



Dry matter yield and chemical composition of grass – legume mixtures as influenced by sowing date

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Abstract

The experiment was conducted to evaluate the effects of sowing date of grass on dry matter yield and chemical composition of three grass-legume mixtures (*Sorghum alnum-stylosanthese hamata*, *Sorghum alnum-Centrosema pascourum* and *Sorghum alnum-Centrosema pubescens*). The study was carried out at the Livestock Research Farm of the Faculty of Agriculture Bayero University Kano, Nigeria. Seeds of mixtures obtained from National Animal Production Research Institute Shika, Zaria were sown in $2 \times 3 \text{ m}^2$ plots in an alternate arrangement replicated in four blocks. Distances between plots and blocks were $0.5 \text{ m} \times 1 \text{ m}$, respectively. The treatments consisted of four sowing dates of grass in mixture with legumes (0, 1, 2 and 3 weeks after sowing of legumes) and three grass-legume mixtures factorially combined as 4×3 factorial in a randomized complete block design. The results indicated that cumulative total dry matter yield values were significantly greater ($P < 0.05$ in *Sorghum alnum-Centrosema pascourum* and *Sorghum alnum-Centrosema pubescens* compared to *Sorghum alnum-stylosanthese hamata*. *Sorghum alnum-Centrosema pascourum* and *Sorghum alnum-Centrosema pubescens* had similar crude protein values which were higher ($P < 0.05$) than that of *Sorghum alnum-stylosanthese hamata*. Similarly, neutral detergent fiber decreased with delayed sowing date of the grass in mixture. It can be concluded that *Sorghum alnum-Centrosema pascourum* and *Sorghum alnum-Centrosema pubescens* produced higher dry matter yields and proved better in quality indices. Hence, *Sorghum alnum-Centrosema pascourum* is recommended for higher yield and percentage of legume in mixture which is indicative of legume survival. Furthermore, sowing of grass 3 weeks after legumes in mixtures improved quality parameter and reduced fiber fractions (NDF and ADF) significantly. In the light of this, dates of sowing of grass and legume in mixtures should be staggered with the legume sown ahead of the grass.

Key words: Grass; legume; chemical composition; Fiber fractions; Sowing date

Introduction

One of the factors limiting livestock production and productivity is feed shortage in both quality and quantity especially during the dry and cool seasons (Volatsara, 2013). The feed shortage problem is made worse by soil degradation, high input cost and effects of climate (Vagen *et al.*, 2006). One sure alternative to alleviate the aforementioned constraint is the development of grass-legume mixtures (Adesogan *et al.* 2000).

Some of the advantages conferred by grass-legume mixtures include, increased crop

productivity through enhanced soil fertility. Rasmussen *et al.* (2009) reported that transfer of nitrogen to companion non fixing species can contribute substantially to their nitrogen supply with estimates ranging from 0-68% of the N content in the companion crops. Other advantages of mixtures include efficient use of growth resources and improved quality via complementarity effect of associated species (Lithourgidis *et al.*, 2007).

The development of grass-legume mixture in the tropics has been faced with problems, the survival of legume in mixtures has always been

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an issue (Baba *et al.*, 2017). This perhaps may be attributed to differences in photosynthetic pathways and variability in climatic factors. It was hypothesized that the survival of legume in mixture may be improved by tinkering with the sowing date of grass in mixtures. The objective of this paper was therefore to evaluate the effects of dry matter yield and chemical composition grass-legume forage mixtures as influenced by sowing dates of three mixtures (*Sorghum alnum-stylosanthes hamata*, *Sorghum alnum-Centrosema pacourum* and *Sorghum alnum-Centrosema pubescens* in which the grass in mixtures was sown at four sowing dates. (same day, one, two and three weeks after sowing of legume

Material and Methods

Experimental Location

The experiment 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. It is characterized by tropical wet and dry climate. Mean annual temperature ranges from 21°C to 39°C while annual rainfall from 500 mm to 1000 mm (KNARDA, 2001).

Treatment and Experimental Design

The treatment were three grass legume mixtures (*Sorghum alnum-stylosanthes hamata*, *Sorghum alnum-Centrosema pacourum* and *Sorghum alnum-centrosema pubescens*) and 4 sowing dates of the grass in mixtures (0, 1, 2 and 3 weeks after sowing of legumes) combined in 3*4 factorial arrangement in a randomized complete block design

Land Preparation and Field Culture

The Experiment commenced in the dry season (February 2018) and lasted up to early rainy season(July) of the same year. The experimental land was ploughed, harrowed and demarcated into plots of 2×3m². There was a total of 48 plots and 4 blocks with each block

containing 12 plots. Distances between plot and blocks were maintained at 0.5 and 1m respectively. The total land area was 29.5×15m². Fertilizer was applied at sowing at the rate of 50kg/ha⁻¹ using single super phosphate and muriate of potash while weeding was done as and when required by hoeing. Seeds of grass (*Sorghum amum*) and the legumes (*Stylosanthes hamata*, *Centrosema pacourum* and *Centrosema pubescens*) were sown in an alternate arrangement in the 2×3 m² plots at the rate of 5 seeds per sowing hole which translated to about 10 kg/ha⁻¹, taking into cognizance the respective sowing dates of the grass in mixtures. Sowing was done in rows by scratching the soil surface to create a shallow hole (1-3 cm depth) into which the seeds were sown and covered lightly with soil. However, the legumes were treated for hard seededness by immersing in hot water at 80°C for 3 minutes prior to sowing.

Harvesting was conducted at four weekly intervals each time taking into cognizance the sowing date of the grass in mixture. For instance, mixtures sown on the same day (0 week) were the first to be harvested followed by those in which the grass was sown 1 week ahead of legume and continued in that order, a total of 2 harvests were taken. During each harvest grass and legume stands at the middle of each plot within an area of 0.5×0.5m² were harvested at 5 cm stubble height from the ground level using a sickle. Fresh weights were taken separately for grass and legume using a digital balance. The plant materials were then wrapped in separate envelopes and put in an oven at 65°C for 72hr to determine the yield on dry matter basis. The dry matter yield was determined by taking the weights of the oven dried materials and relating the weights to the original fresh weight of each species taking into cognizance the plot size that produced the dry matter yield of the species and conversion was made on kg/ha basis

Chemical Analysis

Oven dried sample of each mixture was ground to pass through 2mm sieve and later stored in plastic containers for a month until used. The ground samples were subjected to proximate analysis to determine crude protein (CP), Ash, crude fiber, fat and nitrogen free extract according to procedure described by A.O.A.C (1995). Neutral and acid detergent fibers (NDF and ADF respectively) were determined by the method of Van Soest *et al*, (1991).

Data Analysis

Data were analyzed by ANOVA Using SAS (Version 9.2, 2009) while differences among means were separated using (Duncan 1955) multiple range test (DMRT) at 5% probability.

Result

Effects of Mixtures and Sowing Date on Dry Matter Yield

The effects of mixtures and sowing date are shown in Table 1. At first harvest, the grass in T3 (*Sorghum alnum-centrosema pubescens*) produced significantly higher dry matter yield ($P<0.05$) than T1 (*Sorghum alnum-stylosanthese hamata*), while the grasses in T2 (*Sorghum alnum-Centrosema pascourum*) and T3 were not significantly different. In the case of legumes in mixtures, *Centrosema pascourum* (T2) gave significantly higher ($P<0.05$) yield than *Stylosanthese hamata* (T1) and *Centrosome pubescens* (T3). Total dry matter yield values for mixtures at first harvest indicated that T2 and T3 had significantly higher ($P<0.05$) yield than T1. At the second harvest, there was no significant difference among the grass in mixtures irrespective of the species combination. The legumes were however, significantly different and *Centrosema pascourum* produced superior ($P<0.05$) yield compared to stylo and pubescens. Total dry matter yield was not significantly different among mixtures, but *Sorghum alnum-pascourum* mixture tended to

produce higher dry matter yield than other mixtures in absolute terms. Cumulative dry matter yield values also indicated greater ($P<0.05$) yield values for mixtures of *Sorghum alnum-pascourum* and *Sorghum alnum-pubescens* compared to *Sorghum alnum-stylo*.

The results indicated that treatment 2 (*Sorghum alnum-Centrosema Pascourum* mixture) gave higher cumulative total dry matter yield compared to treatments 1 and 3. This could be attributed to the fact that the total dry matter yield of mixtures in treatment 2 was consistently the highest at both first and second harvests possibly due to the higher yield of the legume in treatment 2. Higher yield of legume in grass-legume mixtures connotes higher amount of nitrogen made available to the grass via the process of nitrogen fixation. One of the major advantages conferred by mixture of grass and legume is that of increased productivity through enhanced soil fertility. Rumussen *et al*. (2009) reported that transfer of nitrogen to companion non fixing species can contribute substantially to their nitrogen supply with estimates ranging from 0 - 68% of the nitrogen in the companion crop. Similarly, Jorgenssen *et al*. (1999) observed an estimated 1.7-7.5 g N m⁻² Nitrogen transferred from clover to perennial rye grass. The better performance of centrosema as against stylo could be due to the climbing/ trailing growth habit of centrosema compared to the somewhat erect nature of sylo. The trailing growth habit may have shrouded the growing points of centrosema leading to quick regeneration after harvest unlike the exposed growing point of stylo by virtue of the erect habit.

In terms of the effect of sowing date, sowing grass and legume on the same day (0 week) produced higher ($P<0.05$) dry matter yield of grass compared to staggered sowing of grass in mixture (1, 2

Table 1. Effects of Mixtures and Sowing Date on Dry Matter Yield

Mixtures	First Harvest			Second Harvest			TDM Y	Cumulative TDMY
	DMYG	DMYL Kgha ⁻¹	TDMY	% Grass	% legume	DMYG	DMYL Kgha ⁻¹	
T1	4983.0 ^b	940.0 ^b	5923.0 ^b	84.12	15.87	12432	1251.7 ^b	19707 ^b
T2	6817.0 ^a	3150.0 ^a	9967.0 ^a	68.39	31.6	19157	2583.3 ^a	31707 ^a
T3	8833.0 ^a	985.0 ^b	9818.0 ^a	89.96	11.15	15829	661.7 ^b	26309 ^{ab}
P value	0.0235	0.0001	0.0045			0.1416	0.0005	0.0815
Sowing date (Weeks)								
0	11044 ^a	1473.3 ^b	12518.0 ^a	88.22	11.77	18538	960.0 ^b	32016
1	4800 ^b	1384.4 ^b	6184.0 ^b	77.62	22.38	20167	2673.3 ^a	29024
2	5711 ^b	2311.1 ^a	8022.0 ^b	71.19	28.8	12624	957.8 ^b	21604
3	5956 ^b	1597.8 ^{ab}	7583.0 ^b	78.54	21.06	12028	1404.0 ^b	20985
Pvalue	0.0015	0.0001	0.0012			0.0878	0.0055	0.0669

Means within the same column with different superscripts are significantly different (P<0.05). T1= *Sorghum alnum-stylosanthes* hamata, T2=*Sorghum alnum-Centrosema pascourum* T3=*Sorghum alnum-centrosema pubescens* DMYG=Dry matter yield grass, DMYL= Dry matter yield legume, TDMY= Total dry matter yield

and 3 weeks after legume). In the case of legumes, sowing of grass 2 and 3 weeks after the legume gave higher ($P<0.05$) dry matter yield values than same day sowing and sowing 1 week after the legume. Total dry matter yield for mixtures was significantly ($P<0.05$) the greatest when grass and legumes were sown on the same day compared to other sowing dates. At harvest 2, there was no significant effect of sowing date on dry matter yield of grass. However, dry matter yield of legume was significantly affected by sowing date. The dry matter yield of legume was significantly the highest ($P<0.05$) when the grass was sown 1 week after the legume. There were no significant effects of sowing date on total and cumulative dry matter yields of mixtures at harvest 2. However, in absolute terms, mixtures sown on the same day tended to produce higher cumulative dry matter yield. The yield declined with delayed sowing of grass in the mixture in the order $0>1>2>3$. The superior yield of grass in mixtures sown on the same day might be explained in the context that the grass being more competitive in the acquisition of resources for growth had the initial advantage of suppressing the growth of the legume early enough hence remained dominant in the mixture. Almost similar reason could be proffered for the higher dry matter yield of legumes in mixtures sown at 2 and 3 weeks ahead of the grass. Although in this case the legumes may not have been more competitive but had the initial advantage of being alone and cornered resources that favored their growth and thus led to the high yield. By and large, staggering the sowing date of grass in mixture had no significant effect on the overall dry matter yield of mixtures but when sowing of grass was delayed by 1, 2 and 3 weeks after legume, the yield of legume appreciated.

Effects of Mixtures and Sowing Date on Proximate and Fiber fractions

These are depicted in Table 2. Mixtures were not significantly different in terms of percentage ash. Similarly, sowing date did not significantly influence the ash content. In contrast to the effect of mixtures on ash content, crude protein content of mixtures was significantly different. Treatment 2 (22.33%) and 3 (22.75%) recorded higher ($P<0.05$) crude protein compared to Treatment 1 (20.84%).

In the same connection sowing date also influenced the crude protein content of mixtures significantly. Mixtures sown on the same day had higher ($P<0.05$) crude protein (23.24%) than those in which the legumes preceded the grass by 1, 2 and 3 weeks. The higher CP value observed in treatment 2 than treatment 1 could be as a result of the comparatively higher dry matter yield of legume in the mixture. Carr *et al* (1998) indicated that a significant proportion of legume is required in intercrop mixture in order to increase the intercrop protein yield.

With regards to crude fiber, Treatment 1 had significantly higher ($P<0.05$) crude fiber (41.99%) than treatment 2 (39.79%) and treatment 3 (35.10%). Crude fiber of mixtures was significantly affected by sowing date. Mixtures sown on the same day had greater ($P<0.05$) crude fiber than those in which the grass was sown 1, 2 and 3 weeks after legume. The relatively greater crude fiber value of mixtures sown on the same day may not be unconnected with the higher proportion of the grass in the mixtures, as grass has more fiber than legumes.

Mixtures were significantly different in terms of ether extract content. Treatment 3 had superior ($P<0.05$) ether extract value (6.35%) followed by treatment 1 (5.8%) and treatment 2 (4.55%). Sowing date did not significantly affect the ether extract composition of mixtures.

In the case of nitrogen free extract, significantly higher ($P<0.05$) value was obtained in treatment 3 (29.91%) compared to treatment 2

(27.66%) and treatment 1 (26.23) while mixtures in which the grass was sown at 1, 2 and 3 weeks after legumes gave higher ($P<0.05$) value of NFE than same date sowing. NFE represents the soluble carbohydrate in feed, the higher values observed in T2 and T3 might be due to the correspondingly lower ADF and NDF values recorded in the aforementioned treatments.

Both ADF and NDF were significantly superior ($P<0.05$) in treatment 1 compared to 2 and 3, no significant difference was found between treatments 2 and 3. Sowing of grass 1 week after legume led to significantly greater ($P<0.05$) ADF compared to 2, 3 weeks and same day sowing of grass and legume.

However, same day sowing of grass and legume produced higher ADF than 2 and 3 weeks. In a somewhat similar fashion, the NDF values in mixtures sown on the same day and those in which the legume preceded the grass by 1 week were significantly the highest ($P<0.05$) compared to other dates. The lower NDF and ADF values in T2 and T3 may be explained by the higher proportion of legume at all harvest especially in treatment 2. Chapko (1991) reported that cereal forage could have lower NDF and ADF content in cereal-legume intercroppings. Significant interactions were observed between mixtures and sowing date on proximate and fiber fractions except in Ash and ether extract, These are shown in figures 1-3

Table 2. Effects of mixtures and sowing date on proximate composition fiber fractions and their interactions

Mixtures	Ash	CP	CF	EE	NFE	ADF	NDF
T1	5.26	20.84 ^b	41.99 ^a	5.8 ^b	26.23 ^b	41.15 ^a	70.56 ^a
T2	5.6	22.33 ^a	39.79 ^b	4.55 ^c	27.66 ^b	35.64 ^b	56.64 ^b
T3	5.64	22.75 ^a	35.10 ^c	6.35 ^a	29.91 ^a	35.24 ^b	50.75 ^b
P value	0.187	0.0001	0.0001	0.0001	0.0081	0.0001	0.0001
Sowing date (weeks)							
0	5.55	23.24 ^a	41.45 ^a	5.8	24.40 ^b	36.87 ^b	63.15 ^a
1	5.75	22.28 ^b	36.75 ^b	5.5	29.61 ^a	40.48 ^a	62.62 ^a
2	5.67	20.89 ^c	40.24 ^b	5.48	27.72 ^a	36.6b ^c	57.58 ^b
3	5.48	21.48 ^c	37.41 ^b	5.47	30.01 ^a	35.42 ^c	53.92 ^c
P value	0.1	0.0001	0.0005	0.108	0.0012	0.0001	0.0001
interaction	NS	**	**	NS	**	**	**

Means with similar superscripts within the same column are not significantly different ($P<0.05$)

Conclusion

It can be concluded that *Sorghum alnum-Centrosema pascourum* and *Sorghum alnum-Centrosema pubescens* produced higher dry matter yields and proved better in quality indices. However, the yield appeared to be higher in *Sorghum-almum-pascourum* mixture hence *Sorghum-almum-pascourum* is recommended for higher yield and greater content of the legume in mixtures. Furthermore, sowing grass 3 weeks after legumes in mixtures

reduced fiber fractions (NDF and ADF) significantly. Thus, it is recommended that date of sowing of grass and legume in mixtures should be staggered with the legume sown ahead of the grass by 3 weeks.

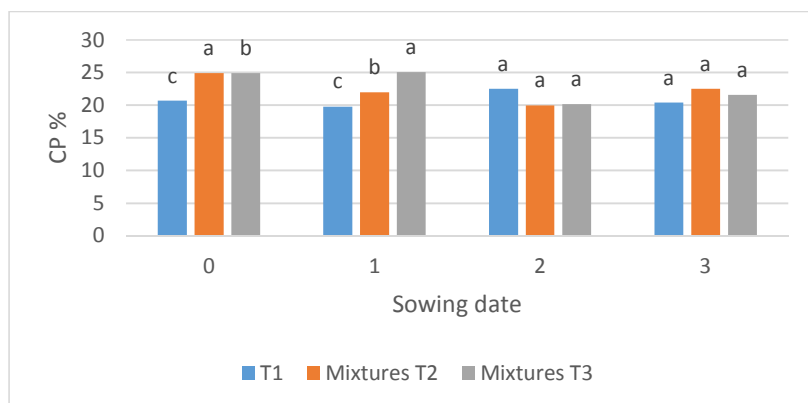


Figure 1. Interaction between mixtures and sowing date on CP

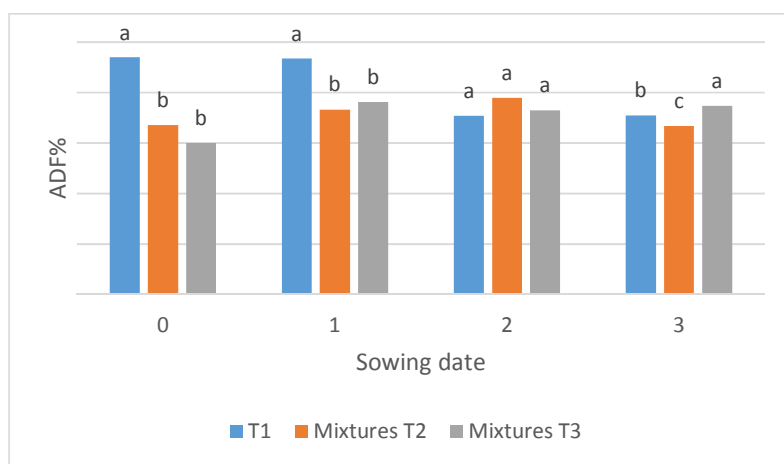


Figure 2. Interaction between mixtures and sowing date on ADF

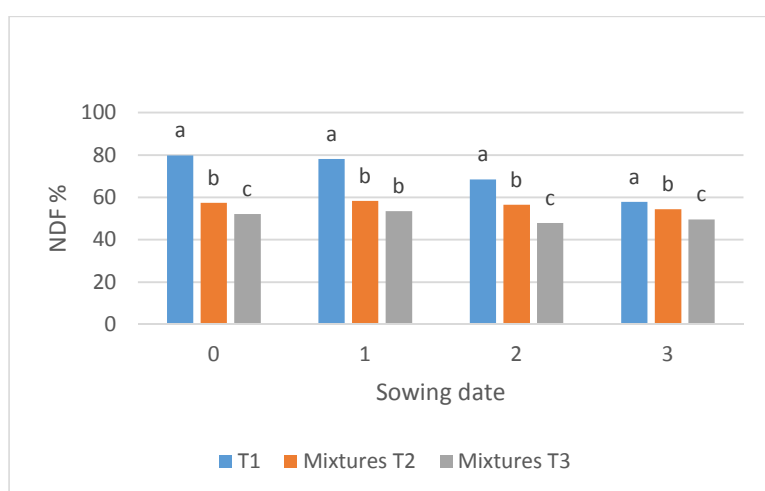


Figure 3. Interaction between mixtures and sowing date on NDF

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