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The Analysis of Al Guarshah Agricultural Project Soil Estimation of TDS, pH, Available Chloride, Carbonate and Bicarbonate

Hawaa S. Elferjani[1], Samira A. Ben Mussa[2], Mabrouka A. El –Shakhi[3], Noria A. El zanati[4]

Department of Chemistry, Faculty of Science, University of Garyounis, Benghazi, Libya 2008

Abstract: ***The present work was devoted to the study Chloride, carbonate, bicarbonate pH, conductivity and TDS values of Al Guarshah agricultural project. Samples were collected in April month, from deferent places at different depths by using of auger. Before sieving leaves, grass and any large external objects should be removed. The samples were dried at room temperature by air. Sieving was done mechanically by mechanical sieving apparatus and passed through a sieve with a 2 mm mesh. Extraction was done by mechanical shaker. Chloride ion determined by volumetric titration with standard solution of silver nitrate and potassium chromate as indicator. Carbonate and bicarbonate was determined by titration with 0.01N H_2SO_4 and ph.ph. and methyl orange indicators. The results were compared with previous studies for central lab of soil and water and Phosyn results.***

Keywords: Soil, Extraction, chloride,CO_3^{2-},HCO_3^-,TDS, pH .

1. Introduction

Soil is a mixture of minerals, water, air and living organisms. Soil is formed by the weathering of parent rock and the decomposition of organic matter. The physical and chemical properties of soil can vary considerably with geographical location.

Soil has numerous uses but the most vital is their use for growing crops, without which no human or animal could survive. The main characteristic of the soil is its fertility, or bioproductivity, and it is property that is utilized by agriculture. The fertility depends on physical features such as soil depth and texture (i.e. proportion of sand, sandy-loam, clay-loam and clay in soil mineral mass), chemical (pH, buffering capacity, content of various nutrients)[1]. Soil solution supplies a part of the food nutrients absorbed by plants from the soil is necessary to know the nature and behavior of soil solution. Before, however the nature of soil solution can be studied it is necessary to separate it from the soil mass in the form in which it exists. Its separation from the soil mass, however, is not a simple matter, as any attempt to do so at changes its composition [2]. The amount of acid or alkali in the soil determines the availability of many nutrients for plant growth and maintenance. It is important that the soil have the correct balance of acid and alkali for the amount of nutrients to be released from the soil particles for their use. Most plants grow best when the soil pH is between 5.5 and 6.5 (on the slightly acid side of neutral). If soil tests too low, the pH can be raised by applying lime (calcium and magnesium compounds). If soil tests too high, the pH can be lowered by applying sculpture or aluminum sulphate[3]. when rain percolates freely through well- drained soil, some of these dissolved ionic species are retained at various depths by interaction with soil particles. At time, weathering and leaching can cause dissolution of elements from the soil. Soil pore water composition therefore is determined by a combination of removal and dissolution reaction. Salt-affected soils are classified with respect to their pH , electrical conductivity (EC)of the solution extract[4]. Plants grown on saline soils tend to be relatively small in size, three theories have been advanced to account for different aspects of the detrimental effects of soil salinity: the water availability theory, the osmotic – inhibition theory, and the specific toxicity theory. In some instances, differential plant response to salts having a common ion may be attributable to the common ion. Such was the case with sodium chloride and sodium sulfate. The excess uptake of chloride was presumed to be largely responsible for the unfavorable effect of the calcium chloride because the limited information obtained on calcium indicated that the calcium content of the leaves was not increased. Chloride is blamed more frequently than any other specific ion for poor growth of plants on salty soils. The general impression of the magnitude of specific ionic effects in salty soils perhaps is exaggerated [5].

2. Experimental Part

2.1 Preparation of Soil Samples

1) Soil samples were collected from Al Guarshah agricultural project, south of Benghazi.
2) Five samples were collected from different places by using auger at different depths (from 0 to 100cm). The auger, simple in design and easy to use, is suitable for the sampling of hard soils. It consists of a sharpened spiral blade attached to a central metal rod which can be screwed into the soil. The auger was screwed to the desired depth and the sample was withdrawn.
3) Soil samples were transferred to plastic bags and were labeled.
4) In the laboratory, the samples were dried at room temperature by air. Leaves, grass and any external objects were removed.
5) Sieving was done in mechanical engineering lab by mechanical sieving apparatus which consists of different sizes of meshes (10.0- > 0.075 mm) after rolling the samples to break down the large masses of the soil particles.
6) The sieved samples were preserved in labeled plastic bags.

2.2 Extraction of the samples

1) 50 g of each of the soil samples was weighed, transferred to 250 ml Stoppard conical flask and was shaken with exactly 50 ml of distilled water (1:1 ratio), the shaking was done by using mechanical shaker for 10 minutes.
2) After shaking, the equilibration was taken place by leaving the samples for 30 minutes.
3) Then, the samples were filtered into Buchner funnels by using filter papers Whatman no. 42.
4) In the case of turbid filtrates, they were centrifuged by using 3000 cycle/min centrifuge for 5 min.

Note: For pH measurements the soil samples were not filtrated but allowed to stand then the pH were measured in the suspension solution.

2.3 Materials and Reagents

All reagents were of analytical grade.

1) 0.01 N $AgNO_3$ was prepared by dissolving 1.696g of the pure dry salt in distilled water and it was transferred to 1L volumetric flask, and then it was standardized by using exactly 0.01N NaCl which was prepared by weighing out 0.585g of the pure dry salt, and dissolving it in 1L in a volumetric flask.
2) 2-5% potassium chromate prepared by dissolving 5g K_2CrO_4 in 100 ml of dist. water.
3) 0. 01N H_2SO_4 prepared by measuring out by means of a graduated cylinder 2.7 ml pure conc. H_2SO_4 , transferred to a 1L volumetric flask in which was containing distilled water and the volume was completed to the mark, from this solution transfer 100 ml in to one liter volumetric flask and completed the volume up to the mark, then it was standardized by using exactly 0.01N sodium carbonate which was prepared by weighing out 1.05989g into small beaker and dissolve in dist. Water and transfer it into 1L volumetric flask and complete to the mark by dist. water.
4) 1% phenolphthalein indicator was prepared by dissolving 1g of the reagent in 100ml ethanol.
5) 0.1% Methyl red was prepared by dissolving 0.1g in 100ml dist. water.
6) Standard Buffer solutions of pH's 4, 7 and 10.

2.4 Apparatus

Mechanical shaker, centrifuge, pH meter, combination glass electrode and Conductivity meter.

2.5 Methods of Analysis

a) pH

The pH meter was first standardized by using standard Buffer solutions of pH's 4, 7 and 10 and the combination glass electrode then was immersed in each supernatant soil sample and the pH reading was recorded.

b) Conductivity

The Conductivity meter was first calibrated by using standard KCl and then the conductivity for each extracted soil sample was measured.

c) Carbonate and bicarbonate

1) 5ml from extracted solution was transferred to a conical flask and 2 drops of phenolphthalein indicator were added.
2) Titration was done by using standardized 0.01 N H_2SO_4 until the pink color just disappeared and the burette reading was recorded. (this volume equivalent to the amount of carbonate which transferred to bicarbonate and to calculate the total amount of carbonate present, the burette reading was multiplied by 2, according to the following equations:

$$H_2SO_4 + CO_3^{2} \longrightarrow HSO_4^- + HCO3$$
$$HSO_4^- + HCO3 \longrightarrow SO_4^{2-} + CO2 + H2O$$

3) Two drops of methyl orange were added to the same solution and titration was continued until the color changed from yellow to orange (this volume equivalent to the total bicarbonate, and to calculate the amount of bicarbonate present in the original sample, the volume of Sulphuric acid which equivalent to the carbonate was minimized from that of the total bicarbonate.) [9]

d) Chloride

Chloride was determined according to Mohr's method in which 10 ml of the extracted sample was titrated against 0.01 N AgCl and 5% K_2CrO_4 was used as indicator. At the end point, excess of silver ions react with chromate to precipitate Ag_2CrO_4 which is a distinctive reddish-brown precipitate.

Note: the methods are taken from reference No. [1], [8],[9], [10]

3. Result and Discussion

The most frequently measured parameters that influence the physical properties of the soil are the pH and the conductivity as we will be discussed later in this section. The results obtained from the analysis of soil samples and their depths are summarized in the following tables:

Table1: The values of pH, EC and TDS for soil sample1

Symbol	*pH*	*ºC*	*EC ms\cm*	*TDS mg\L*
S_1S_0	8.06	27.70	0.97	620.8
S_1S_1	**7.76**	27.90	5.12	3276.8
S_1S_2	7.84	28.00	4.63	2963.2
S_1S_3	7.84	28.10	3.71	2374.4
S_1S_4	7.87	28.30	3.78	2419.2

Table 2: The values of pH, EC and TDS for soil sample2

Symbol	*pH*	*ºC*	*EC ms\cm*	*TDS mg\L*
S_2S_0	7.96	27.70	2.74	1753.6
S_2S_1	7.93	27.30	6.17	3948.8
S_2S_2	7.82	27.80	4.96	3174.4
S_2S_3	7.90	28.10	3.68	2355.2

Table 3: The values of pH, EC and TDS for soil sample3

Symbol	*pH*	*°C*	*EC ms\cm*	*TDS mg\L*
S_3S_0	8.44	27.70	1.06	678.4
S_3S_1	8.65	27.20	2.05	1321.0
S_3S_2	7.99	27.30	9.76	6246.4
S_3S_3	7.98	27.10	7.71	4934.4

Table 4: The values of pH, EC and TDS for soil sample4

Symbol	*pH*	*°C*	*EC ms\cm*	*TDS mg\L*
S_4S_0	8.15	28.00	0.87	556.8
S_4S_1	8.00	27.10	2.28	1459.2
S_4S_2	8.02	27.10	2.20	1408.0
S_4S_3	8.08	27.10	2.23	1427.2
S_4S_4	7.95	27.20	3.12	1996.8

Table 5: The values of pH, EC and TDS for soil sample5

Symbol	*pH*	*°C*	*EC ms\cm*	*TDS mg\L*
S_5S_0	7.87	27.50	2.41	1542.4
S_5S_1	8.08	27.00	3.73	2387.2
S_5S_2	7.90	27.20	4.80	3072.0
S_5S_3	8.09	27.10	3.22	2060.8

pH values

From the above tables (1-5) pH values for soil samples are slightly alkaline (7.76 – 8.65). According to Phosyn study based on over 200 analysis of samples representing a widespread geographical area from farms throughout agricultural development projects soil pH ranges between 7.0-9.5 (average 8.2) optimum level 7.0[7].As shown in fig.1there is difference between our study and Phosyn study and although it is more than that obtained by soil and water laboratory for the same region in 1982[9].soil pH may vary from season to season and from year to year , generally increasing during periods of high rainfall and decreasing during periods of low rainfall[1]. Alkaline soils are those that have an alkaline reaction or whose pH greater than 7.0. They differ from calcareous, soils which also have pH higher than 7; the alkaline reaction of calcareous soils is mainly due to the presence of calcium and magnesium carbonates while alkaline soils owe their alkalinity to the preponderance of sodium salts in soil solution or the presence of sodium clay, or both. They are formed in arid and semiarid regions which have very low rain fall [2]

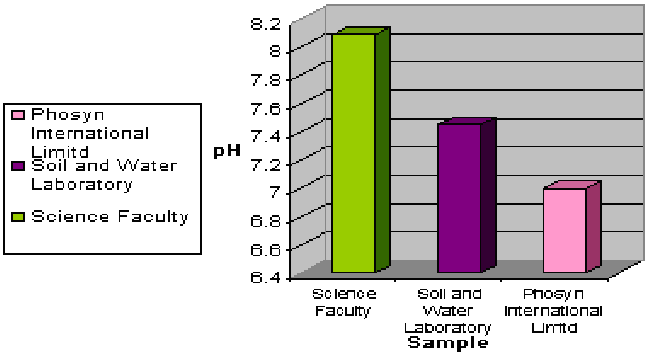

Figure 1: Comparison of pH values between faculty of Science soil and water lab, optimum Phosynn international limited.

The pH gives an indication of the acidity or alkalinity and this makes it valuable for soil characterization. Many chemical reactions are pH dependent and knowledge of the pH can enable us to predict the extent and speed of chemical reactions. Also the availability of different nutrients depends strongly on the pH. The soil pH can be used as a quick diagnostic tool to inform us about the state of the soil. The soil pH depends on a number of factors: parent material, climate, vegetation, fertilizer and lime application. The pH of most mineral soils is between 5.5 and 7.5 soils with higher pH values as, high as 10.5, may be encountered in calcareous, dolomitic and sodic soils from arid areas.

The soil pH measures active soil acidity or alkalinity. Usually the most desirable pH range for mineral soils is 6.0 to 7.0 and for organic soils 5.0 to 5.5. The soil pH is the value that should be maintained in the pH range most desirable for the crop to be grown.[1]

Conductivity

From tables (1and 2) for uncultivated soils we noted that the conductivity values are low in surface and high in subsurface 1due to leaching , then decreasing dawn ward continuously due to the dry soil(arid regions). Tables from 3-5 shows there is nearly increasing dawn ward then decreasing due to the weather and behavior of the ions. Comparison between our results, soil and water lab. And Phosyn limited shown in (fig.2). Because of differences among soils, plants, and environmental conditions, the values 4 millimhos\cm for the specific conductivity of saturation extracts and 15% for the degree of saturation of the cation- exchange capacity with sodium must be regarded as general averages that are subject to revision upward or downward for specific circumstances, it is clear that the solute suction of the soil water inferred from the specific conductivity of the saturation extract is lower than that of the soil solution to which plants are subjected under field conditions[2]. It is possible to obtain a field measurement of the total concentration of just the ionic components in solution by taking advantage of the fact that ions are charged species. A solution containing charged species will act as a conductor and permit the flow of electricity through the solution. The amount of the current that flows is proportional to the concentration and types of dissolved ions in solution. Conductivity is the quantity that is usually recorded as a measure of total dissolved solids.

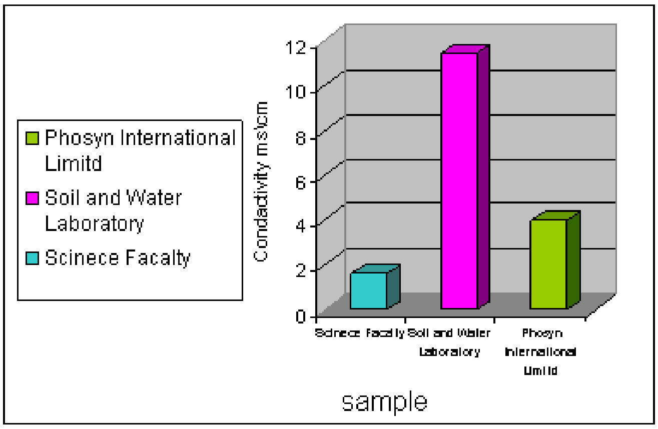

Figure 2: Comparison of conductivity between science faculty soil and water lab. and optimum Phosyn international limited

TDS

TDS values are agreement with the conductivity values as recorded in tables (1-5) in our studies for soil samples from figure (No.3) it is clear that large amount of TDS is present in sample NO. 3 it is about (678.4-6246.4).the movement of ions and nature of soil is responsible to the increasing and decreasing of TDS values .As is clear from fig. No.4 by comparing the amount of TDS obtained from our results and the results obtained from Phosyn international limited we not there is closely agreement but large deference with soil and water lab. for the same region. When the solution is dilute as is often the case in cultivated soils, a greater proportion of the salts is present in ionic states. The total amount of dissolved chemical species is called total dissolved solids, abbreviated TDS, and is a good general measure of the concentration of ionic substances in the water of the soil. By whatever method soil solution is separated, it shows that it contains a number of salts in solution. The salts are present in both ionic and molecular forms. Molecular appear only when the solution gets concentrated, e.g. during dry spell in dry season or in arid regions. Among the anions, bicarbonate, sulphate and chloride ions are commonly present in soil solution in large quantities. Of these, the bicarbonate ions are usually present in greater quantities than the other two, except in saline soils where sulphate and chloride ions are in preponderance [4]

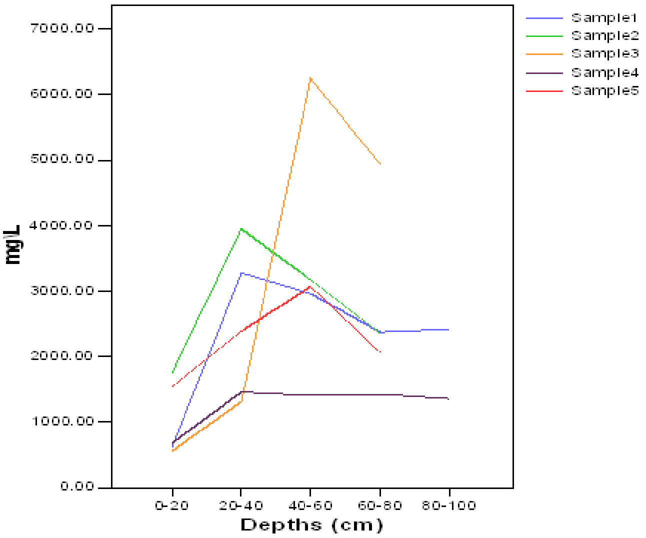

Figure 3: Relationship between TDS depths

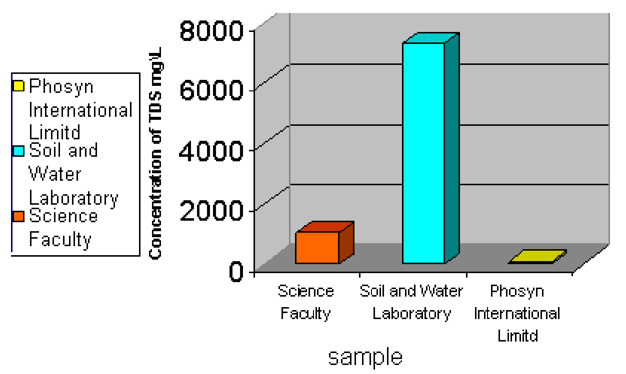

Figure 4: Comparison of TDS between Science faculty soil and water lab. and optimum Phosyn limited

The results for the analysis of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L and their standard deviations for the soil samples are summarized in the following tables:

Table 6: Values of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L the soil sample1

symbol	Cl⁻		CO3²⁻		HCO3⁻	
	meq\L	mg\L	meq\L	mg\L	meq\L	mg\L
S_1S_0	9.23±0.060	327.32±2.050	0.60±0.000	18.003±0.000	2.70±0.000	164.727±0.000
S_1S_1	47.80±0.000	1694.51±0.000	0.40±0.000	12.002±0.000	1.90±0.000	115.919±0.000
S_1S_2	41.50±0.000	1471.17±0.000	0.40±0.000	12.002±0.000	1.70±0.000	103.717±0.000
S_1S_3	35.03±0.060	1241.93±2.046	0.40±0.000	12.002±0.000	1.70±0.000	109.818±0.000
S_1S_4	25.20±0.000	893.34±0.000	0.60±0.000	18.003±0.000	1.60±0.000	97.616±0.000

Table7: Values of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L the soil sample2

symbol	Cl⁻		CO3²⁻		HCO3⁻	
	meq\L	mg\L	meq\L	mg\L	meq\L	mg\L
S_2S_0	19.07±0.460	675.90±16.30	1.00±0.000	30.005±0.000	4.80±0.000	292.848±0.000
S_2S_1	48.40±0.000	1715.80±0.000	0.40±0.000	12.002±0.000	2.10±0.000	128.121±0.000
S_2S_2	45.47±0.000	1611.69±0.000	0.20±0.000	6.001±0.000	1.80±0.000	109.818±0.000
S_2S_3	33.83±0.060	1199.39±5.658	0.60±0.000	18.003±0.000	2.00±0.000	122.02±0.000

Table 8: Values of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L the soil sample3

symbol	Cl^-		$CO3^{2-}$		$HCO3^-$	
	meq\L	mg\L	meq\L	mg\L	meq\L	mg\L
S_3S_0	7.333±0.050	242.24±1.181	0.80±0.000	24.004±0.000	4.00±0.350	244.04±21.134
S_3S_1	14.20±0.000	503.39±0.000	0.60±0.000	18.003±0.000	3.00±0.000	183.03±0.000
S_3S_2	81.53±0.120	2980.35±4.089	0.40±0.000	12.002±0.000	2.20±0.000	134.222±0.000
S_3S_3	72.03±0.150	2553.58±5.415	0.40±0.000	12.002±0.000	1.60±0.000	97.616±0.000

Table 9: Values of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L the soil sample4

symbol	Cl^-		$CO3^{2-}$		$HCO3^-$	
	meq\L	mg\L	meq\L	mg\L	meq\L	mg\L
S_4S_0	6.47±0.120	229.24±4.120	1.00±0.000	30.005±0.000	2.10±0.000	128.121±0.000
S_4S_1	12.23±0.115	433.65±4.090	0.60±0.000	18.003±0.000	2.80±0.000	18.003±0.000
S_4S_2	10.03±0.060	355.68±2.040	0.93±0.230	28.004±16.496	1.27±0.150	83.279±15.213
S_4S_3	11.07±0.120	392.30±4.093	0.00±0.000	0.00±0.000	0.00±0.000	0.00±0.000
S_4S_4	9.70±0.000	343.86±0.000	0.40±0.000	12.002±0.000	1.27±0.150	170.828±0.000

Table10: Values of available Cl^-, CO_3^{2-} and HCO_3^- in mg/L and meq/L the soil sample5

symbol	Cl^-		$CO3^{2-}$		$HCO3^-$	
	meq\L	mg\L	meq\L	mg\L	meq\L	mg\L
S_5S_0	6.17±0.290	218.60±10.23	0.60±0.000	18.005±0.000	1.60±0.000	97.616±0.000
S_5S_1	10.43±0.060	369.86±2.092	0.80±0.000	24.004±0.000	2.20±0.000	134.222±0.000 1
S_5S_2	11.50±0.000	407.67±0.000	0.60±0.282	18.279±6.002	2.40±1.131	146.424±48.807
S_5S_3	9.50±0.000	336.77±0.000	0.80±0.000	24.004±0.000	2.20±0.000	134.222±0.000

Chloride

Determination of chloride ions in Al Guarshah Agricultural Project Soil are listed in tables (6-10). It is clear from the tables and from (fig.5) chloride concentrations are very high in sample No.3, moderate in sample No.1 and 2, and very low in samples No.4 and 5. From fig. no. 6 we noted that amount of chloride according to our results moderate very low according to Phosyn and very high according to soil and water lab. The increasing in chloride concentration is agreement with the increasing in EC. Numerous studies have shown that chloride readily leach from soils. They are generally not considered to be retained to any extent by sorption processes; although workers in Virginia have indicated that limited adsorption of Cl^- by soil clays is possible. Chlorides will be removed more rapidly by water percolating through coarse-textured soils than through fine- textured soils, largely because fine-textured soils retain a large amount of water and there is less leaching with a given amount of rainfall. [6].

The reaction of saline soils is slightly to moderately alkaline and varies between pH 7.5 and 8.5. The distinctive feature of these soils is the high salt concentration. When the electrical conductivity of the saturation extract is more than 4 mmhos per centimeter, the soil is saline enough. There is a tendency for the soluble salts to have the higher proportionate content of sodium and chlorine [5].

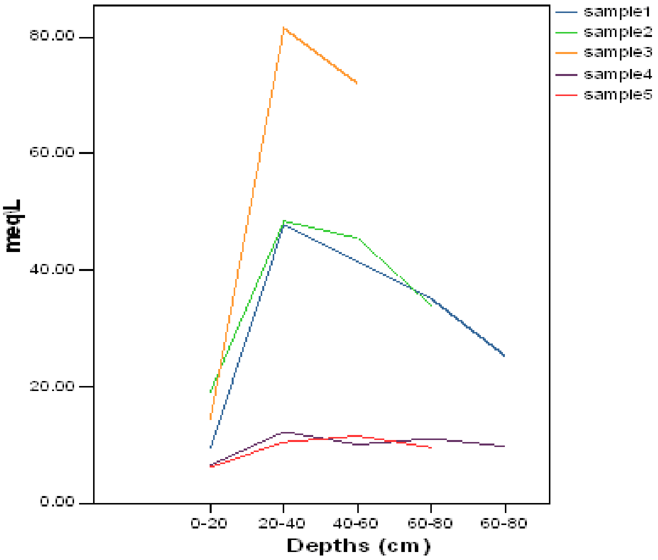

Figure 5: Relationship between chloride concentration and depthe

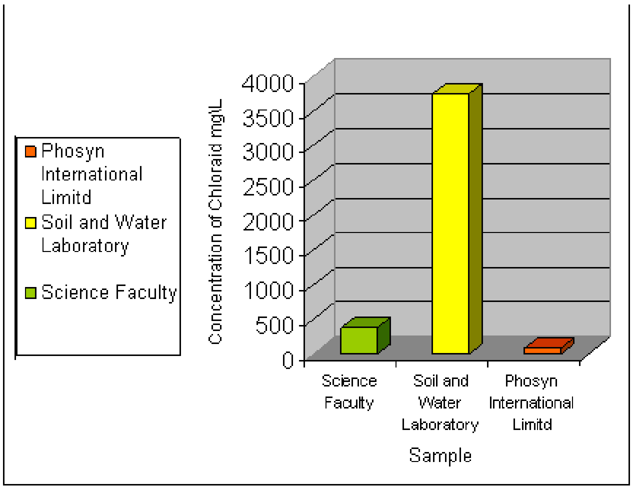

Figure 6: comparison of chloride between Science faculty soil and water lab and optimum Phosyn limited

Carbonate and bicarbonate

From the readings in the tables (6-10))we noted that

- The amount of carbonate in Al Guarshah Agricultural Project Soil is nearly absent.
- Concentration of bicarbonate is low and these results are supported by pH values, which are vary between (7.76 – 8.65).
- High concentration of bicarbonate is present in the surface because the time of collection was done on April month, during this month the rainfall was rare.

Alkalinity in soil arises manly because of the dissolution of calcite ($CaCO_3$)

$$CaCO_3 + H_2O \rightleftharpoons Ca^{2+} + HCO_3^{-} + OH^{-}$$

This results in an increase in pH. Calcareous, dolomitic and sodic soils are alkaline due to their content of $CaCO_3$, $MgCO_3$ and Na_2CO_3. Some soils from arid and semi-arid regions may have pH values as high as 9.9. The bicarbonate, carbonate levels increase as the soils become more alkaline. Alkalinity in soils can have important effects on soil processes, with consequently undesirable effects on plants. High bicarbonate concentrations inhibit Fe and Mn uptake and utilization by plants and this, in turn, interferes with the production of chlorophyll. Bicarbonate can reduce the uptake of phosphorus. The low solubility of phosphate in alkaline soils also contributes. Alkalinity in soils may also arise from high bicarbonate levels in irrigation waters. If irrigation water has high concentrations of calcium, bicarbonate and carbonate ions. $CaCO_3$ may precipitate, blocking pores in the soil and reducing water permeation. This could influence other physicochemical processes in the soil which in turn could lead harmful effect [1].

From comparisons of our results and soil and water lab. We noted that there is large deference between the two results as it is clear from fig. no. 8 this result is support by pH values as it clear from Fig.1 (i.e. pH increase with increase in bicarbonate values).

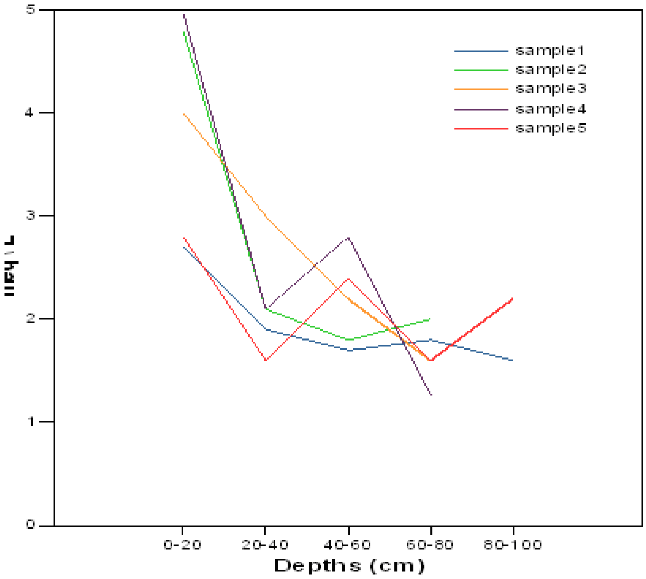

Figure 7: Relationship between bicarbonate values and depths

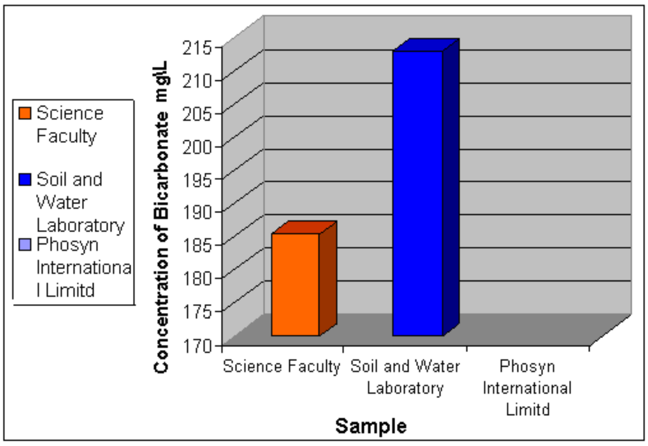

Figure 8: Comparison of bicarbonate between Science faculty soil and water lab. And optimum Phosyn limited

4. Conclusion

Conclusion can be drawn from this study and the main indications are as follows:

1) Sampling of the soil sample and preparing are the main important factors to good accuracy and precision
2) There is agreement between conductivity and TDS values according to the theory conductivity increasing as TDS increase.
3) Also there is agreement between pH values and carbonate and bicarbonate values because pH values vary from (7.76 – 8.65), this is indication of the absence of carbonate and low concentration of bicarbonate in the soil samples
4) Increasing in conductivity identical with increasing the chloride concentration. This fact support our results, because chloride ion have high solubility and conductivity
5) Comparison study between our results and optimum Phosyn international limited shows close agreement in case of TDS, conductivity and chloride, and big difference with soil and water lab.
6) Behaviors of some ions and physical parameters in soil is effected by seasons and type of soil our study must be continue for determine trace metals for make sure that this soil is convenient or not for agricultural Projects at future, because this project is ceased now, and there is large relationship between pH values and some ions such as Mg and Ca. For example, soils with pH of around 7 have a higher availability of Mg, Ca, K, while Fe, Zn and Cu are less available at high pH.[1]

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