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The productivity of forage crops as pasture in ex coal mining land during the rainy season

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The productivity of forage crops as pasture in ex coal mining land during the rainy season

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Abstract. Due to the reduction in fertile land availability, ex coal-mining land can be used to produce animal feed plant (AFP). The objective of this study is to determine the productivity of grass for grazing areas planted in ex-coal mining land. Soil samples were chemically analyzed by the Soil Research Institute. The design used was a randomized block design (RBD), with plant varieties for treatment, namely *B. humidicola* (A), *C. dactilon* (B), *P. notatum*, (C) *S. secundatum* (D) *and P. purpurium* cv Mott (E). Plant grass each in plots measuring 5 x 7 m, and repeated three times with spacing of 0.5 x 0.5 m. The results showed that plant varieties had a significant effect (P <0.05) on the production of biomass (grams plot^{-1}) and plant height (cm). The highest production and grass height were *P. purpureum* cv Mott with a production of $52,716.57 \pm 6,366.12$ g plot^{-1} and 104.26 ± 2.46 (cm). It is concluded that *P. purpureum* cv Mott has the potential to be developed as a pasture grass in ex-coal mining land.

1. Introduction

Coal is the most productive mineral mining material in Indonesia [1]. Mining activities have an impact on environmental biophysical damage as soil biodiversity and microbes decrease, microclimate change, and soil productivity [2]. One way to reduce damage to landscapes, ecosystems, and soil fertility is to maintain plants at the expected fall of the ecosystem [3]. The use of ex-mining land for pasture will increase soil fertility by fertilizing livestock manure. Its use of manure and urea could increase the productivity of animal feed plants in ex-coal mining areas [4]. Because of regard to the possibility of contamination of heavy metals, elephant grass planted in ex-coal mining areas contains Hg, As, Pb, Fe, Mg, and Mn which are still within safe limits [5].

Animal feed plants (AFP) in grazing areas come from natural sources grass and introduced grass. The pasture is divided into heavy, medium, and light grazing. Type of AFP for heavy pasture (*B. decumbens, P. notatum, P. dilatatum, C. dactylon, C. muconoides, P. phaseloides*), moderate (*C. gayana, B. mutica, C. plectostachyus, Setaria spp, Desmodium spp, C. pubescen*), mild (*B.humidicola, A. gayamus, D. decumbens, C. ciliaris, Stilosanthes spp, M. atropurpureum*) [6]. The selection of AFP for pasture land in ex-mining areas, in addition to paying attention to productivity and nutritional content, as well as the ability to grow in marginal lands. *Brachiaria humidicola* is capable to increase soil fertility in marginal lands [7], while *Cynodon dactilon* is a grass that can be used for phytoremediation on land with heavy metal content [8]. In addition, *Stenotaphrum secundatum* has moderate nutritional content and can improve the growth performance of cattle with a body condition score of 3.8 [9]. Added *Pennisetum purpureum* cv Schum (Mott) contains dry matter, crude protein and crude fiber 16.4; 8.8 and 33.1[10], in the form of hay had dry matter intake of 676 (g day^{-1}) [11]. Bahia

grass *(Paspalum notatum)* contains dry matter and crude protein content of 22.3% and 12.1% in the first harvest and 17.1% and 7.9% in the second crop [12]. Based on the results of previous research, it is necessary to conduct research to determine which AFP is suitable for grazing in ex-coal mining areas. The objective of this study is to determine the productivity of AFP *(B. humidicola, P. notatum, C. dactilon, S. secundatum,* and *P. purpureum* cv Schum (Mott)) for grazing in ex-mining land in the rainy season.

2. Materials and methods

Research has been conducted on the ex-coal mining area at PT Kitadin, which is located in Kutai Kartanegara, East Kalimantan, from December 2016 to April 2017.

2.1. Materials

Soil samples were taken at each location at three predetermined points as deep as ± 20 cm, the distance between points ± 25 m. Soil samples were cleaned from plant residues and roots and then positioned in 1 kg plastic bags each. The point one to the second point is ± 25 m, and the same distance from the second point to the third point. Its soil samples were cleaned of plant and root residues, after being clean put in 1 kg plastic bags each.

2.2. Methods
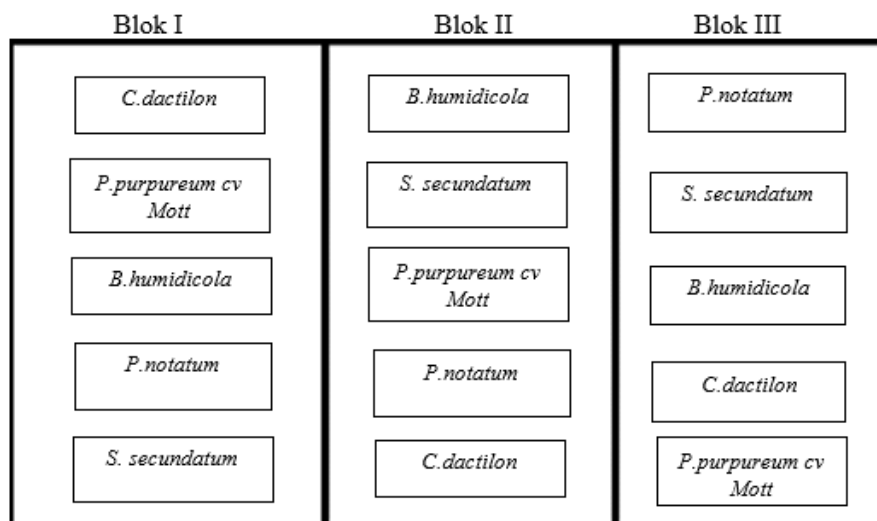
Figure 1. The layout of the planting of forage plant.

Observation parameters and analysis methods are as follows: pH 1: 5 with H_2O, organic matter C with Walkley & Black [13], total N% with Kjeldahl [14], P, K, Ca, and Mg (ppm) with Bray [15] mineral content of Na, Fe, Al , Mn, Cu, Zn and B with Ex Total (HNO_3) (ppm) [16].

This study used a randomized block design (5 x 3), the grass type being treated, and the group being replicated. The grass types used were *Brachiaria humidicola*, *Cynodon dactilon*, *Paspalum notatum, Stenotaphrum secundatum, Pennisetum purpureum* cv Schum (Mott) which were planted each on an experimental plot with a size of 5 x 7 m, with a spacing of 0.5 x 0.5 m and three times repeated.

The data obtained were analyzed for variance, with a randomized block design (RBD) using SPSS 16 software, if there is a significant difference, continue with the Duncan test [17]

3. Results and discussion

3.1. Soil chemical content in the former coal mining area

The results of soil analysis are presented in Table 1. The acidity (pH) of H_2O is classified as alkaline, with low organic matter content (C, N, P, K, Ca, and Mg). This result differs from the results of research on ex-coal mining land in Kaltim Prima Coal (KPC) with a pH <4.5, but the Mn and Cu content are also high [5]. Other studies have resulted in soil acidity (pH) in five ex-coal mining areas which are classified as very acidic to slightly acidic (4.10 to 6.46), low to high organic C (0.48 to 4.82%), material content low to high organic matter (1.85 to 8.30%), low to medium C/N ratio (12.47 to 22.9), very low to moderate total N (0.08 to 0.21%), low available P (3.52 to 7.72 ppm), high available K (11.47 to 92.80 ppm and low Pb heavy metal content (4.87 to 11.40 ppm) [18]. Bulk density, porosity, infiltration, permeability, organic matter, and soil pH have improved along with the growing age of land reclamation [15]. Ultisol soils in ex-coal mining land have problems with agricultural development due to low organic matter content, high Al saturation, the need for liming or phosphate (P), and KCl fertilization [16]. The mineral content of Mn, Cu, and Zn in high in this study. Sludge soil improvement can reduce the concentration of Fe, Mn, Zn, and Cu in ex-coal mining areas [17]. After recovery and rehabilitation, ex-coal mine land can be used for the development of animal feed plants [19].

Table 1. Results of analysis of soil chemicals.

No	Properties of soil	Pre research	After a Research study	Quality of standards TCLP**)
1	pH H_2O	6.51	-	-
2	Organic matter (%)			
	C	1.79	1.67 low *	-
	N	0.11	0.11 low*	-
	P		0.04 low*	-
	K		0.43 low*	-
	Ca		0.23 very low*	-
	Mg		0.31 very low*	-
	P_2O_5	67.38		
	K_2O	20.63		
3	Eks Total (HNO3)			
	(ppm)	16.25 (high)		5.0
	Pb		0.08	-
	Na		2.07	-
	Fe		0.60	-
	Al		543.00 (high)	-
	Mn		24.33 (high)	10.0
	Cu		54.00 (high)	50.0
	Zn		6.01	-
	B			

Note : *) [20] ; ** [21] .

3.2. Forage of crops productivity

The results of forage production can be found in Table 2. Grass types have a very significant effect on the production and plant height of P <0.05. *Pennisetum purpureum* cv Schum (Mott) has a production of $52,716.57 \pm 6366.12$ g plot^{-1} and plant height of 104.26 ± 2.46 cm. The highest plant height was *Pennisetum purpureum* cv Schum (Mott), namely 104.26 cm, followed by *Cynodon dactilon*, *Brachiaria humidicola*, *Paspalum notatum,* and finally *Stenotaphrum secundatum*. The results of other studies show that *Pennisetum purpureum* cv Schum (Mott) dry matter production (kg m^{-2} year^{-1}) 27.29 or 163.73 t ha^{-1}year^{-1} with a production capacity of 46.78 (Animal Unit ha^{-1} year^{-1}) is introduced [10]. The advantages of *P. purpureum* cv Schum (Mott) are rapid growth, downy hair, soft leaves, soft stems, preferable to livestock, faster regrowth, and can be used in grazing and cutting and carrying systems [22], and can be grown in ex-mining areas. open that has been abandoned for more than ten years [23]. *Stenotaphrum secundatum* also has a high enough production, namely 15,266.33 g of plot-1 followed by *B. humudicola, C. dactilon*, and finally *Cynodon dactilon*. *C. dactilon* is a type of grass that can survive in poor soil conditions despite its low production [24]. Stenotaphrum has a plant height of 40.49 cm with a fresh production of 89.714 (kg m^{-2}) or 3.14×10^6 (g plot^{-1}) and dry matter production of 2.4×10^3 (g plot^{-1}), and dry matter content of 28.62%[9]. Fast growing soil cover legumes such as *Calopogonium sp*, *Pueraria sp*, *Centrosema sp*, *Kerandang* [3]can be developed at an early stage. Bahia grass *(Paspalum notatum)* is a type of pasture grass with low height so that it has a higher intake of livestock than tall grass [12].

Table 2. Grass production and height in pastures.

Treatment	grass type	Production (g plot^{-1})	Height (cm)
1	*Brachiaria humidicola*	$34,148 \pm 14,507.93$ b	61.5 ± 10.11 b
2	*Cynodon dactilon*	$27,248.17 \pm 5,971.01$ b	92.66 ± 4.82 b
3	*Paspalum notatum*	$7,264 \pm 1,553.93$ b	32.5 ± 1.15 b
4	*Stenotaphrum secundatum*	$15,266.33 \pm 5,115.08$ b	25.3 ± 1.97 b
5	*Pennisetum purpureum* cv Schum (Mott)	$52,716.57 \pm 6,366.12$ a	104.26 ± 2.46 a

Note: Numbers followed by different letters in the same row and column show significantly different effects (P <0.05).

In ex-coal mining areas, *P. purureum* can be used as grazing grass as a forage crop and is also for revegetation of the former mining area, besides being animal feed plant.

4. Conclusions

Pennisetum purpureum cv Mott can be developed for pasture grass in ex-coal mining areas because it has high plant productivity as much 0.3514 t ha^{-1} fresh weight equal 1.757 t ha^{-1} yr^{-1}.

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