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Study of Morphology, Growth, and Flowering of Five Hoya Species from Borneo, Indonesia

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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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Short Communication

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Abstract

Hoya is a diverse tropical ornamental plant group widely distributed in Southeast Asia, with high species richness in Indonesia. Despite its horticultural and ecological importance, information on growth behavior and flowering characteristics of many species remains limited, particularly under new cultivation environments.This study evaluated the vegetative growth and flowering characteristics of five *Hoya* species from Borneo, Indonesia, in a new growing environment in East Java, Indonesia, over a 50-week observation period. Growth was assessed using leaf number, node number, primary branch number, and plant height.

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Hoya walliniana exhibited the most vigorous vegetative growth, with significantly higher increases in nodes, leaves, and branches, particularly after 20 weeks, while *H. nabawanensis* achieved the greatest plant height. In contrast, *H. callistophylla* and *H. elliptica* showed relatively minimal vegetative development. Flowering analysis revealed that *H. latifolia* did not flower during the study period. Among the four remaining species, *H. walliniana* and *H. callistophylla* reached anthesis more rapidly, and *H. nabawanensis* required the longest time. All flowering species showed a similar flower longevity of approximately 3 ± 1 days. *H. walliniana* produced the highest number of flowers per rachis, while *H. elliptica* had the largest floral structures. Overall, *H. walliniana* demonstrated superior performance across both vegetative and reproductive parameters, exhibiting the fastest vegetative growth and the highest flower production, indicating its strong growth potential under the growing conditions in East Java, Indonesia.

Keywords: Asclepiadaceae; flowering phenology; ornamental plants; wax flowers.

1. Introduction

Hoya is a genus in the **Apocynaceae** family. *Hoya* is widely used as a hanging ornamental plant because of its trailing growth habit. *Hoya* possesses flower petals arranged to resemble stars and a semi-glossy appearance in various colors. For instance, *H. imperialis* displays dark purple flowers, while *H. multiflora* has white, spearhead-shaped petals. Some *Hoya* species also have unique and attractive leaves, such as *H. kerrii*, with heart-shaped leaves, and *H. compacta*, with wrinkled, curved leaves. Several *Hoya* species, such as *H. carnosa*, are known to absorb pollutants from the air (Rahayu et al., 2018) and some species have medicinal value (Rumaling et al., 2024). *Hoya* thrives under varying environmental conditions, depending on the species. Generally, *Hoya* prefers temperatures ranging from 16-29°C and indirect light.

Hoya is a native tropical plant of Southeast Asia, distributed from the southern part of the Himalayas, Papua New Guinea, and China to Japan and eastern Australia (Hafiz et al., 2013). There are 400-500 published *Hoya* species names worldwide, with over 100 found in Indonesia (Rahayu, 2021), making Indonesia the country with the highest *Hoya* biodiversity. Rahayu (2006) reported the Hoya diversity in Central Kalimantan, whereas Daawia et al. (2023) reported Hoya species found in Papua. Unfortunately, the biodiversity contrasts with the scarcity of information available for *Hoya*, as details on its life cycle, flowering characteristics, and cultivation are limited. Information on leaf characteristics, for example, is important for understanding their ecological adaptations (Putri et al., 2025). This lack of information results in limited utilization of *Hoya* for knowledge and economic purposes.

Plant identification was conducted to obtain species-specific morphological information. In our study, growth and flowering characteristics were examined to evaluate *Hoya* growth in a new growing environment. The presented results may support future research on ornamental plant domestication, breeding, and conservation, particularly for tropical species with high horticultural potential. This research offers practical information, particularly the time to flower for Hoya, that may be useful for commercial flowering-plant growers and ex situ conservation efforts.

2. Materials and Methods

The study was conducted from November 2021 to December 2022 in Tumpang, Malang (604 meters above sea level), East Java, Indonesia. The temperatures range from 19-28 °C with an average of 24.1 °C, and 210 rainy days per year. Relative humidity ranges from 60-96% with an average of 79.9%. The plant materials consisted of rooted cuttings of five *Hoya* species from West Borneo (Cici Nursery, Sekadau): *H. callistophylla*, *H. elliptica*, *H. latifolia*, *H. nabawanensis*, and *H. walliniana*. Sekadau is characterized by a tropical rainforest climate, extensive biodiversity, and heavily forested landscapes with altitudes of 100-150 m above sea level. The rooted cuttings were planted in 15 cm pots (volume 1244 cm^3), and the planting medium consisted of equal volumes of burnt rice husks, bamboo compost, and cocopeat (1:1:1), with slow-release fertilizer Osmocote N-P-K 13-13-13.

The study was set up as a completely randomized design with the Hoya species as a single factor tested. Each species was represented by three replicates. Data was recorded and processed using Microsoft Excel and RStudio 2023.12.1 Build 402. Vegetative growth data at week 50 were analyzed using one-way analysis of

variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) at a significance level of 5% to determine differences among species.

Vegetative growth measurements were conducted on the number of leaves, nodes, branches, and stem height. The longest stem length and the number of nodes were measured at the start of the experiment to obtain the initial growth data. Stem height was measured with a tape measure from the base of the stem to the tip of the shoot, following Yulianti et al. (2018). The number of branches represented the number of primary branches that emerged from the main stem. The number of leaves represented the overall leaf count in a single plant pot.

Flowering characteristics included days to anthesis, flowering duration from anthesis until the flowers wilted, the number of flowers per rachis, rachis length, flower diameter, corolla diameter, corona diameter, and flowering branch diameter. Height to first peduncle was measured from the stem base to the first peduncle insertion. The diameter of the flowering branch was measured on the stem where the peduncle emerged.

3. Results and Discussion

3.1 Vegetative Growth of *Hoya* Species

Fig. 1 presents the growth chart of five *Hoya* species over a 50-week observation period in terms of leaf count, primary branch count, stem node count, and plant height. *H. walliniana* showed a significantly higher increase in node, leaf, and primary branch count compared to other species, especially after 20 weeks. *H. callistophylla* and *H. elliptica* showed minimal increase in the three parameters. In terms of plant height, *H. nabawanensis* reached the greatest height, followed closely by *H. walliniana* and *H. elliptica,* with *H. callistophylla* and *H. latifolia* exhibiting slower growth. We found that *H. walliniana* and *H. nabawanensis* were the most vigorous species across most growth metrics.

Many Hoya species have leathery, often fleshy or succulent leaves, but there are variations across species (Hafiz et al., 2013; Rodda et al., 2020). In general, the thickness correlates directly with drought tolerance: thicker leaves store more water, making them more adapted to dry conditions. All Hoya species in this study are climbers with succulent leaves but vary in size and thickness (Fig. 2). In terms of growth, most Hoyas are climbers, except for *Hoya lasiantha*, which is epiphytic and shrubby (Rodda et al., 2020).

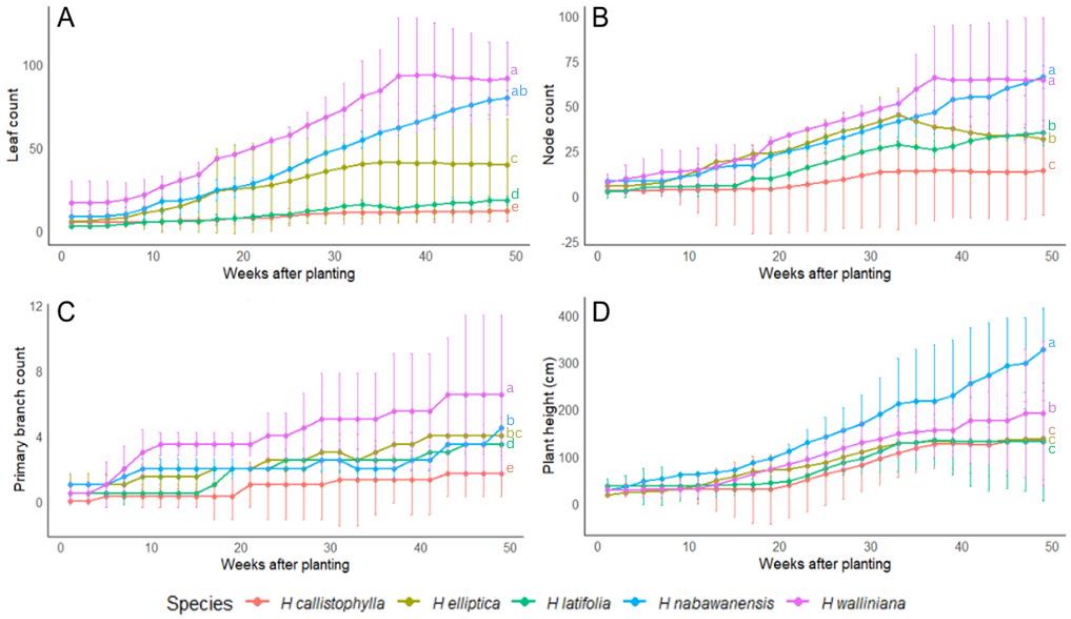

Fig. 1. Leaf number (A), node number (B), primary branch number (C), and plant height (D) of *H. callistophylla, H. elliptica, H. latifolia, H. nabawanensis,* and *H. walliniana* at Tumpang, East Java, Indonesia. Values represent means ± standard deviation (n = 3). Letters following values indicate significant differences among species based on Duncan's Multiple Range Test (DMRT, p ≤ 0.05) at week 50

3.2 *Hoya* Flowering

Table 1 presents data on the flowering characteristics of the *Hoya* species. *Hoya latifolia* did not flower during the 50-week study period. Therefore, *H. latifolia* was excluded from the flowering analysis, as it likely requires more than 50 weeks from cuttings to reach the generative phase, consistent with Rahuya et al. (2019), who reported that *Hoya* reaches the generative phase at 1.5–2 years of age.

The *Hoya* in this study had a shorter flowering period than that reported by Rahayu (2010), who found that Hoya flower buds took over a month to reach anthesis and then bloomed for 4 to 14 days.

Hoya nabawanensis took the longest days from planting to reach anthesis, followed by *H. elliptica*. *H. callistophylla* and *H. walliniana* both reached anthesis more quickly (Table 1). All four species exhibited a similar duration for flowers to wilt after blooming, with 3 ± 1 days. *H. walliniana* produced the most flowers per rachis, followed by *H. nabawanensis*, *H. elliptica*, and *H. callistophylla*. In terms of height to first peduncle, *H. nabawanensis* was the tallest, while *H. callistophylla* had the shortest. *H. elliptica* also had the largest flower diameter, corolla diameter, and corona diameter, while the other species had smaller values. The peduncle was the longest in *H. nabawanensis.* The stem diameter was the largest in *H. walliniana* (Table 1).

Table 1. Flowering characteristics of several *Hoya* species*

Species	*H. elliptica*	*H. callistophylla*	*H. nabawanensis*	*H. walliniana*
Time to anthesis (days)	183 ± 2.0	115 ± 6	273 ± 2	115 ± 8
Time to flower wilt (days)	3.0 ± 1.0	3.0 ± 1.0	3.0 ± 1.0	3.0 ± 1.0
Number of flowers per *rachis*	24.0 ± 4.9	22.5 ± 6.6	24.9 ± 3.3	32.0 ± 1.6
Height to first peduncle (cm)	98.7 ± 23.7	66.0 ± 13.5	137.8 ± 74.5	98.5 ± 51.7
Flower diameter (mm)	53.0 ± 4.0	43.0 ± 6.0	29.0 ± 2.0	30.0 ± 4.0
Corolla diameter (mm)	13.4 ± 0.4	7.4 ± 3.0	5.1 ± 1.2	4.2 ± 0.7
Corona diameter (mm)	5.9 ± 1.0	5.5 ± 0.0	2.4 ± 1.0	2.8 ± 0.0
Peduncle length (mm)	29.8 ± 8.0	7.8 ± 5.0	31.1 ± 9.0	23.0 ± 14.0
Stem diameter (mm)	1.8 ± 0.6	1.6 ± 0.5	1.4 ± 0.3	4.7 ± 0.4

**Values represent means ± standard deviation (n = 3).*

3.3 Flowering Phenology of *H. callistophylla, H. elliptica, H. nabawanensis,* and *H. walliniana*

Fig. 2 presents the flowering phenology of four *Hoya* species that flowered in East Java, arranged from left to right. The phenological photos demonstrated the first visible emergence of floral buds, pedicel elongation, floral bud swelling, color changes, and anthesis. In the first stage, floral buds were visible as a small cluster at the tip of the peduncles. In the second stage, the floral buds grew outward to form a typical umbrella-like shape (umbel) characteristic of the genus *Hoya*. In the third stage, the corolla and corona structures swelled further and displayed clearer colors specific to each species. The final phase, anthesis, showed the opening of the corollas. At this stage, the floral fragrance started to emerge. Basyir et al. (2024) reported that Hoya fragrance comes from the floral glands, indicating the presence of secondary aromatic metabolites that play a role in interactions between plants and environmental factors.

Of the four flowered *Hoya* species, *H. elliptica* reached anthesis the fastest at 23 days, whereas *H. callistophylla* required the longest at 30 days from the first visible floral bud initiation (Fig. 2). Note that these values measure bud-to-anthesis duration, distinct from the days-from-planting to anthesis as reported in Table 1. The flowers of all species, however, showed similar duration from anthesis to wilting, approximately 3 days (Table 1). This characteristics, however, are highly influenced by environmental factors. According to Sulaeman et al. (2019), abiotic factors that most influence Hoya growth, flowering, and their existence were air humidity and canopy cover. The fact that four out five Hoya from the lowland West Borneo grew well and flowered in the new environment (600 m dpl) suggests that these Hoya species can adapt to the highland environment of East Java.

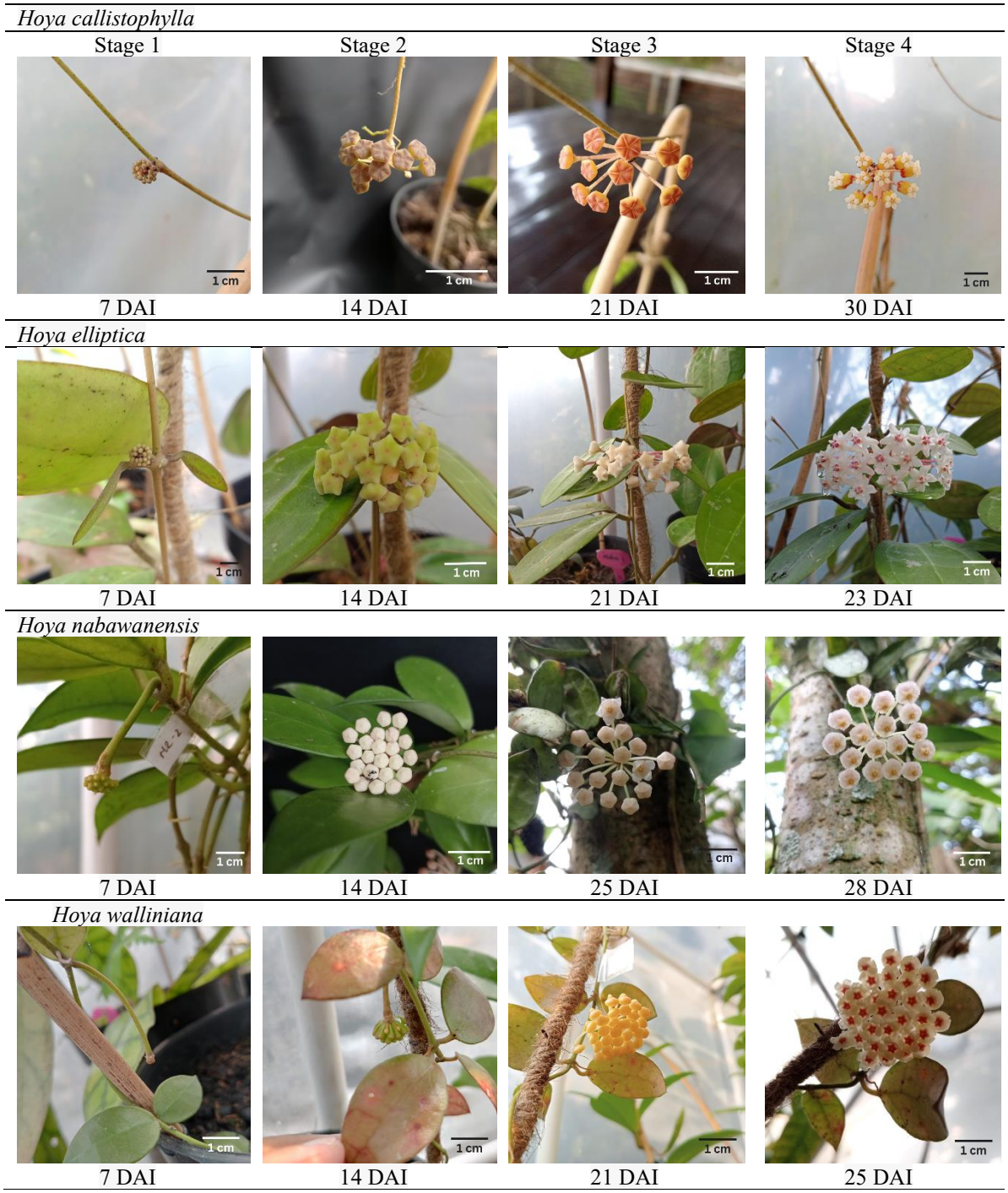

Fig. 2. Flowering phenology of *Hoya callistophylla, H. elliptica, H. nabawanensis,* and *H. walliniana*.
DAI = days after the first visible floral bud initiation. Stage 1: the first visible floral bud initiation; stage 2: the floral buds grew outward to form an umbel; stage 3: corolla and corona structures swelled and displayed clearer colors; stage 4: anthesis

This study has limitations, including a low number of plants used. This occurs in studies of plants collected from natural habitats and domesticated in other areas because such work requires permits, transfers, and transportation, which take time and a lot of resources. However, this study provided information on the growth and flowering characteristics of *Hoya* species originating from Borneo, Indonesia, when grown in East Java. This type of information would be valuable for cultivation efforts, commercial production development,

breeding, and conservation (Schmeller et al., 2008), particularly when an ornamental species is domesticated in a new region far from its original habitat.

4. Conclusions

The five *Hoya* species from Borneo, Indonesia, exhibited different growth rates. *H. walliniana* exhibited the highest growth rate in terms of leaf count, stem segment count, and branch count, while *H. nabawanensis* achieved the greatest plant height. Four out of five species flowered within the 50-week study period *(H. elliptica, H. callistophylla, H. nabawanensis, and H. walliniana). H. walliniana* showed superior flowering performance, producing the highest number of flowers per rachis and reaching anthesis most rapidly alongside *H. callistophylla,* while *H. elliptica* produced the largest floral structures. This information is useful for commercial *Hoya* growers who wish to introduce *Hoya* from its native habitat to a new growing environment.

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. Grammarly was used to edit the English.

Competing Interests

The authors have declared that no competing interests exist.

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