



Research Article

Plant Species in Immature Oil Palm Plantation Areas in Kolaka Regency, Indonesia

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Abstract | This study analyses the botanical composition, species diversity, dominance, and evenness of plant species in immature oil palm plantation areas in Kolaka Regency. The study area is 7.698,46 hectares, with 2.732,91 hectares of immature oil palm plants. The study was conducted for eight months, from January to August 2024, in two main sub-districts, namely Tanggetada and Watubangga. Data were collected through field observation methods with exploration and sampling using the transect method to identify plant community types. Sampling was carried out in six villages such as Kastura Village, Polenga Village, Kukutio Village (Watubangga District), as well as Pundaipa Village, Oneeha Village, and Tinggo Village (Tanggetada District), with a total of 50 sample points per village. Vegetation analysis using the *Summed Dominance Ratio* (SDR) calculation, which includes Absolute Density (AD), Absolute Frequency (AF), Relative Density (RD), Relative Frequency (RF), Importance Value (IV), Species Diversity Index (H'), Dominance Index (C), and Evenness Index (E). The findings show that the dominant species vary in each village, including *Panicum maximum* (Jacq.) (Polenga, SDR: 3.4592%), *Mikania micrantha* Kunt. (Kastura, SDR: 3.6073%), *Phymatodes* sp. (Kukutio, SDR: 3.6183%), *Nephrolepis bisserrata* (Pundaipa, SDR: 3.6072%), *Chromolaena odorata* (L.) King (Tinggo, SDR: 3.9861%), and *Asystasia coromandeliana* Ness. (Village, SDR: 3.5335%). The species diversity value ($1 < H' < 3$) at all locations is moderate, indicating a stable plant diversity.

Received | January 01, 2025; **Accepted** | February 16, 2025; **Published** | May 13, 2025

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Citation | Damhuri, D., L.O.M. Munadi., L. Darlian and S.W. Ahmad. 2025. Plant species in immature oil palm plantation areas in kolaka regency, Indonesia. *Sarhad Journal of Agriculture*, 41(2): 737-751.

DOI | <https://dx.doi.org/10.17582/journal.sja/2025/41.2.737.751>

Keywords | Plant species, Oil palm plantation, Immature, Summed dominance ratio, Diversity, Dominance, Evenness



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Introduction

Indonesia has the largest area of oil palm plantations in the world, reaching 15.435,70 million hectares

in the last year. Oil palm plantations strategically support the national economy by contributing to exports, employment absorption, and rural development (Munadi *et al.*, 2023; Sani *et al.*, 2023). West Kalim-

antan Province is the province with the largest area of oil palm plantations in Indonesia, which is 2.200,80 million hectares, which reflects the great potential for natural resource management in the region. In contrast, North Maluku Province has the smallest area of oil palm plantations, only 5,60 thousand hectares, which illustrates the disparity in the development of the plantation sector between regions in Indonesia.

In Southeast Sulawesi, the area of oil palm plantations is 75.921 hectares, showing the significant contribution of this region to the national plantation sector. One of the districts that are the centre of oil palm plantation activities in this province is Kolaka Regency, with a total plantation area of 31.291 hectares. Kolaka Regency, Tanggetada District and Watubangga District are the main areas for oil palm development, each with a plantation area of 5.085,81 thousand hectares and 2.612.73 thousand hectares (Efendy and Lataniambo, 2024).

This research focuses on the oil palm plantation area in Kolaka Regency, with a total research area of 7.698,46 thousand hectares. Of this area, around 2.732,91 hectares are oil palm plants that have not yet been produced. The existence of these immature plants presents challenges in land management and efforts to increase productivity, considering that this stage requires special attention in terms of maintenance and management of natural resources (Sani *et al.*, 2021; Munadi *et al.*, 2021; Sani *et al.*, 2021). The research area, which consists of immature oil palm plantations, also has interesting ecological characteristics, especially regarding the diversity of plant species that grow in the area. These plants include various species that can function as natural ground cover, carbon absorbers, and protection against soil erosion. However, these plants also need to be appropriately managed not to inhibit the growth of oil palms.

Oil palm plantation areas in Southeast Sulawesi, especially in Kolaka Regency, have challenges in the form of environmental management. The vast area of plantation land is often associated with deforestation and changes in land use, which can impact the local ecosystem. Therefore, an integrated approach between economic, social, and environmental aspects is key in developing this area. In the socio-economic context, oil palm plantations in Tanggetada and Watubangga Districts serve as the local community's primary livelihood source. Many families depend on activities

in this plantation sector, either as plasma farmers, workers, or providers of supporting services. On the other hand, the vast area of oil palm land that has not yet been produced is an opportunity to apply modern technology in plantation management.

This study also considers the potential for increasing productivity through diversification of area use. For example, planting intercrops compatible with oil palm can provide additional income for farmers while improving soil health. In addition, an agroforestry approach can be implemented to integrate oil palm with forest plants with high ecological value (Zulkarnain *et al.*, 2021; Astarika *et al.*, 2023). Another important aspect is the analysis of plant species composition in the oil palm plantation area, which has not yet been produced. This information can be used to identify the potential use of local plants as a source of animal feed, organic materials for fertilizer, or other industrial raw materials. A deep understanding of plant diversity can also support biodiversity conservation amidst plantation intensification.

Supporting sustainable management, this study provides data and analysis that can be used to plan more effective management of oil palm plantation areas. This includes the management of plant diversity for the implementation of environmentally friendly agricultural practices. The novelty of this study lies in the specific analysis of immature oil palm plants in the study area. The focus on the diversity of local plant species growing around immature plants aims to provide a new perspective on the ecological and economic potential that has received little attention. This study is also one of the first to examine the diversity of plant species in oil palm plantations in Kolaka Regency. This study not only offers practical solutions for plantation management but also contributes to developing a sustainable oil palm management model in Indonesia.

Materials and Methods

Research Location

This research was conducted in an immature oil palm plantation area located in Kolaka Regency. The study was conducted for eight months, from January to August 2024. The research activity began with observations of the conditions and area of the oil palm plantation, which was the focus of the study. The research location covered two main sub-districts: Tanggetada

Administrative Map of Tanggetada District

Administrative Map of Watubangga District

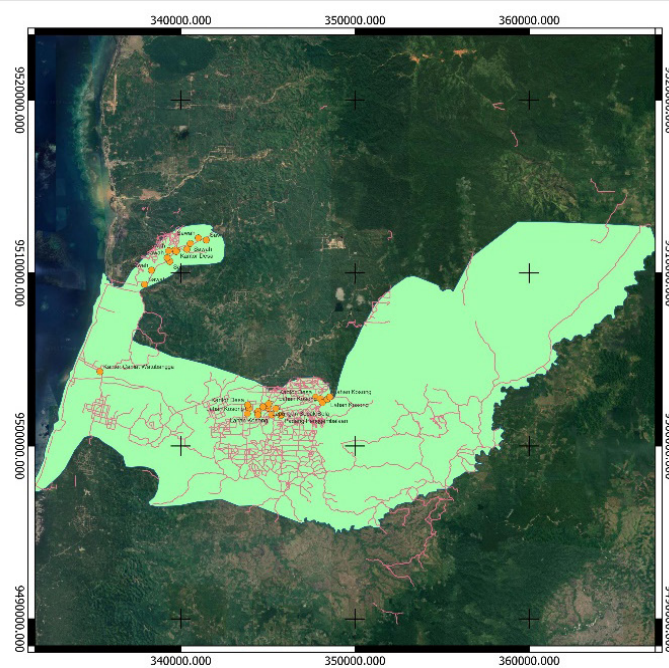
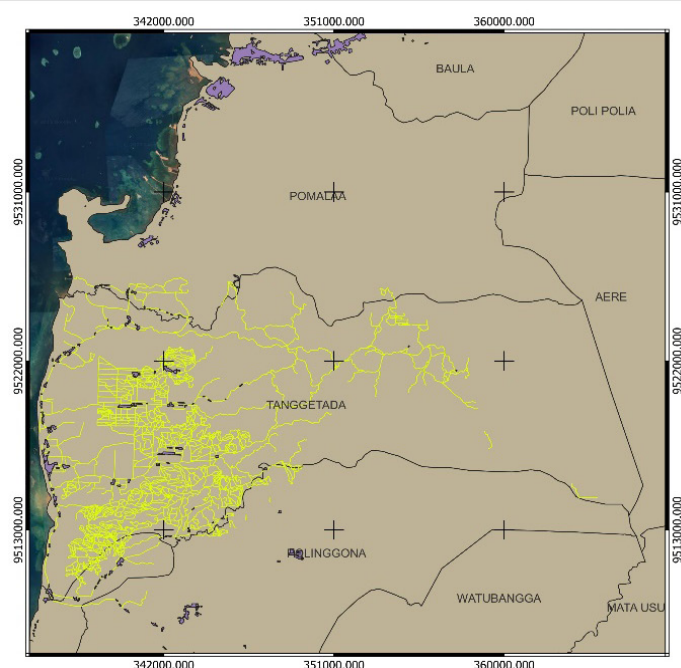


Figure 1: *Administrative Map of Research Location.*

and Watubangga (Figure 1). The selection of these two locations was based on the area of immature oil palm plantations, which reached 2.732,91 hectares. Oil palm plants in this area are immature, so they are relevant objects to be analyzed in managing, maintaining, and optimising the area's potential.

Tools and Materials

The equipment used includes a questionnaire to obtain information, a GPS (Global Positioning System) to determine the coordinates of the research location, a digital camera to document field conditions, and a roll meter to measure the area accurately. In addition, devices such as tropical greenery E-books are used as field references, compasses for direction orientation, raffia ropes, digital scales, bamboo, machetes, scissors, large plastic, label paper, newspaper, and stationery are the prominent supporters in the process of taking and processing samples. The materials studied in this study include various types of greenery that grow in oil palm plantation areas.

Data Collection and Sampling

The research data were obtained through observation, direct observation, and identification processes in the oil palm plantation area. The research sample included all types of plant species found in the unproductive oil palm plantation area located in Watubangga District and Tanggetada District.

Data Collection Technique

Data collection techniques used field observation methods, such as exploring and taking transect samples, to determine the plant community type in the oil palm plantation area. At each point, a transect measuring 10x30 m² was made with a width of 10 meters on the right and left. Then, identified the types of plants, record, and compare the types of plants using tropical greenery E-books, the internet, and other literature.

Botanical Composition Sampling

Sampling for botanical composition analysis was conducted in six villages across two sub-districts. In Watubangga Sub-district, the research locations included Kastura Village, Polenga Village, and Kukutio Village. Meanwhile, the research was conducted in Tanggetada Sub-district, Pundaipa Village, Oneeha Village, and Tinggo Village. In each village, samples were taken from unproductive oil palm plantation areas with 50 sample points per village. Overall, the transect method was used to sample all research locations, with 300 points. Identification of plant species was carried out through field exploration and herbarium collections. Plant specimens were collected from each location based on the specific conditions of the unproductive oil palm plantation area (Figure 2 and Figure 3). Furthermore, the collected plant specimens were identified by comparing the physical

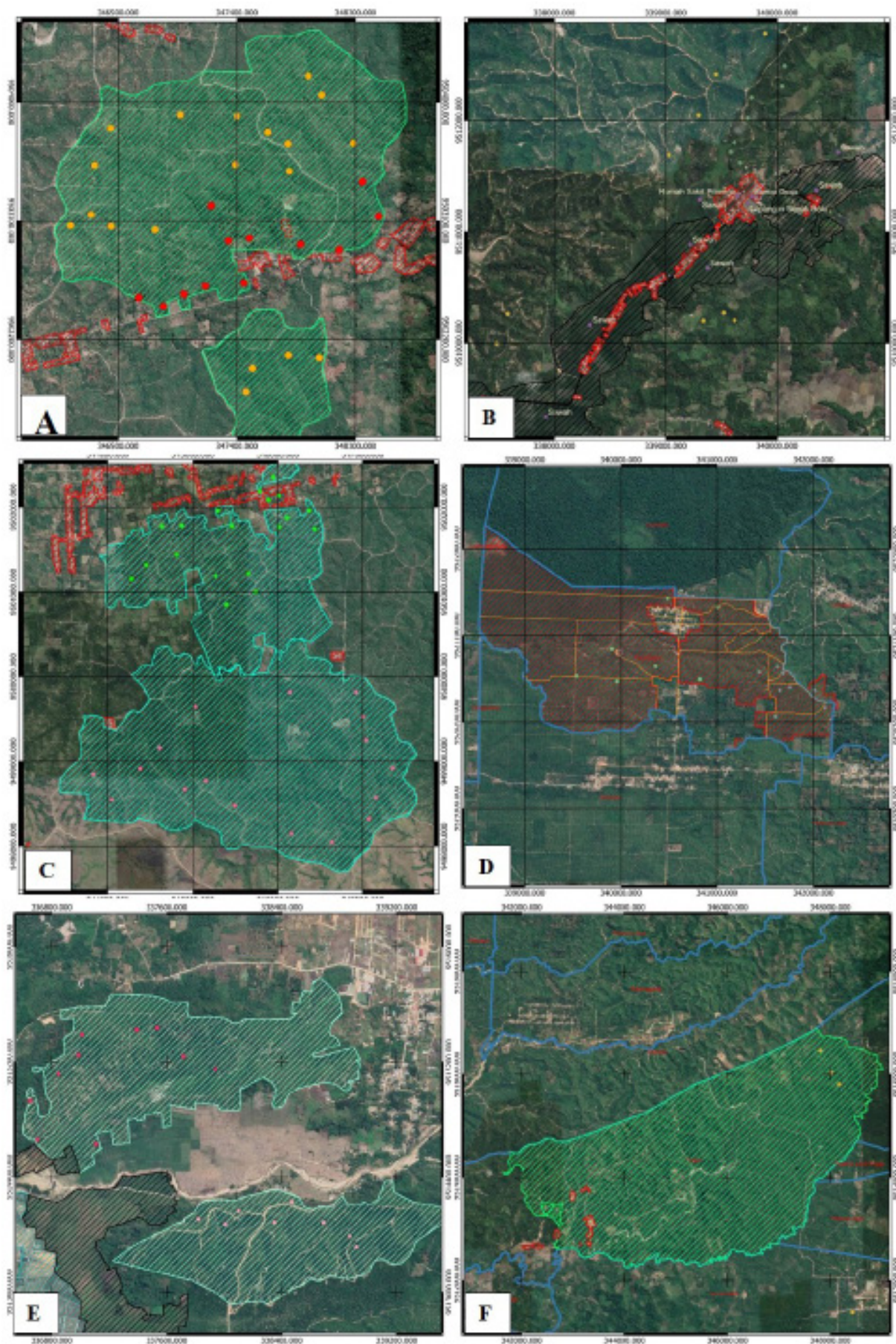


Figure 2: Research Village Area where the oil palm plantation area has immature (Watubangga sub-district and Tanggetada sub-district), A: Kastura Village, B: Polenga Village, C: Kukutio Village, D: Pundaipa Village, E: Onee-ha Village, and F: Tinggo Village.

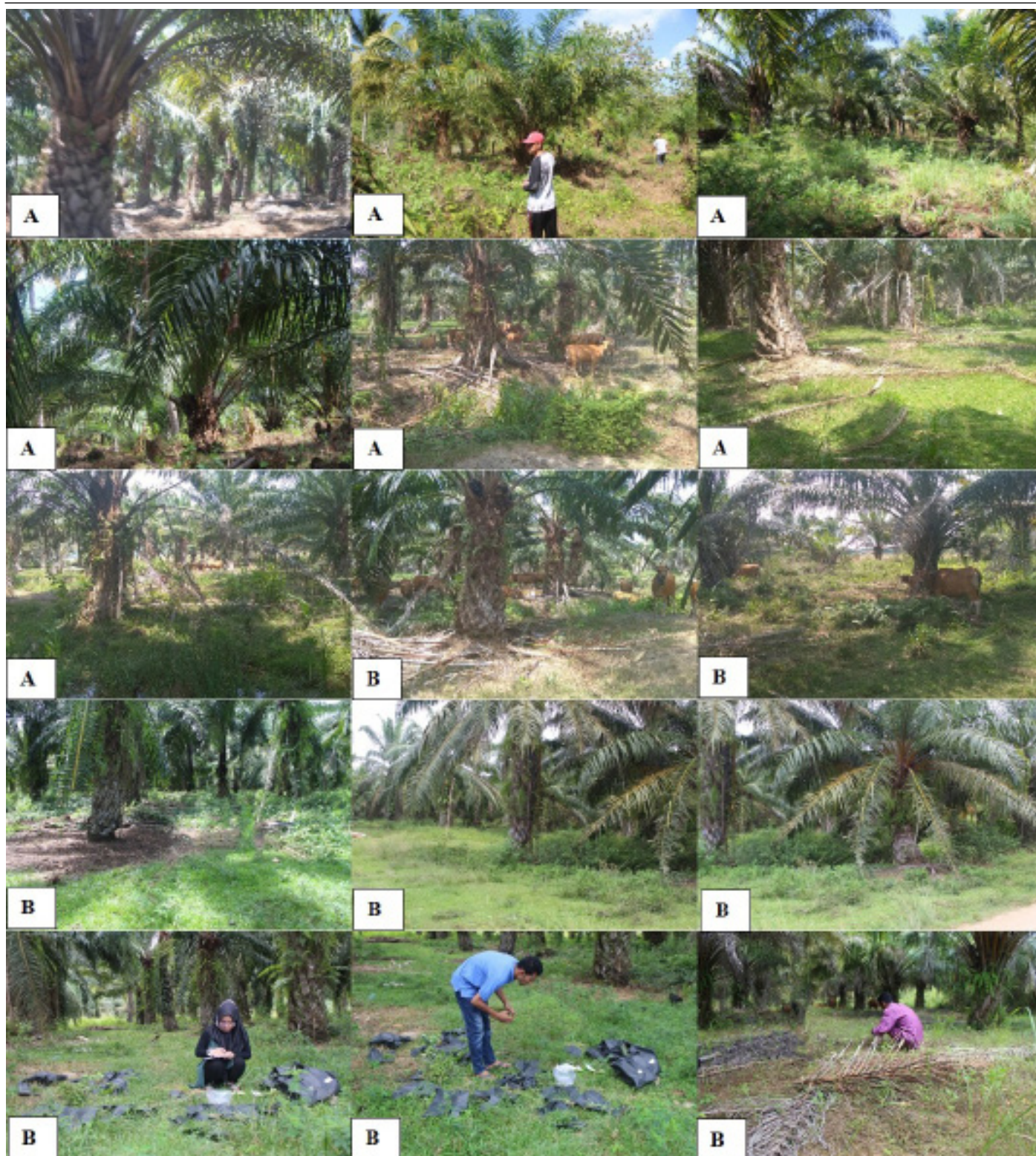


Figure 3: Research Sampling Locations in Oil Palm Plantation Areas in Watubangga District (A) and Tanggetada District (B)

characteristics of the plants with related scientific literature to determine the type name and Latin name of the plant.

Analysis of Data

Summed Dominance Ratio (SDR)

The calculations used to analyze vegetation on oil

palm plantations use the Summed Dominance Ratio (SDR), including Absolute Density (AD), Absolute Frequency (AF), Relative Density (RD), Relative Frequency (RF), and Important Value (IV) (Moenadir, 1993; Sembodo, 2010; Kastanja, 2011).

Species Diversity Index (H')

$$H' = \sum_{i=1}^s p_i \ln p_i$$

Where;

H' = Species diversity index.

P_i = Opportunities of interest for each species= n_i/N .

N_i = Number of individuals of each species.

N = Total number of individuals.

The classification of diversity values is as follows:

$H' < 1$ = Low diversity

$1 < H' < 3$ = Moderate diversity

$H' > 3$ = High diversity.

Dominance Index

$$C = \sum_{k=0}^n (n_i/N)^2$$

Where;

C = Dominance index.

N_i = Importance values for each species.

N = Total value of interest.

Dominance index result criteria:

$0 < C < 0,5$ = There is no dominant type.

$0,5 < C < 1$ = There is a type that dominates.

Evenness Index

$$E = H'/H_{maks}$$

Where;

E = Evenness index.

H' = shanon-wiener diversity index.

$H'_{maks} = \log 2 S = 3,3219 \log S$.

S = Number of taxa.

The following criteria are used to determine the evenness value:

$>0,6$ = High.

$0,3-0,6$ = Moderate.

$<0,3$ = Low.

Results and Discussion

SDR

Plant species in oil palm plantation areas that have not yet been produced in various regions have differ-

ent numbers of species because they are influenced by the intensity of light that directly hits the soil base where the species grows. Light is an environmental factor that affects secondary plants' growth, development, and metabolism and has an optimal light range for growth (Guo *et al.*, 2006; Zoratti *et al.*, 2014; Yang *et al.*, 2018). The SDR of Immature plants in Watubangga District is presented in Table 1.

Warastra *et al.* (2016) plant species on unproductive oil palm plantations in Aluebilie District, Naganraya Regency are *Nephrolepis bisserata* 31.90%, *Stenochlaena palustris* 22.24%, *Asystasia gangetica* 13.48%, and *Derris elliptica* 23.64%. This is certainly different from the results of research that has been carried out in Polenga Village; the plant species with the highest SDR value was *Panicum maximum* (Jacq.) 3.4592%, and the lowest was the *Phymatopteris triloba* (Houtt.) Pic. Serm. with a value of 1.5313%. Study Nasution *et al.* (2017) that on oil palm plantations there are *Eleusine indica* species has a value of 21.61%, *Echinochloa colona* 12.33%, *Synedrella nodiflora* 18.60%, *Asystasia intrusa* 20.95%, and *Paspalum conjugatum* 9.79%.

Abdi *et al.* (2018) reported that plant species found in the unproductive oil palm plantation area in the PTPN V plantation, Kampar Regency, Riau Province, have varying SDR values based on type such as *Ageratum conyzoides* 21.22%, *Axonopus compressus* 17.02%, *Amarantus spinosus* 15.48%, and *Cyperus kyllingia* 12.88%. This finding contrasts with the research results in Kastura Village, where the species with the highest SDR value was *Mikania micrantha* Kunt., recorded at 3.6073%. Meanwhile, the species with the lowest SDR value was *Asystasia coromandeliana* Ness, with a value of 1.4305%.

At the research location of Kukutio Village, the plant species with the highest SDR value was *Phymatodes* sp. with a value of 3.6183% and the lowest was the plant species *Scleria sumatrensis* Retz with a value of 1.6634%. The SDR value of plant species in immature oil palm stands in Tanggetada District is presented in Table 2.

This shows that the plant species with the highest SDR value in Pundaipa Village was *Nephrolepis bisseratai* 3.6072%, while the lowest species was *Pennisetum purpureum* Schumach with 1.4932% SDR value. Tinggo Village has the highest SDR value of species *Chromolaena odorata* (L.) with value of 3.9861%; the

Table 1: Summed Dominance Ratio of Watubangga District.

Family	Species	SDR (%) Polenga	SDR (%) Kastura	SDR (%) Kukutio
Acanthaceae	<i>Asystasia coromandeliana</i> Ness.	2.1609	1.4305	3.5335
	<i>Mikania micrantha</i> Kunt.	2.4964	3.6073	2.0198
Adiantaceae	<i>Taenitis blechnoides</i> (Willd.) Sw.	2.0343	1.5920	2.7892
Aspleniaceae	<i>Asplenium macrophyllum</i> Sw.	1.6860	1.6911	3.5492
	<i>Asplenium nidus</i> L.	2.1481	2.7853	4.0030
	<i>Asplenium platyneuron</i> (L.)	3.1860	2.3488	2.0292
Asteraceae	<i>Ageratum conyzoides</i> L.	2.6524	2.0285	1.7985
	<i>Chromolaena odorata</i> (L.) King	3.1050	2.6296	1.9852
Cyperaceae	<i>Cyperus distans</i> L.f.	2.6477	1.6769	2.4705
	<i>Cyperus rotundus</i> L.	2.3885	1.9095	2.4642
	<i>Cyperus kylingia</i>	2.1059	2.3205	1.8062
	<i>Scleria sumatrensis</i> Retz.	2.5961	2.4026	1.6634
Dennstediaceae	<i>Nephrolepis bisserata</i>	1.6954	2.7259	2.3260
	<i>Euphorbia hirta</i> L.	2.4213	2.7174	2.6918
Euphorbiaceae	<i>Phyllanthus amarus</i> Schumach. & Thonn	1.8092	2.0624	2.2317
Gleicheniaceae	<i>Gleichenia linariis</i>	2.6101	2.7542	1.7136
Lycopodiaceae	<i>Lycopodium cernuum</i>	2.4260	3.2785	3.5303
Malvaceae	<i>Urena lobata</i> L.	3.0757	2.8533	2.7201
Melastomataceae	<i>Clidemia hirta</i> (L.) D.Don	2.9443	1.9460	2.3354
Mimosaceae	<i>Mimosa pudica</i> L.	1.8936	1.6033	2.6950
Poaceae	<i>Axonopus compressus</i> (Sw.) P.Beauv.	2.2372	2.5471	2.0575
	<i>Brachiaria miliformis</i>	2.5245	2.1587	2.0355
	<i>Brachiaria mutica</i> (Forssk.) Stapf	2.7602	2.0738	2.7232
	<i>Cynodon dactylon</i> (L.) Pers.	1.8655	2.3517	1.8376
	<i>Cyrtococcum accrencens</i>	2.8787	3.5903	2.8112
	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	2.8318	1.9378	2.4485
	<i>Digitaria ciliaris</i>	2.0871	3.2643	2.0575
	<i>Imperata cylindrica</i> (L.) P.Beauv.	2.6008	2.7089	2.3857
	<i>Ischaemum timorense</i> Kunth.	2.4226	2.8703	1.9727
	<i>Panicum brevifolium</i> (Link) Kunth.	2.8084	2.7598	2.7609
	<i>Panicum maximum</i> (Jacq.)	3.4592	2.1021	2.0606
	<i>Panisetum polystachyon</i>	1.7423	3.6045	1.7136
	<i>Pennisetum purpureum</i> Schumach.	2.0918	2.8448	3.1174
	<i>Davalia denticulata</i>	2.3663	1.5183	2.4705
Polypodiaceae	<i>Goniophlebium persicifolium</i>	2.6852	2.7627	1.7136
	<i>Phymatodes</i> sp.	2.2700	2.5018	3.6183
	<i>Phymatopteris triloba</i> (Houtt.) Pic.Serm.	1.5313	2.7287	2.4076
	<i>Borreria latifolia</i> (Aubl.) K.Schum.	1.9780	1.4928	1.8847
Rubiaceae	<i>Solanum torvum</i> Sw.	3.2410	2.4933	2.3794
Solanaceae	<i>Stachytarpheta indica</i> (L.) Vahl.	2.3275	1.5183	1.7513
Verbenaceae	<i>Calopogonium mucunoides</i> Desv.	1.9464	3.3266	2.3794
Leguminaceae	<i>Alysicarpus vaginalis</i> (L.) DC.	2.1528	2.1644	2.3574
	<i>Desmodium triflorum</i> (L.) DC.	2.5398	2.8986	2.3888

Source: Data Analysis Results, 2024.

Table 2: Summed Dominance Ratio of Tanggetada District.

Family	Species	SDR (%) Pundaipa	SD (%) Tinggo	SDR (%) Onecha
Acanthaceae	<i>Asystasia coromandeliana</i> Ness.	2.3648	2.2919	3.5335
	<i>Mikania micrantha</i> Kunt.	2.0991	2.2153	2.0198
Adiantaceae	<i>Taenitis blechnoides</i> (Willd.) Sw.	2.7466	1.5913	2.7892
Aspleniaceae	<i>Asplenium macrophyllum</i> Sw.	2.9326	3.1690	3.5492
	<i>Asplenium nidus</i> L.	2.1607	2.1785	4.0030
	<i>Asplenium platyneuron</i> (L.)	2.3285	2.3402	2.0292
Asteraceae	<i>Ageratum conyzoides</i> L.	2.1944	1.9117	1.7985
	<i>Chromolaena odorata</i> (L.) King	1.5884	3.9861	1.9852
Cyperaceae	<i>Cyperus distans</i> L.f.	2.6804	2.5503	2.4705
	<i>Cyperus rotundus</i> L.	2.4536	3.1490	2.4642
	<i>Cyperus kylingia</i>	2.3720	1.7846	1.8062
	<i>Scleria sumatrensis</i> Retz.	2.5897	3.4641	1.6634
Dennstediaceae	<i>Nephrolepis bisserata</i>	3.6072	2.7121	2.3260
	<i>Euphorbia hirta</i> L.	2.1218	2.4085	2.6918
Euphorbiaceae	<i>Phyllanthus amarus</i> Schumach. & Thonn	2.0174	3.1207	2.2317
Gleicheniaceae	<i>Gleichenia linariis</i>	3.0350	2.4652	1.7136
Lycopodiaceae	<i>Lycopodium cernuum</i>	2.1380	2.3066	3.5303
Malvaceae	<i>Urena lobata</i> L.	2.2061	2.4001	2.7201
Melastomataceae	<i>Clidemia hirta</i> (L.) D.Don	2.7874	3.2824	2.3354
Mimosaceae	<i>Mimosa pudica</i> L.	3.5846	2.8738	2.6950
Poaceae	<i>Axonopus compressus</i> (Sw.) P.Beauv.	2.0447	3.4725	2.0575
	<i>Brachiaria miliformis</i>	2.6396	2.4568	2.0355
	<i>Brachiaria mutica</i> (Forssk.) Stapf	2.4147	1.8298	2.7232
	<i>Cynodon dactylon</i> (L.) Pers.	2.1944	2.0566	1.8376
	<i>Cyrtococcum accrengens</i>	2.7602	1.6029	2.8112
	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	2.5126	1.8182	2.4485
	<i>Digitaria ciliaris</i>	2.2015	2.2636	2.0575
	<i>Imperata cylindrica</i> (L.) P.Beauv.	2.2650	1.8749	2.3857
	<i>Ischaemum timorense</i> Kunth.	2.0537	2.1417	1.9727
	<i>Panicum brevifolium</i> (Link) Kunth.	1.8742	2.1417	2.7609
	<i>Panicum maximum</i> (Jacq.)	2.6215	2.7572	2.0606
	<i>Panisetum polystachyon</i>	2.9053	2.9474	1.7136
	<i>Pennisetum purpureum</i> Schumach.	1.4932	2.4821	3.1174
	<i>Davalia denticulata</i>	2.1490	2.6354	2.4705
	<i>Goniophlebium persicifolium</i>	2.3149	2.1900	1.7136
Polypodiaceae	<i>Phymatodes</i> sp.	1.8924	3.3927	3.6183
	<i>Phymatopteris triloba</i> (Houtt.) Pic.Serm.	1.9585	1.9547	2.4076
Rubiaceae	<i>Borreria latifolia</i> (Aubl.) K.Schum.	2.8464	1.4411	1.8847
Solanaceae	<i>Solanum torvum</i> Sw.	3.4666	1.5630	2.3794
Verbenaceae	<i>Stachytarpheta indica</i> (L.) Vahl.	1.9948	1.7983	1.7513
Leguminaceae	<i>Calopogonium mucunoides</i> Desv.	2.6668	1.5430	2.3794
	<i>Alysicarpus vaginalis</i> (L.) DC.	1.8269	2.1249	2.3574
	<i>Desmodium triflorum</i> (L.) DC.	2.2469	1.9716	2.3888

Source: Data Analysis Results, 2024.

lowest was *Borreria latifolia* (Aubl.) K.Schum. with a value of 1.4411%. [Kardianto et al. \(2018\)](#) PT. Buana Tunas Sejahtera West Kalimantan *Scleria sumatrensis* has the highest SDR value 40.44% and *Cyperus iria* 15.08%. [Lubis et al. \(2018\)](#) In PT. Socfindo Kebun Bangun Bandar, located in Dolok Masihul District, Serdang Bedagai Regency, the plant species with the highest SDR values are *Nephrolepis biserata* (31.90%), *Derris elliptica* (23.65%), *Stenochlaena palustris* (22.24%), and *Asystasia gangetica* (13.48%).

[Suyani et al. \(2019\)](#) The immature oil palm plantation area in Tanjung Rejo Village, Margo Tabir District, Merangin Regency, exhibits varying SDR values, with *Paspalum conjugatum* at 14.94%, *Imperata cylindrica* at 11.68%, and *Eragrostis tenella* at 9.04%. This differs from the research conducted in Onecha Village, where the highest SDR values were recorded for *Asystasia coromandeliana* Ness. (3.5335%), *Asplenium macrophyllum* Sw. (3.5492%), *Asplenium nidus* L. (4.0030%), *Lycopodium cernuum* (3.5303%), *Pennisetum purpureum* Schumach. (3.1174%), and *Phymatodes* sp. (3.6183%). ([Dahlianah, 2019](#)) plant species in the oil palm plantation area that has immature have the highest SDR values of *Borreria latifolia* 23.20%, *Eleusine indica* 23.43%, and the lowest are *Chromolaena odorata* 9.29%, and *Althernanthera philoxeroides* 8.30%.

Diversity of Types, Dominance, and Evenness of Plant Species

The species diversity index is an indicator that shows the community structure and ecosystem stability. The better the species diversity index of an ecosystem, the better the stability of the ecosystem, while the dominance index is a parameter that states the level of concentration of species dominance in a community and the evenness index functions to determine the evenness of each type in each community ([Morris et al., 2014](#); [Thukral et al., 2019](#); [Qureshi et al., 2020](#)). Study on diversity index, dominance index, and evenness index of plant species in oil palm plantation areas that have not yet been produced based on observation plots totalling 50 plots measuring 10×30m² in Polenga Village, Kastura Village, and Kukutio Village, which are included in the administrative area of Watubangga District.

The research results in the oil palm plantation area have not yet produced Polenga Village ([Table 3](#)), which has an average value of $1 < H' < 3$ or is included in the moderate category. This is caused by the inten-

sity of land clearing, sunlight, and livestock footholds that consume green fodder in the oil palm plantation area, as well as herbicide spraying activities by plantation workers. The plant species found in each observation plot in the oil palm plantation area have differences, such as those found in Polenga Village. [Nasution et al. \(2017\)](#) that the dominance index value is 0.92, which means that there are species that dominate the growth media or $0.5 < C < 1$. However, all plant species do not grow evenly because they have a value of < 0.3 or are in the low category.

The diversity index of species, dominance index, and evenness index of plant species in plants have not yet produced Kastura Village ([Table 3](#)). The diversity index of plant species in Kastura Village shows a figure of $1 < H' < 3$ or falls into moderate diversity. The species' dominance index is relatively high but not evenly distributed in each observation plot. This is influenced by the activities of oil palm plantation workers in cleaning the plantation area so that the primary plants are not disturbed by the activities of weeds or other plants. [Pranjaya et al. \(2017\)](#) The composition of plant species in peatlands of oil palm plantations is 0.05. This shows that the species composition in oil palm plantations is not uniform or even.

[Pertiwi et al. \(2018\)](#) reported plant species on peatlands of oil palm plantations in Tebing Tinggi Okura Village, Rumbai Pesisir District, showed the level of species diversity of each research station included in the moderate category because the value obtained was $> 1H' < 3$ as well as the value of the weed dominance index at Station I to Station III was 0.25-0.38. The evenness index of each Station was 0.14, 0.15, and 5.6. The level of dominance was influenced by the intensity of light that inhibited plant development, or in other words, the number of species of a plant community was negatively correlated with shade because the shade would affect the entry of light into the soil to help plant species in carrying out the process of photosynthesis. Plant diversity includes all forms of life, including genes, plant species, ecosystems, and ecological processes and plant diversity also plays a role in maintaining various nutrients in the soil so that it can affect the biogeochemical cycle and significantly affect the stability and sustainability of nature ([Patel et al., 2011](#)).

The species diversity index, dominance index, and plant evenness index have immature Kukutio Village

Table 3: *Diversity of Types, Dominance, and Evenness of Plant Species in Immature Oil Palm Plantation Areas in Watubangga District.*

P	Polenga Village				Kastura Village				Kukutio Village			
	N	H'	E	C	N	H'	E	C	N	H'	E	C
P1	117	2.8452	0.8539	0.0335	433	3.1764	0.9532	0.0326	380	3.1608	0.9486	0.0298
P2	110	2.6803	0.7368	0.0331	447	2.5515	0.7014	0.0317	392	2.7110	0.7453	0.0301
P3	89	2.7581	0.7427	0.0379	265	3.2249	0.8684	0.0336	344	3.0264	0.8150	0.0273
P4	99	2.6510	0.7236	0.0316	326	2.9746	0.8120	0.0273	307	2.6159	0.7140	0.0299
P5	107	2.8700	0.7780	0.0307	292	2.3638	0.6408	0.0275	326	2.6519	0.7189	0.0279
P6	111	1.7782	0.5281	0.0285	260	1.8087	0.5371	0.0343	385	1.8264	0.5424	0.0309
P7	114	1.6992	0.5497	0.0314	267	1.9113	0.6183	0.0330	363	1.7200	0.5565	0.0304
P8	107	2.0415	0.6194	0.0331	228	1.9569	0.5937	0.0368	351	2.0815	0.6315	0.0314
P9	114	2.0447	0.6276	0.0295	272	1.8953	0.5817	0.0350	341	2.1931	0.6731	0.0317
P10	134	1.8265	0.5674	0.0305	312	1.9130	0.5943	0.0293	356	2.0033	0.6224	0.0286
P11	106	2.0719	0.6218	0.0349	314	1.8550	0.5567	0.0285	379	1.8930	0.5681	0.0294
P12	110	1.2985	0.4265	0.0355	347	1.2115	0.3979	0.0287	348	1.3219	0.4342	0.0311
P13	98	1.5267	0.4804	0.0354	245	1.5462	0.4865	0.0339	335	1.7257	0.5430	0.0324
P14	105	2.0373	0.6050	0.0347	309	2.1744	0.6458	0.0302	386	2.2646	0.6725	0.0304
P15	119	1.5742	0.5171	0.0323	300	1.5004	0.4928	0.0316	337	1.6071	0.5279	0.0335
P16	109	1.7230	0.5353	0.0319	273	1.6496	0.5125	0.0332	257	1.7984	0.5587	0.0363
P17	102	1.7608	0.5697	0.0336	333	1.7713	0.5730	0.0294	384	1.8860	0.6102	0.0297
P18	112	2.3256	0.6906	0.0335	281	2.0032	0.5949	0.0325	255	2.1766	0.6464	0.0370
P19	101	1.8626	0.5940	0.0348	255	1.7682	0.5639	0.0332	265	1.7979	0.5734	0.0375
P20	111	1.5679	3.1355	0.0007	274	1.4819	3.1355	0.0001	334	1.8925	3.1355	0.0001
P21	292	2.2374	0.6578	0.0313	263	2.1324	0.6270	0.0358	306	2.3517	0.6914	0.0301
P22	304	2.4261	0.7205	0.0315	269	2.2583	0.6707	0.0342	307	2.2264	0.6612	0.0315
P23	283	2.7443	0.8878	0.0311	273	2.7306	0.8834	0.0321	328	2.5525	0.8258	0.0281
P24	263	2.2681	0.7847	0.0321	286	2.2846	0.7904	0.0326	284	2.4302	0.8408	0.0335
P25	254	2.1335	0.6804	0.0309	325	2.4368	0.7772	0.0299	299	2.3064	0.7356	0.0312
P26	262	2.6840	0.8816	0.0320	255	2.6531	0.8714	0.0324	314	2.5077	0.8237	0.0324
P27	254	2.4034	0.7213	0.0334	330	2.5694	0.7711	0.0295	304	2.2736	0.6823	0.0329
P28	310	2.5139	0.8257	0.0302	273	2.3016	0.7560	0.0322	336	2.5311	0.8314	0.0310
P29	262	2.3879	0.7843	0.0336	276	2.3948	0.7866	0.0304	325	2.3793	0.7815	0.0309
P30	282	2.3867	0.7510	0.0309	311	2.5308	0.7963	0.0312	320	2.4108	0.7586	0.0301
P31	280	2.4625	0.7313	0.0320	388	2.1521	0.6391	0.0361	273	2.6805	0.7960	0.0350
P32	275	2.4481	0.8041	0.0330	446	2.4350	0.7998	0.0328	265	2.3239	0.7633	0.0358
P33	305	2.4660	0.8232	0.0293	404	2.3401	0.7811	0.0312	308	2.4328	0.8121	0.0313
P34	258	2.1997	0.7934	0.0362	392	2.4896	0.8979	0.0367	287	2.5946	0.9358	0.0330
P35	310	2.5046	0.9033	0.0310	340	2.3335	0.8416	0.0376	308	2.1148	0.7628	0.0337
P36	252	2.2989	0.7437	0.0309	490	2.4286	0.7857	0.0306	305	2.3288	0.7534	0.0335
P37	274	1.9168	0.6510	0.0315	433	2.0250	0.6877	0.0322	391	2.0496	0.6961	0.0268
P38	310	2.1167	0.5663	0.0302	480	2.4206	0.6476	0.0316	254	2.0315	0.5435	0.0367
P39	243	2.1285	0.5695	0.0336	439	2.1584	0.5775	0.0314	285	2.0996	0.5617	0.0330
P40	331	2.4364	0.7312	0.0297	481	2.2568	0.6773	0.0305	334	2.4786	0.7438	0.0297
P41	276	2.2712	0.7858	0.0339	495	2.1415	0.7409	0.0312	269	2.0206	0.6991	0.0336
P42	303	2.4410	0.8804	0.0288	438	2.1685	0.7821	0.0351	292	2.5048	0.9034	0.0322
P43	281	1.7658	0.5997	0.0323	441	1.8346	0.6231	0.0302	279	1.8932	0.6430	0.0338
P44	302	2.3523	0.7989	0.0309	438	2.5162	0.8546	0.0337	332	2.6743	0.9083	0.0310

P45	238	2.7507	0.9709	0.0354	466	2.9405	1.0379	0.0309	274	2.7462	0.9693	0.0343
P46	320	2.3803	0.7490	0.0295	326	2.4592	0.7738	0.0376	259	2.0808	0.6547	0.0359
P47	279	2.4489	0.7608	0.0310	448	2.4932	0.7746	0.0312	306	2.8243	0.8774	0.0298
P48	315	2.3800	0.7591	0.0017	483	2.3723	0.7566	0.0006	316	2.5693	0.8194	0.0000
P49	306	2.5923	0.8268	0.0301	481	2.6361	0.8407	0.0292	318	2.4988	0.7969	0.0323
P50	263	2.6292	0.7730	0.0333	452	2.6382	0.7757	0.0316	312	2.4061	0.7074	0.0323

Information: P (Plot), $P^{1,2,3,4,\dots}$ (Plot Point), N (Number of Species), H' (Species Diversity Index), E (Dominance Index), C (Evenness Index), Source: Data Analysis Results, 2024.

(Table 3), showing that the species diversity index of plants in the oil palm plantations of Kukutio Village was not much different from the species diversity index in Polenga Village and Kastura Village. The research results in Kukutio Village can prove that the plant diversity index of various species is at $1 < H' < 3$ or is included in the moderate category. Meanwhile, these plant species turn out to be able to dominate the growing media, but there are no species that grow evenly in each research plot. This is to the research results carried out by Dahlianah (2019) the level of species diversity depends on the distance between oil palm plants because if the distance between plants is narrow, it is difficult for plant species to grow, and vice versa, the wider the distance between plants, the easier it is for these plant species to grow.

The results of the study are in Table 4. The diversity index of plant species is in the moderate category or has a value of $1 < H' < 3$ and an even dominance index, as evidenced by the value > 0.6 in almost all observation plots. However, no species grow evenly in each research plot. This is due to the intensity of cleaning plant species in oil palm plantation areas because they are considered weeds that interfere with oil palm plants.

Each place has different plant species, agricultural land, forest areas or settlements. This is in line with the research of Mardiyanti et al. (2013), which states that plant diversity is the diversity that occupies an ecosystem. All types of species can grow well if they are not disturbed by human activities and environmental conditions. According to the research of Hikmat and Setyawati (2017), habitat disturbance can result in changes in the composition and structure of stands and vegetation types, decreasing plant species diversity.

The results of the study on the species diversity index in Tinggo Village (Table 4) are not much different from the results of the survey conducted in Pundaipa

Village (Table 4), which has a species diversity index value of $1 < H' < 3$ and dominates the growing media but does not grow evenly in each research plot. Each plant species illustrates that a community can grow well if enough nutrients and light are needed. These plant species can be found in tropical rainforests, humid grasslands, roadsides, and rivers.

Yang et al. (2018) state that light intensity directly affects the photosynthesis of a plant species. This shows that the diversity index of plant species in the immature oil palm plantation area in Oneeha Village is not much different from the results of research conducted in the immature oil palm plantation area in Tinggo Village and Pundaipa Village. This illustrates that there are still species that dominate even though the evenness index of these plant species is not even. The level of diversity of understory plant species (H') is classified as low, with a value of 0.637 for productive plants and 1.94 for non-productive plants (Vasilevich, 2009). The concept of species diversity includes the components of species richness and evenness. Species richness is the number of species per unit area, and evenness is the distribution of species abundance in a community.

Corlett (2016) states that plant species continue to decline due to human activities in opening up areas, and most plant species are lost, especially in tropical regions. Wan et al. (2020) reported that 2.914 plant species showed no increase in species richness and an explicit decrease in plant species performance. Ensslin et al. (2015) reported that changes in nature and loss of native habitat cause a decline in plant species in area even though there are species that can survive and can invade other species such as *Chromolaena odorata*, which is a species of perennial shrub that grows abundantly in Asia and sub-Saharan Africa (Olawale et al., 2022). The level of evenness of a plant species generally depends on rainfall, variety, soil conditions and density of a plant species.

Table 4: *Diversity of Types, Dominance, and Evenness of Plant Species in Immature Oil Palm Plantation Areas in Tanggetada District.*

P	Pundaipa Village				Tinggo Village				Onecha Village			
	N	H'	E	C	N	H'	E	C	N	H'	E	C
P1	151	3.1226	0.9371	0.0342	405	3.1217	0.9368	0.0312	168	3.0612	0.9187	0.0333
P2	149	2.5503	0.7011	0.0318	363	2.6204	0.7204	0.0324	162	2.5836	0.7103	0.0335
P3	172	2.9188	0.7860	0.0312	348	2.7551	0.7419	0.0299	185	2.8508	0.7677	0.0283
P4	167	2.3724	0.6476	0.0288	361	2.5886	0.7066	0.0279	146	2.2975	0.6271	0.0285
P5	164	2.5587	0.6936	0.0273	286	2.4443	0.6626	0.0349	185	2.6072	0.7068	0.0284
P6	116	1.6244	0.4824	0.0357	310	1.6798	0.4989	0.0342	180	1.4922	0.4432	0.0293
P7	149	1.7720	0.5733	0.0313	235	1.5161	0.4905	0.0463	155	1.3530	0.4377	0.0363
P8	130	2.0108	0.6101	0.0361	257	1.7732	0.5380	0.0436	469	1.7839	0.5413	0.0397
P9	122	2.0134	0.6180	0.0376	267	2.3404	0.7183	0.0398	379	1.9603	0.6017	0.0518
P10	156	2.0844	0.6475	0.0343	214	1.8366	0.5706	0.0506	342	1.7351	0.5390	0.0533
P11	146	1.7752	0.5327	0.0332	281	2.3429	0.7031	0.0426	297	1.4217	0.4267	0.0622
P12	162	1.2491	0.4103	0.0320	277	1.5339	0.5038	0.0374	334	1.1410	0.3748	0.0544
P13	156	1.5625	0.4917	0.0304	241	1.6941	0.5331	0.0443	319	1.0561	0.3323	0.0548
P14	118	1.9962	0.5928	0.0346	217	2.0505	0.6089	0.0481	337	2.0697	0.6147	0.0581
P15	167	1.3587	0.4463	0.0308	221	1.6828	0.5527	0.0497	328	1.4833	0.4872	0.0522
P16	164	1.6817	0.5224	0.0319	348	1.6413	0.5099	0.0327	285	0.9132	0.2837	0.0613
P17	164	1.7991	0.5820	0.0309	452	1.6698	0.5402	0.0274	419	1.5715	0.5084	0.0461
P18	131	2.0765	0.6167	0.0336	321	1.7525	0.5204	0.0299	447	1.7458	0.5185	0.0419
P19	159	1.6193	0.5164	0.0303	392	1.6563	0.5282	0.0301	572	1.8128	0.5781	0.0317
P20	174	1.4996	3.1355	0.0016	364	1.3066	3.1355	0.0701	355	1.2471	3.1355	0.0286
P21	244	2.5593	0.7525	0.0325	173	2.4936	0.7331	0.0359	438	2.2746	0.6688	0.0455
P22	258	2.0178	0.5992	0.0299	171	2.0622	0.6124	0.0327	402	2.0150	0.5984	0.0509
P23	205	2.5990	0.8408	0.0333	167	2.5054	0.8105	0.0319	363	2.2345	0.7229	0.0501
P24	243	2.2826	0.7897	0.0301	156	2.2466	0.7773	0.0348	373	1.9050	0.6591	0.0478
P25	227	2.3061	0.7355	0.0355	166	2.4907	0.7944	0.0335	352	2.0822	0.6641	0.0504
P26	228	2.3839	0.7830	0.0332	182	2.5383	0.8337	0.0320	374	2.4117	0.7921	0.0488
P27	226	2.0930	0.6281	0.0334	163	2.5085	0.7528	0.0356	361	1.8161	0.5450	0.0497
P28	227	2.5729	0.8451	0.0312	163	2.7279	0.8960	0.0340	445	2.1959	0.7213	0.0454
P29	267	2.3927	0.7859	0.0301	152	2.2489	0.7387	0.0339	420	2.4565	0.8068	0.0468
P30	176	2.2344	0.7031	0.0438	202	2.5259	0.7948	0.0294	409	2.4225	0.7623	0.0436
P31	244	2.2529	0.6690	0.0330	143	2.2522	0.6689	0.0376	322	2.3043	0.6843	0.0531
P32	248	2.1002	0.6898	0.0322	146	2.2041	0.7239	0.0377	330	2.2184	0.7287	0.0357
P33	271	2.4578	0.8204	0.0309	146	1.9078	0.6368	0.0376	380	2.1213	0.7081	0.0316
P34	239	2.4354	0.8784	0.0315	183	2.2887	0.8255	0.0310	401	2.3379	0.8432	0.0297
P35	279	2.2397	0.8078	0.0308	163	2.2082	0.7964	0.0349	403	2.1550	0.7772	0.0315
P36	251	2.2655	0.7329	0.0317	168	2.2851	0.7393	0.0362	365	2.0408	0.6602	0.0352
P37	258	2.2229	0.7549	0.0298	167	2.0206	0.6862	0.0313	396	1.9841	0.6738	0.0295
P38	230	1.9579	0.5238	0.0333	179	2.1772	0.5825	0.0329	319	1.7195	0.4600	0.0377
P39	241	2.0390	0.5455	0.0319	162	1.8268	0.4887	0.0321	385	1.8553	0.4964	0.0302
P40	236	2.4620	0.7388	0.0309	163	2.6075	0.7825	0.0352	355	2.4343	0.7305	0.0327
P41	296	2.0374	0.7049	0.0322	166	2.0163	0.6976	0.0303	396	2.2552	0.7802	0.0311
P42	340	2.4375	0.8791	0.0292	136	2.0887	0.7533	0.0359	395	2.4203	0.8729	0.0302
P43	293	1.8186	0.6176	0.0352	89	1.4641	0.4973	0.0441	365	1.6515	0.5609	0.0300
P44	294	2.3287	0.7909	0.0311	156	2.1585	0.7331	0.0307	411	2.3170	0.7869	0.0290

P45	349	2.5130	0.8870	0.0298	147	2.3968	0.8460	0.0345	373	2.3730	0.8376	0.0322
P46	317	2.1519	0.6771	0.0350	168	2.2092	0.6951	0.0315	389	2.4170	0.7605	0.0321
P47	368	2.6501	0.8233	0.0284	162	2.5543	0.7935	0.0330	446	2.6115	0.8113	0.0296
P48	363	2.1151	0.6746	0.0017	127	2.0738	0.6614	0.0620	390	2.3977	0.7647	0.0009
P49	271	2.2385	0.7139	0.0368	167	2.4407	0.7784	0.0295	313	2.1991	0.7013	0.0367
P50	316	2.1373	0.6284	0.0324	159	2.3711	0.6971	0.0300	424	2.1716	0.6385	0.0318

Information: P (Plot), $P^{1,2,3,4,\dots}$ (Plot Point), N (Number of Species), H' (Species Diversity Index), E (Dominance Index), C (Evenness Index), Source: Data Analysis Results, 2024.

Conclusions and Recommendations

The study was conducted for eight months in six villages across Watubangga District (Kastura Village, Polenga Village, Kukutio Village) and Tanggetada District (Pundaipa Village, Oneeha Village, Tinggo Village). The study results showed that the dominant species varied in each village, including *Panicum maximum* (Jacq.) (Polenga Village, SDR: 3.4592%), *Mikania micrantha* Kunt. (Kastura Village, SDR: 3.6073%), *Phymatodes* sp. (Kukutio Village, SDR: 3.6183%), *Nephrolepis bisserrata* (Pundaipa Village, SDR: 3.6072%), *Chromolaena odorata* (L.) King (Tinggo Village, SDR: 3.9861%), and *Asystasia coromandeliana* Ness. (Oneeha Village, SDR: 3.5335%). The species diversity value ($1 < H' < 3$) at the six research locations is included in the moderate category, indicating a stable level of species diversity. Factors such as land clearing intensity, sunlight, and livestock footing activities that eat green fodder in the plantation area affect the vegetation composition in the research area.

Acknowledgements

With deep gratitude and appreciation, we thank the Rector of Halu Oleo University and the Head of the UHO Research and Community Service Institute (LPPM) for the moral support and facilities in carrying out this research. We also thank the Head of the Palm Oil Plantation Company, PT. Damai Jaya Lestari, thank you for the cooperation and access provided so that this research can run smoothly. We also appreciate the contribution of students who have helped in data collection and analysis and all the people who sincerely gave their time, information, and support during the research process. Hopefully, this collaboration will be the first step to contribute to the development of science and community welfare.

Novelty Statement

The novelty of this research lies in the specific analysis of immature oil palm plants in the research area. The focus on the diversity of local plant species growing around immature plants aims to provide a new perspective on the ecological and economic potential that has received little attention.

Author's Contribution

Damhuri Damhuri: Acting as the principal researcher responsible for designing research, determining objectives and methodology, leading the implementation of field surveys, data analysis, and compiling the final research report.

La Ode Muh. Munadi: Plant species identification, biodiversity analysis, and field data collection.

Lili Darlian: Processing and statistical analysis of research data and interpretation of analysis results;

Sitti Wirdhana Ahmad: Aspects of documentation and scientific literature by conducting literature reviews, verifying plant-related data, and ensuring the quality and completeness of references in compiling research manuscripts.

Conflict of interest

There is no conflict of interest in this article's research, writing or publication.

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