Egypt. J. Soil Sci. **44**, No. 1, pp. 97 - 107 (2004)

Calcareous Soil Definition from the Hydraulic and Physical Point of View

M.E. Shawky, S.B. El-Amir, H.M. Nasr, A.A. Wahdan* and M.A. Bakry*
Soil Science Department, Faculty of Agriculture, Cairo University; and Soil , Water and Environment Research Institute, Cairo, Egypt.*

CALCAREOUS soils are of a wide occurrence under arid and semiarid climates, where the presence of $CaCO_3$ are in considerable amounts. These soils cover more than one million feddan of agricultural soils and more than 30% of desert soil in Egypt.

One hundred and twenty soil samples were chosen from sixty soil profiles representing a wide range of $CaCO_3$ content and different textural classes were chosen in this study. The total and active $CaCO_3$ content were determined. Different physical and hydraulic properties were determined including, bulk density, aggregates size distribution, retention moisture characteristics, pore size distribution, infiltration rate, and saturated hydraulic conductivity.

A definition of the studied calcareous soils was found out. These soils can be defined from the hydraulic and physical point of view as the soils which contain more than 16, 15, and 16% total $CaCO_3$ content or more than 5,4, and 6% active $CaCO_3$ content in their relation to basic infiltration rate (BIR), saturated hydraulic conductivity (Ks) and the soil moisture constants. Generally, these soils can be also defined as the soils which contain more than 14 – 17% total $CaCO_3$ or 4 – 7% active $CaCO_3$ in relation to the whole soil hydraulic properties.

Keywords: Calcareous soil, Total carbonate, Active carbonate , Basic infiltration rate, Saturated hydraulic conductivity, Soil moisture constants.

Many definitions of calcareous soils were proposed in the last years. These definitions were mainly depending on the chemical properties and the total $CaCO_3$ content regardless the active $CaCO_3$ content and the physical and hydraulic properties of these calcareous soils.

Meester (1973) mentioned that "calcareous" is a general term for soil containing $CaCO_3$ "carbonatic" is well defined and "Marl" is used in geology, and the cement is used in industry for soft lime. According to the definition given by Hilal *et al.* (1973), the soil with a $CaCO_3$ content of 8% or more should be considered calcareous. The calcareous soils were defined by El-Gabaly (1973) as the soils containing amounts of calcium carbonate which affect distinctly soil physical and chemical properties and other properties related to plant nutrients, etc. Louay (1973) and Fitzpatric (1980) defined the calcareous soils as those soils with high calcium carbonate content whose physical problems of land and water use for crop production are primarily dominated by the high content of $CaCO_3$ especially the active fraction. Rozanov *et al.* (1982), said that calcareous soils are those having more than 5% (by weight) of free $CaCO_3$ in some horizons of profile. On the other hand, Balba (1987), mentioned that the soils are considerd calcareous when they contain more calcium carbonate under partial pressure for CO_2 in the ambient air.

Negm *et al.* (1990); Gile *et al.* (1998); El-sersawy (1999) and Senei & Mershedi (2000) found that, increasing active $CaCO_3$ content leads to a decrease of infiltration rate and saturated hydraulic conductivity.

Talha *et al.* (1986); Nasr (1989) and Mohamed & Awad (1998) found a highly and negative correlation between soil moisture constants and each of total and active $CaCO_3$ content in the calcareous soils. The main objectives of this study are: i) studying the main properties of the calcareous soils, (ii) studying the effect of total and active $CaCO_3$ content on the hydraulic properties, (iii) calculating some equations that help in determining the quantitative relationship between $CaCO_3$ % and the hydraulic properties and consequently defining the calcareous soils in relation to these properties.

Material and Methods

Sixty soil profiles were chosen to represent a wide range of total and active $CaCO_3$ content (2.5–75%) in the studied soils. These calcareous soils are covering different texture classes (from sandy, to clayey soils). The collected samples were subjected to the particle size analysis as described by Gee and Bander (1986). The wet sieve analysis was performed and the water stable aggregates were determined by a wet sieving devices as described by Kemper and Rosenu (1986). Soil moisture desorption curve (P^F), was determined using undisturbed soil samples. The completely saturated soil cores samples were exposed to constant levels of –10, -20, -33, -100, -300, -500 and –1500 KP_a. The attained water content percentage at each pressure was determined using the presseure Cooker and membrane (Klute, 1986). The soil moisture constants, *i.e.*, field capacity (FC), wilting percentage (WP) and available water capacity (AWC) were determined on volume basis from the moisture retained at pressure of 0.1, 0.2 and 0.33 atm, for the light textured soils, moderately textured soils and heavy textured soils, respectively, according to Massoud *et al.* (1971) and Talha *et al.* (1986). The pore size distribution was calculated according to Deleenheer and De-Boodt (1966). The saturated hydraulic conductivity (Ks) was determined with constant head method at laboratory (Klute and Drieksen, 1986). The basic infiltration rate (BIR) was measured using Double-ring infiltrometer as described by Witum and Strazeuki (1972). The total $CaCO_3$ content was determined gasiometerically as cited by Nelson (1982). The active $CaCO_3$ content was determined as percentage of soil weight, according to Yallon (1957).

Results and Discussion

Soil samples under investigations have different texture classes (clay, sandy clay, clay loam, loamy, loamy sand, sandy loam and sandy soils). Data presented in Table 1 show the range, mean and standard deviations (Sd) of the important studied soil hydraulic and physical properties. These data show a wide variations between the studied soil samples in their $CaCO_3$ content, physical properties and hydraulic properties.

TABLE 1. The range, mean and standard deviation (Sd) for the main soil physical properties of the soils under investigation.

Soil properties	Range	Mean	Sd
BIR (cm/h)	3.18 – 31.98	13.66	7.72
Ks (cm/h)	2.10 – 54.96	12.90	11.64
FC (%v/v)	9.10 – 40.18	27.37	9.45
WP (% v/v)	2.52 – 23.24	11.07	4.71
AWC (% v/v)	6.45 – 27.24	16.30	4.71
Total $CaCo_3$ %	3.60 – 62.50	27.83	14.01
Active $CaCo_3$ %	0.33 – 34.10	11.18	8.13
Clay %	2.14 – 52.50	21.31	13.48
Silt %	2.15 – 39.16	31.86	7.38
Sand %	3.03 – 88.28	31.02	18.02
Total aggregates %	23.94 – 61.10	40.73	8.80
2-1mm aggregates %	0.97 – 16.10	4.88	2.91
1- 0.5mm aggregates%	9.45 – 25.16	16.83	4.06
0.5-0.25 mm aggregates %	7.25 – 29.25	15.98	4.75
Total prosity (% v/v)	35.61 – 55.49	45.72	5.45
QDP %	8.29 – 29.18	18.36	4.80
SDP %	1.66 – 10.30	5.66	1.84
WHP %	3.12 – 21.82	10.64	3.55
F.C.P %	2.52 – 23.03	11.07	3.55
Applied pressure (KP_a):	**Moisture content under different suction**		
10 KP_a	9.19 – 45.10	27.37	9.45
20 KP_a	8.54 – 42.49	24.53	9.04
33 KP_a	6.22 – 40.18	21.71	8.35
66 KP_a	0.17 – 36.88	19.07	8.02
100 KP_a	4.72 – 33.18	17.17	7.10
300 KP_a	4.23 – 29.89	15.19	6.45
500 KP_a	3.10 – 26.58	13.39	5.88
1500 KP_a	2.52 – 23.03	11.07	5.24

Data presented in Table 2 show the simple correlation coefficients (r) between the studied hydraulic properties and the different soil parameters. It is clearly noticed that most of the studied soil physical parameters and $CaCO_3$ content affected the soil hydraulic properties of the calcareous soils. On the other hand, the step-wise statistical analysis program was computed between these hydraulic properties and all the studied physical parameters . The data revealed that the main soil properties affecting the hydraulic properties in the calcareous soils could be summarized in the following multiple regression equations:

TABLE 2. Simple correlation coefficients (r) between (BIR), (KS), (F.C), (WP) and (AWC) and the different soil physical parameters of the studied calcareous soils.

Soil properties	(r) (BIR)	(r) (KS)	(r) FC	(r) WP	(r) AWC
Particle size (%):					
Clay	-0.895**	-0.741**	0.923**	0.934**	0.812**
Slit	-0.755**	-0.636**	0.711**	0.707**	0.761**
Clay + silt	-0.861**	-0.767**	0.934**	0.864**	0.745**
Fine sand	0.309*	+0.060	-0.349**	-0.342**	-0.318**
Coarse sand	0.608**	0.821**	-0.899**	-0.878**	-0.727**
C. sand + F. sand	0.634**	0.731**	-0.787**	-0.691**	-0.776**
$CaCO_3$ (%):					
Total $CaCo_3$	-0.858**	-0.837**	0.891**	0.871**	0.819**
Active $CaCo_3$	-0.893**	-0.893**	0.906**	0.904**	0.814**
Water stable aggregates (%):					
Aggregates 5-2 mm	-0.149	-0.095	0.151*	0.093	0.101
Aggregates 2-1 mm	0.328*	0.532**	-0.215*	-0.179*	-0.231*
Aggregates 1-0.5 mm	0.680**	0.581**	-0.712**	-0.698**	-0.653**
Aggregates 0.5-0.25 mm	0.688**	0.588**	-0.651**	-0.592**	-0.641**
Mean weight diameter (MWD)	0.462**	0.463**	-0.403**	-0.412**	-0.355**
Pore size (%) :					
QDP	0.746**	0.708**	-0.909**	-0.866**	-0.802**
SDP	-0.561**	-0.579**	0.659**	0.517**	0.748**
WHP	-0.803**	-0.679**	0.911**	0.799**	0.939**
FCP	-0.887**	-0.768**	0.955**	0.999**	0.804**
Total porosity	-0.562**	-0.751**	0.556**	0.576**	0.799**

* significant at 5%
** significant at 1%.

$Y_1 = 13.208 - 0.314X_1\% + 0.00991X_2\% + 0.1622X_3\% + 0.1232X_4\% - 0.163X_5\%$. $R^2 = (0.908)^{**}$

$Y_2 = 11.913 - 0.751X_1\% + 0.918X_2\% + 0.039X_3\% + 0.312X_4\% - 0.306X_6\% + 0.697X_7\% - 0.697X_9\%$. $R^2 = (0.827)^{**}$

$Y_3 = 2.138 + 1.0X_{10}\% + 1.0X_9\% + 1.0X_8\%$. $R^2 = (1.00)^{**}$

$Y_4 = 14.839 + 0.363X_1\% \quad 0.036X_2\% + 0.723X_3\% + 0.142X_5\% + 0.057X_6\% \quad 0.348X_7\% + 0.253X_9\%$. $R^2 = (0.838)^{**}$

$Y_5 = 26.124 + 0.569X_1\%0.191X_2\% + 0.138X_5\% + 0.224X_6\% + 0.662X_7\% + 0.387X_{10}\%$. $R^2 = (0.909)^{**}$

Where :
Y_1 = basic infiltration rate (BIR, Cm/h) .
Y_2 = saturated hydraulic conductivity (Ks, cm/h) .
Y_3 = soil moisture content at field capacity (FC) (%volume) .
Y_4 = soil moisture content at wilting percentage (WP) (% volume) .
Y_5 = soil moisture content at available water capacity (AWC) .
X_1 = active $CaCO_3$ content (%) .
X_2 = coarse sand (%) .
X_3 = water stable aggregates (1 – 0.5 mm diameter) (%).
X_4 = water stable aggregates (0.5 – 0.25 mm diameter) (%) .
X_5 = clay content (%) .
X_6 = silt content (%) .
X_7 = quickly drainable pores (QDP) (%) .
X_8 = slowly drainable pore (SDP)(%) .
X_9 = water holding pores (WHP) (%) .
X_{10} = fine capillary pores (FCP) (%) .

The above mentioned relations, indicated that the active $CaCO_3$ content and some physical parameters are governing the variations in most of the studied soil hydraulic properties. Subsequently, in order to define the studied calcareous soils in relation to their hydraulic properties (BIR, KS, FC, WP and AWC), the relationship between these hydraulic properties and each of total and active $CaCO_3$ content were expressed through a linear, logarithmic, exponential, power, and quadratic equations as presented in Tables 3 and 4. The equations indicate that, the power equation (best fitting relationship) can be used in plotting the relationships between these hydraulic properties and each of total and active $CaCO_3$ percentages, (Fig . 1 a, b, c, d, e, f). From these power equations, the rate of change was calculated of soil hydraulic properties and each of total and active $CaCO_3\%$ (dy/dx) were calculated. When the rate of change becomes nearly to be constant (*i.e.*, dy/dx = ±1), indicating that such properties become nearly constant with increasing values of total or active $CaCO_3\%$. Therefore, from the soil hydrology point of view, the values represent the lower limits of total or active $CaCO_3\%$ can be considered threshold values for the calcareous soils. The obtained formula were used to calculate such values to the soil from hydraulic properties point of view (Table 5). Generally, the calcareous soils can be defined from hydraulic properties point of view as those which contain more than 14-17% total $CaCO_3$ or 4 – 7 % active $CaCO_3$.

TABLE 3. The relationships between each of basic infiltration rate (BIR), saturated hydraulic conductivity (KS cm/h) and total carbonate (X_1) and active carbonate (X_2) of the studied soils.

Equation type	BIR(Y_1)		KS(Y_2)	
	Equation	r	Equations	r
Linear	$Y_1 = 26.76 - 0.471\ X_1$ $Y_1 = 25.698 - 0.109\ X_2$	-0.794** -0.765**	$Y_2 = 21.896 - 0.666\ X_1$ $Y_2 = 34.381 - 9.882\ X_2$	-0.762** -0.939**
Exponential	$Y_1 = 33.523\ e^{-0.0389X_1}$ $Y_1 = 25.47\ e^{-0.0723X_2}$	-0.812** -0.851**	$Y_2 = 168.84\ e^{-0.0479X_1}$ $Y_2 = 116.166\ e^{-0.08279X_2}$	-0.886** -0.939**
Logarithmic	$Y_1 = 46.318 - 10.595\ \mathrm{Ln}\ X_1$ $Y_1 = 25.698 - 6.109\ \mathrm{Ln}\ X_2$	-0.898** -0.817*	$Y_2 = 45.479 - 10.791\ \mathrm{Ln}\ X_1$ $Y_2 = 24.421 - 6.534\ \mathrm{Ln}\ X_2$	-0.786** -0.836**
Power	$Y_1 = 143.755\ X_1^{-0.8046}$ $Y_1 = 28.690\ X_2^{-0.47119}$	-0.898** -0.925**	$Y_2 = 221.387\ X_1^{-0.9978}$ $Y_2 = 31.676\ X_2^{-0.6156}$	-0.897** -0.913**
Quadratic	$Y_1 = 32.27 - 0.965X1 + 0.0085\ X_1^2$ $Y_1 = 26.50 - 1.728\ X_1^2 + 0.347\ X_2^2$	0.889** 0.941**	$Y_2 = 47.526 - 2.88X1 + 0.025\ X_1^2$ $Y_2 = 33.498 - 3.151X2 + 0.0722\ X_2^2$	-0.873** -0.846**

TABLE 4 . The best fitting equations between each of soil moisture at field capacity (Y_1), wilting point (Y_2) and available moisture capacity (Y_3) and each of total carbonate content (X_1) and active carbonate content (X_2) , of the studied soil samples.

Equation type	Field capacity (Y_1)		Wilting point (Y_2)		Available moisture content (Y_3)	
	Equation	r	Equation	r	Equation	r
Linear	$Y_1= 10.632+0.6013 X_1$ $Y_1 = 12.879+0.352X_2$	0.8914** 0.896**	$Y_2= 1.996+0.326 X_1$ $Y_2= 4.55539+0.5826X_2$	0.9592** 0.958**	$Y_3 = 8.635 + 0.275X_1$ $Y_3= 9.491+0.491X_2$	0.815** 0.854**
Exponential	$Y_1 = 12.98 e^{0.024X1}$ $Y_1= 16.042 e^{0.0417X_2}$	0.879** 0.872**	$Y_2= 3.759 e^{0.034 X_1}$ $Y_2= 5.031 e^{0.0587X_1}$	0.808** 0.867**	$Y_3= 9.203 e^{0.0188X_1}$ $Y_3= 10.906 e^{0.0316X_2}$	0.809** 0.789**
Logarithmic	$Y_1= -13.149 + 12.83 \ln X_1$ $Y_1= 12.879 + 7.53 \ln X_2$	0.879** 0.898**	$Y_2= -10.248 + 6.0752 \ln X_1$ $Y_2= 3.461 + 3.861 \ln X_2$	0.834** 0.849	$Y_3= 2.901 + 6.081 \ln X_1$ $Y_3= 9.417 + 3.491 \ln X_2$	0.836** 0.854**
Power	$Y_1= 5.25116 X_1^{0.0488}$ $Y_1= 14.0688 X_2^{0.28002}$	0.916** 0.9379**	$Y_2= 0.866 X_1^{0.765}$ $Y2= 0.962 X_2^{0.875}$	0.901** 0.932**	$Y_3= 5.387 X_1^{0.30615}$ $Y_3= 10.47 X_2^{0.1741}$	0.887** 0.914**
Quadratic	$Y_1= 6.47 + 0.97 X_1 - 0.0064 X_1^2$ $Y_1= 12.55 + 0.84X_2 - 0.0302 X_2^2$	0.903** 0.931**	$Y_2=1.69+0.4002X_1- 0.0013 X_1^2$ $Y_2=3.644+0.819X_2- 0.0091 X_2^2$	0.852** 0.911**	$Y_3=5.303+0.5742X_1- 0.005 X_1^2$ $Y_3=8.912+1.0206X_2 - 0.021 X_2^2$	0.852** 0.868**

* significant at 5% ** significant at 1%

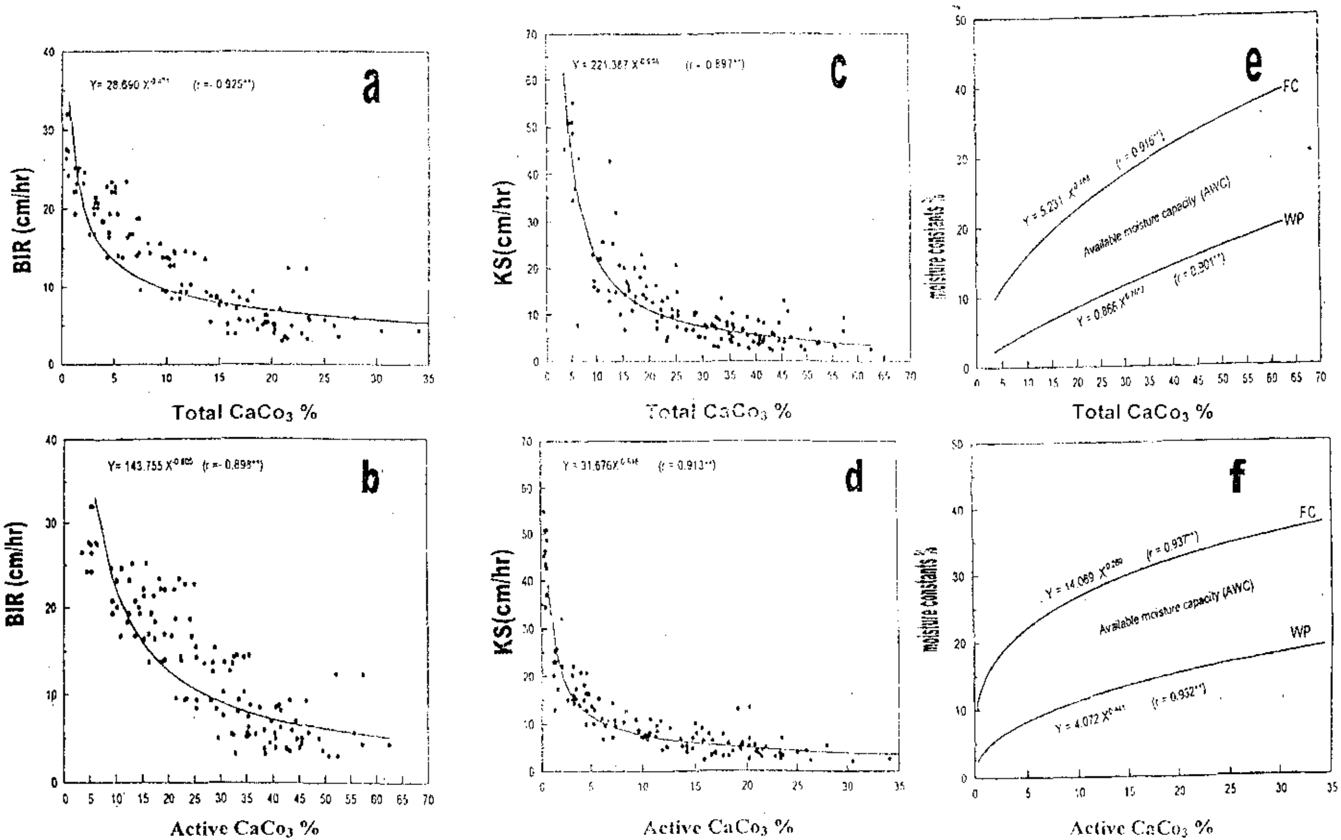

Fig.1. The relationship between total and active carbonate and each of BIR, KS,FC, WP, and AWC of the studied soils .

TABLE 5. Predicted values of total $CaCO_3$% and active $CaCo_3$% for defining the studied calcareous soils in relation to some hydraulic and physical properties.

Hydraulic properties	Total $CaCO_3$ (%)	Active $CaCo_3$ (%)
Basic infiltration rate (BIR)	16	5
Saturated hydraulic conductivity (Ks)	15	4
Soil moisture content at:		
Field capacity (FC)	15	7
Wilting point (WP)	17	6
Available water capacity (AWC)	14	5
Mean	16	6

Reference

Balba, A.M. (1987) Soil reclamation and improvement. *Alex. Egypt. J. Agric.*, 189.

Deleenher, L. and De Boodt, M. (1966) *Soil Analysis,*International training Center for Post graduate. Soil Sci. Gent, Belgium.

El-Gabaly, M.M. (1973) Reclamation and management of the calcareous soils of Egypt. *FAO soils Bull.* **21**,123.

El-Sersawy, M. (1999) Improvement of soil water properties and their reflection on fodderbeet production under the condition of saline calcareous soils of Wadi Sudr, South Sinai. *Desert Institute Bulletin Egypt* **46**, 241.

Fitzpatrick, E.A. (1980) *"Soil-Their Formation,Classification and Distribution"*, Longman Group Lyd, London.

Gee, G.W. and Bander, J.W. (1986) Particle size analysis. In: *"Methods of soil Analysis"*, Part 1, A.Klute (Ed.), Agronomy No. 9.

Gile, J.; Corral, I.; Contreras, C.; Bermudez, T. and Jejada, M. (1998) Structure stability of calcareous Mediterranean soils from southern Spain. *Cencia dei Suelo* **16**, 128, Spain.

Hilal, M.H.; Anter, F. and El-Damaty, M. (1973) A chemical and biological approach towards the definition of calcareous soils. I. Movement and retention of P^{32} in soils as affected by percentage and particle size of calcium carbonate. *Plant and Soil* **39**, 469.

Kemper, W.D. and Rosenu, R.C. (1986) Aggregate stability and size distribution. In: *"Methods of Soil Analysis"*, Part, 1, A. Klute (Ed.), Agronomy No. 9, pp 635- 662.

Klute, A. (1986) Water retention: Laboratory method. In: *"Methods of Soil Analysis"*, A. Klute (Ed.), Part 1. 2nd ed . Agronomy No. 9, pp. 635 - 662.

Klute, A. and Driksen, C. (1986) Hydraulic conductivity and diffusivity: Laboratory methods. In: *"Methods of Soil Analysis"*, part1., A. Klute (Ed.), pp. 687-734, American Soc. Agronomy, Madison WI. USA.

Louay, T. (1973) Distributions of calcareous soils in the near East region, their reclamation and land use measures and achievements". *FAO Soils Bulletin*, 21,17.

Massoud, F.I., El-Gably, M.M. and El-Tality, A.F. (1971) Moisture characteristics of the highly calcareous soils of Mariut extension project Egypt. *Alex. J. Agric. Res.* **19**, 351.

Meester, T. De. (1973) Highly calcareous lacustrine soils in the Jreat Konya Basin Tureky. *Agric. Res. Rep.* 752.

Mohamed, S. and Awad, Y. (1998) Evaluation of the physical and chemical properties of soils with application of wheat straw and waste-water sludge. *Arab Univ. J. Agric. Sci.* **6**, 597.

Nasr , H.M. (1989) Water use Efficiency and seedling emergence as affected by soil crust formation in Egyptian Calcareous soils. *Ph. D. Thesis*, Fac. Agric., Ghent Univ., Belgium.

Negm, H.A.; Fanous, N.E. and Mikhail, M.I. (1990) Some correlations between physical and chemical properties of Maryut desert soils . *Egypt . J. Soil Sci.* **30**, 91.

Nelson, R.E. (1982) Carbonate and gypsum. In: "*Methods of Soil Analysis*", part 2, page (Ed.), pp. 181-197, A5, Agronomy Nomograph No. 9, Madison, Wisconsin.

Rozanov, B.G.; Gewaifel, I.M. and Esavi, M.E. (1982) Genesis of calcareous soils of the Mediterranean cost of Egypt. Translated *from pochvovedeiye* 3, 22 (*c.f.* A.M. Moustofa *M.Sc. Thesis*, Fac. Agric. Alex. Univ., 1987)

Senei, A. and Morshedi, A. (2000) Hydraulic conductivity of calcareous soils as affected by salinity and sodicity. *Communication in Soil Science and Plant Analysis* **31**, 69, Shiraz, Iran.

Talha, M.; Abd El-Samie, A.G. and Ghazy, A. (1986) Soil moisture characteristics of calcareous soils. *Egypt. J. Soil Sci.* **19**, 105.

Witum, Z. and Strazeuki, K. (1972) *"Soil Mechanics in Foundation Engineering"*, Vol. **1**, pp. 81-109, International text Book company ltd.

Yallon, D.H (1957) Problems of soil testing on calcareous soils. *Plant and Soil* **8**, 275.

Recevied 10/2002

تعريف الأراضـــي الجيريـــة مـــن خـــلال الصـــفات الفيزيائيـــة والهيدروليكية للتربة

محمد عصام الدين شوقي ، صلاح الدين بكر الأمير ، حمدي محمد نصر ، عواطف أيوب وهدان* و محمد عادل أحمد بكري*.
كلية الزراعة – جامعة القاهرة – قسم الأراضي و * معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – القاهرة – مصر .

تنتشر الأراضي الجيرية في المناخ الجاف وشبه الجاف ، حيث تتوافر كربونات الكالسيوم بكميات ملموسة . وتغطي هذه الأراضي اكثر من مليون فدان من الأراضي الزراعية واكثر من ٣٠ ٪ من صحراء مصر .

اختير في هذه الدراسة مائة وعشرون عينة تربة من ستين قطاعا أرضيا ممثلة لمدى واسع من كربونات الكالسيوم ورتب قوامية مختلفة. تم تقدير كميات كربونات الكالسيوم الكلية وكربونات الكالسيوم النشطة. كما قدرت الخواص الفيزيائية والهيدروليكية المختلفة للتربة والتى شملت الكثافة الظاهرية ، التوزيع الحجمي للتجمعات ، خواص الشد الرطوبي ، التوزيع الحجمي للمسام ، معدل الرشح والتوصيل الهيدروليكي المشبع.

تم تعريف الأراضي الجيرية المدروسة . وتعرف هذه الأراضي من الناحية الفيزيائية والهيدروليكية على أنها تلك الأراضي التي تحتوى على اكثر من ١٦، ١٥ ، ١٦ ٪ كربونات كالسيوم كلية أو اكثر من ٥ ، ٤ ، ٦ ٪ كربونات كالسيوم نشطة وذلك من خلال علاقتها بمعدل الرشح الأساسى ، والتوصيل الهيدروليكى المشبع والخواص الرطوبية الثابتة للتربة.

وبصفة عامة تعرف الأراضى الجيرية على أنها تلك الأراضي التي تحتوي أكثر من ١٤- ١٧٪ كربونات كالسيوم كلية ، أو أكثر من ٤-٧ ٪ كربونات كالسيوم نشطة من وجهة نظر علاقتها بالخواص الهيدرولوكية للتربة مجتمعة.