J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 3 (12): 1137 - 1151, 2012

EFFECT OF SOME SOIL MANAGEMENT PRACTICES AND NITROGEN FERTILIZER LEVELS ON SOME SOIL PROPERTIES AND ITS PRODUCTIVITY AT NORTH DELTA

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ABSTRACT

A field experiment was conducted at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt to evaluate the effect of subsoiling, sandy mole drains and nitrogen fertilization on improving some soil properties, some water relations and yields of wheat (2008/2009) and maize (2009) in clayey salt affected soils. The design of this experiment was laid in split-split plot design with four replicates. The main plots were assigned to nitrogen fertilizer levels (75, 90 and 110 kg N/fed.). The subplots were devoted to mole drain spacing (2, 4, and 6m), while the mole types (subsoiling and mole drain filled with sand) were allocated in sub-sub plots.

The most important findings could be summarized as follows:

- The application of subsoiling at 2m spacing with addition of 110 kg N /fed., gave the highest production of wheat (2632 kg grain/fed. and 3680 kg straw /fed.) and maize (3380 kg grain /fed. and 5361 kg straw /fed.).
- The values of ECe and SARe in the top soil layer after harvesting of wheat and maize crops were lower than that in subsoil layers.
- The installation of sandy moles at 2m spacing was more effective in leaching of soil salts comparing to that with or without subsoiling. Therefore, the highest mean values of ECe and SARe after harvesting of wheat (6.35 dSm^{-1} and 12.36, respectively) and after harvesting of maize (5.05 dSm^{-1} and 11.10, respectively) were achieved with sandy moles at 2 m spacing.
- The highest values of field water use efficiency for wheat grains 1.14 kg/m^3 was achieved from interaction between sandy mole at 6m spacing with 110 kg N/fed. While the highest value of crop water use efficiency (2.03kg/m^3) was achieved with sandy mole drains at 2m spacing under 110kg N /fed.
- The highest values of field water use efficiency for maize grains (1.0 kg/m^3) was obtained from combination between the control treatment and 90 kg N/fed ,while the highest value of crop water use efficiency (1.52 kg/m^3) was achieved from sandy mole at 6m spacing under 110 kg N /fed.

* The subsoiling followed by sandy mole at 2m spacing were more effective on basic infiltration rate and achieved the highest values of basic infiltration rate.

Keywords: Subsoiling, mole drain, soil properties, wheat, maize, salt affected soils, Nile Delta.

INTRODUCTION

Some heavy clayey salt affected soils with low permeability in Nile Delta are not generally adapted for crop production. Therefore, an efficient drainage system is an important factor to improve these soils to be suitable for crop production in short term with low cost. The major concern in these soils is to maintain of adequate water infiltration and soil aeration. In arid and semi arid areas, agriculture depends mainly on irrigation where drainage is a necessary. Soil salinity build-up depends on irrigation water salinity, depth and salinity of water table, hydraulic conductivity, leaching fraction and frequency of irrigation (Amer *et al*.1996). Currently, mole drainage systems are most commonly used for surface water control in perched water table situation as a temporary subsurface drainage system for the reclamation of saline and alkaline soils (Spoor, 1993). Mole drain is formed by pulling a torpedo shaped object, which is attached to a vertical blade through the soil at a depth of 50-60 cm (Hathoot, 1987). Installation of sandy mole clearly magnified basic infiltration and decreased EC values of the soil (Abou EL-Soud *et al* 1996). Shams EL-Din *et al*.(2000) concluded that mole drain increased soil productivity and improved some soil physical and chemical properties. Mole drainage is widely used on heavy soils to improve productivity of pastures and crops (David, 2002). Subsoiling or the mole drainage seeks to lift and shatter the soil beds to induce improved structure and so improve the water movement to the permanent pipe system (Abdel-Mawgoud *et al*.2006).

Moling or subsoiling will enhance downward movement of irrigation water carrying of excess salts from surface layers (Moukhtar *et al*., 2002-a). Afterwards, subsequent irrigations will gradually reduce the salt content in groundwater and will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper ones (Moukhtar *et al*., 2002- b). Said (2003) concluded that the cumulative and basic infiltration rate of the treated soil by subsoiling markedly increased relative to the untreated one. He also, found that the treated soil resulted in a sharp decrease in the bulk density and penetration resistance in coincidence with a sharp increase in total porosity and macro pores relative to the untreated soils. The subsurface tillage treatments seemed to be effective in lowering soil salinity and sodicity. The reduction mean values of soil salinity up to 60 cm depth than control after three seasons were 4.65,4.74,3.72 and 3.85 dS/m for subsoiling, sandy mole, laser landleveling+subsoiling and laser landleveling + sandy mole, respectively (Aiad *et al*. 2012 and El- sanat *et al* 2012).

The amount of the irrigation water applied was increased with unfilling sand mole in the first season, while the second season took the opposite trend. Also, these values as well as the water productivity and water use efficiency were increased with decreasing mole spacing (Zamil 2012).

The superiority of sand constructed moles with 3m spacing since it led to the lowest values of both ECe and SAR (EL Sabry *et al*. 1992). The mole technique leached 53.67% of soil soluble salts while field ditch at spacing of 20m leached 46.74% of soil salts (Shams, El-Din 2001). The reduction of salinity after three years from experiment installation were 86.71, 96.81 and 98.76% for subsoiling, moling and subsoiling+ moling, respectively over the control (Anter *et al* 2008).

Wheat is one of the most important cereal crop used in human food and animal food in Egypt and all over the world. Recently, a great attention of several investigators has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption. Increasing wheat yield per unit area can be achieved by breeding high yielding varieties. Nitrogen is the most important nutrient in wheat and maize plants growth. The results showed that increasing nitrogen level up to 150 kg/fed. caused a significant increase in yield and its components (Zaki *et al*.2004). The increase in nitrogen level significantly increased yield components, biological and straw yields (Shafshak *et al* .2003). The increase in nitrogen levels from 80 to 110 or 140kg/fed., significantly delayed tasseling and silking, while application of 140kg/fed. gave the highest grain yield (El-Morshedy, 2002). Nitrogen uptake by maize crop highly significantly affected by application the recommended dose (90 kg N/fed) and 135 kg/fed. (Shabana, 2010).

This investigation is aimed to evaluate the effect of some soil management practices on some soil properties and yield of wheat and maize at North Delta.

MATERIALS AND METHODS

A field experiment was carried out during two successive seasons of (2008/2009 and 2009) at Sakha Agricultural Research Station Farm, Kafr EL-Sheikh Governorate to study the effect of mole drain and nitrogen fertilizer levels on some water relations and yield of wheat and maize, as well as, the productivity of salt affected soils. A split-split plot design with four replicates was used. Plot area was 2000 m^2 (100 m length and 20 m width). The location is situated at 31-07N latitude. 30-37E longitude with an elevation of 6 meters above the mean of sea level.

Experimental treatments were carried out as follow:

1- The main plots were occupied by nitrogen fertilizer levels; 75 kg N/fed (N_1), 90 kg N/fed (N_2) and 110 kg N/fed. (N_3).
2- The subplots were assigned to mole drain spacing; 2 m (S_1), 4 m (S_2) and 6 m (S_3)
3- The mole types were allocated in sub-sub plots; without subsoiling (control) (T_1), subsoiling (T_2) and sandy mole (T_3).

Mole drains and subsoiling lines were established at 60 cm depth and perpendicular to the open field drains.

Wheat cultivar (Sakha 93) was planted on November 22, 2008 and harvested on April 10, 2009. Maize (Hybrid 310) was planted on May 25, 2009 and harvested on September 15, 2009. All the agronomic practices were conducted according to the usual recommendations in the area.

The soil of the experimental field is heavy clayey and salt affected soils as shown in Table (1).

Soil samples were collected from all plots after harvesting of wheat and maize crops from four depths (0-15, 15-30, 30-45 and 45-60 cm) for some physical and chemical analysis.

Salinity level was determined in saturated soil paste extract according to Page *et al*. (1982).

* Exchangeable sodium percentage (ESP) was calculated according to Gazia (2001): $ESP= -0.8843+1.4107(SAR)-0.0133(SAR)^2$

Where SAR=Sodium adsorption ratio.

* Soil bulk density: was measured after harvesting of wheat and maize using the core sampling technique as described by Campbell (1994).
* Field capacity and wilting point were determined by using the pressure plate extractor with regulated air pressure (Garcia, 1978).
* Grain, straw yields (kg/fed.) and 100-grain weight (gm) were determined for both crops at maturity stage for different treatments.

Table 1. Some initial soil properties of soil the experimental field.

Soil depth cm	PH*	Particle size distribution			Texture grade	EC(dS/m) at 25 C° **	SARe **	ESP	Soil moisture characteristics			B.d (g/cm^3)
		Sand%	Silt%	Clay%					F.C%	P.W.P%	A.W%	
0-15	7.95	18.87	36.68	44.75	clay	6.98	13.12	15.33	42.8	22.91	19.89	1.18
15-30	8.11	17.87	34.75	47.38	clay	7.78	13.76	16.0	40.61	22.11	18.50	1.24
30-45	8.26	17.99	32.48	49.53	clay	8.69	14.56	16.84	39.63	21.35	18.28	1.29
45-60	8.38	17.12	31.70	51.18	clay	9.94	15.59	17.88	38.75	20.78	17.97	1.34
mean	8.18	17.96	33.90	48.21	clay	8.35	14.26	16.51	40.35	21.79	18.66	1.26

Measured in 1-2.5 soil water suspension** * determined in soil paste extract**

* Amount of irrigation water applied (m^3/fed) was measured by using cutthroat flume (30*90 cm) according to Early (1975). The total amount of water applied in including effective rainfall.
* Water consumptive use (CU) was calculated as m^3/fed according to Israelsen and Hansen (1962) according to the following equation:

$$Cu = \sum_{i=1}^{n=1} \frac{(\theta_2 - \theta_1)}{100} * Bd * d * 4200$$

Where:

n: number of irrigation.
θ_2: soil moisture content (%), two days after irrigation.
θ_1: soil moisture content (%), before the next irrigation.
Bd = soil bulk density (gm / c m^3).
d: depth of root zone in (cm).

* Water application efficiency (W.A.E) was calculated according to Israelsen and Hansen (1962) as follow:

$$W.A.E = \frac{\text{Total water stored in the effective root zone}}{\text{Total water applied}} * 100$$

* Field water use efficiency (F.W.U.E) was calculated according to Doorenbos and Pruitt (1975) as follow:

$$F.W.U.E\ (kg / m^3) = \frac{\text{Grain yield (kg/fed.)}}{\text{Water applied } (m^3/\text{fed.})}$$

* Crop water use efficiency (C.W.U.E) was calculated according to Abd El-Rasool *et al* (1971) as follow:

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

- Data of yield and its components were subjected to the statistical analysis according to Snedecor and Cochran (1982).
- Basic infiltration rate (Basic I.R): were measured before experiment and after harvesting of each crop in each treatment using double ring infiltrometer, according to (Garcia 1978). The rate at which a soil absorbs water usually decreases rather rapidly with time. After several hours, however, it usually becomes nearly constant. This is called basic infiltration rate (cm/hr.).

RESUELTS AND DISCUSSION

1- Yield and its components:

Tables (2-3) show the mean values and relative yield of wheat and maize as affected by nitrogen fertilizer, mole drain spacing and mole types. It could be noticed that nitrogen fertilization has highly significant effect on yields and yield components of wheat and maize, where N_3 was the best treatment. While, the lowest yields were obtained under N_1 level. However, the grain yield was increased by about 5.2 and 8.4 % for wheat and by about 2.7 and 5.2 % for maize, with N_2 and N_3 respectively, compared to N_1 level.

The data revealed that mole drain spacing highly significantly affected the yields and their components of both crops. So, mole drain spacing at 2m increased the yield of wheat and maize more than 4m or 6m spacing. Consequently, the grain yields of wheat and maize were increased with 2m spacing by about 2.4% and 3.6%, respectively, compared to that obtained with 6m spacing.The yield and yield components of wheat and maize highly significantly affected by mole types. Applying of subsoiling (T_2) or sandy moles (T_3) increased the grain yield of wheat by about 4.0 and 7.3% and increased grain yield of maize by about 6.4 and 10.9 %, respectively, over the control (T_1).

It is clear from the data also that the interaction between nitrogen fertilizer level, mole spacing and mole type highly significantly affect on yields and their components for wheat and maize crops.

Finally, it could be concluded that applying of subsoiling or sandy mole at 2 m spacing and N_3 level achieved the highest yields for wheat (2632 kg grain/fed. and 3680 kg straw /fed.) and maize (3380 kg grain /fed. and 5361 kg straw /fed.). These findings were in harmony with those obtained by Gazia *et al*. (1996), Shams El-Din (2001) and Aiad *et al* (2012).

Table 2. Effect of nitrogen fertilizer, mole spacing and mole types on relative yield and its components of wheat and maize crops.

treatment	wheat				maize		
	Grain	Straw	Bio.	1000 g.	Grain	Straw	100 g.
N1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N2	105.2	113.7	106.6	104.6	102.7	114.3	100.9
N3	108.4	122.2	116.1	109.3	105.2	126.8	101.5
S1	102.4	104.3	105.3	103.1	103.6	105.0	103.9
S2	101.6	100.7	101.5	101.6	102.0	102.6	101.8
S3	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T2	107.3	106.1	109.9	112.1	110.1	110.9	106.4
T3	104.0	99.1	104.4	111.1	107.9	106.6	104.5

N_1 = 75 kg N/fed N_2 = 90 kg N/fed N_3 = 110 kg N/fed
S_1 = 2 m spacing S_2 = 4 m spacing S_3 = 6 m spacing
T_1 = without subsoiling T_2 = subsoiling T_3 = sand y mole

Table 3. Yield and their components of wheat and maize as affected by different treatments.

Treatments	Wheat (2008/2009)				Maize (2009)		
	Grain yield kg/fed.	Straw yield kg/fed.	Biological yield kg/fed.	1000-grain weight (gm)	Grain yield kg/fed.	Straw yield kg/fed.	100-grain weight (gm)
Nitrogen fertilizer							
N1	2237c	2795 c	5032 c	55.7 c	3011 c	3871 c	64.2c
N2	2352b	3178 b	5367 b	58.3 b	3092 b	4422 b	64.8 b
N3	2426a	3416 a	5842 a	60.9 a	3167 a	4910 a	65.2 a
F-test	**	**	**	**	**	**	**
L.S.D 0.05	25.2	103.7	29.22	0.16	49.38	12.27	0.238
L.S.D 0.01	157.12	157.1	44.28	0.228	74.82	18.59	0.360
Mole spacing							
S_1	2364a	3210 a	5575 a	59.1 a	3142 a	4506 a	66.0 a
S_2	2343b	3099 b	5373 b	58.4 b	3095 b	4405 b	64.6 b
S_3	2308c	3079 b	5293 c	57.4 c	3033 c	4291 c	63.5c
F-test	**	**	**	**	**	**	**
L.S.D 0.05	9.69	60.29	9.26	0.074	46.73	6.61	0.166
L.S.D 0.01	82.6	82.6	12.68	0.102	64.03	9.06	0.227
Mole type							
T_1	2253 c	3076 b	5169c	54.1 c	2915 c	4158 c	62.4 c
T_2	2345 b	3049 b	5394b	60.1 b	3145 b	4433 b	65.2 b
T_3	2418 a	3264 a	5679a	60.7 a	3209 a	4612 a	66.5 a
F-test	**	**	**	**	**	**	**
L.S.D 0.05	15.15	71.09	13.12	0.059	6.38	0.174	0.174
L.S.D 0.01	94.67	94.67	17.47	0.079	8.51	0.232	0.232
Interaction							
N*S	**	**	**	**	ns	**	*
N*T	**	**	**	**	**	**	**
S*T	**	**	**	**	**	**	**
N*S*T	**	**	**	**	ns	**	ns

N_1 = 75 kg N/fed N_2 = 90 kg N/fed N_3 = 110 kg N/fed
S_1 = 2 m spacing S_2 = 4 m spacing S_3 = 6 m spacing
T_1 = without subsoiling T_2 = subsoiling T_3 = sand y mole

2-Soil salinity and sodicity:

Data presented in Table (4)) and Figs (1-3) show that application of mole drain filled with sand and subsoiling at different spacing seemed to be more effective in decreasing soil salinity and sodicity. The salinity (ECe) and sodicity (SARe and ESP) of the soil were increased markedly with increasing of soil depth.

It could be observed from the data that mole spacing at 2m surpassed other spacing in leaching salts. The mean values of ECe were decreased by 25.15, 18.8 and 12.93%, , and SARe were decreased by about 15.22, 13.04 and 6.87% , while the mean values of ESP were decreased by about 13.91, 11.92 and 6.23% with 2,4 and 6m mole spacing , respectively, comparing to their values obtained before planting. The subsoiling and sandy moles are more efficient in leaching soil salts than the control. The values of ECe were lowered by about 4.9, 14.7 and 23.4%, whereas the mean values of SARe were decreased by about 2.7, 8.7 and 11.3 %, while the mean values of ESP were decreased by about 2.4, 7.86 and 10.28 % from the control, subsoiling and sandy mole, respectively. Finally, it could be concluded that installation of sandy mole or subsoiling at 2m spacing achieved the highest leaching of soil salts. These results could be attributed mainly to that subsoiling or sandy mole form many lines with numerous effective capillary pores and big cracks extended from soil surface to subsoil layer (50-60 cm depth). All these cracks together break the soil matrix and encourage downward of water with the soluble salts. The life of these soil cracks may be found several months. Afterwards, regular subsequent irrigations will gradually reduce the salt content in groundwater at least when it is close to soil surface. The percolating water will constitute a temporary front preventing the saline groundwater in subsurface soil layers from linking with the upper one. These results are in agreement with those obtained by Shams El-Din (2001), Moukhtar *et al*. (2002-a), Moukhtar *et al*. (2002-b) , Aiad *et al* (2012) and El-Sanat (2012).

Basic infiltration rate (IR):

Data in Table (5) showed that the values of basic infiltration rate were decreased with the elapsed time which increased with all tested drain spacing to reach the basic infiltration rate. The mole drain at 2m spacing achieved the highest value of basic infiltration rate comparing to that obtained with 4 and 6m mole spacing or untreated soil. Such increase in basic infiltration rate may be due to the presence of better drainage condition with 2m drain spacing. These results are in agreement with those obtained by Antar *et al* (2008), Zamil, (2012) and El- Sanat (2012).

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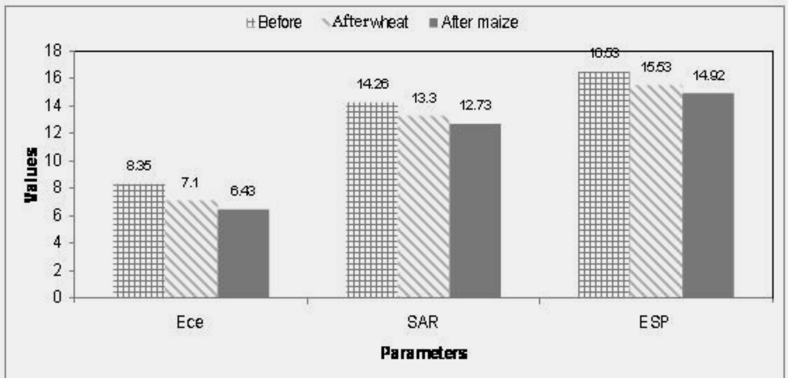

Fig 1: ECe ,SARe and ESP as affected by wheat and maize crops.

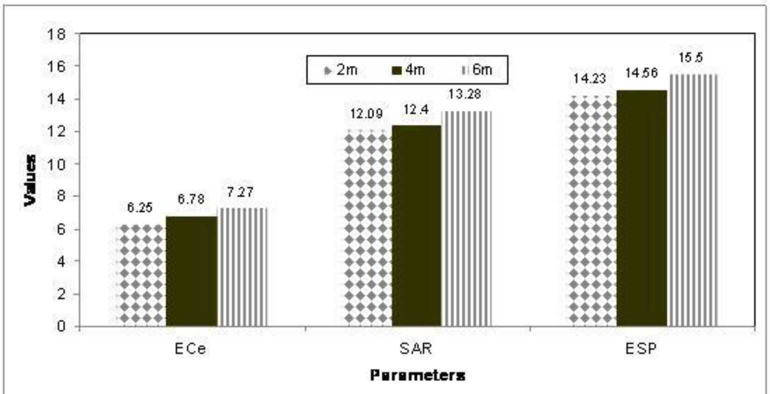

Fig 2 : ECe ,SARe and ESP as affected by mole spacing

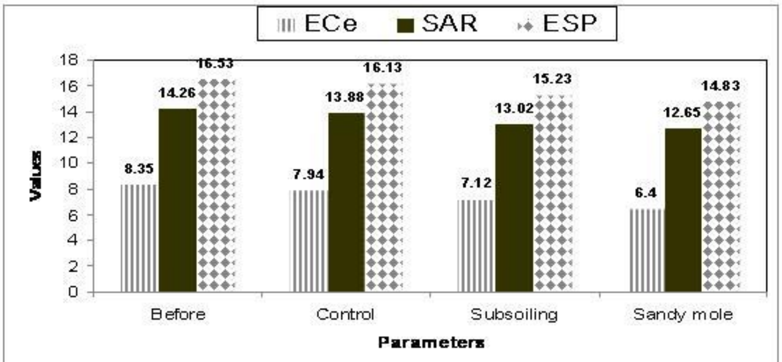

Fig 3 : ECe ,SARe and ESP as affected by mole type

Concerning the effec of mole type on infiltration rate, the data revealed that mole filled with sand are more effective on basic infiltration rate in the first growing season (wheat crop), while with maize crop in the second growing season the sandy mole and subsoiling are more effective than the control , where the value of basic infiltration rate is 0.6 cm/hr before planting and increased to 1 , 0.9 and 0.8 cm/hr with 2,4 and 6m spacing, respectively of sandy mole and increased to 1.4 , 1.1 and 0.9 cm/hr with 2 , 4 and 6m spacing, respectively for subsoiling after the first growing season. In the second growing season, the basic infiltration rate values are increased to 1.3 , 1.2 and 0.9 cm/hr with 2, 4 and 6m mole spacing, respectively for sandy moles and 1.5 , 1.3 and 1.1 cm/hr with 2., 4 and 6m spacing , respectively for subsoiling, while the values were decreased with the control.

Table 5. Basic infiltration rate (cm/hr) and cumulative infiltrated depth(cm) as affected by different treatments.

Mole type	Spacing(m)	Before treatments		After first season		After second season	
		Basic IR	Cumul.	Basic IR	Cumul.	Basic IR	Cumul.
Control		0.6	5.4	0.6	5.4	0.6	5.4
Subsoiling	2	0.6	5.4	1.4	8.2	1.5	9.3
	4	0.6	5.4	1.1	7.5	1.3	7.9
	6	0.6	5.4	0.9	6.7	1.1	7.0
Sandy mole	2	0.6	5.4	1.0	7.6	1.3	8.6
	4	0.6	5.4	0.9	7.2	1.2	8.2
	6	0.6	5.4	0.8	6.1	0.9	7.9

3 - Some water relations:

***Amount of irrigation water applied:**

Wheat: The average amount of irrigation water included the rainfall delivered to each treatment is presented in Table (6). The mole drain spacing at 6m received the lowest amount of water as compared to 2m and 4m spacing. Also, the control (without subsoiling) received the lowest amount of water applied compared to subsoiling and sandy mole. It is obvious from the obtained data that the highest values of water applied to wheat are obtained with subsoiling at 2m spacing (56.91 cm), while the lowest value was recorded with check treatment (48.94 cm).

Maize: It is clear from data in Table (6) that the highest value of water applied to maize was recorded with subsoiling at 2m spacing (83.94cm), while the lowest value was obtained with the control (73.3cm).These results are in agreement with those obtained by Gazia *et al* (1996) and Zamil (2012).

*** Water consumptive use:**

Values of water consumptive use by wheat and maize crops as affected by different treatments are presented in Table (6). It can be noted that the seasonal water consumptive use was increased with subsoiling at 2m spacing in both growing seasons. The highest values of actual water consumptive use by wheat were obtained by subsoiling and sandy mole at 2m spacing (30.43 and 54.11cm, respectively). While, the lowest values were obtained with the control under wheat cultivation and subsoiling at 6m spacing under maize (28.67 and 50.74cm, respectively). These results are in agreement with those obtained by Zamil (2012).

*** Water application efficiency:**

Data presented in Table (6) show that the water application efficiency values for wheat and maize were higher with mole drain at 2m spacing than that with 4 and 6m spacing. Also, water application efficiency with sandy mole was higher than that with subsoiling or the control. The highest value of water application efficiency was obtained with sandy mole at 6m spacing under wheat and maize (60.21% and (74.52 %, respectively). While, the lowest values of water application efficiency were recorded with the subsoiling at 2m spacing under wheat and maize crops (57.19 and 64.09%, respectively).

Table 6. Mean values of amount of water applied, stored , consumed and irrigation application efficiency% for wheat and maize under different treatments.

Treatments		wheat				Maize			
Mole spacing(m)	Mole type	Water applied (m^3/fed.) including rainfall	Water stored (m^3 /fed.)	Water consumed(m^3/fed.)	Irrigation application efficiency%	Water applied (m^3/fed.)	Water stored (m^3/fed.)	Water consumed (m^3/fed.)	Irrigation application efficiency%
2m	control	2055.65	1348.49	1204.10	65.60	3078.94	2238.14	2169.30	72.69
	Subsoiling	2390.3	1367.10	1298.86	57.19	3525.66	2414.76	2258.18	64.09
	sandy mole	2303.95	1440.64	1276.36	62.53	3479.78	2390.86	2272.50	68.70
mean		2374.13	1403.87	1287.61	59.86	3502.72	2402.81	2265.34	66.40
4m	Subsoiling	2245.49	1448.49	1286.30	64.51	3448.50	2393.42	2266.66	69.40
	sandy mole	2198.49	1435.75	1261.18	65.31	3376.84	2306.06	2203.24	68.29
mean		2221.99	1442.12	1273.74	64.91	3412.67	2349.74	2234.97	68.84
6m	Subsoiling	2145.69	1385.33	1249.60	64.56	3262.48	2322.90	2133.14	71.20
	sandy mole	2109.74	1396.94	1236.18	66.21	3197.80	2383.00	2179.76	74.52
mean		2127.71	1391.13	1242.89	65.38	3230.14	2352.95	2156.45	72.86
mean subsoiling		2260.49	1400.31	1278.25	62.08	3321.21	2377.03	2219.32	68.23
mean sandy mole		2204.06	1424.44	1257.91	64.68	3351.47	2359.97	2218.50	70.50

*** Field and crop water use efficiencies:**

Data in Table (7) revealed that the highest values of field and crop water use efficiencies were achieved with N_3 treatment for wheat grain (1.14 and 2.03kg/ m^3, respectively), and for maize grain (1.00 and 1.52 kg/m^3, respectively). The higher values of field and crop water use efficiencies may be due to higher yield obtained and less amount of water applied or consumed. These results are harmony with that obtained with Walter and Bishay (1992) and Zamil (2012).

Thus it can be concluded that application of mole drain technique at 2m spacing was more effective in leaching of salts from surface layer and achieve the highest grain yields of wheat and maize. On the other hand, mole drain at 6m spacing recorded highest value of water productivity.

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تـأثير بعض ممارسـات إ دارة التربـة ومستويات التسميد النيتروجينـى علـى بعض خواص التربة وانتاجيتها بشمال الدلتا

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أجريت تجربة حقلية بالمزرعة البحثية بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ لتقييم تـأثير نـوع الخدمـة (الحـرث العـادى , الحـرث تحـت التربـة وانفـاق الصـرف الرمليـة) و ابعـاد خطـوط الحـرث (2 , 4 , 6 متـر) و معدلات التسـميد النيتروجينـى (75 , 90 , 110 كجـم نيتـروجين /الفـدان) وذلـك علـى تحسين بعض خـواص التربـة وبعض العلاقـات المائيـة ومحصـول كـل مـن القمـح (موسـم 2008 – 2009) والذرة (موسم 2009) وذلك بالاراضى الطينية المتـاثرة بـالأملاح . وتـم استخدام تصـميم القطـع المنشـقة مـرتين مع أربعة مكررات حيث كانت القطع الرئيسية تمثل معدلات التسميد النيتروجينـى ومثلت ابعاد خطوط الحرث تحت التربة و أنفاق الرمل القطع المنشقة الاولـى , كمـا مثلت أنـواع المـادة المالئـة لأنفـاق الصـرف المـولى القطـع المنشقة الثانية.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :-

* أعطـى الحرث العميق علـى مسافة 2 متر بالتفاعل مع اضافة 110 كجم نيتروجين / فدان أعلـى محصـول لكل مـن القمـح (2632 كجـم حبـوب / فـدان , 3680 كجـم قـش / فـدان) والـذرة (3380 كجـم حبـوب / فـدان , 5361 كجم قش / فدان).
* لوحظ انخفاض قيم التوصيل الكهربـى للتربـة فـى الطبقـة السطحية بعد حصـاد كل مـن محصـولى القمـح والـذرة وذلك مقارنة بالطبقات العميقة.
* أدى إنشاء أنفاق الصرف بالرمل علـى مسـافة 2 متـر الـى غسيل الأمـلاح بالتربـة بكفـاءة مقارنـة بـالحرث تحت التربـة والحـرث العـادى (معاملـة المقارنـة) , و كانـت قيم الــ SAR , EC المتحصـل عليهـا بعد حصـاد القمح (6.35 ديسيسيمنز /م , 12.36 على التوالى) وبعد حصـاد الذرة (5.5 ديسيسيمنز /م , 11.1 علـى التـوالى) .
* أعلى قيم كفاءة استخدام مياه الرى للقمح (1.14 كجم حبوب / م^3) كانت مـع أنفاق الرمل علـى ابعـاد 6 متـر واضـافة 110 كجم نيتروجين / فدان , بينما كانت أعلى قيم كفاءة الرى المحصولية (2.3 كجم حبوب / م^3) مع أنفاق الصرف بالرمل واضـافة 110 كجم نيتروجين / فدان , بينمـا كانـت هذة القيم مـع محصـول الـذرة (1.0 , 1.52 كجم حبـوب /م^3 علـى التـوالى) وذلـك مـع معاملـة المقارنـة مـع اضـافة 90 كجـم نيتـروجين / فدان.
* خدمة تحت التربة على أبعاد 2 متر كان أكثر كفاءة فى التأثير على معدل رشح الميـاه بالتربـة مقارنـة بالخدمـة العادية حيث ادى إلى أكبر القيم يلية أنفاق الصرف بالرمل .

قام بتحكيم البحث

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Table 4. Mean values of ECe and SARe before planting and after harvesting of wheat and maize crops under different treatments

Crop	Depth (cm)	Before planting		Control		Mole spacing(m)											
						2				4				6			
						Mole type											
						Subsoiling		Sandy mole		Subsoiling		Sandy mole		Subsoiling		Sandy mole	
		ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR	ECe ds/m	SAR
After harvesting of wheat	0-15	6.98	13.12	6.75	12.75	5.97	12.09	5.18	11.20	6.18	12.26	5.93	12.01	6.35	12.43	5.80	11.90
	15-30	7.78	13.76	7.29	13.29	6.75	12.75	6.21	12.30	7.17	13.21	6.87	12.93	7.42	13.44	7.29	13.30
	30-45	8.69	14.56	8.61	14.53	7.02	13.07	6.50	12.60	7.58	13.60	7.05	13.10	7.98	13.95	7.46	13.50
	45-60	9.94	15.59	9.76	15.54	7.78	13.76	7.52	13.28	8.75	14.66	7.88	13.95	9.05	14.84	8.59	14.46
mean		8.35	14.26	8.10	14.03	6.88	12.92	6.35	12.36	7.42	13.43	6.93	12.99	7.70	13.67	7.29	13.29
After harvesting of maize	0-15	6.98	13.12	6.55	12.6	5.22	11.3	4.43	10.4	5.63	11.7	5.13	11.2	6.15	12.2	5.48	11.5
	15-30	7.78	13.76	7.11	13.2	5.81	11.9	4.67	10.7	6.38	12.5	5.98	12.1	6.92	13.0	6.65	12.7
	30-45	8.69	14.56	8.29	14.2	6.16	12.2	5.29	11.3	6.68	12.8	6.31	12.4	7.35	13.4	6.92	13.0
	45-60	9.94	15.59	9.15	14.9	6.54	12.6	5.82	11.9	8.34	14.2	6.59	12.7	8.71	14.6	8.14	14.1
mean		8.35	14.26	7.78	13.73	6.68	12.00	5.05	11.08	6.76	12.8	6.00	14.35	7.28	13.30	6.79	12.83

Table 7. Mean values of field and crop water use efficiencies (kg/m^3) as affected by different treatments under cultivation of wheat and maize crops

Treatments		Nitrogen fertilizer ***																				
		N_1							N_2							N_3						
		Mole spacing (m)																				
		cont.	2		4		6		cont.	2		4		6		cont.	2		4		6	
			S	M	S	M	S	M		S	M	S	M	S	M		S	M	S	M	S	M
Wheat																						
FWUE*	G	1.05	0.98	0.99	1.03	1.01	1.00	1.05	1.14	1.09	1.09	1.06	1.07	1.09	1.08	1.12	1.10	1.08	1.14	1.11	1.14	1.13
	S	1.26	1.59	1.19	1.23	1.22	1.27	1.25	1.43	1.42	1.43	1.39	1.38	1.43	1.40	1.50	1.54	1.52	1.58	1.55	1.60	1.58
CWUE**	G	1.79	1.80	1.79	1.78	1.77	1.83	1.80	1.95	1.90	1.90	1.86	1.87	1.88	1.86	1.91	2.03	1.95	1.99	1.94	1.95	1.93
	S	2.15	2.94	2.15	2.16	2.13	2.19	2.13	2.45	2.48	2.48	2.42	2.41	2.45	2.39	2.72	2.80	2.75	2.77	2.70	2.75	1.69
Maize																						
FWUE	G	0.91	0.92	0.90	0.91	0.92	0.96	0.94	0.93	0.94	0.92	0.94	0.94	0.98	0.97	1.00	0.96	0.93	0.94	0.95	0.99	0.98
	S	1.19	1.20	1.19	1.14	1.18	1.18	1.17	1.34	1.39	1.29	1.38	1.29	1.41	1.35	1.52	1.52	1.43	1.51	1.47	1.49	1.50
CWUE	G	1.29	1.43	1.38	1.39	1.40	1.47	1.40	1.32	1.47	1.41	1.43	1.44	1.49	1.45	1.42	1.49	1.43	1.43	1.45	1.52	1.44
	S	1.69	1.88	1.82	1.73	1.80	1.80	1.75	1.90	2.17	1.97	2.10	1.98	2.15	1.98	2.16	2.37	2.19	2.30	2.25	2.28	2.20

* FWUE = field water use efficiency ** CWUE=crop water use efficiency *** N_1 = 75 kg N/fed
*** N_2 = 90 kg N /fed *** N_3 = 110 kg N / fed