

Optimization of Concentration and Frequency of Nutrient Application Based on Goat Manure Concentrate in Orchid Nurseries (*Phalaenopsis amabilis*) in a Smart Farming System

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Abstract. Achieving optimal flower quality depends on precise cultivation practices, particularly in managing environmental and nutritional factors. Inadequate nutrient management can reduce vegetative growth, photosynthetic pigment levels, and flower quality, while suboptimal water and nutrient regulation often hamper seedling productivity. Because moon orchids require specific humidity, watering frequency, and nutrient concentrations, smart farming technology is needed to control these conditions accurately. This study investigated the interaction between nutrient concentration and application frequency on the growth of *Phalaenopsis* orchids in a smart farming system, employing a factorial randomised block design. Treatments included nutrient concentrations of 30%, 3%, and 0.3% (v/v) and application frequencies of once, twice, and three times daily at two-day intervals. Observed variables included leaf number, leaf area, chlorophyll content, and plant weight gain. Results showed no significant interaction between the two factors across all parameters. However, the 0.3% concentration produced the best growth response, comparable to 3%, while 30% inhibited growth. Application frequency significantly affected leaf area and weight gain, with once- and twice-daily treatments yielding similar results. Overall, low nutrient concentrations (0.3–3%) applied once or twice daily were identified as the most efficient and sustainable strategy for cultivating *Phalaenopsis* orchids in smart farming systems.

Keywords: *Phalaenopsis* orchids, nutrient management, local microorganisms, growth optimization, smart farming

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1. Introduction

Phalaenopsis (moon orchids) are one of the most commercially valuable ornamental plants in the global horticultural industry. Their beautiful flowers, wide color variety, and long blooming period make them highly sought after as both potted plants and cut flowers. In Indonesia, moon orchids have both cultural and economic value and are widely used in home decoration, ceremonial events, and commercial displays. Therefore, producing high-quality Phalaenopsis plants requires precise management of the growing environment and nutrients, as imbalances—either nutrient deficiencies or excesses—can reduce growth, photosynthesis, and flowering quality [1, 2].

As epiphytic plants, Phalaenopsis are highly sensitive to changes in temperature, humidity, light intensity, and media moisture, requiring careful irrigation and nutrient management. Smart farming provides solutions through the integration of real-time sensors, the Internet of Things (IoT), and automation systems, enabling precise monitoring and adjustment of environmental needs. This technology enables automated regulation of irrigation, nutrients, lighting, and ventilation, thereby increasing resource efficiency and maintaining a stable growing environment. Research indicates that the application of smart farming can enhance plant performance and improve fertiliser efficiency in sensitive commodities, such as orchids [3].

The development of smart agricultural technology further strengthens the potential of smart farming in orchid cultivation. IoT-based fertigation systems have been proven to optimize nutrient delivery by regulating solution concentration and volume based on real-time sensor feedback. Several studies conducted between 2020 and 2024 have demonstrated that automated irrigation and nutrient management can enhance water use efficiency, promote plant health, and reduce labour requirements and operational costs. These systems also minimize cultivation errors such as overwatering, nutrient buildup, and irregular fertigation schedules. This research implemented an IoT-based automated fertigation system with NodeMCU, environmental sensors (DHT11, DS18B20, soil moisture), and the Blynk platform to control pumps and solenoid valves. This enables the precise and timely delivery of liquid goat manure fertiliser, while also facilitating remote monitoring and data recording [4].

The concentration and frequency of nutrient application are critical factors in orchid growth. A concentration that is too high can cause osmotic stress, inhibit water absorption, and increase the risk of ion toxicity due to orchids' relatively slow nutrient uptake rate. Conversely, too low a concentration can result in essential nutrient deficiencies that affect photosynthesis, chlorophyll formation, and vegetative growth. In addition to concentration, application frequency determines the stability of nutrient availability in the root zone: too infrequent application can cause fluctuations in nutrient availability, while too frequent application can trigger salt accumulation, increased EC, and reduced oxygen diffusion. Therefore, striking a balance between concentration and application frequency is crucial for maintaining root health and ensuring stable nutrient uptake [3, 5, 6].

The integration of smart farming technology into orchid cultivation opens up opportunities for precisely regulating the interaction between nutrient concentration and application frequency. Sensor-based automated systems can adjust watering and fertilization schedules based on media humidity, EC values, and environmental fluctuations [7]. This precision is crucial for orchids, which require stable conditions to support their physiological functions. Thus, automated irrigation systems can prevent media saturation, while dosing devices can maintain nutrient concentrations within the optimal range throughout the growth

phase [8]. This need for precision is becoming increasingly relevant as the demand for high-quality orchid seedlings grows. Each stage of production—from seedling growth and vegetative development to flowering induction—requires different nutritional and environmental conditions. Smart farming technology enables parameter adjustments tailored to the growth phase, enhancing uniformity, minimizing plant losses, and promoting more efficient and sustainable cultivation practices [9]. Automated management also reduces fertilizer runoff, conserves water, and optimizes input use, aligning with global trends in sustainable agriculture. This study was designed to investigate the impact of a combination of nutrient concentration and application frequency on *Phalaenopsis* cultivation in a smart farming system. By evaluating parameters such as leaf number, chlorophyll content, leaf area, and biomass accumulation, this study aimed to identify the most efficient management strategies. The primary objective was to determine whether lower nutrient concentrations, applied at appropriate frequencies, could produce equivalent or better growth than higher concentrations, while enhancing nutrient efficiency and reducing production costs [10]. Environmentally, this research contributes to the development of sustainable precision agriculture practices. Excessive fertiliser use poses risks to both terrestrial and aquatic ecosystems; optimising application rates and frequencies helps minimise these environmental impacts.

The study's novelty also extends to its sustainability orientation, investigating whether lower nutrient concentrations applied at controlled frequencies can achieve growth outcomes comparable to or better than higher concentrations commonly used in practice. This approach not only reduces input use and production costs but also minimizes fertilizer runoff and salt stress—issues of growing concern in precision horticulture. By demonstrating how smart farming technology can optimize nutrient efficiency while supporting high-quality *Phalaenopsis* seedling production, this research contributes a new, scalable model for sustainable orchid cultivation that may also be transferable to other high-value ornamental crops that require refined nutrient management.

In conclusion, the integration of smart farming technologies with calibrated nutrient concentration and application frequency presents a promising approach for enhancing the growth and productivity of *Phalaenopsis* orchids. This research is expected to provide actionable recommendations that support economically viable, environmentally sustainable, and technologically advanced orchid production systems.

2. Research Methods

2.1 Smart Farming System

A smart farming system is designed to automate plant cultivation techniques, specifically orchids, using a NodeMCU-based control unit. The system integrates humidity, temperature, and soil moisture sensors, all connected to solenoid valves and mini pumps that regulate nutrient flow from the reservoir to each pot channel. In this study, it was primarily utilized to regulate nutrient irrigation [4]. System operations are managed through the Blynk IoT platform, which enables remote control, real-time data monitoring, and precise scheduling of liquid goat manure applications based on treatment combinations. This automated fertigation setup ensures even distribution, consistent timing, and efficient use of water and nutrients throughout the trial period, as illustrated in Figure 1.

The development timeline for the Smart Farming project for orchids is designed to last 14 weeks, beginning with the initial study and planning phase, which lasts for two weeks. This phase involves analysing the orchid plant's needs, studying the greenhouse layout, selecting the necessary hardware, and developing a system block diagram and initial budget.

This phase then continues with three weeks of system design, encompassing mechanical design for device placement, electronic design for sensor and actuator connections, and development of control logic and an IoT dashboard interface [5].

The next phase is prototype development, which lasts four weeks. During this phase, hardware such as sensors, pumps, valves, and a microcontroller are installed, while software for the microcontroller and IoT dashboard is developed to ensure the system's basic functions are functioning properly. Following this, a three-week trial and refinement phase was conducted, during which the system was tested across all gutters to evaluate its performance and efficiency. Analysis of the trial data was used to calibrate and refine the system for greater stability [5].

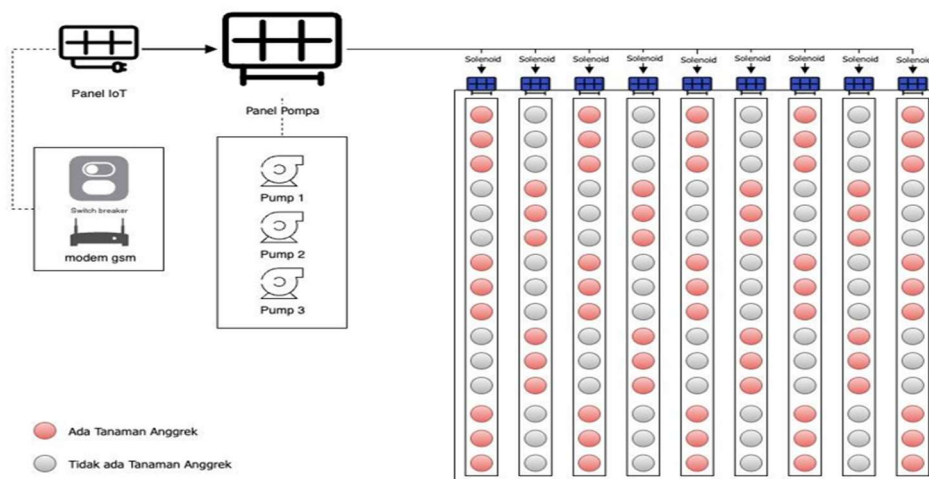


Fig. 1. Layout of IoT Smart Orchid greenhouse and fertigation lines.

Finally, during the two-week documentation and proposal presentation phase, all aspects of the project were documented, including a description of the system, trial results, and benefits. A complete proposal was then prepared for presentation to sponsors or supporting parties, complete with a prototype demonstration. This timeline provided the project with a systematic development structure to ensure its successful implementation.

2.2 Location and Research Methods

The research was conducted from June to August 2025 in the open greenhouse of the Faculty of Agriculture, Universitas Islam Malang, East Java, Indonesia. Environmental conditions were maintained as follows: a temperature range of 23–28°C, humidity of 70–85%, and light intensity of 70% (using shade netting). The growing medium used was a mixture of moss and kadaka roots. The tools used included a microcontroller-based smart farming system with an automatic pump, a precision digital scale, and a SPAD meter for measuring chlorophyll content.

The research design used a factorial randomized block design (FRBD) with two treatment factors. Factor 1: Nutrient concentration (goat manure concentrate) consisting of three levels (K_1 : 30%, K_2 : 3%, K_3 : 0.3% v/v). Factor 2: Application frequency consisting of three levels (F_1 : once, F_2 : twice, F_3 : three times daily). Applications were carried out every two days. Nine treatment combinations were produced, each replicated three times. Each treatment consisted of three sample plants, resulting in a total of 81 pots.

Orchid seedlings were planted in 5 cm diameter plastic pots with a mixture of sphagnum moss and kadaka root. The smart farming system was set to control the nutrient solution delivery according to the treatment, with the solution volume per application adjusted (20 cc) to maintain optimal moisture levels without excess water. Routine maintenance, including weeding, removing moss from the pot surface, and controlling pests and diseases, was performed manually without the use of synthetic chemical pesticides.

2.3 Observation Variables

Vegetative Growth Observation Variables: The number of leaves (blades) was counted on fully opened leaves. Leaf area growth (cm^2) was measured using the $LA_n = LA_n - LA_{(n-1)}$. Leaf area was calculated using the formula: $LA = LL \times LW \times CF \times NoL$; LA = Leaf area growth, LL = Leaf length, LW = Leaf width, CF = Correction factor and NoL = Number of leaves, $n = n^{\text{th}}$ observation, Chlorophyll content was measured using a SPAD (Soil Plant Analysis Development) meter, a rapid and non-destructive method. Fresh weight gain per plant (g) was calculated from the average of the total fresh sample plants.

2.4 Data Analysis

Observation data were analyzed using analysis of variance (ANOVA) in accordance with the FRBD experimental design at a 95% confidence level. If a significant interaction between treatments was detected, an Honestly Significant Difference (HSD) test was conducted at the 5% level.

3. Results and Discussion

The results of the study showed that there was no interaction effect between the application concentration treatment and the frequency of goat manure concentrate application on all observed variables (number of leaves, leaf area, plant weight, chlorophyll content). This indicates that both factors work independently in influencing the growth of *Phalaenopsis* orchids. The nutrient absorption mechanism of orchid plants, such as *Phalaenopsis*, through their epiphytic root systems is designed to absorb nutrients in low but consistent doses. This structure resembles their natural conditions where nutrients are available from the decay of organic matter attached to tree bark. A study conducted by [11] on orchid physiology stated that nutrient ion absorption is additive and cumulative. This means that plants can achieve optimal nutritional status either through infrequent applications of high concentrations (large doses) or frequent low concentrations (small but frequent doses), as long as the total volume of nutrients given in a given cycle is relatively equal. Thus, the effects of each factor (concentration and frequency) are linear and separate, not interconnected. Furthermore, the characteristics of the goat manure concentrate solution itself support the absence of interactions. Liquid organic fertilisers, particularly those derived from well-fermented goat manure, contain nutrients in a more readily available and stable form. However, their daily release rate is relatively slow and consistent compared to inorganic fertilisers. This stability reduces drastic nutrient fluctuations, making plants less responsive to variations in application frequency. In other words, whether applied three times a week or once a week had no significant effect. The growing medium served as a buffer, continuously providing nutrients and eliminating any synergistic or antagonistic effects between the two treatments.

Furthermore, these results may suggest that one factor has such a dominant influence that it "masks" or renders the influence of the other factor insignificant when combined. For example, if the nutrient concentrations used are already at optimal or even supra-optimal levels (e.g., all concentration treatments meet or exceed the plant's basic needs), then

variations in application frequency become irrelevant. Conversely, if the application frequency is very frequent (for example, daily), thus creating a constant nutrient availability, then variations in concentration may not show significant differences. This finding aligns with Liebig's Law of the Minimum, which states that growth is limited by only one limiting factor at a time, not by a combination of several factors simultaneously [12].

The application frequency treatments showed no significant effect (1, 2, or 3 times every two days). This indicates that the growing medium acts as an effective nutrient reservoir or buffer. Orchid media, such as a mixture of moss and kadaka roots, have a high cation exchange capacity (CEC), which allows them to absorb and release nutrient ions gradually. Therefore, once nutrients are applied, the medium stores them and makes them available to the plant roots for a considerable period, making more frequent reapplications (three times every two days) no better than once every two days.

The physiological properties of orchid roots further support this finding. Epiphytic orchid roots are covered with velamen, a spongy tissue that absorbs water and nutrients and temporarily stores them. This storage capacity allows the plant to be independent of the continuous daily availability of nutrients [1]. Stated that less frequent application patterns mimic the natural conditions of orchids in their habitat, where they receive nutrients from rainwater that sporadically dissolves organic debris. Therefore, under adequate media and nutrient conditions, increasing the frequency does not have a significant additional impact.

The results, which showed significant differences between low concentrations (0.3% and 3%) and high concentrations (30%) for all observed variables, are highly consistent with the theory of nutrient uptake and the properties of liquid organic fertilizer (POC). Goat manure concentrate, even after fermentation, still contains quite high levels of dissolved salts and organic compounds. Application at very high concentrations (30%) likely created osmotic stress on the sensitive root system of *Phalaenopsis* orchids. This explains why variables such as root length, leaf area, and biomass decreased drastically in the 30% treatment.

Conversely, concentrations of 0.3% and 3% yielded better results and did not differ significantly from each other. This indicates that the nutrient requirements of *Phalaenopsis* orchids were optimally met within this concentration range. Research by [8] suggests that orchids, as epiphytic plants, have evolved to grow optimally with low but consistent nutrient doses. The macro- and micronutrient content in goat manure concentrate, when diluted at levels of 0.3% to 3%, provides an ideal nutrient environment without causing toxicity or osmotic inhibition, thus stimulating maximum vegetative growth.

The composition of goat manure itself also supports this finding. In this research, it was reported that goat manure contains significant concentrations of macronutrients. Proper dilution (such as 3%) ensures balanced availability of nitrogen (N) for leaf growth, phosphorus (P) for rooting, and potassium (K) for plant resilience, allowing for efficient absorption [10]. In other words, a concentration of 3% likely reached a plateau or saturation point in absorption efficiency for the test plants under these research conditions, making a tenfold increase (30%) toxic and counterproductive.

3.1 Number of Leaves (Sheets)

The analysis of variance for leaf number (Appendix 1) showed no interaction between the nutrient concentration of goat manure concentrate and spraying frequency. However, each showed a significant effect on leaf number separately. The average leaf number values after testing with the 5% BNJ test are presented in Table 1.

The results of Tukey's 5% analysis in Table 1 indicate that the spraying frequency of once a day (F₁) differed significantly from the spraying treatments of twice a day (F₂) and three times a day (F₃). The number of leaves increased with the once-daily spraying treatment.

However, the K₂ (250 ppm) and K₃ (125 ppm) concentration treatments were not significantly different from each other, but both were significantly different from the K₁ (375 ppm) concentration treatment. At the high K₁ concentration (375 ppm), the number of leaves actually decreased. Excessive spraying frequency likely increases leaf surface humidity, reducing photosynthetic efficiency and causing mild physiological stress that inhibits growth [9]. Regarding concentration, the K₂ (250 ppm) and K₃ (125 ppm) treatments were not significantly different, but both were significantly different from K₁ (375 ppm). The decrease in leaf number at the high concentration (K₁) indicates potential ion toxicity or excessive osmotic pressure, which inhibits leaf cell division and enlargement [11]. Therefore, medium to low concentrations and moderate spraying frequencies are optimal for leaf growth.

Table 1. Average leaf number values for each treatment of spraying frequency and nutrient concentration (goat manure concentrate) on moon orchids.

Treatment	Number of Leaves (Sheets)				
	Observation 1	Observation 2	Observation 3	Observation 4	Observation 5
F ₁	3.89b	3.78b	3.78b	3.33b	2.89b
F ₂	3.44a	2.67a	3.33a	3.11a	2.78b
F ₃	2.78a	2.56a	2.33a	2.44a	2.33a
HSD 5%	0.44	0.40	0.38	0.24	0.42
K ₁	2.56a	2.33a	2.33a	2.22a	2.11a
K ₂	3.78b	3.56b	3.56b	3.33b	2.89b
K ₃	3.78b	3.11b	3.56b	3.33b	3.00b
BNJ 5%	0.44	0.40	0.38	0.24	0.42

Description: Numbers with the same letter in the same column indicate no significant difference in the 5% HSD test.

3.2 Leaf Area (Cm²)

The analysis of variance results for the leaf area variable showed no significant interaction across all observations. Individually, each treatment showed a significant effect. The average leaf area results, as determined by Tukey's 5% test, are presented in Tables 2 and 3.

Table 2. Average leaf area values for each treatment, spraying frequency and nutrient concentration (goat manure concentrate) in moon orchids.

Treatment	Leaf Area (Cm ²)				
	Observation 1	Observation 2	Observation 3	Observation 4	Observation 5
F ₁	46.77b	46.06b	47.61b	42.90	41.29
F ₂	37.67a	37.45ab	40.71ab	40.49	38.76
F ₃	34.12a	34.56a	36.60a	36.30	38.85
HSD 5%	14.91	14.90	10.84	tn	tn
K ₁	27.21a	27.35a	25.55a	23.63a	21.74a
K ₂	43.63b	45.00b	47.74b	46.26b	47.70b
K ₃	47.71b	45.72b	51.64b	49.79b	49.45b
HSD 5%	14.91	14.90	10.84	9.63	12.50

Note: Numbers with the same letter in the same column indicate no significant difference in the 5% BNJ test. % . tn = no significant effect. HSD = Honestly Significant Difference

In terms of spraying frequency, at the beginning of growth, the F1 and F2 treatments produced higher leaf areas, but there was no significant difference; however, they were significantly different from the F₃ treatment. But at the end of the observation, there was no real difference. In terms of nutrient concentration, the K3 (375 ppm) treatment consistently showed the greatest leaf area growth, although it was not significantly different from the K2 (250 ppm) treatment. Both were significantly different from the K1 treatment. This indicates that leaf area is significantly influenced by nutrient concentration. Early in growth, the F1 and F2 spraying frequency treatments produced higher leaf area, although not significantly different from each other; however, both were significantly different from F3. At the end of the observation, no significant differences were found between spraying frequencies. This phenomenon aligns with the concept that growth responses in the early phase are often influenced by water availability and the effectiveness of foliar surface application [9]. In contrast, nutrient concentration had a more consistent effect: the K3 treatment (375 ppm) produced the greatest leaf area growth, although it was not significantly different from the K2 treatment (250 ppm). Both were significantly different from K1. This indicates that leaf area is more influenced by nutrient availability, consistent with the theory that increasing nutrient concentrations to optimal levels can increase leaf expansion and photosynthesis [9].

3.3 Total Plant Weight

The results of the analysis of variance for total plant fresh weight showed no significant interaction between spraying frequency and goat manure concentrate nutrient concentration. Separately, the average Total Plant Fresh Weight values after testing with the 5% HSD test are presented in Table 3. Spraying frequency had no significant effect in any of the observations. However, the goat manure concentrate had a significant effect in observations 2, 3, and 5, with no significant difference in observation 4. Meanwhile, the nutrient concentration treatment in observations 1 through 3, treatment K₂ (250 ppm), produced the heaviest Total Plant Fresh Weight value but was not significantly different from K₃ (125 ppm). However, at the end of the observation, K₃ was heavier. Early in growth, the F1 and F2 spraying frequency treatments produced greater leaf area, although not significantly different from each other, and both were significantly different compared to F3. At the end of the observation, no significant differences were found between spraying frequencies.

Table 3. Average total fresh plant weight values for each nutrient concentration treatment (goat manure) and application frequency for moon orchids

Treatments	Total Fresh Plant Weight (g)				
	1	2	3	4	5
F ₁	22.44	23.23	24.32	25.33	33.78
F ₂	22.88	23.39	24.15	26.33	35.52
F ₃	19.57	21.24	21.78	26.22	35.22
HSD 5%	tn	tn	tn	tn	tn
K ₁	17.61 a	18.70 a	20.32 a	25.44	36.11 ab
K ₂	24.23 b	25.33 b	25.63 b	26.30	30.61 a
K ₃	23.04 b	23.82 b	24.30 ab	26.15	37.80 b
HSD 5%	4.33	5.47	5.65	tn	6.11

Note: Numbers with the same letter in the same column indicate no significant difference in the 5% BNJ test. % tn = no significant effect. HSD = Honestly Significant Difference

The analysis results showed no significant interaction between spraying frequency and goat manure concentrate nutrient concentration on total plant fresh weight. Spraying frequency had no significant effect at all observation times, indicating that differences in application intervals did not significantly alter plant biomass accumulation. A similar finding was also found by [7], who stated that growth response was more determined by nutrient adequacy than application frequency. Conversely, nutrient concentration had a significant effect in several observations (2nd, 3rd, and 5th). In the initial phase, the K2 (250 ppm) treatment yielded the highest plant fresh weight, although it was not significantly different from K3. However, at the end of the observation, K3 (125 ppm) showed a higher fresh weight, consistent with findings [12, 9] that increasing organic nutrient concentrations tended to increase biomass to an optimal limit. Meanwhile, at the beginning of growth, the F1 and F2 frequency treatments produced a larger leaf area than F3, although without significant differences. This response aligns with the report [7], which indicates that the early vegetative phase is more sensitive to changes in humidity and nutrient distribution, whereas at the end of growth, the differences disappear due to the plant's physiological adaptation.

3.4 Leaf Chlorophyll Amount

The results of the analysis of variance for leaf chlorophyll amount indicate no interaction effect between spraying frequency and goat manure nutrient concentration in all observations. Separately, the spraying frequency treatment did not have a significant effect, while the nutrient concentration treatment had a significant effect on the first and second observations (Table 4). Table 4 shows that the spraying frequency treatment was not significantly different among all treatments. The concentration treatment showed a significant difference between the first and second observations.

Table 4. Average number of leaf Chlorophyll in each treatment of spraying application frequency and nutrient concentration (Goat Manure Concentrate) in moon orchid plants.

Treatments	Klorophyl ($\mu\text{g}/\text{cm}^2$)			
	Observation 1	Observation 2	Observation 3	Observation 4
F ₁	50.31	50.42	50.23	50.23
F ₂	50.53	48.56	48.38	49.22
F ₃	49.26	50.65	44.91	42.00
HSD 5%	tn	tn	tn	tn
K ₁	53.06b	52.16b	50.82	52.25
K ₂	49.21a	50.50a	46.01	44.37
K ₃	47.83a	46.91a	46.69	44.84
HSD 5%	5.96	5.96	tn	tn

Description: Numbers accompanied by the same letter in the same column indicate no significant difference in the 5% BNJ test. % tn = no significant effect. HSD = Honestly Significant Difference

The analysis showed no interaction between spraying frequency and goat manure nutrient concentration on leaf chlorophyll content, indicating that both factors operate independently. Separately, spraying frequency had no significant effect, likely due to the relatively similar leaf absorption capacity despite different spraying frequencies [13]. Conversely, nutrient concentration had a significant effect in both the first and second observations. Higher nutrient concentrations increased nitrogen availability, which is essential for chlorophyll synthesis, resulting in increased leaf chlorophyll content [11]. Nitrogen is a core constituent of chlorophyll molecules. It drives chloroplast development and photosynthetic capacity, so increasing nitrogen availability through higher nutrient concentrations directly supports greater chlorophyll synthesis at the biochemical level [14]. Empirical experiments across various crops confirm this mechanism: plants receiving higher nitrogen treatments consistently exhibit higher leaf chlorophyll (SPAD/total chlorophyll) and associated increases in photosynthetic indicators. In contrast, nitrogen-limited treatments display reduced chlorophyll content [6]. Together, these biochemical and experimental lines of evidence strengthen the interpretation that raising nutrient concentration (within an appropriate range) elevates nitrogen availability and thereby increases leaf chlorophyll; they also imply a need to target an optimal nutrient range because beyond that point, further increases may not raise chlorophyll proportionally and can harm growth [14].

4. Conclusions

Based on the research results regarding the effect of spraying frequency and goat manure nutrient concentration, the following conclusions can be drawn.

1. In general, spraying frequency and goat manure concentrate nutrient concentration did not show any interaction effect on any of the observed variables. Spraying frequency had a significant effect only on the number of leaves and leaf area. A good spraying frequency is spraying once a day.
2. The goat manure concentrate nutrient concentration significantly affected all observed variables. Concentrations of 125 ppm–250 ppm produced good results for all observed variables (number of leaves, leaf area, chlorophyll, and total plant fresh weight).

For best results, it is recommended to spray three times daily with a goat manure nutrient with concentration of 125 ppm–250 ppm.

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