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ELECTRICAL CONDUCTIVITY, pH, ORGANIC MATTER AND TEXTURE OF SELECTED SOILS AROUND THE QATAR UNIVERSITY CAMPUS

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ABSTRACT

Assessment of soil quality by soil analysis is a valuable tool for a farm as it determines the inputs required for efficient and economical production. A proper soil test helps ensure the application of sufficient fertilizers to meet the requirements of the crop while taking advantage of the nutrients and conditions already present in the soil. Though soil pH, electrical conductivity (EC), organic matter and texture are important features that determine the fertility of the soil, quantitative information on these properties are limited. The objective of the present study was to assess the pH, EC, organic matters and texture of four selected locations around the Qatar University campus including Biology Field (BF), Science Garden (SG), Greenhouse Inside (GHI) and Greenhouse Outside (GHO). We observed significant differences in the pH, EC and organic matter contents among the four locations. The highest pH was observed in SG and lowest in GHI whereas highest EC was observed in GHI and lowest in BF. Highest organic matter was found in GHI and lowest in BF. The soil texture of the BF and SG was sandy clay while that of GHI and GHO was loamy sand. Considering all four parameters analyzed in the present study, the GHI soil was found more suitable for plant growth.

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INTRODUCTION

Soil is the fragile or fragmented surface covering of the earth's surface. Soil consists of fractured rock materials that have been altered by environmental, biological and chemical factors, including weathering and erosion. Soil provides nutrients, water and minerals to plants and trees, stores carbon and is home to billions of insects, small animals, bacteria and many other micro-organisms. Although, soil-grown plants are the major source of food for all organisms such as humans and animals, and even some plants themselves, but these are also rich in minerals of all kinds and forms. There are numerous elements that influence soil quality. Soil is also known as one of the real sinks to contaminations and some perilous metals that have toxicological effects on many living organisms. Likewise, soils may have a buildup of pesticides which additionally have toxicological impact on many living creatures (De La Rosa, 2008).

One of the components that influence the soil chemical environment is the pH which is the proportion of the soil arrangement's causticity and alkalinity. The pH is impacted by the corrosive and base shaping cations in the soil, for example, the Al^{3+}, Fe^{2+}, Fe^{3+} and Ca^{2+}. Besides, the accessibility of supplements and holding of them in the soil is related to the cation and anion exchange capacity limits which is affected by the pH (McCauley *et al*., 2009). Soil pH is an indication of the acidity or alkalinity of soil. From pH 7 to 0, the soil is increasingly more acidic, and from pH 7 to 14, the soil is increasingly more alkaline or basic. Soil pH measurement is useful because it is a predictor of various chemical activities within the soil. As such, it is also a useful tool in making management decisions concerning the type of crops suitable for cultivation, the possible need to modify soil pH, and a rough indicator of availability of nutrients for the plants in the soil. Soil pH affects nutrient availability, nutrient toxicity and microbial activity, as well as extend a direct effect on the protoplasm of plant root cells (Larcher, 1980; Marschner, 1986). Soil pH directly affects the activity of nitrogen fixing microbes and the solubility of many of the nutrients in the soil needed for proper plant growth and development. Some elements like potassium, magnesium, calcium and phosphorus are likely to be unavailable to plants in acidic soil and in basic soil, elements like copper, zinc, boron, manganese and iron are not easily absorbed by plants (Neina, 2019). The electrical conductivity (EC) of a soil is a measure of soil salinity which directly influences crop growth and development in a soil. When ions (salts) are present, the EC of the solution increases. If no salts are present, then the EC is low, indicating that the soil solution does not conduct electricity well. Salts are influenced by various factors such as rainfall amount and timing, internal soil drainage, and irrigation practices. Usually, rainfall contains low amounts of salts and acts to dilute salts that are present in the soil. During drying conditions, water is lost from the soil due to evaporation, and salts are effectively concentrated. The utility of soil and water electrical conductivity (EC) is immense as indicators of condition and stewardship of farmlands and water resources (Patni *et al*., 1998).

Texture is considered as one of the most important properties influencing nearly all soil processes and the suitability of soils for crops. Soil texture is determined through established laboratory procedures that measure the relative proportion of soil separates (Zobeck, 2004) or in the field where the sample's apparent "texture-by-feel" is estimated based on grittiness, cohesiveness, and stickiness (Rowell, 1994). Field estimation of soil texture is considered a fundamental practice (Franzmeier and Owens, 2008) universally applied by resource scientists to classify and understand the behavior, health, and management of soil systems. Because laboratory analysis of soil texture is costly and often takes time to analyze, recent work has suggested that texture-by-feel estimates can replace laboratory analysis altogether (Vos, *et al*., 2016). Soil organic matter (SOM) is the organic matter component of soil, consisting of plant and animal detritus at various stages of decomposition, cells and tissues of soil microbes, and substances that soil microbes synthesize. SOM provides numerous benefits to the physical and chemical properties of soil and is especially critical for soil functions and quality (Beare et al., 1994).

Correct soil pH, EC, and organic matter contents are essential to ensure optimal plant growth and crop yield, because it allows nutrients to be freely available for plants to absorb. Testing the pH and EC of soil helps to determine which plants are best suited for a particular area. Hence, the objectives of this study was to investigate the pH, electrical conductivity, organic matter and texture of soil from four selected locations around the Qatar University campus.

MATERIALS AND METHODS

Soil sample collections

Soil samples were collected from four locations in the Qatar University campus in triplicates: Biology Field (BF) located in the east of Qatar University Science Building; Science Garden (SG) located in front of Qatar University Science Building; Qatar University Greenhouse Inside (GHI) and Greenhouse Outside (GHO).

Measuring pH and electrical conductivity

For each sample**,** 20 g of soil was mixed with 50 ml of deionized water and mixed by a shaker for 30 min. The soil solutions were then filtered by filter paper. The filtered liquid sample was used to detect pH and electrical conductivity (EC) by a pH meter and EC meter.

Measuring organic matter content

Approximately 10 g (f) soil sample was taken in porcelain crucible and placed inside a Muffle furnace and burnt at 500°C for 24 h. The crucibles were cooled down to room temperature and the weights were measured. The mass after heating the sample was measured by the following equation [(g) = total mass - weight of the Porcelain crucible], the difference in weight is approximately equal to the organic content of the sample: (h) = (f) - (g) and is expressed as a percentage of the sample mass by SOM (%) = h/f x 100% (Storer, 1984).

Soil texture analysis by sieve and feel method

Approximately 15 g of soil was placed on the top of the sieve arrangement (4.00, 1.00, 0.50 and 0.25 mm mesh size sieves) and shaken by hand for approximately 10 min. Soil particles from each sieves were weighed. Soil texture was analyzed by the percentages of each type of soil obtained from each sieves using the equation: [soil obtained from each sieve (g)/ Total weight of soil (g)] x 100. For feel test, approximately 15 g of soil was placed in the palm of the hand with a few drops of water and the soil type was determined following the methods of (Rowell, 1994).

Statistical analysis

The data on pH, EC and organic matters of the four different locations were analyzed by a one way analysis of variance (ANOVA) followed by Tukey's test and was considered significant at 5% level of probability. The soil texture data were analyzed by a two way ANOVA. All the statistical analysis was done on SPSS.

RESULTS AND DISCUSSION

pH and Electrical Conductivity

The highest mean pH value was observed in the Science Garden (SG) (8.32) and lowest in the Green House Inside (GHI) samples (7.18). The pH values of the Biology Field (BF) and SG were significantly different from those of GHO and GHI ($P<0.05$) (Table 1). However, no significant difference was observed between the mean pH values of GHO and GHI ($P>0.05$). The mean electrical conductivity (EC) of GHI was found to be the highest (18.49 µS/cm) and that of BF was found to be the lowest (12.3 µS/cm) ($P<0.05$). No significant difference was observed between the mean EC values of SG and GHO ($P>0.05$).

Soil pH values below 7 indicate acidic soil, and above 7 indicate basic (alkaline) soil which is determined largely by soil composition, cation exchange processes, and hydrolysis reactions associated with the various organic and inorganic soil components as well as by the CO_2 concentration in the soil gaseous and liquid phase (Thomas and Hargrove, 1984). Besides the actual soil fertility, the buffer capacity of a soil is of great importance in determining the pH. Most soils have pH values between 3.5 and 10 (Narsimha *et al*., 2013). According to Kadam (2016), soil can be classified into three main categories on the basis of pH: acidic soil: pH<6.5 (low pH), Normal soil: pH 6.5-7.8 (Medium pH), and alkaline soil: pH>7.8 (High pH) (). Based on these criteria, the soils of the Greenhouse Inside (GHI) and Greenhouse Outside (GHO) are normal and those of

Biology Field (BF) and Science Garden (SG) are alkaline (Table 1). The alkalinity of BF and SG soils might have caused by calcium carbonate or free calcium rich in dry environment. In addition, this might have happened due to addition of sodium, calcium and magnesium through the irrigation water or due to construction activity which might also introduce alkaline compound such as limestone gravel.

Table 1. The mean pH and Electrical Conductivity (EC) of the experimental soil*

Soil Samples	pH	Conductivity (μS/cm
BF	8.19 ± 0.05^{a}	5.59 ± 1.59^{a}
SG	8.32 ± 0.07^{b}	10.82 ± 0.34^{bc}
GHI	7.18 ± 0.06^{c}	18.49 ± 0.31^{d}
GHO	7.22 ± 0.04^{c}	11.54 ± 0.92^{c}

*Means followed by different alphabetical superscripts in the same column are significantly different ($P<0.05$)

The electrical conductivity of the GHI soil sample was found to be the highest and that of the BF was found to be the lowest (Table 1). Significant differences were observed among the mean EC values of all the pairs of mean EC values ($P<0.05$) except between the EC values of the SG and GHO soils ($P>0.05$). This indicates that BF has low ions and this is acceptable because samples were taken from a very dry area. The result of EC is mainly affected by different environmental factors such as climate, geology, local biota, and anthropogenic activities that change soil characteristic. A pH from 7.3 to 8.5 indicates the presence of $CaCO_3$; the presence of strong concentrations of neutral soluble salts in a saturated extract is reflected by a high electrical conductivity (EC >4 dS/m); a pH greater than 8.5 indicates the presence of significant amounts of exchangeable CO_3; the electrical conductivity is generally low (EC <4 dS/m) (Narshimha *et al*., 2013).

Soil EC is a useful indicator in managing agricultural systems and the interpretation of EC of a soil or media must be made considering the plant(s) to be grown (Arnold *et al*., 2005). The EC of the soil has little direct detrimental effect on sandy mineral soils or on media. However, EC directly affects plants growing in the soil or media.

The apparent soil EC is influenced by various factors such as soil porosity, concentration of dissolved electrolytes, texture, quantity and composition of colloids, organic matter and water content in the soil (Rhoades *et al.*, 1976). The EC of soils varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. In the present study, we have observed higher EC in loamy sand soils of GHI and GHO compared to the sandy clay soils of BF and SG (Table 1). In general, an EC range of 0–1 dS/m indicates good soil health; EC values above 1–2 dS/m result in reduced growth of salt-sensitive plants and disruption of the microbial mediated processes of nitrification and denitrification (Smith *et al*., 1996). The results of the present study indicate that BF has low ions and this is acceptable because sample taken from very dry area.

Organic matter content

The mean organic matter varied from 12.3 to 26.3%. The organic matter of GHI was significantly higher than those of BF, SG and GHO ($P<0.05$) (Figure 1). The GHI contained significantly higher organic matter compared to the other three soils ($P<0.05$). No significant difference was observed among the organic matter contents of GHO, BF and SG ($P>0.05$). This indicates that the soil of the GHI is of good quality, because greenhouse soil is protected from harsh condition here in Qatar such as high temperature, dryness, evaporation. On the other hand, BF and SG result show low organic matter content which is reasonable due to the harsh climate.

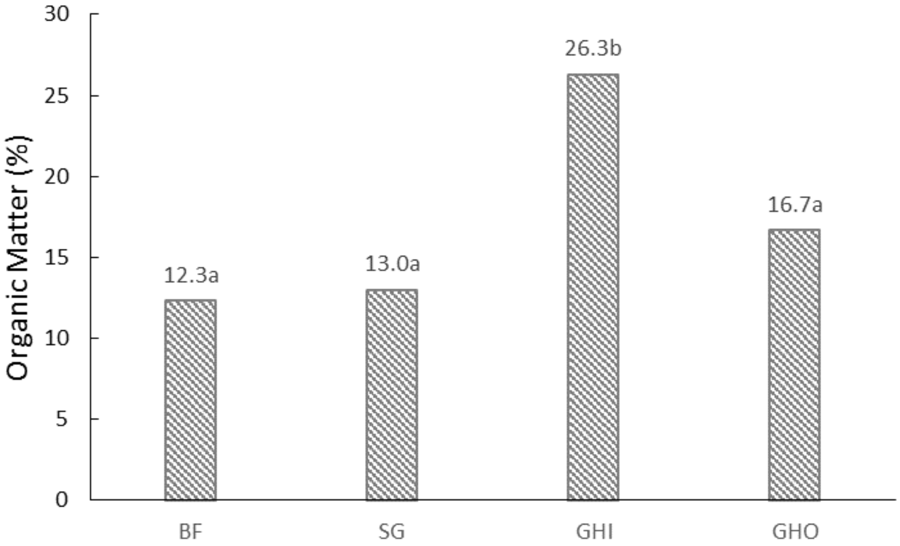

Figure 1. Mean soil organic matter content (%) of the four locations. BF-Biology Field, SG-Science Garden, GHI-Greenhouse Inside, GHO-Greenhouse outside. Bars containing different alphabets are significantly different (P<0.05).

Organic matter is a key attribute of soil and environmental quality because it is an important sink and source of main plant and microbial nutrients and moreover exerts a profound influence on physical, chemical and biological functions (King *et al*., 2020). Organic matters incorporated into the soil can affect its structure, as denoted by porosity, aggregation, and bulk density, as well as cause an impact as expressed in terms of content and transmission of water, air and heat, and of soil strength (King *et al.*, 2019). Organic matters also exert an influence on chemical properties of soils. During organic matter decomposition, nutrients such as N, P, and S are released into the mineral nutrient pool and contribute to increasing crop yield (Oldfield *et al.,* 2018; Oldfield *et al*., 2020; Wade *et al*., 2020).

Soil texture analysis

Texture indicates the relative content of particles of various sizes, such as sand, silt and clay in the soil. Texture influences the ease with which soil can be worked, the amount of water and air, it holds, and the rate at which water can enter and move through soil. Sieve analysis was used to classify the soil based on soil particle distribution into different grain size. The 4 mm mesh size content of BF was found to be the highest (3.5%) and that of GHI was found to be the lowest (0.6%). On the other hand, the 1.0 and 0.5 mm mesh size contents of BF were found to be the lowest and those of the SG were found to be the highest (Table 2). However, the two way ANOVA did not show any significant variations in the sieve test data of soils of the four sampling sites (P>0.05).

Sand, the largest particle of the soil, is visible to the eye. It is gritty, holds little water, and is not slick or sticky when wet. Sand particles are between 2 and 0.05 millimeters in diameter. Medium-sized soil particles are called silt. Silt feels like flour or talcum powder. It holds moderate amounts of water and has a somewhat sticky feel when wet. Silt particles are between 0.05 and 0.002 millimeters in diameter. The smallest particles of soil are called clay. Most individual clay particles can only be seen with a powerful microscope. Clay feels sticky when wet, and hard when dry. Clay is more chemically active than sand and silt. Clay particles are less than 0.002 millimeters in diameter (Salley *et al*., 2018).

Table 2. Texture of soil obtained by sieve method and feel method (%)

Sieve mesh size (mm)	BF	SG	GHI	GHO
4.0	3.5	1.6	0.6	17.5
1.0	2.6	10.8	3.8	3.2
0.5	1.1	12.1	3.1	2.1
0.25	5.7	17.1	28.2	9.4
Less than 0.25	7.1	8.4	9.4	11.5
Feel	Sandy Clay	Sandy Clay	Loamy sand	Loamy sand

Soil texture describes through by using feel method by placing a small portion of the soil in the hand palm and adding water drops to distinguish the texture of the soil. The result shows that the soil of BF is sandy clay and that SG is smooth sandy clay. The soils of GHI and GHO are loamy sand which indicates good quality and are suitable for growth of most of plants (Table 2). Soil texture is one of the most important properties to know how to measure, as it affects many other chemical, physical, and biological soil processes and properties such as the available water-holding capacity, water movement though the soil, soil strength, how easily pollutants can leach into groundwater, and the natural soil fertility.

In conclusion, we have analyzed the physico-chemical and organic properties of soils from four different locations at Qatar University campus. We found that the soils of the Greenhouse Inside is of good quality and suitable for crop production.

COMPETING INTEREST

The authors declare that they have no competing interests.

REFERENCES

1. Arnold SL, Doran JW, Schepers J, Wienhold B, Ginting D, Amos B and Gomes S, 2005. Portable probes to measure electrical conductivity and soil quality in the field. Communications in Soil Science and Plant Analysis, 36 (15-16): 2271-2287.
2. Beare MH, Hendrix PF, Cabrera ML, and Coleman DC, 1994. Aggregate-protected and unprotected organic matter pools in conventional- and no-tillage soils. Soil Science Society of America Journal, 58 (3): 787-795.
3. De La Rosa D and Sobral R, 2008. Soil quality and methods for its assessment. In Land Use and Soil Resources. https://doi.org/10.1007/978-1-4020-6778-5_9.
4. Franzmeier D and Owens P, 2008. Soil texture estimates: A tool to compare texture-by-feel and lab data. Journal of Natural Resources and Life Sciences Education, 37: 111-116.
5. Kadam PM, 2016. Study of pH and electrical conductivity of soil in Deulgaon Raja Taluka, Maharashtra. International Journal of Research in Applied Science and Engineering Technology, 4 (IV): 399-402.
6. King AE, Congreves KA, Deen B, Dunfield KE, Voroney RP and Wagner-Riddle C, 2019. Quantifying the relationships between soil fraction mass, fraction carbon, and total soil carbon to assess mechanisms of physical protection. Soil Biology and Biochemistry, 135: 95–107.

7. King AE, Ali GA, Gillespie AW and Wagner-Riddle C, 2020. Soil Organic Matter as Catalyst of Crop Resource Capture. Frontiers in Environmental Science, 8: 1-8.
8. Larcher W, 1980. *Physiological Plant Ecology,* 2nd Edition. Springer-Verlag, New York. 303 pp.
9. Marschner H, 1986. *Mineral Nutrition of Higher Plants.* Academic Press, London. 674 pp.
10. McCauley A, Jones C and Jacobsen J, 2009. Soil pH and organic matter. Nutrient Management Module, 8: 1-12.
11. Narsimha A, Narshimha CH, Srinivasulu P and Sudarshan V, 2013. Relating apparent electrical conductivity and pH to soil and water in Kanagal surrounding area, Nalgonda district, Andhra Pradesh. Der Chemica Sinica, 4(2): 25-31.
12. Neina D, 2019. The Role of Soil pH in Plant Nutrition and Soil Remediation. Applied and Environmental Soil Science, 2019, Article ID 5794869, p9.
13. Oldfield EE, Bradford MA., and Wood SA, 2018. Global meta-analysis of the relationship between soil organic matter and crop yields. Soil, 5: 15–32.
14. Oldfield EE, Woods SA and Bradford MA, 2020. Direct evidence using a controlled greenhouse study for threshold effects of soil organic matter on crop growth. Ecological Applications, 30(4).
15. Patni NK, Masse L and Jui PY, 1998. Groundwater Quality under Conventional and No Tillage: I. Nitrate, Electrical Conductivity, and pH. Journal of Environmental Quality, 27: 869–877.
16. Rhoades JD, Raats PA and Prather RJ, 1976. Effects of Liquid-phase Electrical Conductivity, Water Content, and Surface Conductivity on Bulk Soil Electrical Conductivity. Soil Science Society of America Journal, 40: 651–655.
17. Rowell DL, 1994. Soil science: Methods & applications. Routledge. 386p.
18. Salley SW, Herrick JE, Holmes CV, Karl JW, Levi MR, McCord SE, van der Waal C, and Van Zee JW, 2018. A Comparison of Soil Texture-by-Feel Estimates: Implications for the Citizen Soil Scientist. Soil Science Society of America Journal, 82:1526–1537 doi:10.2136/sssaj2018.04.0137.
19. Smith JL and Doran JW, 1996. Measurement and use of pH and electrical conductivity for soil quality analysis. In: Doran, J.W. and Jones, A.J., (eds) Methods for Assessing Soil Quality, 49: 169–185. Storer DA, 1984. A simple high sample volume ashing procedure for determining soil organic matter. Communications in Soil Science and Plant Analysis, 15: 759-772.
20. Thomas GW and Hargrove WL, 1984. The chemistry of soil Acidity. In. Soil Acidity and liming (Second Edition), F. Adams (ed). P. 3.56, Agronomy Series No. 12. 1984, American Society of Agronomy Madison.
21. Vos C, Don A, Prietz R, Heidkamp A and Freibauer A, 2016. Field-based soil-texture estimates could 643 replace laboratory analysis. Geoderma, 267: 215-219.
22. Wade J, Culman SW, Logan JAR, Po H, Demyan MS, Grove JH, Mallarino AP, McGrath JM, Ruark, M and West, JR, 2020. Improved soil biological health increases corn grain yield in N fertilized systems across the Corn Belt. Nature Scientific Report, 10: 3917.
23. Zobeck TM, 2004. Rapid soil particle size analyses using laser diffraction. Applied Engineering in Agriculture, 20: 633-640.