Investigating the Correlation Between Abiotic Factors and Their Influence on Species Abundance and Distribution Along a Line Transect in St. Laurensia School's Frontyard

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Chapter 1

Proposal

1.1 Objectives

1) To investigate the **presence of monotonic environmental gradients** along a line transect within quadrats by analyzing **abiotic factors** (temperature, soil moisture, pH, light intensity).
2) To analyze the **monotonic correlations between abiotic factors**.
3) To investigate how **abiotic factors** influence **species abundance** along a **line transect**.

1.2 Hypothesis

1) There are significant monotonic environmental gradients in at least one abiotic factor across the quadrats along the line transect.
2) There are significant monotonic correlations between two or more abiotic factors.
3) Abiotic factors are significantly associated with species abundance across the quadrats.

Chapter 2

Data

2.1 Data Tables

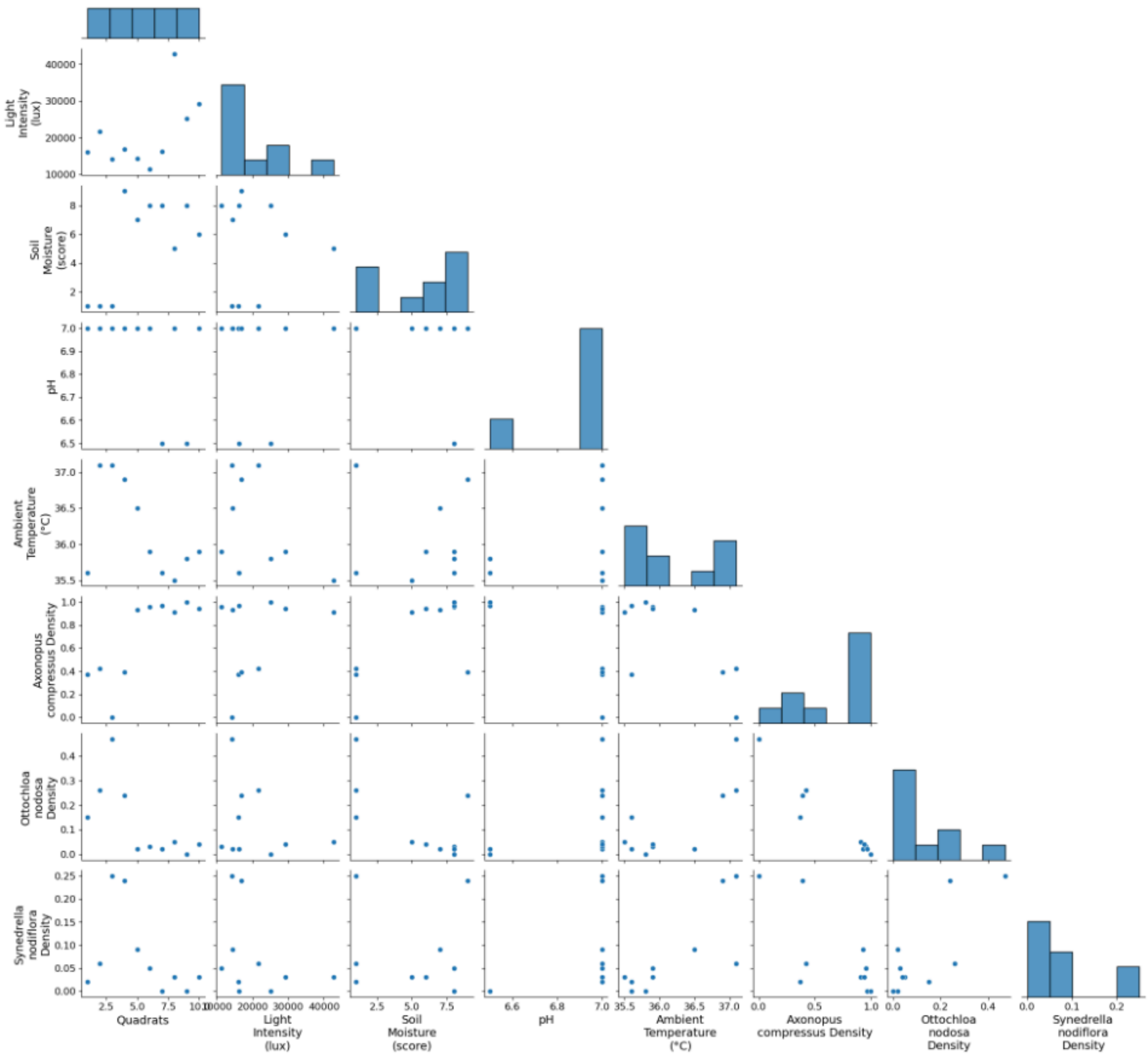
Table 1. Species abundance and distribution while varying abiotic factors.

	Abiotic Factors				Biotic Factors		
	Light Intensity	Soil Moisture	pH	Ambient Temperature	*Axonopus compressus* Density	*Ottochloa nodosa* Density	*Synedrella nodiflora* Density
Quadrats	*lux*	*score*	*pH*	*°C*	*Relative Cover*	*Relative Cover*	*Relative Cover*
1	16100	1	7.0	35.6	0.37	0.15	0.02
2	21590	1	7.0	37.1	0.42	0.26	0.06
3	14210	1	7.0	37.1	0	0.47	0.25
4	16900	9	7.0	36.9	0.39	0.24	0.24
5	14370	7	7.0	36.5	0.93	0.02	0.09
6	11360	8	7.0	35.9	0.96	0.03	0.05
7	16220	8	6.5	35.6	0.97	0.02	0
8	42730	5	7.0	35.5	0.91	0.05	0.03
9	25200	8	6.5	35.8	1	0	0
10	29250	6	7.0	35.9	0.94	0.04	0.03

1) Each row represents a quadrat placed at regular 2-meter intervals along the line transect. Columns show abiotic and biotic variables measured within each quadrat. This layout helps visualize variation along the transect more clearly.
2) Species identification is only based on morphology, which is slightly inaccurate.

2.2 Data Diagrams

Below is a scatter matrix that shows every pairwise relationship between two variables.



Light Intensity (lux)
Soil Moisture (score)
pH
Ambient Temperature (°C)
Axonopus compressus Density
Ottochloa nodosa Density
Synedrella nodiflora Density
Quadrats

Chapter 3

Analysis

3.2 Descriptive Statistics

A summary statistics can be calculated using Jupyter Notebook for initial insights.

	count	mean	std	min	25%	50%	75%	max	skew
Quadrats	10.0	5.50	3.03	1.0	3.25	5.50	7.75	10.00	0.00
Light Intensity (lux)	10.0	20793.00	9454.42	11360.0	14802.50	16560.00	24297.50	42730.00	1.58
Soil Moisture (score)	10.0	5.40	3.24	1.0	2.00	6.50	8.00	9.00	-0.62
pH	10.0	6.90	0.21	6.5	7.00	7.00	7.00	7.00	-1.78
Ambient Temperature (°C)	10.0	36.19	0.65	35.5	35.65	35.90	36.80	37.10	0.54
Axonopus compressus Density	10.0	0.69	0.36	0.0	0.40	0.92	0.96	1.00	-0.88
Ottochloa nodosa Density	10.0	0.13	0.15	0.0	0.02	0.04	0.22	0.47	1.44
Synedrella nodiflora Density	10.0	0.08	0.09	0.0	0.02	0.04	0.08	0.25	1.43

Data with skewness values less than -1 or greater than -1 are considered highly skewed, so the average is determined by its median instead of mean – to reduce bias.

An average soil moisture of 5.40 and pH of 7.00 indicate a moderately moist and neutral soil. An interquartile range 57.5% of the median light intensity suggests that different parts of the frontyard receive varying levels of sunlight. An average ambient temperature of 36°C is recorded, which is moderately warm.

We can infer that both *Axonopus compressus* and *Ottochloa* are abundant based on their average relative cover, which is 0.69 (mean) and 0.22 (median) respectively. It is also supported by their maximum coverage in a quadrant, which is 1.00 (full coverage) and 0.47 respectively, while *Synedrella nodiflora* only has an average coverage of 0.08 and maximum coverage of 0.25.

3.2 Spearman Correlation

To statistically check for any monotonic correlation, we can perform a calculation to get a Spearman correlation matrix.

	Quadrats	Light Intensity (lux)	Soil Moisture (score)	pH	Ambient Temperature (°C)	Axonopus compressus Density	Ottochloa nodosa Density	Synedrella nodiflora Density
Quadrats	1.000000							
Light Intensity (lux)	0.527273	1.0						
Soil Moisture (score)	0.465982	-0.018639	1.0					
pH	-0.435194	-0.174078	-0.446144	1.0				
Ambient Temperature (°C)	-0.440386	-0.348639	-0.125407	0.395285	1.0			
Axonopus compressus Density	0.769697	0.212121	0.602671	-0.696311	-0.41592	1.0		
Ottochloa nodosa Density	-0.662617	-0.079028	-0.579577	0.654778	0.52455	-0.8997	1.0	
Synedrella nodiflora Density	-0.469521	-0.396349	-0.150026	0.700569	0.818465	-0.646353	0.639147	1.0

A variable relationship with itself will always be perfect (1.0 in spearman correlation), so this value gets filtered out. Then, computing its p-value matrix and highlighting the ones below 0.05 gives:

	Quadrats	Light Intensity (lux)	Soil Moisture (score)	pH	Ambient Temperature (°C)	Axonopus compressus Density	Ottochloa nodosa Density	Synedrella nodiflora Density
Quadrats								
Light Intensity (lux)	0.12							
Soil Moisture (score)	0.17	0.96						
pH	0.21	0.63	0.20					
Ambient Temperature (°C)	0.20	0.32	0.73	0.26				
Axonopus compressus Density	(<0.05)	0.56	0.07	(<0.05)	0.23			
Ottochloa nodosa Density	(<0.05)	0.83	0.08	(<0.05)	0.12	(<0.05)		
Synedrella nodiflora Density	0.17	0.26	0.68	(<0.05)	(<0.05)	(<0.05)	(<0.05)	

We can see that there is not enough evidence to suggest that there is a monotonic abiotic factor gradient, as their p-value against quadrats (which is ordered from 1 to 10) is higher than 0.05.

There is also not enough evidence to show that there are monotonic correlations between abiotic factors, with the same reasoning. Any further insight below without written reasonings is assumed to be based on their p-value being higher than the threshold value (0.05).

There is only a single strong monotonic correlation between an abiotic factor and species abundance along a line transect, which is the correlation between the ambient temperature and the abundance of *Synedrella nodiflora*, as the corresponding p-value is below 0.05. This suggests either that ambient temperature affects the condition and spread of the plant, or there might be another untested factor that directly affects both of the factors. Further investigation is required.

3.3 Further Analysis

From the p-value matrix, it is seen that all of the three species coverage (*Axonopus compressus*, *Ottochloa nodosa*, *Synedrella nodiflora*) is pairwise correlated, as their corresponding p-value is < 0.05. This means that a species (out of the three identified in our research) abundance is correlated with another species.

This might suggest that there is a strong biotic interspecies interaction, such as competition or symbiotic relationships. Undoubtedly, competition is a strong suggestion, as the frontyard is almost entirely covered with grass, so there is a tight space limitation for both *Axonopus compressus* and *Ottochloa nodosa* – two of the abundant species – to grow independently of each other.

There is also another possibility of a niche overlap, where both species prefer the same microclimate environment of St. Laurensia School's frontyard.

Chapter 4
Conclusion

4.1 Result

From the analysis above, we can conclude that:

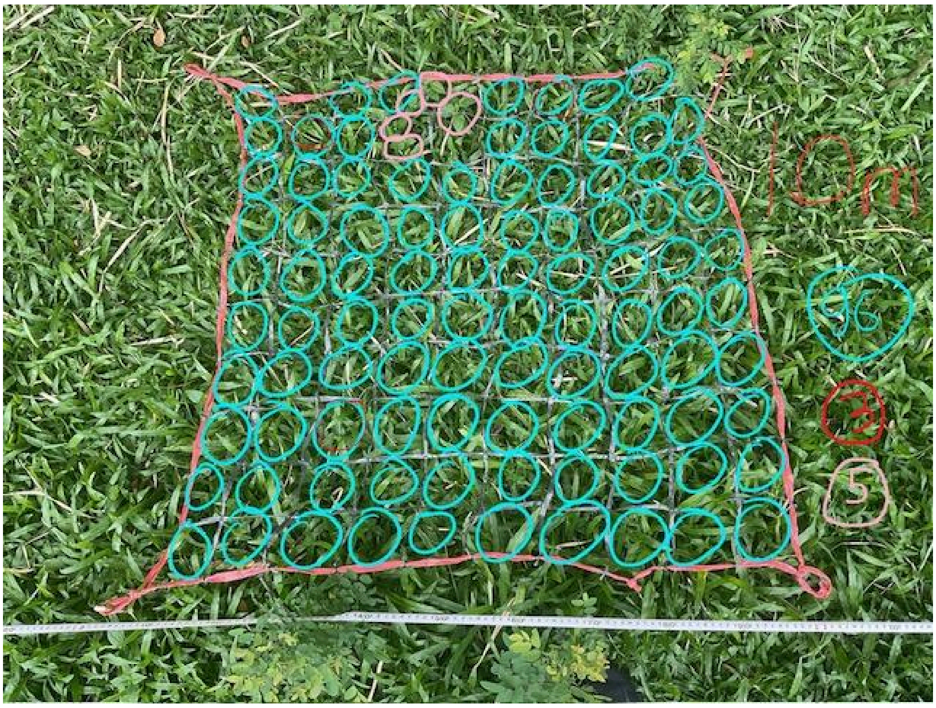
1. There is not enough evidence to show that there is a significant monotonic environmental gradient in at least one abiotic factor, i.e., the abiotic factors within an environment are homogeneous along the line transect.
2. There is not enough evidence to show correlation between two or more abiotic factors. That means that the abiotic factors are pairwise independent.
3. Some abiotic factors are significantly associated with species abundance across the quadrats. This is shown by the significant correlation between the ambient temperature and *Synedrella nodiflora*. On the other hand, most of the abiotic factors are not significantly correlated with species abundance.

4.1 Further Research

Further statistical analysis needs to be conducted to determine whether abiotic factors are mutually independent or not, as there is a possibility that an abiotic factor is dependent on a combination of the other abiotic factors in the collection.

A better line transect can also be placed, with signs of clear environmental gradient, e.g. presence of sparse vegetation zones, permanent shades, etc., to get better statistical results and an understanding of the correlation between the abiotic and biotic factors of an environment.

Appendix (Documentation)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18m
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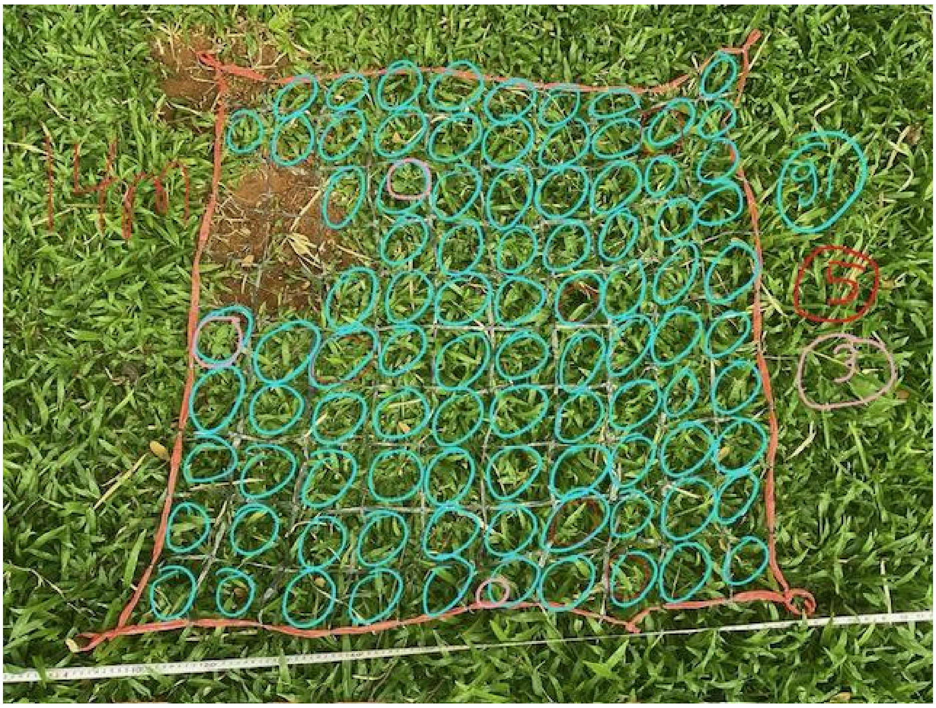
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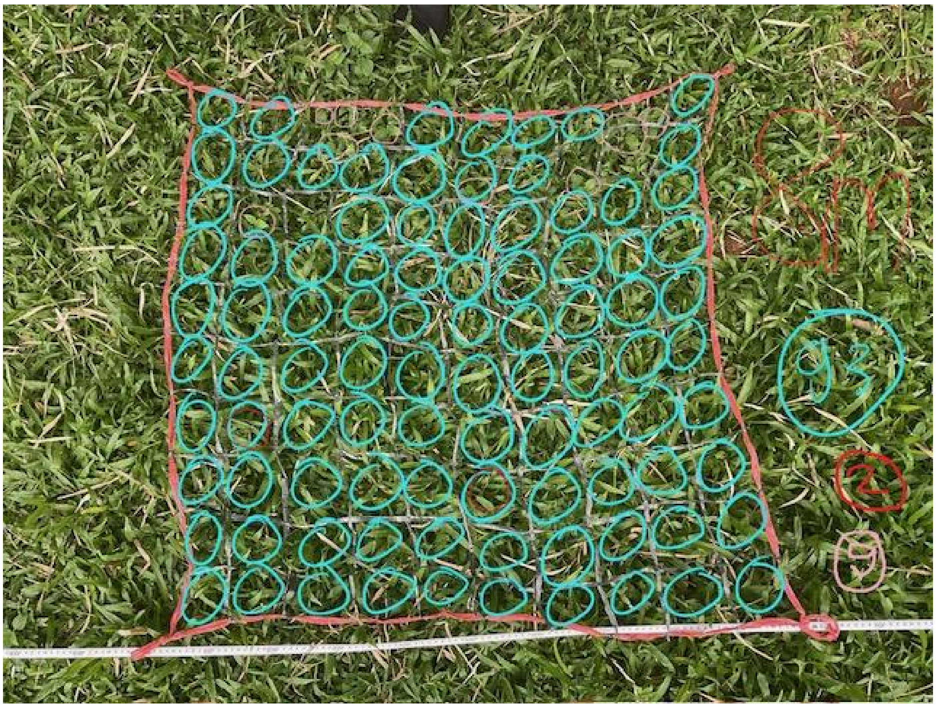
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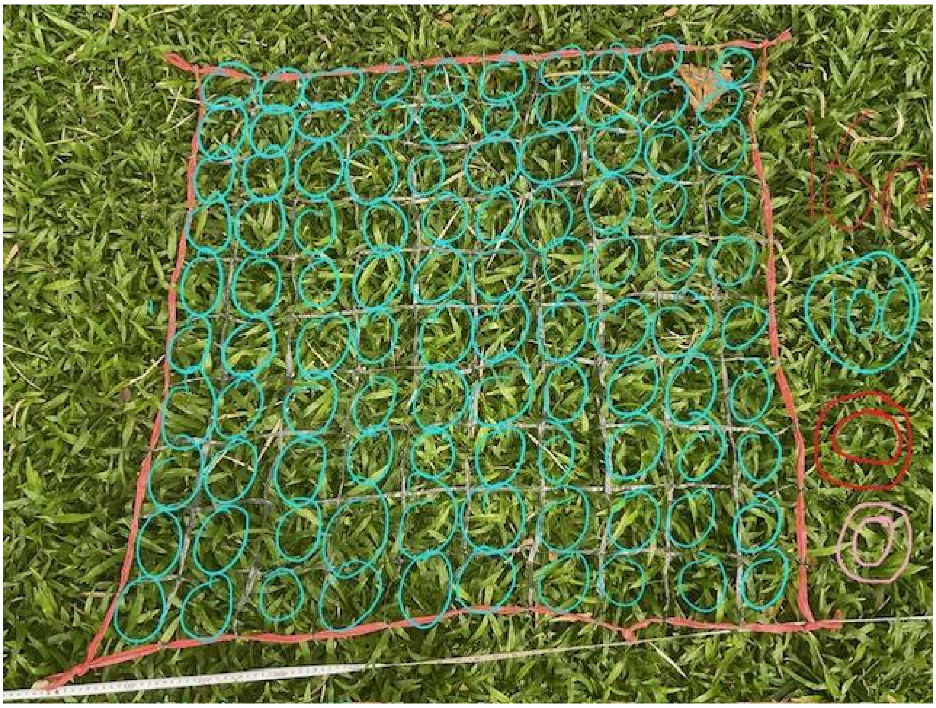

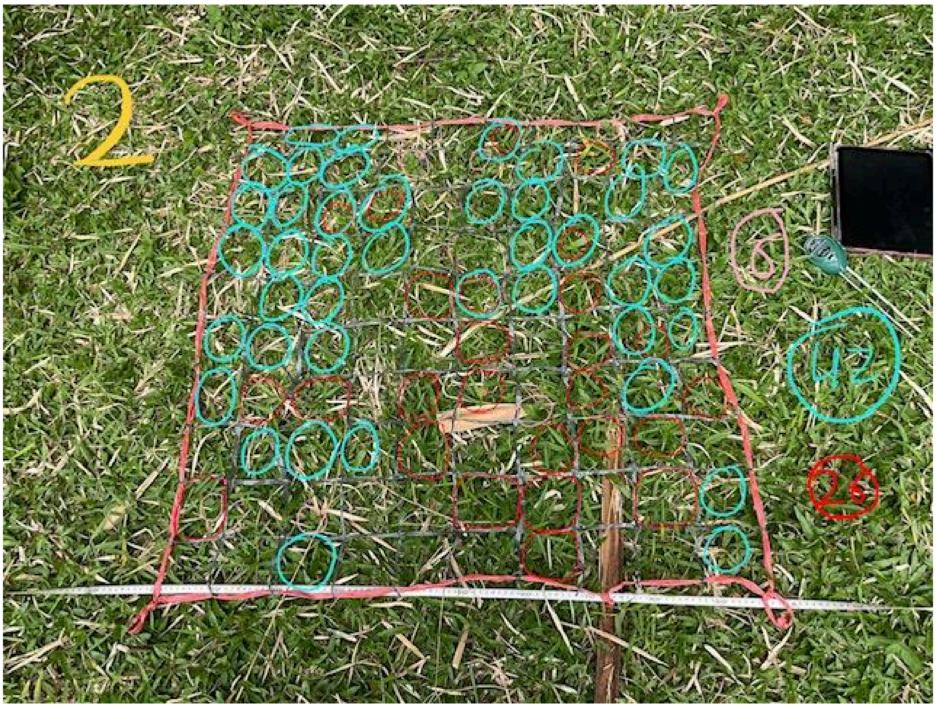
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3
25
0
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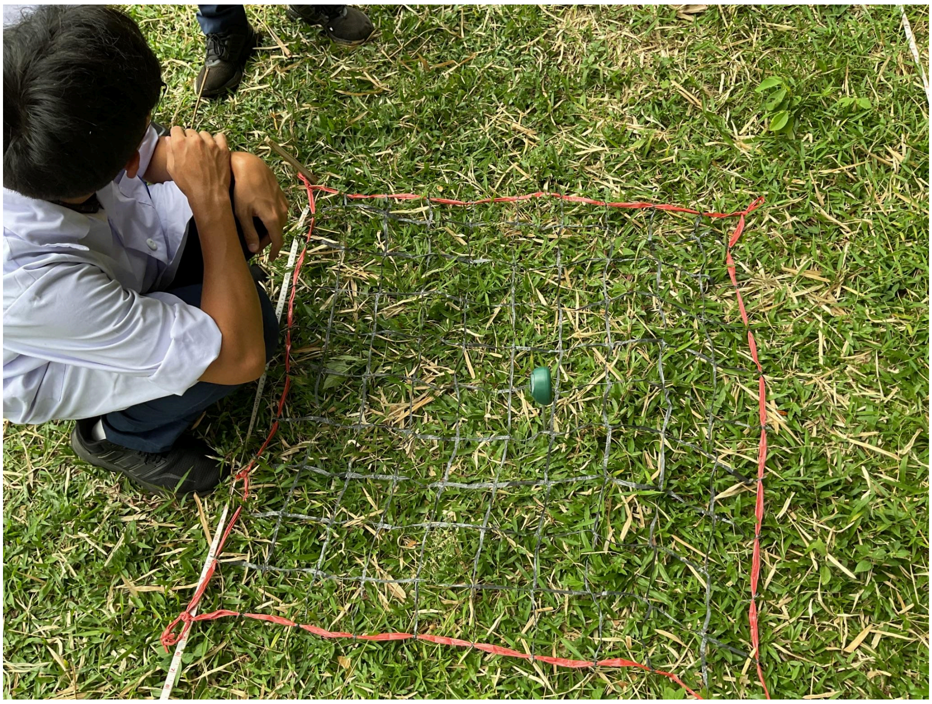
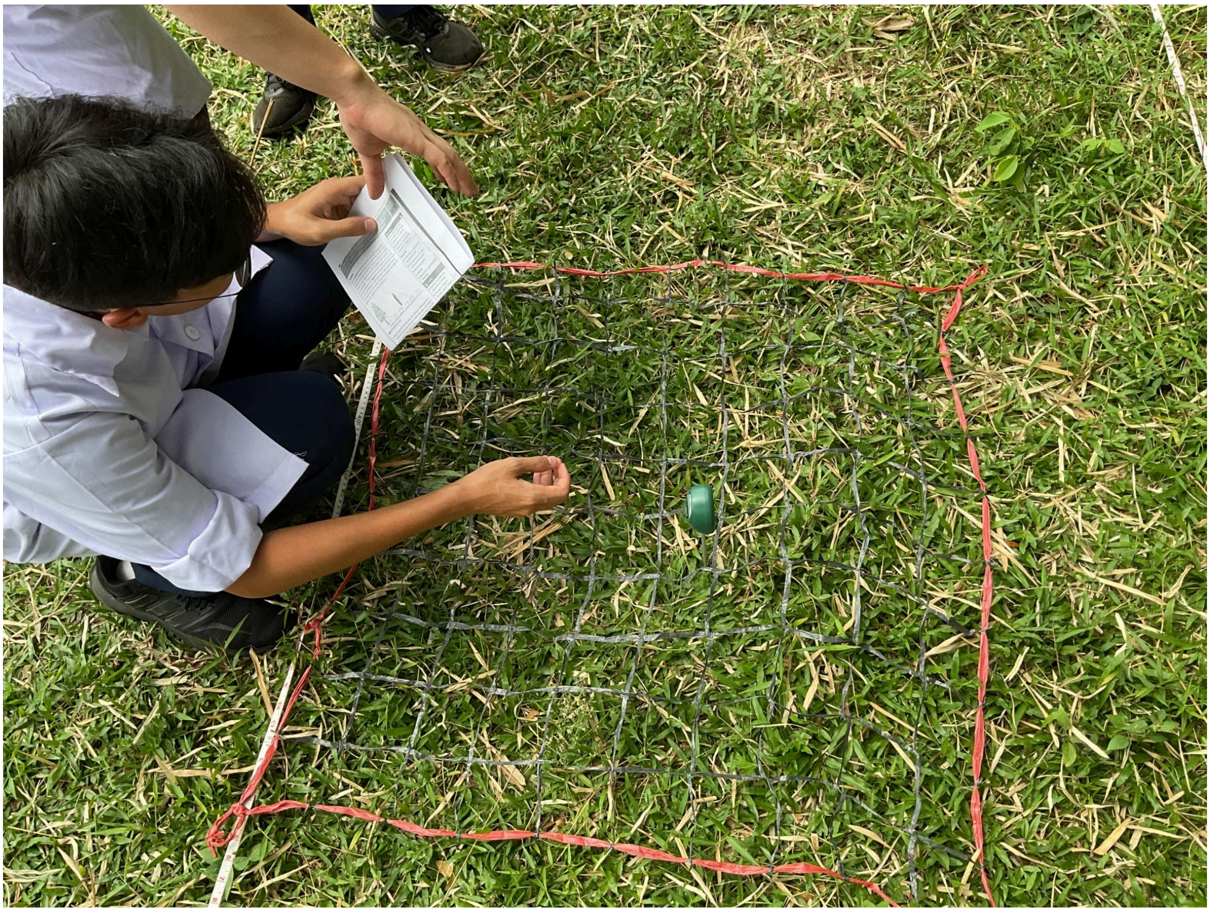
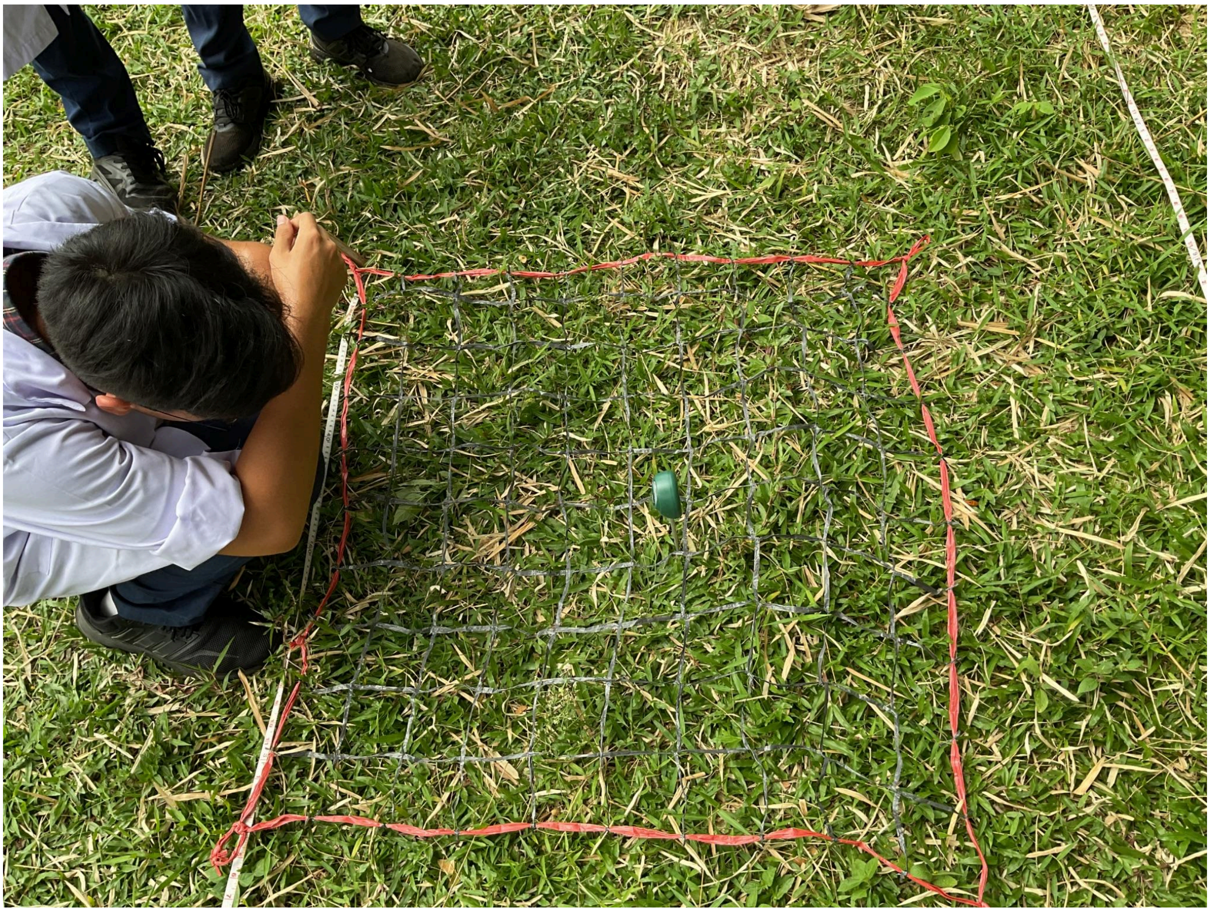







18m


14m


12m


10m


8m


6m


14m

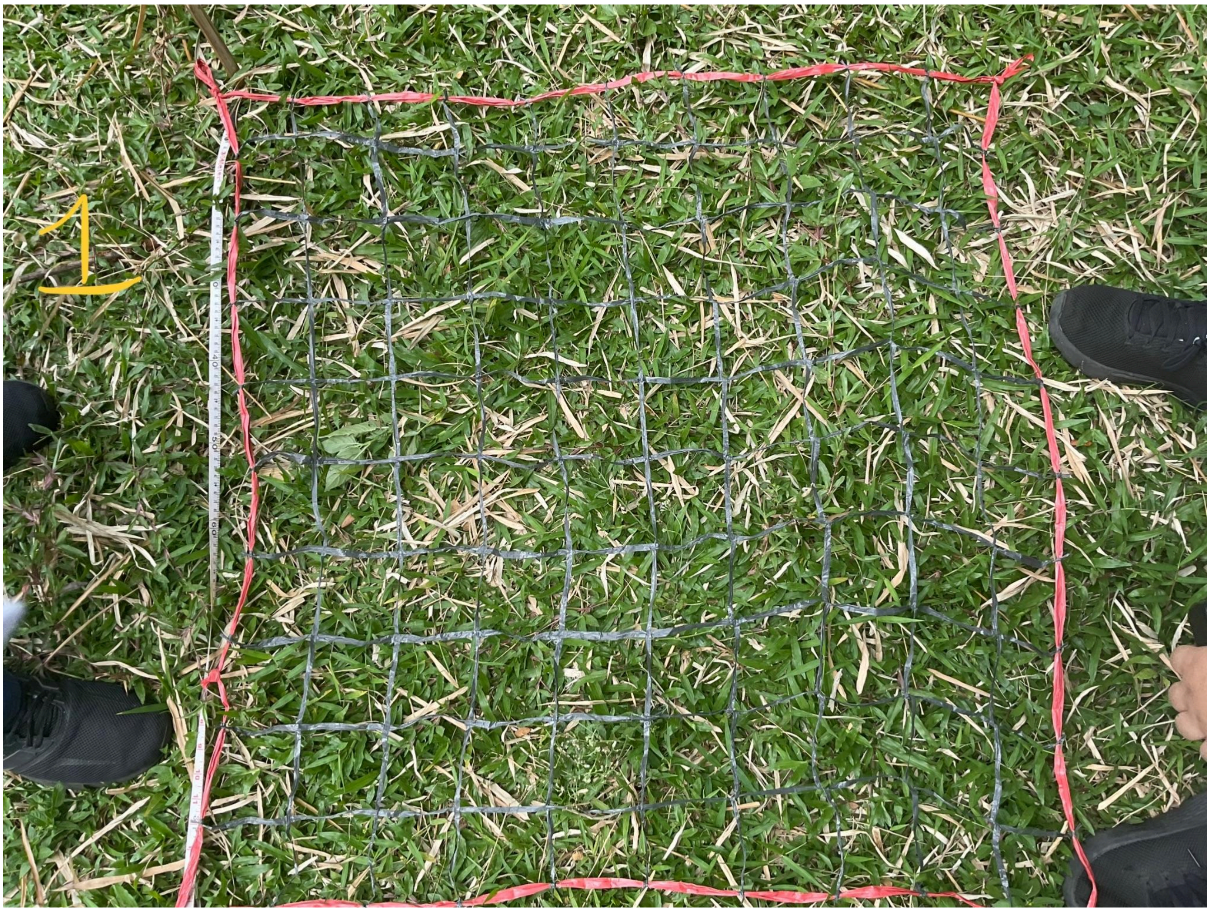

12m


10m


8m


6m


16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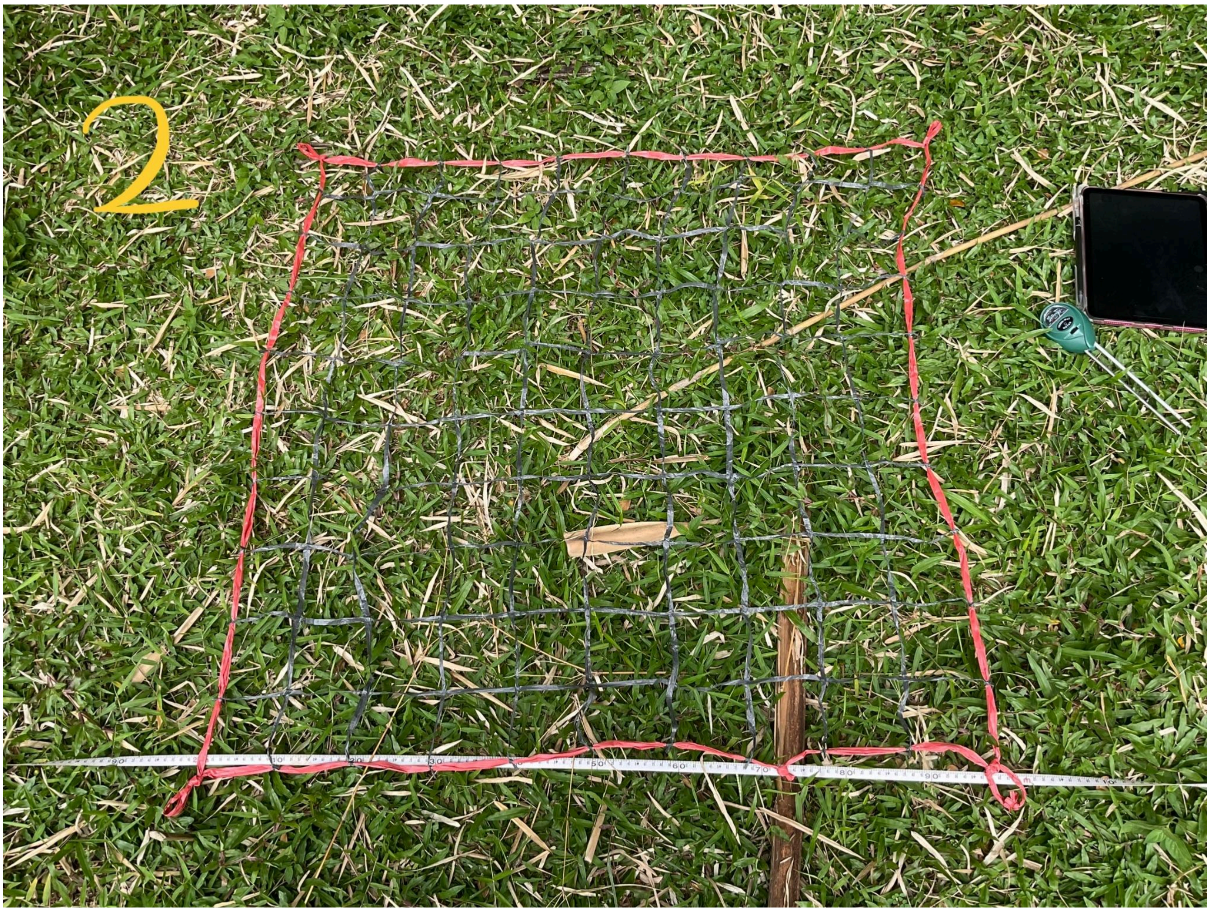
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