THE INTERACTION BETWEEN WEED AND ARTHROPODS OF AGROFORESTRY ECOSYSTEMS IN CENTRAL JAVA, INDONESIA †

[LA INTERACCIÓN ENTRE MALEZAS Y ARTRÓPODOS DE ECOSISTEMAS AGROFORESTALES EN JAVA CENTRAL, INDONESIA]

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SUMMARY

Background. The province of Central Java, Indonesia, hosts various well-developed agroforestry systems. **Objective.** To explore the interaction of weed diversity on the diversity of soil arthropods, specifically in four stations based on distinct ecosystems, namely teak (*Tectona grandis* L.f.) based agroforestry, complex agroforestry, cajeput (*Melaleuca cajuputi* (L.) Powell.) based agroforestry, and teak monoculture. **Methodology.** Data was collected from February to June 2022 in Geyer District, Grobogan Regency, Central Java Province, Indonesia, using the point interception method for weed vegetation and the pitfall trap method for soil arthropods. **Results.** The results showed that the dominant species observed in the agroforestry and monoculture ecosystems differ. *Cynodon dactylon* L.Pers. is the most dominant weed in all three agroforestry ecosystems, while *Imperata cylindrica* Beauv is the most dominant in teak monoculture. *Oecophylla smaragdina* F., an ant species locally known as *rangrang*, was the most dominant insect at all four stations. The Poaceae family was shown to be the most prevalent weed species on all stations. However, the agroforestry system displayed a greater variety of arthropods. **Implications.** The results of this study indicate that in agroforestry systems, the diversity, distribution, and density of soil-based arthropods are intimately related to the specific weed species that have evolved mutually beneficial interactions. **Conclusion.** This phenomenon demonstrates the intricate interplay between different species and the interspecies affinity within the community.
Key words: Agroforestry; Soil Arthropod; Insect; Weed; Poaceae.

RESUMEN

Antecedentes. La provincia de Java Central, Indonesia, alberga varios sistemas agroforestales bien desarrollados. **Objetivo.** Explorar la interacción de la diversidad de malezas con la diversidad de artrópodos del suelo, específicamente en cuatro estaciones basadas en ecosistemas distintos, a saber, agrosilvicultura basada en teca (*Tectona grandis* L.f.), agrosilvicultura compleja, agrosilvicultura basada en cajeput (*Melaleuca cajuputi* (L.) Powell.), y monocultivo de teca. **Metodología.** Los datos se recopilaron de febrero a junio de 2022 en el distrito de Geyer, Grobogan Regency, provincia de Java Central, Indonesia, utilizando el método de interceptación puntual para la vegetación de malezas y el método de trampa de caída para artrópodos del suelo. **Resultados.** Los resultados mostraron que las especies dominantes observadas en los ecosistemas agroforestales y monocultivos difieren. *Cynodon dactylon* L. Pers. es la maleza más dominante en los tres ecosistemas agroforestales, mientras que *Imperata cylindrica* Beauv es la más dominante en el monocultivo de teca. *Oecophylla smaragdina* F., una especie de hormiga conocida localmente como rangrang, fue el insecto más dominante en las cuatro estaciones. Se demostró que la familia Poaceae es la especie de maleza más prevalente en todas las estaciones. Sin embargo, el sistema agroforestal presentó una mayor variedad de artrópodos. **Implicaciones**. Los resultados de este estudio indican que, en los sistemas agroforestales, la diversidad, distribución y densidad de los artrópodos del suelo están íntimamente relacionados con las especies específicas de malezas que han desarrollado interacciones mutuamente beneficiosas. **Conclusión.** Este fenómeno demuestra la intrincada interacción entre diferentes especies y la afinidad entre especies dentro de la comunidad.
Palabras clave: Agroforestería; artrópodo del suelo; Insecto; Hierba; Poáceas.

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INTRODUCTION

Agroforestry is a crucial component for the continued advancement of sustainable agriculture. Agroforestry is a sustainable land management technique that optimizes yields by simultaneously cultivating crops, trees, and forest plants and animals, frequently in accordance with local cultural practices (Latumahina *et al*., 2020; Staton *et al*., 2022). Agroforests, like natural or secondary forests, naturally foster the growth of undergrowth, including weeds, herbs, and shrubs (Kiseleva, Stonozhenko and Korotkov, 2020). This undergrowth, in turn, supports the proliferation of fauna, leading to the creation of distinct ecosystems (Balfour and Ratnieks, 2022). Biodiversity is sustained by the interactions and preferences of the different components within an ecosystem (Staton *et al*., 2022). Agroforestry systems exhibit intricacy, as they include the management of multiple species within a confined space, while monocultures concentrate on maintaining a solitary plant species. The Geyer District, located in the Grobogan Regency of Central Java, possesses a distinctive advantage in implementing both agroforestry and monoculture systems (Suryanto, 2019).

Weeds are an inevitable part of both complex agroforestry systems and monocultures (Shorewala *et al*., 2021). Weeds are vegetation that develops in cultivated regions that have been disrupted by human activity. They possess the ability to hinder or displace cultivated plant populations, or they may have ecological and aesthetic significance (Navas, 1991; Colbach *et al.*, 2021). The diversity of weeds is shaped by the weed species' capacity to acclimatize to distinct environments (Rijanta, 2018). Weeds thrive in a wide range of conditions because to their quick germination, rapid regeneration rates, and strong adaptability, which surpass those of cultivated plants (Widaryanto, Saitama and Zaini, 2021). The rate of photosynthesis in weeds is influenced by the availability and intensity of sunlight, as well as the density and height of surrounding plants and weeds. Adequate spacing and low population densities can promote the growth of weeds as they require more competition for soil nutrients. Weeds thrive in higher elevations due to the greater intensity of sunlight they receive (Sharma *et al.*, 2021).

Weeds in agro-ecosystems play a crucial role in maintaining biodiversity, as they have strong connections with other components of the ecosystem, such as arthropods. Several studies have found significant relationships between weed diversity and the diversity of other organisms in the ecosystem (Marshall *et al*., 2003; Bàrberi *et al*., 2010; Ruiz *et al*., 2018; Munir *et al*., 2020). The food chain illustrates the interdependence between weeds and arthropods. Weeds, acting as primary producers, serve as nourishment for herbivorous arthropods, which are then preyed upon by carnivorous soil arthropods. Weeds generate assimilates by photosynthesis, which are then stored in storage organs such tubers, leaves, and stems (Kristiandi *et al*., 2021). Furthermore, weeds can serve as pathways for the migration of soil arthropods, providing them with shelter and breeding sites, particularly for pollinator insects (Leksono, Press and Media, 2017; Balfour and Ratnieks, 2022). The diverse array of weed species, particularly those that are native, have a crucial role in the preservation of native arthropods, and as a result, both organisms have a significant impact on preserving ecological equilibrium (Tarjuelo *et al*., 2019; Effah *et al*., 2020). Hence, it is imperative to take into account both the quantity and variety of their population. The objective of this study is to ascertain the interaction of weed diversity on soil arthropod diversity in three agroforestry ecosystems located in Central Java, Indonesia compared to monoculture practice.

MATERIAL AND METHOD

Research location

The study was carried out between February 2023 and July 2023 in the Agroforestry Area of Geyer District, Grobogan Regency, located in the Central Java Province of Indonesia. The district has a total area of 205.14 square kilometers and is situated at coordinates 7°16'0.86"S and 110°52'17.58"E. The ground exhibits a range of topographical features, ranging from level to gently undulating, with generally limited slope distances. The soil composition at the study location consists of an entisol layer with a depth ranging from around 10 to 15 cm, and a regolith layer with a depth exceeding 50 cm. The mean annual precipitation is 2,500 millimeters, exhibiting significant yearly fluctuations. The research location's climate is classified as type C, using Schmidt and Ferguson's categorization, characterized by eight months of rainfall and three months of drought (BPS, 2023).

The research site (see Figure 1) was divided into four stations based on distinct ecosystems, namely teak (*Tectona grandis* L.f.) based agroforestry, complex agroforestry, cajeput (*Melaleuca cajuputi* (L.) Powell.) based agroforestry, and teak monoculture. The teak based agroforestry habitat is located at the precise geographical coordinates of 7°15'33.78"S latitude and 110°53'35.70"E longitude. The main focus of cultivation is on teak trees and food crops, particularly corn. The cajuput-based agroforestry environment is located in the geographical coordinates 7°15'38.46"S and 110°54'14.22"E. The crops included in this category are primary crops, eucalyptus, and secondary food crops such corn, banana, and cassava. The complex ecosystem is located at the precise geographical coordinates 7°16'11.46"S and 110°51'49.80"E. It consists of teak and rosewood (*Dalbergia oliveri* Gamble ex Prain) trees, together with food crops including banana trees and cowtail beans. The monoculture habitat consists exclusively of teak trees and is located at coordinates 7°15'55.38"S and 110°52'36.84"E.

Procedure

Following preliminary the acquisition of the appropriate permits from the local forest management unit, surveys were conducted to the study location's research plots and final sampling locations were set up in coordination with the authorities. Sampling plots for weeds were designed with the point intercept method, recording weeds with a height of more than 20cm (Firmansyah *et al*., 2020) within sampling plots measuring 100cm x 100cm (Kartawinata and Abdulhadi, 2016). Following species identification and quantification, all data acquired from sampling plots were aggregated by research plot. Arthropod sampling was conducted by Pitfall Trap in accordance with IBOY (International Biodiversity Observation Year) sampling guidelines. Initial data on arthropod species identification was recorded per station.

Data analysis

All species observed and collected during in the field were identified and classified at the biology laboratory of Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta. Weed species were classified according to Steenis (2007) and arthropod were classified according to Gibb and Oseto (2006). Further quantitative descriptive analysis of the weed species was conducted to determine the Summed Dominance Ratio (SDR) which is expressed by the following indices: Relative Species Density (RD), Relative Dominance of a Species (RDo), Relative Frequency of a Species (FNSS) and Importance Value

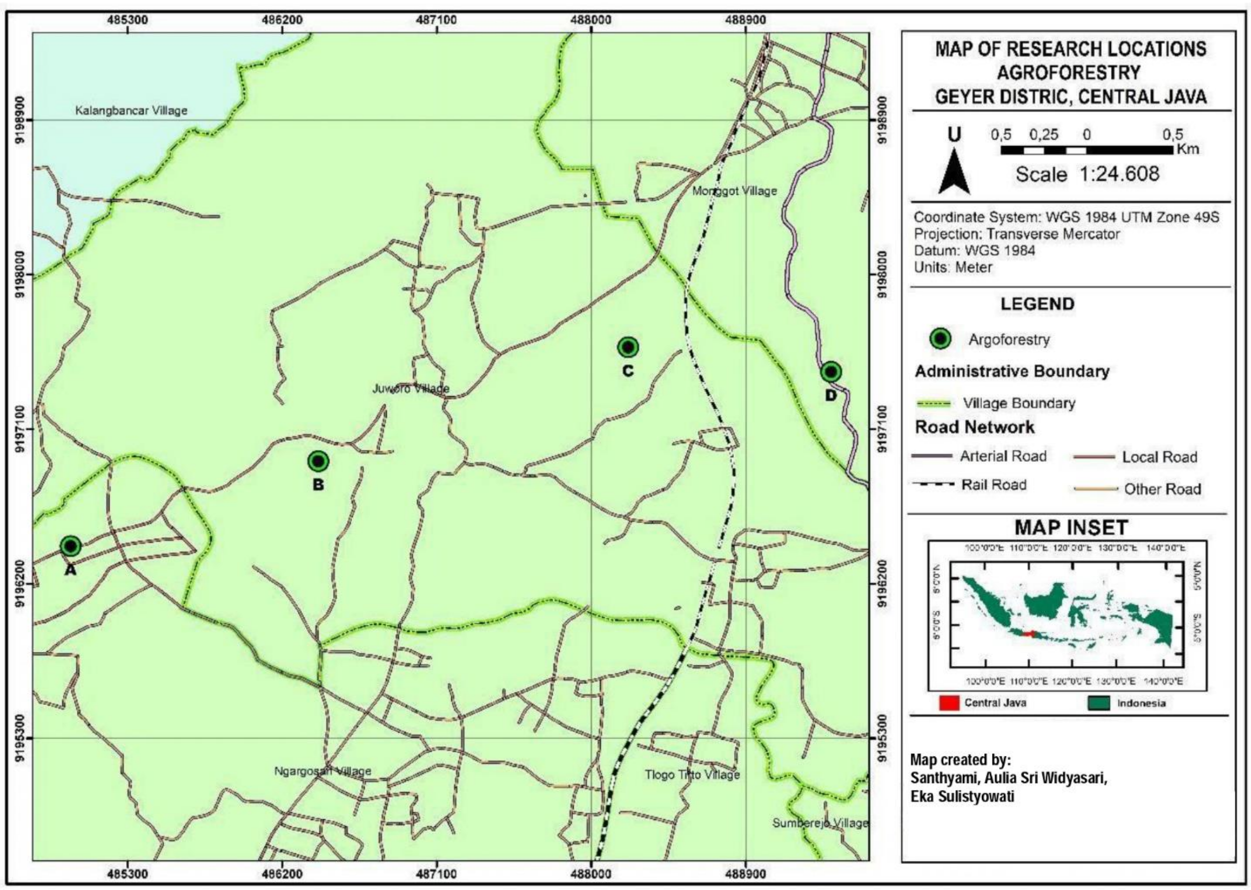

Figure 1. Research location in the agroforestry area of Central Java, Indonesia. A) Complex Agroforest B) Teak Monoculture C) Teak Agroforest D) Cajuput Agroforest.

(IV) (Dombois and Ellenbergh, 2016). The index of species diversity was calculated using the Shannon-Wiener Index (SWI) (Shannon and Wiener, 1963). Meanwhile, quantitative descriptive data on soil arthropods was limited to Species Diversity Index (H') using the Shannon-Wiener Index (SWI) and the dominance index using the Simpson dominance index

RESULTS

Composition and dominance of weed species

A total of 37 weed species were identified during the study in the agroforestry and teak monoculture of Geyer District, Grobogan Regency, Central Java. In the teak agroforestry ecosystem, 18 weed species were found from 10 families (Table 1). In the cajuput agroforestry ecosystem, 14 weed species were found from 9 families (Table 2). In a complex agroforestry ecosystem, 14 weed species from 10 families were found (Table 3). Meanwhile, in the monoculture ecosystem, 15 weed species were found from 11 families (Table 4).

The dominant species observed in the agroforestry and monoculture ecosystems are different. *Cynodon dactylon* L.Pers., a species locally known as *Grinting* Grass, has the highest Important Value (IV) and Summed Dominance Ratio (SDR) among three agroforestry ecosystems (Tables 1, 2, and 3). The weed species with the highest IV (136%) and SDR (45.4%) in the monoculture ecosystem is *Imperata cylindrica* Beauv, locally known as *alang alang* grass (see Table 4).

Composition and dominance of Arthropod species

A total of 12 species of soil arthropods were observed and identified in the research area. (Table 5). All species were catagorized based on morphological characteristics. *Oecophylla smaragdina*, an indigenous ant species locally known as *rangrang*, was the most dominant insect at all 4 stations with a total of 154 individuals spread over the 4 different stations.

Table 1. Composition and dominance of weed species in teak agroforestry, Geyer District, Grobogan Regency, Central Java, Indonesia.

No	Family	Spesies	Local Name	RD (%)	RF (%)	RDO (%)	IV (%)	SDR (%)	IVF (%)
1.	Poaceae	*Cynodon dactylon* L. Pers.	Rumput grinting	29.92	16.28	39.2	85.45	28.5	204.09
		Axonopus compressus P. B	Rumput jukut pait	37.67	16.28	19.38	73.33	24.4	
		Oplismenus undulatifolius (Ard.) Roem. & Schult.	Rumput keranjang	3.442	9.302	3.54	16.29	5.43	
		Eragrostis amabilis O.K.	Jukut karukun	0.86	0.86	2.12	5.31	1.77	
		Imperata cylindrica Beauv.	Alang-alang	9.56	9.56	11.82	23.71	7.9	
2.	Papilionaceae	*Centrosema pubescens* Benth.	Kacang sentro	5.067	11.63	8.74	25.44	8.48	30.39
		Desmodium triflorum L.	Sisik Betok	2.39	2.326	0.23	4.95	1.65	
3.	Compositae	*Elephantopus scaber* L.	Tapak Liman	1.338	2.326	1.18	4.84	1.62	14.47
		Synedrella nodiflora Gaertn.	Jotang Kuda	1.434	1.434	3.54	9.63	3.21	
4.	Verbenaceae	*Stachytarpheta jamaicensis* Vahl	Pecut kuda	1.912	1.912	3.78	12.67	4.22	12.67
5.	Asteraceae	*Ageratum conyzoides* L.	Bandotan	1.147	6.977	2.36	10.49	3.5	10.49
6.	Araceae	*Amorphophallus muelleri* Blume	Porang	0.478	4.651	0.94	6.07	2.02	8.73
		Xanthosoma sagittifolium (L.) Schott	Kimpul	0.096	0.096	0.23	2.66	0.89	
7.	Malvaceae	*Urena lobata* L.	Pulutan	3.537	2.326	1.18	7.04	2.35	7.04
8.	Euphorbiaceae	*Achalypha indica* L.	Anting-anting	0.191	0.191	0.47	2.99	1	5.65
		Phyllanthus urinaria L.	Meniran	0.096	2.326	0.23	2.658	0.89	
9.	Annonaceae	*Annona squamosa* L.	Srikaya	0.574	2.326	0.70	3.60	1.2	3.60
10.	Mimosaceae	*Mimosa invisa* Mart.	Rembete	0.287	2.326	0.23	2.85	0.95	2.85
	Total			**100**	**100**	**100**	**300**	**100**	**300**

Table 2. Composition and dominance of weed species in cajuput agroforestry, Geyer District, Grobogan Regency, Central Java, Indonesia.

No	Family	Spesies	Local Name	RD (%)	RF (%)	RDO (%)	IV (%)	SDR (%)	IVF (%)
1.	Poaceae	*Cynodon dactylon* L. Pers.	Rumput grinting	45.30	19.04	33.82	98.18	32.7	151.83
		Eleusine indica Gaertn.	Rumput belulang	1.47	2.38	0.45	4.32	1.44	
		Imperata cylindrica Beauv.	Alang-alang	13.96	14.28	21.07	49.33	16.4	
2.	Rubiceae	*Spermacoce glabra* Michx.	Rumput kancing halus	19.36	16.66	22.89	58.93	19.6	58.93
3.	Convulvulaceae	*Ipomoea batatas* L.	Ubi jalar	7.98	11.90	7.51	27.4	9.13	27.4
4.	Curcubitaceae	*Cucumis sativus* L.	Mentimun	1.92	9.52	2.39	13.84	4.61	22.42
		Citrullus lanatus Thunb.	Semangka	2.43	2.38	3.75	8.58	2.86	
5.	Asteraceae	*Ageratum conyzoides* L.	Bandotan	1.84	4.76	2.39	9.00	3	12.51
		Tridax procumbens L.	Gletang	0.44	2.38	0.68	3.51	1.17	
6.	Compositae	*Synedrella nodiflora* Gaertn.	Jotang Kuda	2.44	4.76	3.75	10.96	3.65	10.96
7.	Euphorbiaceae	*Euphorbia hirta* L.	Patikan kebo	0.73	4.76	0.56	6.07	2.02	8.64
		Euphorbia heterophylla L.	Daun katemas	0.07	2.38	0.11	2.57	0.86	
8.	Mimosaceae	*Mimosa invisa* Mart.	Rembete	0.96	2.38	0.45	3.78	1.27	3.78
9.	Malvaceae	*Sida rhombifolia* L.	Sidaguri	1.03	2.38	0.11	3.53	1.18	3.53
	Total			**100**	**100**	**100**	**300**	**100**	**300**

Table 3. Composition and dominance of weed species in Complex agroforestry, Geyer District, Grobogan Regency, Central Java, Indonesia.

No	Family	Spesies	Local Name	RD (%)	RF (%)	RDO (%)	IV (%)	SDR (%)	IVF (%)
1.	Poaceae	*Cynodon dactylon* L. Pers.	Rumput grinting	30.28	23.26	45.45	99	33	139.54
		Oplismenus undulatifolius (Ard.) Roem. & Schult.	Rumput keranjang	10.47	6.97	10.26	27.72	9.24	
		Axonopus compressus P. B	Rumput jukut pait	8.47	2.32	2.02	12.82	4.27	
2.	Compositae	*Synedrella nodiflora* Gaertn.	Jotang Kuda	18.66	23.26	12.62	54.55	18.2	54.55
3.	Asteraceae	*Ageratum conyzoides* L.	Bandotan	0.95	6.97	1.68	9.61	3.2	25.24
		Tridax procumbens L.	Gletang	2.28	9.30	4.04	15.63	5.21	
4.	Papilionaceae	*Centrosema pubescens* Benth.	Kacang sentro	6.57	6.977	5.72	19.27	6.42	19.27
5.	Mimosaceae	*Mimosa invisa* Mart.	Rembete	9.33	2.32	8.24	19.91	6.64	19.91
6.	Rubiceae	*Borreria alata* Aubl.	Goletrak	8.28	2.32	3.36	13.98	4.66	13.98
7.	Malvaceae	*Sida rhombifolia* L.	Sidaguri	0.47	2.32	1.01	3.81	1.27	11.09
		Urena lobata L.	Pulutan	0.95	4.65	1.68	7.28	2.43	
8.	Compositae	*Chromolaena odorata* L.	Kirinyu	2.85	4.65	3.19	10.71	3.57	10.71
9.	Balsaminaceae	*Impatiens balsamina* L.	Pacar air	0.28	2.32	0.50	3.11	1.04	3.11
10.	Euphorbiaceae	*Phyllanthus urinaria* L.	Meniran	0.09	2.32	0.16	2.59	0.86	2.59
	Total			**100**	**100**	**100**	**300**	**100**	**300**

Table 4. Composition and dominance of weed species in teak monocultur, Geyer District, Grobogan Regency, Central Java, Indonesia.

No	Family	Spesies	Local Name	RD (%)	RF (%)	RDO (%)	IV (%)	SDR (%)	IVF (%)
1.	Poaceae	*Cynodon dactylon* L. Pers.	Rumput grinting	7.84	2.22	5.70	15.8	5.26	151.8
		Imperata cylindrica Beauv.	Alang-alang	67.66	24.4	44.10	136	45.4	
2.	Moraceae	*Fatoua villosa* (Thunb.) Nakai	Murbey liar	3.86	13.3	13.68	30.9	10.3	30.9
3.	Compositae	*Elephantopus scaber* L.	Tapak liman	0.21	2.22	0.76	3.2	1.07	28.51
		Eclipta prostrata L.	Urang aring	4.61	8.89	9.12	22.6	7.54	
		Chromolaena odorata L.	Kirinyu	0.10	2.22	0.38	2.71	0.9	
4.	Orchidaceae	*Spathoglottis plicata* Blume	Anggrek tanah	1.82	13.3	6.46	21.6	7.21	21.6
5.	Convulvulaceae	*Ipomoea obscura* L. Kerl	Kangkung bintang putih	2.90	6.67	7.60	17.2	5.72	17.2
6.	Caesalpiniaceae	*Caesalpinia sappan* L.	Secang	0.75	11.1	1.90	13.8	4.59	13.8
7.	Liliaceae	*Smilax walteri* Pursh	Smilax	5.80	4.44	0.76	11	3.67	11
8.	Vitaceae	*Vitis aestivalis* Michx.	Anggur liar	1.61	2.22	2.66	6.49	2.16	6.49
9.	Papilionaceae	*Centrosema pubescens* Benth.	Kacang sentro	0.96	2.22	0.38	3.57	1.19	3.57
10.	Annonaceae	*Annona squamosa* L.	Srikaya	0.10	2.22	0.38	2.71	0.9	2.71
11.	Araceae	*Amorphophallus muelleri* Blume	Porang	0.10	2.22	0.38	2.71	0.9	2.71
Total				**100**	**100**	**100**	**300**	**100**	**300**

Table 5. Composition and dominance of weed species in teak agroforestry and monoculture ecosystems, Geyer District, Grobogan Regency, Central Java, Indonesia.

No	Spesies	Order	Family	Function	Total Population (Station)			
					I	II	III	IV
1	*Hahnia pusilla* C. L.	Araneae	Hahniidae	Predator	4	2	-	2
2	*Trochosa abdita* G.	Araneae	Lycosidae	Predator	2	-	1	-
3	*Pycnoscelus surinamensis* L.	Blattodea	Blaberidae	Herbivore	4	-	-	-
4	*Canthidium annagabrielae* S.	Coleoptera	Scarabaeidae	Carnivore	30	12	19	8
5	*Chlaenius flaviguttatus* C.	Coleoptera	Carabidae	Predator	7	7	7	4
6	*Clinidium sculptilis* N.	Coleoptera	Carabidae	Predator	-	-	1	-
7	*Lampyris noctiluca* L.	Coleoptera	Lampyridae	Carnivore	-	-	1	-
8	*Euborellia annulipes* L.	Dermaptera	Anisolabididae	Predator	-	-	7	-
9	*Oecophylla smaragdina* F.	Hymenoptera	Formicidae	Predator	34	50	40	30
10	*Allonemobius fasciatus* D. G.	Orthoptera	Trigonidiidae	Herbivore	53	5	7	2
11	*Anacridium aegyptium* L.	Orthoptera	Acrididae	Herbivore	17	-	-	-
12	*Gryllus pennsylvanicus* B.	Orthoptera	Gryllidae	Herbivore	21	-	-	-
Total number of individuals					172	76	83	46
Total number of spesies					9	5	8	5

Station I (Cajuput based agroforestry), Station II (Teak based agroforestry), Station III (Complex agroforestry), Station IV (Teak monoculture)

Weed and arthropod diversity

Based on the above stated data obtained, the Shannon-Wiener diversity index value (H') was calculated for both weed and soil arthropod diversity. It is thus concluded that all three agroforestry and monoculture ecosystems are classified as moderate (Tables 6 and 7). From these results it can be seen that the diversity of weeds affects the diversity of soil arthropods. The highest (H') was observed in the complex agroforests for both weeds and soil arthropods; while conversely, the lowest (H') was observed in the Teak based Monoculture ecosystem.

Table 6. Shannon-Wiener Index (H') of weed vegetation in agroforestry and teak monoculture ecosystems, Geyer District, Grobogan Regency, Central Java, Indonesia.

Station	H’	Description
Teak based Agroforestry	1.81	Medium
Eucalyptus Agroforest	1.7	Medium
Complex Agroforest	2.05	Medium
Teak Monoculture	1.32	Medium

Table 7. Shannon-Wiener Index (H') of soil arthropods in agroforestry and teak monoculture ecosystems, Geyer District, Grobogan Regency, Central Java, Indonesia.

Station	H’	Description
Teak based agroforestry	1.06	Medium
Cajuput based agroforestry	1.83	Medium
Complex agroforestry	1.73	Medium
Teak monoculture	1.01	Medium

Abiotic factors supporting the diversity of weeds and soil arthropods

Environmental or abiotic factors were also measured, in all stations to provide a holistic picture as to the differences in (H') values observed (Table 8). Soil pH was measured in all stations, with the average pH of 7 while the teak based agroforestry system measured at 6.8. Average air temperature measured at the various stations ranging from the coldest (29. 9 °C) at the teak based agroforestry system and the highest (38.4 °C) at the cajuput-based agroforestry system. Average air humidity was observed highest (82%) at the teak monoculture system.

Table 8. Abiotic factors in agroforestry and teak monoculture ecosystems, Geyer District, Grobogan Regency, Central Java, Indonesia.

Abiotic Factors	Station			
	S1	S2	S3	S4
Soil pH	6.8	7	7	7
Air Temperature (°C)	30.4	38.4	34.4	29.9
Air Humidity (%)	72	80	75	82

S1: Station 1 (teak agroforestry),
S2: Station 2 (cajuput agroforestry),
S3: Station 3 (complex agroforestry),
S4: Station 4 (teak monoculture)

DISCUSSION

Within the limited expanse of the Geyer district, distinct flora and fauna have been seen in every research location, as evidenced by the measurements recorded. The distribution and density of weed species indicate the distinct ecological conditions fostered by agroforestry systems (Roziaty and Pristiwi, 2020; Setiawan and Sarjiyah, 2021). *Cynodon dactylon* L.Pers., commonly called *Grinting* grass, is the most prevalent weed in agroforestry systems. *Cynodon dactylon* exhibits remarkable resilience (Vergiev, 2022), enabling it to thrive in arid conditions and endure prolonged flooding. Such resilience in the face of harsh environmental conditions, including human interventions such as heavy conventional de-weeding or tilling (de Pedro *et al*., 2020; Shabani *et al*., 2020; Winkler *et al*., 2023), causing *Cynodon dactylon* to have a largely negative impact agricultural areas and plantations, due to competition for space and resources (Yulifrianti *et al*., 2015; Zhang *et al*., 2019). *Cynodon dactylon* exhibits a significantly superior rate of survival when compared to other grass species, such as *Teki* grass (*Cyperus rotundus* L.) or *Gajah* grass (*Pennisetum purpureum* Schumach) (Cahyanti and Etica, 2020), contact with the soil.

Imperata cylindrica Beauv, commonly referred to as *Alang alang* Grass, is the primary weed species in the teak monoculture system. This exhibits substantial differences from the agroforestry systems studied in this research. *Imperata cylindrica* is a native weed species found in habitats spanning southeast Asia to east Africa. *Imperata cylindrica* is an allelopathic plant that inhibits the growth of other grasses by releasing arundoin, cylindrin, and fernenol (Kato-Noguchi, 2022). The plant predominantly reproduces through rhizomes, although each spikelet has the potential to generate up to 3000 seeds. Either human or natural disturbances in the environment then disperse these seeds. *Imperata cylindrica*, with its root systems reaching a length of 2m, has the ability to thrive in environments where other grass species cannot, often resulting in the displacement of local species. Once established, *Imperata cylindrica* exhibits remarkable resilience, persisting in harsh environments such as arid and infertile plains, regardless of the presence of shade plants (Syahrinudin et al., 2020; Grebner *et al*., 2022). The prevalence of *Imperata cylindrica* in the teak monoculture ecosystem can be attributed to its superior tolerance to shade compared to other grass species, particularly in regions with mature trees older than 20 years (Radzikowski *et al.*, 2020; Setiayu *et al*., 2020; Colbach *et al*., 2021).

Therefore, the Poaceae family is the most prevalent in agroforestry and monoculture environments, as indicated by Tables 1, 2, 3, and 4. Species of weeds belonging to the Poaceae family share a high degree of resilience to various environmental circumstances, enabling their survival in both wet and dry habitats (Khomsah and Zulfikar, 2021). Species from the Poaceae family are capable of rapid reproduction under harsh settings characterized by significant flooding and extended droughts (Vergiev, 2022). Furthermore, the ability to propagate by rhizomes, tubers, and shoots, in addition to dispersing seeds, allows species of the Poaceae to quickly spread in the aftermath of unfavorable environmental conditions. In addition to multiple propagation methods. Poaceae possesses robust rhizome roots that are able to regenerate quickly (Jumatang *et al.*, 2020). As a result, they typically dominate and outcompete other species, to the detriment of desirable plants (Ikhsan *et al*., 2020).

From an ecological perspective, Poaceae are ideal for providing ground cover and creating habitats for soil-dwelling arthropods. The interactions between weeds and arthropods are part of a complex system in which weeds, as the base of the food chain, serve as a regulator not only of the species but also the population of the said species through the availability of habitat, the quality of the habitat and the availability of the resources within the said habitat. It is noted that various species of arthropods are "attracted" to specific species of weeds. This interspecies affinity is essential to the management of artificial/ managed ecosystems. Since both prevalent weed species in Java are native to the region, the soil microbiome remains unchanged. Consequently, this environment continues to support local soil-dwelling arthropod species that thrive in Poaceae-based agroforests, just as they would in secondary forests (Latumahina *et al*., 2020; Barbercheck and Wallace, 2021; da Silva and Zank, 2022). The agronomic utilization of this principle is often used in the management of pests, as certain weed species are intentionally grown to provide the optimal habitat for "beneficial" predatory arthropods that help regulate the herbivorous arthropod population (Bàrberi *et al*., 2010).

The prevalence of the Poaceae in all stations is further evidenced by the consistent presence of soil arthropod species observed (Zidan *et al*., 2022). *Oecophylla smaragdina* is the dominant Arthropod species observed at all stations. This ant species exhibits remarkable resilience, as it can thrive in several settings, including scorching and arid deserts in Australia, wet and tropical jungles in southeast Asia, and freezing highlands in the Himalayas. *Oecophylla smaragdina*, typically considered arboreal, has been documented constructing nests and foraging in trees, shrubs, and on the ground. *Oecophylla smaragdina*, like many other ant species, engages in a symbiotic relationship with aphids and other honeydew producers. These organisms supply the essential nutrients required for the survival and growth of the ant colony (Narayana, 2021). *Oecophylla smaragdina* is known for having some of the largest nests in the world, which have intricate structures that serve different purposes, including breeding, farming, and defensive "barracks". *Oecophylla smaragdina* exhibits highly territorial behavior, vigorously protecting its colonies against any potential dangers, whether they are from the same species or different (Parag and Deepak, 2021; Pierre and Ramli, 2022). *Oecophylla smaragdina* plays a crucial role in terrestrial ecosystems as it acts as a predator, herbivore, scavenger, and granivore. Research conducted by Hasyimuddin *et al.* (2017) provides strong evidence that *Oecophylla smaragdina* has a significant role in soil development, pollination, and tree fertilization.

The Poaceae family was shown to be the most prevalent weed species. However, the agroforestry system displayed a greater variety of arthropods. This phenomenon demonstrates the intricate interplay between different species and the interspecies affinity within the community. The higher abundance of tree species within the managed agroforestry ecosystem also contributes to the augmented variety of arthropods that utilize the more significant number of habitats and resources that each arthropod species prefers. It is also noted that diverse ecosystems can halt the spread of pests and the various illnesses vectored by pest arthropods (Bàrberi *et al*., 2010; Sharma *et al*., 2021).

The identified abiotic factors measured, namely pH, atmospheric pressure, temperature, and humidity, are general indicators of general health and can influence species diversity. The pH 6.8 to 7, slightly acidic to neutral, is within the optimal range (6.5-7.5) for growth and nutrient availability. Soil pH determines plants' ease and rate of nutrient absorption (Suryatini, 2018). The pH range considered optimal for insects' proliferation ranges from pH 6.4-7 (Paliama *et al.*, 2022). The air temperature of the four ecosystems ranges from 29.9 to 38 °C. The optimum temperature for weed development is 18-35 °C (Uluputty, 2014). Meanwhile, the optimal temperature range for insect life is 15 °C to 45 °C (Prakoso, 2017). The lowest observed average temperature of 29.9 °C in the teak monoculture is due to the general maturity of the population (> 20 years), hence the dense canopy limiting the intensity of sunlight that penetrates the forest floor. The air humidity observed ranges from 72-82%. The optimum moisture for weed growth and seed germination ranges from 40-85% (Handayani *et al.*, 2018). Meanwhile, soil arthropods thrive at 71.9% - 74.3% (Paliama *et al.*, 2022). The highest humidity (82%) observed in the teak monoculture is due to allowing teak leaves to litter the forest floor, becoming mulch, thus affecting the humidity of the surrounding area. The large size of teak leaves also affects the quantity and quality of mulch (Setyaningsih *et al.*, 2017; Santhyami *et al*., 2022).

CONCLUSION

This paper has demonstrated the effect of weed diversity on soil arthropod diversity. It has been well established that weed diversity is a cornerstone of the general well-being of ecosystems. In all three agroforestry systems and the monoculture ecosystem, the diversity, spread, and density of soil-based arthropods are directly connected to the specific species of weeds that have evolved mutually beneficial relationships. The specific preferences of native arthropods to native weeds, despite different environmental conditions, have been demonstrated, further corroborating previous studies into arthropods' interspecies affinity to native and invasive species. The possibility of utilizing the unique interactions between weeds and soil arthropods in innovative strategies of intentional weed control, maximizing yields, and minimizing the use of herbicides warrants further elaboration of the specific preferences of each soil arthropod species for specific weed species and the subsequent effect upon the greater ecosystem.

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Compliance with ethical standards. This is a first-time publication that has not been previously published to any other journal. No approval from a bioethical committee was necessary for this study.

Data availability. The data used to support the findings of this study are available from the corresponding author upon reasonable request.

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