UTILIZATION OF ORGANIC FERTILIZER ON GROWTH AND PRODUCTION OF *Brachiaria humidicola* cv. Tully AND *Pennisetum purpureum* cv. Mott IN COCONUTS BASED FARMING SYSTEM

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Abstract

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. This expensive product due to the fattening cattle in country use concentrate as animal feed rather than forages as practice in other country such as Australia. 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. Integrating systems always facing with competition of water and nutrient. Therefore external input of nutrient in form of fertilizer is important to avoid the negative effects of deficiency of nutrient especially to coconut as main crops. Utilization of an-organic fertilizer is more simple but costly and has some negative environmental impact. Chicken manure is available abundantly and some time promotes soil and water contamination. The aim of this research was to study the effects of organic fertilizer utilization on growth and production of two common tropical grasses of Brachiaria humidicola cv. Tully and Pennisetum purpureum cv. Mott to be highly and moderately shade tolerant species grown underneath mature coconuts. Both species has good performance in term of dry matter yield and quality, persistent during dry seasons and palatable for ruminant. Chicken manure was fermented with effective micro-organism (EM4) during 7 days until the beginning temperature at 50°C down to around 20°C called "bokashi". The experiment was conducted at coconut research centre area (BALITKA) Manado at the end of rainy season, since February 2017 until August 2017. The plant material used in this study was tillers of both species. They were taken from field laboratory of Forages science department, Faculty of Animal Science, University of Sam Ratulangi Manado. 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, this plant has been trimming to get homogeny re-growth, and then was transplanted to experimental plot in the field. The field where the experiment was done has approximately 70% of flat land and 30% surge. The soil has an average pH of 6 and its colour 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°C to 37°C. These climate conditions were suitable for the growth and production of both experimental plants. The elephant grass plant space was 100 x 100 cm apart and B. humidicola space was 50 x 50 cm apart. Bokashi has applied at the same time of plot preparation plowing and harrowing since this type of fertilizer needs enough time of dilution before planting. This experiment using completely randomized factorial design with 2 factors. The first factor was two species of grasses being evaluated were Brachiaria humidicola cv. Tully and Pennisetum purpureum cv. Mott. The second factor was three different levels of bokashi (B) where: B0 = five ton of bokashi application, B1 = application of 10 ton per ha, B2 = application of 20 ton per ha. Each treatment was allocated randomly at experimental plots in the field. The variables include fresh weight yield (ton/ha), dry weight yield (ton/ha), crude protein yield (ton/ha), crude fiber yield (ton/ha), and ash yield (ton/ha). 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. 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 as 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 plot was 30 consisting of both grasses 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. purpureum cv. Mott was done simultaneously when the ages of plants has arrived 35 days after replanting time in the field. P. purpureum 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 in the middle to avoid the border effects, two times in each plot. Sample of P. purpureum has take five plants in two places in each plot so there were 10 plants as sample in each plot. Samples were dried at 60°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. The result of this research show that dry matter yield of both species of grasses received 20 ton ha^{-1} of organic fertilizer bokashi was 41% significant higher than other treatment. In term of crude protein yield it was 77% significant higher compared to other treatment. The effect of that treatment on NDF yield was 58% significant higher. Furthermore carrying capacity of both species of grasses received organic fertilizer bokashi at 20 ton ha^{-1} was significant higher at 40% than those at 5 ton ha^{-1}. It could be concluded that both species response positively utilization of organic fertilizer bokashi chicken manure. Utilization of organic fertilizer in form of bokashi could provide forages to support ruminant production integrated with coconuts plantation. By that way could be enhance economic value of this integrated systems.

Key word: organic, fertilizer, *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 has been selected as species tolerance growth under shade environment in coconuts plantation. Dry matter (DM) production of *Pennisetum purpureum* including dwarf genotype is enhanced by high input of inorganic fertilizer [4] 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 [6] 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 [10]. It also increases the soil levels of the macro elements of nitrogen (N), phosphorus (P), and potassium (K) [8][7] improves soil physical properties, enhances DM yield, and improves the crude protein concentration of herbages [9]. Utilization of inorganic fertilizer for forages production is costly for smallholder farmers and risks environmental

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The manuscript was received: 17.09.2018
Accepted for publication: 22.12.2018

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 were tillers of both species. Tiller were 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 a.m on a sunny day as PAR underneath mature tall coconuts averaged 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 25^0C to 37^0C. *The Pennisetum 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. The first factor was two species of grasses being evaluated were *Brachiaria humidicola* cv. Tully and *Pennisetum purpurem* cv. Mott. The second factor was three different levels of bokashi (B) where B1= five ton of bokashi application, B2 = application of 10 ton per ha, B3 = application of 20 ton per ha. Each treatment was allocated randomly at experimental plots in the field. The variables include fresh weight yield (ton/ha), dry weight yield (ton/ha), crude protein yield (ton/ ha), crude fiber yield (ton/ha), and ash yield (ton/ha). 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. 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 as 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 plot was 30 consisting of both grasses 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 in the middle to avoid the border effects, two times in each plot. Sample of *P.* purpurem has take five plants in two places in each plot so there were 10 plants as sample in each plot. Sampel were dried at 60^0C or 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

Data Table 1 showed dry matter (DM) content of both grasses significantly higher at 20 ton ha^{-1} compared to other level of *bokashi* across all harvesting time. There is not effects significantly of treatment on all attribute quality of forages in this research in term of crude protein (CP), neutral detergent

fiber (NDF) and Ash content, except for NDF content at first harvesting time was significant higher at application of 20 ton ha^{-1} *bokashi* for Pp grass species, and Ash content for Bh grass. Nevertheless, it is presumably CP content tended to be lower thereafter at third harvesting time for Pp grass. In contrast CP content of Bh grass almost steady from first to third harvesting time. This phenomenon is probably due to the ability of this species to keep nitrogen slow release from organic fertilizer since they produced brachialactone a chemical compound as biological nitrogen inhibitor release together root exudete around rooting systems when foliage defoliated occurred [11]. In general CP content of both species was also high enough for quality feeding above the minimum level required for rumen functions [14].

Table 1 Dry matter (DM), crude protein (CP), NDF and Ash content of both grasses during 3 consecutive harvesting times

Attribute (%)	Treatments (bokashi Ton.Ha^{-1})	Harvesting Time					
		1st		2nd		3rd	
		Bh	Pp	Bh	Pp	Bh	Pp
DM	5	17.54 ^{b}	24.41^{b}	16.43^{c}	23.65^{b}	16.75^{b}	24.01^{b}
	10	18.03 ^{b}	24.93^{b}	18.10^{b}	24.10^{b}	17.32^{b}	24.35^{b}
	20	19.56 ^{a}	30.72^{a}	18.53^{a}	29.12^{a}	17.61 ^{a}	28.72^{a}
	Significant	*	*	*	*	*	*
CP	5	10.61	9.88	10.74	8.99	10.73	9.03
	10	10.33	10.95	10.53	10.67	11.31	9.71
	20	11.57	11.58	11.42	11.31	11.47	10.13
	Significant	NS	NS	NS	NS	NS	NS
NDF	5	66.71	70.80^{b}	67.54	71.52	66.31	68.53
	10	65.93	71.51^{b}	65.43	72.43	65.17	67.71
	20	66.66	73.84^{a}	67.11	71.59	65.87	67.54
	Significant	NS	*	NS	NS	NS	NS
Ash	5	10.54^{b}	12.32	10.45	11.35	11.04	11.20
	10	10.80^{b}	10.90	10.72	11.12	10.15	10.76
	20	12.79^{a}	12.42	11.97	11.54	10.27	11.32
	Significant	*	NS	NS	NS	NS	NS

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

Growth attributes of plant height did not different significantly on *Pennisetum purpureum* (Pp) at first harvesting time, but application of *bokashi* at 20 ton ha -1 plant height has significant higher at second and third harvesting time compared to other levels. The effects of treatment on number of tiller of Pp grass in each plant sample or mother plant (MP) was significantly higher at 20 ton of *bokashi* application than other levels, and increase continuously up to third harvesting time. Tiller number increase was consistent with seasonal changes in this attribute with the progression of cutting practice [4]. There was no determine these variable to *Brachiaria* (Bh) since it is has growth habits as prostrate species, but there was ground cover information of this species which is did not different significantly among treatments across three harvesting time. Presumably this species grown with aggressively root development after defoliation [1] [3], and produced abundant tiller [8] and persist under free grazing [7].

Table 2 Plant height and number of tiller of *Pennisetum purpureum* cv. Mott and ground cover of *Brachiaria humidicola* cv. Tully

Variable	Treatments (bokashi Ton.Ha^{-1})	Harvesting Time					
		1st		2nd		3rd	
		Bh	Pp	Bh	Pp	Bh	Pp
Plant height (cm)	5	_#	115	_	135^{b}	_	130^{b}
	10	_	120	_	137^{b}	_	130^{b}
	20	_	121	_	156^{a}	_	162^{a}
	Significant		NS		*		*
Number of tiller (MP^{-1})	5	_	7^{b}	_	12^{c}	_	19^{c}
	10	_	9^{b}	_	15^{b}	_	24^{b}
	20	_	12^{a}	_	21^{a}	_	35^{a}
	Significant		*		*		*
Ground cover (%. M^{-2})	5	50	_	65	_	70	_
	10	55	_	70	_	75	_
	20	60	_	75	_	85	_
	Significant	NS		NS		NS	

Note: Bh= *Brachiaria humidicola* cv. Tully; Pp = *Pennisetum purpureum* cv. Mott; NDF=Neutral Detergen Fiber. NS = Non Significant Difference. # Not determined. MP = mother plant. M $^{-2}$ = meter squre. Symbols with different letters were significantly different among treatments in each harvesting time by the least significant difference (LSD) method at the 5% level

All variable measured DM, CP, NDF and CC of both species of grasses (Pp and Bh) which were received *bokashi* application at 20 ton. ha^{-1} produced DM significant higher compared to other level across all harvesting time. High yield was presumably achieved due to increased nutrient absorption capacity release from organic fertilizer [13] of a high density of roots under regularly defoliated *of B. humidicola* [2][3] and due to improved soil physical properties [5] and continuous nutrient absorption from earlier manure input [6]. Nevertheless, since the nutrient depleted naturally through defoliation outside the system [12] those production attribute tend to be lesser at third harvesting time.

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

Variable	Treatments (bokashi Ton.Ha^{-1})	Harvesting Time					
		1st		2nd		3rd	
		Bh	Pp	Bh	Pp	Bh	Pp
DM (ton ha^{-1})	5	2.91^{b}	11.92^{b}	3.25^{b}	14.10^{b}	3.15^{b}	14.11^{b}
	10	3.22^{a}	12.22^{b}	3.35^{b}	15.70^{b}	4.10^{a}	15.19^{b}
	20	3.47 ^{a}	16.57^{a}	4.10^{a}	18.95^{a}	4.25^{a}	17.75^{a}
	Significant	*	*	*	*	*	*
CP (ton. ha^{-1})	5	0.303 ^{c}	1.125^{c}	0.310^{c}	1.150^{c}	0.320 ^{c}	1.017^{c}
	10	0.331^{b}	1.333^{b}	0.337^{b}	1.402^{b}	0.361^{b}	1.235^{b}
	20	0.393 ^{a}	1.918^{a}	0.381^{a}	1.750^{a}	0.407^{a}	1.419^{a}
	Significant	*	*	*	*	*	*
NDF (ton ha^{-1})	5	1.904^{b}	8.303^{b}	1.875^{c}	8.425^{c}	1.895^{c}	8.275^{b}
	10	2.090^{b}	8.620^{b}	2.160^{b}	8.531^{b}	2.031^{b}	8.316^{b}
	20	2.274^{a}	11.930^{a}	2.265^{a}	10.870^{a}	2.153^{a}	9.854^{a}
	Significant	*	*	*	*	*	*
CC (head. Year^{-1})	5	5.11^{b}	20.13^{b}	5.27^{b}	20.10^{c}	5.09^{b}	18.31^{c}
	10	5.41^{b}	20.73^{b}	5.31^{b}	20.57^{b}	5.35^{a}	19.98^{b}
	20	5.75^{a}	28.61^{a}	5.69^{a}	27.63^{a}	5.47^{a}	24.34^{a}
	Significant	*	*	*	*	*	*

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

CONCLUSIONS

It could be concluded that both species response positively utilization of organic fertilizer bokashi chicken manure. Utilization of organic fertilizer in form of bokashi could provide forages to support ruminant production integrated with coconuts plantation. By that way could be enhance economic value of this integrated systems.

ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to Minister of Research, Technology and Higher Education of the Republic of Indonesia for the financial support of this research through the Rector of the University of Sam Ratulangi Manado. We would also like to express appreciate to the Assessment Institute Agriculture Technology (AIAT) of North Sulawesi for the permission use the land of experimental station.

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