InJAST
Volume 6, Number 1, April 2025
Pages: 41-46

P - ISSN: 2722 - 0133
E - ISSN: 2722 - 0141
DOI: https://doi.org/10.33751/injast.v6i`1.27

Ecological potential of jalawure (*Tacca leontopetaloides* Kuntz) as an alternative food: relationships between plant height and elevational distribution in coastal Garut, West Java

WARDAH[1], YOSSA ISTIADI[2], DOLLY PRIATNA[2,*]

[1]Research Center for Ecology and Ethnobiology, National Research and Innovation Agency (BRIN) – Republic Indonesia, Jl. Raya Jakarta-Bogor KM. 46 Cibinong, Bogor, Indonesia 16915
[2]Graduate School of Environmental Management, Pakuan University, Jl. Pakuan, Tegallega, Bogor Indonesia 16129

*Corresponding author: *dollypriatna@unpack.ac.id*

Submitted 17 January 2024; Accepted 12 August 2025; Published 17 August 2025

ABSTRACT

Jalawure (*Tacca leontopetaloides* Kuntz) is a starch-rich tuberous plant endemic to coastal ecosystems of West Java. This study investigated its growth potential as an alternative food source, analyzing plant height and spatial distribution relative to elevation in Garut Regency's southern coast. Nine observation plots (10 m × 25 m) were established perpendicular to the shoreline across three districts. For each plot, plant height, elevation, distance to shoreline, soil properties, and plant density were measured. Statistical analysis (Kruskal–Wallis, Duncan test, and linear regression) revealed significant variation in plant height across habitats ($p = 0.017$), with optimal growth at moderate elevations (15–20 m asl) and semi-shaded plots. Population densities varied from 440 to 1,400 individuals per hectare, indicating substantial carbohydrate reserves. Elevation gradient accounted for ~30% of height variation. These findings highlight jalawure's potential role in community food resilience and climate adaptation, particularly in drought-prone coastal zones. Promoting jalawure cultivation under agroforestry or coastal restoration frameworks may strengthen local food security.

Keywords: *Tacca leontopetaloides, jalawure, elevation, plant height, alternative food, coastal Garut, Indonesia.*

INTRODUCTION

Indonesia is an agrarian country where agriculture plays a central role in supporting the national economy and community livelihoods. However, this sector is highly vulnerable to the impacts of climate change, which affect cropping patterns, planting schedules, productivity, and the quality of agricultural yields (Nurdin, 2011; Priatna & Khan, 2024). Phenomena such as the El Niño Southern Oscillation (ENSO) can exacerbate these challenges, particularly for food crops (Ismail et al., 2019; Li et al., 2019; Sarvina et al., 2020). Climate change, closely linked to weather variability and global warming, has been reported to reduce agricultural production by 5–20% (Suberjo, 2009) and poses a serious threat to rice production (Boer, 2010). Angles et al. (2011) also observed that reduced rainfall intensity is a major factor contributing to lower crop yields, further demonstrating the adverse effects of climate change on food security (Utami et al., 2011; Priatna & Monk, 2023; Priatna et al., 2025).

Coastal areas are among the most affected regions, including the southern coast of Garut Regency, West Java, which relies heavily on rain-fed agriculture. The unpredictable rainfall in this region has disrupted agricultural cycles and fishery activities, leading to reduced incomes, food shortages, and increased vulnerability of local communities. In response, coastal communities have sought alternative food resources to address food insecurity, one of which is jalawure (*Tacca leontopetaloides*), a wild tuberous plant naturally growing along the southern coast. Jalawure has potential as a local food source due to its high carbohydrate content, comparable to other staple foods.

Tacca leontopetaloides belongs to the family Taccaceae (Draenth, 1972) and is widely distributed in tropical regions of Africa, Asia, Australia, and Oceania (Jukema & Paisooksantivatana, 1996). In Indonesia, this species grows along coastal zones up to approximately 200 meters above sea level, including the districts of Pameungpeuk, Cikelet, and Caringin in Garut Regency. The plant is characterized by an upright annual habit, cylindrical to subcylindrical rhizomes with globose to obovate tubers, ovate to oblong-ovate leaves, and umbels of greenish to yellow flowers (Meena & Yadav, 2010). Jalawure starch contains 83.07%–88.07% carbohydrates (Wardah, 2015; 2017; 2020), making it a promising alternative to rice and wheat flour. Despite its potential, this local resource remains underutilized and lacks significant attention from local governments as part of broader food security strategies.

Previous studies on jalawure in the southern coast of Garut have primarily focused on its nutritional content and general potential as a local food crop (Wardah, 2014). However, ecological information, particularly regarding the relationship between plant growth (height)

and elevation of its natural habitat, remains limited. Understanding these aspects is important for assessing the suitability of jalawure for domestication and sustainable utilization.

Given the limited information on how ecological factors influence jalawure distribution and growth, this study aims to analyze the potential of jalawure (*Tacca leontopetaloides*) as an alternative food source by examining its plant height and elevational distribution in coastal areas of Garut, West Java. Specifically, this research evaluates variations in plant height across different elevations, characterizes the species' distribution patterns, and discusses their implications for the utilization and development of jalawure in community-based food security strategies.

METHODS

Study Area

This research was conducted in February 2022 across six villages located in three districts of Garut Regency, West Java Province, Indonesia. The study sites included Mancagahar Village (Pameungpeuk District), Cikelet, Cigadog, Cijambe, and Cicadas Villages (Cikelet District), and Caringin Village (Caringin District). These locations are situated along the southern coastline of Garut, characterized by sandy coastal ecosystems and rain-fed agricultural landscapes (Figure 1).

Figure 1. Map showing the distribution of jalawure (*Tacca leontopetaloides*) populations along the southern coast of Garut Regency, West Java, Indonesia, and the nine observation plots used in this study.

Data Collection

Plot Design and Sampling

An exploratory survey was conducted following methods commonly applied for vegetation and coastal plant assessments (Mueller-Dombois & Ellenberg, 1974; Kent, 2012). At each study site, a transect plot measuring 10 m × 25 m was established perpendicular to the shoreline to capture the gradient of jalawure (Tacca leontopetaloides) distribution from the coastal edge inland (Figure 2). Each main plot was subdivided into ten 5 m × 5 m subplots to facilitate detailed plant observations. For each jalawure individual within the subplots, the following data were recorded:

- Plant height (cm)
- Geographic coordinates (x and y) using a Garmin GPSmap 76CSx
- Elevation above sea level (m)
- Distance from the shoreline (m)
- Associated plant species within the plot

Voucher specimens of jalawure were collected for taxonomic confirmation and deposited in the Herbarium Bogoriense (BO), Bogor.

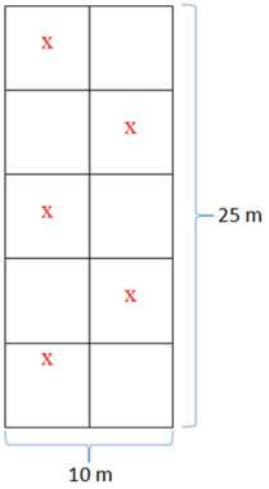


Figure 2. Layout of the 10 × 25 m observation plots subdivided into 5 × 5 m subplots, with soil sampling points (x) positioned perpendicular to the coastline.

Environmental Measurements

Soil samples were collected at five points within each transect (marked "x" in Figure 2) to analyze environmental parameters influencing jalawure growth. Soil properties measured included pH, texture, and nutrient composition (N, P, K, Ca, Mg), following standard soil analysis protocols (Anderson & Ingram, 1993). Analyses were carried out at the Soil Laboratory of the Agricultural Research Institute, Bogor. Additional microclimatic parameters, such as light intensity and humidity, were measured using a lux meter and hygrometer at each plot.

Tools and Materials

Field tools included a lux meter, soil drill, Garmin GPSmap 76CSx, measuring tape, scissors, soil tester, hygrometer, polybags, and specimen plastics. Herbarium specimens were preserved in 70% alcohol during transport and processing.

Data Analysis

Statistical analyses were performed using SPSS version 16. Two main relationships were tested:

1. Effect of habitat on plant height
   - Hypotheses:
     - H_0: Habitat differences have no effect on jalawure plant height.
     - H_1: Habitat differences significantly affect jalawure plant height.
   - Tests: Kruskal–Wallis test followed by Duncan's multiple range test for post-hoc comparisons (Field, 2013).

2. Effect of elevation on plant height
   - Hypotheses:
     - H_0: Elevation has no effect on jalawure plant height.
     - H_1: Elevation significantly affects jalawure plant height.
   - Test: Simple linear regression was applied to evaluate the correlation between elevation and plant height (Zar, 2010).

RESULTS

Distribution and Habitat Characteristics

Jalawure (*Tacca leontopetaloides*) is a tuber-producing plant found growing naturally along the southern coast of Garut Regency, West Java. The plant's tubers are traditionally used as an alternative food source, especially during the dry season when rice and wheat flour are scarce. Field observations confirmed its occurrence across three districts—Pameungpeuk, Cikelet, and Caringin—within nine study plots representing distinct habitat conditions (Table 1). Plots varied in their proximity to the shoreline (7–200 m) and elevation (6–20 m above sea level).

Table 1. Location, geographic coordinates, distance to shoreline, and elevation of nine observation plots in Garut Regency, West Java.

District	Plot	Latitude (°S)	Longtitude (°E)	Distance to shoreline (m)	Elevation (m asl)
Cikelet	1	7.604694	107.638528	35	12
Cikelet	2	7.600278	107.633611	50	8
Cikelet	3	7.610417	107.653944	100	6
Cikelet	4	7.609889	107.654000	200	8
Cikelet	5	7.616972	107.661722	40	9
Pameungpeuk	6	7.668000	107.691000	7	10
Cikelet	7	7.613333	107.657083	40	20
Caringin	8	7.258000	107.479000	100	15
Caringin	9	7.529333	107.480278	35	17

Relationship Between Habitat and Plant Height

Kruskal–Wallis analysis revealed significant differences in jalawure plant height across the nine habitat plots ($\chi^2 = 18.575$, df = 8, $p = 0.017$) (Table 2). Mean rank values ranged from 21.88 (Plot 8) to 52.30 (Plot 5), indicating substantial variation in growth performance between sites.

Table 2. Mean rank of jalawure plant height across nine plots (Kruskal–Wallis test).

Plot	N (individuals)	Mean Rank
1	2	32.25
2	7	29.07
3	18	45.61
4	18	26.97
5	5	52.30
6	5	34.10
7	7	49.93
8	4	21.88
9	5	22.50

Subsequent Duncan post-hoc testing identified significant groupings, with Plot 5 exhibiting the tallest plants (mean 64.40 cm) and Plot 8 the shortest (mean 36.00 cm) (Table 3).

Table 3. Duncan's test grouping of jalawure plant heights across nine plots ($\alpha = 0.05$).

Plot	N (individuals)	Subset 1 (cm)	Subset 2 (cm)
8	4	36.00	
9	5	36.80	
4	18	39.22	39.22
2	7	41.00	41.00
1	2	44.50	44.50
6	5	46.80	46.80
3	18		57.28
5	5		64.40
7	7		65.14

Relationship Between Elevation and Plant Height

Kruskal–Wallis analysis also examined elevation effects on plant height, revealing distinct patterns (Table 4). Mean ranks ranged from 8.00 (Plot 1) to 50.83 (Plot 3), suggesting taller plants were often associated with mid-range elevations (6–15 m asl).

Table 4. Mean rank of jalawure plant height by elevation category across nine plots.

Plot	N (individuals)	Mean Rank
1	2	8.00
2	7	46.79
3	18	50.83

4	18	31.89
5	5	34.40
6	5	27.50
7	7	22.14
8	4	38.50
9	5	21.00

Population Density

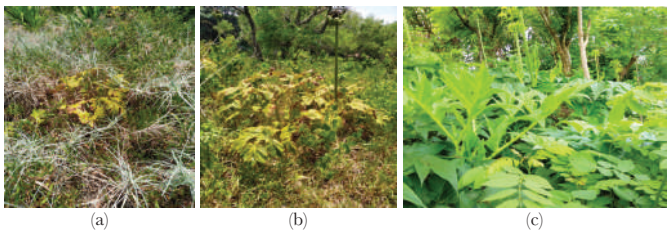
Population density varied considerably among plots, ranging from 440 individuals/ha (Plots 1 and 2) to 1,400 individuals/ha (Plot 3) (Table 5). Higher densities were generally observed in Pameungpeuk and central Cikelet districts.

Table 5. Population density of jalawure in nine observation plots in Garut Regency.

District	Plot	Density (individuals/ha)
Cikelet	1	440
Cikelet	2	440
Cikelet	3	1,400
Cikelet	4	600
Cikelet	5	1,360
Pameungpeuk	6	1,040
Cikelet	7	640
Caringin	8	520
Caringin	9	480

Habitat Conditions

Field observations documented variations in canopy cover among plots, which influenced microclimatic conditions and possibly plant growth. Plots 1–2 and 4–5 were located in relatively open habitats with minimal shade (Figure 3a–b), whereas Plot 3 exhibited moderate shading from surrounding vegetation (Figure 3c).



(a) (b) (c)

Figure 3. Habitat conditions of jalawure in Garut Regency: (a) open plot; (b) semi-open plot; (c) shaded plot.

DISCUSSION

Ecological Distribution and Habitat Variability

This study confirmed that *Tacca leontopetaloides* is naturally distributed along the southern coast of Garut, particularly within the districts of Pameungpeuk, Cikelet, and Caringin. The species thrives in sandy coastal habitats with elevations ranging from 6–20 m above sea level and varying distances from the shoreline (Table 1). Similar ecological preferences have been reported in other tropical coastal zones of Southeast Asia and Oceania, where Tacca species occupy marginal sandy soils and exhibit tolerance to salt spray and periodic drought (Wardah, 2020; Jukema & Paisooksantivatana, 1996). The presence of associated vegetation — from open sandy patches to semi-shaded areas — suggests that microhabitat conditions strongly influence plant growth and population structure.

Variation in Plant Height Across Habitats

Significant differences in plant height were observed among the nine plots (Kruskal–Wallis, $p = 0.017$; Table 6), indicating that local habitat conditions substantially affect morphological development. Plots situated closer to the shoreline or in fully open habitats tended to produce shorter individuals, whereas inland or semi-shaded plots supported taller growth (Table 2). This pattern likely reflects variations in soil moisture retention, organic matter input, and exposure to saline wind, factors previously recognized as key determinants of growth in coastal tuber species (Meena & Yadav, 2010). The Duncan test further identified specific plots (e.g., Plots 5 and 7) as having notably taller individuals, underscoring potential priority zones for conservation or semi-domestication initiatives.

Table 6. Kruskal–Wallis Chi-square test for effect of habitat on plant height.

Variable	Chi-square	df	Asump. Sig.
Height	18.575	8	0.017

Influence of Elevation on Growth Patterns

Although elevation differences across the study sites were modest (6–20 m asl), they exerted measurable effects on plant height, as shown in the elevation rank data (Table 4). Even subtle topographic gradients may influence soil drainage and nutrient availability, thereby shaping plant morphology. Comparable findings have been reported for other lowland root crops, where slight elevation changes modify both above-ground biomass and tuber yield (Angles et al., 2011). Understanding these fine-scale gradients is critical for selecting optimal cultivation sites.

Population Density and Food Security Implications

Population densities ranged from 440 to 1,400 individuals per hectare (Table 5), with higher densities observed in moderately shaded habitats. Given the carbohydrate content of *Tacca* tubers (83–88%), such densities could provide a meaningful caloric reserve for local communities during lean seasons. Ethnobotanical studies across Indonesia and the Pacific have highlighted

Tacca as an emergency food resource during periods of crop failure (Wardah, 2015; Suberjo, 2009). However, its potential remains underutilized due to limited awareness, labor-intensive processing to remove antinutritional compounds, and lack of integration into local food security policies.

CONCLUSION

This study demonstrates that *Tacca leontopetaloides* (jalawure) is naturally distributed along the southern coast of Garut, West Java, and that its growth characteristics — particularly plant height — are significantly influenced by habitat variability and elevation. Plots situated at moderate elevations and semi-shaded habitats exhibited taller plants and higher densities, suggesting these conditions are most favorable for growth. Given its high carbohydrate content and local availability, jalawure holds promise as an alternative food source, especially during periods of food scarcity linked to climate variability in coastal communities.

The results provide baseline ecological and morphological data essential for further domestication and management strategies. Integrating jalawure into coastal food security programs, community-based restoration projects, and local agroforestry systems could enhance resilience against climate-induced food insecurity. Future studies should prioritize agronomic trials, tuber yield evaluations, and nutritional analyses to optimize its utilization and promote sustainable management of this underutilized species.

ACKNOWLEDGEMENTS

We thank the Head of the Ecology and Ethnobiology Research Center, National Research and Innovation Agency, for supporting this research. We also extend our gratitude to Mr. Marko, a Jalawure plant farmer in Cigadog Village, and Mrs. Nur, Cicadas Village, South Garut, for their assistance throughout the research.

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