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Stem-Cutting Propagation of Adlay (*Coix lacryma-jobi* L.): Effects of Genotype and Stalk Portion on Vegetative Growth

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Abstract. Adlay production is constrained by its long seed-propagation maturity period, underscoring the need for alternative propagation methods. This study evaluated the effects of genotype and stem-cutting position on vegetative propagation of adlay. The experiment was conducted from November 2023 to January 2024 under screenhouse conditions at the BISU Bilar Campus, using a 2 × 3 factorial design with three replications in a completely randomized design. Two adlay genotypes (Gulian and Kiboa) and three stalk portions (basal, middle, and upper) were evaluated. Kiboa showed greater sprouting (1.78) and tillering performance (3.00) than Gulian. Stalk portion influenced all vegetative traits measured ($p < 0.001$). Basal cuttings exhibited the highest sprouting percentage (35%) and number of sprouts (4.00), while middle cuttings produced taller plants (155.34 cm) with more leaves (10.00), nodes (6.00), and tillers (5.00). These findings confirm that stem cuttings, particularly from the basal and middle portions, offer a practical and efficient method for rapid, uniform adlay propagation, supporting breeding programs, germplasm conservation, and improved availability of planting material for farmers.

Keywords: adlay; asexual propagation; stalk portion; stem cuttings

1. Introduction

Job's tears (*Coix lacryma-jobi* L.) is an herbaceous grass belonging to the Poaceae family, traditionally cultivated as an annual crop in Asian countries (Bon et al., 2023; Diao, 2017). It is valued for its high nutritional content, rich in protein, fiber, and essential micronutrients, and is also used in traditional medicine to treat various ailments, including inflammation, neuralgia, and warts (Kuo et al., 2011). In the Philippines, it is locally known as *adlay* or *katigbi* and is being promoted by the Department of Agriculture as a climate-resilient alternative staple for smallholder farmers, owing to its tolerance to pests, diseases, and periodic droughts (Aradilla, 2016; Gloria et al., 2015).

Despite this potential, the widespread commercial cultivation of adlay remains limited, particularly in regions such as Bohol, where adlay is often treated as a minor or neglected crop. One major challenge constraining its production is its long maturity period when propagated by seeds, which requires five to six months under optimal conditions and even longer under environmental stress (Aradilla, 2018). This extended cropping cycle discourages farmers from adopting adlay as a reliable food crop and limits its contribution to local food security and climate-resilient agriculture.

Vegetative propagation through ratooning, where regrowth emerges from cut stubble after harvest, has been observed to shorten the cropping cycle to three to four months. Peng et al. (2023) reported that mechanized rice ratooning in China significantly increased grain yield while reducing labor inputs, while Yang et al. (2025) reported that ratoon crops exhibited superior overall grain quality compared with main crops. These findings highlight the potential of vegetative methods to improve cereal production efficiency. However, ratooning relies on a standing root system, which limits opportunities for mass propagation and seedling establishment in new areas. Hence, stem-cutting propagation offers an innovative alternative to mimic ratooning while enabling the establishment of new plants with genetically identical material. In other tropical crops, such as cassava and sugarcane, stem cuttings have proven

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effective for rapid, uniform propagation (Okpara et al., 2021; Singh et al., 2013). However, despite its potential, there is limited information on stem-cutting propagation in adlay, and previous studies have primarily focused on seed-based methods, leaving the effectiveness of asexual propagation largely unexplored. This represents a clear research gap and an opportunity to improve the efficiency and uniformity of adlay production. Therefore, this study aimed to evaluate the feasibility of clonal propagation of adlay through stem cuttings and determine the effects of genotype and stalk position on sprouting and vegetative growth performance. The findings of this study are expected to contribute to the development of efficient propagation techniques, enhance the availability of uniform planting materials for smallholder farmers, and support germplasm conservation through the clonal multiplication of superior adlay genotypes.

2. Materials and Methods

Experimental site

The experiment was conducted at Bohol Island State University – Bilar Campus (9.7181° N, 123.8199° E) from November 2023 to January 2024 (Figure 1). The study area falls under Climate Type IV, characterized by a relatively uniform distribution of rainfall throughout the year with no pronounced dry season. During the experimental period, meteorological data were obtained from the (PAGASA, 2024). Average daily maximum temperatures ranged from 28.05 to 28.98 °C, minimum temperatures from 26.04 to 26.80 °C, and mean temperatures from 27.08 to 27.89 °C. Relative humidity ranged from 82.99% to 87.29%. Total monthly precipitation was 150.08 mm in November, 143.54 mm in December, and 51.98 mm in January. Wind speed measured at 2 m height ranged from 3.98 to 6.80 m s^{-1}. The experiment was conducted in a naturally ventilated screenhouse covered with fine-mesh netting, which reduced wind speed and prevented direct rainfall while maintaining ambient temperature and humidity conditions similar to the external environment.

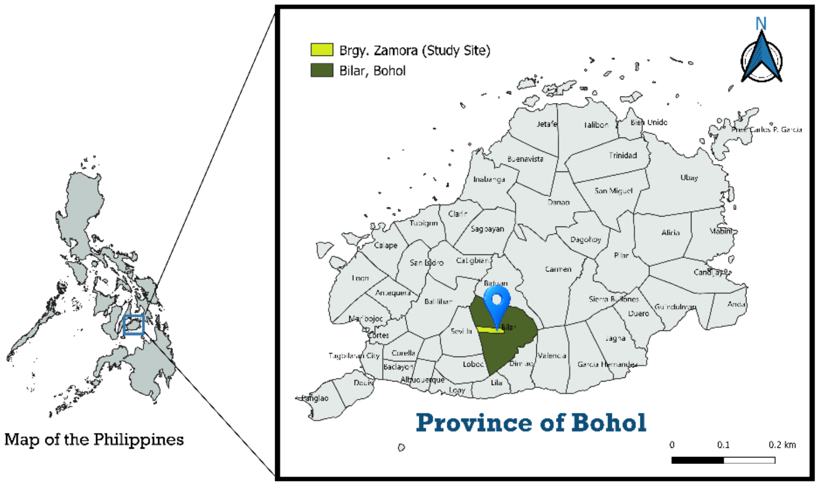

Figure 1. Geographic location of the experimental site at Bohol Island State University - Bilar Campus, Bilar, Bohol, Philippines

Experimental Design

The study used a 2 × 3 factorial experiment arranged in a completely randomized design (CRD) with three replications. Factor A was the adlay genotypes, while Factor B was the different

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portions of stem cuttings of the stalks from adlay seed crops (**Figure 2**). A total of 90 polyethylene bags were used, with two stem cuttings planted per bag. Each bag served as an independent experimental unit. The 6 treatment combinations (2 genotypes × 3 stem portions) were randomly assigned to the bags using a draw-by-lot procedure, with three replications per treatment combination. The treatments were assigned as follows: Factor A (Adlay genotypes): A1 = Gulian, A2 = Kiboa; Factor B (Portions of stem cuttings): B1 = Upper portion, B2 = Middle portion, B3 = Base portion.

Figure 2. Experimental setup for adlay stem-cuttings under screenhouse conditions.

Soil Media Preparation

The study used two types of soil media: forest soil and vermicast. Forest soil was collected from the vicinity of the BISU-Bilar Campus, air-dried for 1 week, and then sieved to remove debris and ensure uniform particle size. Vermicast was sourced from the campus Vermicomposting Project. The potting medium consisted of a 1:1 (v/v) mixture of forest soil and vermicast. Five kilograms were placed in each 6 × 11-inch black polyethylene bag, with 90 bags prepared and used for the experiment.

Soil Sampling and Analysis

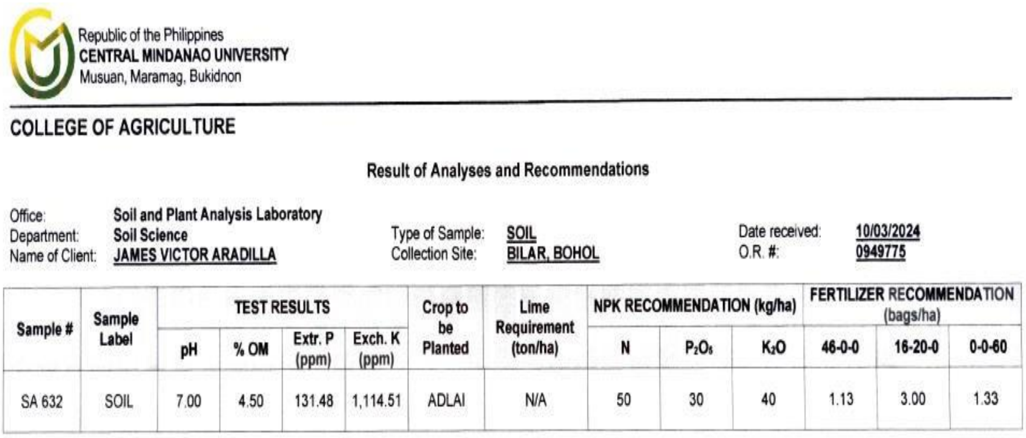
A composite soil sample was collected from the potting medium, a 1:1 mixture of forest soil and vermicast, and analyzed at the Soil and Plant Analysis Laboratory, Central Mindanao University. The results showed a neutral soil pH of 7.0, organic matter content of 4.5%, available phosphorus of 131.48 ppm, and exchangeable potassium of 1,114.51 ppm. These nutrient levels indicate a fertile medium suitable for adlay cultivation. Based on the analysis, fertilizer recommendations were made with nitrogen (N) at 50 kg/ha, phosphorus (P_2O_5) at 30 kg/ha, and potassium (K_2O) at 40 kg/ha (**Error! Reference source not found.**).

Fertilizer Application

Based on the soil analysis results, a total of 8.2 g per hill was applied, consisting of ammonium phosphate (4.5 g/hill), urea (1.7 g/hill), and muriate of potash (2.0 g/hill). This rate represents half of the full fertilizer recommendation, as the study focused solely on the vegetative stage of adlay development. Fertilizers were applied via side dressing 30 days after planting.

Planting Material Preparation and Planting

Uniform main stalks from mature plants of the two adlay genotypes were selected and used as planting material. Each stalk was cut into 20 cm portions representing the basal, middle, and upper portions, with a single node positioned at the center of each cutting. Two stem cuttings were planted per polyethylene bag, ensuring each node was well covered with soil. The soil around each cutting was gently pressed to secure the stem and maintain contact between the soil and the cutting.



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Musuan, Maramag, Bukidnon

COLLEGE OF AGRICULTURE

Result of Analyses and Recommendations

Office: Soil and Plant Analysis Laboratory
Department: Soil Science
Name of Client: JAMES VICTOR ARADILLA

Type of Sample: SOIL
Collection Site: BILAR, BOHOL

Date received: 10/03/2024
O.R. #: 0949775

Sample #	Sample Label	TEST RESULTS				Crop to be Planted	Lime Requirement (ton/ha)	NPK RECOMMENDATION (kg/ha)			FERTILIZER RECOMMENDATION (bags/ha)		
		pH	% OM	Extr. P (ppm)	Exch. K (ppm)			N	P_2O_5	K_2O	46-0-0	16-20-0	0-0-60
SA 632	SOIL	7.00	4.50	131.48	1,114.51	ADLAI	N/A	50	30	40	1.13	3.00	1.33

Figure 3. Results of the routine soil analysis of the 1:1 forest soil and vermicompost mixture used as the potting medium.

Data Collection

Vegetative data were collected from 10 sample plants per treatment combination. Bud sprouting percentage was recorded at 30 days after planting (DAP) by determining the proportion of cuttings that produced visible sprouts. The number of sprouts was counted manually at 14 DAP. At 60 DAP, sprout height was measured from the base of the shoot to the tip of the longest leaf using a measuring tape with 0.1 cm precision. Leaf length was measured from the ligule to the tip of the leaf blade, while leaf width was measured at the widest portion using a ruler. The number of leaves, nodes, and tillers were counted manually. All measurements were taken from the same sample plants to ensure consistency.

Data Statistical Analysis

The data were analyzed using analysis of variance (ANOVA) based on a 2 × 3 factorial arrangement in a completely randomized design (CRD). Treatment means were compared using the least significant difference (LSD) test at the 5% probability level. All statistical analyses were performed using the Statistical Tool for Agricultural Research (STAR) software version 2.0.

3. Results and Discussion

Clonal propagation reliably preserves desirable traits and provides a rapid means of multiplying adaptive genotypes, thereby enhancing early-stage performance in clonal offspring (Barrett, 2015). Stem-cutting propagation has also been shown to rejuvenate mature tissues, supporting early maturity and vigorous growth in clonal progeny (Muniandi et al., 2022).

In this study, analysis of variance revealed significant effects of genotype, stem-cutting portion, and their interaction on several vegetative traits of adlay (Table 1). Genotype significantly influenced the number of sprouts ($F = 4.99$, $p = 0.0453$) and number of tillers ($F = 7.24$, $p = 0.0196$), while the stem-cutting portion highly significantly affected all measured morphological traits ($p < 0.0001$). A significant genotype × stem-cutting position interaction was observed for bud sprouting percentage ($F = 4.34$, $p = 0.0382$) and number of sprouts ($F = 8.05$, $p = 0.0061$), indicating that the effect of stem-cutting position on sprouting differed between genotypes. Specifically, the magnitude of differences among basal, middle, and upper cuttings was inconsistent across genotypes, with Kiboa generally showing higher sprouting values than Gulian at all cutting positions (Table 2).

Stem-cutting portions influenced bud activation and early establishment. Basal cuttings recorded the highest bud sprouting percentage (35 ± 3.33 %) and number of sprouts (4 ± 0.33), followed by middle cuttings (15 ± 2.89 % and 2 ± 0.29 sprouts), whereas upper cuttings failed to produce any

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sprouts (Table 2). This pattern is consistent with previous findings in cassava (Okpara et al., 2021), acid lime (Malakar et al., 2019), and *Jatropha curcas* (Severino et al., 2011), in which basal stem portions demonstrated superior sprouting and establishment. These results demonstrate that adlay can be propagated asexually through stem cuttings. Nevertheless, although basal cuttings performed best, the maximum sprouting percentage observed remains relatively modest for large-scale clonal multiplication. This indicates that while stem-cutting propagation is technically feasible in adlay, further refinement of propagation protocols is necessary to improve efficiency.

Table 1. Analysis of variance (ANOVA) for the effects of genotype (A), stem-cutting portion (B), and their interaction (A x B) on vegetative growth traits of adlay

Treatments		PBS (%)	NS	SH (cm)	NL	LL (cm)	LW (cm)	NN	NT
Genotype (A)	*P* value	0.2074^{ns}	0.0453^{*}	0.4209^{ns}	0.3421^{ns}	0.5913^{ns}	0.3018^{ns}	0.2561^{ns}	0.0196^{*}
	F value	1.78	4.99	0.69	0.98	0.30	1.16	1.42	7.24
Stem Cutting (B)	*P* value	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$	$<0.0001^{**}$
	F value	202.79	270.07	184.98	93.91	7513.17	405.02	166.68	924.59
A x B	*P* value	0.0382^{*}	0.0061^{**}	0.3017^{ns}	0.5913^{ns}	0.3568^{ns}	0.5101^{ns}	0.4286^{ns}	0.1773^{ns}
	F value	4.34	8.05	1.33	0.55	1.12	0.71	0.91	2.01
CV (%)		16.10	14.05	15.75	21.94	2.45	10.58	16.47	7.02

Remarks: *P*-values are interpreted as follows: P < 0.01 = highly significant, P < 0.05 = significant, P > 0.05 = non-significant. CV = coefficient of variation; PBS = percent bud sprout; NS = number of sprouts; SH = sprout height; NL = number of leaves; LL = leaf length; LW = leaf width; NN = number of nodes; NT = number of tillers. Significance levels are indicated as * = significant, ** = highly significant, and ns = non-significant.

Table 2. Mean values of vegetative growth traits of adlay as affected by genotype and stem-cutting portion

Treatments	PBS (%)	NS	SH (cm)	NL	LL (cm)	LW (cm)	NN	NT
Adlay Genotypes (A)								
Gulian	16	1.56^{b}	92.75	6	46.09	2.63	3	2^{b}
Kiboa	18	1.78^{a}	98.68	6	44.73	2.78	4	3^{a}
Stem Cuttings (B)								
Upper	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$	$0^{c} \pm 0.00$
Middle	$15^{b} \pm 2.89$	$2^{b} \pm 0.29$	$155.34^{a} \pm 7.93$	$10^{a} \pm 0.73$	$72.12^{a} \pm 2.18$	$4.27^{a} \pm 0.13$	$6^{a} \pm 0.87$	$5^{a} \pm 0.29$
Basal	$35^{a} \pm 3.33$	$4^{a} \pm 0.33$	$131.81^{b} \pm 6.72$	$9^{a} \pm 0.52$	$64.11^{b} \pm 2.34$	$3.85^{b} \pm 0.16$	$5^{a} \pm 0.45$	$3^{b} \pm 0.15$

Remarks: Values are presented as mean ± standard error (SE). Means within a column followed by the same letter are not significantly different at P < 0.05 using Fisher's Least Significant Difference (LSD) test.

In contrast, the complete absence of sprouting in upper cuttings aligns with previous reports of positional limitations in other species. A similar pattern was reported by Muniandi et al. (2025) in moringa, where apical cuttings showed the lowest performance across shoot and root parameters. Additionally, Okpara et al.

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(2021) reported that the top portion of cassava has a high mortality rate, especially when subjected to stress during the first month after planting. Furthermore, Izadi et al. (2016) and Pigatto et al. (2018) reported that apical cuttings often exhibit higher endogenous auxin levels and lower survival rates than basal segments, a pattern previously linked to greater susceptibility to dehydration and limited stored reserves.

Basal cuttings exhibited higher sprouting capacity; however, middle cuttings demonstrated greater vegetative vigor among successfully established plants. Middle cuttings produced the tallest sprouts (155.34 ± 7.93 cm), longest leaves (72.12 ± 2.18 cm), widest leaves (4.27 ± 0.13 cm), and the highest number of tillers (5 ± 0.29) (**Table *2***). Similar trends have been reported in sugarcane (Ali & Pratiwi, 2022; Hamma et al., 2015), *Pteroceltis tatarinowii* (Li et al., 2019), and cassava (Okpara et al., 2021). According to Kraiem et al. (2010), the establishment and growth performance of stem cuttings are influenced by branch age, stem segment position, and stem diameter. These factors determine the classification of stem cuttings, whether softwood, semi-hardwood, or hardwood, which in turn influences rooting and shoot development (Hartmann et al., 2014; Simanjuntak & Wardani, 2021). In the present study, the enhanced vegetative performance of middle cuttings corresponds to characteristics commonly attributed to semi-hardwood segments.

The findings demonstrate a clear contrast between sprouting success and vegetative vigor along the stem axis, with basal cuttings optimizing establishment and middle cuttings maximizing growth potential. These results contribute to plant propagation theory by demonstrating that stem position influences both establishment and post-establishment growth, and that these responses vary across genotypes. Additionally, stem-cutting propagation offers an accessible, low-cost method for multiplying elite adlay genotypes. Basal cuttings are recommended when maximizing plant establishment from limited material is the priority, whereas middle cuttings are preferable when robust vegetative growth is desired. These evidence-based recommendations can guide farmers and seed systems in developing efficient clonal multiplication protocols for adlay as a climate-resilient crop.

4. Limitations and Future Directions

This study provides important preliminary data on clonal propagation of adlay via stem cuttings; however, several limitations warrant consideration. The relatively low sprouting percentages, especially in basal cuttings, highlight the need to further refine propagation protocols to improve efficiency for commercial application. Experiments were conducted under controlled environmental conditions, which may not fully reflect the diverse and often challenging growing environments faced by smallholder farmers in tropical regions. Additionally, the study included a limited number of genotypes and did not assess physiological parameters such as endogenous hormone levels or carbohydrate reserves, which are critical to understanding the mechanistic basis of cutting performance.

Future research should focus on optimizing propagation techniques by evaluating the effects of exogenous rooting hormone applications, variable humidity and temperature regimes, and mother plant physiological status. Expanding trials across diverse agroecological zones and integrating a broader range of locally adapted genotypes will improve the applicability of the findings. Incorporating biochemical and molecular analyses will further elucidate physiological factors influencing sprouting and growth vigor. Addressing these limitations will help develop reliable, cost-effective propagation methods, ultimately enhancing the availability of high-quality planting materials and supporting sustainable adlay production for smallholder farmers in tropical areas.

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5. Conclusion

Stem-cutting propagation is a viable and effective asexual method for multiplying adlay, addressing the key challenge of long seed-based maturity cycles. Results demonstrated significant differences in sprouting capacity and vegetative growth between genotypes and stem-cutting portions, with basal cuttings producing the highest sprouting rates and middle cuttings exhibiting greater vegetative vigor. Notably, the Kiboa genotype consistently outperformed Gulian across most traits, making it a promising candidate for clonal propagation. These findings provide initial evidence supporting stem-cutting propagation in adlay, although further evaluation across additional genotypes is needed. This study provides one of the most detailed pieces of evidence supporting stem-cutting propagation in adlay, thereby filling an important research gap. In practice, using basal and middle stem segments offers a rapid, uniform, and low-cost approach to multiply elite genotypes, thereby shortening cropping cycles and improving planting material availability for smallholder farmers. Ultimately, adopting this propagation strategy can enhance the productivity and climate resilience of adlay cultivation in tropical farming systems. Future studies should explore a wider range of genotypes, optimize cutting techniques, and investigate hormone treatments to further enhance propagation efficiency.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the author(s) used ChatGPT and DeepSeek to assist with language editing and improving the clarity of the text. The author(s) reviewed and edited the content after using these tools and took full responsibility for the final content of the manuscript.

Authorship Contribution Statement

J.V.R.A.: conceptualization, data analysis, writing, review, and editing; J.R.S.G: writing original draft preparation, writing—review and editing, conducted the experiment, collected the data, and supervised the research process; M.J.A.N: conducted the experiment, collected the data, and writing—review and editing. All authors read and approved the final version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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