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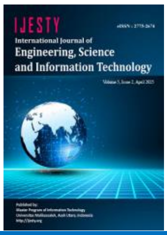

Physiological Characteristics of Weeds in Organic and Conventional Arabica Coffee Plantations in Bener Meriah Regency

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Abstract

This study aims to determine the diversity and differences of weed species found in organic and conventional Arabica coffee plantations in Bener Meriah Regency. Weeds are a limiting factor in crop productivity as they compete for nutrients, water, and sunlight. The research employed a survey method using 50 cm × 50 cm quadrants at four sampling points in each plantation type. Data were quantitatively analysed based on density, frequency, and dry weight, and Shannon-Wiener diversity and Sorensen similarity indices were calculated. The results identified 12 weed species, with *Bidens pilosa L.* as the most dominant. The diversity index was higher in organic plantations (H' = 1.8) than in conventional ones (H' = 1.4), while the weed species similarity index between the two systems was only 42%, indicating substantial differences. Weed chlorophyll content was also generally higher in organic plantations. These findings provide a scientific basis for developing targeted weed management strategies tailored to each plantation system.

Keywords: *Weeds, Arabica Coffee Plantation, Organic, Conventional.*

1. Introduction

Aceh coffee plantations are managed organically and conventionally. Organic plantation is a plantation system that is oriented towards the use of natural (local) ingredients without the use of synthetic chemicals [1]. Agriculture that is free from chemical substances that damage the environment and damage health [2]. Meanwhile, conventional plantations are plantation crop cultivation systems that rely on common agricultural practices and have long been applied with the aim of achieving high production in a relatively short period of time [3].

Weeds are unwanted plants because they can interfere with other plants and decrease productivity [4]. Weeds can suppress growth and lower crop yields because they are highly competitive, easy to multiply, and grow with few resources [5]. Weeds can reduce crop production due to competition for nutrients, water and sunlight and the presence of allelopathic substances released by certain types of weeds [6].

The physiological characteristics of weeds, such as chlorophyll index, stomata density, and rate of photosynthesis, affect their competitiveness against coffee plants [7]. Weeds with superior physiology are more adaptive and difficult to control [8]. This understanding is important for designing effective weed control strategies in Arabica coffee plantations, both organic and conventional [9].

Research by Sondang *et al*. (2020) showed that environmental conditions affect the physiological characteristics of plants, such as chlorophyll index and stomata density, which have an impact on the growth variables of coffee plants [10]. According to Andika & Wicaksono (2020), Environmental conditions affect the physiological characteristics of the plant, such as chlorophyll index and stomata density, which impact the growth variables of the coffee plant.

The physiology of weeds affects adaptation and competition with plants [12]. Weeds with high chlorophyll photosynthesise more efficiently, so they grow faster and take up more resources [13]. Water content, transpiration, and biomass are important for evaluating weed control [14]. Suggest that canopy density affects the rate of photosynthesis, which impacts biomass production and crop yield productivity under natural forest stands [16].

By taking a physiological approach to weeds, it is hoped that the information obtained is not only limited to the aspect of the existence and type of weeds, but also includes the extent to which the weed is able to affect the growth of coffee plants from a biophysical point of view [17]. This approach provides a new dimension in weed management that is more adaptive to local environmental conditions [18].

2. Methods

2.1. Time and Place

This research was carried out at Arabica Coffee Plantations in Bener Meriah Regency on organic and conventional coffee plantations, carried out from October 1, 2024, to November 10, 2024.

2.2. Tools and Materials

The tools used in sampling in the field are meters, knives, scissors, sample plots/frames measuring 50 cm x 50 cm, hoes, shovels, paper envelopes measuring 33 x 43, labels, writing stationery, Google Lens smartphones, and cameras. While the tools in the laboratory are ovens, manila paper and thread. Meanwhile, the material used in the study was a sample of weeds that were in the sample plot/frame.

2.3. Research Methods

This study uses the "survey" method to collect data with direct observation in the field. In conducting vegetation analysis, a square method was used with a sample plot measuring 50 cm x 50 cm. To represent the weed area of the coffee plantation, 4 samples were taken at each of the placements of the frame in each coffee plantation.

2.4. Research Implementation

The activity carried out in the main survey was weed sampling in organic and conventional coffee plantations. The sampling method is by placing sample plots/frames measuring 50 cm x 50 cm diagonally in organic and conventional coffee gardens.
Sampling is carried out by harvesting weeds found in each square exactly as high as the ground level. The harvested weeds are separated by species and then put in envelopes and labelled according to the time and location of the harvest.
Furthermore, the weeds that have been taken from the field are taken to the Laboratory for sorting and identification. The data collected included the name of the weed species, the number of individuals and the abundance of each species. From the data that has been obtained, analysis is carried out using formulas.

2.5. Data Analysis

1. Absolute Density = The number of individuals of a given weed species in the sample parcel

2. Species Diversity Index
   Weed species diversity is calculated using the Shannon-Wiener Diversity Index [19] using the following formula:

$$H' = -\sum pi\ Ln\ (pi) \quad \text{......(1)}$$

Information:
H' = Species diversity index
Pi = Proportion of the number of individuals of the i-type *to* the total number of individuals
The classification of the value of the diversity index is presented as follows:

Table 1. Species Diversity Index Value Criteria

Diversity Index (H')	Condition of Community Structure
H' ≤ 1	Low species diversity
1 ≤ H' ≥ 3	Temperate diversity
H' ≥ 3	High type diversity

3. Community coefficients
   The analysis of weed infestation community coefficients between sampling locations was conducted using the Sorensen Similarity Index.

$$IS = \frac{2.C}{a+b} \quad \text{......(2)}$$

Information:
IS = Sorensen's index
c = The sum of the two lowest quantities for the type of each community
a = The sum of the entire quantity in the first community
b = The sum of the total quantity in the second community
The criteria for determining the similarity analysis can be seen in Table 2.

Table 2. Sorensen's Index Value Criteria

Sorensen Index (IS)	The condition of community similarity
>75%	Very high similarity
>50% - 75%	High similarity
>25% - 50%	Low similarity
<25%	Very low similarity

4. Chlorophyll content of leaves
   The chlorophyll content of the leaves is decomposed using a chlorophyll spray. Measurements are carried out in the morning between 07:00 to 10:00 WIB. Then it was seen whether there was a difference between weeds in organic coffee plantations and conventional coffee plantations.

3. Result and Discussion

3.1. Absolute Density

Table 3 shows a high weed diversity with 12 species recorded, of which Bidens pilosa L. dominates based on an absolute density of 130 and an absolute dry weight of 686.11. This shows that this species can adapt well to both organic and conventional coffee plantation environments. This is due to factors such as light and tillage. The absolute high density of weeds can increase the level of competition in obtaining nutrients in the soil. This happens because weeds grow dense and dense, thus blocking the access of nutrients to the soil. As a result, the nutrients available to the roots of the main plant become limited

Table 3. Quantitative Data on Weeds in Organic and Conventional Coffee Plantations in Bener Meriah Regency

No	Weed Species	AD (%)	RD (%)	AF	RF (%)	ADW	RDW (%)	IV (%)	SDR (%)
1	Oxalis Debilis	41	0,14	4	0,13	231,07	0,14	0,409	0,14
2	Bidens Pilosa L.	130	0,44	8	0,26	686,11	0,42	1,116	0,37
3	Drymaria Diandra B.	14	0,05	2	0,06	181,86	0,11	0,223	0,074
4	Acemella Paniculata	9	0,03	1	0,03	91,12	0,06	0,118	0,04
5	Leersia Hexandra	10	0,03	3	0,10	128,2	0,08	0,209	0,070
6	Commelina Benghalensis L	46	0,15	4	0,13	245,72	0,15	0,434	0,14
7	Euphorbia Hirata	2	0,01	1	0,03	9,12	0,006	0,045	0,015
8	Kylling Brevifolia R.	3	0,01	1	0,03	21,91	0,013	0,056	0,019
9	Oxalis Stricta	31	0,10	4	0,13	32,99	0,020	0,254	0,08
10	Cerastium Fontanum	2	0,01	1	0,03	3,43	0,002	0,041	0,0137
11	Ageratina Altissima	3	001	1	0,03	0,63	0,0004	0,043	0,0142
12	Artemisia Vulgaris	6	0,02	1	0,03	0,74	0,0005	0,053	0,018
	Sum	297	1,00	31	1.00	1632,90	1,00	3,000	1,00

Description: AD (Absolute density), RD (Relative density), AF (Absolute frequency), RF (Relative frequency), ADW (Absolute dry weight), RDW (Relative dry weight), IV (Important value), SDR (Summed dominance ratio).

The high diversity of weeds in coffee plantations is influenced by environmental factors and land management methods. Wang *et al.* (2023) Getting the diversity of weed species tends to be higher in organic farming systems due to the lack of use of pesticides and herbicides. Other factors that affect weed density include soil composition, moisture levels, and crop rotation applied in plantations.

3.2. Diversity Index

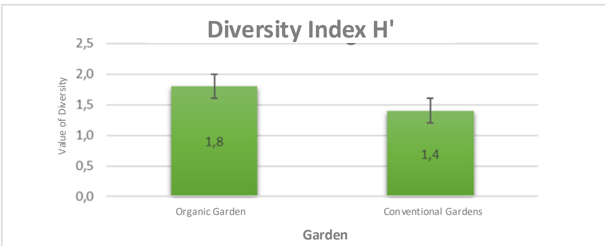

Fig 1. Weed Species Diversity Index Value in Organic and Conventional Coffee Plantations

Table 4. Quantitative Data on Weeds in Organic and Conventional Coffee Plantations

Yes	Coffee Garden	H' Value	Condition of Community Structure
1	Organic garden	1,8	Moderate diversity
2	Conventional garden	1,4	Moderate diversity

Based on Figure 1 and Table 4, the diversity index (H') of organic gardens is 1.8, which is included in the category of medium diversity**.** This shows that organic gardens have a fairly diverse number of species and are relatively balanced in population distribution. Biodiversity in organic gardens tends to be higher due to management that does not use synthetic chemicals, such as pesticides and herbicides. In conventional gardens, the diversity index (H') of 1.4 is in the category of moderate diversity, but lower than in organic gardens. This shows that despite the diversity of species, the distribution of species in conventional gardens is less even than in organic gardens. Lower diversity index values in conventional gardens are most likely due to the use of synthetic chemicals that can degrade populations of non-target organisms.

3.3. Similarity Index

The low percentage of similarity of 42% suggests that although both gardens have some species of weeds in common, many species differ between them. Organic gardens tend to support more species that are tolerant of natural conditions without chemicals, while conventional gardens are more populated by species that can withstand exposure to pesticides and herbicides. According to Setiarno *et al.*

(2022), land management factors such as the use of organic fertilizers and pesticides can affect the diversity and distribution of weed species.

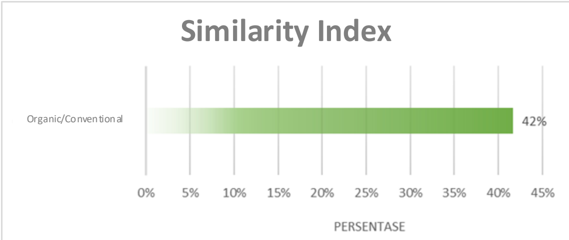

Fig 2. Index of Similarity of Organic and Conventional Coffee Plantations

The difference in the composition of weed species, as seen from the 42% similarity index, also reflects the difference in ecosystem dynamics between the two agricultural systems. In organic gardens, the presence of weeds is often considered part of the biodiversity that supports the balance of the ecosystem. Weeds can serve as a food source for insects and soil microorganisms, as well as help maintain soil structure. In contrast, in conventional gardens, weeds are often considered competitors to be eliminated, so the use of herbicides becomes a common practice. As a result, the dominant weed species in conventional gardens tend to be herbicide-resistant species, which can reduce overall biodiversity.

3.4. Chlorophyll content of weed leaves

Table 5. Chlorophyll content of weed leaves in organic and conventional plantations

Yes	Species	Chlorophyll	
		Organic	Conventional
1	Oxalis Debilis	22,3	17,5
2	Bidens Pilosa L.	26,7	23,9
3	Drymaria Diandra B.	19,2	17,2
4	Acemella Paniculata	36,1	-
5	Leersia Hexandra	24,5	-
6	Commelina Benghalensis L	20,9	18,9
7	Euphorbia Hirata	19,1	-
8	Kylling Brevifolia R.	20,1	-
9	Oxalis Stricta	19,9	17,5
10	Cerastium Fontanum	-	31,1
11	Ageratina Altissima	-	29,4
12	Artemisia Vulgaris	-	28,1

Based on Table 5, the levels of chlorophyll weeds in organic coffee plantations are generally higher than those grown in conventional systems. Let's take a look at the weed Bidens pilose L., whose presence is found in organic and conventional coffee beans. It shows a higher chlorophyll level in organic gardens, 26.7, compared to conventional gardens, 23.9. Species such as Oxalis debilis, Drymaria diandra, and Commelina benghalensis L. have similar values, where the chlorophyll value is higher in the organic system.
The chlorophyll content of weeds on coffee plantations can vary significantly depending on various environmental and land management factors. Chlorophyll is an essential pigment in the process of photosynthesis, which determines the efficiency of plants in capturing light and producing energy. In the context of coffee plantations, weed chlorophyll levels can be affected by the agricultural system applied, such as organic or conventional, light intensity, nutrient availability, and interaction with main crops and soil organisms.
The results of the research in reveal that organic farming systems significantly affect the biological and chemical properties of the soil, which in turn impacts the chlorophyll content of weeds. In contrast, the use of synthetic chemicals such as pesticides and herbicides on conventional plantations can disrupt the balance of soil ecosystems, reduce populations of beneficial microorganisms, and lead to physiological degradation in weeds, which ultimately lowers chlorophyll content.

4. Conclusion

The results of the study show that the weeds that exist in both organic and conventional coffee plantations are Bidens pilosa weeds. In addition, it is known that the physiological characteristics of organic and conventional coffee plantations have different chlorophyll content values. And there are several differences between organic and conventional coffee farms.

References

[1] H. R. Ratnaningsih, L. N. Bayinah, R. N. K. Syarifah, H. Hanifa, and others, "Pemanfaatan Bahan Alami dalam Pemeliharaan Tanaman Kopi: Pendekatan Organik untuk Pertanian Berkelanjutan di Desa Kemawi, Kecamatan Somagede," *AKSILAR Akselerasi Luaran Pengabdi. Masy.*, vol. 2, no. 2, pp. 111–119, 2025.
[2] T. B. Purwantini and N. Sunarsih, "Pertanian Organik: Konsep, Kinerja, Prospek, dan Kendala," *Forum Penelit. Agro Ekon.*, vol. 37, no. 2, p. 127, 2020, doi: 10.21082/fae.v37n2.2019.127-142.
[3] R. N. M. Hidayat, "Studi keanekaragaman serangga di perkebunan apel semiorganik dan anorganik Desa Tulungrejo Kota Batu," *Semin. Nas. Multidisiplin*, pp. 295–299, 2019.
[4] S. Utami, "Murningsih, dan F. Muhammad.(2020). Keanekaragaman dan Dominansi Jenis Tumbuhan Gulma Pada Perkebunan Kopi di Hutan Wisata Nglimut Kendal Jawa Tengah," *J. Ilmu Lingkung.*, vol. 18, no. 2, pp. 411–416.
[5] S. Utami, M. Murningsih, and F. Muhammad, "Keanekaragaman dan Dominansi Jenis Tumbuhan Gulma Pada Perkebunan Kopi

di Hutan Wisata Nglimut Kendal Jawa Tengah," *J. Ilmu Lingkung.*, vol. 18, no. 2, pp. 411–416, 2020, doi: 10.14710/jil.18.2.411-416.

[6] S. Jaya *et al.*, "Invetarisasi Gulma Pada Perkebunan Kopi Rakyat di Desa," vol. 19, no. 2, 2023.

[7] N. Dewi and K. I. Chairani, "Pengaruh Faktor Lingkungan terhadap Karakteristik Agronomi Kopi Robusta pada Dua Tipe Penaung dalam Sistem Agroforestri," *Agrotechnology Res. J.*, vol. 8, no. 2, pp. 101–110, 2024.

[8] D. Dahang, "Analisis vegetasi gulma pada ladang broccoli (Brassica oleraceae var. italica l) di kebun pendidikan Universitas Quality Berastagi," *J. Agroteknosains*, vol. 2, no. 2, 2018.

[9] S. Prijono, A. A. Hanuf, J. Y. Saputri, A. Khoirunnisak, Y. M. Nurin, and D. M. Yunita, *Pengelolaan Tanah di Kebun Kopi*. Universitas Brawijaya Press, 2021.

[10] D. Rizki, B. R. Wijonarko, and P. Purwanto, "Karakter agronomis dan fisiologis tanaman kopi robusta (coffea canephora) pada dataran tinggi di kecamatan pejawaran kab. banjarnegara," *Compos. J. Ilmu Pertan.*, vol. 2, no. 1, pp. 11–16, 2020.

[11] T. R. Andika and K. P. Wicaksono, "Karakter Fisiologi dan Pertumbuhan Tanaman Kopi Arabika (Coffea arabica) pada Manajemen yang Berbeda di Lahan Agroforestri Characteristics of Physilogy and Growth of Arabica Coffee (Coffea arabica) Plants in Different Management in Agroforestry Fields," *J. Produksi Tanam.*, vol. 8, no. 1, pp. 106–111, 2020.

[12] L. N. Bayyinah, P. Purwanto, R. N. K. Syarifah, and R. A. Pratama, "Respons Fisiologis Tanaman Jagung Manis terhadap Aplikasi Herbisida dalam Pengendalian Gulma," *J. Agro Wiralodra*, vol. 7, no. 2, pp. 66–74, 2024.

[13] I. K. Ngawit, N. Farida, and H. Haryanto, "Pengaruh Tumpangsari Jagung (Zea mays L.) dengan Famili Fabaceae terhadap Populasi dan Pertumbuhan Gulma Serta Efisiensi Penggunaan Lahan di Lahan Kering," *J. SAINS Teknol. \& Lingkung.*, vol. 10, no. 3, pp. 498–516, 2024.

[14] E. Widaryanto, A. Saitama, and A. H. Zaini, *Teknologi Pengendalian Gulma*. Universitas Brawijaya Press, 2021.

[15] C. N. S. Karubuy, R. Aditya, and W. Jacobus, "Karakteristik Stomata dan Kandungan Klorofil Daun Anakan Kayu Cina (Sundacarpus Amarus (Blume) C.N.Page) pada Beberapa Intensitas Naungan," *Kehutan. Papuasia*, vol. 4, no. 1, pp. 45–56, 2018.

[16] B. Nurkin, *Buku Ajar Silvikultur*. Fakultas Kehutanan, Universitas Hasanuddin, 2019.

[17] M. IRA, "Pemberian kombinasi ekstrak alang-alang (Imperata cylindrica) dan kirinyuh (Chromolaena odorata) pada tanaman gulma (Ageratum conyzoides) di lahan tanaman kopi Desa Ciptawaras Kabupaten Lampung Barat," UIN Raden Intan Lampung, 2021.

[18] I. Rahim and others, *Manajemen Pertanaman: Strategi Optimal Pendekatan Pertanian Terpadu*. Deepublish, 2024.

[19] T. D. Schowalter, *Insect Ecology An Ecosystem Approach*, Edisi tiga. Unity State of America: Elsevier, 2011.

[20] L. T. Indriyati, S. Santoso, and E. Irianti, "Dampak Pertanian Organik dan Konvenional pada Biodiversitas dan Sifat Kimia Tanah pada Budi Daya Tanaman Padi Sawah," *J. Ilmu Pertan. Indones.*, vol. 29, no. 3, pp. 331–341, 2024, doi: 10.18343/jipi.29.3.331.