Open Journal of Soil Science, 2012, 2, 263-268
http://dx.doi.org/10.4236/ojss.2012.23031 Published Online September 2012 (http://www.SciRP.org/journal/ojss)

Comparison between Calcimetric and Titrimetric Methods for Calcium Carbonate Determination

Pakhshan M. Maulood, Akram O. Esmail*, Mohammed S. S. Dohuki, Dalshad A. Darwesh

Soil and Water Department, College of Agriculture, Salahaddin University, Erbil, Iraq.
Email: *arez96y@yahoo.com

Received May 17th, 2012; revised June 20th, 2012; accepted July 5th, 2012

ABSTRACT

This study was conducted during 2008-2009 ,which included calcium carbonate determination from 84 locations (40 soil samples from Erbil, 24 samples from Sulaimani and Kirkuk in addition to 20 samples from Duhok) using calimetric and titration method. The results indicated to significance correlation coefficient between the studied methods or it means that the results of both methods are similar.

Keywords: Calcium Carbonate; Calcimeter; Calcareous Soil

1. Introduction

Most soils of agricultural areas are calcareous and have an alkaline reaction. pH of calcareous soils is mainly controlled by the amount of calcium carbonate in the soil profile and often is fluctuating between 7.5 to 8.2. Existence or absence of calcium carbonate has an important effect on soil pH and therefore, controlling many chemical reactions in relation to nutrient availability for plants and mobility of these elements in soil [1]. Carbonate is a natural constituent of many soil in the world, most carbonate minerals found in Iraqi soils are calcite ($CaCO_3$) and represent 90% - 95% of total soil carbonates [2]. The distribution and amount of carbonates influence soil fertility. The increase of calcium carbonate in soil usually leads to many problems related to fertilization and nutrient availability. The extent and rate are affecting by the amount of carbonates in the soil, the chemical and physical nature of the carbonates (e.g., particle size and mineralogy) [3,4] Carbonates exert a major effect on soil chemical properties of calcareous soils, like nutrient availability and phosphorus fixation due to chemical fixation of 70% - 90% of applied phosphorus fertilizer to the soil [5]. Soil survey staff [6] indicated to increase in soil pH with increasing soil $CaCO_3$ content. Some attempts have been done to evaluate methods of carbonate determination in arid and semiarid soils including calcareous soils [7-10]. A suitable, accurate method of determining limestone is required whenever quantitative measurements are sought, such as in soil fertility problems where limestone dissolution rates are to be determined, or where lime recommendation procedures take into account residual limestone [11]. The aim of this study is to compare between two methods of $CaCO_3$ determination (Acid neutralization method and calcimetric method).

2. Materials and Methods

The studied soil samples were taken from 84 locations (40 soil samples from Erbil, 24 samples from Sulaimani and Kirkuk in addition to 20 samples from Duhok), during 2008-2009 (**Figures 1-3**). Soils were air dried ground and sieved through 2mm sieve. The equivalent calcium carbonate (E-$CaCO_3$) was determined using 0.5 M HCl for dissolution of $CaCO_3$ and determined between the two titration of the excess acid by using 0.2M NaOH as mentioned by [12]. The second method of E-$CaCO_3$ determination was using calcimeter method as mentioned by [13]. The simple correlation coefficient n (r) was determined between the two studied methods [14].

3. Results and Discussion

The soils $CaCO_3$ content of the studied locations were ranged from (20 - 365.3 $g \cdot Kg^{-1}$ soil) for the soils of Erbil, Sulaimani and Duhok respectively (**Tables 1-3**). The statistical analysis indicated that the correlation co- efficient values (r) between the studied two methods for the three locations (Erbil, Sulaimaniya and Duhok) were (0.993**, 0.998** and 0.994**) respectively (**Figures 4-6**). It means there is a significance correlation between calcimetric and titrimetrc method, or it means the results of both methods are similar and both methods

*Corresponding author.

Table 1. Shows determination of calcimetric and titrimetric methods of calcium carbonate in soil t of Erbil governorate.

Sites No.	Locations	Calcimetric Method	Titrimetric Method	Sites No.	Locations	Calcimetric Method	Titrimetric Method
1	Kalak	287	274	21	Halgort Mountain	20	25
2	Guwer	298.1	297.5	22	Akoyan	227.3	223
3	Yarmcha	312.9	316	23	Rosty	37.3	35
4	Mala-Qara	253	263	24	Hasarot	209.3	199.5
5	Erbil	246.4	239.2	25	Choman	64.7	64
6	Qushtapa	276.3	289	26	Rayat	41	53.5
7	Derband	137	128.5	27	Azadi	209.3	191.8
8	Degala	175.2	188	28	Haji-Omran	152	195
9	Koysenjaq	141.6	153.5	29	Haji-Omran	93.1	91
10	Koysenjaq	239.7	225	30	Chame-Beaje	211.1	202
11	Qarasenj	140.8	140	31	Khalan	216.6	202
12	Bastora	290.9	292.3	32	Mergasor	201.4	193
13	Shaqlawa	209.1	198	33	Malman	291.2	292.3
14	Mama-Jelka	67.1	72.5	34	Soran Village	108.3	112
15	Harer	193	187.5	35	Ashkafta	112	122
16	Spelek	79.1	71.5	36	Rezan	53.3	51.5
17	Jundeyan	220.3	231	37	Barzan	361.4	362
18	Zar-Gali	219.9	205.5	38	Maran	18.6	16
19	Rawndouz	138.1	131.8	39	Peran	15	18.5
20	Soran	55.9	55	40	Mandan	161	171

Table 2. Shows determination of calcimetric and titrimetric methods of calcium carbonate in soils of Sulaymani and Kirkuk governorate.

Sites No.	Locations	Calcimetric Method	Titrimetric Method	Sites No.	Locations	Calcimetric Method	Titrimetric Method
1	Ranya	44.5	43.5	13	Serwan	89.4	81.5
2	Ranya	63.4	65	14	Halabja	108.1	101
3	Qalat Dizah	16.8	18.5	15	Khormal	83.9	88.5
4	Haybat Sultan	163.9	170	16	Bayara	37.8	40
5	Kani Watman	164	170	17	Balkha	49	55.5
6	Kelka smaqa	137.9	132.5	18	Tawela	22.4	28.5
7	Dukan	294.9	292.5	19	Altun Kupri	201.6	199.9
8	Basneh	66	59	20	Kirkuk	153	156
9	Qalat Cholan	65.2	70.5	21	Kirkuk	192.2	192.3
10	Sulaymaniyah	190.4	193	22	Chemano	317.73	313
11	Said Sadek	145.3	151	23	Qara Hanjer	309.9	311
12	Derbandikhan	253.3	252.3	24	Chamchamal	242.6	253

Table 3. Shows determination of calcimetric and titrimetric methods of calcium carbonate in soils of Duhok governorate.

Sites No.	Locations	Calcimetric Method	Titrimetric Method	Sites No.	Locations	Calcimetric Method	Titrimetric Method
1	Qandil bridge	258.2	251	11	Duhok	246.1	251
2	Gawelan	365.3	360	12	Zaweta	203.1	192.5
3	Aqrah	160.3	172.8	13	Mam-Yazden	339.4	329.6
4	Gali-Zanta	323.4	325	14	Swaratuka	185.5	192
5	Lalesh mountain	114.2	101.8	15	Solaf	196	192
6	Atrush	248.8	242.5	16	Serseng	193.6	192.2
7	Atrush mountain	304.4	306	17	Serseng	226.2	221.8
8	Baadrae	242.1	242.3	18	Kani Chnarkae	163.9	170
9	Gali-Derkae	315.8	320	19	Qadash	201.7	192.3
10	Duhok	247.3	251	20	Zakho	251.3	250

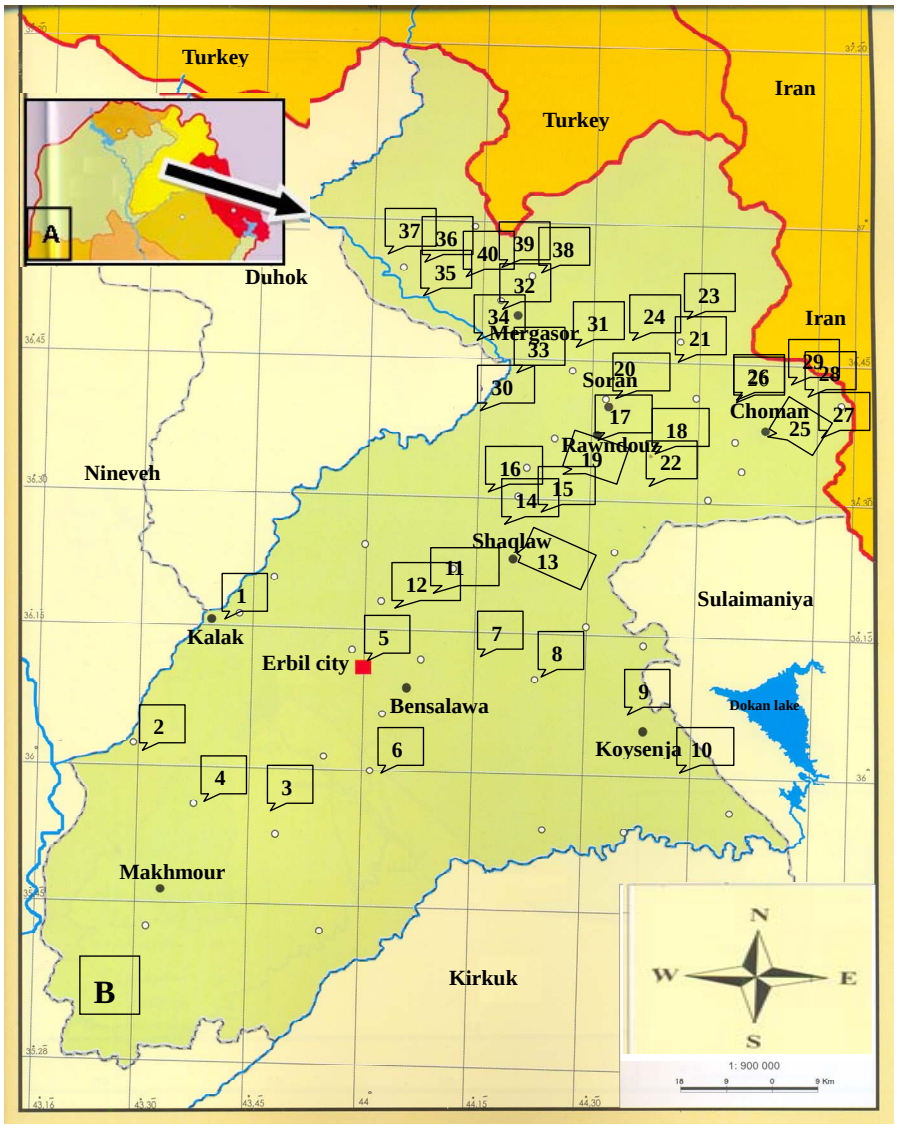

Figure 1. Shows: (A) Map of northern governorate of Iraq; (B) Erbil governorate, sampling sites.

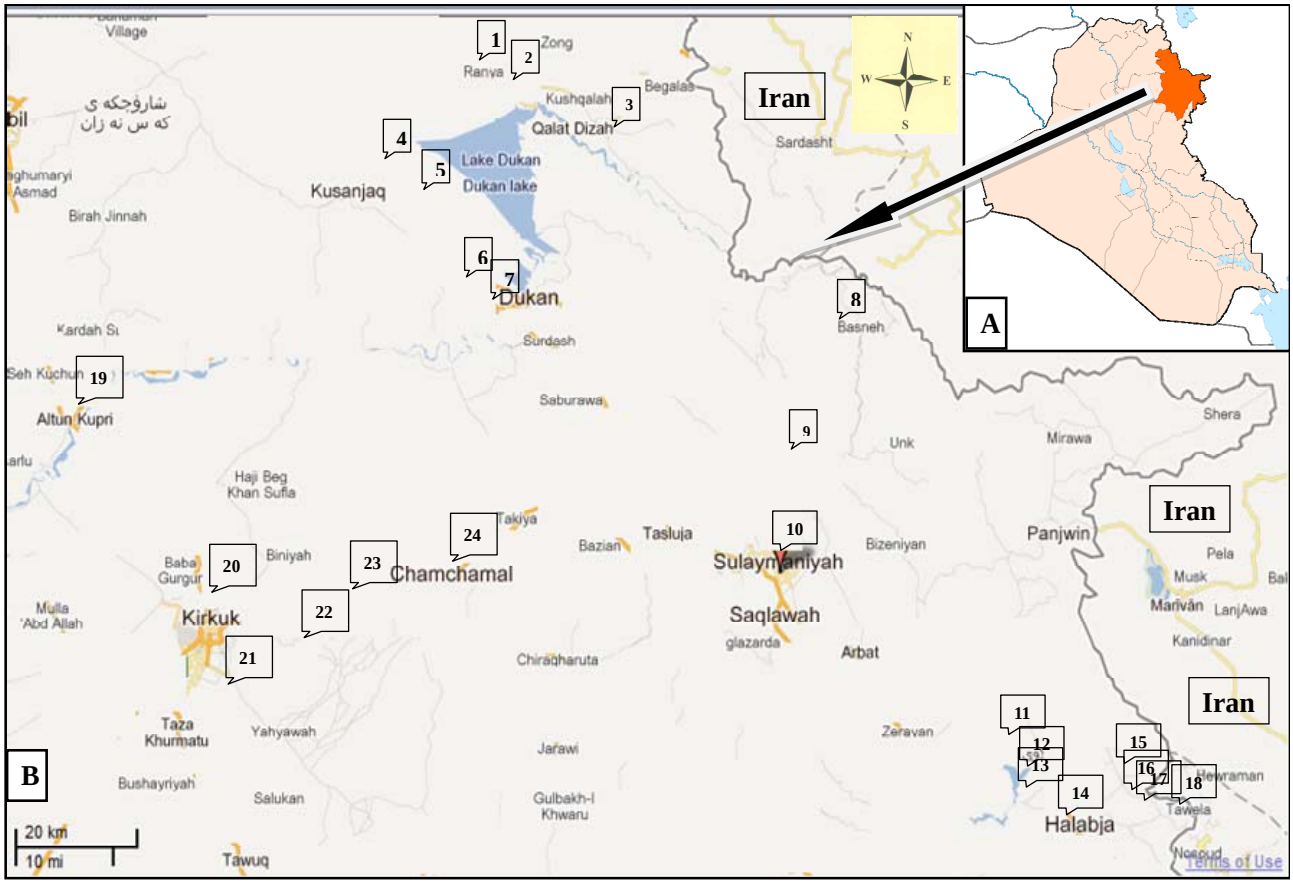

Figure 2. Shows: (A) Map of Iraq; (B) Sulaymaniyah and Kirkuk governorates, sampling sites.

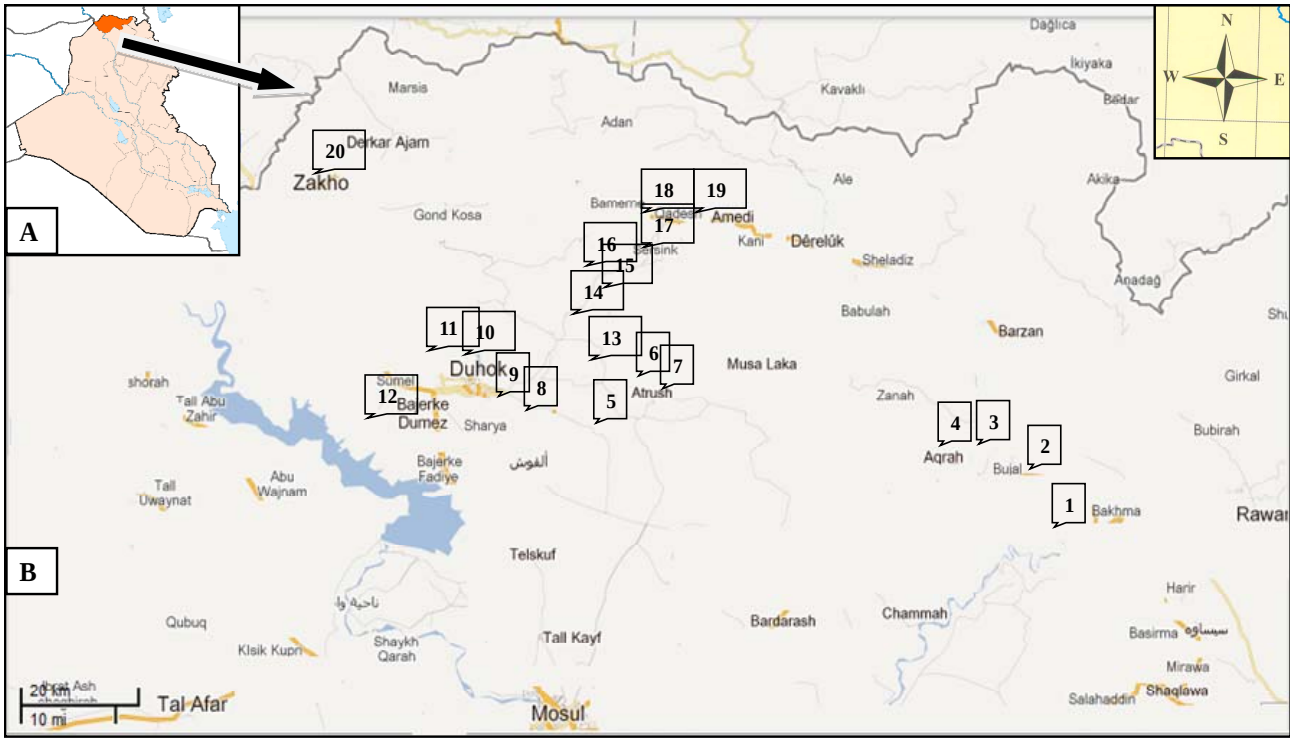

Figure 3. Shows: (A) Map of Iraq; (B) Duhok governorate, sampling sites.

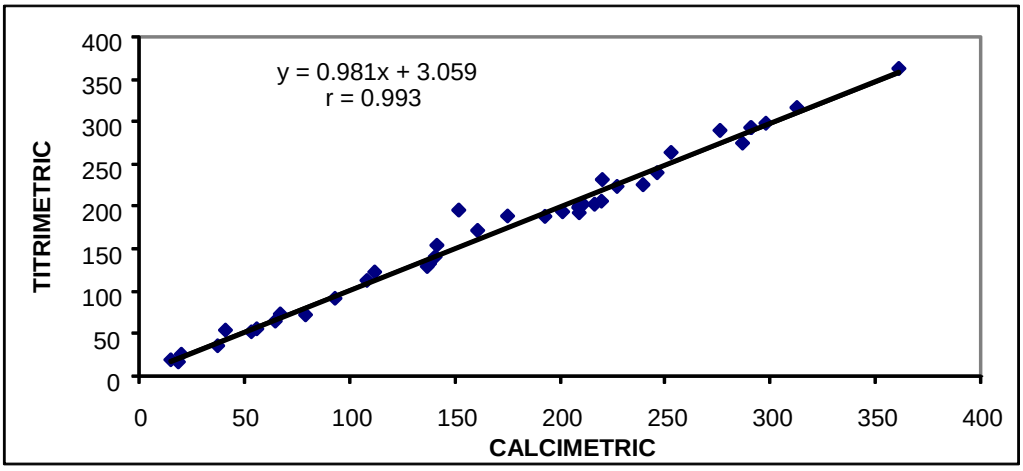

Figure 4. The relationship between titrimetric and calcimetric methods of calcium carbonate determination in soil of Erbil governorate.

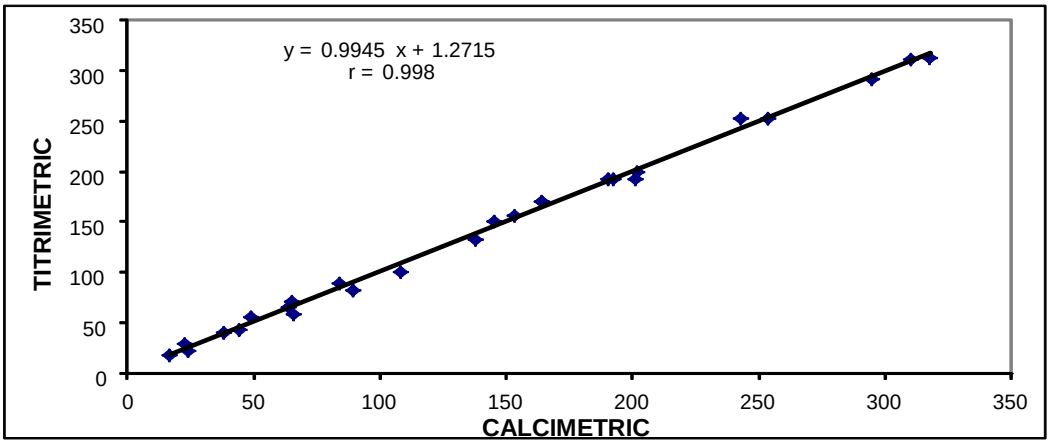

Figure 5. The relationship between titrimetric and calcimetric methods of calcium carbonate determination in soils of Sulaymani and Kirkuk governorates.

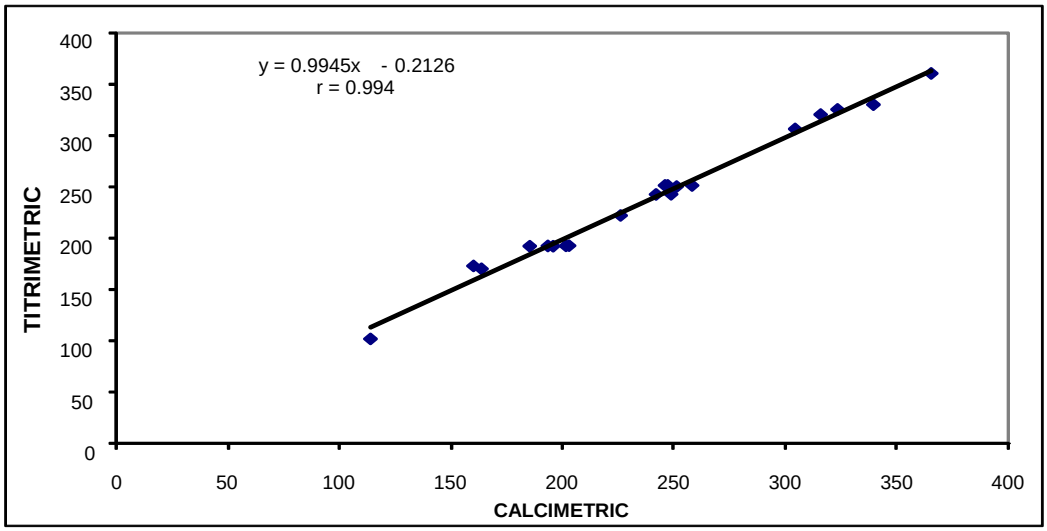

Figure 6. The relationship between titrimetric and calcimetric methods of calcium carbonate determination in soils of Duhok governorate.

Table 4. A comparison of equivalent calcium carbonate determination by two methods in soil samples of Kurdistan Region governorate, data represented as (mean ± SE).

Governorate	Calcimetric Method	Titrimetric Method	Differences
Erbil	169.62 ± 14.78	169.47 ± 14.61	0.15
Sulaimaniya and Kirkuk	139.90 ± 18.22	140.40 ± 18.15	–0.50
Duhok	239.33 ± 14.61	237.79 ± 14.60	1.54

have the same scientific base. The differences shown in (**Table 4**) between mean values of E-$CaCO_3$ content of soil samples measured by the two mentioned methods are non significance. A little difference observed between two methods for soil samples of Erbil, Sulaimaniya-Kirkuk governorates that reached to 0.15 and −0.5 respectively. While the differences was 1.54 unit for Duhok soil samples. Generally, soil samples for E-$CaCO_3$ content were increased gradually from Sulaimaniya-Kirkuk, to Erbil toward Duhok governorate.

REFERENCES

[1] F. Sarmadian, A. Keshavarzi and A. Malekian, "Continous Mapping of Topsoil Calcium Carbonate Using Geostatistical Techniques in a Semi-Arid Region," *Australian Journal of Crop Science*, Vol. 4, No. 8, 2010, pp. 603-608.

[2] S. Al-Kaysi, "Effect of Wetting-Drying Cycles of Soils on Carbonate and Phosphorus Adsorption. Physical and Chemical Properties of Carbonate," 5*th Scientific Science Research Council* (*Baghdad*, *Iraq*), Vol. 1, No. 2, 1989, pp. 29-36.

[3] Y. S. Hamid, "Dissolution Kinetics of Carbonates in Soil," Ph.D. Dissertation, Szent Istvan University, Hungary, 2009.

[4] M. C. del Campillo, J. Torrent and R. H. Loeppert, "The Reactivity of Carbonates in Selected Soils of Southern Spain," *Geoderma*, Vol. 52, No. 1-2, 1992, pp. 149-160. doi:10.1016/0016-7061(92)90080-Q

[5] J. L. Havlin, J. D. Beaton, S. I. Tisdale and W. L. Nelson, "Soil Fertility and Fertilizers," 7th Edition, Pearson Education Inc., Singapore City, 2007.

[6] Soil Survey Staff, "Soil Taxonomy," USA Printing Office, Washigton DC, 1999.

[7] N. A. K. Hassan and B. H. Al-Tawil, "A Study on Lime Status of Iraq Soils," Ministry of Higher Education and Scientific Research, Baghdad, 1973.

[8] W. M. Van Lierop and A. F. Mackenzie, "Carbonate Determination in Organic Soils," *Canadian Journal of Soil Science*, Vol. 54, No. 4, 1974, pp. 457-462.

[9] R. E. Nelson, "Carbonate and Gypsum," *Agronomy Journal*, Vol. 9, 1982, pp. 181-197.

[10] Y. El-Mahi, I. S. Ibrahim, H. M. Abd-Majid and A. M. Eltilib, "A Simple Method for Determination of Calcium Carbonate in Soils," *Soil Scientific Society American Journal*, Vol. 51, No. 11, 1987, pp. 1152-1155.

[11] F. Lamas, C. Irigaray, C. Oteo and J. Chacon, "Selection of the Most Appropriate Method to Determine the Carbonate Content for Engineering Purposes with Particular Regard to Marls," *Engineering Geology*, Vol. 81, No. 1, 2005, pp. 32-41. doi:10.1016/j.enggeo.2005.07.005

[12] A. Dreleimanis, "Quantities Gasometric Determination of Calcite and Dolomite by Using Chittick Apparatus," *Journal of Sedimentary Petrology*, Vol. 32, No. 3, 1962, pp. 20-29.

[13] S. I. A. Al-Sulaivani, "Physicochemical Behavior of Ortho and Pyrophosphate in Some Calcareous Soils from Northern of Iraq," Ph.D. Dissertation, University of Baghdad, Baghdad, 1993.

[14] V. Gupta, "SPSS for Beginners," VJBooks Inc. Publishers, 1999. www.vgupta.com

