Evaluation of Fresh Biomass Yield and the Green Manure Potential of Some Forage Legume Species for adoption into the Farming Systems in Borno State II.

Dr. Bashir Ali Abubakar

Department of Crop Production Technology
School of Agricultural Technology
The Federal Polytechnic Bali, Taraba State
Correspondence e-mail: bashimran23@gmail.com

Abstract

Fresh biomass herbage from forage legume plants is a source of soil organic matter and quality animal feed if used as green manure or in livestock feeding. A pot experiment was conducted in 2013 at the screen house, faculty of Agriculture, University of Maiduguri, to evaluate the fresh biomass yield and the green manure potentials of some forage legume species. The experiment consisted of eight plants-Mucuna pruriens white (T_2), Stylosanthesis guinensis (T_3), Cajanus cajan brown (T_5), Cajanus cajan igbonbu white (T_7), Centrosema pubescens (T_9) Lablab purpereus white (T_{11}), Lablab purpereus black (T_{12}) and Sesbania rostrata Limanti (T_{15}). The plants were grown in plastic pots and at six weeks after sowing, these were harvested, the fresh weights and NPK contents were measured. The result showed that the forage plants richest in NPK were Sesbania rostrata Limanti (T_{15}), Cajanus cajan igbonbu white (T_7), Lablab purpereus black (T_{12}) and Centrosema pubescens (T_9) with 8.45, 8.33, 7.17 and 7.00 % respectively. The highest biomass yields of 23.33, 14.4, 14.0 and 11.3 grams/pot were recorded under Mucuna pruriens white (T_2), Lablab purpereus white (T_{11}), Sesbania rostrata Limanti (T_{15}) and Lablab purpereus black (T_{12}) respctively. Others produced lower biomass yields with 7.3, 5.3, 5.0 and 2.8 g/pot were Cajanus cajan brown (T_5), Cajanus cajan igbonbu white (T_7), Centrosema pubescens (T_9) and Stylosanthesis guinensis (T_3) respectively. The best four biomass yielders were T_2 (23.33), T_{11} (14.4), T_{15} (14.0) and T_{12} (11.3 g/pot). Based on their biomass yields, these four latter forage plants were recommended for adoption in the farming systems of Borno State.

Keywords: **Green Manure, Forage Legume, Biomass.**

I. Introduction

Agricultural productivity in the semi-arid environment (SAE) is the lowest in the world and is manifested in both animal and crop production sectors. Yields of most staple food crops were less than one ton/hectare, far below their potential yields of 2 - 4 tons/ha (Yakubu et al., 2010). Likewise African livestock productivity put at meat (kg) 79 and 6.5 for cattle and sheep/goat respectively in the developed countries and only 14 and 3.7 for Africa. Milk productivity was also the lowest at 360 kg/cow/lactation in Africa compared to 3,130 in the developed countries (ILCA, 1989). Further, in Nigeria average milk yield in the traditional low-input systems is 6 litres/cow/day compared to average yield of purebred Friesian cow in a commercial system is 30 litres/cow/day (FMARD, 2011).

The low agricultural productivity prevailing in the SAE can be attributed to climatic, edaphic and anthropogenic factors. The effects of these factors on farming were treated by other workers (Brady and

Weil, 2002; Yusuf and Yusuf, 2008). But it is agriculturally worthy to note that the drier climate in this agro-ecological zone has reduced agricultural biodiversity. Agricultural biodiversity refer to the variety and variability of animals, plants and microorganisms on earth that are important to food and agriculture (FAO, 2019). This phenomenon of low biodiversity has definitely reduced both the provision of vegetative cover for the land and fodder for livestock feed.

Therefore, considering the scarcity of mineral fertilizers which are necessary to build up soil productivity, coupled with the acute shortage of forage for grazing livestock in the zone, there is need to explore the immense benefits offered by the use of "high biomass yielding and nutrient-fixing forage legumes (Skerman et al., 1988), which abound in northern Nigeria. Biomass is the sum total of the plant components above and below the soil line which affects soil productivity (Kusvuran et al., 2015). Tropical forage legumes consist of a variety of herbaceous and woody plants selected from undomesticated and cultivated legume species (CIAT, 2019). Researchers at the International Centre for Agriculture in the Tropics-CIAT (2019) reported that forage species had multiple uses in the low input farming systems of the tropics. These uses include - restoration of soil fertility of degraded agricultural land; provision of high quality livestock feed, and high potential for carbon sequestration – second only to forests.

Carbon sequestration is the process of capture and storage of carbon dioxide (CO_2) to mitigate dangerous climate change (Agroforestry, 2015). Forage legume plants are excellent green manures while providing vegetative cover for agricultural land against soil erosion. And provide high quality feed to improve ruminant livestock production. Green manure is a plant purposely planted to be incorporated into the soil while still green to improve soil productivity (Bashir, 2019).The objectives of the present study were to evaluate 8 leguminous forage species for their fresh biomass yields and their NPK contents, and to recommend the best four biomass yielders for adoption in the farming systems of Borno State.

II. Materials and Methods

Seeds of the Forage Legume Species

Seeds of best-bet green manure species (Mureithi, 2016) were collected from the National Animal Production Research Institute –NAPRI Shika, Ahmadu Bello University Zaria. These were *Mucuna pruriens* white (T_2), Stylosanthesis guinensis (T_3), Cajanus cajan brown (T_5), Centrosema pubescens (T_9), Lablab purpereus white (T_{11}) and Lablab purpereus black (T_{12}). Similar best-bet leguminous forage species were collected from the Federal University of Agriculture Makurdi, Benue state. There was *Cajanus cajan* Igbonbu white (T_7). Other collection from fields in a local government around Maiduguri (Konduga) was the undomesticated species of the well-known green manure *Sesbania rostrata Limanti (T_{15}). Seeds of Pearl Millet variety 9702 were obtained from Lake Chad Research Institute, Maiduguri, as the test crop.*

Experiment.

A pot experiment was conducted in 2013 at the Screen house, Faculty of Agriculture, University of Maiduguri. The treatments consisted of 8 forage legume plants. The treatments were replicated three times and arranged in a completely randomized design. Topsoil (0-20 cm) was collected from a fallow land in

the University of Maiduguri Farm, air-dried and sieved through a 2-mm screen. 27 plastic buckets were perforated at the bottom with five holes for easy drainage. Three kilograms of the soil were placed in each plastic pot. Seeds that were known to exhibit dormancy, especially *S. rostrata* were soaked in boiled water for one minute and air-dried 24 hours before sowing. Four seeds were sown per pot, and seedlings were thinned down to two per pot a week after emergence.

At six weeks after sowing, the plants were harvested by cutting the shoots at soil surface level and the roots were removed separately and washed with distilled water and fresh weights measured The N, P and K contents in the forage plant materials were determined using the single acid digestion method as described by Marr and Cresser (1983). N–the determination of nitrogen was by macro-kjeldahl method (%) and then titrated with 0.01N HCL acid. P–colorimetric determination of phosphorus in plant was done using vanado-molybdate(yellow) method. K– Determination of potassium was done by flame photometric method.

III. Results and Discussion

The result for macronutrients content of the forage plants was presented in table 1. It showed that *Sesbania rostrata* Limanti accumulated the highest NPK content (8.45 %), and the result was at par with that of *Cajanus cajan* Igbonbu white (8.33 %), Lablab purpereus black (7.17 %) and Centrosema p (7.00 %). The result also showed that Mucuna pruriens white, *Stylosanthesis guinensis*, *Lablab* purpereus black and *Cajanus cajan* brown contained comparatively lower but substantial % NPK of 5.64, 6.53, 6.60 and 6.87 respectively. Adesoji et al. (2014) reported lower result (4.39 – 5.31 % NPK) in green manure plants in Samaru Zaria than the present study, with *Mucuna pruriens* containing the lowest % NPK.

The average NPK percent for the plants in the experiment was (7.0%), while average NPK analysis of farmyard manure (TNAU, 2016) was a meagre 1.15 % (0.6% N, 0.09% P and 0.46% K). As depicted in Fig. 1, four of the forage plants had above average NPK contents. It might be deduced from fig. 2 the average NPK content of legume plants in the experiment (7.0 %) was 508 % higher than the NPK analysis of Farmyard Manure- FYM (1.15 %). These plants might probably enrich the soil when used as green manure. Sullivan (2003) concurred that N, P, K, Ca, Mg, S and other essential nutrients are accumulated by forage legumes when used as green manure during a growing season.

The result for fresh biomass production by the forage legume plants was also presented in Table 1. Mucuna pruriens white, Lablab purpereus white, Sesbania rostrata Limanti and Lablab purpereus black produced the highest biomass weights of 23.3, 14.4, 14.0 and 11.3 g/pot respectively. The lowest biomass of 2.8, 5.0, 5.3 and 7.3 were yielded by Stylosanthesis guinensis Zaria, Centrosema pubescens Zaria, Cajanus cajan Igbonbu and Cajanus cajan brown respectively. Similar result trends were observed by FAO (2011). DPI (-) also reported result of trials where Mucana and Lablab produced higher biomass than Soybean and Cowpea forages. Kusvuran et al. (2015) defined biomass as the sum total of the plant components above and below the soil line and is an important concept, which directly affects soil productivity.

Table 1. Fresh Biomass Yield and NPK Contents of 6 weeks old Leguminous Forage Plants in pot experiment, 2013.

Plant	Biomass yield g/pot	Macronutrients content (%) in plants			
		% N	% P	% K	Combined NPK(%)
Mucuna pruriens white Zaria(T_2)	23.3^{ab}	3.06^{def}	0.12^{a}	2.46^{cd}	5.64
Stylosanthesis guinensis Zaria(T_3)	2.8^{f}	4.30^{abc}	0.07^{b}	2.16^{d}	6.53
Cajanus cajan, brown Zaria(T_5)	7.8^{e}	3.36^{bcdef}	0.08^{b}	3.43^{bc}	6.87
Cajanus cajan, (Igbonbu white) Benue (T_7)	5.3^{ef}	4.13^{bc}	0.09^{b}	4.11^{ab}	8.33
Centrosema pubescens, Zaria(T_9)	5.0^{ef}	2.85^{df}	0.09^{b}	4.06^{ab}	7.00
Lablab purperium White Zaria(T_{11})	14.4^{cd}	2.64^{f}	0.09^{b}	3.87^{ab}	6.60
Lablab purperium black Zaria (T_{12})	11.3^{d}	4.03^{abc}	0.09^{b}	3.05^{bcd}	7.17
Sesbania rostrata, Limanti(T_{15})	14.2^{cd}	4.13^{abcd}	0.09^{b}	4.23^{a}	8.45
Pearl Millet var. 9702(T_{19})	10.0	1.75	0.10	4.48	6.33
S. E.	1.692	0.55	0.013	0.56	-

The average biomass weight for all the plants in the experiment was a high 10 g/pot. As depicted in Fig 1, four of the plants (T_2, T_{11}, T_{15} and T_{12}) yielded above average biomass weights. Under most farming practices in northern Nigeria, peasants remove crop residues from the farm, while stray livestock overgraze the vegetation cover exposing the land to erosion. These combined anthropogenic forces cause land degradation and shortage of animal feed in the dry season. The International Centre for Agriculture in the Tropics-CIAT (2019) reported that forage species had multiple uses in the low-input farming systems of the tropics. These include –restoration of soil fertility of degraded land, provision of high quality livestock feed, and a high potential for carbon sequestration – second only to forests.

The fresh herbage from forage legumes might probably be an environmentally friendly source of organic manure and high quality animal feed. Sullivan (2003) concurred that fresh biomass from forages is the source of organic matter and animal feed. The contribution of organic matter to the soil from a good growth of green manure is comparable to the addition of 20 to 25 tons/hectare of Farmyard Manure (Sullivan, 2003). In animal husbandry; especially dairy and milk production, fresh and sufficient herbage is an indispensable feeding resource. Recent study by CIAT (2019) showed that adoption of forage legume feeding by farmers raised milk yield by 40 % in Africa and reduced the time it takes cattle to mature from 4 years to 20 months in the Brazilian livestock sector.

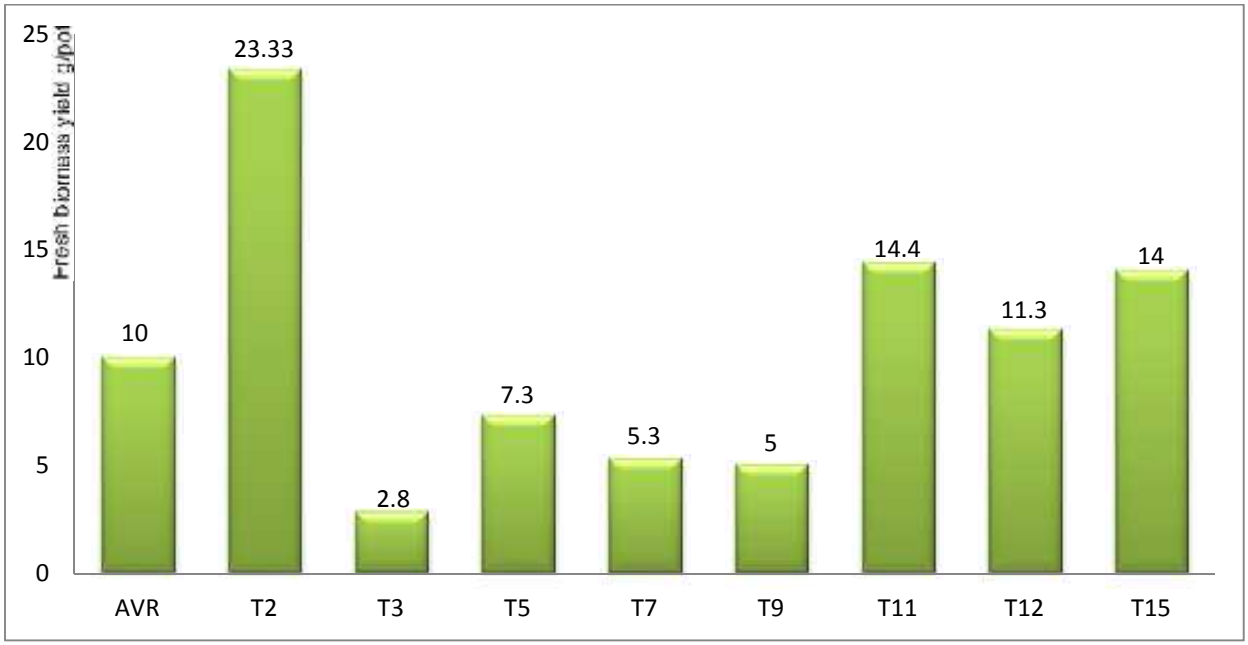

Fig. 1 Comparison of species' biomass weights (for key to T_1 to T_{17} See Table 1)

Capstaff and Miller (2018) emphasized that the most important criteria or trait to assess the performance of any forage crop is rapid biomass production, which depends on the species grown. The ranking of the species according to biomass yields were as follows: Mucuna pruriens white>Lablab purpereus white>Sesbania rostrata Limanti>Lablab purpereus black>Cajanus cajan brown>Cajanus cajan igbonbu white> Centrosema pubescens >Stylosanthesis guianensis.

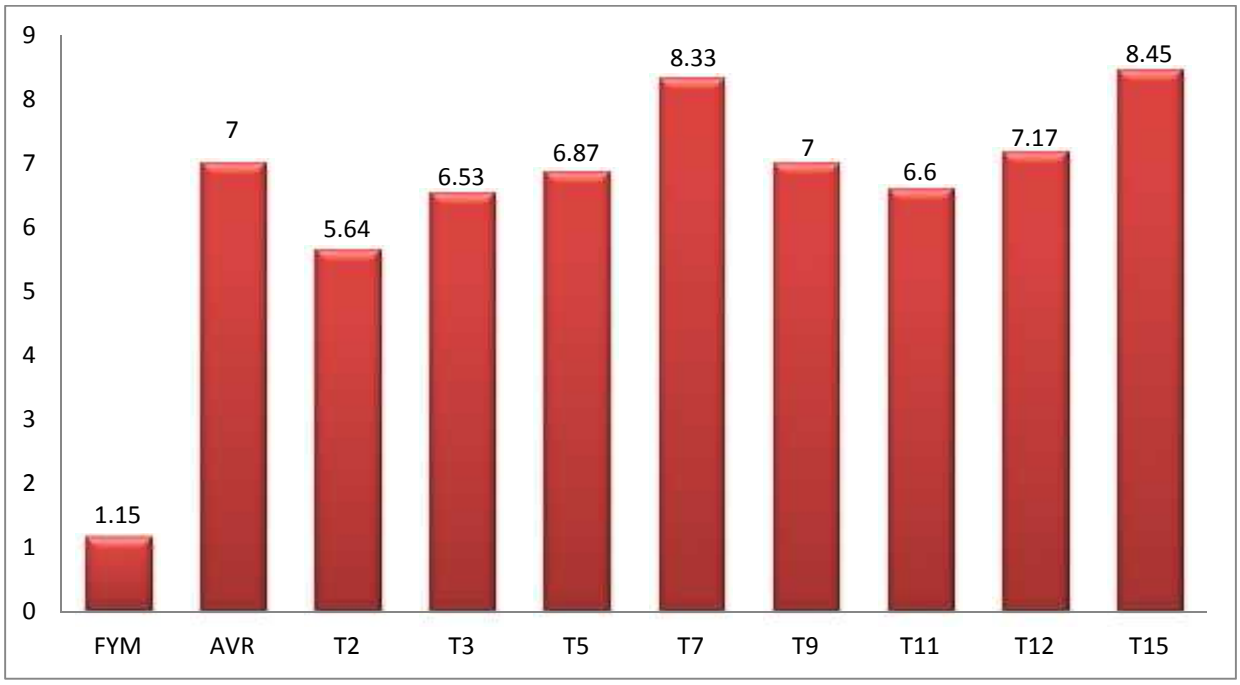

Fig. 2 Comparison of species (%) NPK with FYM (key to T_1 to T_{17} See Table 2)

IV. Conclusion

In the experiment, the forage legume plants richest in NPK contents were Sesbania rostrata Limanti (8.45 %), Cajanus cajan brown (8.33 %), Lablab purpereus white (7.17 %) and Centrosema pubescens (7.00 %). While the best biomass yields (the most important criterion in green manure/forage legume selection) were recorded in *Mucuna pruriens* white, *Sesbania rosrata* Limanti, Lablab purpereus white and Lablab purpereus black. *Recommendation* these four best biomass yielders were recommended for adoption into the farming systems of Borno State. They can provide essential nutrients to livestock and contribute in enriching the soil if used as green manure.

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