



Impact of Organic Fertilizer from Philippine Tree Fern (*Cyathea contaminans*) Leaves on Tuber Performance of Sweetpotato (*Ipomoea batatas*)

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Abstract: Sweetpotato (*Ipomoea batatas*) is a staple crop in the Philippines, yet declining soil fertility poses a challenge to its sustainable production. This study investigates the impact of organic fertilizer from Philippine Tree Fern (*Cyathea contaminans*) leaves as a viable alternative to synthetic fertilizers. Conducted in Basey, Samar—where demonstration farms have been operating since 2019—the study employed a randomized complete block design (RCBD) to compare three treatments: (A) organic fertilizer from *C. contaminans*, (B) no fertilizer (control), and (C) commercial fertilizer (muriate of potash + urea). Results revealed that *C. contaminans* fertilizer significantly improved sweetpotato tuber survival rates, with the highest number of ridges with survived tubers (11 ridges) and the lowest number of ridges with diseased tubers (2 ridges), compared to the control (5 survived, 7 diseased) and synthetic fertilizer (6 survived, 13 diseased) ($\chi^2 = 9.143$, $p = 0.010$). Despite these benefits, no statistically significant differences were observed in tuber weight ($p = 0.698$) or circumference ($p = 0.671$) across treatments. However, treatment A produced slightly heavier (median weight of 0.240 kg) and larger (mean circumference of 133.41 cm) tubers on average. These findings suggest that *C. contaminans*-based fertilizer enhances plant resilience and disease resistance, making it a sustainable and eco-friendly alternative. Further research should explore its long-term impact on soil microbial composition, nutrient availability, and economic feasibility for large-scale adoption.

Keywords: Cultivation; disease resistance; surviving tuber

1. Introduction

Sweetpotato (*Ipomoea batatas*) is one of the most important root crops in the Philippines, serving as a staple food and a primary source of carbohydrates for many Filipinos [1]. It plays a significant role in food security, particularly in climate-vulnerable regions, due to its ability to adapt to extreme weather conditions [2]. The crop's ability to withstand typhoons, droughts, and floods makes it a dependable food source during pandemics and calamities, earning it the moniker "food and calamity." [3-4]. Additionally, sweet potatoes contribute to the economy by serving as a versatile raw material for various food products, including flour, fries, muffins, cookies, chips, and noodles [5], which cater to both local consumption and export markets. Sweetpotato production faces significant challenges due to decreased soil fertility, despite the crop's nutritional and economic benefits. The overuse of chemical fertilizers, inadequate land management, and the impact of climate change on soil nutrients

have all contributed to the gradual deterioration of soil quality. As a result, sustainable and efficient fertilizer management has become crucial for maintaining optimal sweetpotato production [6-7]. Traditionally, sweet potato farmers rely on synthetic fertilizers, particularly complete fertilizers (14-14-14) containing Nitrogen (N), Phosphorus (P), and Potassium (K) [8]. According to PhilRootcrops as cited from the work of Asio & Dela Cruz (2020) [9] and Mustacisa-Lacaba et al. (2023)[10], fertilizer application is divided into different stages: complete fertilizer is applied two weeks after planting to promote vegetative growth and a combination of nitrogen and potassium is added during the tuber bulking stage to enhance carbohydrate accumulation and sweetness.

However, concerns about soil degradation, environmental sustainability, and the rising cost of chemical fertilizers have led to increased interest in organic alternatives [6]. Studies suggest that organic fertilizers, such as animal manure and compost, can improve soil fertility, enhance microbial activity, and promote better root development, ultimately leading to higher sweetpotato yields [11]. However, a significant obstacle to broader adoption is still the scarcity of high-quality organic fertilizers. To address this issue, this study investigates the potential of *C. contaminans* (Philippine Tree Fern) leaves as a novel organic fertilizer for sweet potato farming. *C. contaminans*, locally known as “punit,” is endemic to Samar and is rich in key macronutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), which are essential for plant growth and tuber formation [12-13]. This fern has been historically underutilized in agriculture, despite its biodegradable nature and potential benefits as a soil conditioner [14]. A previous study on sweetpotato cultivation in the Philippines [15] highlighted the need for improved fertilizer strategies that balance yield enhancement with environmental sustainability. Findings from this prior research emphasized that soil amendments with organic components contribute to tuber quality, disease resistance, and soil nutrient retention, which aligns with the current study’s goal of developing an alternative fertilizer that competes with commercially available synthetic fertilizers while remaining cost-effective and eco-friendly.

From a chemical perspective, the organic composition of *C. contaminans* is of particular interest due to its high polyphenol content, enzymatic antioxidants, and bioavailable forms of nitrogen and potassium. These substances have been shown to promote water retention, boost plant immunity against soil-borne diseases, and improve the development of plant root systems [16]. Unlike synthetic fertilizers, which deliver nutrients in an immediate but short-lived burst, organic fertilizers release nutrients gradually, thereby improving long-term soil structure and fertility. This study aims to formulate an organic fertilizer derived from *C. contaminans* leaves and evaluate its effectiveness compared to standard synthetic fertilizers. The research explicitly investigates its impact on sweet potato (*Ipomoea batatas*) tuber survival rate and disease resistance, addressing the challenges commonly encountered in disease-prone farming areas. By analyzing variations in tuber weight and circumference across different fertilizer treatments, this study aims to determine whether organic amendments contribute to enhanced tuber size and overall marketability. Additionally, the findings are expected to support sustainable agriculture initiatives by introducing a cost-effective and environmentally friendly alternative to conventional fertilizers. Such an innovation could offer significant benefits to small-scale farmers in the Philippines, promoting long-term soil health and reducing reliance on chemical fertilizers.

The results of this study will provide key insights into the viability of *C. contaminans* as an agricultural input, potentially offering a scalable solution to the declining soil fertility problem in sweetpotato farms. Furthermore, the findings from this research could inform future policy recommendations on the development of organic fertilizers and climate-resilient farming techniques. This study aims to formulate and evaluate the effectiveness of organic fertilizer derived from Philippine Tree Fern (*Cyathea contaminans*) leaves in improving the growth, yield, and disease resistance of sweetpotato (*Ipomoea batatas*) in a demonstration farm setting. Specifically, the study aimed to attain several objectives. First, it sought to develop and formulate an organic fertilizer using *Cyathea contaminans* leaves (Treatment A). Second, it aimed to assess the survival rate and disease resistance of sweetpotato tubers treated with *C. contaminans* fertilizer (Treatment A) in comparison with those without fertilizer application (Treatment B) and those applied with commercial fertilizer (Treatment C: muriate of potash + urea). Finally, the study intended to compare the effects of *C. contaminans* fertilizer (Treatment A), no fertilizer application (Treatment B), and commercial fertilizer (Treatment C: muriate of potash + urea) on sweetpotato tuber survival rate, disease incidence, weight, and circumference, and to determine the statistical significance of these differences. It tested the null hypothesis (H_0), there is no

significant difference in sweetpotato tuber survival rate, disease incidence, weight, and circumference among Treatment A (*C. contaminans* fertilizer), Treatment B (no fertilizer application), and Treatment C (commercial fertilizer: muriate of potash + urea)..

2. Materials and Methods

2.1 Development of *C. contaminans*-Based Fertilizer

Fresh *C. contaminans* leaves were collected from Brgy. Sto. Niño, Paranas, Samar, about 1 km from the nearest households, to minimize human disturbance. Mature leaves were selected for their higher nutrient content and better decomposition efficiency. Processing was conducted at Samar State University - Basey Campus using a standardized method. Leaves were washed to remove impurities, dried at 180°C for 10–15 minutes, flipped to ensure uniform drying, and then dried for an additional 10 minutes. They were then ground into a fine powder to enhance decomposition and nutrient availability, ensuring quality for experimental application (Refer to Figure 1 for the process flowchart).

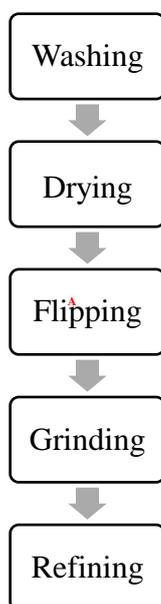


Figure 1. Process of *C. contaminans*-Based Fertilizer

2.2 Study Site and Experimental Design

The study was conducted in Brgy. Balante, Basey, Samar, a site with a semi-loam soil type that has been used for sweetpotato farming since 2019. The area experiences a tropical climate, characterized by warm temperatures ranging from 24°C to 32°C (75°F to 89°F) throughout the year. It receives significant annual rainfall, with the wettest months typically occurring between October and January, aligning with the Northeast Monsoon. The region is predominantly composed of rolling hills and upland terrain, with elevations ranging from 200 to 800 meters above sea level, making it suitable for root crop cultivation, particularly sweetpotato. The experiment employed a randomized complete block design (RCBD) with three fertilizer treatments and 15 replications. Each experimental unit consisted of a ridge measuring 60 cm in width at the top and 30 cm in height. Along each ridge, fifteen (15) sweetpotato cuttings were planted at 25 cm intervals, with each cutting set at an approximate planting depth of 30 cm (one standard ruler length) to ensure proper anchorage and root establishment. This configuration was maintained across all treatments to provide uniform plant density and allow accurate assessment of treatment effects on tuber growth.

2.3 Planting Material and Cultivation Practices

The VSP-6 sweet potato variety, sourced from the Tarlac Agricultural University, was chosen for its high yield potential (14+ tons per hectare), 32% dry matter content, and disease resistance. Its light yellow to white flesh makes it ideal for flour production without altering the final product's color. Known for its adaptability to various soils and climates, VSP-6 thrives in Samar's semi-loam soil and resists common sweetpotato viral infections, ensuring stable yields. To maintain genetic consistency, 25 cm cuttings with five nodes were taken from the mother plant, promoting strong root establishment and uniform growth.

2.4 Treatment Formulation and Application

The study evaluated the effects of three fertilizer treatments on sweetpotato growth, yield, and disease resistance. Treatment A used an organic fertilizer derived from *Cyathea contaminans* leaves, applied at 0.5 grams per ridge seven days before planting to enhance soil fertility and root establishment. Treatment B served as the control group, with no fertilizer application, to assess the natural growth potential of sweetpotato tubers. Treatment C involved a synthetic fertilizer mixture of muriate of potash and urea, applied at 0.5 grams per ridge 45 days after planting to support tuber bulking. Throughout the experiment, irrigation was provided as needed, and manual weeding was performed regularly to minimize nutrient competition and ensure optimal growth conditions. These management practices allowed for an accurate assessment of the effects of each fertilizer treatment.

2.5 Data Collection and Parameters Measured

Observations and data collection were conducted 90 days after planting to evaluate the effects of fertilizer treatments on sweetpotato growth and yield. The study measured survival rate, disease incidence, tuber weight, and circumference. Survival and disease incidence were assessed by recording the number of ridges with survived and insect-damaged tubers, with infected tubers referred to as "bukbok" in Waray-Waray. A Chi-square test ($p < 0.05$) determined statistical differences in survival and disease occurrence. Tuber weight was measured with a digital balance (0.01g precision), and circumference was measured at the widest point using a caliper for accuracy. Data normality was assessed using the Shapiro-Wilk test, while the Kruskal-Wallis test and ANOVA were employed to compare weight and circumference, ensuring a comprehensive statistical analysis.

2.6 Statistical Analysis

All data were analyzed using Statistics Kingdom, an online statistical tool that provided detailed results for various analyses. Nominal data, such as the incidence of survived and diseased sweetpotato tubers, were presented using frequency counts and analyzed using the Chi-square test to determine significant differences in survival and disease incidence among treatments. The Kruskal-Wallis test was applied to compare tuber weights, as the data exhibited a non-normal distribution, whereas ANOVA was used to analyze tuber circumference measurements, which followed a normal distribution. A significance level of $p < 0.05$ was set for all statistical tests to determine meaningful differences among treatments. Additionally, confidence intervals and boxplots were generated to visualize data distributions, providing a clear representation of the variability and trends across different fertilizer applications.

2.7 Experimental Limitations and Considerations

Environmental conditions, such as weather events that could have influenced the results, were not fully monitored. However, measures like irrigation and other interventions were implemented to minimize confounding variables and maintain uniform growth conditions across treatments.

3. Results and Discussion

3.1 Incidence of Survived and Diseased Sweetpotato Tubers Across Treatments

Table 1 presents the incidence of survival, insect damage, and mortality of sweetpotato tubers across the three treatments. To ensure comparability, each treatment was standardized to a total of 15 ridges. Both raw counts and percentages are reported, addressing potential bias that might arise if treatments had unequal numbers of ridges. This dual reporting allows for a more accurate comparison of treatment performance. Treatment A, which involved the application of *Cyathea contaminans* fertilizer seven days before planting,

achieved the highest survival rate (73.33%) and the lowest incidence of insect-damaged tubers (13.33%). In contrast, Treatment C, which received a commercial fertilizer mixture (muriate of potash and urea) applied 45 days after planting, recorded the highest incidence of insect damage (53.33%) and a relatively low survival rate (40.00%). Treatment B (control, no fertilizer) showed moderate survival (33.33%) and moderate insect damage (46.67%).

Table 1. Incidence of Survived and Insect-Damaged Sweetpotato Tubers (no. of ridges)

Treatment	Survived Tubers	% Survived	Insect-damaged tubers	% of insect-damaged tubers	Mortality	% Mortality	Total Ridges
Treatment A ¹	11	73.33%	2	13.33%	2	13.33%	15
Treatment B ²	5	33.33%	7	46.67%	3	20.00%	15
Treatment C ³	6	40.00%	8	53.33%	1	6.67%	15

^{1/} with *C. contaminans* fertilizer application 7 days before planting;

^{2/} no fertilizer application (control);

^{3/} with a mixture of muriate of potash and urea, applied 45 days after planting.

The findings suggest that *C. contaminans* fertilizer improved tuber survival while reducing insect damage, compared to both the control and the synthetic fertilizer treatment. The higher insect damage in Treatment C may indicate that synthetic fertilizer applications alter soil conditions in a way that increases tuber susceptibility.

3.2 Comparison of Sweetpotato Tuber Survival and Disease Incidence Across Treatments

To determine whether the differences in survival and disease incidence were statistically significant, a Chi-square test was conducted (Table 2). The overall Chi-square result ($\chi^2 = 9.143$, $p = 0.010$) indicated a significant difference among treatments, justifying the need for pairwise comparisons. The statistical analysis revealed significant differences in the survival and disease incidence of sweetpotato tubers among the different fertilizer treatments. The comparison between Treatment A (*C. contaminans* fertilizer) and Treatment B (no fertilizer application) showed a significant difference ($p = 0.025$), indicating that the application of *C. contaminans* fertilizer enhanced tuber survival and reduced disease incidence compared to no fertilizer at all. This suggests that *C. contaminans* could contribute to improved plant health and growth conditions.

Table 2. Statistical Comparison of Sweetpotato Tuber Survival and Disease Incidence Across Treatments

Test	df	Value	p-value	Interpretation
Overall Chi-square (χ^2) across all treatments	2	9.143	0.010	Significant
<i>Pairwise Chi-Square Tests</i>				
Treatment A vs. Treatment B	1	4.996	0.025	Significant
Treatment A vs. Treatment C	1	8.719	0.003	Significant
Treatment B vs. Treatment C	1	0.327	0.567	Not Significant

decision rule: significant if $p < 0.05$; not significant if $p > 0.05$

Furthermore, the comparison between Treatment A (*C. contaminans*) and Treatment C (muriate of potash + urea) also showed a highly significant difference ($p = 0.003$). This result strongly suggests that *C. contaminans* fertilizer was more effective than the commercial fertilizer in promoting tuber survival and disease resistance. The enhanced growth observed in Treatment A implies that the organic fertilizer derived from *C. contaminans* may provide superior soil conditioning and nutrient availability compared to synthetic alternatives. On the other hand, the comparison between Treatment B (no fertilizer) and Treatment C (muriate of potash + urea) yielded a non-significant result ($p = 0.567$), suggesting that the application of the commercial fertilizer did not significantly improve tuber survival or disease resistance when compared to the control group. This finding suggests that the synthetic fertilizer mixture may not have significantly contributed to the growth performance of sweet potatoes under the given conditions, highlighting the potential limitations of relying solely on chemical fertilizers. The findings of this study demonstrate that the organic fertilizer derived

from *C. contaminans* had a positive impact on sweetpotato tuber survival and a protective effect against disease, making it a promising alternative to commercial fertilizers. The significant differences observed in tuber survival and disease rates underscore the potential of *C. contaminans* as an effective, sustainable, and eco-friendly fertilizer for sweet potato farming. These results support the broader application of *C. contaminans* fertilizer in promoting soil health and improving crop productivity in an environmentally sustainable manner.

3.3 Comparison of Sweetpotato Tuber Weight Across Three Treatments

Since the normality assumption was violated for Treatments A and C ($p = 0.000$ and $p = 0.003$, respectively), the Kruskal-Wallis test was used to compare tuber weights across the treatments. The median weights were highest in Treatment A (0.240 kg), followed by Treatment B (0.220 kg) and Treatment C (0.210 kg). However, despite these numerical differences, the Kruskal-Wallis test statistic ($H = 0.719$) and p -value (0.698) indicated that the differences were not statistically significant ($p > 0.05$). This suggests that the type of fertilizer did not have a significant impact on tuber weight (Refer to Table 3).

Table 3. Comparison of Sweetpotato Tuber Weight

Descriptive Statistics and Normality Test			
Test	Treatment A	Treatment B	Treatment C
Excess Kurtosis	12.881	-1.171	3.795
Skewness	3.500	0.550	1.949
Normality (p-value)	0.000 (Non-normal)	0.137 (Normal)	0.003 (Non-normal)
Median	0.240	0.220	0.210
Sample Size (n)	15	15	15
Rank Sum (R)	335.500	242.000	242.500
R^2/n	7504.017	4,880.333	4,523.558
Kruskal-Wallis Test Results			
Test Statistic (H)	0.719		
p-value	0.698 (Not Significant)		

decision rule: for normality - normal if $p > 0.05$; non-normal if $p < 0.05$

for significance - significant if $p < 0.05$; not significant if $p > 0.05$;

The distribution of tuber weights varied across treatments. Treatment A (*C. contaminans* fertilizer) had the widest range of tuber weights, as shown in the boxplot (Figure 1), with some tubers achieving significantly higher weights than others. This was supported by its high positive skewness (3.500) and extreme kurtosis (12.881), indicating that while most tubers were smaller, a few had significantly higher weights. Treatment B (no fertilizer application) had a more balanced distribution (skewness = 0.550, kurtosis = -1.171), while Treatment C (muriate of potash + urea) displayed moderate skewness (1.949) and a sharper peak (kurtosis = 3.795). The histogram (Figure 2) further illustrates that most tubers, regardless of treatment, had lower weight values. Treatment A exhibited a more dispersed distribution, indicating greater variability in tuber weight. The findings suggest that applying *C. contaminans* fertilizer (Treatment A) did not significantly increase tuber weight compared to no fertilizer (Treatment B) or commercial fertilizer (Treatment C). While some tubers in Treatment A reached higher weights, the variability in weight distribution suggests inconsistent effects, possibly due to soil properties, environmental conditions, or genetic factors.



Figure 2. Boxplot and Histogram of Sweetpotato Tuber Weight Distribution Across Different Treatments

3.4 Comparison of Sweetpotato Tuber Circumference Across Three Treatments

The results in Table 4 show that not all treatments followed a normal distribution. Treatment A ($p = 0.382$) and Treatment C ($p = 0.211$) were normally distributed ($p > 0.05$), while Treatment B ($p = 0.006$) was non-normal. Because at least one group violated the assumption of normality, the non-parametric Kruskal-Wallis test was used instead of ANOVA.

Table 4. Comparison of Sweetpotato Tuber Circumference

Test	Descriptive Statistics and Normality Test		
	Treatment A	Treatment B	Treatment C
Excess Kurtosis	0.826	-0.017	-0.951
Skewness	0.880	-1.115	-0.079
Normality (p-value)	0.382 (normal)	0.0006 (Non-Normal)	0.211 (Normal)
Median	128.81	119.38	94.25
Sample Size (n)	15	15	15
Rank Sum (R)	335.500	242.000	242.500
R ² /n	7504.017	4,880.333	4,523.558
Kruskal-Wallis Test Results			
Test Statistic (H)	3.231		
p-value	0.199 ($p > 0.05$)		

decision rule: for normality - normal if $p > 0.05$; non-normal if $p < 0.05$
 for significance - significant if $p < 0.05$; not significant if $p > 0.05$;

The descriptive statistics reveal differences in the central tendency and distribution of tuber circumferences. Treatment A exhibited slight positive skewness (0.880) and moderate kurtosis (0.826), suggesting that while most tubers were near the median (128.81 cm), a few larger values extended the distribution. Treatment B showed strong negative skewness (-1.115) and near-zero kurtosis (-0.017), indicating a more compressed distribution with smaller tubers pulling it leftward. Treatment C had near-symmetry (skewness = -0.079) with slightly platykurtic values (-0.951), showing a relatively even spread of tuber sizes around the median (94.25 cm). The Kruskal-Wallis test statistic ($H = 3.231$, $p = 0.199$) indicated no significant differences among the three treatments ($p > 0.05$). This means that the type of fertilizer or treatment applied did not have a significant effect on tuber circumference. The overlapping medians and distribution patterns across treatments reinforce this conclusion. The confidence interval plot (Figure 3) confirmed that the mean circumferences of all treatments overlapped, reinforcing the ANOVA results that no significant differences exist among treatments. The F-distribution curve in Figure 3 visually demonstrates the acceptance and rejection regions, with the computed F-statistic (0.403) falling within the acceptance region, meaning that the null hypothesis (no significant difference) was retained.

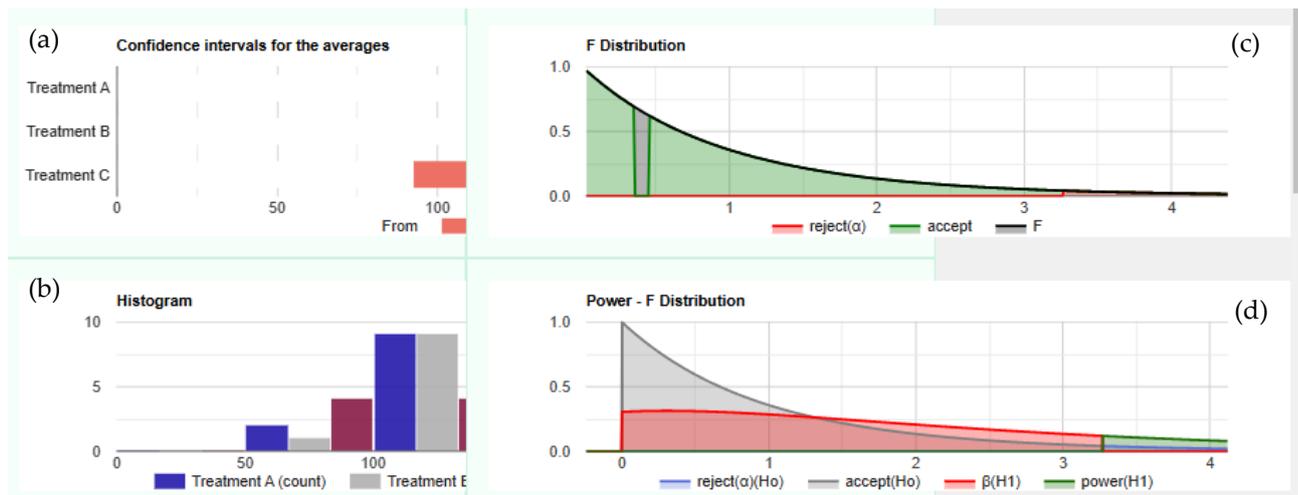


Figure 3. Statistical Distribution and Confidence Intervals for the ANOVA Test on Sweetpotato Tuber Circumference

The histogram illustrates the frequency of circumference measurements, displaying a relatively consistent distribution across treatments, with no extreme variations. The power analysis graph (Figure 1) illustrates the probability of detecting a real difference if one exists. The statistical power appears to be low, suggesting that a larger sample size may be needed for more precise differentiation among treatments. The results indicate that fertilizer type did not significantly affect tuber circumference. While Treatment A (*C. contaminans* fertilizer) produced slightly larger tubers on average, the differences were not substantial enough to be statistically significant. This suggests that environmental conditions, genetic factors, or nutrient absorption rates may have played a larger role in tuber growth than fertilizer application alone. The findings provide strong evidence that organic fertilizer derived from *Cyathea contaminans* leaves significantly enhanced sweetpotato tuber survival and reduced disease incidence compared to both the control (no fertilizer) and commercial fertilizer treatments. Chi-square test results confirmed significant differences in tuber survival and disease resistance among treatments, with Treatment A (*C. contaminans* fertilizer) showing the highest survival rate (11 ridges) and the lowest disease incidence (2 ridges). This aligns with previous research indicating that organic fertilizers rich in nitrogen, phosphorus, and potassium contribute to improved plant health and reduced disease susceptibility [17-18].

In contrast, the high disease incidence in Treatment C (muriate of potash + urea: 13 diseased ridges, 6 survived ridges) suggests that synthetic fertilizers may alter soil microbial activity, increasing plant vulnerability to diseases [19]. Studies indicate that while chemical fertilizers provide immediate nutrient availability, they may degrade soil quality over time, making crops more susceptible to pathogens. This could explain why tubers treated with *C. contaminans* fertilizer exhibited superior disease resistance, as organic fertilizers are associated with enhanced microbial diversity and improved nutrient cycling [19-24]. Despite these benefits, no statistically significant differences were observed in tuber weight and circumference across treatments. The Kruskal-Wallis test for weight and ANOVA for circumference confirmed that while Treatment A produced slightly heavier (0.240 kg) and larger (133.41 cm) tubers on average, the differences were not statistically significant ($p > 0.05$). This suggests that soil structure, environmental factors, and genetic variability may have had a greater influence on tuber growth than the type of fertilizer alone [25]. Further analysis of histogram and boxplot distributions revealed high variability in tuber weight within Treatment A, with skewness (3.500) and kurtosis (12.881) indicating that while some tubers were significantly larger, most were clustered around lower weight values. This aligns with Tadesco et al. [26], who suggested that organic fertilizers may not always increase yield but can enhance crop resilience and sustainability.

4. Conclusions

The findings provide strong evidence that organic fertilizer derived from *Cyathea contaminans* leaves significantly enhanced sweetpotato tuber survival and reduced disease incidence compared to both the control (no fertilizer) and commercial fertilizer treatments. Chi-square test results confirmed significant differences in tuber survival and disease resistance among treatments, with Treatment A (*C. contaminans* fertilizer) showing the highest survival rate (11 ridges) and the lowest disease incidence (2 ridges). This aligns with previous research indicating that organic fertilizers rich in nitrogen, phosphorus, and potassium contribute to improved plant health and reduced disease susceptibility [17-18]. In contrast, the high disease incidence in Treatment C (muriate of potash + urea: 13 diseased ridges, 6 survived ridges) suggests that synthetic fertilizers may alter soil microbial activity, increasing plant vulnerability to diseases [19]. According to studies, the use of chemical fertilizers may increase crop susceptibility to infections by degrading soil quality over time, even when they provide immediate nutrient availability. This could explain why tubers treated with *C. contaminans* fertilizer exhibited superior disease resistance, as organic fertilizers are linked to improved microbial diversity and nutrient cycling [19-24]. Despite these benefits, no statistically significant differences were observed in tuber weight and circumference across treatments. The Kruskal-Wallis test for weight and ANOVA for circumference confirmed that while Treatment A produced slightly heavier (0.240 kg) and larger (133.41 cm) tubers on average, the differences were not statistically significant ($p > 0.05$). This suggests that soil structure, environmental factors, and genetic variability may have had a greater influence on tuber growth than the type of fertilizer alone [25]. Further analysis of histogram and boxplot distributions revealed high variability in tuber weight within Treatment A, with skewness (3.500) and kurtosis (12.881) indicating that while some tubers were significantly larger, most were clustered around lower weight values. This aligns with Tadesco et al. [26], who suggested that organic fertilizers may not always increase yield but can enhance crop resilience and sustainability.

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