Paphayompittayakom School, Thailand

EARWIGS MASS-REARING:

A promising solution to sustainable agriculture?

by :

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AY 2022 - 2023

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Evaluating Environmentally-Friendly Pest Management through Earwigs Mass-Rearing in Different Soil Types

by

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Academic Year 2022 – 2023

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ABSTRACT

This study investigated the impact of environmental factors on the extinction of earwigs in different soil types, including cultivated soil, black rice husk, and mixed soil. The researchers raised two males and six females with an age of approximately 90-day old in 9 boxes for each soil type.

Based on the result, the mixed soil type has the highest incubation success for earwigs due to its suitable relative humidity of 85-87% and lowest temperature. The soil-based cultivation box had the highest survival rates as the soil had the highest average relative humidity.

This also revealed that the earwig's survival and egg growth were affected by soil and air temperature, relative humidity, and pH. A pH level outside the range of 6 to 7 can have a negative impact on them.

Moreover, this research will provide agriculturalists and farmers with a non-chemical method, environment-friendly to eradicate pests and safe for consumers.

INTRODUCTION

Chemical treatment is a favored approach for pest control in agriculture. However, its utilization can result in detrimental effects on humans and the environment.

Researchers are exploring alternative solutions through earwigs' mass-rearing. For those unfamiliar with earwigs or pincher bugs, they are small nocturnal insects with elongated bodies and pincers on their abdomen.

This study will evaluate the effectiveness of non-chemical pest management by studying the breeding and survival rates of pincher bugs in different soil types. Hence, the researchers aim to answer the following questions:

1. **What is the impact of soil composition on the hatching and survival rates of earwigs during cultivation?**

2. **How does relative humidity in soil impact the breeding and survival rate of earwigs?**

3. **In what ways does the temperature in the soil influence the breeding of earwigs and how does this affect the hatching rate?**

4. **What is the effect of pH levels outside of the range of 6 to 7 on the breeding of earwigs and how does this affect the population size?**

The results will provide insights into how environmental factors (soil composition, relative humidity, temperature, and pH level) influence the breeding and survival rates of pincher bugs. In addition, the findings of this research could contribute to reducing the harmful effects of chemical treatments and promoting environmentally-friendly pest control methods in agriculture.

METHODS

The following materials were used for the experiment:

- **9 plastic boxes, size 18 x 25 x 8.5 square centimeters**
- **potting soil**
- **black rice husk**
- **18 pcs of plastic lids**
- **bark**
- **ground cat food**
- **cotton**
- **mesh, size 12 x 14 square centimeters**
- **Cutter**
- **Glue gun/sticks**

Equipment for measuring factors:

- **Analytical balance for soil moisture**
- **Hygrometer for relative humidity**
- **Soil thermometer for soil temperature**
- **Thermometer for air temperature**
- **Litmus paper for pH level**

These steps were taken in conducting a study on earwigs and their reproductive success in different soil types:

1. **Conducted and gathered information about their life cycle, habitat, food, and feeding behavior.**
2. **Established a research site.**
3. **Designed a suitable cultivation box and research protocol for earwigs rearing in each soil type.**
4. **Determined and investigated the feeding areas.**
5. **Released 8 earwigs (2 males and 6 females) into each of the 9 boxes.**
6. **Collected data on soil moisture, air humidity, soil and air temperature, pH levels, and reproductive data (e.g., number of eggs and larvae).**
7. **Analyzed data by using collected measurements from air and soil temperature, soil and air relative humidity, and reproductive success obtained from cultivating earwigs in all three soil types.**

Data Analysis

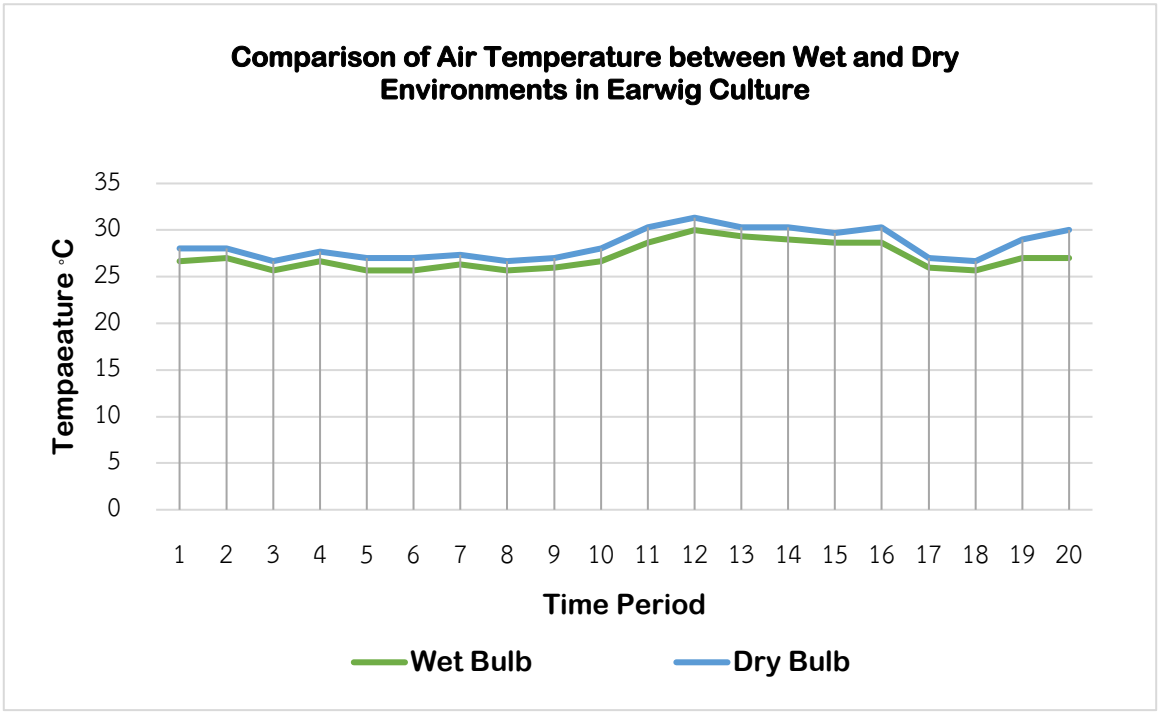
Researchers utilized various statistical data analysis techniques in this study, which started in April 2022 and is scheduled to conclude with data analysis in December 2022 for different purposes. The data in Table 1 - 7 was analyzed using the Mean. Meanwhile, ANOVA (Analysis of Variance) was utilized in Table 8 to prove how soil types were significantly different. In Table 9, correlation analysis was used to determine the relationship between various variables (soil moisture, air humidity, soil and air temperature, pH levels) and earwig reproductive success in different soil types. Overall, researchers performed a comprehensive approach to statistical data analysis to ensure accurate and reliable research findings.

The subsequent table shows the analysis results obtained from the study:

Table 1 : Air Temperature and Relative Humidity at the three locations of cultivation under different conditions

Date	wet bulb °C	dry bulb °C	relative humidity %
01-Dec-22	26.67	28	89.67
03-Dec-22	27	28	92
05-Dec-22	25.67	26.67	92
07-Dec-22	26.67	27.67	92
09-Dec-22	25.67	27	89.67
11-Dec-22	25.67	27	89.67
13-Dec-22	26.33	27.33	92
15-Dec-22	25.67	26.67	92
17-Dec-22	26	27	92
21-Dec-22	26.67	28	89.67
23-Dec-22	28.67	30.33	87.67
25-Dec-22	30	31.33	90.67
27-Dec-22	29.33	30.33	92.33
29-Dec-22	29	30.33	90
31-Dec-22	28.67	29.67	92
02-Jan-23	28.67	30.33	87.67
04-Jan-23	26	27	71
06-Jan-23	25.67	26.67	71
08-Jan-23	27	29	85
10-Jan-23	27	30	78.33
average	**27.1**	**28.42**	**87.82**

The result shows that the average relative humidity in the air is 87.82, which is ideal for hatching.


Comparison of Air Temperature between Wet and Dry Environments in Earwig Culture
Tempaeature °C
35
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
Wet Bulb
Dry Bulb

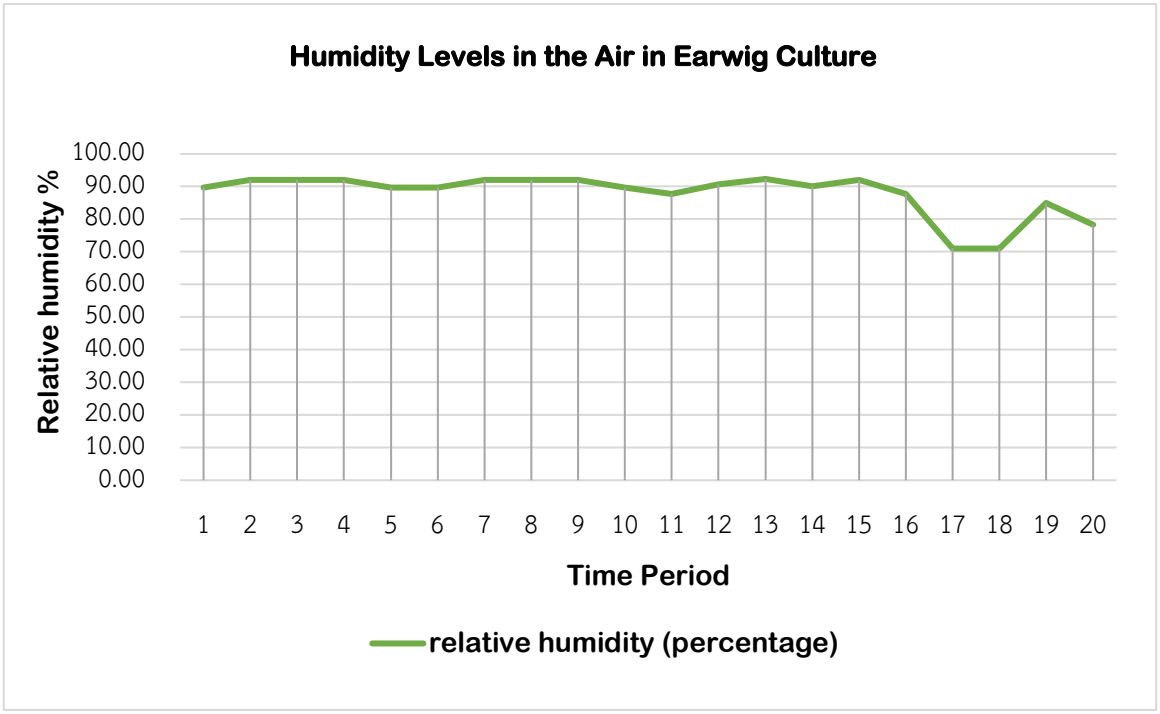
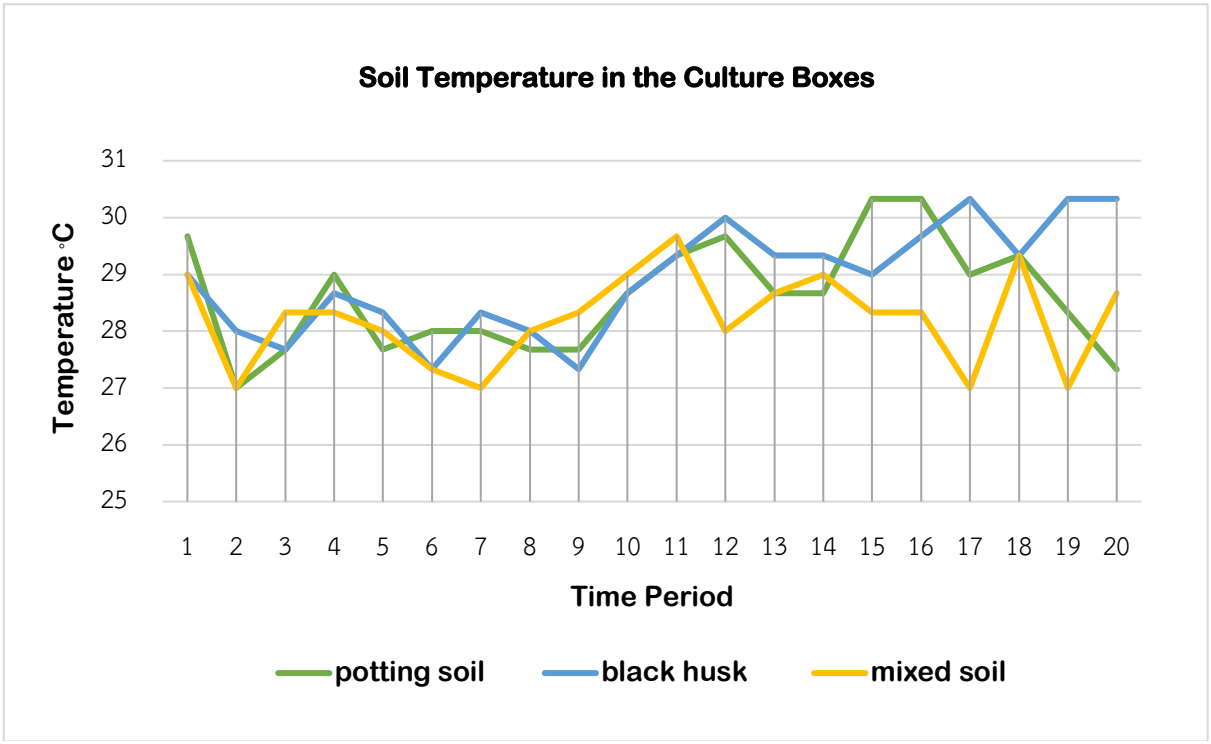

Humidity Levels in the Air in Earwig Culture
Relative humidity %
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
relative humidity (percentage)

Table 2 : Soil Temperature in the Culture Boxes

Date	Temperature °C		
	potting soil	black rice husk	mixed soil
01-Dec-22	29.67	29	29
03-Dec-22	27	28	27
05-Dec-22	27.67	27.67	28.33
07-Dec-22	29	28.67	28.33
09-Dec-22	27.67	28.33	28
11-Dec-22	28	27.33	27.33
13-Dec-22	28	28.33	27
15-Dec-22	27.67	28	28
17-Dec-22	27.67	27.33	28.33
21-Dec-22	28.67	28.67	29
23-Dec-22	29.33	29.33	29.67
25-Dec-22	29.67	30	28
27-Dec-22	28.67	29.33	28.67
29-Dec-22	28.67	29.33	29
31-Dec-22	30.33	29	28.33
02-Jan-23	30.33	29.67	28.33
04-Jan-23	29	30.33	27
06-Jan-23	29.33	29.33	29.33
08-Jan-23	28.33	30.33	27
10-Jan-23	27.33	30.33	28.67
average	**28.6**	**28.92**	**28.22**

It shows that mixed soil with a low temperature was favorable for a substantial quantity of eggs to hatch during incubation.


Soil Temperature in the Culture Boxes
Temperature ◦C
31
30
29
28
27
26
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
potting soil
black husk
mixed soil

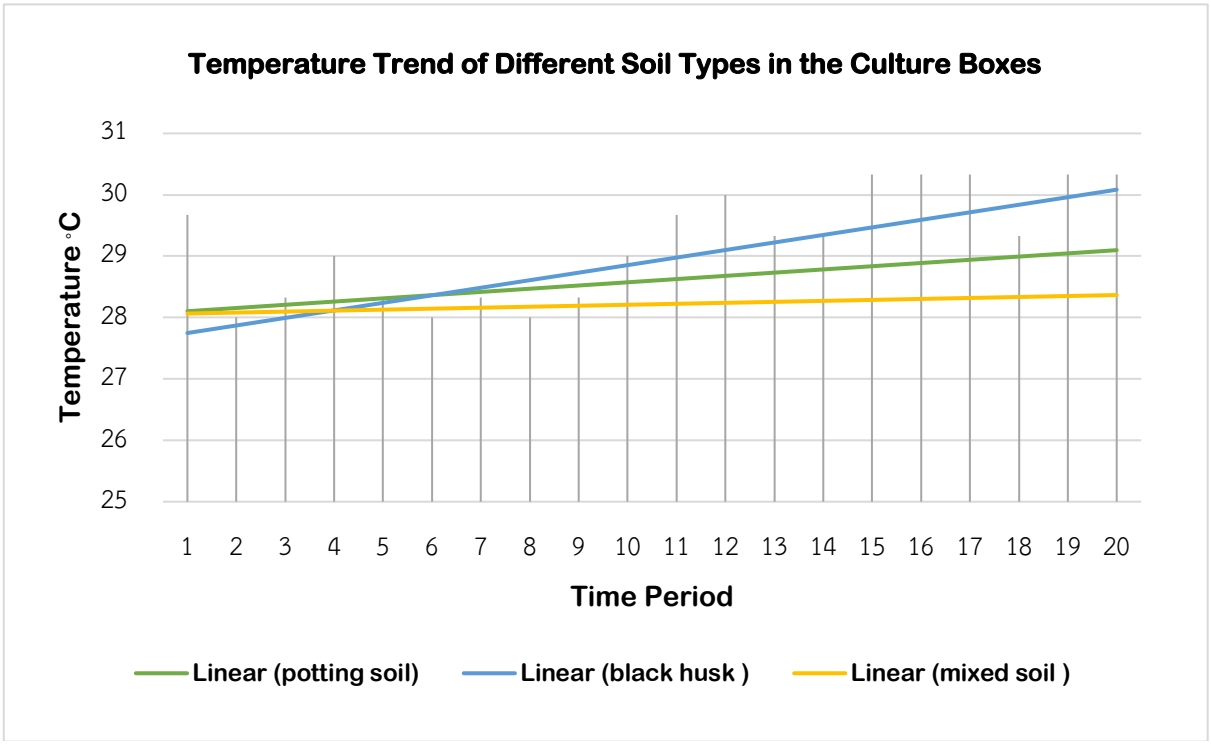
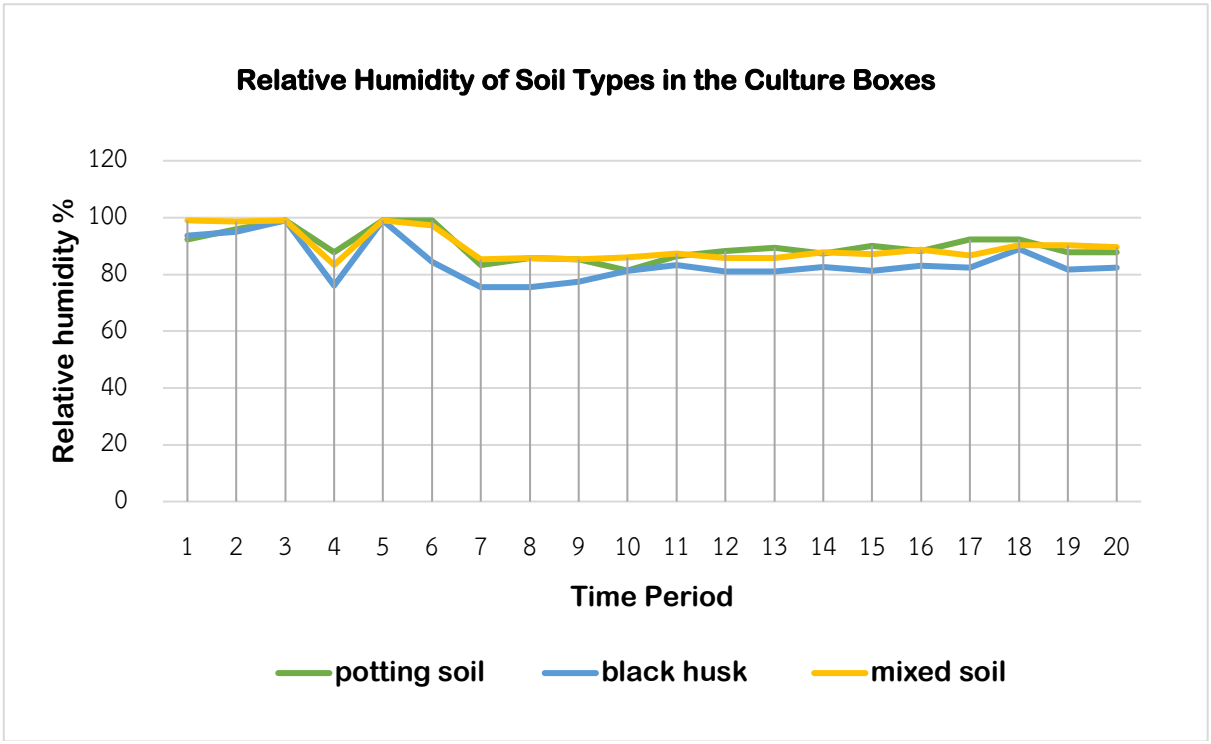

Temperature Trend of Different Soil Types in the Culture Boxes
Temperature ◦C
31
30
29
28
27
26
25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
Linear (potting soil)
Linear (black husk)
Linear (mixed soil)

Table 3 : Relative Humidity of Soil Types in the Culture Boxes

Date	Relative humidity %		
	potting soil	black rice husk	mixed soil
01-Dec-22	92.33	93.67	99
03-Dec-22	96	95	98.67
05-Dec-22	99	99	99
07-Dec-22	87.67	76	83.33
09-Dec-22	99	99	99
11-Dec-22	99	84.33	97.33
13-Dec-22	83.33	75.5	85.33
15-Dec-22	85.67	75.5	85.67
17-Dec-22	85.33	77.33	85.33
21-Dec-22	81.33	81.33	86
23-Dec-22	86.33	83.33	87.33
25-Dec-22	88.33	81	85.67
27-Dec-22	89.33	81	85.67
29-Dec-22	87.33	82.5	87.67
31-Dec-22	90	81.33	87
02-Jan-23	88.33	83	88.67
04-Jan-23	92.33	82.33	86.67
06-Jan-23	92.33	89	90.33
08-Jan-23	87.67	81.67	90.33
10-Jan-23	87.67	82.33	89.67
average	89.92	84.21	89.88

This table demonstrates that for soil types, a result with higher average relative humidity was beneficial for the embryo's growth.


Relative Humidity of Soil Types in the Culture Boxes
Relative humidity %
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
potting soil
black husk
mixed soil

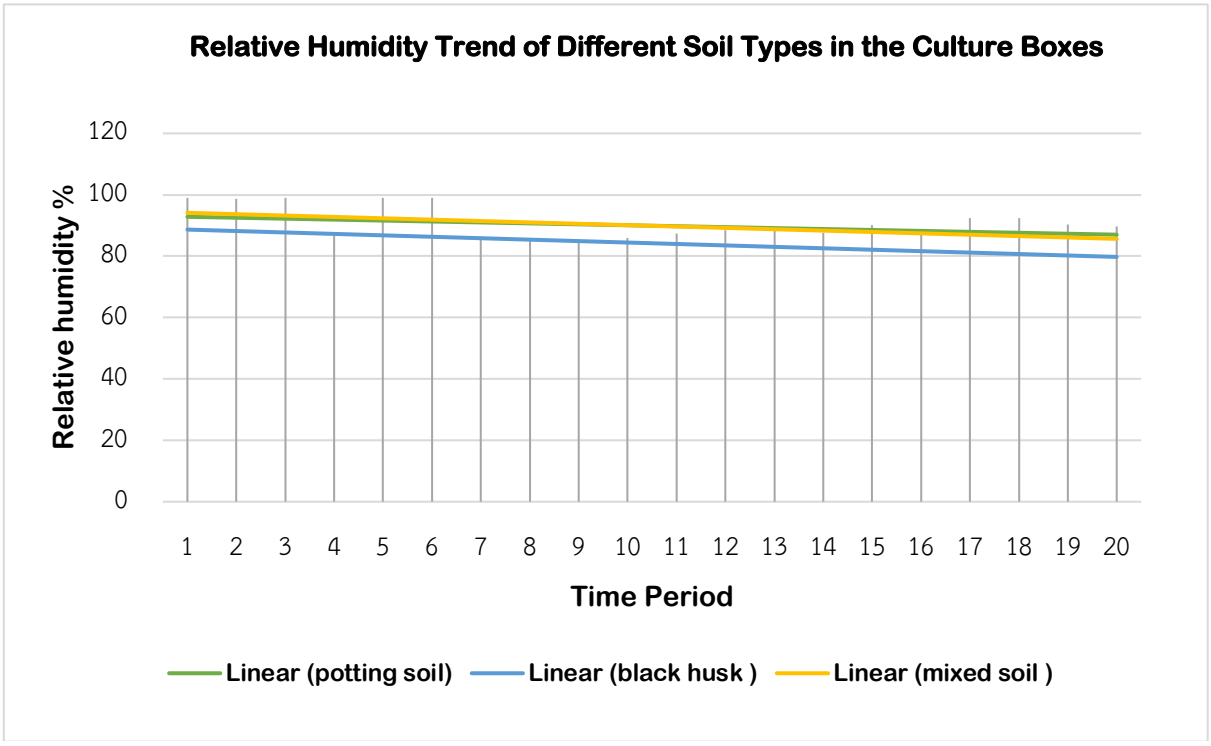

Relative Humidity Trend of Different Soil Types in the Culture Boxes
Relative humidity %
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
Linear (potting soil)
Linear (black husk)
Linear (mixed soil)

Table 4: pH Values of Different Soil Types in the Culture Boxes

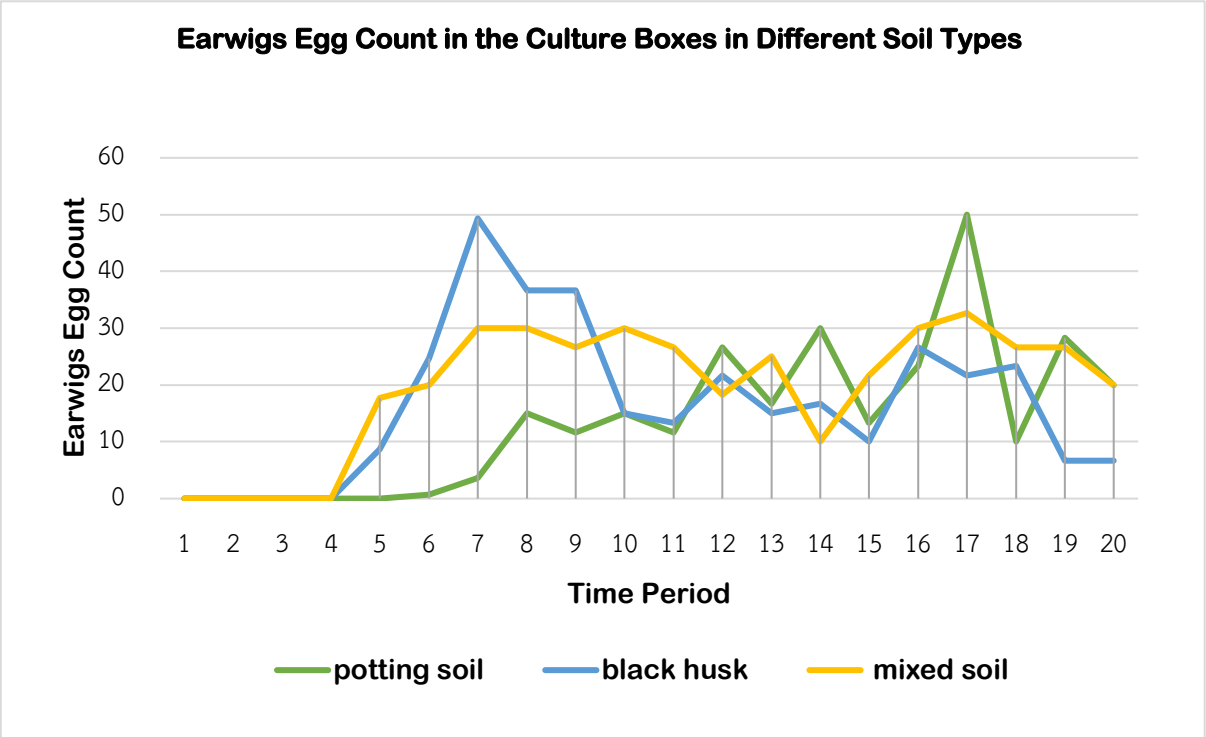
Date	pH		
	potting soil	black husk	mixed soil
01-Dec-22	7	6	6
03-Dec-22	7	6	6
05-Dec-22	7	6	6
07-Dec-22	7	6	6
09-Dec-22	7	6	6
11-Dec-22	7	6	6
13-Dec-22	7	6	6
15-Dec-22	7	6	6
17-Dec-22	7	6	6
21-Dec-22	7	6	6
23-Dec-22	7	6	6
25-Dec-22	7	6	6
27-Dec-22	7	6	6
29-Dec-22	7	6	6
31-Dec-22	7	6	6
02-Jan-23	7	6	6
04-Jan-23	7	6	6
06-Jan-23	7	6	6
08-Jan-23	7	6	6
10-Jan-23	7	6	6
average	7	6	6

This result illustrates that soil types with a pH of 6 was favorable for hatching while 7 was ideal for the survival and development of the embryo.

Table 5 : Earwigs Egg Count in the Culture Boxes in Different Soil Types

Date	potting soil	black rice husk	mixed soil
01-Dec-22	0	0	0
03-Dec-22	0	0	0
05-Dec-22	0	0	0
07-Dec-22	0	0	0
09-Dec-22	0	8.67	17.67
11-Dec-22	0.67	24.67	20
13-Dec-22	3.67	49.33	30
15-Dec-22	15	36.67	30
17-Dec-22	11.67	36.67	26.67
21-Dec-22	15	15	30
23-Dec-22	11.67	13.33	26.67
25-Dec-22	26.67	21.67	18.33
27-Dec-22	16.67	15	25
29-Dec-22	30	16.67	10
31-Dec-22	13.33	10	21.67
02-Jan-23	23.33	26.67	30
04-Jan-23	50	21.67	32.67
06-Jan-23	10	23.33	26.67
08-Jan-23	28.33	6.67	26.67
10-Jan-23	20	6.67	20
average number of eggs	276	332.67	392

The table shows that the highest hatching rate observed in the mixed soil and lowest in the potting soil.


Earwigs Egg Count in the Culture Boxes in Different Soil Types
Earwigs Egg Count
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
potting soil
black husk
mixed soil

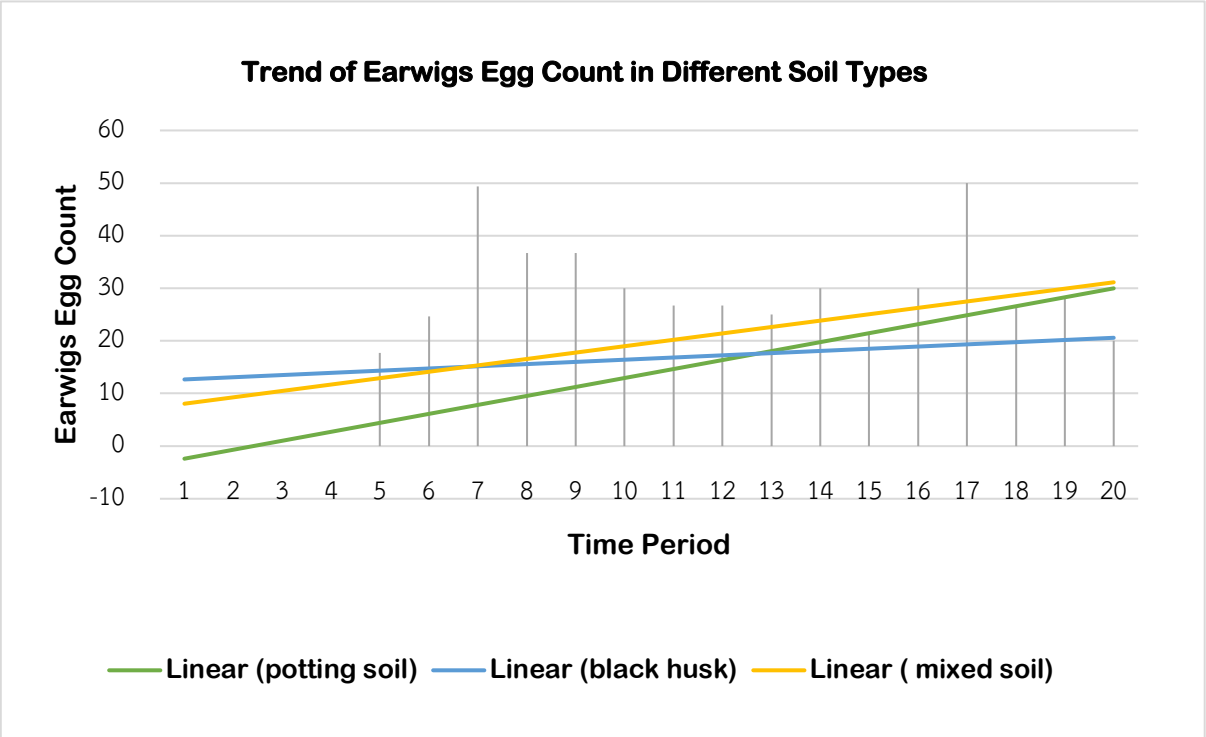

Trend of Earwigs Egg Count in Different Soil Types
Earwigs Egg Count
60
50
40
30
20
10
0
-10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Time Period
Linear (potting soil)
Linear (black husk)
Linear (mixed soil)

Table 6 : Earwigs Larval Count in Cultivation Boxes in Different Soil Types

Date	Time	potting soil	black rice husk	mixed soil
19-Jan-23	3:58 PM	114	57.67	82

This displays the survival count of earwig larvae across three different soil types, where in potting soil has the highest survival rates.

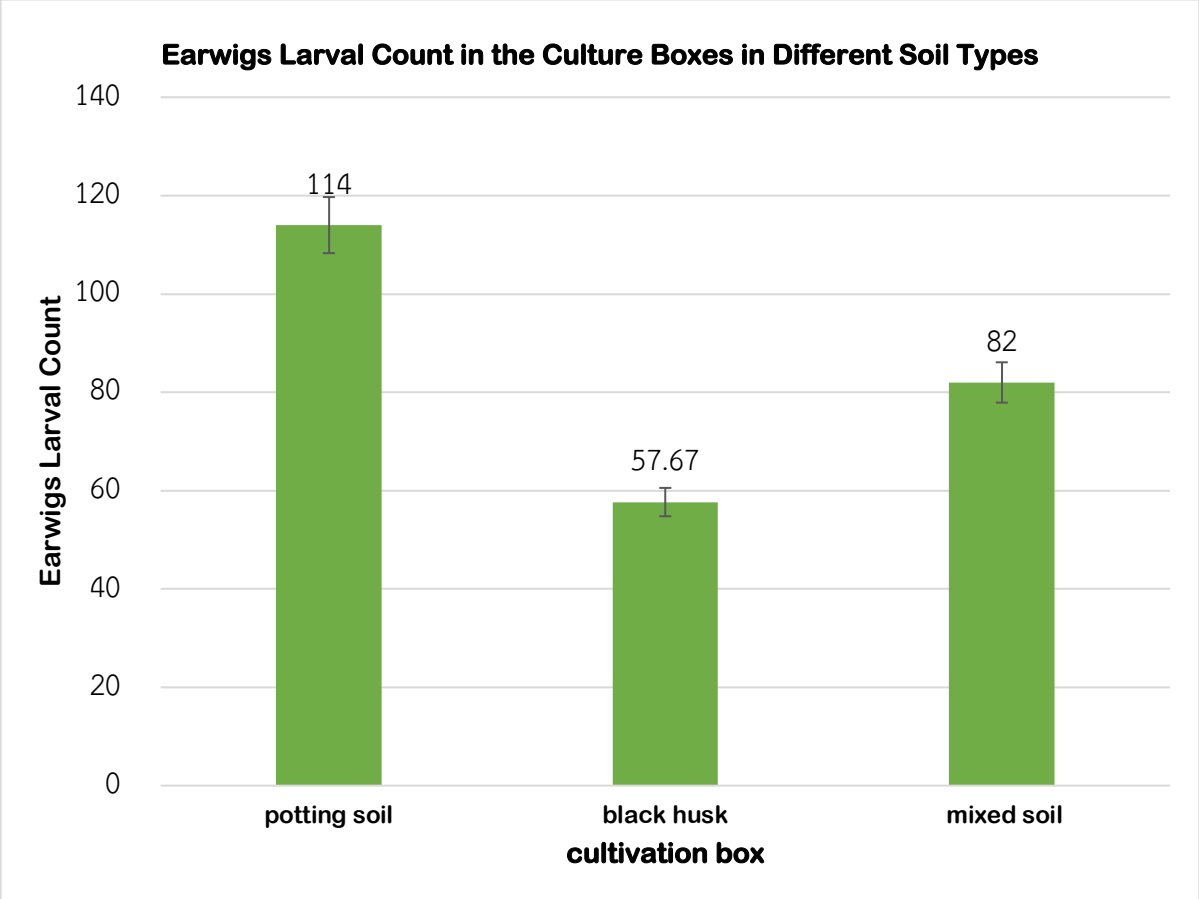


Table 7 : Survival Rates of Earwigs after Incubation in Different Soil Types

Survival rates in Different Soil Types	potting soil	black rice husk	mixed soil
avg egg count	276	332.67	392
avg embryo count	114	57.67	82
survival rates after hatching	41.30%	17.34%	20.92%

The result compares survival rates in different soil types based on egg and embryo count, determining the optimal soil to feed the earwig larvae.

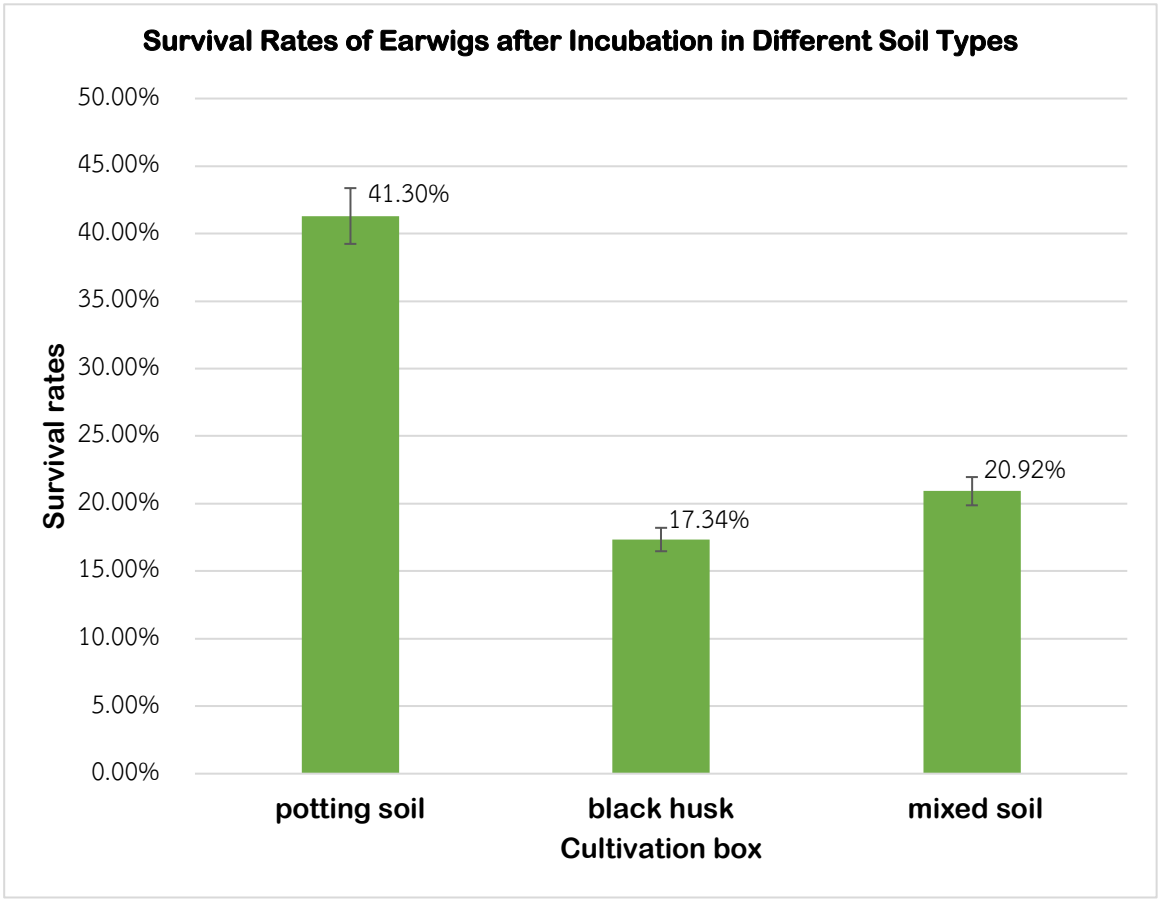


Table 8 : ANOVA Analysis of Egg Count, Relative Humidity, Temperature, pH Values in the Culture Boxes

ANOVA (Analysis of Variance)						
Source of Variation		Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F	Sig.
Egg	Between Groups	1009.378	2	504.689	1.903	.152
	Within Groups	46953.933	177	265.276		
	Total	47963.311	179			
Humidity	Between Groups	1314.878	2	657.439	18.550	.000
	Within Groups	6273.100	177	35.441		
	Total	7587.978	179			
Temperature	Between Groups	14.744	2	7.372	6.487	.002
	Within Groups	201.167	177	1.137		
	Total	215.911	179			
pH	Between Groups	40.000	2	20.000	.	.
	Within Groups	.000	177	.000		
	Total	40.000	179			

ANOVA result shows that soil moisture and temperature have a significant effect on the hatching of earwig eggs as their sig values are lower than 0.005.

Table 9 : The Relationship between Egg Count, Soil Moisture, Temperature, pH Value in the Culture Boxes

Correlations					
Source of Variation		Egg	Humidity	Temperature	pH
Egg	Pearson Correlation	1	-.311**	- .022	- .125
	Sig. (2-tailed)		.000	.767	.095
	N	180	180	180	180
Humidity	Pearson Correlation	-.311**	1	-.228**	.210**
	Sig. (2-tailed)	.000		.002	.005
	N	180	180	180	180
Temperature	Pearson Correlation	- .022	-.228**	1	.014
	Sig. (2-tailed)	.767	.002		.848
	N	180	180	180	180
pH	Pearson Correlation	- .125	.210**	.014	1
	Sig. (2-tailed)	.095	.005	.848	
	N	180	180	180	180
**. Correlation is significant at the 0.01 level (2-tailed).					

The correlations table demonstrates a statistically significant negative correlation between relative humidity and earwig egg production. Higher relative humidity means fewer eggs.

CONCLUSION

In conclusion, the research on earwig mass-rearing for pest control in various soil types has revealed critical factors that influence the breeding process. These findings demonstrate that optimizing the soil conditions is crucial to the successful cultivation of earwigs, which can offer an environmentally-friendly alternative to traditional pest management methods.

The study obtained several significant findings, which are as follows:

1. **Earwig cultivation in mixed soil has the highest hatching rates, while potting soil with a high survival rate is preferable for rearing them.**

2. **The relative humidity in the soil has a significant influence on both earwig breeding and survival. Higher levels of relative humidity in the soil can lead to an increase in breeding and survival.**

3. **There is a significant impact of soil temperature on earwig breeding, with lower temperatures resulting in increased hatching rates.**

4. **The pH level of the soil is a critical factor in earwig breeding. pH levels outside the range of 6 to 7 can have a negative impact on their growth and survival.**

Improving these critical factors could enhance earwig mass-rearing for pest control. It also shows the potential of eco-friendly pest management and emphasizes the need for further research in this area.

SIGNIFICANCE OF THE STUDY

The study on Evaluating Environmentally-Friendly Pest Management through Earwigs Mass-Rearing in Different Soil Types provides valuable guidance to farmers for adopting non-chemical pest control measures that are safe for both consumers and the environment. The results demonstrate that mixed soil is conducive to the optimal growth and survival of earwigs, which can potentially serve as an effective biocontrol agent. By shifting towards non-chemical pest management practices, farmers can ensure the health of humans and protect the environment from the harmful effects of chemical pesticides.

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Special thanks to....

Asst. Prof. Dr. Suphada Kiriratnikom
Lecturer Dr. Wankuson Chanasit
Thaksin University

Chote Chitkhao
Director, Paphayompittayakom School

Appendices

earwig-rearing.

Designing a suitable cultivation box and research protocol for earwigs rearing in each soil type.

earwig-survival.

Measuring an environmental factor involves tallying the surviving number of eggs and larvae upon earwig hatching.

researchers

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