Kingdom of Saudi Arabia
Ministry of Education
General Administration for Education
in the Eastern Province (Girls)
East of Dammam Education Office
Twenty-fifth secondary school in Dammam

The pH Of Water Effect on Plant Growth Rate

Descriptive and experimental research

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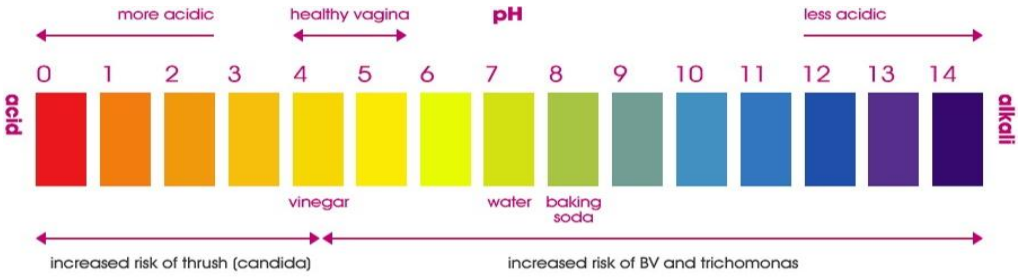


1439-1400 H

Abstract

The problem of our research was about the effect of pH of water on plant growth rate.

We assumed that when plant is irrigated with pure (neutral) water, it grew faster than the plants that were irrigated with acidic or alkaline water.

Our research aims to study the effect of the pH of water on plant growth rate, and to find the reasons for lack or weakness of growth of other plants.

The importance of our research lies on clarifying and interpreting the effect of pH of water on the plant growth rate.

Our research method was by experiment and daily observation of plant growth.

The research methodology is based on experiment and describing what happened to the plant to detect the effect of pH of water on plant growth.

The research tool was the direct observation of the plants growth rate.

We found that the plant that was irrigated with pure water grew faster than other plants.

First Chapter: Research Introduction

- Introduction
- Research Problem
- Research objectives
- Research importance
- Research hypotheses
- Research limits
- Research terms

Introduction

Water is the basis of life on earth, the lifeblood of all living beings without exception, and without it, there is no life, no human, no animal, and no plant.

The materials around us in this nature have characteristics that distinguish them from others; each material has physical, biological, and chemical properties. In this research we will address one of the chemical characteristics of materials, which is the measure of acidic or alkaline of materials.

To measure this ratio, a mathematical logarithmic formula was adopted for the ion values of alkaline and acidic, namely hydronium and oxide ions.

Previous research has found that the presence of high concentrations of soluble salts in saline soil or salt water irrigation adversely affects the plant due to the reduction of osmotic pressure in multiple places in Egypt

Where the land turns from fertile soil in which fruitful plants to saline soil that grow on it unwanted plants (1).

So what is the measure through which the nature of the physical medium is defined whether it is acid, alkaline, or neutral?

Moreover, what is the effect of knowing the nature of the medium, especially the water, on the plant? this is what we will address in our research.

In this research, we target farmers, ecologists and all groups interested in plants.

- Research problem

What is the effect of pH of water on plant growth rate?

Research variables:

Constants:

- Time of exposure to the sun
- Quantity of water
- The amount and type of soil.
- Plant type
- Quantity of seeds.

Independent variables:

- pH of water

Dependent variables:

- Plant growth

- Research objectives

- Study the effect of pH of water on plant growth rate.

- To find the reasons for lack or weakness of growth of other plants.

- ## Research importance

The research clarifies and interprets the effect of pH of water on the plant growth rate.

- ## Research hypotheses

When plant is irrigated with pure (neutral) water, it grew faster than the plants that were irrigated with acidic or alkaline water.

- ## Research limits

- **Objective limits:** The effect of the pH of water on plant growth rate.

- **Locational limits:** Twenty-fifth secondary school in Dammam

- **Time limits:** Second semester of the year 1439 – 1440 H

• Research terms

pH: Is the negative value of the logarithm of the hydrogen ion concentration in the solution which determines the acidity, alkalinity and neutral of the liquids. The negative value of the logarithm, and the concentration of the hydrogen ion in the solution.

Acidic solutions: are fluids with a pH of 0 to less than 7.

Alkaline solutions: are fluids with a pH of more than 7 to 14.

Neutral solutions: are fluids with a pH of 7.

Reagents: are chemical dyes whose colors are affected by acidic and alkaline solutions, giving color in the acidic solution other than alkaline solution.

Acid rain: Rainfall that has a pH of about 5.2 or less, and nitrogen oxides resulting from sulfur dioxide (SO2) emissions from some human activities, often due to combustion of fossil fuels.

Second Chapter: Definition of pH

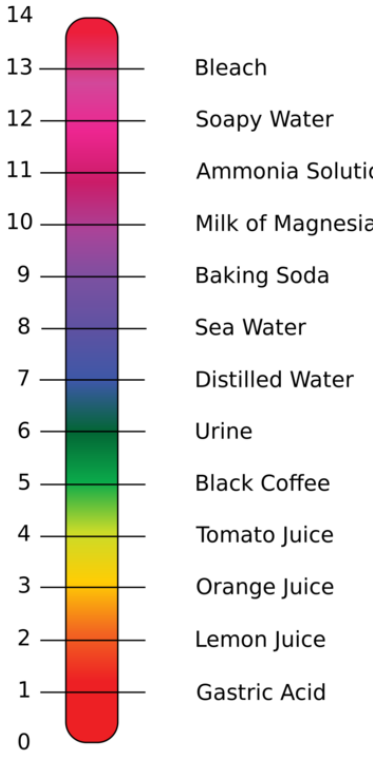
- How do you know the degree of acidity of any liquid?
- Methods of measuring pH.

- How do you know the degree of acidity of any liquid?

- By using pH index.

- Can be calculated mathematically by finding the negative of the ten-logarithm of the concentration of hydrogen ion in a solution, and the resulting number indicates the amount of acidity.

- $pH = -\log [H_3O^+]$



- Methods of measuring pH.

1- **Voltmeter:** A porous ball made of glass is filled with a buffer solution, then dip into the solution to measure its pH where hydrogen ions tend to stick to the silica layer of the glass surface and produce an electric voltage that is the amount of pH.

2- **Reagents:** Different types of reagents are used to distinguish acidic or alkaline, such as sunflower leaf, to determine the pH. Some natural reagents, such as potatoes, cabbage, beets, wild grapes, and strawberries.

3- pH meter: Is an electronic instrument used to measure the pH of a given liquid usually consists of a glass pole connected to an electronic scale that measures and displays the pH

Third Chapter: The effect of pH of water on plant growth rate

- Report of the experiment of white beans.
- Growth stages of white beans.
- Report of the experiment of fenugreek plant.
- Growth stages of fenugreek plant.

- # Report of the experiment of white beans.

- Objective of the experiment

  Clarifying the effect of pH of water on the plant growth rate.

- Question of the experiment

  What is the effect of pH of water on the plant growth rate?

- hypothesis of the experiment

  When the plant is irrigated with pure (neutral) water grew faster than the plants that are irrigated with acidic or alkaline water.

- Materials and tools:
  - 3 vessels of equal size.
  - Agricultural soil.
  - Distilled water (neutral).
  - Acidic water (water + vinegar), concentration: 5% vinegar.
  - Alkaline water (water + Calcium hydroxide), concentration: 1 molar.
  - Seeds of white beans.
  - Measuring cylinder

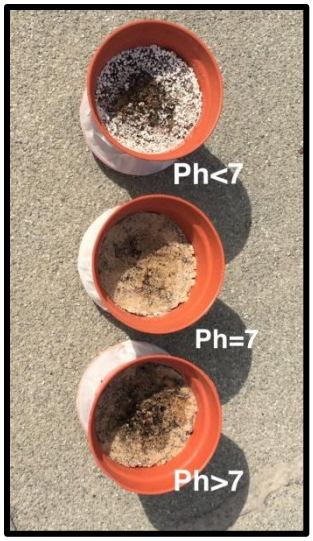
- # Procedures:

1) I put equal quantity of soil in the three vessels.
2) I planted two seeds of white beans in each vessels.
3) Exposure the vessels to the same amount of sun and air.
4) By using of measuring cylinder, the vessels were irrigated with same quantity of water; one was with acidic water, the second with distilled water, and the third with alkaline water for three weeks.
5) Note the speed of plant growth on the three vessels and capture images that document plant growth.

- Remarks and data:

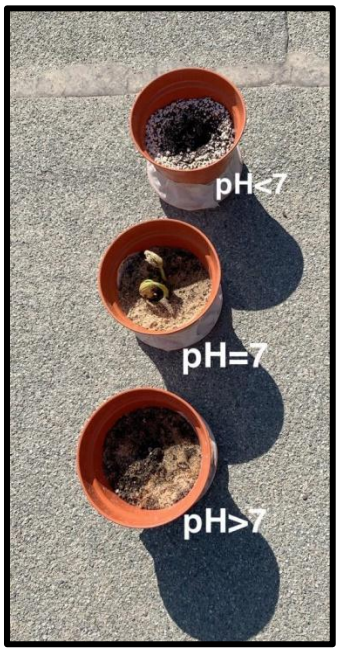
Second day: 24 January 2019

We noticed the appearance of white saline substance on the plant that was irrigated with acidic water, and there was no change in the other plants.



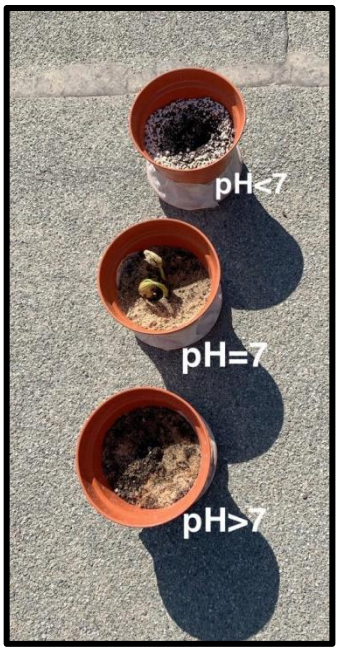
Fifth day: 27 January 2019

We noticed increase of white saline substance on the plant that was irrigated with acidic water, and there was no change in the other plants.



Twelfth day: 3 February 2019

On this day, we noticed sprouting of the plant that was irrigated with distilled water, for other plants no change happened.



Nineteenth day: 10 February 2019

We noticed increased growth for the plant that was irrigated with distilled water, dissolve of salts for the plant that was irrigated with acidic water due to rainfall at that day, and there was no change for the plant that was irrigated with alkaline water

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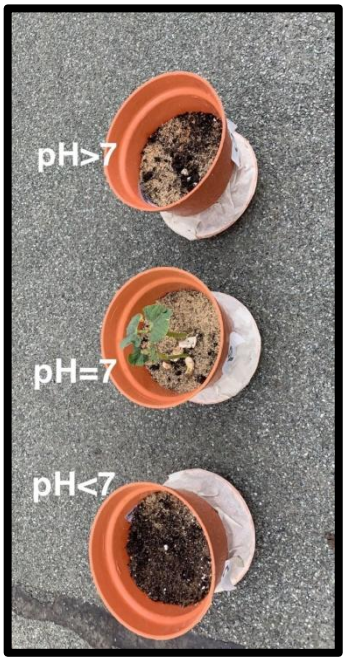


- # Report of the experiment of fenugreek plant.

- Objective of the experiment

  Clarifying the effect of pH of water on the plant growth rate.

- Question of the experiment

  What is the effect of pH of water on the plant growth rate?

- hypothesis of the experiment

  When the plant is irrigated with pure (neutral) water grew faster than the plants that are irrigated with acidic or alkaline water.

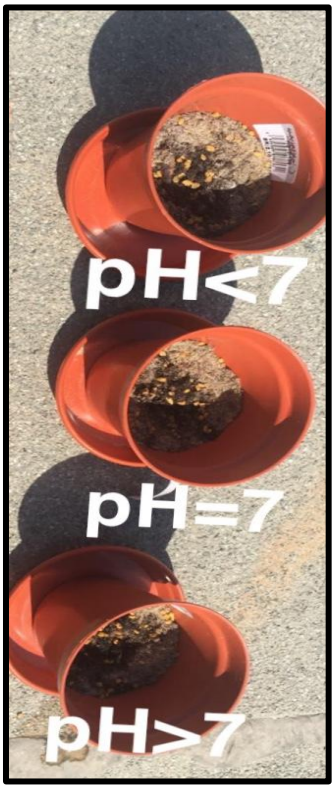
- Materials and tools:
  - 3 vessels of equal size.
  - Agricultural soil.
  - Distilled water (neutral).
  - Acidic water (water + vinegar), concentration: 5% vinegar.
  - Alkaline water (water + Calcium hydroxide), concentration: 1 molar.
  - Seeds of fenugreek plant.
  - Measuring cylinder.

- # Procedures:

1) I put equal quantity of soil in the three vessels.
2) I planted 70 seeds of fenugreek plant in each vessels.
3) Exposure the vessels to the same amount of sun and air.
4) By using of measuring cylinder, the vessels were irrigated with same quantity of water; one was with acidic water, the second with distilled water, and the third with alkaline water for three weeks.
5) Note the speed of plant growth on the three vessels and capture images that document plant growth.

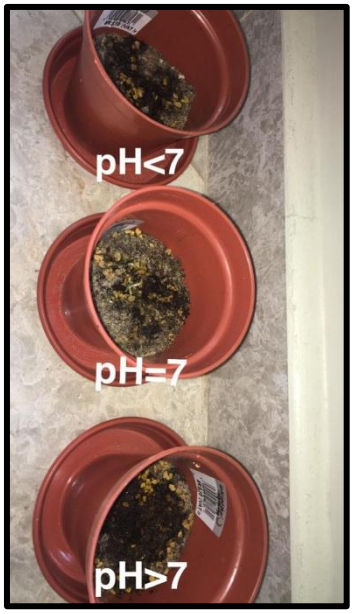
- Remarks and data:
- **Second day: 14 February 2019**

  We did not notice any change in the three plants.



- **Fourth day: 16 February 2019**

  There was a little white saline substance on the plant that was irrigated with acidic water; some of the seeds that were irrigated with distilled water sprouted, and no change happened for the seeds that were irrigated with alkaline water.



- **Fifth day: 17 February 2019**

  More seeds sprouted that were irrigated with distilled water, and no change happened for the other plants.

- **Fifth day: 17 February 2019**

  Most of the seeds, around 50 seeds that were irrigated with distilled water sprouted, and no change happened for the other plants.

Fourth Chapter: Reasons for non-growth of other plants

- Acid rain
- Basal water (alkaline)

It is common knowledge that plants grow only when irrigated with neutral water, and this is what we have observed through our experiment. We expect that the reason for the non-growth of plants that were irrigated with acidic or alkaline water is that plants do not tolerate a pH greater than or less than the pH of 7. There are other types of plants that tolerate with this type of water, but with specific conditions and characteristics in specific places or dedicated to them.

- Water and acid rain:

Because of the acid rain, the trees are stripped of their leaves, and there is an equilibrium imbalance in the soil; thus, causing absorption disturbed in roots, and the result is a large loss of crops.

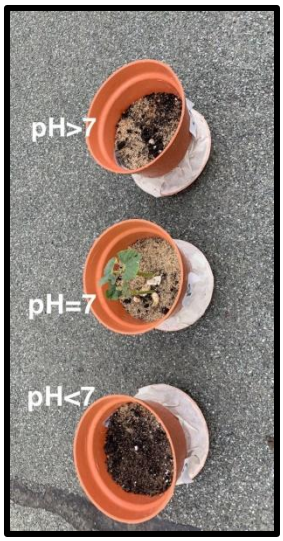
That is what studies by researchers found since more than a decade that the fall of acid rain on forests in the Czech Republic has been increasing to the extent that it began affecting the entire biosphere, threaten forests and trees, which experience the phenomenon of "dieback" where trees die standing, as they say. The upper leaves are directly exposed to the acid rain, which kills the green stuff in them and then the effect is transferred to the lower leaves. (2)

- Basal water (alkaline)

The reason why the plant, which is irrigated with basal water, did not grow is that sedimentary layers lead to a dielectric layer and increased sedimentation may prevent the growth of the seed.

Third day of the experiment

Last day of the experiment



Fifth Chapter: Research Procedures

- The research methodology
- Research tools
- Statistical methods
- Conclusions and discussion
- Recommendations and suggestions

- **The research methodology**
  The research methodology is based on experiment and description of what happened to the plant to detect the effect of pH of water on plant growth.

- **The research tools**
  The research tool was the direct observation of plant growth rate.

- **Statistical methods**

Table No. 1: White beans seeds growth rate throughout the days.

pH of water	Number of days			
	2	5	12	19
pH < 7	Did not grow	Did not grow	Did not grow	Did not grow
The successful group pH = 7	Did not grow	Did not grow	One seed sprouted	Two seeds sprouted
pH > 7	Did not grow	Did not grow	Did not grow	Did not grow

Table No. 2: Fenugreek plant growth rate throughout the days.

pH of water	Number of days			
	2	4	5	6
pH < 7	Did not grow	Did not grow	Did not grow	Did not grow
The successful group pH = 7	Did not grow	13 seeds sprouted	33 seeds sprouted	50 seeds sprouted
pH > 7	Did not grow	Did not grow	Did not grow	Did not grow

- Relative growth rate was measured by the following equation:

$$CVG = \frac{\text{total number of seeds } (A1+A2+\ldots\ldots+Ax)}{(A1T1+A2T2+\ldots..+AxTx)}$$

Where A represent seeds in a specific day T

In this equation, the higher the number obtained, the faster the germination.

The percentage of seeds germination was measured by the following equation:

$$\frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \text{ X } 100$$

Table No. 3: Relative growth rate and percentage of germination of white bean seeds.

pH of water	percentage of germination	Relative growth rate
pH < 7	0%	Zero
pH = 7	100%	194
pH > 7	0%	Zero

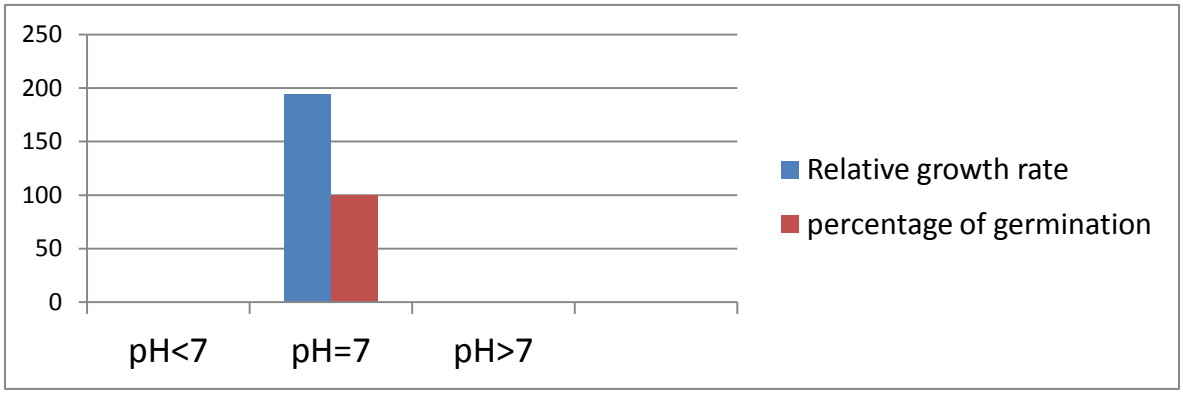
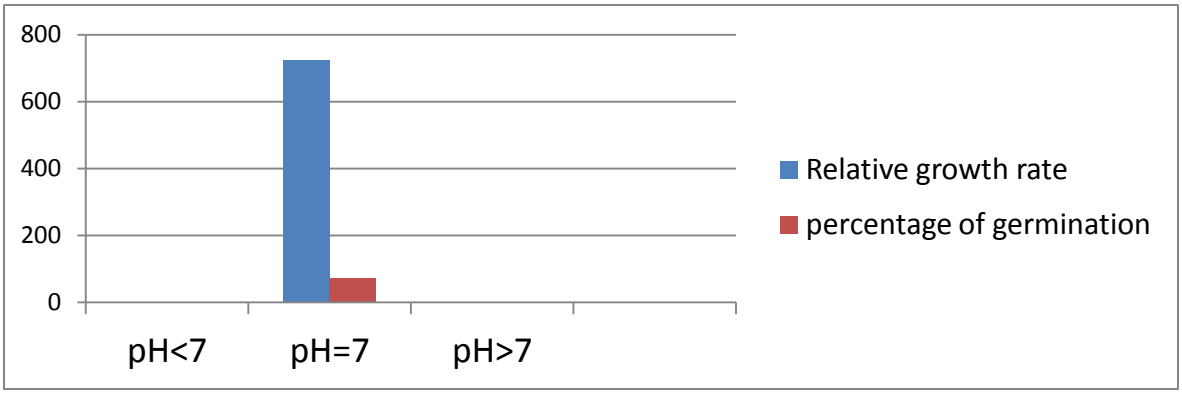


Table No. 4: Relative growth rate and percentage of germination of fenugreek seeds.

pH of water	percentage of germination	Relative growth rate
pH < 7	0%	Zero
pH = 7	74.1%	723.8
pH > 7	0%	Zero



- **Conclusions and discussion**

1) The plant that was irrigated with neutral water grew faster than other plants.

2) Acidic water create sedimentation in soil which lead to difficulty or lack of absorption of plant root organic matter which cause slow or lack of growth.

3) Alkaline water causes a decrease in growth properties compared to neutral water.

- **Recommendations and suggestions**

1) Care must be taken to balance the type of fertilizer depending on the quality of water used in irrigation.

2) To reduce the problem of acid rain, it is necessary to reduce the release of pollutants caused by fuel combustion, and conservation of energy by:

   - Reducing the use of public transport and cars shall lead to reduction of emissions.

   - Reducing the consumption of electricity in homes shall lead to reducing the energy consumed in production of electricity.

3) Pay attention to providing logistical support to farmers so they can improve farming conditions.

References:

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College of education, Ibn Hayan for pure science. (2012). Acid rain and its risks to the environment and human. Bahrain: electronic media department.

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Sixth Chapter: Additions

- Cooperation
- Society impact
- Communication with a STEM specialist
- Exploring STEM professions

- Additions

Cooperation:

The researchers cooperated and distributed tasks among them as follows:

- *Hawra Yousef Aloadah:* drew conclusions, wrote proposals, recommendations, and references.
- *Sahar Badar Alsalman:* written the literature of research, introduction, and abstract.
- The two researchers participated in performing the experiment; noted the results and wrote the additions.

Society impact

This research convinces environmental organizations about the importance of knowing the pH value of water and its impact on plant growth, and the provision of water sources with moderate hydrogen numbers for owners of agricultural land.

Communication with a STEM specialist

We communicated with the department of biology at the University of Imam Abdulrahman bin Faisal. We held a meeting with them; the research was followed by professor of plant environment Dr.: Wafa Abdulrahman Al-Tessan.

Exploring STEM professions

This research is closely related to biology, environmental researchers and farmers. Besides that, this research helps students understand the environment better and explore the reasons for improving plant growth.

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