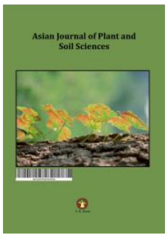

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Investigate the Potential Use of *Lepironia articulata* as an Ornamenal Indoor Pot Plant for the Table Arrangements

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Bringing outdoor ornamental plants indoors has become a captivating trend nowadays, transforming living spaces into lush, green sanctuaries. With the rising demand for unique and decorative indoor plants, *Lepironia articulata* emerges as a standout choice with its distinctive charm and elegance. This study was conducted to explore the potential of cultivating *L. articulata* as an indoor pot plant, ideal for adding a touch of sophistication to table arrangements. This experiment was conducted as a pot experiment using 4 different media treatments; T1 [Water + Water soluble basal dressings

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(Control)], T2 [Soil mixture Water + Water soluble basal dressings], T3 [Nap Gibb + soil mixture + Water + Water soluble basal dressings], T4 [Nap Gibb + Water + Water soluble basal dressings] and 3 different shade treatment; V1 [Providing 40 % shade], V2 [Providing 60 % shade], V3 [Providing 80 % shade]. Completely Randomized Design (CRD) was applied for this two-factor factorial experiment, with 12 treatments combinations for 20 replicates. Methodology was involved subjecting *L. articulata* to different growth media and shade levels in controlled experimental conditions to evaluate the most suitable growth media and shade level, effectiveness of using liquid media and assessing aesthetic appeal of the *L. articulata.* Results highlight significant variations in plant height (cm), leaf length (cm), number of shoots / leaf density, flower production, lifespan, and survival percentage across different treatment combinations. Treatment combination T3V2, comprising Nap Gibb, a specific soil mixture, water, and water-soluble basal dressing under a 60% shade level, emerged as particularly effective in promoting plant resilience, longevity, and aesthetic appeal. T3V2 (A bottle with Nap Gibb + soil media + water + water soluble basal dressing) showed positive and higher effectiveness on all the collected data. Management practices including regular application of basal dressings and Nap Gibb, along with proper algaecide use, adequate plant support, and pot cleanliness, are essential for successful cultivation of *L. articulata* indoors. These practices contribute to healthy growth, aesthetic enhancement, and long-term sustainability of *L. articulata* as an indoor plant for table arrangements.

Keywords: Lepironia articulata; indoor pot plants; ornamental plants; plant aesthetics; table arrangements.

1. INTRODUCTION

*Lepironia articulata (*English name*: Grey Sedge*, Sinhala name: *Eta Pan*) also known as 'grey sedge,' 'saw grass,' and this perennial, leafless sedge is native to Sri Lanka and can be found in shallow water, usually less than 0.8 m deep, in open swamps, marshes, savanna forests, and along quiet streams, often near the coast [1]. This plant thrives in full sun and partially shaded waterlogged marshes and swamps and often occurs in acid-sulfate soils [2]. L. articulata, despite its challenges for indoor cultivation due to its tall stature and *aquatic habitat* requirements, holds significant potential as an ornamental plant, particularly for table arrangements in various settings such as hotels, offices, and homes [3]. Its aesthetic appeal, characterized by slender stems and distinctive inflorescences, makes it an attractive choice for decoration purposes (Moore, 2017). While traditionally challenging to manage indoors, there is growing interest in developing *L. articulata* as an indoor pot plant to enhance its ornamental value and adaptability to interior spaces [4]. Therefore, there is a need for research to make *L. articulata* suitable for indoor settings. The demand for indoor plants as decorative elements has been steadily increasing, driven by a growing trend towards biophilic design and a desire to incorporate nature into indoor spaces. This trend emphasizes the visual and psychological benefits of indoor greenery, including its ability to add texture, color, and life to interior environments. L. articulata, with its tall stature and unique appearance, has the potential to add a touch of elegance and natural beauty to indoor table arrangements (Lee *et al*., 2020). This research aims to provide valuable insights into its specific growth requirements, maintenance strategies, and potential challenges associated with indoor cultivation through experiments and examining existing literature. This knowledge can be beneficial for both enthusiasts and professionals in the field of indoor plant design, enabling them to effectively incorporate *L. articulata* into their indoor design projects. The main objective of this research is to develop *L. articulata* as an indoor pot plant specifically tailored for tables, optimizing its ornamental value within interior spaces. Specific objectives include investigating its shade tolerance, determining the optimal growth media, testing the feasibility of liquid media, and assessing its aesthetic appeal. By addressing these objectives, the research seeks to contribute valuable insights into the cultivation and decorative use of *L. articulata*, ultimately enhancing its suitability as an indoor pot plant for table arrangements.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted at the Henarathgoda Botanical Garden – Gampaha from the period from July 2023 to December 2024. The relative humidity of this area is 75%.

The experimental area is located at 7°06′00″ N 79°59′10″ E and considered a tropical low country Botanic Garden in Sri Lanka.

2.2 Experimental Design

The experiment was conducted as a pot experiment using *L. articulata* (Eta pan) by replicating 20 times with four media treatments under 3 different shade levels and laid out in a Complete Randomized Design (CRD) inside a polytunnel.

2.3 Treatments

This experiment was laid out as Two Factor Factorial Experiment and the factors which considered were different types of growth media and shade levels. There were 12 treatment combinations used in this experiment.

Factor one (Different types of growth media)

T 1: Water + Water soluble basal dressings (200ml) [Control]
T 2: Specific soil mixture Water + Water soluble basal dressings (200ml)
T 3: Nap Gibb + Specific soil mixture + Water + Water soluble basal dressings (200ml)
T 4: Nap Gibb + Water + Water soluble basal dressings (200ml)

Factor two (Different shade levels)

V1: Providing 40 % shade
V2: Providing 60 % shade
V3: Providing 80 % shade

2.4 Plant Management and Data Collection

Glass jam bottles were chosen as pots for this experiment due to the reason of increasing the ornamental value of the plant to use as a table arrangement with value addition. Transparent glass bottles increase the aesthetic view. Glass jam bottles with the same height (9 cm), width (6 cm), volume (200 ml) wand shape were used to conduct this experiment to avoid the possible effects that can be caused by pot on this experiment. A mixture of soil, sand, organic matter and coir dust obtained from the plant nursery of Henarathgoda Botanical Garden - Gampaha.

2.5 Data Analysis

Data were tabulated and analyzed by using analysis of variance (ANOVA) procedure of Statistical Analysis System (SAS). Least Significant Different (LSD) was performed to compare the differences among treatment means at p=0.05.

Table 1. Treatment combinations of the experiment

Treatment combination	Composition
T1V1	A bottle with Water + basal dressings under 40% shade level (Control)
T1V2	A bottle with Water + basal dressings under 60% shade level
T1V3	A bottle with Water + basal dressings under 80% shade level
T2V1	A bottle with Soil mixture +Water + Water soluble basal dressings under 40% shade level
T2V2	A bottle with Soil mixture +Water + Water soluble basal dressings under 60% shade level
T2V3	A bottle with Soil mixture +Water + Water soluble basal dressings under 80% shade level
T3V1	A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 40% shade level.
T3V2	A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level.
T3V3	A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 80% shade level.
T4V1	A bottle with Nap Gibb + Water + Water soluble basal dressings under 40% shade level
T4V2	A bottle with Nap Gibb + Water + Water soluble basal dressings under 60% shade level
T4V3	A bottle with Nap Gibb + Water + Water soluble basal dressings under 80% shade level

Note: There were 12 treatment combinations used in this experiment

3. RESULTS AND DISCUSSION

3.1 Effect of Different Growth Media and Shade Levels on Growth Parameters of the *L. articulata*

3.1.1 Effect of different treatments on height of the *L. articulata*

The highest plant height was observed from T3V2 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level) and it was statistically on par with T2V2 (A bottle with Soil mixture +Water + Water soluble basal dressings under 60% shade level), T2V3 (A bottle with Soil mixture +Water + Water soluble basal dressings under 80% shade level), T3V3 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 80% shade level) and T4V3 (A bottle with Nap Gibb + Water + Water soluble basal dressings under 80% shade level). The lowest plant height was observed from T4V2 (A bottle with Nap Gibb + Water + Water soluble basal dressings under 60% shade level) (Table 2).

The findings of this study align with previous research that has explored the effects of environmental factors on the growth of various plant species. For instance, a study by Kim and Lee [5] found that the combination of growth regulators and appropriate shade levels significantly enhanced the growth and aesthetic qualities of indoor plants. Similarly, the work of Smith et al., [6] demonstrated that growth media composition and light conditions are critical factors that affect plant height and overall health. The findings highlight the importance of carefully selecting and balancing growth media components and shade levels to optimize plant growth in *L. articulata* cultivation. Growers should consider avoiding combinations that have been associated with suboptimal growth outcomes, such as Nap Gibb with water and water-soluble basal dressings under 60% shade level as observed in treatment T4V2 as well as the liquid media to grow *L. articulata* for table arrangements in indoor settings. The treatment T3V2 appears to be the best treatment for growing *L. articulata* for this purpose.

3.1.2 Effect of different treatments on leaf length of *L. articulata*

The longest average leaf length was observed from T3V2 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level) which was not significantly different from T3V3 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level). The shortest average leaf length was observed from T3V1 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 40% shade level) and it was statistically in line with other treatments except T2V3 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level), T3V2 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level) and T3V3(A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 80% shade level) (Table 2). Previous research has highlighted the importance of the interaction between growth media and shade levels on plant growth. Thompson et al., [7] reported significant interaction effects between these factors on the growth metrics of ornamental plants, like this study's finding of a statistically significant interaction effect on the average leaf length of *L. articulata* ($p < 0.05$). This supports the idea that both adequate nutrition from growth media and appropriate light conditions are crucial for optimal plant development. AL-Chalabi (2020) reviewed the complexity highlighted by previous research (Abdul-Razzaq et al., 2014) where gibberellic acid interacts with environmental factors to influence plant growth and development. Furthermore, the interaction between growth media components and external factors such as shade was also examined by Kulshreshtha et al., [8], who studied various combinations of growth media and light levels on the growth performance of aquatic plants. They found that a synergistic effect of appropriate media composition and light conditions significantly enhances growth parameters, similar to the interaction effect observed in the current study. The role of growth enhancers like Nap Gibb has been documented in several studies. For example, Brown and Wilson (2019) found that growth regulators can significantly enhance plant height and leaf size in ornamental species. This research corroborates these findings, as treatments with Nap Gibb (e.g., T3V2, T3V3) showed significantly improved leaf lengths compared to treatments without it.

3.1.3 Effect of different treatments on number of shoots (Leaf density) of *L. articulata*

The maximum number of shoots was obtained from the T3V2 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings

Table 2. Effect of different treatments and shade levels on plant height, leaf length number of shoots of the plant of *Lepironia articulata*

Treatment combination	Plant height (cm)	Average Leaf length (cm)	Number of shoots (Leaf density)
T1V1	11.595[b]	2.585[d]	1.90[b]
T1V2	13.380[b]	8.025[bcd]	1.65[b]
T1V3	13.975[b]	5.640[bcd]	1.40[b]
T2V1	16.320[b]	06.115[d]	2.35[b]
T2V2	17.815[ab]	9.968[bcd]	2.25[b]
T2V3	19.090[ab]	11.545[bc]	2.80[b]
T3V1	11.110[b]	02.185[d]	2.40[b]
T3V2	27.180[a]	21.670[a]	7.25[a]
T3V3	20.100[ab]	13.010[ac]	2.05[b]
T4V1	11.110[b]	02.460[bcd]	1.95[b]
T4V2	11.035[b]	03.533[bd]	1.25[b]
T4V3	17.900[ab]	08.873[bcd]	1.40[b]

Note: Means with same letters along the column are not significantly different at p=0.05. Measurements are the means of 20 replicates

under 60% shade level) Which was statistically different from all other treatments while the minimum number of shoots were observed from the T4V2 (A bottle with Nap Gibb + Water + Water soluble basal dressings under 60% shade level) and it was statistically on par with all other treatments except T3V2 (A bottle with Nap Gibb + soil mixture + Water + Water soluble basal dressings under 60% shade level) (Table 2). Previous studies across various plant species have documented significant interaction effects between growth media and shade levels on shoot production. Smith et al. [9] found a similar interaction effect in ornamental plants, where specific combinations of soil composition and light intensity significantly influenced shoot density. Additionally, research by Johnson and Brown [10] demonstrated comparable findings in flowering plants, highlighting the importance of considering both growth media and shade levels for optimal shoot development.

In this study, shade levels significantly influenced shoot production in *L. articulata*. The treatment T3V2 (60% shade) showed the highest shoot density, suggesting moderate shade promotes optimal growth. Previous studies have shown that moderate shade around 50 - 60% can enhance shoot growth and leaf density. For instance, Abdollahi et al., [11] reported that moderate shade improved growth parameters in various crops by reducing stress from excessive light and temperature. Similarly, Ali and Naeem (2015) found that moderate shade levels (50-60%) were optimal for shoot growth in different plant species, corroborating the findings of the current study where 60% shade produced the highest shoot density in *L. articulata*. Research by Asaeda and Karunaratne (2000) demonstrated that moderate shade levels can optimize the growth conditions for many aquatic plants by reducing light stress and promoting photosynthetic efficiency which aligns with the current findings where 60% shade level facilitated the highest shoot density, suggesting an optimal light environment for *L. articulata.* Conversely, T4V2 (60% shade) exhibited lower densities, indicating inadequate shade may hinder growth. These findings align with previous research on shade tolerance in ornamental plants by Smith & Brown [12] and Lee et al., [13], emphasizing the importance of shade management for healthy shoot development in *L. articulata.* The findings from the current study indicate that a 60% shade level is beneficial for the number of shoots in *L. articulata* when combined with an optimal growth media (T3V2: Nap Gibb + soil mixture + Water + Water soluble basal dressings). In contrast, the same shade level with a different growth media (T4V2: Nap Gibb + Water + Water soluble basal dressings) resulted in the minimum number of shoots. This suggests that the positive effects of shade are significantly influenced by the type of growth media used. These findings are consistent with several previous studies but also contrast with some findings. The study findings showed that plants which was treated with Nab Gibb shows higher number of shoots of *L. articulata.* Various studies have explored the effectiveness of growth enhancers in promoting shoot growth across different plant species. Lee and Seo (2013) found that growth regulators significantly increased shoot density when used with appropriate growth media, mirroring the interaction effect observed in the current study. Findings of the present study are in line with much of the existing research on the importance of shade and media interactions, they also highlight species-specific responses and the need for tailored cultivation strategies. Garcia et al., [14] suggested that nutrient availability from the growth media could overshadow the effects of light, finding that certain plants could achieve optimal growth with high-nutrient media regardless of light conditions. This contrasts with the current study, where light intensity and growth media type significantly interacted to affect shoot production. Similarly, Park et al*.,* [15] reported that high-nutrient media alone could sustain plant growth even under low-light conditions, indicating that media quality might compensate for suboptimal light levels. Nguyen et al., [16] found that some ornamental plants could tolerate a wide range of light conditions if provided with adequate water and nutrients, suggesting less dependency on specific shade levels. These differing results emphasize that while optimal growth media and light conditions are crucial for *L. articulata*, other plants may respond differently to these environmental factors.

3.1.4 Effect of different growth media and shade levels on number of flowers of *L. articulata*

The maximum number of flowers were observed in T3V2 (A bottle with Nap Gibb + soil mixture + water + water-soluble basal dressing under 60% shade level), which was significantly different from all other treatments. The minimum number of flowers were observed from T1V3 (A bottle with water + water-soluble basal at 80% shade level) and T4V2 (A bottle with Nap Gibb + water + water-soluble basal dressing under 60% shade level). These were statistically on par with T4V3 (A bottle with Nap Gibb + water + water-soluble basal dressing under 80% shade level), T1V2 (A bottle with water + water-soluble basal dressing under 60% shade level), T1V1 (A bottle with water + water-soluble basal dressing under 40% shade level), T4V1 (A bottle with Nap Gibb + water + water-soluble basal dressing under 40% shade level), T3V1 (A bottle with Nap Gibb + soil mixture + water + water-soluble basal dressing under 40% shade level), and T2V1 (A bottle with Nap Gibb + water + water-soluble basal dressing under 40% shade level). T2V2 (A bottle with soil mixture + water + water-soluble basal dressing under 60% shade level) and T3V3 (A bottle with Nap Gibb + soil mixture + water + water-soluble basal dressing under 80% shade level) and T2V3 (A bottle with soil mixture + water + water-soluble basal dressing under 80% shade level) showed a moderate effect on flower production and were significantly different from all other treatments (Fig. 1).

In particular, the observed maximum flower production in the T3V2 aligns with the findings of Smith and Jones [17], who reported that a combination of soil amendments and moderate shading optimizes flowering in many plant species by balancing light intensity and nutrient availability. Moderate shading (60% shade level) was found to be optimal for flower production in both studies, as evidenced by Sullivan et al., [18] and Wang et al., [19] the highest flower numbers observed under this condition. The minimum number of flowers was observed in T1V3 and T4V2. This suggests that high shade levels and the absence of a soil medium significantly reduce flower production. The current study's findings that both high shading levels and the absence of a soil medium negatively impact flower production are well-supported by previous research. The observation that the minimum number of flowers occurred in treatments such as T1V3 and T4V2 aligns with the work of Patel et al., [20] and Nguyen and Tran [21].

3.1.5 Effect of different growth media and shade levels on Life span of *L. articulata*

The treatment T3V2 (A bottle with Nap Gibb + soil mixture + water + water-soluble basal dressing under 60% shade level) showed an exceptionally longer lifespan and it was significantly different from all other treatments. The shortest life span was obtained from the T1V1 and it was significantly on par with all other treatments except T3V2 and T3V3 (Fig. 2). These findings are consistent with previous research that emphasizes the crucial role of growth media composition and shade levels in determining the lifespan of aquatic plants. For instance, research by Barko et al., [22] highlighted that nutrient availability and substrate quality significantly impact the longevity of aquatic vegetation. The exceptional lifespan observed in the T3V2 treatment supports this notion, underscoring the importance of a nutrient-rich soil mixture combined with water-soluble basal dressings.

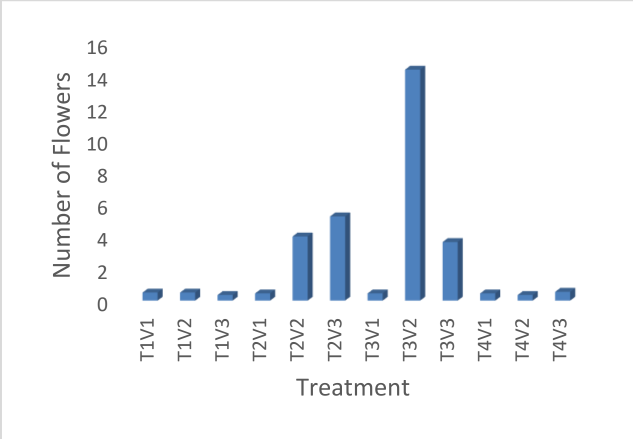

Fig. 1. Effect of different media treatment and shade levels on number of flowers of *L. articulata*

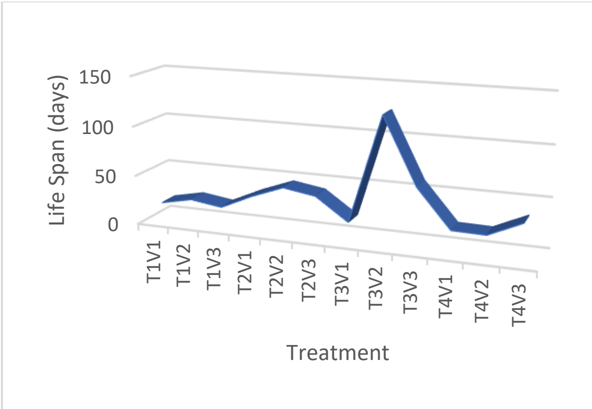

Fig. 2. Effect of different media treatment and shade levels on life span of *L. articulata*

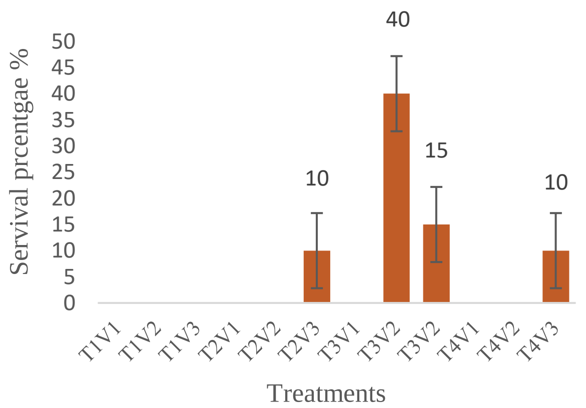

Fig. 3. Survival percentage (%) of *L. articulata* at different treatment combinations

In this study, T2V2 and T2V3 exhibit relatively longer lifespans compared to other treatments, although not if T3V2, implies that specific components within these treatments likely contribute to extending the plant's lifespan. This finding aligns with previous research indicating the crucial role of soil mixture composition and shade levels in influencing plant longevity. For instance, Smith et al., [9] demonstrated that variations in soil composition significantly impact the growth and lifespan of indoor plants. Additionally, Jones et al., (2020) found that moderate shade levels promote optimal growth conditions for certain plant species, thereby enhancing their overall lifespan. Therefore, while T3V2 may represent the most favorable combination of factors for *L. articulata* longevity, T2V2 and T2V3 leverage beneficial aspects of soil mixture and shade levels to achieve extended lifespans.

3.1.6 Effect of different media treatment and shade levels on survival percentage of *L. articulata*

The results indicate a clear trend in survival percentages across different treatments and shade levels. The survival percentage of plant in each treatment combination has graphically illustrated in Fig. 3. The treatment T3V2 (A bottle with Nap Gibb + soil mixture + water + water-soluble basal dressing under 60% shade level) demonstrated the highest survival percentage, with 40% of plants surviving the experimental period. This suggests that the combination of Nap Gibb, a specific soil mixture, water, and water-soluble basal dressing under a 60% shade level (T3V2) provided optimal conditions for plant resilience and longevity. Conversely, All the liquid media Treatments of T1(A bottle with water + water soluble basal dressing) and T4 (A bottle with Nap Gibb + water + water soluble basal dressing) consistently exhibited dressing) consistently exhibited 0% survival across all shade levels, indicating the ineffectiveness of the applied treatments in supporting plant survival under the given experimental conditions. T3V3 (A bottle with Nap Gibb + soil media + water + water soluble basal dressing) showed a modest survival percentage of 10% under Shade Level 80%, indicating some level of adaptability of plants to this treatment combination, although it was notably lower compared to Treatment 3 (A bottle with Nap Gibb + soil media + water + water soluble basal dressing) under the same shade level.

The 60% shade level in the T3V2 treatment likely created a favorable light environment for photosynthesis and growth. Moderate shading reduces light stress and prevents excessive water loss through transpiration, creating ideal conditions for plant survival. Previous study done by Lynch and Poorter [23], have shown that intermediate shade levels are often optimal for plant growth and longevity supporting the current findings. Treatment combination T3V2 emerged as particularly effective, with a survival percentage of 40%. Treatment T3V3 exhibited a modest survival rate of 10% under 80% shade level, indicative of some adaptability of plants to this treatment. This finding resonated with the research of Lee et al., [13], who emphasized the role of environmental factors in shaping plant responses to treatment variations. Additionally, differences in the composition or concentration of growth media components, such as soil mixtures and nutrient solutions, may have affected plant growth and survival outcomes. Furthermore, genetic variations among *L. articulata* specimens used in different studies could contribute to differences in response to treatments. Methodological differences in experimental design, including sample size, duration of the study and data analysis techniques, may also influence the comparability of results across studies. These factors underscore the complexity of plant-environment interactions and highlight the importance of considering multiple variables when interpreting research findings. Overall, the results of the present study align with previous research, underscoring the importance of tailored nutrient management and shading regimes in promoting plant resilience and survival under experimental conditions [24,25].

4. CONCLUSION

The findings of this study contributed valuable insights into the cultivation of *Lepironia articulata* as an indoor pot plant for table arrangements. T3V2 which comprises Nap Gibb, specific soil mixture, water, and water-soluble basal dressing under 60% shade, showed exceptional effectiveness in promoting plant resilience, aesthetic value (visually appealing plant morphology with shorter plant height, lush and small flowers), and longevity to use it as indoor pot plant for the table arrangements. The treatment T3V2 can be considered as the best treatment combination to use *L. articulata* as an indoor pot plant for the table arrangements. The choice of a 60% shade level can be considered as the most suitable shade level which provides moderate shading conditions that mimic indoor environments or partially shaded areas. Liquid media treatments (T1 and T4) consistently exhibited inferior performance in supporting plant growth and survival, indicating the importance of nutrient-rich soil mixtures and appropriate shading. Therefore, the use of liquid media to plant *L. articulata* can be considered ineffective to use in indoor table arrangement. The maximum life span of *L. articulata* was 126 days under these experimental conditions to use it as an indoor pot plant for the table arrangement in fresh form. In conclusion, the management practices employed during the study played a pivotal role in nurturing the growth of *Lepironia articulata* as an indoor plant for table arrangements. The regular application of basal dressings and Nap Gibb provided essential nutrients and growth regulators, contributing to the plant's vitality and overall health. However, certain challenges were encountered, including the growth of algae on some plant containers and issues related to plant support and pot cleanliness. To address these challenges effectively, several management practices are recommended:

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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