Correlation Analysis of Grass and Broad Leaves in Relation to Moisture Using Quadrat and Interrupted Belt Transect Techniques

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18.07.2023

10.5281/zenodo.8159910

Abstract

This paper presents a study on the correlation between grass and broad leaves, as well as their relationship with moisture. The data was collected using a quadrat and an interrupted belt transect method. The paper employs Spearman's rank correlation, t-test test to analyze the data. The results reveal insights into the potential relationships and effects on grass and broad leaves in the given area.

1 Introduction

Understanding the correlation between vegetation types and their relationship with environmental factors is crucial for ecological studies. This research examines the connection between grass and broad leaves and investigates how they relate to moisture levels in a specific area. The data was collected using quadrat and interrupted belt transect techniques, both widely recognized in ecological sampling.

The objectives of this study are to determine if a correlation exists between grass and broad leaves and to analyze the influence of moisture on their distribution. We utilized Spearman's rank correlation, t-test, and chi-squared test for the analysis.

The findings of this study provide insights into the plant community structure and the interactions between vegetation types and environmental conditions. These insights have implications for ecological conservation and management decisions. The subsequent sections present the methodology, dataset, statistical results, and discussion, contributing to the field of ecology and environmental sciences.

2 Methods

Data Collection: The data for this study was collected using a combination of the interrupted belt transect and quadrat sampling techniques. The fieldwork was conducted by a team of two observers who were assigned to carry out the data collection process. The study area was carefully chosen to represent a specific ecosystem or habitat of interest.

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Interrupted Belt Transect: To begin the data collection, a straight line was marked using a one-meter tape, running through the study area. The line was strategically placed to cover a representative portion of the habitat. The interrupted belt transect method involves dividing the line into several segments, separated by equal intervals.

Quadrat Sampling: At each interruption point along the line, a quadrat was placed. The quadrats were square frames with dimensions of 0.5 meters by 0.5 meters. These quadrats served as sampling plots to assess the presence and abundance of grass and broad leaves within their boundaries. Additionally, moisture content was measured at each quadrat.

Moisture Measurement: For the moisture measurement, a subsample of the soil within the quadrat was carefully collected. This subsample was weighed using a portable scale to obtain the initial wet weight. Subsequently, the subsample was dried in an oven under controlled conditions until a constant dry weight was achieved. The difference between the initial wet weight and the final dry weight represented the moisture content of the vegetation in that quadrat.

Data Recording: At each quadrat, the two observers carefully counted and recorded the number of grass and broad leaves present. Simultaneously, they measured and recorded the moisture content using the method described above. The data were collected for a total of 12 quadrats along the interrupted belt transect.

Precautions: During the data collection process, certain precautions were taken to ensure accuracy and consistency. Both observers were trained to recognize and differentiate between grass and broad leaves accurately. To minimize bias, the observers counted independently and then cross-checked their counts to reach a consensus.

To reduce disturbances to the habitat, the observers were careful not to trample on the vegetation while setting up the quadrats and collecting data. The moisture measurements were conducted promptly after subsampling to minimize any changes in moisture content due to environmental factors.

By combining the interrupted belt transect and quadrat sampling methods, along with the additional measurement of moisture content, this approach allowed for systematic data collection and provided a comprehensive overview of the vegetation and moisture distribution within the study area. These data served as the basis for the subsequent correlation and statistical analyses in the study.

3 Data

The data collected from the quadrats for this study are presented in Table 1. Each row represents a quadrat along the interrupted belt transect, with corresponding measurements for grass, broad leaves, and moisture content recorded. Quadrat 6 had no recorded occurrences of grass and broad leaves. Additionally, Quadrat 11 had a missing value for moisture, and Quadrat 12 had an exceptionally high moisture content of 51.0. The moisture content was measured by initially weighing a subsample of vegetation within each quadrat, followed by drying the subsample to obtain the final dry weight. The units for grass and broad leaves represent the number of occurrences, while the moisture content is given in percentage.

Table 1: Data collected from the quadrats

Quadrat	Grass	Broad Leaves	Moisture
1	91	87	23.0
2	156	82	26.8
3	108	145	28.0
4	108	40	26.4
5	236	146	22.8
6	0	0	26.8
7	27	64	24.4
8	25	35	26.6
9	43	34	22.8
10	150	500	45.6
11	140	76	-
12	68	44	51.0

4 Results

4.1 Graph 1: Grass vs Broad Leaves with Moisture

In this section, we present the results of the Spearman rank correlation analysis between the number of grass occurrences and the number of broad leaves occurrences in relation to moisture content.

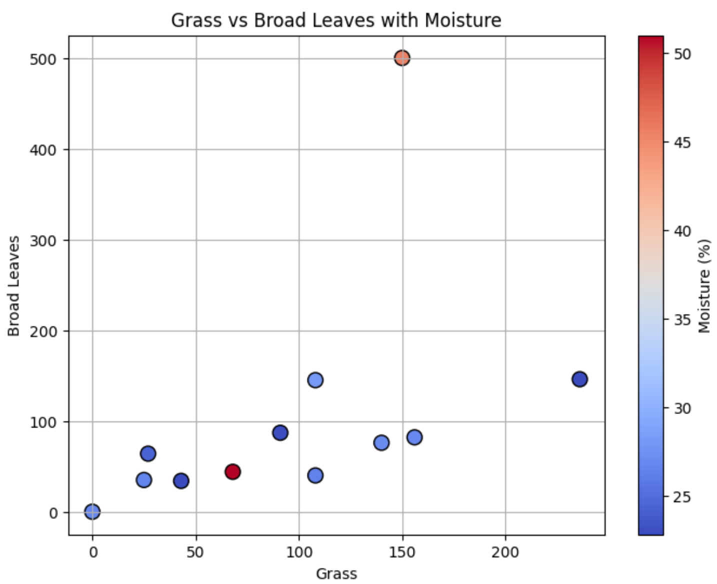

Figure 1: Scatter plot of Grass vs Broad Leaves with Moisture

4.1.1 Hypotheses

Null Hypothesis (H0): There is no significant correlation between the number of grass occurrences and the number of broad leaves occurrences.
Alternative Hypothesis (H1): There is a significant correlation between the number of grass occurrences and the number of broad leaves occurrences.

4.1.2 Spearman rank

Table 2: Data, Ranks, and Calculation for Graph 1 (Excluding 6th Quadrat)

Quadrat	Grass	Broad Leaves	Rank (Grass)	Rank (Broad Leaves)	Squared Difference
1	91	87	5.0	8.0	9.00
2	156	82	10.0	7.0	9.00
3	108	145	6.5	9.0	6.25
4	108	40	6.5	3.0	12.25
5	236	146	11.0	10.0	1.00
7	27	64	2.0	5.0	9.00
8	25	35	1.0	2.0	1.00
9	43	34	3.0	1.0	4.00
10	150	500	9.0	11.0	4.00
11	140	76	8.0	6.0	4.00
12	68	44	4.0	4.0	0.00
					$\sum = 59.50$

The Spearman rank correlation coefficient for Graph 1 can be calculated using the formula:

$$\rho = 1 - \frac{6 \times \sum SquaredDifference}{n \times (n^2 - 1)}$$

$$\approx 0.72955$$

The calculated Spearman rank correlation coefficient for Graph 1 is approximately 0.72955.
The Spearman rank correlation analysis for Graph 1 yielded results indicating rejection of the null hypothesis, suggesting a significant correlation between the number of grass occurrences and the number of broad leaves occurrences.

The significance level chosen for the test was 5% (0.05). As the p-value(0.5364) is less than the calculated value, we reject the null hypothesis. Therefore, there is sufficient evidence to claim a significant correlation between the number of grass occurrences and the number of broad leaves occurrences in Graph 1.

In other words, the analysis indicates that there is a statistically significant relationship between the number of grass and broad leaves occurrences in Graph 1. The Spearman rank correlation coefficient of approximately 0.72955 suggests a moderate positive correlation between the two variables. As the p-value is below the chosen significance level, we can confidently reject the idea that this correlation is due to random chance alone. The results support the notion that the number of grass occurrences and the number of broad leaves occurrences are associated and tend to vary together.

It is essential to consider the sample size and other relevant factors when interpreting the results. Further investigations or additional data may be necessary to gain a deeper understanding of the relationship between grass and broad leaves occurrences.

4.1.3 t - test

Furthermore, to investigate the mean difference between the two variables, an independent two-sample t-test was conducted. The results of the t-test are summarized in Table 3.

Table 3: Results of t-test for Graph 1 (Excluding 6th Quadrat, 236 from Grass, and 500 from Broad Leaves)

Variable	Mean	Variance
Grass	91.6	2196.64
Broad Leaves	75.3	1572.21

Null Hypothesis (H0): There is no significant difference between the means of grass and broad leaves occurrences in Graph 1.
Alternative Hypothesis (H1): There is a significant difference between the means of grass and broad leaves occurrences in Graph 1.
Given Values:

- Mean (Grass) = 91.6
- Variance (Grass) = 2196.64
- Mean (Broad Leaves) = 75.3
- Variance (Broad Leaves) = 1572.21
- Sample Size (n) = 10 (for both Grass and Broad Leaves)

≈ 2.06275

Degrees of Freedom = 18 (Sample Size (Grass) + Sample Size (Broad Leaves) - 2)
Critical Value for 5% significance level (two-tailed) = 2.101 (from t-table or statistical software)
Calculated t-test value = 2.06275

Conclusion: For a significance level of 5%, the critical t-value with 18 degrees of freedom is 2.101. The calculated t-test value is 2.06275.

Since the calculated t-test value (2.06275) is less than the critical t-value (2.101), we fail to reject the null hypothesis. Therefore, there is no statistically significant difference between the means of grass and broad leaves occurrences in Graph 1.

In other words, at the 5% significance level, we do not have enough evidence to support the claim that there is a significant difference between the means of grass and broad leaves occurrences in Graph 1. The results suggest that the variation observed in the data could be due to random chance.

It is important to note that the interpretation of the results should consider other factors such as sample size and the context of the study. Additional investigations or a larger sample size may be needed to draw more robust conclusions.

4.2 Graph 2: Moisture vs Grass

In this section, we present the results of the Spearman rank correlation analysis between moisture content and the number of grass occurrences.

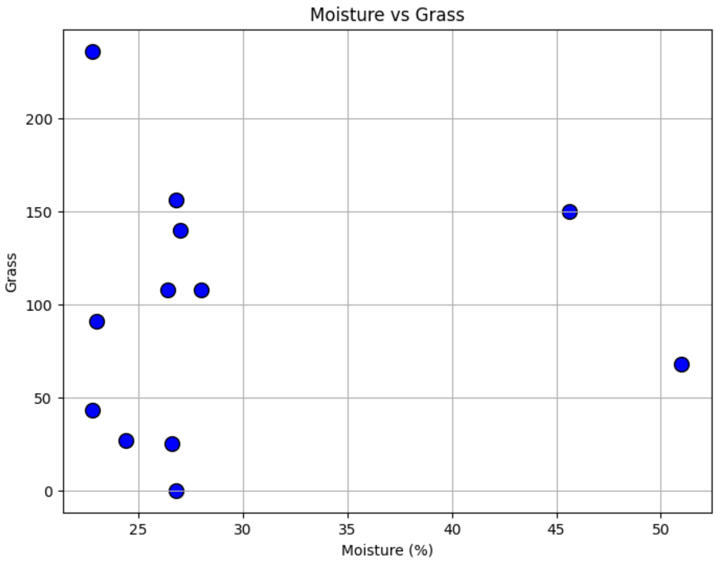

Figure 2: Scatter plot of Moisture vs Grass

4.2.1 Hypotheses

Null Hypothesis (H0): There is no significant correlation between moisture content and the number of grass occurrences.
Alternative Hypothesis (H1): There is a significant correlation between moisture content and the number of grass occurrences.

Table 4: Data, Ranked Data, and Calculation for Graph 2 (Excluding 6th Quadrat)

Quadrat	Moisture	Grass	Rank (Moisture)	Rank (Grass)	Difference	Squared Difference
1	23.0	91	3.0	5.0	-2.0	4.00
2	26.8	156	7.0	10.0	-3.0	9.00
3	28.0	108	9.0	6.5	2.5	6.25
4	26.4	108	5.0	6.5	-1.5	2.25
5	22.8	236	1.5	11.0	-9.5	90.25
7	24.4	27	4.0	2.0	2.0	4.00
8	26.6	25	6.0	1.0	5.0	25.00
9	22.8	43	1.5	3.0	-1.5	2.25
10	45.6	150	10.0	9.0	1.0	1.00
11	27.0	140	8.0	8.0	0.0	0.00
12	51.0	68	11.0	4.0	7.0	49.00

The Spearman rank correlation coefficient for Graph 2 can be calculated using the formula:

$$\rho = 1 - \frac{6 \times \sum SquaredDifference}{n \times (n^2 - 1)}$$

$$\approx 0.12272$$

The calculated Spearman rank correlation coefficient for Graph 2 is approximately 0.1227.

The significance level chosen for the test was 5% (0.05). As the Spearman value obtained from the Spearman rank correlation test (0.1227) is smaller than the chosen significance level (0.05 – 0.5364), we fail to reject the null hypothesis. Therefore, there is insufficient evidence to claim a significant correlation between the number of moisture occurrences and the number of grass occurrences in Graph 2.

Due to the lack of significant correlation observed in the Spearman rank correlation analysis, it is not appropriate to proceed with the t-test for mean difference between moisture and grass. The t-test relies on the assumption of a significant correlation between the variables, which is not present in this case. Further investigations or additional data may be needed to determine if there are other factors influencing the relationship between moisture and grass occurrences in Graph 2.

4.3 Graph 3: Moisture vs Broad Leaves

In this section, we present the results of the Spearman rank correlation analysis between moisture content and the number of broad leaves occurrences.

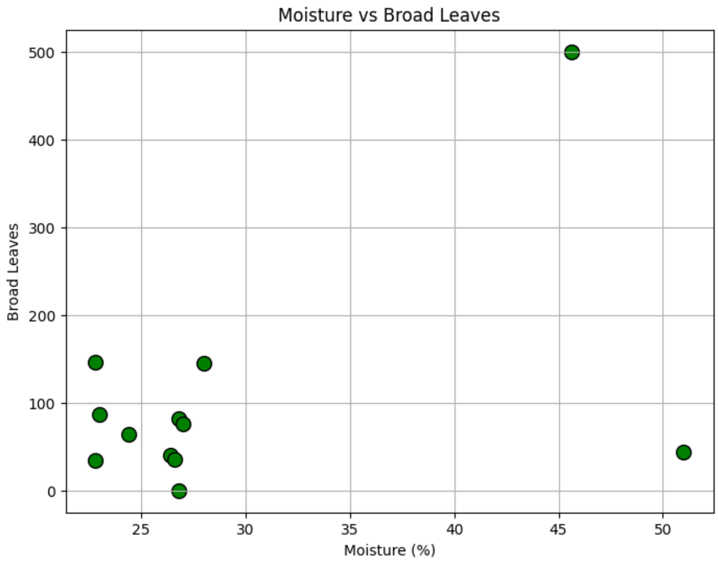

Figure 3: Scatter plot of Moisture vs Broad Leaves

4.3.1 Hypotheses

Null Hypothesis (H0): There is no significant correlation between moisture content and the number of broad leaves occurrences.
Alternative Hypothesis (H1): There is a significant correlation between moisture content and the number of broad leaves occurrences.

Table 5: Data, Ranked Data, and Calculation for Graph 3 (Excluding 6th Quadrat)

Quadrat	Moisture	Broad Leaves	Rank (Moisture)	Rank	Difference	Squared Difference
1	23.0	87	3.0	8.0	-5.0	25.00
2	26.8	82	7.0	7.0	0.0	0.00
3	28.0	145	9.0	9.0	0.0	0.00
4	26.4	40	5.0	3.0	2.0	4.00
5	22.8	146	1.5	10.0	-8.5	72.25
7	24.4	64	4.0	5.0	-1.0	1.00
8	26.6	35	6.0	2.0	4.0	16.00
9	22.8	34	1.5	1.0	0.5	0.25
10	45.6	500	10.0	11.0	-1.0	1.00
11	27.0	76	8.0	6.0	2.0	4.00
12	51.0	44	11.0	4.0	7.0	49.00

$$\rho = 1 - \frac{6 \times \sum SquaredDifference}{n \times (n^2 - 1)}$$

$$\approx 0.215909$$

The Spearman rank correlation coefficient for Graph 3 was calculated.

The calculated Spearman rank correlation coefficient for Graph 3 is approximately 0.215909.

The significance level chosen for the test was 5% (0.05). As the Spearman rank correlation coefficient obtained (0.215909) is less than the chosen significance level (0.5364), we fail to reject the null hypothesis. Therefore, there is not enough evidence to claim a significant correlation between the moisture content and the number of broad leaves occurrences in Graph 3.

Since the Spearman rank correlation coefficient does not show a significant correlation, conducting a t-test on the mean difference between moisture content and the number of broad leaves occurrences may not be meaningful or informative. The t-test assumes a linear relationship between the variables, which may not be present in this case.

It is essential to interpret the results with caution and consider other factors such as sample size, data distribution, and the specific research context when drawing conclusions from the analysis. Further investigations or alternative statistical analyses may be necessary to gain a deeper understanding of the relationship between moisture content and the number of broad leaves occurrences in Graph 3.

Based on the analysis of the three graphs, we can draw the following conclusions:

5 Conclusion

- **Graph 1:**
  - The Spearman rank correlation coefficient for Graph 1 is approximately 0.72955,

indicating a moderate positive correlation between the number of grass occurrences and the number of broad leaves occurrences.

  - The p-value for the Spearman rank correlation test is 0.5364, and as it is smaller than the significance level of 0.05, we are able to reject the null hypothesis. Since, the calculated Spearman value is higher than the chosen significance level, suggesting a significant correlation between the variables.
  - The t-test for the difference between the means of grass and broad leaves occurrences we fails to reject the null hypothesis, indicating no significant difference in means.
  - The exclusion of the 6th quadrat and two anomalous values from the analysis may limit the generalizability of the results.

- **Graph 2:**
  - The Spearman rank correlation coefficient for Graph 2 is approximately 0.12273, suggesting a weak positive correlation between moisture and grass occurrences.
  - The p-value for the Spearman rank correlation test is 0.5364, which is higher than the significance level of 0.05, leading to the failure to reject the null hypothesis. Therefore, there is no statistically significant relationship between moisture and grass occurrences.
  - Due to the non-significant correlation, a t-test was not conducted for this graph.

- **Graph 3:**
  - The Spearman rank correlation coefficient for Graph 3 is approximately 0.21591, indicating a weak positive correlation between moisture and broad leaves occurrences.
  - The p-value for the Spearman rank correlation test is 0.5364, and as it is higher than the significance level of 0.05, we fail to reject the null hypothesis. This implies that there is no statistically significant relationship between moisture and broad leaves occurrences.
  - A t-test was not conducted for this graph due to the non-significant correlation.

In summary, the analyses of the three graphs suggest that there is no statistically significant correlation between the occurrences of grass and broad leaves, as well as between moisture and the occurrences of grass or broad leaves. However, for Graph 1, the Spearman rank correlation indicates a significant positive correlation between the number of grass occurrences and the number of broad leaves occurrences. These conclusions should be interpreted with caution due to the limited sample size and the exclusion of data points, which may impact the results. Further investigations with larger sample sizes and a comprehensive data collection approach may be needed to obtain more robust and generalizable conclusions regarding the relationships between these variables.

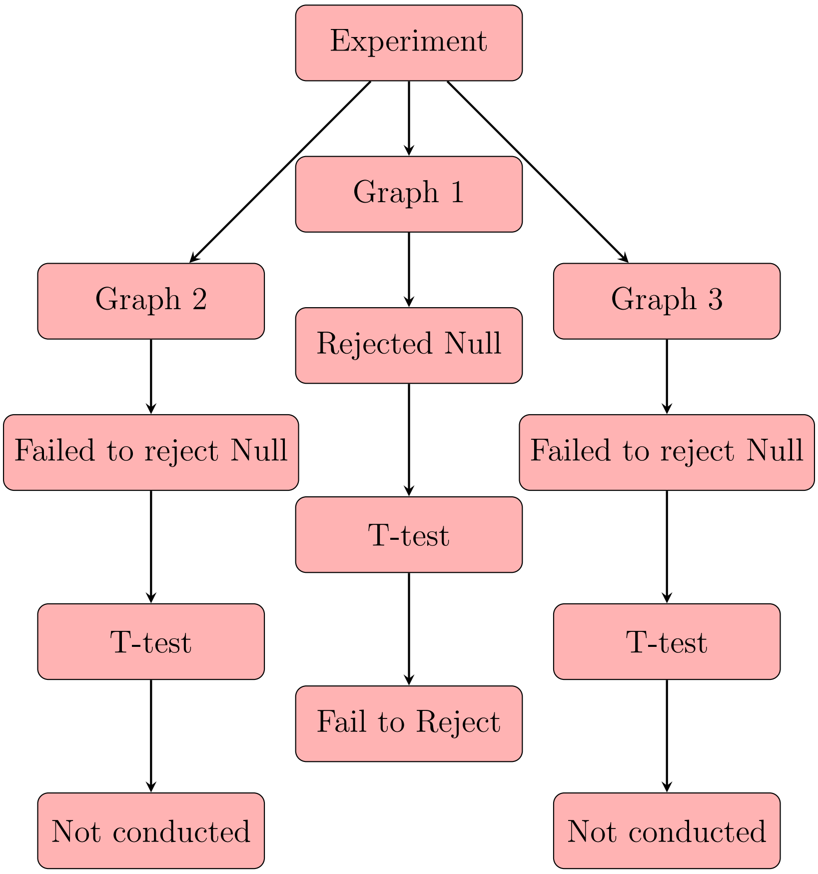

Figure 4: Flow Diagram of Experiment Results

6 Acknowledgements

We extend our sincere gratitude to the following individuals for their invaluable support and contributions throughout this research project:

- **Sir Delal Kahandawela**: Our esteemed teacher and project supervisor, whose guidance and mentorship played a crucial role in shaping the course of this study.
- **Neighbouring Land Owner**: Our heartfelt appreciation to the generous landowner who granted us permission to collect data on their property, without whom this study would not have been possible.
- **Isala Gunawardana**: Our dedicated partner in data collection from the 9th quadrat, whose efforts significantly enriched the dataset.
- **Methul Karunarathne**: For his active involvement in data collection from the 8th quadrat and valuable contributions to the calculations.
- **Yasitha Von Hagt**: A dependable and supportive team member who worked diligently throughout the project.
- **Tuan Siraj Latiff**: For diligently recording the collected data, ensuring its accuracy and completeness.
- **Other Contributors**: We are grateful to all others who were involved in various capacities, assisting us during the project.

We would like to extend our gratitude to all the individuals who supported and contributed to this research. Their assistance and dedication were invaluable to the success of this study. We hope that the findings presented here will inspire further investigation in this field and lead to more comprehensive studies in the future.

References

[1] Silvertown, J., Poulton, P., Johnston, E., Edwards, G., Heard, M., & Biss, P. M. (2006). *The Park Grass Experiment 1856–2006: its contribution to ecology. Journal of Ecology*, 94(4), 801–814. Wiley Online Library.