Sultanate of Oman
Ministry of Education
Ain Jaloot School for Basic Education

# Soil salinity and its effect on some physical and chemical properties of Omani lemon

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**Ain Jaloot School for Basic Education**

**North Batinah Governorate**

**Sultanate of Oman**

## Summary

The objective of this study is to study the effect of soil salinity differences in some physical and chemical properties of Omani lemons in Suwaiq Willayte, to answer the following questions:

- What is the effect of high soil salinity on the size of Omani lemon?
- How does soil salinity affect the volume of juice in the lemon?
- What is the relationship between soil salinity and the acidity of lemon juice?

Two sites were identified for the study, one with a higher salinity than the other. Four lemon trees were selected from each site and five lemons from each tree were harvested with 20 lemons from each site for measurements. Soil and water characteristics were studied at both sites through the application of the soil and water protocol, respectively.

Results showed that the average weight of lemons and juice and the percentage of juice decreased significantly with the high level of soil salinity. However, the high salinity of the soil increased the acidity of the lemon juice of Oman by a small percentage.

Results also showed that the salinity of the soil significantly affected the size of the lemon and lemon juice of Oman and the percentage of juice where it decreased significantly, while the high salinity of the soil leads to high acidity of the lemon juice.

Based on the results and conclusions, we recommend that farmers and specialists address the problem of soil salinity on the coast of Batinah by working on the establishing a proper drainage network and land tillage. In addition to irrigating the soil with brackish water, surface discharge of irrigating water and to add organic fertilizers.

**Key terms:**

- Soil salinity: High salinity level in soil.
- Physical properties: Any measurable property whose value can describe the state of a physical system.
- Chemical properties: The material reaction under standard pressure and temperature conditions.

**Research questions:**

This research sought to answer the following questions:

1. What is the effect of high soil salinity on the size of Omani lemon?
2. How does soil salinity affect the volume of lemon juice?
3. What is the relationship between soil salinity and the acidity of lemon juice?

**Introduction and literature review:**

Lemon belongs to the Citrus family which is highly nutritious because they contain vitamins, mineral salts and some elements such as calcium, potassium and others. Lemon is a scientific plant known as Citrus aurantifolia and is considered one of the most important plants for domestic use, either as food or medicine.(البراء, 2019)

Al-Batinah coast is characterized by high salinity. The people in Suwaiq Willayate who are living near the coast during the cultivation of lemon trees suffer from the lack of fruit crop and their small size, that is probably because the increased salinity of the soil causes multiple damages on plants, one of them is the reduction of the level of photosynthesis and reducing the size of the leaves, resulting in low yields (Dionisio, etal, 1997). In a five-year study of lemons using four salinity levels (Cerda et al., 1990), they found that increased salinity resulted in a significant reduction in tree diameter as well as yield by increasing salinity in the root region.

In order to determine the effects of different soil salinity levels in the physical properties (weight of lemon fruits, weight of lemon juice) and chemical (lemon juice acidity) for the fruits of the lemon trees of Oman, this study was conducted.

**Research Methods:**

First: Research Plan:

- Identify the problem of research and formulate research questions.

- Identification of two different soil salinity sites for study (close to the coast and far from the coast).

- Schedule a research time plan.

**Table (1):** Research time plan.

| Month | Target |
|---|---|
| Formulating the research problem<br>Determination of the study sites | October 2018 |
| Gather information from scientific sources and references | December 2018 |
| Data collection and analysis<br>Reach conclusions and recommendations and write research | February 2019 |
| Design the research poster and submitting the research | March 2019 |

- Identify the tools and devices needed to carry out the research and data collection.

- Implementation of soil and water protocols.

**Table (2):** The protocols applied in the research:

| The protocol | The application | Date |
|---|---|---|
| Soil | Studying soil properties at the two sites | 16/2/2019<br>17/2/2019 |
| Water | Studying the characteristics of irrigating water at the two sites | 18/2/2019<br>20/2/2019 |

- Collect lemon fruits from the sites for study and analysis.

**Table (3):** the number of lemon fruits from the two sites:

| Number of lemon fruits | Location | Date of Collection |
|---|---|---|
| 20 (4 lemon trees; 5 fruits from each tree) | Dayan Al-Jahawir | 18/2/2019 |
| 20 (4 lemon trees; 5 fruits from each tree) | Dayan Al-Busaid | 20/2/2019 |

- Application of research in practical experimentation.

**Table (4):** Practical application for interpreting research questions

| Research question | Application Method | Date |
|---|---|---|
| Question 1 | Measuring the weight of each fruit in grams for each location separately using the electronic weight scale | 19/2/2019 21/2/2019 |
| Question 2 | Squeezing each fruit using the electric juicer and taking the weight of the juice of each fruit using the electronic weight scale | 22/2/2019 23/2/2019 |
| Question 3 | Using a PH sensor probe to determine the PH of the juice of each fruit. | 22/2/2019 23/2/2019 |

- Interviews with owners of lemon farms at the two sites.

- Interview with agricultural engineer in the Department of Agricultural Development to collect sufficient information about the research.

- Data collection and organizing the data collected in tables.

- Data entry in the program site (WWW.GLOBE.GOV).

- Data analysis and representation in graphs.

- Reaching conclusions and recommendations.
- Writing scientific research and poster design.

**Second: Study Location:**

(Sultanate of Oman, North Batinah Governorate, Al Suwaiq Willayate ), Dyan Al-Jahawir farm, Dyan Al Busaid farm, February 2019, Cold weather, soil and water protocols were used.


Dyan Al Busaid farm

Dyan Al-Jahawir farm

**Picture (1):** Location of the study.

**Third: Data collection and analysis:**

The research on the Omani lemon trees was carried out at two sites: the Dyan Al-Jahwar Farm (about 5 Km far from the coast) and the Al-Busaid farm (near the coast).

**- Data collection methods:**

**A- Practical experimentation:**

1. Selection of lemon trees from the two locations (four trees from each location).
2. Collection of the lemon fruits from the two locations; five fruits from each tree (20 lemon fruit from each site).
3. Measuring the weight of each fruit in grams in each location by using the electronic balance and taking the arithmetic mean.
4. The juice of all fruits was extracted separately using the electric juicer and the weight of the juice of each fruit was measured using the electronic balance and then the arithmetic mean was taken.
5. Calculation of the percentage of juice in the fruit was done by dividing the weight of juice per fruit on the weight of the fruit.
6. The pH of each fruit juice was measured using the pH probe and then the arithmetic mean of the PH was calculated for each site.

**Picture (2):** Collecting the lemon fruits and performing the measurements.

**B. Interviews:**

1- Interview with the Agricultural Engineer Amer Al-Barhi, Director of Agricultural Development Department in Barka, who provided us with information on the nature of the soil on the coast of Batinah Governorate and that it is characterized by its high salinity.

2- Interviews with the owners of the farms at the two sites where the following questions were addressed:

- What are the characteristics of lemon fruits (size and quantity of juice) in your farm?
- What is the quantity of the resulting crop?

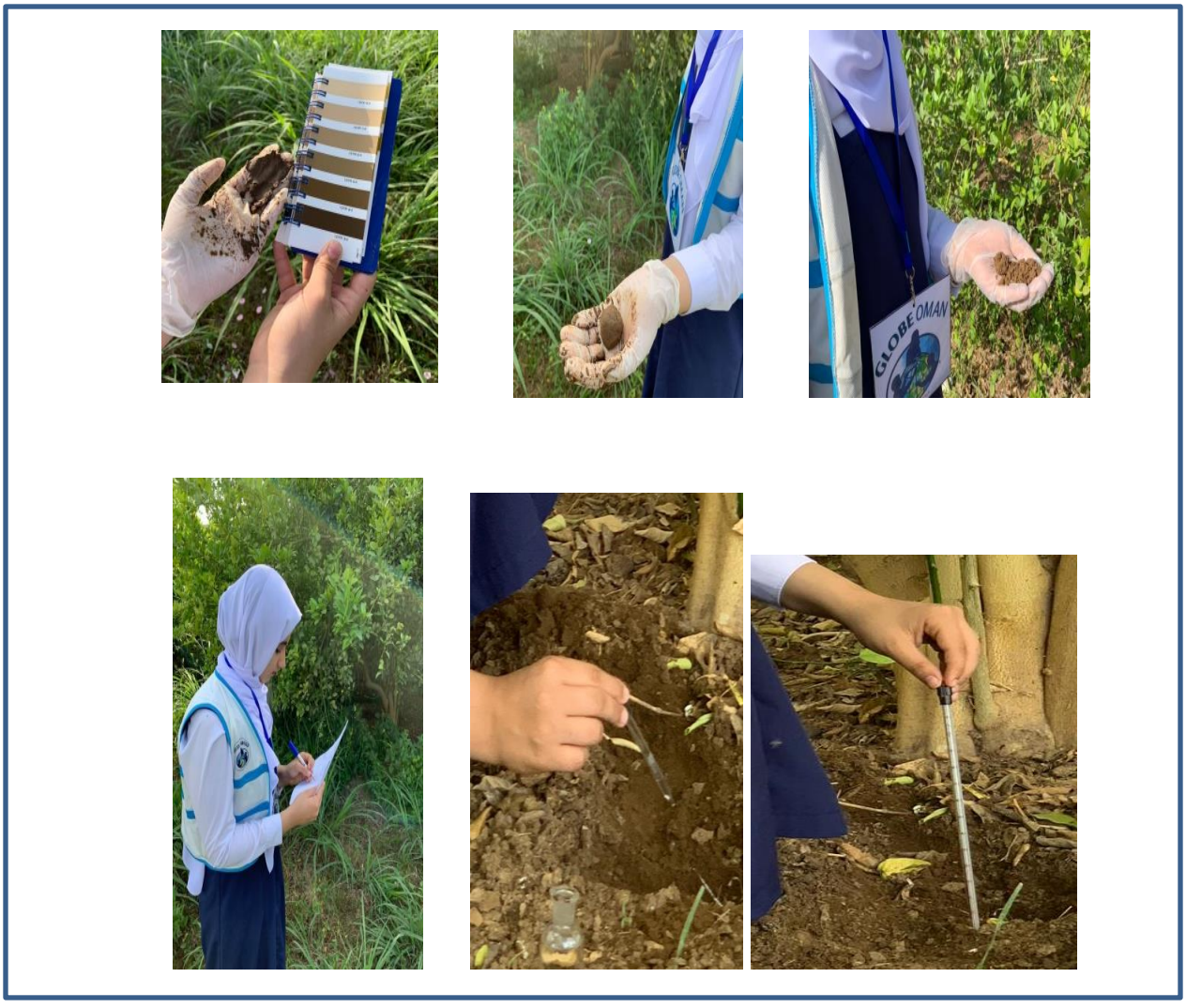
The owner of the farm of Dyan Al-Jahawir informed us that the production of the lemon fruit, its size and the amount of juice are all excellent. However, the owner of the farm of Dyan Al-Busaid complained about the lack of crop and the lack of juice in fruit.

**Picture (3):** interview with the agricultural engineer: Amer Al-Barhi

**Picture (4):** interview with the owner of Dyan Al-Jahawir farm

## C- Application of the Soil Protocol:

Field application was applied at the two sites to study soil properties, temperature, pH, salinity, conductivity using soil color booklet, thermometer, pH meter, salinity scale and electronic conductivity, respectively. The samples were prepared to measure acidity, salinity and conductivity by mixing 40 g of dry soil per site with 40 ml of distilled water and stirring well, then stirring for 30 seconds and waiting 3 minutes for five consecutive times. Then the mixture was left to settle until we got a separate layer. (البلوشية, 2016)




**Picture (5):** Application of soil protocol.

## D- Application of water protocol:

The water used to irrigate the lemon trees was studied in each location. The transparency, temperature, salinity, conductivity, pH and dissolved oxygen were measured. Transparency was measured using the transparency tube and the thermometer was used to measure the water temperature. The pH meter probe was used to determine the pH of the water. Salinity and conductivity of water were measured using salinity scale and electronic conductivity. To determine the amount of dissolved oxygen in water, a special tool was used to measure the oxygen dissolved in water. All previous measurements were performed three times and the arithmetic mean was taken.(البلوشي, 2016)

**Picture (6):** Application of water protocol at the two study locations

## Results:

The results obtained at the study sites were as follows:

**Table (5):** Results of physical and chemical properties of Omani lemons at the two sites

| Attributes studied | Average weight of lemon fruit(g) | Average weight of lemon juice(g) | Percentage of juice in lemon fruit | Average pH |
|---|---|---|---|---|
| Dyan Al-Jahawir ( less salinity) | 51.48 | 17.26 | 33.53 | 2.48 |
| Dyan Al-Busaid (more salinity) | 20.47 | 4.86 | 23.72 | 2.65 |

The following graph shows a comparison between the results of two sites:

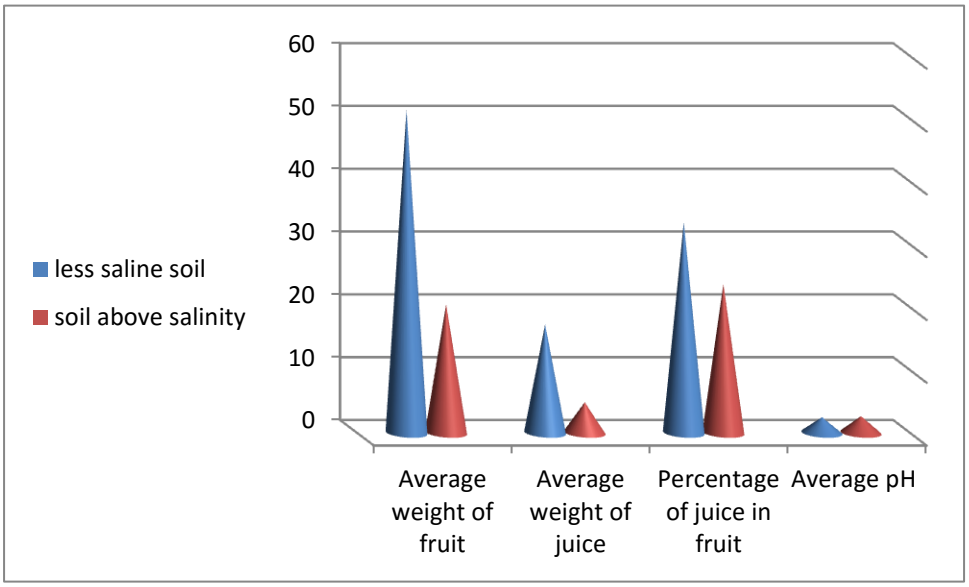



**Chart (1):** Comparison of physical and chemical properties of Omani lemon

The following table shows soil characteristics through application of soil protocol at the sites:

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**Table (6):** Soil properties at the two sites

| Soil properties | Dyan Al-Jahawir | Dyan Al-Busaid |
|---|---|---|
| Structure | granular | blocky |
| Main color | 10YR 3/4 | 10YR 4/4 |
| Secondary color | 10YR 4/4 | 10YR 5/4 |
| Consistence | friable | friable |
| Texture | Clay loam | Clay loam |
| Rocks | few | few |
| Roots | a lot | a lot |
| Carbonates | few | few |
| Salinity(ppm) | 408 | 852 |
| Conductivity(µs) | 586 | 940 |
| pH | 7.47 | 7.55 |
| Temperature(°C) | 22 | 22 |
| Location coordinates | 57.14077(East)<br>23.51534(North) | 57.15491(East)<br>23.53551(North) |

The following charts show a comparison between (Salinity, Conductivity) and(Temperature, pH) of the soil in the two sites :

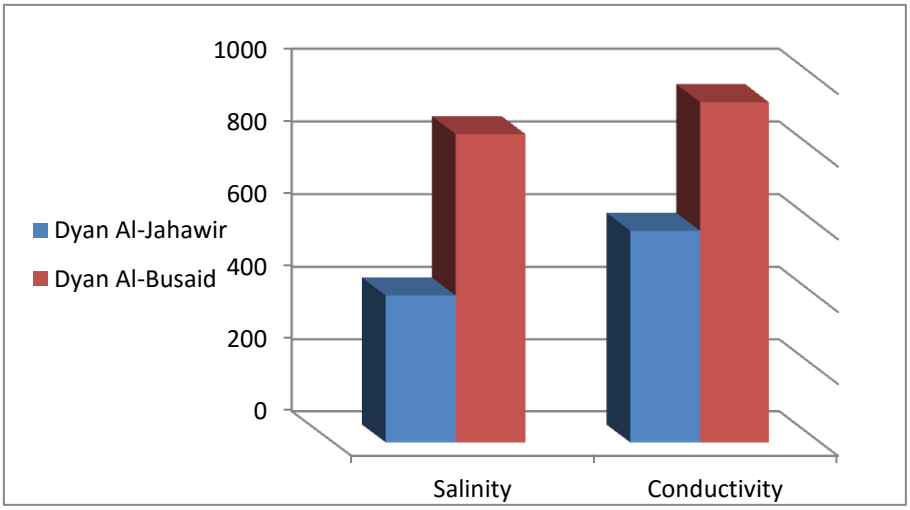



**Chart (2):** Comparison between salinity and conductivity in the two sites.

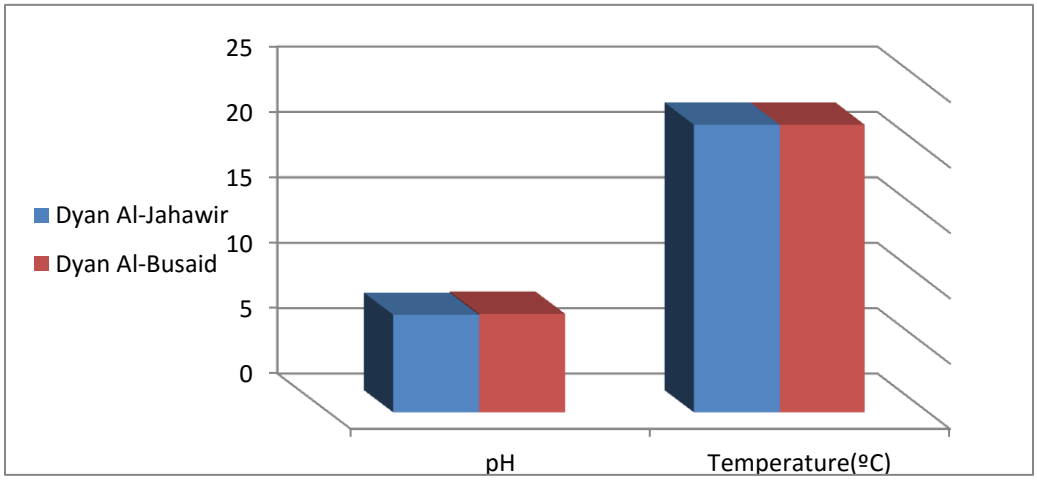
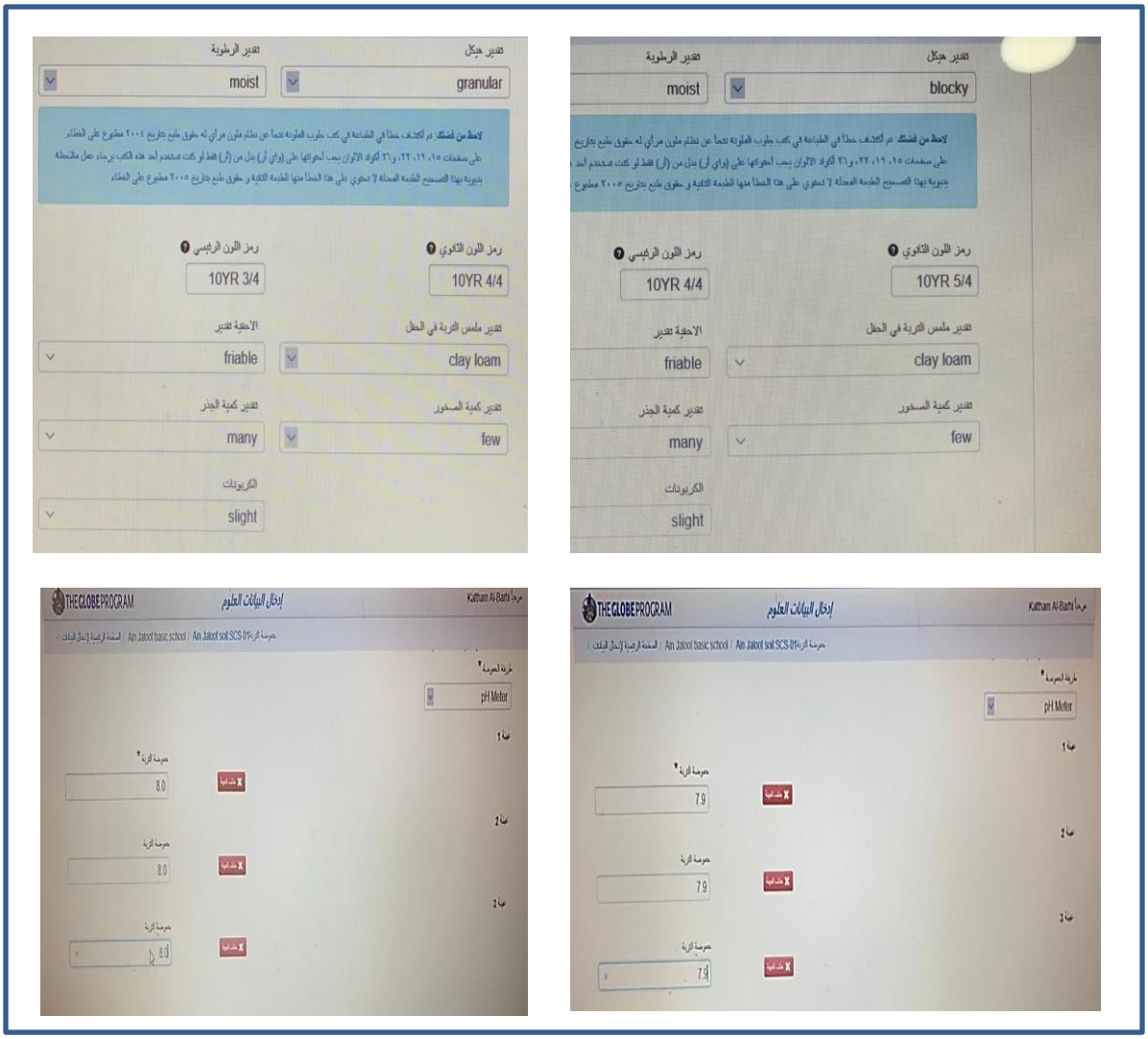



**Chart (3):** Comparison between Temperature and pH in the two sites




**Picture (7):** Enter soil protocol data in the program site.

The following table shows the characteristics of water through application of water protocol at the sites:

Table (7): Water characteristics at the two sites

| Water characteristics | Dyan Al-Jahawir | Dyan Al-Busaid |
|---|---|---|
| Transparency | More than 120 cm | More than 120 cm |
| Temperature(ºC) | 26 | 25 |
| pH | 7.45 | 7.66 |
| Salinity(ppm) | 667 | 887 |
| Conductivity(µs) | 668 | 834 |
| Amount of dissolved oxygen in water(mg/L) | 6 | 6 |

The following charts show water characteristics at the two sites:

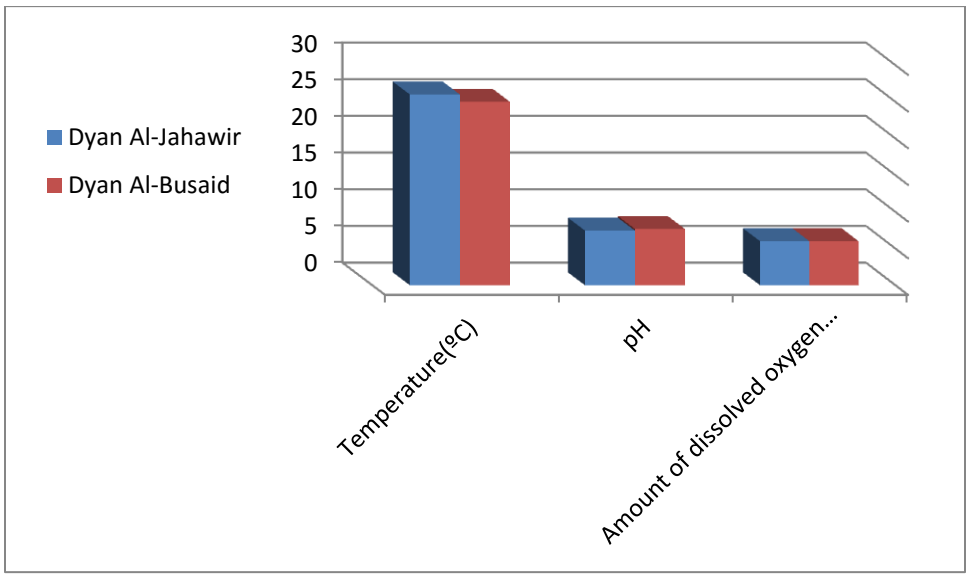



**Chart (4):** Comparison between water characteristics at the two sites

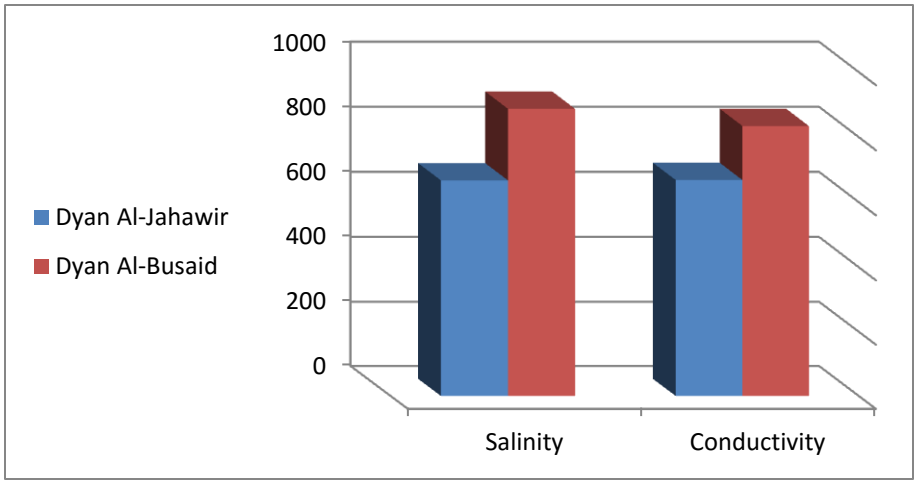
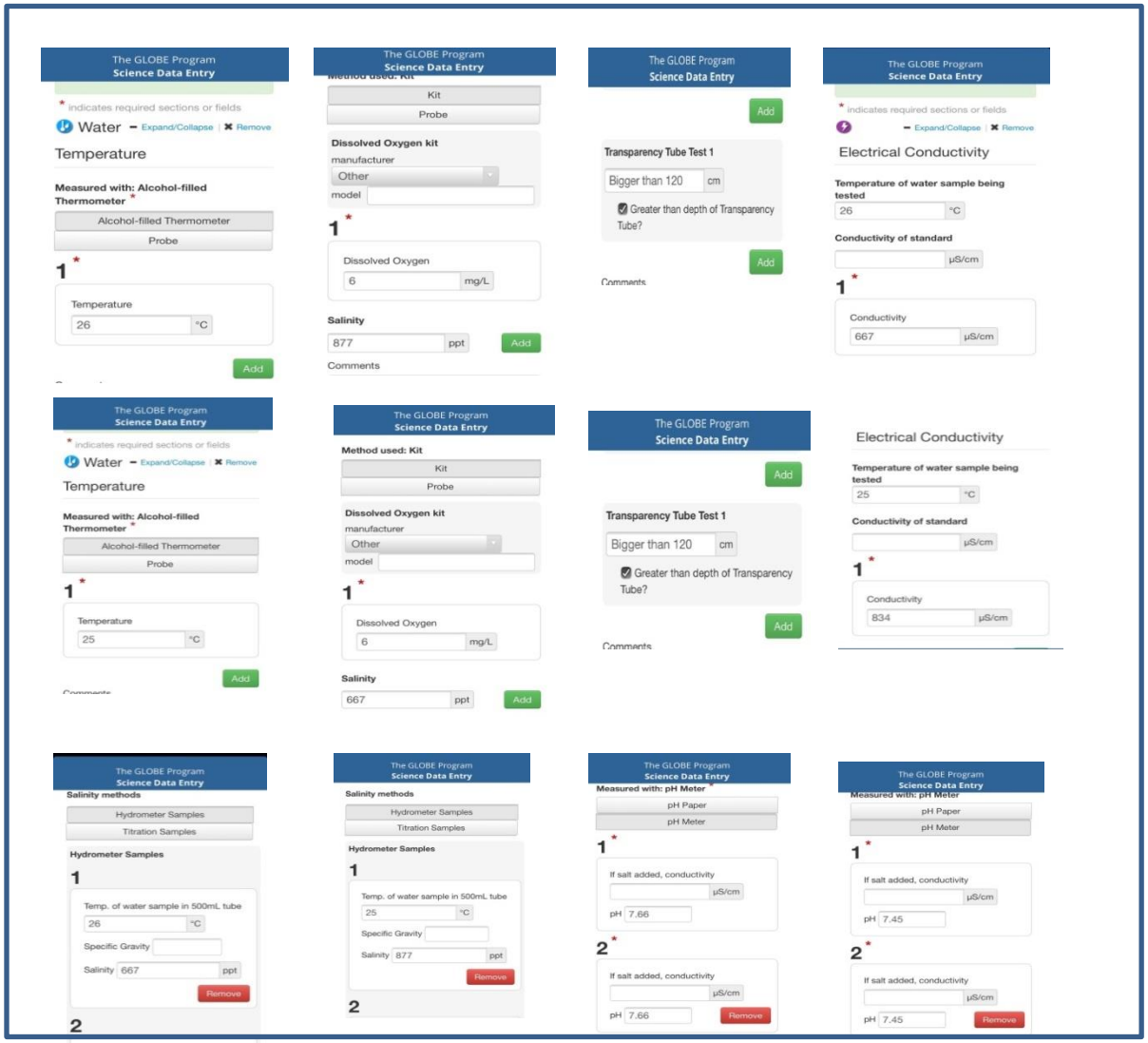



**Chart (5):** Comparison between Salinity and conductivity of water at the two sites




**Picture (8):** Enter water protocol data in the program site.

## Discussion of results:

The results shown in Table (5) indicate that the increase in salinity of the soil led to a decrease in the average weight of lemon significantly. The average weight of lemon from Wadi Al-Jahawir is 51.48 grams, and that in Dyan Al-Busaid is 20.47 grams, which means that the percentage of the reduction was 60.24% for the high salinity site compared to the lower saline location.

The same is true with regard to the average weight of the juice, as a significant reduction in the content of the juice by increasing the level of soil salinity. The average weight of the juice is 17.26 grams in the trees growing in Dyan Al-Jahawir and 4.86 grams in Dyan Al-Busaid.

The probable reason for the decrease in the average weight of fruits and juice is the increase in salinity of the soil to the negative effects of increasing soil salinity, which in turn increases the pressure of the toxic solutions of the soil which reduces the amount of water available to the plant. This adversely affects the vegetative growth of the plant and thus the amount of nutrients obtained. This is consistent with Cerda et al (1990), who noted that increased salinity in the root zone leads to a significant reduction in the volume and content of the juice of citrus fruits.

As shown in Table (5), the percentage of fruit juice in the lower salinity location is significantly higher than those the highest salinity site; 33.53% in Dyan Al-Jahawir compared to 23, 72% in Dyan Al-Busaid. These results are consistent with what Al-yassin (2004) found that salinity leads to reduced citrus yield.

The average acidity of lemon juice was 2.48 in Dyan Al-Jahawir and 2.65 in Dyan Al-Busaid, which indicate that there is a slight increase in the pH of lemon juice at the location with higher salinity compared to the less salinity site. These results are consistent with what Cerda et al. (1986) found that high soil salinity has increased the acidity of citrus fruits.

By applying the soil protocol, (Table 6), we found that the structure of the granular soil in the Dyan Al-Jahawir, while its structure is blocky in the Dyan Al-Busaid area. The consistency and texture of the signatory soil is friable and clay loam at both sites. The soil of the signatories is characterized by few rocks, abundant roots and low carbonates. The salinity and conductivity results showed that the soil of Dyan Al-Busaid was higher salinity and conductivity (852,940) (ppm , µs) compared to the soil of Dyan Al-Jahawir which was (408, 586) (ppm , µs). The pH of Dyan Al-Jahawir and Dyan Al-Busaid soil was 7.47 and 7.55 respectively, and the soil temperature of both locations was 22 ° C.

The results showed that the pH Dyan Al-Jahawir water (7.45) was slightly less than the pH level of Dyan Al-Busaid (7,66). Regarding the salinity and conductivity of Dyan Al-Busaid, it was 877, 834 (ppm, µs), respectively, which is higher than the salinity and conductivity of the Dyan Al-Jahawir (668, 667) (ppm, µs).

## Conclusion

By comparing the results between the two sites, we found that the high salinity of the soil greatly affects the size of the Omani lemon and lemon juice and the percentage of juice in the lemon, which decreased

significantly. In addition, results showed that the high salinity of the soil leads to high acidity lemon juice. The land cover protocol can be applied to add information and data on the soil cover and the height of grass plants near lemon trees.

One of the strengths of the research methodology was that the study was conducted at two sites where soil salinity was different and the results were compared which added to the accuracy of the results. The comparison of the results of the two sites helped in determining the effect of soil salinity on the physical and chemical properties of the Omani lemon. The weakness of our study is the difference in the salinity and conductivity of irrigating water at the sites where they may have an effect on the characteristics of the lemon fruits.

In order to improve research, it is possible to improve the study for several years by planting lemon trees using seeds at different sites and following up the growth of these trees and study the resulting fruits in each site where follow-up from the beginning and under the same environmental conditions.

**Acknowledgments**

I would like to thank Ms. Kaltham Al-Barhi, the schoolprogram supervisor for her efforts in helping me to complete this research. I also thank Mr. Amer Al-Barhi for the valuable information and the laboratory technicians at our school and Mariam Bint Omran School for help and support in carrying out the tests. I thank the farms owners for their cooperation to carry out the study in their farms.

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