 May - 28 June, 1980.

FAO, Rome. FAO (1997). Management of agricultural drainage water quality need for artificial drainage, Rome,.

FAO International Fertilizer Association, (IFA) (2000) *Fertilizers and Their Use.* Published by FAO and IFA., Rome,.

Gomez, K.A. and Gomez, A.A. (1984) *Statistical Procedures for Agricultural Research.* 2nd ed., Wiley Dons, New York. Washington, U.S.A.

Klute,. A. (1986) *Methods of Soil Analysis.* Part 1. *Physical and Mineralogical Methods.* Second edition. American Society of Agronomy, (2nd ed), Agron. Monogram. 9, ASA, and SSSA, Madison. pp. 906–926.

Kohnke, H. (1979) *"Soil Physics"* reprinted in India by Arrangement with Mc Graw-Hill. Inc. New York. TMH Edition.

Li,. J.T. Zhong, X.L., Wang F. and Zhao, Q.G. (2011) Effect of poultry litter and livestock manure on soil physical and biological indicators in a rice-wheat rotation system. P.S.E., **57,** (8), 351–356.

Maammoun, H. A. and EL- Sherbiny, W.A. (2014) Effect of rice straw compost on some soil physical properties and wheat production on treated foliar selenium under salinity conditions. *Egypt .J. Appl. Sci.,* **29** (5) 336-354.

Maammoun, H. A. and EL- Sherbiny, W.A. (2015) Response of Pearl Millet (pennisetum Glaucuml) fodder yield to residual effect of rice straw compost and Nitrogen fertilization under salinity condition. *Egypt. J. Appl. Sci.,***30** (1): 1-22.

Madramootoo, D.M. and Buckland, G. D. (1990) The use of shallow sub –surface drains to reclaim in saline and waterlogged lands due to canal seepage in Southern Alberta, Canada 4th-INT., Ommission Irrigation and Drainage, DRI, Cairo, Egypt .

Marinari., S., Marinari, G., Masciandaro, B., Ceccanti and Grego, S. (2000) Influence of organic and mineral fertilizers on soil biological and physical properties. Bioresource Technology Volume 72, Issue 1, March, 9–17.

Moukhtar, M. M., EL-Hadidy, E. and EL-Shewikh, M. B. (2003) Improving water table condition in deteriorated salty clay soil in Egypt. *Drainage*

Workshop, Sept. 10 -13 2003, Utrecht, The Netherlands.

Ochs, W. J. and Bishay, B. G. (1992). *Drainage Guidelines'* World Bank Technical Paper Number 195.Washington, D.C.

Oosterbaan, R. J. (1994) Agricultural drainage criteria .H.P. Ritzema (Ed), *Drainage Principles and Applications,* ILRI Publication 16, second edition, Wageningen, The Netherlands.

Roy, S. M. and Kashem. A. (2014) Effects of Organic Manures in Changes of Some Soil Properties at Different Incubation Periods. *Open J. Soil Sci*, **4,** 81-86

Russel, E.W. (1989) *Soil Conditions and Plant Growth.* Edition of 11th ed. English Long. Book Soc. Longman.

Scott, H. D. (2000) *"Soil Physics"; Agricultural and Environmental Applications,* 73-74. Iwa State Univ. Press.

Skaggs R.W. (1990) Simulation drainage system performance as affected by irrigation managements. *Symposium Con. On land drainage for salinity control in arid and semiarid regions.* February 25th to March 2nd 1990, Cairo, Egypt, **(3)** 163-174.

Wesseling, J. (1980) Subsurface flow into drains (c.f.. *Drainage Principles and Applications.* International Inset. For Land Reclamation and Improvement (ILRI), Pup 16111 Wageningen, The Netherlands)

Zachary G. M. and James O. O.(2013) Effects of land use and management on aggregate stability and hydraulic conductivity of soils within River Njoro Watershed in Kenya. *International Soil and Water Conservation Res.*Vol.1, Issue 2 Pages 80–87.

(*Received:* 7/8/2016; *accepted* :10/1/2017)

اثر مستوى الماء الأرضى على التربة وإنتاجية القمح فى واحة سيوة

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منطقة سيوة تندرج تحت الاراضى المروية. ويهدف هذا البحث إلى دراسة مدى تاثير كل من مستوى الماء الارضى والصرف الزراعى واستخدام السماد البلدى على خواص التربة الطبيعية وانتاجية القمح عام ٢٠١٥/٢٠١٤ و ٢٠١٦/٢٠١٥. فقد وجدت علاقه معنويه سالبة عند تنفيذ الصرف الزراعى واضافة السماد البلدى مع كل من الكثافه الظاهرية وملوحه التربه بينما كانت معنويه موجبه مع المساميه الكليه والتوزيع الحجمى للمسام وكذلك التوصيل الهيدروليكى وكان متوسط نسبة االانخفاض فى االكثافه الظاهريه عند تطبيق الصرف ٠,٧ ٪ وعند تطبيق الصرف واضافة المـــاده العضويه كانت ١,٨ ٪ انخفضت الملوحه بنسبه ٧ و ٩ و ٥١ و ٥٤ ٪ للطبقات الاولى والثانيه الثالثه والرابعة مع تطبيق الصرف وبنسبة ٢١ و١٤ و٥٢ و٥٣ ٪ للطبقات الاربع على الترتيب باضافة المادة العضوية بجانب الصرف و كان متوسط نسبة الزياده للمساميه الكلية عند تطبيق الصرف كان ١٥ ٪ ومع اضاف المادة العضويه زادت الى ١٨ ٪ كما زاد كل من المسام (الواسعه والمتوسطه والصغيره) بنسبة ٢٠ و ١٤ و ١٤ ٪ على الترتيب مع تطبيق الصرف وبنسبه ٢٢ و١٧ و١٧ ٪ مع اضافة المادة العضوية أيضاً كان متوسط نسبه الزيادة للنوصيل الهيدروليكى٢٢١ ٪ مع الصرف وبنسبة ١٥٦٪ باضافة السماد البلدى بجانب الصرف و كذلك زادت كفاءة الصــــــرف عندما كانت المسافة بين المصارف ٣٠م مقارنة بمسافة ٥٠ م كذلك زاد المحصول عند تنفيذ الصرف مع اضافة المادة العضوية بالسنة الثانية للموقع الاول والثانى ٧١ ، ١٨ ٪ بينما فى السنه الاولى فكان متوسط الزيادة من ٥٩ الى ٢٣ ٪ هذا يرجع الى تحسين خواص التربه و لذا يوصى بتطبيق نظام الصرف مع اضافة السماد البلدى ٧ طن للفدان فى اراضى سيوه لتحسين خواص التربه الطبيعيه والتخلص من ملوحه وغدق الاراضى.