Kingdom of Saudi Arabia

Ministry of Education General

Department of Education in Taif

Tenth Secondary School

Research Title:

The Effect of Electric Field on Soil

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In the name of Allah, the Most Gracious, the Most Merciful

”(And it is He who sends down from the sky rain, by which We bring forth vegetation of every kind, and from it We bring forth green crops from which We produce grain piled up, and from the date palms, from their spathes, clusters of dates hanging low, and gardens of grapes, olives, and pomegranates, alike and not alike. Look at their fruit when they bear fruit and their ripening. Indeed, in that are signs for a people who believe.)”

Surah Al-An’am – Ayah 99

Dedication

To those who purified their intentions and raised the banner of knowledge…

To those who stayed up late searching for the truth, striving with all their might toward the light of science…

To those who learned knowledge to illuminate the path of others, becoming like a lantern that brightens the darkness of ignorance…

And to those who sought and mastered knowledge, making their mastery a trust that they convey with sincerity and honesty…

You are the beacons of light, the pillars of construction, and the hope of future generations.

You have all our appreciation and respect, for with you nations rise and prosper.

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Research Abstract

The Kingdom of Saudi Arabia aims to benefit from renewable energy sources through Vision 2030 and to achieve environmental sustainability for all generations. As individuals in this society, and through our observations of climate change, we have conducted a study on the effect of the electric field on soil and the potential benefit of the increasing lightning phenomenon in the Kingdom as a source to enhance soil fertility.

We conducted an experiment on two samples, one exposed to an electric field generated by a 0.02A current, and we reached the following results:

1- The electric field affects the alkalinity of the soil

2- If an electric field with a current intensity of 0.02A affects the soil's alkalinity, it is certain that lightning, which has a field strength exceeding 1A, will have a significant impact on soil alkalinity.

3-Through the theoretical framework, we observed that certain types of plants prefer alkaline soil, especially in desert regions. Therefore, lightning can be greatly beneficial, as each lightning strike generates an electric field and causes a discharge into the ground. Lightning rods can be installed in desert areas to make the soil alkaline, which could then be used to grow plants that prefer alkaline soil

4- Another study could be conducted by increasing the magnitude of the electric field or the duration of exposure to the electric field, and examining the effect of that on soil alkalinity.

5- Due to the lack of sufficient equipment to study soil characteristics, and our focus solely on alkalinity, it may be possible to conduct further studies on other characteristics, such as nitrates, nitrogen, or the increase and decrease of nutrients in the soil

Our recommendations were as follows:

1Conduct further studies to explore the value of the electric field and the duration of its exposure to plants.

2- Expand the study to include other soil characteristics, such as nitrates or soil mineral elements.

3-Conduct experiments on lightning using lightning rods over specific areas and observe their impact on the soil.

- **Chapter One**

A- Introduction to the Research
B- Research Problem
C- Research Objectives
D- Importance of the Research
E- Research Hypotheses
F- Scope of the Research
G- Research Terminology

The Introduction

Preface

Given the climatic changes that the Kingdom of Saudi Arabia is experiencing, including the increase in lightning strikes, which have risen significantly in recent years, and despite the associated damages, and since

lightning is an electrical discharge, the aim of this study is to investigate the impact of electric fields on the soil. The study will be conducted by applying an electric current to the soil."

The Research Problem

The Main Question**:**

- ✓ What is the effect of the electric field on the soil?

Sub-questions:

1-Does the electric field affect the soil's alkalinity?

2-Does the duration of exposure to the electric field affect the soil?

Research Objectives:

The aim of this research is to shed light on the phenomenon of frequent lightning strikes and their potential benefits to the soil, through simulation using an electric field.

It consists of:

1. Identifying the effects of electric current on soil properties.
2. Understanding the impact of increased exposure duration to the field on soil properties.
3. Exploring whether there is a link between the study and the frequency of lightning strikes in the Kingdom of Saudi Arabia.
4. Investigating whether the electric field can be utilized to increase vegetation cover in the soil

Importance of the Research

The research aims at two main objectives:

Its importance to society

- Benefiting from natural energy sources such as the phenomenon of lightning.
- Increasing vegetation cover and providing a green environment in line with Vision 2030.

Its importance to researchers:

The importance of vegetation cover in reducing the phenomenon of thermal emissions, which ensures a sustainable environment for future generations.

Research Hypotheses

- The electric field causes a change in the soil's alkalinity.
- Increasing the duration of exposure to the electric field does not affect soil properties.
- Increasing the intensity of the electric field causes a significant change in soil properties

Scope of the Research:

The scope of the research includes three aspects:

The subject boundaries: The study in the practical aspect included conducting an experiment on two soil samples. One sample was independent and not affected by the field**.**

Spatial boundaries: The Tenth Secondary School.

The time frame: The study was conducted in 1446 AH - 2024 AD.

Research Terms:

The concept of electric field:

> The electric field is known as the force that forms in the vacuum surrounding each charge or group of electric charges. Electrical forces are considered the main cause of the electric field. The following mathematical equation represents the law of the electric field.

The concept of electric current intensity:

Electric current is generally defined as the flow of electrical charges through an electrical conductor. The amount of charges that cross the conductor during a certain period of time is called the “intensity of the electric current.” Electric current is divided into two types: Direct current (DC) and alternating current (AC). (Tawil, 2021)

Alkalinity (PH):

The number (ph) expresses the negative decimal logarithm of the concentration of hydrogen ions in the solution, or the inverse logarithm of the concentration of these ions. (Al-Hassan, 2012)

•Chapter Two

Research literature:

A- Theoretical framework

B- Previous studies.

Firstly:

Theoretical framework:

1-Electric field:

The electric field is defined as the force that forms in the vacuum surrounding each charge or group of electric charges. Electrical forces are considered the main cause of the electric field. The following mathematical equation represents the law of the electric field:

E=F/q

The newton/coulomb, N/c, represents the unit of electric field, which is measured in volts/meter.

The electric field is mainly divided into the following types:

1. Uniform electric field: A uniform electric field is known as the field in which the field strength is constant at all points, and the field lines are parallel, meaning the distance between them is equal, A regular field arises when there is a potential difference between two charged or conductive plates that are a fixed distance apart and kept in a homogeneous or completely pure insulating medium. The regular electric field lines are in the middle of the plates, but at the edges of the plates the matter may differ so that the field is irregular, and the strength of the field depends on Both the voltage difference factor and the actual distance between the two conductors. If the voltage difference is high , The electric field was strong, and if the distance between the two conductors was large, the field was weak.
2. An irregular electric field is known as a field in which the magnitude and direction of the electric field intensity are not the same at all points. The irregular field arises from fixed point charges or
   Static, non-uniform electric field can be obtained by a pair of asymmetric electrodes or an asymmetric tube or microchannel, and the non-uniform field lines are not parallel or equidistant. (Al-Rashdan, 2021)

2-Electric current intensity

Electric current is generally defined as the flow of electrical charges through an electrical conductor, and the amount of charges that cross the conductor during a certain period of time is called the “intensity of the electric current.” Electric current is divided into two types: Direct current (DC) and alternating current (AC).

The unit of measurement for electric current is the ampere (A), named after the French scientist André-Marie Ampère. Current is measured using a device called an ammeter, and an ampere is defined as the current resulting from the passage of a charge of 1 coulomb during one second through a conductor. (Tawil, 2021)

Law of electric current:

**Law of electric current intensity:

$I=\frac{Q}{t}$

Whereas:

I = current intensity measured in amperes

Q = Quantity of charge measured in coulombs

T = Time duration measured in seconds

Factors affecting the intensity of electric current:

- Electrical resistance: the resistance of a material to the passage of electrons through a conductor every second.

Voltage Difference (Voltage): Increasing the voltage difference between two points in a circuit leads to an increase in the current passing between them, provided the resistance remains constant.

Conductor Properties: The nature of the material from which the conductor is made, its length, and its cross-sectional area affect its resistance, and thus the current intensity. (Sam, 2021)

:PH

The pH symbol is known as the hydrogen ion concentration or acidity level, and it measures whether a liquid is acidic, basic, or neutral. Liquids are considered to have a high acidity if their pH is greater than 7, while they are considered to have low acidity if their pH is less than 7. It is also worth noting that the pH level of any solution can be determined using a pH indicator.

Alkali Soil is soil with a high level of alkalinity, with a pH of 8.5 or higher, or soil that contains a high percentage of exchangeable sodium (15% or more of cation exchange capacity), or both. It contains enough alkalinity (sodium) to negatively affect the growth of most crop plants. In other words, the sodium content in the soil particles increases beyond the usual level, causing soil particles to disperse from each other, which leads to poor drainage and the land becoming waterlogged. The sodium also affects the plant's ability to absorb nutrients. Common signs of alkali soil include the growth of reed and bulrush plants, water accumulation, and surface waterlogging.

Some plants that grow in alkali soil include buffalo grass, aromatic herbs, fruit trees, and vegetables.

Secondly

Previous Studies:

There are no specific studies that focus on the direct effect of the electric field on soil alkalinity. Therefore, it is important to conduct further research to understand the precise relationship between the electric field and soil alkalinity. For this reason, we attempted in our research to study this relationship using simple tools.

Chapter 3: Study Procedures

1. Research Sample

2. Research Methodology

3. **Research Tools**
4. **Research Variables**
5. **Statistical Methods**

Research Sample:

Two soil samples were used: one exposed to an electric field generated by a current passing through a voltage difference of 1.5 V. The same water sample was used for both, and both samples were exposed to .sunlight

Research Methodology:

The study follows the experimental approach, involving the testing of two soil samples.

Research Tools:

- Soil Samples
- 1.5 V Battery
- Exposed Wires

- Temperature Gauge
- pH Meter
- Photographic Documentation of Samples

Variables of the Research:

Based on the previous information, the variables of the research include the following:

Independent Variable:

1) Electric current intensity

Dependent Variables:

2) Temperature, pH

Statistical Methods:

The researchers used descriptive statistics by collecting data from the research sample and summarizing it using graphical representations to better understand and interpret the results.

- **Chapter Four:**

A-Results of the Study
B-Discussion of the Study

Discuss the results related to the sub-question using graphs, which help :convey the information more efficiently to the reader

”?**The first sub-question: “Does the electric field affect soil alkalinity**

Sample **B**		Sample **A**		--------
PH	**Temperature**	**PH**	**Temperature**	**Day**
7	**20**	**7**	**20**	**First**
8.5	**21**	**7.5**	**21**	**Second**
9	**18**	**7.5**	**18**	**Third**
9	**17**	**7.5**	**17**	**Fourth**

Table (1)

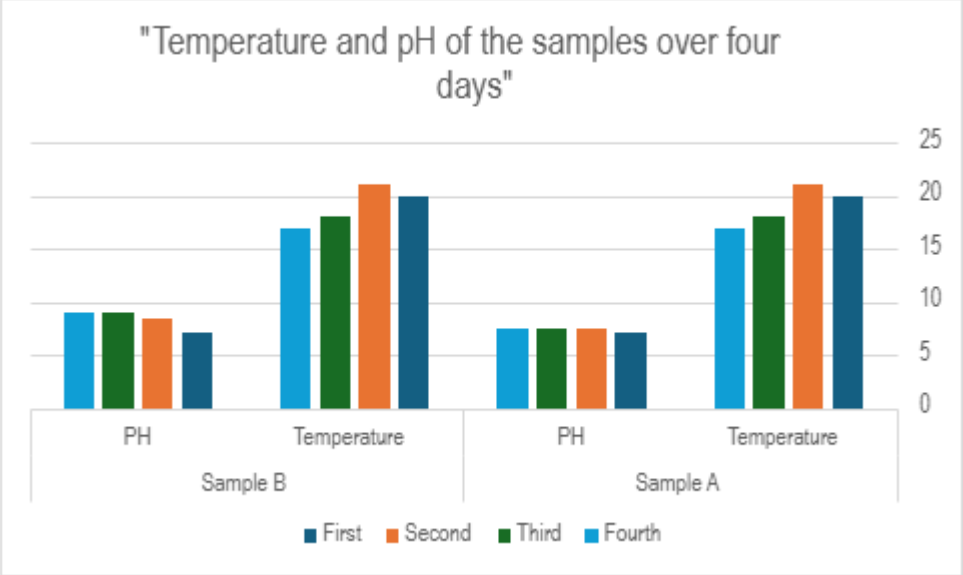

Figure (1)

By referring to Table (1) and Figure (1), we observe that Sample B, which was exposed to an electric current of 0.02 A (with resistance of 100 Ω and battery voltage of 1.5 V), shows an increase in pH levels starting on the third day due to exposure to the electric field. Since any current is accompanied by an electric field, this suggests that the electric field influenced the pH level by causing an increase in alkalinity.

In contrast, Sample A, which was not exposed to the electric field, maintained a stable pH level throughout the four days.

The second sub-question: "Does the duration of exposure to the electric field affect the soil?

Based on Figure (1) and Table (1), we observed that the electric field influenced soil alkalinity during the four days of exposure, with exposure lasting between 4 to 6 hours daily. Therefore, extending the exposure period could lead to a greater impact. However, due to time constraints, the experiment was conducted over only four days with a fixed current intensity. In future studies, varying the current intensity and extending the exposure duration may yield more pronounced results.

Results and Discussion:

This research yielded several key findings despite the time constraints:

1) The electric field affects soil alkalinity.
2) A current intensity of 0.02 A impacted soil alkalinity. It is expected that stronger electric fields, such as lightning with fields exceeding 1 A, will have a more significant effect on soil alkalinity.

3) Based on the theoretical framework, certain plants prefer alkaline soil, particularly in desert regions. Therefore, lightning, which generates electric fields, could be utilized. Installing lightning arresters in desert areas could help make the soil more alkaline, facilitating the cultivation of plants that thrive in alkaline conditions.
4) A further study could explore the impact of increased electric field strength or extended exposure periods on soil alkalinity.
5) Due to limited equipment availability focused solely on soil alkalinity, future studies could investigate other soil properties, such as nitrate and nitrogen levels or variations in nutrient content.

Chapter Five:

1-Recommendations and Suggestions
2-Conclusion

Recommendations and Suggestions:

Based on the results of this study, the researchers recommend the following:

1) Conduct further studies focusing on varying electric field values and exposure durations to plants.
2) Expand the study to include other soil properties such as nitrate levels or mineral content.
3) Conduct experiments on lightning through lightning arresters in specific areas to observe their impact on soil.

Conclusion:

In conclusion, scientific research in the field of plant studies is essential for environmental conservation and global food security. Enhancing knowledge about plants contributes to improving their productivity, sustainability, and resistance to environmental challenges. Continued focus on this area of research opens up opportunities for innovative agricultural techniques that conserve natural resources and maintain ecological balance. Therefore, attention to this vital field is not just an option but a necessary step to ensure a sustainable future for future generations.

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