J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (7): 785 - 797, 2011

IRRIGATION WATER UTILIZATION AS A FUNCTION OF SOIL MECHANICS AND ITS PROPERTIES

El-Banna, E. B.; Z. I. Ismail; A. E. Abu El-Magd and M. A. El-Gamal.
Agric. Eng. Dept., Fac. Agric., Mansoura University.

ABSTRACT

An experiment was conducted for identifying the most efficient tillage method using the sub-soiling plough for enhancing some of physical properties of the heavy clayey soils. The experiment was conducted on a heavy clayey soil of an area 1800 m^2 located in Serewa village – Belqas – Daqahlia. This area divided into 4 adjacent plots, each one has a dimensions of (9m x50m) and was allocated only, for one treatment. The surface irrigation was the system applied and the amount of irrigation water added was equal for each plot (22.5m^3) and was applied at the same time for all plots. Furthermore, an accounting for the rate of water flux in mm/day beneath soil profile along subsequent ten days from saturation was the last objective of this research. Only, four treatments were involved in this research as (Treat.1): sub-soiling plough at 40cm depth with a lateral spacing of 150cm, (T2): sub-soiling plough at 60cm depth with a lateral spacing of 150cm, (T3): sub-soiling plough at 40cm depth with a lateral spacing of 300cm and (T4): sub-soiling plough at 60cm with a lateral spacing of 300cm. For all plots, the sub-soiling plough was followed by chisel plough at 20cm depth and laser-controlled leveller at the dead level. All the data obtained clearly indicated that, the second treatment (T2) achieved the highest mean value of soil infiltration rate (2.2 mm/h) over all treatments and the lowest mean values for the cone penetration resistance, water content and bulk density at the surface layer of soil profile after tillage (2.41 M.Pa), (17.74 % w/w) and (1.17 g/cm^3), respectively. Whereas, at saturation, it achieved the highest mean value of the water content (62.78 %w/w) and the lowest mean value of penetration resistance (.01 M.Pa). On the other hand, the mean value of the water content rested in the soil of the second treatment at the tenth day from saturation was (24.68 %w/w), producing the highest water flux (4.29 mm/day). Also, the second treatment achieved the shortest period of time needed until all amount of the deluge imposed on the soil surface after irrigation be completely infiltrated (20 h.).

INTRODUCTION

In Egypt, in Nile Valley and Delta, especially, northern Delta, it is known well that, the heavy clayey soil (which is classified as an imperfect or poor drained because of its low hydraulic conductivity <1mm/day, salinity, alkalinity) is the most spread type of soils, the most irrigation system applied is that surface irrigation and chiseling is the most tillage method used. As a result of these familiar farming practices and poor drainage conditions of the heavy clay soils, a considerable portion of the deluge of irrigation water added by the surface irrigation system is evaporated from the soil surface, especially, during the first sowing irrigation. Witney (1988) reported that, the water status being exist in the soil governs the rate of drainage and the rate of evapotranspiration. Hence, as the soil dries out, as a draining of additional water from the soil, becomes progressively more difficult. Thus, not regarding for this fact in the past has led to excessively high estimates of soil workdays. Bowles (1984) explained that, a distinction has been made between the water content determined in the laboratory on laboratory specimens and water content, which indicates the instantaneous field value (determined in situ).This later value is termed the natural water content of the soil and given the symbol (wn).Ibrahim (2004) defined available water as, the amount of water a soil holds between its condition at field capacity (at a negative apparent pressure of .1 to .33 bar) and at its permanent wilting point (at 15 bars). The total available water will vary from 25cm/m for silt loams to as low as 6cm/m for sandy soils. Also, Keller and Bliesner (1990) reported that, the total amount of soil water available for plant use in any soil is the sum of the available water holding capacities of all horizons occupied by plant roots. Witney (1988) explained that, the water storage capacity of the soil after deducting the water films held on the particle surfaces at the permanent wilting point is often called the antecedent soil moisture index.

Barnes (2000) reported that, the fine grained soil (silt or clay) usually behaves as a plastic or cohesive material since, a lump of such soil can have its shape changed or re-moulded without a change in soil volume or breaking it up. Those two properties (plasticity and cohesiveness) are found to be dependent on the amount and mineralogy of the fines and the amount of water present. Iqbal (1998) added that, if either liquid or plastic limit cannot be determined, the soil is termed non-plastic or NP. The plastic state of a natural soil is indicated by the liquidity index (LI). Asawa (2005) demonstrated that, the infiltration of water is the property of a soil which affects surface irrigation. It not only controls the amount of water entering the soil but also the overland flow. Infiltration is a complex process which depends on: soil properties, initial soil moisture content, previous wetting history, permeability and its changes due to surface water movement, cultivation practices, type of crop being sown and climatic effects. El-Banna and Helmy (1992) reported that, the soil bulk density also, can said to be wet density and dry density. Since, wet density refers to the total soil mass (the weight of soil particles plus water), whereas the term dry density only expresses the weight of dry solids in the soil sample. Michael (1986) explained that, when the bulk density of a medium to fine-textured sub-soils exceeds about 1.7 g/cm^3, the hydraulic conductivity value will be so low, the drainage may become difficult. Luo-XiWen, *et al.* (1997) stated that, the soil strength decreased by using a winged sub-soiling plough. Khalilian, *et al.* (1999) reported that, there was a significant reduction in cone index values at the top 30cm of the dry soil plots in comparison to the plots which were irrigated without tillage. Witney, *et al.* (1982) and El-Banna (1986) found that, the soil strength was related to the main physical and mechanical properties of the soil such as (cohesion, adhesion, angle of internal friction, soil metal friction, viscosity, elastic modulus and bulk modulus), (bulk density and water content), geometry of the probe and manner of the probe movement in the soil. El-Banna and Witney (1987) stated that, the cohesion is directly proportional to the clay ratio and inversely proportional to an exponential function of the soil water content. El-saadawy and abd El-latif (1998) showed that, the levelling under.1% ground surface slope achieved high water application efficiency (WAE). It is also,better to use 50m irrigation border length for obtaining the highest value of water utilization efficiency (WUE). El-Mowelhi, *et al.* (1995d) stated that, the traditional method of land levelling followed by the dead level treatment, received the highest amount of irrigation water, while at ground surface slope .1% treatment received the lowest amount of irrigation water.

The present research aimed to select the most efficient tillage method using the sub-soiling plough for enhancing some of physical properties such as the soil infiltration, water holding capacity and drainage conditions of the heavy clayey soils in Egypt, terminating a protection for a portion of the flooded irrigation water added by the first sowing irrigation from evaporation.

MATERIALS AND METHODS

Research headlines and soil sampling techniques in detail:

- In this study, it was need not for cultivating any crop or a plant coverage, since, the most significant quantity of irrigation water lost by evaporation is only from the first sowing irrigation. Furthermore, a tracing for that period of time elapsed until all amount of water added in irrigation be completely infiltrated from the soil surface, was involved in this research. Since, this elapsed time, was anticipated to be in a proportion to the different tillage treatments.
- Just before coming into the different treatments, five soil samples were taken by the hand auger at the three layers of soil profile for determining the initial water content of the soil and also, there were a five cores used for obtaining another five samples for determining soil bulk density at the same positions and layers of the last others taken by the auger.
- It was very significant for all levelling processes to be carried out at the dead level for all plots of the experimental field.

The equipments used in tillage and levelling operations: All tillage and levelling duties were conducted using the tractor Belarus (D243.1). Its technical specifications as in table (1):

Table (1): Technical specifications of the tractor used in tillage:

Model	D 243.1
Engine: Power, KW(Hp), No. of cylinders Cooling system Crank speed, rpm. Fuel injection system Fuel consumption rate, gm/Hp.hr	67.1 (90 Hp) 4 Water 2200 Direct injection 165
Length, mm.	3850
Wheel base, mm.	2370
P.T.O. speed rpm.	540/1000

All plots of the experimental field were tilled at 20cm depth using the mounted chisel plough two crossed times, after the tillage by the sub-soiling plough has been done (Table 2).

Table (2): The specifications of the mounted chisel plough:

No.	Items	Specifications
1	Model	M–7 H2 Raw
2	Manufacturing	El- Behera co. Egypt
3	Number of shares	7(4 fixed on the back row and three on the forehead)
4	Share spacing,cm	50
5	Total width, m.	1.75
6	Mass, kg.	365
7	Share angle, deg.	20°

The sub-soiling plough used: The tillage using sub-soiling plough was performed at a depth of 40cm. for the first and third plots with a lateral spacing of 1.50 and 3.00m. respectively, in-between each two adjacent tiles. But, for the second and fourth plots, it was conducted at 60cm. depth with a lateral spacing of 1.50 and 3.00m, respectively.

Table (3): The specifications of sub-soiling plough used:

Model	SO.GE.MA.
Manufacturing	Japanese
Mass, Kg	280
Number of shares	1
Length, m Width, m Height, m	1.00 1.80 1.20
power, Hp(Kw)	(52.23 KW)

The chemical analyses of the tested soil and irrigation water: A number of five water samples obtained from a positions extended along the irrigation water supply and at an approximate depth of 30cm below the water surface. Also, other number of five soil samples were collected randomly by the hand auger at three layers (20,40 and 60cm) from the whole area of the tested soil before coming into the different treatments. Both soil and water samples were brought to the soil and water research laboratory so that, Ec, SAR, Caco3 analyses can be determined using the procedures of Black *et al.* (1965).

Particle size distribution analysis: The analysis for separating soil assemblies was conducted using the international Pepette method based on Gee and Bauder (1986) using the hydrometer method and the sodium hexameta phosphate was the dispersing agent used.

Determination of soil bulk density (ρb): The soil bulk density was determined using the core method of Black (1965). Since, a number of five soil samples were collected from the tested soil by the cores of a size (53mm inner diameter by 50mm depth) and placed into an oven to be dried well at

105 °c for 24 hours. Hence, the bulk density was calculated using the following formula:

$$\rho b = \frac{Ws}{Vt} \quad \text{--------- (1)}$$

Where:

ρb = soil bulk density (g/cm³); Ws = weight of dried mass, g;
Vt = total volume of soil mass, cm³.

Determination of soil penetration resistance: The standard cone penetrometer was used to obtain soil strength values by direct measuring in the experimental field at three depths (20, 40, 60cm.) of soil profile and also, at five positions were randomly selected over the soil surface. Readings of the cone penetrometer were recorded before and after tillage and along subsequent ten days after irrigation. The model of the cone penetrometer used was S4612, C.O.E. type. It is furnished with a calibrated proving ring, handle extension, two cones and a calibration chart.

Soil water content:

The soil water content was determined for that five soil samples which were collected by the hand auger of a 7cm diam. at (20, 40 and 60cm) depths of the tested soil using the laboratory procedure of the gravimetric method of ASAE (1978):

$$w = \frac{Ww}{Ws} X100 \quad \text{----------- (2)}$$

Where: w = water content (w/w) %; Ww = weight of water, (g);
Ws = weight of the dried soil, (g).

Determination of soil infiltration rate: The infiltration rate was determined over five sites before and after tillage using the standard test of ASTM (2003) using the double ring infiltrometer. This device has two cylinders or rings of a size (the inner ring of 30cm diameter, the outer one of 60cm diameter and both the two rings of 50cm height).

The model equation used for soil water flux computations:

The soil water flux through soil profile in (mm/day) for each treatment along subsequent ten days from saturation was calculated using the final form of the following equation for El-Banna (1993):

$$Qr = e \quad K \ln \theta n\text{-}1 \quad \text{----------- (3)}$$

Where:

Qr = drainage flow, mm/day;
θn–1 = water content on previous day, mm;
K = hydraulic conductivity, mm/day, (It was statistically analyzed previously for different soil types by El-Banna 1993).

RESULTS AND DISCUSSION

Table (4) :The soil fractions (%) and plastic limit data:

Soil fractions			Texture class	Plastic limit (%)
Clay %<.002	Silt % .002 - .02	Sand % > .02		
68.1	19.92	10.98	Heavy clay	42.74

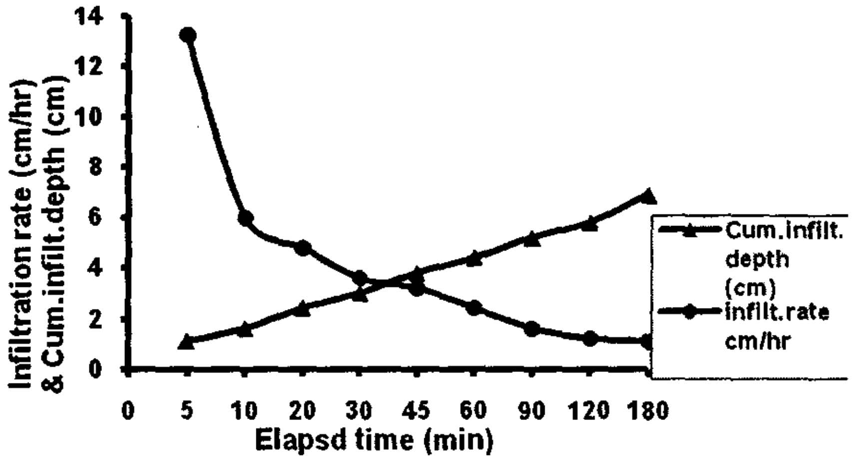

Fig.(1): Cum. infilt. depth (cm.) and infiltration rate (cm/h) plotted against time (min.) for the whole area of the tested soil.

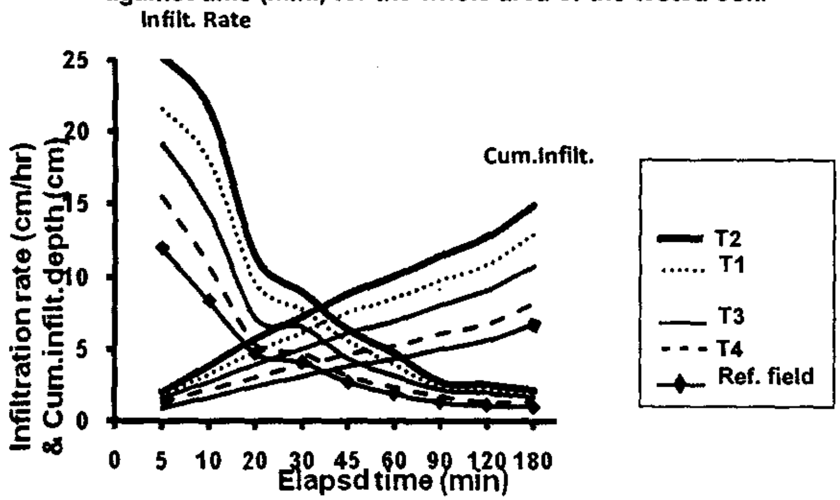

Fig.(1.1): Cum. infilt. depth (cm.) and infilt. rate (cm/h) plotted against time (min.) for all treatments and for the reference field after tillage.

Referring to, the relationships plotted in figures (1and1.1) for the whole area of the tested soil before tillage and for all plots after tillage. The mean value of the basic infiltration rate obtained from the whole area of the tested soil before tillage was the lowest one (1.1cm/hr) under all the mean values obtained after tillage. This value of the basic infiltration rate of the experimental field before tillage, is essentially, appears to be normal, since, the soil before tillage is generally, anticipated to be more compacted than after. Whereas, the mean values obtained from all plots of the tested soil after tillage, when compared to each other, the second treatment (T2) recorded the highest mean value (2.2cm/hr) over all treatments and the third treatment (T3) recorded the lowest value among them (1.4 cm/hr) but when the mean values of the four plots were compared to the other of the reference field, the latter recorded the most little one among them (1.2 cm/hr).Those preceded mean values and the differences among the different treatments found to be reflected by the same manner in fig.(3.2).Since, the plotted curve of the T2 found to be at the highest position over all other plots of the different treatment and reference field.

Soil penetration resistance:

Table (5): The mean values of soil penetration resistance for the experimental field before and after tillage.

Time of reading	Treatments	Soil strength in M.pa.at a depth:		
		20cm	40cm	60cm
Before tillage	(The whole area of the tested soil)	2.63	2.36	2.13
After tillage	T1	2.44	2.16	1.90
	T2	2.41	2.13	1.87
	T3	2.49	2.22	1.95
	T4	2.46	2.19	1.92
	Ref. field	2.52	2.25	1.98
At saturation	T1	.012	.014	.016
	T2	.01	.012	.014
	T3	.015	.017	.019
	T4	.013	.015	.017
	Ref. field	.017	.019	.021

Considering, the data obtained of cone penetration resistance in the previous table (5). It was clearly shown that, the mean values measured for the whole area of the tested soil before tillage, were significantly larger than of the others obtained for all treatments after tillage along the three studied layers of soil profile. On the other hand, after tillage, when each treatment was compared to each other, it was noticed that, the third treatment (T3) recorded the highest mean values among them (2.49, 2.22 and 1.95 M.pa.) but the lowest values were obtained from the second treatment (2.41, 2.13 and 1.87 M.pa.). Generally, all values of the soil strength obtained from all treatments indicate that, all the deep tillage treatments using sub-soiling plough caused the sever cohesion known well for the heavy clayey soil when dry to be loosened up, resulting in, at the same time, a more enhancement for its bulk density and porosity.

Considering, fig. (2), the second treatment recorded the lowest mean value at the first day from saturation (.079, .023 and .012M.pa.) for the three studied layers, respectively and also, along the subsequent ten days from saturation under all the different treatments. Also, as in fig. (3.3), its plotted curve, shown to be placed at the lowest position under all the different treatments. On the other hand, the third treatment achieved the highest mean values (.18, .132 and .077m.pa.) at the first day from saturation and its plotted curve found to be at the highest position and to a much more high the reference field is.

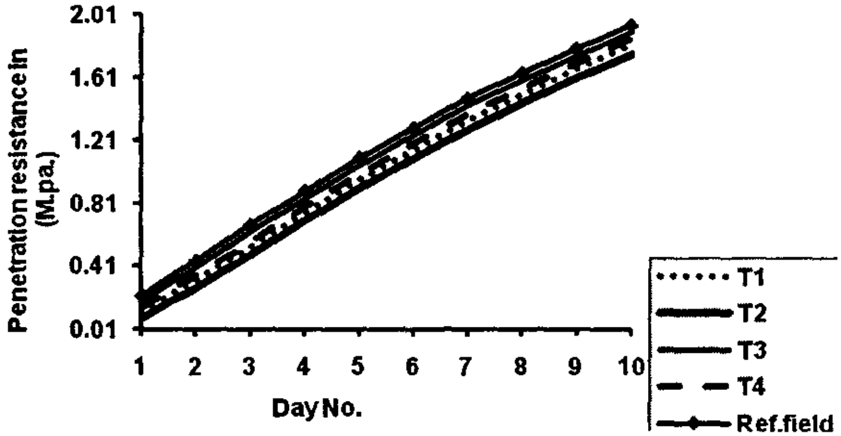

Fig. (2): The mean values of penetration resistance in (M.pa.) at 20cm depth plotted along subsequent ten days from saturation for all treatments.

The soil water content:

The data recorded in table (6) for the mean values of soil water content calculated as % (w/w) and associated bulk densities, it is clearly noticed that, the water content values obtained for the whole area before tillage along the three considered layers of soil profile were generally, higher than those obtained from all plots after tillage.

Also, as shown in table (6), relating to the different treatments after tillage, when compared to each other, it can be generally seen that, the second treatment (T2) possessed the lowest mean values (17.74, 19.93 and 21.32 %w/w for layers A, B and C, respectively), but the highest ones were obtained from the third treatment (T3) (20.64, 22.83 and 24.22 %w/w for layers A, B and C, respectively) and the mean values of the first treatment (T1) (18.84, 21.03 and 22.42 %w/w for layers A, B and C, respectively) were slightly lower than the fourth treatment (T4) (19.44, 21.63 and 23.02 %w/w for layers A, B and C, respectively).

Table (6): The mean values of soil water content % (w/w) and bulk density (g/cm³) for the whole area of the tested soil before tillage and (for all treatments and reference field) after tillage:

Time of sampling	Treatments	Layer in cm.	Water cont. % w/w	Bulk dens. g/cm³
Before tillage	The whole area of the tested soil	0 – 20	22.58	1.22
		20 – 40	24.77	1.30
		40 – 60	26.16	1.32
After tillage	First plot (T1)	0 – 20	18.84	1.18
		20 – 40	21.03	1.28
		40 – 60	22.42	1.34
	Second plot (T2)	0 – 20	17.74	1.17
		20 – 40	19.93	1.27
		40 – 60	21.32	1.30
	Third plot (T3)	0 – 20	20.64	1.19
		20 –40	22.83	1.29
		40 – 60	24.22	1.33
	Fourth plot (T4)	0 – 20	19.44	1.18
		20 – 40	21.63	1.28
		40 – 60	23.02	1.31
	Ref. field	0 – 20	21.46	1.18
		20 – 40	23.65	1.31
		40 – 60	25.04	1.33

The plotted curves in fig. (3) also, were in harmony with the preceded mean values recorded in table (13) since, the plotted curve of the second treatment shown to be at the lowest position beneath all the plotted curves but, of the third treatment inversely, at the highest position over all treatments and to a much more high for the reference field which achieved mean values of (21.46, 23.65 and 25.04 %w/w for layers A, B and C, respectively).

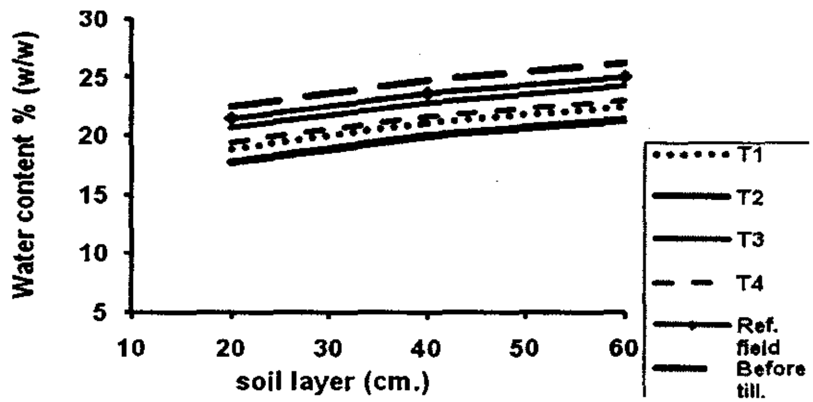

Fig. (3): The mean values of soil water content % (w/w) through the studied layers of soil profile for (the whole area before tillage) and (for all treatments and reference field) after tillage.

A tracing for the soil water flux under different tillage treatments:
The soil water flux term is related mainly to the conception of drainage co-efficient which was subsequently derived from the soil hydraulic conductivity computations using Darcy´s law.

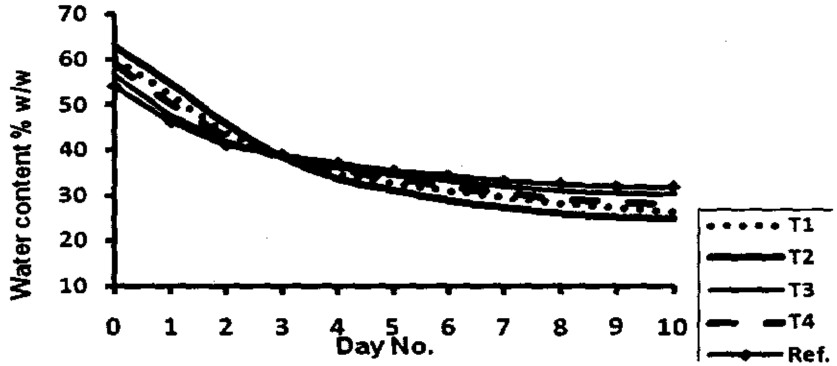

Fig. (4): The water content %(w/w) plotted against day No. through the top layer of soil profile and along subsequent ten days from saturation for all treatments and also, for the reference field.

The plotted curves in fig. (4) indicate that, when the soil water flux only through the top layer for all treatments is compared, it found that, the second treatment (T2) recorded the highest mean value of the steady state rate of soil water flux at the tenth day among them (6.57 mm/day). On the other hand the third treatment (T3), inversely, possessed the lowest mean value among them (5.37mm/day) also, at the day (No.10). It can be also shown, there is a slight deference between both the two treatments (T1 & T4). Since, the mean value of the first treatment (4.59mm/day) was slightly higher than of the fourth treatment (4.83mm/day).

The plotted curve of the second treatment is placed at the highest position at saturation but, as a result as its higher rate of drainage, it changed rapidly to be placed at the lowest position since, its mean value of the water content remained in the soil at the tenth day (24.68%w/w) became the lowest one among the different treatments which subsequently, produces the highest drainage rate as mentioned above. It should be noticed that, the lower numerical value of the soil water flux for any treatment means that, the drainage is reached to its steady state condition at a lower value of the water content but the soil water flux then, is being described as a higher. Thus, the plotted curve of the second treatment shown to be under all of the other treatments, throughout the ten days after irrigation.

Conclusion

As a main points extracted from the preceded discussion, it can be noticed well that, the soil of the second plot (T2) which was tilled using a sub-soiling plough at 60cm depth with a lateral spacing of 150cm, recorded the lowest mean values of the water content after tillage among the different deep tillage treatments of this study (17.74 for layer A, 19.93 for layer B and 21.32 for layer C %w/w).

Inversely, it achieved the highest mean values of the water content at saturation (62.78 for layer A, 64.89 for layer B and 66.29 for layer C %w/w) and also, it achieved the highest mean values of the steady state water flux at the tenth day from saturation (4.29 for layer A, 5.31 for layer B and 6.57 for layer C mm/day) over all plots of the experimental field. Since, the mean values of the water content obtained from the reference field were (21.46 for layer A, 23.65 for layer B and 25.04 for layer C %w/w), (54.03 for layer A, 56.14 for layer B and 57.54 for layer C %w/w) after tillage and at saturation, respectively, and also, the mean values of the steady state soil water flux obtained from the reference field at the tenth day from saturation were (5.57 for layer A, 6.79 for layer B and 7.94 for layer C mm/day). Thus, it can be said that, those results obtained from the second treatment would have been shown to be significantly larger than the others obtained from the reference field (control field), if a comparison was occurred among them. Also, the period of time needed or the time elapsed until all the deluge of irrigation water imposed on the soil surface for the second treatment was the shortest one among all treatments. Since, through a visually tracing for the irrigation water flooded, this elapsed time was appreciated to be 20 hours for the second treatment and (28, 32 and 40 hours) for the first, fourth and third treatments, respectively, but for that plot of the soil which was selected apart to be as a reference or as a control field, it was approximately two days. So, within the previous data, it was clearly shown that, in such type of the heavy clayey soils, the deep tillage applied in the second treatment is the most effective manner using the sub-soiling plough for enhancing such soil physical properties attached to the soil-water relationships and at the same time, if any increase occurred in tillage depth over 60cm or any lateral spacing narrower than 150cm can cause an inverse action in the process of irrigation water conservation, since, an excessive water flux through soil profile than permissible, then, would be occurred.

REFERENCES

Asawa, G. L. (2005). Irrigation and water resources engineering. Chapt. (Soil water relations and irrigation methods), pp: 92 – 120. Published by New Age International (P) Ltd., 4835/24, Ansari Road, ASAE, (1978). Agricultural machinery management data. Agric. Engineering year book, ASAe, St. Joseph, MI 49085.

ASTM, (2003). ASTM, (D3385-03). Standard test method for infiltration rate of soils in field using double-ring infiltrometer. Annual book of ASTM standards 04.08. Amer. Soc. Testing Materials, West Conshohocken, PA.

Barnes, G. E. (2000). Soil mechanics: Principles and Practice (2nd edition). Chapter: Soil description and classification, pp: 25 – 32. First published 2000 by MACMILLAN PRESS LTD.

Black, C. A. (1965). Methods of soil analysis. Amer. Soc. Agron. Inc., Madison, Wisconsin, USA.

Bowles, E. (1984). Text book; (Physical and geotechnical properties of soils) (Second ed.).Mc Graw-Hill book Co., Singapore for manufacture and export.ISBNO-07-006772-4Chapt.(2):pp.26 – 63.

El-Banna, E. B. (1986). Agricultural machinery selection: Soil strength and operational timeliness. Unpublished Ph.D. thesis, Edinburgh Univ., U. K.

El-Banna, E. B. (1993).Moisture tension and hydraulic conductivity in agricultural soils. Misr J. of Agric. Eng.Vol.10 No. (4): pp. 722 –737.

El-Banna, E. B. and M. A. Helmy, (1992). Influence of precision tillage systems on soil compaction, power requirements and wheat crop yield. Misr J. of Agric. Eng., Vol. 9 (4): pp. 537 – 558.

El-Banna, E. B. and Witney, B. D.(1987).The cone penetration resistance equation as a function of soil moisture content, soil specific weight and clay ratio. J. Terramech. 24(4): 41 – 56.

El-Mowelhi, N. M.; M. S. Abo Soliman; S. A. Abd El-Hafez, and E. A. Gazia, (1995d). On farm water management in soils of Kafr El-Sheikh. IV: Evaluation of land leveling practices. Soil and Water Res. Int., Agric. Res. Center, Conf. On farm irrigation and Agroclimatology, 2 – 4 January, 1995. Dokki, Egypt. pp. 147 – 186.

El-Saadawy, A. M. and Z. Y. Abd El-latif, (1998).Rational application of water through land leveling.Misr J. Agric. Eng., 15(2): 304 – 312.

Gee, G. W. and Buder, J. w. (1986).Particle size analysis in methods of soil analysis. C. E. Klute, A. (ed.) Part 1. Agron., 9,15: 383 – 409. Amer. Soc. Agron. Maison, Wisconsin, USA.

Hillel, D. (1982). Introduction to soil physics. Academic Press, San Diego. Ibrahim, M. M. (2004). Computer-aided mapping irrigation scheduling. Agric. Eng. Dept., Faculty of Agric., Mansoura Univ. Ph.D. Thesis, pp. 19 – 29.

Iqbal, H. (1998). A textbook of (Geotechnical engineering). Chapter (Physical properties of soils), pp: 11 – 15. Published by Asoke K. Ghosh, Prentice-Hall of India Private Limited, M-97, Connaught Circus, New Delhi-110001.

Keller, J. and R. D. Biesner, (1990). Sprinkler and trickle irrigation. An avi book, Van Nostrand Reinhold, New York, 652P.

Khalilian, A; M. J. Sullivan; R. R. Hallman; W. B. Smith; P. Dugger, (ed.) and D. Richter, (1999). The effects of tillage and tape depth placement in drip irrigation system.1999 Proceedings Beltwide Cotton Conferences, Orlando, Florida, USA, 3 – 7 January., (1): 384 – 387.

Luo, Xi Wen; Y. G. Shao; G. Q. Qiu, and H. B. Wen, (1997). The application of soil deep loosening technique in sugarcane production. Transactions of the Chineese Society of Agricultural Machinery., 28 (1): 39 – 42.

Michael, A. M. (1986). Text book; (Irrigation; theory and practice) Vani Educational Books a division of Vicas Publishing House Pvt Ltd. Regd. Office: 5 Ansari Road, Chapter (7): pp. 448 – 584.

Witney, B. D. (1988).Choosing and using farm machines.Text book (first publ.1988).Chapter: (Soil, Weather and Workdays), pp: 205 – 255.

Witney, B. D.; K. Eradat Oskoui, and R. B. Spears, (1982). A simulation model for predicting soil moisture status. Soil and Tillage Res., 2: 67– 80.

ترشيد إستخدام مياه الرى كداله فى ميكانيكا التربه وبعض الخواص الطبيعيه

الشحات بركات البنا، زكريا إبراهيم إسماعيل، على السيد أبو المجد و معتز عبد الغنى الجمل.
قسم الهندسه الزراعيه– كلية الزراعه – جامعة المنصوره.

حيث أن الأراضى الطينيه الثقيله تشغل مساحات كبيره فى وادى النيل والدلتا خصوصا فى شمال ووسط الدلتا، هذه الأراضى تتصف بسوء الصرف الناتج غالبا عن ارتفاع مستوى الماء الأرضى، كما أنها تتصف بالإلتصاق عند الإبتلال والتماسك الشديد عند الجفاف الأمر الذى يؤدى بدوره إلى التسرب البطىء لمياه الرى من سطح التربه مما يؤدى فى نهاية الأمر إلى بقاء فيضان مياه الرى على سطح التربه لفتره من الزمن تمتد من يومين إلى ثلاثة أيام خصوصا مع إستعمال نظام الرى السطحى الشائع جدا فى مصر فيحدث فقدان لجزء من هذا الفيضان بالبخر. لذا كان الهدف من إجراء هذا البحث هو إختيار أنسب طرق الحرث باستخدام المحراث تحت التربه التى تؤدى لتحسين الخواص الفيزيائيه للأراضى الطينيه الثقيله خصوصا (سعة الإحتفاظ بالمياه وظروف الصرف) بما يؤدى فى النهايه إلى حماية جزء من مياه الرى المتجمعه على سطح التربه من التبخير بعد أداء رية الزراعه الأولى التى تضاف دائما على أرض خاليه من أى زراعات بطريقة الرى السطحى كما هو معروف فى مصر.

هذا البحث تم تنفيذه على مساحة ١٨٠٠م مربع من أرض طينيه ثقيله تقع فى قرية سريوه التابعه إداريا لمركز بلقاس – محافظة الدقهليه.هذه المساحه تم تقسيمها إلى أربع أقسام متساويه بحيث لكل قسم (٤٥٠ م٢) ذو أبعاد (٩ × ٥٠م). قطاع التربه تحت الدراسه تم إختياره ليكون بعمق ٦٠سم مقسم إلى ٣ طبقات (٢٠، ٤٠، ٦٠سم) وذلك مع كل الأقسام على طول البحث. أيضا تم تخصيص حقل مرجعى بمساحة ٤٥٠ م٢ بالقرب من أرض التجربه حيث ترك للمارسات الزراعيه الطبيعيه لمقارنة نتائج المعاملات المختلفه لأرض التجربه.

المعاملات التجريبيه: الحرث بالمحراث تحت التربه على عمق ٤٠سم مع ترك مسافه جانبيه بين الخطوط ١٥٠سم للمعامله الأولى، أما الثانيه فكان عمق الحرث ٦٠سم مع نفس المسافه الجانبيه ١٥٠سم، أما الثالثه فكان عمق الحرث ٤٠سم مع ترك مسافه جانبيه ٣٠٠سم، أما الرابعه فكان عمق الحرث ٦٠سم مع ترك مسافه جانبيه ٣٠٠سم. فى كل معامله تم إستخدام المحراث الحفار على عمق ٢٠سم مرتين متعامدتين بعد المحراث تحت التربه ثم أجريت التسويه على الأفقى تماما.

من خلال القيم المتوسطه للقياسات الفيزيائيه المختلفه نستنتج أن طريقة الحرث التى نفذت فى المعامله الثانيه (الحرث بالمحراث تحت التربه على عمق ٦٠سم مع ترك مسافه جانبيه ١٥٠سم ما بين الخطوط) أدت للوصول لأعلى معدل من تحسين خواص التماسك الشديد المعروف للأراضى الطينيه الثقيله، حيث حققت أعلى قيمه للتسرب2.2mm/hr وأقل قيم لمقاومة الإختراق والمحتوى الرطوبى والكثافه الظاهريه بعد الحرث(2.41M.pa), (17.74 % w/w), (1.17g/cm³) على التوالى. أما عند التشبع فكانت (.01 M.pa), (62.78% w/w), (1.17 g/cm³). أيضا بتتبع القيم المتوسطه لمعدلات الصرف اليومى على مدى عشرة أيام بعد الرى نجد أن المعامله الثانيه حققت أقل محتوى رطوبى متبقى فى التربه فى اليوم العاشر 24.68 %w/w الذى يدل على أعلى معدل صرف (4.29 mm/day). أيضا المعامله الثانيه حققت أقصر فتره زمنيه حتى تسرب فيضان مياه الرى (20 hr).

قام بتحكيم البحث

أ.د / ماهر محمد إبراهيم عبد العال	كلية الزراعة – جامعة المنصورة
أ.د / محمود علي محمد	كلية زراعة شبين الكوم – جامعة المنوفية