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Effect of Tillage Implements on The State of Compaction in Different Soils

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THE CURRENT study was conducted to evaluate the effect of different plow type i.e., chisel (CH); subsoiler (SS); subtiller (ST), on the state of soil compaction in different soils. These soils located at West Nubaria (site 1,2) and Maryut (site 3) areas representing various textural class, calcium carbonate content and compacted layers. Bulk density, total porosity, macropores, penetration resistance and infiltration characters were used for evaluating the effect of the studied tillage implements on the state of compaction of the studied soils.

The obtained results could be summarized as fallows : 1-The comparative efficiency of plow types on reducing bulk density and soil strength simultaneous with increasing total porosity and macropores of the compacted soil could be arranged in the order: subtiller > subsoiler > chisel for site (1) and subsoiler > subtiller > chisel for site (2) and site (3).From the above mentioned results, it could be concluded that subsoiling plows, especially subtiller for the relatively coarse textured soil and subsoiler for the relatively fine textured soil, mitigates the subsurface compacted layer at the limits of the plowing effective depth. 2-Cumulative and basic infiltration rate of the tilled soil by deep plowing markedly increased relative to the non tilled soil (control). 3-The data clarify that applying subsoiling plows loosen the subsoil compacted layer, consequently increases the vertical flow of water. On the other hand, the dimensions of horizontal wet front decreased in the plowing treatments as a result of loosening the subsurface layer relative to the control. With regard to soil moisture profile following infiltration test,the three specific zones, characterize the pattern of soil moisture distribution were detected. The obtained results also revealed that (SS) and (ST) plowing result in an appreciable increase in soil moisture content especially below the surface 20 cm layer of the soil profile.

Keywords: Tillage implements, Subsoiling, Physical properties, Basic infiltration rate.

In agriculture, soil compaction generally refers to the negative aspects of volume decrease and deformation of soil by anthropogenic causes, especially field traffic which often is not adapted to soil type, structure and water content (Horn and Baumgartl, 2000). The detrimental impact of soil compaction is of increasing concern. Such effects were reported by many investigators in a number of ways; decreased plant growth, restricted root growth, reduced soil aeration, reduced water infiltration, minimize internal drainage, and thereby the effectiveness of drainage system, increased the machine amortization and energy costs for tilling the compacted soil, as well as many other economical and environmental consequences on agricultural production (Soane and Van Ouwerkerkt, 1994, Hillel, 1998, Scott, 2000 and Sumner, 2000), Soil compaction problems can be alleviated and remedied via proper agronomic and tillage practice.These practices depend upon soil condition, type of machine and the grown crops.

In the current study, the effectiveness of deep plowing on ameliorating compaction of soils sites differs depending on their characteristics and management practices. The soils are located in:

i) West Nubaria site 1 and 2, where relatively higher levels and sizes of tillage tools are used,

ii) Maryut, site 3 located in the Agricultural Experimental Station of the Desert Research Center (DRC).

Due to the fact that compaction changes the pore size distribution, infiltration test was used also for evaluating the remedial effect of the employed plows.

Material and Methods

Three sites characterized by the presence of a subsurface compacted layer in representative soil profiles, were selected in two locations.The first and second sites are located at West Nubariá, where advanced tillage machines are used and the third site is locate at Maryut, in the Experimental Station of D.R.C.

For all sites representative soil samples were collected from the various horizons and analyzed to determine the physical and chemical properties of the soils.

The applied treatments include two systems of plowing as follows:

1. Shallow plowing by chisel plow with 7 shares for two passes at 20 cm plowing depth (CH).

2. Deep plowing to breakdown and disrupt the compacted layer by two types of plows, namely subsoiler (SS) and subtiller(ST) plows. The first plow type has one share and plows up to 80 cm depth; the second type has 5 shares and plows to 70-cm depth. For all treatments, a disc harrow was used to break out the large clods and crumbles as well as to refine the coarse soil condition.

For all the studied sites the remedial effect of applied tillage treatment was evaluated using the following measures:

a) Penetration resistance (PR) at the different depths of the representative profile of the studied sites using an electrical penetrologger as described by Klute(1986).

b) Soil bulk density (BD) of the different layers of the soil profile before and after the applied treatments using the core-sampling technique as recomend by Campbell (1994).

c) Infiltration tests for the experimental plots representing the different treatment using the double ring infiltrometer as described by Klute (1986).

At the end of each test, the dimensions of the wetted soil profile were measured and samples representing the different zones of such wet profile were collected to determine soil moisture distribution for the studied treatments.

The particle size distribution, total soluble salts, pH and soluble cations and anions of saturated soil extract and total carbonate were determined using the standard methods described by Richards (1954). Pore size distribution was calculated using the formula recommended by De Lenheer and De Boodt (1969).

The experimental treatments were statistically analyzed using randomized complete blocks (Steel and Torrie, 1980).

Results and Discussion

Soil characteristic

The analytical data of the different layers of the representative profiles of the studied sites are given in Table 1. The results reveal that the soil of (site 1) west Nubaria is sandy loam calcareous, non-saline and non-alkali class loam through the profile. Values of bulk densities range between 1.50 and 1.61 Mg/m^3 with a highest value for the second layer (22-50 cm). Furthermore, the obtained data show the soil strength of each layer expressed by penetration reading (PR) at soil moisture equivalent to the permanent wilting percentages, range between 1.76 and 2.72 Mpa with the highest value for the second layer of the soil profile.

In this respect, it is stricking to note that penetration resistance (PR) is highly dependent on the soil moisture content at time of measurement (Afifi, 1974 and Hakansson and Voorhees, 1997). Therefore, for each layer, the statistical regression analysis were carried out between the two variables. Thereafter and in order to compare the state of compaction in the different layers of the studied profiles the obtained regression equations were used for estimating the (PR) at the moisture content corresponding to the (PWP) of such layers. As the penetration resistance (PR) is an integrated indication of soil compaction and the value of PR>2.OMpa is generally considered to severely restrict root growth, (Glinsk and Lipiec, 1990), so the data indicate that the second layer of this soil profile deem a compacted layer. Regarding the site 2 at West Nubaria the data point out that the soil is sandy clay loam calcareous, non saline and non alkali up to 80 cm depth and the values of bulk densities range between 1.37 and 1.46 Mg/m^3, it is also evident that the second layer have 3.38 Mpa. As regard to the soil of site (3) at Maryut, the obtained results indicate that the soil is calcareous non saline-non alkali and texture ranges between sandy loam for the surface layer (0-30 cm) depth and clay loam for the subsurface layers (30-60 m), (60-80 cm depth). Bulk density values vary from 1.39 to 1.48 Mg /m^3 with the highest value at (30-60 cm) depth. PR values vary widely from 2.38 to 4.35 Mpa which indicates that the compacted soil being slightly hard at the surface layer down to 30 cm to extremely hard at the subsurface layer down to 80 cm depth. Furthermore, it is clearly noticed that the values of PR are directly proportional to clay and $CaCO_3$ contents.

In order to elucidate the effect of different plow types on altering the state of compaction in the studied soils, the obtained results will be discussed as follows:

a) Soil strength, bulk density and porosity

Table 2 shows bulk density (BD), total porosity (TP), macro pores as well

TABLE 1. Physical (a) and chemical (b) properties of the studied soils before treatment.

(a)

Site	Depth cm	C.Sand	F. Sand	Silt%	Clay%	Texture	Particle Density Mg/m^3	BD Mg/m^3	TP %	Macro-pores %	PR Mpa
1	0-22	23.94	42.95	16.21	16.90	S L	2.64	1.52	42.42	18.94	1.76
	22.50	22.19	40.16	20.72	16.93	S L	2.63	1.61	38.78	10.69	2.72
	50-80	18.25	45.22	19.42	17.11	S L	2.64	1.50	43.18	13.21	1.98
2	0-30	21.43	45.90	11.77	20.90	SCL	2.62	1.37	47.71	14.76	2.07
	30-50	13.65	36.82	16.57	32.96	SCL	2.60	1.46	43.85	3.95	3.38
	50-80	1143	39.61	24.20	24.76	SCL	2.62	1.40	46.56	9.29	2.65
3	0-30	3.65	56.32	22.22	17.81	S L	2.61	1.43	45.21	11.86	2.38
	30-60	0.46	35.10	29.36	35.08	C L	2.59	1.48	42.86	1.08	4.35
	60-80	0.21	44.98	23.52	31.29	C L	2.62	1.42	45.80	6.21	3.76

(b)

Site	Depth cm	pH	E C	Soluble Cations me/L				Soluble Anions me/L				$CaCo_3$
				Na	K	Ca	Mg	Cl	HCO_3	CO_3	CO4	
1	0-22	7.80	1.14	6.86	0.24	4.45	1.76	8.18	1.39	-	3.75	18.95
	22-50	8.10	1.24	16.71	034	18.45	9.55	28.21	2.65	-	26.50	32.42
	50-80	8.25	1.07	18.1	0.26	16.97	5.16	20.77	1.89	-	17.86	27.76
2	0-30	8.15	2.25	12.13	0.71	11.75	3.31	14.25	2.79	-	1.86	21.54
	29-50	8.00	3.60	16.17	0.34	18.45	9.55	28.21	2.65	-	26.50	36.58
	50.80	8.05	3.80	18.13	0.26	16.96	5.16	20.77	1.89	-	17.86	32.05
3	0-30	7.95	3.11	25.13	0.96	11.30	6.70	29.10	3.08	-	11.91	36.12

as soil strength in terms of penetration reading (PR) at constant matric potential corresponding to -15 atm. As regard to the surface layer, the obtained data reveal that soil tilling has resulted in a sharp decrease in BD and PR in coincidence with a sharp increase in TP and macro pores relative to the control. The difference among the applied plows are negligible concerning the sub surface layer, the obtained data of site 1 indicate that the effect of subtiller plow on decreasing BD; PR and increasing TP and macro pores is more pronotmeed than subsoiler plow. On percentage basis, the reduction of BD and PR is 0 ; 4.35 ; 6.21% and 0 32.35 ; 38.97% relative to the control for CH ,SS and ST, respectively. Otherwise, the increment of TP and macro pores is 0 ; 6.86 ; 9.82 and 0, 67.63 ; 77.92% relative to control in the same sequence. Such effect appears to be contradictory for site 2 and site 3. In other words, subsoiler plow is more effective than subtiller plow in relieving the subsurface compacted layer. As for site 2, the reduction of BD and PR attains 0 ; 8.21; 4.79% and 0; 184.30 ; 132.4% relative to the control in the same sequence. Regarding site 3 the reduction of BD and PR reaches 0 ; 5.4 ; 4.05% and 0 ; 42.43 ; 38.53% relative to the control in the same sequence. The increment of TP and macro pores attains 0 ; 7.21 5.39% and 0 ; 490.74 ; 355.56 relative to the control in the same sequence. Concerning the bottom layer , it is obvious that subsoiling plows has a less appreciable effect on the studied physical properties of such layer. It could be concluded that subsoiling plows, especially subtiller for the fine textured soil and subsoiler for the heavy textured soil, elevate the subsurface compacted layer in the limits of the plowing effective depth.

b) Infiltration rate

Data of cumulative infiltration and infiltration rate for the studied soil treatments were processed to fit the Kostiakov equation (1932):

$$D = Kt^n; I = Knt^{n-1}$$

where D is the cumulative infiltration after time t; I is the infiltration rate; K and n are infiltration parameters. Taylor (1964) stated that K and n are soil parameters that depend upon soil properties and initial soil conditions. He added that, parameter K indicates how fast water enters the soil initially and n indicates how the initial rate diminishes with time.

The results are illustrated in Fig. 1. As for (site 1), the data show an increase in D at the end of the elapsed time in the tilled soil in comparison with the initial

TABLE 2. Effect of plowing treatments on bulk density and poresize distribution of the studied soils.

Site	Depth cm	CH				SS				ST			
		BD Mg/m^3	TP%	Macro Pores %	PR MPa	BD Mg/m^3	TP%	Macro Pores %	PR MPa	BD Mg/m^3	TP %	Macro Pores %	PR MPa
1	0-20	1.46	44.70	27.71	1.13	1.41	44.32	27.13	1.21	1.46	44.70	28.48	1.18
	20-50	1.61	38.78	10.69	2.79	1.54	41.44	17.92	1.84	1.51	42.59	19.02	1.66
	50-80	1.50	43.18	13.29	1.98	1.47	44.32	16.74	1.78	1.48	43.94	18.15	1.82
	L .S.D :D.	0.00527	0.24570	0.18190									
	L .S.D : pl.	0.00386	0.19530	0.12820									
2	0-20	1.30	50.38	25.09	1.59	1.29	50.76	26.91	1.55	1.29	50.76	26.12	1.53
	20-30	1.39	46.95	19.05	2.10	1.30	50.38	23.19	1.57	1.32	49.62	20.12	1.61
	30-50	1.46	43.85	3.95	3.39	1.34	48.46	11.23	2.15	1.39	46.95	9.18	2.26
	50-80	1.41	46.18	14.29	2.65	1.39	46.95	17.23	2.29	1.40	46.56	16.06	2.31
	L .S.D : D.	0.00506	0.19984	0.15001									
	L .S.D : Pl.	0.00509	0.15154	0.28084									
3	0-20	1.34	50.57	22.15	1.70	1.32	49.43	24.66	1.59	1.34	50.57	23.19	1.62
	20-30	1.43	45.21	17.18	2.44	1.33	49.04	21.43	1.72	1.36	47.89	19.93	1.81
	30-60	1.48	42.86	1.08	4.36	1.40	45.95	6.38	2.51	1.42	45.17	4.92	2.68
	60-80	1.42	45.80	8.21	3.76	1.40	46.56	11.53	2.94	1.41	45.04	8.21	3.45
	L .S.D : D.	0.03269	0.19542	0.13544									
	L .S.D : Pl.	0.03434	0.19560	0.15360									

L.S.D D. at 0.05 for Depth
L.S.D.pl. at 0.05 for Plow

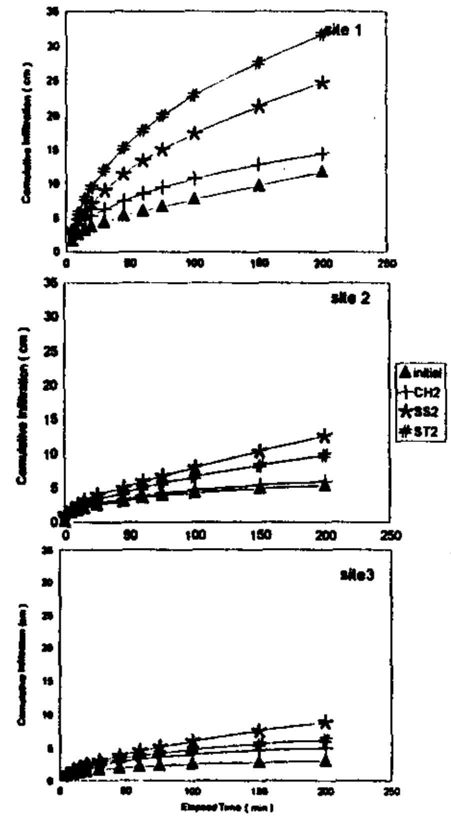
soil. Such increase approaches 23.14 ; 111.22 and 170.71% relative to the control for CH, SS and ST, respectively.

The basic infiltration rates as affected by plowing treatments for the studied sites are presented in Table 3. The data of site (1) point out that the basic infiltration rates of the tilled soil by deep plowing markedly increase relative to the control (non tilled soil). Moreover, the variation between SS and ST treatments is less pronounced with the superiority of the latter one. The increases of basic infiltration rate reach 73.1 and 108.4% relative to the control for SS and ST treatments, respectively. Meanwhile, shallow plowing (CH) shows a non-significant decrease of basic infiltration rate relative to the control. According to Kohnke (1968), the ability of such soil site to transmit water, under the condition of the studied treatments is moderate (Table 3).

The values of n parameter (Table 3) clarifies that such parameter is compatible with the values of the basic infiltration rate. The effectiveness of the applied treatment on the basis of such parameters on the studied sites can be arranged in the order ST > SS > control > CH. These results prove that ST is superior to the other treatments in amelioration the compacted soils.

The increase of basic infiltration rate for the deep plowing treatments relative to the control and/or to the shallow plowing treatment could be ascribed to the plowing depth which allow plows share to break the compacted layers. Data in Table 2 indicate that the action of subsoiling plows decreases bulk density and increases total porosity as well as the number of macro pores responsible for water movement in soils. In this respect, Ankeny *et al.* (1990) reported that infiltration of water into the soil is directly related to soil macro pores. On the other hand, shallow plowing result in a slight mixing of the soil surface above the compacted layer which obstructs water flow. In this regard, Hillel (1982) mentioned that the final infiltrability is limited by the presence of impeding layer inside the soil profile.

Concerning site 2, the data in Fig. 1 illustrates that the increase of D at the end of elapsed time are 11.38, 134.70 and 82.28% relative to the control for CH, SS and ST treatments, respectively. Also, Table 3 indicate that deep plowing markedly increases the basic infiltration rate especially in SS treatment as compared to the control. In other words, infiltration rate class step up from moderately slow for the control and shallow plowing to moderate for subsoiling



Treatments	Kostiakov's Equation	r	n
Initial	$D = 0.2746\ t^{0.5106}$	0.998**	11
CH	$D = 0.2967\ t^{0.4611}$	0.999**	
SS	$D = 0.1813\ t^{0.6021}$	0.9978**	
ST	$D = 0.393\ t^{0.5006}$	0.994**	
Initial	$D = 0.7619\ t^{0.4604}$	0.9933**	11
CH	$D = 0.6737\ t^{0.4482}$	0.989**	
SS	$D = 0.7986\ t^{0.49}$	0.9989**	
ST	$D = 0.6437\ t^{0.5067}$	0.9984**	
Initial	$D = 0.9317\ t^{0.4023}$	0.9868**	11
CH	$D = 0.6316\ t^{0.4812}$	0.9910**	
SS	$D = 0.9136\ t^{0.5581}$	0.9987**	
ST	$D = 0.5424\ t^{0.4646}$	0.9972**	

Fig.1. Comulative infiltration (cm) of the studied soil treatments.

TABLE 3. Infiltration parameters and classes of the studied soil treatments.

Plowing treatments	Basic Infiltration rate cm/hr	n Parameter	Infiltratio Class	Representing infiltration equation	r
Site (1)					
Control	2.38	0.5106	M	D= $0.2746\ t^{0.5106}$	0.998**
CH	2.00	0.4511	M	$0.2967\ t^{0.4511}$	0.999**
SS	4.12	0.5821	M	$0.1813\ t^{0.5821}$	0.9978**
ST	4.96	0.5965	M	$0.393\ t^{0.5965}$	0.994**
Site (2)					
control	0.98	0.4804	MS	$0.7619\ t^{0.4804}$	0.9933**
CH	0.64	0.4492	MS	$0.5737\ t^{0.4492}$	0.9890**
SS	2.69	0.6300	M	$0.7986\ t^{0.63}$	0.9989**
ST	1.74	0.5967	M	$0.8437\ t^{0.5967}$	0.9984**
Site (3)					
control	0.28	0.4023	S	$0.9317\ t^{0.4023}$	0.9868**
CH	040	0.4812	S	$0.8316\ t^{0.4812}$	0.9910**
SS	1.57	0.5881M	MS	$0.9135\ t^{0.5881}$	0.9987**
ST	0.86	0.4548	S	$0.5424\ t^{0.4548}$	0.9972**

M = Moderate

Ms = Moderately slow

S = Slow

treatments. The increase of basic infiltration rates approaches 174.49 and 77.55% relative to the control for SS and ST treatments, respectively. On the contrary, shallow plowing exhibits a damping effect on infiltration rate relative to the control, in other words, even though bulk density is greater and total porosity is lower for the non-tilled soil in comparison with the shallow plowing treatment (Table 3) the infiltration rate for the former is greater than the latter. This may probably due to the presence of continuous earthworm and old root chanels providing numerous pathings for water flow (Azoz and Ashad, 1996).

It is worth to mention that the values of n parameter parallel the values of basic infiltration rate where SS treatment shows the highest n value followed by ST, control and CH treatments.

Concerning site 3, D values at the end of the tested period exhibited a pronounced increase of such value for the studied treatments attaining 64.12, 193.36, and 105.98 % for CH, SS and ST treatments relative to the control, respectively. Furthermore, data in Table 3 indicate higher infiltration rate values for the subsoiling treatments than for the control with the superiority of SS treatment. On percentage basis, such increase reaches 460.71 and 207.14 % for SS and ST treatments relative to the control, respectively. On the other hand, shallow plowing displays nonsignificant increase in basic infiltration rate in comparison with the control. The data of n parameter confirm the above mentioned results indicating higher efficiency of SS treatment followed by ST and CH, in improving soil compactness.

Furthermore, the above results indicate that the infiltration rate in site 3 has a lower value than in the other sites. This behaviour may be due to the increase of clay and $CaCO_3$ contents and low macro-pores which may be responsible for the higher hard setting of such soil of site 3 as compared to the other sites. Moreover, the data clearly displays a better efficiency of SS treatment relative to ST under the conditions of sites 2 and 3, while the reverse is true under the conditions of site 1.

Soil moisture profile

Since the readiness of water movement, and thus its distribution and availability are vital to the plant growth, it could be taken as valuable measure for describing the remedial effect of tillage implements. Therefore,by the end of infiltration tests (afier 200 min), the two dimensions, i.e., vertical (LV) and horizontal distance (LH)of the wet zone were measured and tabulated in Table 4. For site 1, the data reveal that (LV) is greater than (LH) thereby, the ratio between (LV) and (LH) approaches 1: 0.91, 1: 0.88, 1: 0.30 and 1.039 for control, (CH), (SS) and (ST) treatments, respectively. It is clearly noticed that the ratio of LV and LH is nearly the same for control and (CH) treatments. This behavior could be attributed to the presence of a subsurface compacted layer which impeds the downward advance of the wet front. On the other hand, the data clearly show that the subsoiling results in a progressive increase in the wet front of the vertical direction relative to the horizontal direction. This indicates that the pattern of wetting has a cone shape as a result of loosening the subsurface compacted layer. As regard to the wet front of site 2, Table 4 indicates that the ratio of (CH) to (LV)for (CH) treatment is approximately similar to the control due to unaffected subsurface compacted layer by shallow plowing.

TABLE 4. Effect of plowing treatments on vertical (LV) and Horizontal (LH) distance (cm) of the wet front at the end of the elapsed time of the studied sites.

Site	Wet front	Initial	CH	SS	ST
1	LV	25.40	24.15	58.20	56.50
	LH	23.90	21.25	17.55	20.75
	LV: LH	1:0.94	1:0.88	1: 0.30	1:039
2	LV	28.70	27.60	47.90	42.95
	LH	39.45	34.05	28.50	32.35
	LV: LH	1:1.37	1:1.23	1:0.59	1:0.75
3	LV	22.10	28.80	41.30	34.65
	LH	27.60	22.90	20.15	21.05
	LV: LH	1:1.25	1:0.69	1:0.49	1:0.61

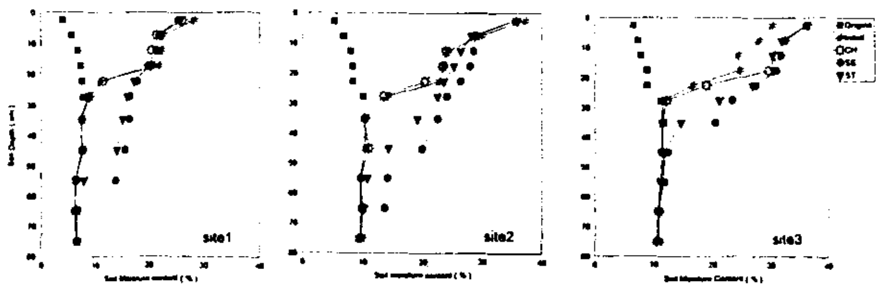
As for the site 3, Table 4 shows that plowing the soil caused an increase advance of the wet front in the vertical direction, especially in the (SS) treatment. Such increase may be attributed to loosening the subsurface compacted layer. On the contrary, it is clearly noticed that plowing the soil decrease the advances wet front in the lateral direction relative to the control. The ratio between (LV) and (LH) is 1:125, 1: 096, 1: 0.49 and 1: 061 for the control. (CH), (SS) and (ST) treatments, respectively.

It could be concluded that the advance of the wet front in the vertical direction depends mainly on the depth of the compacted layer. As the subsoiling plows break the compacted layer, the distance of (LV) depend mainly on soil texture and pore size distribution.

On the other hand, the advances in lateral movement depends mainly on soil texture and pore size distribution. Thus the relationship between (LV) and (LH) depends on the gravitational force and on the matric potential for the former and on the matric potential only for the latter.

Data of moisture distribution within profiles after infiltration are illustrated in Fig. 2. Such figure exhibits the three specific zones characterizing the pattern of soil moisture distribution as reported by Bodman and Colman (1944) . The first one represents the saturation zone which extends to 20 cm below the soil surface. Chisel treatment in each soil did not influence neither the moisture content nor the depth of the characterstic zones of moisture profile Nevertheless, (SS) and (ST) plowing result in an appreciable increase in soil moisture content especially below 20 cm.

This behaviour is more pronounced in the two Nubaria sites compared to Maryut site.This may taken as indicator for higher effectiveness of deep plowing in ameliorating compactness of West Nubaria than Maryut soil.



L.S.D at0.05

Depth	0.3664	0.2331	0.3313
plowing	0.2470	0.1571	0.2233

Fig.2. Soil moisture distribution of the studied soil treatments.

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أثر استخدام آلات الحرث على حالة الاندماج فى أراضى مختلفة

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قسم كيمياء وطبيعة الأراضى ، مركز بحوث الصحراء ، المطرية ، القاهرة ، مصر.

تهدف الدراسة الحالية إلى تقييم أثر استخدام أنواع مختلفة من المحاريث (الحفار السطحى - الحفار العميق ذو السلاح الواحد - الحفار العميق متعدد الاسلحة) على بعض الخواص الطبيعية لثلاث أراضى مندمجة بمنطقتى غرب النوبارية (الموقع الأول والثانى) ومريوط (الموقع الثالث) لتمثل أراضى مختلفة فى القوام وكمية كربونات الكلسيوم والطبقة المندمجة.

وقد تم قياس الصفات التالية: الكثافة الظاهرية - المسامية الكلية - المسام الواسعة - مقاومة الأراضى للاختراق - الرشح قبل وبعد إجراءعمليات الخدمة. ويمكن تلخيص النتائج المتحصل عليها كما يلى:

١- يمكن ترتيب كفاءة أنواع المحاريث المستخدمة على خفض الكثافة الظاهرية وصلابة التربة والمتزامنة مع زيادة المسامية الكلية والمسام الواسعة كما يلى:

الموقع الاول والثانى (غرب النوبارية): المحراث العميق متعدد الأسلحة > المحراث الحفار ذو السلاح الواحد > المحراث السطحى.

الموقع الثالث (مريوط) : المحراث العميق ذو السلاح الواحد > المحراث الحفار العميق متعدد.الاسلحة > المحراث السصحى.

ومن النتيجة السابقة يمكن أستنتاج أن المحاريث العميقة خاصة المحراث الحفار العميق متعدد الاسلحة للاراضى الخفيفة القوام والمحراث الحفار العميق ذو السلاح الواحد للاراضى الثقيلة القوام يؤدى الى تخفيف اندماج الطبقة التحت سطحية وذلك فى حدود كفاءة الحرث.

٢- يزداد الرشح التراكمى ومعدل الرشح الآساسى زيادة واضحة بأستخدام المحاريث العميقة وذلك بالمقارنة مع الآراضى غير المحروثة والتى تدل على التحسن الواضح فى قابلية الآراضى

للرشح كما أن كفاءة المحاريث المستخدمة على زيادة قابلية الأراضى للرشح تأخذ نفس الترتيب المذكور آنفا للتغير فى الخواص الطبيعية فى المواقع تحت الدراسة.

٣- فيما يختص بدراسة الجبهة المبتلة بالمواقع الثلاثة فقد أوضحت النتائج أن استخدام المحاريث العميقة أدى الى زيادة تحرك الماء رأسيا وعلى الجانب الآخر قل تحرك الماء أفقيا فى معاملات الحرث كنتيجة لتفكك الطبقة السطحية وذلك بالمقارنة مع معاملة الكنترول.

تميز التوزيع الرطوبى للثلاث مناطق من حيث محتواها الرطوبى كما أدى تكسير الطبقة المندمجة الى نقص المحتوى الرطوبى تدريجيا مع العمق حتى عمق الحراث للمحاريث المستخدمة مع زيادة المحتوى الرطوبى وعمق الجبهة المبتلة فى معاملة المحراث الحفار العميق ذو السلاح الواحد بالنسبة للمحراث الحفار العميق متعدد الاسلحة. وقد كان التوزيع الرطوبى للأراضى تحت الدراسة متشابها من حيث الشكل وأن اختلف من حيث المحتوى الرطوبى وذلك تبعا لاختلاف طبقات الأرض.