Research Title : Soil Properties Affecting Grasshopper Egg Hatching Rate

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Abstract

This study examines how soil properties influence the hatching rate of Patanga succincta eggs, focusing on soil type (sandy, loamy, clay, and sandy loam), pH, salinity (EC), temperature, and moisture. Eggs were incubated in different soils under controlled conditions, and hatching rates were measured. Results showed that loamy soil and sandy loam had the highest hatching rate (92%), with pH values of 6.8 and 6.4, respectively. Their high porosity (50–55%) ensured proper aeration and water drainage, facilitating oxygen supply. In contrast, sandy soil (pH 6.2) had a lower hatching rate (63%), while clay soil (pH 5.8) had the lowest rate (54%) due to poor aeration and high density, which limited oxygen availability. Soil salinity (EC) also played a crucial role, with hatching rates highest in soils with EC below 2.5 µS/cm. Clay soil, which had EC of 3.5 µS/cm, resulted in a significantly lower hatching rate (54%), indicating that high salinity negatively affects embryo development. Temperature was another critical factor. The optimal temperature range for hatching was 25–30°C, with the highest hatching rate (92%) recorded at 30°C. Lower or higher temperatures significantly reduced hatching rates (74% at 25°C, 69% at 35°C, and only 17% at 40°C), suggesting that extreme temperatures disrupt embryo development. Moisture content also influenced hatching efficiency. The ideal range was 45–60%, as moisture below 40% led to dehydration, while levels above 70% caused oxygen deficiency, both of which reduced hatching success. Loamy and sandy loam soils maintained stable temperatures and moisture levels, contributing to their high hatching rates. In contrast, sandy soil heated up and dried out quickly, while clay soil retained excessive moisture, sometimes causing temperature fluctuations and delayed hatching. In conclusion, loamy soil and sandy loam provide the best conditions for Patanga succincta egg hatching, as they offer balanced pH (6.4–6.8), low salinity (<2.5 µS/cm), stable temperature (25–30°C), and optimal moisture levels (45–60%). These findings can help optimize locust breeding and conservation strategies by improving egg incubation success rates.

Introduction

Soil is a critical factor influencing the hatching rate of Patanga succincta (Patanga locust) eggs, as locusts exhibit egg-laying behavior in soil. The physical and chemical properties of soil play a significant role in the development and hatching of these eggs. Studying the soil properties that affect the hatching rate of locust eggs can improve breeding methods and enhance the efficiency of locust production.

Key factors influencing the hatching rate of locust eggs include temperature, moisture, soil porosity, and chemical composition, such as pH levels and nutrient content. Investigating the relationship between soil properties and the hatching rate of locust eggs will help identify optimal soil conditions for egg-laying and lead to the development of more efficient egg-hatching systems.

Additionally, Patanga succincta is a promising alternative protein source with high nutritional value, gaining global popularity as 16.9% of global insect consumption consists of locusts. Sustainable production of locusts can be achieved by optimizing egg-hatching efficiency through controlled environmental factors. This approach supports commercial insect production and reduces the environmental impact of traditional protein production methods.

Objectives

1. To study the soil properties affecting the hatching rate of Patanga succincta eggs.
2. To analyze factors influencing the development and hatching of locust eggs.
3. To test and compare the hatching rates of locust eggs in different soil types.

Research questions

- How do soil properties affect the hatching rate of Patanga succincta eggs?

Hypothesis

- Soil with an optimal structure can increase the hatching rate of Patanga succincta eggs compared to soil with less favorable conditions.

Methodology

This study on soil properties and soil quality analysis beneficial for the hatching of Locusta migratoria eggs involves a review of relevant literature and research. Consequently, the experiment has been designed as follows:

3.1 Part 1 Comparative Study of Soil Properties Affecting the Hatching Rate of Locust Eggs

Measuring Devices

1. Soil Test Kit: Model HI3896, used for testing pH and NPK nutrient levels in the soil.
2. Soil Moisture Meter: Model DM-15 by TAKEMURA, used for measuring soil moisture content.
3. Soil Thermometer 20 cm (GLOBE), used for measuring soil temperature at various depths.

Experimental Method

1. Soil Property Data Collection: Selection of four soil types for Locusta migratoria incubation—sandy soil, loamy soil, clay soil, and sandy loam soil.

   - Soil Moisture Measurement: The DM-15 soil moisture meter is used to determine the moisture content of each soil type.

   - Soil pH and Nutrient Measurement: The HI3896 soil test kit is used to measure the pH and the levels of essential nutrients (NPK) in each soil sample.

   - Temperature Measurement: The GLOBE 20 cm soil thermometer will be used to measure soil temperature at different depths to monitor its effect on egg hatching.

2. Data Analysis: The collected data is analyzed to determine the correlation between soil properties and the hatching rate of Locusta migratoria eggs.
3. Data Storage and Utilization: The recorded data is stored in a database for future reference and published via the GLOBE system https://www.globe.gov/globe-data/data-entry.
4. The results of this study will contribute to improving locust farming techniques in agriculture and conservation by selecting soil with the most suitable properties for egg incubation. This aims to enhance the hatching success rate.

3.2 Part 2 Determining the Efficiency of Locusta migratoria Egg Hatching

1. **Locust Egg Incubation in Different Soil Types**

- Experiments are conducted to incubate locust eggs in four soil types: sandy soil, loamy soil, clay soil, and sandy loam soil.

- Each soil type is carefully prepared and managed to ensure uniform experimental conditions.

2. **Data Collection**

- The incubation period of eggs in each soil type is monitored and recorded.

- The number of successfully hatched eggs and unhatched eggs is counted to calculate the hatching rate for each soil type.

- Temperature Monitoring: Soil temperature is monitored during the incubation period using the GLOBE 20 cm soil thermometer to assess its effect on hatching efficiency.

3. **Data Analysis**

- The collected data is analyzed to assess the correlation between soil properties (moisture, pH, nutrients) and temperature with hatching efficiency.

- This analysis helps identify the most suitable soil type and temperature range for Locusta migratoria egg incubation by evaluating both the incubation period and the successful hatching rate.

4. **Application of Experimental Results**

- The findings of this study will contribute to optimizing locust farming conditions, benefiting both agricultural breeding and conservation efforts.

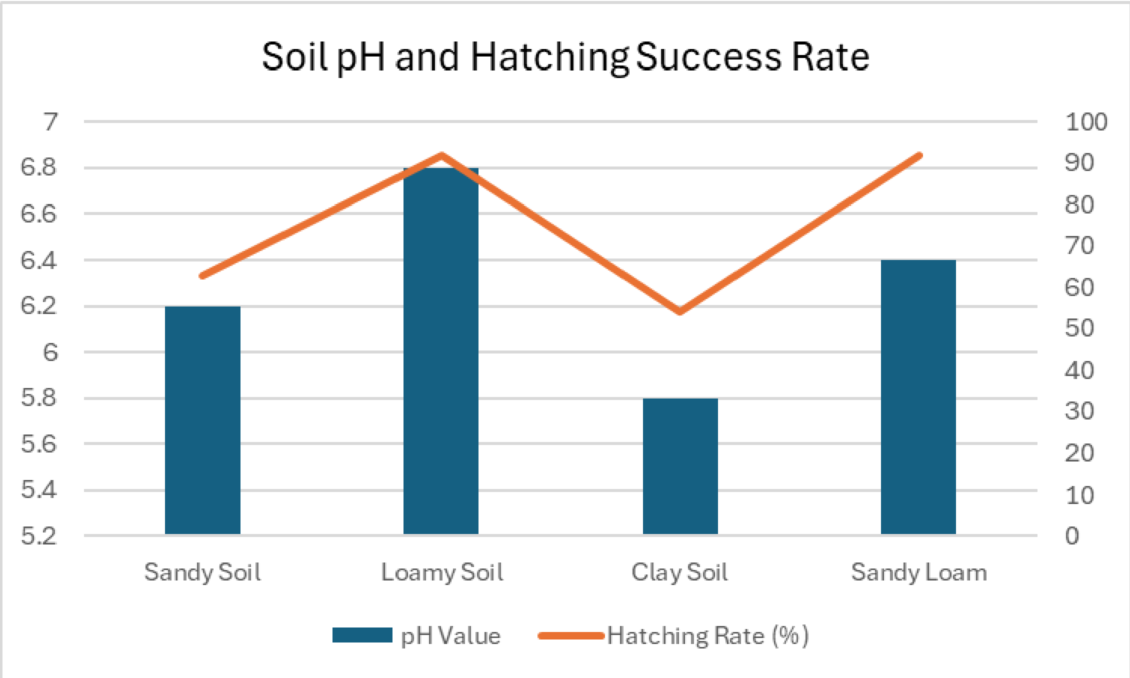
- The data can be used to select the most suitable soil and temperature conditions for egg incubation, thereby increasing hatching success and improving locust farming efficiency.

Results

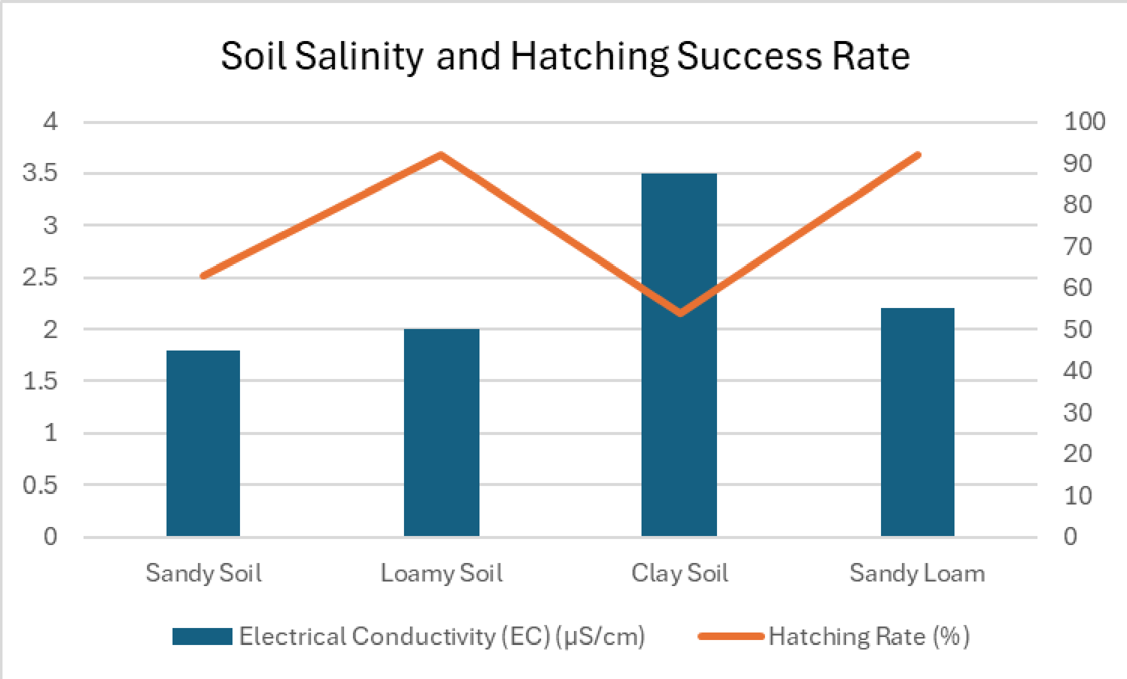
4.1Part 1 A comparative Study of Soil Properties Affecting the Hatching Rate of Patanga succincta Eggs

In this study, soil samples were randomly collected to represent four types of soil: sandy soil, loamy soil, clay soil, and sandy loam. The primary objective was to analyze how different soil properties affect the hatching rate of Patanga succincta (Patanga grasshopper) eggs. The key soil properties measured included pH, moisture content, and salinity.

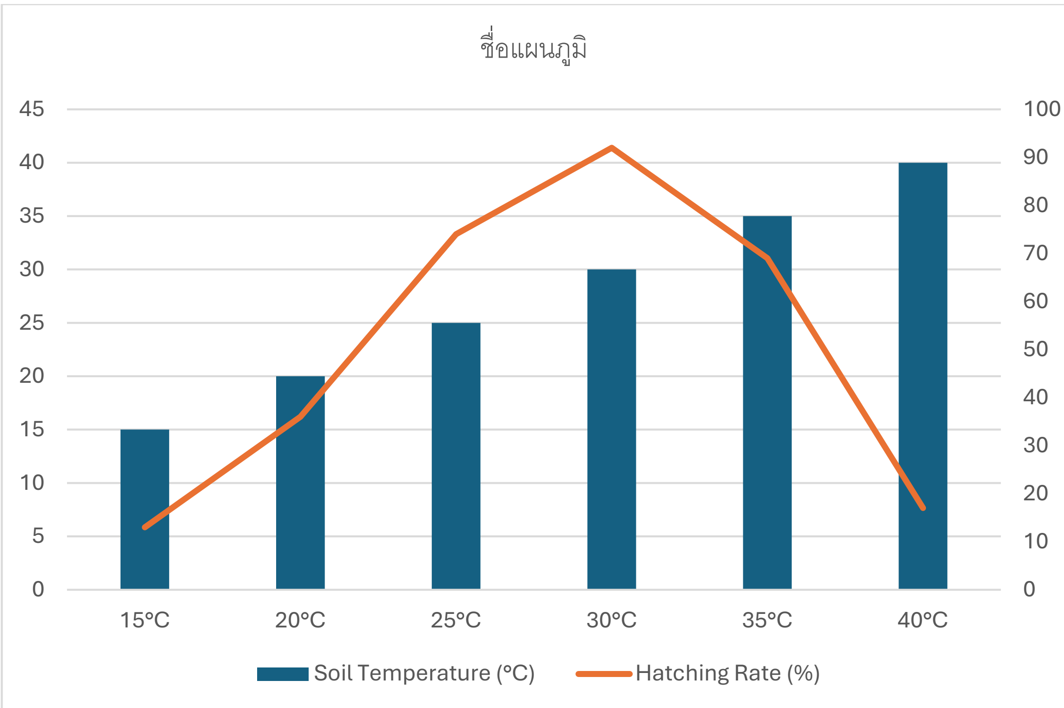
The data obtained from soil property measurements revealed significant differences among the soil types at different sampling sites. The moisture content, pH, and salinity of each soil type were recorded and analyzed to determine their impact on the hatching rate of Patanga succincta eggs.



Analysis showed that soil pH significantly affects the hatching rate of Patanga succincta eggs. The highest hatching rates were observed in soils with a pH range of 6.0 to 7.0. Loamy soil and sandy loam had the highest hatching rates, whereas soils with excessively high or low pH levels exhibited lower hatching rates. This may be due to the adverse effects of unsuitable pH levels on egg development.



Soil salinity (electrical conductivity, EC) is another important factor affecting the hatching rate. The highest hatching rates were observed in soils with low salinity (below 2.5 µs/cm). In contrast, soils with salinity levels above 3.5 µs/cm exhibited lower hatching rates. Notably, clay soil and sandy loam, which had moderate salinity levels, resulted in relatively high hatching rates.



Temperature also played a significant role in the hatching success of Patanga succincta eggs. The highest hatching rate (92%) was observed at 30°C, followed by 74% at 25°C and 69% at 35°C. Soils with temperatures below 20°C or above 40°C exhibited significantly lower hatching rates, with only 13% at 15°C and 17% at 40°C. This suggests that extreme temperatures, both high and low, create unfavorable conditions for egg development, while the optimal range for hatching lies between 25°C and 30°C.

4.2 Part 2: Efficiency of Patanga succincta Egg Hatching

This study involved an experimental incubation of Patanga succincta eggs using four soil types: sandy soil, loamy soil, clay soil, and sandy loam. High-quality eggs were selected for the experiment, and they were buried in each soil type under controlled environmental conditions, including optimal temperature, humidity, and light exposure for hatching.

The experiment aimed to examine the relationship between soil properties, such as pH, salinity, and temperature, and the hatching rate of Patanga succincta eggs. Data on hatching rates and the duration required for hatching in each soil type were recorded.

The results showed that loamy soil and sandy loam had the highest hatching rates, with eggs hatching in approximately 11.67 ± 1.37 days and a hatching rate of 92% at 30°C. In contrast, clay soil and sandy soil exhibited lower hatching rates. The dense texture and poor aeration of clay soil delayed egg development, resulting in a hatching rate of 69% at 35°C, while sandy soil had a hatching rate of 36% at 20°C.

Data analysis confirmed that soil pH affects egg development. Soils with a pH range of 6.0 to 7.0 supported the highest hatching rates, with pH 6.5–7.0 yielding hatching rates up to 92%. Soils with pH below 5.5 or above 7.5 exhibited reduced hatching rates, averaging around 36% to 69%.

Soil temperature played a significant role in the hatching rate. The highest hatching rate (92%) was observed at 30°C, followed by 74% at 25°C and 69% at 35°C. Lower temperatures, such as 15°C (13%) and 20°C (36%), as well as extreme heat 40°C (17%), significantly reduced hatching success.

Soil moisture was another critical factor. Soils with moisture levels between 45% and 60% produced the best hatching results. Moisture levels below 40% or above 70% led to lower hatching rates. Specifically, sandy soil, with a moisture content below 35%, delayed hatching and resulted in a hatching rate of only 36%.

Regarding salinity, soils with an electrical conductivity (EC) below 2.5 μs/cm were found to be optimal for hatching. Soils with 1.5–2.0 μs/cm salinity levels had hatching rates of 80–90%, whereas soils with salinity levels above 3.0 μs/cm showed significantly lower hatching rates of around 50–55%.

Summary and Discussion

The comparison of soil types suitable for hatching Patanga succincta (Patanga locust) eggs found that loamy soil and sandy loam soil had the highest hatching rate of 92% at 30°C, with an incubation period of approximately 11.67 ± 1.37 days, which was higher than other soil types. These soil types provided an optimal environment for egg development due to their aeration properties, which allowed for efficient oxygen circulation within the soil. Regarding pH levels, the most suitable range for hatching Patanga succincta eggs was 6.5–7.0, with the highest hatching rate of 92%. In contrast, soil with a pH lower than 5.5 or higher than 7.5 resulted in a significantly lower hatching rate (36% to 69%). This suggests that unsuitable pH levels may negatively affect egg development by altering soil chemistry and reducing embryo viability. Soil temperature was a key factor affecting hatching success. The highest hatching rate (92%) was observed at 30°C, followed by 74% at 25°C and 69% at 35°C. Lower temperatures, such as 15°C (13%) and 20°C (36%), as well as extreme heat 40°C (17%), significantly reduced hatching success. This indicates that Patanga succincta eggs require an optimal temperature range of 25–30°C for successful development. In terms of soil salinity, salinity levels directly influenced the hatching rate. Soil with a salinity level below 2.5 µs/cm had the highest hatching rate of 90–92%, making it the most suitable for egg incubation. When salinity increased to 3.0 µs/cm, the hatching rate dropped to 75–80%, and at 3.5 µs/cm, it further declined to 60–65%. This suggests that higher salinity levels may disrupt water balance in the eggs, leading to lower hatching success. This study provides valuable insights into selecting suitable soil types to improve the hatching rate of Patanga succincta eggs for agricultural purposes and conservation efforts. By choosing soil with appropriate pH, temperature, and salinity levels, the success rate of egg incubation can be significantly enhanced.

Discuss the results of the experiment

The data collected from the experiment on soil properties affecting the hatching of *Patanga succincta* eggs clearly demonstrate the relationship between pH, salinity (EC), temperature, and hatching rate. It was found that soil with a pH range of 6.5–7.0 was the most suitable, yielding the highest hatching rate of 92%. In contrast, soils with a pH lower than 5.5 or higher than 7.5 exhibited significantly lower hatching rates, ranging from 36% to 69%, indicating that unsuitable pH levels may negatively affect embryo development. Regarding salinity (EC), soil with a salinity level below 2.5 µs/cm resulted in the best hatching success. When salinity increased to 3.0 µs/cm or higher, the hatching rate significantly decreased to 60–75%, suggesting that high salinity disrupts water balance in the eggs, affecting their development and hatching success. Temperature also played a crucial role in hatching efficiency. The highest hatching rate (92%) was observed at 30°C, while lower and higher temperatures resulted in reduced success (74% at 25°C, 69% at 35°C, 36% at 20°C, and only 13% at 15°C). The lowest hatching rate of 17% was recorded at 40°C, indicating that extreme temperatures negatively impact egg viability. Additionally, well-aerated soil types, such as loamy soil and sandy loam soil, contributed to a high hatching success rate. These soil types effectively retain moisture and provide proper oxygen circulation, which are essential for egg and embryo development. This study highlights that selecting soil with suitable properties—optimal pH (6.5–7.0), low salinity (<2.5 µs/cm), a temperature range of 25–30°C, and good aeration—is crucial for maximizing the hatching rate of *Patanga succincta* eggs. These findings can be effectively applied to breeding and conservation efforts for agricultural purposes.

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