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COMPARTIBILITY BETWEEN *Panicum mombasa* GRASS AND FIVE LEGUME FORAGES

Mohammed Baba[1*], Aminu Sani Ayuba and Inuwa Bello[2]
[1]Department of Animal science, Bayero University Kano; [2]Agronomy Department, Ahmadu bello University Kano, Nigeria*

**Corresponding author:* - babamuhammad01@yahoo.com

The experiment evaluated monocultures of *Panicum mombasa, Stylosanthese hamata, Stylosanthese guianensis, Centrosema pubescens, Centrosema pascourum and Alysicarpus vaginalis* and mixtures of panicum with each of the legumes in a 2:2 sowing ratio to determine the nature of competition among the species. Competition indices analyzed included Relative yield (RY), relative yield total (RYT), relative crowding coefficient (k) and aggressivity index (AI). The experimental design is a randomized complete block design consisting 11 treatments replicated in four blocks. Each plot size measured 1× 1 m^2 while distances between plots and blocks were 0.5 m and 1 m respectively. Results of the study indicated no significant differences (P>0.05) among the parameters measured. However *Centrosema pascuorum* had numerically higher yield (1403.3 kg/ha) than other monocultures of grass and legumes. Mixtures were also not significantly different but *Panicum mombasa-Centrosema pascourum* mixture tended to produce numerically higher yield than other mixtures (1973.3 kg/ha). Total relative yield values of all mixtures albeit not significantly different were observed to be greater than unity suggestive of advantage of mixture over monoculture. Relative crowding coefficient of *Centrosema pascuorum* was numerically the highest (0.8932) among legumes in mixtures. It was concluded *that Panicum Mombasa-Centrosema pascourum* mixture was the mixture of choice based on its relatively higher dry matter yield and competitive ability of the companion legume among other legumes in mixture.

Keywords: Dry matter, Relative yield, Relative crowding coefficient, Aggressively index

Livestock production is a dominant farming enterprise in the semi-arid and arid regions of Africa. However, livestock keeping in these regions is limited by the availability of grazing resources in terms of quantity and quality during the dry season occasioned by cyclical variation in weather and climate. Sabiiti (1992) reported that during the dry season in Nigeria crude proten content of forages declines to as low as 3% which is below the critical level of 7% recommended by NRC for efficient rumen function (Minson,1982). This limits feed intake and digestibility with attendant low animal productivity.

One way of improving the grazing resources of natural pastures is to integrate forage legumes into the pastures, with the aim of increasing species diversity and at the same time increasing the amount of protein available for the grazing animals as well as increasing nitrogen uptake by associated forage grass (Macharia, 2003). Grasses generally have lower crude protein (CP) compared to legumes, the CP content gets even lower below the level that can sustain animal production, hence the need for intercropping with forage legumes. In recent years, the use of forage legumes in livestock production systems for ruminants in the tropics has increased with benefits such as serving as cover crop for the control of erosion, conversion of atmospheric nitrogen to forms of nitrogen which plants can take up and recycle within the plant-animal-soil system (Tarawali, 1991; Said and Tolera, 1993; Humphreys, 1995). Forage legumes can be grazed, harvested and fed fresh or stored as hay or silage (Harricharan *et al*., 1983). A better way to improve the feeding value of tropical pastures especially for the poor resource small holders is through intercropping the grasses with forage legumes. Owing to the fact that use of fertilizers to improve forage yield and utilization of commercial concentrates as livestock supplements are limited due to inability of farmers to purchase them (Sodeinde *et al*., 2006).The importance of forage legumes in increasing herbage production from grasses and enhancing the quality of feed produced has been recognized (Muinga *et al*., 2007). Legumes benefit grasses by contributing nitrogen to the soil through atmospheric fixation, decay of dead root nodules or mineralization of shed leaves (Aderinola, 2007).

Intercropping forage legume with grasses has been reported to increase forage dry matter yield, forage quality in term of crude protein content, voluntary feed intake and digestibility (Aderinola, 2007). Legume grown with grasses offer several advantages over grasses grown alone. Alalade *et al*., (2012) reported that inclusion of legumes in pastures usually results in increased herbage yield, higher quality and improved seasonal distribution of forage. Legume-grass mixtures have reduced weed encroachment and erosion and have led to greater stand longevity than legume or grass monoculture (Akinlade *et al*., 2003).

However, the realization of some of the benefits above conferred by intercropping will very much depend on compatibility between the components species in the mixture. Several indices, such as relative yield (RY), relative crowding coefficient (RCC), and aggressivity index (AI), have been used to analyze competition in intercropping (Banik *et al*., 2000; Ghosh, 2004; Midya *et al*., 2005). RY shows the advantage of mixture compared to monocultures in terms of utilization of resources; RCC indicates the competitive ability of one crop relative to another while AI gives a measure of aggressor and aggressee in a competition between two crops.the objective of the research was to determine the nature of competition between *Panicum mombasa* and five (5) legumes (*Stylosanthes hamata, Stylosanthes guianensis, Centrosema pascourum, Centrosema pubescence and Alysicarpus vaginalis*)

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Livestock Teaching and Research farm of the Faculty of Agriculture, Bayero University Kano. Kano lies between latitude 9° 31´ and 12° 30´ North, longitude 9° 30´ and 8° 42´ East in the Sudan Savannah ecological zone of Nigeria. Mean annual temperature ranges from 21°C to 39°C while annual rainfall from 500 mm to 1000 mm (Knarda, 2001).

Treatments and Experimental Design

The treatments consisted of monocultures of *Panicum Mombasa, Stylosanthes guiniensis, Stylosanthes hamata, Centrosema pubescence, Centrosema pascourum, Alysicarpus vaginalis* and mixtures of *Panicum mombasa* with each legume at 2:2 sowing ratio. There were eleven (11) treatments replicated in four blocks in a randomized complete block design.

Land Preparation and Field Culture

The land was ploughed, harrowed and demarcated into plots of 1 × 1m^2 size; legume seeds were scarified using hot water at 80°C for 5 minutes to break seed dormancy in order to improve germination and enhance establishment (Baba *et al.*, 2011). Seeds were purchased from National Animal Production Research Institute (NAPRI) Shika, Zaria. Ten seeds of each species were sown during the rainy season of year 2016. The seeds were sown in shallow holes of 2 cm depth dug at the four corners of each plot at a distance of 0.25m from the plot margins. Seedlings were later trimmed to 3 per sowing hole.

Weeding and fertilizer application

Weeding was done as and when required. Fertilizer NPK was applied to grass monoculture at a basal rate of 50 kg NPK/ha while P and K fertilizer were applied at a basal rate of 50 kg P K/ha to sole legume and grass–legume mixtures. Fertilizer N was obtain from urea while P and K from single super phosphate and muriate of potash respectively

Harvesting was carried out just before flowering of *Panicum mombasa* and the fallowing parameters were measured.

- Dry matter yield was measured by harvesting the material at a stubble height of 5cm to the ground fresh weights were taken. The materials were oven dried at 65°C for 72 hrs to obtain the dry yield
- Leaf area meter model YMJ – A was used to measure leaf area.
- Competition indices such as relative yield, relative crowding coefficient and aggressivity index were calculated using the formula below

Calculations of Competition Indices

Relative yield (RY) shows the degree to which different species in a mixture share common resources.

Relative yield grass (RYG) = DMYGL/DMYGG ---------- 1

Relative yield legume (RYL) = DMYLG/DMYLL---------- 2 (Ghosh *et. al.*, 2006)

Total relative yield (TRY) = summation of formula 1 and 2

Relative crowding coefficient (RCC) is the relative competitive ability of one species over the other (De Wit, 1960).

RCCGL=DMYGL/(DMYGG – DMYGL)

RCCLG=DMYLG/(DMYLL – DMYLG)

Aggressivity index (AI) is use to show the aggressor and aggressee in a relationship between two species (McGilchrist, 1965; McGilchrist and Trenbath, 1971).

AIGL=(DMYGL/DMYGG) – (DMYLG/DMYLL)

AILG=(DMYLG/DMYLL) – (DMYGL/DMYGG)

Where:

G = grass

L = legume

DMYGL is dry matter yield of grass grown in mixture with legume and

DMYGG means dry matter yield of grass grown as sole

DMYLL means dry matter yield of legume grown as sole

DMYLG means dry matter yield of legume grown in mixture with grass (De Wit, 1960).

Data Analysis

Data collected were analyzed by ANOVA Using SAS (Version 9.2, 2009), differences among means were separated using Duncan's multiple range test (DMRT).

RESULTS

The dry matter yield values for grass and legume monocultures are shown in Table 1. Monocultures of grasses and legumes were not significantly different, however in absolute terms *Centrosema pascourum* had the highest dry matter yield (1403.30 kg/ha) while *Stylosanthes hamata* had the least (390 kg/ha). The dry matter yield values were in the order *Centrosema pascourum* > *Panicum mombasa*> *Stylosanthes guianensis*> *Alysicarpus vaginalis*> *Centrosema pubsescens*> *Stylosanthes hamata*.

Dry matter yields of grass and legumes in mixtures were not significantly different (Table 2), similarly for total dry matter yield of mixtures, however grass in mixture with *Centrosema pascourum* produced the highest yield in absolute terms (1366.7 kg/ha) while the grass in grass *Alysicarpus vaginalis* mixture recorded the least dry

Table 1: Dry matter yield of grass and legumes (kg/ha) monocultures

Treatment	**DMYG**	**DMYL**	**TDMY**
Mombasa	1356.7	-	1356.7
Hamata	-	390.0	390.0
Guianensis	-	820.0	820.0
Pascourum	-	1403.3	1403.3
Pubescence)	-	510.0	510.0
Alysicarpus	-	806.7	806.7
P value	0.9113	0.2550	0.5635

Table 2: Total dry matter yield of grass and legume grown in mixture

Treatment	DMYG	DMYL	TDMY
Mombasa- hamata	1066.7	143.3	1210.0
Mombasa-. guianensis	1290.0	353.3	1643.3
Mombasa-pascourum	1366.7	606.7	1973.3
mombasa –. pubescens	1353.3	463.3	1816.7
Mombasa- Alysicarpus	930.0	206.7	1136.7
P value	0.9113	0.2550	0.0324

Table 3: Leaf area of grass- legume mixture

Treatment	LAG	LAL
Mombasa- hamata	145.46	20.767
Mombasa- guianensis)	162.47	18.877
Mombasa- Pascourum	142.42	27.457
Mombasa –. Pubescence)	121.84	23.00
Mombasa- alysicarpus	147.40	17.750
P value	0.7047	0.5845

matter yield (930 kg/ha). In the case of legumes in mixture *Centrosema pascourum* was observed to produced numerically higher yield (606.70 kg/ha) while *Alysicarpus vaginalis* had the least (206.7 kgha). Comparatively, the total dry matter yields of mixture were in the order *Panicum mombasa - Centrosema pascourum > Panicum mombasa – Centrosema pubsescens> Panicum mombasa - Stylosanthes guianensis> Panicum mombasa – Stylosanthes hamata> Panicum mombasa - Alysicarpus vaginalis*.

Morphological Characteristics

Leaf area of grass in mixtures (Table 3) was observed to be the highest in absolute term in the *Panicum mombasa – Stylosanthes giuanensis* mixture (162.47) while that of legume was higher (P>0.05) in *Panicum mombasa - Centrosema pascourum* mixture (27.46).

Competition Index

Relative yield values for grass and legumes in mixtures were numerically highest (p>0.05) in *Panicum mombasa – Centrosema pubsescens* mixtures (1.11 and 1.69 respectively) same thing goes for total relative yield (2.79).

Relative crowding coefficient of grass in mixture was greatest in *Panicum mombasa – Stylosanthes hamata* (8.472) mixture followed by *Panicum mombasa - Alysicarpus vaginalis* (4.03), *Panicum mombasa - Centrosema pascourum* (1.80) and *Panicum mombasa – Stylosanthes giuanensis* (0.55).

In the case of legumes in mixtures with grass *Centrosema poscourum* had numerically the highest relative crowding coefficient.

Aggressivity Index

The grass in *Panicum mombasa – Stylosanthes hamata* (0.39), *Panicum mombasa - Centrosema pascourum* (0.53) and *Panicum mombasa - Alysicarpus vaginalis* recorded positive aggressivity

Index compared to their legume counterpart, in the case of legume *Stylosanthes giuanensis* and *Centrosema pubsescens* were more aggressive than their grass counterpart.

Table 4: Relative yield of grass- legume mixture

Treatment	RYG	RYL	TRY
Mombasa- hamata	0.7393[a]	0.3482	1.0875
Mombasa- guianensis	1.1000	1.2726	2.3726
Mombasa-.pascourum	0.9708	0.4402	1.4110
Mombasa -pubescence	1.1109	1.6968	2.7977
mombasa- alysicarpus	0.6892	0.3029	0.9921
P value	0.8484	0.3989	0.1628

Table 5: Relative crowding coefficient (K) of grass – legume mixture

Treatment	RCCG	RCCL
Mombasa- hamata	8.472	0.5703
Mombasa-guianensis	0.548	0.3087
mombasa- pascourum	1.802	0.8932
mombasa –pubescence	-2.938	-1.2325
mombasa- Alysicarpus	4.030	0.5077[a]
P value	0.3025	0.0452

Table 6: Aggressivity index of grass – legume mixture

Treatment	AIG	AIL
Mombasa- hamata	0.3911	-0.3911
Mombasa- guianensis	-0.1726	0.1726
Mombasa-. Pascourum	0.5305	-0.5305
Mombasa –Pubescence	-0.5759	0.5759
Mombasa-alysicarpus	0.3862	-0.3862
P value	0.8353	0.8353

DISCUSSION

Animal production is a function of pasture productivity. The relatively higher dry matter yield recorded by monoculture of *Centrosema pascourum* could be due to its climbing growth habit which might have enabled the plants to position itself towards the direction of solar radiation for optimum photosynthesis. The same explanation may hold for the performance of *Centrosema poscourum* in mixture with *Panicum mombasa.* In addition the seemingly higher ($p>0.05$) total dry matter yield recorded by the aforementioned mixture may be due to the numerically higher dry matter yields of *Centrosema pascourum* in comparison to other legumes. This might have translated in to higher nitrogen fixed by the legume via nitrogen fixation for the uptake of both the grass and legume. Lithourgidis and Dordas (2010) reported that cereal– legume intercropping may improve yield in a farm land area by making more efficient use of the available growth resources, in the same vein Zhou *et al.*, (2011) also reported increase biological activities in the soil. Moreover the contribution of both the *Mombasa* and *pascourum* in mixture were the highest compared to other legumes. From a physiological point of view, the seemingly higher (>0.05) leaf area recorded in *Centrosema pascourum* may have provided the legume with the added advantage of absorbing more solar radiation for photosynthesis hence the higher yield value.

Relative yield indicates the extent to which species in a mixture share common resources, all mixtures had relative yield total of above 1.0 suggesting advantage in having the mixtures than monoculture (Tessema and Baars, 2006) except *Panicum mombasa – Alysicarpus vaginalis* mixture which had close to 1.0 indicating that the species in this mixture shared resources equally.

It further buttressed the fact that one specie aided the growth of the other in the manner of the legume aiding the growth of grass through nitrogen fixation or better still, species may have been taking their resources from different layers of the soil thereby avoiding competition for soil resources altogether.

The higher relative crowding coefficient value recorded by *Panicum mombasa* in almost all mixtures may be explained in the context that *Panicum mombasa* was more competitive than the legumes. This could be due to its fibrous root system that absorbs water and nutrient faster from the soil coupled with it being a C4 plant with higher photosynthetic ability in warm climate.

Aggressivity index gives an indication of the aggressor and aggressee in a mixture. Species that have positive values are the aggressors while those with negative values are the aggresses. In this context *Panicum mombasa* displayed some degree of aggressiveness in the following mixtures *Panicum mombasa- Stylosanthes hamata, Panicum Mombasa- Centrosema pascourum* and *Alysicarpus vaginalis* whereas *Stylosanthes guianensis, and Centrosema pubescence* were found to be more aggressive than their counterpart grass

CONCLUSION

It can be concluded that *Panicum mombasa - Centrosema poscourum* gave numerically higher total dry matter yield among mixtures. This is not unexpected given the relatively higher yield of both grass and legume in the mixture and higher competitive ability of *Centrosema poscourum* as attested by its higher relative crowding coefficient value among legumes in mixtures.

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