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Analysis of Weed Vegetation on Ex-Burned Oil Palm Plantation Land

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Abstract**—** Weeds frequently present challenges in agricultural settings, leading to crop damage and diminished yields. The size of the current weed population is often closely linked to these issues. The primary factor at play is the competition between crops and weeds for space, nutrients, and light essential for growth. Given that weeds are considered undesirable, their control represents a significant area of focus. A method to assess effective weed control strategies involves vegetation analysis, offering insights into weed distribution and density. The data aids in formulating an effective control strategy to reduce the adverse effects of weeds on oil palm yield. This investigation seeks to analyze the composition and structure of weeds, as well as evaluate the efficacy of weed control measures on ex-burned land. This study employs field surveys to catalog the types and quantities of individual weeds, alongside vegetation analysis to assess weed structure through relative density, frequency, and dominance metrics. The findings revealed a total of 275 distinct weed compositions, encompassing 15 species across 10 families. The prevalent weed species identified included *Eleocharis dulcis*, *Paspalum conjugatum*, and *Fimbristylis miliacea*. The density, frequency, and dominance values of these three weeds were notably high. The weed diversity index in the peatland was measured at 2.13, indicating a high classification. The approach to weed management involves an integration of both physical and chemical techniques.

Keywords**—**Weed, Analysis Vegetation, Oil Palm, Ex-Burned Land

I. INTRODUCTION

Palm oil is Indonesia's main export in the agricultural plantation subsector, projected to reach a value of US$20 billion by 2024. The area of oil palm plantations in Indonesia increased by 7.05% from 2018 to 2022. The average plantation area increased by 1.73% each year, equivalent to 250 thousand hectares per year. East Kalimantan is among the top five provinces in Indonesia for the area of oil palm plantations, with an area of 1.3 million hectares in 2022 (Direktorat Statistik Tanaman Pangan, 2023; Gunawan, 2025). The productivity of oil palm plants is influenced by various factors, including seed quality, soil fertility, climate, technology, labor, and environmental conditions (Dilipkumar et al., 2020). Weeds play an important role in the productivity of oil palm plantations. Weeds in oil palm plantations can lead to a decrease in the quantity and quality of fresh fruit bunch (FFB) production, hinder plant growth, increase the incidence of pests and diseases, disrupt water utilization, and generally raise agricultural costs. The interaction between weeds and crops can produce both beneficial and detrimental effects. Negative interactions occur when weeds compete with cultivated plants for essential resources such as groundwater, sunlight, nutrients, air, and growing space. Additionally, weeds can release allelopathic substances that inhibit plant growth and productivity, reduce irrigation system efficiency, and cause water wastage due to faster evaporation (Nufvitarini et al., 2016). The composition of weeds in oil palm plantations in Indonesia usually consists of a mixture of ferns, broadleaf plants, and grasses, with broadleaf species being the most dominant. Depending on the crop type, climate, weed type, and field conditions, weeds can cause significant losses in plantation crops. For example, areas that are dominated by harmful weeds or heavy competitors, such as creeping plants (*Mikania micrantha*), cogongrass (*Imperata cylindrica*), and *Asystasia cromandeliana*, can lead to a reduction in production of up to 20% (Adriadi et al., 2012; Afrianti et al., 2015; Dahliani & Elban, 2019; Satriawan & Fuady, 2019).

One of the challenges increasingly faced in managing oil palm plantations is land fires. Natural factors and human activities, such as uncontrolled land clearing, can cause land fires. Burned land experiences significant changes in physical, chemical, and biological soil characteristics, including a decrease in organic matter content, soil structure damage, and the loss of essential microorganisms. This condition creates a new ecosystem that is heavily influenced by the presence of weeds as pioneer vegetation capable of growing and thriving in disturbed environments.

On land that has been burned, the dynamics of the weed community tend to differ compared to undisturbed land. Some weed species can exhibit high dominance due to their ability to adapt to extreme conditions, including high temperatures and low nutrient availability. In addition, certain weeds also demonstrate rapid regeneration capabilities through seeds or vegetative organs. Research findings Sumbari & Dwipa (2019) indicate that new vegetation grows after a fire, as the seeds present in the soil deposits are prompted to germinate by adapting to the fire, which causes the breaking of dormancy in certain seeds present in the soil. The presence of certain types of small and light seeds due to the open conditions of the post-fire forest area makes these seeds easily blown by the wind and able to grow back. Utomo (2013) asserts that the seeds play a crucial role in determining the compatibility of the post-fire plant generation's growth and development. Seed reserves in secondary forests play an important role as a seed source for the plant colonization process in succession. Therefore, the analysis of weed vegetation in former fire-affected areas is very important for understanding community structure, species composition, and the adaptation strategies they possess. We can use this information to plan more precise, efficient, and environmentally friendly weed control.

Weed control in oil palm cultivation is one of the components of plant maintenance activities. This activity aims to facilitate the optimal growth of oil palm plants by reducing the impact of weeds that can hinder their development and productivity. The effectiveness of weed control depends on the understanding of the types of weeds present and the methods used for control. The effective implementation of weed control measures will yield sustainable benefits for the sustainability of oil palm production. This study aims to assess the diversity of weeds in oil palm plantations located on ex-burned land.

II. METHOD

A. Studi Site

This research was conducted in the oil palm plantation of Kelinjau Ulu Village, Muara Ancalong District, East Kutai Regency, East Kalimantan Province, on ex-burned land.

B. Research method

We conducted the vegetation analysis directly in the field using the squares method. Data analysis uses descriptive methods based on the results found in the field.

Purposive sampling produced 14 observation plots, each measuring 1 x 1 m. Vegetation analysis in each plot involved recording weed populations, assessing weed dominance, and measuring biomass. This analysis documented the weed species present in the sample plots and determined the dominance of each species through biomass measurement. Weed biomass measurement involves collecting weeds, classifying them by type, and identifying them. We enumerated each species and documented the density data. Then, we determined the dry weight to assess dominance by placing the sample in a newspaper envelope and putting it in the oven.

C. Data Analysis

We analyzed the data from the research location by calculating the Summed Dominance Ratio (SDR) (equation 4) and the diversity index value (H') (equation 5). The SDR and H' values are obtained by first calculating the species density (KM), which is derived from the number of individuals of each type of weed in the sample plot. Based on these calculations, the relative density (KR) is then calculated (equation 1). Next, we calculate the species frequency (FM) based on the number of sample plots that contain a specific type of weed. Equations 2 and 3 then proceed to calculate the relative frequency (FR), dominance (DM), and relative dominance (DR). The calculation formulas refer to the research (Firmansyah & Pusparani, 2019; Permatasari et al., 2023; Satriawan & Fuady, 2019; Suwinda et al., 2019).

$$Relative\ Density\ (KR) = \frac{Density\ of\ species\ A}{Density\ of\ all\ species} \times 100\% \quad (1)$$

$$Relative\ Frequnecy\ (FR) = \frac{Frequnecy\ of\ species\ A}{Frequency\ of\ all\ species} \times 100\% \quad (2)$$

$$Relative\ Dominace\ (DR) = \frac{Dominanceof\ species\ A}{Dominance\ of\ all\ species} \times 100\% \quad (3)$$

$$Summed\ Dominance\ Ratio\ (SDR) = \frac{KR+FR+DR}{3} \quad (4)$$

$$H' = \sum_{i-l}^{s} pi \ln pi \quad (5)$$

Information (equation 5):
H'= species diversity index
Pi = importance chance of each species = ni/N
ni = number of individuals of each species
N = the total number of individuals

According (McCarthy & Magurran, 2004), the classification of diversity value is as follows:
H'<1: Lower diversity
1 <H'<3: Moderate diversity
H'> 3: High diversity

III. RESULTS AND DISCUSSION

A. Weed Composition and Strukture

Vegetation analysis was used to determine the various weed species growing in the ex-burned oil palm plantation. These weeds consisted of 15 species (Figure 1) belonging to 10 families (Table 1). These families consisted of broadleaf, nutgrass, and lawn weeds, totaling 275 species. In terms of groups, the broadleaf group dominates, with eight families encompassing eight types of weeds. Meanwhile, the grass group consists of 1 family with three types, and the sedge group also has one family with three types.

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Table 1. Composition of weeds

No	Species	Famili	Total Species
1.	*Eleocharis dulcis*	Cyperaceae ***	82
2.	*Fimbristylis miliacea*	Cyperaceae ***	40
3.	*Cyperus esculentus*	Cyperaceae ***	18
4.	*Neprolepis biserrata*	Nephrolepidaceae *	6
5.	*Dicranopteris linearis*	Gleicheniaceae *	4
6.	*Melastoma malabathricum.*	Melastomataceae *	5
7.	*Eleusine indica.*	Poaceae **	6
8.	*Paspalum conjugatum*	Poaceae **	60
9.	*Leersia hexandra.*	Poaceae **	8
10.	*Stenochlaena palustris*	Blechnaceae *	11
11.	*Solanum mauritianum*	Solanaceae *	2
12.	*Mikania micrantha*	Asteraceae *	7
13.	*Praxelis clematidea*	Asteraceae *	8
14.	*Ceratopteris thalictroides*	Parkeriaceae *	13
15.	*Ludwigia octovalvis*	Onagraceae *	5
		Total Number Of Species	**275**

(*: broadleaf, **: nutgrass, ***: lawn)

Based on Table 1, the dominant family on ex-burned land in oil palm plantations is the *Cyperaceae* family, consisting of three species and 140 individuals. Apart from *Cyperaceae*, *Poaceae* is the family with the largest number of individuals, at 74. The smallest family is the *Solanaceae* family, with one type and two individuals.

The dominant weed species is *Eleocharis dulcis*. *Eleocharis dulcis,* an aquatic plant belonging to the *Cyperaceae* family*,* commonly inhabits watery environments like rice fields, riverbanks, and swamps. It has a cylindrical, erect, hollow stem with small flowers arranged in spikelets at the end of it. As a weed, it competes with cultivated plants for light, water, and nutrients, which reduces the productivity of cultivated plants. Its rapid growth and spread through rhizomes make it difficult to control, both mechanical and chemical management methods are required. *Eleocharis dulcis* poses a dual threat while its edible tubers are valued in many cultures, it can also be a pervasive weed in wetland ecosystems. Its ability to reproduce through seeds and rhizomes allows it to dominate and disrupt native plant communities, resulting in significant ecological and economic impacts. *Eleocharis dulcis* thrives at 30 to 35°C, with soil moisture levels between 98% and 100%. The optimal soil for this plant's growth is humus-rich clay with a pH range of 6.9 to 7.3; however, it can also thrive in acidic soil conditions. This plant is characteristic of acid sulfate soil due to its resistance to elevated soil acidity (pH 2.5–3.5), serving as an indicator species for such soils. This plant can thrive in extreme soil chemical conditions, including low pH, high aluminum, elevated sulfate (exchangeable content with other compounds), and high dissolved iron levels. This plant can grow well in soil with a pH of 3, where the aluminum (Al) level is 5.35 me/100 g, the dissolved sulfate (SO_4^{2-}) level is 0.90 me/100 g, and the dissolved iron (Fe) level is 1.017 ppm (Santosa et al., 2021; Zhang et al., 2022).

In addition to *Eleocharis dulcis*, the dominant plant in oil palm plantations on ex-burned land is *Paspalum conjugatum*, a species of grass belonging to the *Poaceae* family, with 60 individuals. This grass species from the genus *Paspalum* in the *Poaceae* family grows in tropical and subtropical regions, often thriving in humid areas like riverbanks, swamps, and wet meadows. It has upright or slightly drooping stems, green leaves shaped like ribbons with finely serrated edges, and flowers arranged in panicles. It is able to adapt to a wide range of soil conditions, including waterlogged and nutrient-poor ones, which makes it moderately invasive. *Paspalum conjugatum* is a weed that can grow rapidly in oil palm plantations. This is in accordance with Asbur et al. (2020), which states that *P. conjugatum* dominates growth in oil palm plantations aged 9, 13, and 18 years with densities of 15.0 individuals/m², 24.9 individuals/m², and 30.9 individuals/m², respectively.

According to Adriadi et al. (2012), *Paspalum conjugatum* is a weed that is prevalent in plantations and is a significant contaminant in various crops. *P. conjugatum* is an annual grass that rapidly disseminates across the soil surface at a distance of 5 to 15 cm, producing roots and leaf seedlings that can reach a height of 30 cm. The grass has velvety, dark green stems that are 1 cm wide and up to 20 cm long. The stems are hairy on both surfaces and have wrinkled edges. A ligula is an exceedingly brief membrane, measuring less than 1 mm in length, and is enveloped by a rim of long filaments. *P. conjugatum* individuals have the capacity to generate 1,500 seeds that germinate instantaneously and disseminate rapidly. It was originally located in the forests and forest edges of humid tropical regions; however, it is now prevalent in numerous plantations and other annual agricultural lands. *P. conjugatum* is capable of flourishing in full sunlight and is also tolerant of partial shade, as well as impoverished, acidic soils (Rojas-Sandoval, 2018).

In addition to *Eleocharis dulcis* and *Paspalum conjugatum*, the predominant weed is *Fimbristylis*

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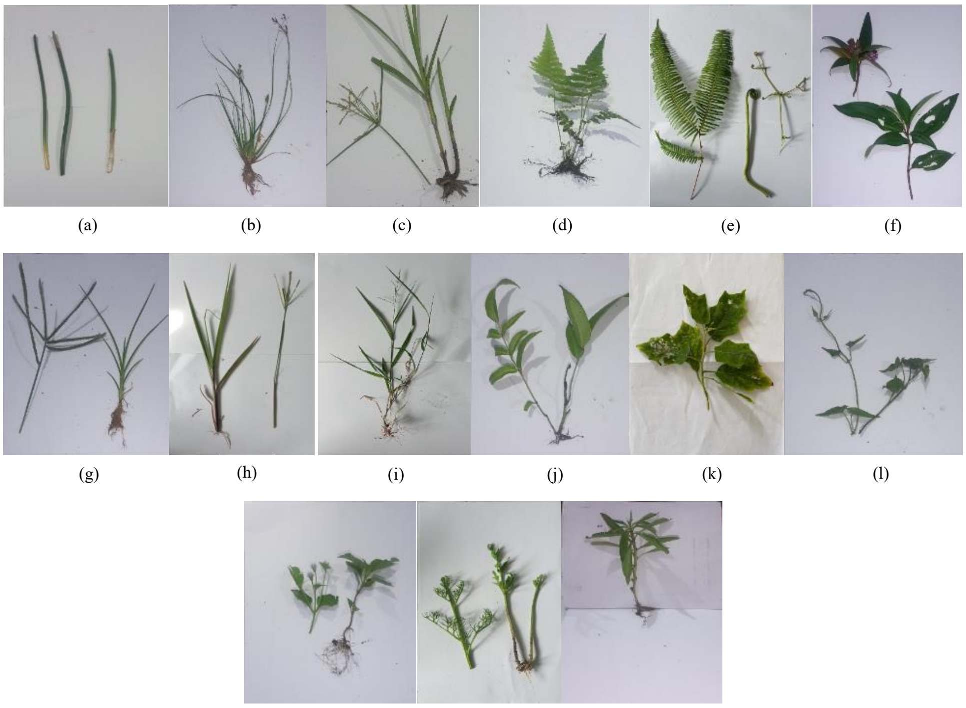
miliacea. *F. miliacea* is a C4 perennial species characterized by an upright and flattened stem, linear, flat, and pliable leaves arranged in two overlapping rows, and numerous spikelets that are globose to ovoid in form, exhibiting a brown to brown-orange hue. This plant has superior efficiency in resource utilization, enabling its survival in scarcity conditions. Consequently, this plant emerges as a preeminent competitor in the acquisition of nutrients and water (Awan et al., 2022). Research by Morla et al. (2022) indicates that the weed *F. miliacea* can impact plant growth and yield by 11-38.7%.

Solanum mauritianum, from the Solanaceae family, is the least common weed in oil palm plantations on this burned land, with two individuals. This weed, often known as the wild tobacco tree, is an invasive plant species from the Solanaceae family. It grows as a shrub or small tree, reaching up to 10 meters in height. Its large, hairy, grayish-green leaves contrast with its purple flowers, which have striking yellow stamens. The fruit is a berry that turns from green to yellow when ripe and contains many small seeds. Due to its ability to grow quickly and compete with cultivated plants, *S.mauritianum* poses a serious threat to native ecosystems (Cowie et al., 2018).

Solanum mauritianum has the ability to alter the composition of soil. The soil dominated by *S. mauritianum* exhibits a pH level nearing neutrality (5.7), which enhances nutrient availability (N, P, and K) and facilitates improved cation exchange. Consequently, the soil infested with *S. mauritianum* has the potential to enhance its physical and chemical characteristics (Ruwanza, 2021). Prior investigations have demonstrated that the invasion of non-native plant species leads to alterations in soil characteristics, influencing both soil composition and processes (Linders et al., 2019), which in turn impacts ecosystem functionality. Previous investigations have indicated that alterations in soil characteristics due to the introduction of non-native plant species may facilitate their spread (Ruwanza & Shackleton, 2016). demonstrates that alterations in soil properties specific to invasions can account for plant invasions and their effects. Reductions in diversity and cover were also observed in fields dominated by *S. mauritianum*, attributed to resource competition, allelopathic effects, and alterations in soil nutrient composition. For example, certain invasive alien plants can surpass native species in the competition for resources like light and soil nutrients, leading to a reduction in the diversity of native species. Furthermore, the process of germination and the recruitment of indigenous species. indicates that *Solanum mauritianum* may outcompete native species due to its competitive edge, dominance, and alteration of ecosystem conditions. Nonetheless, *Solanum mauritianum* is capable of coexisting with native species, even in the presence of competitive interactions (Reynolds & Cooper, 2010; Sholto - Douglas et al., 2017; van Wilgen et al., 2020)



(a) (b) (c) (d) (e) (f)

(g) (h) (i) (j) (k) (l)

(m) (n) (o)

Figure. 1. Weed on Ex-burned oil palm land include (a) *Eleocharis dulcis*;(b) *Fimbristylis miliace*;(c) *Cyperus esculentus*;(d) *Neprolepis biserrata*;(e) *Dicranopteris linearis*;(f) *Melastoma malabathricum*;(g) *Eleusine indica*;(h) *Paspalum conjugatum*;(i) *Leersia heaxandra*;(j) *Stenochlaena palustris*;(k) *Solanum maurutianum*;(l) *Mikania micrantha*;(m) *Praxelis clematidea*;(n) *Ceratopteris thalictroides*;(o) *Ludwigia octovalvis*

B. Weed Dominancy and Diversity

As shown in Table 2, *Eleocharis dulcis* had a relative density of 29.82%, a relative frequency of 16%, and a relative dominance of 13.97% compared to other weeds. This behavior is attributable to its high number of individuals per plot and its wide distribution, which is indicative of its dominant status as a weed. Consequently, *Eleocharis dulcis* possesses the highest importance value and SDR of 59.79% and 19.93%, respectively.

In addition to *Eleocharis dulcis*, the most prevalent weeds were *Paspalum conjugatum* (21.82%), followed by *Fimbristylis miliacea* (14.55%), with a relative density, frequency, and dominance of 12% and 16.54%, respectively. This is attributable to the quantity of individuals observed in each designated plot. Consequently, *Paspalum conjugatum* and *Fimbristylis miliacea* exhibited high importance values and SDR values, with *Paspalum conjugatum* at 50.36% and 16.79%, and *Fimbristylis miliacea* at 40.09% and 13.70%, respectively. The degree of weed dominance was determined by calculating the summed dominance ratio (SDR) value of each species. Dominance is defined as the ability of a weed species to compete with other weed species and survive in a particular ecosystem (Yuliana & Ami, 2020).

As shown in Table 2, the summed dominance ratio (SDR) values for the three weed species, *Eleocharis dulcis*, *Paspalum conjugatum*, and *Fimbristylis miliacea*, vary widely. This finding suggests that these three weed species are prevalent in the study area and exhibit a high degree of adaptability to conditions characteristic of ex-burnt land. The elevated SDR value underscores the significance of prioritizing the regulation of these species to sustain the productivity of oil palm plants.

The *Cyperaceae* family has the highest prevalence. The *Cyperaceae* family emerged as the predominant weed species, exhibiting an SDR value of 40.01%. The *Cyperaceae* family is classified in the lawn group, which is known for reproducing in two main ways: through sexual reproduction and asexual reproduction. The production of flowers, seeds, and rhizomes by *Cyperaceae* facilitates the species' ability to reproduce and ensure its survival within specific agroecosystems. The elevated SDR value of the *Cyperaceae* family indicates this condition (Yuliana & Ami, 2020).

Table 2. The value of SDR various weed species

No	Species	Number of Species	KR	FR	DR	SDR
1	*Eleocharis dulcis*	82	29,82%	16%	13,97%	19,93%
2	*Fimbristylis miliacea*	40	14,55%	10%	16,54%	13,70%
3	*Cyperus esculentus*	18	6,55%	6%	9,19%	7,25%
4	*Neprolepis biserrata.*	6	2,18%	6%	3,68%	3,95%
5	*Dicranopteris linearis.*	4	1,45%	2%	1,84%	1,76%
6	*Melastoma malabathricum*	5	1,82%	4%	2,76%	2,86%
7	*Eleusine indica*	6	2,18%	4%	4,60%	3,59%
8	*Paspalum conjugatum*	60	21,82%	12%	16,54%	16,79%
9	*Leersia hexandra*	8	2,91%	6%	4,60%	4,50%
10	*Stenochlaena palustris*	11	4,00%	6%	7,35%	5,78%
11	*Solanum mauritianum*	2	0,73%	4%	1,29%	2,00%
12	*Mikania micrantha*	7	2,55%	8%	4,50%	5,02%
13	*Praxelis clematidea*	8	2,91%	4%	3,68%	3,53%
14	*Ceratopteris thalictroides*	13	4,73%	6%	5,97%	5,57%
15	*Ludwigia octovalvis*	5	1,82%	6%	3,49%	3,77%
	Total	**275**	**100%**	**100%**	**100%**	**100%**

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Table 3. Weed Diversity index on ex-burned oil palm plantation land

No	Species	Number of Species	Pi	lnPi	H'
1	*Eleocharis dulcis*	82	0,30	-1,21	-0,36
2	*Fimbristylis miliacea*	40	0,15	-1,93	-0,28
3	*Cyperus esculentus*	18	0,07	-2,73	-0,18
4	*Neprolepis biserrata*	6	0,02	-3,83	-0,08
5	*Dicranopteris linearis*	4	0,01	-4,23	-0,06
6	*Melastoma malabathricum*	5	0,02	-4,01	-0,07
7	*Eleusine indica*	6	0,02	-3,83	-0,08
8	*Paspalum conjugatum*	60	0,22	-1,52	-0,33
9	*Leersia hexandra*	8	0,03	-3,54	-0,10
10	*Stenochlaena palustris*	11	0,04	-3,22	-0,13
11	*Solanum mauritianum*	2	0,01	-4,92	-0,04
12	*Mikania micrantha*	7	0,03	-3,67	-0,09
13	*Praxelis clematidea*	8	0,03	-3,54	-0,10
14	*Ceratopteris thalictroides*	13	0,05	-3,05	-0,14
15	*Ludwigia octovalvis*	5	0,02	-4,01	-0,07
	$\sum$	**275**	**1**	**-49,22**	**2,13**

The findings from the weed diversity index presented in Table 3 indicate a value of 2.13. The findings indicate that the weed diversity index is classified as having moderate diversity. A community exhibits high species diversity when it comprises numerous variations. Analysis reveals notable variations in the range of values across multiple observation stations. Nevertheless, the majority of the weed species identified in this study are prevalent in plantations, including oil palm, rubber, or natural forests (Rembold et al., 2017). The considerable diversity observed in the research plots can be attributed to the extensive spacing between the oil palm trees. The expansive growth area beneath the oil palm canopy creates conditions conducive for weeds to flourish, as they can take advantage of the nutrients, water, sunlight, and space that are accessible. It also leads to competition for resources such as nutrients, water, and light, which disrupts the growth and yield of oil palm. The process by which the development and yield of oil palm are inhibited may entail nutrient competition, resulting in stunted growth, as evidenced by the trunk diameter, plant height, and thin fronds> Moreover, it is hypothesized that nutrient competition extends the flowering period, complicating harvesting efforts due to the necessity for increased vigilance in locating and distinguishing ripe fruit amidst fallen produce in regions impacted by weed proliferation. This is supported by the research findings of Krisnarini et al. (2020); Umami & Mandili (2023), which state that the negative influence of allelochemicals from weeds can inhibit the growth in plant height, stem diameter, and root volume, which are strongly correlated with the dry weight of the canopy.

In areas with a high weed diversity index, weed control strategies should take into account the diversity of the existing weed species. The diversity of these species suggests adaptation or tolerance to different control methods, necessitating a more comprehensive and integrated approach for optimal outcomes. The weed diversity index is crucial for identifying effective weed control strategies. In regions characterized by a high diversity index, signifying a substantial variety of weed species, effective weed control necessitates a more comprehensive and integrated strategy. The integration of physical and chemical control methods is highly pertinent in this context. Physical control methods, including uprooting and cutting, may prove insufficient for managing diverse weed species due to the significant labor and time demands associated with each species. Herbicides, as a component of chemical control strategies, are effective in regions characterized by a high weed diversity index for multiple reasons. Herbicides can simultaneously target multiple weed species. This capability is significant in regions characterized by high diversity, where various weeds may exhibit differing adaptations or tolerances to control measures. Herbicides effectively manage multiple weed species in a single application, facilitating comprehensive and efficient control. Herbicide application offers benefits regarding efficiency in time and labor. Herbicide-based weed control generally necessitates less labor than physical methods, which frequently entail manually uprooting or cutting weeds. This benefit facilitates expedited and more efficient weed management. The application of herbicides should consider ecological sustainability through the selection of suitable active ingredients, the use of beneficial weeds, and the enforcement of regulations on chemical usage. Nasution et al. (2024) assert that effective weed management requires consideration of herbicide type, application dosage, and method, alongside weed control practices and the adoption of sustainable management strategies, including the cultivation of beneficial weeds for oil palm production and environmental sustainability.

IV. CONCLUSION

Oil palm plantations often have fifteen species of weeds growing in the ex-burnt soil. The Cyperaceae family consists of the largest number of species, including three varieties of weeds: *Eleocharis dulcis*, *Fimbristylis miliacea*, and *Cyperus esculentus*, while the Poaceae family also contains three types of weeds: *Paspalum conjugatum*, *Leersia hexandra*, and *Stenochlaena palustris*. The most abundant and dominant weed species is *Eleocharis dulcis*. *Eleocharis dulcis*, paspalum conjugatum, and fimbristylis miliacea disrupt the growth of oil palm plants by competing for nutrients and water. Weed management that can be implemented involves combining physical and chemical methods, such as planting cover crops in the inter-row areas, manually clearing around the plant basins, and spraying herbicides in areas that exceed the economic threshold. Further research is needed to determine the main factors influencing weed diversity in oil palm plantations and to develop effective and efficient weed management strategies at different stages of oil palm age.

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