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Estimation of Weed Biomass as Forage Production under Oil Palm Plantation

Nur Rochmah Kumalasari[1*], Andriyani Prasetiyowati[1], Sunardi[2], and Suryahadi[1]

[1]Departement of Nutrition and Feed Technology, Faculty of Animal Science, IPB University; e-mail: nurku@apps.ipb.ac.id
[2]Faculty of Agriculture, University of Nusa Bangsa

ABSTRAK

Perkebunan kelapa sawit memiliki potensi untuk menyediakan hijauan sebagai sumber energi bagi ternak ruminansia. Tujuan dari penelitian ini adalah untuk mengestimasi produksi dan kualitas gulma di bawah naungan sawit sebagai pakan ternak ruminansia. Identifikasi dilakukan untuk dapat mengetahui informasi tentang komposisi botani, produksi dan kualitas untuk memperkirakan gulma potensial untuk pakan ternak. Penelitian dilakukan dengan rancangan acak kelompok pada perkebunan kelapa sawit umur 6 dan 8 tahun dengan 10 plot sampel. Parameter yang diukur adalah komposisi botani, dominansi dan keragaman gulma, serta potensi produksi hijauan pakan. Berdasarkan hasil penelitian, 19 spesies dari 11 famili ditemukan dan didominasi oleh graminae. Komposisi botani gulma dan tingkat keragaman dipengaruhi oleh umur pohon kelapa sawit. Pada perkebunan kelapa sawit 8 tahun, jumlah spesies gulma dan tingkat keragamannya menurun yaitu 10 spesies dan H' 2,41 sedangkan pada perkebunan berumur 6 tahun jumlah gulma sebanyak 13 dan H' 3,14. Berdasarkan jenis gulma, *Paspalum conjugatum* P.J. Bergius merupakan gulma yang memiliki potensi tertinggi yang dapat digunakan sebagai hijauan pakan ternak ruminansia dengan estimasi produksi segar 730,42 kg ha^{-1}. Nilai pendugaan produksi segar hijauan ruminansia dari gulma yang didominasi rerumputan mencapai 1,87 ton kg ha^{-1}

Kata kunci: Gulma, Perkebunan Kelapa Sawit, Hijauan, Ternak Ruminansia

ABSTRACT

Palm oil plantations have the potency to provide forage as a source of energy for livestock. The objective of this research was to estimate the production and quality of weeds under palm plantations as ruminant feed. Identification was conducted to find out information about botanical composition, production, and nutritional content to estimate potential forage. The study was conducted using a randomized block design with 2 blocks of 6- and 8-years old palms and 10 sample plots. The research parameters were botanical composition, weed dominance, and diversity, and also forage production potency. The results showed that 19 species from 11 families were found and dominated by Gramineae. The weed botanical composition and diversity level were affected by oil palm plantation age. During the 8 years old oil palm plantation, the number of weed species and diversity level decreased, reaching 10 species and H' 2.41 while in the 6 years old were 13 species and H' 3.14. Based on the type of weed, *Paspalum conjugatum* P.J. Bergius is a weed that has the potential to be used as the highest forage as a ruminant animal feed with an estimated production of 730.42 kg ha^{-1} of fresh biomash. The estimation of weed production ruminant forage was dominated by grass that had up to 1.87 tons ha^{-1} of fresh biomash.

Keywords: Forage, Palm Plantation, Ruminant, Weed

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1. Introduction

Oil palm or *Elaeis* spp. Plantations covering extended areas in Indonesia reach 14 456 611 ha (BPS 2019). In the oil palm plantation, the standard spacing resulted in weed invasion under the oil palm trees (Kothari and Schweiger, 2022). Weeds compete with the main crops for nutrients, water, and sunlight which reduces in main crops quality and animal products quality (Iderawumi and Friday 2018). The effective control methods for weeds that are a problem in forage crops are still not available, unfortunately. Most weed control using herbicides that are costly and effects on environmental health (Ryadin et al 2022).

Recent research revealed that weed vegetation under oil palm plantations could be one of forage resources for ruminants (Ramdani et al 2017; Kumalasari 2020). Weed control using ruminant

could optimize land use as integrated beef cattle in oil palm plantations to fulfill the animal forage needed (Sandiah et al 2021). Proper management in integrating beef cattle under oil palm plantations can reduce weeding and fertilization cost (Darras et al 2019).

In order to optimize the weed utilization as forage, weed vegetation analysis is needed to identify the botanical composition and forage production. In the previous research, the number of weed diversity under oil palm plantations was varied that ranged from 16 to 36 with the average of total fresh biomass production was 13.37 ton ha^{-1} without palatability consideration (Akbar et al 2021). This research was conducted to evaluate the botanical composition, diversity level and estimate the weed production under oil palm plantation as ruminant forage based on plant palatability.

2. Method

2.1. Study area

The research was located at Cikabayan oil palm plantation from January to April 2019. The vegetation identification and processing were conducted at the Laboratory of Agrostology, Faculty of Animal Science IPB University.

2.2. Procedure

Sampling plots were carried out on different ages of oil palm plantation, i.e.: 6 and 8 years old. Vegetation was sampled using quadrants in size 50 cm x 50 cm, 10 times randomly. Weed samples were identified and then confirmed by Global Biodiversity Information Facility (GBIF) as reference.

Forage was collected from each plot and harvested ±5 cm above soil area. Fresh weight was measured at each plot after harvesting. Dry weight was measured after sample drying in an oven with a temperature of $60^{o}C$ in 48 hours.

2.3. Data Analysis

Botanical composition analysis by following the *Dry Weight Rank* methods (Mannetje dan Haydock 1963). Weed dominance was calculated using data of density, relative density, frequency and relative frequency (Kainde et al. 2011), Important Value Index (Brower et.al 1990), and Summed Dominance Ratio (SDR) (Mueller-Dombois and Ellenberg 1974).

Forage production potency was calculated using equation as follows P = C x (10.000 – (LP x JS)), where P was weed production (kg $hectare^{-1}$), C was weed fresh weight per m^2, LP was plate width area of oil palm tree and JS was number of oil palm tree in a hectare (Daru et al. 2014). Carrying capacity calculation based on forage production in a year that assumed there were 6 harvest times with 60% proper use factor. Diversity index (H') was analysed using the Shanon-Wiener method (Brower et.al 1990).

Data was computed using Microsoft Excel and the results were presented in tables. Forage diversity level was statistically analyzed using Analysis of Variance (ANOVA). The LSD test was applied as the post hoc test using software R.3.5.3 to determine homogenous groups. Forage palatability was investigated using secondary data.

3. Result and Discussion

3.1. Environmental condition

Based on Meteorological, Climatological, and Geophysical Agency data, the average temperature in January until April 2019 were in the range $23^{0}C$ - $27^{0}C$, with humidity being 70-90%. The 6 years old of oil palm plantation has latosol type with pH 4.94, while at 8 years old it was 4.52. Land was maintained with fertilizer every 6 months. Sunlight intensity was measured using a lux meter on each area. The average light intensity in the 6 years old oil palm plantation was 12170 lux, while in the 8 years old it was 2100 lux.

3.2. Botanical composition

Based on the result (Table 1) showed that different oil palm plantation ages affect the weed botanical composition under the trees. There were 19 weed species belonging to 11 families under oil palm plantation. Thirteen weed species belonging to 9 families were found only in the 6 years old oil palm plantation. There were less species under 8 years old palm plantation, i.e. 10 species belonging to 5 families. These were herbs, herbaceous climbers, shrubs, climbing shrubs, trees, small trees, ground and epiphytic ferns.

In the 6 years old oil palm plantation, the highest percentage of weed was *Ageratum conyzoides* L. (39.86%), followed with *Sphagneticola trilobata* (L.) Pruski (15.11%) and *Clibadium surinamense* L. (9.07%). In the 8 years old oil palm plantation, the highest percentage of weed was *Paspalum conjugatum* P.J. Bergius (31.33%), *Axonopus compressus* (Sw.) P. Beauv. (24.32%) and *Melastoma candidum* D. Don (20.78%). This result conforms to findings of Oluwatobi and Olorunmaiye (2021) that Asteraceae dominate young oil palm plantations because of their efficient mechanism of seed dispersal. The weed percentage pattern was gradually changed to the grass family after 7 years of oil palm plantation (Essandoh et al 2011).

Table 1. Weed botanical composition of under the different age of oil palm plantation

Weed species	Family	Weed Percentage (%)	
		6 years	8 years
Ageratum conyzoides L.	Asteraceae	39.86	0.00
Melastoma candidum D. Don	Melastomataceae	0.00	20.78
Paspalum conjugatum P.J. Bergius	Poaceae/gramineae	0.00	31.33
Digitaria ciliaris (Retz.) Koeler	Poaceae/gramineae	0.00	17.31
Sphagneticola trilobata (L.) Pruski	Asteraceae	15.11	0.00
Axonopus compressus (Sw.) P. Beauv.	Poaceae/gramineae	0.19	24.32
Clibadium surinamense L.	Asteraceae	9.07	0.00
Cynodon dactylon (L.) Pers.	Poaceae/gramineae	0.00	9.07
Setaria barbata (Lam.) Kunth	Poaceae/gramineae	5.86	0.00
Centotheca lappacea (L.) Desv	Poaceae/gramineae	0.00	6.18
Sida rhombifolia L.	Malvaceae	3.21	0.00
Tetracera indica (Houtt. ex Christm. & Panz.) Merr.	Dilleniaceae	0.00	5.36
Asystasia gangetica (L.) T. Anderson	Acanthaceae	2.83	1.65
Commelina diffusa Burm.f.	Commelinaceae	0.04	0.00
Peperomia pellucida (L.) Kunth	Piperaceae	0.06	0.00
Richardia brasiliensis Gomes	Rubiaceae	0.06	0.08
Chamaesyce hirta (L.) Millsp.	Euphorbiaceae	0.04	0.00
Amaranthus dubius Mart.ex Thell.	Amaranthaceae	0.04	0.00
Other weeds		2.88	4.69

Table 2. Weed species distribution

Weed species	6 years old oil palm plantation (%)				6 years old oil palm plantation (%)			
	RD	RF	IVI	SDR	RD	RF	IVI	SDR
Ageratum conyzoides L.	66.29	21.28	87.57	43.78	0.00	0.00	0.00	0.00
Paspalum conjugatum P.J. Bergius	0.00	0.00	0.00	0.00	11.62	16.67	28.28	14.14
Digitaria ciliaris (Retz.) Koeler	0.37	2.13	2.50	1.25	14.94	12.50	27.44	13.72
Cynodon dactylon (L.) Pers.	0.00	0.00	0.00	0.00	17.43	8.33	25.76	12.88
Tetracera indica (Houtt. ex Christm. & Panz.) Merr.	0.00	0.00	0.00	0.00	16.18	12.50	28.68	14.34
Melastoma candidum D. Don	0.00	0.00	0.00	0.00	9.54	12.50	22.04	11.02
Sphagneticola trilobata (L.) Pruski	11.61	10.64	22.25	11.12	0.00	0.00	0.00	0.00
Axonopus compressus (Sw.) P. Beauv.	2.43	10.64	13.07	6.54	24.07	12.50	36.57	18.28
Clibadium surinamense L.	3.00	2.13	5.12	2.56	0.00	0.00	0.00	0.00
Setaria barbata (Lam.) Kunth	5.62	8.51	14.13	7.06	0.00	0.00	0.00	0.00
Sida rhombifolia L.	0.94	4.26	5.19	2.60	0.00	0.00	0.00	0.00
Centotheca lappacea (L.) Desv	0.00	0.00	0.00	0.00	3.32	4.17	7.49	3.74
Asystasia gangetica (L.) T. Anderson	0.37	2.13	2.50	1.25	0.41	4.17	4.58	2.29
Commelina diffusa Burm.f.	0.56	4.26	4.82	2.41	0.00	0.00	0.00	0.00
Peperomia pellucida (L.) Kunth	0.94	4.26	5.19	2.60	0.00	0.00	0.00	0.00
Richardia brasiliensis Gomes	1.50	4.26	5.75	2.88	0.41	4.17	4.58	2.29
Chamaesyce hirta (L.) Millsp.	0.37	2.13	2.50	1.25	0.00	0.00	0.00	0.00
Amaranthus dubius Mart.ex Thell.	0.19	2.13	2.31	1.16	0.00	0.00	0.00	0.00
Other weeds	5.81	21.28	27.08	13.54	2.07	12.50	14.57	7.29

RD: Relative Density, RF: Relative Frequency, IVI: Important Value Index, SDR: Summed Dominance Ratio

3.3. Weed dominance level

On the 6 years old oil palm plantation, *Ageratum conyzoides* L. was the most dominant species with the important value indices (IVI) of 87.57% followed by *Sphagneticola trilobata* (L.) Pruski (22.25 %) and *Setaria barbata* (Lam.) Kunth (14.13%). The species on the 8 years old oil palm showed a different dominance pattern. In the older oil palm plantation, *Axonopus compressus* (Sw.) P. Beauv. and *Tetracera indica* (Houtt. ex Christm. & Panz.) Merr. were the most dominant species with IVI value of 36.57% and 28.68%. Other notable species were *Paspalum conjugatum* P.J. Bergius (28.28%), *Digitaria ciliaris* (Retz.) Koeler (27.44%), *Cynodon dactylon* (L.) Pers. (25.76%) and *Melastoma candidum* D. Don (22.04%).

The low IVI values on the older oil palm plantation could be due to the sharing of resources, especially spaces that limited plant dispersal and minimize plant interaction among the species (Liao et al 2013). Furthermore, the low IVI values could be due to low light intensity on the 8 years old oil palm plantation (2100 lux) compared to the 6 years old (12170 lux). Dormann et al (2020) reported that the reduced light availability would decrease the plant species richness.

Table 3. Weed diversity and biomass production

Parameter	Age	
	6	8
Diversity index (H')	3.14±1.14[a]	2.41±1.50[b]
Number of individuals/plots	53.60±21.65[a]	24.10±15.61[b]
Fresh biomass (kg/ha)	7845.50±27.31	6264.00± 38.25
Dry biomass (kg/ha) (60^{o}C)	1846.42±3.67	1566.72±8.85

Table 4. Potency of fresh forage production

Weed	Yield proportion (%)	Number plot	Fresh biomass potency (kg ha^{-1})
Paspalum conjugatum P.J. Bergius	9.81	4	730.42
Axonopus compressus (Sw.) P. Beauv	7.61	8	690.42
Digitaria ciliaris (Retz.) Koeler	5.42	4	450.42

3.4. Weed diversity index

The high diversity of weed species represented by Shanon's (3.14) for the 6 years old oil palm plantation (Table 3). The higher diversity of weed species on the 6 years old oil palm plantation than 8 years old occurred in response to transmitted gap light (Jia et al 2015). Oil palm plants can cause light limitation in shade-intolerant species that suppress the plant growth while increasing growth of the tolerant species. The different seed remnant species may have varying responses to the radiation gradient that stimulates seed germination and plant growth (Kothari et al 2021).

In each plot (0.5 m^2) the number of weed individuals ranged from 9 to 75. The number of weed individuals in the 6 years old oil palm plantation ranged from 22 to 75, with mean value of 53.60. This number of individuals is higher than the 8 years old oil palm plantation that ranged from 9 to 39, with a mean value of 24.10 (Table 3). This result was similar to Hilwan and Santosa (2019) that reported the oil palm plantation caused biodiversity loss up to 60% than the prior plants and the older plantation would reduce more. In the older oil palm plantation, the main plant would grow rapidly and take more space that the combining several cover crop species with partitioning of physical space could govern the other number of individuals (Liao et al 2013).

The number of individuals in each plot affected the biomass production in the oil palm plantation. The biomass production on 6 years old oil palm plantation (7845.50 kg/ha) was higher than 8 years ol oil palm plantation (6264.00 kg/ha). The result was higher than Ramdani et al (2017) that reported the biomass ranged 6.10 ton ha^{-1} to 6.49 ton ha^{-1}. The biomass production decreases in older oil palm plantation age related with the micro environmental changes in the oil palm plantation, especially soil characteristics (Le et al 2023), light and shade trees degree (Akbar et al 2021).

3.5. Forage potential

Based on the botanical composition, there are several types that can be consumed by livestock including *Paspalum conjugatum* P.J. Bergius, *Digitaria ciliaris* (Retz.) Koeler, *Axonopus compressus* (Sw.) P. Beauv and *Cynodon dactylon* (L.) Pers (Table 4). *Paspalum conjugatum* has the highest important value index at several plantations, such as coffee (Hartoyo et al 2023) cassava (Qomariyah et al 2014) and coconut plantation (Ngawit and Farida 2019). Roba et al (2017) reported that shade plants have an effect on increased pH, organic carbon, total nitrogen, cation exchange capacity, and kalium. The high tolerance of *P. conjugatum* on highly acidic soil conditions is commonly found amongst cover crop plants (Lestari et al. 2019). The weed rank as forage was determined based on plant palatability for ruminants that the highest palatable was grasses, legume, than other plants (Treydte et al 2013). Another consideration are the concerns of bloat and some plant toxicities (Marsalis et al 2020).

4. Conclusion

The weed botanical composition and diversity level were affected by oil palm plantation age. The older oil palm plantation reduces the number of weed species and diversity level. The estimation of weed production ruminant forage was dominated by grass that had up to 1.87 ton ha^{-1} of fresh biomash.

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