

Change of Some Soil Physical Properties in Newly Reclaimed Soils Following Poor Soil Management: A Case Study in Al-Qasasin, Egypt

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJSSPN/2022/v8i3161

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/93907>

Original Research Article

Received 11 October 2022
Accepted 01 December 2022
Published 05 December 2022

ABSTRACT

Background: In newly reclaimed areas, some improper farming practices like using heavy machines in tillage, adding excessive quantity of fertilizers, irrigation by flooding method and intensity cultivation could affect the soil physical properties.

Objective: Therefore, eighty soil samples were collected from the twenty-seven profiles to evaluate the change of soils' physical properties at four locations (A, B, C and D) after different improper soil managements.

Methods: The study area is located in Al-Qasasin, Ismailia Governorate, Egypt northern tip of it extended between latitudes 30° 33' 1.147" N and 30° 28' 16.096" N, and longitudes 32° 4' 12.984" E and 32° 4' 15.696" E, with total area of 144.25 km² (34345.1 Feddan) which falls in the semi-arid zone. Profile depth, soil texture, total porosity (TP), bulk density (BD), hydraulic conductivity (HC) and infiltration rate (IR) were determined according to the standard procedures.

Results: According to the values of general mean of the studied properties in the four locations, BD takes the order: C>B>A>D. While the TP take the opposite trend of BD (D>A>B>C), on the other

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hand, both HC and IR follow the same order: C>A>B>D. These results attributed to that the locations B and D using surface flooding irrigation system, while A and C locations using sprinkler and drip irrigation systems, respectively. In addition to the intensive cultivation and the conventional tillage planting system are used in the B and D locations. Where the tillage tools like heavy plows, disks or chisels are used seasonally. While in A and C sites light tillage and orchards planting only are used commonly.

Conclusion: These findings should be considered in future research to improve the soil management programs in these examined areas particularly the fourth location that should stop flooding technique and terns to the drip or sprinkler method.

Keywords: Soil physical properties; improper management; plowing-irrigation; intensive cultivation; Al-Qasasin.

1. INTRODUCTION

The complex process of soil degradation is the outcome of extensive alterations in soil characteristics produced by anthropogenic and/or natural sources [1]. Occasionally, agricultural practices have a negative impact on the environment. The deterioration and instability of soil quality is one of the adverse effects brought on by agricultural practices [2]. Flood irrigation and other conventional irrigation practices resulted in a significant rise in groundwater levels and salt deposition in soil surface layers [3]. Water diversion and irrigation used in agricultural production raise the underground water level and push it past the critical depth in areas with high evaporation, which leads to continuous water evaporation and significant surface salt accumulations. Soil salinization is also common in these regions [4]. Hydraulic conductivity, porosity, and water infiltration rate decrease when salt concentration in soil rises due to structural degradation features such as formation of surface crust, swelling, dispersion, and slaking [5]. Generally, the water flow and retention, crusting, recycling of nutrients, root penetration, and crop production of a soil is all influenced by its structure [6]. Utilizing fertilizer alters the physicochemical and biological properties of the soil in addition to increasing crop yields [7]. Addition of mineral fertilizers along with organic manure increased the Mean weight diameter and the available N, P, K and micronutrients [8]. While, using fertilizers in excess of the recommended amounts promotes the development, accumulation, and concentration of fertilizer mineral salts, which leads to change the properties in the long term [9]. The continued addition of mineral fertilizer led to decline in soil health [10]. From planting until harvesting, the majority of field tasks in contemporary agriculture are carried out mechanically by large agricultural equipment

[11,12]. However, the pressures from these large equipment may result in compress the soil [13]. Over the last several decades, agricultural intensification has resulted in catastrophic biodiversity losses [14]. In agricultural soils, compaction is induced by agricultural machinery and trampling of animals applying stresses larger than soil bearing capacity [15]. The soil becomes more compacted as agricultural equipment passes over the same spots repeatedly [16]. The soil resistance to penetration increased after only 4 passes of a heavy machine [17]. Tillage practices alter the soil's chemical, physical, and biological properties, which can alter the roots' traits, growth, and development [18]. The soil physical and chemical properties vary between the samples obtained where the tractor's wheels crossed them and those taken elsewhere [19]. Compaction induced soil structure disturbance can lead to crusting, fast nutrient recycling, decreased water and air access to roots [6] and mostly damages big pores [20]. Consequently, crop performance is decreased due to stunted aboveground growth and decreased the expansion of roots [21].

Therefore, this study aimed to evaluate some soils' physical characteristics after different improper management of four locations in AL-Qasasin region.

2. MATERIALS AND METHODS

2.1 Location of the Study Area

The study area is located in Al-Qasasin, Ismailia Governorate, Egypt northern tip of it extended between latitudes 30° 33' 1.147" N and 30° 28' 16.096" N, and longitudes 32° 4' 12.984" E and 32° 4' 15.696" E, with total area of 144.25 km² (34345.1 Feddan) which falls in the semi-arid zone. Fig. (1) shows the location of study area.

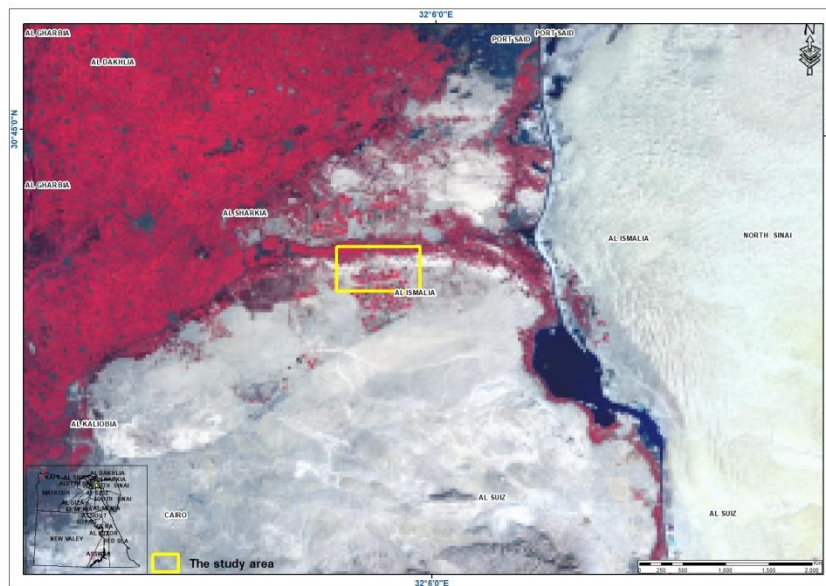


Fig. 1. Location of the study area

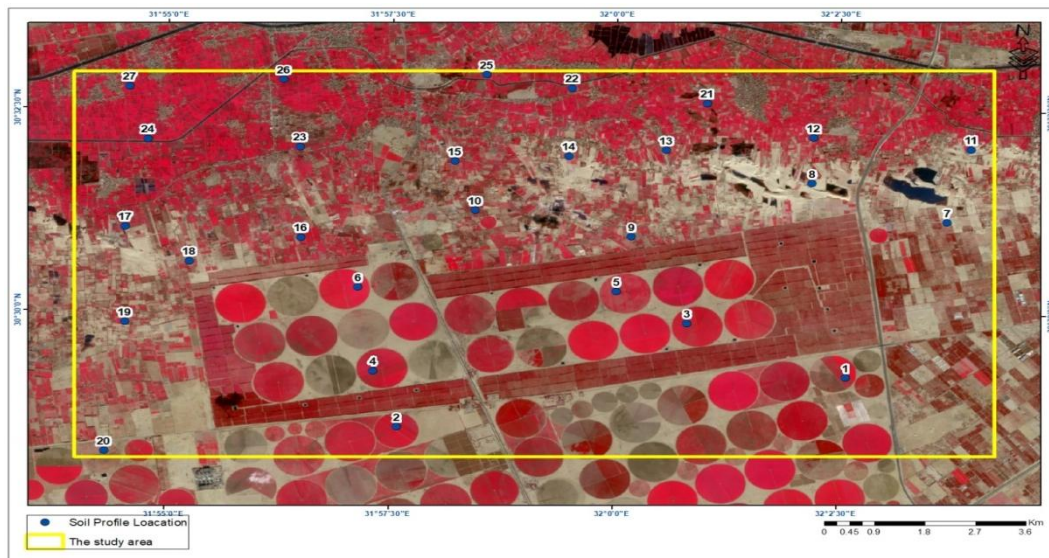


Fig. 2. Locations of the studied soil profiles

2.2 Field Work

Eighty soil samples were collected from the twenty-seven profiles to evaluate the soils' physical properties at four locations (A, B, C and D) after different improper soil managements. Disturbed and undisturbed soil samples were taken at different soil depths to determine some physical soil properties according to the standard procedures. The soil profiles were selected by using Global Position System (GPS) and their random distribution. Soil profiles were described and defined according to guideline of Soil Survey

Manual (2017). Fig. (2) shows the location of the studied soil profiles.

The main water source in the studies area is Ismailia Canal. Both of mineral and organic fertilization are applied in the studied area. Based on collected agricultural services data in each area covered by the studied land sectors; applied irrigation system, field observations of soil features and productivity, the studied area was classified to four locations as showed in Table (1).

Table 1. Location, soil agro eco-system, irrigation method and the number of observed soils profile

Location	Soil texture	Soil agro eco-system	Irrigation method	Number of observed soils profile
A	Loamy sand	<ul style="list-style-type: none"> • Primary tillage system • light tillage tools • Type of crop cycle is wheat, onions, garlic and alfalfa 	sprinkler	6 (from 1 to 6)
B	Loamy sand	<ul style="list-style-type: none"> • conventional tillage planting system • Heavy tillage tools like plows, disks, or chisels are used seasonally • This location is planted intensively with field crops, vegetables and fruits 	flooding	9 (from 7 to 15)
C	Loamy sand and Sandy	<ul style="list-style-type: none"> • Primary tillage system • light tillage tools • This location is planted only with fruits; citrus, mango, peaches and apricots 	drip	5 (from 16 to 20)
D	Loamy sand, Sandy loam and Clay loam	<ul style="list-style-type: none"> • conventional tillage planting system • tillage tools like plows, disks, or chisels are used seasonally • the fourth location is planted with wheat, alfalfa, corn and tomatoes 	flooding	7 (from 21 to 27)

2.3 Laboratory Analyses

- The soil samples were analyzed for particle size distribution, soil bulk density (BD), and particles density (PD) Burt [22].
- Total soil porosity was calculated as described in Klute [23].
- The saturated hydraulic conductivity (HC) was measured using the constant head method [24].
- Infiltration rate (IR) was determined using a double ring infiltrometer according to method described by Klute [23].

2.4 Softwares

ERDAS Imagine version 2015 was used for Layer stacking, Pre- Processing, image enhancement. Arc GIS version 10.4.1 software was used for input data in various formats, and produce thematic maps in different formats. Microsoft office (Excel and Word).

3. RESULTS AND DISCUSSION

The land form map illustrated that, lakes, swamp, fish ponds and urban covered about 109.66, 263.98, 30.45, 1860.14 fed., that covered 0.32, 0.77, 0.09 and 5.42% of the total studied area (34345.1 Feddan), respectively. These uncultivated areas represent 6.6% of the total studied area.

3.1 Degradation Degree of Soil Physical Properties

3.1.1 Profile depth

Data in Fig. (3) and Table (2) indicated that, the deep soil class dominated in the study area covered about 16533.33 feddans (Feddan = 4200 m²) and forms 48.14% of the total area. According to FAO [25], the moderately deep class follows the deep soil depths class and covers an area of about 12024.15 feddans (35.01%). Only 10.26% of the total study area is considered as very deep soil class with an area of about 3523.42 feddans. The profile depth of

the first (A), second (B), third (C), and fourth (D) locations reached 130, 100, 125, and 115 cm, respectively. And thus, the locations A, followed by C, are characterized by deep profiles in contrast to the other locations (B and D). This may be due to the second and fourth locations (B and D) being irrigated by flooding techniques that raise the water table and form shallow profiles.

3.2 Soil Texture

One of the most crucial factors influencing soil behavior and management is soil texture, which has effectiveness on a variety of chemical and physical soil properties. Data in Tables from 3 to 6 showed that in the first location the predominant texture class is loamy sand.

The results in Table (4) showed the particle size distribution and the soil texture of the profiles number 7 to 15 that collected from the second location. Similar texture class was found with all soil samples selected from the second location. The predominant texture class of all soil samples that were taken from different depths was loamy sand.

The texture classes of soil samples of third location representing the profile number 16 to 20 were showed in Table (5). The major texture class of all soil samples was loamy sand, except for the soil samples collected from the deeper layers i.e., 60 -120, 60-110, 75 -125, 60-120 and 75-120cm of soil profiles number 16,17,18,19 and 20, respectively have a sandy texture.

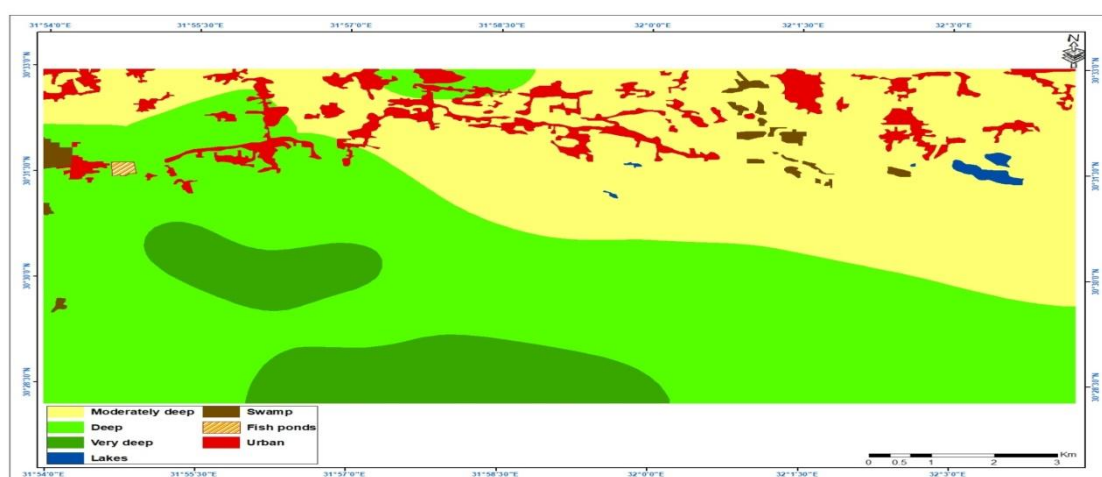


Fig. 3. Profile depth of the surface layer of the studied area

Table 2. Effectiveness deep classes and area of each class as feddan* and its percent (%) of the studied area

Effective depth classes	Area(F) *	Percentage (%)
Moderately deep	12024.15	35.01
Deep	16533.33	48.14
Very deep	3523.42	10.26

*Feddan = 4200 m²

Table 3. Particles size distribution (%) and soil texture in the selected soil profiles from the first location

Profile No.	Soil depth (cm)	Particles size distribution (%)				Texture class
		Clay	Silt	Fine sand	Coarse sand	
1	0-30	5.9	14.5	41.3	38.3	Loamy sand
	30-60	4.6	13.6	41.1	40.7	Loamy sand
	60-120	3.2	12.2	44.5	40.1	Loamy sand
	Mean	4.6	13.4	42.3	39.7	
2	0-25	5.1	12.8	43.3	38.8	Loamy sand
	25-75	3.7	12.5	42.6	41.2	Loamy sand

Profile No.	Soil depth (cm)	Particles size distribution (%)				Texture class
		Clay	Silt	Fine sand	Coarse sand	
3	75-130	2.5	11.1	44.0	42.4	Sandy
	Mean	3.8	12.1	43.3	40.8	
	0-20	6.0	15.6	41.3	37.1	Loamy sand
	20-50	5.7	14.2	39.4	40.7	Loamy sand
	50-120	3.3	13.5	42.8	40.4	Loamy sand
4	Mean	5.0	14.4	41.2	39.4	
	0-25	6.2	14.2	43.8	35.8	Loamy sand
	25-70	5.3	13.3	41.0	40.4	Loamy sand
	70-90	4.0	12.0	44.8	39.2	Loamy sand
	90-120	3.2	11.3	44.0	41.5	Sandy
5	Mean	4.7	12.7	43.4	39.2	
	0-25	6.3	14.8	42.5	36.4	Loamy sand
	25-70	5.8	14.5	40.2	39.5	Loamy sand
	70-90	4.5	13.2	40.5	41.8	Loamy sand
	90-120	4.1	12.3	43.6	40	Loamy sand
6	Mean	5.2	13.7	41.7	39.4	
	0-20	6.6	15.0	42.8	35.6	Loamy sand
	20-50	5.0	13.0	41.1	40.9	Loamy sand
	50-125	5.0	11.3	43.5	40.2	Loamy sand
	Mean	5.5	13.1	42.5	38.9	
General mean		4.8	13.2	42.4	39.6	

Table 4. Particles size distribution (%) and soil texture in the selected soil profiles from the second location

Profile No.	Soil depth (cm)	Particles size distribution (%)				Texture class
		Clay	Silt	Fine sand	Coarse sand	
7	0-15	7.3	15.8	40.3	36.6	Loamy sand
	15-50	6.5	15.0	40.7	37.8	Loamy sand
	Mean	6.9	15.4	40.5	37.2	
8	0-20	8.1	14.6	41.1	36.2	Loamy sand
	20-70	7.3	13.9	41.9	36.9	Loamy sand
	Mean	7.7	14.3	41.5	36.6	
9	0-15	6.7	15.2	40.4	37.7	Loamy sand
	15-50	6.1	14.2	41.0	38.7	Loamy sand
	50-80	5.9	14.1	40.5	39.5	Loamy sand
	Mean	6.2	14.5	40.6	38.6	
10	0-20	6.5	16.5	41.0	36.0	Loamy sand
	20-65	5.2	15.3	40.6	38.9	Loamy sand
	65-90	4.3	12.4	43.6	39.7	Loamy sand
	Mean	5.3	14.7	41.7	38.2	
11	0-25	6.3	16.5	40.0	37.2	Loamy sand
	25-50	5.9	15.9	39.7	38.5	Loamy sand
	50-75	5.6	13.3	42.1	39.0	Loamy sand
	Mean	5.9	15.2	40.6	38.2	
12	0-15	7.0	15.4	40.5	37.1	Loamy sand
	15-40	6.7	14.5	40.3	38.5	Loamy sand
	40-90	5.0	12.3	43.6	39.1	Loamy sand
	Mean	6.2	14.1	41.5	38.2	
13	0-25	7.8	15.1	40.3	36.8	Loamy sand
	25-60	6.5	14.3	40.5	38.7	Loamy sand
	60-100	5.3	12.0	42.4	40.3	Loamy sand
	Mean	6.5	13.8	41.1	38.6	
14	0-20	6.2	14.2	40.4	39.2	Loamy sand
	20-60	5.0	13.6	42.7	38.7	Loamy sand

Profile No.	Soil depth (cm)	Particles size distribution (%)				Texture class
		Clay	Silt	Fine sand	Coarse sand	
15	Mean	5.6	13.9	41.6	38.95	
	0-25	8.3	16.9	40.3	34.5	Loamy sand
	25-70	7.0	15.3	39.3	38.4	Loamy sand
	70-90	6.1	14.3	42.1	37.5	Loamy sand
	Mean	7.1	15.5	40.6	36.8	
General mean		6.4	14.6	41.1	37.9	

Table 5. Particles size distribution (%) and soil texture in the selected soil profiles from the third location

Profile No.	Soil depth (cm)	Particles size distribution (%)				Texture class
		Clay	Silt	Fine sand	Coarse sand	
16	0-25	4.2	15.1	42.4	38.3	Loamy sand
	25-60	3.2	13.1	41.2	42.5	Loamy sand
	60-120	2.5	12.4	44.0	41.1	Sandy
	Mean	3.3	13.5	42.5	40.6	
17	0-20	4.1	14.1	42.0	39.8	Loamy sand
	20-60	3.2	13.1	42.1	41.6	Loamy sand
	60-110	2.5	12.3	43.2	42.0	Sandy
	Mean	3.3	13.2	42.4	41.1	
18	0-25	3.7	15.1	42.4	38.8	Loamy sand
	25-75	3.3	13.9	41.2	41.6	Loamy sand
	75-125	2.5	12.3	43.2	42.0	Sand
	Mean	3.2	13.8	42.3	40.8	
19	0-15	3.4	13.7	44.0	38.9	Loamy sand
	15-60	4.6	12.6	44.3	38.5	Loamy sand
	60-120	2.2	12.5	42.8	42.5	Sandy
	Mean	3.4	12.9	43.7	39.97	
20	0-25	4.3	12.5	44.1	39.1	Loamy sand
	25-75	3.5	11.2	43.1	42.2	Sandy
	75-120	2.1	11.1	43.5	43.3	Sandy
	Mean	3.3	11.6	43.6	41.5	
General mean		3.3	13	42.9	40.8	

Table 6. Particles size distribution (%) and soil texture in the selected soil profiles from the fourth location

Profile No	Soil depth (cm)	Particles size distribution (%)	(%) Fine sand	Coarse sand	Texture class	
	0-20	Clay 8.5	Silt 15.6	40.6	35.3	Loamy sand
21	20-70	7.3	14.1	39.4	39.2	Loamy sand
	70-90	6.0	13.2	41.1	39.7	Loamy sand
	Mean	7.3	14.3	40.4	38.1	
22	0-20	9.5	17.0	38.4	35.1	Sandy loam
	20-50	9.4	16.6	37.3	36.7	Sandy loam
	50-80	8.5	15.2	39.3	37.0	Sandy loam
	Mean	9.1	16.3	38.3	36.3	
23	0-30	11.5	23.5	36.4	28.6	Sandy loam
	30-70	10.1	22.6	34.3	33.0	Sandy loam
	70-100	8.3	17.3	38.0	36.4	Sandy loam
	Mean	9.97	21.1	36.2	32.7	
	0-25	12.4	19.9	36.1	31.6	Sandy loam
	25-70	10.2	19.9	35.1	34.8	Sandy loam

Profile No	Soil depth (cm) 0-20	Particles Clay 8.5	size distribution Silt 15.6	(%) Fine sand 40.6	Coarse sand 35.3	Texture class Loamy sand
24	70-100	9.7	17.8	37.2	35.3	Sandy loam
	Mean	10.8	19.2	36.1	33.9	
	0-20	35.3	37.3	23.8	3.6	Clay loam
	20-60	33.5	35.1	22.2	9.2	Clay loam
25	60-115	25.2	29.3	31.5	14.0	Loamy
	Mean	31.3	33.9	25.8	8.9	
	0-30	35.7	36.4	22.0	5.9	Clay loam
	30-70	34.9	35.5	19.6	10.0	Clay loam
26	70-100	31.2	35.3	18.3	15.2	Clay loam
	Mean	33.93	35.7	19.97	10.4	
	0-25	38.4	39.8	16.5	5.3	Clay loam
	25-65	37.6	39.5	15.2	7.7	Clay loam
27	65-95	35.2	37.5	19.5	7.8	Clay loam
	Mean	37.1	38.9	17.1	6.9	
General mean		19.9	25.6	30.6	23.9	

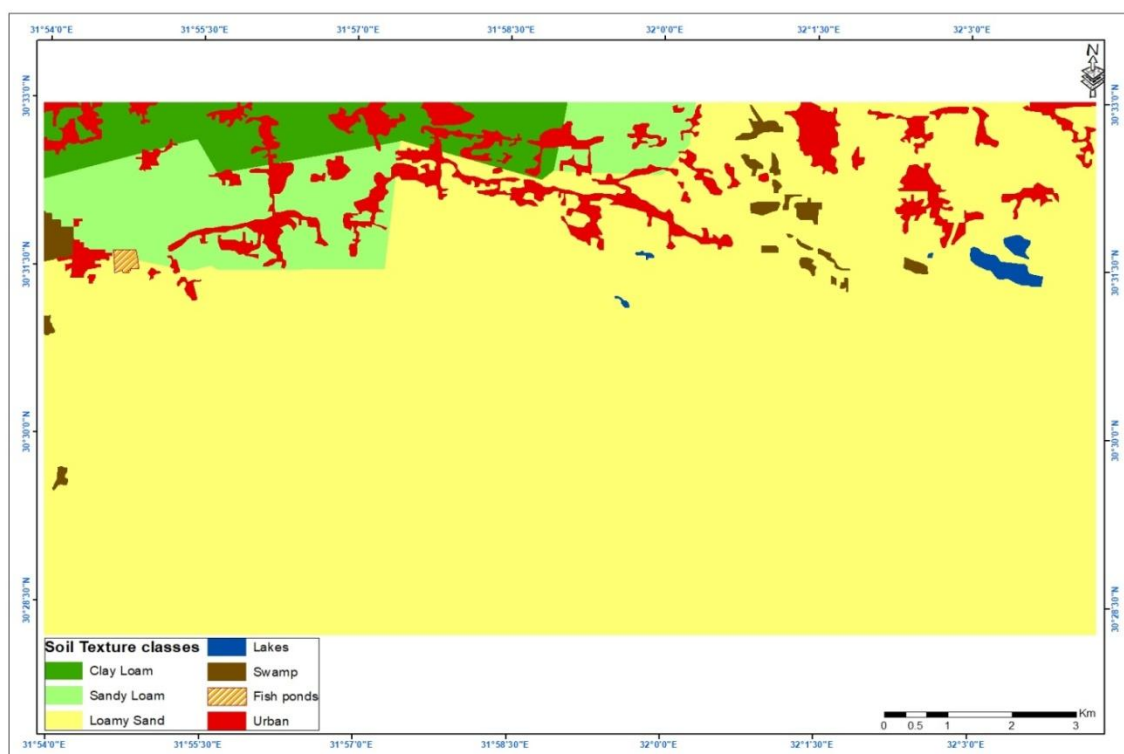


Fig. 4. Soil texture map of the studied area

Table 7. Soil texture classes of the studied area and the area of each class as feddan and percent (%) of all area

Texture Classes	Area-(F)	Percent (%)
Clay Loam	1357.9	4.0
Loamy Sand	28447.0	82.8
Sandy Loam	2276.0	6.6

Data in Table (6) also showed that, the texture class of soil samples representing the soil samples of fourth location (profiles 21 to 27) appeared wide variations in their texture class. This texture class was loamy sand in profile number 21, sandy loam in profiles number 22, 23 and 24 and was clay loam in the profiles number 25, 26 and 27. As evidenced by the surface layer data in (4) and Table (7), the loamy sand class is prevalent in the study area. It covered an area of about 28447.0 feddans and forms 82.8% of the total study area. On the other hand, the sandy loam class covered an area of about 2276.0 feddans and forms 6.6% of the total study area. However, clay loam class is the least abundant texture where it covered an area of about 1357.9 feddans and forms 4% of the total studied area.

3.3 Bulk Density (BD)

Soil bulk density which considered as an indicator on soil compaction is a form or one indicator of physical degradation resulting in distortion of the soil [26,27]. This could be reduced the biological activity, total porosity and permeability of agricultural soils. The soil compaction process can be resulting from using heavy agricultural machines and animals as well as from high agriculture intensity and use massive quantity of mineral fertilizers. According to the values of general mean of BD (Fig. 5), the four locations representing the studied area may be arranged as follows: the third (1.65 g/cm^3) > the second (1.64 g/cm^3) > the first (1.60 g/cm^3) > the fourth (1.41 g/cm^3). Increasing the sand fraction percentage in the first three places (A, B and C) led to raising the values of BD in their profiles and vice versa in the fourth location (D). The highest value of BD recorded in the C location was attributed to increasing the sand fraction. While increasing BD values in the B site are interpreted not only by increasing sand percentage, but also by increasing agricultural service intensity using heavy machines in tillage that compact the soil layers.

3.4 Total Porosity (TP)

Total porosity of the soil samples under study calculated based on soil BD at each soil depth and real density of 2.6 g/cm^3 and found values were listed in Table (8). This Table shows a wide range of TP in the values of TP within the studied soil samples which ranged between 51.54% at soil depth of 0-30 cm of profile number 26 in the fourth location and 35.77% in soil profile number

17 at soil depth 20-60 and 60-110cm of the third location. Based on the general mean of TP values in the four locations, these locations take the order: the fourth (45.64%) > the first (38.39%) > the second (36.89%) > the third (36.67%). This order is reversible with that recorded with soil BD. In all soil profiles under study, TP were decrease with increase in soil depth. Therefore, TP values may be used as an indicator for soil compaction and its degradation degree which decreased with the increase in TP.

3.5 Hydraulic Conductivity (HC)

Soil hydraulic conductivity "HC" of soil considered one important of soil physical properties, where it's related with many chemical and physical properties of the agricultural soils. Fig. (5) showed that, the arrangement of the four locations under study based on the general mean values of their HC was the third (4.747 cm h^{-1}) > the first (4.425 cm h^{-1}) > the second (4.078 cm h^{-1}) > the fourth (3.029 cm h^{-1}). Generally, the four locations arranged in the rank $C > A > B > D$ according to the mean values of H.C. Increasing the values of H.C of the C site may be attributed to 1) increasing of sand percentage 2) using low tillage system by light machines 3) there is no agriculture intensification and no need to use the heavy machines.

3.6 Infiltration Rate (IR)

Infiltration rate (IR) consider good indicator for many soil physical and chemical properties. Therefore, it's played a major role in the management of agricultural soil as well as in crops rotation. Fig. (4) showed that based on the general mean value of IR separately for each location, may be observed that these location takes the order: the third (7.4 cm h^{-1}) > the first (5.9 cm h^{-1}) > the second (4.3 cm h^{-1}) > the fourth (2.5 cm h^{-1}). These variations may be used as indicator for soil health and soil degradation, where the degree of soil degradation is negatively related with its IR value. The mean values of IR followed the identical order of hydraulic conductivity; $C > A > B > D$. This finding is attributed to the same reasons that affect the H.C values as mentioned before. Seasonal tillage with heavy machines coupled with the surface irrigation method (wet conditions) could be responsible for the compaction of soil layers and the slowdown of the infiltration rate.

Table 8. Total porosity "TP" % in the different soil depths (cm) in the soil profiles representing the four locations in the studied area

Location number											
First			Second			Third			Fourth		
Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %
1	0-30	38.46		0-15	38.46		0-25	36.92		0-20	41.15
	30-60	38.08	7	15-50	38.08		25-60	36.54		20-70	40.38
	60-120	36.92		Mean	38.27	16	60-120	36.54	21	70-90	38.08
	Mean	37.82		0-20	36.92		Mean	36.67		Mean	39.87
2	0-25	38.08	8	20-70	36.92		0-20	36.15		0-20	41.54
	25-75	36.92		Mean	36.92		20-60	35.77		20-50	40.77
	75-130	36.92		0-15	36.92	17	60-110	35.77	ZZ	50-80	40.38
	Mean	37.31		15-50	36.54		Mean	35.90		Mean	40.90
3	0-20	39.23	9	50-80	36.54		0-25	36.92		0-30	45.77
	20-50	38.85		Mean	36.67		25-75	36.92		30-70	45.00
	50-120	36.92		0-20	38.08	18	75-125	36.54	23	70-100	41.92
	Mean	38.33		20-65	36.54		Mean	36.79		Mean	44.23
4	0-25	39.62	10	65-90	36.54		0-15	38.08		0-25	45.77
	25-70	39.62		Mean	37.05		15-60	37.31		25-70	45.38
	70-90	38.85		0-25	36.92	19	60-120	36.92	24	70-100	42.31
	90-120	36.92		25-50	36.54		Mean	37.44		Mean	44.49
	Mean	38.75	11	50-75	36.54		0-25	36.54		0-20	49.62
5	0-15	39.23		Mean	36.67		25-75	36.54		20-60	49.23
	15-60	38.85		0-15	36.54	20	75-120	36.54	25	60-115	46.54
	60-90	38.46		15-40	36.15		Mean	36.54		Mean	48.46
	90-150	38.08	12	40-90	36.15		General mean	36.67	26	0-30	51.54
	Mean	38.65		Mean	36.28					30-70	50.77
6	0-20	40.38		0-25	36.92					70-100	50.38
	20-50	40.00	13	25-60	36.92					Mean	50.90
	50-125	38.08		60-100	36.54				27	0-25	51.15
	Mean	39.49		Mean	36.79					25-65	50.38
General mean		38.39	14	0-20	36.92					65-95	50.38

Location number											
First			Second			Third			Fourth		
Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %	Profile No	Soil depth (cm)	TP %
				20-60	36.54					Mean	50.64
				Mean	36.73				General mean		45.64
			15	0-25	36.92						
				25-70	36.54						
				70-90	36.54						
				Mean	36.67						
			General mean		36.89						

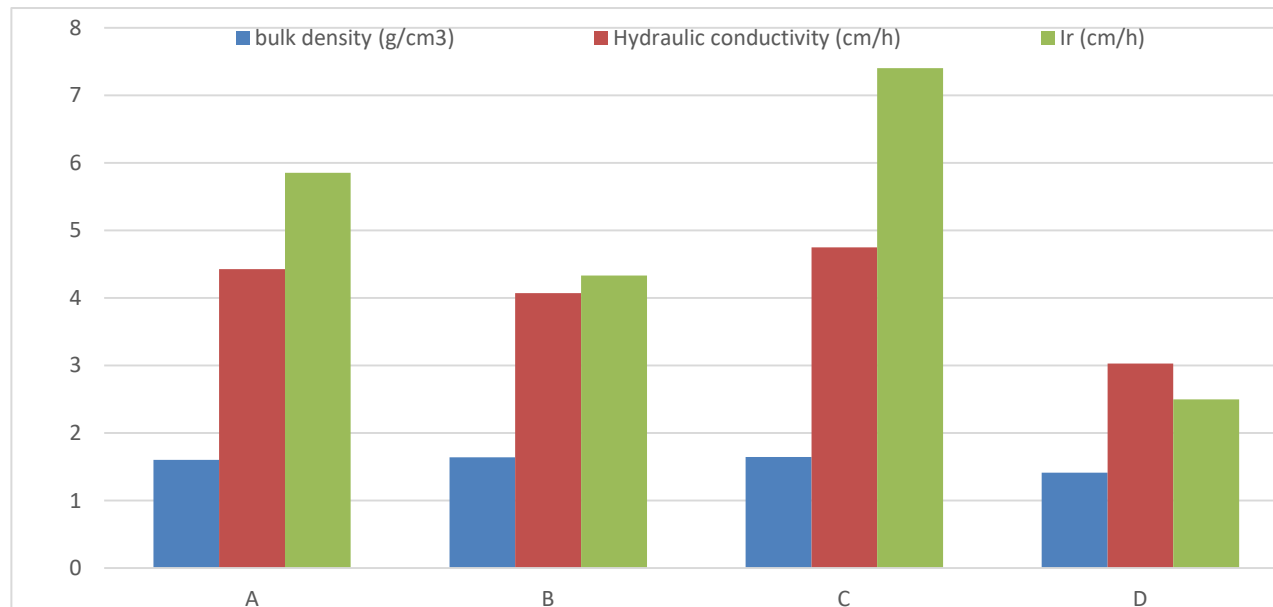


Fig. 5. Bulk density "BD" (g/cm³), hydraulic conductivity "HC" (cm/h) and infiltration rate "IR" (cm h⁻¹) in the four locations of the studied area

4. CONCLUSION

Some improper farming practices like using heavy machines in tillage, adding excessive quantity of fertilizers, irrigation by flooding method and intensity cultivation could affect the soil physical properties. Increasing the sand fraction percentage in the first three places (A, B and C) led to raising the values of BD in their profiles and vice versa in the fourth location (D). The highest value of BD recorded in the C location was attributed to increasing the sand fraction. While increasing BD values in the B site are interpreted not only by increasing sand percentage, but also by increasing agricultural service intensity using heavy machines in tillage that compact the soil layers. Increasing the values of HC and IR of the C site may be attributed to 1) increasing of sand percentage 2) using low tillage system by light machines 3) there is no agriculture intensification and no need to use the heavy machines. Generally, seasonal tillage with heavy machines coupled with the surface irrigation method (wet conditions) could be responsible for the compaction of soil layers and the slowdown of the infiltration rate. These findings should be considered in future research to improve the soil management programs in these examined areas particularly the fourth location that should stop flooding technique and turns to the drip or sprinkler method.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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