Productivity of *Brachiaria humidicola* as Results of Different Nutrient Source Application

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ABSTRACT

In many tropical pastures invasive weed like *Chromolaena odorata* becomes a serious species with no redeeming feature and causes poor and low calving rates of local cattle. Utilization of *C. odorata* biomass as organic nutrient source may be an alternative management to eliminate the distribution of the weed and improve pasture productivity. A field study in mini pastures was conducted to recognize annual forage production (AFP), carrying capacity, N and P Uptake, and protein production of *Brachiaria humidicola* (signal grass) grown on soil amended with *C. odorata* biomass and feces as organic nutrient source. Block Randomized Design consisting of: no treatment (blank control = P0); 7.2 kg plot^{-1} of *C. odorata* (PC); 21 kg plot^{-1} of manure (PF); combination of *C. odorata* (3.6 kg plot^{-1}) and manure (10,5 kg plot^{-1}) (PCF) and inorganic fertilizer (573.3 g urea plot^{-1} and 217 g super phosphate plot^{-1} (positive control=PA), with 4 replications. Carrying capacity was calculated according to simulation of accumulate grass production throughout the year. Dried herbage was use to determine forage production, N and P uptake. Protein production was calculated from N concentration multiplied by 6.25. The results showed that PC improved ($p<0.01$) AFP about 225% and 110% as compared to P0 and PF, respectively. PC and PF are able to substitute inorganic fertilizer about 60% and 50%, respectively in resulting similar AFP as compared with those of PA. PC and both PF and PCF increased ($p<0.05$) carrying capacity of the pasture up to 1.7 and 1.3 Animal Unit, respectively as compared with P0. PC, PF and PCF produced higher protein production ($p<0.05$) than P0, and substituted to inorganic fertilizer by 46%, 40% and 49%, respectively.

Key words: Brachiaria humidicola, Chromolaena odorata, manure

INTRODUCTION

High intensity of pasture use due to intensive animal rearing for replacement stock leads to soil and nutrient degradation. In many pasture area in Indonesia, most of degraded pasturelands are invaded by invasive weed species like *Chromolaena odorata*. It is a perennial species and has other name *Eupatorium odoratum* L., *E. Conyzoides* Vahl and *Osmia odorata* (L.) Schultz-Bip (Hanum and Maesen, 1997). In Indonesia it is known with name Kirinyu or Babanjaran (Tjitrosoedirdjo *et al*., 2002 and Sipayung *et al*., 2002). *Chromolaena* grows very aggressive and has ability to intensive sprouting that can change of botanical composition, reduce of pasture quality and cause toxic to animals. Our previous study records that reduction of pasture area due to *Chromolaena* invasion ranged 8-15% a year depending on grazing intensity. It becomes a serious species with no redeeming feature and causes poor and low calving rates of local cattle.

To maintan pastureland and eradicate *Chromolaena*, an alternative management has been studied in this experiment to utilize its biomass as mulch material, rather than eradicating with chemical agent (because it is harmful to animals). From chemical composition view point of *Chromolaena* indicated high quality of mulch material, because rate of decomposition and nutrient mineralization is affected by both nutrient content and chemical composition of the plant material (Abdullah, 2001; Bossuyt *et al*. (2001); Breland (1997). *Chromolaena* has a relatively high quality as compared to other weed species. It's leaves have a lower C/N ratio (25.8%) and C/P ratio (395), lower lignin (13.1%), ADF (53.3%) and cellulose (40.2%) content than common pastoral weed species (Abdullah, 2001).

Base on its chemical composition, it is expected that amendment of *Chromolaena* as mulch material (organic nutrient) can supply nutrient into soil slowly, through decomposition process and mineralization. The presence of fungi and bacteria in soil cause the major chemical transformations in decomposition, e.g. the degradation of polysaccharide complexes of plant litter to carbon dioxide, and mineralization of protein to ammonium and nitrogen and organic phosphorus to inorganic P. The soil microorganism activities in soil during decomposition are strongly influenced by soil moisture content (Taylor *et al*., 1999), litter type and fertilizer (Donnison *et al*., 2000), and temperature (Grisi *et al*., 1998)

The objective of the experiment were to recognize the effect of *Chromolaena* biomass compared with conventional fertilizer (manure and inorganic fertilizer) on *Brachiaria humidicola* (signal grass) growth, dry matter production and calculated carrying capacity, and to investigate the contribution of *Chromolaena* amendment ability to compensate inorganic fertilizer.

MATERIALS AND METHODS

The field experiment was conducted in 2004 in research station of Grassland Science Division, Faculty of Animal Science, Bogor Agricultural University (IPB). The site has two seasons, the rainy season with seven to eight consecutive wet months and the dry season up to four consecutive dry months. The average monthly rainfall during experiment was 364 mm $month^{-1}$ (4375 mm $year^{-1}$). The highest rainfall intensity was on April with 639 mm (25 days) and the lowest rainfall intensity was on June (169 mm, 8 days) as reported by Abdullah (2009).

Signal Grass Plots

Experimental plots were formerly used by Abdullah (2009) for one year before current experiment. There was no agronomical treatment before the plots used in the experiment. Signal grass had well established and produced 594.9 g/plot/harvest or 2092 g/plot/year (3487 kg/ha/year). The plots were made by marking each border of plots, and separated with bare area (50 cm). Before application of fertilizer, signal grass was trimmed to avoid physiological effect of grass individual.

Mulch Material and Manure Preparation

Chromolaena biomass (before flowering stage) collection was according to Abdullah (2009), originated from pasture area that invaded grazing area of university grassland. The collected biomass was chopped with 10 cm length before application. The amount of biomass as mulch material (consisting of all above ground biomass) applied on each plot was 12 ton fresh weight/ha (3 folds of potential biomass production of *Chromolaena*. This amount of applied biomass contributed to 398 kg N/ha and 186 kg P/ha. According to laboratory analysis, nitrogen and phosphorus content of *Chromolaena* biomass were 3.32% and 0.16%, respectively. Based on those calculations, the amount of biomass applied on each plot was 7.2 kg fresh weight/plot

Nitrogen and phosphorus content of manure were analyzed before application. The N and P content of the manure were 1.13% and 0.37% (Abdullah, 2009). Manure was collected from university farm. The manure originated from manure produced by 1.5 animal units (this animal numbers was accordingly the carrying capacity of signal grass pasture each ha/year). The amount of applied manure was 4 folds of manure production (54,750 kg fresh weight/ha or 21 kg fresh weight/ha). This amount of manure contributed to about 618 kg N/ha and 130 kg P/ha. Based on this calculation, for combination treatment, the amount of both *Chromolaena* and manure were a half of single treatment dosage 3.6 kg/plot and *Chromolaena* 10.5 kg/plot.

The Inorganic fertilizers used in the experiment were urea (45% N) and SP-36 (36% P_2O_5). The dosage of applied urea and SP-36 was based on N and P supply contributed from both *Chromolaena* and manure i.e.: 895.6 kg urea/ha and 361.1 kg SP-36/ha (537.3 g/plot and 217 g/plot, respectively).

Mulch and Fertilizer Application

Mulch and manure were applied (5 cm thick) directly on the top of trimmed signal grass according to experimental design. Urea and SP-36 were applied using broadcast method on trimmed grass surface. A half dosage was applied at the beginning of experiment and other half dosage was applied prior to dry season.

Parameters Observations

During growing, signal grass was taken care. Some parameters including number and length of stolon (primer and secondary stolon), tiller number and tillering rate were measured every two weeks. To enable measuring stolon length and counting tiller numbers at certain grass individual, observed individual of grasses were marked by using different color of pennant. Primer stolons were main stolon that grew directly from main crown and produced tillers (daughter tiller) at their nodes. Secondary stolons were branches of stolon that grew from daughter tillers and produced granddaughter tillers from their nodes Tiller numbers consisting of daughter and granddaughter tillers were calculated from plots every two weeks. Tillering rate was ratio of granddaughter tiller number to daughter tiller number resulted within a week.

Dry matter production was investigated every harvesting time. Sample of dry forage was analyzed to recognize the N and P content of the forage. Forage was harvest every 60 days, and dry matter production was accumulated according to seasons (dry season and rainy season).

Experimental Design

The fertilizer sources, which were used as treatments, originated from *Chromolaena* biomass, manure (cow manure) and inorganic N and P fertilizer (Urea and SP-36). The experimental design used in this study was block randomized design, consisting of: PO = blank control, P*C* = *Chromolaena* biomass (7,2 kg fresh weight/plot), PF = manure (21 kg fresh weight/plot)**,** P*C*+F = combination of *Chromolaena* biomass (3,6 kg fresh weight/plot) and manure (10,5 kg fresh weight/plot), Pi = inorganic fertilizer (urea 537,3 g/plot and SP-36 217 g/plot) as an positive control. Each treatment was repeated 4 times, so that the number of experimental plots was 20 plots. Collected data were analyzed using analyses of variance, and significant differences of average data on each treatment were tested with orthogonal contrast (Steel and Torrie, 1991), and compared with blank control and positive control.

RESULTS AND DISCUSSION

Effect of Fertilizer on Stolon and Till Growth

Application of *Chromolaena* as mulch material and manure as single treatment and their combinations significantly increased primer stolon number ($P<0,01$), secondary stolon number, daughter tiller and length of stolon, length rate of primer stolon ($p<0.05$) as compared with blank control (Table 1). However fertilizer application did not significantly affect grand daughter tiller number, tillering rate and length of secondary stolon. Application of either *Chromolaena* or manure as single treatment and their combination significantly doubled primer stolon comparable to blank control. However, combination of both *Chromolaena* and manure resulted in lower stolon number than those of plot applied with *Chromolaena* or manure as single nutrient source. Different from primer stolon, application of *Chromolaena* and manure did not affect secondary stolon number, but application of inorganic fertilizer resulted in highest stolon number.

Table 1. Effect of different nutrient sources on stolon and tiller growth of signal grass

Parameters	Fertilizer application				
	PO	P*C*	PF	P*C*+F	Pi
Primer stolon number (stolon/plot)	2.3[d]	5.5[b]	5.2[b]	4.9[c]	13.7[a]
Secondary stolon number (stolon/plot)	0[b]	1[b]	0.8[b]	0.3[b]	3[a]
Daughter tiller number (tillers/plot)	0.75[b]	8.62[a]	9,28[a]	8.97[a]	7.59[a]
Granddaughter tiller no. (tillers/plot)	0	1.75	0.77	0.25	0.74
Tillering Rate (no./week)	0	0.18	0.07	0.02	0.22
Length of stolon (cm/week)	5.8[c]	20.3[a]	17.2[a]	14.7[b]	20.3[a]
Length rate of primer stolon (cm/week)	0[c]	7.5[a]	3.2[b]	3.3[b]	6.9[a]
Length rate of secondary stolon (cm/week)	2.07	2.53	2.61	2.71	2.70

Note: PO = blank control, PC = *Chromolaena* amendment, PF = manure application, PC+F = combination of Chromolaena and manure, Pi = inorganic fertilizer.

Table 2. Effect of different nutrient sources on dry matter production of signal grass and ruminant carrying capacity

Parameters	Fertilizer application				
	PO	PC	PF	PC+F	Pi
Average DM production in rainy season (g/plot)	512[d]	1224[b]	1024[c]	1046[c]	2034[a]
Average DM production in dry season (g/plot)	282[d]	422[c]	495[b]	443[c]	738[a]
Cumulative DM production (kg/ha/year)*	3043[d]	6857 [b]	5973[c]	5997 [c]	11457 [a]
Calculated animal carrying capacity (ST/ha/year)*	1.3 [c]	3.0 [b]	2.6 [b]	2.6 [b]	5.0 [a]

Note: PO = blank control, PC = *Chromolaena* amendment, PF = manure application, PC+F = combination of Chromolaena and manure, Pi = inorganic fertilizer.

Application of *Chromolaena* or manure and their combination resulted in significant higher tiller number of daughter (8-9 folds) and length of stolon as compared with control, but has no different tiller number of daughter as compared with inorganic fertilizer (Table 1). However combination of *Chromolaena* and manure resulted in lower length of stolon than those of other three fertilizer application. *Chromolaena* and manure application was able to substitute 35%-39% the use of inorganic fertilizer to result in a same number of grass stolon.

Forage Production

As depicted in Table 2, amendment of *Chromolaena*, manure and their combination as nutrient sources for the grass improved respectively about 139% and 100% of average DM production during rainy season. Application of inorganic fertilizer resulted in the highest average DM production. It is shown in Table 2, that *Chromolaena* application resulted in higher DM production than those of either manure or combined fertilizer.

During dry season, grass production reduced drastically, in particular grasses that grew on the plots fertilized with *Chromolaena* biomass and inorganic fertilizer. It may be caused that *Chromolaena* and inorganic fertilizer can supply faster inorganic nutrient than manure and combined fertilizer. This was approved by research results of our previous study finding that *Chromolaena* was the fastest degradable materials and very fast recovery of mineralization, that indicate fast release and fast supply of organic nutrients.

Application of *Chromolaena* resulted in higher DM production ($p<0.05$), as well as combination of Chromolaena and manure. Application of manure as single fertilizer led to produce higher grass production than those of *Chromolaena* or combined nutrient sources. Application of inorganic nutrient resulted in the highest grass production.

Cumulative grass production was signify-cantly influenced ($p<0.01$) by *Chromolaena* amendment, manure application and inorganic fertilizer. Application of *Chromolaena* doubled cumulative grass production, and manure and combined fertilizer application as well. Application of inorganic fertilizer resulted in the highest cumulative DM production of signal grass. Application of organic nutrient sources can only reach a half of grass production comparable to inorganic nutrient sources.

Carrying capacity is the capability of area that can supply forage for animals throughout a year without causing destruction of the pasture area. The carrying capacity was calculated and based on cumulative dry matter production of the grass and converted to one ha. It is assumed that animal consumes 6.29 kg DM of grass/day/head (Indonesian condition). Application of organic nutrient sources originating from *Chromolaena*, manure and their combination significantly increased 1.3-1.7 animal units. Application of inorganic fertilizer increased carrying capacity about 3.7 animal units.

Amendment of *Chromolaena* biomass into soil improves nutrient supply 32 days after application (Abdullah, 2002). Our results confirmed this finding, and showed that amendment of *Chromolaena* biomass at the beginning of application led to immobilization of released nutrient by soil microorganisms. This was indicated by yellow leaves of signal grass at the beginning of application, but then the grass grew better and leaves showed green.

Increased tiller number and dry matter production was associated with increase of stolon number and stolon length. Application of fertilizer gave more chance to grass to extent their solons. There was a tendency that application of combine organic fertilizers (*Chromolaena* and manure) led to slower growth than application of them as single treatment. In general, it can be mentioned that application of *Chromolaena* as mulch material resulted in better growth performance of signal grass.

CONCLUSIONS

Amendment of biomass originated from *Chromolaena* and manure and their combination improved signal grass growth, production and carrying capacity and could substitute about 50% of chemical fertilizer (urea and SP-36). Use of *Chromolaena* may be an alternative pasture management to sustain quality and production of signal grass pasture.

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