International Journal of Science, Environment and Technology, Vol. 3, No 6, 2014, 2231 – 2241

ISSN 2278-3687 (O)

DRY MATTER YIELD AND NUTRITIONAL QUALITY OF *PANICUM MAXIMUM – CENTROSEMA PUBESCENS* MIXTURES AT DIFFERENT PLANT PROPORTIONS AND CUTTING INTERVALS

Muhammad Rusdy
Department of Forage and Grassland Management
Faculty of Animal Science Hasanuddin University, Makassar Indonesia
E-mail: muhrusdy79@yahoo.co.id (**Corresponding Author*)

Abstract: An experiment was conducted to determine dry matter yield, yield advantage and nutritional quality of *Panicum maximum*cv Ntcisi (guniea grass) -*Centrosemapubescens* (centro) mixtures (intercrops) and their monocultures grown at different proportions and cutting intervals. Proportions of guinea grass – centro grown were 100 : 0%, 75 : 25%, 50 : 50%, 25 : 75% and 0 : 100% and cutting intervals were 30, 45 and 90 days. Population of plants grown was 4 plants/pot. Resultsof the experiment showed that dry matter yield of intercrops were significantly higher ($P < 0.05$) than that their monocultures and sole guinea grass produced higher dry matter yield than solecentro. The yield advantages (relative yield total) also implied similar trends for dry matter yield. The highest yield advantage achieved when guinea grass - centro at the ratio of 50: 50%. As increasing proportion of centro in the mixtures and decreasing cutting interval, crude protein, calcium contents and digestibility were increased. With exception of sole guinea grass cut at interval of 45 and 90 days, crude protein and IVDMD values of all sole crops and intercrops of guinea grass – centro are above the minimum requirements for maintenance of ruminant animals
Keywords: Guinea grass, centro, intercrops, dry matter yield, nutritive value.

1. Introduction

In densely populated country such as Indonesia, natural grazing lands are continually decreasing because they are converted to crop cultivation to satisfy the needs of increasing human population. Consequently, livestock are forced to graze on unconventional fields such as marginal lands, road sides, river bank, plantation areas etc. Nowadays, mainly due to shortage of feeds, Indonesia is importing nearly up to 40% of meat needs, especially from Australia.

The conversion of grazing land to crop cultivation is partly, associated with the belief that income from rearing livestock is lower than from crop cultivation. This assumption may be true when livestock are grazed on natural grassland growing on marginal lands of low soil fertility, but when grazed on improved grasses, livestock productivity is quite high and income may higher than growing cultivation of many crops. In north-east Thailand, net

*Received Nov 16, 2014 * Published Dec 2, 2014 * www.ijset.net*

returns of forage grown for sale are very high (US$2500 – 3800/ha/year, which far exceeds the gross return of US$590/ha/year from rice production (Nakamanee et al. 2008).

In Indonesia, there are many species of improved grasses that have a high production potential and have adapted to local conditions. One of them is *Panicum maximum* (guinea grass). In Indonesia, this grass is used as cut or grazing grass. Although its dry matter is not high as elephant grass, its protein yield and dry matter intake are higher than elephant grass (Man and Wiktorsson, 2003).

Animal production from guinea grass pasture in quite high. In Puerto Rico, Vicente-Chandler (2001) reported that intensively managed guinea grass with carrying capacity 8.8 head/ha gained 1200 kg/ha/year. In Hawaii, Mathews et. al. (2000) reported that guinea grass pasture mixed with *Arachispintoi* cv. AmariIlo with stocking rate of 2 to 5 head $ha^{-1}$of 280 kg Brangus heifers and steers gained from 0.72 – 0.95 $kgday^{-1}$.

Because of its high dry matter and animal production potentials, guinea grass needs high fertility soils. Maintaining high soil fertility can be achieved through fertilizer application and introduction of legume into the pasture. Application of fertilizer to increase dry matter yield and nutritive value have been suggested to be one method to improve animal production in developing countries (Peyard and Astigarraga,1998), however the high price of commercial fertilizer make it unaffordable for most subsistence farmers. Besides, the use of an-organic nitrogen can increase environmentally related problems due to excessive release of nitrogenous compounds. The high applied rate of nitrogen chemical fertilizers on pasturelands in Western Europe has been has been becoming hazardous impact on the release of NO_2 and NH_3 into the atmosphere (Mannetje, 2002). The introduction of legume into guinea grass pasture may be the promising alternative because it may be cheaper, do not harm environment and legume is more nutritious than grass. Guinea grass has been reported to combined well with *Centrosemapubescens* (Baba *et al*. 2011). The main constrains for low productivity of grass – legume are inappropriate ofguinea grass – legume proportion and lack of cutting management. This experiment was undertaken to evaluate the effects of cutting interval on dry matter yield, yield advantages and nutritional quality of guinea grass – centro mixtures at different proportions.

2. Materials and Methods

2.1. Experimental site

This experiment was carried out at Field Laboratory of Forage and Grassland Management, Faculty of Animal Science Hasanuddin University Makassar Indonesia, located at (5^{o}8’23”S latitude and 119^{o}25'119" longitude) with 8 m elevation above sea level. The mean temperature was 26.2^o C and mean annual rainfall was 2875 mm.

3.2. Treatments

The experimental design was a factorial combination of five plant proportions and three cutting intervals x three replications in randomized block design. Proportions of guinea grass – centro grown were 100: 0% (G4L0), 75: 25% (G3L1), 50: 50% (G2L2), 25: 75% (G1L3)and 0: 100% (G0L4). Population of plant grown was 4 plants/pot. The cutting intervals were 30, 45 and 90 days.

The plants were planted into 45 pots. The pots were 31 cm tall with a top diameter of 22.5 cm and a bottom diameter of 13 cm. Each pot was filled with 1.4 kg of sun dried soil. The soil was clay loam texture of ultisol soils with concentrations of N, P_2O5 and K_2O was 0.40%, 15.54 and 10.47 mg/100g, respectively. The soils used were obtained from the beneath of centro growing naturally at Hasanuddin University campus. The soil was passed through a 5 mm sieve and well mixed prior to use.

To get a more homogenous growth, seeds of centro were sown 30 days earlier than planting of tiller of guinea grass. Phosphate fertilizer at the rate of 100 kg P_2O_5 kg/ha was applied one week before centro seeds were sown. To stimulate early centro growth, all pots were applied with N fertilizer (urea) at the doses of 50 kg/ha. After planting, the pots were transferred and placed under field/open conditions. Weeds appeared were hand cleared and watering was conducted as needed. The first harvest was done at 75 days after planting.

Two months after guniea grass planting, all plants were cut uniformly at 10 cm above soil level and cutting interval were counted from that time of cutting. At harvest, all plants of each pot were cut at 10 cm above ground level with manual shear and guinea grass and centro were separated and oven dried at 60^{o}C for 24 hours for determination of dry matter yield, yield advantage and nutritional quality.

Dry matter yield obtained by multiplying dry matter content and fresh yield. Yield advantage (land equivalent ratio) was measured by relative yield total (RYT) using formula of De Wit (1960): RYT GL = (DMY GL/DMY GG) + (DMY LG/DMYLL) where GL is dry matter yield of guinea grass intercropped with centro, LG is dry matter yield of centro intercropped with guniea grass, GG is dry matter yield of sole guinea grass and LL is dry matter yield of sole centro. Nutritional quality measured were crude protein, digestibility and calcium and phosphorus contents. N content was analyzed using Kjeldahl procedure (AOAC, 1990) and converted to crude protein as N x 6.25.Digestibility determination using method proposed by

Goto and Minson (1977). Calcium was determined using atomic absorption spectrophotometer and phosphorus by Vonadomolybdatecalorimetry method of AOAC (1990).

3.3. Statistical analysis

The data collected were subjected to analysis of variance (ANOVA) using factorial combinations of five planting proportions and three cutting intervals with three replications in completely randomized design. Difference among each mean were analyzed using least significant difference.

3. Results and Discussion

3.1. Dry matter yield and yield advantages

Plant proportion and defoliation interval significantly influenced dry matter yield. From Table 1 it was shown that dry matter yield of guinea grass – centro mixtures significantly higher than dry matter yield of guinea grass or centro planted as monoculture.

Table 1. Dry matter yield and relative yield total (RYT) of sole and guinea grass –centro mixtures grown at several proportions and defoliated at different intervals.

Plant pro portions	Dry matter yield (g/pot) Cutting intervals				RYT Cutting intervals			
	30 days	45 days	90 days	Mean	30 days	45 days	90 days	Mean
G4L0	30.10	29.90	28.63	29.54a	1.00	1.00	1.00	1.00b
G3L1	31.60	35.93	32.92	35.15b	1.46	1.60	1.65	1.57b
G2L2	31.40	36.86	33.66	35.97b	1.52	1.57	1.67	1.59b
G1L3	30.50	36.83	32.30	34.54b	1.40	1.48	1.50	1.46ab
G0L4	26.65	27.80	27.60	27.35a	1.00	1.00	1.00	1.00a
Mean	33.62b	33.46b	30.89a		1.46a	1.54b	1.46a	

Means of dry matter yield and RYT values with different letter are significantly different (*P*<0.05).

RYTs value of intercrops were > 1 indicating their yield advantages over the monocultures. In this study, mean of RYTs for mixtures ranged from 1,46 to 1.60 (Table 1), indicating a yield advantage of 46 to 60% over that of mean sole guinea grass and sole centro. The increased dry matter yield of grass – legume mixtures over monoculture had been widely reported in literatures (Ajayi and Babayemi,2008, Baba *et al*. 2011 and Sturludottir *et al*.,2013). Yields are generally higher in mixture because of more efficient light utilization and transfer of symbiotically fixed nitrogen to grasses (Ledgard, 1991). In this study, the two species may complementary in space because tap root in centro may be able to extract water and nutrients from a deeper soil profile than guinea grass with fibrous roots which concentrating in the top soil layer. Both species also may complementary in time, as centro establish earlier than guinea grass because it was sown earlier. In the intercrops, guinea grass and centro may competed partially for limiting resources because competition for N would be less since centro, via the *Rhizobium* symbiosis, has access N in the atmosphere and centro could use atmospheric nitrogen to increase soil N pool

Dry matter yield of guinea grass – centro cut at interval of 90 days significantly lower than that defoliated at 30 and 45 days (Table 1). This indicated that to produce high dry matter yield, guinea grass-centro mixtures should be cut at intervals of 30 or 45 days and this was consistent with Pretorius *et al* (1974) that four to six – weekly defoliation of *Panicum maximum* to be the best with regard to dry matter production. As dry matter yield of centro was less when cut every 4 weeks than 6 and 8 weeks (Marmo*et al.*, 2005), to get sustainable yield, guinea grass – centro mixture should not be cut at short interval (30 days). The higher dry matter yield at 30 and 45 days days of cutting interval may be related to the higher leaf area residues and carbohydrate reserve levels in stem base and roots as affected by shorter defoliation interval (Miller *et al*.,1986).

3.2. Crude protein and dry matter digestibility

Crude protein content and IVDMD of guinea grass – centro mixtures and their monoculture are presented in Table 2.

Table 2. Crude protein content and *in vitro* dry matter digestibility of sole and guinea grass – centro mixtures planted at several proportions and cut at different intervals.

Plant proportions	Crude protein (%) Cutting intervals				Digestibility (%) Cutting intervals			
	30 days	45 days	90 days	Mean	30 days	45 days	90 days	Mean
G4L0	8.51	6.60	5.21	6.77	55.16	54.08	52.48	53.91a
G3L1	10.96	9.43	9.02	9.80	59.42	57.11	55.36	58.43b
G2L2	12.92	11 .85	10.03	11.27	59.74	57.78	57.76	58.43b
G1L3	14.00	13.86	13.43	13.76	59.90	59.12	58.50	59.17b
G0L4	16.20	15.84	15.45	15.50	61.38	59.53	58.50	59.80b
Mean	12.52b	11.52ab	10.23a		59.12b	57.48ab	56.52a	

Means of crude protein and digestibility with different letter are significantly different (P<0.05)

Plant proportion and cutting interval significantly (P<0.05) influenced protein content and digestibility. As expected, with increasing proportion of centro and decreasing cutting interval, crude protein content and digestibility increased (Table 2).

The increase of crude protein content as increasing legume proportion in grass – legume mixture have been reported elsewhere (Richter and Schmaler, 1997; Ajayi and Babayemi, 2008 and Zemenchik *et al*., 2002). The increase of crude protein content of intercrops in this study was attributed to the higher crude protein content of centro compared to guinea grass (Table 2). Crude protein contents of intercrops obtained in this study were lower than intercrops of guinea grass – centro reported by Ajayi and Babayemi (2008), but were higher than reported by Ezenwa and Aken'ova (1998) that might be attributed to differences in environmental conditions in which the experiments conducted.

Increasing crude protein contents as increasing cutting interval also have been reported by Okwori and Magani (2010) and Ojo *et al*.,(2013). This increase of crude protein might be attributed to the higher rate of increase of structural component as plant ages. Crude protein content of sole guinea grass cut at 30 intervals in this study was comparable to guinea grass cut at 40 days reported by Ram and Trivedi, 2012). In this study, the sole guinea grass cut every month and all intercrops contained crude protein levels exceeding the minimum of 7% suggested as necessary for rumen function (Milford and Minson, 1966). This indicated that guinea grass cut at short intervals and inclusion of centro into guinea grass pasture are very beneficial to increase pasture quality and meeting protein requirement of animals.

Digestibility values in this study was compare favorably with those of Minson (1972) who reported digestibility value ranging from 52% for mature regrowth to 61% for one month old regrowth but lower than reported by Amar (2014). As increasing centro proportion in guinea grass-centro mixtures, digestibility values also increased (Table 3). This was in agree with Reid *et al* (1987) and was attributed to the higher digestibility in centro compared to that of guinea grass (Table 2). Digestibility of plants increased with decreasing cutting interval (Table 2) and this was parallel with Okwori and Magani (2010). This might be attributed to the higher ADF contents as forage plant ages. As protein, all intercrops and sole guinea grass cut every month produced values of digestibility above the minimum requirement for maintenance for animals in the tropics (McDowell *et al*., 1992).

3. Calcium and phosphorus contents

Table 3. Calcium and phosphorus contents of guinea grass – centro mixtures and their monocultures planted at some proportions and cut at different intervals.

Plant proportions	Calcium (%) Cutting intervals				Phosphorus (%) Cutting intervals				
	30 days	45 days	90 days	Mean	30 days	45 days	90 days	Mean	Ca:P ratio
G4L0	0.85	0.66	0.52	0.68a	0.38	0.31	0.28	0.32	2.06
G3L1	0.89	0.74	0.62	0.75ab	0.42	0.30	0.24	0.32	2.34
G2L2	0.92	0.79	0.71	0.81b	0.39	0.32	0.26	0.39	2.10
G1L3	1.00	0.86	0.72	0.86b	0.41	0.31	0.17	0.41	2.10
G0L4	1.16	1.10	0.81	1.02c	0.46	0.38	0.29	0.46	2.22
Mean	0.96c	0.83b	0.68a		0.41b	0.32a	0.27a		

Means of calcium and phosphorus values sharing different letter are significantly different (P<0.05).

Calcium values of sole guinea grass in the current study were comparable to reports of Tona (2011) and Aladade *et al*., (2014), but phosphorus contents were lower than reported by Tona (2011) and higher than reported by Aladade *et al.,* (2014).This might be due to differences in availability of these elements in the soils.

As proportion of centro increased, calcium content was increased but phosphorus content was unaffected (Table 2). The higher calcium content as increasing centro proportion was due to the higher calcium content of centro than guinea grass (Table 3) The inclusion of centro into the guinea grass stand did not affect phosphorus content and this might be due to similarity of phosphorus content of guinea grass and centro (Daccord*et al*., 2001).

Increasing cutting interval decreased calcium and phosphorus contents. This was in agree with Jumbo *et al*., (1995) and Tudsri (2014) that with advancing maturity of forage, calcium and phosphate decrease while fiber concentrations increase. This decline might due to dilution of these elements in a great quantity of dry matter that accumulated with advancing age of plants.

Calcium and phosphorus requirements of lactating cows as indicated by NRC (2000) is 0.58 and 0.26%, respectively. Based on this standard, calcium and phosphorus concentrations for all plants in this study were adequate for lactating cows. Mean Ca: P ratio of all plants in this study also were within the tolerable range for ruminants (McDowell, 1992)

Conclusion

The results show the potentials to produce high quantity of forage of higher nutritional quality with inclusion of centro into the guinea grass stand. It needs further experiment to study the effects of mixing of guinea grass and centro under farm conditions to improve livestock production

References

[1] Ajayi, F.T., & Babayemi, O.J. (2008). Comparative evaluation of mixtures of *Panicum maximum* cvNtchisi with stylo (*Stylosanthesguianensis*), lablab (*Lablab purpureus*), centro (*Centrosemapubescens*) and histrix (*Aeschynomenehistrix*). Livestock Research for Rural Development, 20 (6).

[2] Aladade, J.A., Akingbade, A.A. Akinlade, J.A. Aanbi, W.B., Gbadamosi, J., Akenigi, G. Ajibade, A.O. and Akanji, K.A. (2014). Herbage yield and nutritive quality of *Panicum maximum* intercropped with different legumes. Int. J. Sci. Environ. Technol. 3(1): 224 – 232.

[3] Amar, A.L. (2014). Nitrogen content and digestibility of guinea and sabi grasses as influenced by tree legume canopy. Majalah Ilmiah Peternakan, 7 (2): 1 – 14.

[4] Association of Official Analytical Chemist (AOAC), 1990. Official Method of Analysis, 16th Edn. Arlington, Virginia USA.

[5] Baba, M., Halim, R.A., Alimon, A.R. and Abubakar, I. (2011). Grass-legume mixtures for enhanced production: Analysis of dry matter yield and competition indices. Afr. J. Agric. Res. 6 (23): 5242 – 5250.

[6] Daccord, R., Arroyo, Y. Kessler, J. Jeangros, B. Scehovic, J. Schubiger, F.X. and Lechman, J. (2001). Nutritive value of grasslands plants: contents of calcium, phosphorus, magnesium and potassium. J. Agrarforschung, 8 (7): 264 – 269.

[7] Ezenwa, I. and Aken'ova, M.E. (1998). Performance of mixtures of selected grasses and adapted herbaceous in south-west Nigeria. Trop. Grassld, 32: 131 – 138.

[8] Goto, I. and Minson, D.J. (1977). Prediction of dry matter digestibility of tropical grasses using a pepsin – cellulose assay. Anim. Feed Sci. Technol. 2: 247 – 253.

[9] Jumbo, O. Isaac, S.O. Wandigo, N.F. Suttle and E.A. Hunter, (1955). Effects of soil origin and mineral composition on herbage species on the mineral composition of forages in Mount Elgon region of Kenya. I. Calcium, phosphorus, magnesium and sulfur. Digital repository university of Nairobi. www.erepository.nonbi.ac.ke/handle/11235/16415.

[10] Ledgard, S.F. (1991). Transfer of fixed nitrogen from white clover to associated grasses in swards grazed by dairy cows estimated using ^{15}N methods. Plant Soil, 131: 215 – 223.

[11] Man, N.V. and Wiktorsson, H. (2003). Forage yield, nutritive value, feed intake and digestibility of three grass species as affected by harvest frequency. Trop. Grassld., 37: 101 – 110.

[12] Mannetje, L.T. (2002). Advances in Grassland Science. Netherlands Agric. Sci, 50: 195 – 221.

[13] Marmo, J.F., Morillo, D.E and Chirinos, Z. (2005). Effect of defoliation frequencies on dry matter yield and nutrient of two *Centrosema* species. Archivos Latinoamericanus de Produccion Animal, 13 (1): 13 – 18.

[14] Mathews, B.W., Carpenter, J.R., Cleveland, E., Gibson, Z. and Niino-Du Ponte, 2000. Perennial forage peanut (Arachis pintoi) in pastures for raising replacement heifers/stocker steers in Hawaii. J. Hawaiian Pacific Agric. 11: 1 –10.

[15] McDowell, L.R. (1992). Minerals in Animal and Human Nutrition. Acedemic Press, Inc. San Diego, California.

[16] Milford, R. and Minson, D.J. (1966). Intake of tropical pasture species. Proc. 11th Grassld Congr., Brazil, 1964, p. 814.

[17] Miller, R.F. Seufert, J.M. and Haferkamp, M.R. (1986). The ecology and management of bluebunch wheatgrass (*Agropyronspicatum*): A review. Oregon Agricultural Experiment Station.

[18] Minson, D.J. (1972). The digestibility and voluntary intake by sheep of six tropical grasses. Aust. J. Experimental Agric. Anim. Husb. 12: 21 – 27.

[19] Nakamanee, G., Srisomporn, W., Phengsavanh, P., J. Samson, J. and Stur, W. (2008). Sale of fresh forage–a new cash crop for smallholder farmersinYasothon, Thailand. Trop. Grassld, 42: 65-74.

[20] NRC., (2000). Nutrient Requirement of Dairy Cattle.7th rev. ed. National Research Council, Nat. Acad. Sci. Washington, DC.

[21] Ojo, V.O.A., Dele, P.A., Amole, T.A., Anele, U.Y., Adeoye, Hassan, O.A. Olanite, J.A. and Idowu, O.J. (2013). Effects of intercropping *Panicum maximum*var.Ntchisi and Lablab purpureus on the growth, herbage yield and chemical composition of *Panicum maximum* var. Ntchisi at different harvesting times. Pak. J. Nutr. 16 (22): 1605 – 1608.

[22] Okwori, A.I. & Magani, I.E. (2010). Influence of nitrogen sources and cutting interval on the digestibility of four (4) grass species in the southern guinea savanna of Nigeria. Agric. Biol. J.N. Am., 1(4): 526 – 533.

[23] Peyard, I. and Astigarraga, L. (1998). Review of the effects of nitrogen fertilization on the chemical composition and nitrogen balance. J. Anim. Feed Sci. and Technol. 72: 235 – 259.

[24] Pretorius, M.W., Grunow, J.O. and Rabie, J.W. (1974). Influence of frequency and intensity of defoliation on production and morphological development of *Panicum maximum* Jack. Cv. Sabi. Afr. J. Range and Forage Sci., 9 (1): 111 – 116.

[25] Ram, S.N. and Trivedi, B.K. (2012). Response of guinea grass (*Panicum maximum* Jack.) to nitrogen, farm yard manure and harvest intervals. Forage Res., 38 (1): 49 – 52.

[26] Reid, R.L., Templeton, W.C., Teal, J., Ranney S. and Rayne, W.V. (1987). Digestibility, intake and mineral utilization of combinations of grasses and legumes by lambs. J. Anim. Sci. 64: 1725 - 1734

[27] Richter, K. and K. Schmaler, (1997). Yield formation and changes in quality of legume-grass mixtures as affected by N-fertilization, irrigation and grass species. www.internationalgraslands. Org/files/igc/publications/1997/1-22-177.pdf.

[28] Sturludottir, E., Brophy, C. Belanger, G.A., Gustavasson, A.M., Jorgensen, M., Lunnan T. and Helgadottir, A. (2013). Benefits of mixing grasses and legumes for herbage yield and nutritive value in northern Europe and Canada. Grass and Forage Sci. 25: 1 – 12.

[29] Tona, G. (2011). Chemical composition and nutrient digestibility of *Panicum maximum* and *Piliostigmathonningii* leaves fed to West African dwarf ram as dry season feed. Ozean J. Applied Sci. 4(3): 189 – 192.

[30] Tudsri, S., Pachanawan, S.N. Swasdiphanich, S., N. Bumrung, N and Yang, Y. (2014). Productivity of CP-Pangola (*Digitariadecumbens* cv. CP-1) under different management conditions. 1. Effect of frequency and height of cutting. FAO of the United Nations.http://agris.fao.org/agris-search/search.do?recordID=TH2001001216.

[31] Vicente-Chandler, J. (2001). Intensive management of forage grasses in the humid tropics. In: Tropical Forage Plants: Development and use. Ed. by A. Sotomoyor-Rios and W.D. Pitman. CRC Press, Boca Ratoon, London.

[32] Zemenchick, R.A., Kenneth, A. Albretch, A and Sahaver, R.D. (2002). Improved nutritive value of Kura-Clover and Birdsfoot Trefoil Grass mixtures compared with grass monoculture. Agron J. 94 (1): 1131 – 1138.

[33] de Wit, C.T. (1960). On competition. Verslagen Landbowkundige Onderzoekengen, 66:: 1 – 82.