Effect of weeds management toward understorey species diversity and soil fertility under oil palm plantation

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Abstract. The objectives of this study was to determine soil fertility and types of plants in understorey ecosystems in oil palm plantation stand which are managed in different ways. The data collection method was a direct observation on smallholder oil palm plantation at 15 years of age with different management, namely: 1) weed control using herbicides, 2) without management, and 3) used for beef cattle grazing. The data consisted of soil fertility and identification of understorey species in each management. The soil samples were taken in a composite manner and analyzed in the laboratory, while the plant species samples were gathered using the 1x1 m^2 method and identified using an identification manual. From the results, weed control in oil palm plantation with cattle grazing has a positive impact on soil fertility compared to the use of herbicides and without control. The diversity of understorey species in cattle grazing locations is less, namely, as much as 11 species compared to the use of herbicides (15 species) and without control (22 species). Weed management by grazing cows in the oil palm plantation increased land fertility and the dominance of understorey plants as a source of animal feed.

1 Introduction

Oil palm is the dominant plantation commodity in Indonesia, the area of oil palm plantations reaches 14.33 million ha and 40.62% is smallholder plantation [1]. Oil palm began to be developed since the 1970s in Sumatera and Kalimantan [2]. Oil palm has become one of the leading plantation commodities in Bengkulu Province with an area of 208,627 hectares or 50.36% of the total plantation area [3]. The problems faced by farmers in the management of oil palm plantations are that they are not optimal and lack the handling of plant maintenance factors, including soil fertility and the management of undergrowth of oil palm plantation which causes low production.

Undergrowth under oil palm plantation is often considered a weed that is detrimental to farmers and needs to be controlled. Whereas understorey under oil palm plantation can be

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integrated with beef cattle with semi-intensive and extensive livestock rearing patterns [4]. These two commodities (palm and cattle) can be synergized so that the land is used optimally. To meet the needs of the growing and developing oil palm plants requires food intake in fertilizer derived from cows, while oil palm undergrowth can be used as cattle feed [5, 6].

Understorey management is carried out in various ways, such as being controlled with herbicides (considered as oil palm weeds), and without herbicides and beef cattle grazing, and used integrating with beef cattle grazing. Grazing beef cattle under oil palm plantation will be beneficial for oil palm plantations. Cattle that consume understorey can reduce weeding costs, reduce fertilization costs due to livestock manure (feces and urine) from grazing activity.

Lubuk Banyau Bengkulu village has three oil palm plantation management (controlled with herbicides, without herbicides and beef cattle grazing and integrated with beef cattle grazing. The grazing fields management will increase soil fertility and palm oil production. Therefore, the study aimed to determine the soil fertility and types of plants in understorey ecosystems in oil palm plantation managed in several ways.

2 Materials and method

The research was carried out in Lubuk Banyau Village, Padang Jaya District, North Bengkulu Regency, Bengkulu Province from April to May 2021. The location was chosen because North Bengkulu is an area that has a lot of oil palm planting and Lubuk Banyau is one of the smallholder oil palm plantations in Bengkulu Province. The method used in this study was the identification and direct observation of smallholder oil palm plantation around >15 years with different management, namely 1) weed control using herbicides, 2) 2) without using herbicides and beef cattle grazing , and 3)used for beef cattle grazing. The composite soil samples were analyzed in the soil laboratory with some chemical and physical parameters. Meanwhile, the sampling method of understorey was using the 1x1 meter square and identified using an identification guide book. In addition, interview questions with three landowners were conducted to get an overview of their management. The questions covered the weeds management and fields management. The data obtained were analyzed descriptively.

3 Result and discussion

3.1 Management of the existing understorey of the oil palm plantation

Lubuk Banyau Village is a lowland area located in the Padang Jaya sub-district, North Bengkulu Regency. The area of oil palm plantations in North Bengkulu is 11,887.5 ha [7] consisting of private plantations and smallholder plantations. The development of smallholder oil palm began around 2004 and the application of technology in the management of oil palm is still traditional. The management of oil palm is presented in **Table 1**.

Cattle rearing is carried out extensively, kept around oil palm plantation day and night, not caged but tethered or tied around the land. To meet the feed needs of Bali cattle, farmers do not provide concentrate but the feed is obtained from the grass around the oil palm plantation and every three days the cows are moved to a place where the plants have not been eaten. When farmers move cattle to the next place, livestock manure is taken and placed around the oil palm plantations. In addition, with cattle grazing in oil palm plantation, the

land becomes clean due to being always eaten by cattle. [8] more cattle graze on their oil palm plantation own and few farmers provide additional food.

Table 1. Management of existing the understorey of the oil palm plantation in Lubuk Banyau

No.	Technology Components	Management of oil palm plantation understorey		
		Herbicides	Without herbicides and beef cattle grazing	Beef cattle grazing
1	Palm age	15 years	15 years	15 years
2	Seed	Superior	Superior	Superior
3	Planting distance	9x10 m	9x10 m	9x10 m
4	Anorganic Fertilizer	Not available	Not available	Not available
5	Weeding	Twice a year	Not available	Not available
6	Cattle raising	Not available	Not available	Available (Bali Cattle)

Extensive cattle rearing is expected to sustain in Lubuk Banyau Village. Therefore, it is essential to know the carrying capacity of the understorey in oil palm plantation so that the government can plan a beef cattle development program in smallholder oil palm plantation to improve the welfare of farmers.

3.2 Identification of soil fertility in understorey oil palm plantation

Weed management in different oil palm plantation will affect soil fertility. Based on the results of soil analysis, the soil fertility of each plantation whose management used herbicides, without herbicides and Bali cattle grazing was found (**Tab.1**). Soil is one of the essential natural resources that needs serious attention to avoid damage that can reduce productivity. It can be seen that the soil texture in oil palm plantation with different weed management has different textures, namely clay, clay and dusty clay. Soil texture is the relative ratio between the fractions of sand, silt and clay. Soil particles whose effective diameter is < 2 mm, which is closely related to the movement of water and solutes, air, heat movement, soil volume weight, specific surface area, ease compacted soil.

Table 2. Soil fertility conditions in oil palm plantation understorey between management using herbicides, non-herbicides and cattle rearing.

Parameter	Management of oil palm plantation understorey					
	Herbicides		Without herbicides and beef cattle grazing		Beef cattle garazing	
	Value	Criteria	Value	Criteria	Value	Criteria*)
Water Content (%)	21.89	-	14.85	-	19.36	-
Texture	Clay		Loamy		Dusty Clay	
pH (H_2O)	5.8	Slightly Acid	5.5	Slightly Acid	5.5	Slightly Acid
C-organic (%)	4.9	High	3.7	High	10.3	Very High
N (%)	0.03	Very Low	0.03	Very Low	0.63	High
P-Bray (ppm)	0.51	Very Low	0.50	Very Low	0.58	Very Low
K-dd (cmol kg^{-1})	0.10	Low	0.15	Low	0.15	Low
KTK (mol (+)/kg	23.49	Moderate	16.57	Moderate	22.7 4	Moderate
Na-dd (cmol kg^{-1})	0.16	Low	0.18	Low	0.19	Low
Ca-dd (cmol kg^{-1})	3.49	Low	2.00	Low	2.12	Low
Mg-dd (cmol kg^{-1})	0.16	Low	0.04	Low	0.07	Low
Al^{3+}	0.06		3.40		3.80	
K (HCl 25%)	0.10	Very Low	0.15	Very Low	0.15	Very Low
P (HCl 25%)	0.51	Very Low	0.50	Very Low	0.58	Very Low

*) Source [7]

The level of acidity (pH) of the soil in the three managements above ranged from 5.5 to 5.8 and was classified as slightly acidic, there was no difference in the three treatments. This situation is still suitable for oil palm plantations. According to the opinion [10], oil palm plants can grow at a pH of 4 - 6.5 with an optimum pH of 5 - 5.5. Furthermore, observations of organic C, including high to very high. Cattle grazing gave the highest yield of 10.3% compared to management without herbicides (3.7%) and herbicides (4.9%). The increase of organic C comes from plant litter and cow feces and urine. Fertilizers derived from cow feces and urine contain many decomposing microorganisms that are useful for increasing nutrients and microorganisms.

Management of oil palm plantation with cattle grazing indicated that the nitrogen content was high, while the herbicide and without herbicide N content was very low, ranging from 0.03%. The N content in cattle grazing is high due to the addition of manure. This is supported by [11], that the manure applied to oil palm plantations on the soil significantly affects the availability of the total N-content of the soil.

Another nutrient status in the three treatments, such as P's availability is deficient, and the availability of bases (Na, Mg, K and Ca) is low, while the CEC is moderate. In general, the fertility rate in the proper management of oil palm with cattle grazing is more fertile when compared to herbicides and non-herbicides. This is due to cattle grazing management inadvertently adding organic matter to the soil through the manure produced by grazing cattle.

3.3 Identification of understorey species in oil palm plantation

Types of the understorey in oil palm plantation in Lubuk Banyau Village are very diverse, influenced by weed management techniques. Based on the identification results in the three plantations in the research location, it was found that the total number of understorey species in oil palm plantation was 34 species classified into 28 genera and 17 families (Table 3).

From the three managements of oil palm plantation, the most types were obtained in the management without herbicides, meaning that the oil palm plantation were left unattended without any management, while in herbicide management and cattle grazing, it would affect the underlying plants. [12] The vegetation that grows around the plantations varies widely, depending on the age of the oil palm plantations. Furthermore, [4] the control of understorey on plantation land using herbicides will affect the success of understorey.

The undergrowth in oil palm plantation can be used as cattle feed [13, 14, 15, 16]. Although besides being used as animal feed, it also reduces the cost of weeding or eradicating weeds [4], the cost of weed eradication can be saved in the range of 30-60%. Furthermore, other benefits of the undergrowth of oil palm can also be used for human purposes, especially for herbal medicines such as *melastoma melabatricum* [17].

Tabel 3. The results of the identification of plant species based on management with herbicides, without herbicides and Bali cattle grazing

Family	Genus	Spesies	Management of oil palm plantation understorey		
			Herbi-cides	Without Herbicides and beef cattle grazing	Beef cattle grazing
1. Poaceae	1. *Acroceras*	1. *Acroceras munroamum*		√	√
	2. *Axonopus*	2. *Axonopus compressus*	√	√	√
	3. *Centotheca*	3. *Centotheca lappacea*	√		
	4. *Ischaemum*	4. *Ischaemum muticum*	√	√	√
	5. *Paspalum*	5. *Paspalum conjugatum*			√
2. Asteraceae	6. *Ageratum*	6. *Ageratum conyzoides*		√	
	7. *Praxelis*	7. *Praxelis clematidea*		√	
	8. *Synedrella*	8. *Synedrella nudiflora*		√	
3. Rubiaceae	9. *Mitracarpus*	9. *Mitracarpus hirtus*		√	
	10. *Oldenlandia*	10. *Oldenlandia auricularia*	√		
	11. *Spermacoce*	11. *Spermacoce alata*		√	√
		12. *Spermacoce articularis*			
4. Cyperaceae	12. *Cyperus*	13. *Cyperus rotundus*		√	√
		14 *Cyperus shacelatus*		√	
	13. *Scleria*	15. *Scleria bancana*	√		
5. Lamiaceae	14. *Hyptis*	16. *Hyptis capitata*		√	
6. Linderniaceae	15. *Lindernia*	17. *Lindernia dubia*		√	√
	16.*Legazpia*	18. *Legazpia polygonoides*			√
7. Schizaeaceae	17. *Lygodium*	19. *Lygodium flexuosum*	√	√	
8. Melastomataceae	18. *Clidemia*	20. *Clidemia hirta*	√	√	
	19. *Melastoma*	21. *Melastoma malabathricum*	√	√	
9. Phyllanthaceae	20. *Phyllanthus*	22. *Phyllanthus debilis*		√	
10. Acanthaceae	21. *Asystasia*	23. *Asystasia gangetica*	√	√	
11. Fabaceae	22. *Desmodium*	24. *Desmodium heterophyllum*		√	
12. Gleicheniaceae	23. *Dicranopteris*	25. *Dicranopteris linearis*	√	√	
13. Onagraceae	24. *Ludwigia*	26. *Ludwigia hyssopifolia*			√
		27. Spermacoce articularis			√
14. Lycopodiaceae	25. *Lycopodiella*	27. *Lycopodiella cernua*		√	
15. Commelinaceae	26. *Murdannia*	28. *Murdannia spirata*			√
16. Verbenaceae	27. *Stachytarpheta*	29. *Stachytarpheta jamaicensis*		√	
17. Tectariaceae	28. *Tectaria*	30. *Tectaria crenata*	√	√	
		31. Anonim	√		
		32. Anonim	√		
		33. Anonim	√		
		34. Anonim	√		
			15	22	11

3.4. Palm oil production in understorey palm oil plantation management

The productivity of palm oil smallholders is still low, as can be seen from the yield of palm oil harvested in the form of Fresh Fruit Bunches (FFB). Harvesting is done two times a month. The management of oil palm plantation with cattle rearing gives better results than herbicide and non-herbicide management and is presented in Table 4.

Table 4. Production of oil palm plantations (kg/ha)

Description	Management of oil palm plantation understorey			PORC*)
	Herbicide	Without Herbicide	Bali Cattle Herding	
Productivity TBS (Kg/ha)	20.400	18.240	27.360	S1=32.000 S2 =30.000 S3= 28.500

Note *) TBS (Fresh Fruit Bunch), PORC = Palm Oil Research Center, S1,2,3 = Sales 1,2,3

Based on Table 4, it was found that the management of oil palm plantation, with Bali cattle grazing, gave the highest yield (27,360 kg/ha/year) compared to management using herbicides (20,400 kg/ha/year) and without herbicides (18,240 kg/ha/year). The oil palm productivity produced in the three oil palm plantation is still low compared to the Oil Palm Research Center [16], 32,000 kg/ha/year at the age of 15 years. Oil palm productivity depends on the environment, technical culture and the treatment given [18]. The results obtained by farmers from raising Bali cattle are higher because livestock consume plants under oil palm. In addition, the yield of palm FFB is also higher because cow faeces and urine are fertilizers that can fertilize oil palm growth. [19], cattle grazing with oil palm acts as a compost producer, while feed comes from the biomass found in the plantation area. According to [20], solid feces from cows contains P, while cow urine contains N and K. Furthermore, [21] stated that cow urine without any addition contains N, P and K respectively 5.80%, 3.80% and 0, 45%. Achmad and Aisyah [22, 23] mentioned that cow urine contains certain hormones that can stimulate plant development and contains more N and K. Biourin can provide an increase in plant yields that is almost the same as plant fertilizers (BPT) [24].

4 Conclusion

Weed management by beef cattle grazing under oil palm plantation positively impacts soil fertility with the high organic carbon and nitrogen parameter value. The other positive impact of using this management will increase oil palm productivity compared to other oil palm plantation understorey management and is closer to marginally suitable (S3).

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