Understanding Dendrobium Sampran's Growth Responses to Different Photoselective Shading Techniques

Pearl Princess Mae A. Abaya, Erna Lynn T. Dungo, and Nanette D. Santos*

School of Chemical, Biological and Materials Engineering and Sciences, Mapua University, Manila, Philippines
Email: ndsantos@mapua.edu.ph (N.D.S.); ppmaabaya@mymail.mapua.edu.ph (P.P.M.A.A.); eltdungo@mymail.mapua.edu.ph (E.L.T.D.)
*Corresponding author

***Abstract*—Dendrobium Sampran, a vibrant orchid hybrid, holds immense economic significance in Southeast Asia's floriculture industry. This study investigates the effects of photoselective shade netting on the growth of this prized species, focusing on the critical roles of temperature and humidity. This study reveals that set-ups 2B and 3B, 50% and 75% green net, significantly enhance growth metrics such as plant height, number of leaves, and flower production. Specifically, set-up 3B achieved an impressive F-value of 283.65 for humidity, underscoring its critical role in promoting vertical growth. In contrast, set-up 2B consistently yielded high flower counts and leaf development. The Analysis of Variance (ANOVA) results highlighted the negligible impact of temperature on growth, emphasizing that humidity is the driving force behind the successful cultivation of these orchids. By implementing these optimal set-ups, growers can enhance the health and productivity of Dendrobium Sampran, ensuring a thriving yield that meets the demands of the floriculture market. By implementing the identified optimal set-ups, growers can unlock the full potential of Dendrobium Sampran, driving economic growth and environmental stewardship in the floriculture sector.**

***Keywords*—analysis of variance, Dendrobium Sampran, floriculture, optimal set-up, photoselective shade netting**

I. Introduction

Within the broader Dendrobium genus, Dendrobium Sampran is a hybrid orchid with bright blooms and strong growth qualities. It is well-known for its capacity to adapt to varied growth situations and produce yearly blossoms. Dendrobium orchids are prized for their aesthetic appeal and ease of care in professional and amateur gardens. The Dendrobium genus is noted for its wide range of blossom color, shape, and size, making it a popular decorative plant. Dendrobium orchids, particularly hybrids such as Sampran, are economically valuable due to their great demand in the worldwide floriculture industry. Dendrobium Sampran is an integral part of the agricultural economy in Southeast Asia, with Thailand being one of the world's largest orchid exporters [1].

The growth of orchids, such as Dendrobium Sampran, is heavily influenced by several vital variables specific to their growing environment. The development and flowering of these plants are influenced by temperature, making it a critical component. Since excessive temperatures can cause stunted growth, limited blooming, or even plant death, dendrobiums thrive best in warm areas with daytime highs of 25 to 30 degrees Celsius and nighttime lows of 18 to 22 degrees Celsius. Being epiphytes that depend on atmospheric moisture, orchids require high humidity to remain healthy. A typical 50% to 70% range is ideal humidity for Dendrobium orchids [2]. Prolonged exposure to high humidity levels can lead to bacterial and fungal infections and dehydration.

Additionally, Dendrobium Sampran thrives in bright, indirect light; too much direct sunshine will scorch leaves and stress them, while insufficient light can result in poor growth and poor blooming. The pace at which photosynthesis occurs and the plant's capacity to generate new growth and blooms are directly impacted by the amount and quality of light available [3]. By controlling the quantity of light that reaches the plants, shade netting helps to ensure that they get the ideal amount of light for robust and healthy development. Using photoselective shade nets, plants can function better by enhancing particular wavelengths that encourage blooming and vegetative development. By slowing the pace of evaporation, shade nets also aid in maintaining the steady humidity levels that orchids require to surround the plants [4].

Since most previous studies have been on other Dendrobium or orchid genera, there is an apparent vacuum in the body of knowledge on studies that focus on Dendrobium Sampran. While most research has looked at broad growth circumstances, it does not detail the particular requirements or how Dendrobium Sampran reacts to different environmental elements. Studies on

Manuscript received June 27, 2025; accepted July 17, 2025; published September 23, 2025.

doi: 10.18178/joaat.12.1.7-14

different crops or decorative plants have been done; however, photoselective shadow netting has been acknowledged as a valuable technique for improving plant development by altering the light spectrum [5]. To assist growers in establishing the ideal circumstances for Dendrobium Sampran, researchers must understand how various kinds of shadow netting affect the orchid's growth. To improve growth and bloom quality, they might modify their growing techniques.

The purpose of this study is to forecast how various types of photoselective shade netting would affect Dendrobium Sampran development, with a particular emphasis on how temperature and humidity affect orchid growth. The study will examine how the orchid develops morphologically, determining the ideal humidity and temperature ranges to maximize growth characteristics such as plant height and the quantity of leaves, flowers, and buds. To determine which nets result in statistically significant changes in growth characteristics, the study will compare growth results under various netting settings using Analysis of Variance (ANOVA) as a means of data interpretation. Essential elements that lead to effective orchid production in various shade netting set-up will be identified with the aid of this study.

This study aims to promote sustainable orchid farming techniques to contribute to Sustainable Development Goal (SDG) 12. It focuses on improving photoselective shade nets to enhance plant health and productivity with fewer inputs, minimizing waste and increasing resource efficiency. It also tackles climatic variability issues in orchid farming by determining how temperature and humidity impact development. This aids in developing methods to improve orchid cultivation's resilience to climate-related stresses, contributing to Sustainable Development Goal, SDG, 13. The study also contributes to SDG 15 on biodiversity conservation by supporting the protection and sustainable use of plant species like Dendrobium Sampran. It promotes behaviors that benefit the health and proliferation of orchid species, critical components of many ecosystems.

II. Methodology

1) *Sample population*

All of the seedlings of Dendrobium Sampran are bought from one store. The garden shade net also came from one store on Metro Manila premises. Twenty-one seedlings of Dendrobium Samprann and three black and green nets are bought.

A. *Research Design*

The study is conducted in a garden at an elementary school on the corner of Abad Santos and Recto Avenue. By limiting the amount of light received and influencing other environmental components like air and soil temperature, humidity, air velocity, and ventilation rate, screens and nets employed as shading devices can regulate how quickly a plant develops. Thus, using an artificial neural network, the effects of black and green shade nets on Dendrobium Sampran and the shade percentage they provide were determined. Subjects will be assigned to various treatments in this study using a Completely Randomized Design. As shown in Fig. 1 the study will have seven set-ups, including one control group and six sample groups. The control group is the Dendrobium Sampran without garden shade nets above the set-up. There are three replicates of orchids for each set-up, in which the study lasted for three months. The data on the following variables that may affect the set-up are collected every 4 hours: temperature, humidity, and light intensity. The components of orchids that are measured every day are the number of flowers and buds, the height of the plant, and the number of leaves. Analysis of Variance (ANOVA) is used to analyze the correlation between the growth of orchids and photoselective shade nets after three months of collecting data.

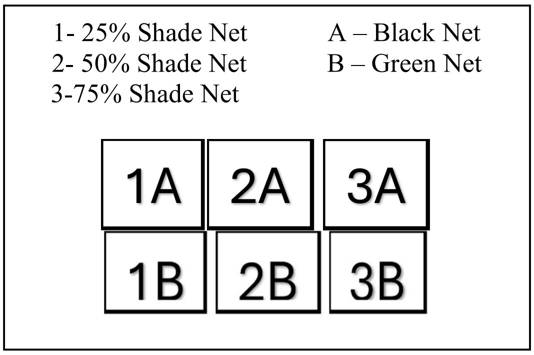

Fig. 1. Research design of testing of Dendrobium Sampran.

2) *Sample preparation*

There are seven set-ups with different net colors and shade percentages. The first three set-ups use a black net, but with varying shade percentages, there are 25%, 50%, and 75% shade net percent. The other three set-ups use green nets with the exact shade percentages. The last set-up is the control variable, with the orchid without the shade nets. Each set-up consisted of three replicates of the orchid to ensure a reliable and accurate result. The plants are planted in a black orchid pot with coconut husk for orchids as its field soil and irrigated using overhead misting.

B. *Statistical Analysis of Data*

The study employs an Analysis of Variance (ANOVA) using Minitab to investigate the growth rates of Dendrobium Sampran orchids under varying environmental conditions. The primary objective is to assess the effects of different photoselective shade netting treatments on multiple growth parameters, including the number of buds, flowers, leaves, and plant height. Data were collected over three months, with temperature and humidity measured as input variables. Each treatment was replicated three times to ensure statistical validity.

The ANOVA methodology allows for the simultaneous examination of these dependent variables, providing a comprehensive understanding of how the different shading conditions influence orchid growth. In Minitab, the collected data were organized and analyzed to determine the significance of the effects of shade netting on the growth metrics. The analysis involved checking the assumptions of normality and homogeneity of variance, followed by applying the ANOVA test to evaluate the overall impact of the treatments [6]. The results from this analysis will elucidate which environmental conditions are most conducive to the growth of Dendrobium Sampran, thereby informing best practices for orchid cultivation and contributing to the revitalization of the orchid industry.

The correlations between Dendrobium Sampran growth characteristics and critical environmental factors—specifically, temperature and humidity—were investigated in this study using the Generalized Linear Model (GLM) inside the Analysis of Variance (ANOVA) framework. Since the GLM technique can simulate the link between several independent factors and the dependent variables—in this example, the orchid's development characteristics—it was selected due to its versatility in handling a variety of data distributions [7, 8].

Dendrobium Sampran plant height, flower and bud count, and leaf count were the dependent variables. Using temperature and humidity as independent factors and growth characteristics as dependent variables, the GLM was used to evaluate the effects of each growth characteristic on temperature and humidity [9].

An ANOVA was performed within the Generalized Linear Model to determine the statistical significance of the correlations between the independent factors (temperature and humidity) and the dependent variables (growth characteristics). The F-test was employed to determine if the variance inside the error term was considerably smaller than the variance explained by the model. The significance level was established at a *p*-value threshold of 0.05, signifying a high probability that the observed correlation between an environmental factor and a growth characteristic was not the result of chance [7, 10].

An analysis of the primary impacts of these environmental variables on each growth parameter may gain an understanding of how temperature and humidity affect orchid growth. The interaction effects were also examined to learn how these elements influence the development features.

III. Results and Discussion

A. Growth Rate under Different Shade Nets

The growth rate of Dendrobium Sampran orchids was analyzed using a graph created in Excel that plotted the number of buds, flowers, leaves, and plant height against the date over the 3-month study period. This raw data graph visually represents how the different growth metrics changed over time under the various shade netting treatments. The graph revealed clear trends in the growth trajectories of the orchids, with some set-ups exhibiting faster growth rates and higher yields of buds, flowers, and leaves than others.

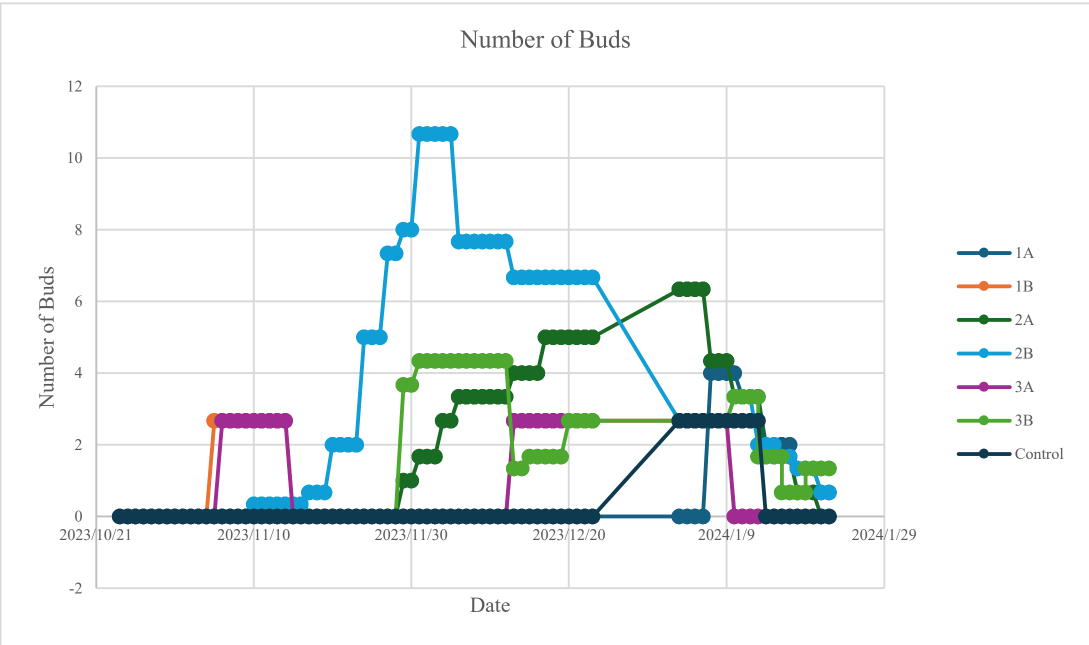

Fig. 2. Number of buds for 3 months.

The graph of the number of buds over time showcases the varying responses of Dendrobium Sampran orchids to the different shade netting configurations. Fig. 2 shows set-up 2B demonstrates a substantial increase in buds, followed closely by set-up 3B. However, both set-ups exhibited buds decline during the last two weeks of the observation period. This trend indicates a potential limitation in sustaining bud development as the experiment progresses, warranting further investigation into the factors influencing this decline.

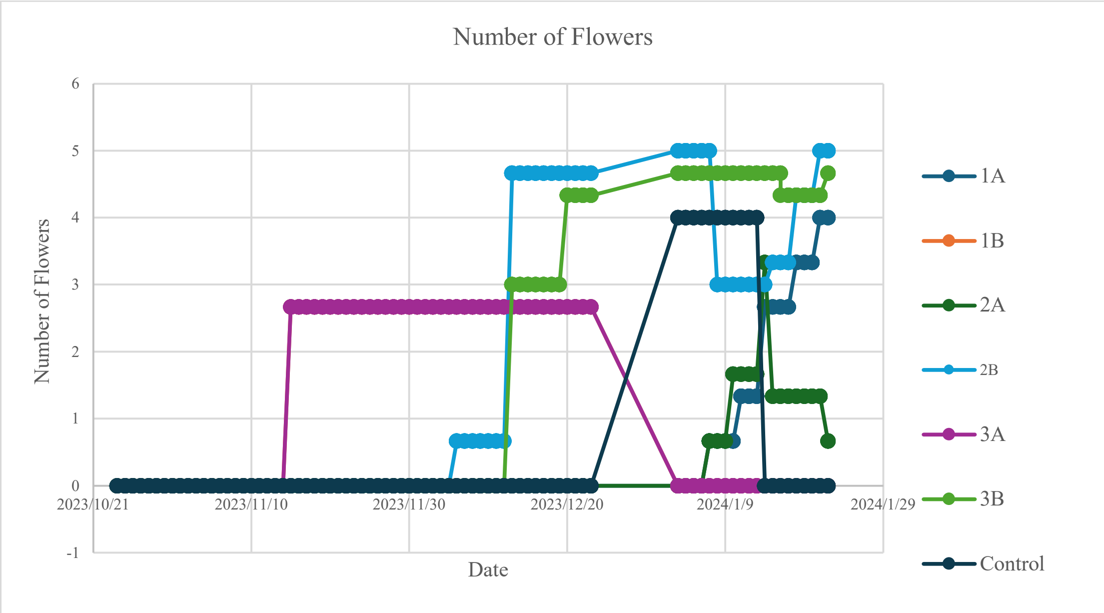

Fig. 3. Number of flowers for 3 months.

The number of flowers produced by the orchids is a crucial indicator of their overall health and reproductive success. Fig. 3 reveals that set-ups 2B and 3B consistently outperform the other configurations, with a steady increase in flower counts over the three months. Similar to the bud data, there is also a decline or stabilization in the number of flowers during the last two weeks. This pattern is consistent with the findings for the number of buds. The control group, while showing a significant increase in flower production during the middle of the experiment, ultimately faces a decline due to insect infestations that hinder its ability to maintain flower counts.

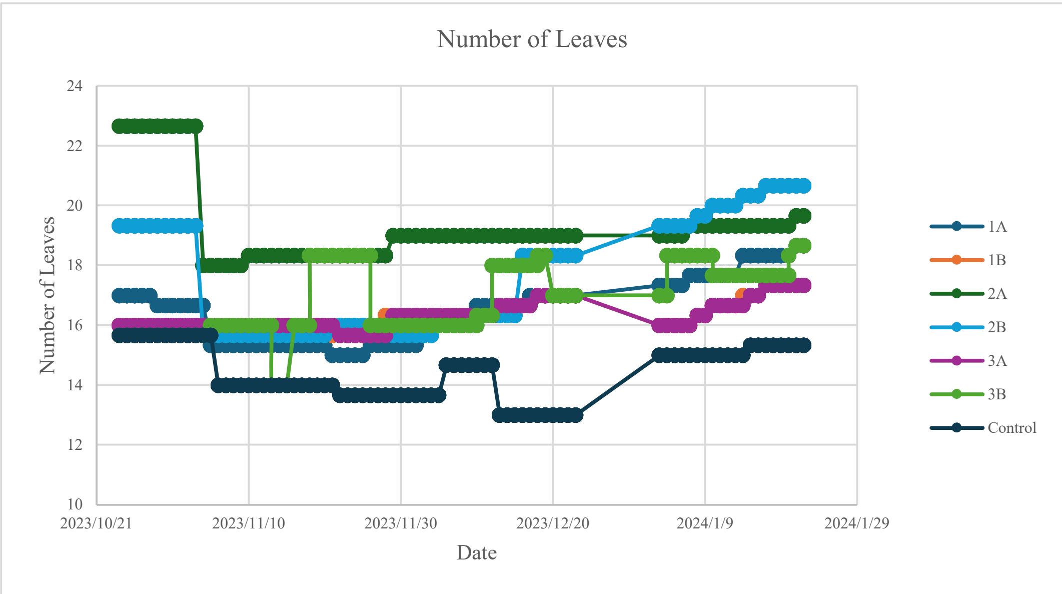

Fig. 4. Number of leaves for 3 months.

Leaf growth is essential for photosynthesis and overall plant vigor. Fig. 4 indicates that set-up 2B maintains the highest leaf count throughout the experiment, exhibiting a constant value. Set-up 3B shows a steady average increase in leaf number. In contrast, the control group demonstrates a more gradual increase, with some periods of decline. This highlights the benefits of shade netting in enhancing leaf growth, suggesting that the controlled environments provided by the nets contribute positively to leaf production.

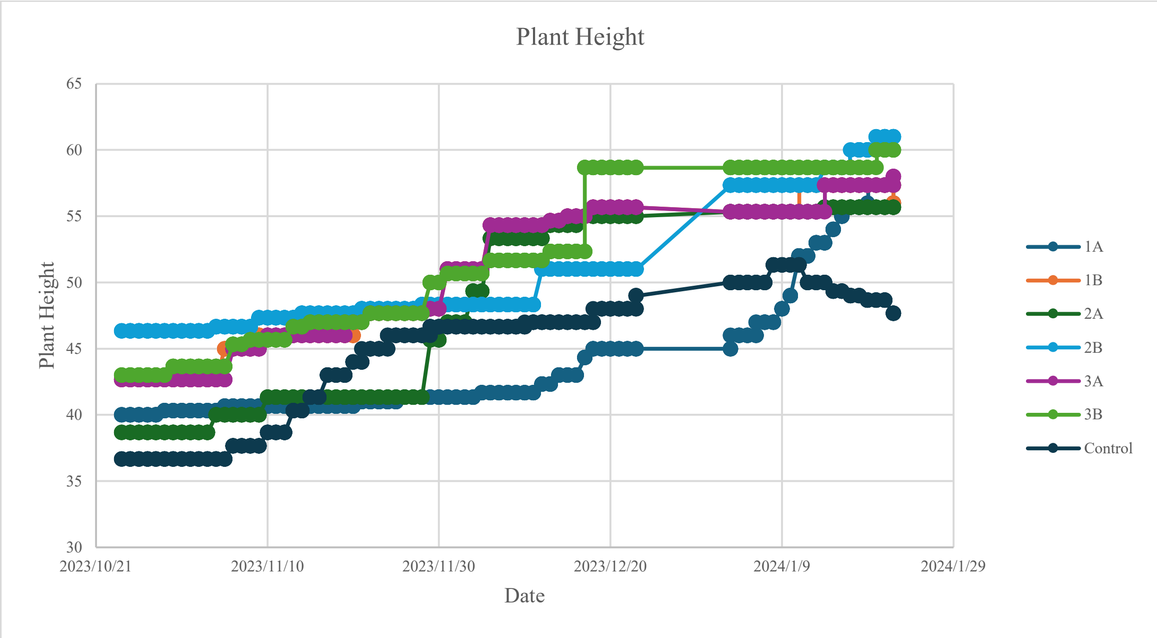

Fig. 5. Plant height for 3 months.

Plant height is a reliable indicator of overall growth. Fig. 5 reveals that set-ups 2B and 3B consistently outperform the other configurations, exhibiting a pronounced increase over time. The control group shows a rapid initial height increase but experiences a slowdown as the experiment progresses. This emphasizes the importance of optimizing environmental conditions for enhanced vertical growth, as the control group's inability to sustain growth rates may be linked to the lack of shade netting.

The graphs depicting the raw data clearly represent how Dendrobium Sampran orchids respond to various shade netting configurations. The outstanding performance of set-ups 2B and 3B across all growth parameters—number of buds, flowers, leaves, and plant height—suggests that these environments are ideal for orchid cultivation. In contrast, the control group, which lacked shade netting, underscores the advantages of shade nets in enhancing overall plant growth and development.

B. Analysis of Variance (ANOVA) Result

1) Bud growth vs temperature and humidity

According to Table I, the F-values for humidity varied significantly across different set-ups, with higher values indicating a more substantial effect on bud growth in specific set-ups. Temperature had low F-values, suggesting that temperature did not significantly affect bud growth.

TABLE I. BUD GROWTH

ANOVA Test	Variable	Control	1A	2A	3A	1B	2B	3B
F-value	%RH	0.01	10.26	7.02	22.13	29.25	83.03	11.32
	T(˚C)	1.08	0.90	0.86	0.80	1.33	0.76	0.94
P-value	%RH	0.905	0.001	0.008	0.000	0.000	0.000	0.001
	T(˚C)	0.299	0.742	0.795	0.902	0.030	0.948	0.627

The P-values for humidity were significant ($p < 0.05$) in most netted set-ups, with shallow values in all set-ups. The control set-up had a negligible effect, suggesting that netting plays a crucial role in modulating the impact of humidity on bud growth. Temperature had all P-values above 0.05 in most set-ups, except for set-up 1B ($p = 0.030$), indicating that temperature generally does not significantly affect bud growth. The lack of significance for temperature in most set-ups reinforces the conclusion that temperature is not a critical factor influencing bud growth in this study, except for a slight effect observed in set-up 1B.

Humidity significantly influenced bud growth in all netted set-ups, with high F-values and low P-values. The negligible effect of humidity in the control set-up suggests that netting is essential for humidity to exert its influence on bud growth. Temperature did not significantly affect bud growth across most set-ups, with F-values consistently low and P-values well above the significance threshold. The results suggest that controlling humidity, particularly in environments with netting, is crucial for optimizing bud growth in Dendrobium Sampran orchids. Temperature, on the other hand, can be considered less critical under the conditions tested.

2) Flower growth vs temperature and humidity

Based on Table II, the results show that humidity plays a significant role in promoting flower growth, particularly in set-ups 2B and 3B, where it shows both high F-values and significant P-values. Conversely, temperature is generally low across all set-ups, ranging from 0.76 to 2.01. This suggests that temperature does not significantly affect flower growth, similar to bud growth.

TABLE II. FLOWER GROWTH

ANOVA Test	Variable	Control	1A	2A	3A	1B	2B	3B
F-value	%RH	53.02	1.23	27.59	17.47	7.28	83.03	47.53
	T(˚C)	0.94	2.01	1.92	0.97	1.04	0.76	1.27
P-value	%RH	0.000	0.268	0.000	0.000	0.007	0.000	0.000
	T(˚C)	0.639	0.000	0.000	0.555	0.382	0.948	0.066

The P-values for humidity are significant ($p < 0.05$) in several set-ups, particularly in set-ups 2A, 3A, 2B, and 3B, with values as low as 0.000, indicating a vital statistical significance. The lack of significance in set-up 1A suggests humidity's effect may be less pronounced under certain netting conditions. Temperature also shows significance in set-ups 1A and 2A, suggesting that temperature could impact flower growth under specific conditions. However, this is not consistent across all set-ups.

Set-up 2B appears to be the best for promoting flower growth, with the highest F-value (83.03) for humidity, statistically significant P-value (0.000) for humidity, and low F-value (0.76) and non-significant P-value (0.948) for temperature. This indicates humidity is a crucial factor influencing flower growth, while temperature is insignificant in this set-up.

In conclusion, humidity is a significant factor influencing flower growth, particularly in set-ups 2B and 3B, which show both high F-values and significant P-values. Temperature is generally insignificant, except in set-ups 1A and 2A, where it might play a role under specific conditions. Set-up 2B is likely the optimal condition for flower growth, given the high impact of humidity and the insignificance of temperature.

3) Height growth vs temperature and humidity

As seen in Table III, the results show that humidity is a dominant factor affecting height growth, with the most significant effects observed in set-ups 3B and 2B, where the plants experienced optimal conditions under specific netting and density configurations. Temperature minimally affects height growth, with consistently low F-values ranging from 0.95 to 1.40.

TABLE III. HEIGHT GROWTH

ANOVA Test	Variable	Control	1A	2A	3A	1B	2B	3B
F-value	%RH	21.79	25.62	27.77	6.37	15.70	227.25	283.65
	T(˚C)	1.05	1.40	1.35	0.95	1.05	1.03	1.33
P-value	%RH	0.000	0.000	0.000	0.012	0.000	0.000	0.000
	T(˚C)	0.371	0.012	0.029	0.613	0.368	0.407	0.035

TABLE IV. LEAF GROWTH

ANOVA Test	Variable	Control	1A	2A	3A	1B	2B	3B
F-value	%RH	48.12	3.78	169.94	7.23	0.07	4.26	247.51
	T(˚C)	1.12	1.42	1.45	1.48	1.46	1.48	1.45
P-value	%RH	0.000	0.053	0.000	0.007	0.788	0.040	0.000
	T(˚C)	0.101	0.009	0.009	0.006	0.006	0.005	0.009

Humidity is statistically significant across all set-ups, with most being 0.000, indicating a genuine and impactful factor. The P-values for temperature are mixed, with some significance in specific set-ups but less consistent overall compared to humidity. The occasional significance in set-ups like 1A and 3B suggests that temperature may interact with other factors to influence height under specific conditions, but its role is secondary.

Set-up 3B emerges as the best condition for height growth, with the highest F-value for humidity (283.65) and a significant P-value of 0.000, indicating a robust effect of humidity. While temperature also shows significance in this set-up ($p = 0.035$), the overwhelming influence of humidity suggests that it is the primary driver of height growth under these conditions. Set-up 2B is also highly effective, with a slightly lower F-value for humidity (227.25) but still significant. This set-up also shows no significant effect of temperature ($p = 0.407$), meaning that humidity alone is likely sufficient to maximize height growth.

In conclusion, humidity is the most critical factor for height growth in Dendrobium Sampran orchids, with high F-values and significant P-values across all set-ups, indicating that optimizing humidity levels, particularly under netting, is crucial for maximizing plant height. Temperature's overall influence on height growth is inconsistent and generally weaker than humidity's, so managing humidity should be the primary focus, with temperature being a secondary consideration.

4) Leaf growth vs temperature and humidity

As per Table IV, the results show that humidity plays a significant role in leaf growth, particularly in set-ups like 3B and 2A, with the highest F-values observed in these conditions. However, the humidity effect highly depends on the specific environmental set-up.

If the basis is the F-value, temperature has a minimal influence on leaf growth, with low F-values across all set-ups, ranging from 1.21 to 1.51. This suggests that temperature has a consistent but weak effect on leaf growth, similar to its effect on height growth. Humidity also significantly affects specific set-ups, such as 3B, 2A, and Control, with humidity significantly influencing leaf growth. However, in set-up 1B, humidity does not significantly impact. However, with P-value, temperature also significantly influences leaf growth across multiple set-ups, with P-values indicating significance in set-ups such as 1A, 2A, and 3A. Although the overall effect might be weaker than humidity, it still plays a statistically significant role in leaf growth across different set-ups.

Set-up 3B is identified as the best set-up for promoting leaf growth, with the highest F-value for humidity (247.51) and a highly significant P-value of 0.000. This set-up also shows a significant influence of temperature (p = 0.009), suggesting that both factors are optimized in this set-up to promote maximum leaf growth.

In conclusion, humidity remains the most critical factor for leaf growth in Dendrobium Sampran orchids, with humidity playing a crucial role. Temperature, however, shows a more consistent and significant impact on leaf growth across multiple set-ups, suggesting that while humidity is crucial, temperature must also be carefully managed to optimize leaf growth.

C. Summary of ANOVA Result

The study examined the growth of Dendrobium Sampran orchids under various environmental set-ups, focusing on the effects of humidity and temperature on various growth metrics. The analysis employed ANOVA to assess the significance and magnitude of these effects, focusing on F-value and P-value results across different set-ups.

Humidity significantly influenced Buds' growth, especially in set-ups like 2B and 3A, where F-values were high (83.03 and 22.13, respectively). This indicates a strong positive impact of humidity on the number of buds. Temperature's influence on bud growth was less consistent, with significant effects observed only in specific set-ups like 1B.

Humidity strongly influenced flower growth, particularly in set-ups 2B and 3B, which showed high F-values (83.03 and 47.53) and significant P-values (p = 0.000). Humidity is a critical factor for flower development, while temperature significantly influences flower growth in set-ups like 1A and 2A.

Height growth was most significantly affected by humidity, particularly in set-ups 3B and 2B, indicating that humidity is essential for promoting taller plants. Temperature's effect on height growth was less pronounced, with only a few set-ups showing significant results, such as set-up 1A.

Leaves growth was also a key factor, with humidity emerging as a critical factor in leaf growth, with set-ups like 3B and 2A showing solid effects. Temperature played a more consistent role in leaf growth, suggesting that temperature plays a more active role in vegetative growth than reproductive growth.

After thoroughly examining the F- and P-values for every growth indicator, 3B is the best configuration for the overall growth of Dendrobium Sampran orchids. Substantial impacts of humidity were repeatedly shown in this setting for all growth metrics, including buds, flowers, height, and leaves, and substantial P-values confirmed the consistency of the data. Furthermore, set-up 3B's temperature was shown to be a significant factor in some metrics, such as the growth of leaves, indicating that this configuration is appropriate for fostering robust and healthy plant development.

For the most outstanding results regarding bud, flower, height, and leaf growth, set-up 3B provides the ideal balance of environmental factors, especially humidity. It is distinguished by a temperature range promoting general plant health and high humidity levels, which are necessary for vegetative and reproductive development.

Additionally, set-up 2A was quite successful, especially for the growth of flowers and leaves. It may be used as a backup plan in cases where somewhat different environmental conditions are preferred or when the parameters of set-up 3B are impractical.

IV. Conclusion

The study on the growth of Dendrobium Sampran orchids under various photoselective shade netting conditions yielded significant findings regarding the influence of humidity and temperature on key growth metrics. Analysis of Variance (ANOVA) results indicated that humidity consistently played a crucial role in enhancing the growth of buds, flowers, leaves, and overall plant height. Specifically, set-ups 2B and 3B demonstrated the highest growth rates across all measured parameters, with set-up 3B showing the most pronounced effect on height growth, reflected by an F-value of 283.65 and a P-value of 0.000, indicating vital statistical significance. In contrast, temperature had minimal impact on growth, with most set-ups showing non-significant P-values, thus reinforcing the conclusion that humidity is the primary driver of growth in these orchids.

Based on the findings, the optimal set-ups for cultivating Dendrobium Sampran orchids are identified as 2B and 3B. These configurations provided the ideal humidity conditions and demonstrated superior performance in promoting bud and flower production. The results suggest that these specific shade netting strategies can significantly enhance orchid growth, improving yields and overall plant health. As such, growers are encouraged to adopt these set-ups to optimize their cultivation practices, ensuring sustainable and productive orchid farming.

Conflict of Interest

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

NDS provided professional supervision throughout the project, ensuring that it went efficiently while adhering to the highest academic standards. Her continuous support was important in determining the study's path, and her rigorous examination of the paper's content guaranteed that the study fulfilled strict academic standards. PPMAA and ELTD performed critical roles in the research's implementation and dissemination. They were in charge of carrying out the study, supervising the extensive data gathering procedures, and doing a complete and in-depth data analysis. They co-authored the manuscript, drafting and refining it for publication. All authors had approved the final version.

ACKNOWLEDGMENT

The authors sincerely thank everyone who walked alongside them through this study. They extend their gratitude to each of the people who have been a part of their study journey from the start, providing them with comfort and support every step of the way.

Additionally, the authors would like to express their sincere gratitude to their instructors in the School of Chemical, Biological, & Material Engineering and Sciences of Mapua University. Their insightful comments and challenging questions encouraged them to broaden their view of their study from various perspectives. Their wisdom and insightful advice greatly influenced the development of this study.

REFERENCES

[1] K. Obsuwan, P. Deesubin, A. Tongam, and O. Juneenat, "Influence of paclobutrazol on growth of Dendrobium 'Sonia Jo Daeng' under salt stress condition in tissue culture," *Science, Engineering and Health Studies*, vol. 15, 2021. https://doi.org/10.14456/sehs.2021.3

[2] S. Zhang, Y. Yang, J. Li, J. Qin, W. Zhang, W. Huang, and H. Hu, "Physiological diversity of orchids," *Plant Divers*., vol. 40, no. 4, pp. 196–208, 2018. https://doi.org/10.1016/J.PLD.2018.06.003

[3] H. N. Rasmussen, K. W. Dixon, J. Jersáková, and T. Těšitelová, "Germination and seedling establishment in orchids: A complex of requirements," *Ann. Bot.*, vol. 116, no. 3, pp. 391–402, 2015. https://doi.org/10.1093/AOB/MCV087

[4] H. Singh, B. L. Dunn, C. Fontanier, and H. Singh, "Colored shade nets affect growth but not flowering of four greenhouse-grown potted ornamental species," *HortScience*, vol. 58, no. 9, pp. 1075–1076, 2023. https://doi.org/10.21273/HORTSCI17256-23

[5] Q. Zhang, G. Bi, T. Li, Q. Wang, Z. Xing, J. LeCompte, and R. L. Harkess, "Color shade nets affect plant growth and seasonal leaf quality of Camellia sinensis grown in Mississippi, the United States," *Front. Nutr.*, vol. 9, 2022. https://doi.org/10.3389/fnut.2022.786421

[6] K. A. Pituch and J. P. Stevens, *Applied multivariate statistics for the social sciences: Analyses with SAS and IBM's SPSS*, Routledge/Taylor & Francis Group, 2015.

[7] M. McFarquhar, "Modeling group-level repeated measurements of neuroimaging data using the univariate general linear model," *Frontiers in Neuroscience*, vol. 13, p. 352, 2019. doi: 10.3389/fnins.2019.00352

[8] F. J. Carvalho, D. G. de Santana, and L. B. de Araújo, "Why analyze germination experiments using generalized linear models?" *Journal of Seed Science*, vol. 40, no. 3, pp. 281–287, Jul. 2018. doi: 10.1590/2317-1545v40n3185259

[9] W. Zhang, W. Huang, and S. B. Zhang, "The study of a determinate growth orchid highlights the role of new leaf production in photosynthetic light acclimation," *Plant Ecol*, vol. 218, no. 8, pp. 997–1008, Aug. 2017. doi: 10.1007/s11258-017-0747-5

[10] M. S. Liao *et al.*, "On precisely relating the growth of Phalaenopsis leaves to greenhouse environmental factors by using an IoT-based monitoring system," *Comput Electron Agric*, vol. 136, pp. 125–139, Apr. 2017. doi: 10.1016/j.compag.2017.03.003