JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 8 No. 3 September 2026

DOI :https://doi.org/10.36378/juatika.v8i3.5949
eissn 2656-1727
pissn 2684-785X
pages : 973 – 986

RESEARCH ARTICLE Open Access

Analysis of Vegetation Weeds in Coconut Plantations Palm Oil (*Elaeis guineensis* Jacq.) People Based on Difference Year Plant

Angga Prastiawan[1,*], Muhammad Yusuf Dibisono[1], Hamzah Manurung[1]

Abstract

Oil palm (*Elaeis guineensis* Jacq.) is one of Indonesia's strategic plantation commodities. Weed occurrence in oil palm plantations affects plantation management because weeds compete with the crop for light, water, nutrients, and growing space. This study aimed to analyze weed vegetation, identify dominant weed species based on the Important Value Index (IVI), and describe weed diversity in smallholder oil palm plantations established in different years in Jaya Agung Village, Bagan Sinembah District, Rokan Hilir Regency, Riau Province. The study was conducted from November 2024 to February 2025 using a field survey and purposive sampling. Vegetation analysis included density, frequency, the Important Value Index (IVI), the Summed Dominance Ratio (SDR), and the Shannon–Wiener diversity index (H′). The results showed that plantations established in 2005 contained five weed species, with Asystasia gangetica as the dominant species (IVI: 68.69%; SDR: 34; H′ = 1.19). Plantations established in 2010 contained nine weed species and were dominated by Ageratum conyzoides (IVI: 42.89%; SDR: 21; H′ = 1.85), whereas plantations established in 2014 contained thirteen weed species and were dominated by Kyllinga brevifolia (IVI: 47.73%; SDR: 24; H′ = 1.71). Across all observation plots, 17 weed species comprising 2,595 individuals were recorded. The findings indicate differences in weed species composition, dominance, and diversity among smallholder oil palm plantations of different planting ages, highlighting the importance of age-specific monitoring and targeted weed management based on the dominant species.

Keywords: Ecological Indices, Species Composition, Species Richness, Sustainable Weed Management, Weed Dominance

1. Introduction

Oil palm (*Elaeis guineensis* Jacq.) is a strategically important commodity in Indonesia's economy, contributing to foreign exchange earnings, employment, and the supply of raw materials for various industries. Efforts to improve oil palm productivity are influenced by various cultivation factors, including weed management. Weeds are plants that grow in places or at times when they are not desired and can compete with the main crop for light, water, nutrients, and growing space. If not managed properly, weeds can hinder plant growth and reduce the efficiency of plantation management (Susanti et al., 2021; Tambunan & Zaman, 2025).

Weed composition and dominance in oil palm plantations are influenced by environmental conditions and plantation management systems. Differences in the age or planting year of oil palms can cause changes in canopy structure, light intensity, humidity, temperature, and soil-surface conditions, which in turn affect weed community composition. In younger plantations, relatively open canopies generally support the growth of weeds that require high light intensity. In older plantations, where the canopy is denser, shade-tolerant species tend to dominate (Siregar et al., 2021; Sitinjak, 2022). Therefore, differences in planting year may result in differences in weed composition, dominance, and diversity within a plantation area. However, information on the structure and changes in weed communities in smallholder oil palm plantations

*Correspondence: aprastiawan771@gmail.com
1) Institut Teknologi Sawit Indonesia - Jl. Willem Iskandar, Kenangan Baru, Kecamatan Percut Sei Tuan, Kabupaten Deli Serdang, Sumatera Utara 20371, Indonesia

across different planting years remains limited. Further studies are therefore needed to provide a scientific basis for more precise weed management tailored to plantation conditions.

Vegetation analysis is a commonly used approach for describing weed community structure through parameters such as density, frequency, the Important Value Index (IVI), the Summed Dominance Ratio (SDR), and diversity indices. These parameters provide information about dominant species and the level of vegetation diversity, and can therefore inform the development of more effective weed management strategies suited to field conditions (Priosejati et al., 2023; Pangestu et al., 2025).

Several studies have examined weed vegetation in oil palm plantations under different conditions and with different research focuses. Andriani and Wahyudi (2024) reported that smallholder oil palm plantations in Kuantan Singingi Regency had varying weed diversity across locations, including differences in species numbers and weed groups. Djaingsastro (2025) noted that identifying weeds in oil palm plantations is important for determining dominant species and those with the potential to compete with the crop. Rizki (2024) analyzed weed vegetation in oil palm plantations by identifying its composition and structure. Anggraini and Pebrianti (2022) also showed that changes in stand conditions resulting from replanting activities can affect weed composition and diversity. These studies indicate that plantation stand and environmental conditions influence weed community structure. However, few studies have specifically compared weed composition, dominance, and diversity across different planting years in smallholder oil palm plantations.

Unlike previous studies, this research compares weed communities in smallholder oil palm plantations established in 2005, 2010, and 2014 in Rokan Hilir Regency, Riau Province. Comparing these planting years is a novel aspect of the study because it provides information on changes in weed community structure associated with plantation age, which can inform more targeted weed management based on stand conditions and dominant species.

Based on the description above, this study aims to analyze weed vegetation, identify dominant weed species using the Importance Value Index (IVI), and describe weed diversity in smallholder oil palm plantations with different planting years in Jaya Agung Village, Bagan Sinembah District, Rokan Hilir Regency, Riau Province. This descriptive study is expected to provide scientific information about weed community structure and serve as a basis for weed management in smallholder oil palm plantations.

2. Material and Methods

2.1. Location and Time of Research

The study was conducted from November 2024 to February 2025 in smallholder oil palm plantations in Jaya Agung Village, Bagan Sinembah District, Rokan Hilir Regency, Riau Province (1°34′51.04″ N, 100°35′03.56″ E), at an elevation of approximately 25 m above sea level. The study site was selected purposively because it contains oil palm plantations established in different years—2005, 2010, and 2014—allowing for a comparison of weed vegetation composition across planting years.

2.2. Research Design

This study used an observational, descriptive survey approach to analyze weed community structure in smallholder oil palm plantations with different planting years. Observations were conducted in three representative plantation areas established in 2005, 2010, and 2014. Each area covered approximately 2 ha and served as the boundary of the study site. Vegetation analysis was based on weed inventory data collected from sample plots.

For each planting year, six plots measuring 20 m × 30 m were selected through purposive sampling, taking into account the uniformity of planting conditions, topography, and garden management. One 1 m × 1 m subplot was established within each plot as the observation unit for weed vegetation. Thus, 18 subplots were observed, with a total vegetation sampling area of 18 m².

All weed species found in each subplot were identified, and the number of individuals of each species was recorded. The data were used to calculate vegetation parameters, including density (K), relative density (KR), frequency (F), relative frequency (FR), Importance Value Index (IVI), summed dominance ratio (SDR), and the Shannon–Wiener diversity index (H′). These parameters were calculated from the vegetation inventory data for each planting year. The analysis was descriptive and aimed to characterize weed community structure; no treatments or statistical tests were applied.

2.3. Observation Vegetation Weeds

All weeds found in each subplot were identified to the species level, and the number of individuals of each species was recorded. Identification was based on morphological characteristics, using plant identification guides and relevant taxonomic databases. The identifications were then checked with a plant identification app as an additional aid. Scientific names were standardized according to current nomenclature and verified using Plants of the World Online (POWO), ensuring that species identities were reported accurately and scientifically.

The vegetation parameters recorded included the number of individuals of each species, density, relative density (KR), frequency, relative frequency (FR), Importance Value Index (INP), Summed Dominance Ratio (SDR), and the Shannon–Wiener diversity index (H′).

2.4. Data analysis

Weed vegetation was analyzed to characterize community structure using the following parameters: density (K), relative density (KR), frequency (F), relative frequency (FR), Importance Value Index (INP), and Summed Dominance Ratio (SDR), following Mueller-Dombois and Ellenberg (1974), as well as the Shannon–Wiener diversity index (H′), following Shannon and Weaver (1949). Data processing and calculations were performed using Microsoft Excel 2021.

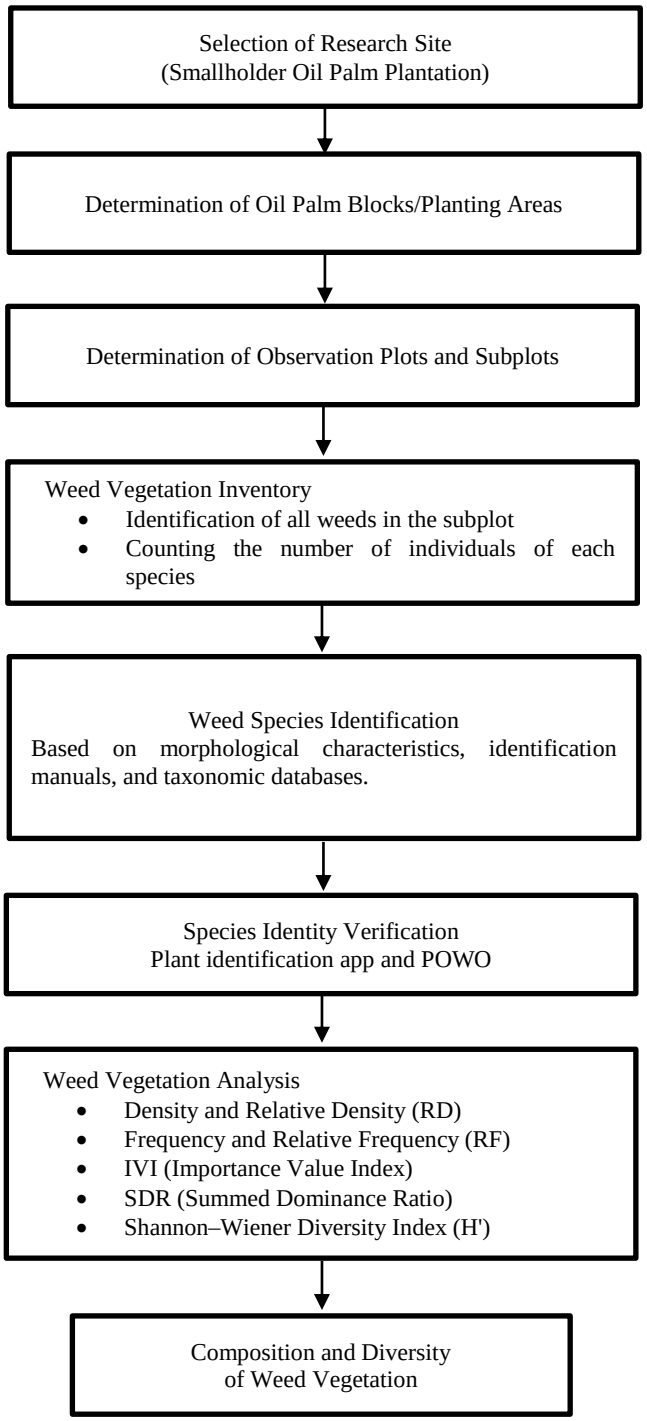


Figure 1. Flowchart Study

Each parameter was calculated using the following formulas:

2.4.1. Density (K)

Density shows the number of individuals of a certain species in a unit area.

$$K = \frac{ni}{A}$$

Information :
K = Density of species i-th (individuals m ^{2})
n_i = Total individuals of the i-th species
A = Total area of the plot observed (m^2)

2.4.2. Density Relative (KR)

Density relative shows the percentage contribution of a species' density to the total density of all species.

$$KR = \frac{Ki}{\sum K} \text{x } 100\%$$

Information :
KR = Density relative (%)
K_i = Density of species i-th
ΣK = Total density across all species

2.4.3. Frequency (F)

Frequency shows the level distribution of a species across all observation subplots.

$$F = \frac{Pi}{P}$$

Information :
F = Frequency of species i-th
P_i = Number of subplots found with species i-th
P = Total number of observation subplots

2.4.4. Frequency Relative (FR)

Frequency relative shows the percentage frequency of a species relative to the total frequency of all species.

$$FR = \frac{Fi}{\sum F} \text{x } 100\%$$

Information :
FR = Frequency relative (%)
F_i = Frequency of the i-th species
ΣF = Total frequency of all species

2.4.5. Importance Value Index (IVI)

In this study, the Importance Value Index (IVI) was calculated using two parameters: relative density (KR) and relative frequency (FR). Because the study focused on understory vegetation (weeds and herbs), relative dominance (DR) was not included.

$$INP = KR + FR$$

Information:
INP = Importance Value Index (%)
KR = Density relative (%)
FR = Frequency relative (%)

In analysis, vegetation weeds apply:

$$\sum KR = 100\%$$
$$\sum FR = 100\%$$

so that

$$\sum INP = 200\%$$

The average INP value is calculated using the formula:

$$\bar{INP} = \frac{200}{S}$$

Information:

S = Total species weeds

2.4.6. Summed Dominance Ratio (SDR)

The Summed Dominance Ratio (SDR) is the average of relative density and relative frequency and is used to describe the degree of dominance of a species.

$$SDR = \frac{KR + FR}{2}$$

Information:
SDR = *Summed Dominance Ratio* (%)
KR = Density relative (%)
FR = Frequency relative (%)

The higher the SDR value, the greater the dominance level of species in the weed community.

2.4.7. Shannon–Wiener diversity index (H')

Diversity index used for the known level of diversity of weed species in every study.

$$H' = -\sum_{i=1}^{S} P_i \ln P_i$$

with

$$P_i = \frac{n_i}{N}$$

Information:
H' = Index Shannon–Wiener diversity
P_i = Proportion of the i-th species
n_i = Total individuals of the i-th species
N = Total number of individuals across all species
S = Total species

Criteria mark index diversity according to Shannon–Wiener is :

H' < 1 = Diversity low
1 ≤ H' ≤ 3 = Diversity currently
H' > 3 = Diversity tall

Analysis results are presented in table form, then interpreted in a descriptive way to compare species composition, dominance and level diversity of weeds in each planting year.

2.5. Limitations Study

This study is a descriptive study conducted in three plantation areas with different planting years within one research area. Therefore, the results describe the weed vegetation at the observed locations and are not intended to generalize a causal relationship between planting year and weed vegetation characteristics. The interpretation focuses on describing patterns in the composition, dominance, and diversity of weeds found at the study sites.

3. Results and Discussion

3.1. Analysis of density and frequency based on year of planting

Weed vegetation in each planting year was analyzed using the parameters of density (K), relative density (KR), frequency (F), and relative frequency (FR) to describe the abundance and distribution of each species in the weed community. The values of these four parameters for smallholder oil palm plantations established in 2005, 2010, and 2014 are presented in Tables 1, 2, and 3, respectively.

Table 1. Density Parameters (K), Density Relative (KR), Frequency (F), and Frequency Relative (FR) of Weeds in Coconut Plantations Jaya Agung Village People's Oil Palm Year Planted in 2005

Species Weeds	Amount Individual	Plot Found	K	KR %	F	FR %
Dryopteris marginalis	18	6	3.00	1.88	1.00	20.00
Synedrella nodiflora	63	5	10.50	6.58	0.83	16.67
Clinopodium vulgare	77	6	12.83	8.05	1.00	20.00
Asystasia gangetica	466	6	77.67	48.69	1.00	20.00
Kyllinga brevifolia	331	6	55.17	34.59	1.00	20.00
Leather-leaf fern	2	1	0.33	0.21	0.17	3.33
Total	957.00		159.50	100.00	5.00	100.00
Average	159.50		26.58	16.67	1	16.67

Table 2. Density Parameters (K), Density Relative (KR), Frequency (F), and Frequency Relative (FR) of Weeds in Coconut Plantations Jaya Agung Village, People's Oil Palm Year Planting 2010

Species Weeds	Amount	Plot Found	K	KR %	F	FR %
Ageratum conyzoides	207	3	34.50	32.55	0.50	10.34
Blumea baisamifera	34	4	5.67	5.35	0.67	13.79
Digital sanguine	137	3	22.83	21.54	0.50	10.34
Clidemia hirta	50	3	8.33	7.86	0.50	10.34
Oplismenus undulatifolius	89	3	14.83	13.99	0.50	10.34
Clinopodium vulgare	36	3	6.00	5.66	0.50	10.34
Leather-leaf fern	11	4	1.83	1.73	0.67	13.79
Dryopteris marginalis	9	3	1.50	1.42	0.50	10.34
Dichanthelium chandestium	63	3	10.50	9.91	0.50	10.34
Total	636.00	29.00	106.00	100.00	4.83	100.00
Average	70.67	3.22	11.78	11.11	0.54	11.11

Table 3. Density Parameters (K), Density Relative (KR), Frequency (F), and Frequency Relative (FR) of Weeds in Coconut Plantations Jaya Agung Village People's Oil Palm Year Planting 2014

Species Weeds	Amount	Plot Found	K	KR %	F	FR %
Kyllinga brevifolia	349	4	58.17	34.83	0.67	12.90
Ageratum conyzoides	209	4	34.83	20.86	0.67	12.90
Digital sangulnalis	82	3	13.67	8.18	0.50	9.68
Dichanthelium Chandestiam	29	1	4.83	2.89	0.17	3.23
Asytasia Gangetica	245	3	40.83	24.45	0.50	9.68
Lantana camara	3	2	0.50	0.30	0.33	6.45
Bridelia monoica	1	1	0.17	0.10	0.17	3.23
Clinopodium vulgare	26	2	4.33	2.59	0.33	6.45
Dryopteris marginalis	6	4	1.00	0.60	0.67	12.90
Chomolaena odorata	22	2	3.67	2.20	0.33	6.45
Leather-leaf fern	6	2	1.00	0.60	0.33	6.45
Arudinaria gigantea	3	1	0.50	0.30	0.17	3.23
Affine melastoma	21	2	3.50	2.10	0.33	6.45
Total	1002.00	31.00	167.00	100.00	5.17	100.00
Average	77.08	2.38	12.85	7.69	0.40	7.69

Based on Tables 1–3, the highest average weed density was found in the oil palm plantation established in 2005, at 26.58 individuals m^{-2}. Density then decreased to 12.85 individuals m^{-2} in the 2014 planting and 11.78 individuals m^{-2} in the 2010 planting. This pattern indicates that weed abundance varied among plantations of different ages, resulting in differences in community structure. This finding is consistent with Djaingsastro and Saroha (2021), who reported that weed communities in oil palm plantations are dynamic because they are affected by changes in microhabitat conditions as the plants grow.

The species with the highest density also differed among planting years. The 2005 planting was dominated by *Asystasia gangetica*, with a density of 77.67 individuals m^{-2}; the 2010 planting by Ageratum conyzoides, at 34.50 individuals m^{-2}; and the 2014 planting by *Kyllinga brevifolia*, at 58.17 individuals m^{-2}. This shift in species indicates that weeds differ in their ability to adapt to changing habitat conditions as oil palm plants develop. This result is consistent with Ferdinand et al. (2023), who stated that microclimatic changes resulting from oil palm canopy development contribute to changes in weed composition by selecting for species better able to adapt. Sari et al. (2025) also explained that high density reflects a species' success in forming a population in a particular habitat. However, this parameter alone cannot be used to determine a species' ecological dominance.

Average relative density showed a decreasing trend, from 16.67% in the 2005 planting to 11.11% in the 2010 planting and 7.69% in the 2014 planting. This pattern suggests that the proportion of individuals among species became more evenly distributed, reducing the dominance of any single species in the community. It also indicates that changes in plant age were accompanied by changes in weed community structure.

The highest relative density was recorded for *Asystasia gangetica* in the 2005 planting (48.69%), Ageratum conyzoides in the 2010 planting (32.55%), and *Kyllinga brevifolia* in the 2014 planting (34.83%). The replacement of the species with the highest relative density indicates changes in each species' contribution to the weed community as the plantation aged. This finding supports Motmainna et al. (2021), who reported that changes in canopy structure and light intensity affect which species dominate plantation areas. According to Priosejati et al. (2023), relative density describes the contribution of a species' individuals to the overall community and can therefore be used to assess changes in vegetation structure resulting from differences in habitat conditions.

Average weed frequency showed a decreasing trend, from 1.00 in the 2005 planting to 0.54 in the 2010 planting and 0.40 in the 2014 planting. These results indicate that weeds were present in fewer observation plots as the plantation aged, suggesting a change in species distribution. The variation in frequency values shows that not all species were able to maintain a broad distribution across plantations of different ages.

The highest frequency value was recorded in the 2005 planting (1.00) for *Dryopteris marginalis*, *Clinopodium vulgare*, *Asystasia gangetica*, and *Kyllinga brevifolia*. This indicates that these species were found in every observation plot. In the 2010 planting, the highest frequency value was 0.67, recorded for *Blumea balsamifera* and leather-leaf fern. The 2014 planting also had a highest frequency value of 0.67, recorded for *Kyllinga brevifolia* , Ageratum conyzoides , and *Dryopteris marginalis* . The shift in species with the highest frequency suggests that weed distribution patterns changed in response to changing

habitat conditions. Mawandha et al. (2022) explain that species with high frequency generally have better adaptive abilities, enabling them to persist across a large proportion of the growing area. This finding is also consistent with Sitinjak (2022), who reported that microclimatic changes in plantations influence weed distribution patterns.

Average relative frequency decreased from 16.67% in the 2005 planting to 11.11% in the 2010 planting and 7.69% in the 2014 planting. This pattern suggests that the distributional contribution of each species to the community became more even, with no single species consistently dominating across plantations of different ages.

The highest relative frequency in the 2005 planting was 20.00%, recorded for *Dryopteris marginalis* , *Clinopodium vulgare* , *Asystasia gangetica* , and *Kyllinga brevifolia* . In the 2010 planting, the highest value was 13.79%, recorded for *B. balsamifera* and leather-leaf fern. In the 2014 planting, the highest value was 12.90%, recorded for *Kyllinga brevifolia* , A. conyzoides , and *Dryopteris marginalis* . These shifts suggest that weed distribution patterns changed as habitat conditions developed in plantations of different ages. This finding is consistent with Siregar et al. (2021), who stated that relative frequency reflects a species' ability to persist in a community. Pani et al. (2022) also reported that changes in light intensity and humidity are associated with changes in weed distribution patterns in cultivated fields.

Overall, changes in density, relative density, frequency, and relative frequency indicate that weed communities change as oil palm plantations age. The replacement of species with the highest values for each parameter suggests that weeds respond adaptively to changes in microhabitat conditions, as also reported by Djaingsastro and Saroha (2021), Ferdinand et al. (2023), and Motmainna et al. (2021). However, these four parameters describe different aspects of weed community structure. Therefore, identifying the truly dominant species requires using the Importance Value Index (IVI), which integrates relative density and relative frequency.

3.2. Analysis of the Importance Value Index (IVI) and Summed Dominance Ratio (SDR) of Weeds Based on Year Planted

Based on the vegetation analysis of smallholder oil palm plantations established in 2005, 2010, and 2014, the Importance Value Index (INP) and Summed Dominance Ratio (SDR) differed among weed species. Both parameters were used to identify the degree of dominance of each weed species in the vegetation community. The INP and SDR values for each planting year are presented in Table 4.

Based on Table 4, the highest average Importance Value Index (INP) was recorded in the 2005 oil palm planting (33.33). It decreased to 22.22 in the 2010 planting and 15.38 in the 2014 planting. This pattern indicates that the relative contribution of weeds to community structure changed as the oil palm plantations aged. Changes in INP values reflect shifts in vegetation composition, which may be affected by variations in individual abundance, frequency of occurrence, and environmental conditions resulting from the development of the plant canopy.

The Importance Value Index (INP) describes the role of a species by combining its relative density and relative frequency. Unlike these two parameters, which describe abundance and distribution separately, INP provides a more comprehensive picture of each species' ecological contribution to a community. According to Sari et al. (2025), INP values are classified as low (<21.96), moderate (21.96–42.66), or high (>42.66). The higher the INP value, the greater a species' influence on the structure of the weed community.

Asystasia gangetica dominated the 2005 planting, with an INP value of 68.69, placing it in the high category. This dominance indicates that the species had greater relative density and frequency than the other weeds, making it a major component of the community. Its rapid growth, vegetative reproduction, and tolerance of shaded conditions may be key factors contributing to its success. These results are consistent with Anggraini (2020), who stated that species with high INP values have the greatest ecological influence in determining plant community structure. The findings also support previous studies identifying *Asystasia gangetica* as a dominant weed in mature oil palm plantations because of its high adaptability to environments with decreasing light intensity.

Ageratum conyzoides had the highest INP value in the 2010 planting, at 42.89, placing it at the threshold of the high category. This indicates that the weed could still use the available growing space and light before the oil palm canopy had fully closed. These results are consistent with Pani et al. (2022), who described Ageratum conyzoides as a broadleaf weed with a high capacity to colonize open habitats. However, its INP value in the 2010 planting was lower than that in the 2005 planting, suggesting that community dominance had begun to become more evenly distributed among species as the understory vegetation became more complex.

Kyllinga brevifolia had the highest INP value in the 2014 planting, at 47.73, placing it in the high category. Its dominance indicates a shift in weed composition from broadleaf species to sedges as the oil palm plants aged. As the canopy develops and closes, humidity increases and light intensity decreases, creating more favorable conditions for the growth of *Kyllinga brevifolia* . This finding is consistent with Susanti et al. (2021), who noted that some ground-cover weeds, particularly sedges, adapt well to moist environments and can contribute to ecosystem stability when their populations are controlled. The change in dominant species across planting years suggests that microclimatic changes play an important role in shaping

weed community structure.

Table 4. Importance Value Index (IVI) and *Summed Dominance Ratio* (SDR) of Species Weeds in Coconut Plantations Jaya Agung Village People's Oil Palm Year Planted in 2005

Year Planted in 2005		
Species Weeds	**INP**	**SDR**
Dryopteris marginalis	21.88	10.94
Synedrella nodiflora	23.25	11.62
Clinopodium vulgare	28.05	14.02
Asystasia gangetica	68.69	34.35
Kyllinga brevifolia	54.59	27.29
Leather-leaf fern	3.54	1.77
Total	200.00	100.00
Average	33.33	16.67
Year Planting 2010		
Species Weeds	**INP**	**SDR**
Ageratum conyzoides	42.89	21.45
Blumea baisamifera	19.14	9.57
Digital sanguine	31.89	15.94
Clidemia hirta	18.21	9,10
Oplismenus undulatifolius	24.34	12.17
Clinopodium vulgare	16.01	8.00
Leather-leaf fern	15.52	7.76
Dryopteris marginalis	11.76	5.88
Dichanthelium chandestium	20.25	10.13
Total	200.00	100.00
Average	22.22	11.11
Year Planting 2014		
Species Weeds	**INP**	**SDR**
Kyllinga brevifolia	47.73	23.87
Ageratum conyzoides	33.76	16.88
Digital sangulnalis	17.86	8.93
Dichanthelium Chandestiam	6.12	3.06
Asytasia Gangetica	34.13	17.06
Lantana camara	6.75	3.38
Bridelia monoica	3.33	1.66
Clinopodium vulgare	9.05	4.52
Dryopteris marginalis	13.50	6.75
Chomolaena odorata	8.65	4.32
Leather-leaf fern	7.05	3.53
Arudinaria gigantea	3.53	1.76
Affine melastoma	8.55	4.27
Total	200.00	100.00
Average	15.38	7.69

Overall, the results show a change in the dominant species: *Asystasia gangetica* in the 2005 planting, Ageratum conyzoides in the 2010 planting, and *Kyllinga brevifolia* in the 2014 planting. This shift suggests that the age of oil palm plants influences weed community composition and structure through changes in microclimatic conditions. These findings are consistent with previous studies reporting that increasing plant age changes light intensity, humidity, and growing space, leading to weed succession on the plantation floor. This confirms that INP is a useful parameter for identifying dominant species because it integrates aspects of abundance and distribution into a single ecological value.

Based on Table 4, the highest average Summed Dominance Ratio (SDR) value was recorded in the 2005 planting, at 16.67. It then decreased to 11.11 in the 2010 planting and 7.69 in the 2014 planting. This decline indicates that weed dominance generally decreased as the plants aged. It also suggests that the weed community became more diverse, with dominance becoming more evenly distributed among species.

The Summed Dominance Ratio (SDR) describes the

relative dominance of each species in a vegetation community. In this study, the SDR value was calculated by dividing the INP by two, reflecting the combined effects of relative density and relative frequency. According to Salima et al. (2025), SDR is an indicator that can be used to determine the degree to which a species dominates a vegetation community, making it easier to identify the weeds that play the most important role in an ecosystem.

Asystasia gangetica had the highest SDR value in the 2005 planting, at 34.35. This value indicates that it was the most dominant weed species. Its dominance may be related to its rapid vegetative reproduction and spread, as well as its tolerance of shaded conditions, which allow it to maintain high abundance and broad distribution. These results support the findings of Anggraini (2020), who stated that species with high INP values generally also have high dominance in vegetation communities.

Ageratum conyzoides was the dominant species in the 2010 planting, with an SDR value of 21.45. This value indicates that the weed retained a high competitive ability during the growth phase of the oil palm, when the canopy had not yet fully closed. This result is consistent with Pani et al. (2022), who explained that Ageratum conyzoides grows optimally in habitats with relatively high light intensity and often dominates cultivated areas that are still open.

Kyllinga brevifolia had the highest SDR value in the 2014 planting, at 23.87. Its dominance indicates that microclimatic changes resulting from oil palm canopy development may give sedges an ecological advantage over other weeds. This finding is consistent with Susanti et al. (2021), who explained that certain ground-cover weeds can grow well in moist, shaded conditions and may become dominant if not appropriately controlled.

The SDR pattern follows the same trend as the INP values: the dominant weed shifted from *Asystasia gangetica* in the 2005 planting to Ageratum conyzoides in the 2010 planting, and then to *Kyllinga brevifolia* in the 2014 planting. This consistency reinforces the conclusion that changes in oil palm age affect community structure by modifying growing conditions. These results support previous findings on weed succession across different oil palm growth stages. Thus, SDR can serve as a supplementary parameter to clarify the interpretation of INP values when evaluating weed dominance and community structure.

3.3. Analysis Index Shannon–Wiener Diversity (H') of Weeds Based on Year Plant

Based on the vegetation analysis of smallholder oil palm plantations established in 2005, 2010, and 2014, the Shannon–Wiener diversity index (H′) differed among planting years. The H′ value describes the diversity of the weed community in each planting year. The calculated Shannon–Wiener diversity index (H′) values are presented in Table 5.

Based on Table 5, the Shannon–Wiener diversity index (H′) differed among oil palm planting years. The H′ value was 1.19 for the 2005 planting, increased to 1.85 for the 2010 planting, and then decreased slightly to 1.71 for the 2014 planting. Nevertheless, all study sites fell within the moderate-diversity category ($1 < H' < 3$). This pattern suggests that oil palm age influences weed community structure, but that increasing plantation age does not always lead to a linear increase in diversity.

The Shannon–Wiener diversity index (H′) describes species diversity based on the number of individuals and the relative abundance of each species in a community. Its value is influenced by species richness and the distribution of individuals among species; the more evenly individuals are distributed, the higher the H′ value. Mawandha et al. (2022) stated that the diversity index is influenced by species dominance and evenness in a vegetation community. This is consistent with Sitinjak (2022), who reported an H′ value of 1.37 for a weed community in a smallholder oil palm plantation, placing it in the moderate-diversity category. The community was dominated by Ottochloa nodosa , indicating that the distribution of individuals among species was not yet even.

The lowest H′ value in this study was recorded for the 2005 planting, at 1.19. This value indicates that the weed community was dominated by a few species, particularly *Asystasia gangetica* , which had the highest INP (68.69) and SDR (34.35) values. The dominance of this species resulted in a relatively uneven distribution of individuals among species and, consequently, a relatively low diversity value. This value is lower than that reported by Anggraini and Pebrianti (2022) for an oil palm plantation managed by PTPN II in North Sumatra, where the H′ value was 2.39 in an area before replanting. This difference may be related to the greater number of weed species and higher evenness at their study site compared with the site in the present study.

The H′ value increased to 1.85 for the 2010 planting. This increase indicates that individuals were distributed more evenly among species than in the 2005 planting. The shift in the dominant species from *Asystasia gangetica* to Ageratum conyzoides , as indicated by the INP and SDR values, suggests that no single species overwhelmingly dominated the community. This may have allowed more species to thrive, resulting in a more heterogeneous community structure. The H′ value for the 2010 planting was higher than that reported by Sitinjak (2022) ($H' = 1.37$), but lower than the value of 2.39 reported by Anggraini and Pebrianti (2022). These differences may be influenced by variation in species composition, species evenness, plant age, and garden management conditions among the study sites.

The H′ value for the 2014 planting was 1.71, slightly lower than that for the 2010 planting, but it remained within the moderate-diversity category. This decrease

indicates that, although the number of weed species increased, the distribution of individuals among species became slightly less even as the dominance of *Kyllinga brevifolia* increased. This species had the highest INP (47.73) and SDR (23.87) values. Its dominance resulted in a less even distribution of individuals and a slight decline in the H′ value. These results show that an increase in the number of species does not always lead to an increase in the diversity index if one species continues to dominate the community. Anggraini and Pebrianti (2022) similarly noted that H′ is strongly influenced by the relative abundance of each species, not only by the number of species present.

Table 5. Shannon–Wiener Diversity Index (H ′) of the Weed Community in Coconut Plantations People's Oil Palm in Jaya Agung Village Based on Year Planted in 2005, 2010 and 2014

Year Planted in 2005			
Species Weeds	***pi***	**ln (*pi*)**	**pi x ln (pi)**
Dryopteris marginalis	0.0188	-3.9734	-0.0747
Synedrella nodiflora	0.0658	-2,7207	-0.1791
Clinopodium vulgare	0.0805	-2.5200	-0.2028
Asystasia gangetica	0.4869	-0.7196	-0.3504
Kyllinga brevifolia	0.3459	-1.0617	-0.3672
Leather-leaf fern	0.0021	-6,1707	-0.0129
Total (H')			1.19

Year Planting 2010			
Species Weeds	***pi***	**ln (*pi*)**	**pi x ln (pi)**
Ageratum conyzoides	0.3255	-1.1225	-0.3653
Blumea baisamifera	0.0535	-2.9288	-0.1566
Digital sanguine	0.2154	-1.5352	-0.3307
Clidemia hirta	0.0786	-2.5432	-0.1999
Oplismenus undulatifolius	0.1399	-1.9666	-0.2752
Clinopodium vulgare	0.0566	-2.8717	-0.1625
Leather-leaf fern	0.0173	-4.0573	-0.0702
Dryopteris marginalis	0.0142	-4.2580	-0.0603
Dichanthelium chandestium	0.09906	-2.3121	-0.2290
Total (H')			1.85

Year Planting 2014			
Species Weeds	***pi***	**ln (*pi*)**	**pi x ln (pi)**
Kyllinga brevifolia	0.3483	-1.0547	-0.3673
Ageratum conyzoides	0.2086	-1.5674	-0.3269
Digital sangulnalis	0.0818	-2.5030	-0.2048
Dichanthelium Chandestiam	0.0289	-3.5425	-0.1025
Asytasia Gangetica	0.2445	-1.4085	-0.3444
Lantana camara	0.0030	-5,8111	-0.0174
Bridelia monoica	0.0010	-6,9098	-0.0069
Clinopodium vulgare	0.0259	-3.6517	-0.0948
Dryopteris marginalis	0.0060	-5,1180	-0.0306
Chomolaena odorata	0.0220	-3.8187	-0.0838
Leather-leaf fern	0.0060	-5,1180	-0.0306
Arudinaria gigantea	0.0030	-5,8111	-0.0174
Affine melastoma	0.0210	-3.8652	-0.0810
Total (H ′)			1.71

Differences in H′ values among the three planting years show that oil palm age influences weed community structure through changes in microclimatic conditions, particularly light intensity, humidity, and canopy cover. These changes were accompanied by a shift in the dominant species: from *Asystasia gangetica* in the 2005 planting to Ageratum conyzoides in the 2010 planting, and then to *Kyllinga brevifolia* in the 2014 planting. However, changes in the dominant species do not always increase diversity, because H′ also depends on how evenly individuals are distributed among species. These findings support those of Sitinjak (2022) and Anggraini and Pebrianti (2022), who reported that changes in weed community structure in oil palm plantations are influenced by interactions among plant age, species dominance, and environmental conditions, and that diversity values

generally fall within the moderate category.

3.4. Recapitulation Amount Individual Every Species Weeds Based on Year Plant

Based on the observations, the number of individuals of each weed species in the smallholder oil palm plantations in Jaya Agung Village varied among planting years. The number of individuals of each weed species by planting year (2005, 2010, and 2014) is presented in Table 6.

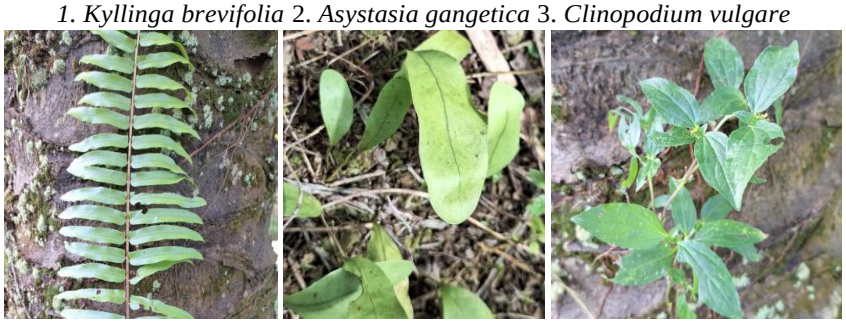
Table 6. Total Number of Individuals of Each Weed Species in Coconut Plantations People's Oil Palm, in Jaya Agung Village Based on Year Planted

Species Weeds	Amount Individual		
	2005	2010	2014
Kyllinga brevifolia	331	0	349
Ageratum conyzoides	0	207	209
Digital sangulnalis	0	137	82
Dichanthelium Chandestiam	0	63	29
Asytasia Gangetica	466	0	245
Lantana camara	0	0	3
Bridelia monoica	0	0	1
Clinopodium vulgare	77	36	26
Dryopteris marginalis	18	9	6
Chomolaena odorata	0	0	22
Leather-leaf fern	2	11	6
Arudinaria gigantea	0	0	3
Affine melastoma	0	0	21
Blumea baisamifera	0	34	0
Clidemia hirta	0	50	0
Oplismenus undulatifolius	0	89	0
Synedrella nodiflora	63	0	0

Based on Table 6, 17 weed species were identified in the smallholder oil palm plantations in Jaya Agung Village. The area planted in 2005 had six weed species: *Kyllinga brevifolia* (331 individuals), *Asystasia gangetica* (466 individuals), *Clinopodium vulgare* (77 individuals), *Dryopteris marginalis* (18 individuals), leatherleaf fern (2 individuals), and Synedrella nodiflora (63 individuals). Photographs of the weed species found in the 2005 planting area are presented in Figure 2.



1. Kyllinga brevifolia 2. *Asystasia gangetica* 3. *Clinopodium vulgare*



4. *Dryopteris marginalis* 5. *L. fern* 6. *S. nodiflora*

Figure 2. Documentation: Study Year Planted in 2005

Figure 2 shows the weed species found in the smallholder oil palm plantation planted in 2005: *Kyllinga*

brevifolia , *Asystasia gangetica* , *Clinopodium vulgare* , *Dryopteris marginalis* , leatherleaf fern, and Synedrella nodiflora . The weed community at this site was dominated by *Asystasia gangetica* (466 individuals) and *Kyllinga brevifolia* (331 individuals), while the other species were found in relatively lower numbers. The dominance of *Asystasia gangetica* indicates its high adaptability to conditions beneath the oil palm canopy, including its rapid vegetative growth and shade tolerance. These traits enable it to occupy growing space and suppress the development of other weeds. This finding is consistent with Ashbur et al. (2022), who reported that *Asystasia gangetica* can grow rapidly and cover the ground in oil palm plantations, potentially becoming the dominant species in the plant community. This is also supported by Anggraini and Pebrianti (2022), who found that weed communities in oil palm plantations are generally characterized by the dominance of a few species with a high capacity to adapt to garden conditions. Thus, vegetation composition is influenced by plant age, canopy conditions, and the level of interspecific competition.

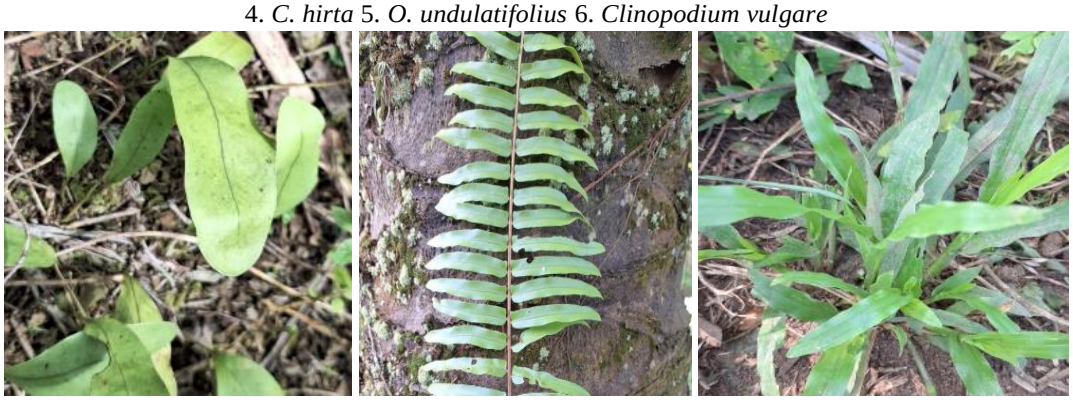
According to Table 6, the area planted in 2010 had nine weed species: Ageratum conyzoides (207 individuals), *Blumea balsamifera* (34 individuals), Digitaria sanguinalis (137 individuals), Clidemia hirta (50 individuals), Oplismenus undulatifolius (89 individuals), *Clinopodium vulgare* (36 individuals), leatherleaf fern (11 individuals), *Dryopteris marginalis* (9 individuals), and Dichanthelium clandestinum (63 individuals). Photographs of the weed species found in the 2010 planting area in the smallholder oil palm plantations of Jaya Agung Village are presented in Figure 3.



1. A. conyzoide 2. *B. baisamifera* 3. *D. sanguinalis*



4. *C. hirta* 5. *O. undulatifolius* 6. *Clinopodium vulgare*



7. *L. fern* 8. *Dryopteris marginalis* 9. *D. chandestium*

Figure 3. Documentation Study Year Planting 2010



1. *Kyllinga brevifolia* 2. *A. conyzoides* 3. *D. sanguinalis*



4. *D. chandestiam* 5. *Asystasia gangetica* 6. *L. camara*



7. *B. monoica* 8. *Clinopodium vulgare* 9. *Dryopteris marginalis*



10. *C. odorata* 11. *L. fern* 12. *A. gigantea*



13. *M. affine*

Figure 4. Documentation Study Year Planting 2014

Figure 3 shows that the weed community in the area planted in 2010 was dominated by Ageratum conyzoides (207 individuals), followed by Digitaria sanguinalis (137 individuals). The dominance of these two species suggests that the oil palm canopy at this stage still allows shade-intolerant weeds to grow well. This finding is consistent

with Salima et al. (2025), who reported that Ageratum conyzoides reproduces rapidly and readily colonizes open cultivated land, often becoming a dominant species. However, the weed composition in this study differs from that reported by Sitinjak (2022), who found that oil palm plantation weed communities were dominated by Ottochloa nodosa, rather than Ageratum conyzoides. This difference may be influenced by the age of the oil palms, canopy cover, environmental characteristics, and differences in plantation management, resulting in different species becoming dominant at each site.

These findings show that weed dominance in oil palm plantations is dynamic and influenced by the ecological conditions at each study site. The high number of Ageratum conyzoides individuals indicates that this species competes effectively for resources such as light, growing space, and nutrients in the area planted in 2010. The presence of Digitaria sanguinalis as the second-most abundant species also shows that grasses play an important role in shaping the vegetation community at the study site. These findings suggest that the weed community in the 2010 planting area comprises several species with strong adaptive abilities. Therefore, weed management should account for each species' biological characteristics to ensure that control measures are more effective and targeted.

According to Table 6, the area planted in 2014 had 13 weed species: *Kyllinga brevifolia* (349 plants), Ageratum conyzoides (209 plants), Digitaria sanguinalis (82 plants), Dichanthelium clandestinum (29 plants), *Asystasia gangetica* (245 plants), Lantana camara (3 plants), Bridelia monoica (1 plants), *Clinopodium vulgare* (26 plants), *Dryopteris marginalis* (6 plants), Chromolaena odorata (22 plants), leatherleaf fern (6 plants), Arundinaria gigantea (3 plants), and Melastoma affine (21 plants). Photographs of the weed species found in the 2014 planting area in the smallholder oil palm plantations of Jaya Agung Village are presented in Figure 4.

Figure 4 shows that the weed community in the area planted in 2014 was dominated by *Kyllinga brevifolia* (349 individuals), followed by *Asystasia gangetica* (245 individuals) and Ageratum conyzoides (209 individuals). The dominance of *Kyllinga brevifolia* indicates that this species adapts well to conditions beneath the increasingly dense oil palm canopy and can therefore maintain a large population. The relatively high numbers of *Asystasia gangetica* and Ageratum conyzoides suggest that both species also adapt well despite changes in the microclimate as the palms mature.

These findings differ from those of Satriawan et al. (2020), who reported that the understory vegetation in oil palm plantations was largely dominated by Asystasia intrusa, a potentially important ground-cover species. In the present study, however, *Kyllinga brevifolia* was the most abundant species. This difference suggests that weed composition is strongly influenced by habitat characteristics, plant age, and plantation management, and that the dominant species may vary among study sites. The findings are also supported by Satriawan et al. (2019), who showed that weed dominance in oil palm plantations changes with plant age: the dominant species at each growth stage is not always the same because of changes in conditions beneath the canopy. Overall, the weed community in the area planted in 2014 appears to reflect ongoing ecological changes as the oil palms develop.

4. Conclusion

The study results show that the planting year of smallholder oil palms influences weed community structure, as reflected in changes in species composition, dominance, and diversity. These findings can inform the development of weed management strategies tailored to palm age, improving control effectiveness and supporting sustainable oil palm plantation management.

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