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The effect of beneng taro leaf extract (*Xanthosoma* undipes K. Koch) as a bioherbicide on the growth of *Cyperus rotundus*

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ABSTRAK

Teki weed (*Cyperus rotundus*) is among the most invasive weeds threatening agricultural productivity. This study aims to determine the effect of taro leaf extract (Xanthosoma undipes K. Koch) as a bioherbicide on the growth of teki weeds. The study used a Group Randomized Design (RAK) with six levels of extract concentration: T0 (Control), T1 (30%), T2 (45%), T3 (60%), T4 (75%), and T5 (90%). The parameters observed included weed height, weed wet weight, weed dry weight, and phytotoxicity level. The results of the fingerprint analysis showed that administering taro leaf extract had a very significant effect on weed height (14–28 DAT), wet weight, and weed dry weight. The T5 treatment (90%) gave the best results, with the lowest weed height of 23.40 cm, wet weight of 1.02 g, and dry weight of 0.28 g. The highest level of phytotoxicity was obtained at T5 with a value of 12% (moderate poisoning category). Thus, beneng taro leaf is a potential bioherbicide against teki weed.

Keywords: ***Cyperus rotundus*; bioherbicide; allelopathy; Xanthosoma undipes; phytotoxicity**

INTRODUCTION

Agriculture is a crucial sector in ensuring global food security. However, its productivity is often hindered by various biotic factors, including weed infestations. In Indonesia, the tropical climate with high rainfall and optimal sunlight intensity allows weeds to grow and reproduce much faster than cultivated crops. One of the most damaging and invasive weeds in agricultural fields is teki weed (*Cyperus rotundus*). According to Muthoharoh & Nikmah (2019) teki weed exhibits extraordinary adaptability across a range of extreme conditions, from dry to

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waterlogged soils, and is tolerant of pH and temperature fluctuations. This weed not only competes for water, nutrients, and light but also acts as a host for pests and diseases and releases allelopathic compounds that inhibit the growth of surrounding plants (Anwar *et al*., 2020).

To date, weed management challenges in Indonesia have been addressed primarily through mechanical Control or synthetic herbicides (Rahmadi *et al*., 2023). The continuous use of synthetic herbicides has been shown to trigger a cascade of negative impacts, such as weed resistance, environmental pollution, and risks to human health (Nurzanah *et al*., 2024). Therefore, the transition toward sustainable agricultural practices demands weed control strategies that are both effective and environmentally friendly.

The use of bioherbicides derived from natural sources is now a promising alternative to synthetic chemical herbicides (Lamonda *et al*., 2025). Bioherbicides have comparative advantages in that they are biodegradable, selective, and do not induce resistance in target weeds. Research by Simon & Sombolayuk (2025) also confirms that bioherbicides are safe for soil ecosystems, do not contaminate groundwater, and have low toxicity levels toward non-target organisms.

Research into natural materials for bioherbicides has largely focused on allelochemicals derived from plant extracts. Susanto *et al*. (2024) states that allelochemical compounds generally accumulate most highly in leaves, which serve as the center of secondary metabolism. One potential local plant rich in bioactive compounds is the beneng taro (*Xanthosoma undipes* K. Koch), an endemic species native to Pandeglang Regency, Banten, which exhibits extremely rapid growth. The potential of beneng taro leaves has been demonstrated by Fatmawaty *et al*. (2020), who found that the leaf extract exhibits strong antifungal activity against *Fusarium oxysporum*. Additionally, research on the same family (*Araceae*) by Oriyomi *et al*. (2022) showed that the leaf extract exhibits dose-dependent bioherbicidal effects, with a 90% concentration producing the strongest inhibitory effects, including chlorosis and necrosis, on weeds.

Although taro leaf extract has been shown to contain bioactive compounds with potential as biological control agents (Fatmawaty *et al*., 2020), to date, no studies have specifically evaluated the effect of taro leaf extract on the growth of teki weed (*Cyperus rotundus*). This research gap is important to bridge to reduce agriculture's reliance on synthetic chemicals while simultaneously enhancing the utility of underutilized local plants.

This study offers a novel approach by specifically exploring the potential of beneng taro leaf extract (*Xanthosoma undipes* K. Koch) as an allelopathic agent or bioherbicide against teki weed (*Cyperus rotundus*). This sustainable weed control method has not been previously studied.

Given these issues and gaps, this study aims to examine the effect of Beneng taro leaf extract, an environmentally friendly bioherbicide, on the growth inhibition of teki weed (*Cyperus rotundus*). The results of this study are expected to provide a new scientific foundation for the development of practical, sustainable weed management technologies for farmers by leveraging local biological resources.

METHODOLOGY

1. Type, Location, and Timing of the Research

This study is an experimental research conducted on farmland in the Banjar Agung Indah Housing Complex, Cipocok Jaya Subdistrict, Serang Regency, Banten Province (6°07'26"S and 106°12'07" E, elevation 37 m above sea level) and at the Plant Protection Laboratory of the Faculty of Agriculture, Sultan Ageng Tirtayasa University. This study took place from November 2025 to January 2026.

2. Tools and materials

The main equipment used in this study included an analytical balance, a 100-mesh sieve, a blender, and an oven. The main materials used were fresh beneng taro leaves (*Xanthosoma undipes* K. Koch), teki weed tubers (*Cyperus rotundus*), distilled water, and animal manure and soil as growing media.

3. Research Design

This study employed a non-factorial randomized block design (RBD) because grouping was necessary to control for variations in sunlight intensity at the experimental site (Koutra et al., 2023). The single factor tested was the concentration of taro leaf extract with 6 treatment levels: T0 = Control (without extract); T1 = 30% extract; T2 = 45% extract; T3 = 60% extract; T4 = 75% extract; T5 = 90% extract. Each treatment was repeated 5 times, resulting in 30 experimental units.

4. Conduct of the Research

Sowing and planting: The teki weed tubers used are selected based on visual criteria (firm, hard, dark brown) and uniform diameter (1–1.5 cm) to ensure consistent sprout viability (Benvenuti, 2025). Fourteen days after sowing, tubers with a uniform number of leaves are transplanted into poly bags.

Preparation of bioherbicide extracts: Extraction of taro leaves is conducted by maceration method using distilled water as the solvent for 24 hours at room temperature to prevent degradation of the active compounds (Koutra et al., 2023). The crude extract (100%) was then filtered and diluted to the appropriate concentration for each treatment (30% to 90%).

Application: The extract was evenly sprayed over the entire canopy at a dose of 10 mL per experimental unit, every two days. Applications were made in the afternoon, starting from 2 days after transplanting (DAT) through 28 DAT.

5. Observation Parameters

Parameters included weed height, fresh weight, and dry weight. Biomass drying was performed in an oven at 70°C until a constant weight was reached, in accordance with the standard for measuring weed biomass (Koutra et al., 2023). Symptoms of herbicide toxicity in weeds were assessed visually using a scoring method (0–4) adapted from the standard procedure for testing herbicide efficacy (Septiyani, 2025). A score of 0 indicates no symptoms, while a score of 4 indicates severe damage (>50% abnormal leaves, necrosis, or death).

6. Data analysis

Quantitative observational data were analyzed using Analysis of Variance (ANOVA) to test the significance of treatment effects. If the ANOVA results indicated a significant effect, the analysis was followed by Duncan's Multiple Range Test (DMRT) at the 5% level to determine specific differences between treatment means. Data analysis using DSAASTAT software This statistical analysis was not applied to the ordinal phytotoxicity level variable.

RESULTS AND DISCUSSION

1. Weed Height (cm)

Weed height is one of the parameters used to determine the observed rate of weed growth. Lower weed height reflects the success of inhibiting vegetative weed growth. This is important because, according to Moenandir (2010) and Purba et al. (2025) faster-growing weeds will dominate the canopy and shade crops beneath them. In line with the statement by Aisyah et al. (2022) the success of a bioherbicide is assessed by its ability to suppress weed growth; thus, the lower the resulting weed height, the more effective the bioherbicide is.

Based on the results of the analysis of variance, the application of taro leaf extract had a significant effect on the suppression of teki weed at 14 days after sowing, and a highly significant effect at 21 and 28 days after sowing. Among all treatment levels, T5 (90% extract concentration) was the best, consistently yielding the lowest weed height.

At the 7-day DAT observation, the extract treatments had not yet shown any significant differences. According to Irmawal et al. (2024) this condition indicates that during the early growth phase, bioactive compounds have not yet been sufficiently absorbed and accumulated in the weed tissues to produce a visibly significant inhibitory effect. This is supported by Unruh et al. (2025), who state that crabgrass tubers contain very large carbohydrate reserves as a source of energy for early growth, thereby providing high initial resistance to chemical stress.

From observation 14 to 28 days after sowing, treatment T5 (90% extract) exhibited the strongest phytotoxic effect. At the end of the observation period (28 days after treatment), treatment T5 resulted in the lowest weed height of 23.40 cm (significantly lower than the Control at 47.70 cm), with an inhibition percentage of approximately 50.9%. According to

Pohan et al. (2023) a bioherbicide is considered effective if it suppresses weed growth by more than 40% compared to the control; thus, the 50.9% inhibition rate in this study is considered effective.

This high treatment efficacy is attributed to Cahyani (2019) finding that, at high concentrations, allelopathic compounds in the bioherbicide extract act more strongly to inhibit cell elongation in the apical meristems of weeds. This is consistent with the research by Susanto et al. (2024) which found that higher extract concentration was associated with a stronger inhibitory effect on weed growth.

Table 1.
Average height of teki weed (cm)

Treatment	Observation (cm)			
	7	14	21	28
T0 (Control)	19.80	29.80^{b}	42.40^{c}	47.70^{d}
T1 (30% Extract)	18.60	26.80^{ab}	33.90^{b}	37,60^{c}
T2 (45% Extract)	19.60	24.40^{ab}	31.80^{b}	34.80^{bc}
T3 (60% Extract)	18.20	26.00^{ab}	30.70^{b}	32.70^{bc}
T4 (75% Extract)	19.80	24.40^{a}	29.60^{b}	29.90^{b}
T5 (90% Extract)	17.80	23.00^{a}	23.90^{a}	23.40^{a}

Note: Numbers with different letters within a column indicate significant differences, according to Duncan's Multiple Range Test (DMRT) at a 5% confidence level.

2. Wet Weight of Weeds (g)

Weighing the fresh weight of weeds serves as an indicator of weed growth and development following treatment. Fresh weight reflects the water content and total biomass accumulated in plant tissues. According to Arrofiqi et al. (2024) in the context of bioherbicide testing, the lower the weed fresh weight, the more effective the bioherbicide is at inhibiting the growth and development of the target weeds.

Based on the results of the analysis of variance, the concentration of taro leaf extract had a highly significant effect on the fresh weight of teki weed. This indicates that applying taro leaf extract can influence weed growth, particularly by reducing the accumulation of water-filled biomass within plant tissues.

Among all treatment levels, T5 (90% extract) showed the best result, with the lowest weed fresh weight of 1.02 g. This result differs significantly from treatment T0 (Control), which grew optimally without chemical inhibition and produced the highest fresh weight of 3.19 g. The reduction in fresh weight in treatment T5 reached approximately 68.0% compared with the Control, the highest suppression among all treatments.

The low fresh weight in the T5 treatment indicates that, at a 90% concentration, the active compounds in the taro leaf extract effectively disrupt osmosis and water uptake in weed cells. According to Sumi et al. (2018) compounds in taro leaf extract, such as saponins, are known to disrupt cell membrane integrity, thereby impairing cells' ability to maintain turgor and absorb water. Furthermore, according to Mora et al. (2022) tannins can inhibit the activity of enzymes involved in water and nutrient metabolism within weed plant tissues. When enzyme activity is disrupted, plant physiological processes such as water absorption, nutrient transport, and other metabolic processes do not function optimally. Consequently, the plant's physiological balance may be disrupted, leading to inhibited weed growth.

Table 2.
Average wet weight of weeds (g)

Treatment	Wet Weight of Weeds (g)
T0 (Control)	3.19c
T1 (30% Extract)	2.00b
T2 (45% Extract)	1.99b
T3 (60% Extract)	1.81b
T4 (75% Extract)	1.45ab
T5 (90% Extract)	1.02a

Note: Numbers with different letters within a column indicate significant differences, according to Duncan's Multiple Range Test (DMRT) at a 5% confidence level.

3. **Dry weight of weeds (g)**

Dry weight of weeds is the value derived from the weight of the weeds after the drying process. According to Li et al. (2021) dry weight is an indicator of photosynthetic product accumulation and the plant's overall metabolic processes; thus, a decrease in dry weight indicates disruption of the weeds' physiological processes.

Based on the results of the analysis of variance, the concentration of taro leaf extract had a highly significant effect on the dry weight of teki weed. This highly significant effect indicates that the bioactive compounds contained in the extract play a strong role in inhibiting the growth of the target weed.

Among all treatment levels, the lowest dry weight was obtained in the best treatment, T5 (90% extract concentration), at 0.28 g. This result differed significantly from the control treatment (T0), which yielded the highest dry weight of 0.80 g. The high dry weight in T0 indicates that, in the absence of herbicide treatment, weeds can grow optimally. This aligns with the statement by Sari et al. (2025) that weeds growing without chemical constraints will accumulate maximum dry matter because water, nutrient, and light uptake occur without interference from competition or allelopathy.

The significantly lower dry weight in the T5 treatment indicates that the 90% extract concentration contains the most toxic phytochemical compounds (such as alkaloids, flavonoids, tannins, and saponins) against weeds. According to Saputro et al. (2022) at high concentrations, these compounds are believed to be capable of damaging cell membranes, inhibiting the activity of enzymes involved in metabolism, and disrupting the photosynthesis process more intensively, thereby severely inhibiting the accumulation of dry matter in weeds.

This pattern confirms that beneng taro leaf extract acts in a dose-dependent manner. This is consistent with the finding Widhayasa (2023) that disruptions to cell membranes and photosynthetic processes caused by exposure to allelochemicals at high concentrations reduce the efficiency of converting light energy into organic matter, thereby significantly inhibiting overall dry biomass accumulation in weeds.

Table 3.
Average dry weight of weeds (g)

Treatment	Dry Weight of Weeds (g)
T0 (Control)	0.80d
T1 (30% Extract)	0.52c
T2 (45% Extract)	0.41b
T3 (60% Extract)	0.38ab
T4 (75% Extract)	0.36ab
T5 (90% Extract)	0.28a

Note: Numbers with different letters within a column indicate significant differences, according to Duncan's Multiple Range Test (DMRT) at a 5% confidence level

4. Toxicity Level

Toxicity is a measure of a substance's ability to cause damage, inhibit physiological functions, or even lead to the death of a target organism. According to Septiyani (2025) allelopathic compounds can cause phytotoxicity in weeds, with symptoms such as chlorosis (yellowing of leaves), necrosis (tissue death/brown spots), leaf drop, and stunted growth.

Based on the phytotoxicity scoring results, the control treatment (T0) showed a 0% score. This indicates no toxicity, and the weeds grew normally without exposure to chemical inhibitors. Conversely, the most pronounced toxic effect was observed with the highest concentration, namely T5 (90% extract). Treatment T5 produced the highest phytotoxicity value (12%) and a score of 2, placing it in the moderate toxicity category.

The level of toxicity in the T5 treatment indicates that as the concentration of the administered extract increases, the extent of damage to the weeds increases as well. According to Li et al. (2022) higher extract concentrations contain greater amounts of allelochemical compounds, enabling them to effectively disrupt plant physiological processes such as nutrient uptake, enzyme activity, and chlorophyll formation.

The accumulation of phenolic and allelochemical compounds from the plant extract at 90% concentration suppressed weed growth by inhibiting vegetative growth. These findings confirm that an increase in the concentration of taro leaf extract is directly proportional to an increase in phytotoxicity, making it highly promising for use as an environmentally friendly bioherbicide.

Table 4.
Weed phytotoxicity scoring

Treatment	Value (%)	Phytotoxicity Scoring
T0 (Kontrol)	0	0
T1 (30% Ekstrak)	2	0
T2 (45% Ekstrak)	6	1
T3 (60% Ekstrak)	8	1
T4 (75% Ekstrak)	7	1
T5 (90% Ekstrak)	12	2

Note: 0 = No poisoning occurred (poisoning 0-5%), 1 = Mild poisoning (poisoning 6-10%), 2 = Moderate poisoning (poisoning 11-20%), 3 = Severe poisoning (poisoning 21-50%), and 4 = Very severe poisoning (poisoning >50%).

Figure 1. The toxicity level of treatment T5 in plot 1, with a phytotoxicity value of 12% and a score of 2

CONCLUSION

The application of taro leaf extract effectively inhibited teki weed (*Cyperus rotundus*) growth, with a 90% concentration (T5) providing the optimal inhibitory effect. This effectiveness is demonstrated by the best result in suppressing the weed growth rate, with the maximum value recorded at 28 DAT (23.40 cm), as well as the suppression of fresh weight (1.02 g), total dry weight of weeds (0.28 g), and canopy dry weight (0.10 g), while also inducing the highest level of phytotoxicity with a toxicity rate reaching 12%. As a follow-up to optimize the use of this local natural material, it is recommended that future research test the effectiveness of taro leaf extract against various weed species commonly found in agricultural fields to better understand its bioherbicide activity spectrum.

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