Sultanate Of Oman
Ministry Of Education

Study of the effectiveness of alum powder in improving the alkalinity coefficient of sandy soil in Al Buraimi Governorate

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Hafsah bint Sirin basic School (5-9)

(2021/2022)

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Summary:

This study aims to evaluate the effectiveness of alum in reducing the PH value of sandy soils, and study its effect on crop growth in the Hamasa area in Al Buraimi Governorate, where sandy soils predominate and suffer from high PH value and nutrient deficiency. . The research questions are: How effective is alum in reducing the alkalinity coefficient of sandy soil? What is the effect of adding alum to the soil on the growth of agricultural crops? The amount of alum was determined and mixed in the sandy soil in the amount(10 g of alum: 3 kg of sand) and the addition of compost in one sample. Soil and water protocols were applied besides applying the ground cover protocol to mung plant and following up on the characteristics every two weeks, and the results showed a decrease in the soil PH value for the samples that added alum alone and the mixed sample. With organic manure(7.2-7.8) and (6.8-7.7), respectively, compared to the control. The results also showed that plant growth was better in soil samples mixed with alum powder. We conclude that adding alum is an effective means in lowering the PH value of the soil, which contributed to plant growth and improved nutrient absorption, and the results did not show any toxic effects in the plant or the soil. Based on the results of the study, we recommend publishing the results among the population and making them aware of the properties of alum and how to benefit from it in home gardens, taking into account the testing of soil pH and determining the amount of alum before application.We also recommend conducting other studies to study the effectiveness of alum powder in reducing soil alkalinity and benefiting from it in enhancing its fertility and raising the level of nutrients.

Basic terms:

Alum: It is a crystal-shaped stone extracted from rocks. It is solid, transparent, and colorless. It has an acidic taste that tends to sweetness. It is soluble in water and is rich in aluminum and potassium sulfates.

Research questions:

1- What is the effectiveness of alum in reducing the alkalinity coefficient of sandy soil?

2- What is the effect of adding alum to the soil on the growth of agricultural crops?

Introduction:

Sandy soils that suffer from low nutrients and water and a high filtration rate dominated the Arabian Peninsula and the Arabian Gulf countries. (Al-Hitroushi,2014). Also, most of the fertilization problems in crops are because of inappropriate pH (Abdoul, 1988). The high pH of some sandy soils is one of the major challenges facing the agricultural sector, which requires special practices in terms of management to change some of its properties to get a fruitful cultivation, as high pH can cause nutritional deficiency, besides that, some species require acidic soils. To grow in it well, the use of organic and mineral soil conditioners leads to changing some of the physical and chemical properties of the soil, and it is a fertilizer source that adds some important nutrients to the plant.

We know that sulfur is an essential element in plant growth, and it has an effective role in reducing the effects of salinity and alkalinity through improving the physical and chemical properties of alkaline soils and reducing the pH (Mohamed et al., 2007). However, aluminum potassium sulfate, known locally as alum, is fast soluble and provides immediate results instead of taking months to act like sulfur, which is also used to lower soil pH (Dawn Walls-Thumma, 2017). Studies (Al-Zuhairi, 2017 and Al-Ajili, 2010 and Mahdy, AM, Elkhatib, EA and Fathi, 2007) showed that alum powder can modify the pH of the soil and increase plant growth.

As for the organic matter, it has a role in improving the properties of the soil, as it increases the ability of the soil to keep nutrients and lowering the soil PH (Ali et al., 2014). Therefore, the success of vegetable cultivation in desert lands depends on fertilization (Hassan, 1993). By adding fertilizers, both organic and mineral, to improve the properties of the soil and nourishes the crops (Abdul-Hadi, 1986).

In view of the lack of available studies on alum fertilization; The idea of this study came to assess the effect of adding alum powder on sandy alkaline soils and its effectiveness in reducing soil PH and its impact on the growth of agricultural crops.

Research methods:

First: the research plan:

1. Meeting with the team, choosing the research problem and distributing roles.

2. Locate the study.

3. Collecting soil samples from the study site.

4. Prepare the fine alum powder by grinding the alum stone and then mixing it into the soil.

5. Apply appropriate protocols (ground cover, water, soil).

The Protocol	Application mechanism
Soil Protocol	Study the soil properties (conductivity, salinity, acidity, temperature, humidity)
Land Cover Protocol	Cultivation of mung plant seeds in the same type of soil and watering them with the same amount of water with dividing the soil into three samples: The first sample: the control (without soil additives). Second sample: add alum powder. The third sample: add alum powder and organic fertilizer Plant growth was observed, and data recorded.
Water protocol	Study the properties of water used for irrigation, and measure (temperature, conductivity, salinity, acidity)

Mechanism for applying protocols to data collection

6. Recording the growth data of the mung plant every two weeks for two months and watering it with equal quantities of water.

7. Communicate with the agricultural engineer Nasser Al-Whaibi - a senior plant nutrition researcher - and the school's science and mathematics teachers to analyze the results.

8. Entering data into the program's website (www.globe.gov).

9. . Compare results and write recommendations.

Schedule of research plan:

The month	work plan
November / 2021	Formulation of the research problem and identification of tools
November - December/2021	Data collection and analysis
February - January/2022	Reaching conclusions and writing the research
March/2022	Submit the research

Distribution of roles work on the research team:

Students	The work
Hamda - Aisha - Fakhara	Formulation of the research problem
Sara - Hamda - Aisha	Collecting and analyzing data through the application of soil and water protocols
Sara - Hamda - Aisha	Collection and analysis of data through the application of the land cover protocol
Fakhara - Hamda	Reaching conclusions, drafting the abstract, and writing the paper

Second: Study Location:

(Sultanate of Oman, Al Buraimi Governorate, Hamassah, longitude 24.1438.7, latitude 55.4553.7 months of November and December, the weather is cold, the water, soil and land cover protocol was applied).

Third: Data collection and analysis:

This experiment was conducted in the school garden, where fine alum powder was prepared by grinding alum stone and determining the amount of it (10 g: 3 kg of sand) to be added to the soil, and the water protocol applied to study the properties of water used in irrigation.

To answer the first question, sandy soil was brought from the study area and divided equally into plastic pots into three samples, equivalent to 3 kg in each pot:

-The first sample: the control (without soil additives).

-Second sample: add alum powder.

-The third sample: adding alum powder and organic fertilizer.

Then the properties of the second and third soil samples were followed up and compared to the control every 10 days for two months in terms of (temperature, electrical conductivity, PH, salinity, color, moisture).

To answer the second question, we planted mung bean seeds by 4 seeds per pot to ensure germination, after which we manually diluted them to one plant. Measurements were taken for the studied characteristics of the plant in each pot for two months:

1 -Plant height (cm): The height of the plant was measured using the ruler, starting from the surface of the soil in the pot to the top of the plant, then the average was extracted from the product of dividing the total plant height in each sample by the number of times of measurement.

2 -Number of leaves: The number of leaves of the plant was calculated in each sample, then the average was extracted from the product of dividing the total number of plant leaves by the number of times measured.

3 -The color of the leaves.



Results:

1- The water protocol:

- Characteristics of water used for irrigation:

Dissolved oxygen	conductivity	Salinity ppm	PH
7	234	213	7.4

Table (1) data on the characteristics of the water used in irrigation

2- The soil protocol

- Soil properties without additives (control soil):

The color	Conductivity Ds/m	Salinity	PH	Soil texture	Soil type
7.5YR4/6	0.272	243	10.2	Sandy granules soft	Control soils

Table (2) Soil properties data without additives (control soil):

- Observe the effect of adding alum powder on the properties of sandy soil:

Soil moisture	The color	PH	Salinity	Conductivity Ds/m	Temperature	Date
Damp	7.5YR5/6	7.6	250	0.274	21° C	4/11/2021
Damp	7.5YR5/6	7.7	449	0.509	23° C	18/11/2021
Damp	10YR4/6	8.5	465	0.525	21° C	2/12/2021
Damp	10YR4/4	7.2	474	0.535	19° C	16/12/2021
Damp	10YR4/4	7.5	515	0.584	17° C	30/12/2021

Table (3) Characteristics data of sandy soil after adding alum powder

- Observe the effect of adding alum powder and organic fertilizer on the properties of sandy soil

Soil moisture	The color	PH	Salinity	Conductivity Ds/m	Temperature	Date
Damp	5YR4/6	6.8	1053	1.162	21° C	4/11/2021
Damp	7.5YR5/6	7.7	350	0.356	23° C	18/11/2021
Damp	7.5YR4/6	8.2	306	0.349	21° C	2/12/2021
Damp	10YR5/8	7.2	826	0.409	19° C	16/12/2021
Damp	10YR4/4	7.4	560	0.625	17° C	30/12/2021

Table (4) Characteristics of sandy soil after adding alum powder and organic fertilizer together

3- The land cover protocol

- Comparison of the growth rate of the mung plant:

number of leaves	Color of leaves	leg length / cm	soil sample
3.6	yellow	8	**control soil**
5.2	green	13.4	**Soil with alum powder**
10.2	green	15.2	**Soil with alum powder and compost**

Table (5) observe the effect of adding alum powder on the vegetative growth of the mung bean plant

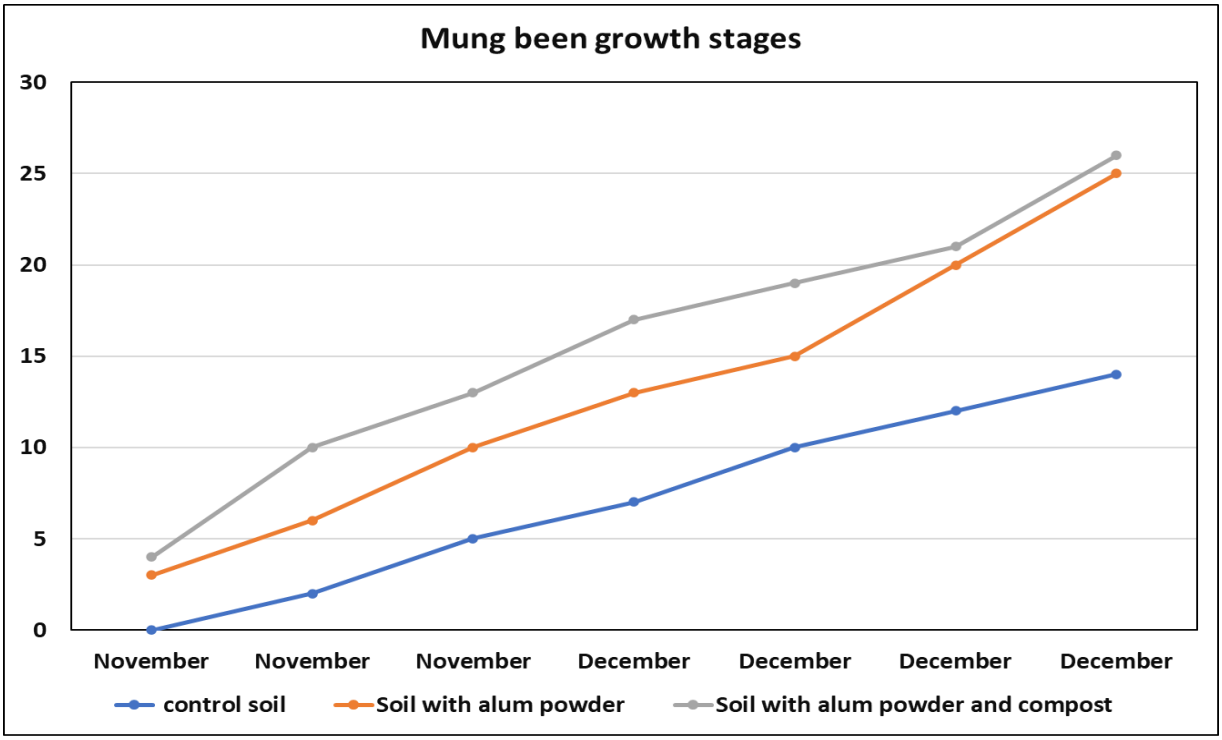
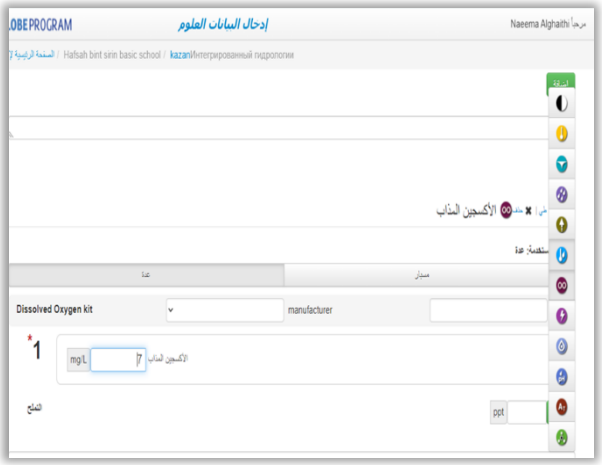


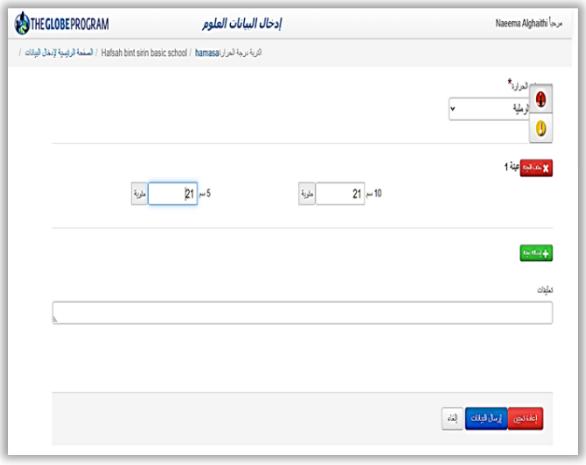
Diagram **(1) Comparison of mung plant growth in sandy soil**

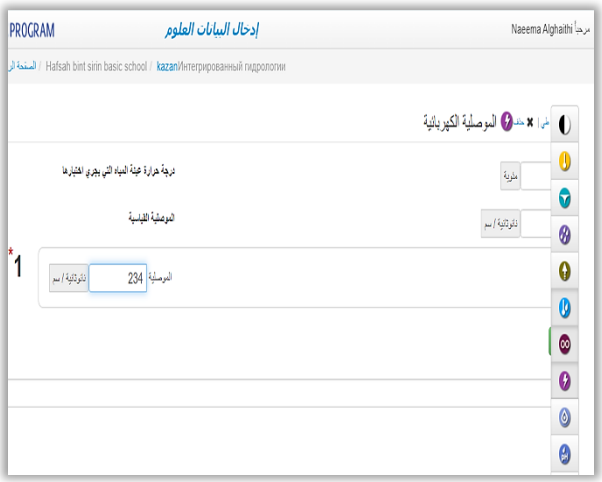
Soil + alum powder + compost	Soil + alum powder	control soil

Picture (1) comparing the growth of mung bean seeds in sandy soil

The data has been entered in the program website (www.Globe.com) where the study sites were added and enter data collected in research:







Discussion of the results:

We note through the measurements and readings that were taken during the application of the water protocol that the percentage of dissolved oxygen was appropriate in the irrigation water (7 m/L), and the pH measurement results indicated it was appropriate according to the Omani standards for water quality, which amounted to (7.4) as in the table (1).

The results showed the PH value of the soil applied in the study amounted to (10.2), so it is alkaline soil. In terms of salinity, we classified it as a low-salinity soil according to (FAO, 1990), where the value of the electrical conductivity is (0.272ds/m) as shown in Table (2). We conclude from this that the soil is alkaline, low in salinity and poor in nutrients, so it is suitable for cultivation by reclamation (fertilization and irrigation).

As an answer to the first question, the results showed that adding alum powder, individual or mixed with organic fertilizer, is an effective substance in reducing soil pH, as it reached the lowest value in the sample to which alum was added only (7.2), as shown in Table (3), while the lowest value of PH in the sample added It has both compost and alum (6.8) Table (4). Since the optimum pH range for most plants is between (5.5-7.5), these values are appropriate for plant growth, and this result was identical to the result of the study (Mahdy, AM, Elkhatib, EA and Fathi, 2007), which showed that potassium aluminum sulfate (alum) can change soil PH to increase plant growth, especially in alkaline soils considering soil nutrients and pH interaction with alum under field conditions.

The value of the electrical conductivity ranged between (0.264 - 0.584 Ds/m) in the soil to which alum was added only, while it ranged between (0.349 - 1.162 Ds/m) in the soil sample to which alum powder and organic fertilizer were added together as mentioned in Table (3) and (4) Therefore, it is classified as a low-salinity soil according to (FAO, 1990). We conclude from this that the alum powder does not lead to soil salinization when applied according to the appropriate rates.

The results also showed that the alum powder, alone or mixed with the organic fertilizer, increased the water retention capacity of sandy soil, and it kept the soil moist throughout the week, in contrast to the control soil that was exposed to drought. Table (3) and (4). This result is consistent with the study (Al-Zuhairi, 2017), which showed that add alum leads to a decrease in soil dispersal and fracture modulus, an increase in the ability of soil to keep water, and an improvement in the stability of aggregates, thus reducing soil crusting.

As for the growth of plants, and as an answer to the second question, the results stated in Table (5) that alum powder had a significant effect on the growth of mung bean plant, where the highest rate of plant height (15.2 cm) and number of leaves (10.2 leaves) in the soil sample to which alum powder and organic fertilizer were added. Together, the average plant height when adding alum to the soil was (13.4 cm) and the number of leaves (5.2 leaves) compared to the control, where the average plant height was (8 cm) and the number of leaves was (3.6).

The color of the leaves indicates that the plant growth was good in the samples in which the alum powder was applied, while the color of the leaves in the control sample was yellowish as in the picture (1). This can be explained by the fact that the organic matter in the soil has a role in adding nutrients, which increases their absorption from the plant, which has a role in the manufacture of food and the building of new cells, thus increasing plant growth (Delfi, 2013). This is also because the alum powder contains potassium, phosphorous, nitrogen and sulfur, which are major nutrients for the plant, as mentioned (Engineer Nasser Al-Whaibi, General Directorate of Agricultural Research),this result agreed with the study (Al-Ajili, 2010) which showed that adding alum and sludge led to a clear effect on growth indicators and millet yield by increasing the level of addition. This supports the idea that alum does not have any damage to the soil or plant growth if it is applied according to the required rates and appropriate for the type of soil

Conclusion:

The results indicated the significant role that add alum powder contributes to improving the physical and chemical properties of sandy soil and its immediate and rapid effectiveness in modifying the pH value of alkaline soil, which increases the solubility of nutrients and thus the plant absorbs them and improves its growth.The results also showed that the single effect of alum powder stimulated the growth of the mung plant, but when added with the organic fertilizer in the soil, it stimulated the growth of the plant to a higher degree, and despite that we know that alum is not a fertilizer, its first and main use is to improve the pH of the soil, which is a purpose to amend the soil. Thus, treating the alkalinity of sandy soils using alum powder as an environmentally friendly compound that does not have any hazardous effects on ecosystems is a promising approach to continuously improve the fertility of sandy soils and enhance crop growth, and thus these results are positively reflected in mitigating the effects of climate change and reducing desertification at the local and regional levels.

The strengths of the research were to get influential results and available valuable information for farmers about the properties of alum powder, which can be applied as one of the auxiliary and successful solutions in adjusting the value of soil PH in their farms and home gardens within a short period because of its availability in abundance in local markets and economically inexpensive, and it should be noted The current study benefits the vast agricultural areas, so the competent authorities can benefit from the results in reclaiming the soil in the study area and cultivating the land in it. The challenge that we faced during the study was the exposure of the plant to the leaf borer insect, and we could overcome that after searching the internet through the experience of using alum powder as an insecticide after mixing it in water, so we can add another benefit to applying alum in the agricultural field. For the success of the use of alum, we suggest focusing on the following principles: the application rate and measuring the pH of the soil before application.

We believe that the research can be applied again to large agricultural areas under similar conditions, and the effectiveness of alum powder as a natural compound and its use as an insecticide in eliminating agricultural pests can be studied.

Thanks and appreciation:

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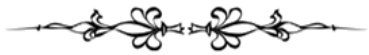
Badges:



- ❖ Be a Collaborator
- ❖ Be a Data Scientist
- ❖ Make an Impact

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