

The Effect of *Golden Grow* Concentration on the Growth of New Arabica Coffee Shots (*Coffea arabica* L.)

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ABSTRACT: Arabica coffee (*Coffea arabica* L.) is a high-value plantation commodity whose productivity is influenced by vegetative growth. New shoot growth plays an important role in canopy development and the formation of productive branches. This study aimed to determine the effect of *Golden Grow* concentrations on new shoot growth and identify the concentration that produced the best growth response. The study was conducted in Belantih Village, Kintamani District, Bangli Regency, Bali, using a Randomized Block Design with three *Golden Grow* concentrations: 0 mL/L, 2 mL/L, and 4 mL/L, each replicated five times. The observed variables included new shoot length, shoot diameter, and number of leaves. Data were analyzed using analysis of variance (ANOVA) at the 5% significance level, followed by Duncan's Multiple Range Test at the 5% level when significant differences were detected. The results showed that *Golden Grow* produced different responses in new shoot growth parameters. The 2 mL/L concentration tended to produce better vegetative growth than the control and 4 mL/L concentration. However, increasing *Golden Grow* concentration did not consistently improve shoot length, diameter, or leaf number. Therefore, appropriate *Golden Grow* concentrations may support new shoot growth in Arabica coffee plants under field conditions.

KEYWORDS: Arabica coffee, concentration, *Golden Grow*, new shoots, vegetative growth.

INTRODUCTION

Arabica coffee (*Coffea arabica* L.) is a plantation commodity with high economic value and plays a vital role in the Indonesian economy. Arabica coffee has a distinctive flavor, aroma, and acidity, as well as a relatively lower caffeine content than Robusta coffee. Indonesia is one of the world's largest coffee producers, with an average Arabica coffee area of 257,060 hectares, or approximately 20.99% of the total coffee area in Indonesia. In Bali Province, Arabica coffee is a leading plantation commodity, particularly in the Kintamani area of Bangli Regency. Environmental conditions, including altitude, temperature, rainfall, and suitable soil characteristics, make this area a potential location for Arabica coffee development. However, Arabica coffee plant productivity still needs to be improved through the application of appropriate cultivation techniques and plant nutrient management (Ardhiariska *et al.*, 2022; Fiala *et al.*, 2023). Vegetative growth is a critical aspect in determining the sustainable growth and productivity of Arabica coffee plants. One indicator of vegetative growth in coffee plants is the growth of new shoots. New shoots play a role in leaf formation, crown development, and the provision of productive branches, which subsequently support flowering and fruit formation. New shoot growth is influenced by various factors, including plant genetics, environmental conditions, light intensity, humidity, nutrient availability, and cultivation techniques. Appropriate environmental conditions and nutrient availability can support cell division and enlargement and increase photosynthetic activity, thus optimal vegetative growth (Lestari, 2021; Salim *et al.*, 2022).

Adequate nutrient availability is a crucial factor in supporting the growth of new shoots in Arabica coffee plants. Nutrients absorbed by plants play a role in various physiological and metabolic processes, such as chlorophyll formation, photosynthesis, protein synthesis, cell division, and plant tissue formation. Proper nutrition not only supports new shoot growth but also plays a role in maintaining the plant's physiological condition, which in turn supports coffee plant productivity. Therefore, effective and efficient plant nutrient management is necessary to enhance the vegetative growth of Arabica coffee plants. One ingredient that can be used to support plant growth is *Golden Grow*. *Golden Grow* is a plant growth supplement containing essential nutrients that have the potential to support various physiological and metabolic processes in plants. Administering *Golden Grow* is expected to increase nutrient availability, support photosynthesis, and stimulate the formation and development of plant tissue. With

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sufficient nutrient availability, cell division and enlargement can occur more effectively, potentially increasing shoot length, shoot diameter, and leaf formation on new shoots in Arabica coffee plants. In this thesis, *Golden Grow* is used as a nutrient input to enhance the growth and productivity of Arabica coffee plants. Plant response to nutrient administration is significantly influenced by the concentration provided. Concentrations that are too low can result in inadequate nutrient requirements, while nutrient administration at too high concentrations does not always result in increased plant growth. This condition can be caused by nutrient imbalances, decreased nutrient absorption efficiency, and differences in plant physiological conditions. Therefore, determining the correct *Golden Grow* concentration is crucial for optimal vegetative growth of Arabica coffee plants.

II. RESEARCH METHODOLOGY

Research Location and Time

The research was conducted from November 2024 to October 2025 at two locations: Belantih Village, Kintamani District, Bangli Regency, Bali Province (at an elevation of approximately 1,200 meters above sea level), and the Agronomy and Horticulture Laboratory of the Agroecotechnology Study Program, Faculty of Agriculture, Udayana University.

Materials and Equipment

The equipment used in this study consisted of a sprayer, a ruler, a SPAD unit, writing instruments, and a mobile phone camera. The materials used were Arabica coffee plants, *Golden Grow* (G), water, and labels.

Experimental Design

The research employed a Randomized Block Design (RBD) with a single factor treatment, namely *Golden Grow* (G), which composed of three levels:

- G_0 = 0 ml *Golden Grow*/L water (control)
- G_2 = 2 ml *Golden Grow*/L water
- G_4 = 4 ml *Golden Grow*/L water

Each treatment was replicated five times, resulting in a total of 15 Arabica coffee plants as samples. Treatments were randomly assigned to each block according to the field design.

Research Implementation

The research consisted of several stages, each detailed as follows:

1. Selection of Arabica coffee trees as research samples

The Arabica coffee selected as samples was Arabica coffee that had already produced fruit and was fully productive, typically at 6-8 years old. The trees selected as samples came from plantations under the same ownership (one owner) and with the same maintenance history, with relatively uniform tree height and canopy size. This tree selection criterion was crucial to ensure the tree samples had a homogeneous soil environment, microclimate, and canopy density.

2. Plant Maintenance

The plant/tree sample maintenance process was conducted using the Standard Operating Procedure (SOP) for proper Arabica coffee cultivation, including weeding, fertilization, pest and disease control, pruning, and other procedures to ensure optimal tree growth.

3. Application of the *Golden Grow* Treatment

Golden Grow was applied three times using the soil drenching method, which involves pouring the solution evenly onto the soil around the base of the tree. The first application was made 15 days before flowering, the second application at fruit set, and the third application 1.5 months after the second application. Each application was carried out according to the specified treatment concentration level.

Observation Variables

The variables observed included parameters of vegetative growth, namely:

1. Shoot length (cm)
2. New shoot diameter (mm)
3. Number of new shoot leaves (strands)
4. Number of flowers per bunch (units)
5. Number of flower clusters per branch (unit)
6. Leaf chlorophyll content (SPAD)

Shoot length was measured using a ruler from the base to the tip of the shoot. The number of new leaves on each sample plant was counted directly. Branch diameter was measured using a vernier caliper at a predetermined point on the branch. Number of

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flowers per bunch, and Number of flower clusters per branch were counted directly. While Leaf chlorophyll content (SPAD) was measured using a chlorophyll meter.

Data Analysis

After obtaining the data, data analysis was performed using a 1-factor Randomized Block Design (RBD). The data obtained were analyzed using a 5% analysis of variance (ANOVA) to determine the effect of the treatment on the observed parameters. If the ANOVA results showed a significant or very significant effect, further testing was carried out using the Duncan test at the 5% level to determine differences between treatments.

III. RESULTS

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Analysis of variance (ANOVA) results indicate that *Golden Grow* concentrations had no significant effect on all observed variables of Arabica coffee (*Coffea arabica* L.). The treatments did not significantly affect shoot length, new shoot diameter, number of new shoot leaves, number of flowers per bunch, number of flower clusters per branch, or leaf chlorophyll content. These results indicate that increasing *Golden Grow* concentration up to 4 mL/L did not cause statistically significant changes in vegetative growth, flowering parameters, or leaf chlorophyll content under the conditions of this study.

Table 1. The Results of the Significance of *Golden Grow* Concentration on The growth of New Shoots of Arabica Coffee

No	Observation Variables	Significance
1	Shoot length	ns
2	New shoot diameter	ns
3	Number of new shoot leaves	ns
4	Number of flowers per bunch	ns
5	Number of flower clusters per branch	ns
6	Leaf chlorophyll content	ns

Note: ns = unreal ($P \geq 0.05$); * = real ($P < 0.05$); ** = very real ($P < 0.01$).

Table 2. Effect of *Golden Grow* treatment on Shoot length, New shoot diameter, and Number of new shoot leaves

Treatment	Shoot length (cm)	New shoot diameter (mm)	Number of new shoot leaves (unit)
G ₀	3.86 a	2.07 a	2.22 a
G ₂	3.74 a	2.00 a	2.28 a
G ₄	3.71 a	1.98 a	2.31 a
BNT 5 %	0.29	0.16	0.13

Description: Numbers followed by the same letter indicate no significant difference in the 5% least significant difference (LSD) test.

The analysis results showed that the *Golden Grow* concentration treatment had no significant effect on the length, diameter, and number of leaves of Arabica coffee (*Coffea arabica* L.) new shoots. This is indicated by the same letter notation across all treatment levels. The highest new shoot length was obtained in the G₀ (0 mL/L) treatment at 3.86 cm, followed by G₂ (2 mL/L) at 3.74 cm, and G₄ (4 mL/L) at 3.71 cm. Although there was a tendency for shoot length to decrease with increasing *Golden Grow* concentration, this difference was not statistically significant. The highest new shoot diameter was also obtained in the G₀ treatment at 2.07 mm, followed by G₂ at 2.00 mm, and G₄ at 1.98 mm. These results indicate that increasing the *Golden Grow* concentration was not able to significantly increase the diameter of new shoots. Conversely, the number of leaves on new shoots showed a tendency to increase with increasing *Golden Grow* concentration. The highest number of leaves was obtained in the G₄ treatment at 2.31 units, followed by G₂ at 2.28 units, and G₀ at 2.22 units. However, these increases in leaf number were not statistically significant. Overall, application of *Golden Grow* at concentrations of 2 mL/L and 4 mL/L did not significantly increase shoot length, shoot diameter, or the number of new leaves compared to the control. However, there was a trend toward increased leaf number at higher *Golden Grow* concentrations.

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Table 3. Effect of *Golden Grow* treatment on Number of Flower per Bunch, Number of Flower clusters per branch, and Leaf Chlorophyll content

Treatment	Number of flowers per bunch (units)	Number of flower clusters per branch (unit)	Leaf chlorophyll content (SPAD)
G ₀	2.88 a	5.70 a	70.77 a
G ₂	2.93 a	5.97 a	68.72 a
G ₄	3.03 a	6.04 a	68.70 a
BNT 5 %	0.29	0.57	3.55

Description: Numbers followed by the same letter indicate no significant difference in the 5% least significant difference (LSD) test.

The analysis results showed that the *Golden Grow* concentration treatment had no significant effect on the number of flowers per cluster, the number of flower clusters per branch, and the chlorophyll content of Arabica coffee (*Coffea arabica* L.) leaves. This is indicated by the same letter notation across all treatment levels. The highest number of flowers per cluster was obtained in the G₄ treatment at 3.03 units, followed by G₂ at 2.93 units, and G₀ at 2.88 units. Although there was a trend toward increasing flower number with increasing *Golden Grow* concentration, the difference between treatments was not statistically significant. The number of flower clusters per branch also showed an increasing trend, with the highest value in the G₄ treatment at 6.04 units, followed by G₂ at 5.97 units, and G₀ at 5.70 units. However, these increases were not statistically significant. The highest leaf chlorophyll content was obtained in the G₀ treatment at 70.77 SPAD, while the G₂ and G₄ treatments produced chlorophyll contents of 68.72 SPAD and 68.70 SPAD, respectively. These results indicate a tendency for a decrease in leaf chlorophyll content in plants treated with *Golden Grow*, but the difference between treatments was not statistically significant. Increasing the *Golden Grow* concentration to 4 mL/L did not significantly affect the number of flowers per cluster, the number of flower clusters per branch, or leaf chlorophyll content. However, *Golden Grow* did show a trend toward increasing flower number and flower clusters per branch, while leaf chlorophyll content tended to decrease in plants treated with *Golden Grow*.

IV. DISCUSSION

The results showed that application of *Golden Grow* at concentrations of 0 mL/L, 2 mL/L, and 4 mL/L had no significant effect on new shoot length, new shoot diameter, number of leaves per new shoot, number of flowers per cluster, number of flower clusters per branch, and chlorophyll content of Arabica coffee (*Coffea arabica* L.) leaves. This indicates that increasing the *Golden Grow* concentration to 4 mL/L was unable to produce significant changes in vegetative growth, flowering, and leaf physiological condition compared to the control. Plant response to nutrient application is influenced by the plant's initial nutrient status, environmental conditions, growth phase, concentration and application time, and the plant's ability to absorb and utilize nutrients (Rouphael *et al.*, 2020). The highest new shoot length was obtained with G₀ at 3.86 cm, followed by G₂ at 3.74 cm and G₄ at 3.71 cm. The diameter of new shoots also showed a similar pattern, with the highest value for G₀ at 2.07 mm, followed by G₂ at 2.00 mm and G₄ at 1.98 mm. Although shoot length and diameter tended to decrease numerically with increasing *Golden Grow* concentration, the differences were not statistically significant. This suggests that increased nutrient availability does not always translate into increased growth if the plant's nutrient requirements are met or if nutrients are not a primary limiting factor. Plants have the ability to regulate nutrient uptake and utilization according to their physiological needs, so the response to additional nutrients is strongly influenced by the initial plant conditions and the growing environment (Oldroyd *et al.*, 2020).

Furthermore, coffee vegetative growth is influenced by the plant's phenological phase and the distribution of photosynthates among organs. As the plant enters the flowering and fruit-forming phases, some photosynthates can be allocated to support the development of generative organs, so additional nutrients are not always used to increase shoot elongation and enlargement. The relationship between vegetative and generative growth in coffee plants is complex and influenced by plant physiological conditions, the environment, and plant management (Unigarro *et al.*, 2025). In contrast to shoot length and diameter, the number of leaves per new shoot showed an increasing trend, from 2.22 units in G₀ to 2.28 units in G₂ and 2.31 units in G₄. Although this increase was not significantly different, this pattern indicates a tendency for plant resources to be allocated to leaf formation rather than shoot elongation or enlargement. Leaves are the primary photosynthetic organs, responsible for producing photosynthates to support vegetative growth and generative development. However, an increase in leaf number is not always accompanied by an increase in shoot length and diameter, as plants can allocate resources differently to each growth organ (Mathan *et al.*, 2021).

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The number of flowers per cluster and the number of flower clusters per branch also did not differ significantly between treatments. However, both variables showed a tendency to increase with increasing *Golden Grow* concentration. The number of flowers per cluster increased from 2.88 units in G₀ to 2.93 units in G₂ and 3.03 units in G₄, while the number of flower clusters per branch increased from 5.70 units in G₀ to 5.97 units in G₂ and 6.04 units in G₄. This trend suggests that the plant response to *Golden Grow* may be more visible in the formation of new organs and generative development than in the increase in shoot size. However, because the differences were not statistically significant, these results can only be interpreted as numerical trends and do not yet prove that *Golden Grow* increases flowering. Coffee flower formation is a complex physiological process influenced by the growth of productive branches and nodes, the availability of carbohydrates and nutrients, plant water conditions, temperature, rainfall, solar radiation, and the plant's phenological phase. Therefore, nutrient availability is not the sole factor determining flowering success. Furthermore, natural variability among coffee plants in branch age, number of productive nodes, canopy condition, root system, and previous production load can increase data variation, so that differences in average values between treatments are not yet statistically significant (Unigarro *et al.*, 2025).

The highest leaf chlorophyll content was found in G₀ at 70.77 SPAD, then decreased to 68.72 SPAD in G₂ and 68.70 SPAD in G₄. However, these differences were not statistically significant. The lack of increase in chlorophyll content may indicate that the control plants had sufficient nutritional status to maintain chlorophyll formation, so the addition of *Golden Grow* did not produce a physical response significant physiological effects. Chlorophyll content is influenced by nutrient status, particularly nitrogen and magnesium, as well as leaf age and position, plant water conditions, light intensity, and measurement time. Therefore, small changes in SPAD values between treatments cannot be directly interpreted as a positive or negative effect of *Golden Grow* (Padilla *et al.*, 2021).

V. CONCLUSION

The application of *Golden Grow* at concentrations of 0, 2, and 4 mL/L had no significant effect on new shoot length, new shoot diameter, number of leaves per new shoot, number of flowers per cluster, number of flower clusters per branch, or leaf chlorophyll content of Arabica coffee (*Coffea arabica* L.). Increasing the *Golden Grow* concentration tended to decrease shoot length, shoot diameter, and leaf chlorophyll content, while the number of new shoot leaves, flowers per cluster, and flower clusters per branch tended to increase. However, these numerical trends were not statistically significant. Therefore, under the conditions of this study, application of *Golden Grow* up to 4 mL/L did not significantly improve the vegetative growth, flowering, or leaf chlorophyll content of Arabica coffee plants. Further studies with a wider range of concentrations, longer observation periods, and additional physiological and yield parameters are needed to determine the optimal concentration and long-term effects of *Golden Grow* application on Arabica coffee plants.

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