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UTILIZATION OF ORGANIC FERTILIZER ON GROWTH, PRODUCTION AND QUALITY OF *Brachiaria humidicola* AND *Pennisetum purpureum* UNDERNEATH COCONUTS BASED FARMING SYSTEM

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Abstract

Utilization of inorganic fertilizer is more simple but costly and has some negative environmental impact. Livestock waste available abundantly and sometime promote soil and air contamination. The aims of this research was to studied the effects of organic fertilizer utilization on growth, production and quality of two common tropical grasses known as Brachiaria humidicola cv. Tully and Pennisetum purpurem cv. Mott grown underneath mature coconuts plantation. Treatments consisted of two kind of organic fertilizer called "bokashi" based on manure of chicken and ruminant fermented with effective microorganism (EM4). Treatments were put as factorial arrangement based on completely randomized design. The variables measured were dry matter production, quality of forages and predicted carrying capacity. Data was using ANOVA followed by HSD. The results shown all variable were significant higher of both kind of grasses with organic fertilizer at level of 20 tons ha^{-1}. It could be concluded that both species of grasses response positively utilization of organic fertilizer bokashi, but in term of DM and CP content utilization of bokashi based on chicken manure fermented with effective micro-organisms EM4 was better than those of ruminant manure. Utilization of organic fertilizer in form of bokashi could provide forages to ruminant production integrated with coconuts plantation. By that way could be enhance economic value of this integrated systems.

***Key words**: fertilizer, quality, B. humidicola, P. purpureum, coconuts.*

INTRODUCTION

Indonesia is one of the among five country with big human population in the world, still import red meat to meet demand of this meat in country, since the price of this commodity is higher than those import. The problem is supply of forages is insufficient due to limitation of space for forage production. On the other hand there is some under utilize space in coconut plantation since Indonesia is the largest production of coconuts in the world. Furthermore, some tropical grasses have been selected as species tolerance growth under shade environment in coconuts plantation (Rumokoy et Toar, 2014). Dry matter (DM) production of *P. purpureum* including dwarf genotype is enhanced by high input of inorganic fertilizer (Hasyim et al., 2014), but this increases the cost of forage production. Chemical fertilizer is widely used in agriculture. However, in recent years, serious concern has arisen about long-term adverse effects of continuous and indiscriminate use of chemical fertilizer in intensive agriculture on the deterioration of soil structure and function and environmental pollution (Farede et al., 2010). Livestock manure is an organic fertilizer that plays a key role in chemical and biological soil functions of intensively cropping fields under sustainable and environmentally harmonized herbage production. Since manure has a high concentration of organic matter, its application as a fertilizer helps decelerate depletion of organic matter in arable land, especially when there is a high frequency of heavy erosion (Prasad et al., 2002). It also increases the soil levels of the macro elements of nitrogen (N), phosphorus (P), and potassium (K) (Kaligis et al., 2013; Kaligis et al., 2012). improves soil physical properties, enhances DM yield, and improves the crude protein concentration of herbages (Kaligis et al., 2017). Utilization of in-organic fertilizer for forages production is costly for smallholder farmers and risks environmental pollution by rapid nutrient leaching under heavy rainfall. On the other hand organic manure application has lower risk of nutrient leaching by mineralization when compared with chemical fertilizer input. The objectives of this research were to study the effects organic fertilizer application on growth, yield and estimated carrying capacity of two tropical grasses grown integrated in coconut based farming system.

MATERIALS AND METHODS

The plant material used in this study was tillers of both species. Tiller was put in individual poly bags (1 plant/poly bag) which were filled with 2 kg growing media. The plants were nursed for 3 months in growing media. After 3 months of the nursery period, these plants has been trimming to get homogeny re-growth, then were transplanted to experimental plot in the field since February 2017 until August 2017. Experimental site receives an average rainfall of 2700 mm, and the distribution fairly even, except for the period of lower rainfall by 100-150 mm monthly, from July to September. The pH of the fertile, sandy loam soil is around 6. Light transmission at 10.00 am on a sunny day as PAR underneath mature tall coconuts average 73%. The soil has an average pH of 6 and its color was dark brown clay. Precipitation peaks took place in January, with high rainfall intensity. This caused high relative humidity (80%). Air temperature ranged from 25^{0}C to 37^{0}C.The *P. purpureum* cv. Mott grass plant space was 100 x 100 cm apart and *B. humidicola* space was 50 x 50 cm apart. This experiment using completely randomized factorial design with 2 factors. Treatments consisted of different level of two kind of organic fertilizer called "bokashi" based on chicken and ruminant manure fermented with effective microorganism (EM4).The first factor was two species of grasses being evaluated were *B. humidicola* cv. Tully and *P. purpurem* cv. Mott. The second factor was two sources of bokashi based on chicken manure (bokashi-1) and ruminant manure (bokashi-2), Three different levels of bokashi applications (B) where B1 = 5 tons, B2 = 10 tons, and B3 = 20 tons ha^{-1}. Each treatment was allocated randomly at experimental plots in the field. The variables include fresh weight yield (tons/ha), dry weight yield (tons/ha), crude protein, crude fiber and ash content. Dry matter yield of each plot was calculated through the value of green forage production and dry-weight percentage. Combining the dry matter yield with crude protein, crude fiber, and ash content data allowed us to calculate the mean crude protein, crude fiber, and ash yield. Predicted carrying capacity was determined by the information obtained from the forage harvested; it was collected from productivity estimation of each plot and converted to one ha. Available forage was calculated based on 70% of the total used factor. It is assumed that animal consumes 6.29 kg DM of forage/day/head (Indonesian condition). The plot size was 10 x 10 m. The total number of plots was 60 consisting of both grasses x 2 sources of bokashi x 3 level of bokashi x 5 replications. Data were then statistically analyzed by using analysis of variance (ANOVA) by means of MINITAB (Version 16). Honestly Significance Difference (HSD) was applied to determine the difference among treatments. Differences were considered at $P<0.05$. Harvesting biomass of *B. humidicola* cv.Tully and *P. purpurem* cv. Mott was done simultaneously when the ages of plants has arrived 35 days after replanting time in the field. *P. purpurem* cv. Mott was defoliated at first node from the soil surface (approximately 10 cm above ground). *B. humidicola* was defoliated at 10 cm level above ground. To get sample of *B. humidicola* has been used square 1 x 1 meter. This square was placed two time in the middle of each plot to avoid the border effects. Sample of *P. purpurem* has take five plants in two difference places in each plot so there were 10 plants as sample in each plot. Sample was dried at 60^{0}C for about 48 h to determine the dry weight. The samples were analyzed for dry matter, crude protein, crude fiber and ash according to the standard procedure of Association of Official Analytical Chemists.

RESULTS AND DISCUSSION

The effect of treatments on quality of grasses has been measured (Table 1). Data showed the effects of application both types of bokashi at 20 tons ha^{-1} produced dry matter (DM) content of both grasses significantly higher compared to other level.

Table 1. Dry matter (DM), crude protein (CP), NDF and ash content of both grasses under different kind and levels of bokashi

Attribute (%)	Treatments (bokashi tons.ha^{-1})	Treatment Bokashi-1 Bh	Bokashi-1 Pp	Bokashi-2 Bh	Bokashi-2 Pp
DM	5	16.75^{b}	24.01^{b}	15.71^{b}	20.01^{b}
	10	17.32^{b}	24.35^{b}	16.82^{b}	19.15^{b}
	20	17.61^{a}	28.72^{a}	18.51^{a}	23.22^{a}
	Significant	*	*	*	*
		17.23^{b}	25.69^{a}	17.01^{b}	20.79^{a}
		21.46^{a}		18.90^{b}	
CP	5	10.73	9.03	9.75	8.05
	10	11.31	9.71	11.01	9.11
	20	11.47	10.13	12.07	11.13
	Significant	NS	NS	NS	NS
		11.17^{a}	9.62^{b}	10.94	9.43
		10.39		10.18	
NDF	5	66.31	68.53	63.31	67.63
	10	65.17	67.71	64.16	65.71
	20	65.87	67.54	66.77	66.14
	Significant	NS	NS	NS	NS
		65.78	67.93	64.75	66.49
		66.85		65.62	
Ash	5	11.04	11.20	10.84	10.70
	10	10.15	10.76	10.35	11.16
	20	10.27	11.32	10.23	10.52
	Significant	NS	NS	NS	NS
		10.49	11.09	10.47	10.79
		10.79		10.60	

Note: Bh= B. humidicola cv. Tully; Pp = P. purpureum cv. Mott; NDF=Neutral Detergent Fiber; NS = Non Significant Difference. Symbols with different letters were significantly different among treatments by the least significant difference (LSD) method at the 5% level

There were not significantly effects of treatment on all attribute quality of forages in this research, in term of crude protein (CP), neutral detergent fiber (NDF) and Ash.

In general CP content of both species was also high enough for quality feeding above the minimum level required to fulfill the needs of functioning of rumen microbes (Van Soust, 1994). Even though, CP content of *B. humidicola* (11.17%) with bokashi-1 application was significant higher than*P. purpureum* (9.62%). More over DM content of both grasses was significant higher effected by bokashi-1 (21.46%) than bokashi-2 (18.90%). Growth attribute in term of plant height, number of tiller and ground cover has been measured (Table 2).

Data showed growth attributes of plant height did not different significantly on *P. purpureum* (Pp) except application of both type of bokashi at 20 tons ha^{-1} plant height has significant higher compared to other levels, but among them bokashi-1 has significant higher of plant height than bokashi-2.

The effects of treatment on number of tiller of Pp grass in each plant sample or mother plant (MP) was significantly higher at 20 tons of both type of bokashi application than other levels, and again bokashi-1 showed significant higher number of tiller than the other type. Tiller number increase was consistent with seasonal changes in this attribute with the progression of cutting practice (Hasyim et al., 2014). There was no determine these variable to *Brachiaria* (Bh) since it has growth habits as prostrate species, but there was ground cover information of this species which is did not different significantly among treatments.

Table 2. Plant height and number of tiller of *P. purpureum* cv. Mott

Variable	Treatments (bokashi tons.ha^{-1})	Treatment Bokashi-1 Bh	Bokashi-1 Pp	Bokashi-2 Bh	Bokashi-2 Pp
Plant height (cm)	5	_	130^{b}	--	120^{c}
	10	_	130^{b}	--	133^{b}
	20	_	162^{a}	--	150^{a}
	Significant		*		*
			140.6^{a}		134.3^{b}
Number of tiller (MP^{-1})	5	_	19^{c}	--	15^{c}
	10	_	24^{b}	--	19^{b}
	20	_	35^{a}	--	28^{a}
	Significant		*		
			26.00^{a}		20.67^{b}
Ground cover (%. M^{-2})	5	70	_	73	--
	10	75	_	76	--
	20	85	_	80	--
	Significant	NS		NS	
		76.66	--	76.33	

Note: Bh= *Brachiaria humidicola* cv. Tully; Pp = *Pennisetum purpureum* cv. Mott; NDF=Neutral Detergent Fiber; NS = Non Significant Difference; MP = mother plant; M $^{-2}$= meter square. Symbols with different letters were significantly different among treatments in each harvesting time by the least significant difference (LSD) method at the 5% level.

Table 3. Dry matter (DM) Crude protein (CP), Neutral Detergent Fiber (NDF) yield and predicted of carrying capacity (CC) of both grasses

Variable	Treatments (bokashi tons ha^{-1})	Treatment Bokashi-1 Bh	Bokashi-1 Pp	Bokashi-1 Bh	Bokashi-1 Pp
DM (tons ha^{-1})	5	3.15^{b}	14.11^{b}	2.95^{b}	13.41^{b}
	10	4.10^{a}	15.19^{b}	4.02^{a}	14.79^{b}
	20	4.25^{a}	17.75^{a}	4.15^{a}	17.05^{a}
	Significant	*	*	*	*
		3.83	15.68	2.32	15.08
		9.75		8.70	
CP (tons ha^{-1})	5	0.320^{c}	1.017^{c}	0.310^{c}	1.210^{c}
	10	0.361^{b}	1.235^{b}	0.343^{b}	1.305^{b}
	20	0.407^{a}	1.419^{a}	0.411^{a}	1.381^{a}
	Significant	*	*	*	*
		0.363	1.224	0.355	1.298
		0.793			0.826
NDF (tons ha^{-1})	5	1.895^{c}	8.275^{b}	1.791^{c}	7.775^{b}
	10	2.031^{b}	8.316^{b}	1.931^{b}	8.216^{b}
	20	2.153^{a}	9.854^{a}	2.055^{a}	9.354^{a}
	Significant	*	*	*	*
		2.026	8.815	1.925	8.448
		5.421		5.186	
CC (head year^{-1})	5	5.09^{b}	18.31^{c}	4.89^{b}	17.31^{c}
	10	5.35^{a}	19.98^{b}	5.05^{a}	19.08^{b}
	20	5.47^{a}	24.34^{a}	5.23^{a}	23.39^{a}
	Significant	*	*	*	*
		5.303	20.87	5.05	19.92
		13.08		12.48	

Note: Bh = *B. humidicola* cv. Tully; Pp = *P. purpureum* cv. Mott; NDF = Neutral Detergent Fiber; NS = Non Significant Difference; CC = carrying capacity. Symbols with different letters were significantly different among treatments by the least significant difference (LSD) method at the 5% level.

Presumably this species grown with aggressively root development after defoliation (Anis et al., 2011; Anis et al., 2015) and produced abundant tiller (Kaligis et al., 2013) and persist under free grazing (Kaligis et al., 2012). Yield and predicted of carrying capacity has been measured in this experiment (Table 3). Data showed both species of grasses which were received both type of *bokashi* application at 20 tons ha^{-1} produced all variable measured yield of DM, CP, NDF and predicted CC significant higher compared to other level.

High yield was presumably achieved due to increased nutrient absorption capacity release from organic fertilizer (Utamy et al., 2018). Efficiencies used of nitrogen in soil by chemical compound released called *brachialactone* through root exudate of *B. humidicola* (Subarao et al., 2009) and of a high density of roots under regularly defoliated of this species (Anis et al., 2012; Anis et al., 2015) and the ability adaptation of *P.purpureum* (Utamy et al., 2011; Utamy et al., 2018) due to improved soil physical properties (Fukagawa et al., 2000) and continuous nutrient absorption from earlier manure input. (Farede et al., 2010)

CONCLUSIONS

It could be concluded that both species of grasses response positively utilization of organic fertilizer bokashi, but in term of DM and CP content utilization of bokashi based on chicken manure fermented with effective micro-organisms EM4 was better than those of ruminant manure. Utilization of organic fertilizer in form of bokashi could provide forages to ruminant production integrated with coconuts plantation. By that way could be enhance economic value of this integrated systems.

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