Exploratory study of weed density, distribution and soil seed bank composition in a selected abaca (Musa textilis) plantation at Baybay City, Philippines

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Short Report

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Exploratory study of weed density, distribution and soil seed bank composition in a selected abaca (*Musa textilis*) plantation at Baybay City, Philippines

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Abstract

Abaca (*Musa textilis*), a major fiber crop in the Philippines, remains vulnerable to yield losses from weed competition and pathogen transmission. This study assessed the density, distribution, and persistence of weeds in abaca plantations in Baybay City, Philippines, with emphasis on their above-ground vegetation (ABV) and soil seed bank (SSB). Weed communities were surveyed using quadrats, while soil samples were analyzed through the seedling emergence method under greenhouse conditions. Phytosociological parameters, diversity indices, and Sørensen's similarity index were employed to compare ABV and SSB composition. Results showed that broadleaf weeds dominated both ABV (70.1%) and SSB (83.8%), with grasses and sedges contributing minimally. Species diversity was higher in ABV (H′ = 0.73) than SSB (H′ = 0.56), suggesting stronger ecological dominance within the seed bank. *Chromolaena odorata* was most prevalent above ground, while *Ageratum conyzoides* dominated the seed bank, indicating a potential future shift in weed pressure. Both species are of concern as they can serve as alternate hosts of *Pentalonia nigronervosa*, the vector of Abaca bunchy top virus (ABTV), and reservoirs of plant pathogens. These findings highlight the dual role of weeds as competitors and disease reservoirs in abaca systems. Effective management should integrate timely control of broadleaf weeds, soil seed bank depletion strategies, and vector management to protect abaca yield and fiber quality.

Keywords: *Musa textilis*, weed community, soil seed bank, broadleaf weeds, abaca bunchy top virus

Introduction

The abaca (*Musa textilis*), native to the Philippines and internationally known as Manila hemp, produces fibers valued for strength, durability, and flexibility

(Gutiérrez et al., 2023; Lalusin & Villavicencio, 2025). In Eastern Visayas, abaca remains a major crop, with a report of 24% yield increase in 2025 compared to 2023 (Philippine News Agency, 2025). Despite its economic value, abaca production faces challenges from weeds that compete for resources and may act as alternate hosts of abaca bunchy top virus (ABTV) and other pathogens.

In May 2025, rapid emergence of various weed species was observed in abaca plantations in Baybay City after land clearing. Effective weed management requires baseline knowledge on weed density, distribution, and persistence. Soil seed banks, which serve as reservoirs of future infestations, are especially critical to understand but remain poorly studied in abaca systems.

This study aimed to (1) determine weed density and distribution in abaca plantations, (2) assess the soil seed bank and weed emergence after clearing, and (3) evaluate the similarity between soil seed bank composition and aboveground vegetation to provide baseline information for future weed management strategies.

Materials and Methods

Study site and weed density assessment

The study was conducted in an abaca (*Musa textilis*) plantation located in Barangay Pangasugan, Baybay City, Leyte, Philippines (10.752801430729212, 124.7964960603303). The abaca plants were cultivated under a coconut-based farming system, and the weed samples used in this study were obtained from within the abaca plantation. Weed density and composition were assessed using 1 m × 1 m quadrats randomly placed across the plantation (n = 5). Within each quadrat, all weeds were identified, counted, and recorded. The following parameters were calculated for above-ground vegetation: weed density (plants/m^2), relative density (%), and frequency (%). Specimens were collected and identified morphologically, with verification using standard taxonomic references.

Soil seed bank analysis

Soil seed bank composition was assessed following Matlou et al. (2019) with modifications. A 1 kg of soil was randomly collected from multiple points at three depths (0–10, 10–20, and 20–30 cm) and spread over 100 cm^2. Samples were spread on trays and maintained under greenhouse conditions. The seedling emergence method was used, with regular watering and weekly monitoring over 6 weeks. Emerged seedlings were counted, identified to the lowest possible taxonomic level, and classified.

Data Analysis

Weed community composition was assessed both in the above-ground vegetation (ABV) and the soil seed bank (SSB). For the ABV, density, relative density, and frequency were calculated following standard phytosociological methods. For the SSB, diversity was evaluated using the Shannon Diversity Index (Magurran, 2004) (H'), species richness (S), and evenness (J'), where evenness was derived from the ratio of H' to the natural logarithm of species richness $J' = H'/\ln(S)$. Sørensen's similarity index (SI) (Chao et al., 2006) was used to compare species composition between the ABV and SSB, calculated as

$$\text{S}\varnothing\text{rensen's index} = \frac{2C}{2C + A + B}$$

where A and B represent the number of species in each community and C is the number of shared species. Dominant species and morphological groups (broadleaf, grasses, sedges) were also identified to determine structural differences between above-ground and soil seed bank communities.

Results and Discussion

The weed community assessment revealed that broadleaf weeds dominated both above-ground vegetation and the soil seed bank, followed by grasses, while sedges were least represented (Figure 1). Broadleaf species not only exhibited the highest density, relative density, and frequency in the field but also maintained a strong presence in the soil seed bank, indicating their ecological resilience and capacity for rapid regeneration after disturbance. This dominance reflects their competitive ability and adaptability to abaca field conditions, posing a significant challenge for crop productivity.

From a management perspective, the prevalence of broadleaf weeds has direct implications for abaca health. Certain species, such as *Ageratum conyzoides* and *Chromolaena odorata*, can serve as alternate hosts for aphids (*Pentalonia nigronervosa*), which are known vectors of the Abaca Bunchy Top Virus (ABTV). Their persistence increases the risk of pathogen transmission and pest pressure in abaca plantations. Therefore, effective weed management must not only aim to reduce competition for resources but also consider the role of weeds as reservoirs of pests and diseases. Integrated strategies that combine cultural practices, timely manual removal, and the introduction of cover crops or biological controls are essential to suppress weed populations, limit their regrowth from the soil seed bank, and ultimately protect abaca yield and health.

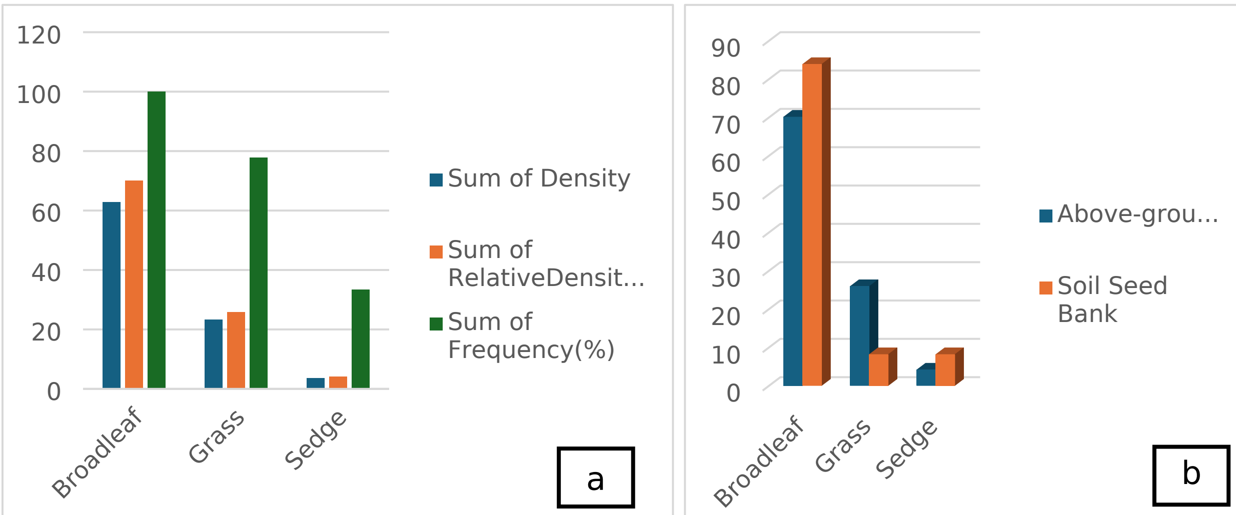

Figure 1. Composition and distribution of weed flora in abaca (Musa textilis) fields. (a) Density, relative density, and frequency of weeds grouped by gross morphology (broadleaf, grass, and sedge). (b) Comparison of above-ground vegetation and soil seed bank composition, highlighting the predominance of broadleaf species across both weed reservoirs.

Attribute	**Above-ground Vegetation**	**Soil Seed Bank**
Species richness (S)	3	3
Shannon diversity (H′)	0.73	0.56
Evenness (J′)	0.66	0.51
Dominant morphology (%)	Broadleaf (70.1%)	Broadleaf (83.8%)
Key dominant species	*Chromolaena odorata*	*Ageratum conyzoides*
Sorensen similarity (SI)	–	1.00 (morphology-level)

Table 1. Summary of diversity indices, dominant morphology, and key dominant species in the above-ground vegetation and soil seed bank. Sørensen's similarity index is shown at the morphology level.

The results show that both the above-ground vegetation and the soil seed bank are heavily dominated by broadleaf weeds, accounting for 70.1% and 83.8% of the populations, respectively (Table 1). Diversity was slightly higher in the above-ground vegetation ($H' = 0.73$) compared to the seed bank ($H' = 0.56$), meaning the standing flora is more mixed while the seed bank is more strongly controlled by a few species. Evenness followed the same trend. At the morphological level, both communities contained the same three groups (broadleaf, grasses, sedges), which explains the high Sørensen similarity value of 1.0, though this likely overstates the true overlap because species-level data usually show more differences. Notably, *Chromolaena odorata* dominated the above-ground vegetation, while *Ageratum conyzoides* was the leading species in the seed bank. This indicates that while *C. odorata* currently exerts strong above-ground pressure, the seed bank holds a large reserve of *A. conyzoides*, suggesting a potential shift in weed dominance in the future.

Ageratum conyzoides could also pose indirect risks to abaca (*Musa textilis*) production by acting as a reservoir of plant pathogens and insect vectors. The weed has been reported as a natural host of begomoviruses such as *Ageratum yellow vein virus* and *Ageratum enation virus*, which have close relatives infecting banana and abaca through vector transmission (Varma & Malathi, 2003, PNAS; Kumar et al., 2015). Furthermore, *A. conyzoides* supports populations of aphids and other insect vectors that can transmit viral diseases such as Banana bunchy top virus (BBTV) and Abaca bunchy top virus (ABTV), both of which are devastating to abaca plantations. Thus, the presence of this weed in abaca fields may facilitate pathogen spillover and vector persistence, highlighting the importance of integrated weed and vector management in abaca disease control.

Conclusion

This study demonstrated that broadleaf weeds dominate both the above-ground vegetation and the soil seed bank in abaca plantations, with *Chromolaena odorata* and *Ageratum conyzoides* identified as key species of concern. Their persistence not only threatens abaca through resource competition but also by serving as potential reservoirs of pathogens and vectors of Abaca bunchy top virus (ABTV). These findings underscore the need for integrated weed and vector management strategies to reduce weed pressure, limit seed bank regeneration, and safeguard abaca productivity.

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Clinical Trial Number

Clinical Trial Number: Not Applicable

Consent to Publish declaration: Not Applicable

Consent to Participate declaration: Not Applicable

Data Availability:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics declaration:

Plant Guidelines and Permission

The collection and handling of plant materials for this study complied with institutional, local, and national regulations regarding the ethical utilization of plants. The weed specimens collected for the study were obtained from cultivated land within a designated abaca (*Musa textilis*) plantation area located in Baybay City, Leyte, Philippines.

All sampling activities, including the collection of weed specimens and soil samples for seed bank analysis, were performed in accordance with accepted research and environmental guidelines, ensuring minimal disturbance to the study site and surrounding vegetation. The sampling strictly adhered to field safety and ethical standards outlined by the Visayas State University research protocols.

Prior to sampling, written permission was obtained from the Director of the National Coconut Research Center – Visayas (NCRC-V), authorizing the conduct of weed and soil sampling within the designated plantation area. The study did not involve any endangered or protected plant species as listed by the International Union for Conservation of Nature (IUCN).

Supplementary Files

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- AlibioWeedDensityetcData..xlsx